SURVEYOR

NSQF LEVEL - 5

1st Year (Volume I of II)

TRADE THEORY

SECTOR: Construction

Directorate General of Training

DIRECTORATE GENERAL OF TRAINING
MINISTRY OF SKILL DEVELOPMENT & ENTREPRENEURSHIP
GOVERNMENT OF INDIA

NATIONAL INSTRUCTIONAL MEDIA INSTITUTE, CHENNAI

Post Box No. 3142, CTI Campus, Guindy, Chennai - 600 032

Sector : Construction

Duration : 2 - Year

Trade : Surveyor 1st Year (Volume I of II) - Trade Theory - NSQF level - 5

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FOREWORD

The Government of India has set an ambitious target of imparting skills to 30 crores people, one out of every four Indians, by 2020 to help them secure jobs as part of the National Skills Development Policy. Industrial Training Institutes (ITIs) play a vital role in this process especially in terms of providing skilled manpower. Keeping this in mind, and for providing the current industry relevant skill training to Trainees, ITI syllabus has been recently updated with the help of Media development committe members of various stakeholders viz. Industries, Entrepreneurs, Academicians and representatives from ITIs.

The National Instructional Media Institute (NIMI), Chennai, has now come up with instructional material to suit the revised curriculum for **Surveyor, 1st Year (Volume I of II) Trade Theory NSQF Level - 5 in Construction Sector under Semester Pattern.** The NSQF Level - 5 Trade Practical will help the trainees to get an international equivalency standard where their skill proficiency and competency will be duly recognized across the globe and this will also increase the scope of recognition of prior learning. NSQF Level - 5 trainees will also get the opportunities to promote life long learning and skill development. I have no doubt that with NSQF Level - 5 the trainers and trainees of ITIs, and all stakeholders will derive maximum benefits from these Instructional Media Packages IMPs and that NIMI's effort will go a long way in improving the quality of Vocational training in the country.

The Executive Director & Staff of NIMI and members of Media Development Committee deserve appreciation for their contribution in bringing out this publication.

Jai Hind

RAJESH AGGARWAL
Director General/ Addl.Secretary
Ministry of Skill Development & Entrepreneur-ship,
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New Delhi - 110 001

PREFACE

The National Instructional Media Institute (NIMI) was established in 1986 at Chennai by then Directorate General of Employment and Training (D.G.E & T), Ministry of Labour and Employment, (now under Directorate General of Training, Ministry of Skill Development and Entrepreneurship) Government of India, with technical assistance from the Govt. of the Federal Republic of Germany. The prime objective of this institute is to develop and provide instructional materials for various trades as per the prescribed syllabi under the Craftsman and Apprenticeship Training Schemes.

The instructional materials are created keeping in mind, the main objective of Vocational Training under NCVT/NAC in India, which is to help an individual to master skills to do a job. The instructional materials are generated in the form of Instructional Media Packages (IMPs). An IMP consists of Theory book, Practical book, Test and Assignment book, Instructor Guide, Audio Visual Aid (Wall charts and Transparencies) and other support materials.

The trade practical book consists of series of exercises to be completed by the trainees in the workshop. These exercises are designed to ensure that all the skills in the prescribed syllabus are covered. The trade theory book provides related theoretical knowledge required to enable the trainee to do a job. The test and assignments will enable the instructor to give assignments for the evaluation of the performance of a trainee. The wall charts and transparencies are unique, as they not only help the instructor to effectively present a topic but also help him to assess the trainee's understanding. The instructor guide enables the instructor to plan his schedule of instruction, plan the raw material requirements, day to day lessons and demonstrations.

IMPs also deals with the complex skills required to be developed for effective team work. Necessary care has also been taken to include important skill areas of allied trades as prescribed in the syllabus.

The availability of a complete Instructional Media Package in an institute helps both the trainer and management to impart effective training.

The IMPs are the outcome of collective efforts of the staff members of NIMI and the members of the Media Development Committees specially drawn from Public and Private sector industries, various training institutes under the Directorate General of Training (DGT), Government and Private ITIs.

NIMI would like to take this opportunity to convey sincere thanks to the Directors of Employment & Training of various State Governments, Training Departments of Industries both in the Public and Private sectors, Officers of DGT and DGT field institutes, proof readers, individual media developers and coordinators, but for whose active support NIMI would not have been able to bring out this materials.

R. P. DHINGRA
EXECUTIVE DIRECTOR

Chennai - 600 032

ACKNOWLEDGEMENT

National Instructional Media Institute (NIMI) sincerely acknowledges with thanks for the co-operation and contribution extended by the following Media Developers and their sponsoring organisations to bring out this Instructional Material **(Trade Theory)** for the trade of **Surveyor** under the IT & ITES Sector

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NIMI records its appreciation for the Data Entry, CAD, DTP operators for their excellent and devoted services in the process of development of this Instructional Material.

INTRODUCTION

TRADE THEORY

The manual of trade theory consists of theoretical information for the first semester course of the Surveyor Trade NSQF - Level 5. The contents are sequenced according to the practical exercise contained in the manual on trade practical. Attempt has been made to relate the theortical aspects with the skill covered in each exercise to the extent possible. This correlation is maintained to help the trainees to develop the perceptional capabilities for performing the skills.

The Trade theory has to be taught and learnt along with the corresponding exercise contained in the manual of trade practical. The indicating about the corresponding practical exercise are given sheet of this manual.

It will be preferable to teach/learn the trade theory connected to each exercise at least one class before performing the related skills in the shop floor. The trade theory is to be treated as an integrated part of each exercise.

The material is not the purpose of self - learning and should be considered as supplementary to class room instruction.

TRADE PRACTICAL

The trade practical manual is intended to be used in practical workshop / Hall. It consists of a series of practical exercises to be completed by the trainees during the first semester course of Surveyor trade under NSQF Level 5 syllabus, which is supplemented and supported by instructions/ informations to assist in performing the exercises. These exercises are designed to ensure that all the skills in prescribed syllabus are coverd.

Module 1	Safety
Module 2	Basic Engineering Drawing
Module 3	Chain Surveying
Module 4	Compass Surveying
Module 5	Computer aided surveying

The skill training in the shop floor is planned through a series of practical exercises centred around some practical object. However, there are few instances where the individual exercise does not form a part of project.

CONTENTS

LEARNING / ASSESSABLE OUTCOME

On completion of this book you shall be able to

- **Recognize & comply safe working practi ces, environment regulation and housekeeping.**
- **Concept of drawing & sheet layout.**
- **Draw lettering & numbering applying drawing instruments.**
- **Draw plain geometrical figures, curves & conics.**
- **Construct plain scale, diagonal scale, comparative scale, vernier scale.**
- **Draw orthographic projections of different objects with proper dimensioning & lettering.**
- **Draw conventional signs & symbols used in surveying.**
- **Perform site survey using chain/ tape 7 prepare a site plan.**
- **Perform the site survey using prismatic compass.**
- **Perform Auto cad drawing.**

SYLLABUS - SURVEYOR

1st Year (Volume I of II) **Duration : 06 Months**

Week No.	Reference Learning Outcome	Professional Skills with Indicative Hours	Professional Knowledge
1-2	Recognize & comply safe working practices, environment regulation. Concept of drawing & sheet layout.	1. Importance of trade training, Demonstrate of tools & equipment used in the trade. (6 hrs) 2. Occupational safety & Health. (6 hrs) 3. Introduction of safety equipments and their uses. (10 hrs) 4. Introduction of first aid, health, safety & environmental guidelines, legislations & regulations as applicable. (8 hrs) 5. Personal Protective Equipment (PPE). (8 hrs) 6. Hazard identification and avoidance, Safety signs for Danger. (4 hrs) 7. Use of drawing instruments and equipments with care. (4 hrs) 8. Method of fixing of drawing sheet on drawing board. (2 hrs) 9. Layout of different size of drawing sheet and folding of sheets. (8 hrs)	Importance of safety and general precautions related to the trade. All necessary guidance to be provided to the new comers to become familiar with the working of ITI system. Importance of survey or trade Job after completion of training. Introduction of First aid. Job responsibility of the trade. • Overview the subject to be taught. • List of the instrument equipments to be used during training • Layout of drawing sheet • Dimensions of drawing sheet.
3-6	Draw lettering & numbering & dimensioning applying drawing instruments.	10. Lettering & numbering (Single &double stroke) (70 hrs) 11. types of lines and dimensioning. (42 hrs)	Details layout of lettering, lines & dimensioning system .
7-8	Draw plain geometrical figures, curves & conics	12. Construction of plain geometrical figures, curves &conics. (56 hrs)	Introduction of surveying, typesof surveying, use, applicationprincipal.

9-10	Construct plain scale, diagonal scale, comparative scale, vernier scale.	13. Drawing of : - 14. Construction of scales – plain, diagonal, vernier. (56 hrs)	Knowledge of different types ofscales, determine of R.F & uses of scales.
11-14	Draw orthographic projections of different objects with proper dimensioning & lettering.	15. Drawing of three views in orthographic projection of point,line, plane, solid objects. (40 hrs) 16. Section of solids. (32 hrs) 17. Isometric projection of geometrical solids. (40 hrs)	Different types of projection views orthographic, sectional , isometric view.
15	Draw conventional signs & symbols used in surveying	18. Drawing of conventional signs & symbols (10 hrs) 19. Free hand sketch of linermeasurement instruments(18hrs)	Use & application of conventional signs & symbols.
16-18	Perform site survey using chain/ tape & prepare a site plan.	20. Practice of folding & unfolding ofchain. (5 hrs) 21. Equipment and instrment usedto perform surveying & testing of chain. (5 hrs) 22. Ranging (direct/ indrect) &distance measure with chain/ tape. (10 hrs) 23. Offset taking & entering field book. (6 hrs) 24. Overcoming obstacles inchaining. (6 hrs) 25. Chaining on sloping ground. (10hrs) 26. Conduct a chain survey of a small area with all details and plotting the map. (20 hrs) 27. Calculating the area of site. (6hrs) 28. Prepare a site plan by the help of chain / tape. (16 hrs)	Uses of Chain/ tape, testing of a chain & correction. Ranging (direct & indirect), Principle of chain survey, application. Terms used in chain survey, Offset, types of offsets, limit of offset, field book, types of field book, entry of field book method of chaining in slopping ground. Field procedure of chain survey errors in chain survey, plotting procedure. Calculation of area (regular & irregular figure) Knowledge of site plan.

19-22	Perform the site survey using prismatic compass	29. Temporary adjustment of prismatic compass. (10hrs) 30. Measure fore & back bearing of a line. (10 hrs) 31. Measure true bearing of a line. (20 hrs) 32. Prepare a closed & open traverse using prismatic compass measure the bearings, entry intofield book, calculation of correct bearing and adjust. (Local attraction), determine the closing error and adjust. Plotting the same. (72hrs)	Basic terms used in compass survey. Instrument & its setting up. Conversion of bearing web to R.B. Calculation of included angle from bearing local attrac-tion, magnetic declination and true bearing, closing error. Adjustment of closing error, precaution in using prismatic compass.
23	Perform Auto CAD drawing	33. Practice with AutoCAD using commands (28 hrs)	Introduction to Auto CAD. Use AutoCAD command.
24	**Project work** a) Prepare a map by using chain /tape & compass. (Close traverse), plotting & calculate the area.		
25	**Revision**		
26	**Examination**		

List of Instruments and equipment to be used in the trade

In addition to drawing equipment the following survey instrnments.

1 Metallic tape / invartape
2 Steel tape
3 Chain (Engineers) - 20m, 30m
4 Ranging rods
5 Arrows
6 Cross statf (Wood)
7 Cross statf (Metal)
8 Cross statf (French)
9 Optical square
10 Planimeter ete.....
11 Compass (Prismatic)
12 Plane Table with Accessoris
13 Levelling Intrument & staff accessoris
14 Theodolite Tacheometry
15 Minor intruments
16 Degital Theodolite
17 Total station
18Remote sensing
19 GPS
20 CAD ..... Etc

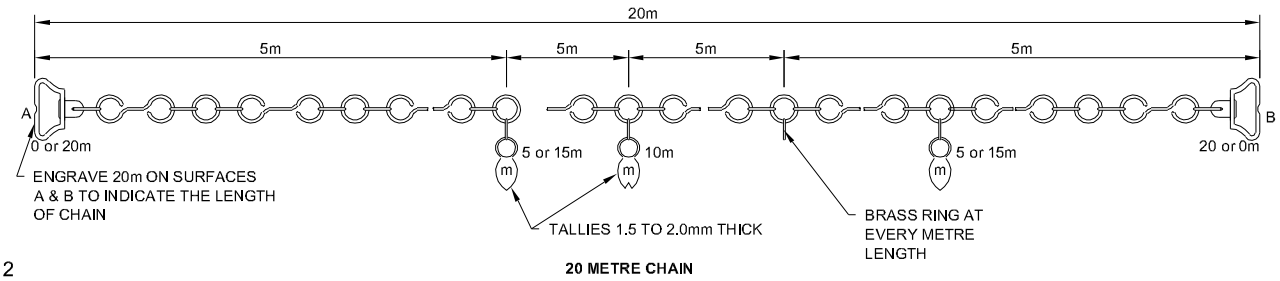
Tools and equipments used in the trade

Objectives : At the end of this exercise, you shall be able to

- **Demonstrate the chain survey instruments**
- **Demonstrate plane table instruments**
- **Demonstrate levelling instruments**

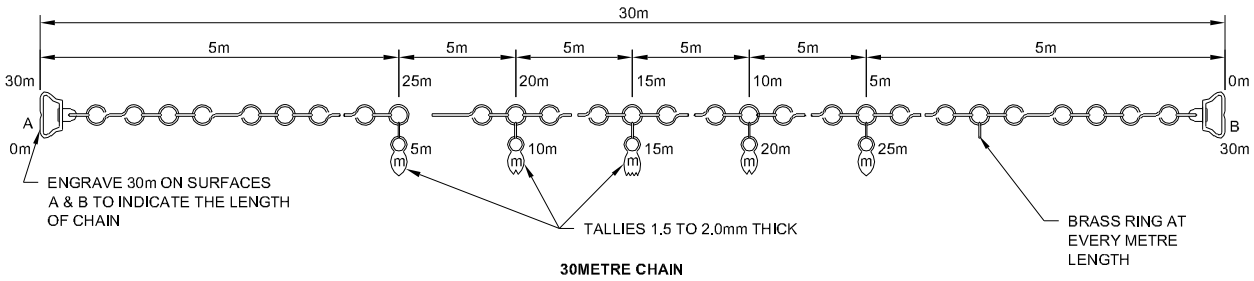
Instructor should demonstrate how to unfold the chain and flod the chain and state the safety precaution.

Fig 1



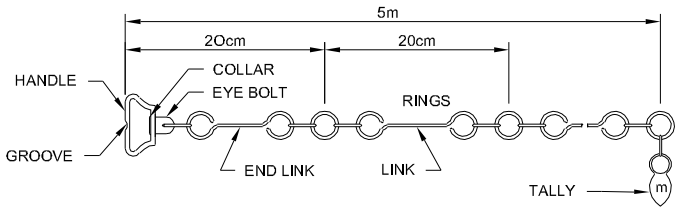
20 METRE CHAIN

Fig 2



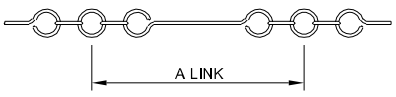
30METRE CHAIN

Fig 3



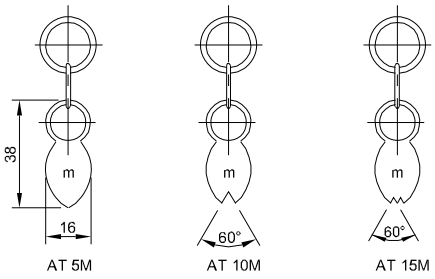
DETAILS OF A METRIC CHAIN

Fig 4



A LINK OF A CHAIN

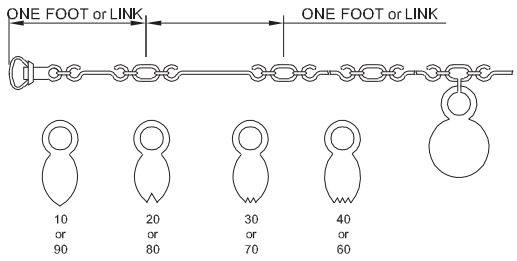
Fig 5



SHAPE OF TALLIES IN 30m METRIC CHAIN

SUN110111

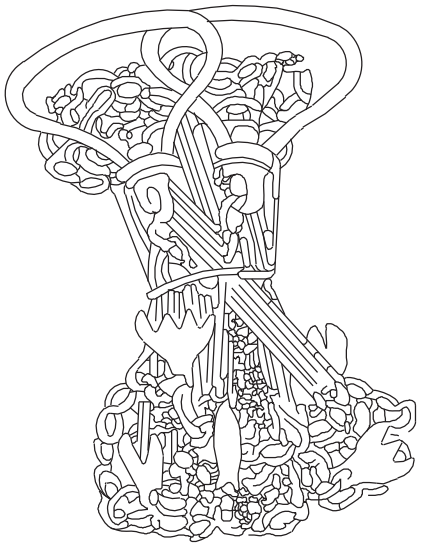
Fig 6



NON-METRIC CHAIN AS GUNTER'S or ENGINEER'S

SUN110116

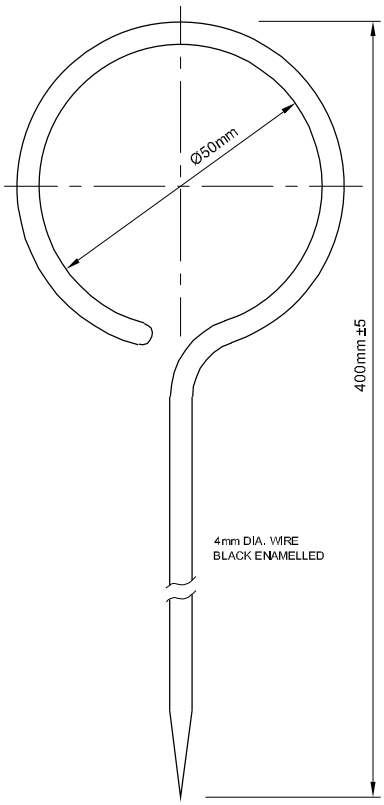
Fig7



FOLDING OF CHAIN

SUN110117

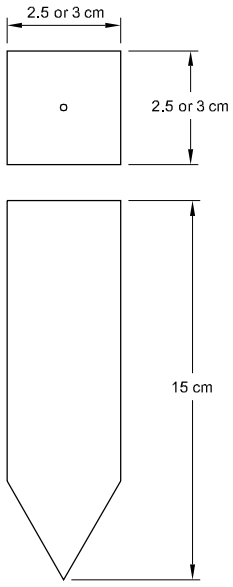
Fig 8



ARROW

SUN110118

Fig 9



WOODEN PEG

SUN110119

Fig 10

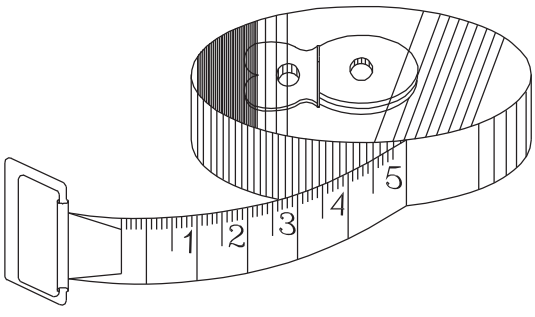


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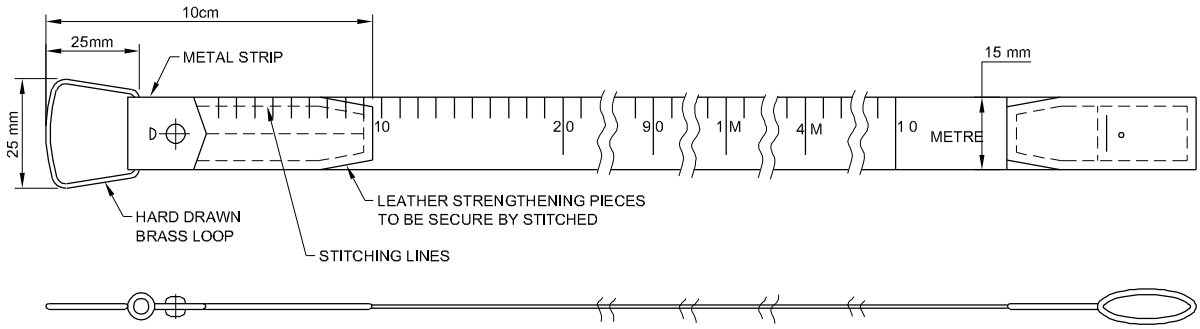
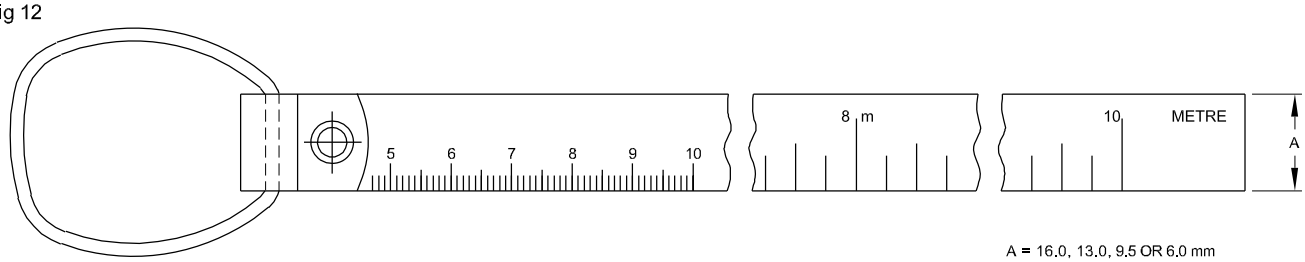
Fig 11



METALLIC TAPE

SUN11011B

Fig 12



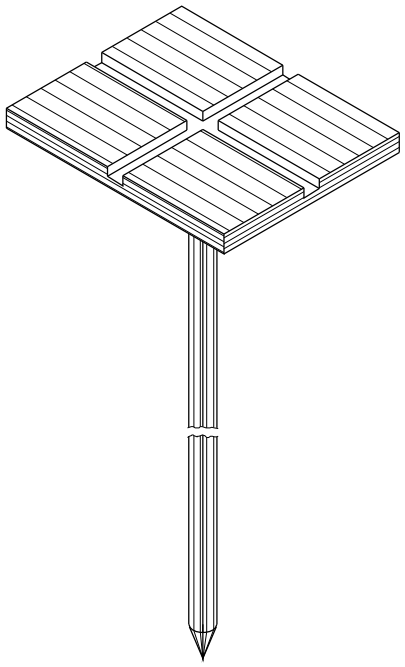
A = 16.0, 13.0, 9.5 OR 6.0 mm

STEEL TAPE

SUN11011C

Note :Instructor should demonstrate the handling of different types of taps.

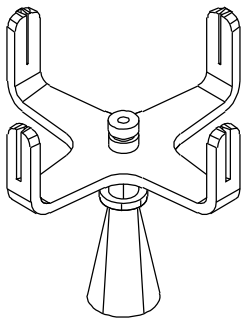
Fig 13



WOODEN CROSS STAFF

SUN11011D

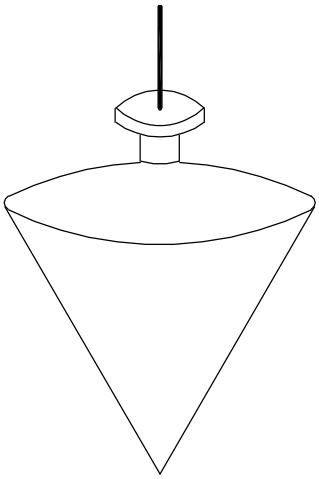
Fig 14



METAL ARM CROSS-STAFF

SUN11011E

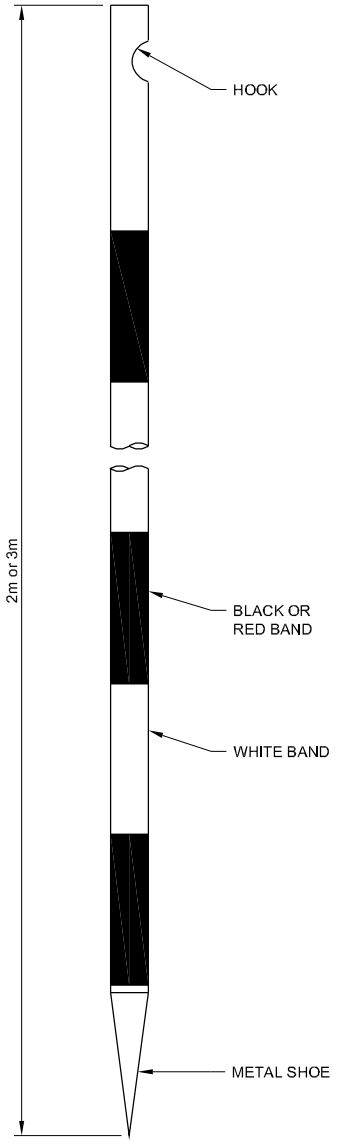
Fig 15



PLUMB BOB

SUN1011F

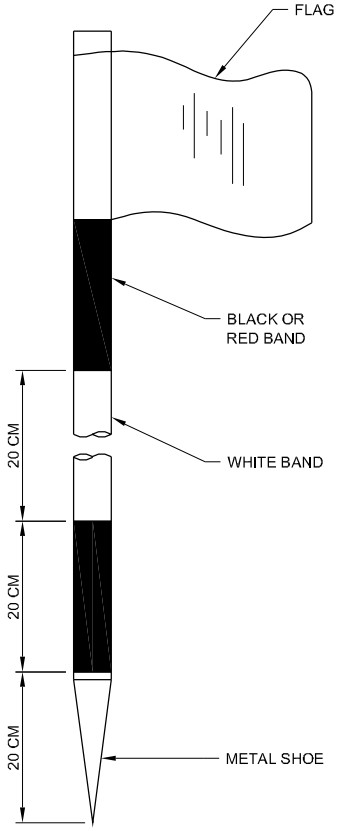
Fig 16



OFFSET ROD

SUN1011G

Fig 17



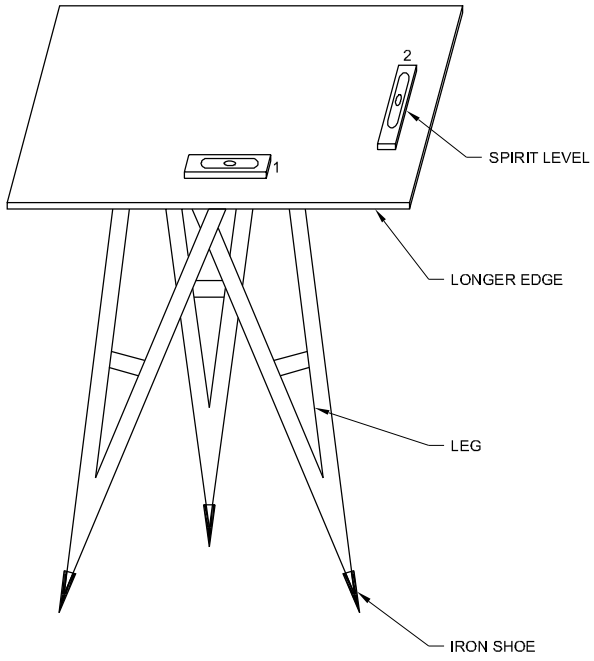
RANGING ROD

SUN11011H

Demonstrate

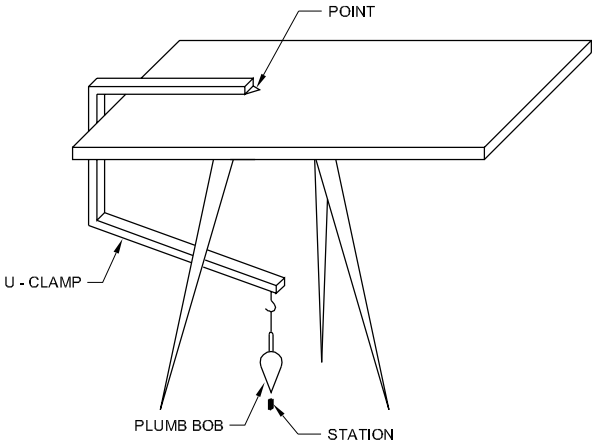
Plane Table Instrument

Fig 18



LEVELLING THE PLANE TABLE

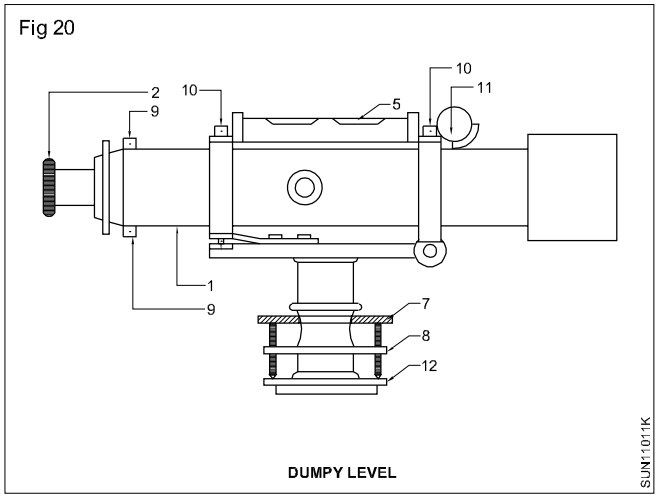
Fig 19

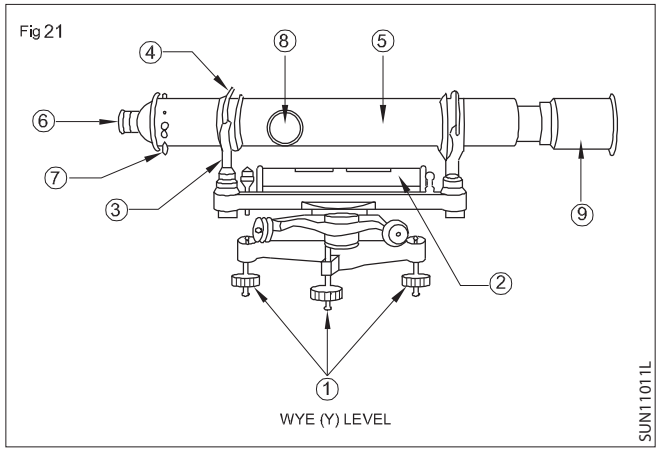


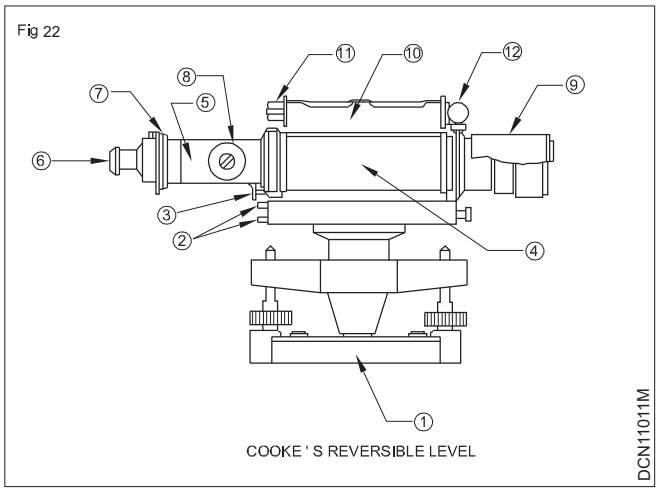
CENTERING THE STATION

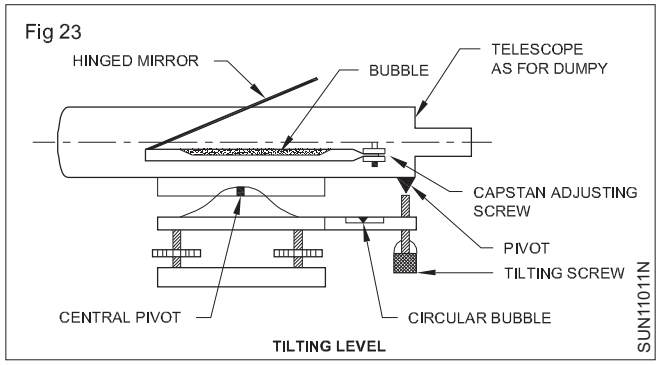
Demonstrate

Levelling Instrument









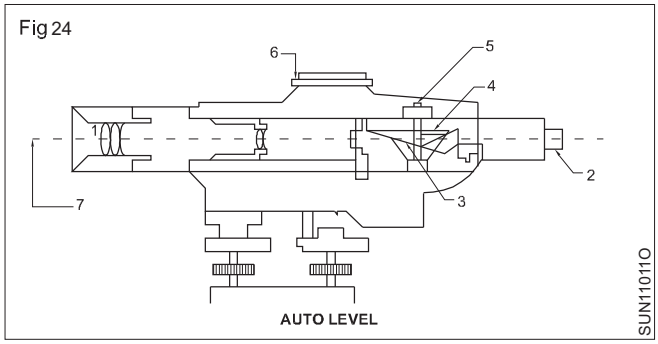
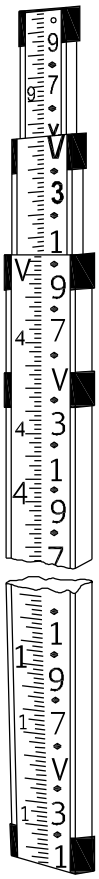
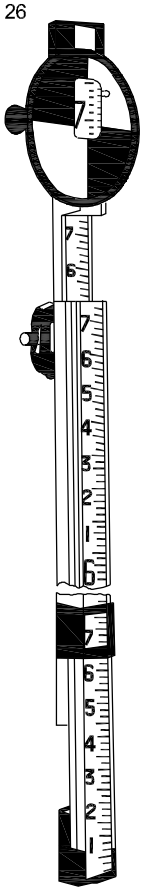


Fig 25



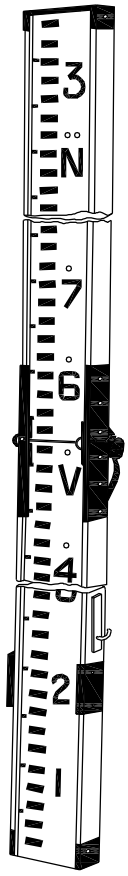
TELESCOPIC STAFF

Fig 26



TARGET STAFF

Fig 27



FOLDING STAFF

SUN11011P

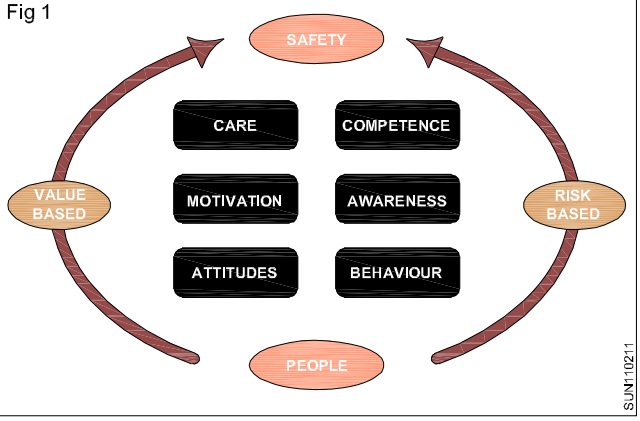
Occupational safety and health

Objectives: At the end of this lesson you shall be able to
- **define occupational safety and health**
- **state the importance of safety and health at workplace**
- **state the role of employer, trade union & employee for health & safety program.**

Occupational Safety and Health (OSH) is an area concerned with protecting the safety, health and welfare of people engaged in co-workers, family members, employees, customers, and many others who might be affected by the workspace environment.

Workspace safety : Owner/Occupier of industries have to comply with legal directions to take care for the safety, health and welfare of their employees. Equally the workers have moral responsibilities to follow all safety norms and healthy on the shop- floor. (Fig 1)

Fig 1



Occupational health : Health at work is also called occupational health. It is concerned with enabling an individual to undertake their day to day work fully knowing the health hazards they are exposed to and preventing them at the workspace.

Good safety and helath practices can also reduce employee injury and illness related costs, including medical care, sick leave and disability benefit costs. (Fig 2)

Fig 2

The joint ILO/WHO committee on occupational health (1995) main focus in occupational health is on three different objectives.

i The maintenance and promotion of workers health and working capacity.

ii The improvement of working environment and work to become conductive to safety and health.

iii Development of work organization and working cultures in a direction which supports health and safety at work and in doing so also promotes a positive social climate and smooth operation and may enhance productivity of the undertakings.

Employment and working conditions in the formal or informal economy embrace other important determinants, including working hours, salary, workspace policies concerning maternity leave, health promotion and protection provisions etc.

The health of the workers has several determinants, including risk factors at the workspace leading to accidents, musculoskeletal diseases, respiratory diseases, hearing loss, circulatory diseases, stress related disorders and communicable diseases and others.

Creating safe and healthy working conditions is a challenge to all industries, as the new technologies and new patterns of work are fast growing. The challenges, changes resulting new risks and disorders are many. When safety and health measures are not followed or fail, accidents, injuries, diseases and even deaths may occur.

Victims of workspace injuries and occupational diseases have to be compensated properly. Prevention actions at workspace are needed so that similar cases will be prevented. The industries and the working population and their families including the dependent population will benefit from the good practice of occupational safety and health.

Safety problems in work settings range from immediate threats like toxic substances and grievous bodily injuries to subtle progressive dangers such as repetitive motion injuries, high noise levels, and air quality. In general, workplace hazards can be categorized into three groups:

1 **Chemical hazards,** in which the body absorbs toxins.

2 **Ergonomic hazards,** in which the body is strained or injured, often over an extended period, because of the nature (design) of the task, its frequency, or intensity.

3 **Physical hazards,** in which the worker is exposed to harmful elements or physical dangers, such as heat or moving parts.

In the modern context, corporate management increasingly has viewed industrial safety measures as an investment - one that may save money in the long run by way of reducing disability pay, improving productivity and avoiding lawsuits.

Prevention is better than cure :

No place of work can always be completely safe all the time and whilst some work places present greater risks than others. Industry nowhere is immune to the possibility of an accident. Hence all industries should develop the ability to carry out risk assessment processes and to take all precautionary steps to ensure the safety of the workforce. It is a group collective effort that includes each and every member of the workforce. Employers should always ensure they do the following.

- Provide adequate control of the health and safety risks.
- Consult with employees on matters affecting their health and safety.
- Provide and maintain safe plant and equipment.
- Ensure safe handing and use of substances.
- Provide information, instruction, supervision and training so that employees are competent to carry out their role.
- Review and revise all these policies regularly.

Health and Safety programmes

For all of the reasons (Fig 3), it is crucial that employers, workers and unions are committed to health and safety, addressing the following areas.

Fig 3

- Workplace hazards are controlled - at the source whenever possible ;
- Records of any exposure are maintained for many years.
- Both workers and employers are informed about health and safety risks in the workplace.
- Establish an active and effective health and safety committee that includes both workers and management.
- To observe that the workers' health and safety efforts are ongoing.

Effective workplace health and safety programmes can help to save the lives of workers by reducing hazards and their consequences. Health and safety programmes also have positive effects on both worker morale and productivity, which are important benefits. At the same time, effective programmes can save employers a great deal of money.

Healthy workplace, hazard free work environment, zero accident work-life can help to save the lives of workers by reducing hazards and diseases. Effective programmes can also have positive effects on both worker morale and productivity. All put together enhance the human values at work and prosperity of the nation.

1 Occupational health and safety encompasses the social, mental and physical well-being of workers in all occupations.

2 Poor working conditions have the potential to affect a worker's health and safety.

3 Unhealthy or unsafe working conditions can be found anywhere, whether the workplace is indoor or outdoor.

4 Poor working conditions can affect the environment workers live in. This means that workers, their families, other people in the community, and the physical environment around the workplace, can all be at risk from exposure to workplace hazards.

5 Employers have a moral and often legal responsibility to protect workers.

6 Work-related accidents and diseases are common in all parts of the world and often have many direct and indirect negative consequences for workers and their families. A single accident or illness can mean enormous financial loss to both worker and employers.

7 Effective workplace health and safety programmes can help to save the lives of workers by reducing hazards and their consequences.

8 Effective programmes can also have positive effects on both worker morale and productivity, and can save employers a great deal of money.

Occupational hazard

Objectives: At the end of this lesson you shall be able to
- **explain various occupational hazard**
- **state occupational hygiene**
- **describe occupational disease disorders and its prevention.**

All jobs, primarily provides many economic and other benefits, But equally there are a wide varieties of workplace dangers and hazards, which are risky to the health and safety of people at work.

Basic hazards

Employers have a responsibility to protect workers against health and safety hazards at work. Workers have the right to know about potential hazards and to refuse work that they believe is dangerous. Workers also have a responsibility to work safely with hazardous materials. Health and Safety hazards exist in every workplace. Some are easily identified and corrected, while others create extremely dangerous situations that could be a threat to your life or long-term health. The best way to protect oneself is to learn to recognize and prevent hazards in the workplaces.

Physical hazards are the most common hazards and are present in most workplace at some point of time. Examples include; live electrical cords, unguarded machinery, exposed moving parts, constant load noise, vibrations, working from ladders, scaffolding or heights, spills, tripping hazards. Physical hazards are a common source of injuries in many industries. Noise and vibration, Electricity, Heat, Ventilation, Illumination, Pressure, Radiation etc.

- **Ventilation** and air circulation have major say on the health and working comfort of the worker. There must be good ventilation, a supply of fresh, clean air drawn from outside is required. It must be uncontaminated and circulated around the workspace. Closed of confined spaces also present a work hazard, which has limited openings for entry and exit and unfavorable natural ventilation, and which is not intended for continuous employee occupancy.

Spaces of this kind can include storage tanks, ship compartments, sewers, and pipelines. Asphyxiation is another potential work hazard in certain situations. Confined spaces can pose a hazard not just to workers, but also to people who try to rescue them.

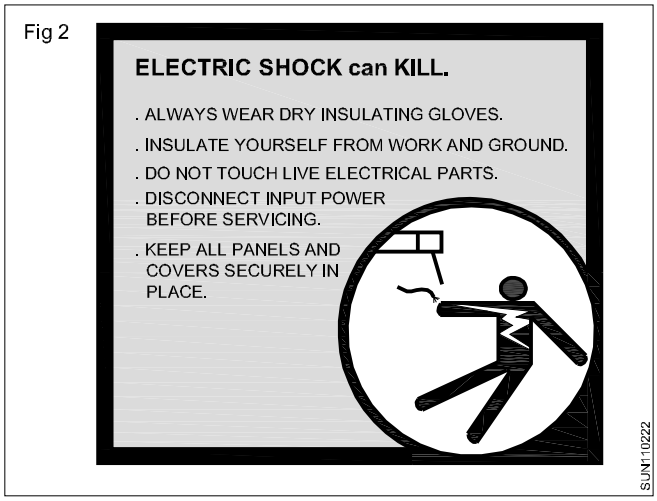
- **Noise and Vibration :** Noise and vibration are both fluctuations in the pressure of air (or other media) which affect the human body. Vibrations that are detected by the human ear are classified as sound. We use the term 'noise to indicate unwanted sound. Noise and vibration can harm workers when they occur at high levels, or continue for a long time.(Fig1)

Fig 1

- **Electricity** poses a danger to many workers. Electrical injuries caused by contact with electric energy can be divided into four types
- fatal electrocution,
- electric shock,
- burns,
- falls .

Wires and electrical equipment pose safety threats in the workspace. When employees mishandle electrical equipment and wires, they are taking risks. (Fig 2)

Fig 2



- **Temperature (Heat Stress) :** A reasonable working temperature, for strenuous work, local heating or cooling where a comfortable temperature is to be maintained which is safe and does not give off dangerous or offensive fumes, Thermal clothing and rest facilities where necessary (for example, for 'hot work' or work in cold storage areas). Sufficient space in workrooms etc. are under the legislation for implementation by the owner of the factories.
- **Illumination (lighting) :** Good light lighting is essential for productivity Natural light is preferred where possible. Glare and flickering should be avoided.

HEAT EXHAUSTION/HEAT STROKE & TREATMENT

- NORMAL BODY CORE TEMPERATURE - 37°C
- HEAT EXHAUSTION - 38°C - 40°C
- HEAT STROKE 41°C AND HIGHER

SIGNS AND SYMPTOMS

HEAT EXHAUSTION	HEAT STROKE
• RESTLESS	• REDUCED LEVEL OF CONCIOUSNESS
• WEAK	• IRRITABLE
• DIZZY	• MUSCULAR PAIN
• RAPID PULSE	• RAPID PULSE
• LOW BLOOD PRESSURE	• HIGH BLOOD PRESSURE
• NAUSEA	• NAUSEA
• VOMITTING	• VOMITTING
• MENTAL STATUS - NORMAL	• MENTAL STATUS - CONFUSED
• BEHAVIOR - NORMAL	• BEHAVIOUR - ERRATIC
	• HOT, DAY, RED SKIN
	• DEATH

TREATMENT

• LAY PERSON DOWN & ELEVATE LEGS	• MOVE PERSON TO COOL VENTILATED AREA
• ENSURE NORMAL BREATHING	• CHECK FOR BREATHING, PULSE & CIRCULATION
• IF THIRSTY GIVE WATER TO DRINK	• IF POSSIBLE COVER THE PERSON WITH ICE PACKS OR COLD WATER TO REDUCE THE BODY TEMPERATURE
• REPORT INCIDENT TO SUPERVISOR	• GIVE WATER TO DRINK
	• MONITOR VITAL SIGNS
	• GET PERSON TO HOSPITAL
	• REPORT INCIDENT TO SUPERVISOR

Chemical hazards are present when you are exposed to any chemical preparation (solid, liquid or gas) in the workplace. Examples include: cleaning products and solvents, vapours and fumes, carbon monoxide or other gases, gasoline or other flammable materials. Chemicals hazards are the major causes of concern. Many chemicals are used not on generic names but on brands. The chemicals have biological effects on the human body if digested, inhaled or if direct skin contact with the chemicals, injuries occurs.

Accidents involving chemical spills, exposure and inhalation can lead to burns, blindness, rashes and other ailments. Most of them cause acute poisoning when taken orally, eye-skin irritation, Respiratory injuries etc. Long term effects of chemicals on blood, nerve, bones, kidneys, livers etc., my lead to serious diseases/ disorders. The only way is to understand their chemical nature and handle them very carefully.

CHEMICAL POISONING

Poison : An agent or substances which may cause structural damage or functional disorders when introduced into the body by:

- **Ingestion**
- **Inhalation**
- **Absorption or**
- **Injection**

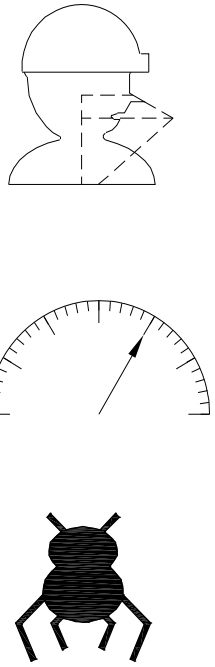
Biological hazards (Fig 3) come for working with people, animals or infectious plant material. Examples include; blood or other bodily fluids, bacteria and viruses, insect bites, animal and bird droppings. Biological hazards are due agent like bacteria, virus, fungi, mold, blood-borne pathogens etc., are main agents to cause various illness. (Fig 4)

Fig 3

BIOLOGICAL HAZARD

SUN110223

Fig 4



BIOLOGICAL HAZARD

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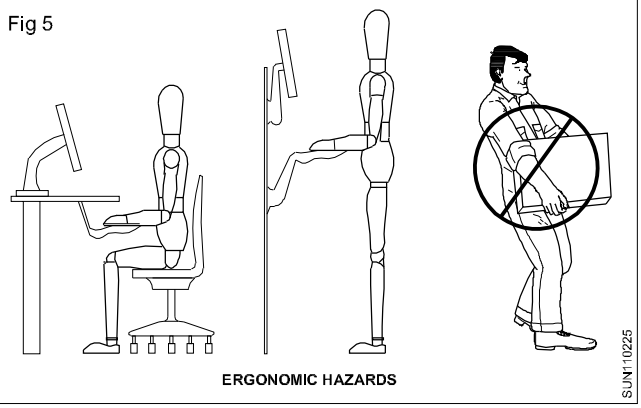
Ergonomic hazards (Fig 5)

Ergonomic hazards occur when the type of work you do, your body position and/or your working conditions put a strain on your body. They are difficult to identify because you don't immediately recognize the harm they are doing to your health. Examples include : poor lighting, improperly adjusted workstations and chairs, frequent lifting, repetitive or awkward movements. Musculo Skeletal Disorders (MSDs) affect the muscles, nerves and tendons. Work related MSDs are one of the leading causes injury and illness.

Fig 5



ERGONOMIC HAZARDS

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Workers in many different industries and occupations can be exposed to risk factors at work, such as lifting heavy items, bending, reaching overhead, pushing and pulling heavy loads, working in awkward body postures and performing the same or similar tasks repetitively. Exposure to these known risk factors for MSDs increases a worker's risk of injury.

Mechanical hazards are factor arise out of varieties of machines in industries including manufacturing, mining, construction and agriculture. They are dangerous to the worker when operated without training and experience. Operating machines can be risky business, especially large, dangerous machines. When employees don't know how to properly use machinery or equipment, they risk such injuries as broken bones, amputated limbs and crushed fingers. Many machines involve moving parts, sharp edges, hot surfaces and other hazards with the potential to crush, burn, cut, shear, stab or otherwise strike or wound workers if used unsafely.

Various safety measures exists to minimize these hazards, lockout-tagout procedures for machine maintenance and roll over protection systems for vehicles. Machines are also often involved indirectly in worker deaths and injuries, such as in cases in which a worker slips and falls, possibly upon a sharp or pointed object. Safeguarding machinery decreases accidents and keeps employees who use the machine safer.

Falls (Fig 6) are a common cause of occupational injuries and fatalities, especially in construction, extraction, transportation, healthcare, and building cleaning and maintenance. Slips and falls to be the leading cause of workplace injuries and fatalities. From slippery surfaces to un-railed staircases, the possibility of slipping, tripping or falling on the job is a workplace safety hazard. Broken bones, fractures, sprained wrists and twisted ankles constitute some of the physical injuries caused by falling accidents.

Fig 6

SUN110226

Falls in the workplace is effectively prevented by putting caution signs around slippery surfaces (Fig 7), having rails on every staircase and making sure that wires on the floor are covered to avoid tripping. They are perhaps unavoidable in certain industries, such as construction and mining, but over time people have developed safety methods and procedures to manage the risks of physical danger in the workplace. Employment of children may pose special problems.

Fig 7

CAUTION BOARD

SUN110227

Psychosocial hazards : psychosocial hazards are related to the way work is designed, organized and managed, as well as the economic and social contexts of work and are associated with psychiatric, psychological and/or physical injury or illness. Linked to psychosocial risks are issues such as occupational stress and workplace violence which are becoming a major challenge to occupational health and safety.

Workplace inspections prevent hazards

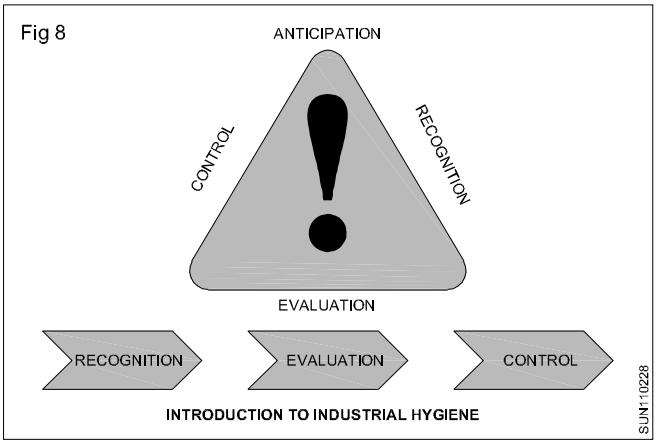
Regular workplace inspections are another important factor in preventing injuries and illnesses. By critically examining all aspects of the workplace, inspections identify and record hazards that must be addressed and corrected.

A workplace inspection should include

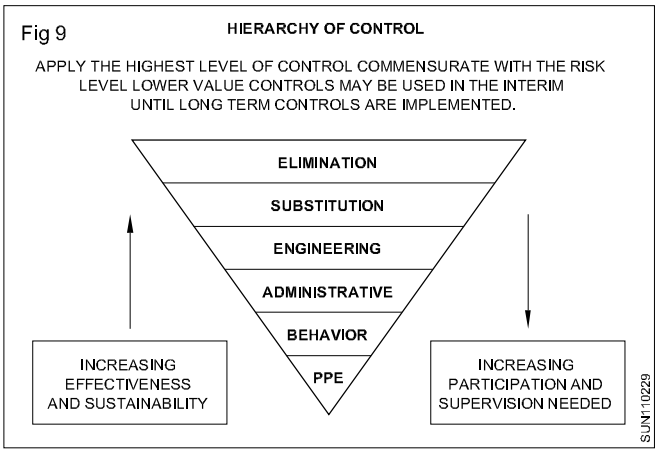
- Listening to the concerns of workers and supervisors.
- Gaining further understanding of jobs and tasks.
- Identifying existing and potential hazards.
- Determining underlying causes of hazards.
- Monitoring hazard controls (Personal protective equipment, engineering controls, policies, procedures)
- Recommending corrective action.

Occupational hygiene

Occupational hygiene (Industrial hygiene) (Fig 8) is the discipline of anticipating, recognizing, evaluating and controlling health hazards in the working environment with the objective of protecting worker health and well-being and safeguarding the community at large.



Occupational hygiene uses science and engineering to prevent ill health caused by the environment in which people work. It helps employers and employees to understand the risks and improve working conditions and working practices. (Fig 9)



Occupational disease/Disorders & its prevention

Occupational disease, illness incurred because of the conditions or environment of employment. Unlike with accidents, some time usually elapses between exposure to the cause and development of symptoms. In some instances, symptoms may not become evident for may years and hence the relationship between work and disease is ignored.

Among the environmental causes of occupational disease are subjection to extremes of temperature leading to heatstroke, air contaminants of dust, gas, fumes causing diseases of the respiratory tract, skin, or muscles and joints or changes in atmospheric pressure causing decompression sickness, excessive noise causing hearing loss, exposure to infrared or ultraviolet radiation or to radioactive substances. The widespread use of X rays, radium and materials essential to the production of nuclear power has led to an special awareness of the dangers of radiation sickness. Hence careful checking of equipment and the proper protection of all personnel are now mandatory.

In addition there are industries in which metal dusts, chemical substances, and unusual exposure to infective substances constitute occupational hazards. The most common of the dust and fiber inspired disorders are the lung diseases caused by silica, beryllium, bauxite and iron ore to which miners, granite workers and many others are exposed causing pneumoconiosis and those caused by asbestos is cancer - mesothelioma, Fumes, Smoke and Toxic liquids from a great number of chemicals are other occupational dangers. Carbon monoxide, Carbon tetrachloride, Chlorine, Creosote, Cyanides, Dinitrobenzene, Mercury, Lead Phosphorus and nitrous chloride are but a few of the substances that on entering through the skin, respiratory tract or digestive tract cause serious and often fatal illness.

Occupational hazards also are presented by infective sources. Persons who come into contact with infected animals in a living or deceased state are in danger of acquiring such diseases as anthrax. Doctors, Nurses and other hospital personnel are prime targets for the tuberculosis bacillus and for many other infectious organisms.

Familiarisation and information about the institute and trade

Objectives: At the end of this lesson you shall be able to
- **state the general training system**
- **state the information about the trade**
- **state the rules and regulation of the institute and trade.**

Training system

General

The Directorate General of Training (DGT) under Ministry of Skill Develpment & Entrepreneurship offers range of vocational training courses catering to the need of different sectors of economy labour market. The vocational training programmes are delivered under aegis of National Council of Vocatinal Training (NCVT). Craftsman Training Scheme (CTS) and Apprenticeship Training Scheme (ATS) are two pioneer programmes of NCVT for propagating vocational training.

Surveyor trade under CTS is one of the popular courses delivered nationwide through network of ITIs. The course is of two years (04 semester) duration. It mainly consists of Domain area and Core area. In the Domain area-trade theory and practical impart professional skills and knowledge; while core area imparts workshop calculation and science, Engineering Drawing, and Employability Skills impart requisite core skills & knowledge and life skills. After passing out the training programme, the trainee is being awarded National Trade Certificate (NTC) by NCVT which are recognized worldwide.

Candidates broadly need to demonstrate that they are able to :

- Read & interpret technical parameters / documentation, plan and organize work processes, identify necessary materials and tools.
- Perform work with due consideration to safety rules, Govt. Bye laws and environmental protection stipulations.
- Apply professional knowledge, core skills & employability skills while performing the work
- Check the work as per sketches and rectify erros
- Document the technical parameters related to the work undertaken.

Options for employment are

Employment opportunities for trainee from this trade as draftsman, surveyor and land surveyor shall be available in Central & State Governmnet Departments.

Private sector opportunities shall be as Draftsman, Construction Supervisor with Architect, Civil Engineer, and Civil Contractor, Builders.

Options for Self- Employment are

The Trainee shall be able to independently undertake planning, drawing, estimation & costing and supervision of civil construction work. He can set up his own office for above work and also to supply Civil Construction materials.

Rules and regulation of the institute and trade

- The trainees who are all got admission in I.T.I has to follow same general rales stiuplated by the institution, and those are given below
- The trainees who are all got admission in I.T.I has to follow same general rates stipulated by the institution, and those are given below
- He should try to earn good room from the institution
- The trainees should attend the institution to the correction in punctuality should be maintained.
- He should be very sincere and faithfull not only to this instructor but also other instructors and staff the institute.
- He should attend were proper formal dress as specified by the institute.
- He should not wear loose clothes and this may be the cause for accident while crossing in shops floor.
- He should have good attitude and behave with good manner to all the staff members his fellow students and to this senior students.
- He should take part in the activities of the institute.
- He should maintain discipline of the class room and the institution.
- He should not spoil the environment of institute.

(Note : The above rules and regulation are also compulsory for the Girl trainees to adhere)

Fire safety

Objectives: At the end of this lesson you shall be able to
- **state different type of fire**
- **state the different types of fire extinguishers and their basic function.**

Fire safety : Fire is the most common serious hazard that one faces in a typical chemistry laboratory. While proper procedure and training can minimize the chances of an accidental fire, you must still be prepared to deal with a fire emergency should it occur.

Typically, a fire extinguisher consists of a hand-held cylindrical pressure vessel containing an agent which can be discharged to extinguish a fire.

There are two main types of fire extinguishers :

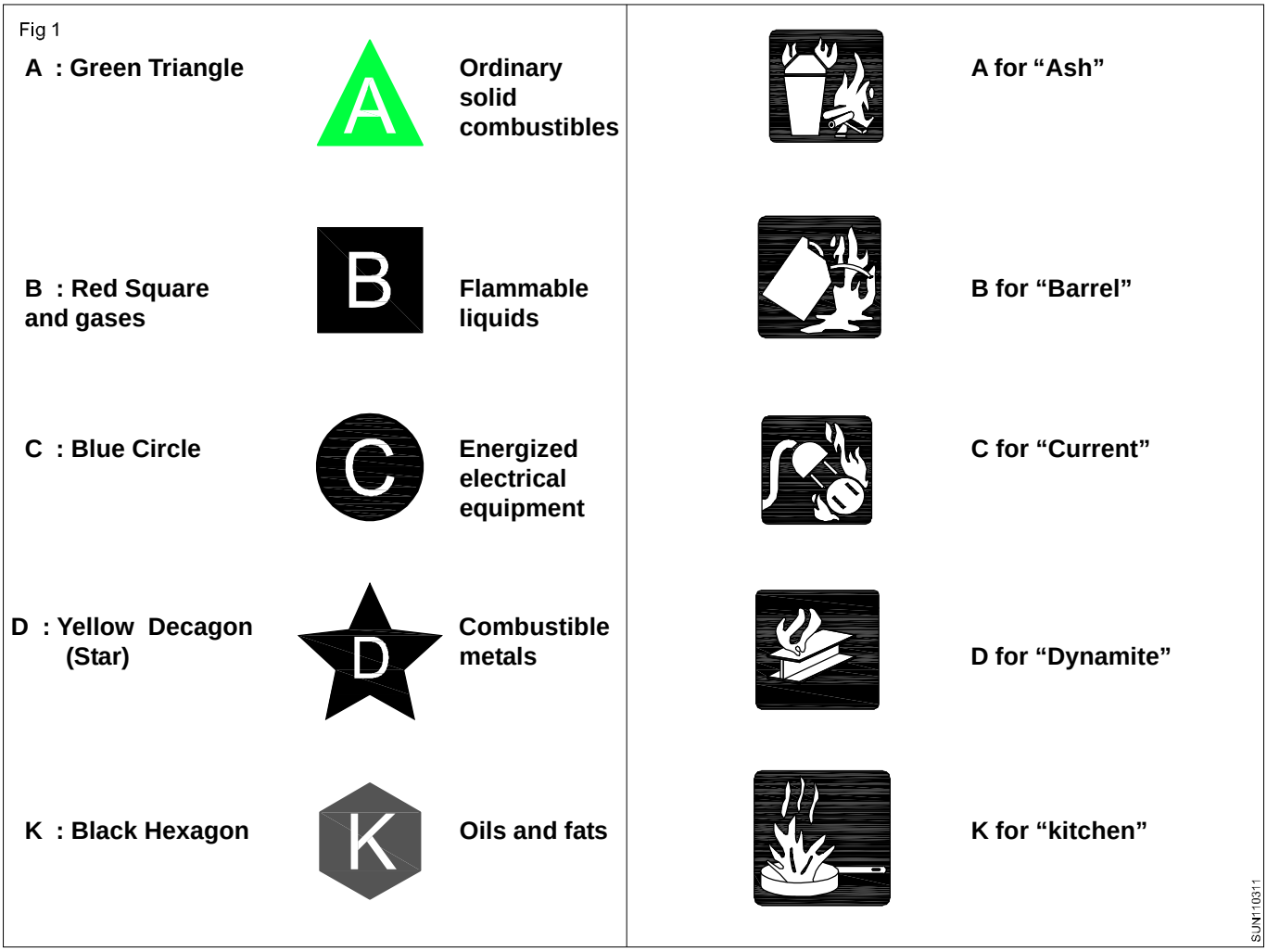
- Stored pressure
- Cartridge-operated.

In stored pressure units, the expellant is stored in the same chamber as the firefighting agent itself. Depending on the agent used, different propellants are used. With dry chemical extinguishers, nitrogen is typically used, water and foam extinguishers typically use air. Stored pressure fire extinguishers are the most common type.

Carbon-dioxide extinguishers contain the expellant gas in a separate cartridge that is punctured prior to discharge, exposing the propellant to the extinguishing agent. This type is not as common, used primarily in areas such as industrial facilities, where they receive higher-than-average use. They have the advantage of simple and prompt recharge, allowing an operator to discharge the extinguisher, recharge it and return to the fire in a reasonable amount of time. Unlike stored pressure types, these extinguishers use compressed carbon dioxide instead of nitrogen, although nitrogen cartridges are used on low temperature (-60 rated) models.

Cartridge operated extinguishers are available in dry chemical and dry powder and in water, wetting agent, foam, dry chemical (classes ABC and B.C.) and dry powder (class D) types in the rest of the world.

Fig 1



Class A : This is suitable for cloth, wood, rubber, paper, various plastics, and regular combustible fires. It is usually filled with 2 ½ gallons (9.46 litres) of pressurized water.

Class A fire extinguishers are designed to put out fires that have started from household items that are made out of materials that will quickly ignite. These materials include paper products and furniture made from wood. The Type A fire extinguisher contains water. The number on the canister represents how much water it contains. If there is a No. 1, the extinguisher will have a little more than I gallon of water. The higher the number, the more water it contains. The letter A stands for ash. A fire that burns from household items will leave ashes.

Class B : This is suitable for grease, gasoline or oil-based fire is usually filled with a dry chemical. Extinguishers smaller than 6lbs (2.72kg) are not recommended.

Class B fire extinguishers are used to put out fires that have started from highly flammable liquids. These liquids include any type of lacquer or oil-based paint products, paint thinners and lacquer thinners, oils and gasoline. According to the phoenix fire department, the letter B represents a barrel. Most of these chemicals are transported in a barrel-like container. The number on the extinguisher represents how many square feet it will cover. A 3 would represent 3 square feet, which is not a very large area. A larger fire could not be extinguished with this extinguisher.

Class C : This is suitable for electrical fires caused by appliances, tools and other plugged in gear. It can contain either halon or CO_2. Halon expensive and depletes the ozone layer and its use is restricted.

Class C : fire extinguishers are used to put out fires that have started from an electrical source. The source could be from appliances, lighting or your electrical system. This extinguisher uses carbon dioxide to put out the fire. Carbon dioxide will basically remove the oxygen from the air around the fire. Carbon dioxide is also used in some Type B extinguishers.

Class D : This is used for water-reactive metals such as burning magnesium and will be located in factories using such metals. It comes in the form of a powder that must cover the material to extinguish it.

Class D : Class D extinguishers are used to put out fires on metals that are capable of burning. These types of metals are found in the manufacturing industry only. This extinguisher uses a dry powder to put out the fire. You will not likely ever have a need for this type of extinguisher unless you work with titanium, sodium or magnesium.

Class K : This contains a special purpose wet chemical agent for use in kitchen fires and deep fryers to stop fires started by vegetable oils, animal fats, or other fats started in cooking appliances.

Class K : Many people have not heard of the Type K fire extinguisher. This extinguisher can be found in large kitchens. Many restaurants use large deep fryers full of cooking oils to deep fry foods. The typical Type B extinguisher would not be sufficient to put out a grease fire of this magnitude.

Fire fighting methods

Starvation/Blanketing	- Elimination of fuel
Smothering	- Limitation of oxygen
Cooling	- Removal of temperature

Accident & Safety

Objectives: At the end of this lesson you shall be able to
- **state the base principle for protective equipment**
- **state the accident prevention technique**
- **describe the controls of accidents & safety measures.**

Basic Principles for Protective Equipment (PPE)

Personal protective equipment, commonly referred to as "PPE", is a equipment worn to minimize exposure to serious workplace injuries and illnesses. (Fig 1) These injuries and illnesses may result from contact with chemical, radiological, physical, electrical, mechanical or other workplace hazards. Personal protective equipment may include items such as gloves, safety glasses and shoes, earplugs or muffs, hard hats, respirators or coveralls, vests and full body suits. (Fig 2 & Fig 3)

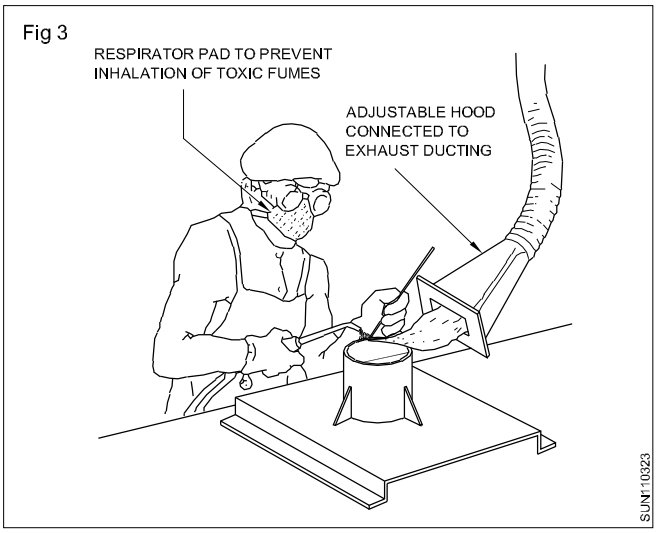
Fig 1

Fig 2

Use of personal protective equipment : All personal protective equipment should be of safe design and construction, and should be maintained in a clean and reliable fashion. It should fit well and be comfortable to wear, encouraging worker use. If the personal protective equipment does not fit properly, it can make the difference between being safely covered or dangerously exposed. When engineering, work practice and administrative controls are not feasible or do not provide sufficient protection, employers must provide personal protective equipment to their workers and ensure its proper use.

Employers are also required to train each worker required to use personal protective equipment to know:

Fig 3



- When it is necessary?
- What kind is necessary?
- How to properly put it on, adjust, wear and take if off.
- The limitations of the equipment
- Proper care, maintenance, useful life and disposal of the equipment.

If PPE is to be used, a PPE program should be implemented. This program should address the hazards present; the selection, maintenance and use of PPE; the training of employees and monitoring of the program to ensure its ongoing effectiveness.

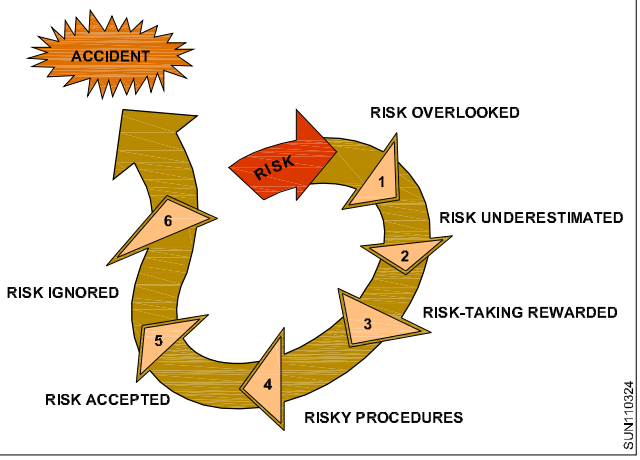
Accident prevention techniques-control of accidents and safety measures

Accident are unplanned, undesired event, not necessarily resulting in an injury or illness, but damaging property and/or interrupting the activity in process. Accident happen at all jobs. There are certain accidents that are common to a job. All employees should be trained and reminded how to do their job correctly to prevent unnecessary injuries while at work. An accident can occur when a machine malfunction or a person isn't paying attention to the work they are suppose to be doing. Even a small accident can cause major problems for an employee and their employer. The best practice to avoid all types of accidents is to teach and promote a safe and happy workplace. (Fig 4)

Accidents can happen anytime at any place they are more likely to happen when a person is participating in an unsafe act. That is why it is important to follow all safety rules and guidelines while working. If a taking a few more minutes to do the job safe is worth saving your life.

Overexertion in the workplace is a serious issue. Prevent damage to your back, knees and arms is very important. Train all employees on how to prevent overexertion by following safety rules and guidelines while completing workplace task.

Fig 4

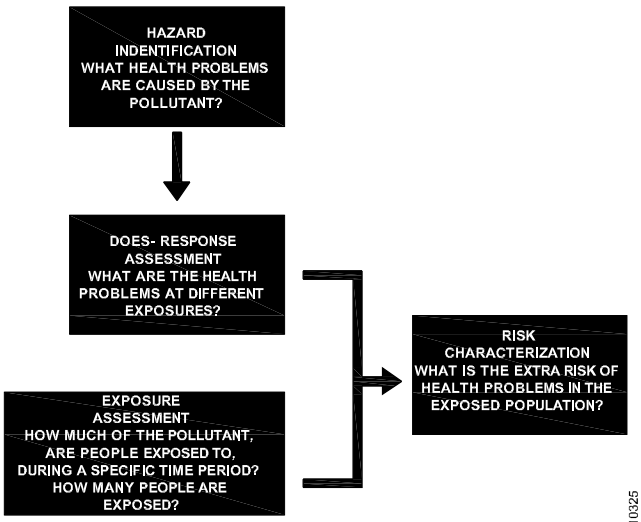


Control of accidents are done by reducing exposure to a hazards through engineering, work practices, administration or protective equipment.

Responsibilities

At department level the supervisors are made to instruct their employees regarding the requirements of this program, effectively enforce compliance of this program's procedures, including the use of disciplinary action, for any violations or deviations from the procedures outlined in this program; assure that the equipment required for compliance with this program is in proper working order, inspected and tested as required, and made available for use to their employees, promptly investigate and report all on-the-job accidents or job related health problems. (Fig 5)

Fig 5



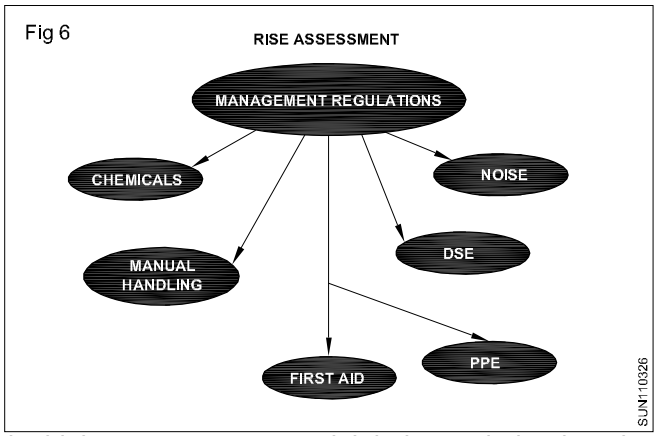
THE 4 STEP RISK ASSESSMENT PROCESS

Recognizing and controlling hazards

Engineering controls minimize employee exposure by either reducing or removing the hazard at the source or isolating the worker from the hazard. Engineering controls include eliminating toxic chemical and substituting non-toxic chemicals, enclosing work processes or confining work operations, and the installation of general and local ventilation systems. Work practice controls alter the manner in which a task is performed. Some fundamental and easily implemented work practice, controls include changing existing work practices to follow proper procedures that minimize exposures. While operating production and control equipment, inspecting and maintaining process and control equipment on a regular basis, implementing good housekeeping procedures, providing good supervision and mandating that eating, drinking, smoking, chewing tobacco or gum, and applying cosmetics in regulated areas be prohibited.

Administrative controls, include controlling employees' exposure by scheduling production and tasks, or both, in ways the minimize exposure levels. (Fig 6) For example, the employer might schedule operations with

Fig 6



the highest exposure potential during periods when the fewest employees are present. When effective work practices or engineering controls are not feasible or while such controls are being instituted, appropriate personal protective equipment must be used. Examples of personal protective equipment are gloves, safety goggles, helmets, safety shoes, protective clothing and respirators. To be effective, personal protective equipment must be individually selected, properly fitted and periodically refitted, consciously and properly worn, regularly maintained and replaced, as necessary.

The employees have to comply with the procedures of this program, consult with their supervisor, when they have questions regarding the safety and health conditions of their workplace, report any accidents or job related injuries or illnesses to their supervisor and seek prompt medical treatment, if necessary.

Employees are responsible for exercising appropriate care and good judgment in preventing injuries and illnesses, adhering to all safety and health rules, policies and procedures and reporting all unsafe conditions, malfunctioning or unsafe equipment, work related accidents, injuries and illnesses, and unsafe work practices to their immediate supervisor. If that is not feasible, a report should be made to the head of their department, the plant operations safety officer, or a member of the work safe/be well committee.

First Aid

Objectives: At the end of this lesson you shall be able to
- **explain how to take care of injured & sick persons at workplaces**
- **explain how to provide first aid & transportation to sick person**
- **state ABC of first aid**
- **state how to report an emergency.**

Purpose of First Aid

- To sustain life
- To prevent suffering
- To prevent secondary complications
- To promote speedy recovery
- To prepare for further medical treatment

Each separate work site or shop should have a fully stocked first aid kit available for injuries or emergencies. First aid kits will be regularly inspected to insure they are adequately stocked with consumables and equipment. All first aid kits should conform to the most recent guidelines for first aid kits.

For temporary work sites, first aid kits may be stored in gang boxes, on vehicles, or other similar locations, as long as easy access for all workers at the temporary site is maintained, each worker knows where the first aid kit is located, and the kit is maintained in accordance with.

In situations where workers are injured beyond the need for general first aid, medical treatment will be provided in accordance with the plant workplace health and medical treatment program. At anytime a potential life threating injury has been incurred, workers will contact local emergency response services immediately, by the quickest means available.

Workers receiving medical treatment or surveillance examinations may be supplied with copies of the written opinions of the examining physicians as required by regulation, or recommended by the physician. Medical records for employees must be kept strictly confidential with access restricted to information directly related to work activities. Generally, medical records will be kept in the control of the examining physician/staff of the first-aid centre.

In emergency situations, such as fires, criminal, terrorist or civil disturbances, situations involving spills of, releases of, or exposure to hazardous materials (e.g. Chemical, Biological, Radiological), situations of severe weather, such as storms, tornadoes, blizzards, etc., or the loss of utility services, such as electricity, water, heat etc., workers should take appropriate actions to safeguard their lives, the lives of building occupants, and if possible the property of the university. Workers are to contact the appropriate agency as outlined.

First aid is defined as the immediate care and support given to an acutely injured or ill person, primarily to save life, prevent further deterioration or injury, plan to shift the victims to safer places, provide best possible comfort and finally help them to reach the medical centre/hospital through all available means. It is an immediate life-saving procedure using all resources available within reach.

Imparting knowledge and skill through institutional teaching at younger age group in schools, colleges, entry point at industry level is now given much importance. Inculcating such habits at early age, helps to build good healthcare habits among people.

ASSESSING THE SICK OR INjURED

PRIMARY SURVEY

- Is an initial rapid assessment of a casualty to establish and treat conditions that are an immediate threat to life.

DANGER

RESPONSE

AIRWAY

BREATHING

CIRCULATION

DR ABC

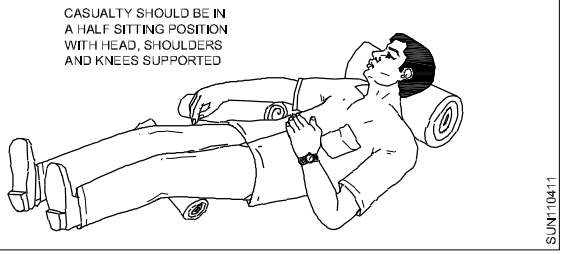
First-aid procedure often consists of a range of simple and basic life saving techniques that an individual performs with proper training and knowledge.

The key aims of first aid can be summarized in three key points :

- **Preserve life :** If the patient was breathing, a first aider would normally place them in the recovery position, with the patient leant over on their side, which also has the effect of clearing the tongue from the pharynx. It also avoids a common cause of death in unconscious patients, which is choking on regurgitated stomach contents. The airway can also become blocked through a foreign object becoming lodged in the pharynx or larynx, commonly called choking. The first aider will be taught to deal with this through a combination of 'back slaps' and 'abdominal thrusts'. Once the airway has been opened, the first aider would assess to see if the patient is breathing.

- **Prevent further harm :** also sometimes called prevent the condition from worsening, or danger of further injury, this covers both external factors, such as moving a patient away from any cause of harm, and applying first aid techniques to prevent worsening of the condition, such as applying pressure to stop a bleed becoming dangerous. Victim should be in half sitting position with head, shoulder & neck support. (Fig 1)

Fig 1



- **Promote recovery :** First aid also involves trying to start the recovery process from the illness or injury, and in some cases might involve completing a treatment, such as in the case of applying a plaster to a small wound.

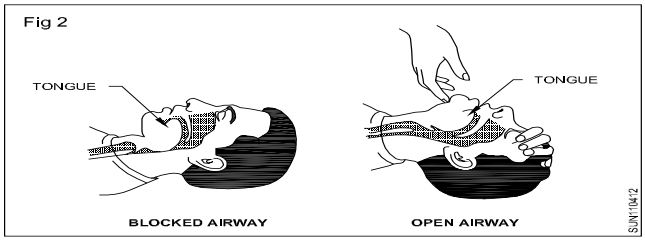
Training : Basic principles, such as knowing to use an adhesive bandage or applying direct pressure on a bleed, are often acquired passively through life experiences. However, to provide effective, life-saving first aid interventions requires instruction and practical training. This is especially true where it relates to potentially fatal illnesses and injuries, such as those that require Cardio Pulmonary Resuscitation (CPR), these procedures may be invasive and carry a risk of further injury to the patient and the provider. As with any training, it is more useful if it occurs before actual emergency, and in many countries, emergency ambulance dispatchers may give basic first aid instructions over the phone while the ambulance is on the way.

Training is generally provided by attending a course, typically leading to certification. Due to regular changes in procedures and protocols, based on updated clinical knowledge, and to maintain skill, attendance at regular refresher courses or re-certification is often necessary. First aid training is often available through community organizations such as the red cross and St. John ambulance.

ABC or First-aid : ABC stands for Airway, Breathing and Circulation

Airway : Attention must first be brought to the airway to ensure it is clear. Obstruction (choking) is a life-threatening emergency. (Fig 2)

Fig 2



Breathing : Breathing if stops, the victim may die soon. Hence means of providing support for breathing is an important next step. There are several methods practiced in first-aid.

Circulation : Blood circulation is vital to keep person alive. The first aiders now trained to go straight to chest compressions through CPR methods. (Fig 3 & Fig 4)

Fig 3

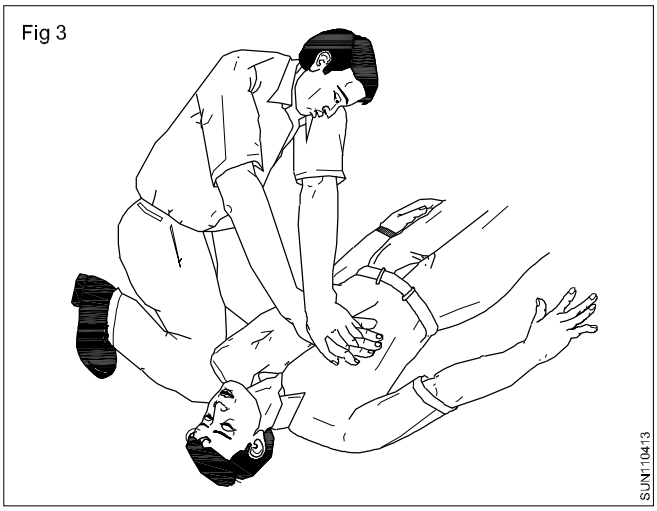
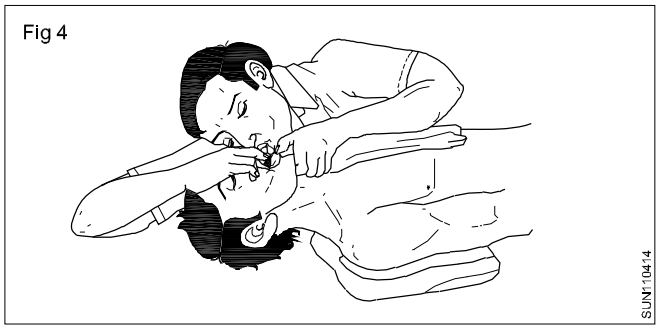


Fig 4



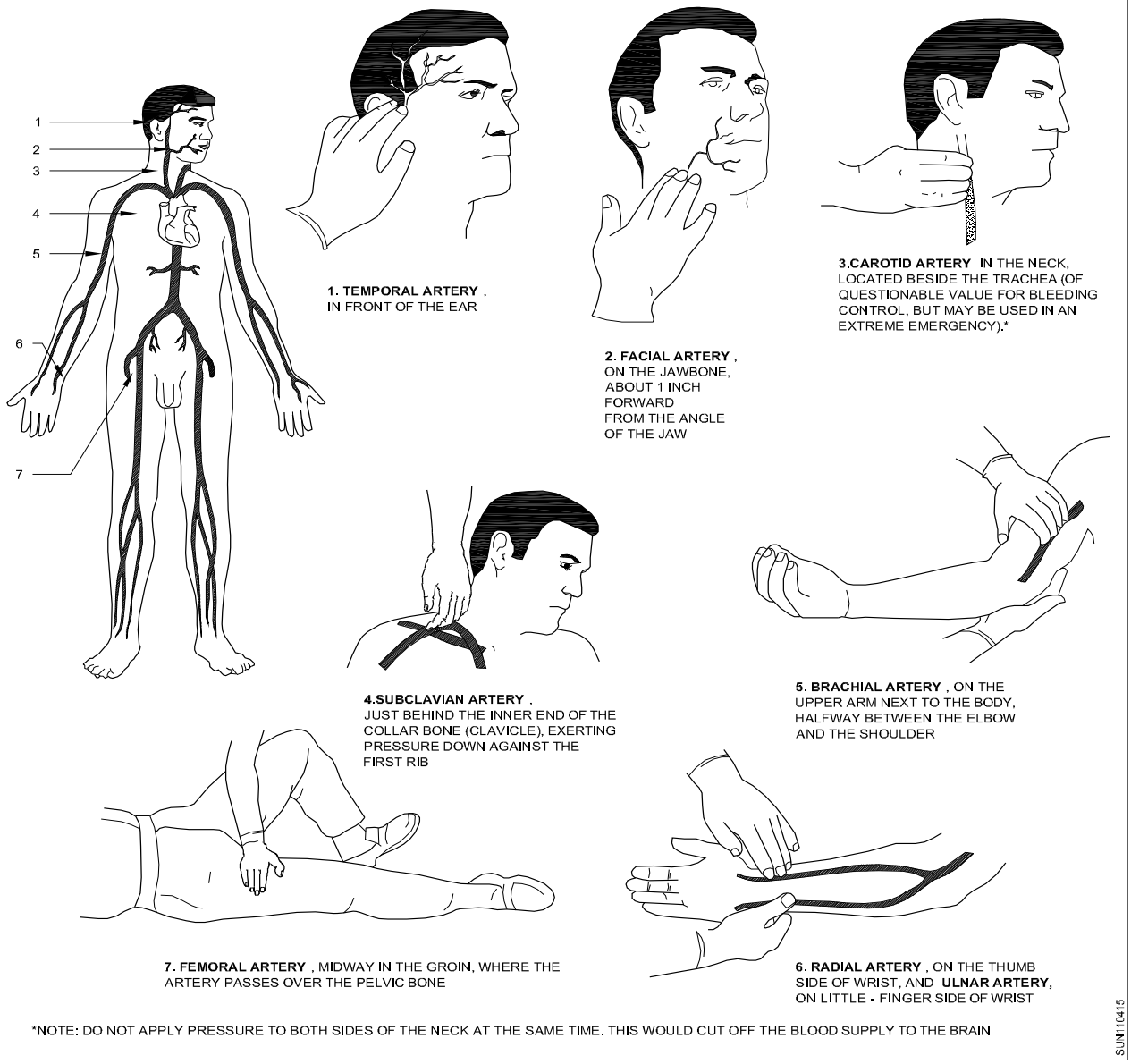
When providing first aid one needs to follow some rule. There are certain basic norms in teaching and training students in the approach and administration of first-aid to sick and injured. (Fig 5)

Not to get panic : Panic is one emotion that can make the situation more worse. People often make mistake because they get panic. Panic clouds thinking and causes mistakes. First-aider need calm and collective approach. if the first-aider himself is in a state of fear and panic gross mistakes may result. It's far easier to help the suffering, when they know what they are doing, even if unprepared to encounter a situation. Emotional approach and response always lead to wrong doing and may cloud one to do wrong procedures. Hence be calm and focus on the given situation. Quick and confident approach can lessen the effect of injury.

Call medical emergencies : If the situation demands, quickly call for medical assistance. Prompt approach may save the life.

Surroundings play vital role : Different surrounding require different approach. Hence first-aider should study the surrounding carefully. In other words, one need to make sure that they are safe and are not in any danger as it would be of no help that the first aider himself get injured.

Fig 5



Do no harm : Most often, enthusiastically practiced First-Aid Viz. administering water when the victim is unconscious, wiping clotted blood (which acts as plug to reduce bleeding), correcting fractures, mishandling injured

parts etc., would leads to more complication. Patients often die due to wrong FIRST-AID methods, who may otherwise easily survive. Do not move the injured person unless the situation demands. It is best to make him lie wherever he is because if the patient has back, head or neck injury, moving him would cause more harm.

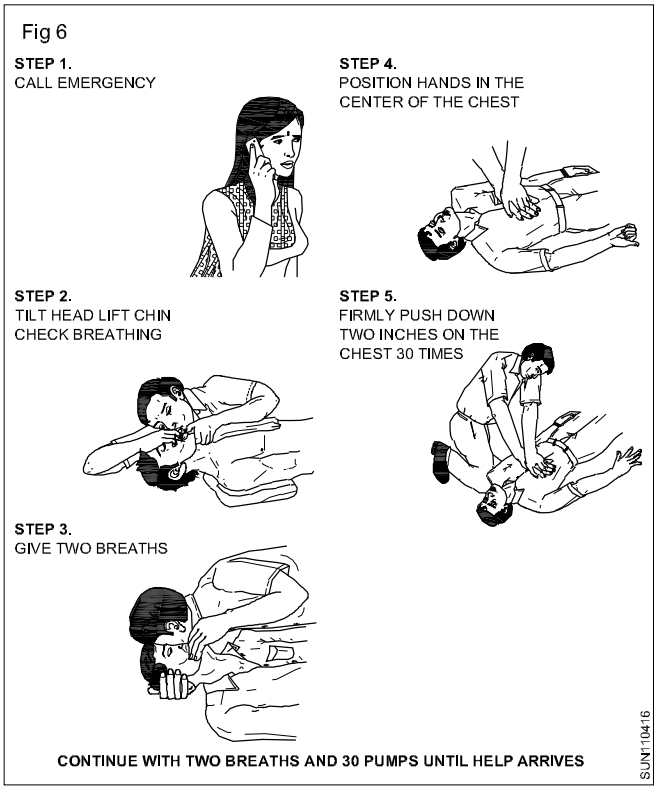
This does not mean do nothing. It mean to make sure that to do something the care givers feel confident through training would make matters safe. If the first-aider is not confident of correct handling it is better not to intervene of do it. Hence moving a trauma victim, especially an unconscious one, need very careful assessment. Removals of an embedded objects (like a knife, nail) from the wound may precipitate more harm (e.g., increased bleeding). Always it is better to call for help.

Reassurance : Reassure the victim by speaking encouragingly with him.

Stop the bleeding : If the victim is bleeding, try to stop the bleeding by applying pressure over the injured part.

Golden Hours : India have best of technology made available in hospitals to treat devastating medical problems viz. head injury, multiple trauma, heart attack, strokes etc, but patients often do poorly because they don't gain access to that technology in time. The risk of dying from these conditions, is greatest in the first 30 minutes, often instantly. This period is referred to as golden period. By the time the patient reach hospitals, they would have passed that critical period. First-aid care come handy to save lives. It helps to get to the nearest emergency room as quickly as possible through safe handling and transportation. The shorter that time, the more likely the best treatment applied. (Fig 6)

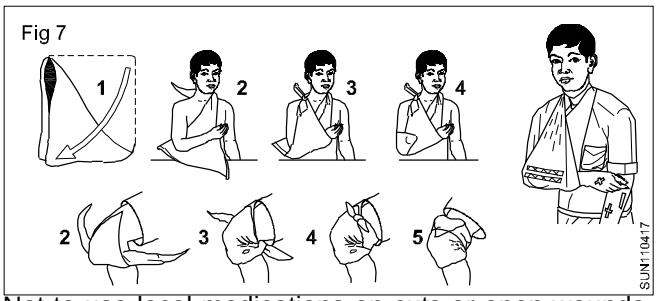
Fig 6



Maintain the hygiene : Most importantly, first-aider need to wash hands and dry before giving any first aid treatment to the patient or wear gloves in order to prevent infection.

Cleaning and Dressing (Fig 7) : Always clean the wound thoroughly before applying the bandage. Lightly wash the wound with clean water.

Fig 7



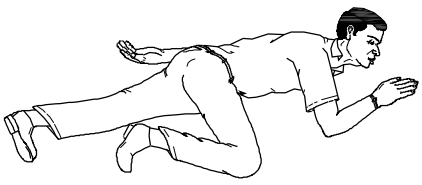
Not to use local medications on cuts or open wounds. They are more irritating to tissue than it is helpful. Simple dry cleaning or with water and some kind of bandage are best.

Stay with the victim until help arrives : Try to be a calming presence for the victim until assistance can arrive.

Unconsciousness

Loss of consciousness may threaten life if the person is on his back and the tongue has dropped to the back of the throat, blocking the airway. Make certain that the person is breathing before looking for the cause of unconsciousness. If the injuries permit, place the casualty in the recovery position with the neck extended.(Fig 8) Never give anything by mouth to an unconscious casualty. Unconscious also referred as **coma,** is a serious life threatening condition, when a person lie totally senseless and do not respond to calls, external stimulus. But the basic heart, breathing, blood circulation may be still intact, or they may also be failing if unattended it may lead to death.

Fig 8



The condition arises due to interruption of normal brain activity. The causes are too many.

- Shock (Cardiogenic, Neurogenic)
- Head injury (Concussion, Compression)
- Asphyxia (Obstruction to air passage)
- Extremes of Body temperature (Heat, Cold)
- Cardiac Arrest (Heart attack)
- Stroke (Cerbro-vasular accident)
- Blood loss (Haemorrhage)
- Dehydration (Diarrohoea & vomiting)
- Diabetes (Low or high sugar)
- Blood pressure (Very low or vey high)
- Over dose of alcohol, drugs
- Poisoning (Gas, pesticides, bites)
- Epileptic Fits (Fits)
- Hysteria (Emotional, Psychological)

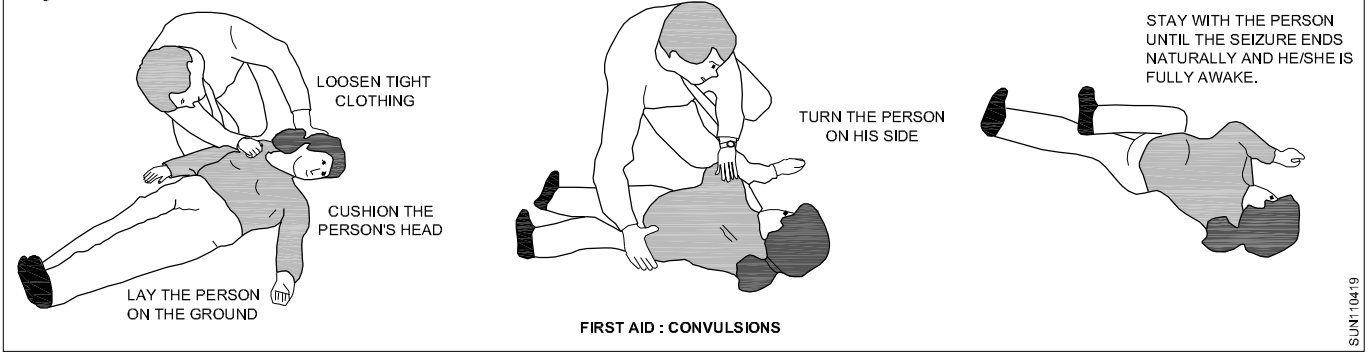
The following symptoms may occur after a person has been unconscious : (Fig 9)

- Confusion
- Drowsiness
- Headache
- Inability to speak or move parts of his or her body (see stroke symptoms)
- Light headedness
- Loss of bowel or bladder control (incontinence)
- Rapid heartbeat (Palpitations)
- Stupor

First aid

- Call emergency number.
- Check the person's airway, breathing and pulse frequently. If necessary, begin rescue breathing and CPR.
- If the person is breathing and lying on the back, and after ruling out spinal injury, carefully roll the person onto the side, preferably left side. Bend the top leg so

Fig 9

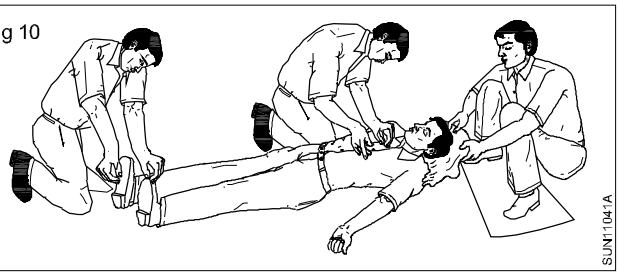


FIRST AID : CONVULSIONS

both hip and knee are at right angles.Gently tilt the head back to keep the airway open.If breathing or pulse stops at any time,roll the person on to his back and begin CPR.

- If there is a spinal injury, the victims position may have to be carefully assessed. If the person vomits, roll the entire body at one time to the side. Support the neck and back to keep the head and body in the same position while you roll.
- Keep the person warm until medical help arrives.
- If you see a person fainting, try to prevent a fall. Lay the person flat on the floor and raise the level of feet above and support.
- If fainting is likely due to low blood sugar, give the person something sweet to eat or drink when they become conscious. (Fig 10)

Fig 10



Do Not

- Do not give an unconscious person any food or drink.
- Do not leave the person alone.
- Do not place a pillow under the head of an unconscious person.
- Do not slap an unconscious person's face or splash water on the face to try to revive him.

First-aid box

Small, medium and large dressings : These are sterile pads with bandages attached that can be used to control heavy bleeding and cover minor wounds. Triangular bandages - These are an extremely versatile piece of equipment. Folded into a pad, they can be used as a cold compress or as padding around a painful area. They can provide cover for burns or large scrapes and support broken bones.

Adhesive bandage (for small wounds), **Non-adhesive sterile dressings (various sizes), safety tape, adhesive tape and hypoallergenic tape.** Dressing can be cut to size and used to cover scrapes, burns and small wounds.

Gauze swabs : For use with water to clean wounds.

Ace bandages, compression bandages, tubular bandage : For use in providing support to sprains and strains.

Disposable gloves : For use in managing body fluids.

Blunt-ended scissors : tweezers.

Transport safety : Use one of the most safer methods.

CPR (Cardio-Pulmonary Resuscitation) : CPR can be life sustaining. If one is trained in CPR and the person is suffering from choking or finds difficulty in breathing, immediately begin CPR. However, if one is not trained in CPR, do not attempt as you can cause further injury. But most people do it wrong. This is a difficult procedure to do in a crowded area. Also there are many studies to suggest that no survival advantage when bystanders deliver breaths to victims compared to when they only do chest compressions. Second, it is very difficult to carry right manever in wrong places. But CPR, if carefully done by highly skilled first-aiders is a bridge that keeps vital organs oxygenated until medical team arrives.

Declaring death : It is not correct to declare the victim's death at the accident site. It has to be done by qualified medical doctors.

How to report an emergency?

Reporting an emergency is one of those things that seems simple enough, until actually when put to sue in emergency situations. A sense of shock prevail at the accident sites. Large crowd gather around only with inquisitive nature, but not to extend helping hands to the victims. This is common in road side injuries. No passer-by would like to get involved to assist the victims. Hence first-aid management is often very difficult to attend to the injured persons. The first-aiders need to adapt multi-task strategy to control the crowd around, communicate to the rescue team, call ambulance etc., all to be done simultaneously. The mobile phones helps to a greater deal for such emergencies. Few guidelines are given below to approach the problems.

Assess the urgency of the situation. Before you report an emergency, make sure the situation is genuinely urgent. Call for emergency services if you believe that a situation is life-threatening or otherwise extremely disruptive.

- A crime, especially one that is currently in progress. If you're reporting a crime, give a physical description of the person committing the crime.
- A fire, if you're reporting a fire, describe how the fire started and where exactly it is located. If someone has already been injured or is missing, report that as varies - 100 for Police & Fire, 108 for Ambulance.
- A life-threatening medical emergency that requires immediate attention. If you're reporting a medical emergency, explain how the incident occurred and what symptoms the person currently displays.
- A car crash - Location, serious nature of injuries, vehicle's details and registration, number of people involved etc.

Call emergency services : The emergency number varies - 100 for Police & Fire, 108 for Ambulance.

Report your location : The first thing the emergency dispatcher will ask is where you are located, so the emergency services can get there as quickly as possible. Give the exact street address, if you're not sure of the exact address, give approximate information.

Give the dispatcher your phone number : This information is also imperative for the dispatcher to have, so he or she is able to call back if necessary.

Describe the nature of the emergency : Speak in a calm, clear voice and tell the dispatcher why you are calling. Give the most important details first, then answer the dispatcher's follow-up questions as best you can.

Do not hang up the phone until you are instructed to do so. Then follow the instructions you were given.

How to do basic first aid?

Basic first aid refers to the initial process of assessing and addressing the needs of someone who has been injured or is in physiological distress due to choking, a heart attack, allergic reactions, drugs or other medical emergencies. Basic first aid allows one to quickly determine a person's physical condition and the correct course of treatment.

Important guideline for first-aiders

Evaluate the situation (Are there things that might put the first-aider at risk)? When faced with accidents like fire, toxic, smoke, gases, an unstable building, live electrical wires or other dangerous scenario, the first-aider should be very careful not to rush into a situation, which may prove to be fatal.

Remember A-B-Cs : The ABCs of first aid refer to the three critical things the first-aiders need to look for.

- Airway - Does the person have an unobstructed airway?
- Breathing - Is the person breathing?
- Circulation - Does the person show a pulse at major pulse point (Wrist, carotid artery, groin)

Avoid moving the victim : Avoid moving the victim unless they are in immediate danger. Moving a victim will often make injuries worse, especially in the case of spinal cord injuries.

Call emergency services : Call for help or tell someone else to call for help as soon as possible. if alone in at the accident scene, try to establish breathing before calling for help, and do not leave the victim alone unattended.

Determine responsiveness : If a person is unconscious, try to rouse them by gently shaking and speaking to them.

If the person remains unresponsive, carefully roll them onto the side (recovery position) and open his airway.

- Keep head and neck aligned.
- Carefully roll them onto their back while holding his head.
- Open the airway by lifting the chin.

Look, listen and feel for signs of breathing : Look for the victim's chest to rise and fall, listen for sounds of breathing.

If the victim is not breathing, see the section below.

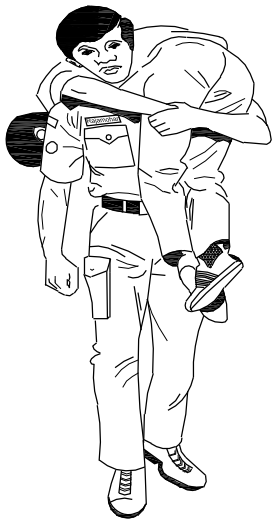
- If the victim is breathing, but unconscious, roll them onto their side, keeping the head and neck aligned with the body. This will help drain the mouth and prevent the tongue or vomit from blocking the airway.

Check the victim's circulation : Look at the victim's color and check their pulse (the carotid artery is a good option; it is located on either side of the neck, below the jawbone). if the victim does not have a pulse, start CPR.

Treat bleeding, shock and other problems as needed: After establishing that the victim is breathing and has a pulse, next priority should be, to control any bleeding. Particularly in the case of trauma, preventing shock is the priority. Some of the ways are mentioned in Fig 11, 12, 13 & 14 how to handle victims.

- **Stop bleeding :** Control of bleeding is one of the most important things to save a trauma victim. Use direct pressure on a wound before trying any other method of managing bleeding.
- **Treat shock :** Shock, a loss of blood flow to the body, frequently follows physical and occasionally psychological trauma. A person in shock will frequently have ice cold skin, be agitated or have an altered mental status, and have pale color to the skin around the face and lips. Untreated, shock can be fatal. Anyone who has suffered a severe injury or life-threatening situation is at risk for shock.
- **Choking victim :** Choking can cause death or permanent brain damage within minutes.

Fig 11



FIRE-MAN LIFT METHOD

SUN11041B

Fig 12

FORE AND AFT METHOD

SUN11041C

- **Treat a burn :** Treat first and second degree burns by immersing or flushing with cool water. Don't use creams, butter or other ointments, and do not pop blisters. Third degree burns should be covered with a damp cloth. Remove clothing and jewellery from the burn, but do not try to remove charred clothing that is stuck to burns.

Fig 13

HAND SEAT METHOD

SUN11041D

Fig 14

HUMAN-CRUTCH METHODS

SUN11041E

- **Treat a concussion :** If the victim has suffered a blow to the head, look for signs of concussion. Common symptoms are; loss of consciousness following the injury, disorientation or memory impairment, vertigo, nausea and lethargy.
- **Treat a spinal injury victim :** If a spinal injury is suspected, it is especially critical, not move the victim's head, neck or back unless they are in immediate danger.

Basic provisions for OSH

Objectives: At the end of this lesson you shall be able to

- **state the basic provisions of safely, health, welfare under legislation of India.**

India has legislation on occupational health and safety for over 50 years. A safe and health work environment is the basic right of every worker. The constitutional provision for occupational safety and health under the Article 24 - No child below the age of fourteen years shall be employed to work in any factory or mine or engaged in other hazardous employment.

Article 39 (e & f) - The state shall in particular direct its policy towards securing.

e that the health and strength of workers, men and women, and the tender age of children are not abused and that citizens are not forced by economic necessity to enter vocations unsuited to their age and strength.

f That children are given opportunities and facilities to develop in healthy manner and in conditions of freedom and dignity and that childhood and youth are protected against exploitation and against moral and material abandonment.

Article 42 - The state shall make provision for securing just and human conditions of work and maternity relief.

National policy

Safety and health occupies a very significant position in India's constitution which prohibits employment of children under 14 in factories, mines and in hazardous occupations. Policy aims to protect the health and strength of all workers. It prevents employment in occupations unsuitable for the age and strength of the workers. It is the policy of the state to make provisions for securing just and humane conditions of work. The constitution provides a broad framework under which policies and programmes for occupational health and safety could be established.

National Legislation

Legislation provides an essential foundation for safety. To be meaningful and effective legislation should be reviewed and updated regularly as scientific knowledge develops.

The most important legislation cover occupational safety, health and welfare are :

- The Factories Act 1948. amended 1954, 1970, 1976, 1987.
- The Mines Act, 1952.
- The dock workers (safety, health and welfare) Act, 1986.
- The plantation labour Act, 1951.
- The Explosives Act, 1984.
- The Petroleum Act, 1934.
- The Insecticide Act, 1968.
- The Indian Boilers Act, 1923.
- The Indian Electricity Act, 1910.
- The Dangerous Machines (Regulations) Act, 1983.
- The Indian Atomic Energy Act, 1962.
- The Radiological Protection Rules, 1971.
- The Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989.

Environment

Objectives: At the end of this lesson you shall be able to
- **state the meaning and definition of environment**
- **list out and explain the components of environment**
- **explain atmosphere and its composition**
- **state the relationship between society and environment**
- **state the factors responsible for destruction and natural disasters.**

Environment Education is a process which makes the world community conscious about the problem of the environment. By this way we may understand the problem and find its solution and may also protect future problems.

Environmental Education (EE) can be linked with three main components

- Education about the environment (Knowledge).
- Education for the environment (Values, attitudes & positive actions).
- Education through the environment (A resource).

Meaning and definition of environment

In general, the word **environment** refers the cover of our surroundings, which includes our earth, soil, water and the atmosphere situated on it. The environment is the important system which covers all the living and non-living system. So it is necessary every layman and literate person to know its meaning.

The word environment is composed of two words- **'environ'** and **'ment'** their meaning is 'to surround' or 'to enwrap', which gives the meaning of sense of situation of the surroundings or cover.

The dictionary meaning of the environment is the "particular surroundings in which living and non-living things exist".

In universal encyclopedia, it is defined as "Environment is the sum of all those condition, systems and influences which influence the development life and death of organisms and their species. On **5th June** every year **world environment** day is celebrated.

Some eminent scholars defined the environment as follows:-

According to **E.J.Ross,** "Environment is an external force which influences us"

According to **Dr. D.H. Davis,** "In relation to man environment means all those physical forms spread all around man on land by which he is influenced continuously.

According to **Kovits,** "Environment is the sum of all those external conditions which influences the development cycle of the organisms on the surface of the earth.

Components of Environment

The components of environment can be classified as shown in the flow diagram.

Land, water, air, soil etc are important inanimate (or) abiotic components. Man, animal, plants and other organisms are biotic components.

Natural Environment

The natural environment is the environment, which comes into existence without interference of man.

Overview of the subject to be taught in each semester

Objectives: At the end of this lesson you shall be able to
- **state the subject to be learned in each semester.**

Overview of the subject to be taught for each semester

During the two years duration, a candidate is trained on subject viz. Professional Skill, Professional Knowledge, Workshop Science & Calculation and Employability Skills. In addition to this, a candidate is entrusted to undertake project work and Extra Curricular Activities to build up confidence. The practical skills are imparted in simple to complex manner & simultaneously theory subject is taught in the same fashion to apply cognitive knowledge while executing tasks. The practical part starts with simple geometrical drawing and finally ends with preparing sanction plan of Residential / Public building; drawing of roads, bridges, railway tracks, dams and Estimation and costing of civil works at the end of the course.

The broad components covered under Professional Skill subject are as below.

Job area after completion of training

After completion of this training trainees maybe able to earn their livelihood. Environment of I.T.I is differs from the schools education. In I.T.I we concentrate more time in practical training i.e he has to obtain good skill in the trade in which he trained. Hence we can say I.T.I.s are institutions which lay the carpet for self job opportunity and differ job opportunity in public sector and private sector.

There are so many departments in public sector and private sector which provides the job opportunity for the trade of surveyor.

The name of some public sectors are given below.

- Central public works department
- Central archetech department
- Military Engineering service
- National High ways department
- Central geological department
- Survey of India
- Railways
- State P.W.D.
- Nagar palkas
- Private building construction companies

Now Government of India passed an order in parliament those are all trained in particular group of trades such as D'man Civil, D'man Mechanic and Mechanic shop group of trades, they can join in 2nd year of diploma courses in the respective states.

Subject to be taught in the trade of surveyor for each semester

Ist Semester

- Occupational safety and health
- First Aid and introduction of PPF
- 5S concept
- Power failure, fire alarm
- Use of drawing instruments and equipment, their care and maintenance
- Layout of drawing sheets and following of different size of drawing sheets.
- Plane and solid geometrical figures
- Simple problems on projection of points, lines surfaces and solids.
- Drawing of sketches from modles (Plan, sections and elevation)
- Conventional signs and symbol of drawing
- Read and use of plain,diagonal,comparative,vernier and scale of chords.
- Chain surveying and preparation of site plan
- Observe the bearings of lines
- Traverse survey using compass, auto cad. commands used.
- Auto cad commands uses.

II SEMESTER

Plane table survey

- Orientation method
- Intersection method
- Resection method
- Traversing

Theodolite survey

- Horizodal angle measurement
- Vertical angle measurement
- Traverse

Levelling survey

- Types of levelling
- Types of instrument
- R.L. calaulation
- Tacheometry using theodolite
- Auto cad commands & uses.

III SEMESTER

- Introduction to contour
- Various methods of contour
- Cantour gradient
- Introduction to curves.
- Types of curves.
- Various method of setting and curves.
- Simple curve, compound curves.
- Modern survey instruments.
- Use of total station.
- Working procedure of total station
- Digital planimeter uses
- Perpare Topographical map.
- Preparation of a road project.
- Auto cad commands & survey soft ware uses.

IV SEMESTER

- Drawing simple conical projection
- Varions types of cartographic projection for mapping.
- Introduction to GPS
- Introduction to DGPS
- Plotting contour lines with Auto cad
- Finding out cross sectional area of river measure velocity of flow.
- Handling of eco sounder.
- Marking tentative alingnment
- Conduct reconnaissance/ preliminary survey.
- Various types of Building material, Type of Faundation
- Draw double storied residential building plan prepare detail estimate.

Drawing Instruments, Equipments and materials

Objectives: At the end of this lesson you shall be able to
- **state instruments, equipments and materials**
- **list out instrument, equipments and materials**
- **state the standard as per 962-1987**
- **to use different drawing instruments, equipments and materials**
- **follow Precautions in the use of instruments, equipments and materials.**

Introduction

Engineering Drawing is the language of engineers, the accuracy and neatness of the engineering Drawing depends on the quality of the instruments, equipments and material used. Hence, preference should be given to standard instruments and equipments and surveyor should be able to use different drawing instruments.

List of instruments

- Drawing board
- Tee-square or Mini Drafter
- Set-square
- Scale
- Protractor
- French curves
- Stencil
- Drawing instruments box

List of equipments

- Drafting machine
- Computer for Auto CAD. (Monitor UPS, CPU, key board, mouse, etc.)
- Plotter/Printer

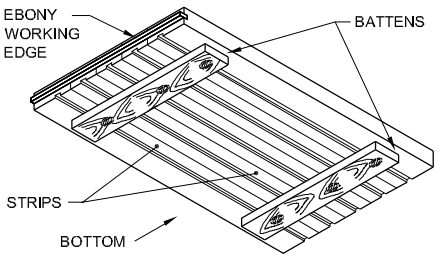
List of materials

- Drawing papers
- Drawing pencils
- Rubber/ Eraser
- Drawing papers fasteners (Drawing pins, Cello tape)
- Tracing paper or tracing film

Drawing board (Fig 1)

The standard size should be as per IS: 1444-1963/1977 of Bureau of Indian Standards.

Fig 1



DRAWING BOARD

SUN1207111

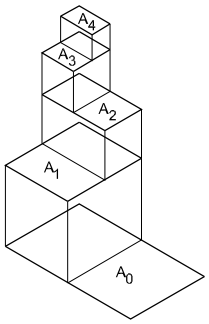
Sl. No.	Drawing Boards		Drawing sheets to be used with designation
	Designation	Sizes in mm (L x W x T)	
1	BO	1500 x 1000 x 25	AO
2	B1	1000 x 700 x 25	A1
3	B2	700 x 500 x 15	A2
4	B3	500 x 350 x 15	A3

The following precaution may be taken in handling the drawing boards:

- Always keep an extra sheet on the top surface of the drawing board.
- Do not keep anything on the top flat surface of the drawing board.
- Take sufficient care in up keeping the straightness of the ebony edge.

Drawing papers: (Fig 2)

Fig 2



HALVING AND DOUBLING

SUN1207112

The standard size as per Bureau of Indian standard (B.I.S)

Designation	Trimmed size (mm)	Untrimmed size (mm)
A0	841 x 1189	880 x 1230
A1	594 x 841	625 x 880
A2	420 x 594	450 x 625
A3	297 x 420	330 x 450
A4	210 x 297	240 x 330
A5	148 x 210	165 x 240

1 The size of the drawing sheets to be used depends on the size of the object to be drawn and the scale to be used.

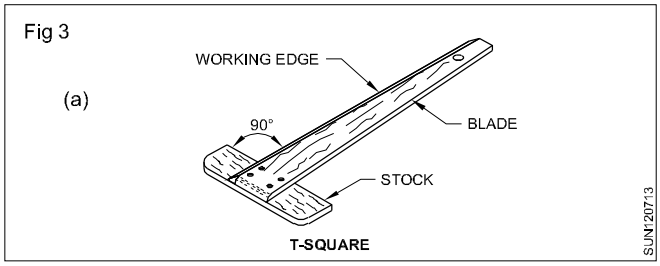
2 The length of the drawing sheet can be horizontal or vertical while drawing.

3 A2 size of drawing sheet is most convenient for drawing purposes in the class room.

4 The width to length ratio of drawing sheet is $1:\sqrt{2}$

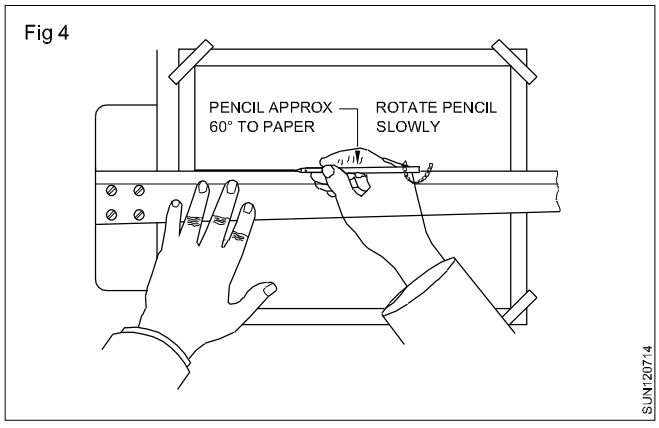
5 Area of A0 drawing sheet is 1.00 square metre.

T-square (Fig 3)



It consists of two parts, a long strip called blade and a short strip called head or stock. The blade is fitted with an ebony or plastic piece on its upper edge to form a working edge.

The following precautions may be taken in handling the T-square: (Fig 4)



1 When not in use, T-square should be left flat on the drawing board or suspended from the hole at the end of the blade.

2 Clean the blade with moist cloth to remove lead particles.

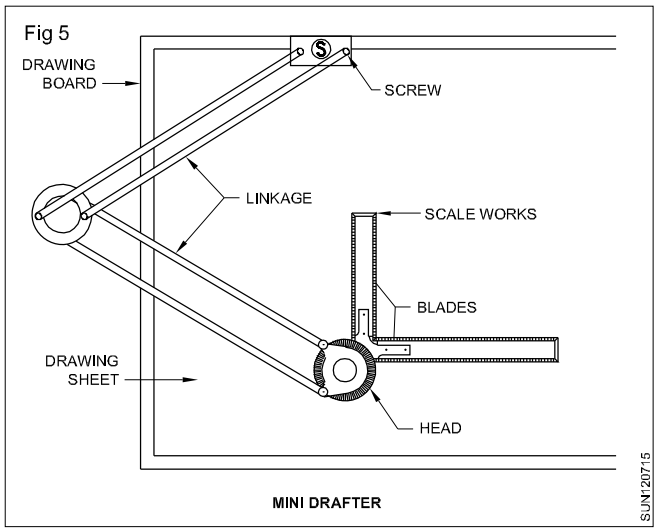
3 Do not use T-square as a hammer to drive in the drawing pins etc.

4 Do not use the ebony edge as a straight edge for cutting paper with knife.

5 Ensure that the screw heads are tight.

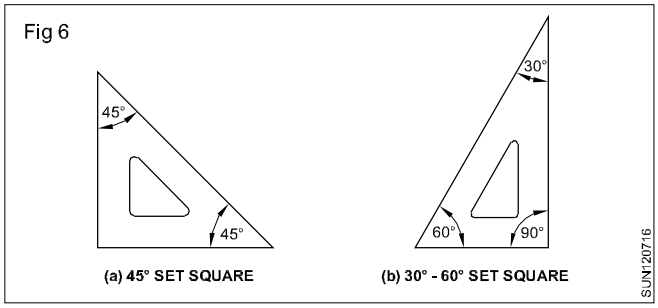
T-square is used to draw only horizontal lines. Do not use lower edge of the T-square to draw horizontal lines. While drawing horizontal lines, the pencil should be slightly inclined towards the right. Vertical and inclined lines are drawn with the help of set squares.

Mini drafter(Fig 5)



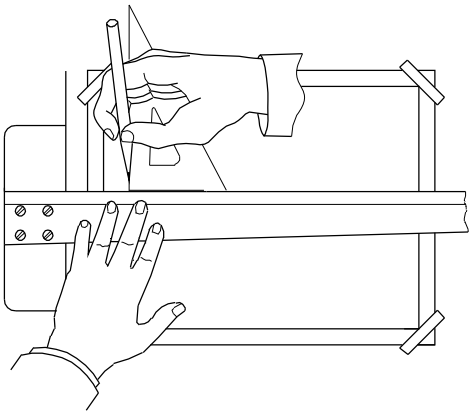
It is a simple and small shaped instrument of the drafting machine. Now-a-days these are mostly used by the engineering students. All the working functions of T-Square, Set-Square, Protractor, Scales and their merits are co-ordinated in a Mini-Drafter.

Set-square (Fig 6 and Fig 7)



It is made of transparent celluloid plastic in triangular shape They are available in two types, 30^0-60^0 and 45^0-45^0.

Fig 7



SUN1207I7

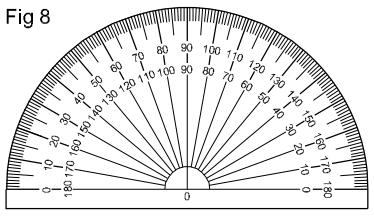
Engineer's scales (Table)

It is used to make full size, reduced size or enlarged size drawings conveniently, depending upon the size of the object and that of the drawing sheet. They are made of cardboard, plastic and as recommended by Bureau of Indian Standards, are available in set of eight scales. They are designated from M1 to M8.

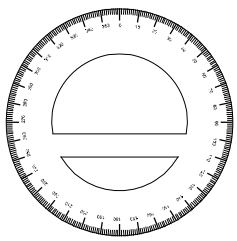
Table

Designation	Description	Scales
M1	Full size	1:1
	50 cm to a metre	1:2
M2	40 cm to a metre	1:2.5
	20 cm to a metre	1:5
M3	10 cm to a metre	1:10
	05 cm to a metre	1:20
M4	02 cm to a metre	1:50
	01 cm to a metre	1:100
M5	5 mm to a metre	1:200
	2 mm to a metre	1:500
M6	3.3 mm to a metre	1:300
	1.66 mm to a metre	1:600
M7	2.5 mm to a metre	1:400
	1.25 mm to a metre	1:800
M8	1 mm to a metre	1:1000
	1.5 mm to a metre	1:2000

Fig 8



SEMI-CIRCULARPROTRACTOR



CIRCULAR PROTRACTOR

SUN1207I8

Protractor: (Fig 8)

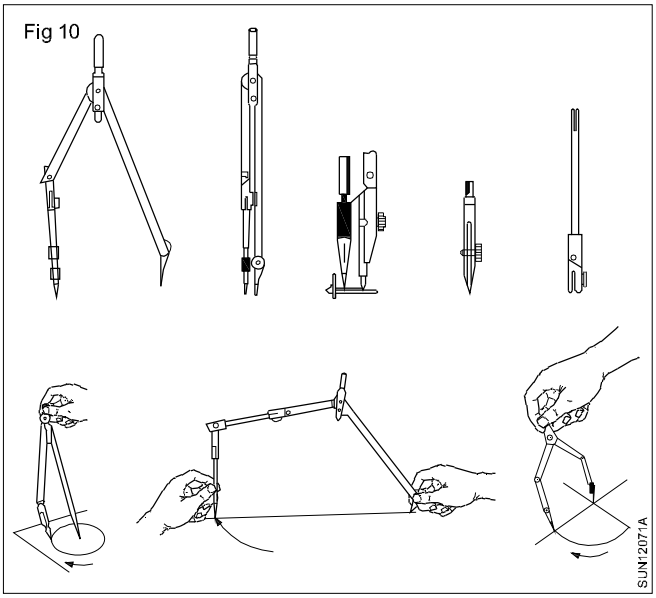
It is made of transparent celluloid plastic, available in semi circle or circle.

Compass (Fig 9)

It is used for drawing circles both in pencil and in ink. It consists of two legs hinged at one end. One leg is attached with a steel needle by means of a screw while the other leg is provided with a socket to accommodate interchangeable attachments.

Dividers (Fig 10)

Fig 10



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Dividers are similar to the compass and are made in square, flat and round forms. They are used for:

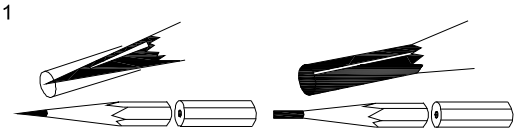
1 Dividing curved or straight lines into any number of equal parts.

2 Transferring dimensions from one part of the drawing to another part.

3 Setting dimensions form the scale to the drawings.

Drawing pencils (Fig 11)

Fig 11



SUN1207IB

These are in many grades. The grade HB denotes medium soft. The grade H denotes the degree of hardness in an increasing order. Similarly, grade B indicates the degree of softness in an increasing order.

The lead of the wood pencil may be sharpened in the following ways

1 Cylindrical

2 Conical

3 Wedge (Chisel edge)

4 Bevel

Fig 9 a

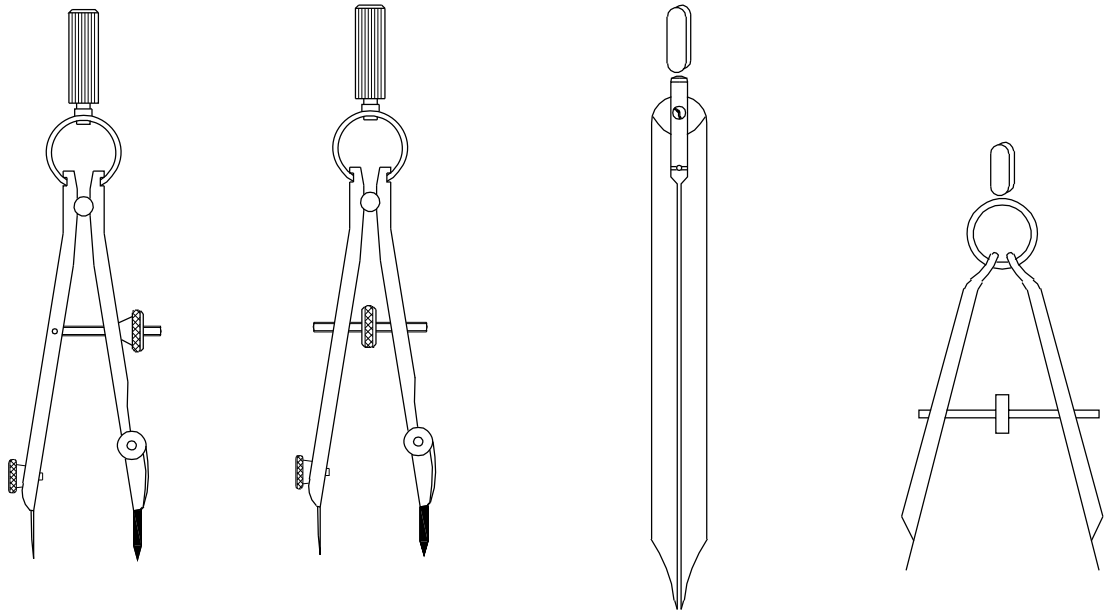
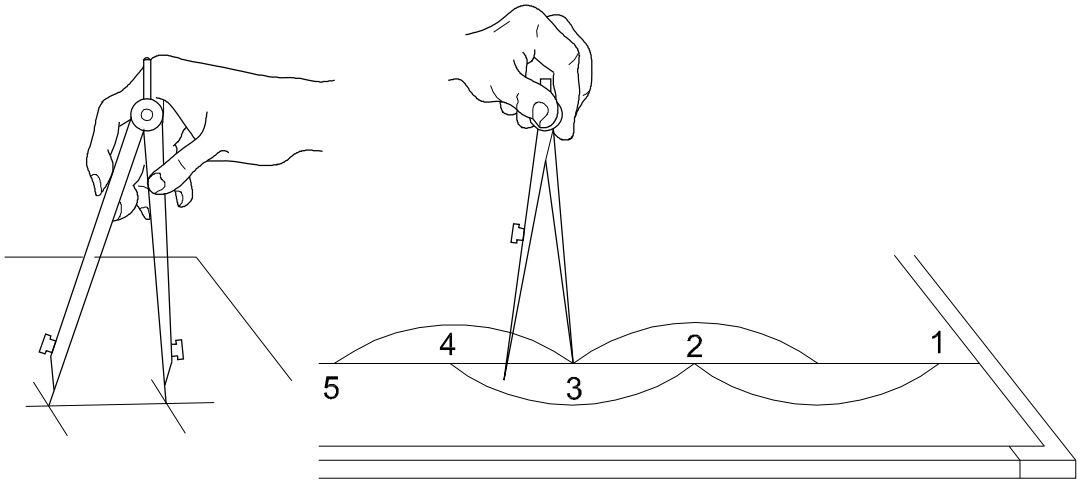


Fig 9 b



SUN120719

Mechanical clutch pencil is very common in use. This is very simple, easy to use, requires no sharpening time and even cheaper in long run. Hence, this type of pencil is preferred by professional surveyor. Students using these types of pencils will save a lot of time.

1 Only a sharp pencil can make quality drawing and hence, sharpen the pencil as and when it is necessary.

2 Sharpen the pencil only where there is no grade mark.

3 In a compass H pencil sharpened to bevel point, having its wedge shaped side slopping outside, is used.

4 As a general guide, use:

I HB pencil for sketching

II H for outlines, visible lines, finishing, dimensioning, lettering, arrows etc.

III 2H for construction lines, dimension lines, centre lines, section lines etc.

Eraser

Soft pencil erasers are ideal for erasing pencil marks. This eraser will not destroy the surface of the paper and hence drawing can be re-penciled.

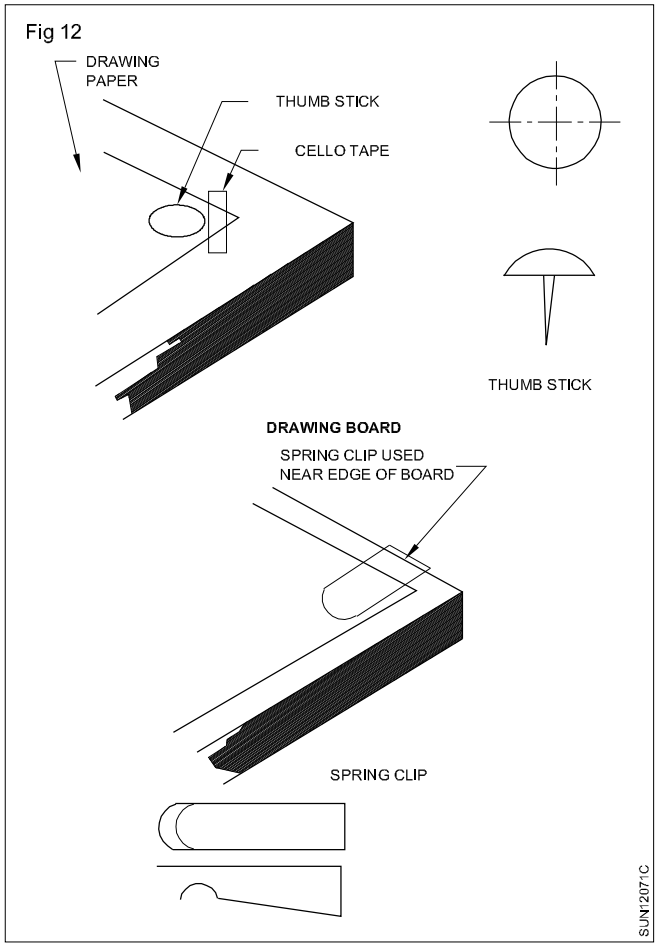
Fastener: (Fig 12)

Following materials are used to fix the drawing sheet on the drawing board.

- Thumb pins
- Cello tapes
- Fold back gap spring clips.

Template

Templates are available for drawing circles, arcs, ellipses, triangles, squares and other polygons. Also, symbols used by various engineering faculties, such as architectural, mechanical, electrical, chemical etc. are now available in the form of templates.

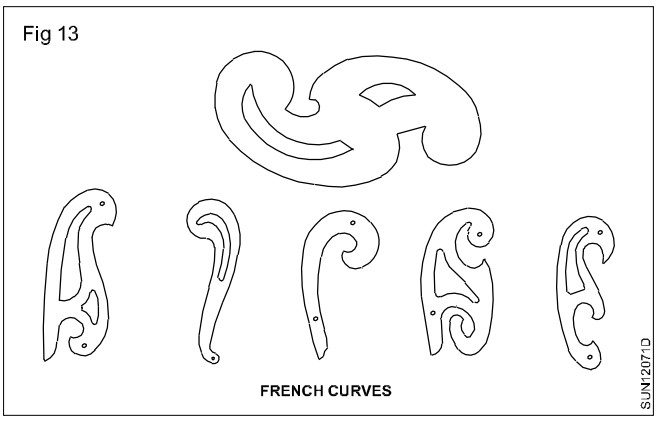


Stencils

Stencil is a thin flat piece of celluloid used to write letters and numerals. This helps the draftsmen to write neatly and uniformly and at a faster rate.

French curves (fig.13)

A French curve is a curved ruler used for drawing irregular curves that are neither circles nor circular arcs. It is made of wood, plastic or transparent celluloid. There are different forms and sizes of French curves.



Flexible curve

Flexible curve is made out of materials having flexibility. It is made of lead bar enclosed in rubber and can be bent into any shape to form a curve. It helps to draw smooth curve passing through any given points. Flexible curves of various sizes are now available in the market.

Selection

- HB- For free hand works
- H- For making drawing and lettering
- 2H- for drawing construction lines, dimensions lines, section lines and centre lines.
- 3H, 4H- For drawing minute details
- B- For shading

Precautions in the use of instruments:

Following precautions should be taken while doing the drawing works,

1 The lower edge opposite to the working edge of the Tee-Square should not be used for drawing horizontal lines.

2 T- Square should not be used as hammer to drive to drawing board pins.

3 Measuring scales should not be used as hammer to drive to drawing pins.

4 Drawing sheets should never be cut by blade or knife with the T-Square blade as the guide.

5 All the instruments and drawing sheet etc. Should be thoroughly dusted off and cleaned before starting the work.

6 No end of the pencil should be kept in mouth.

7 No oiling should be done to the joints of the instruments; otherwise, oil will give stains or spots on the drawing sheets.

8 Only required instruments should be kept on the drawing board. All extra instruments should be kept away in drawer.

9 Divider should not be used as pincer.

10 Soaking paper should not be used for drying the ink.

11 After completing the work all the instruments should be properly cleaned.

Conclusions

One should practice handling and using drawing instruments before attempting complex drawing problems. Developing correct drawing habits will enable to make continuous improvement in the quality of drawings. Each drawing will offer an opportunity for practice. Later on, good form in the use of instruments will become a natural habit.

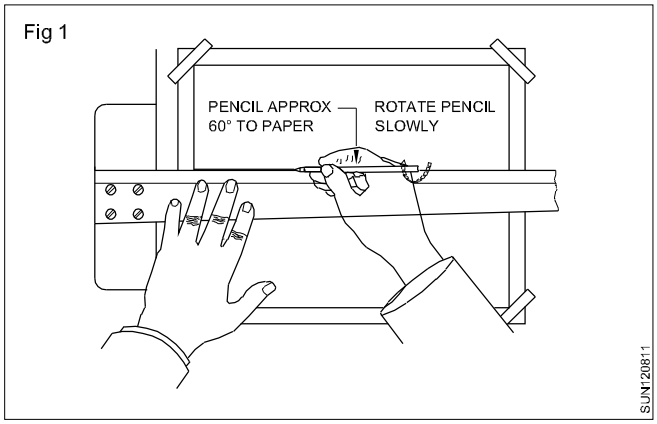
Fixing of drawing sheet on drawing board

Objectives: At the end of this lesson you shall be able to
- **Explain the method of fixing of drawing sheet in board**

Task 1. Fixing the drawing sheet on drawing board

- Place the drawing paper centrally on the drawing board.
- Butt the Tee square head with the working edge of the drawing board and align the top edge of the drawing sheet.
- Hold the drawing sheet by hand in the same position and fix the sheet in this position with drawing pin/ cellulose tape.(Fig 1)
- Set off the margin distance using scale.
- Draw four border lines as shown.
- mark and draw the title block.

Fig 1



Layout of drawing sheet and title block

Objectives: At the end of this lesson you shall be able to
- **state the system of Layout of drawing sheet**
- **list the different layout for designated drawing sheet**
- **explain the Title block.**

Lay out : Layout is standard arrangement of placing margin, title block etc for a particular size of drawing paper. It was explained earlier that the size of drawing sheets and standardised and designated as A0, A1, A2,A3,A4 &A5.Different layout styles for drawing papers from A0 to A5 sizes as per IS : 10711 - 1983. (Figs 1 &2)

Margin : Margin enable the prints to be trimmed After fixing the drawing paper over the drawing board,before commencing the drawing , the layout is to be drawn. The drawing should be drawn within the layout boundary. The layout lines are called borders. 'borders' are enclosed by the margins from edges of the trimmed size of sheet.

It is recommended that within the borders on the left side have minimum width 20mm for the sheet sizes A0, A1 and 10mm for the sheet sizes A2, A3,A4& A5 for the space for filing. (Refer Figs 1& 2)

Fig 1

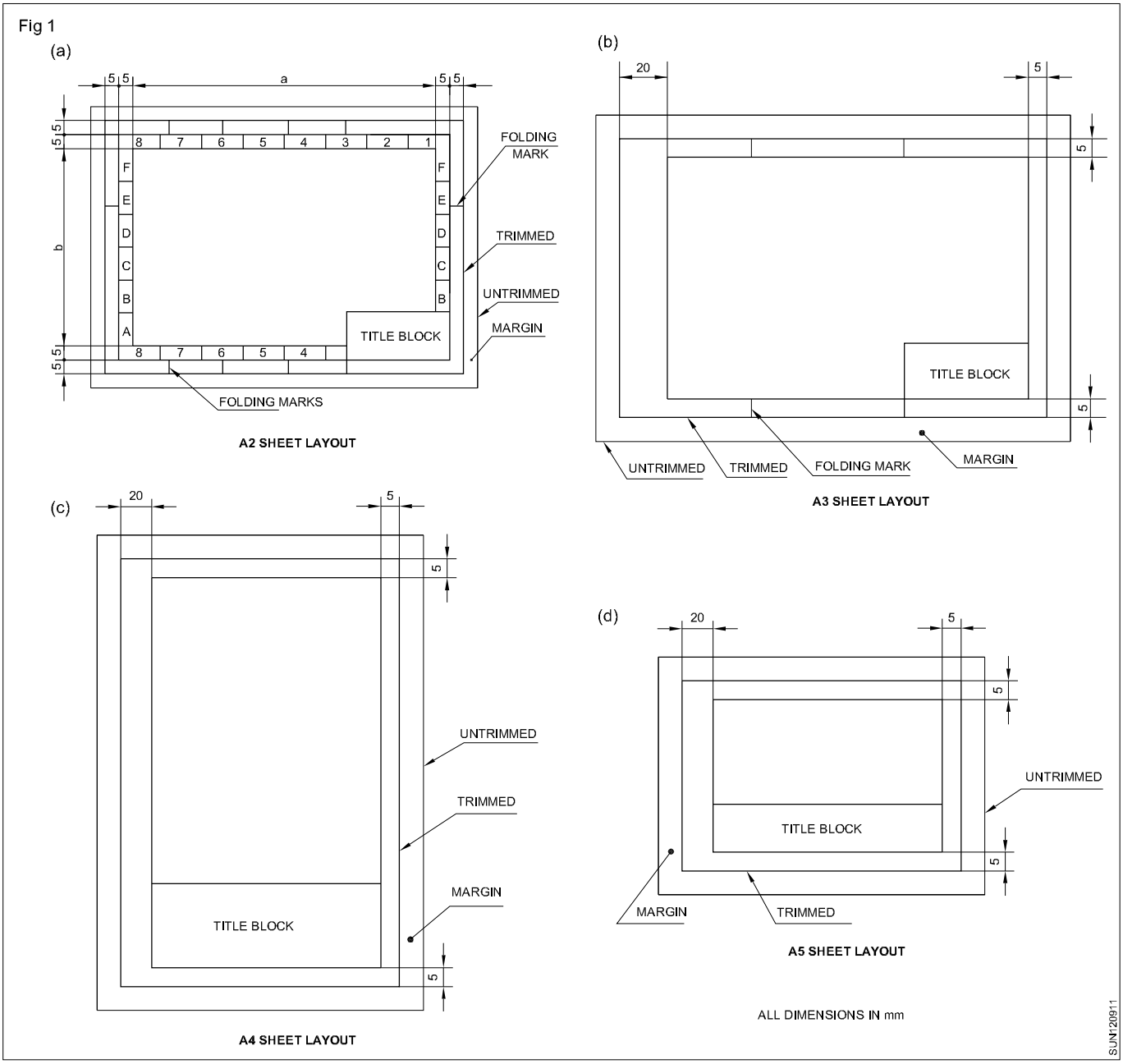
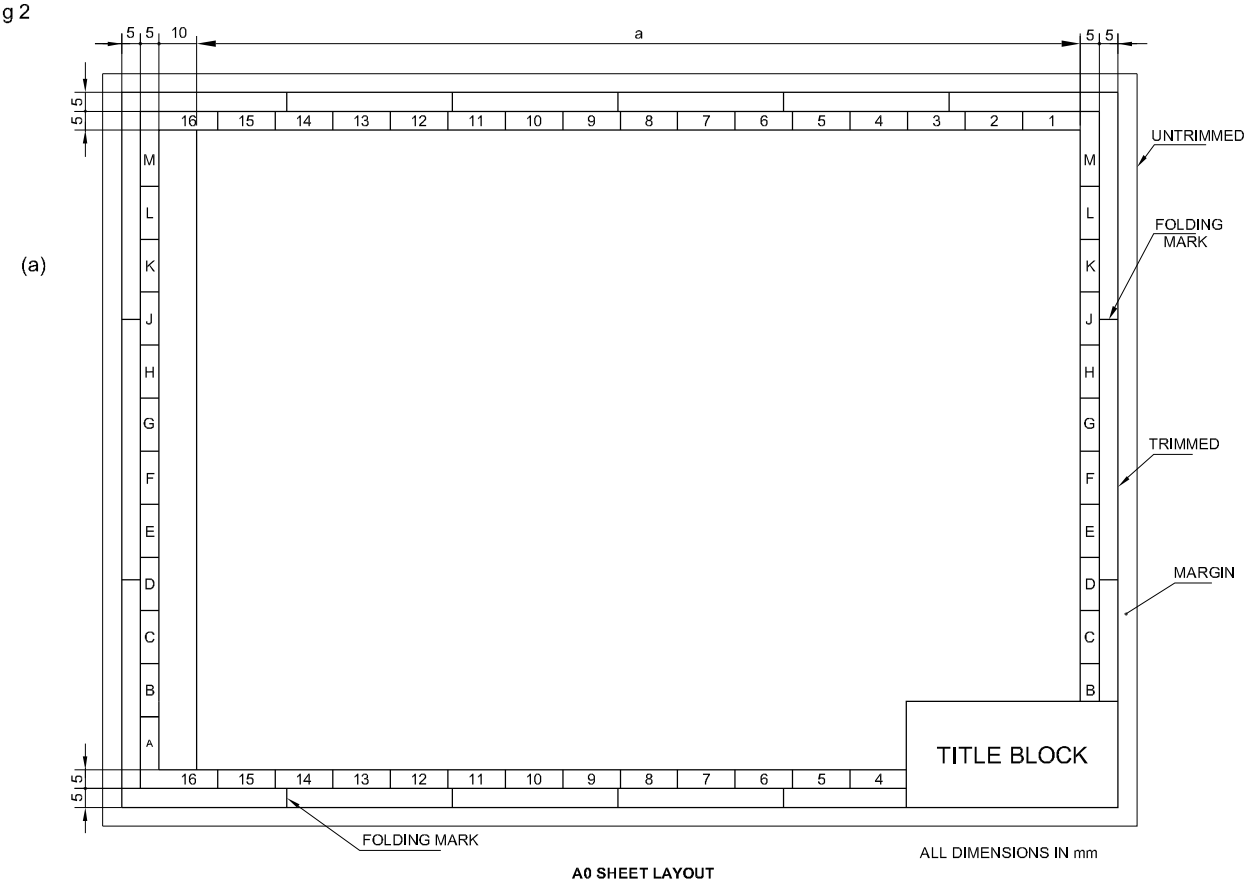
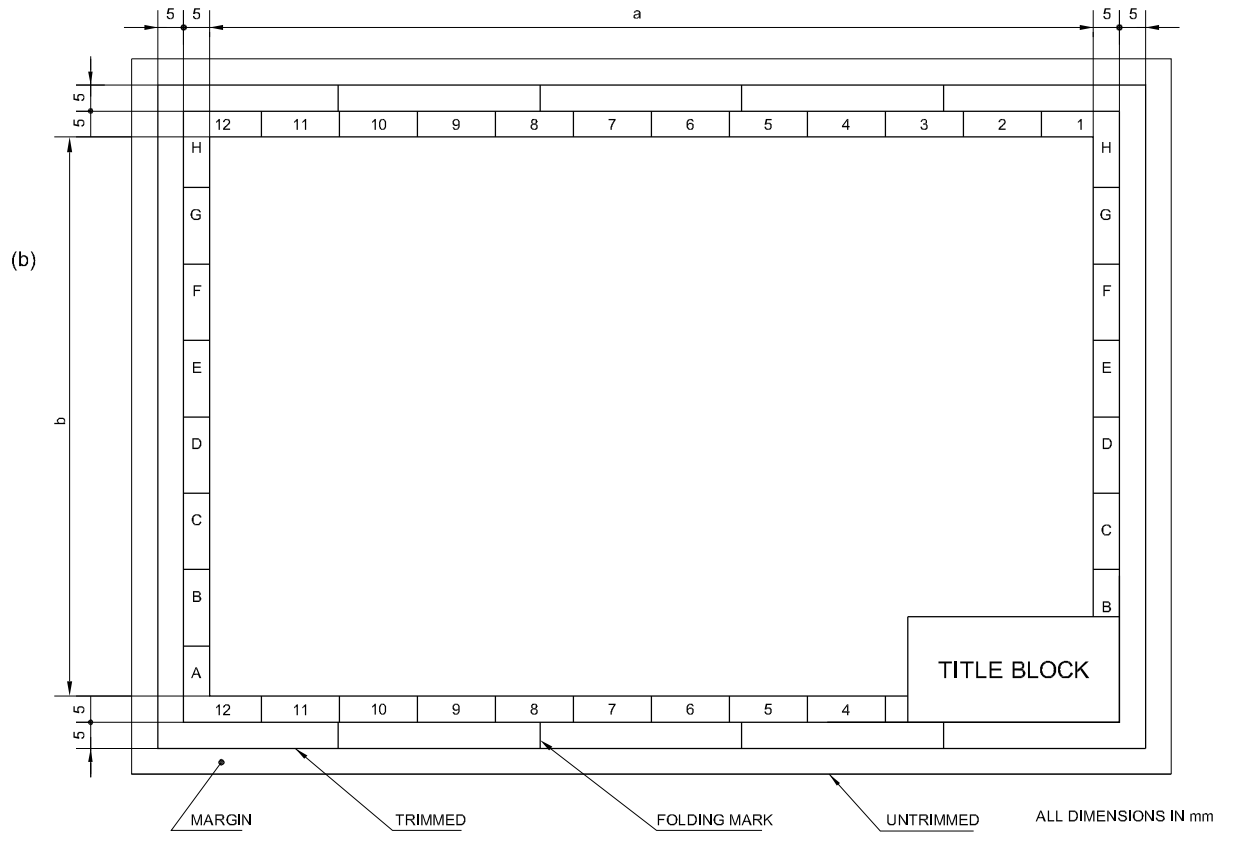


Fig 2



A0 SHEET LAYOUT

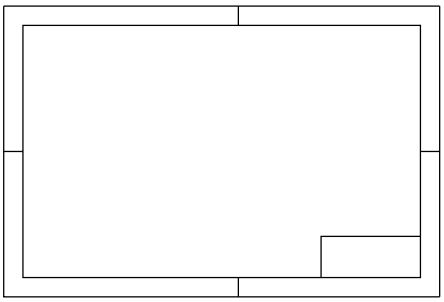


A1 SHEET LAYOUT

the sheet be taken horizontal or vertical depending upon the nature of the drawing as sheet type 'X' and sheet type 'Y'. (Fig 3 & 4)

Frame : The frame limitting the drawing space should be executed with continouus thin line of 0.5mm.

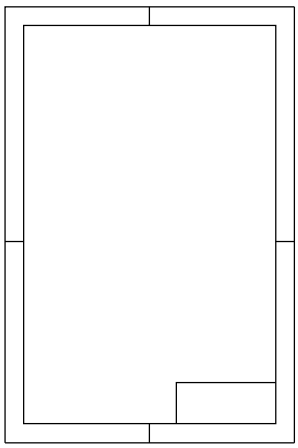
Fig 3



HORIZONTAL SHEET TYPE X

SUN1209I3

Fig 4



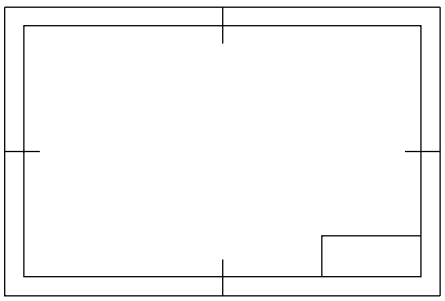
VERTICAL SHEET TYPE Y

SUN1209I4

Title block (Fig 5)**:** This is the block in which the particulars of the organisation. Name of the drawign and other particulars are printed. It is situated in the bottom right hand corner of the drawing sheet. Figs 1 & 2 shows the position of the title block. Contents of the title block and their relative position vary to suit individual concern.

Centering marks (Fig 6)**:** When the drawings on the drawing sheet are to be microfilmed (preserving by taking negatives) centering marks to be provided.

Fig 6



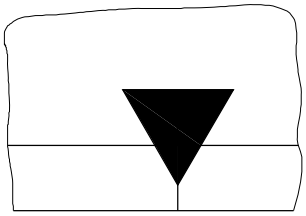
CENTRING MARKS

SUN1209I6

These marks shall be placed at the ends of the two axis of symmetry of trimmed sheet. It is executed with 0.5 mm minimum thick stroke, starting from the edges of the trimmed sheet. It shall extend approximately 5 mm beyond drawing frame.

Orientation marks (Fig 7)**:** Orientation marks are used in order to indicate the orientation of the drawing (arrow head) sheet on the drawing board. These marks consist of arrow heads and should be placed across the frame one at shorter side and one at longer side coinciding with the centering marks. One of the orientation marks always points towards the draughtsman.

Fig 7

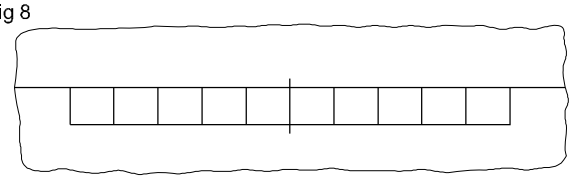


ORIENTATION MARKS

SUN1209I7

Metric reference graduation (Fig 8)**:** It is shown only on drawings without (metric) dimensions. It shall have minimum 100 mm long divided into 10 equal intervals max. width 5 mm. It should be executed with thin continuous line (0.5 mm) disposed symmetrically about a centering mark.

Fig 8

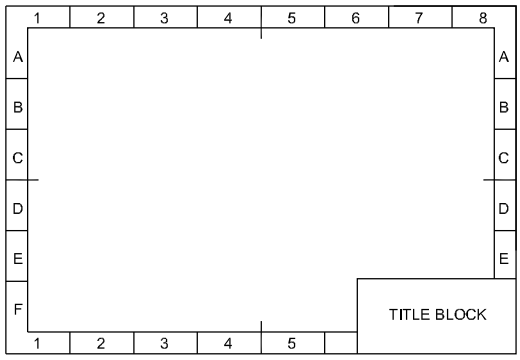


METRIC REFERENCE GRADUATION

SUN1209I8

Grid reference (Fig 9)**:** In order to facilitate easy location of features on large drawings (assembly) grid reference system is recommended. It is similar to lines of latitude and longitude on a map. The number of divisions shall be divisible by two. The length of any side of the rectangle of the grid shall not be less than 25 mm and not more than 75 mm along the frame. These are the special requirements for production of assembly drawings.

Fig 9

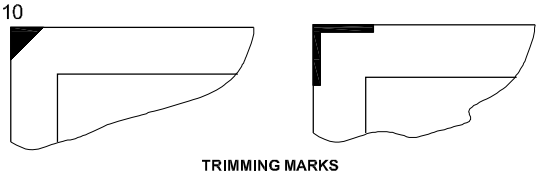


GRID REFERENCE SYSTEM

SUN1209I9

Trimming marks (Fig 10)**:** These marks are required for the sheets which require trimming. Example printed copies of drawings. In such cases the trimming marks are drawn on the drawing tracing sheet.

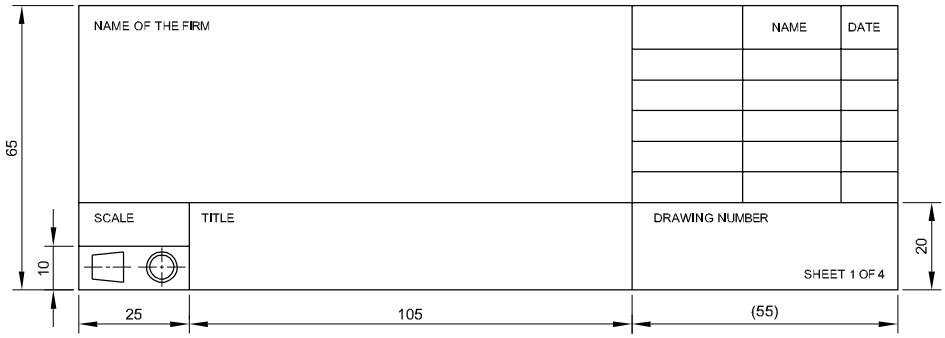
Fig 10

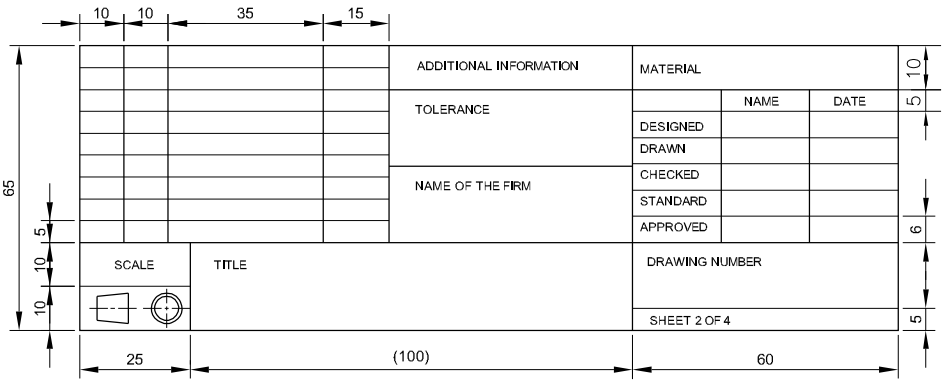


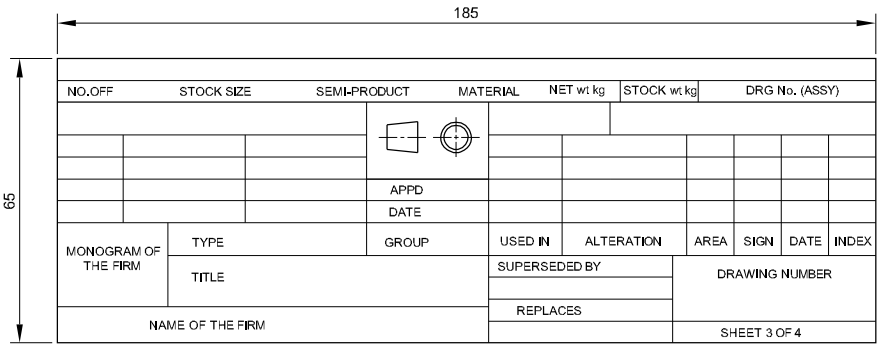
TRIMMING MARKS

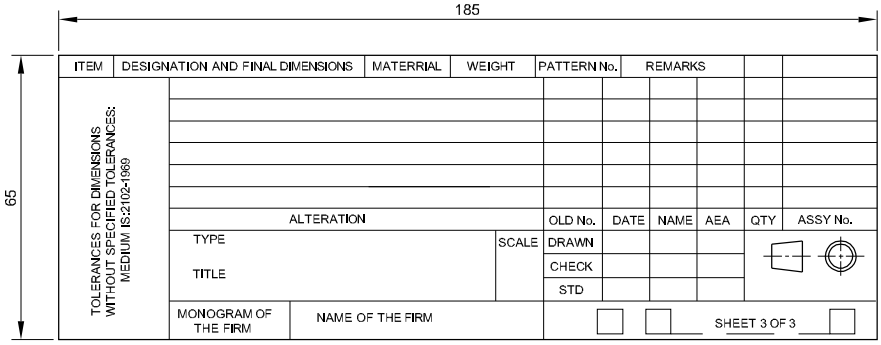
SUN1209IA

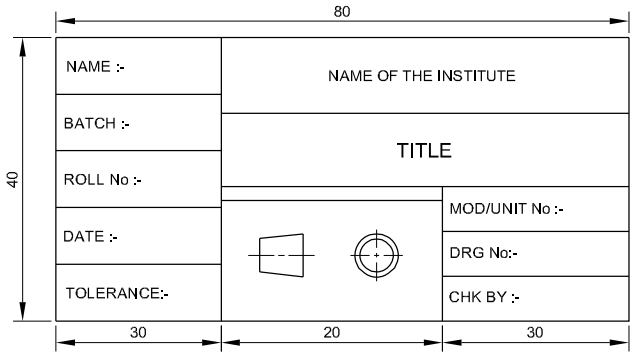
Fig 5











TITLE BLOCK TYPICAL LAYOUTS

SUN1209/5

Folding of sheets

Objectives: At the end of this lesson you shall be able to
- **explain the method of folding in different size of drawing sheets.**

The purpose of folding the drawing sheet for storing to the correspondence files. For binding in special reports is illustrated in the file.

All the maps and plans are folded to final size for convenience of record in office files.

Method of fold the different sizes of drawing sheets.

Lower portion of the left-hand margin of the sheet may be cut after retaining 297mm long top portion in order to provide for filing the drawing in the files.

Plans may be opened out easily by holding firmly the top left-hand corner and pulling the bottom right-hand corner.

The following procedure shall be adopted inorder

a) Always fold vertically first.

b) Fold horizontally next.

c) Folded drawing to be of A4 size.

d) Title block to be on the topmost fold for easy reference.

A0-size

Fold the A0-size sheet.

Folding vertically, from left side to right side.

1st fold 210mm

2nd & 3rd - fold each 109.5mm

Other 4th to 6th folding are 190mm each.

Fold horizontally 7th folding from the top to bottom 247mm.

8th folding is from the 7th folding point 297mm.

Title block will always come top of the right side corner.

9th folding is top left side rectangular portion folded diagonally. (Fig 1)

After completion of folded the drawing sheet. (Fig 2)

Fold the A1 Size sheet: (594 x 841)

Folding vertically, from left side to right side.

1st fold 210mm

2nd & 3rd - fold each 125.5mm

Other 4th 190mm

Folding horizontally from top

Fig 1

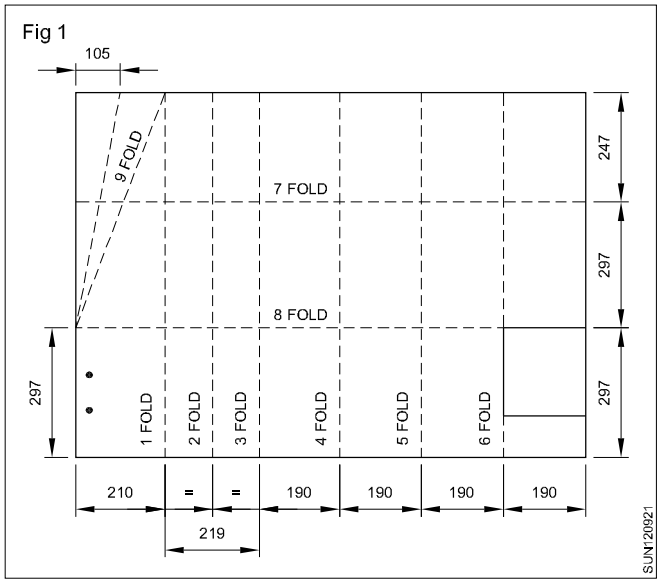
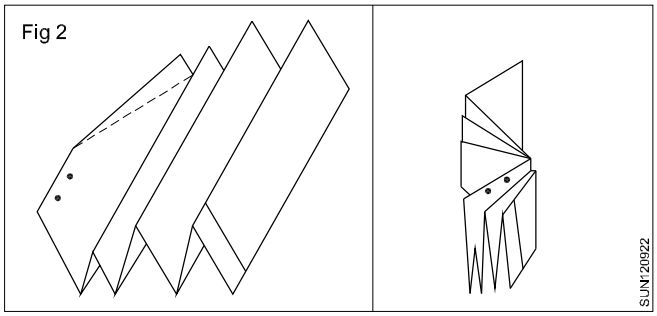
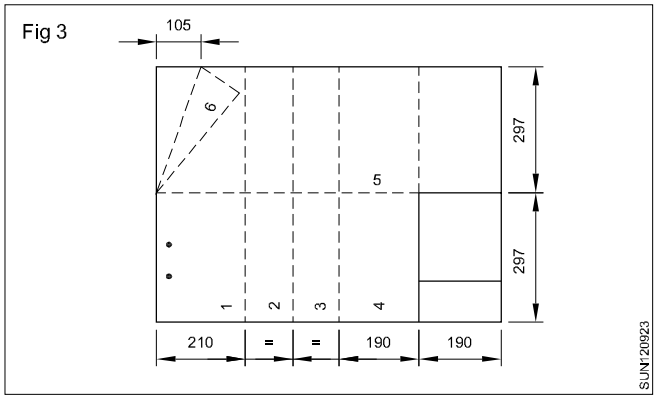


Fig 2



5th folding 297mm.(Fig 3)

Fig 3



6th folding is top left side rectangular portion folded diagonally as shown in figure.

After completion of folded the drawing sheet. (Fig 4)

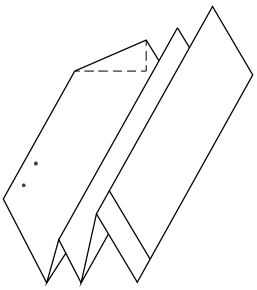
Fold the A2 Size sheet: (420 x 594)

Folding vertical, from left side to right side.

1st folding 210mm.

2nd folding 190mm from the right side.

Fig 4



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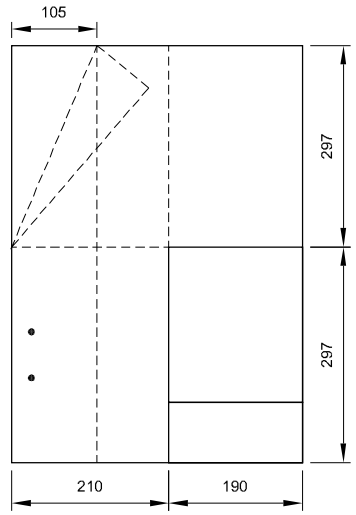
Folding horizontally from bottom

3rd folding 297mm. (Fig 5)

Fig 5



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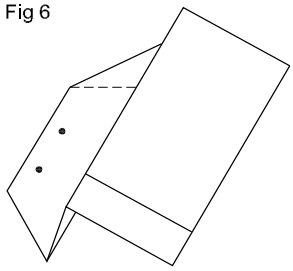
4th folding is top left side rectangular portion folded diagonally as shown in figure.

After completion of folded the drawing sheet. (Fig. 6)

Fig 6



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Fold the A2 Size sheet: (594 x 420)

Folding vertically from left side to right side.

1st folding 210mm

2nd flolding 192mm from the right side of the drawing sheet.

Folding horizontally from the bottom, 3rd folding 297mm.

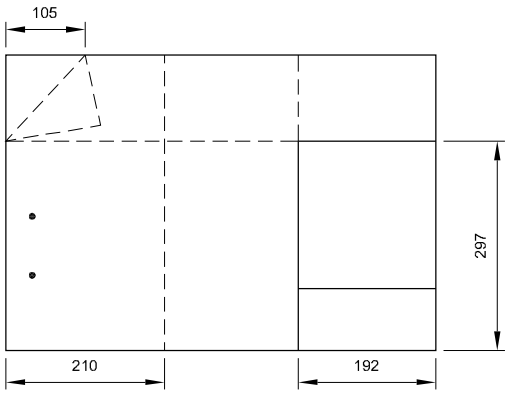
4th folding is top left side rectangular portion folded diagonally as shown in (Fig. 7)

After completion of folded the drawing sheet. (Fig. 8)

Fold the A3 size sheet: (297 x 420)

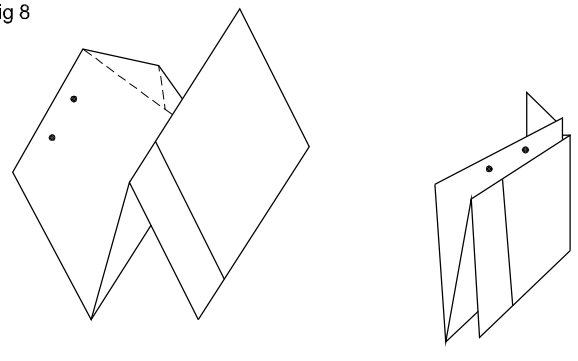
Folding vertically from left side.

Fig 7



SUN120927

Fig 8



SUN120928

1st folding 210mm.

2nd folding 190mm from the right side of the drawing sheet. (Fig. 9 & 10)

The method of folding the drawing sheet, the title block should appear at the right bottom of the folded sheet finally.

Fig 9

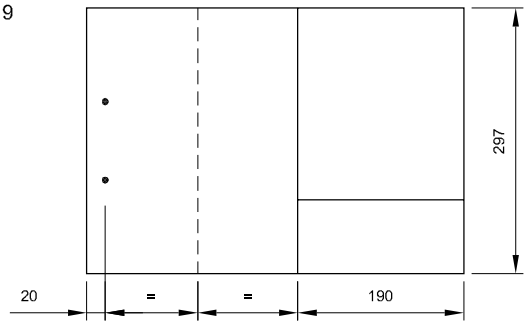


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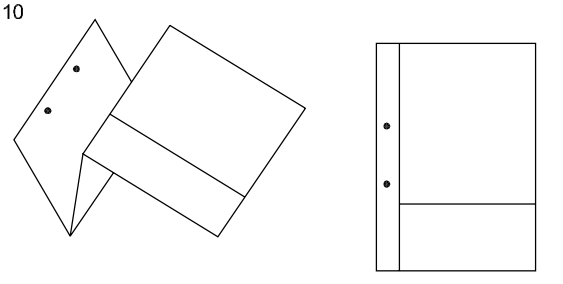
Fig 10



SUN12092A

Lettering styles

Objectives: At the end of this lesson you shall be able to
- **recognise different lettering styles**
- **designate the letters and numerals as per IS norms**
- **state standard proportion for height, width and spacing of letters.**

Apart from graphical elements (lines, arcs, circles etc) technical drawings will also contain written informations.

These written informations are referred as “lettering”.

Styles of lettering: Many styles of lettering are in use to day. However, a few styles which are commonly used are shown in Fig 1.

Fig 1

Standard heights/Width: The standard heights recommended by BIS (IS:9609-1983) are in the progressive ratio of “square root 2”. They are namely 2.5 - 3.5 - 5 - 7 - 10 - 14 and 20 mm. The height of lower case letter (without tail or stem) are 2.5, 3.5, 5, 7, 7, 10 and 14 mm.

There are two standard ratios for the line thickness “d”. They are A & B. In A = line thickness (d) is h/14 and in B = line thickness (d) is h/10.

The width of different letters in terms of “d” is as follows:

Lettering A

Width (W)	Capital letters	Width
1	I	1d
5	J,L	5d
6	C,E,F	6d
7	B,D,G,H,K,N,O,P,R,S,T,U & Z	7d
8	A,Q,V,X,Y	8d
9	M	9d
12	W	12d

Lower case letters and numerals

Width (W)	Letters/Numerals	Width
1	i	1d
3	j,l	3d
4	f,t,l	4d
5	c,r	5d
6	a,b,d,e,g,h,k,n,o,p,q,s,u,v;3;5	6d
7	a,0 (zero), 2,4,6,7,0,8,9	7d
9	m	9d
10	w	10d

The width of different letters in terms of stroke (line) is as follows:

Lettering B. IS:9609

Width (W)	Capital letters
1	I
4	J
5	C,E,F,L
6	B,D,G,H,K,N,O,P,R,S,T,U & Z
7	A,M,Q,V,X,Y
9	W

Lower case letters and numerals

Width (W)	Letters/Numerals
1	i
2	l
3	j:l
4	c,f,r,t
5	a,b,d,e,g,h,k,n,o,,q,s,u,v,x,y,x
	0,2,3,5 to 9
	0,2,3,5 to 9
6	a,4

Fig 2 & 3 shows the sequence of printing single stroke capitals and lower capital letters in vertical style.

Fig 2

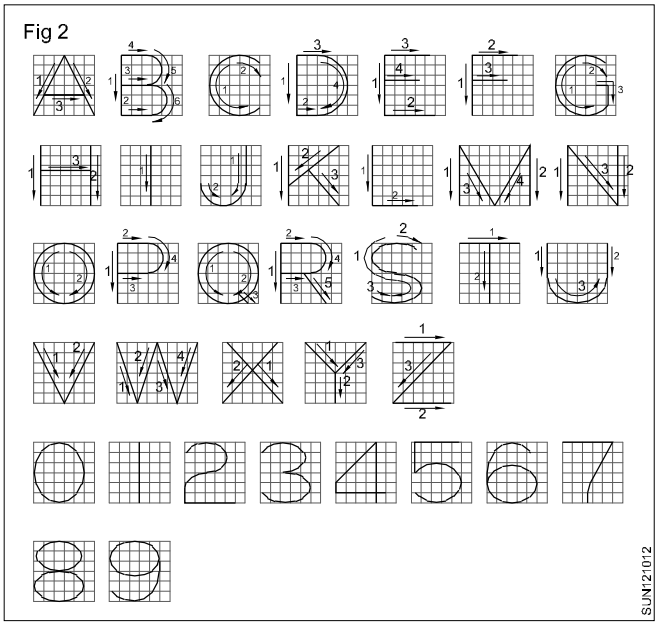
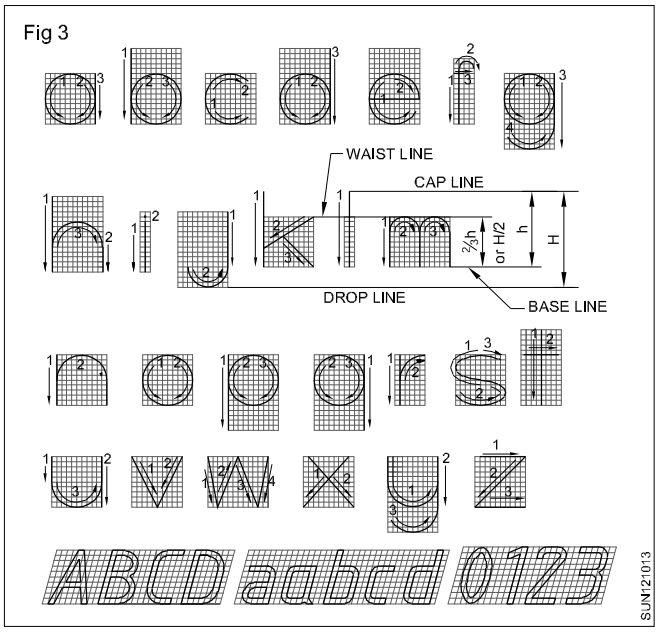


Fig 3



Inclined letters (Fig 3) are drawn at an angle of 15° towards right side, the proportion being the same as of vertical lettering.

Fig 3 shows single stroke/lower case letters also.

Standard letters to suit the nature of instructions, the sizes should be selected. All the lettering should be printed, so that they are read/viewed from the bottom of the drawing.

Lettering makes or mars the appearance and legibility of the drawing. Always maintain uniform lettering (letters and numerals) which can be reproduced within reasonable time with ease. In machine drawing ornamental lettering should never be used.

Spacing of letters: Recommended spacing between character, minimum spacing of base lines and minimum spacing between words as per Indian Standards (IS:9609-1983) is given below in figure No.4 and Table 1 & 2.

Fig 4

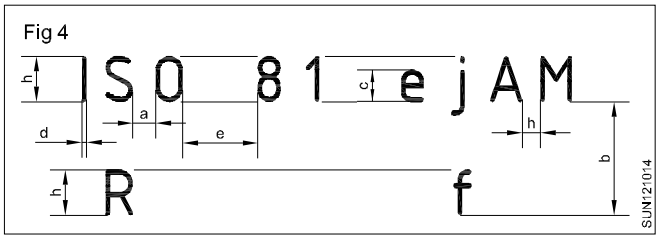


TABLE 1

Lettering A (d = h/14) Characteristic		Ratio	Values in millimetres Dimensions						
Lettering height Height of capitals	h	(14/14)h	2.5	3.5	5	7	10	14	20
Height of lower-case letters (without stem or tail)	c	(10/14)h	-	2.5	3.5	5	7	10	14
Spacing between characters	a	(2/14)h	0.36	0.5	0.7	1	1.4	2	2.8
Minimum spacing of base lines	b	(20/14)h	3.5	5	7	10	14	20	28
Minimum spacing between words	c	(6/14)h	1.06	1.5	2.1	3	4.2	6	8.4
Thickness of	d	(1/14)h	0.18	0.25	0.35	0.5	0.7	1	1.4

The spacing a between two characters may be reduced by half if this gives a better visual effect, as for example LA, TV; it then equals the line thickness d.

TABLE 2

Lettering B (d = h/10) Characteristic		Ratio	Values in millimetres Dimensions						
Lettering height Height of capitals	h	(10/10)h	2.5	3.5	5	7	10	14	20
Height of lower-case letters (Without stem or tail)	c	(7/10)h	-	2.5	3.5	5	7	10	14
Spacing between characters	a	(2/10)h	0.5	0.7	1	1.4	2	2.8	4
Minimum spacing of base lines	b	(14/10)h	3.5	5	7	10	14	20	28
Minimum spacing between words	c	(6/10)h	1.5	2.1	3	4.2	6	8.4	12
Thickness of lines	d	(1/10)h	0.25	0.35	0.5	0.7	1	1.4	2

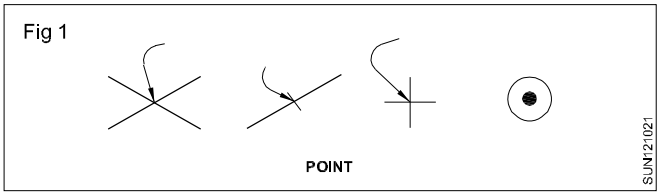
The spacing between two characters may be reduced by half if this gives a better visual effect, as for example LA, TV: it then equals the line thickness d.

Types of Lines

Objectives: At the end of this lesson you shall be able to
- **define points and lines**
- **state the classification of lines**
- **state the different types of angles**
- **explain the method of measuring angles.**

A point represents a location in space, having no width or height. It is represented by drawing intersection of lines or a dot. (Fig 1)

Fig 1



Line is the path of a point when it moves. It has no thickness and are of two types:

– Straight line

– Curved line

Straight line : It is the path of a point when it is moving in a particular direction. It has only length and no width. (Fig 2) Also a straight line is the shortest distance between two points. Straight line, depending on its orienation are classified as Horizontal, vertical and Inclined or Oblique line.

Horizontal line (Fig 2) : Horizontal lines are those which are parallel to a horizontal plane. Example of horizontal plane is the surface of a still water. (Fig 3)

Vertiacl line (Fig 4a) : Lines which are perpendicular to

Fig 2

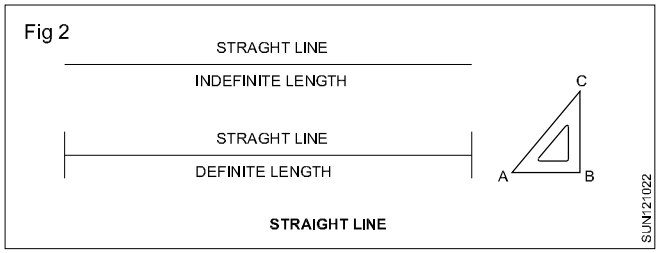
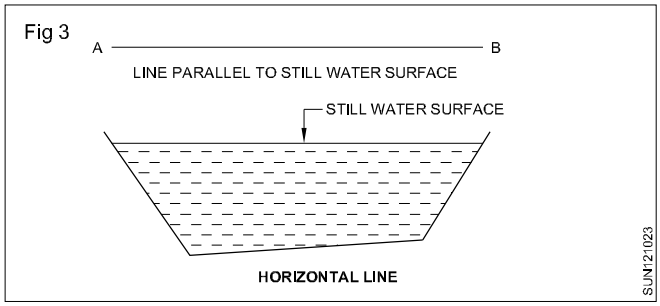


Fig 3



horizontal lines are called vertical lines. It can be treated as a line along the plumb line of the plumb bob or parallel to a plumb line. (Fig 4b)

Inclined line or Oblique line : A straight line which is neither horizontal nor vertical is called an inclined line. (Fig 5)

Fig 4

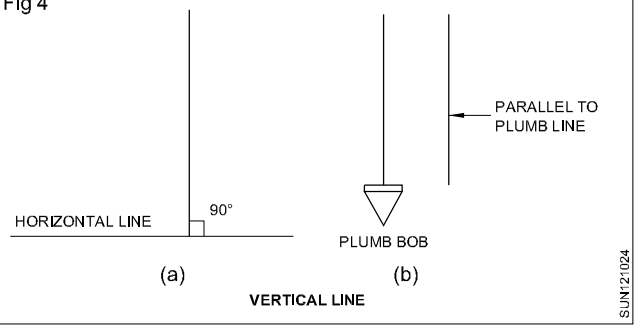
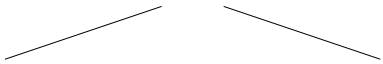


Fig 5

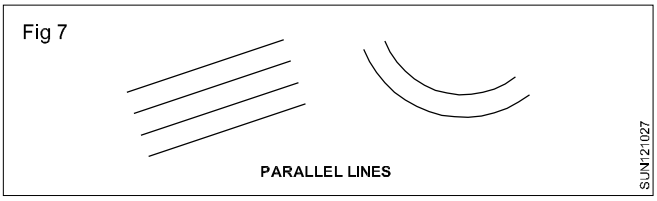


Curved line : It is the path of a point which always changes its direction. Examples of curved lines are shown in(Fig 6)

Fig 6

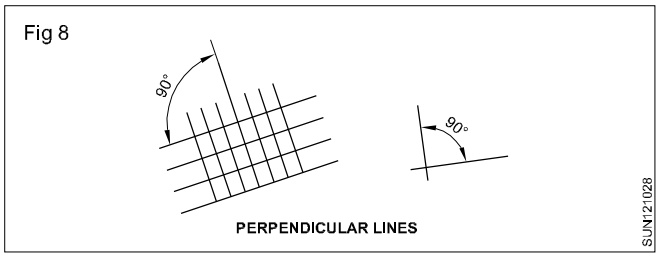
Parallel lines : They are the lines with same distance between them . They may be straight lines or curved lines. Parallel lines do not meet when extended. (Fig 7)

Fig 7



Perpendicular lines : When two lines meet at 90°, the two lines are said to be perpendicular to each other. One of this line is called as reference line. (Fig 8)

Fig 8



Method of Dimensioning

Objectives: At the end of this lesson you shall be able to
- **explain the types of dimensioning**
- **explain the elements of dimensions**
- **explain the methods of indicating dimensions**
- **explain the arrangement of dimensioning**

Importance of dimensioning: Any Component or product manufactured should be confirm to its specification. In fact, without specification of product, there cannot be production. In engineering industry, all manufacturing is controlled by the technical specification of product or components.

Technical specification provides complete information on the shape, size, tolerance, finish, material and other technical aspects such as heat treatment, surface coating and other relevant information required to manufacture a component. In most cases technical specifications of components is given in the form of a technical drawing while shape is described by various types of views i.e Orthographic, pictorial and perspective projection and size is given by dimensions.

Definitions related to dimensioning

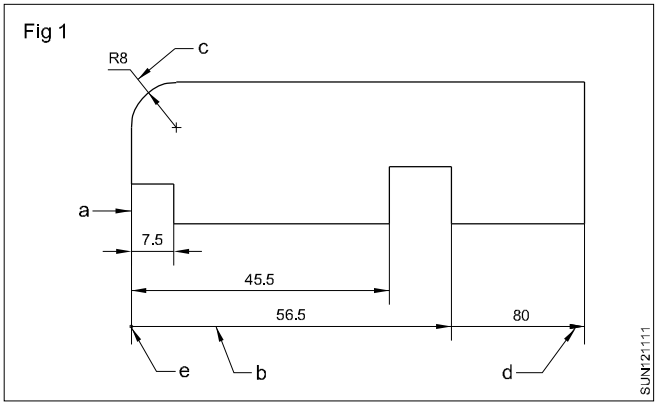
Dimension: It is a numerical value expressed appropriate unit of measurement and indicated graphically on technical drawings with lines, symbols and notes.

Elements of dimensioning

– Extension line - a
– Dimension line - b
– Leader line - c
– Termination of dimension line
– The original (starting point) indication and the dimension (a).

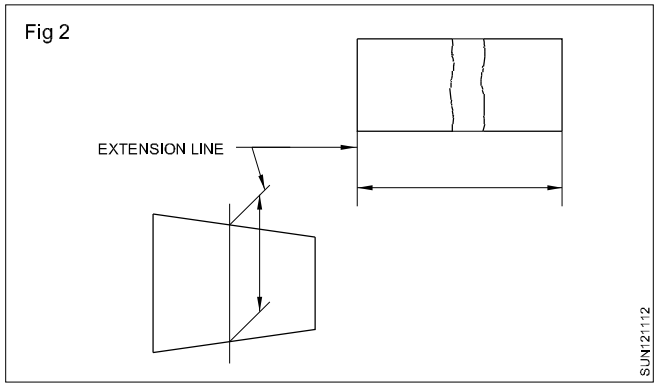
Extension line: It is a thin line projecting from the feature and extending beyond the dimension line. (Fig 1)

Fig 1



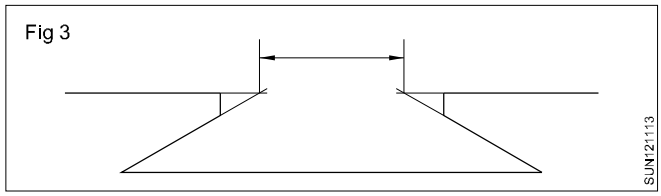
It is normally perpendicular to the feature being dimensioned, but may be drawn obliquely as shown for dimensioning tapers, parallel to each other. (Fig 2)

Fig 2



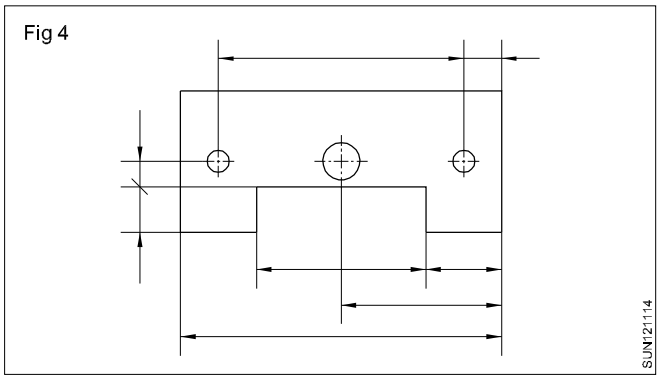
When construction line are required to be shown for practical purposes of the intersecting projection lines extend beyond their point of intersection. (Fig 3)

Fig 3



Extension lines (Projection lines) should not cross the dimension lines, but where not possible the lines should not break. (Fig 4)

Fig 4



Dimension line: These are thin continuous lines, terminated at ends by arrow heads, dots or oblique lines touching the extension line. (Fig 5)

Dimension line may cut or cross another dimension line where there is no other way.

Dimension to the hidden lines be avoided. (Fig 6)

Arrow heads may be placed outside where space is insufficient.

Fig 5

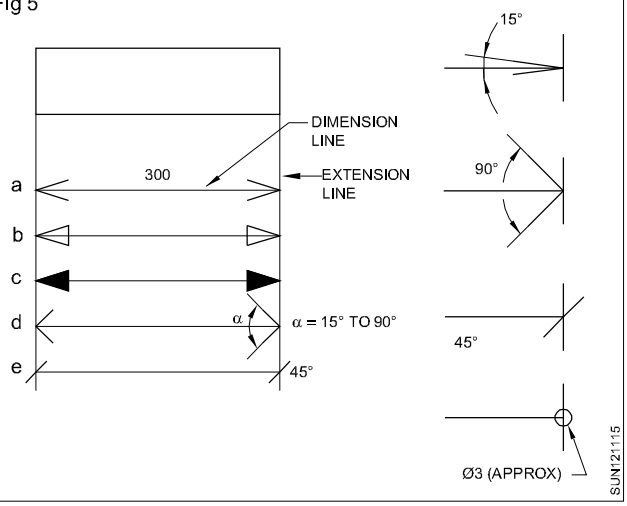
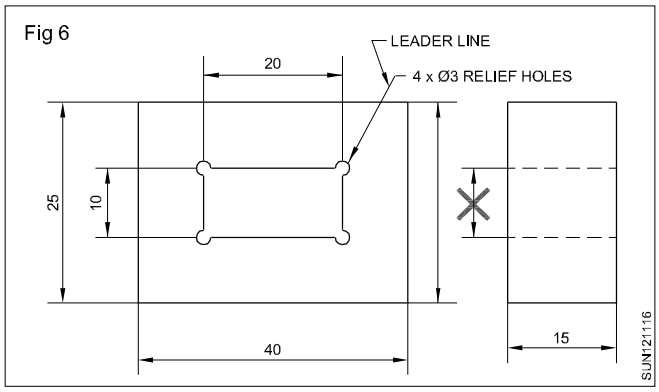


Fig 6



Leader line: It is a thin continuous line. It connects a note or dimension with the features to which it applies. (Fig 6)

Termination and Origin indication: The size of the terminations (arrow heads/oblique strokes) shall be proportional to the size of the drawing. Only one style of arrow head shall be used on a single drawing. However, where the space is too small for the arrow heads, it may be substituted by a dot or by an oblique line. Arrow heads are drawn as short lines forming barbs at any convenient included angle between 15° and 90°. They may be open, closed or closed and filled in. Oblique strokes drawn as short line inclined at 45°. (Fig 5)

Indicating dimensional values on drawings: All dimensional values shall be shown on drawings in characters of sufficient size to ensure complete legibility on the original drawings as well as on reproductions made from micro-filming.

They shall be placed in such a way that they are not crossed or separated by any other line on the drawing.

Methods of indicating values: There are two methods used for indicating the values. Only one method should be used on any one drawing.

Method 1

Dimensional values shall be placed parallel to their dimension lines and preferably near the middle, above and clear of the dimension line. However, values shall be indicated so that they can be read from bottom or from the right-hand side of the drawing. Dimension lines are not broken. Dimensioning of angles also given in the same way. (Figs. 7 & 8) This method is known as **aligned system** of dimensioning.

Fig 7

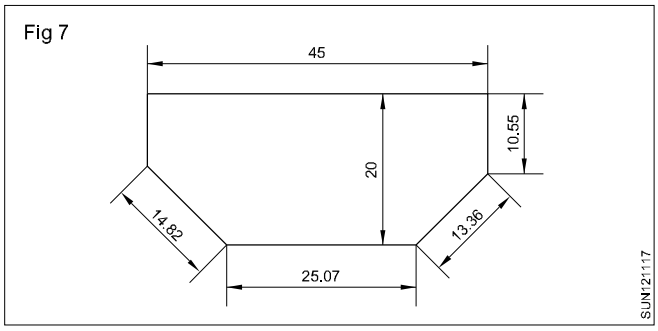
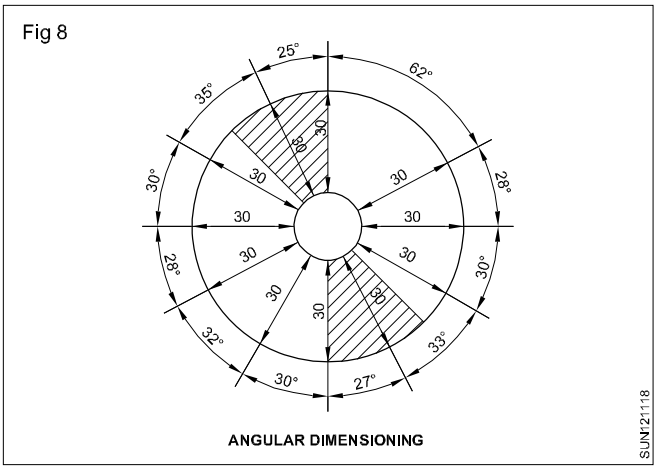


Fig 8



Method 2

Dimensional values shall be indicated so that they can be read from the bottom of the drawing sheet. Non-horizontal dimension lines are interrupted, preferably near the middle so that the value can be inserted. (Fig 9 & 10). This method is termed as **unidirectional system** of dimensioning.

Fig 9

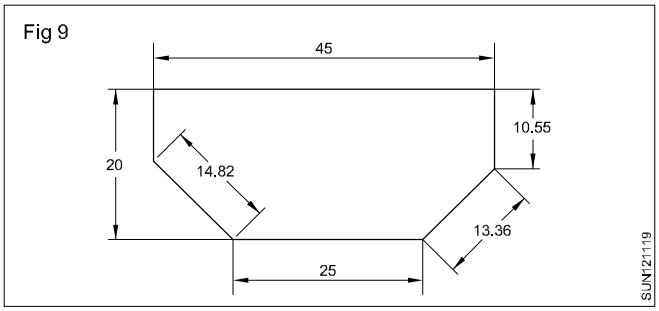
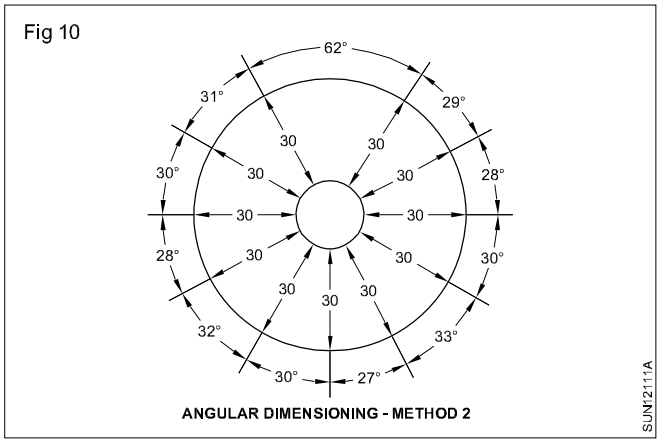


Fig 10



Arrangement and indication of dimensions

The arrangement of dimensioning on a drawing shall indicate clearly the design purpose.

The arrangements of dimensioning are:

– Chain dimensioning

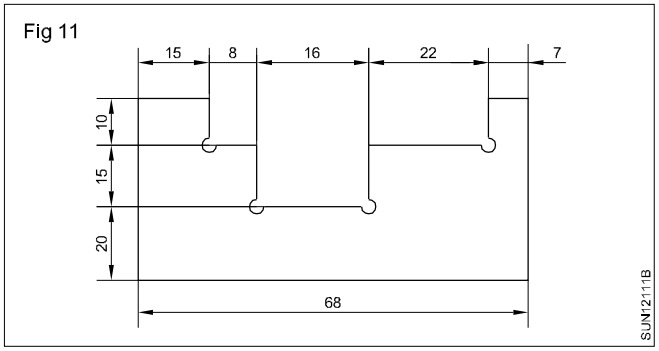
– Dimensioning from a common feature

– Dimensioning by co-ordinates

– Combined dimensioning.

Chain dimensioning: It is used where the possible accumulation of tolerances does not infringe (effect) on the functional requirement of the component. (Fig 11)

Fig 11

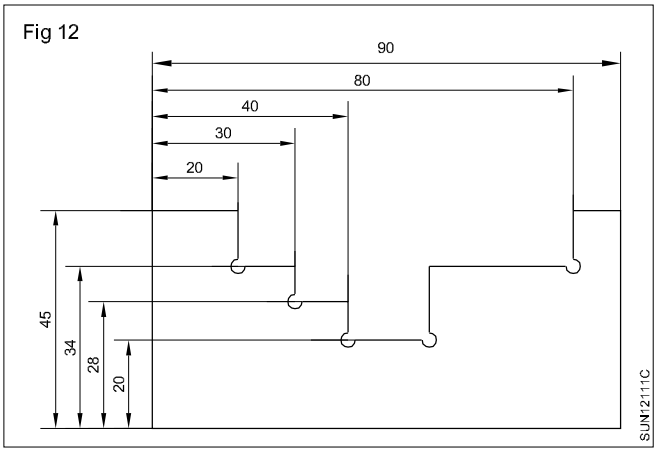


Dimensioning from a common feature is used where a number of dimensions of the same direction relate to a common origin.

Dimensioning from a common feature may be executed as parallel dimensioning or as superimposed running dimensioning.

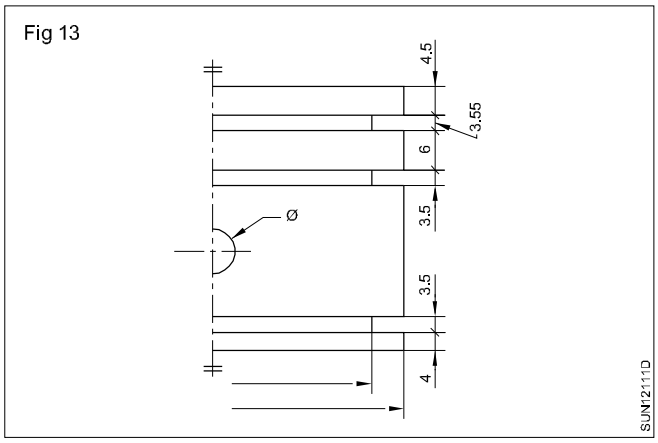
Parallel dimensioning: Dimensions of features are taken from one datum/common origin and are shown parallel to other and placed, so that the dimensional values can easily be added in Fig 12.

Fig 12



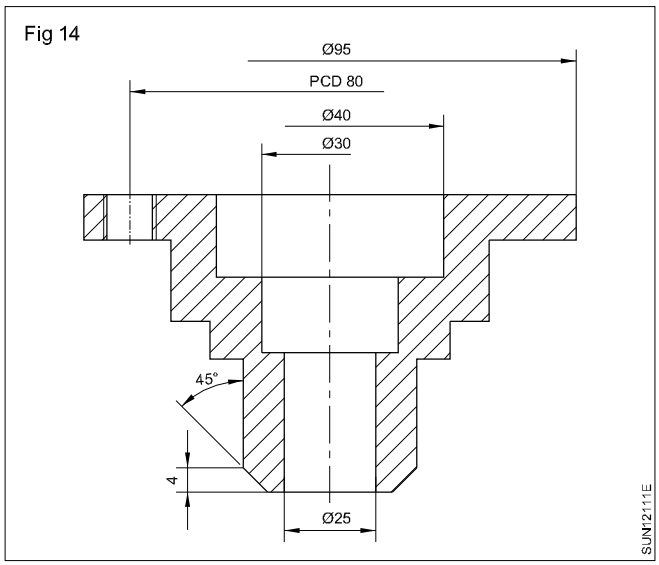
Dimensioning smaller width: Arrow heads are replaced by oblique lines. (Fig 13)

Fig 13



To avoid placing dimensions too far away from feature, dimension lines are drawn closer and not fully. (Fig 14)

Fig 14



Construction of plain Geometrical figures

Objectives: At the end of this lesson you shall be able to
- **state the different types of angle**
- **state the method of measuring angle.**

Angles : Angle is the inclination between two straight lines meeting at a point or meet when extended. AB and BC are two straight lines meeting at B. The inclination between them is called an angle. The angle is expressed in degrees or radians.

Concept of degree : When the circumference of a circle is divided into 360 equal parts and radial lines are drawn through these points, the inclination between the two adjacent radial lines is defined as one degree. Thus a circle is said to contain 360°.(Fig 1)

Acute angle : IF an angle which is less than 90° is called an acute angle. (Fig 2)

Right angle : Angle between a reference line and a perpendicular line is called right angle. (Fig 3)

Fig 1

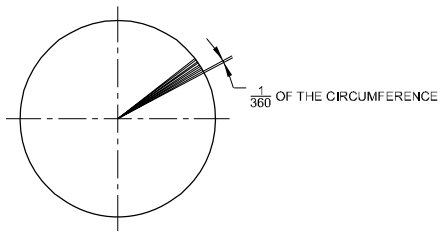


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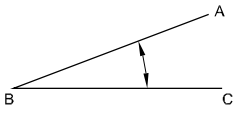
Fig 2



ACUTE ANGLE

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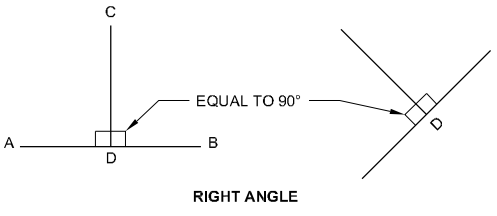
Fig 3

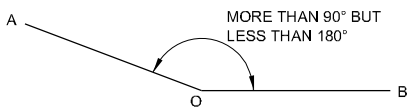


RIGHT ANGLE

SUN1212113

Obtuse angle : This refer to an angle between 90° and 180°. (Fig 4)

Fig 4

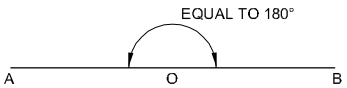


OBTUSE ANGLE

SUN1212114

Stright angle : This refers to angle of 180°. This also called as the angle of a straight line. (Fig 5)

Fig 5



STRAIGHT ANGLE

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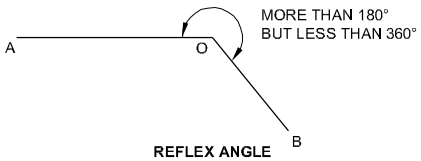
Reflex angle : It is the angle which is more than 180° (Fig 6)

Fig 6



REFLEX ANGLE

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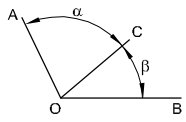
Adjacent angles : These are the angles lying on side of a line. (Fig 7)

Fig 7



ADJACENT ANGLES

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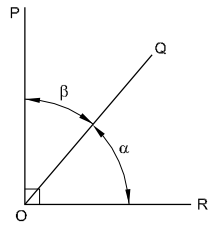
Complementary angles : When the sum of the two angles is equal to 90°, angle POQ + angle QOP+ angle POQ and angle QOR are complementary angles to each other.(Fig 8)

Fig 8



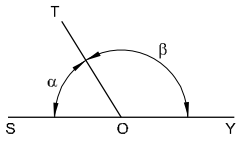
COMPLEMENTARY ANGLES

SUN1212118

Supplementary angle : When the sum of the two adjacent angles is equal to 180°,example angle SOT + angle TOY = 180°,angle SOT and angle TOY are supplementary angles to each other. (Fig 9)

Protractor : Protractor is an instrument for measuring angles. It is semi - circular or circular in shapes and is made of flat celluloid sheet. The details of graduation in a semi- ciccular protractor is shown in figure 10.

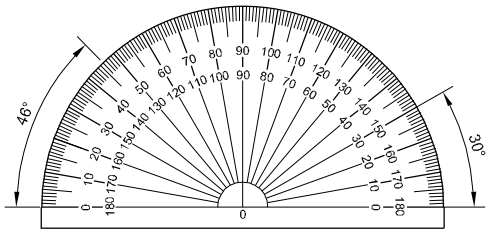
Fig 9



SUPPLEMENTARY ANGLES

SUN121219

Fig 10



SUN121214A

The angles can be set or measured from both sides,aligning the reference line and point '0' with the corner point of the angle.

Figure 10 shows how to read or set the angle protractor can also be used to divide a circle or drawing sectors.

Triangles and their types

Objectives: At the end of this lesson you shall be able to

- **define triangles**
- **name the different types of triangles and state their properties.**

Trlangle is a closed plane figure having three sides and three angles. The sum of the three angles always equals to 180°.

To define a triangle, we need to have a minimum of three measurements as follows.

– 3 sides or

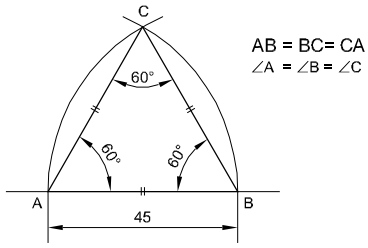
– 2 sides and one angle or

– 2 angles and one side

Types of triangles

– Equilateral triangle is a triangle having all the three sides equal. Also all the three angles are equal (60°) (Fig 1)

Fig 1



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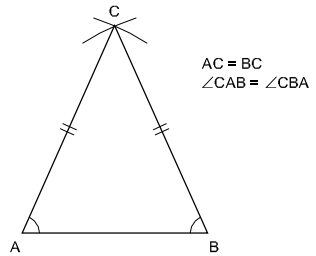
– **Isosceles triangle** has two of its sides equal. The angles opposite to the two equal sides are also equal.(Fig 2)

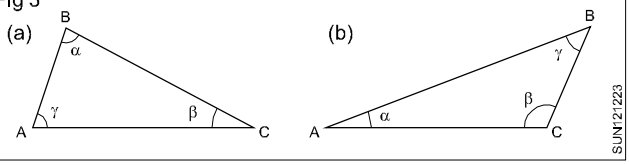
Fig 2



SUN121222

– **Scalene triangle** has all the three sides unequal in lengths. All the three angles are also unequal. (Fig 3)

Fig 3



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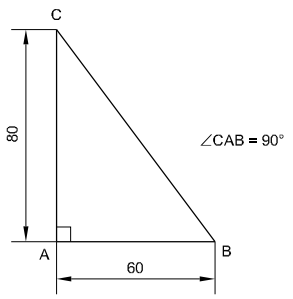
– **Right angled triangle** is one in which one of the angles is equal to 90° (Right angle). The side opposite to right angle is called hypotenuse. (Fig 4)

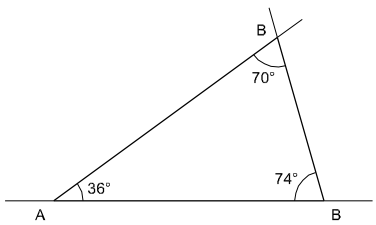
Fig 4



SUN121224

– **Acute angled triangle** is one in which all the three angles are less than 90°. (Fig 5)

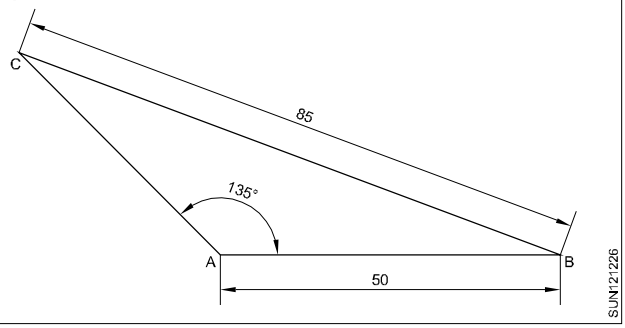
Fig 5



SUN121225

– Obtuse angled triangle has one of the angles more than 90°. (Fig 6)

Fig 6



The sum of the three angles in any triangle is equal to 180°.

The sum of any two sides is more than the third side.

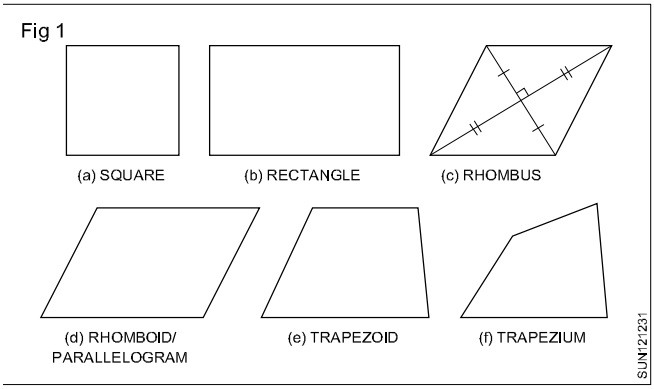
Quadrilaterals and their properties

Objectives: At the end of this lesson you shall be able to
- **define a quadrilateral**
- **name the quadrilaterals**
- **state the properties of quadrilater.**

Quadrilateral is a plane figure bounded by four side and four angles. Sum of the four angles in a quadrilateral is of interior angles is equal to 360°. The side joining opposite corners is called diagonal. To construct a quadrilateral of four sides, four angles and two diagonals minimum of five dimensions are required of which two must be sides. Quadrilaterals are also referred as Trapezoid.

Types of quadrilaterals. (Fig 1)

Fig 1



– Square
– Rectangle
– Rhombus
– Rhomboid/ Parallelogram
– Trapezoid
– Trapezium

Square : In a square all the four sides are equal and its four angles are right angles. The two diagonals are equal and perpendicular to each other.

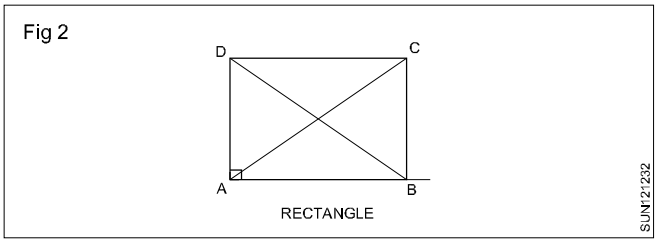
To construct square we need to know (a) length of the side or (b) length of the diagonal.

Rectangle (Fig 2) : In a rectangle, opposite sidea are equal and parallel and all four angles are right angles.

To construct a rectangle we need to know the length (a) two adjacent sides or (b) diagonal and one side.

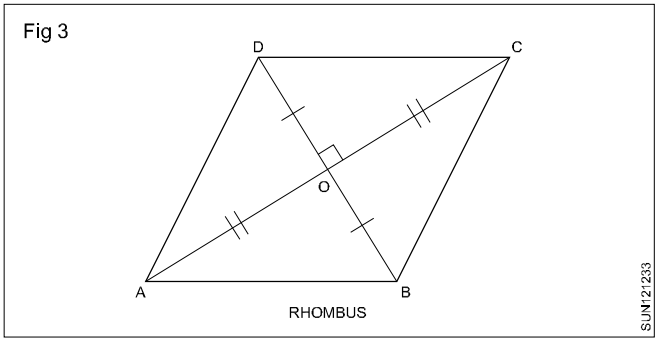
Fig 2 shows a rectangle ABCD. Sides AB = DC and BC = AD. Diagonals AC and BD are equal, bisect but not at right angles.

Fig 2



Rhombus (Fig 3) : In rhombus all the four sides are equal, but only the opposite angles are equal. ABCD is the rhombus where AB = BC = CD =AD.

Fig 3



Angle ABC = Angle ADC and BAD = Angle BCD.

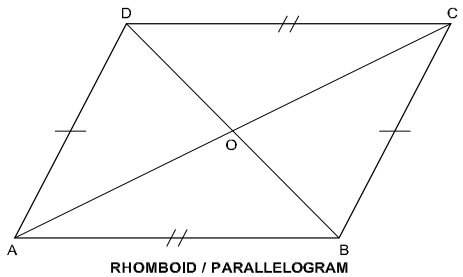
Diagonals AC and BD are not equal but bisecting at right angles.

AO = OC and BO = OD.

To construct a rhombus we need to know (a) two diagonals (b) one diagonal and an opposite angle or (c) one side and its adjacent angle.

Rhomboid/ Parallelogram (Fig 4) : In a parallelogram opposite sides are equal and parallel. Opposite angles are also equal. Diagonals are not equal but bisect each other.

Fig 4



Parallelogram is also known as rhomboid. To construct a parallelogram we need (a) two adjacent sides and angle between them or (b) one side, diagonal, and angle between them or (c) two adjacent sides and perpendicular distance between the opposite sides.

In the parallelogram ABCD, AB =DC; AD = BC

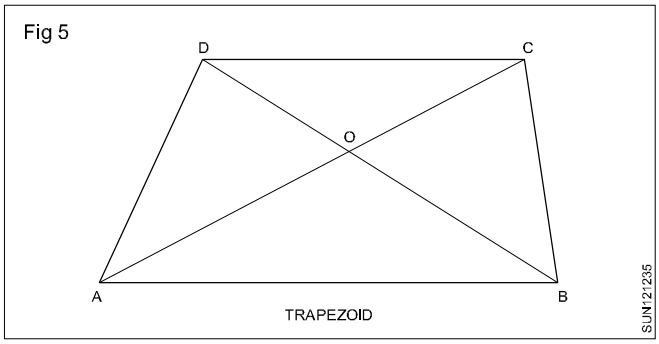
Angle DAB = angle DCB, angle ABC =angle ADC

Sides AB,CD and AD, BC are parallel.

Diagonals AC and BD are not equal but bisect at 0.

Trapezoid (Fig 5) : It is a quadrilateral, all the four sides are different and only two sides are parallel, all the four angles are different. The diagonals do not bisect at right angles.

Fig 5



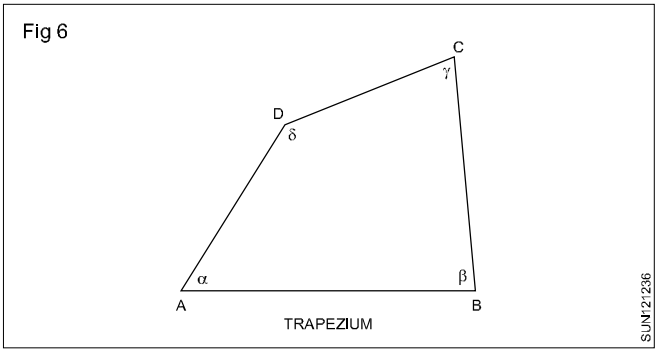
ABCD is a traperzoid, sides AB and DC are paralel but not equal.

Diagonals AC and BD and AO = OC need not be equal.

Sides AD and BC may some times equal.

Trapezium (Fig 6) : It is a plane figure of 4 sides, and any two sides equals to each other.

Fig 6



Polygon and their properties

Objectives: At the end of this lesson you shall be able to
- **define a polygon**
- **name the polygon in terms of the number of sides**
- **state the properties of polygon.**

Polygon is plane fgure bounded by many (usually five or more) straight lines. When all the sides are included angles are equal, it is called as a regular polygon.

Names of polygons : Polygons are named in terms of their number of sides are given below : (Fig 2)

Name	No. of sides
Pentagon	Five sides
Hexagon	Six sides
Heptagon	Seven sides
Octagon	Eight sides
Nonagon	Nine sides
Decagon	Ten sides
Undecagon	Eleven sides
Dodecagon	Twelve sides

Fig 1

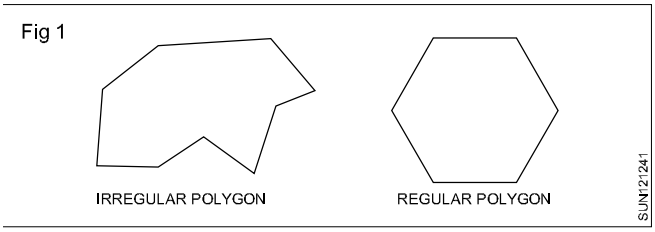
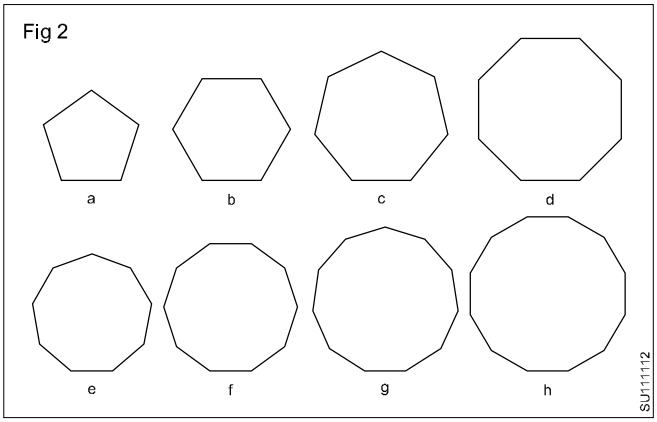


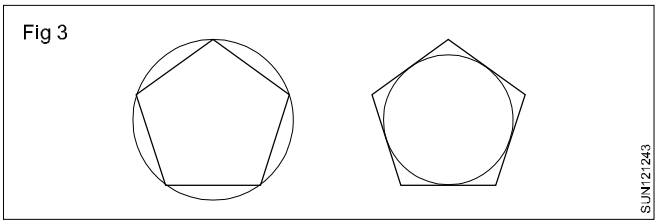
Fig 2



Properties of polygon

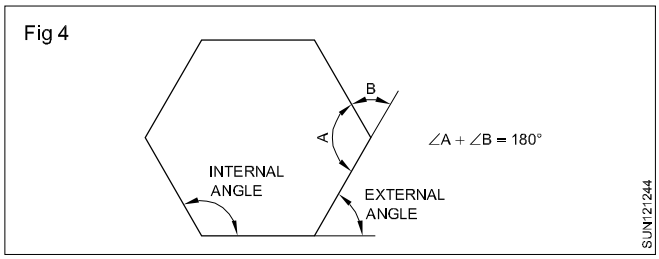
- All corners of a regular polygon lie on the circle. The sides of a regualar polygon will be tangential to circle drawn in side. (Fig 3)

Fig 3



- The sum of the interior angles of a polygon is equal to (2xn-4) x rt angle, where n is the number of sides.
- The sum of exterior angles of a polygon is equal to 360°.
- The sum of the interior angle and the corresponding external angle is 180°. (Fig 4)

Fig 4



Circles

Objectives: At the end of this lesson you shall be able to
- **state what is a circle**
- **name its elements**
- **state the function of a compass**
- **explain concentric and eccentric circles.**

Circle : Circle is a plane figure bound by a curve, formed by the locus of a point which moves so that it is always at a fixed distance from a stationery point the “Centre”.

Radius : The distance from the centre to any point on the circle is called the “Radius”.

Diameter : The length of a straight line between two points on the curve, passing through the centre is called the “Diameter”, D : Dia or d. It is twice the radius.

Circumference : It is the linear length of the entire curve, equal to π D

Arc : A part of the circle between any two points on the circumference or periphery is called an ‘Arc’.

Chord : A straight line joining the ends of an arc is called the chord. (Longest chord of the circle is the diameter)

Segment : A part of the circle or area bound by the arc and chord is the segment of the circle.

Sector : It is the part of a circle bounded by two radii (plural of radius) meeting at an angle and an arc.

Quadrant : Part of a circle with radii making 90° with each other is a quadrant (one fourth of the circle).

Half of the circle is a straight line just touching the circle at a point. It does not cut or pass through the circle when extended. The point of tangent touches the circle is called the “ point of tangency”. The angle between the line joining the centre to the point of tangency and the tangent is always 90°.

Fig 1 shows all the above elements.

Concentric circles : When two or more circles (drawn) having common centre, they are called concentric circles. Ball bearing is the best example of concentic circles. (Fig 2)

Fig 1

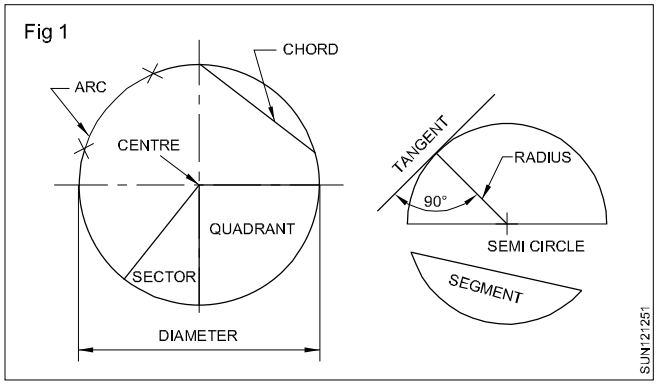
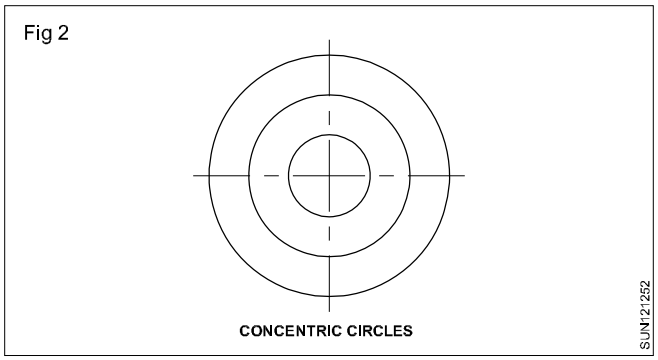
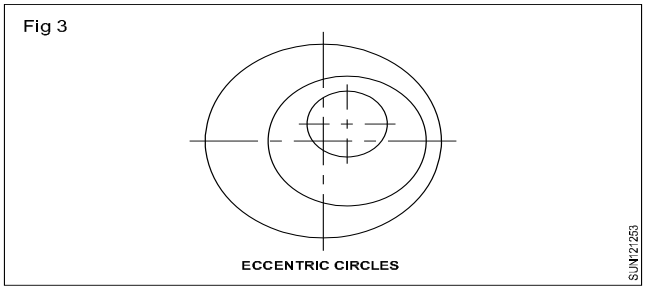


Fig 2



Eccentric circles : Circles within a circle but with different centres are called eccentric circles. (Fig 3)

Fig 3



Introduction about surveying

Objectives: At the end of this lesson you shall be able to
- **define surveying**
- **state the object of surveying**
- **state technical terms**
- **state the classification of surveying**
- **state the principles of surveying**
- **state the work of surveyor**
- **state the accuracy in chain survey**
- **state steel band.**

Surveying

The art of determining the relative positions of the objects on the surface of the earth by taking measurements in both horizontal and vertical plane.

Object of surveying

To obtain a map or a plan of the area to be surveyed.

Divisions:

The two main divisions of surveying are

1 Plane surveying

2 Geodetic surveying

The shape of the earth is elliptical in nature, but assumed to be a spheroid. The line joining of any two points on the earth surface is in an arc of a great circle. This is not a straight line measurement.

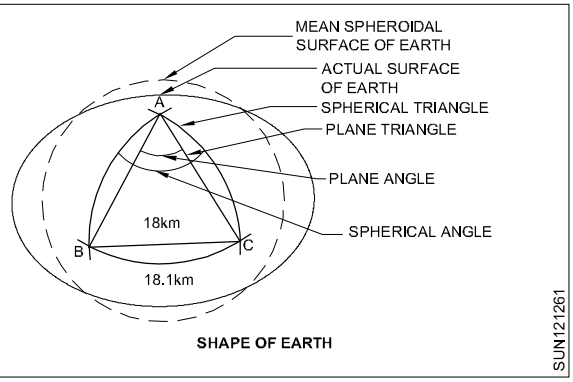
The survey in which the earth surface is assumed as plane and the curvature of earth is ignored is known as plane surveying.

The survey in which the curvature of earth is taken into account is known as Geodetic surveying. This is done by Great Trignometrical Survey (GTS) of India.

Area less than 260 sq.km is treated as plane.

From the Fig 1

Fig 1



SHAPE OF EARTH

As per plane surveying, the straight distance between B and C will be 18km

As per Geodetic surveying, the curved distance between B and C will be 18.1km

Technical Terms

The following technical terms are generally used in surveying

Plan : A plan is the graphical representation of the features on the earth surface or below the earth surface as projected on a horizontal plane. On a plan horizontal distances and directions are generally shown.

Map: The representation of the earth surface on a small scale is called a map. The map must show its geographical position of the earth.

Topographical map: The maps drawn in a large scale to identify the individual features and positions of various objects on the earth surface is called Topographical map.

Triangulation: The area to be surveyed is divided into a network of triangles and the length of its sides measured in the field and no angular measurements are required is known as Triangulation.

Classification of surveying (Fig 2)

Marine/Hydrographical survey: It is the survey, which deals the objects under the water.

Aerial survey: It is the survey in which to collect the details of cyclonic affected areas, flooded areas etc. is done by aeroplane in air.

Astronomical survey: It is the survey, which deals with the stars in the sky.

Land survey

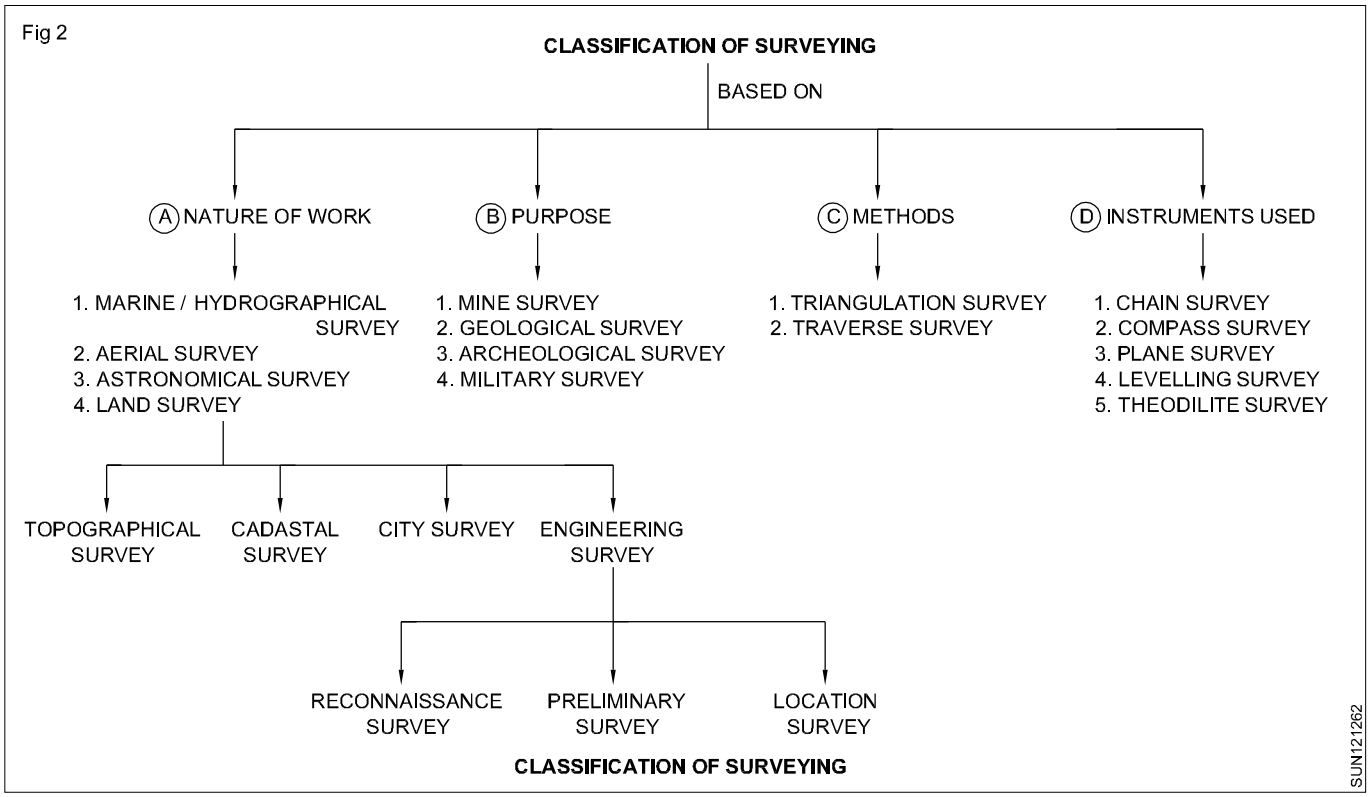
Topographical survey: It is the survey to determine the natrual and artificial features on the earth.

Cadastral survey: It is the survey which deals the additional details of the boundaries of fields, houses etc.

City survey: It is the survey which deals the layout plots, roads, watersupply and severage systems.

Engineering survey: It is the survey which deals with determining the quantities and collecting the data for the design of engineering projects such as roads, dams etc. reservoirs or work in connection with water supply severage etc.

Fig 2



Mine survey: It is the survey which deals in exploring mineral wealth such as gold, coal, copper etc. with in the earth's crust.

Geological survey: It is to determine the different strata in the earth's crust.

Archaeological survey: It is the survey deals in unearthing the relics of the past.

Military survey: It is the survey for determining points of strategic importance both offensive and defensive.

Principles of surveying

All survey works are based on the following two basic principles

1 To work from whole to the part.

2 To locate a point with respect to two reference points.

1 To work from whole to the part (Fig 3)

To survey an area, it is to establish the main control points with great precision.

The main idea is to

– prevent the accumalation of errors

– control and localise minor errors.

2 To locate a point with respect to two reference points (Fig 4)

To fix the position of new stations, atleast two independent positions are required.

The new stations are fixed from points already fixed by

– linear measurements

– angular measurements

– both linear and angular measurements

PQ is the reference line and R is the point to be located.

From Fig 4a, the distance PR and QR can be measured and the point R can be plotted by swinging two arcs with the same scale in which PQ has been plotted.

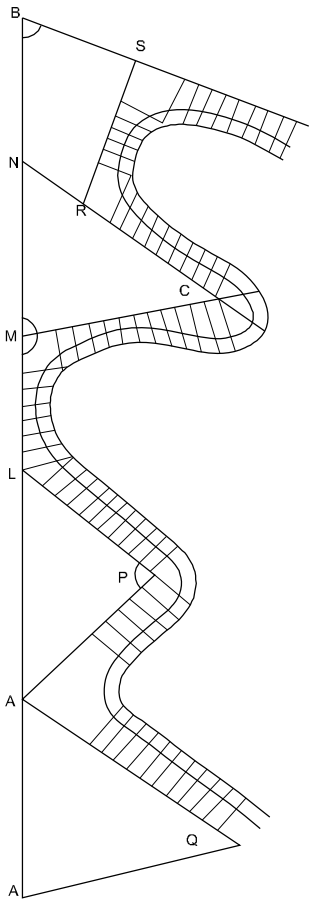
From Fig 4b, a perpendicular RS can be dropped on the line PQ and lengths PS and SR are measured. Then the point R can be plotted by using set square.

From Fig 4c, the distance QR and angle PQR can be measured as α. Then the point R is plotted by means of a protractor or trignometrically.

From Fig 4d, in this method angle RPQ (β) and RQP (α) are measured by using an angle measuring instrument, then point R is plotted either by protractor or solution of triangle PQR.

From Fig 4e, in this method angle RQP (α) and distance PR are measured. Then the point R can be plotted by using protractor and swinging an arc from P.

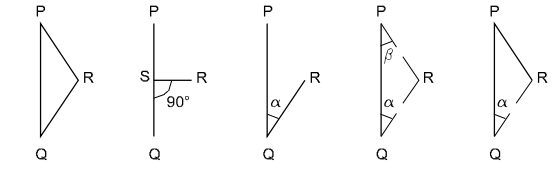
Fig 3



SURVEYING FROM WHOLE TO PART

SUN121263

Fig 4



LOCATION OF A POINT

SUN121264

Work of a surveyor

- Taking measurements in the field.
- Recording field notes.
- Preparing survey maps, plans and sections.
- Calculating the areas and volumes.
- Designing the various structures.
- Handling of survey instruments.
- Care and maintenance of survey instruments.

Steel Tape (Fig. 5)

1 It is used for accurate work.

2 It is lighter weight and easier to handle than the chain.

3 It is 20m or 30m long.

4 It is made from ribbon of steel 16mm wide.

5 The brass handles are provided at the ends of the chain with swivel joint.

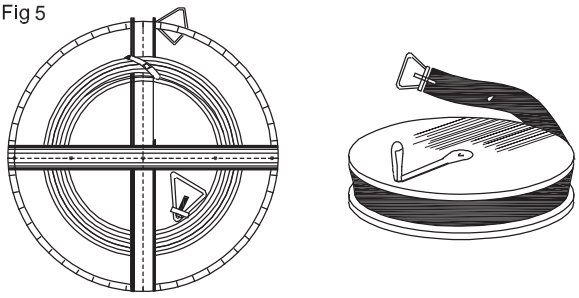
6 It is wound on an open steel cross or a metal reel in a closed case.

7 The graduations are worked in two ways.

8 It is divided by brass studs at 0.2m and numbered at every 1m in the first portion and the last link is subdivided into cm and mm.

9 The graduations are etched as metres, decimeters and centimetres on one side and 0.2m links on the other side. Brass tallies are fixed at every 5 in length.

Fig 5



(A) OPEN STEEL CROSS (B) METAL REEL IN A CLOSED CASE

SUN121265

Types of scales

Objectives: At the end of this lesson you shall be able to
- **state the necessity of scales**
- **explain representative fraction (RF)**
- **list the types of scales**
- **explain plain, comparative scales, diagonal scale.**

Inroduction

Engineering drawings are rarely drawn to the same size of the object. In the preparation of drawings of a building, It is not practically possible to make the drawing to the same size of the building. Here, the drawing is prepared to the reduced size and it is called reduced scale drawing.

Thus, the drawings prepared proportionately to the smaller or larger size than the actual size, are siad to be made to a scale. Scale of a drawing may be defined as the ratio of linear dimension of the same object. Scales used in engineering practice are available in sets of 8 or 12 scales. same times the required scale will not be available. Then, it is necessary to construct a new scale.

Therefore, a convenient scale is always chosen to prepare the darwings of big as well as small object in proportionately samller or larger sizes. So the scales are used to prepare a drawing at a full size, reduced size or enlarged size.

Representative fraction

Representative fraction may be defined as the ratio of the distance between any two points of the object on a drawing to the actual distance between the same points of the object and it is abbreviated as R.F.

Mathematically,

R.F = distance on drawing/Distance on object

Reducing scale

An actual length of 5m of a romm is represented by 25mm length on drawing. Then,

R.F = distance on drawing/Distance on object

= 25mm/5m

= 25/5 x 100 x 10

= 1/200

Scale of drawing is 1: 200

Enlarging scale

An actual length of a typical terminal strip of 10mm is represented by 50mm length on drawinig. Then,

R.F. = Distance on drawings/ Distance on object

= 50mm/10mm

= 5/1

Scale of drawing is 5:1

Full scale

An actual length of an electrical switch board of length 30mm, is repersented by a 30 mm length on drawing.Then,

R.F.= Distance on drawing/ Distance on object

= 30mm/ 30mm

= 1/1

Scale of drawing is 1:1

Scales used to scale drawn large parts in engineering drawings and architecture:

1:40 1:100

1:50 1:150

1:65 1:200

1:80

Typical scale for site plan-unit in m

1:500,1:5000

1:1000,1:1000

1:2000,1:20000

Scale need in surveys

1:50000 1:200000

1:100000 1:50000

Scales used in maps Units in m.

1:1000000

Recommended scales

Scales recommended for use on engineering drawings are give below

Full scale	Reduced scale	Enlarged scale
1:1	1:2	10:1
	1:2:5	5:1
	1:5	2:1
	1:10	
	1:20	
	1:50	
	1:100	
	1:200	

Civil Engineers and Architect generally use reduced scales while Mechanical and Electrical Engineers use both reduced and enlarged scales according to the need of the problems.

Mertric Measurements

Table 11:1

10 millimeters (mm)	1 centimeter (cm)
10 centimeter (cm)	1 decimeter (dm)
10 decimeters (dm)	1 meter (m)
10 meter (m)	1 decameter (dam)
10 decameter (dam)	1 hectometer (hm)
10 hectometer (hm)	1 Kilometer (km)

Types of scales

– Plain scale

– Diagonal scale

– Vernier scale

– Comparative scale

– Scale of chords (for angles)

To construct a scale the following information is essential

RF of the scale

– Units which it must represent example mm, cm, m, ft inches etc.

– the maximum length it must show

– Minimum length of the scale = RF x the maximum length required to be measured.

Plain scales (Fig 1) : Scales are drawn in the form of rectangle, of length 15cm (can be upto 30cm) and width 5mm. It is divided into suitable number of parts. The first part of the line is sub - divided into samller units as required.

Every scale should have the following salient features:

– The zero of the scale is placed at the end of the first division from left side.

– Form zero, mark further divisions are numbered towards right.

– Sub - divisions are marked in the first division from zero to left side.

– Names of units of main divisions and sub divisions should be stated/printed below or at the end of the divisions.

– Indicate the 'RF' of the scale.

Example of construction of a plain scale to measure metres and decimetres. RF = 1/50 and to measure up to 8 metres. Minimum standard length of scale = 15cm.

The length of the scale = RF x maximum length to be measured = 1/50 x8x100cm = 16cm.

Length of 16 cm is divided into 8 equal parts or major divisions each representing one metre. If each major division is divided into 10 sub - divisions each sub - division will represents one decimetre.

A distance of 6.7 m will be shown as in the Fig 1.

Comparative scales (Fig 2) : Comparative scale is a graphical divice to compare or convert one variable into another. It compares two similar units in different systems. For example meters, yards, kilometers, miles, temperature in degrees, centigrades and Fahrenheit etc.

Fig 2 shows the construction of a comparative scale to convert Fahrenheit (F) into Celsius (Centigrade - C) and Celsius into Fahrenheit.

– The line AB (15 cm) is divided equally into 10 equal parts.

– Division on the top side of the scale is divided into 10 equal sub - divisions. Each sub - division is representing 1°C.

– Division on the bottom side of the scale is divided into

Fig 1

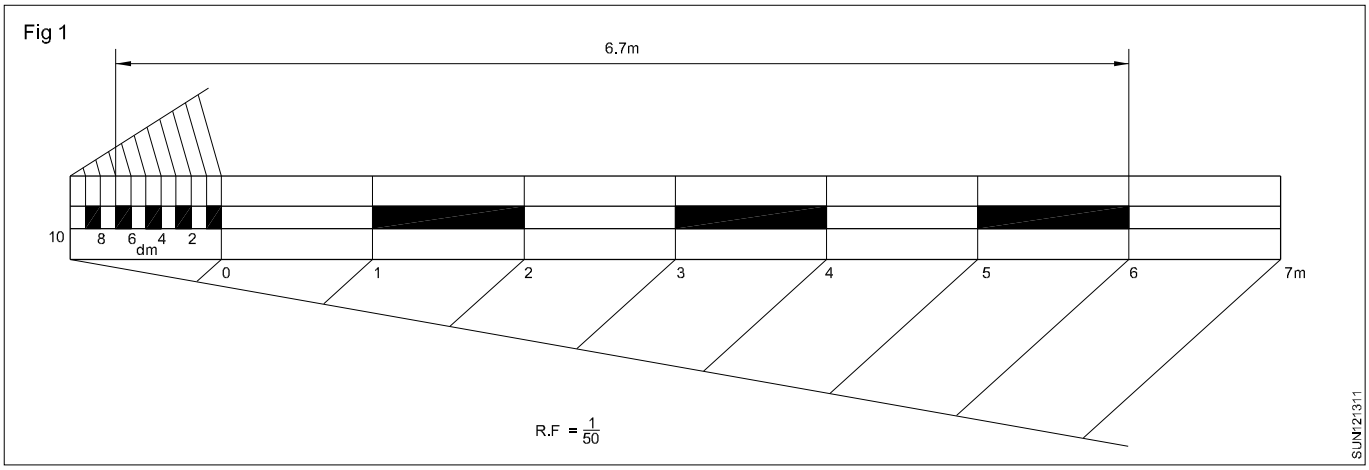
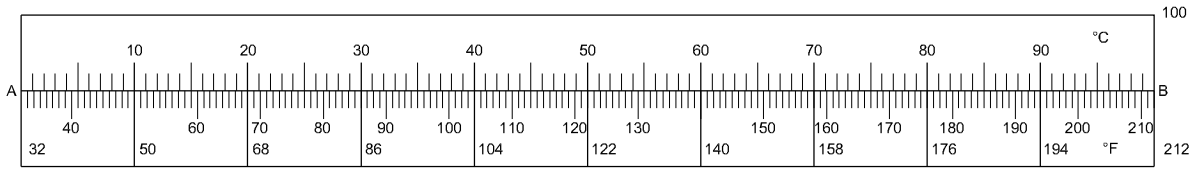


Fig 2



COMPARATIVE SCALE

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18 equal sub - divisions. Each sub - division is called 1°F.

– Datum of 'F' side scale is starting with 32°F instead of 0.
– Conversion from °C to F or vice - versa can be found out directly from the scale.
– 10° C equivalent reading of F scale = 50°F
– 25° C equivalent reading of F sacle = 77°F
– For the verification of the conversion using the scale use the fllowing formulae.

C = (F - 32) x 5/9

F = (C x9/5) + 32

Diagonal scale : Plain scales cannot be used for taking smaller measurement. The distance between the consecutive divisions on a plain scale , at best can only be 0.5mm. In other words, the smallest measurement that can be taken. Using a plain scale of RF 1:1 is 0.5mm. If the RF of a plain scale is 1:5, the smallest measurement such a scale can take is 2.5 mm (0.5 mmx5).

To overcome this limitation two different types of scales are employed. They are

– Diagonal scale
– Vernier scale

Priniciple of diagonal scale : Diagonal scale relies on a " diagonal" to divide a small distance into further equal parts.

Principle of diagonal scale is based on the principle of similar triangles.

Example : A small distance AB is to be divided into 10 equal parts using diagonal scale.

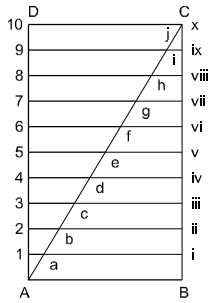
AB is the line to be divided into 10 equal parts.

Diagonal scale is shown in the Figure 3.

Side AD is the line to be divided into 10 equal parts 1 to 10.

Parallel lines are drawn to AB from points 1,2.....10.

Fig 3



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Join one of the diagonal AC.

Join parallel line cuts the diagonal at a,b.....j.

Distance 1 - a is 1th/10 of AB = 0.1AB

Distance 2 - b is 2 th/ 10 of AB = 0.2 AB

Distance a - i is 9th/ 10 of AB = 0.9 AB

Distance b - ii is 8 th/ 10 of AB = 0.8 AB

If AB is 1mm then 1 - a will be 0.1 mm and 2 - b will be 0.2mm.

Similarly a - i will be 0.9 mm and c - iii will be 0.7mm.

Parallel lines on both sides of the diagonal can be considered for measurement.

TASK 3 : **Construct a diagonal scale for 4 m length and show the lengths 2.69 m, 1.09 m and 0.08 m. (RF = 1/ 25) (Fig 4)**

Length of scale required = RF x length to be measured

= x 4 m x 100 = 16 cm.

- Draw a rectangle ABCD of 16 cm x 4 cm.
- Divide the rectangle ABCD into 4 equal parts and mark them EF, GH & IJ and each division represents one metre.
- Divide the line AB into ten equal parts and mark them 1_1, 2_1, 3_1.....10_1.
- Draw vertical lines from points 1, 2..... etc.
- Divide the BF into 10 equal parts and mark them as 1'2'3' etc and each division representing 10 cm (1 dm).
- Draw diagonals on all ten small rectangles in the 1st (lower) block ABFE and complete the diagonal scale.
- Metres are read on EF or line parallel to it i.e GH, IJ & DC. Decimetres are read on the division of line AE and centrimetres are read on points where the diagonals intersect with the vertical parallel lines drawn through the divisions of line AB.
- Mark 2.69 in using the diagonal scale. (Fig 4)

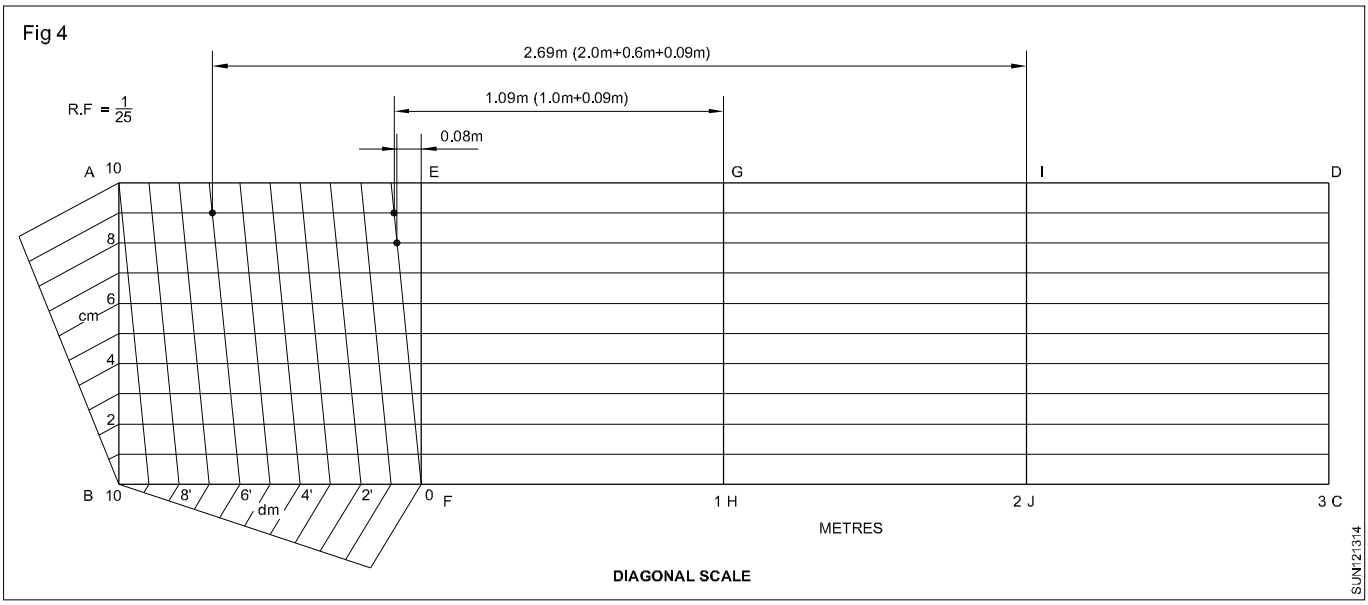
  2.00 m on metre division

  0.60 m on decimetre division

  0.09 in the diagonal cm division

  1.09 m and 0.08 m are also marked in the fig 3 in the same way.

Fig 4



Vernier scale

Objectives: At the end of this lesson you shall be able to
- **Explain vernier scale & scale of chords**

Vernier scale (Fig 1) : As stated earlier vernier scales are yet another means of dividing a small dimension into a number of equal parts so as to facilitate taking smaller measurements than is possible by plain scales.

Vernier scale consists of two parts - secondary scale or vernier scale (VS) and primary scale or main scale (MS)

The smallest measurement that can be taken on the main scale is called main scale division (MSD)

Least count of the vernier scale is the fraction of the main scale division upto which the measurement can be taken.

To Arrive at the fraction of MSD, imaginarily MSD is divided into a number of equal parts (n)

$$n = \frac{\text{MSD}}{\text{Fractional part of msd}}$$

The length of the secondary scale depend upon the MSD and number of divisions (n) we have decided to make.

If one MSD is to be divided into 'n' parts, the length of the secondary scale (vernier) will be equal to the length of either (n-1) or (n + 1) parts of MSD.

Length of the secondary scale is divided into 'n' equal parts.

There by one secondary scale (vernier) division is equal to $\frac{(n-1)\text{MSD}}{N}$ or $\frac{(n+1)\text{MSD}}{N}$ as the case may be.(Fig 2,3)

Direct or forward reading : Vernier scale is the scale constructed having -1 number of MSD as the secondary scale (vernier) length. (Fig 6)

Fig 1

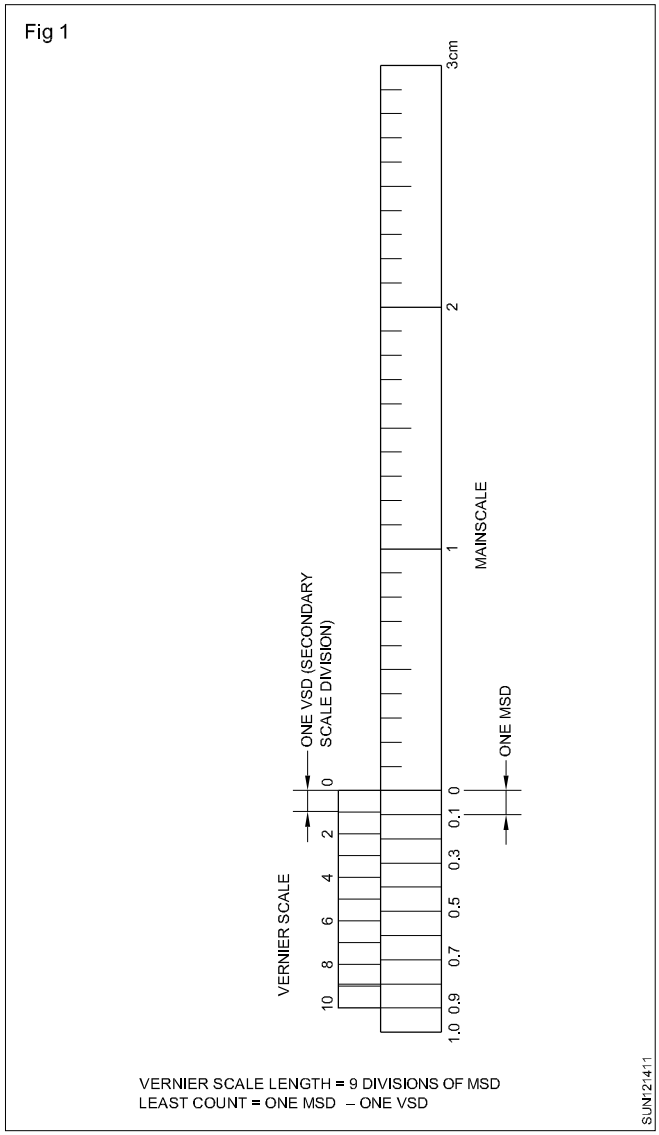
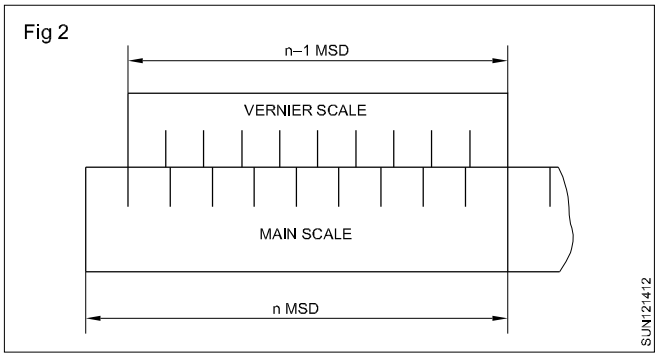
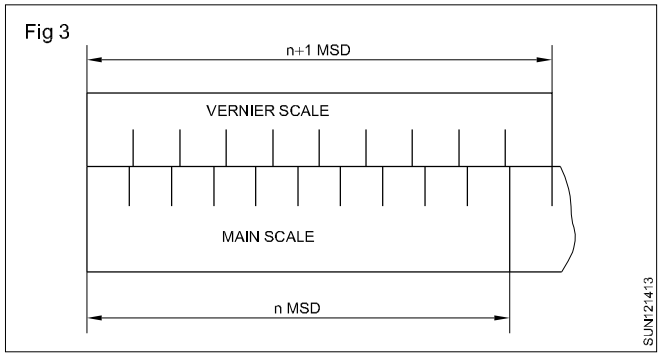


Fig 2



Retrograde or backward reading : Vernier scle is the scale having n + 1 numbers of MSD as the secondary sacle (vernier) length.

Fig 3



According to direct reading vernier

1Main scale division -1 Secondary scale division (vernier) $= \frac{1}{n}$MSD

1cm $-\frac{9}{10}$ $= \frac{1}{10}$cm

According to backward reading vernier

1 Secondary division (vernier) - 1 Main scale division $= \frac{1}{n}$MSD

1.1 cm - 1.0 cm $= \frac{1}{10}$cm

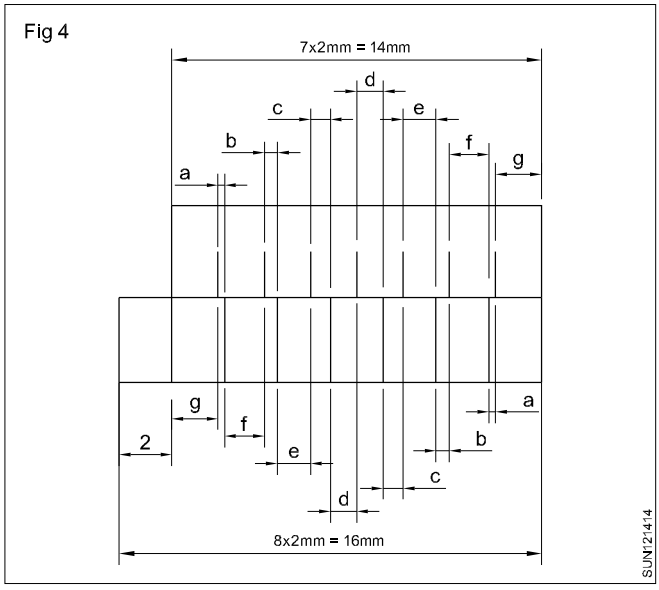
MSD is the least count of the vernier scale

Example on direct reading vernier scale (Fig 4,5) :

Construct directing reading scale with one MSD = 2mm, Least count = 0.25 mm.

First find the number of equal parts MSD (n)

Fig 4



$$n = \frac{MSD}{leastcound} = \frac{2mm}{0.25mm} = 8$$

Length of secondary scale (vernier) is equal to 'n-1' number of MSDs. 7 divisions of MSDs are taken and the length is equally divided into 8 parts on secondary scale

$$\text{(vernier) 1 secondary scale division} = \frac{7 \times 2mm}{8} = 1\frac{3}{4}mm$$

The difference of one MSD and one secondary scaleThe difference of one MSD and one secondsary scale division (vernier) will be

$$2mm - 1\frac{3}{4}mm = \frac{1}{4}mm = 0.25mm$$

It means that the scale can measure upto 1/4 mm (0.25 mm).

In the figure, the fraction of the MSD is shown as the distance between the lines of VSD and MSD and they are marked as a,b,c.....g.

Figure 5 shows a retrograde vernier scale with same least 0.25 mm (1/4 mm) and one MSD = 2 mm.

Length of secondary (vernier) scale is n + 1 number of MSDs.

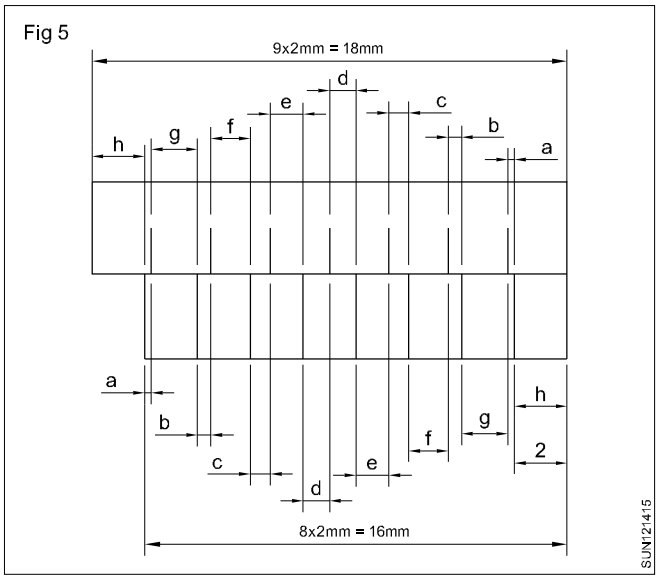
9 MSDs are equally divided into 8 parts on secondary (vernier) scale.

$$\text{1 Secondary (vernier) division} = \frac{9 \times 2mm}{8} = 2\frac{1}{4}mm$$

1 VSD - 1 MSD = least count

Least count = 0.25 mm

Fig 5



Scale of chords (Fig 6) : It is different from conventional linear scales. It is used to construct angles in the absence of a protractor, so called as a scale to measure or set angles or degrees. There is no rigid length of scale, so any convenient length can be taken to construct it.

Fig 6

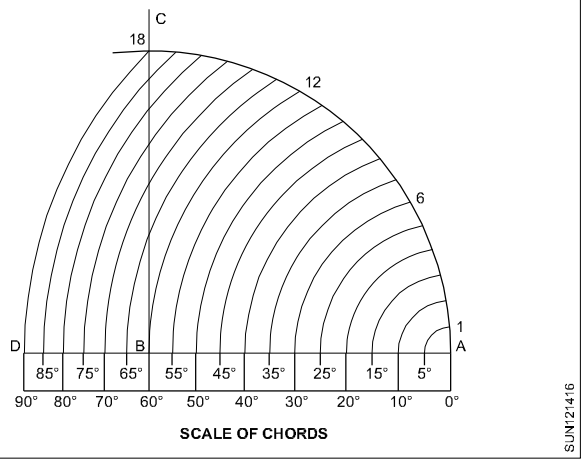


Fig 6 shown the method of constructing the scale of chords.

– Draw a quadrant ABC and extend AB.
– A as centre, AC as radius, draw an arc CD.
– AD is the chord of arc AC.
– Divide the arc AC into 18 equal parts and each part is 5°.
– A as centre, draw arcs with radius. A1, A2, A3.....A18 to intersect line DA and mark them 5°,10°.....90°.

Surveyor - Basic Engineering Drawing
Projection of points and lines

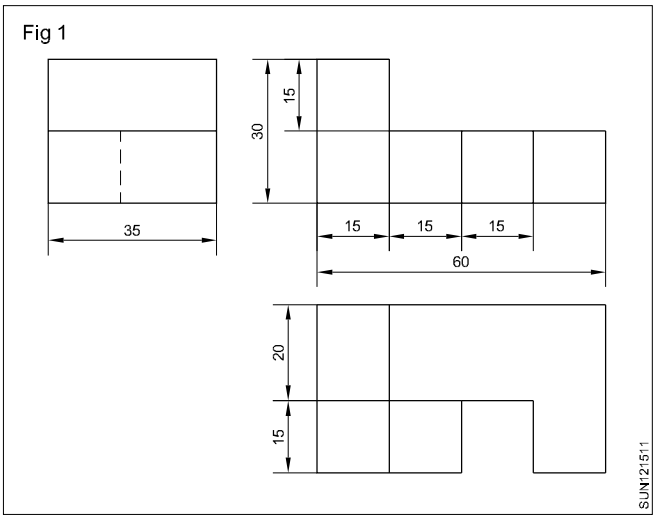
Objectives: At the end of this lesson you shall be able to
- **explain the four dihedral angles**
- **state the meaning of orthographic projection**
- **explain terms plan and elevation as applied to orthographic views**
- **state the relative position of views in first and third angle projection**
- **state the projection of lines of different orientation.**

Graphics are preferred by engineer's and craftsman to communicate their ideas. When graphics are used for communication it is called graphical language. Those who donot have the knowledge of this language are professionally illiterate.

The saying that "A picture is worth a thousand words" is very much relevant in technical work.

An engineering drawing conveys many different types of information of which the most important thing is the shape of the object. Fig 1 shows a sample drawing. In this drawing the shape of the part is represented by three views.

Fig 1



For an untrained person it will be very difficult to conceive the shape of the object from the above drawing.

But in Fig 2, the same object is shown pictorially in a different ways and the shape is easily understood even by a layman.

From Fig 1 & 2, it is clear that there are different ways of describing the shape of a part on a paper. Figure 1 is called as Multiview drawing or Orthographic drawing and the method adopted in figure 2 is called pictorial drawing. The different views in a multiview drawing are called as 'Orthographic views' or Orthographic projections.

To describe the shape of a part in engineering drawings, multiview or orthographic view method is preferred as only Orthographic view can convey the true shape of the object. Whereas in pictorial drawing through this shape is easily understood and it is distorted. To emphasise this point, see Fig 3, wherein a cube with a circular hole is represented pictorially. We know that all corners of the cube are of 90°. But in the pictorial drawing in Fig 3, the same 90° is represented at some places by acute angles and at some other places by obtuse angles.

Fig 2

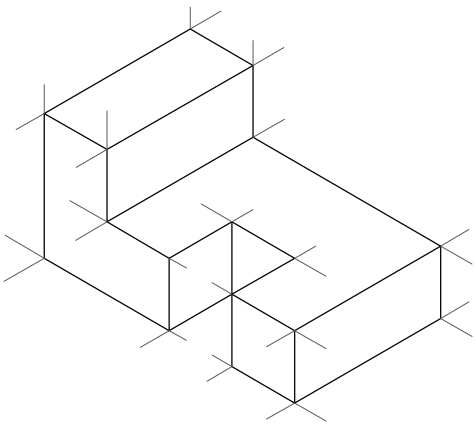
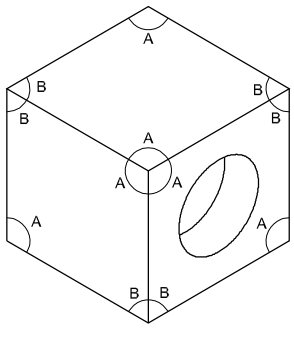


Fig 3

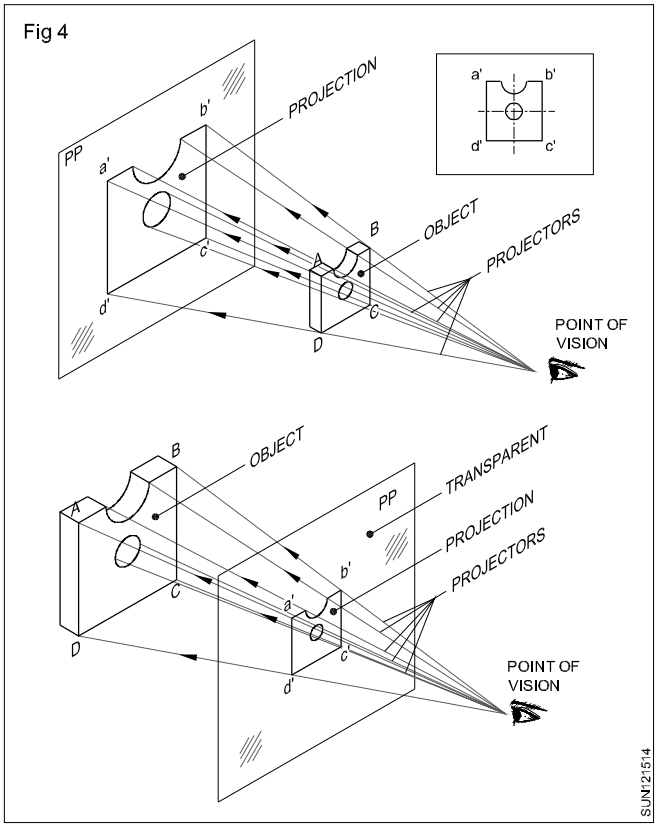


A - OBTUSE ANGLES
B - ACUTE ANGLES

Projection: Projection is commonly used term in draughtsmans vocabulary. In the context of engineering drawing, projectors means image and it is comparable to the image formed on the retina of the eyes. (Projection can also be compared to the image of the object on the screen, where the film is projected (by the cinema projector) by the light rays.

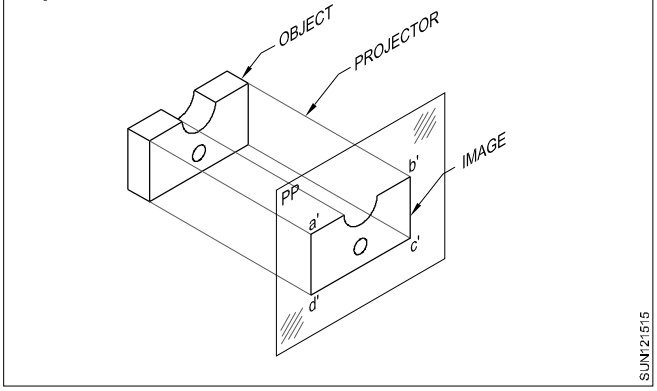
Projection or images can also be formed inbetween the eyes and the object by keeping a transparent plane. (Fig 4)

Fig 4



In this figure 4 the rays from the object converge to the eyes and this image (Projection) is smaller than the object. However if the rays are parallel as in the case of rays coming from the sun, the image (Projection) will be of the same size as that of the objects. Such a projection is called orthographic projection. The parallel lines/rays drawn from the object are called projectors and the plane on which image is formed is called plane of projection. In orthographic projection, the projectors are perpendicular to the plane of projection. (Fig 5)

Fig 5

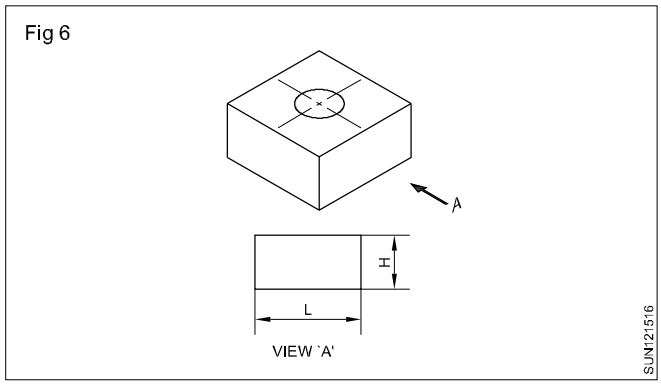


Orthographic projection: The term orthographic is projection derived from the words. Ortho means straight or at right angles and graphic means written or drawn. The projection comes from the Old Latin words PRO means forward and Jacene means to throw. The orthographic projection literally means "Throw to forward", "drawn at right angles" to the planes of projection.

An orthographic system of projection is the method of representing the exact shape and size of a three dimensional object on a drawing sheet or any other plain surface such as drawing board.

A single orthographic view of an object will show only two of its three dimensions. The view in figure 6 shows only the length and height of the object only.

Fig 6

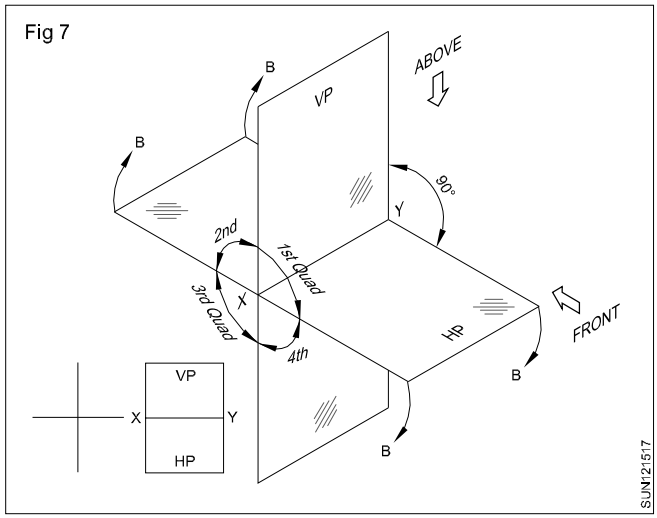


Therefore, it becomes necessary to have an additional view to show the missing dimensions (width). Therefore, we have to make two views to represent the three dimensions of an object.

The two views thus required are to be obtained on two different planes which are mutually perpendicular (one HP and one VP) with the object remaining in the same position. The projection or the view obtained on the horizontal plane is called the top view or plan and the view obtained on the vertical plane is called elevation.

First angle and third angle projection : One vertical plane (VP) and one horizontal plane (HP) intersect at right angles to each other. (Fig 7)

Fig 7



All the four quadrants have one HP and one VP formation. As per convention in mathematics, the quadrants are numbered as 1st, 2nd, 3rd and 4th. These four quadrants are called four dihedral angles, namely 1st angle, 2nd angle, 3rd angle and 4th angle.

To draw two views of an object, we assume that the object is placed in any one of the quadrant/angles, 1st angle & 3rd angle Fig 8a, 9a and its plan and elevation projected to the respective planes. Now tomake it possible to draw the two views (Plan & elevation) in one plane i.e the plane of the drawing paper, the horizontal plane is assumed to be unfolded in clockwise direction through 90° Fig 8b & 9b.

We proceed this way, when the views are made. When the object is placed in the 2nd or fourth quadrant the plan and elevation will get super imposed (one up on the other) Fig 10a & b. Due to this reason the 2nd and 4th angle are not used for making engineering drawings as the three dimensions cannot be easily identified. Hence for representing the three dimension of the object, we assume the object is placed either in 1st angle or in 3rd angle. (Fig 11 & 12)

Fig 8

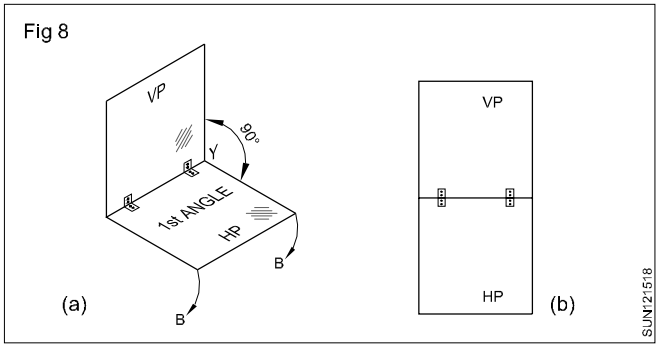


Fig 9

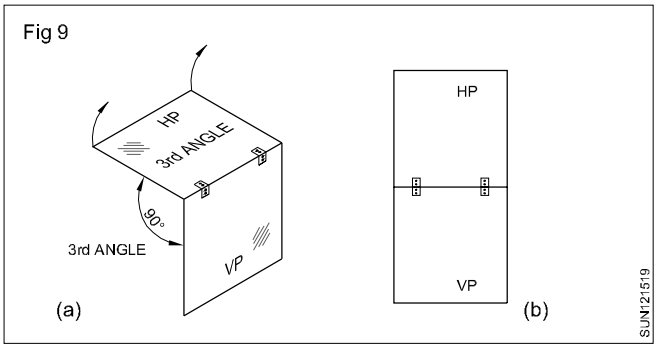


Fig 10

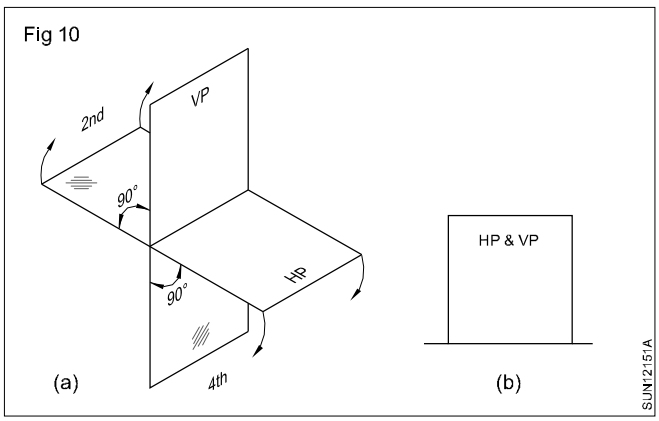


Fig 11

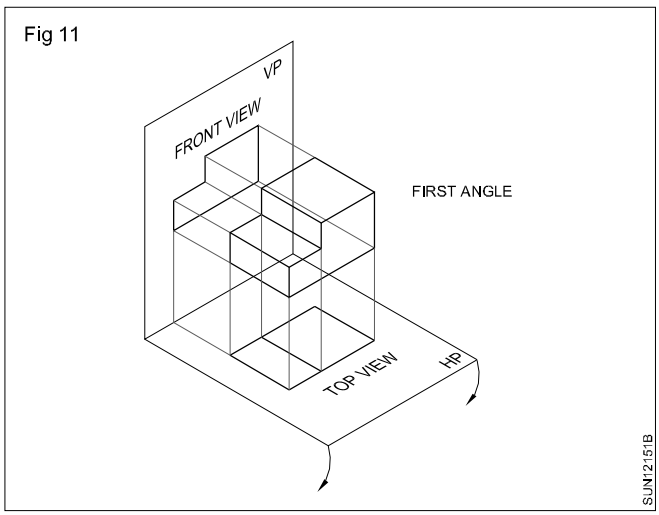
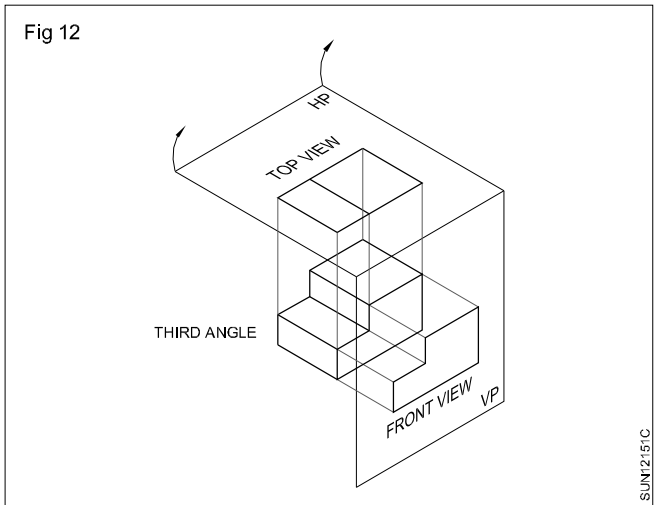


Fig 12



The placement of plan and elevation when the horizontal plane is unfolded will be different in these two systems. It may be observed in Fig 13 that in the first angle projection plan (top views) will be directly below the elevation, whereas in 3rd angle projection plan lies directly above the elevation. (Fig 14)

Fig 13

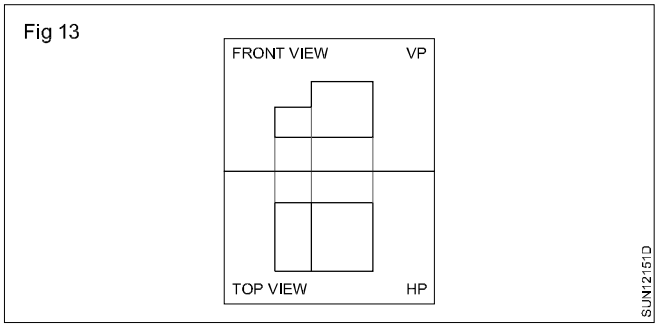
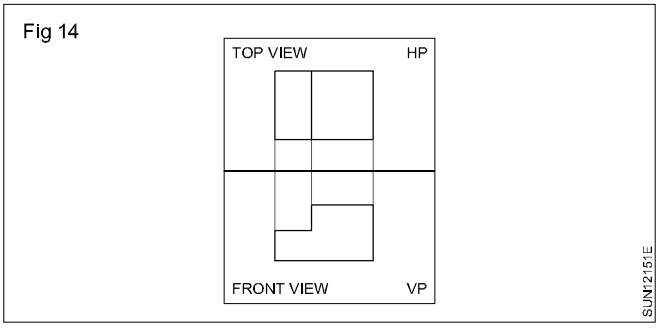


Fig 14



Views can be drawn in any one of these two methods. However Indian Standard (BIS) has recommended the first angle method to be used in our country.

Orthographic views are drawn, based on the principle of projection. To acquire sound knowledge to make orthographic views, one has to study solid geometry which deals extensively with principle of projections. Remember that the purpose of studying solid geometry is to have clear in sight of principle of projection which is the basis of describing the shapes of solid objects on a plain paper.

Solids are made of planes and planes are made of lines and lines and made of points. Hence the solid geometry will be dealt in the order of points, lines, planes and solids.

Projection of a point: The projection of a point no matter where it is placed relative to the plane of projection will always be a point.

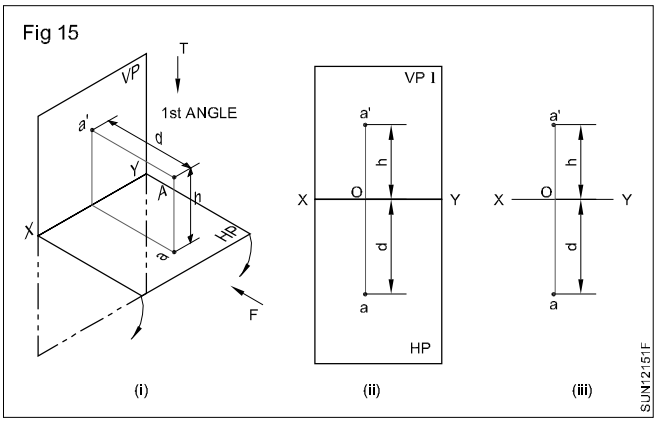
Figures 15 to 18 shows the projection of a point which is at a distance of 'h' and 'd' respectively from HP and VP respectively, where it is placed in 1st, 2nd, 3rd and 4th quadrant. Here, F and T are the directions of the views for projections to VP and HP.

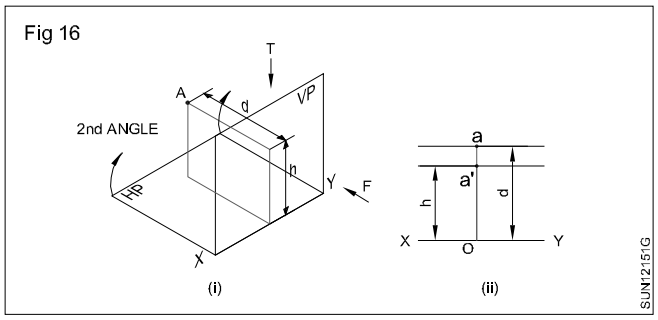
The projectors of a point when it is placed in 1st quadrant is shown in Fig 15.

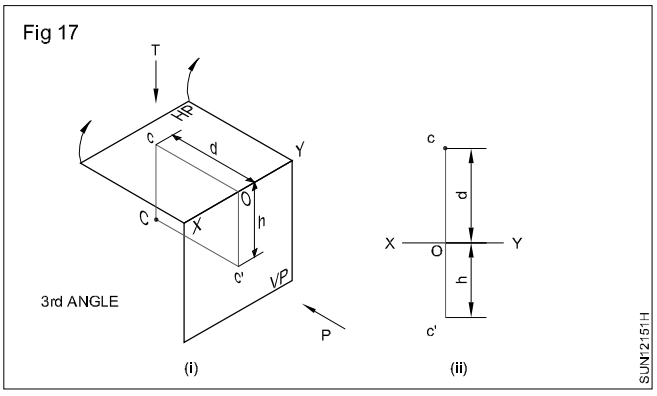
At Fig 15 (i, ii, iii), the two planes forming the quadrant are in horizontal and vertical position whereas at Fig 16, the two plans lie on the same plane. (After rotating the HP clockwise).

Figure 17 shows the projection of the point only as it is customary not to show the planes of projection.

The projector of the point on VP is marked as c' and the projection point on HP is marked as c. The distance 'h' and 'd' are also shown in these figures.







Marking conventions in Orthographic projections: In all the examples in plane and solid geometry the following conventions are practiced.

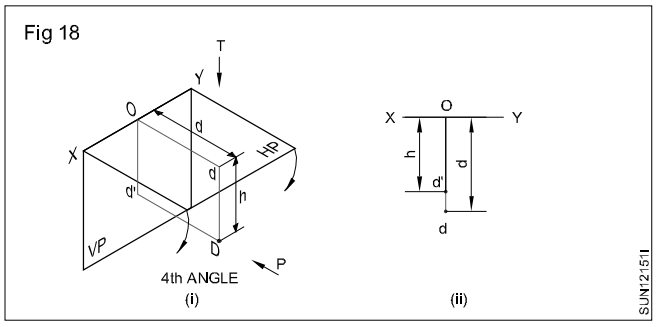
– The intersection line of VP and HP is marked as XY.

– The point to be projected is marked by capital letters and its projections are marked with corresponding small letters.

Example

In figure 15 point to be projected is marked 'A' and its projections are marked as 'a' in HP, a' and a" in VPI and VPII. In this figure VPII is not shown. Hence a" will not be seen. It may be noted that the distance a'. 0 is equal to the distance 'h' of the point from HP. Also the distance a0 is equal to the distances 'd' of the point from the vertical plane.

Projection of the points when it is placed 2nd, 3rd and 4th quadrant is shown in a similar way at i & ii in figures 16,17 & 18.



Projection on a third plane: In our study of making orthographic views, so far we had considered projection only on two mutually perpendicular (one HP and one VP) planes. Sometimes it will be necessary to have projection on additional planes also.

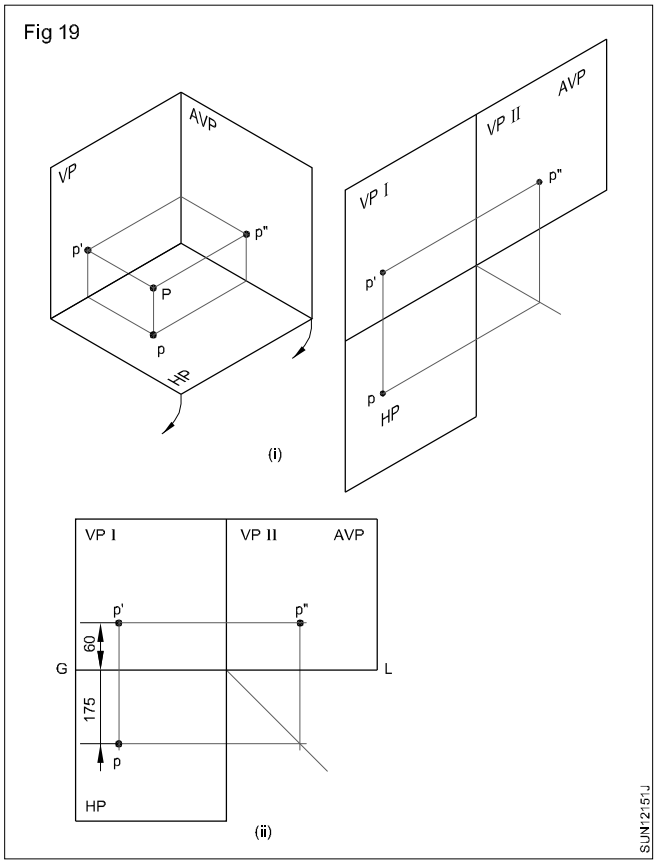
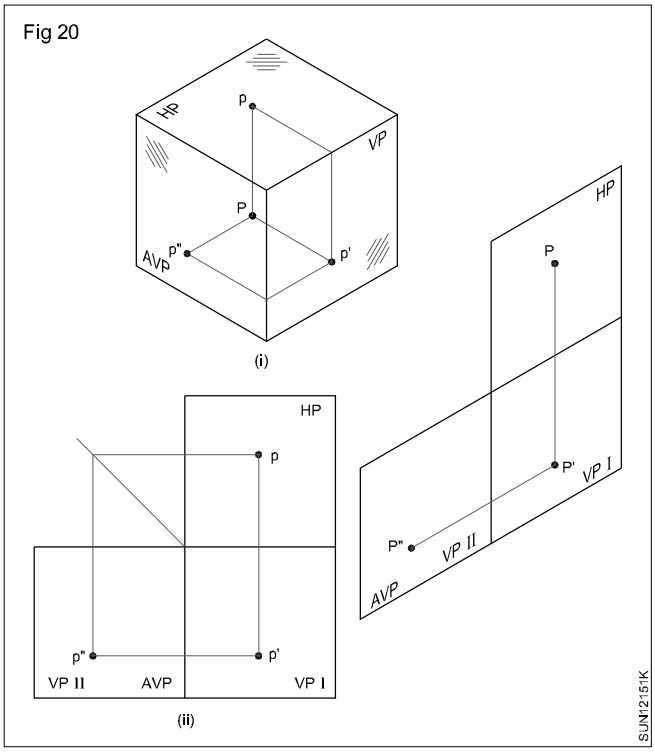
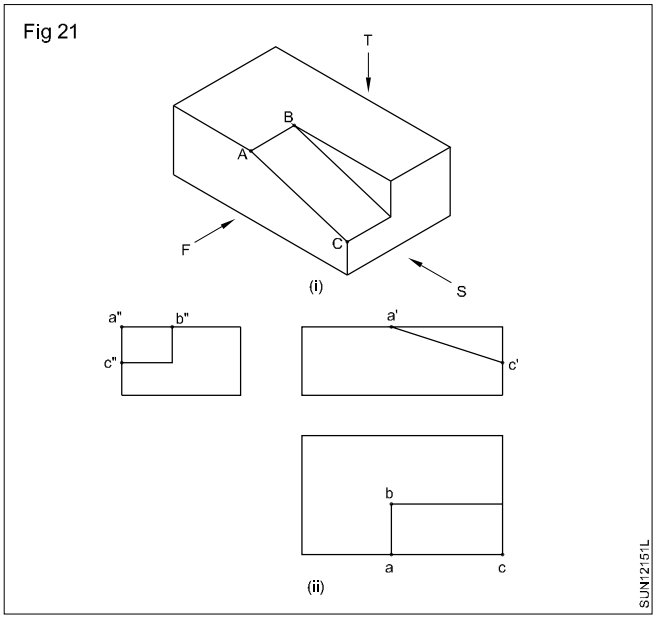


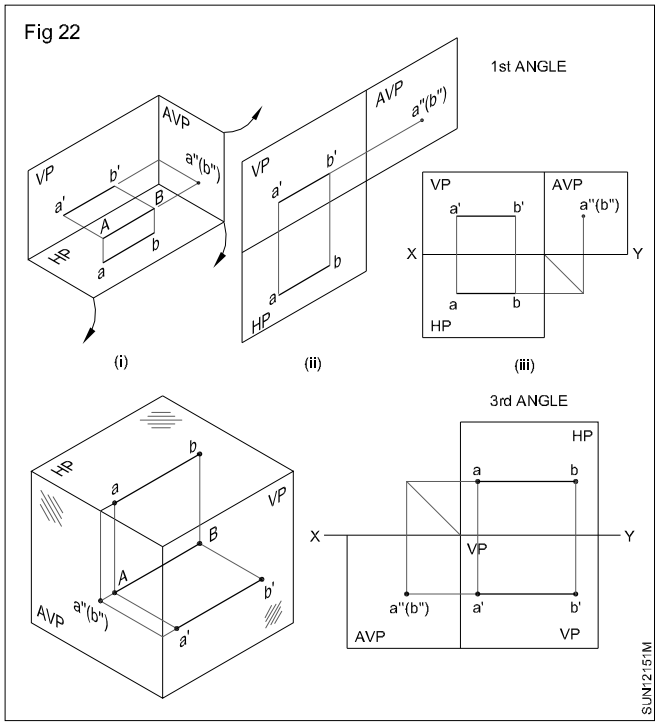
Figure 19 & 20 shows one more plane added to the two planes forming the first angle and third angle (first quadrant and third quadrant) and the projection of a point 'P' on all these planes. The added plane is marked as VPII. VP II and HP are rotated to lie in the same plane (Fig 19 & 20) as VPI. We know that the projection on HP is called as plan or top view and the projection on VPI is the front elevation. The third view on VPII is called side elevations while VPI and HP are called as principle planes, the additional vertical plane (VPII) is called as auxiliary vertical plane. The principle projection of a point as it is applied to a solid part is shown in Fig 21 i & ii.





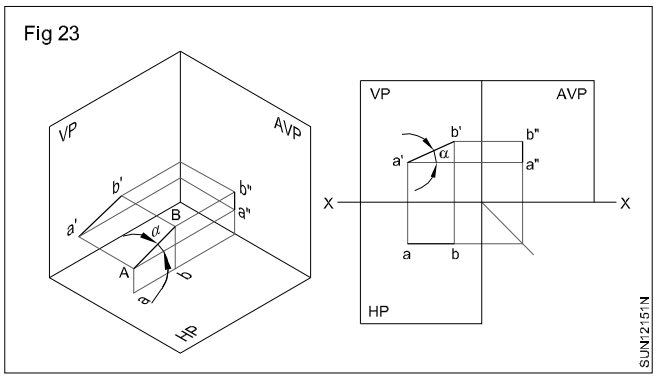
Projection of a line: A straight line connects two points. In otherwords the line has a start point and one end point.

By projecting start point and end point as discussed earlier and joining them we get the projections of a line. However the following points should be noted as guidelines.



– If a line is parallel to the plane of projection, the projection will be of the same length as that of the line. (Fig 22)

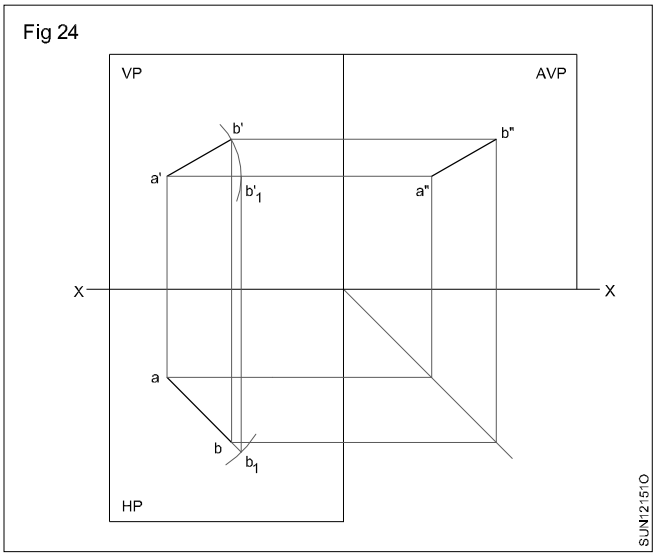
– If a line is perpendicular to the plane of projection, it will be a point.



– If a line is inclined to the plane of projection, its projection is smaller in than the actual length of the line. (Fig 23)

– If the line is inclined to all the true planes i.e plane of projection (HP, VPI and VPII) its projections will be of in smaller than the actual length of the line in all the three planes. (Fig 24)

Fig 24



Projection-orthographic views of prisms, cylinder,pyramids,cone, frustum of cone and sphere

Objective: At the end of this lesson you shall be able to
- **draw orthographics .**

Geometrical solids

Solids: Solids are the objects which have definite shape, size and occupies certain space. They have three dimensions viz., length, breadth or width and height. According to their shapes. They are classified into two groups.

– Polyhedra

– Solid of revolution

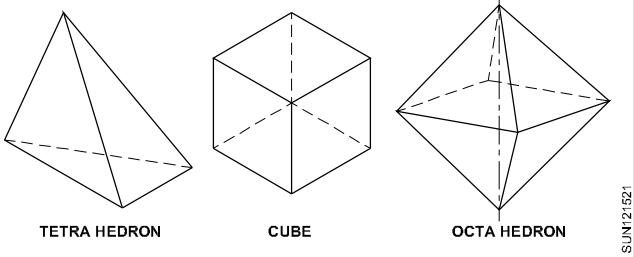
Polyhedra: are solids having (poly-many) more than three flat surfaces called faces. The ends of surfaces meeting with each other are called edges. When the faces are identical to each other, they are called `Regular Polyhedra'. Depending on the number and shape of faces regular polyhedrons are named. Of the many regular polyhedrons three are defined below:

Tetrahedron: A solid having four equilateral triangular faces solid having least number of flat surfaces.

Cube or Hexahedron: A solid having six regular square faces.

Octahedron: A solid having eight equilateral triangular faces. (see Fig 1)

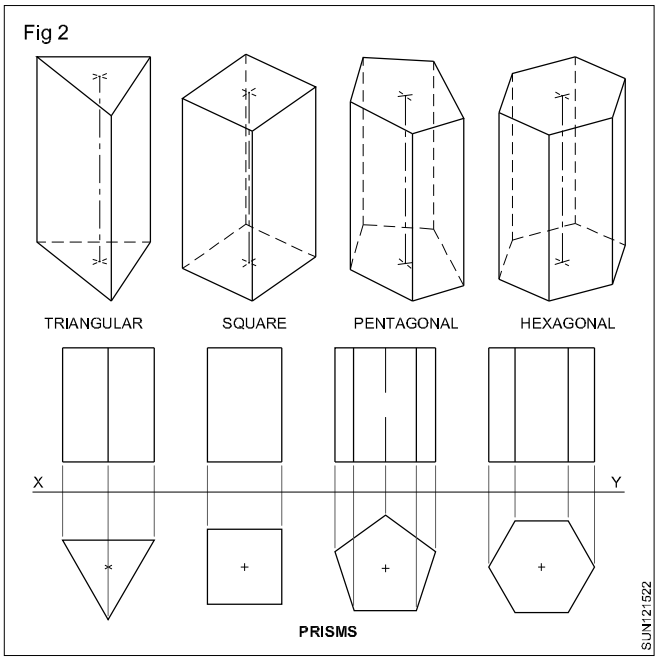
Fig 1



When solids are not composed of identical surfaces, such polyhedrons are either Prisms or Pyramids.

Prism: Prism is `Polyhedron' having two identical end faces. The top and bottom base surfaces are joined by parallelograms or rectangular surfaces. Imaginary line joining the centre of the end faces is called the axis. The axis is right angles to the end faces. Prisms are in general designated according to the shape of the end faces. Eg. Square, rectangular, triangular, hexagonal, pentagonal, octoganal (Prisms) etc. Prisms are right or oblique, the axis of regular prisms is at right angles to the face. Whereas in oblique prisms the axis is inclined to the end face. (Fig 2)

Fig 2



Pyramids: Pyramids are polyhedra solids having a base surface whose shape may be triangular, square or polygon and as many slant triangular faces as there are sides in the base. All the slant triangular faces join at a common point called APEX.

Similar to prisms, pyramids also are known by the shape of their base viz triangular, square, rectangular, pentagonal, hexagonal etc. The imaginary line joining the centre of the base to the apex is called the AXIS.

Fig 3 shows some pyramids and their views.

Solids of revolution: When a plane figure revolves about an axis a solid is generated.

Example

The solid shown in the Fig 4 is formed by the revolution is formed by the revolution of the plane (Fig 4A) abc about the axis ab.

Geometrical solids like cylinder, cone and sphere are solids of revolutions.

Cylinder: When a rectangle rotates about one of its sides a cylinder is generated.

Cylinder has two flat circular faces and a curved surface. (Fig 4B)

Fig 3

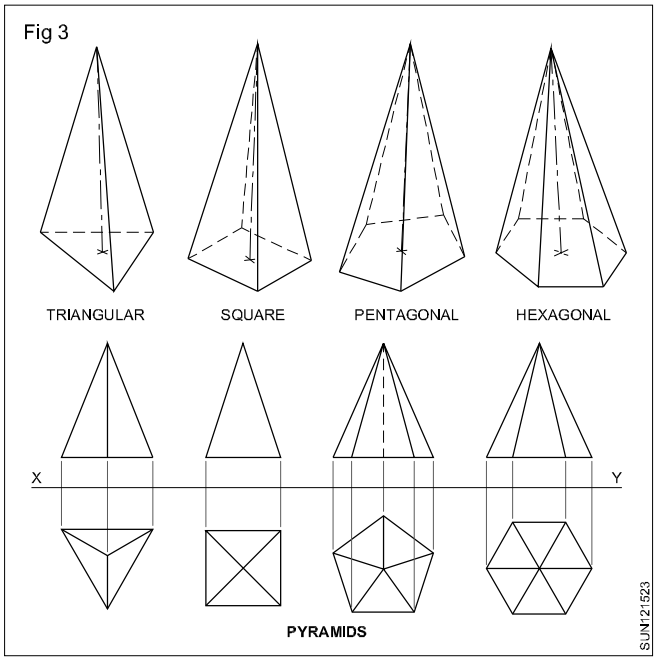
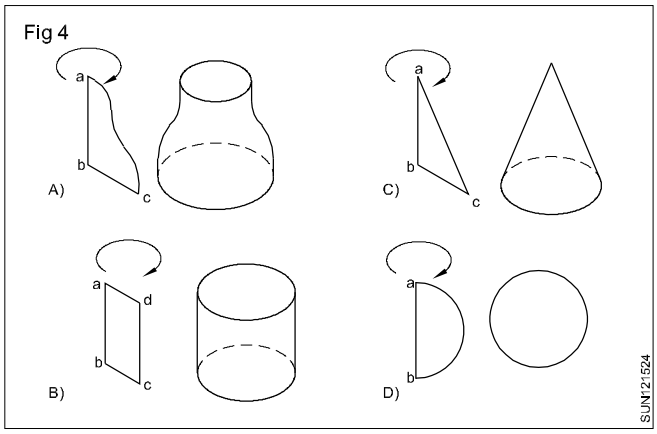


Fig 4



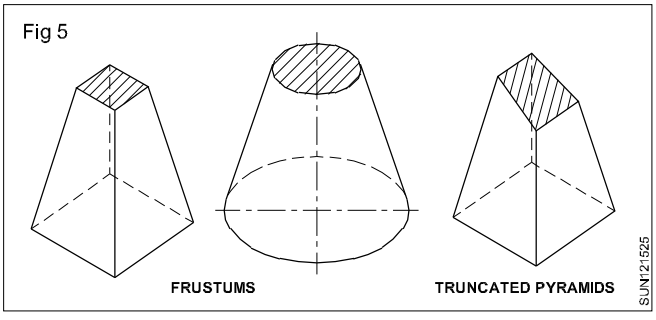
Cone: When a right angled triangle revolves about one of its side forming the right angle, a cone is generated. Cone forming has a circular face and a slant curve surface. (Fig 4c)

Sphere: When a semi-circle revolves about its diameter a sphere is generated. A sphere has no flat surface. (Fig 4D).The term solids of revolution is a mathematical concept and a physical requirement in geometry.

Frustums: Pyramid/cone is cut parallel to the base and the top portion is removed. The remaining bottom portion is called frustum of a pyramid/cone.

If the cutting plane is at an angle to the axis/base, of the pyramids or cone they are called "Truncated pyramids or cones". Fig 5 shows frustums and truncated pyramids.

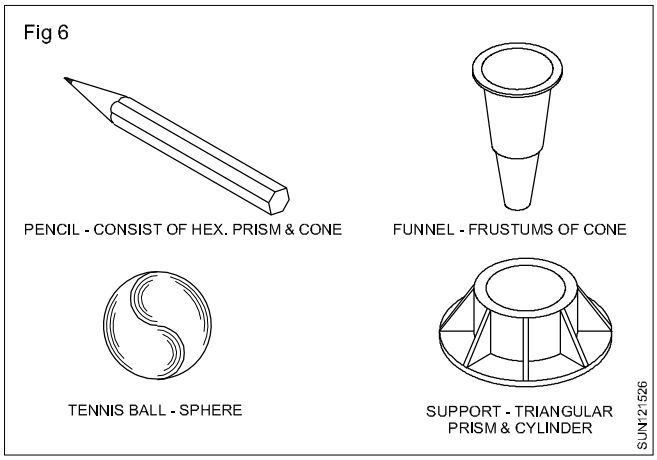
Fig 5



All items we use are solids. Their shapes may confirm to individual geometrical solids like prisms, cones or other combination.

Figure 6 shows some such items.

Fig 6



Views of solids: When dealing with projection of plane figures earlier was stated that solids are enveloped by planes and therefore drawing the views of solids would actually mean drawing the views of planes the solids are composed of.

The faces of solids which are parallel to the planes of projection will be seen in true shape in the respective planes. When planes are not parallel to the plane of projection the views will have a disorted look.

Figures 7,8,9,10,11,12 & 13 indicate the plan, elevation and end view of some solids for the position defined against each.

While drawing the views of solids all the edges of solids may not be visible in the views concerned. For example in the figure shown the edge will not be visible in the front view. Such edges are referred as hidden or invisible edges. All visible edges in a view are drawn usually thick lines. But, invisible edges are drawn using dotted lines of medium thickness. (The thickness of dotted lines is inbetween thickness of thick lines and construction lines) Dotted lines are short dashes.

In some cases it is required to show the axis of solids. Axis is represented by another type of line called centre line.

Fig 7

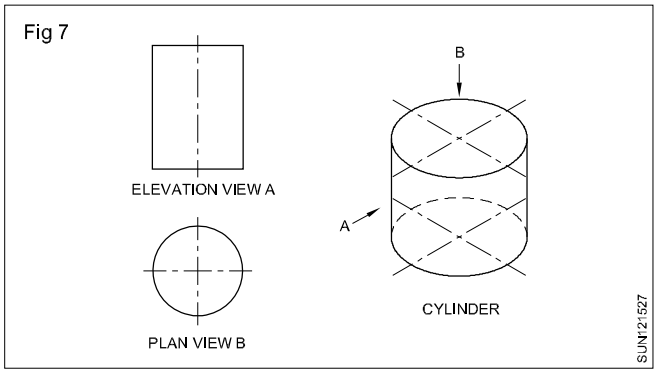


Fig 8

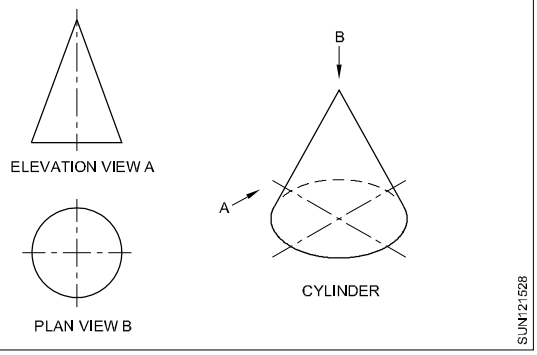


Fig 9

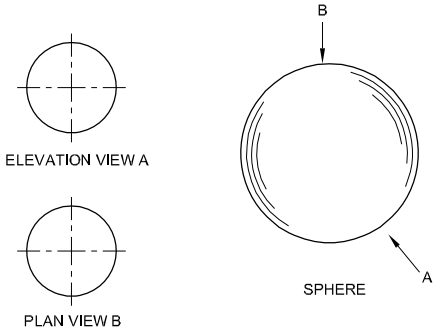


Fig 10

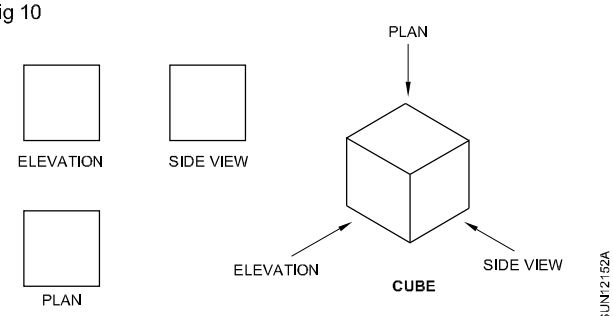
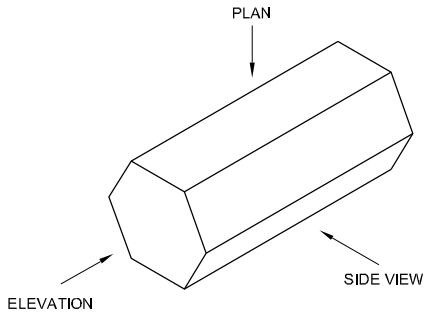


Fig 11



Centre lines are thin lines consisting of alternating, alternate long and short dashes. (Figs 14,15 & 16)

Fig 12

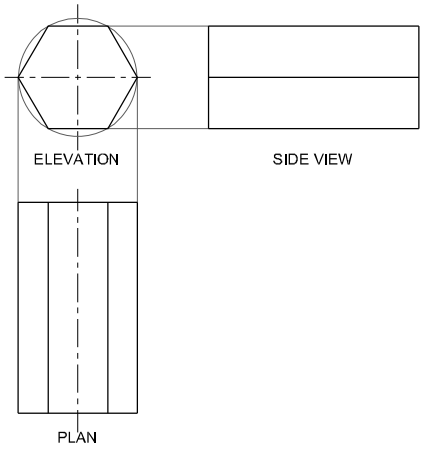


Fig 13

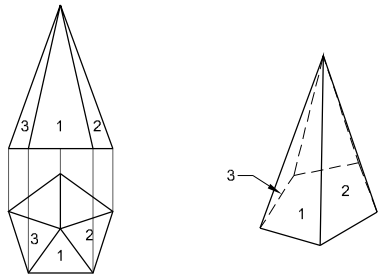


Fig 14

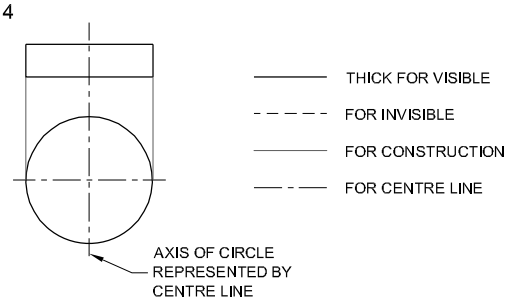


Fig 15

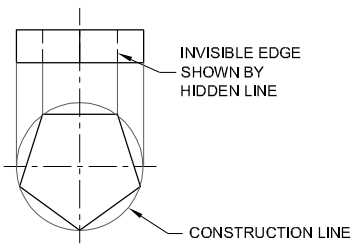
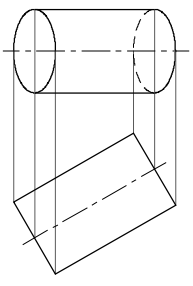


Fig 16



Projection of plane figures

Two dimensional and three dimensional figures: We know that solid object are enveloped by surfaces, while solids are classified as three dimensional surfaces and implies volume and two dimension implies area.

When we draw orthographic views to represent solids in effect, we are drawing the projection of the solids.

Types of surfaces (Fig 1)**:** Surfaces may be flat or curved. Flat surfaces are also referred as planes. (Plain surfaces) Flat surfaces, depending on their orientation, may be vertical, horizontal or inclined. Fig 1 shows a solid and it has flat surfaces and curved surfaces. Flat surfaces are marked as F_1,F_2 etc.

Surfaces F_1,F_4,F_6,F_8,F_9,F_{10},F_{12},F_{13} and F_{14} are vertical surfaces.

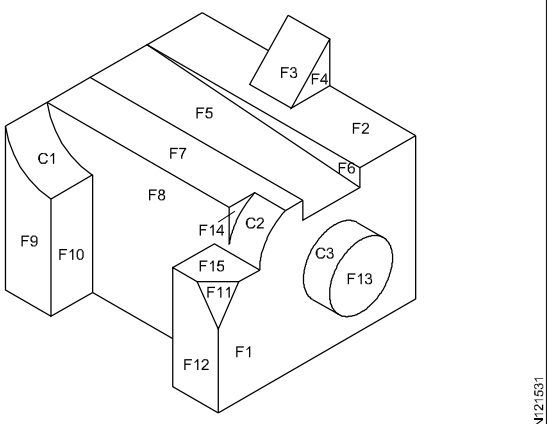
F_2, F_7 and F_{15} are the horizontal surfaces.

C_1,C_2 and C_3 are the curved surfaces.

F_3, F_5 and F_{11} are inclined or oblique surfaces or their combination.

For example in F_3 is rectangular while F_{13} is circular. But surface F_1 is a combination of several plane figure.

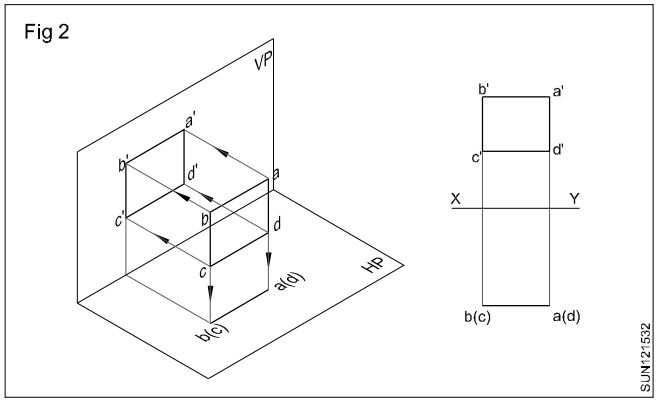
Fig 1



Projection of Flat surfaces: While drawing the projection of surfaces (plane figures) the following points should be noted.

If the surface is parallel to the plane of projection, the resulting projection will be the true shape of the surface. (Fig 2)

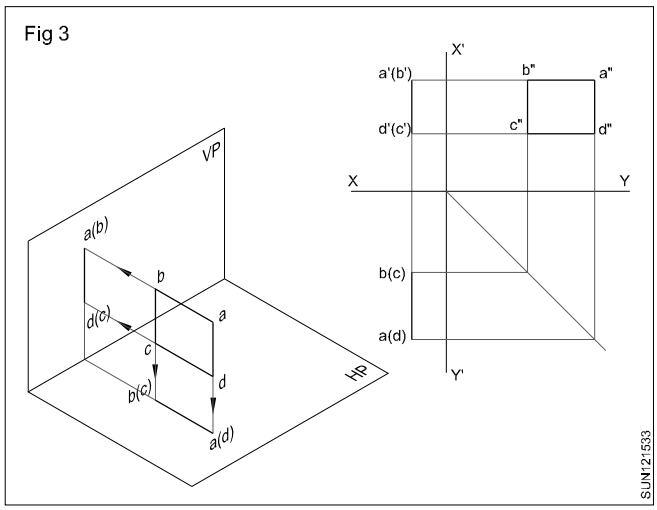
Fig 2



True shape: When the projection of a surface is identical to the surface projected, the projection is said to be of true shape.

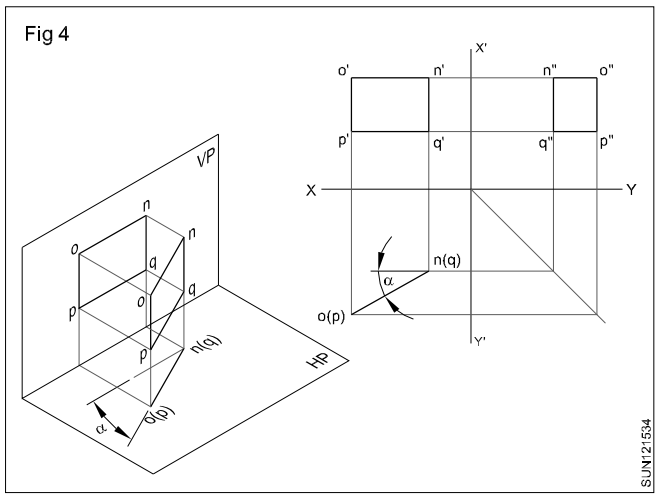
When the surface is perpendicular to the plane of projection, the resulting projection will be a straight line. (Fig 3)

Fig 3



If the surface is inclined to the plane of projection, its projection will not have the true dimensions. They are fore shortened. (Fig 4)

Fig 4



Foreshortened view: Where the projection of a surface is not identical to the surface projected, the projection is said to be foreshortened.

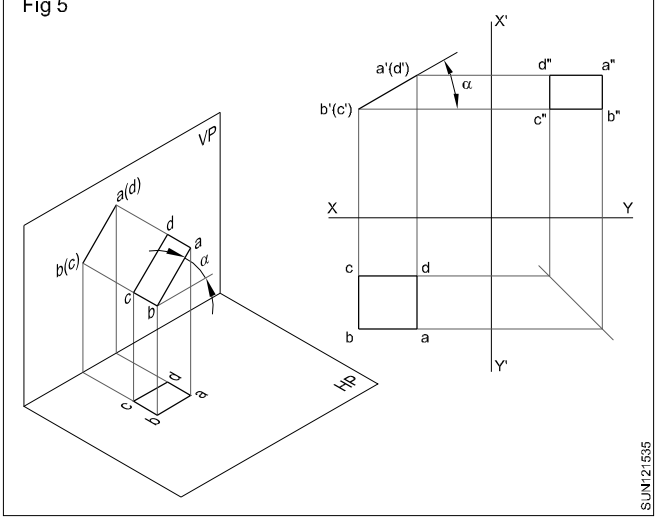
In figure 4, the length pq or the length on is of true length in plan, but in front elevation and in side view same is foreshortened in a different way according to the inclination of the surface to the plane of projection.

If a surface is inclined to a vertical plane, the angle of inclination will be seen on HP and vice-versa. (Fig 4)

If a surface is inclined to horizontal plane the angle of inclination will be seen on VP and vice-versa. (Fig 5)

Guidelines to be followed: The intersection (folding lines) between HP and VP is marked as XY whereas the intersection between VP and AVP is marked as X'Y'. (Fig 5)

Fig 5



In exercises/problems wherein the distances of the object (point, line, surface) from HP, VP and AVP are not given but a convenient distances may be assumed and followed.

Terminology of views/projections:

– The view projected on HP is termed as plan or top view.

– The view projected on VP is termed as elevation or front elevation or front view.

– The view projected on AVP is termed as side view or end view or side elevation or end elevation.

Visualisation

We had done the exercises on projection of plane surfaces and solids with the ultimate objective of applying it to describe the shape of an object on plain paper. We know that a surface parallel to VP will be seen in true shape in front view and as lines in side view and plan. Similarly the surfaces which are inclined to a plane will be seen foreshortened.

The example shown in figure illustrates the above points in a practical situation. The object in Fig 1 has eleven surfaces. Of them A,B,C,D,G,L & M are rectangular in shape where as E,F,H,K are combination of basic geometrical shape (rectangle and triangle). (Fig 2)

Fig 1

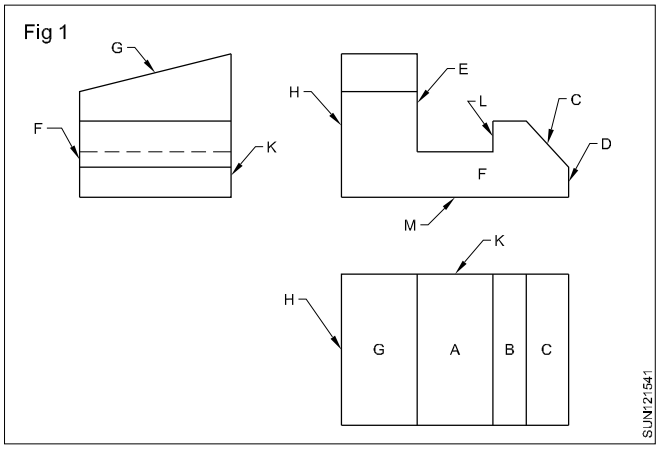


Fig 2

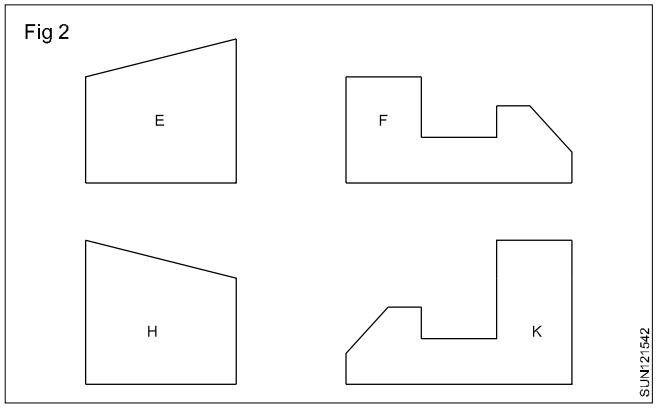
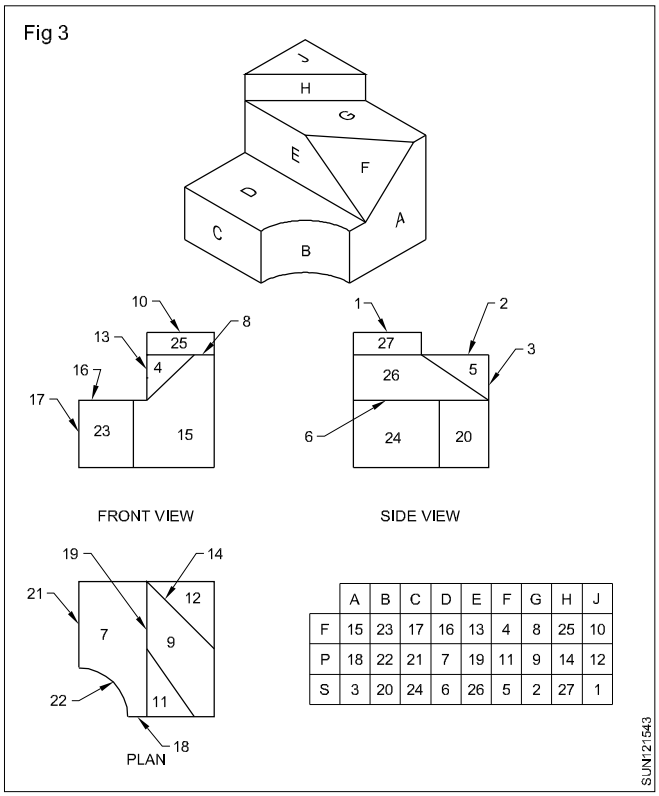


Fig 3



	A	B	C	D	E	F	G	H	J
F	15	23	17	16	13	4	8	25	10
P	18	22	21	7	19	11	9	14	12
S	3	20	24	6	26	5	2	27	1

As per the principle explained in orthographic projection, all the 11 surfaces of this object will have its representation in all the three views. For example surface will be seen as surface in front view where as it will be seen as single line in end view and plan and so on. These principles are further illustrated. In Fig 3 both the isometric view and multi views of a block of an object are given. The table given along is to identify the line that indicates the various surface. Note that the surface 'F' in isometric view is as surface itself in all the three views. The inclined surface 'H' is seen as a surface in end view and front view. Similarly the curved surface 'B' is seen as flat surface in front view and end view. Only in plan it is seen as a curved line.

Visualisation

In the context of engineering drawing visualisation means studying a multi view drawing and forming a mental image of the shape of the object.

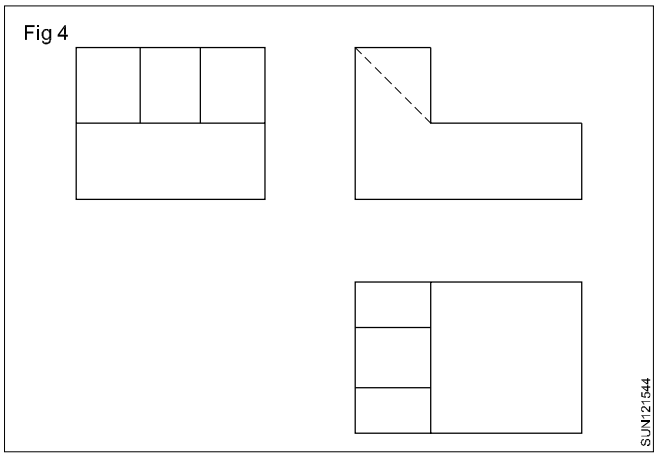
It has been mentioned before, multi view drawing has no 3D effect and do not convey the shape in the first sight itself. One has to recall the principles of projection and analyse each view and do his own reasoning in order to conceive the shape.

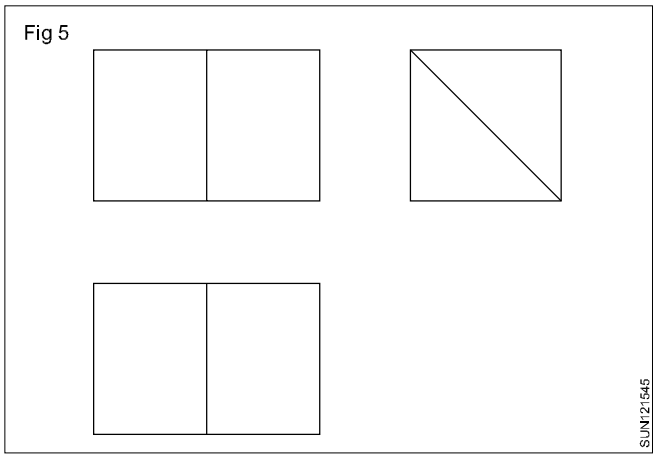
Visualisation is definately not that easy when it comes to difficult shape. A craftsman makes simple drawing, but it is not an indication of his ability to visualise the shape of the object.

In order to manufacture a component, the shape of the component must be understood in unmistakable terms and all those who are associated with manufacturing must be able to visualise the part from its multiview drawing. Ability to read drawing quickly is an added advantage to any engineer/technician and it will help them to go up in professional ladder.

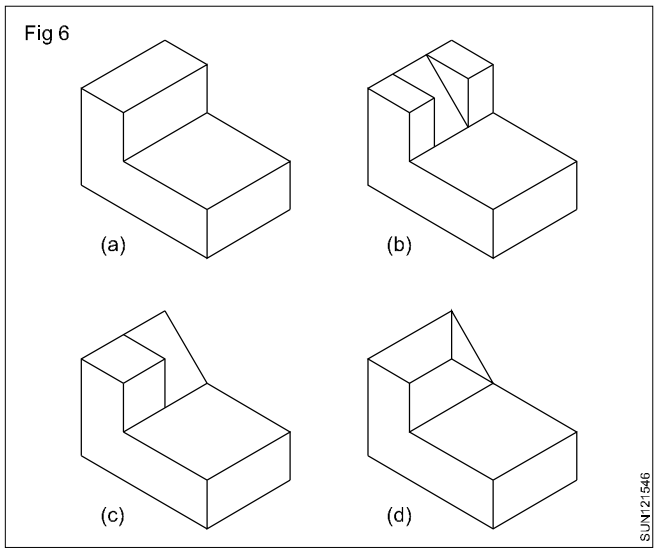
Visualisation procedure: There is no one set of rules to read and visualise the shape of an object from the given multiview drawing. Visualisation is essentially the reverse of the mental process that is gone through for obtaining the shape of the object.

To begin with, choose the view that tells the shape of object most. If no view could be set to be choosen, start from any view. Consider the Figs 4 & 5.



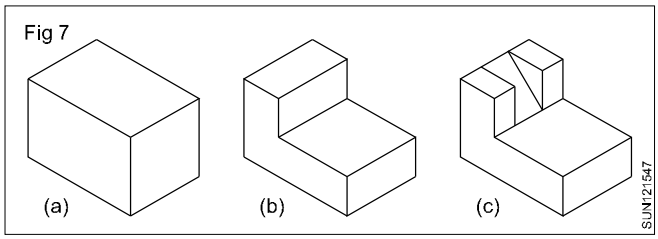


In Fig 4 we can choose the front view first. In this view overall shape of the object is reasonably reaches the mind. Whereas in Fig 5 we start from any view. None of the view is specifically telling anything special. Using the detail available in the view so choosen imagine a shape that fits the view most. For example the front view in Fig 4 but for the inclined hidden line the shape would have been as at Fig 6a.

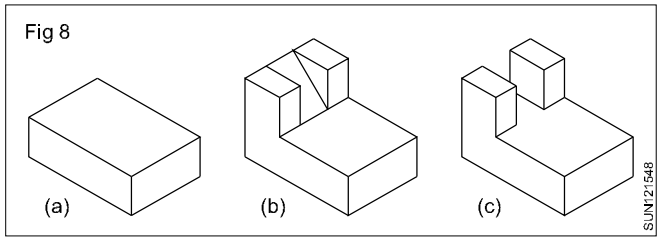


The presence of the hidden line in the front view gives rise to three different possibilities as shown at Fig 6.b,c,d. Now on comparison with the other two views we can eliminate the possibilities that do not match with side view and plan of the object. After the elimination exercise Fig 6b matches with the side view and plan and hence the figure at 6b is the isometric view of the object.

Modelling: When it is difficult to form a mental image one can resort to modelling by means of isometric sketching. This can be done in two ways. Get the area dimensions of a prism Fig 7a that encompasses the object represented by multiview and then draw its isometric view by cutting away the portion of the prism as required till we satisfy with the given views. Fig 7 b &c.



Instead of cutting away, we can also form the object by adding or joining method as shown in Fig 8 a,b,c



Yet another way to assist in visualisation is to model the object using suitable material. For example thermocole, soap, modelling clay etc. are very handy for this purpose. Modelling can also be done either by cutting away technique or by joining technique.

Constant practice is the only key to improve the visualisation ability or skill and hence there is no limit to the number of exercise one has to do to achieve this goal. It may noted that sometimes a well experienced person may get stuck while reading some complicated drawings.

Taking into account the importance of this aspect different types of exercises are devised. Some of them are

– identifying lines and surfaces
– adding views to the given views
– drawing isometric views using multiviews
– identifying missing lines
– finding number of views to the given one or two views
– question answer type

You will not come across the problems given in this exercise in any job drawings/industries. But these are given purely to improve the capability of visualising the shape of any object from the given multiviews.

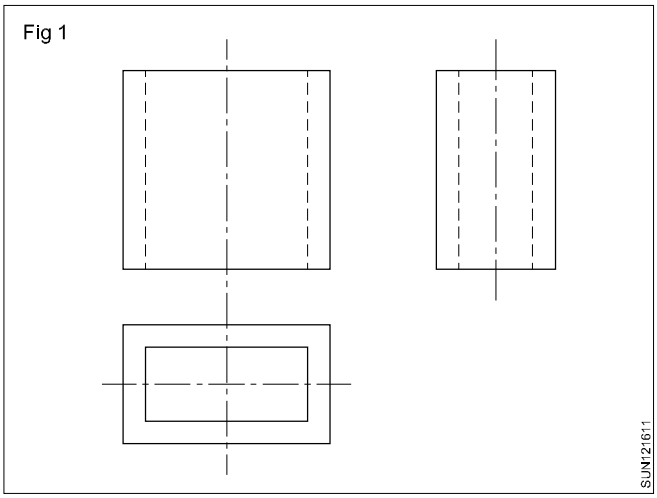
Sectional views

Objectives: At the end of this lesson you shall be able to
- **state sectional views**
- **state type of sections**
- **state the hatching techniques.**

In the normal Orthographic views (plan, elevation and side view), the internal details, their features and relative positions which cannot be seen are shown by dotted lines.

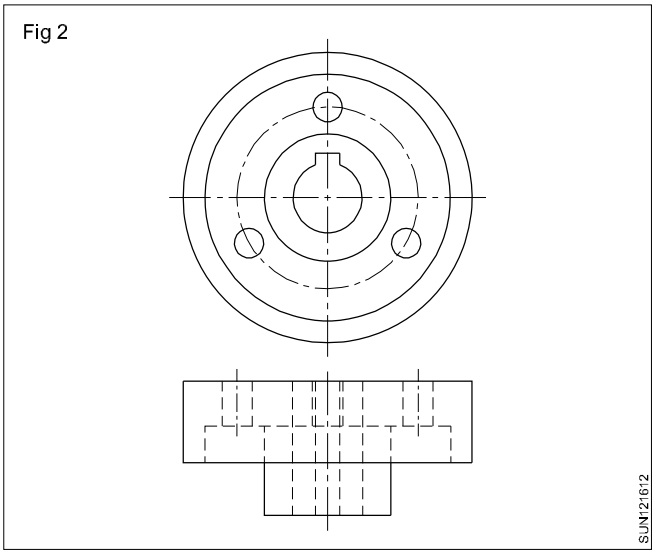
For example in the object shown in figure 1 the hole is invisible in the elevation and side view. Hence it is represented by dotted lines.

Fig 1



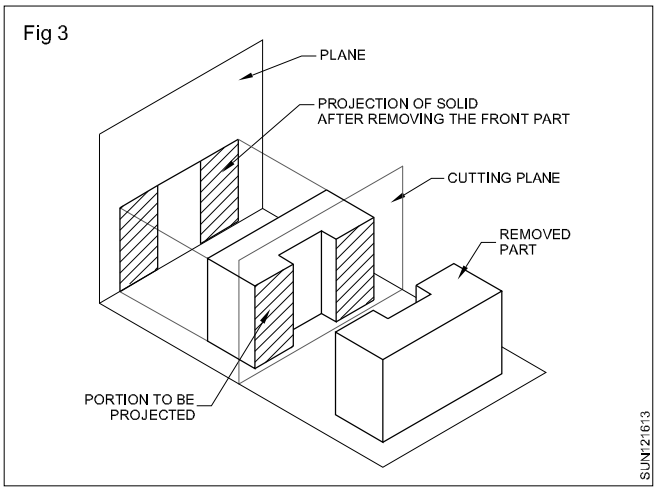
When there are too many dotted lines in a drawing (Fig 2) it is difficult to conceive the details of the object. In such a cases, details can be shown clearly and reading of drawing can be made easier by resorting to what are known as "Sectional views".

Fig 2



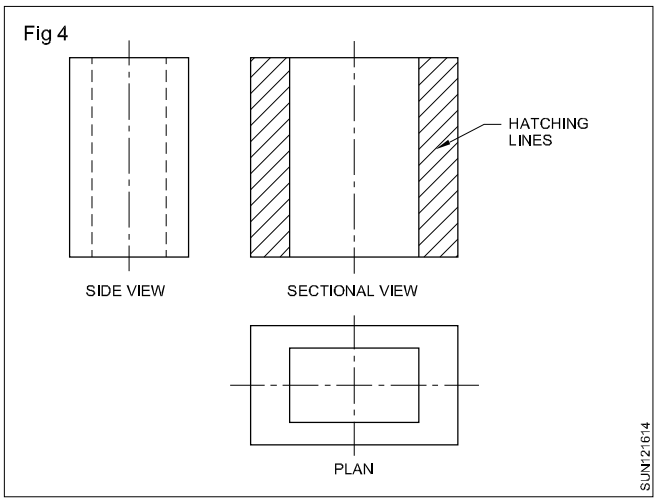
Sectional views: For obtaining sectional views an object it is assumed to be cut by an imaginary plane called cutting plane. The part between the cutting plane and the observer is assumed as removed to reveal the internal details. Then the projection of part left out is projected/ drawn as usual and the view thus made is the sectional view. (see Fig 3)

Fig 3



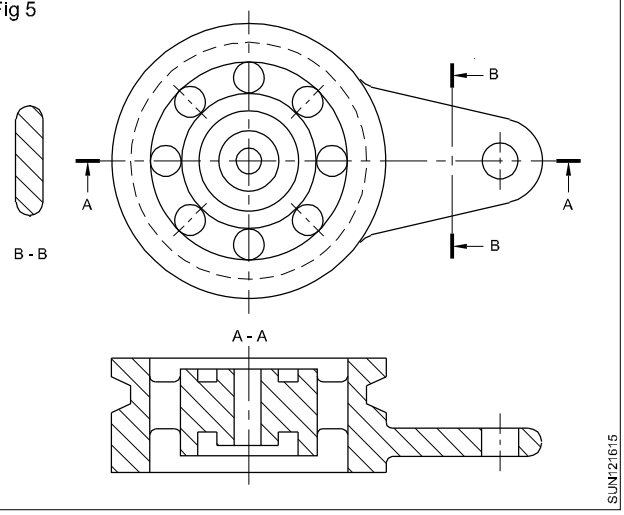
To distinguish a sectional view the surface formed when it is cut by the cutting plane is "hatched". (Fig 4)

Fig 4



Hatching means filling the surface with equi-distant parallel lines.

Fig 5



It may be recalled that the object whose internal details are to be drawn are assumed as cut by an imaginary cutting plane passing through them. The part between the cutting plane and the observer is assumed as removed and the surfaces cut are shown by the inclined parallel lines called section lines. The cutting planes are normally indicated by two capital letters i.e A-A, B-B etc. shown in Fig 5.

Fig 5 shows the general features of sectional views.

The general rules for the arrangement of the views apply equally when drawing sections.

Types of sections: Depending upon the details to be revealed the position of cutting plane can have various orientations. According to the orientation of cutting planes, sectional views are classified as:

– Full-section

– Half-section

– Section through two or more parallel planes

– Section on contiguous planes

– Section on two intersecting planes

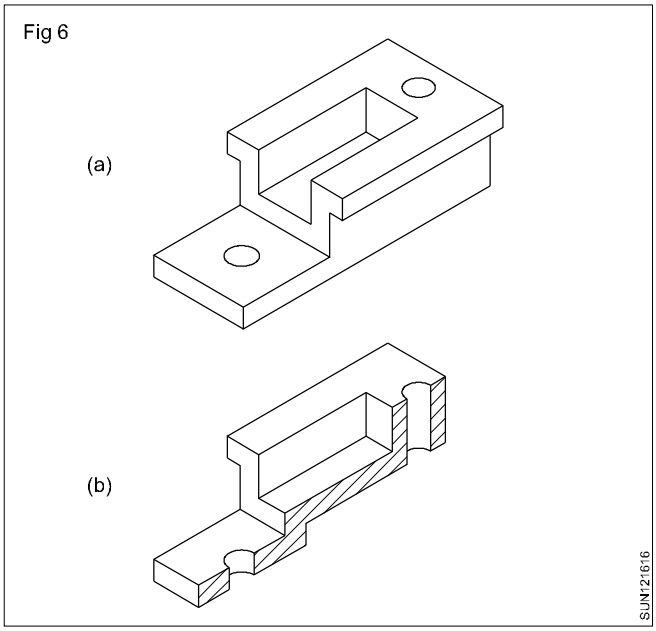
– Removed section

– Revolved section

– Local or broken section.

Full-section: The component is cut by a straight cutting plane is divided into two parts. The part between the cutting plane and the observer is assumed as removed and the view of the cut surface will be a full-section. (Fig 6)

Fig 6



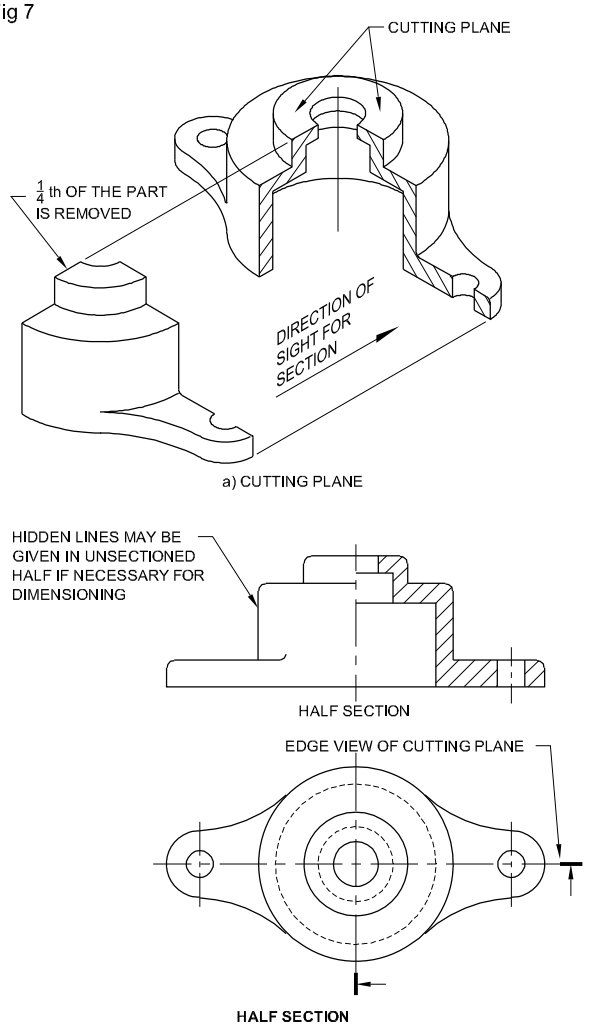
Where the location of a single cutting plane is obvious, no indication of its position is required. Where the locations is not obvious or where it is necessary to distinguish between several cutting planes, the cutting planes shall be indicated by means of thin chain line, thick at ends and change of direction.

Cutting planes are normally parallel to VP and sometime to HP or oblique also.

Half section: When a component is symmetrical it is not necessary to draw a full sectional view. In such case one half of the view is drawn in section and the other half is shown as normal view. Thus in one view we show both the external and internal details. For half section, the cutting plane removes 1/4th of the part. (Fig 7)

Off-set section: When the features of the component/ object are not in one line a full-section or half-section does not reveal all the internal details. In such cases, the cutting plane is off-set as shown in Fig 8. The resulting sectional view is very much like a full-section expecting that the hatch area will not be in the same plane. In the sectional view in Fig 8 hatching line is staggered to indicate the change of plane.

Fig 7



Section in contiguous planes: Certain components such as shown in figure 9 are bent offset at different position. In such cases the cutting plane follow the contour of the part. Here the sectional view is more like a full-section even though the cutting plane is not a single plane. (Fig 9)

Section in two intersecting planes: To reveal the details of the slots and holes in the part shown in figure 10, we will need sectional views along two planes meeting at an angle. Strictly speaking we have to draw different views for both the section planes. However in such cases the view on one plane is rotated to align with the other plane and view for both the cutting planes are shown in one view. In figure 10 the view on cutting planes OY is rotated to align with the view on OX.

Note: Certain parts like arms, webs are not sectioned. The cutting plane is assumed as passing just outside parallel to it.

Fig 8

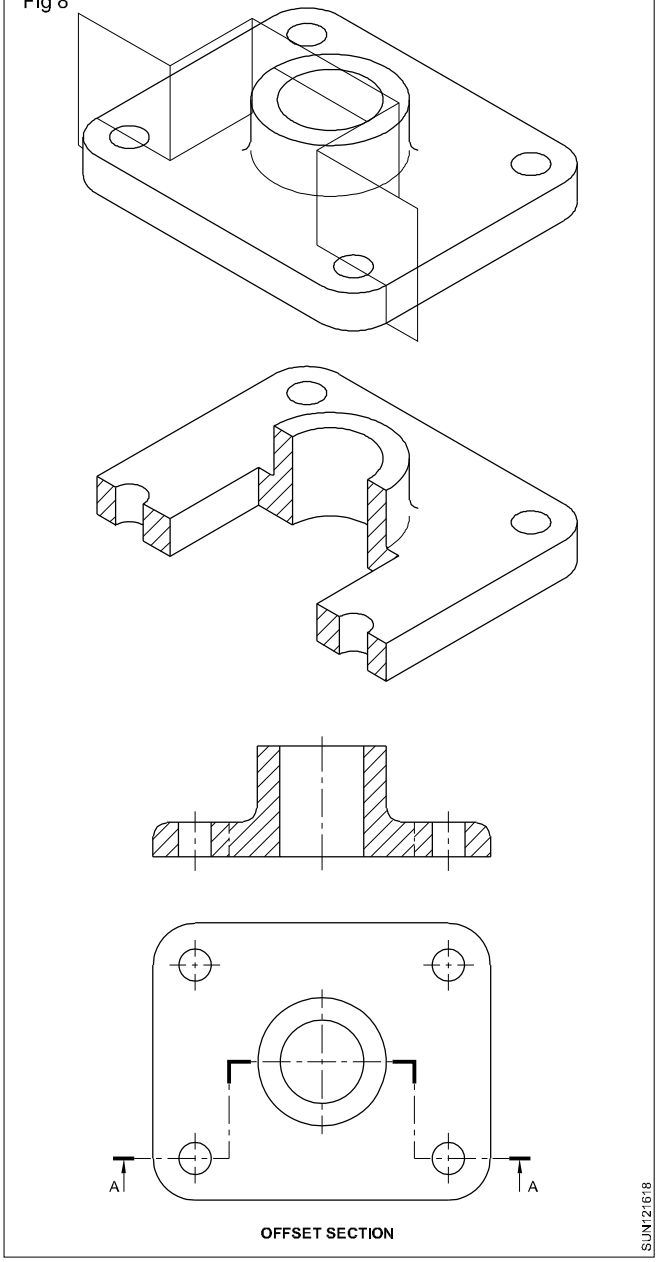


Fig 9

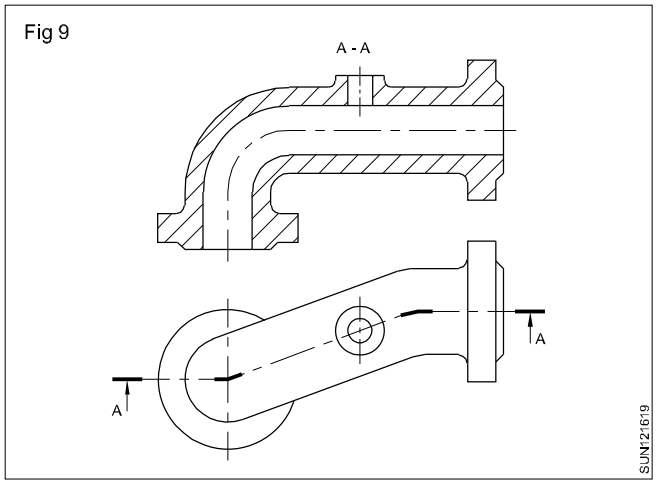
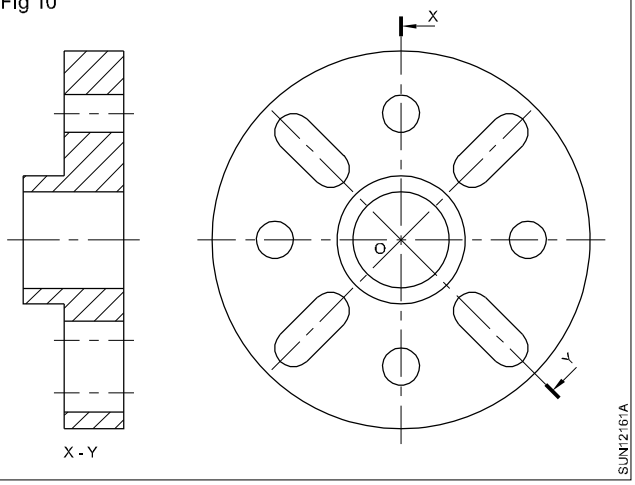


Fig 10



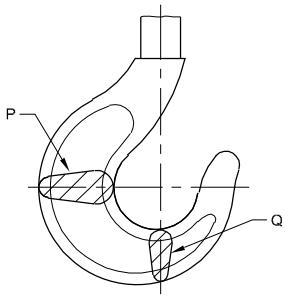
Revolved section: The sectioning methods discussed so far may not be sufficient to reveal the certain features of a part.

For example the crane hook shown in Fig 11 has varying cross-sections and this cannot be shown by any one of the sectional methods described earlier.

In such cases sections are taken at the desired position and the sectional view is drawn after as if the cut face is revolved as shown at P and Q in the figure.

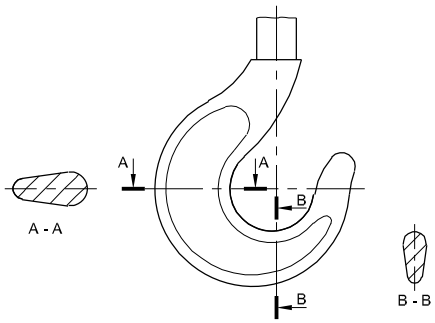
Note: The outline of the revolved sections shall be drawn in continuous thin out line.

Fig 11



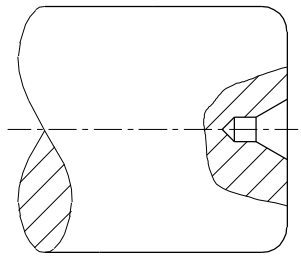
Removed sections: When the space does not permit to show the revolved section or it will be more clear if shown outside. The removed sections may be placed either near to and connected with the views by a chain, thin line or in a different position and identified in the conventional manner as shown in Fig 12.

Fig 12



Local or Broken section: It often happens that only a partial section of a view is needed to expose the internal details. Such a section is limited by a break line as in Fig 13 is called a local or broken or part section.

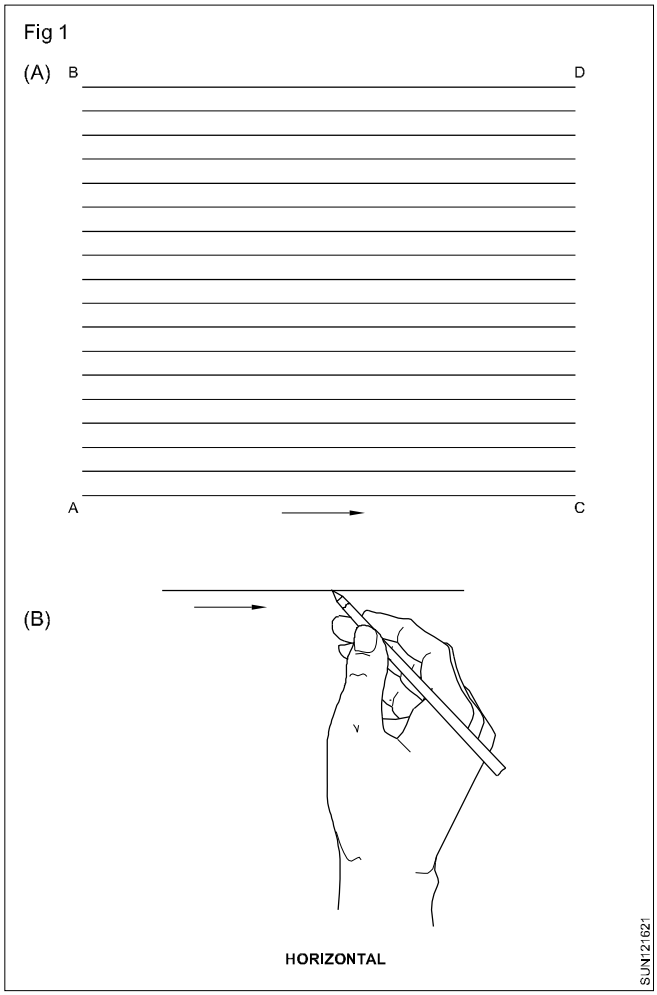
Fig 13



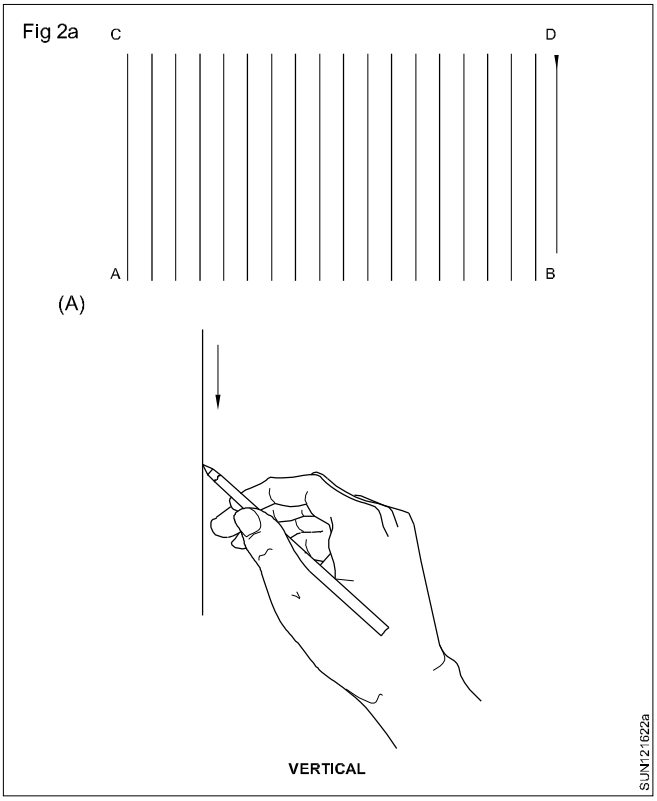
Hatching techniques

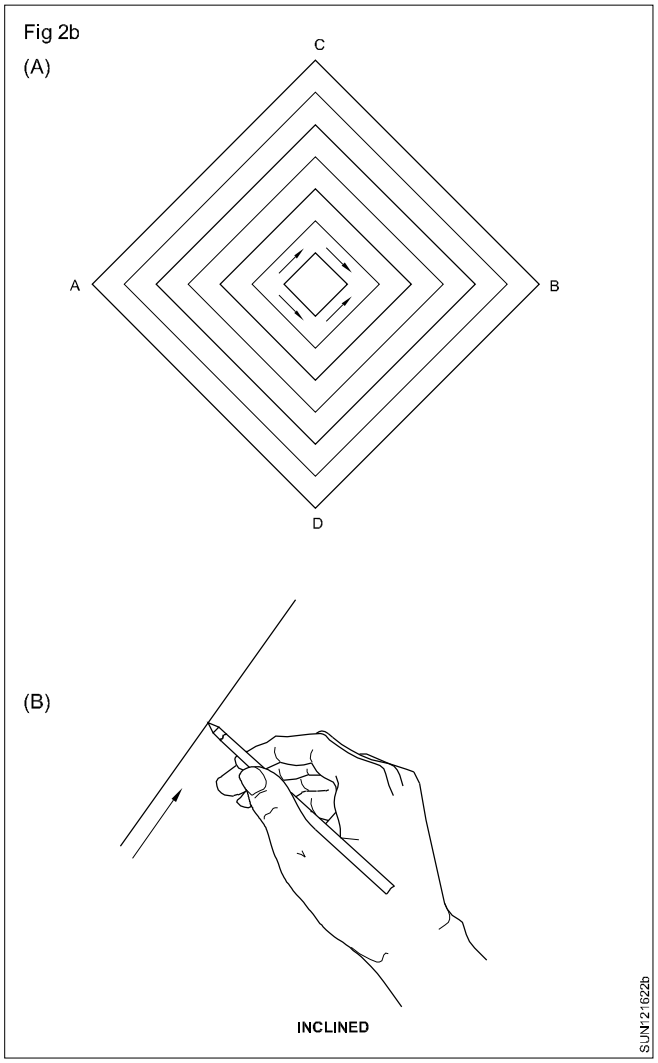
Hatching

Hatching angle: Hatching is used for making the sections evident. Hatching lines are thin lines and are usually drawn at an angle 45° to the horizontal and fill in the entire area undersection. But, depending upon the orientation of the area to be hatched the hatching lines may be horizontal, vertical or any convenient angle. (Fig 1)

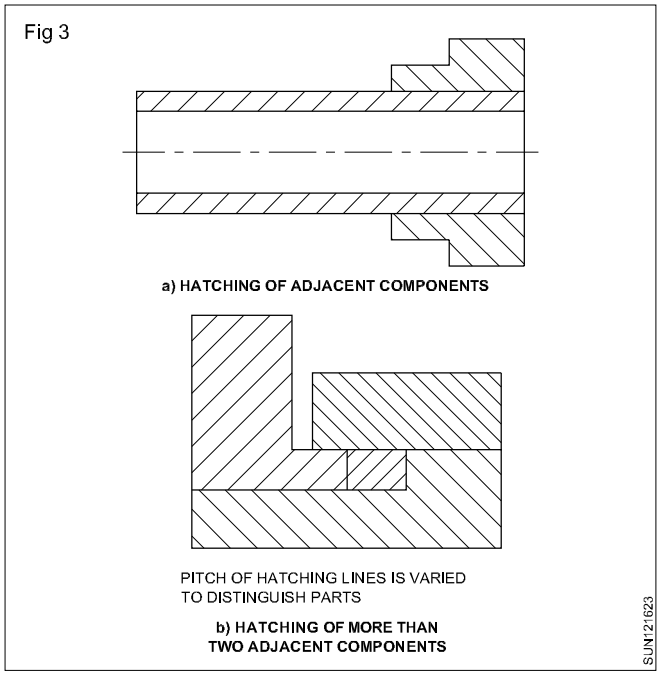


Hatching assemblies: While hatching mating parts of an assembly hatching lines are drawn in different direction as shown in Figs 2a & 2b.



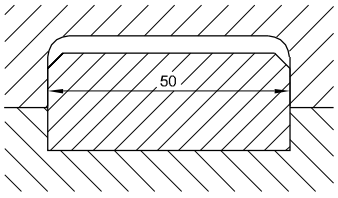


Hatching large areas: In the case of large areas, the hatching may be limited to a zone following the contour of the hatched area. (Fig 3)



Hatching areas in different parallel planes: Where sections of the same part in parallel planes (offset) are shown side by side, the hatching lines should be similarly spaced, but offset along the dividing line between the sections. (Fig 4)

Fig 5

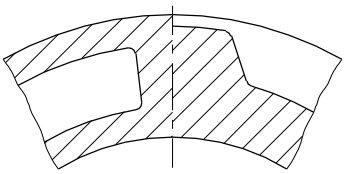


HATCHING INTERUPTED FOR DIMENSION

SUN'21625

Dimensioning within the hatched area: Hatching may be interrupted for dimensioning, if it is not possible to place these outside the hatching. (Fig 5)

Fig 4

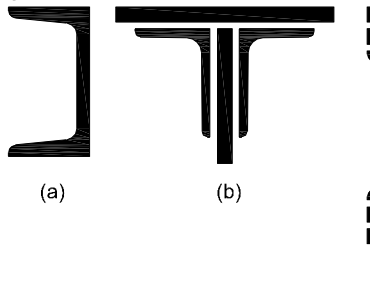


HATCHING OF A PART IN
DIFFERET PARRELLEL PLANES

SUN'21624

Thin sections: Thin sections may be shown entirely black. Thin space is left between adjacent sections of this type. (Fig 6a,b & c)

Fig 6



THIN SECTIONS

SUN'21626

Omission of hatching lines: There are several cases where hatching lines are deliberately omitted even though they are cut by the section plane. For example ribs/webs are not hatched to avoid a false impression of thickness and solidarity. (Fig 7a & b)

In some cases even though section planes passes through it is assumed as not cut. Hence, they are not hatched. Examples of these are rivets, bolts, nuts, shafts, balls, rollers, keys and pins. (Fig 7c)

Fig 8 & 9 shows the conventional method of sectioning of external thread and internal thread.

Fig 10 to 16 shows different sections such as section on one plane, section on two parallel planes and etc. The methods shown in these features to be applied wherever applicable.

Fig 7

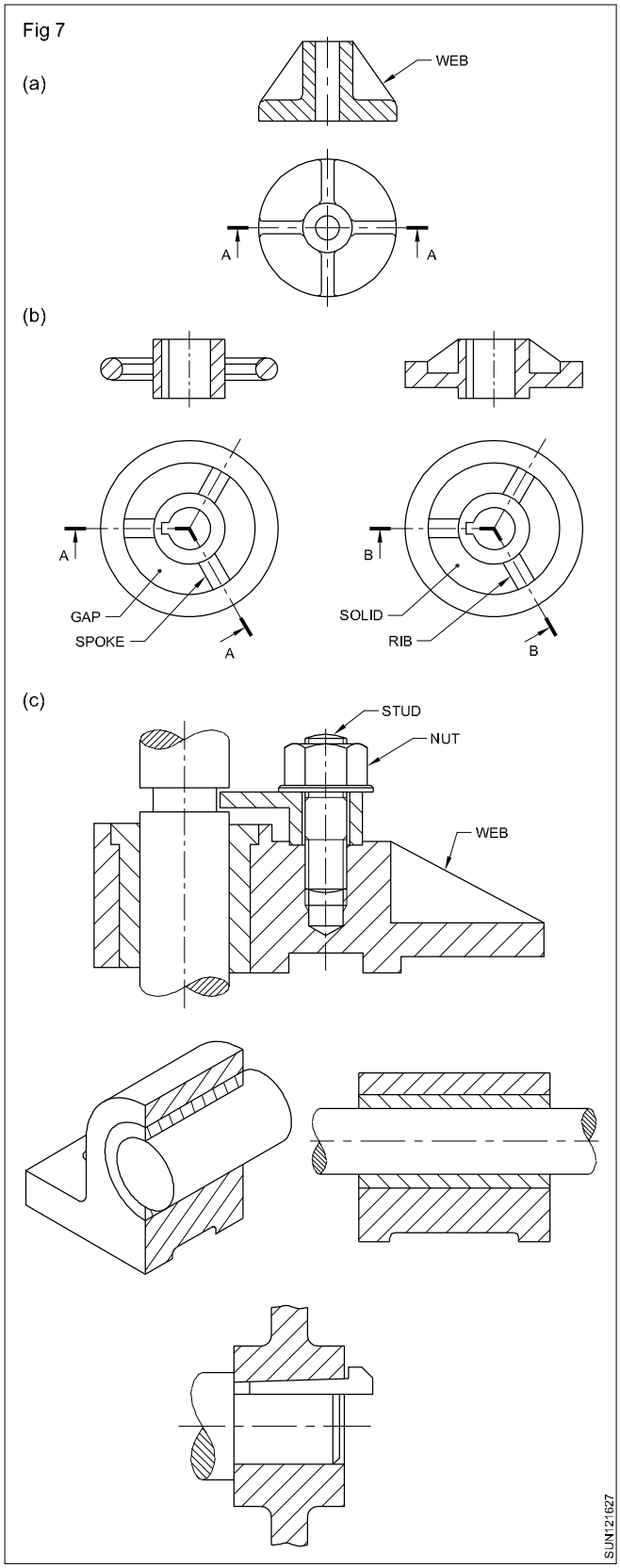


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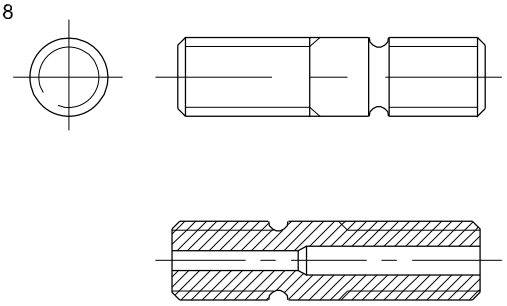
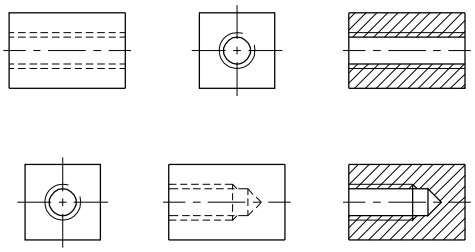
Fig 8



CONVENTION OF EXTERNAL THREAD

SUN'12'1628

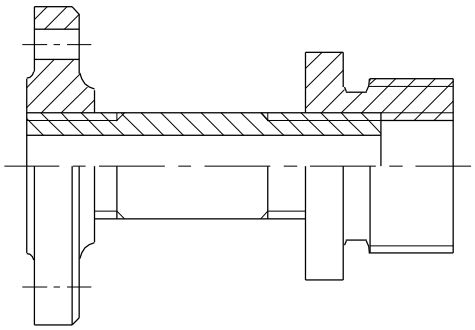
Fig 9



INTERNALTHREAD

SUN'12'1629

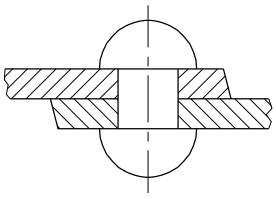
Fig 10



ASSEMBLY OF THREADED PARTS

SUN'12'162A

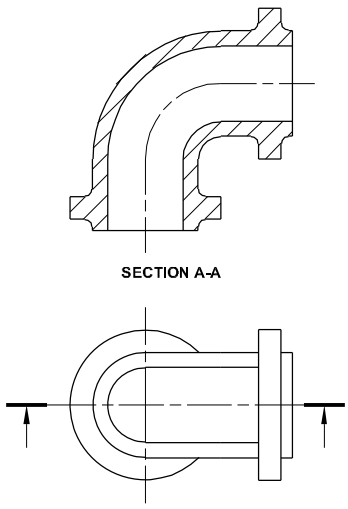
Fig 11



SECTION OF RIVETED JOINT

SUN'12'162B

Fig 12

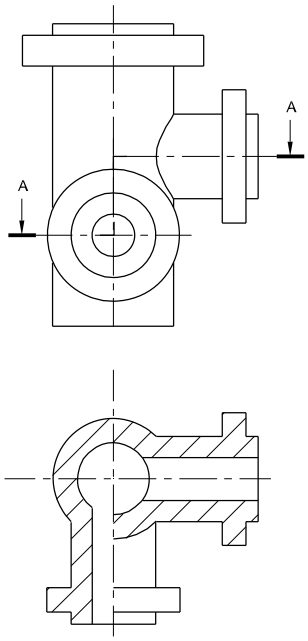


SECTION A-A

SECTION IN ONE PLANE

SUN'12'162C

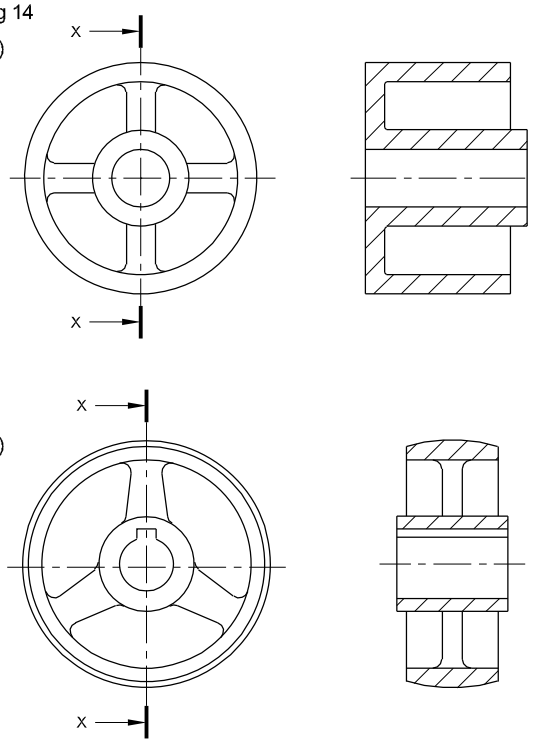
Fig 13



SECTION AA

SUN'12'162D

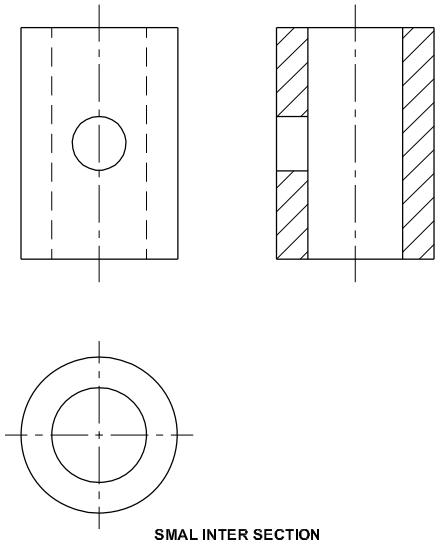
Fig 14



SECTION THROUGH CENTRE A RIBOR WEB

SUN12162E

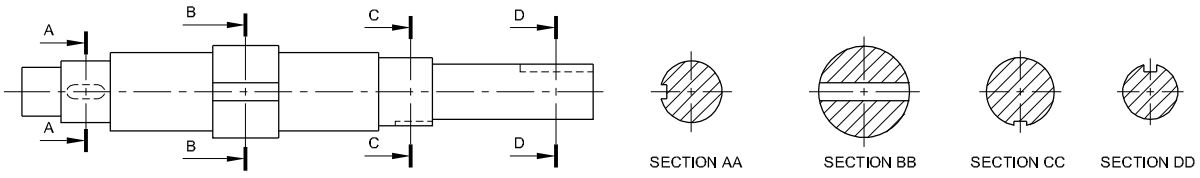
Fig 15



SMAL INTER SECTION

SUN12162F

Fig 16



SUCCESSIVE SECTION

SUN12162G

Isometric projections

Objectives: At the end of this lesson you shall be able to

- **state the importance of pictorial projection**
- **list the kinds of pictorial projection**
- **describe the types of axonometric projections**
- **state what is isometric projection**
- **differentiate between isometric projection and isometric view.**

Pictorial projection: It is possible to show all the 3 faces/ dimensions of an object in one view itself. Such orthographic views are called pictorial drawings or pictorial projections. To get the pictorial drawing the object (say a cube) has to stand on one corner such that 3 of its mutually perpendicular faces are inclined to the plane of projection. (Fig 1)

Fig 2 shows the front view, plan and side view of a rectangular prism positions in the manner stated above. Here notice that two of the views (Plan and side view) lock like solids, the reason being that in each of these two views we can see the three faces of the prism. So in this example both the plan and side view are pictorial views in its own right.

Depending on the angle of inclination of the faces with the plane of projection, pictorial projection are classified as Trimetric, Dimetric or Isometric.

Fig 1

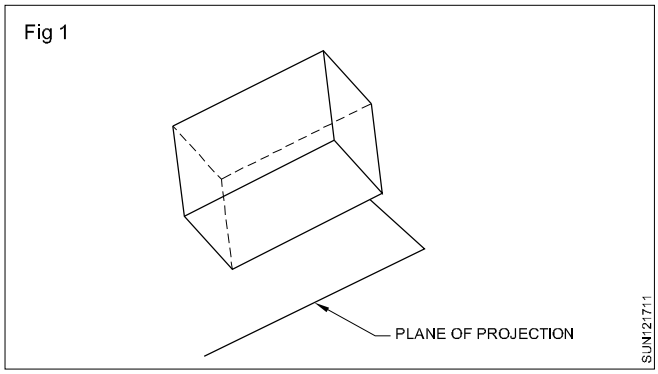
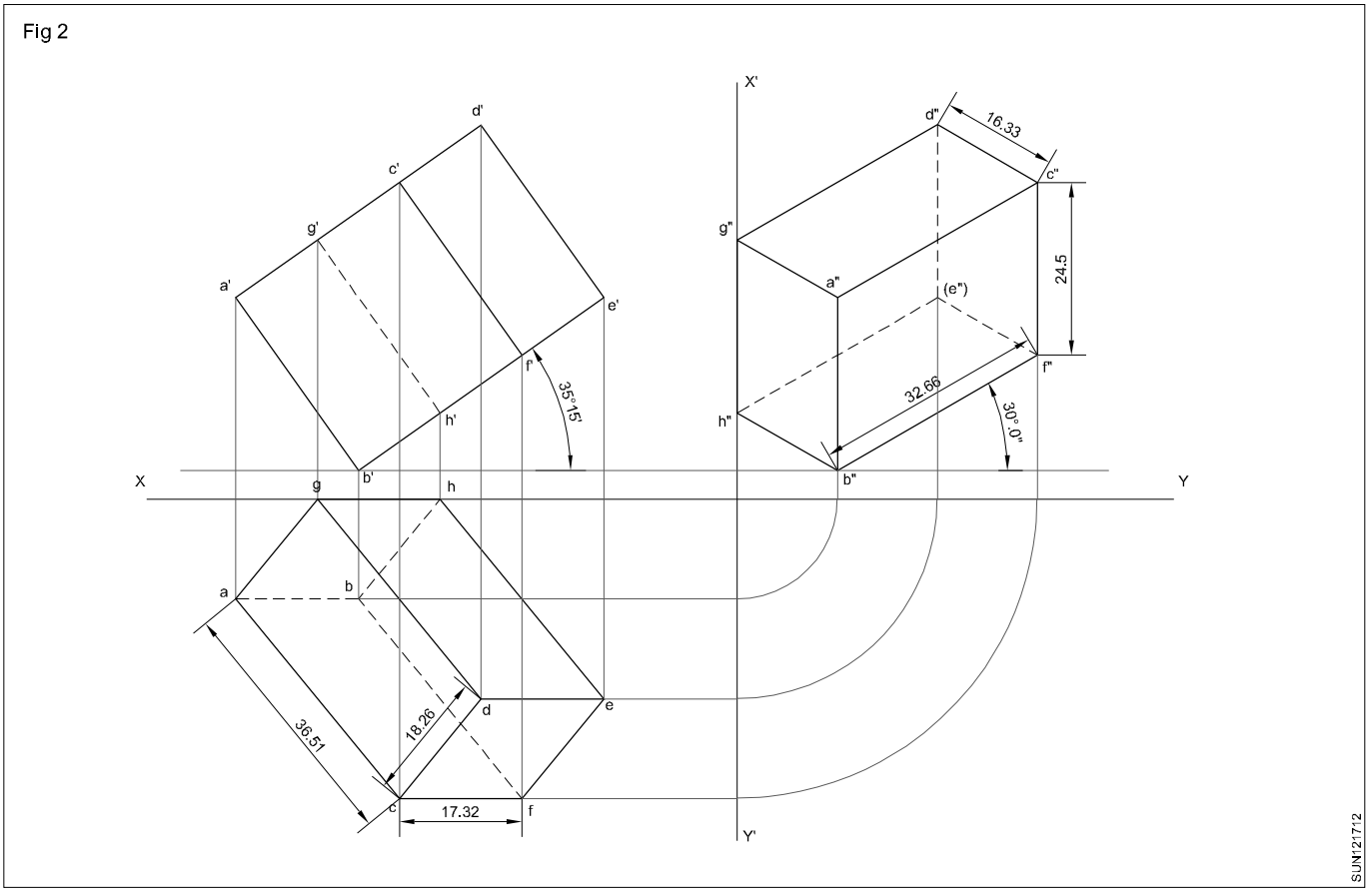
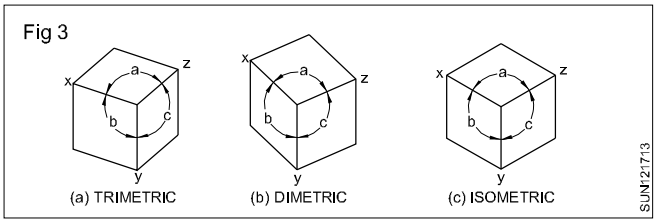


Fig 2



In trimetric projection (Fig 3a) the three faces make unequal angles with the plane of projection whereas in dimetric (Fig 3b) projection 2 faces make equal angles. In isometric projection all the three faces make equal angles. (Fig 3c)



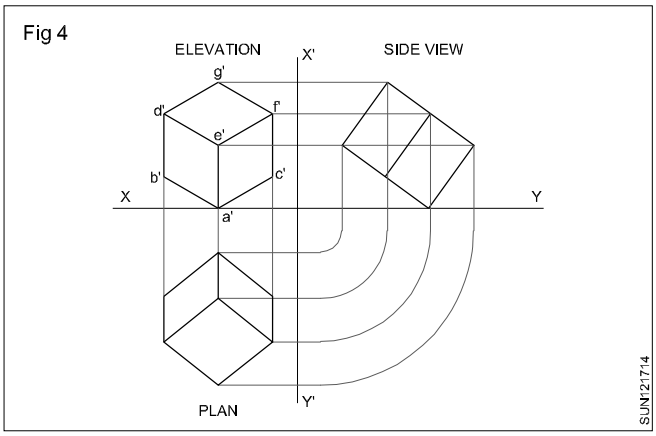
The projections - trimetric,dimetric and isometric projection are generally grouped in one heading called "Axanometric" projection.

In the three types (trimetric, dimetric and isometric) of pictorial projections mentioned above, because the faces of the object are not parallel to the plane of projection the views will not show the true size and shape of the object. The shapes are distorted and lengths of edges are fore shortened. Referring to Fig 2 it may be seen that the true dimensions of the prism is 40 x 30 x 20. But in the front view these dimension measure 32.66 x 24.5 x 16.33 and in plane this corresponding measurements are 36.51 x 17.32 x 18.26. The reason for different lengths in front view and plane is that individual faces make different angles to their respective plane of projection.

Pictorial projections will enable even a common man to understand the shape quickly, even though these pictorial views have a distorted look. In any case, these views are very useful for describign the shapes.

Out of the three types of axanometric projections, isometric views are preferred due to an advantage and hence it is dealt in more detail.

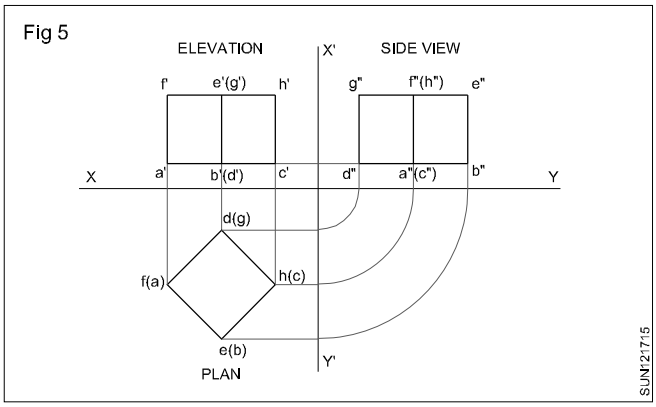
Isometric projection: In an isometric projection the three mutually perpendicular faces make the equal angles with the plane of projection The term isometric is derived from the Greek word ISO means equal and metra means measurement.



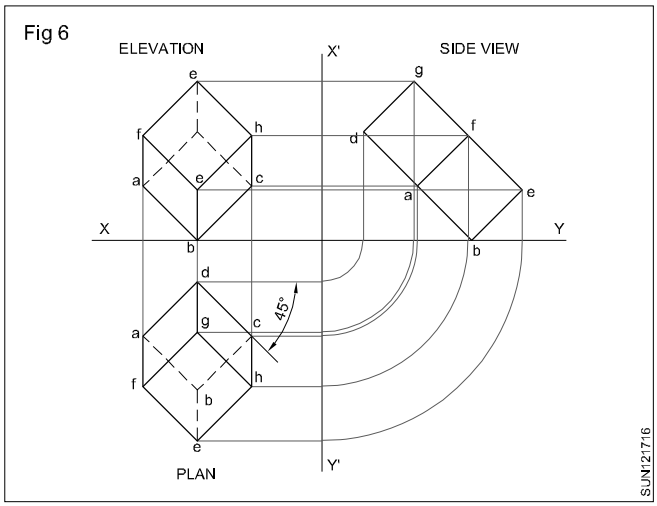
The projection of a cube, the three faces which make equal angles with vertical plane is shown in Fig 4. Here the front view is the isometric projection. Notice that the a'b', a'e', c'f', e'f', c'd', d'g', g'f', b'd', a'c' which represent the various edges of the cube are of equal lengths meaning that all have the same amount foreshortening. Because of this reason isometric projection will give a more natural appearance than trimetric and dimetric and this is extra advantage of isometric projection.

Isometric projection - Method of construction: We can make the isometric projection of any object using the principle of orthographic projection. But the method is best understood by constructing the isometric projection of cube or rectangular prism. The position required for isometric projection may be brought about as follows.

Place the cube on HP such that two of its mutually perpendicular faces make 45° will VP (the plan and side view elevation in the position will be as in Fig 5).



Next tilt the cube towards you with the corner b on HP. Tilt the solid diagonal DE will be at right angles to VP. Now the 3 mutually perpendicular faces will make angles (35°16') with HP. The three views of the cube in this position are shown in Fig 6. Now the elevation will be the isometric projection. To obtain this proceed as follows:



– First reproduce the side view in Fig 5. Such that DE is parallel to XY line.

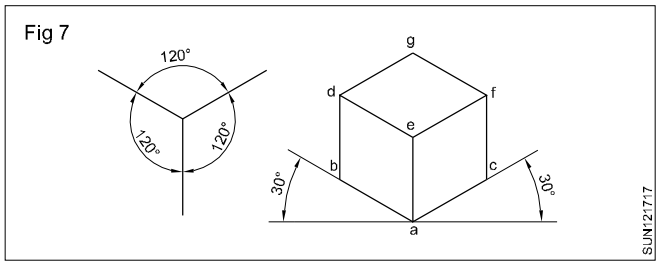
– Project from the above side view and the plan in Fig 5 shall be reproduced in Fig 6.

– Draw the elevation

Note: In figure 6, a plan for the tilted position is also drawn. But this is not an isometric projection. Actually it is a dimetric projection.

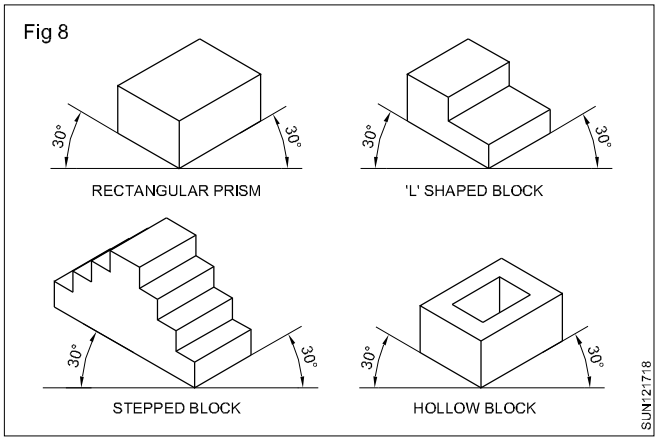
It may be observed from the above construction that the isometric projection gives 3d (3 dimensional) effect as we are able to show the length, breadth and thickness in the same view. However, making isometric projections this way is complicated and time consuming. Therefore, simpler method have been deviced to make pictorial drawing that are identical isometric projection and these methods are discussed below.

Simpler method of isometric projection: On analysing the isometric projection in Fig 6, it will be seen that three mutually perpendicular edges of the cube are at an angle of 120° to each other. These three lines which represent the mutually perpendicular edges are called isometric axes. (Fig 7)



So to draw the isometric projection say of a cube, we firstdraw the three mutually perpendicular edges as in figure and set other lengths. Since of the lengths are foreshortened in isometric projections we must use an "isometric scale" to find out the foreshortened lengths. Thereafter, other edges are drawn parallel to the respective isometric axes to complete the figure.

Instead of drawing the isometric axes, first we can also start from the point `a' .(Fig 7) At this point also 3 mutually perpendicular edges meet. While two of these edges make 30° to the horizontal, the other edge is vertical. (90° to horizontal) After drawing the two 30° lines one vertical line the parallel lines are drawn to complete the cube. Few other objects drawn this way are shown in Fig 8. The length of each edge of corner will be less than the true dimensions and it can be determined by using an isometric scale.



Isometric scale

Objectives: At the end of this lesson you shall be able to

- **explain the difference between true length and isometric length**
- **explain the construction of isometric scales**
- **explain the isometric lines and non-isometric lines**
- **state the different methods of constructing isometric views**
- **state the construction of circles, curves, and circular shaped objects (sphere).**

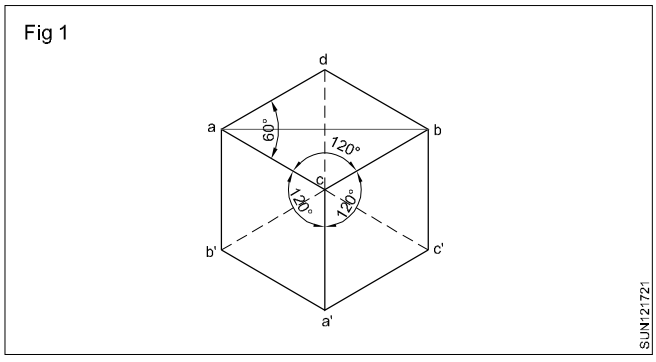
Isometric scales are used to get the foreshortened lengths required for isometric projection.

Before constructing an isometric scale, you must understand is the relationship between the true length of an edge and the length of the same in isometric projection.

To determine the relationship between the true length and corresponding length in isometric projection, proceed as follows:

Consider the isometric projection of a cube. (Fig 1)

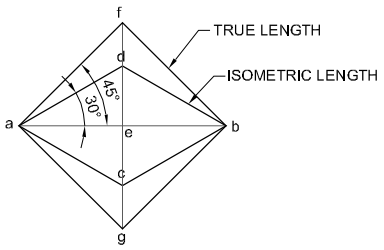
Separately draw the top face of the cube adbc and join the longer diagonal ab. (Fig 2)



Note that the diagonal ab is of same length both in the isometric view of the face and the true face. Assume the top true face of the cube as afbc.

Now superimpose the true top face afbg keeping the diagonal ab common. (Fig 2)

Fig 2



SUN121722

$\angle FAE = 45°$ and $\angle DAE = 30°$

$$AE = AF \times \cos 45° \text{ and } AD = AE \div \cos 30° = AF \times \frac{\cos 45°}{\cos 30°}$$

$$\frac{\text{Isometric length}}{\text{True length}} = \frac{AD}{AF}$$

$$\frac{AD}{AF} = \frac{AF \times \cos 45°}{AF \times \cos 30°} = \frac{\cos 45°}{\cos 30°}$$

$$= \frac{1}{\sqrt{2}} \times \frac{2}{\sqrt{3}} = \frac{\sqrt{2}}{\sqrt{3}} = 0.8165$$

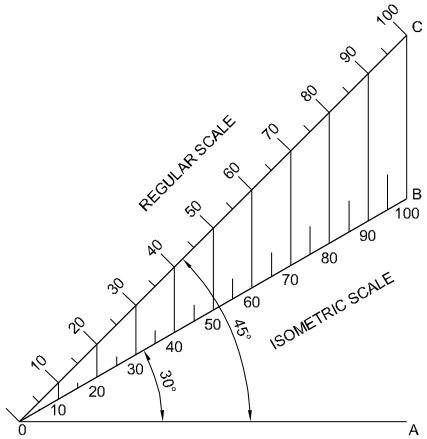
AD = 0.82 AF. This means that the length of a line in isometric projection is 0.82 times of it true length. While drawing an object in isometric projection, the dimensions on or parallel to isometric axes are reduced to this proportion. To make things easier we can construct a scale to the above ratio. Such a scale is called as isometric scale.

Procedure to construct

Isometric scale (Fig 3)

- Draw a horizontal line OA.
- Draw lines OB and OC making 30° and 45° with OA respectively.
- Mark 5 mm, 10 mm, 15 mm upto 100 mm on line OC.
- From the marked points on the regular scale OC, draw perpendiculars to OA meeting at OB.
- Print the corresponding values on the line OB resulting in the isometric scale.

Fig 3



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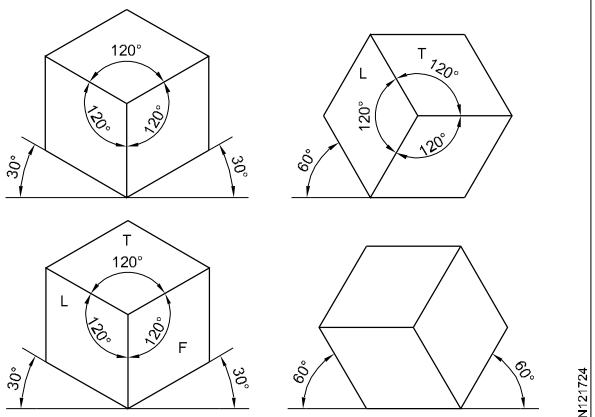
Orientation of isometric axes: While the isometric axes make 120° to each other they may have different orientation as shown in Fig 4. Each of the orientation show3 of the 6 faces (left, right, top, bottom, front and rear) are shown in different combinations.

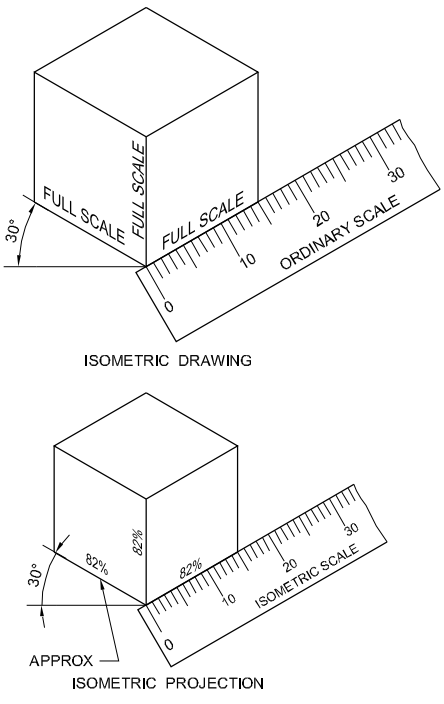
Fig 4



SUN121724

Isometric view and Isometric projection: A drawing is made with true lengths (dimensions) is called isometric view or isometric drawing. Whereas the same drawing made with isometric lengths is termed as isometric projection. (Fig 5)

Fig 5

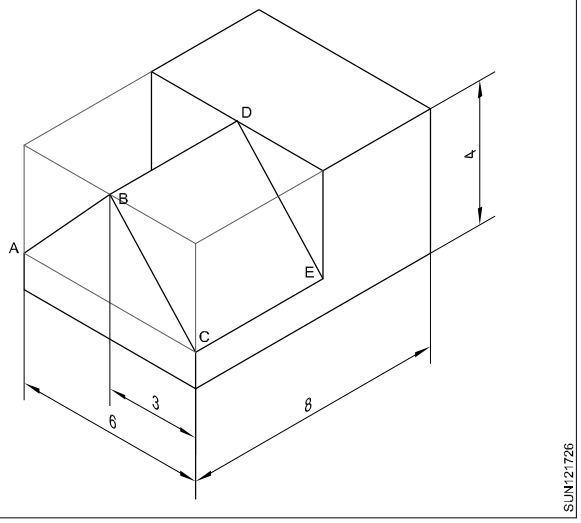


SUN121725

Isometric and non-isometric lines: Fig 6 shows the isometric view of a shaped block. Here all lines except AB, BC and DE are parallel to isometric axis. Lines such as then which are parallel to isometric axes are called isometric lines whereas such as lines AB, BC and DE which are not parallel to isometric axes are called non-isometric lines.

The length of non-isometric lines will not follow the scale used for isometric lines. To proove this point consider the non-isometric lines AB or BC. The true length of both AB and BC is 5 cm while BC will be longer. Because of this reason non-isometric lines are drawn first by locating their starting and end points on isometric lines.

Fig 6



To locate the end points and to draw the non-isometric lines two methods are employed. They are

– Box method

– Off-set method

Box method: The object is assumed to be inside a rectangular box. Starting and end points are located and marked. By joining the points isometric view is drawn.

Off-set method: This method is most suited for the objects consisting of number of planes at a number of different angles.

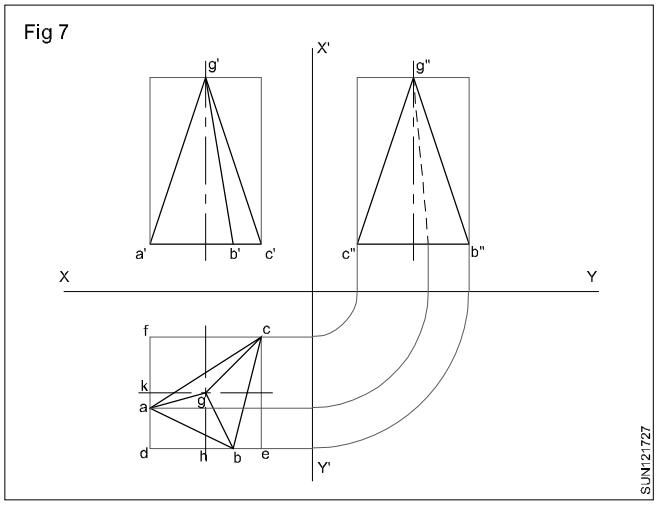
These methods are not only useful for isometric views involving non-isometric lines but also for the isometric views involving isometric lines.

Box method of drawing a pyramid

Example

Draw an isometric view for the triangular pyramid shown in Fig 7 using a box method.

Fig 7



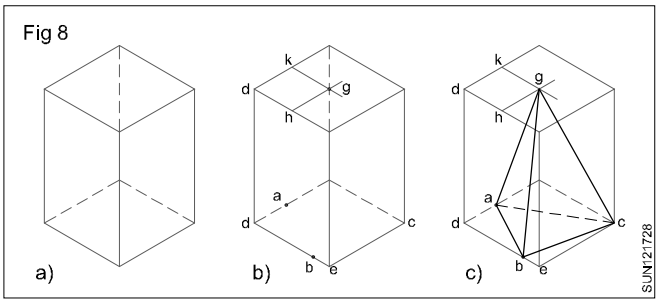
– Construct a rectangular box to the overall size of the pyramid (Fig 8a)

– Mark the distances ad and be from the plan of Fig 7 in the base of the box.

– Mark the distances kg and dh on the top face of box. (Fig 8a)

– Join the points AB, BC, CA, AG, BG and CG and complete the isometric view of the pyramid in box method. (Fig 8b)

Fig 8



Off-set method of drawing a pyramid

Example

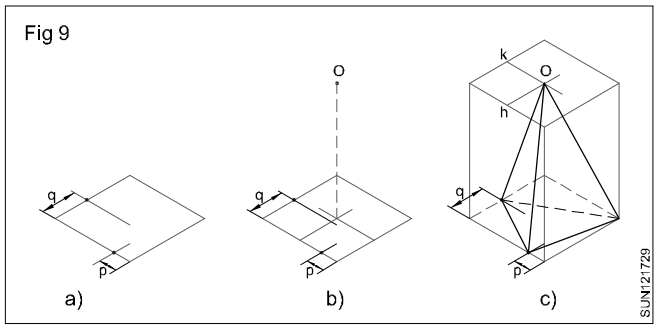
Same triangular pyramid (Fig 7) is considered for drawing isometric view using offset method.

– Draw an isometric square/rectangle considering the corners of the base of the pyramid. (Fig 9a)

– Locate the corners 1,2 & 3 with help of offsets P and Q.

– Locate the projection of the vertex O_1 on the base by offsets x and y and draw the vertical centre line O_1O to the height of the pyramid. (Fig 9b)

Fig 9

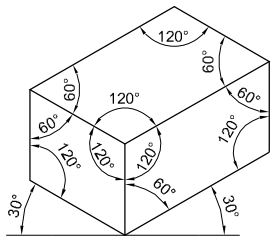


– Join 1-2, 2-3, 1-3, 0-1, 0-2, 0-3 and complete the isometric view of the pyramid. (Fig 9c)

Angles in isometric projection: The angles of inclined surfaces will not have true value in the isometric projection, but will be more in some cases and less in other cases.

For example, in the isometric view of prism shown in Fig 10 the true value of all the angles is 90°. But in isometric projection the angles are 60° in some cases and 120° in others.

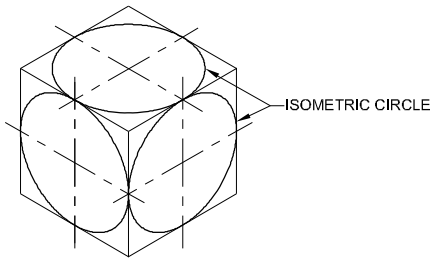
Fig 10



SUN12172A

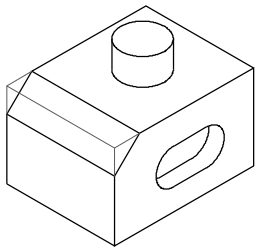
Isometric circles: The term isometric circle refers to the shape of circle in isometric view. An isometric circle will be elliptical in shape as shown in Fig 11 while drawing isometric view of cylindrical features isometric circles will have to be used. (Fig12)

Fig 11



SUN12172B

Fig 12



SUN12172C

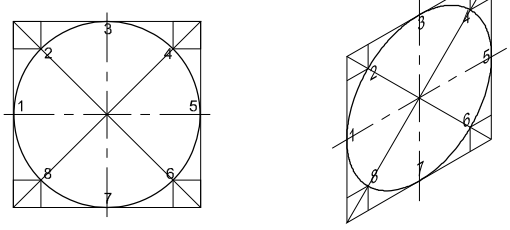
An isometric circle can be drawn either by plotting / offset method or by arc method.

Plotting method (Fig 13)

- Draw a square of side equal to the dia of circle and inscribe the circle.
- Divide the circle into any number of equal parts and mark points such as 1,2,3,4,5,6,7,8 on the circle.
- Through the points 1,2,3 etc draw lines parallel to the both the axis of cylinder.
- Draw isometric view of the square.
- Mark points corresponding to 1,2,3....8 with isometric

Note: The orientation of the isometric circle will depend upon the plane on which the circular feature exists.

Fig 13



SUN12172D

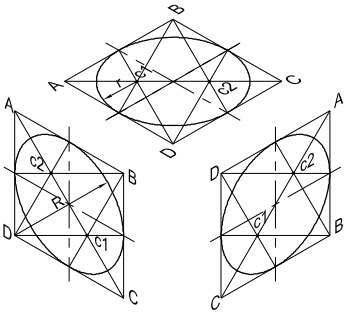
Arc method: Isometric circles drawn by offset method is the ideal method of making isometric circles as the ellipse obtained this way is geometrically true. But by free hand we cannot get a clear line.

Fig 14 shows the construction of isometric circle in 3 different orientation by arc method. Four arcs are to be drawn and the centres an C_1, C_2, B & D. While centre B and D are the corner of the rhombus C_1 and C_2 are intersection points of the longer diagonal with lines from points B or D to the mid point of the side of the rhombus.

Note: The arc method gives a clean ellipse, but this ellipse drawn this way will slightly deviate from true ellipse. It does not matter for our purpose.

The isometric circles can also be drawn using templates which can be bought from stationary shops.

Fig 14



SUN12172E

Isometric views profiles: The profile MN of the block shown in Fig 15 is irregular in nature. The isometric views of such lines may be drawn by offset method described earlier. The points 1,2,3 and 4 lie on the profile. Lines A-1, B-2, C-3, D-4 are isometric lines and their length are same both in Fig 15 & Fig 16. After getting the points 1,2,3 & 4, they joined by smooth curve.

Note: In offset method more the number of points, better will be the accuracy of the curve.

Fig 15

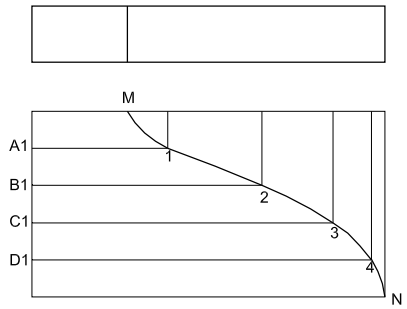


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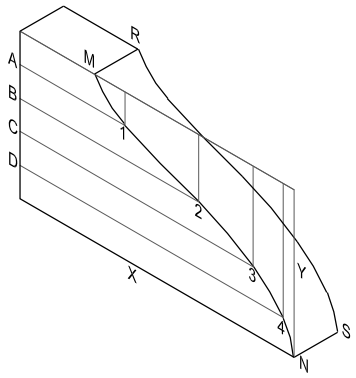
Fig 16



SUN12172G

Isometric projection of sphere: The Orthographic view of a sphere seen from any direction is a circle of diameter equal to the diameter of the sphere. Hence, the isometric projection of a sphere is also a circle of the same diameter.

The front view and the top view of a sphere resting on flat surface are shown in Fig 17a.

O as its centre, D is the diameter and P is the point of contact with the surface.

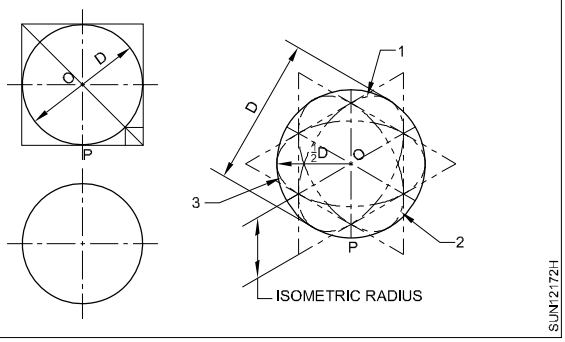
Assume a vertical section the centre of the sphere. Its shape will be a circle of diameter D. The isometric projection of this circle are ellipses 1 & 2 Fig 17(b) drawn in two different vertical positions around the same centre O. The major axis in each case is equal to D. The distance of the point P from the centre O is equal to the isometric radius of the sphere.

Again, assume a horizontal section through the centre of the sphere.

The isometric projection of this circle is shown by the ellipse 3, drawn in a horizontal position around the same centre O. In all the three cases 1,2 & 3 the outermost points on the ellipse from the centre O is equal to 1/2 D.

Thus, it can be seen that in an isometric projection, the distances of all the points on the surface of a sphere from its centre are equal to the radius of the sphere. Hence, the isometric projection of a sphere is a circle whose diameter is equal to the true diameter of the sphere.

Fig 17

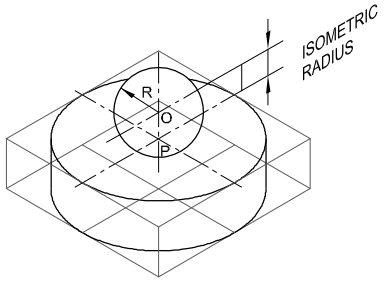


SUN12172H

Also the distance of the centre of the sphere from its point of contact with the flat surface is equal to the isometric radius OP of the sphere.

It is therefore of the utmost importance to note that isometric scale must invariably be used while drawing isometric projection of solids in conjunction with spheres or having spherical parts.

Fig 18



SUN12172I

Conventions and symbols used in drawing

Objectives: At the end of this lesson you shall be able to
- **state the necessity of conventions and symbols used in engineering drawing**
- **identify standard conventions used in engineering drawing.**

Conventional representation is adopted in the cases where complete of the part would involve unnecessary drawing time or space.

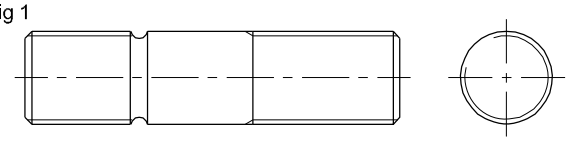
For example a thread on a bolt of M10 and pitch 1.5, it would be very difficult to draw the actual thread profile and is not going to serve any purpose. So a convention to represent the threads is made use of. Similarly gear teeth on gears, a number of holes on a component, spring coils etc are shown in conventions.

General conventions (IS:10715)

Thread convention: Irrespective of type of thread, pitch, dia etc. external, internal, intersectional view, the depth of thread (not to scale) and length of threading is shown by continuous thick, thin line parallel to the axis.

Visible screw threads: For visible screw threads, length of crests should be by continues thick line and the roots should be by continuous thin line. In the side view crest diameter should be shown by a full thick circle and the root diameter should be by three forth of a circle. (Fig 1)

Fig 1



For internal thread or the hidden screw threads lengths of crests and roots should be by hidden (dashed) lines, but one type only on same drawing. But in sectional view length of crests should be by thick line and the length of root should be by thin line. In the side view outer circle (root circle) is of circle and the inner circle (crest circle) is of 3/4th of a circle. Hatching should be extended to the line defining crests of the internal thread for the threaded parts in section. (Figs 2,3 & 4)

Fig 2

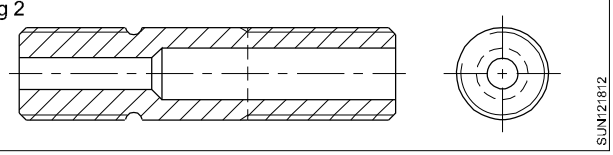
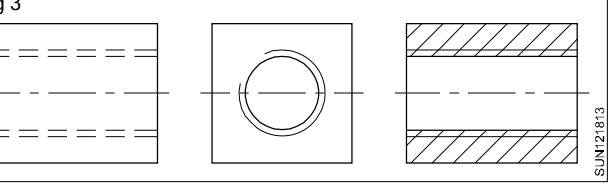


Fig 3



Space between the lines representing the crest and root diameter of the thread be as close as possible to the correct depth of thread.

Conversion of a threaded assembly is shown in Fig 5.

Fig 4

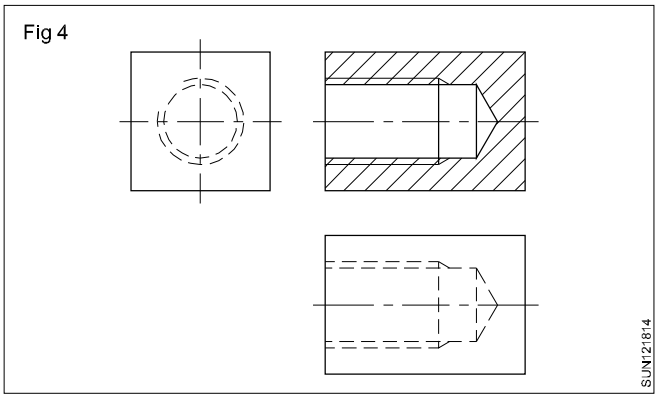
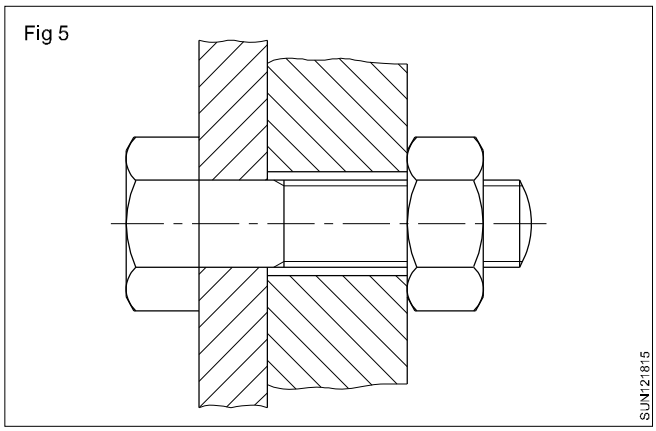
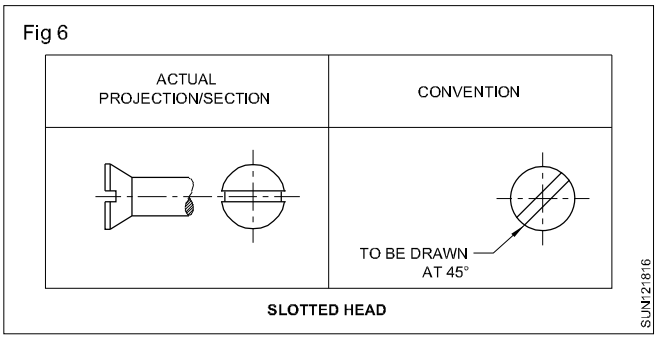


Fig 5



Screwdriver slot: Screwdriver slot on the face of the screw head is always drawn at 45° to the centre line. (Fig 6)

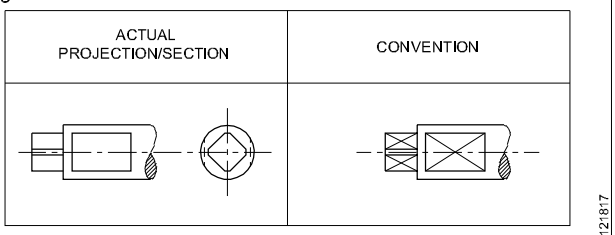
Fig 6



Flat surfaces on shafts: The flat surfaces on the shafts or on ends are shown by square/rectangle with diagonal lines. (Fig 7)

Radial ribs: These are thin metal portions which add strength to the part, but no direct function of it. When the true views are projected some ribs are seen as oblique leading to confusion. In such case the rib is assumed as

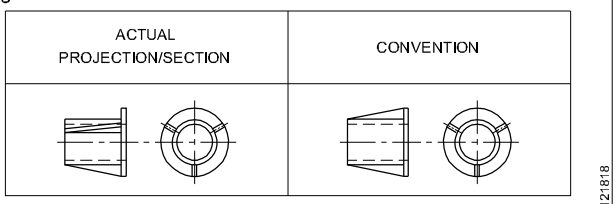
Fig 7



SQUARE END AND FLAT

rotated and brought to the centre line and drawn. This gives a symmetrical shape. (Fig 8)

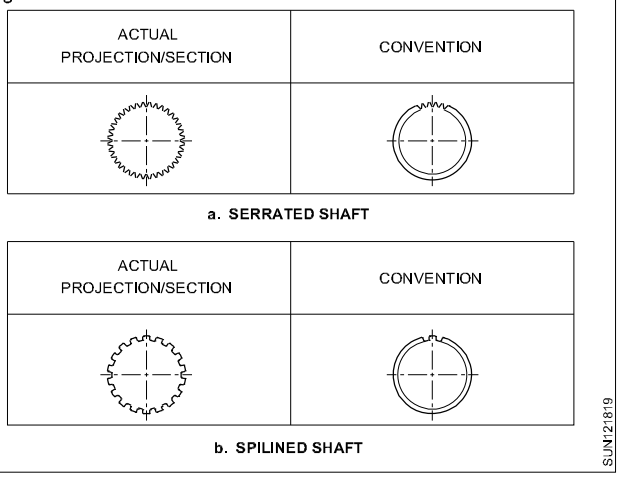
Fig 8



RADIAL RIBS

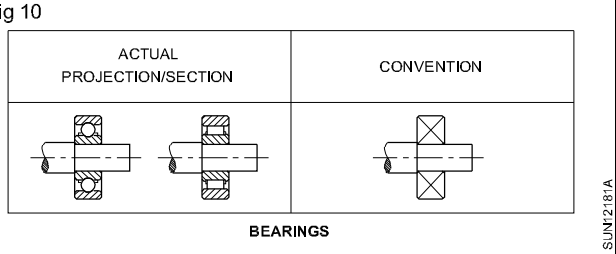
Serrated shafts, splined shafts, chain wheels, ratchet and pinion: They have number of projections at different pitches. To save the time one or two profiles of the features are shown and the rest by a thin continuous circle or chain line circle. (Fig 9)

Fig 9



Standard bearing: Standard bearing on shafts irrespective of type of bearing are simply shown by two rectangles on either side of the shaft with thin diagonals in it. (Fig 10)

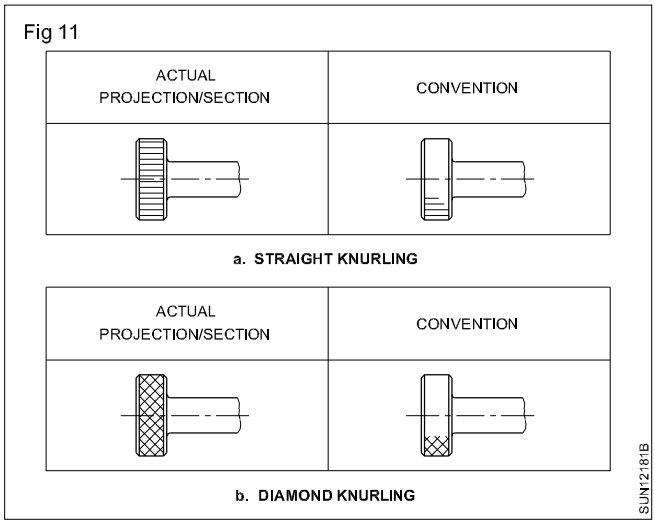
Fig 10



BEARINGS

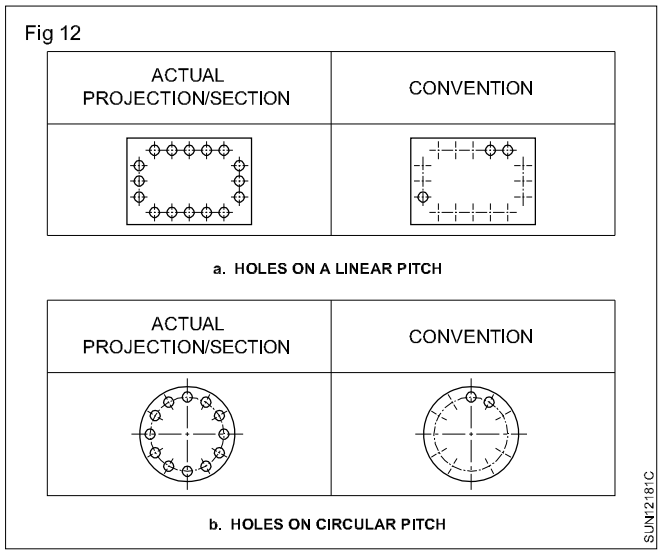
In case of knurlings straight or diamond, irrespective of pitch and dia, only a limited area is shown with the type of knurling, rest is left free. Ref. IS:11663. (Fig 11)

Fig 11



Holes on linear or circular pitch: After marking pitch position of all holes by centre lines, only one or two holes are drawn. When a series of same item/part is to be drawn in a line only one part is drawn with all the features and the rest are shown with thin outline profile only. Ref. IS:10714. (Fig 12)

Fig 12



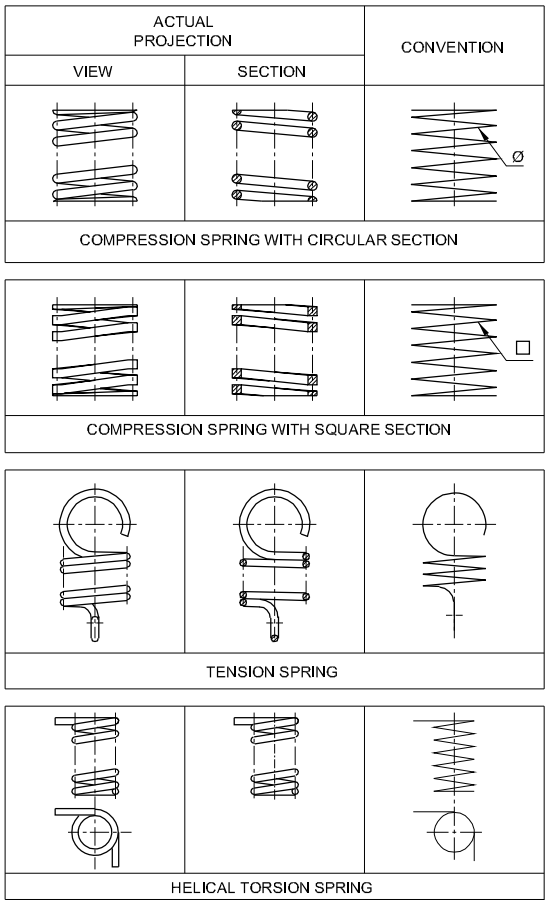
Springs

Helical springs: While drawing the cylindrical helical compression springs of (different) round, square or rectangular cross-section, the detailed features are omitted and continuous zig-zag lines, with a wide definite pitch and width (diameter) are drawn. Compression springs are either in the circular or square section. The ends of the spring are shown by parallel lines at right angle to the axis.

Tension springs: Tension springs are shown as compression spring, but the pitch is comparatively closer and ends are shown as a hook on one end and the other end as a cylinder with a circle on the vertical line centre line.

Torsion spring : Torsion spring is drawn similar to the compression spring without hook and one end extended at right angle to the axis. Fig 13 shows the above spring.

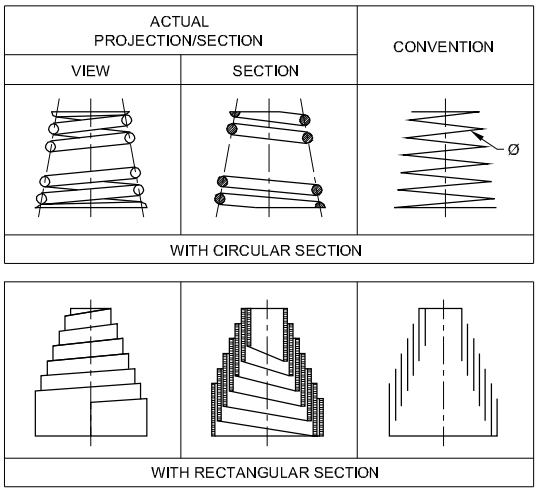
Fig 13



HELICAL SPRINGS

Conical helical spring: Conical helical spring with circular section is shown similar to helical compression spring except to width (dia) is shown as tapering. Conical springs with rectangular section are shown with symmetrical parallel lines to centre line, forming a sort of tower. The bottom and top lines are drawn perpendicular to the axis, typically with one and two lines diagonally opposite joined. (Fig 14)

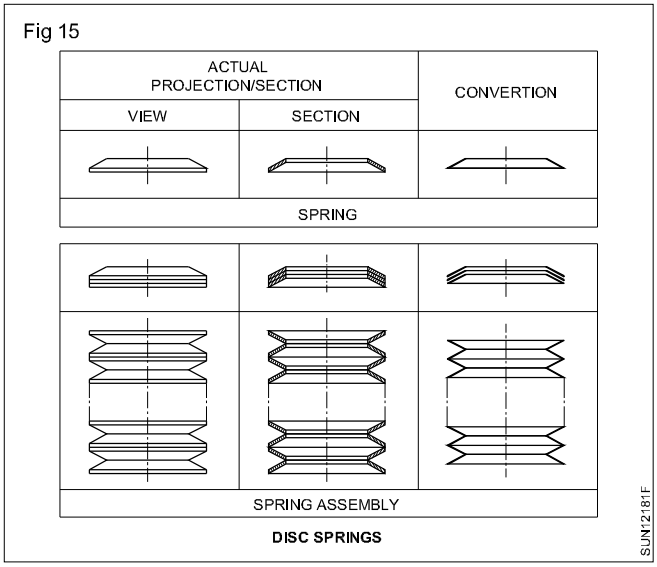
Fig 14



CONICAL HELICAL SPRINGS

Disc spring: A single spring is shown as a truncated cone with cone angle more than 90° and element (slope) is drawn thick. Two different types of assemblies are shown. In one type, discs are placed one above the other facing in one direction. In the other type, discs are placed alternatively. (Fig 15)

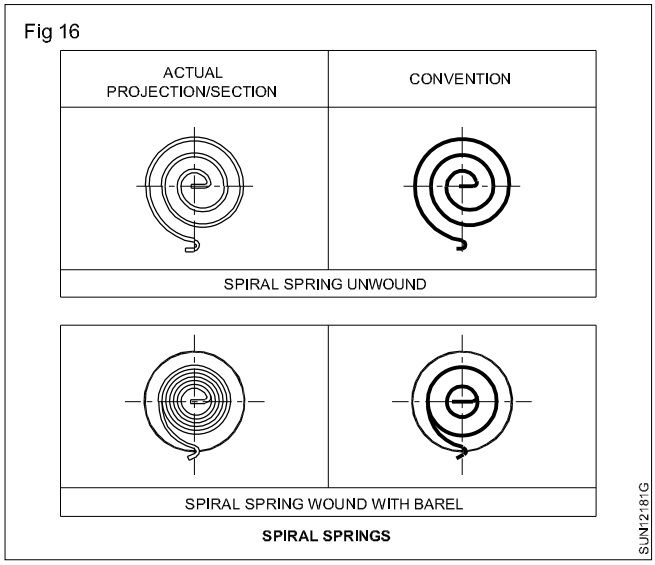
Fig 15



DISC SPRINGS

Spiral springs: These are shown in unwound condition as a spiral with a number of conventions. The inner end is shown as a straight line and the outer one is shown with a sort of hook. (Fig 16)

Fig 16



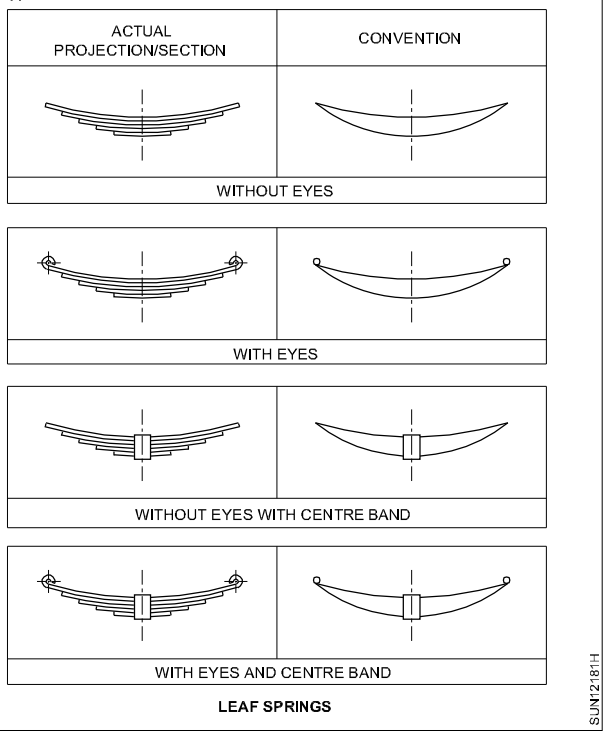
SPIRAL SPRINGS

Spiral spring wound with a barrel is shown as a three quadrant circle in a concentric circle. The inner and outer ends are shown similar to the above.

Leaf springs: Semi-elliptic outlines are shown as enveloping arcs. Two arcs are drawn to represent springs with eyes and a rectangle symmetrically placed on the centre line representing the centre band. Ref.IS:10716. (Fig 17)

Conventions of gears and splines shall be explained at a later stage. Table 2 shows different conventions as per IS:10717 and 11663.

Fig 17



LEAF SPRINGS

Fig 18

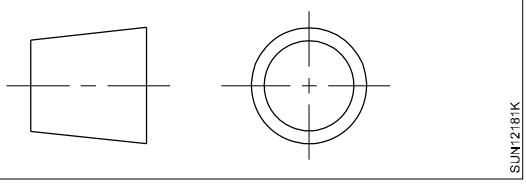
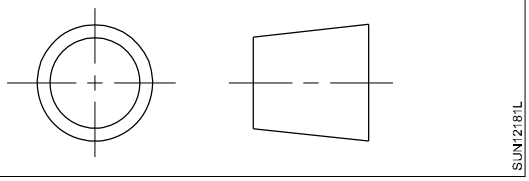


Fig 19



Methods of projection: Two methods of projection are in practice.

– Symbol for 1st angle projection. (Fig 18)

– Symbol for 3rd angle projection. (Fig 19)

Free hand technical sketching

Objectives: At the end of this lesson you shall be able to
- **state the importance of technical sketching**
- **state the types of sketches**
- **explain the methods of sketching pictorial views**
- **explain the verious methods adopted in sketching**
- **multi - vlews of the object/civil working tools.**

Importance of technical sketching : The importance of freehand sketching of machine parts and components in engineering field cannot be over estimated. Free hand technical sketching is a drawing drawn with/without the use of any drawing instruments and drawn not to scale.

The presentation of the views should be in good proportion to the extent possibility and by visual identification. Free hand technical sketching helps the designer in reflecting his thoughts and recording his ideas. Most original ideas and thougts are expressed firts through the medium of free hand sketching. For verbal explanation free hand sketching plays a very important role.

Free hand sketching contains all necessary details such as shape and size description.

The Fig 1 shows a chuck key which records the importance of free hand sketching.

Fig 1 a shows the 'object 'for layman's easy to understand and Fig 1b gives a free hand sketch for easy production with necessary dimensions.

The perfection and proficiency in free hand technical sketching can be obtined only by more practice.

Fig 1a

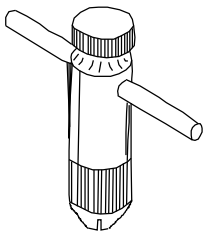
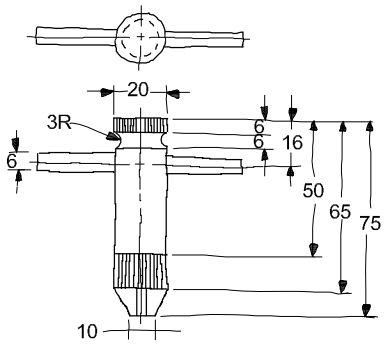


Fig 1b

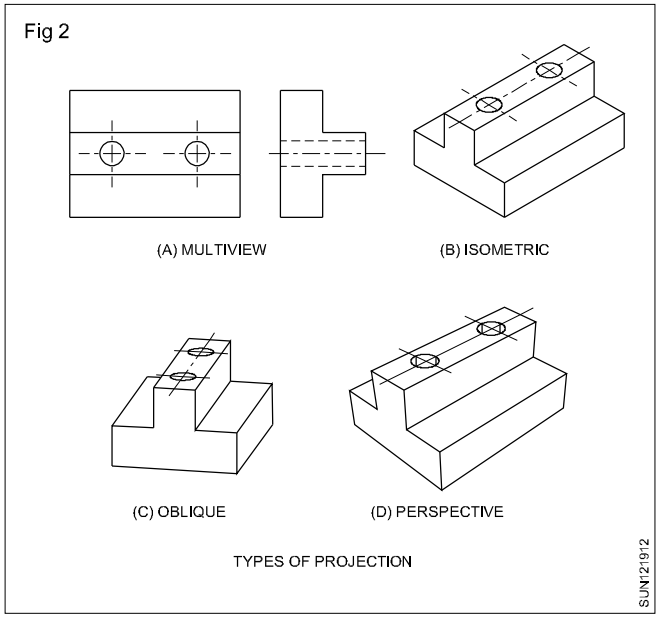


Note : The sketching materials are already explained in earlier lesson of module 1.

Type of sketches

In technical sketching the sketches are prepared from three dimensional objects. The form of the sketch determines approximately to any one of the following standard types of projections. (Fig 2)

Fig 2



– Multi - view
– Isometric
– Oblique
– Perspective

In multi - view (2A) the object is explained by its required views, which has been already discussed in earlier lesson.For ready reference find enclosed the comparative statement of two kinds of projection methods of representation in Fig 3.

The object may be shown in a single view by isometric (Fig 2B, oblique (Fig 2c) and by perspective (Fig 2D) projections.

Scale : Sketches, generally are made not to scale. In technical sketching object should be sketched in proportion to the nearest possible size.

Grid (Cross - section) paper provides a ready scale that may be employed to help in sketching to correct proportions.

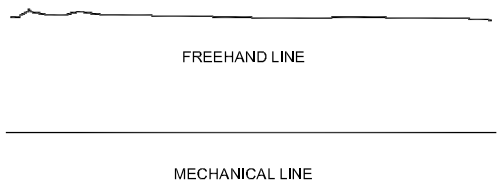
The size of the sketch depends on the complexity of the object and the size of the paper.

Small objects can be sketched to an enlarged view to show the necessary details clearly.

Technique of lines : The main difference between an instrumental technical bearing of a machine part/ component and a free hand technical sketching lies in the character of technique of lines.

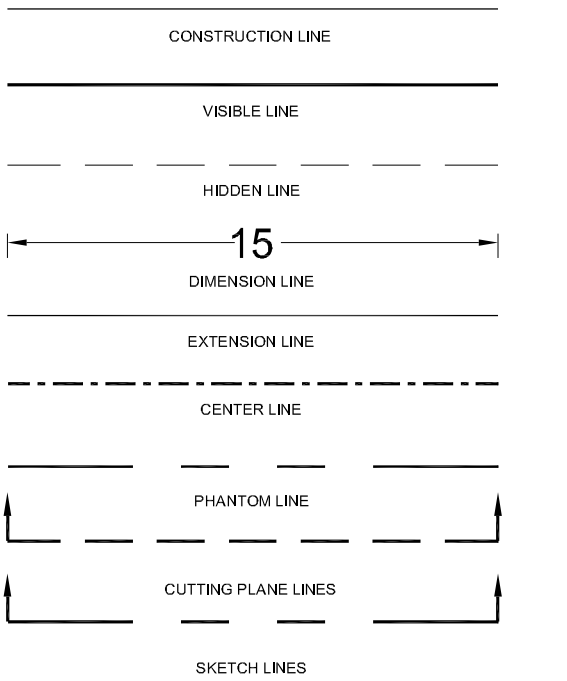
A good and perfect free hand line should not be rigidly straight or perfectly uniform as lines drawn with instruments lie in exact uniformity. (Fig 4)

Fig 4



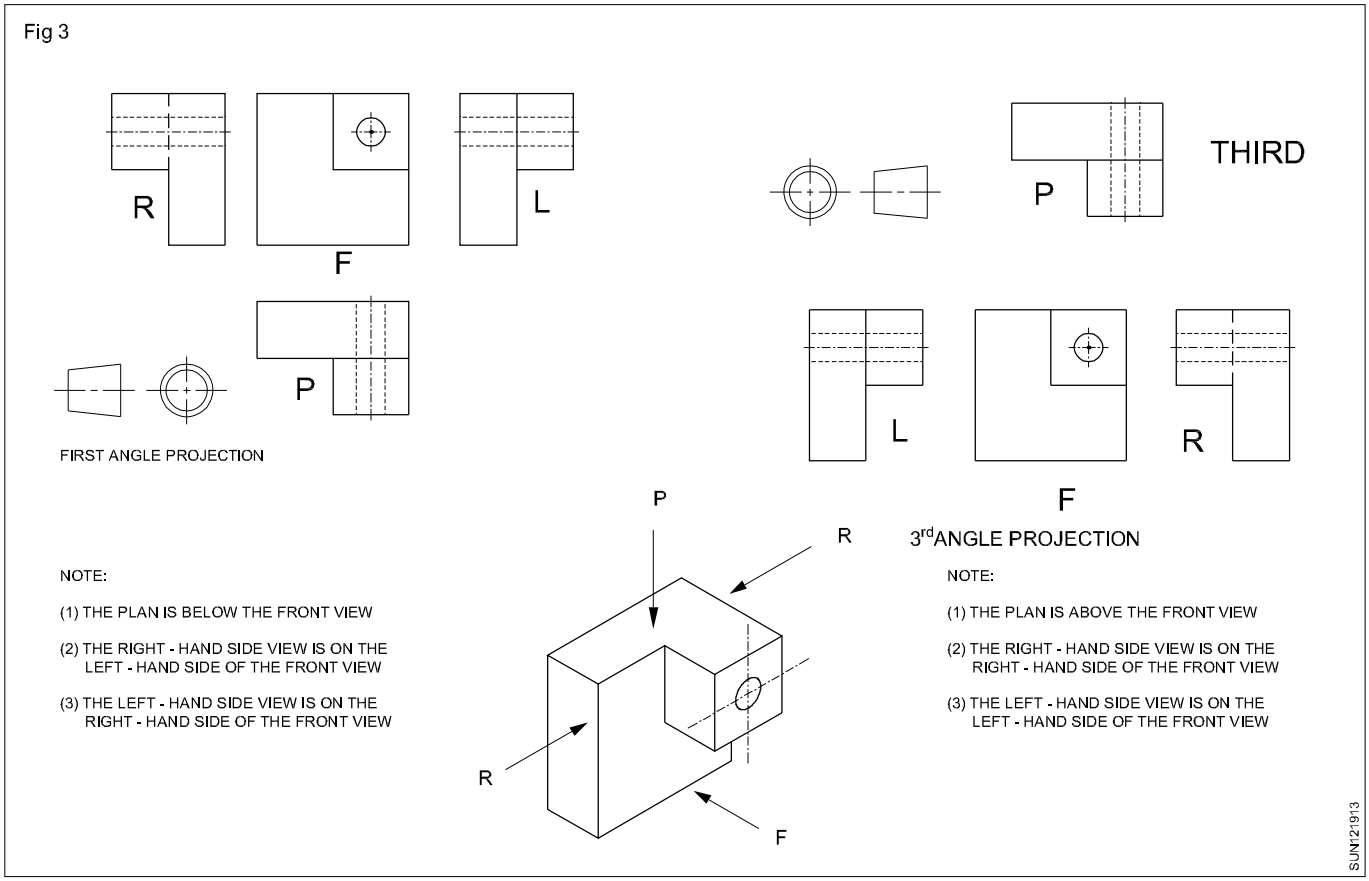
Conventional lines drawn by using instruments are shown in earlier lessons and the corresponding free hand sketches are shown in Fig 5. The free hand construction line is very light rough line in which some strokes may overlap. In free hand technical sketching you should maintain a sharp contrast between the line thickness. In free hand technical sketching, sketch visible lines heavy so the outline will show out clearly, and make hidden lines, centre lines, dimension lines and extension lines thin.

Fig 5



Pictorial sketching : There are several simple methods of preparing pictorial sketching which will be more helpfull in learning of principles of multi - view projection.

Fig 3



Isometric sketching

– To make an isometric sketch from an actual object/ component hold the object/component in hand and tilt towards you as shown in Fig 6A.

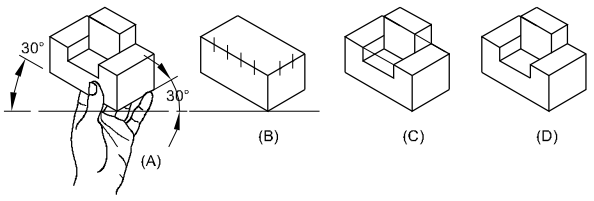
– In this position, the front corner will be vertical and in the other two receding bottom edges will be inclined about 30° to the horizontal.

– Sketch the enclosing box lightly as shown in Fig 6B.

– Block the recess and projecting block. (Fig 6C)

– Erase all construction lines with soft eraser. (Fig 6D)

Fig 6



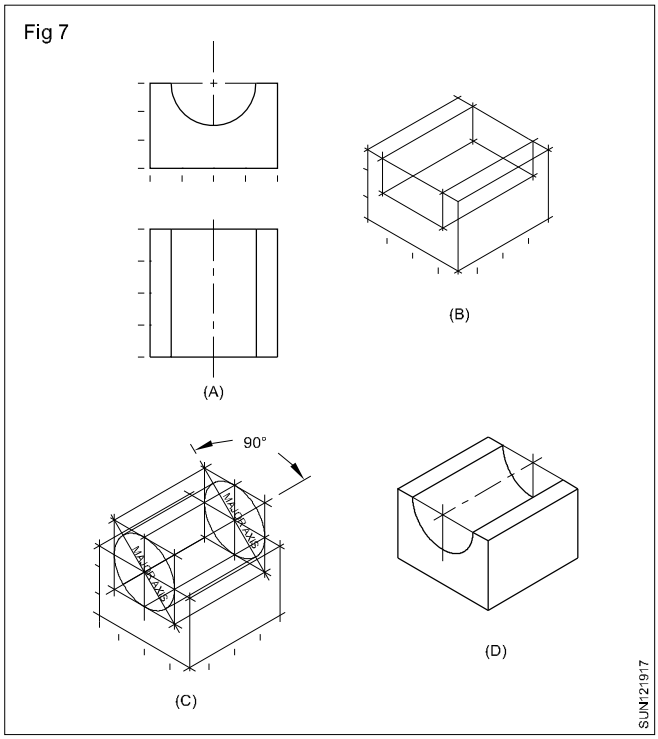
– Sketching an isometric view of a block when two views are given. (Fig 7A)

– Block the given object,including the rectangular space for semi - cylinder. (Fig 7B)

– Block in the box enclosing the full cylinder lightly as shown in Fig 7C.

– Remove all construction lines and dark the all final lines showing only the lower half of the cylinder. (Fig 7D)

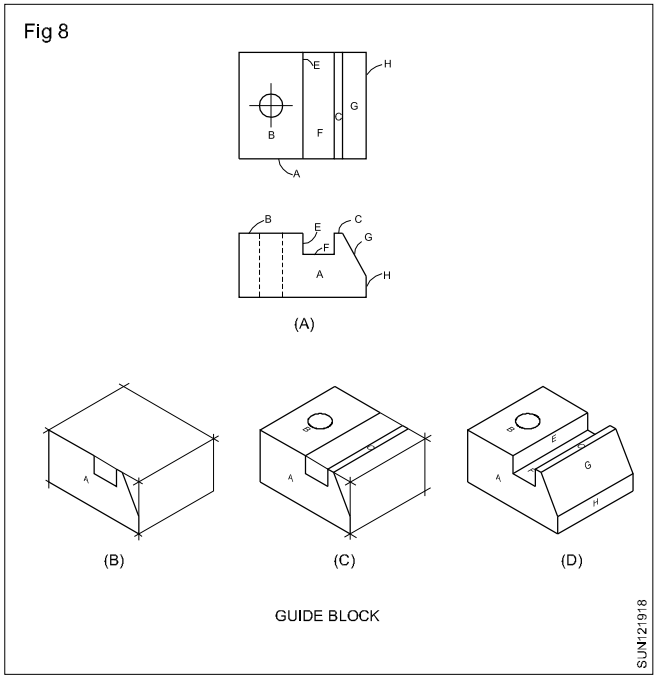
Fig 7



Sketching on isometric paper : Two views (plan and elevation) of a object are shown in Fig 8.

By using a isometric paper which gives perfect visual effect of the object.

Fig 8



By counting off the isometric grid spaces equal to the squares on the corresponding gives views sketch the enclosing box and also the surface A.(Fig 8 B)

Sketch the other surfaces B,C,E etc to complete the isometric views. (Fig 8C & 8D)

Oblique sketching : The another method of pictorial sketching.Fig 9 shows the method of sketching oblique view.

– Hold the object in your hand as shown in Fig 9A.

– Sketch the front view of the object as shown in Fig 9B.

– Sketch the receding lines parallel to each other and at any convenient angle.

The receding lines may be equal to the original length of the object or half of the original length.

If the length is full i.e equals to original length, the sketch is a Cavelier sketch. If half size, the sketch is a cabinet sketch. Sketch the receding lines equals to the full length of the object. (Fig 9C) Fig 9D shows the completed view of the object in oblique view.

Oblique sketching in cross - section paper : Fig 10 explains that the given two views for a bearing bracket, an oblique view is sketched on a cross - section paper.

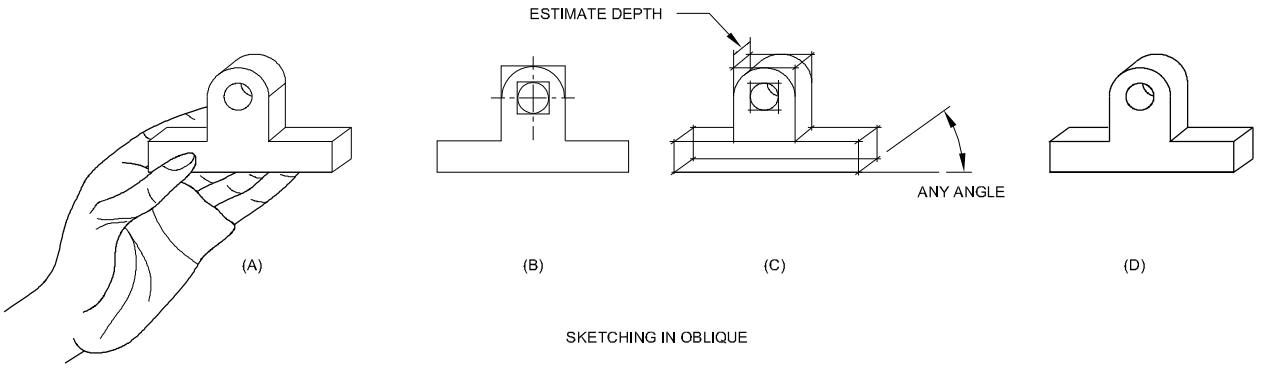
– In this method the dimensions are determined by counting the squares.

– The receding lines are drawn at 45° diagonally through the squares.

To sketch in reduced scale, sketch the receding lines diagonally through half as many square as the given numbers shown at Fig 10A.

Fig 10B, 10C, & 10D are steps or sequence of procedures in developing a oblique view of an object on cross - section paper.

Fig 9



SKETCHING IN OBLIQUE

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Fig 10

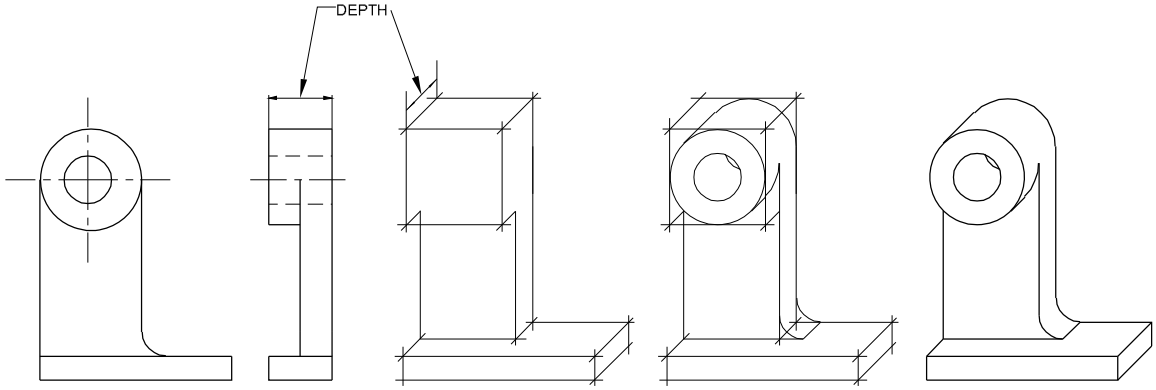

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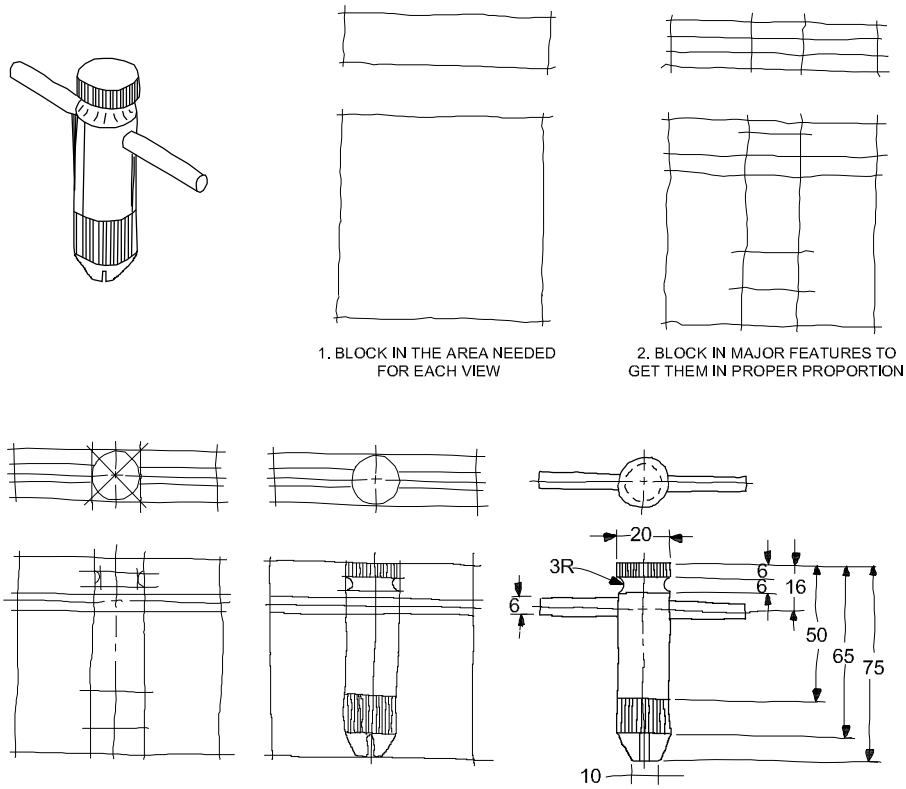
Fig 11



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Sketching multi - view of object : In sketching multi - views of the object teh following steps are most important in this endevour.

– Visualisation of the object
– Determination of the views (whether 1 st angle or 3rd angle)
– Determination of the size of the sketch.
– Location of centre lines
– Allocation of dimensions with proper dimension lines an arrow heads.
– Blocking the main outlines
– Writing titles and any other notes/details with dates
– Checking the drawings.

Before making a free hand technical sketch of a machine part/component the following points is to bear in the mind.

– Before a graphic idea can be developed it is essential that the mental image of it to be definite and clear.
– When making free hand multi - views sketches, it has to begin by blocking the overall size of each view by using very light lines.
– Establish the length, height and width of each view.
– Locate the centre line of the cylindrical features.
– Locate the centres for arcs and circular parts.
– Circular parts and arcs are sketched first followed by horizontal and vertical lines.
– Additional separate views may be sketched rather than complicating views with added lines.
– A machine component can be represented right side up in its natural working position.
– If symmetrical about an axis mostly one half may be sketched.
– Choose a correct scale for the sketch, so that enough space is provided to show all details.
– The rules and methods are same applicable to multi - views drawn by using instruments.

Fig 11 shows a model of free hand sketch for the reference.

Views of objects : A pictorial representation of a drawing or a photograph representation shows an object as it appears to the observer, but not as it is. Hence such a representation cannot describe the object fully and also it does not show the exact shapes and sizes of the several parts.

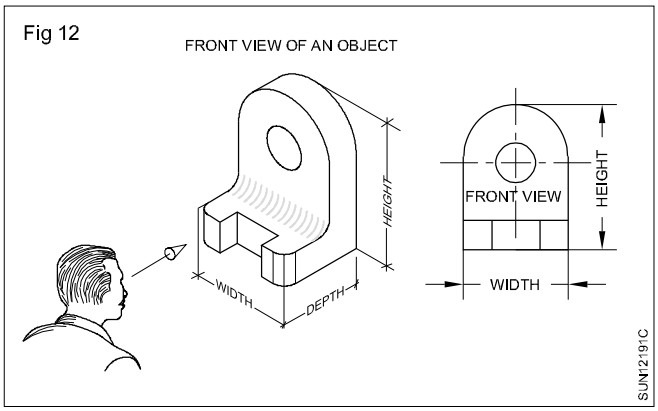
In an industry for the purpose of production, a complete clear description of the shape and size of an object to be made is essential, to sketch certain objects that to be manufactured as intended by the designer. So to provide such information perfectly and correctly a number of views and arranged in multi - views method of projection. In this method each view supplies a certain definite information.

When the view is projected in the direction perpendicular to a principle face or side of the object.

In Fig 12 the observer looks perpendicularly to the face of the object and obtains true shape and size of that side. This has shown in figure. It is known that an object has three principle dimensions such as height, width and depth.

Note : In any one view of a three dimensional object can

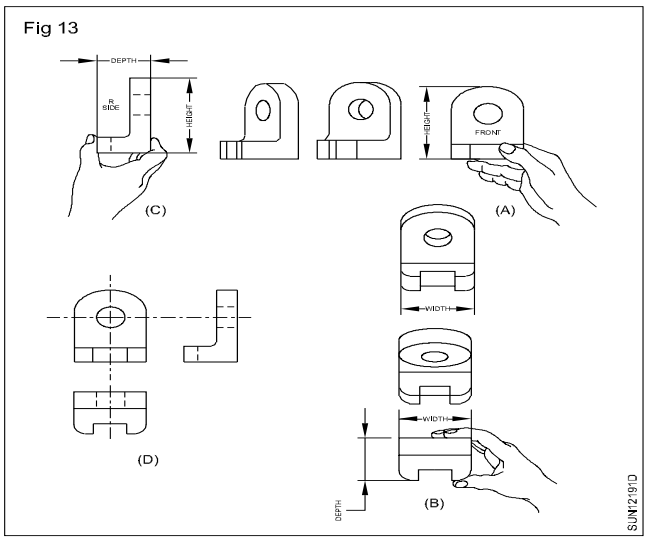
Fig 12



show only two dimensions, the third dimensions will be seen in an adjacent view.

To get the additional views, the object is revolved as shown in Fig 13.

Fig 13

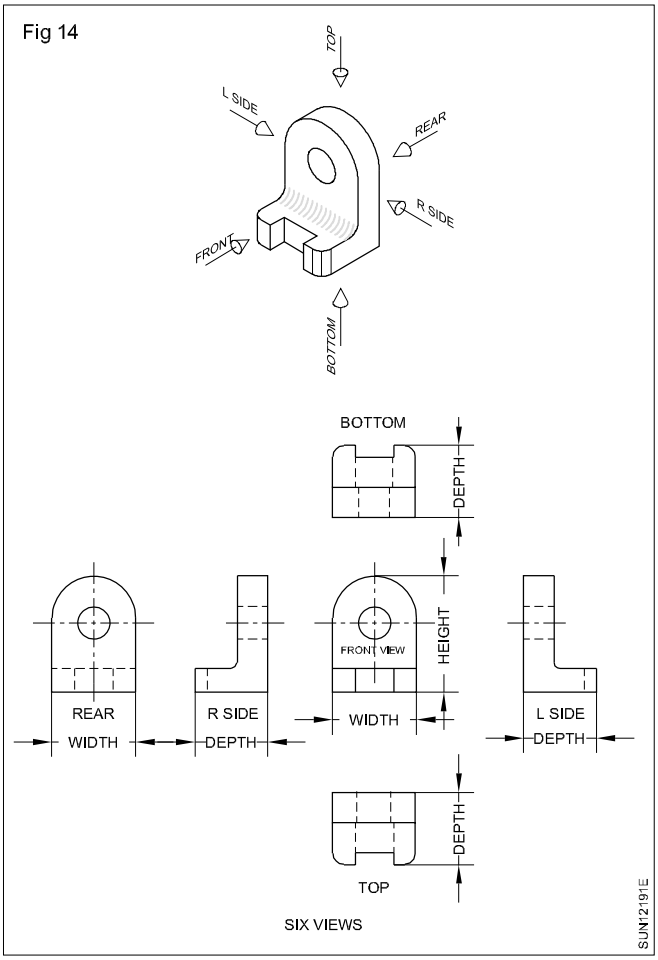


Any object can be visualised from six mutually perpendicular directions as shown in Fig 14 and the arragement of the views shown in Figure. The method of obtaining the views of the objects is discussed in earlier lessons.

Choice of views : It is more important that drawing of the object for use of production should have only such of those views needed for a clear and complete shape description of the object. Fig 15 has three distinctive features that need to be shown on the sketch/drawing and also shows the sketch of six views. The required distintive features are rounded top hole, seen from front.

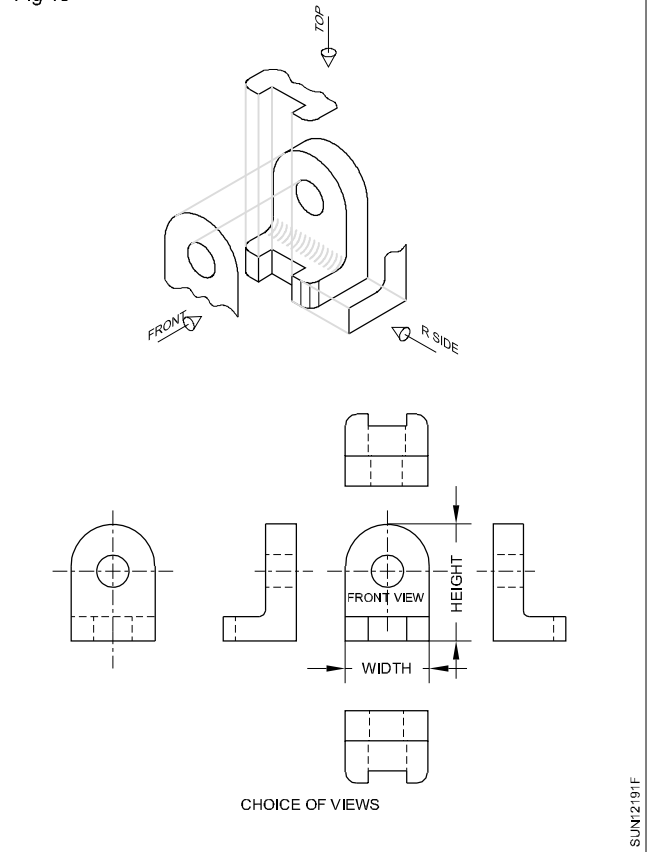
– Rectangular notch and rounded corners seen from the top.

Fig 14



SIX VIEWS

Fig 15



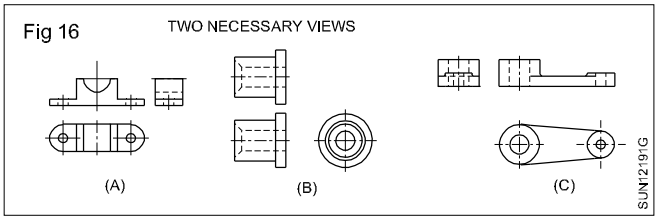
CHOICE OF VIEWS

– Right angle with filleted corner, seen from the side.

The above features can be shown in three views by eliminating the unnecessary view which has shown Fig 15.

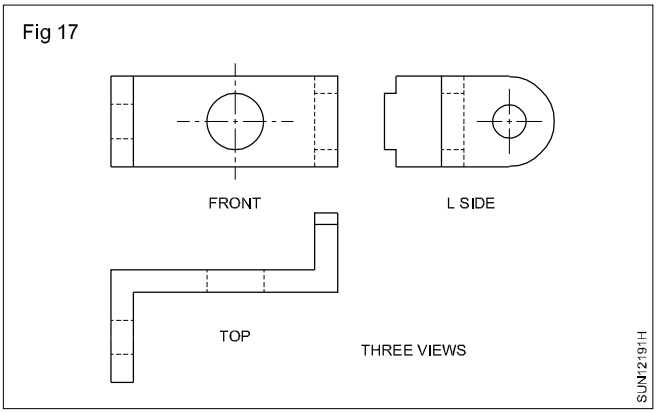
In same cases two views will be sufficient to furnish the features of the object. Fig 16A,B,C are the some example for such cases.

Fig 16



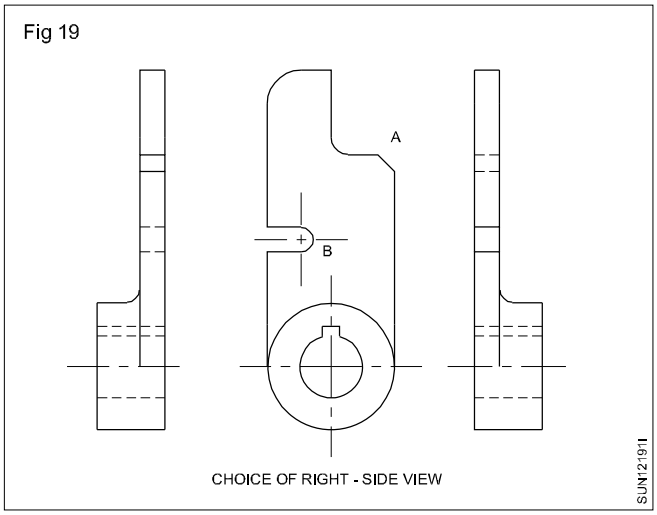
In some cases three views are compulsary. For example Fig 17 shows the three views of a braket. In this cases the top view is omitted, providing the front and side views alone, it is difficult to understand the two view or visulied the object, because the characteristic 'Z' shape of the two view is omitted and also the corners A & B are squares are not filleted. Hence in the example three views are necessary.

Fig 17



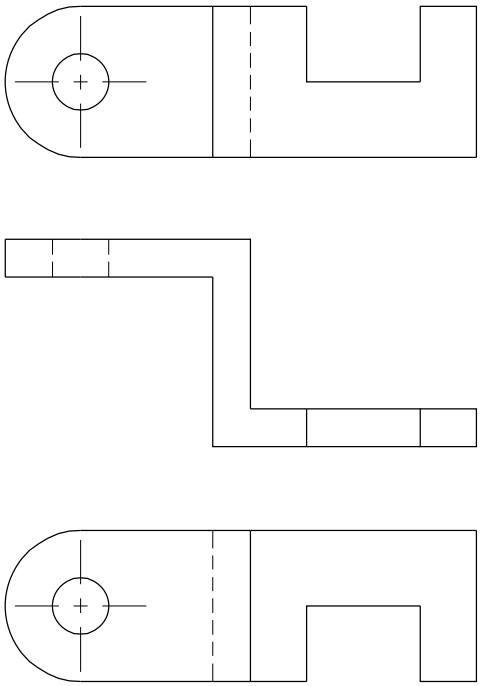
Similarly, it can be views shown in Figs 18,19 & 20.

Fig 19



One view drawings : Often single view with a not lettered symbols is sufficient to explain the feature the object. Fig 21 A one view of the slim, adding a indicating the thickness is sufficient to explain the feature At Fig 21 B one view of a stepped turning piece shown a threaded portion at the end with additional note sufficient to explain the features of the object.

Fig 19



CHOICE OF TOP VIEW

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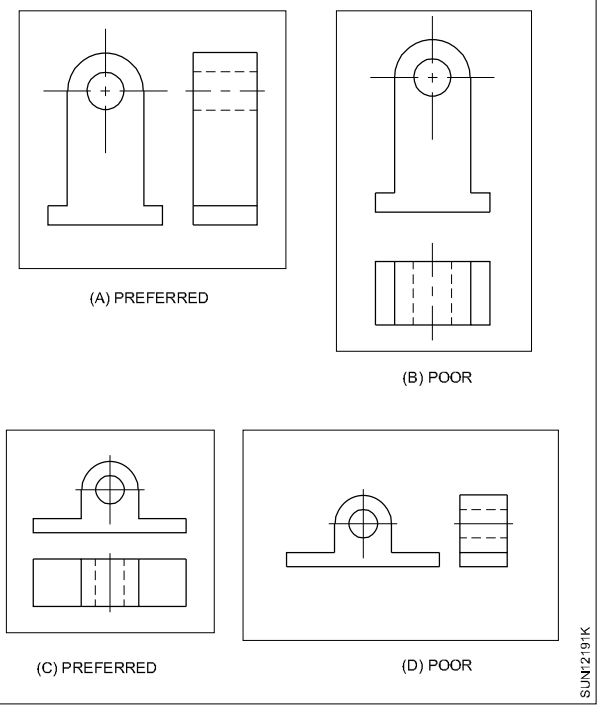
Fig 20 CHOICE OF VIEWS TO FIT PAPER



(A) PREFERRED

(B) POOR

(C) PREFERRED

(D) POOR

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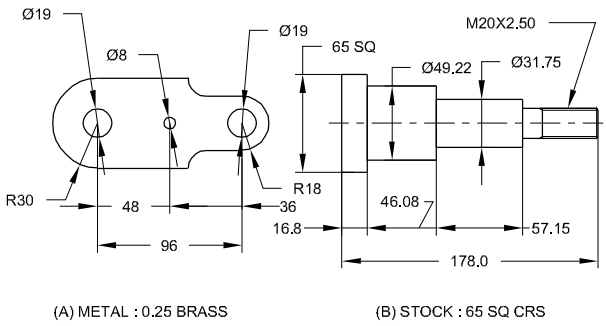
Fig 21

ONE - VIEW DRAWINGS



(A) METAL : 0.25 BRASS (B) STOCK : 65 SQ CRS

SUN12191L

Hidden lines : Correct and incorrect method in sketching drawing hidden lines are shown in Fig 22.

– The following rules can be adopted for the drawing of hidden lines.

– Leave a gap wherever a hidden line dash forms a continuation of a visible line. (Fig 22A)

– A hidden line should intersect to form 'L' or 'T' corners (Fig 22B)

– A hidden line preferably should jump a visible line. (Fig 22 C)

– Parallel hidden lines should be staggered. (Fig 22D)

– When two or three hidden lines meet at a point, the dashes should join. (Fig 22E)

– For showing the counter sunk hole. (Fig 22 F)

– Correct and incorrect methods of hidden arcs. (Fig 22 G & H)

Centre lines : Centre lines are used to indicate arcs of symmetrical objects features. Fig 23 shows the typical applications of the centre lines in various features.

Fig 22

HIDDEN - LINE PRACTICES

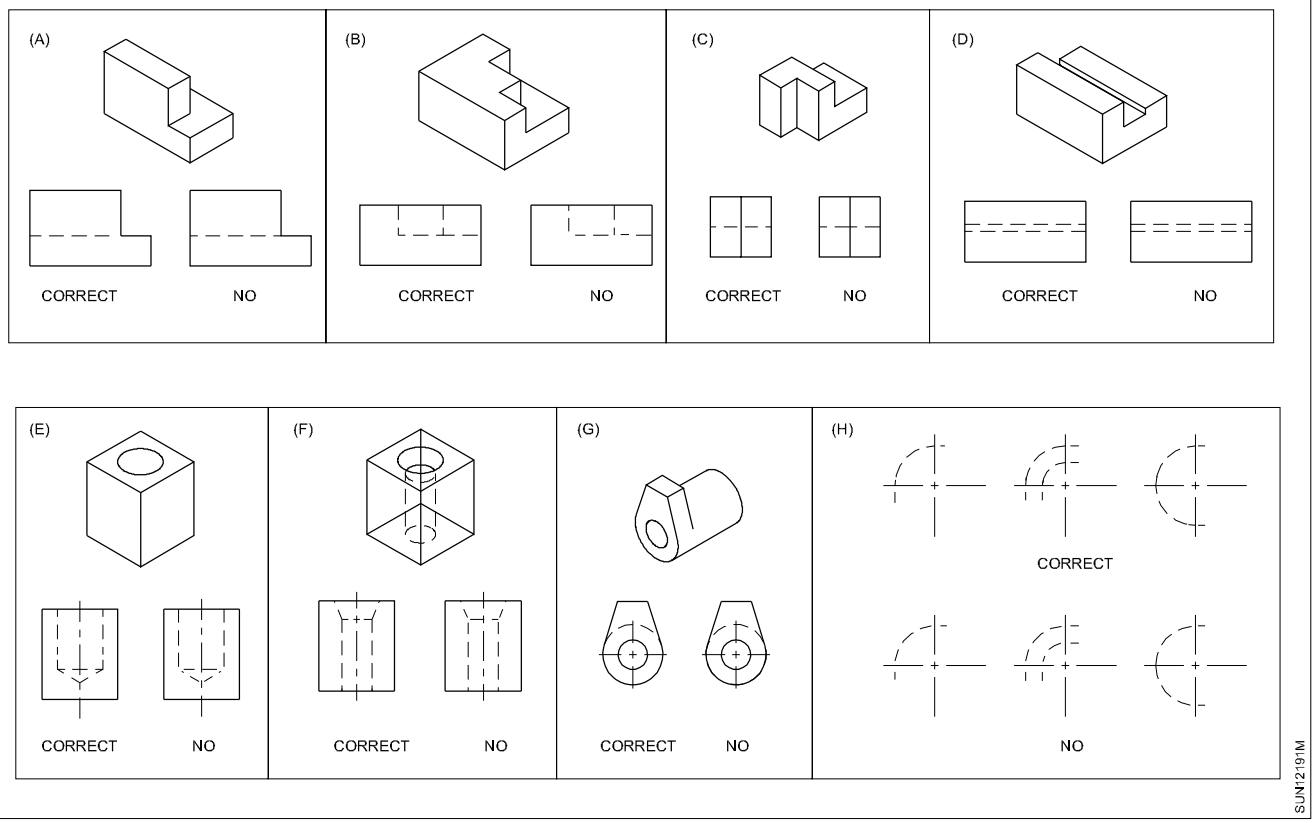
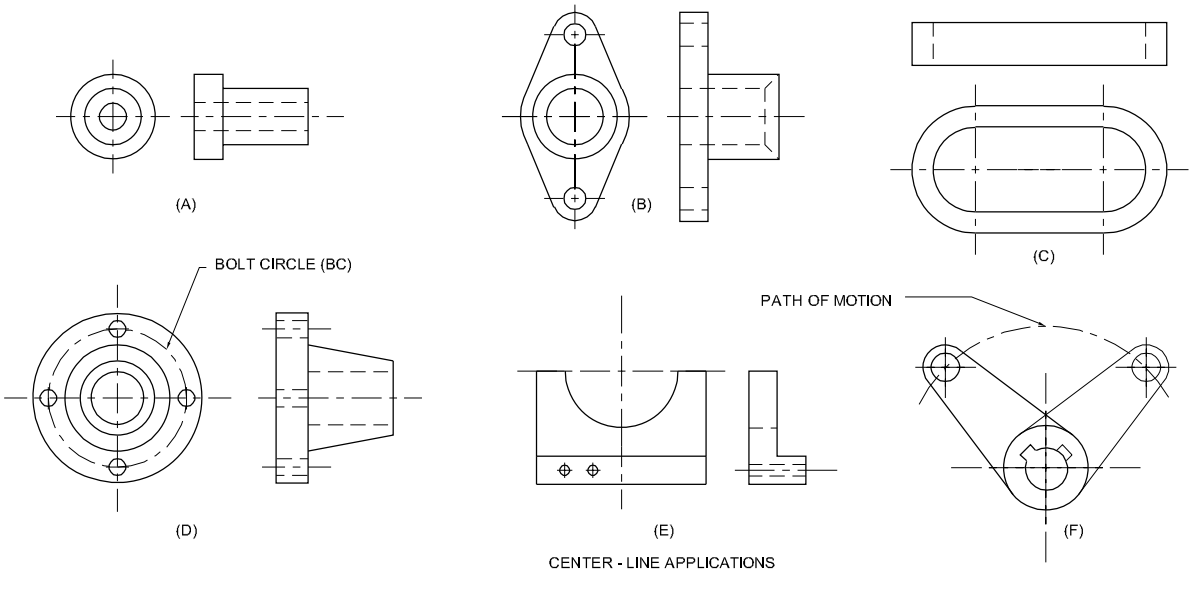


Fig 23



Measurement of distance by a chain and chaining

Objectives: At the end of this lesson you shall be able to
- **state the methods of determining distance**
- **state chaining and chaining a line**
- **state unfolding the chain**
- **describe the reading the chain**
- **state folding the chain**
- **calculate the errors in chaining.**

Measurement of distance

There are two main methods of determining distance.

Direct method and Computative

Direct method: The distances are actually measured on the ground by means of a chain, tape or other instruments.

Computative: The distances are obtained by calculation as in tacheometry or triangulation.

Pacing

For rough and speedy work, distances are measured by pacing (i.e) by counting the number of walking steps of a man. The walking step of a man is considered as 80cm (average). This method is generally employed in the reconnaissance survey of any project.

Measured distance: Length of pace x Number of paces

Passometer

It is a small pocket instrument resembling a watch in size and appearance used for counting the number of steps automatically by some mechanical device. The mechanism requires that it should be carried vertically like in waist coat pocket and the mechanism being operated by the motion of the body.

Pedometer

It is also a similar instrument and is used for the same purpose, but it registers the distance traversed by the person carrying it.

Speedometer

It is an automobiles instrument which is also used to measure the distances approximately.

Perambulator

It is a wheel fitted with fork and handle. It is wheeled along the line, the length of which is desires and the distance is registered automatically on the dials.

Chaining

Definition: The operation of measuring a distance between two points with the help of a chain, or chain with tape is called chaining.

For ordinary works chain is used for measuring the distances but where great accuracy is required, a steel tape is invariably used.

Identification and construction of metric chain

- It is a measuring instrument consists of
- i) 100 links in 20m chain and (Fig. 1)
- ii) 150 links in 30m chain. (Fig. 2)
- It is composed of 4mm dia. mild steel wire.
- Each link having 20cm in length and connected together by means of three circular rings to give flexibility to the chain. (Fig. 3)
- Length of link is the distance between the centres of two consecutive middle rings. (Fig. 4)
- Brass handles are provided at the ends of the chain with swivel joints so that the chain can be turned round without twisting.
- The outside of the handle is the zero point or the end point of the chain.
- The length of the chain is the distance from outside of one handle to the outside of the other handle.
- End links also includes the length of the handle.
- Chain has brass rings at every one metre length.
- Brass tallies are provided at every 5m length as shown in Fig. 5

Chaining a line

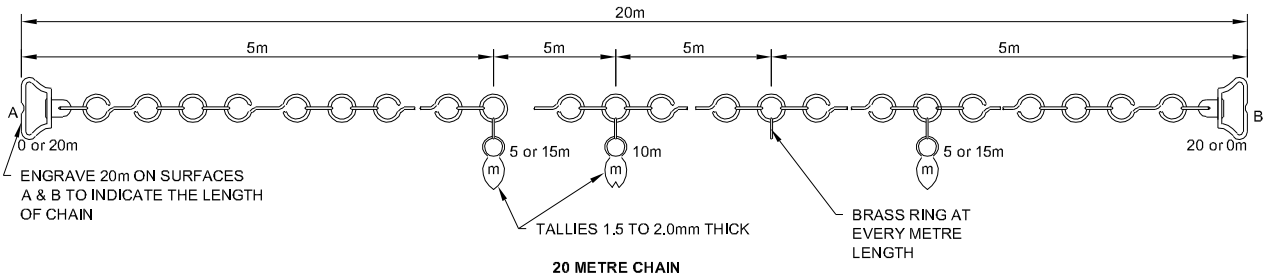
For a chaining operation two chain men are required.

– The chainman at the forward end of the chain is called leader and other chain man at the rear end is called a follower.

– The duties of leader and follower are tabulated under.

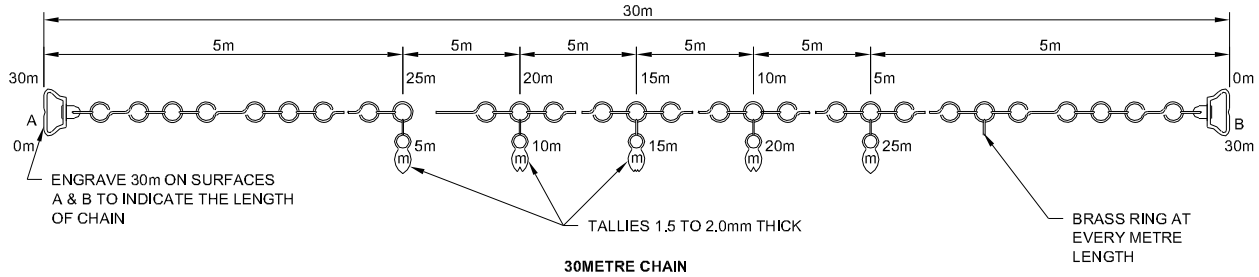
Leader	Follower
To drag the chain forward	To direct the leader to be inline with the ranging rod at the end stations.
To insert an arrow at the end of every chain	To carry the rear end of the chain ensuring that it is dragged above the ground.
To obey the instructions of	To pick up the arrows

Fig 1



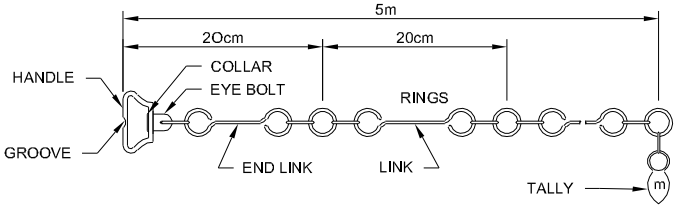
20 METRE CHAIN

Fig 2



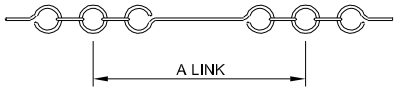
30METRE CHAIN

Fig 3



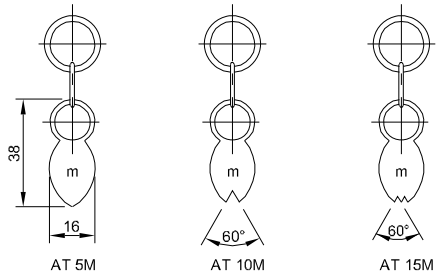
DETAILS OF A METRIC CHAIN

Fig 4



A LINK OF A CHAIN

Fig 5



SHAPE OF TALLIES IN 30m METRIC CHAIN

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the follower inserted by the leader

Unfolding the chain

Before comencing the chain, the surveying or follower keeping both handles of the chain in his left hand, spread the chain with the forward direction iwth the right hand. The leader taking are handle of the chain in his hand and moves forward till the chain is fully extended.

Reading the chain

- The chain is marked by tallies at every 5m length and small brass rings at every 1m length without having difficulty in reading the chain.
- In taking measurements, observe the tag immediately before the end point, which is being measured to and count the number of brass rings and links from it in the forward direction to the end point.
- In reading near the centre of the chain care must be taken to see the position of the central tag.
- To get the total distance add the above fractional part of the chain with the number of full chain, if distance exceeds more than one chain length.

Folding the Chain

After the field work the chain should be folded into a bundle. The chain is folded by taking central two lines in the left hand until the handle of links is formed and lied up with a strip of leather.

Error in length due to in correct chain

Correct or True distance =

In correct (or) measured distance ×

$$\frac{\text{Incorrect length of chain or tape}}{\text{Correct length of chain or tape}}$$

(or)

True distance = Measured distance x $\frac{L'}{L}$

Where L = True length of chain or tape

L' = Incorrect length of chain or tape

Error in area due to incorrect chain:

True area =

Error in volume due to incorrect chain

True volume = Measured volume x $\left(\frac{L'}{L}\right)^3$

Example

Problem 1

The distance between two points measured by 20m chain was recorded as 720m. It was afterwards found that the chain used was 4cm too long. What was the true distance between the points?

Solution

True distance = Measured distance x $\left(\frac{L'}{L}\right)$

Measured distance = 720m

Chain = 20m

Error = (+) 4cm

$\therefore L' = 20 + \frac{4}{100}$ = 20.04m, L = 20m

True distance = 720 x $\frac{20.04}{20}$ = 721.44m

Problem 2

A field was surveyed by a chain and the area was found to be 127.34 hectares. If the chain used in the measurement was 0.8% too long, what is the correct area of the field?

Solution

Chain used = 100 units

True area = Measured area x $\left(\frac{L'}{L}\right)^2$

L' = 100 + 0.8 = 100.8 units, L = 100 units

True area = 127.34 x $\left(\frac{100.8}{100}\right)^2$

= 129.386 hectares

Exercise

1 The length of a line, measured with a 30m chain was found to be 4920m. If the chain was 0.3 link too short, find the true length of the line.

2 A road actually 2660m long was found to be 2652 m when measured with a defective 30m chain. How much correction does the chain need?

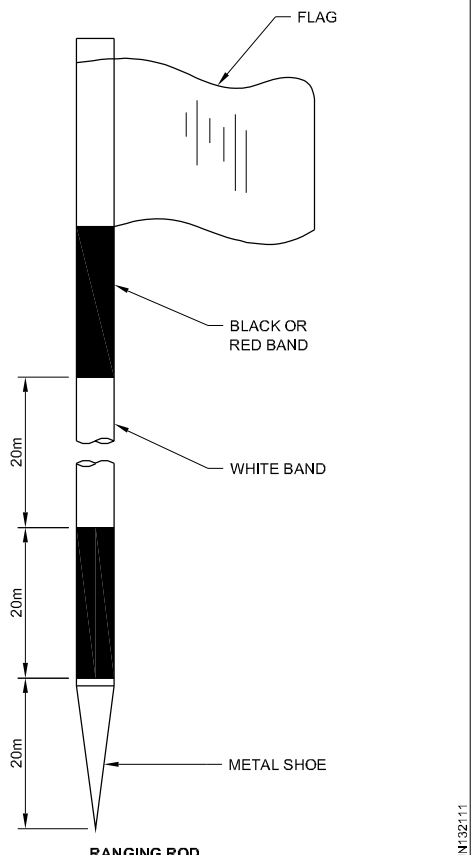
Introduction about chain survey instruments

Objectives: At the end of this lesson you shall be able to
- **state the construction and uses of the following chain survey instruments.**

– Ranging Rod
– Offset Rod
– Arrows
– Wooden peg
– Plumb bob
– Measuring Tapes

Ranging Rod (Fig 1)

Fig 1



RANGING ROD

– It is a wooden/steel pipe of 2m or 3m in length with 3cm in diameter for steel and for wooden is 4 cmø.

– It is painted in red and white or black and white in 20 cm band width.

– Bottom of rod is fixed with a sharp metal shoe for fixing on ground.

– Flag is fixed on the top for visibility when it is more than 200m in distance.

– It is used for marking the position of station in chaining.

– If is also used for fixing intermediate points in ranging.

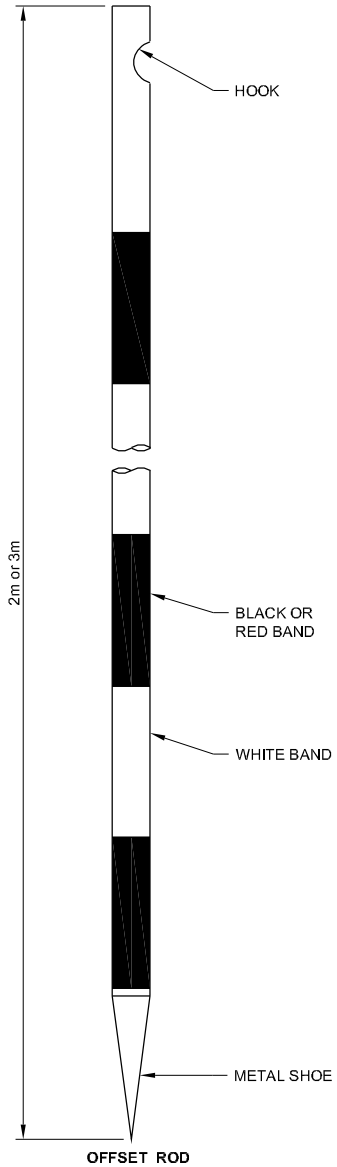
Offset rod (Fig 2)

– It is similar to the ranging rod with a hook at the top.

– It is used for pulling or pushing the chain through hedges and other obstruction.

– It is also used for aligning offset line and measuring short offset.

Fig 2



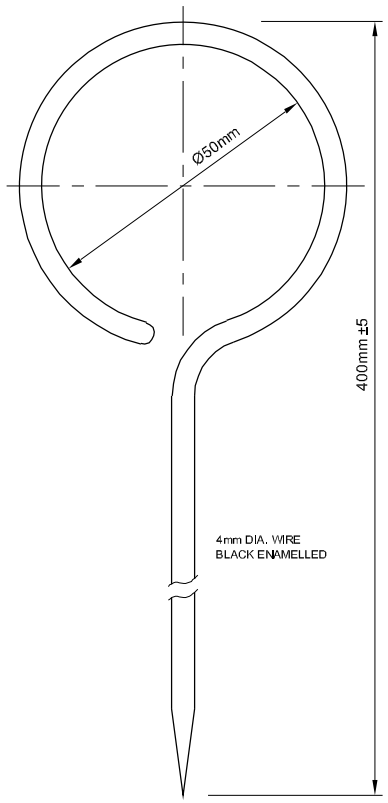
OFFSET ROD

Arrows

– It is made up of 4mm steel wire and 40cm long as shown in Fig 3. It is pointed at one end for inserting into the ground. Another end bent into a ring for easy handling. Each metric chain shall accompanied with 10 arrows as shown in Fig 4.

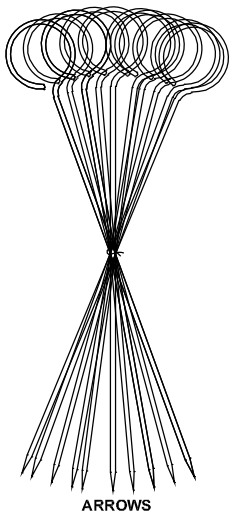
– It is used to mark the ends of each chain during the process of chaining.

Fig 3



ARROW

Fig 4

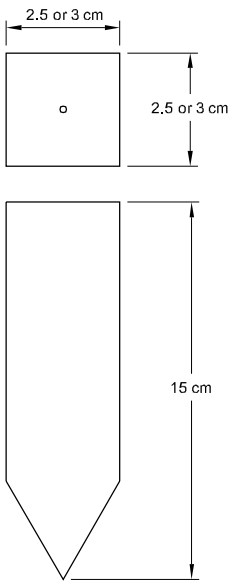


ARROWS

Wooden peg (Fig 5)

These are 15cm in length and tapered at one end. It is used to drive on the ground to mark the position of stations.

Fig 5

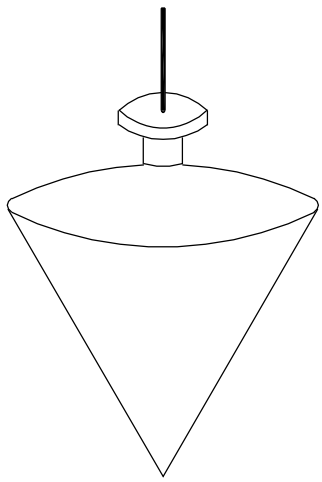


WOODEN PEG

Plumb bob (Fig 6)

While chaining along a sloping ground, it is used to transfer the points on the ground. It is also used as a centering aid in Theodolite, compass and plane table.

Fig 6



PLUMB BOB

Measuring tape

This is the instrument used for measuring distances

They are made of

1 Cloth or linen tape : It is 12 to 15mm wide and is made of linen cloth. It is available in lengths of 10m, 20m and 30m. At the end of this tape is provided with brass handle which is included in the total lengths of the tape.

It is easily affected by dampness.

It is used for taking measurement such as offsets.

2 Metallic tape

3 Steel tape

4 Invar tape

5 Fibre or plastic tape

Metallic tape (Fig 7)

– It is made up of linen and reinforced with fine brass or copper wire. It is covered in a leather case with winding device.

– It is available in 15m (50ft) and 30m(100ft)

– Each metre length is divided into 10 parts (Decimetre) and each part is further subdivided into 10 parts (Centimetre)

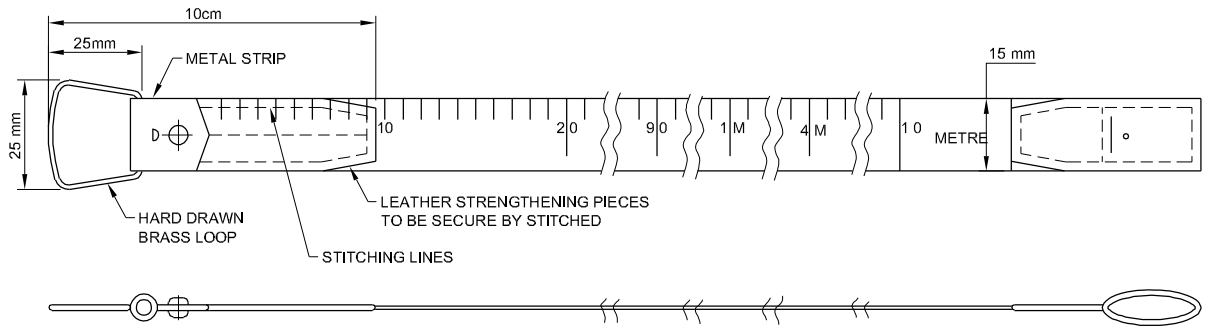
– The other side of the tape is graduated with feet and inches.

– It is commonly used for taking offsets in chain surveying.

– This cannot be used for taking very accurate measurement

Steel tape (Fig 8)

Fig 7



METALLIC TAPE

– It is made of steel ribbon varying in width 6mm to 16mm and available in 1m, 3m, 5m, 10m,15m, 30m and 50m in length.

– Each metre is divided into 200 parts. (Each being 5mm) First 10cm length of the tape is divided into millimetre

– It is used for taking measurements and also used for testing chain lengths.

Invar tape

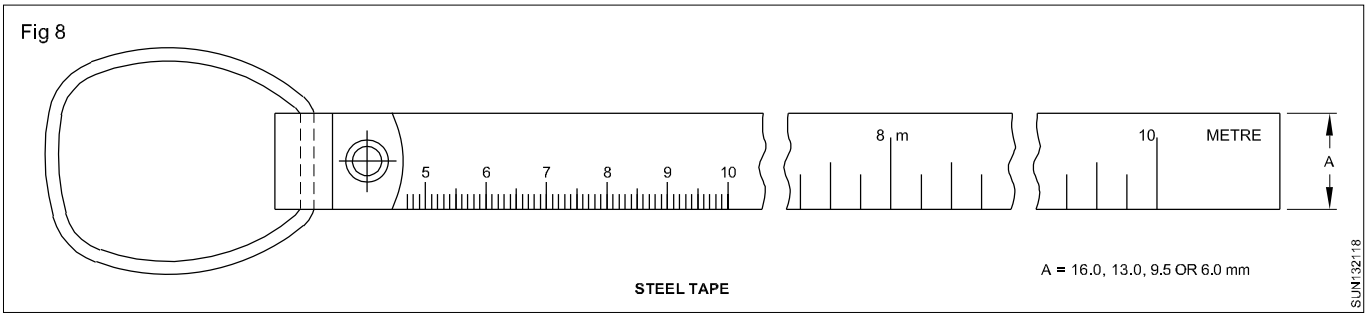
– It is made of an alloy steel (64%) and nickle (36%) and available in 30m, 50m and 100m lengths.

– It is easily kinked and broken, so care should be taken while taking measurements.

– It has very low coefficients of thermal expansion.

– It is only used for highest precision measurement like baseline in triangulation work.

Fig 8



STEEL TAPE

Testing of metric chain (20m/30m)

Objectives: At the end of this lesson you shall be able to
- **state the necessity of checking the chain**
- **state the methods of testing**
- **list out the errors in the chain**
- **state the limits of error in chain**
- **explain the adjust the chain**
- **state Indian optical square.**

Necessity of checking the chain

The length of chain changes due to wear and tear, mud sticking and change in temperature.

The length of chain increases due to

– Stretching of links and joints.

– Opening out of the rings.

– Wear of the wearing surfaces.

– rough handling in pulling it through hedges and fences.

The length of chain decrease due to bending of the links and mud-sticking.

Therefore it becomes necessary to check the chain before commencing the survey work. Before testing the chain the bent uplinks should be straightened and mud should be removed from the joints.

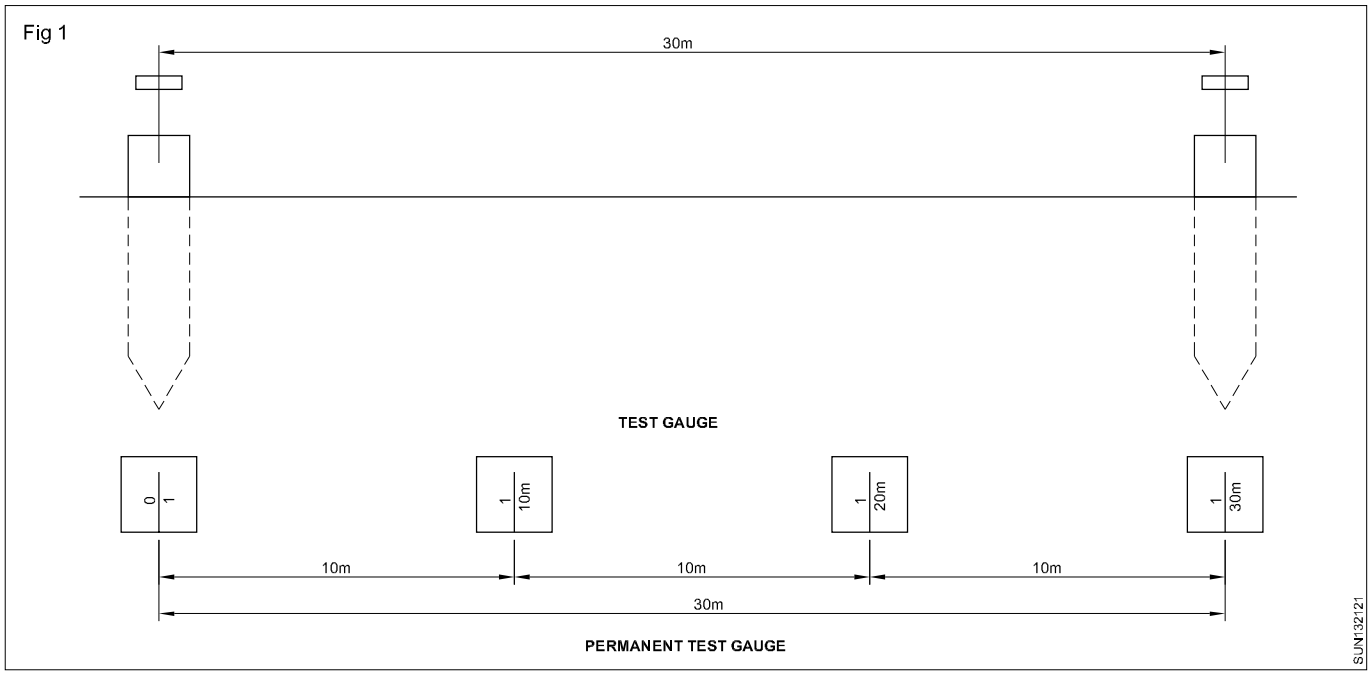
Methods of testing chain

Following are the methods of testing a chain. (Fig 1)

– By comparing it with a chain standard or with a test gauge

– By comparing the chain with the levelling staff laid down successively.

– By comparing the chain with the steel tape reserved specially for this purpose.



Errors in chain

Errors in chain are,

1 **Instrumental error:** They occur due to faulty adjustments of devices such as chain may be too long or too short etc.

2 **Natural errors:** They arise due to variation of temperature

3 **Personal errors:** They are due to chain not being straight

Mistakes in Chaining

Mistakes are generally done by inexperienced chainman. These can be avoided by careful working. Following are the common mistakes made in the field.

i) **Miscounting the chain length:** This is the most serious mistake and occurs due to wrong counting or due to loss of arrow

ii) **Displacement of arrows:** If an arrow is displaced, it may not be replaced correctly. To avoid this mistakes, the end of the chain length should be marked both by scratching a cross on the ground and fixing an arrow.

iii) **Misreading:** It happens due to reading from the wrong end of the chain. It can be avoided by carefully noticing the position of the central tag.

Limits of error in chain

As per Indian standard specifications every metre length of chain should be accurate to within ± 2mm when measured with tension of 8 kg and checked against a certified steel tape which has been standardised at 20^0C

The overall length of chain should be within the following limits.

20m chain : ± 5mm

30m chain : ± 8mm

Adjusting the chain

I If the chain is found to increase in length than the standard length, it may be adjusted

i) By closing up the joints of the opened out rings.

ii) By Hammering back to the shape, of the flattened out rings.

iii) By replacing some of the larger rings by smaller rings.

iv) By removing some of the rings.

v) By adjusting links at the handle.

II If the chain is found to decrease in length than the standard length, it may be corrected.

i) by straightening the bent up links.

ii) by replacing some of the smaller rings by larger ones.

iii) by inserting the new rings as required

iv) by adjusting the links at the handle

Ranging

Objectives: At the end of this lesson you shall be able to
- **state ranging**
- **state the necessity of ranging**
- **state the types of ranging**
- **interpret the signals surveyor and the corresponding actions by assistance.**

Ranging

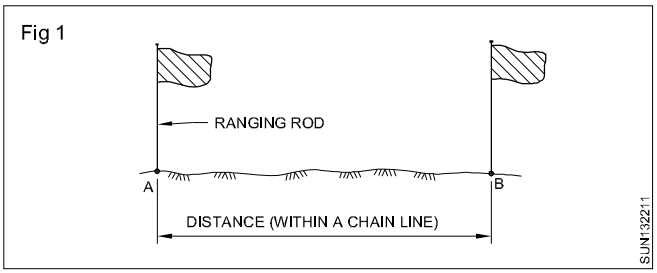
The process of establishing intermediate points in line with the terminal points before chaining is known as ranging. This is necessary when the distance is longer than one chain length.

Necessity of ranging

To measure the length of a survey line also called a chain line, it is necessary that the chain should be laid out on the ground in a straight line between the end stations.

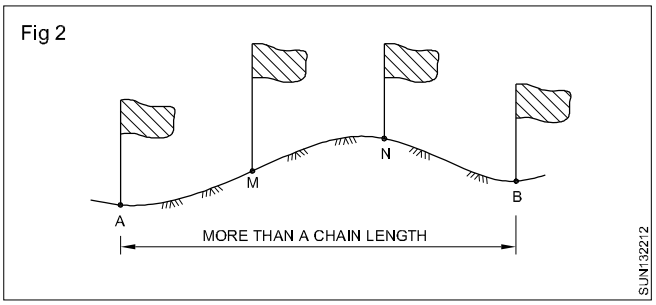
If the line AB is with in a chain length or the end stations are clearly visible, it is easy to put the chain in a true alignment as show in Fig 1.

Fig 1



But if the line AB is more than one chain length or the end stations A and B are not clearly visible, it is necessary to place intermediate ranging rods at M and N to maintain a straight line between the stations as shown in Fig 2.

Fig 2



Types of ranging

There are two types of ranging. They are

– Direct ranging

– Indirect ranging

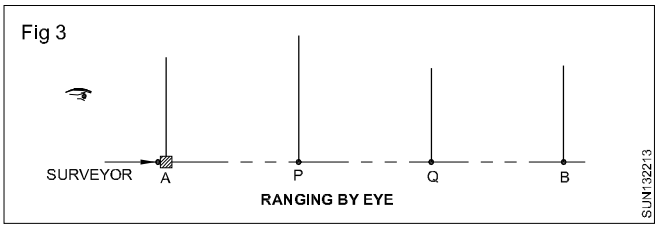
Direct ranging

When intermediate ranging rods are placed along the chain (in between the visible end) line by direct observation from either end station is known as direct ranging.

Direct ranging may be done either by eye judgement or by using line ranger but in important works theodolite is preferably used.

Fig 3 shows A and B are the ends of a survey line and P and Q are the intermediate stations.

Fig 3



Indirect ranging (or) Reciprocal ranging

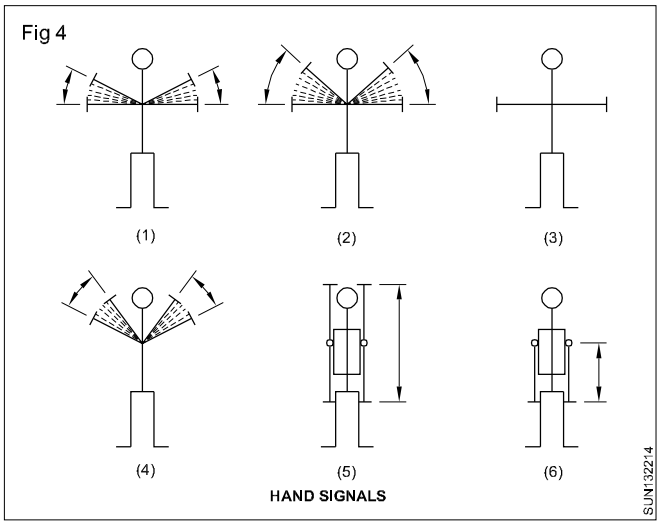
When the ends of the line are not intervisible due to high ground or a hill or a valley intervening, and also when the ends of a line are not distinctly visible from one another due to the distance being too great.

In this case, to fix the intermediate points indirect ranging is adopted.

Hand signals for ranging (Fig.4)

The following hand signal are used by a surveyor to direct the assistant to move to the desired position.

Fig 4



Sl. No.	Signal by the surveyor	Action by the Assistant
1	Rapid sweep with right or left hand	Move considerably to the right or left.
2	Slow sweep with right or left hand	Move slowly to the right or left
3	Right or left arm extended	Move continously to the right or left
4	Right or left arm up and moved to the right or left	Plumb the rod to the right or left
5	Both hands above head and then brought down	The position of the rod is correct
6	Both arms extended forward horizontally and then brought down.	Fix the rod

Offsets and offsetting

Objectives: At the end of this lesson you shall be able to
- **state the meaning of offset and offsetting**
- **state the classification of offsets, its limits and its definition**
- **state the methods of taking offsets for various site conditions.**

Offset

The lateral distance measured from the chain line to the object is called offset.

Offsetting

The process of measuring lateral distances from the chainline to the objects which are to be plotted is called as offsetting.

It is done to locate the objects with reference to the chainline.

These are measured on either side of a chainline.

Classification of offsets

Based on length of chain line

– Short offset

– Long offset

Based on direction of chain line

– Perpendicular offset

– Oblique offset

Limits of Offsets

The length of offset depends upon the degree of accuracy required, scale used, method of setting out the perpendicular and nature of the ground. Hence the length of perpendicular offset should be within 15m

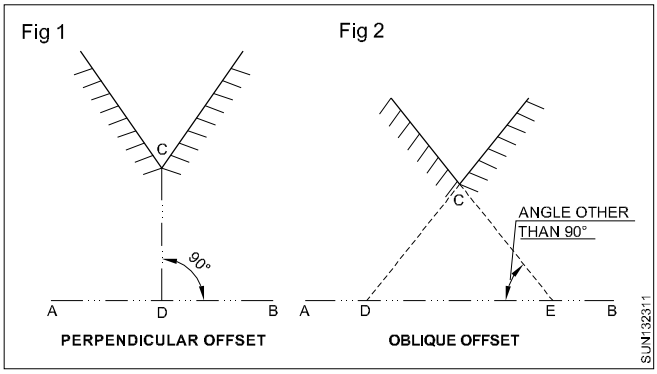
Short offset - Less than 15m
Long offset - More than 15m

Perpendicular offset

It is also known as rectangular offset or right offset. The distance measured at right angles to the chain line from the objects is known as perpendicular offset. (Fig 1)

Oblique offset

Offsets which are other than right angles to the chainline are known as oblique offset such as CD and CE in Fig 2



This is taken when

– The object is at a long distance

– accuracy is required.

Taking offsets

– The operation of taking and recording the distance on either side of a chainline is known as taking offsets.

– The measurement on the chain line is recorded as ‘Chainage’

– Long offsets are measured with steel tape and short offsets are measured with metallic tape.

– When the offsets are short, perpendicular offset is laid by holding the zero end of the tape at the object and swing the tape over the chain to find the chainage.

– The minimum distance will be the perpendicular offset.

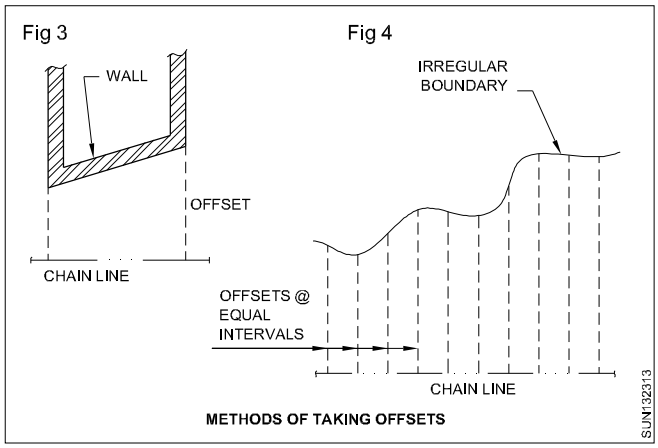
– When greater accuracy is required or the offsets are long, the right angles should be laid out with cross staff or optical square.

Methods of Taking offsets

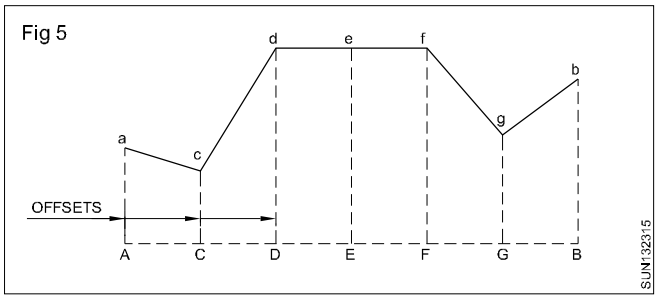
– An offset should be taken wherever the outline of an object changes.

– In case of straight wall or boundary, an offset should taken at each end of the corner. (Fig 3)

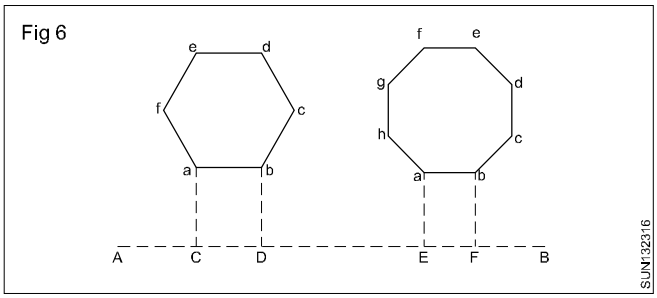
– In case of an irregular boundary, sufficient number of offsets at suitable interval should be taken.(Fig 4)



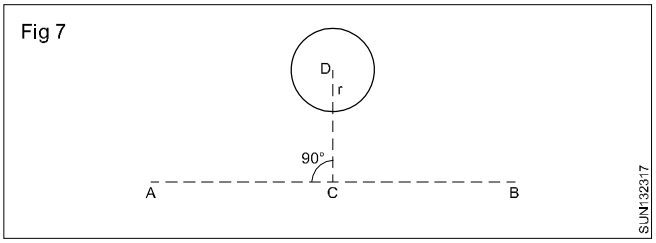
– Whenever the outline of the object changes its direction an offset, must be taken at each change of direction (Fig 5)



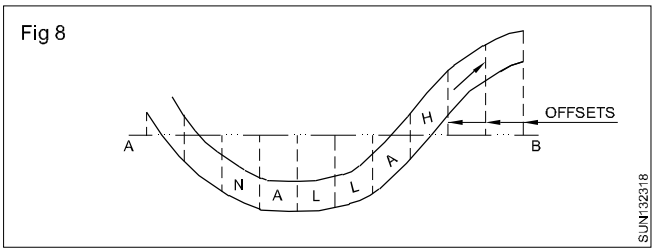
– In case of polygonal objects such as pentagon, Hexagon, Octagon etc, offsets should be taken at the ends of the side nearer to the chainline and the length of the sides (Fig 6)



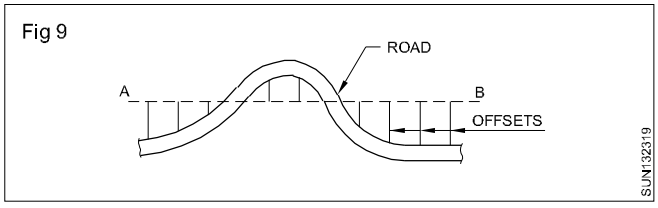
– In case of circular shapes, an offset should be taken to its centre and its radius should be measured. (Fig 7)



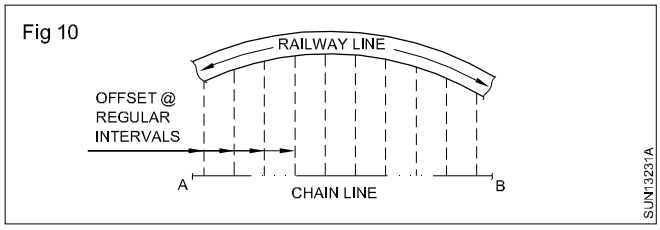
– In case of a nallah, offsets should be taken to both the sides of its width. (Fig 8)



– In case of roads or foot paths with constant width offsets should be taken at the beginning, middle and the end of the curve and at few points in between (Fig 9) width should also be measured.



– In case of fair curve such as railway line, offset should be taken at a regular interval and width should be measured. (Fig 10)



Field book

Objectives: At the end of this lesson you shall be able to
- **name the two types of field book**
- **explain about booking of field book**
- **explain about inking and colouring and using of conventional signs and symbols.**

Field book

The field measurements , sketches, notes are recorded for future reference in a notebook called field book.

It is a rectangular notebook of size 20cm x 12cm and open length wise

There are two kinds of field book.

i) Single line field book

ii) Double line field book

Single line field book

Single line field book is used for large scale survey most detailed dimension work.

A red line is ruled down at the middle of each page.

This single line represents the survey line or chain line

The chainages are entered on the chain line.

Offsets are entered in the order they appear at the chain line.

Objects are sketched and offsetting distance are entered as shown in Fig 1.

Double line field book:

Double line field book is used for all ordinary works.

Two blue lines or red lines are ruled down in the middle of each page.

The space between these two red or blue lines represents the chain line.

The chainages are entered in between these two lines.

Objects are sketched and offsetting distances are entered as shown in Fig 2

Booking Field notes

Following informations are recorded at the beginning of survey

– Date of commencement and completion of survey and names of surveyors.

– Symbol denoting the station point

– Details of survey lines.

– Location sketches of survey stations

– Name of the line (Say AB,BC)

– Booking is commenced at the bottom of the page and worked upwards.

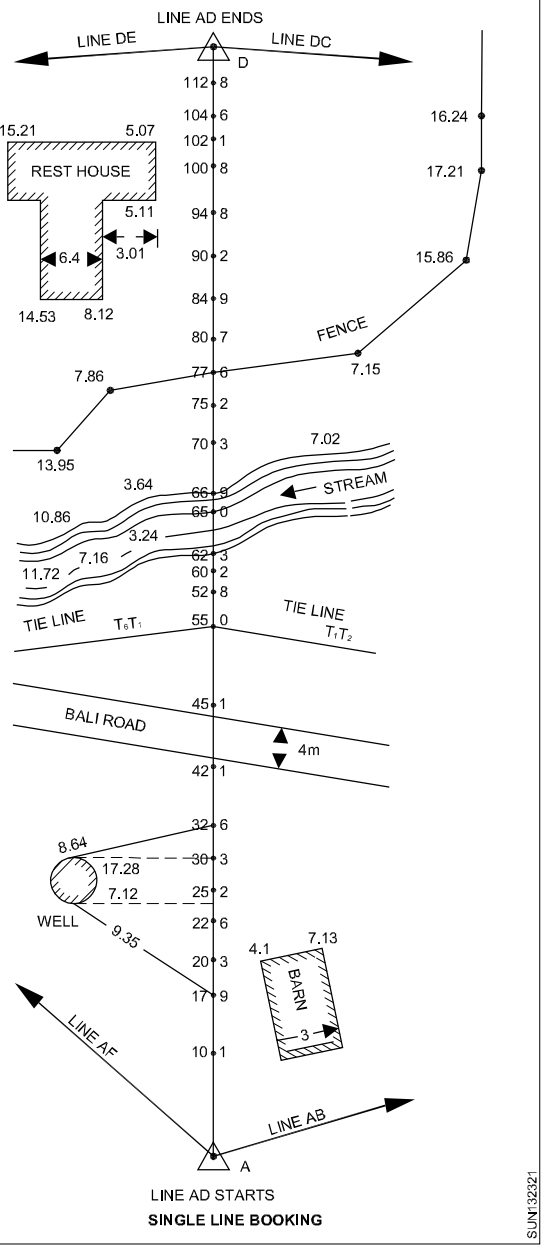
– Each chainline or tie line should be recorded in a separate page.

– The recorder should move in the forward direction of chaining.

– All measurements should be recorded immediately

– Wrong entries should be scored out and correct measurements should be written over the wrong measurements.

Fig 1



– If the entire page is discarded it should be crossed and marked as CANCELLED

– The offsetted objects are sketched with conventional signs (Fig 1 & 2) towards left or right of the central column.

– The sketches should be drawn proportionally

– Figures denoting the dimensions of the details of the objects should be included between the arrow heads.

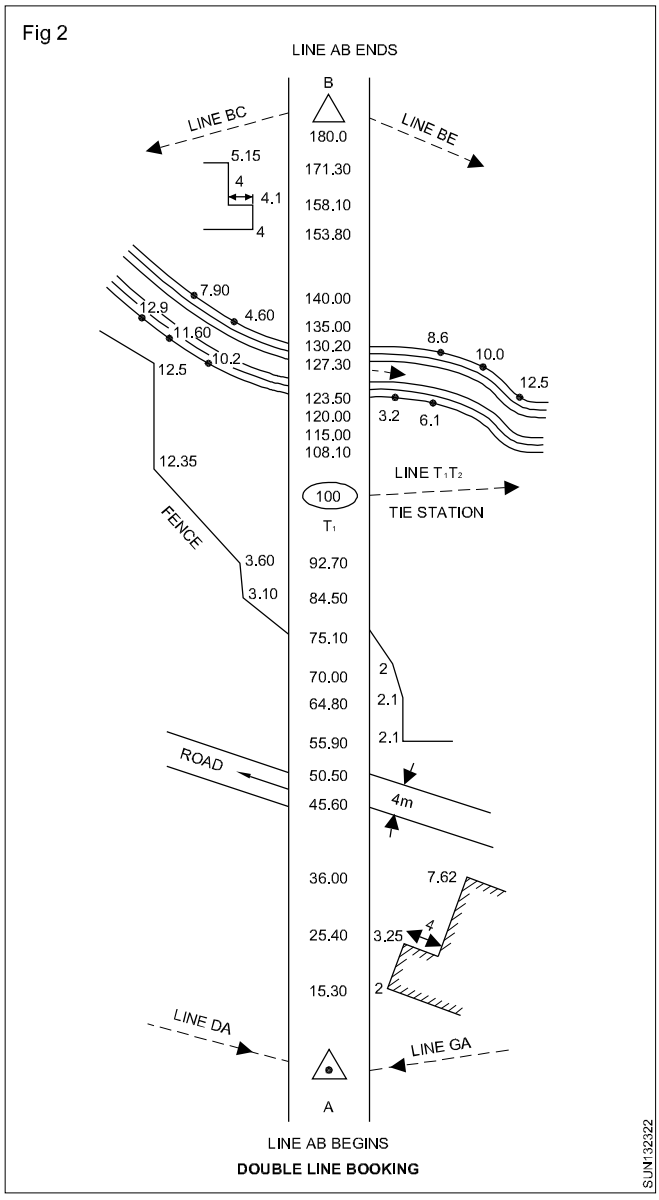
– Numerals should be neatly and legibly written.

– Over writing should not be done.

– Offsets are written close to the points offsetted and exactly opposite to and in line with the chainages.

– To avoid confusion sufficient space should allow between rows of booking.

Fig 2



– When objects such as fence, road, wall etc crosses the chain line, the chainage of the point of intersection should also entered and direction should be noted.

– A symbol Δ is used to denote a main station.

– The zero chainage at the commencement and the closing chainage at the end of a line should written inside the Δ

– The name of the station should written close to the Δ.

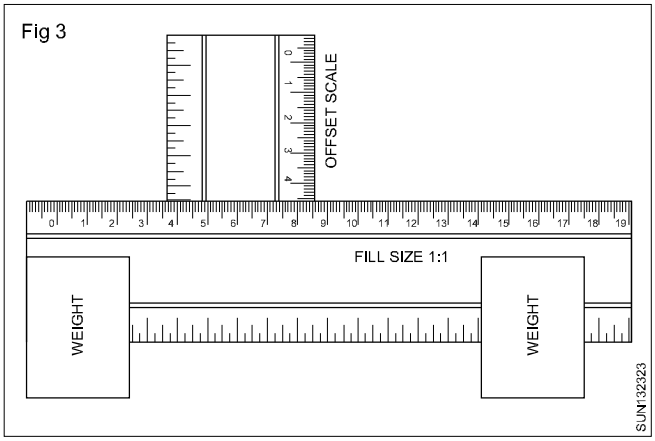
– Tie or subsidiary stations should indicate by circles or ovals round the chainages

Plotting of a chain survey

- Plotting work is started after the field work is over.
- The survey is plotted on the drawing sheet with a suitable scale.
- It should be plotted always north direction, so then the top of the drawing sheet represents north.
- The plotting should be always drown on the centre of the sheet taking sufficient spaces for margin, title and scale.
- The base line is firstly drawn in its proper position.
- Intermediate stations are marked on the base line and complete the frame work of the triangles.
- The triangles are checked by check lines.
- For plotting offsets, mark the chainages of the points along the chain and from which the perpendicular offsets are marked by using an offset scale.
- The plotting of offsets should be continued according to the field book is maintained in the field book.
- The main stations and substations, objects, chain line are shown in accordance with the conventional signs.
- The heading should be written on the top of the drawing sheet.
- The map should not have any dimensions.

Offset scale (Fig 3): Using of offset scale for plotting perpendicular offset

Fig 3



- Put the long scale along the chain line, with its zero mark is exactly at the starting point of the line.
- The offset scale is placed at right angles to the long scale and moved to the required chainages. Then the offset lengths are marked with the help of the pricker.

Inking maps or plans

After completing and checking the plan, it is inked in. It is done to work from top of the plan downwards or from left or right. The inked in lines should be fair. Curved lines should be inked first with the help of French curves after that straight lines should be inked.

Colouring

The following points should be considered in mind while colouring.

– Before commencing colouring clean the drawing throughly

– Mix all colours in light and not too dark.

– Always mix more quantity of colour if one colour is required for the whole of the work.

– While colouring a drawing, the drawing board should be in a flat position to spread the colour evenly.

The following colours are used for the features shown

Features	Colours
Road metalled	Burnt Sienna
Road Unmetalled	Burnt amber
Compound wall	Indigo
Buildings	Crimson lake
Water	Prussian blue
Barren land	Burnt amber
Bench mark	Crimson lake
Truss	H green
Cultivated land	H green

North point

The north point must be shown on a plan in any convenient blank space on the paper preferably at the top pointing upwards

Scale

Scale should be drawn under the title or just inside the border at the bottom of the drawing.

Conventional signs & Symbols

The earth surface contains varities of natural and artifical features. If it is to be shown graphically, it will not be possible without its description. To overcome this difficulty standard symbols have been adopted for each type of details.

The symbols which are drawn to natural or artifical details on a map is known as convetional signs.

Various signs used in Surveying.

Obstacles in chain surveying

Objectives: At the end of this lesson you shall be able to
- **define obstacles**
- **state the three types of obstacles**
- **calculate the obstructed distance.**

Definition

During chaining, sometimes rivers, ponds, buildings, hills, thick jungles may prevent the chainman to take the measurements directly. These obstructions are known as obstacles.`

Type of obstacles

1 Obstacles to ranging

2 Obstacles to chaining

3 Obstacles to both chaining & Ranging.

Obstacles to ranging: Two cases

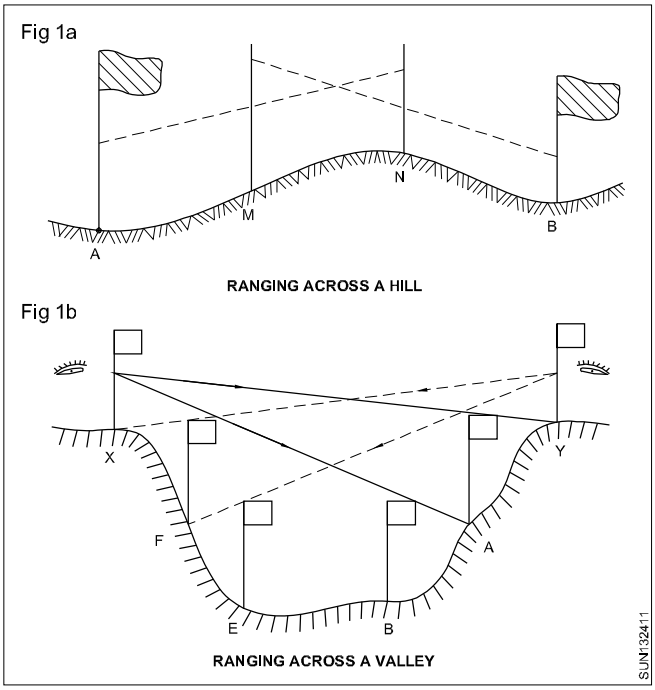
Case (i)

Both ends of the line may be visible from intermediate points on the chain line.

E.g. Hill, Valley (Fig 1a) AB = AM + MN + NB

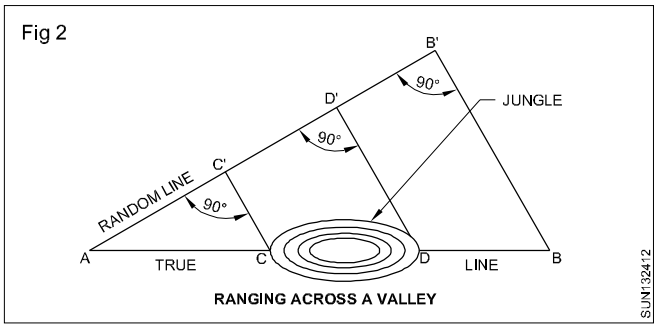
Fig 1b XY = XE + EB + BY

Horizontal distances are calculated by stepping method.



Case (ii)

Both ends of the line may not be visible from intermediate points on the chain line. (Fig.1b)



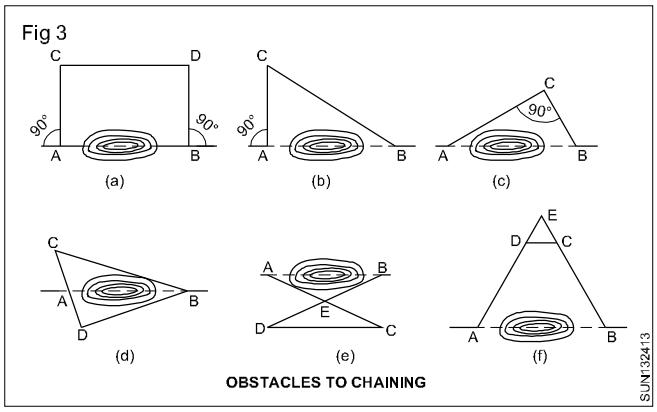
E.g. Thick Jungle (Fig 2) AB = $\sqrt{(AB')^2 + (BB')^2}$

Obstacles to chaining

Case (i)

When it is possible to chain round the obstacle.

E.g. Pond, hedge etc. (Fig 3)



Following are the cases applicable in obstacles to chaining. In all the cases AB is the required chain line but not able to run over the obstacles and is to be calculated.

As in Fig 3a,

AC and BD are perpendiculars to AB, and AC = BD

Then obstructed distance AB = CD

As in Fig 3b,

AC is perpendicular to AB.

Then with known distance of AC and BC obstructed distance AB = $\sqrt{BC^2 - AC^2}$

As in Fig 3c

Lines AC and BC arc meet at an angle of 90^0.

Then with the known distances of AC and BC, obstructed distance, AB = $\sqrt{AC^2 + BC^2}$

As in Fig 3d

With the known distances of BC, CD and DB, obstructed distance,

$$AB = \sqrt{\frac{BC^2 \text{ x } AD + BD^2 \text{ x } AC}{CD} - (AC \text{ x } AD)}$$

As in Fig 3e

Δ^s EAB and EDC are equal in all respects, then obstructed distance AB = DC

As in Fig 3f

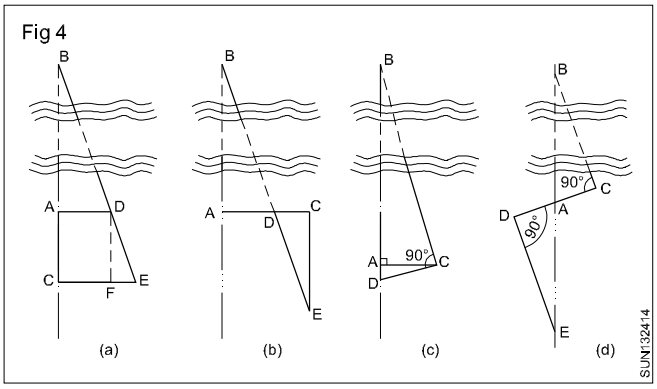
Δ^s AEB and DEC are similar, then $\frac{AB}{DC} = \frac{AE}{DE}$

Thus with the known distance DC, AE and DE, AB is calculated.

Case (ii)

When it is not possible to chain round the obstacles.

E.g. River (Fig 4)



As in Fig 4a

AD and CE are perpendiculars on AC.

B, D and E are in a straight line.

FD is perpendicular to CE at F.

Δ^s ABD and FDE are similar

Then $\frac{AB}{AD} = \frac{FD}{FE}$

Hence FD = AC and FE = CE - AD (CF = AD)

Thus obstructed distance AB = $\frac{AC \text{ x } AD}{CE - AD}$

As in Fig 4b

AC is perpendicular to AB.

AD = DC.

Then ABD and DEC are similar.

Thus obstructed distance AB = CE.

As in Fig 4c

AC is perpendicular to AB.

BAC and BCD are right angled triangle.

Now ABC and DAC are similar.

Then $\frac{AB}{AC} = \frac{AC}{AD}$

Thus AB = $\frac{AC}{AD}$ x AC

Obstructed distance AB = $\frac{AC^2}{AD}$

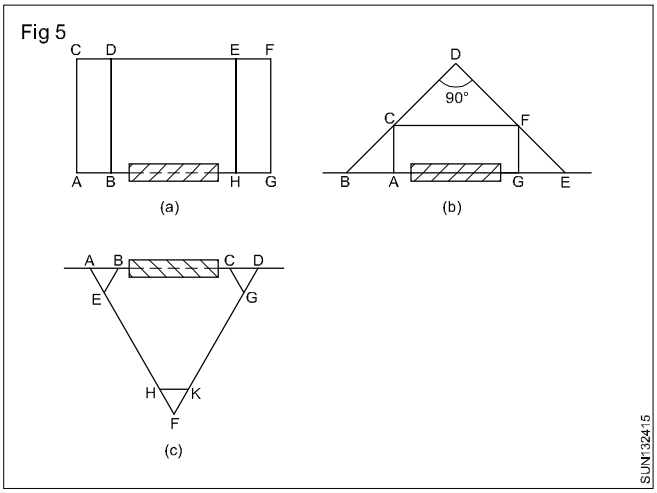
As in Fig 4d

ACB and ADE are right angled triangles, AC = AD

Then obstructed distance AB = AE

Obstacles to both chaining and Ranging

E.g. Buildings. (Fig 5)



Chaining on sloping ground

Objectives: At the end of this lesson you shall be able to
- **explain the methods of chaining on sloping ground**
- **state necessity of calculating horizontal distances.**

Methods of chaining on sloping ground

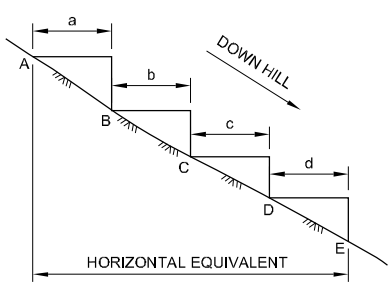
– Direct method

– Indirect method

Direct method

Stepping method (Fig 1): In this method the horizontal distance on sloping ground is directly measured.

Fig 1



Indirect method (Fig 2)

In this method the actual sloping ground is measured and the angle of slope is also measured by an angle measuring instruments.

Then the horizontal distance of the sloping ground is calculated by using the given formula.

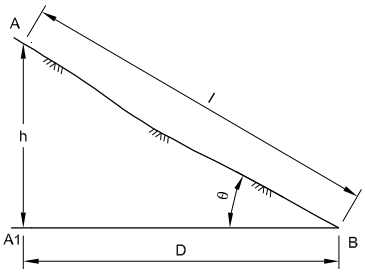
Horizontal distance, $D = A_1B = l \cos\theta$.

Necessity of calculating horizontal distance:

Actually the distances measured on a sloping ground are inclined distance. This will be more than the horizontal distance for plotting purpose only horizontal distance (D) is taken into account.

Hence all the sloping distances are converted into a horizontal equivalent.

Fig 2



Chain survey to an open land for layout plots

Objectives: At the end of this lesson you shall be able to
- **explain about preparation of a map, layout planning and its implementation.**

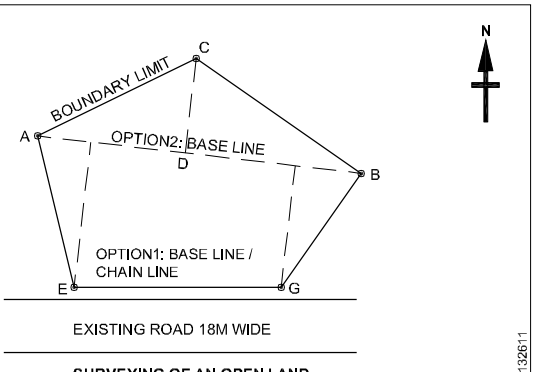
Preparation of map of the open land (Fig 1)

It is necessary to prepare a map for layout plan and implementation.

Layout planning (Fig 2)

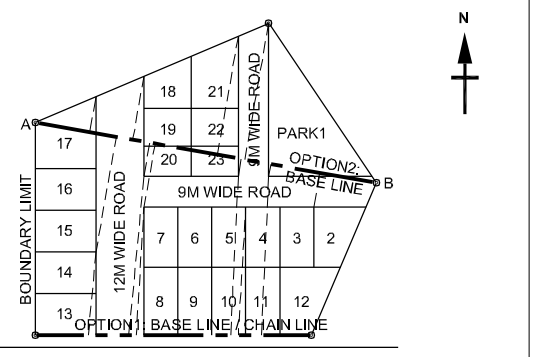
After preparing the map of the land the area is sub divided into plots with access roads and for all other civic amenities without wasting of land. The layout plan prepared according to the purpose of residential or industrial establishments.

Fig 1



SURVEYING OF AN OPEN LAND

Fig 2



OPTION 1: BASE LINE / CHAIN LINE FOLLOWING BOUNDARY LINE
OPTION 2: BASELINE / CHAIN LINE DIAGONALLY FOLLOWING BOUNDARY CORNERS

PROPOSED LAYOUT PLAN.

Reading of the layout plan and implementation

From the prepared layout plan the surveyor to mark all the details directly on the ground as per the layout plan.

As for as possible the chain survey to be done in triangulation method. Equilateral triangle is one easy to form in the field if obstacles are not available.

In an equilateral triangle having the angles and sides are equal.

(i.e) side AC = CD = AD

Take an example

Side AC = 51m

Side CD = 51m

Side AD = 51m

The sum of interior angles of a triangle is equal to 180° in ACD

$$\angle A = \angle C = \angle D$$

Calculation of area

Objectives: At the end of this lesson you shall be able to
- **calculate the areas of an irregular field**
- **apply geometrical formulae for calculating the area**
- **describe the construction and use of planimeter.**

Calculation of the area of an irregular field

In this survey the area of plot may be determined by the direct use of field notes.

In this method of survey a chain line known as base line to be laid through the centre of the area of the field.

The offset are taken to the boundary points in the order of their chinages on both the sides of the base line.

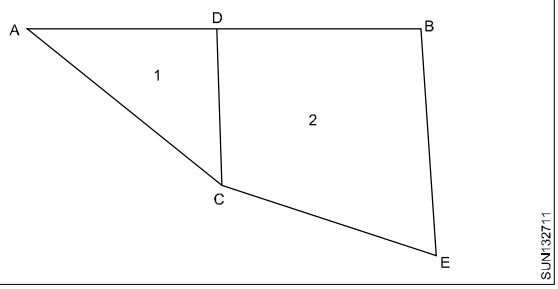
The chainages and offsets are entered in the field book.

With reference to the field book the boundary points are plotted and the area to be divided into number of triangles and trapezium according to the shape.

Application of geometrical formulae for calculating the area

Now apply the geometrical formulae for calculating the according to the shape of the figures. (Fig. 1)

Fig 1



1 Area of triangle

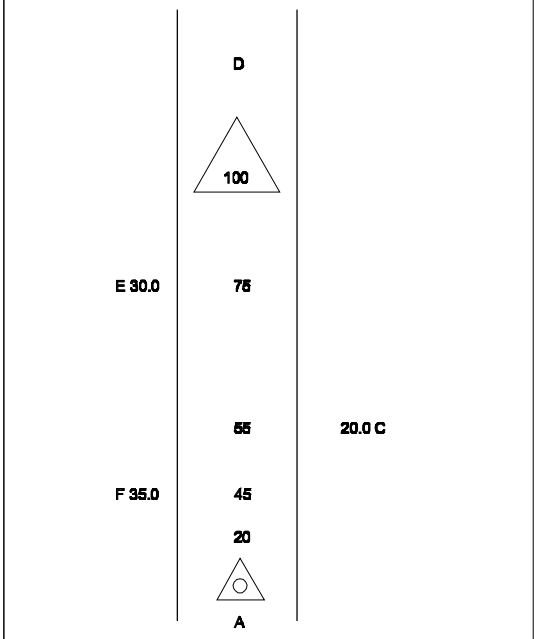
½ x base x height

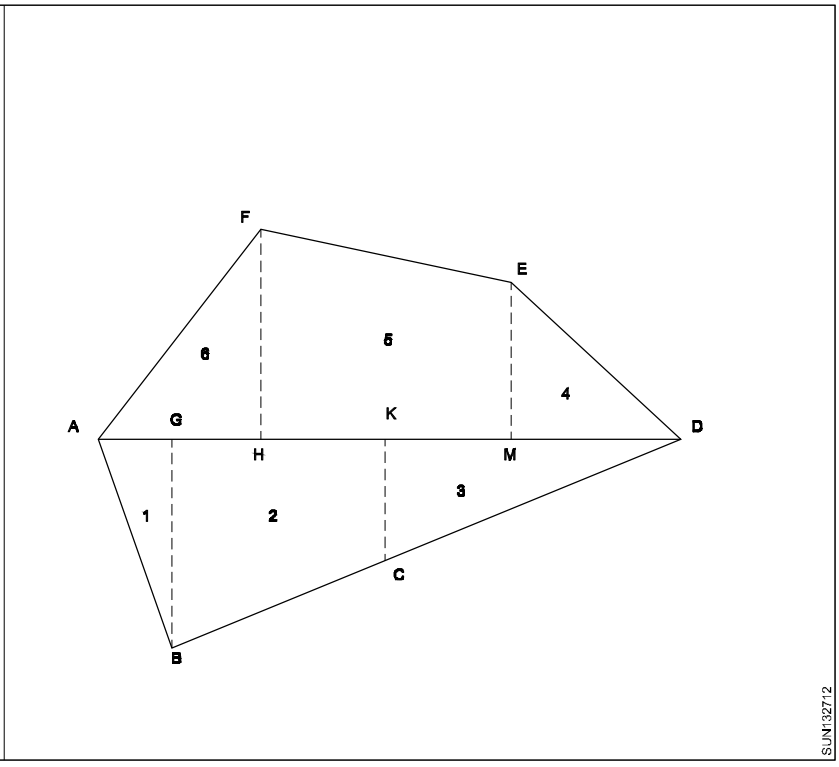
2 Area of trapezium

base (a+b)/2 x height

Plot the following details of a field and calculate its area all measurements are in metres (Fig 2)

Fig 2





Serial No. 1 In ΔABG

Chainage in metres 0 and 20m.

Offsets in metres 0 and 36m.

In Δ ABG

Area = ½ x base x height

=1/2 x 20 x 36

=360 sq.m

Area of trapezium GBCK

Chainage in metres = 2m and 55m = 35m

Offsets in metres 36m and 20m = 28m

=35 x 28 = 980 sq.m

Sl. No. 3

Area of triangle KCD

=45m x 10m = 450 Sq.m

Sl. No. 4

Area of triangle DME = 25 x 15 = 375 sq.m

Sl. No. 5

Area of Trapezium = 30 x 32.50m= 975.00 sq.m

Sl. No. 6

Area of triangle AHF = 45 x 17.50 = 787.50 sq.m

S. No.	Figure	Chainage in metres	Base in Metres	Offsets in metres	Mean offsets in metres	Area in square Metres		Remarks
						+ve	-ve	
1	2	3 4		5	6 7	8	9	
1	ΔABG	0 and 20	20	0 and 36	18	360.00	--	
2	Trapezium GBCK	20 and 55	35	36 and 20	28	980.00	--	
3	ΔKCD	55 and 100	45	0 and 20	10	450.00	--	
4	ΔDME	100 and 75	25	0 and 30	15	375.00	--	
5	Trapezium	75 and 45	30	30 and 35	32.50	975.00	--	
6	ΔAHF	45 and 0	45	35 and 0	17.50	787.50	--	
					Total	3927.50		

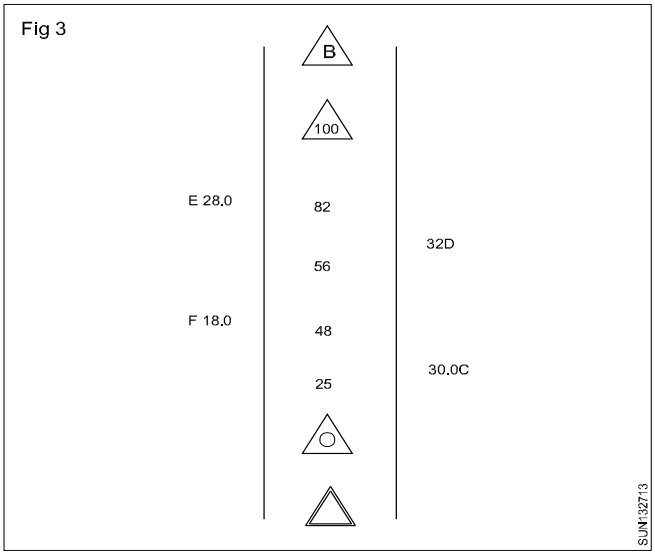
Exercise

The same exercise may be used by planimeter and find the area.

Exercise 1, (2)

The following readings were taken in the field. Plot and calcuate its area. All measurements in metres. (Fig 3)

Fig 3



2 Instrumental method

Planimeter

It is a mechanical device which is used for measuring of the area of any irregular shape of the figure. It gives best results more than that can be achieved by any other method except by direct calculation from the field notes.

Angular polar planimeter

Constructional details of a planimeter (Fig 4)

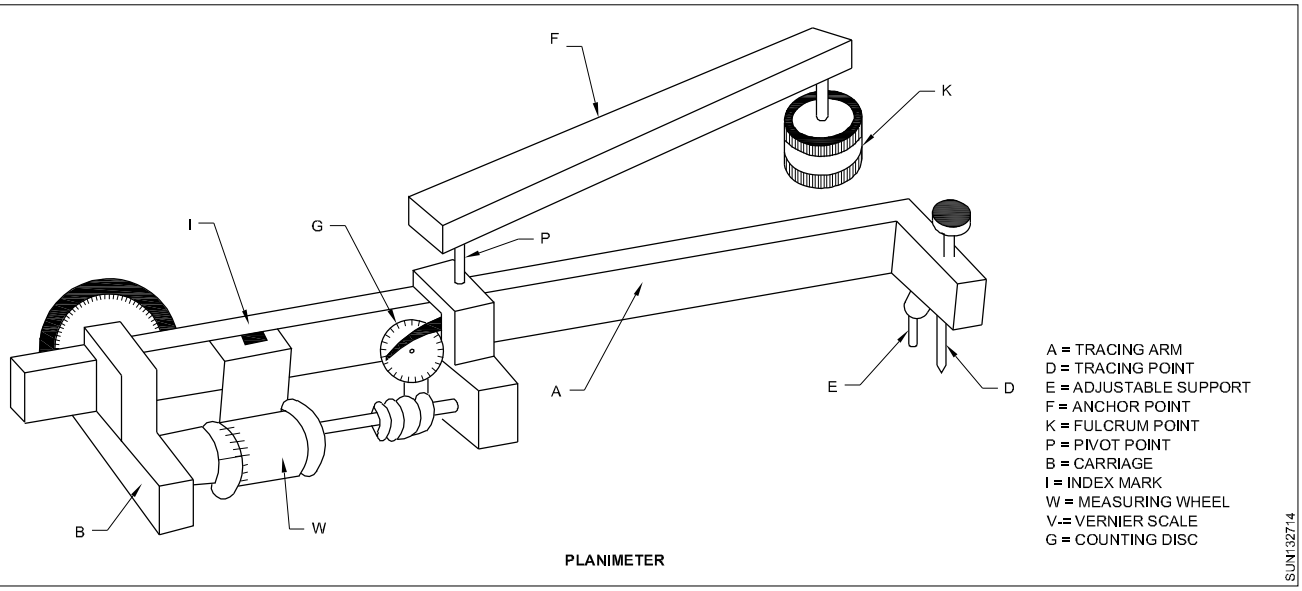
– It consists of two arms. The arm 'A' is called as Tracing arm. Its length can be adjusted and graduated.

– It carries a tracing point 'D' which can be moved along the boundary of the line of the area.

– An adjustable support 'E' which keeps the tracing point just clear of the surface.

– The other arm 'F' is called as the pole arm (or) anchor arm.

Fig 4



PLANIMETER

– It is having a needle point with a weight 'K' at one end.

– The weight forms the centre of rotation.

– The other end of the pole arm can be pivoted at a point 'P' by a ball and socket arrangement.

– A carriage point 'B' which can be set at various points of the tracing arm with respect to the vernier of the index mark I.

– The carriage point having a measuring wheel 'W' and a vernier 'V'.

– The wheel is divided into 100 divisions and the vernier is divided into 10 divisions.

– The wheel and the vernier measure readings upto three places (i.e) 0.145, 0.194 etc.

– The wheel is geared to a counting disc which is divided into 10 divisions. For ten complete revolutions of the wheel, the disc shows a reading of one divisions. Therefore the planimeter shows a reading of four digits (i.e. 1.145, 1.194).

The wheel shows - tenth and hundreth

Vernier shows - Thousandth

The planimeter rests on the tracing point, anchor point and the measuring wheel.

Example 1

The following readings were recorded by a planimeter with the anchor point inside the figure. I.R = 9.377, F.R = 3.336, M = 100 cm^2 and C = 23.521.

Calculate the area of the figure when it is observed that the zero mark of the dial passed the index mark once in the clockwise direction.

Given data

I.R = 9.377
F.R = 3.336
N = -1 (For anticlose wise direction)
M = 100 cm^2
C = 23.521

Area = M (F.R - I.R ± 10N + C)
A = 100 (3.336 - 9.377 - 10 x 1 + 23.521)
= -6.041 - 10 + 23.521
= -16.041 + 23.521
= 7.480 x 100
= 748 cm^2

Example 2

The following particulars were noted while measuring the area of a figure with a planimeter.
a I.R and F.R were 8.652 and 6.798 respectively.

b The tracing arm was set to the natural scale.
c The zero of the dial passed the index mark once in the anticlockwise direction.
d Constant C = 20.
e Scale of the map is 1cm = 10m.
f The anchor point was inside the figure.

Calculate the area of the figure.

Given data

I.R = 8.652
F.R = 6.798
Natural scale means M = 100 cm^2
C = 20
N = -1
Scale 1cm = 10m

Area of the figure A = M (F.R - I.R - 10 x N + C)
= 100 (6.798 - 8.652 - 10 x 1 + 20)
= 814.6 cm^2

Since the scale is 1 cm = 10m
1 cm^2 = 10m^2

Required Area = 814.6 x 100 = 81460m^2

Example 3

The area of an irregular figure was measured with a planimeter having the anchor point outside the figure. The initial and final readings were 4.855 and 8.754 respectively. The tracing arm was set to the natural scale. The scale of the map was 1cm = 5m. Find the area of the figure.

Given data

I.R = 4.855
F.R = 8.754
M = 100 cm^2 (Natural scale)
N = 0 (There is no comment about the crossing of the index mark)
C = 0 (anchor point outside)
Scale = 1cm = 5m

Area = M (F.R - I.R)
= 100 (8.754 - 4.855)
= 389.9 cm^2

Scale of the figure 1 cm = 5m
1 cm^2 = 25m^2

Required Area = 389.9 x 25 = 9747.5m^2

Exercise

Calculate the area of the figrue corresponding to the following data recorded by planimeter.
a I.R = 2.436
b F.R = 7.745
c M = 100 cm^2
d C = 20.00
e The figure traversed clockwise with the anchor point inside and the zero of the dial passed the index mark once in the reverse direction.

(Ans.1530.9 cm^2)

Preparing Site Plan

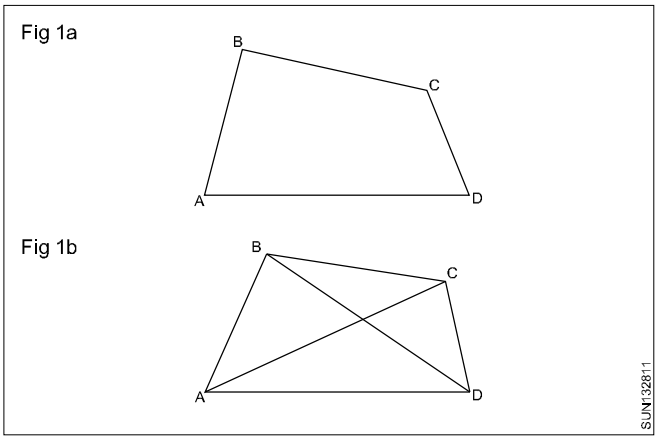
Objectives: At the end of this lesson you shall be able to
- **define the triangulation and traverse in survey**
- **state closed and open traversed survey**
- **state the three types of survey lines in triangulation**
- **explain about field work.**

General Information

As a surveyor, you will not able to plot the Fig 1a without anyone of the angular measurements.

You can able to plot the same figure without any angular measurements, if the length AC and BD is given. (Fig 1b)

Fig 1a is converted into number of triangles as in Fig 1b.



A triangle is the simplest plane figure, which can be drawn without any angular measurements.

Hence the area to be surveyed is divided into a network of triangles.

Triangulation

The method of dividing the whole area to be surveyed into network of triangles and the sides of all the triangles are measured directly in the field and no angular measurements are taken is known as Triangulation survey.

Traverse

A series of connected survey lines of known lengths and directions is called as traverse. The survey lines are measured with chain or tape and directions are determined with angular instruments. It is of two types. They are closed traverse and open traverse.

Frame work

The lines or the triangles covering the whole area to be surveyed is called frame of work such as ABCD in Fig. (1a,b)

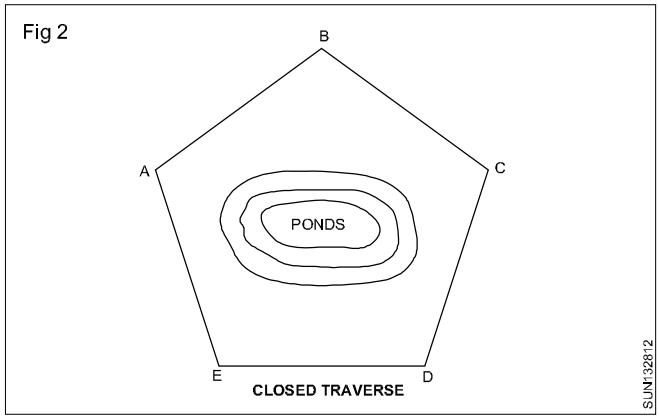
According to the nature and shape of the area of the triangles are to be arranged.

When forming traingles in a chain survey, the angle between the triangles should be selected more than 30° and less then 120°. This process of forming triangles are called as well conditioned triangle.

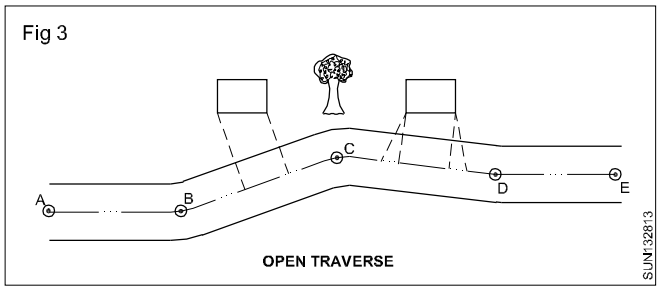
The angles formed in a chain survey should be an equilateral one which is best suited for plotted work.

Closed traverse (Fig 2)**:** When the finishing points of the survey coincides with the starting point of the survey is known as a closed traverse.

It is suitable for the survey of boundaries of forests, ponds, estate, lakes etc.



Open traverse (Fig 3): It consists of series of survey lines extending in the same direction and not returning to the starting point.



It is suitable for the survey of road, railway, river, coast line etc.

State the three types of survey lines in triangulation

To conduct a Triangulation survey stations are to be established.

– The beginning and end points of a chain line is called as survey stations. Stations are denotes as .
– Stations are divided into mainstations and Tie station or subsidiary station.

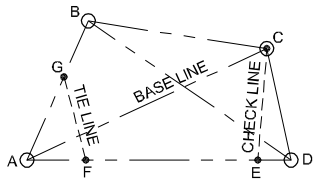
– The stations connecting boundaries of the area are called as main stations (in Fig 4, A,B,C,D)
– The stations other than main stations are called as Tie stations.

Baseline

The longer line of the chain line is considered as baseline is AC (in Fig 4) From this line the chainages and offsets are taken.

The accuracy of the whole survey is mainly based on the accuracy of this line.

Fig 4



Baseline should be decided in such a way that it should divide the whole area approximately equal on both sides of chain line.

Check line/Proof line

A line joining the apex of a triangle 'C' and a fixed point on the opposite side 'E' (In Fig 4) CE is the check line.

It is used to check the accuracy of the frame work

Tie line: A line joining some fixed points on any two lines in a main survey line is known as tie line. (FG in Fig 4)

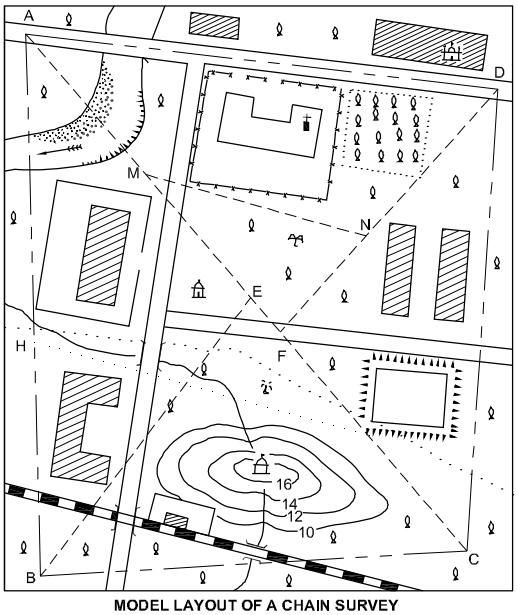
It is used to check the accuracy of framework to locate the interior details which are faraway from main lines.

Fig 5 shows a model layout of chain survey.

Field work

It consists of

Fig 5



MODEL LAYOUT OF A CHAIN SURVEY

1 Reconnaissance

2 Marking and fixing stations

3 Reference sketches

4 Running survey lines

Reconnaissance

The preliminary inspection of the whole area of the site to be surveyed is known as reconnaissance.

It is always essential to fix survey stations for running survey lines and taking details.

Hence the surveyor should walk over the whole area to examine the ground and decide about for laying survey lines.

A key plan also being prepared.

Marking and fixing stations

After preparing a key plan the survey stations are fixed by driving a wooden pegs or nails.

Wooden pegs are used in soft ground and for roads or hard surface nails may be used for fixing on the ground.

Reference sketches

Each and every survey stations are referred with some permanent points.

These permanent points to the survey stations are located by measurement and made with reference sketches.

These are very useful to refix a survey station when it is displaced or lost.

Running survey lines

Survey lines are then laid in between the survey stations and details should be taken by offsetting method.

Chain angles

In a chain traversing the entire work is done only by a chain or tape without having angular instrument is known as chain angle method. It is to be done when the area cannot be divided into triangles such as river, nalla, standing crop etc. (Fig 6 and 7)

Fig 6

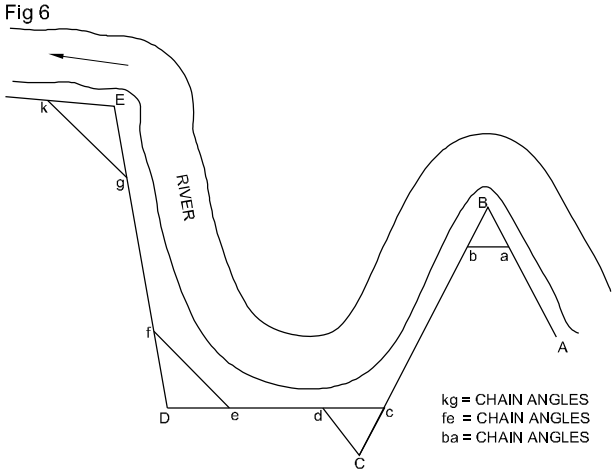
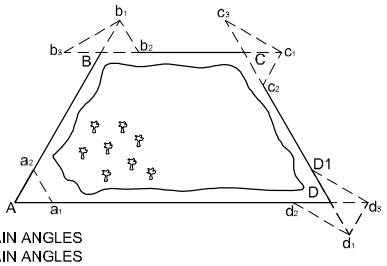


Fig 7

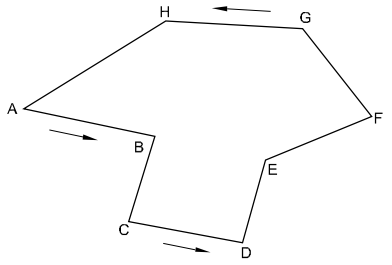


Identification and Parts of instruments in compass survey

Objectives: At the end of this lesson you shall be able to
- **state about traversing**
- **state types of compass**
- **name the prismatic compass and construction**
- **construction of survey's compass.**

Traversing: Traversing is that type of survey in which a number of connected survey lines form the frame work and the directions and lengths of the survey line are measured with the help of an angle measuring instrument and a tape respectively. When the lines form a circuit which ends at the starting point is called closed traverse. Fig 1 If the circuit end elese where it is said to be an open transverse. Fig 2.

Fig 1



CLOSED TRAVERSE

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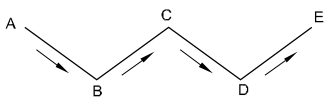
Fig 2



OPEN TRAVERSE

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Compass: A compass is a small instrument which consists essentially of a magnetic needle, a graduated circle and a line of sight. When the line of sight is directed towards a line, the magnetic needle points towards magnetic meridian and the angle which the line makes with the magnetic meridian is read at the graduated circle.

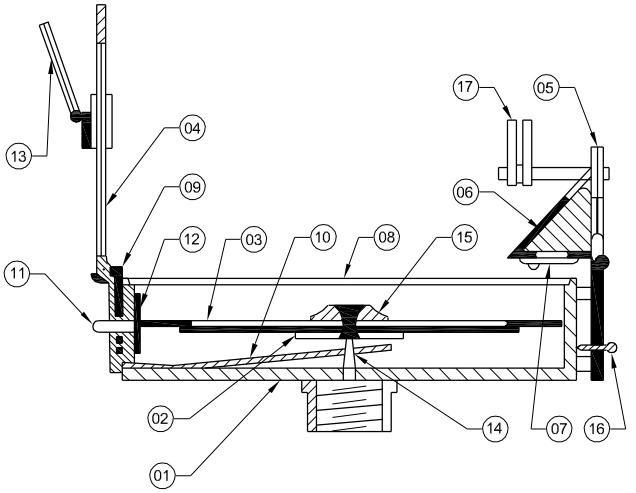
The compass cannot measure the angle directly. If it is desired to find out the angle between the two lines, firstly their angles with the magnetic meridian are determined separately and the difference of the two values is found which is equal to the angle between the lines.

Types of compass: The two forms of the compass commonly used are.

1 The prismatic compass
2 The surveyors compass
3 Trough compass
4 Compass and level

The prismatic compass: It is the most convenient portable magnetic compass, which can either be used as a hand instrument or can be fitted on a tripod. The main parts of prismatic compass are shown in Fig 3.

Fig 3



01. BOX
02. NEEDLE
03. GRADUATED RING
04. OBJECT VANE
05. EYE VANE
06. PRISM
07. PRISM CAP
08. GLASS COVER
09. LIFTING PIN
10. LIFTING LEVER
11. BRAKE PIN
12. SPRING BRAKE
13. MIRROR
14. PIVOT
15. AGATE CAP
16. FOCUSING STUD
17. SUN GLASS

THE PRISMATIC COMPASS

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Construction (Fig 3)

- The prismatic compass consists of cylindrical metal box (1) of 8 cm to 12 cm diameter in the centre of which is a pivot (2) carrying a magnetic needle (3) which is already attached to the graduated aluminium ring (4) with the help of an agate cap (5).
- The ring is graduated to half a degree and is read by a reflecting prism (6) which is protected from dust, moisture etc. by the prism cap (7).
- Diametrically opposite to the prism is the object vane (8) hinged to the box side and carrying a horse hair (9) with which an object is bisected.
- The eye is applied at the eye hole below the sighting slit (10).
- The graduations on the ring can be observed directly by the eye after they are reflected from the diagonal of the prism.
- The graduations can be made clearly visible by adjusting the prism to the eye sight by the focussing screw (11)

- Both the horizontal and vertical side faces of the prism are made convex to give magnified readings.
- To prevent undue wear of the pivot point the object vane is brought down on the face of the glass cover (12) which presses against a lifting pin (13)
- The needle is then automatically lifted off the pivot by the lifting lever (14).
- To damp the oscillations of the needle, before taking a reading and bring it to rest quickly the light spring brake (15) attached to the inside of the box is brought in contact with the edge of the ring by gently pressing inward the brake pin (16).
- If the bearings of very high (or) very low objects are taken the reflecting mirror (17) which slides on the object vane is tilted and image is bisected by the horse hair.
- A pair of sun glasses (18) shall have to be interproposed between the slit and coloured vane when the sun or luminous of objects is to be bisected.
- A metal cover fits over the glass cover as well as the object vane when the compass is not in use.

Fig 4a

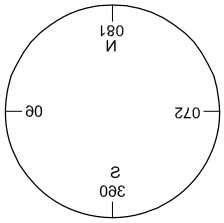
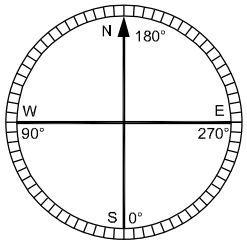


Fig 4b



SYSTEM OF GRADUATION IN PRISMATIC COMPASS

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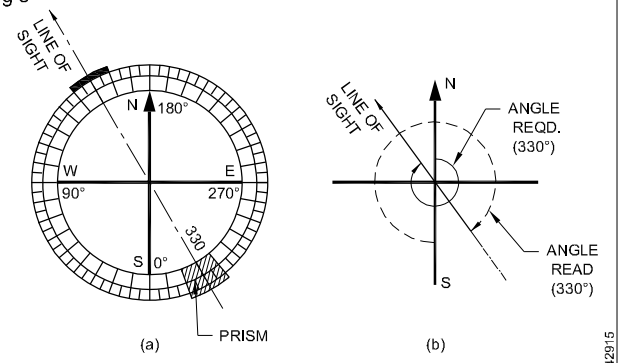
- In the prismatic compass (Fig 4a) graduations are marked on the ring in a clockwise direction with 0 or 360 at south end of the needle.
- So that 90 is marked at the west 180 at the north and 270 at the east.
- The figures are written upside down as in Fig (4b)
- The greatest advantages of prismatic compass is that both sighting the object as well as reading circle can be done simultaneously without changing the position of the eye.

Fig 5



OBSERVATION AND READING IN PRISMATIC COMPASS

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The bearing shows 330^0 at the observers end under the prism (i.e at the south end). (Fig 5)

Surveyors compass: It is similar to prismatic compass except with a following few modification. (Fig 6).

– The graduated ring is directly attached to the circular box and not with the magnetic needle.

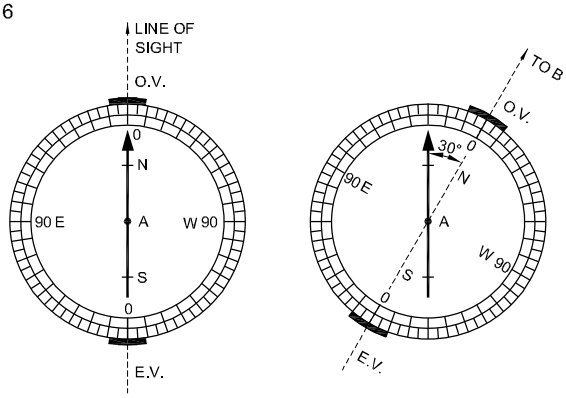
– The magnetic needle floats freely over the pivot.

– No prism is attached to the eye vane and it is having a narrow vertical slit.

– Readings are taken directly with naked eye against the north end of the needle.

– The ring is graduated in quadranted system of having 0^0 at north and south ends, 90^0 at East and west ends. Fig 6a shows the line of sight passes through the meridian. Fig 6b shows when the line of sight towards 'B' and the bearing is N 30^0E.

Fig 6



SYSTEM OF GRADUATION IN SURVEYOR'S COMPASS

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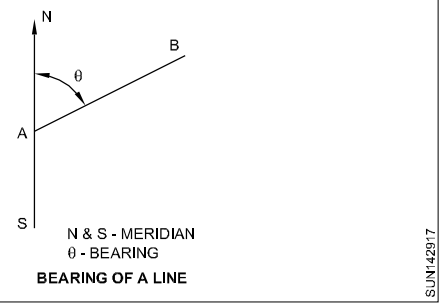
Comparison between prismatic compass and surveyors compass

No.	Item	Prismatic compass	Surveyor's compass
1	Magnetic needle	The needle is broad type and needle does not act as index.	The needle is of edge bar type of needle and acts as the index also.
2	Graduated ring	The graduated ring is attached with the needle. The ring does not rotate along with the line of sight.	The graduated ring is attached to the box and not to the needle. The ring rotates along with the line of sight.
		The graduations are in Whole circle bearing system, having 0^0 at south end 90^0 at west, 180^0 at North and 270^0 at East.	The graduations are in Quadrantal bearing system having 0^0 at North and South, 90^0 at East and West. East and west are interchanged
3	Sighting vane	The graduations engraved are inverted The object vane consists of metal vane with a vertical hair	The graduations engraved are erect. The object vane consists of a metal vane with a vertical hair.
		The eye vane consists of a small metal vane with a slit	The eye vane consists of a metal vane with a fine slit.
4	Reading	The reading is taken with the help of a prism provided with the eye vane.	The reading is taken by directly seeing through the top of the glass.
		Sighting and reading can be done simultaneously from one position of the observer.	Sighting and reading cannot be done simultaneously from one position of the observer.
5	Tripod	It is used with or without Tripod	It cannot be used without a Tripod.

Bearing of a line: It is the horizontal angle which a line make with some reference direction also known as meridian. The reference direction may be any of the following. (Fig.7)

- True meridian.
- Magnetic meridian.
- An assumed meridian.

Fig 7



True meridian: True meridian of a place is a direction indicated by an imaginary circle passing round the earth through that place and the two north and south poles.

True bearing: The horizontal angle between a line and the true meridian is called true bearings of the line. It is also called as azimuth.

Magnetic meridian: The direction indicated by a freely suspended and properly balanced magnetic needle unaffected by local attractive forces is called the magnetic meridian.

Magnetic bearings: The horizontal angle which a line makes wiht this meridian is called magnetic bearings or simply bearings of the line.

An assumed or Arbitary meridian: Arbitrary meridian is any convenient direction towards a permanent and prominent mark or signal such as a church spire or top of a chimney. Such meridians are used to determine the relative positions of lines in a small area.

Arbitary Bearings: Arbitary bearings of a line is the horizontal angle which it makes with any arbitary meridian passing through the one of the extremities or the horizontal angle between a line and this arbitary meridian is called arbitary bearing of the line.

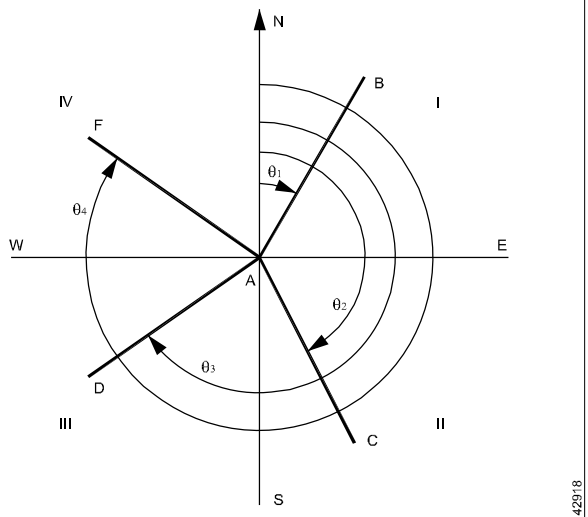
Designation of Bearings: The bearings are expressed the following two ways,

– Whole circle bearings.
– Quadrantal bearings.

Whole circle bearing (W.C.B): In this system, the bearings of a line, is measured from the magnetic north in clockwise direction. The value of the bearing thus varies from 0^0 to 360^0. The prismatic compass measures the bearings of lines in the whole circle system.

Referring Fig 8 the W.C.B of AB is θ_1; of AC is θ_2; of AD is θ_3 and of AF is θ_4.

Fig 8



W.C.B. SYSTEM

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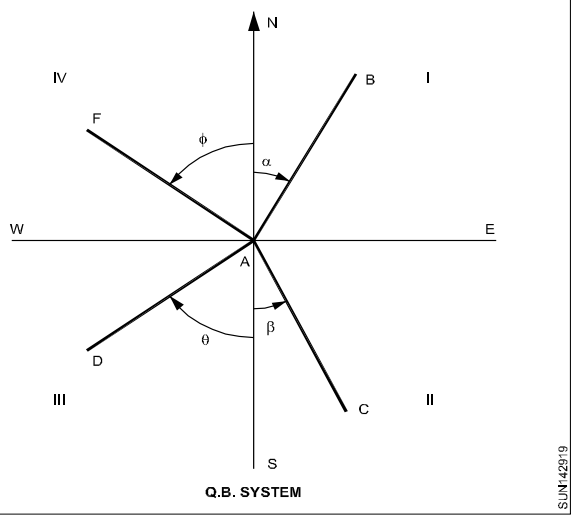
The Quadrantal bearings: In this system, the bearings of a line is measured east ward or westward from north or south which ever is nearer. Thus both North and South are used as reference meridians and the directions can be either clockwise or anticlockwise depending upon the position of the line. These bearings are observed by surveyors compass.

Referring Fig 9 the QB of the line AB is $\propto$ and it is written as N $\propto$ E

The bearing of Line AC is β and it is written as S β E.

Fig 9



Q.B. SYSTEM

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Similarly the bearing of Line AD and AF are written as S θ W and N ϕ W

Conversion of Bearings from one system to other system

Reduced bearing:

When the whole circle bearings exceeds 90^0, then it is to be converted or reduced to quadrantal bearing system which has the same numerical values of the trigonometrical function is known as reduced bearing (R.B).

(i) Referring Fig 8, W.C.B system, the conversion of W.C.B into R.B can be expressed in the following table.

Table 1

Line	W.C.B between	Rule for R.B	Quadrant
AB	0^0 and 90^0	R.B = W.C.B	NE
AC	90^0 and 180^0	R.B = 180^0 - W.C.B	SE
AD	180^0 and 270^0	R.B = W.C.B - 180^0	SW
AF	270^0 and 360^0	RB = 360^0 - W.C.B	NW

(ii) Referring Fig 9 the conversion of R.B into W.C.B can be expressed in the following table.

Table 2

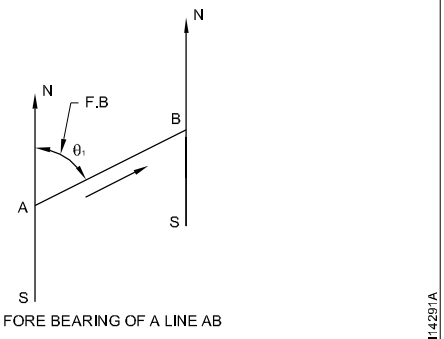
Line	R.B	Rule for W.C.B	W.C.B between
AB	N α E	W.C.B = R.B	0^0 and 90^0
AC	S β E	W.C.B = 180^0 - R.B	90^0 and 180^0
AD	S θ W	W.C.B = 180^0 + R.B	180^0 and 270^0
AF	N ϕ W	W.C.B = 360^0 - R.B	270^0 and 360^0

Fore Bearings and Back Bearings: Every line has two bearings, observed one at each end of the line. The bearing of a line taken in the progress of the survey or in the forward direction is the fore or forward bearing (F.B) of the line. While its bearing taken in the reverse or opposite direction is known as reverse or back bearing (B.B).

Whole circle bearing system

Fig 10 shows, the bearing of line AB expressed in the direction A to B is the F.B of AB

Fig 10



FORE BEARING OF A LINE AB

W.C.B. SYSTEM

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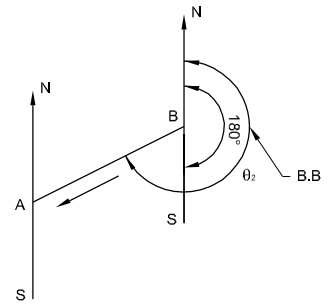
The bearing of line AB when recorded in the opposite direction from B to A is B.B of AB (or) F.B of BA. (Fig 11)

In the whole circle system, the fore and back bearings of a line differ exactly by 180^0.

Fig 11



BACK BEARING OF A LINE AB
W.C.B. SYSTEM

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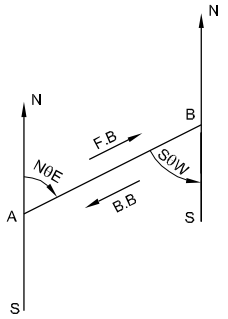
$\therefore$ B.B of a line = F.B $\pm$ 180^0 [Equation 1]

Use plus sign if the given F.B is less than 180^0 and minus sign if it exceeds 180^0.

Quadrantal bearing system

In the quadrantal system F.B and B.B are numerically equal but with opposite cardinal points. B.B of a line may, therefore be obtained by simply substituting N for S or S for N; and E for W or W for E in its fore bearings. (Fig 12)

Fig 12



FORE BEARING OF AB = N θE
BACK BEARING OF AB = S θW
QUADRANTIAL BEARING SYSTEM

SUN14291C

Supposing F.B of a line is N 30^0E then its B.B is equal to S 30^0W

Example

Problems on conversion of bearing

a) Convert the following W.C.B to quadrantal bearings.

i) 12^0 30' ii) 160^0 30' iii) 210^0 30' iv) 285^0 30'

Solution:

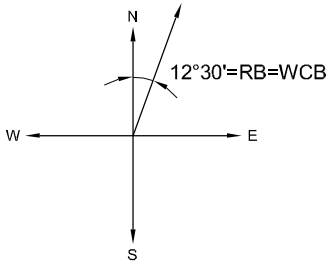
Applying the rules given in the table 1

i) W.C.B = $12^0$30'

W.C.B = 12^0 30' which is less than 90^0

$\therefore$ R.B = N 12^0 30' E (Fig 1)

Fig 13



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ii) W.C.B = 160^0 30'

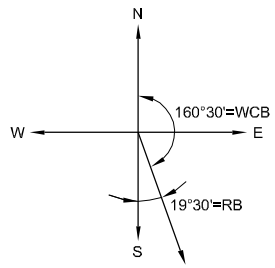
The W.C.B is within 90^0 to 180^0

$\therefore$ RB = 180^0 - W.C.B

= 180^0 - 160^0 30'

= S 19^0 30' E (Fig 2)

Fig 14



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iii) W.C.B = 210^0 30'

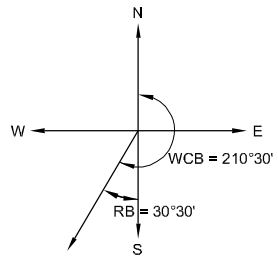
The W.C.B is within 180^0 to 270^0

$\therefore$ RB = W.C.B - 180^0

= 210^0 30' - 180'

= S 30^0 30' W (Fig 3)

Fig 15



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iv) W.C.B = 285^0 30'

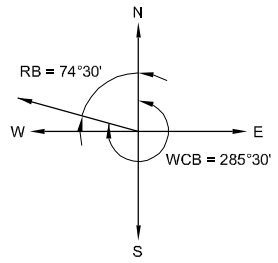
The W.C.B is with in 270^0 to 360^0

$\therefore$ R.B = 360^0 - W.C.B

= 360^0 - $285^0$30'

= N 74^0 30' W (Fig 4)

Fig 16



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b) Convert the following quadranted bearings to whole circle bearings.

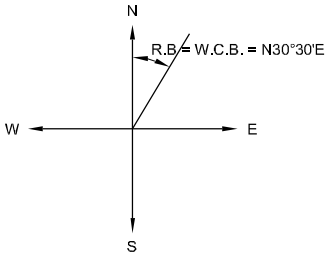
i) N 30^0 30' E ii) S 70^0 30' E iii) S 36^0 30'W
iv) N 85^0 30'W

Solution:

Applying the rules given in Table 2

i) Q.B = N 30^0 30'E
W.C.B = R.B = 30^0 30' (Fig 1)

Fig 17



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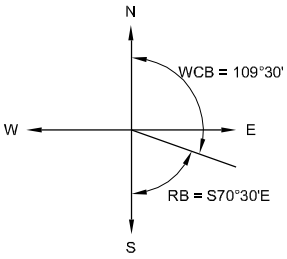
ii) Q.B = S 70^0 30'E
W.C.B = 180^0 - R.B
= 180^0 - 70^0 30'
= 109^0 30' (Fig 2)

Fig 18



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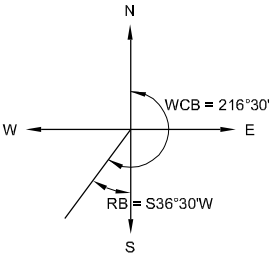
ii) Q.B = S 36^0 30'W
W.C.B = 180^0 + Q.B
= 180^0 + 36^0 30'
= 216^0 30' (Fig 3)

Fig 19



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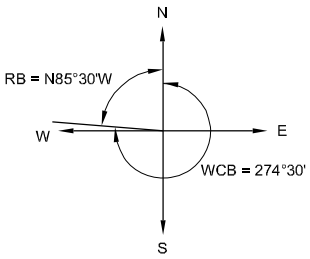
iv) Q.B = N 85^0 30'W
W.C.B = 360^0 - 85^0 30'
= 274^0 30' (Fig 4)

Fig 20



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Exercise

1 Convert the following W.C.B to R.B
a) 87^0 30'
b) 120^0 30'
c) 210^0 00'
d) 266^0 30'
e) 310^0 30'
f) 359^0 30'

2 Convert the following R.B to W.C.B
a) N 46^0 30' E
b) S 20^0 30' E
c) S 10^0 30' W
d) N 50^0 30' W

Example

Find back bearings of the following observed fore bearings of lines AB 63^0 30'; BC 112^0 30'; CD 203^0 30'; DE 320^0 30'

Solution

From the equation (1)

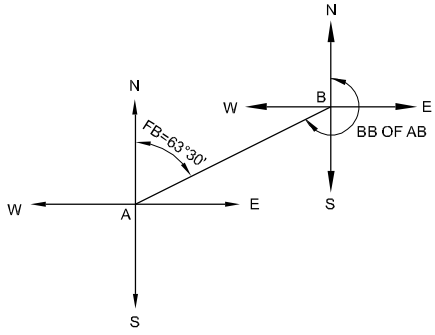
B.B = F.B ± 180^0

Using + sign when F.B is less than 180^0 and - sign more than 180^0

i) F.B of AB = 63^0 30' (Fig 1)

∴ B.B of AB = F.B of AB + 180^0
= F.B of AB + 180^0
= 63^0 30' + 180
= 243^0 30'
B.B of AB = 243^0 30'

Fig 21



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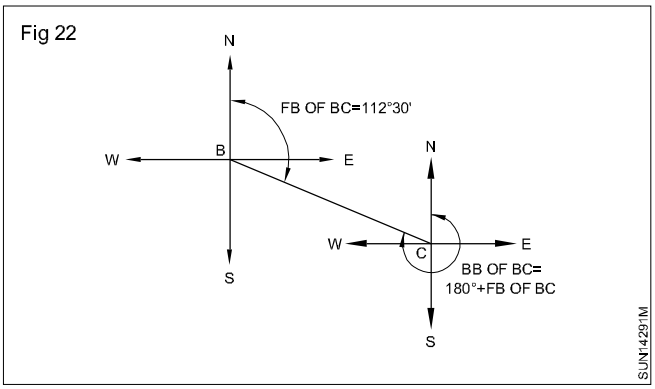
ii) F.B of BC = 112^0 30' (Fig 2)

B.B of BC = F.B of BC + 180^0

= 112^0 30' + 180

= 292^0 30'

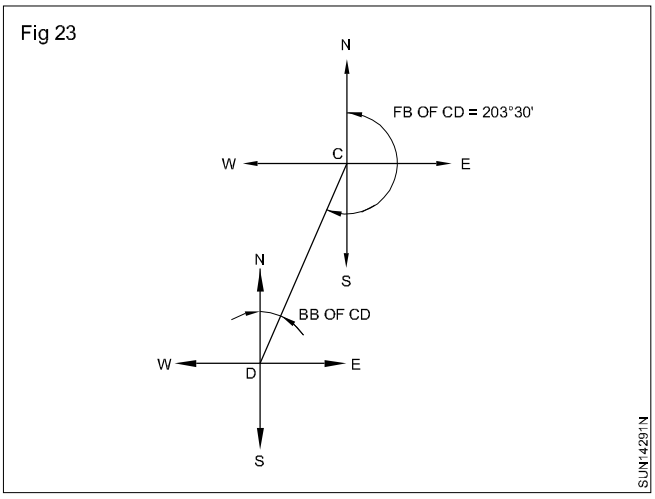


iii) F.B of CD = 203^0 30' (Fig 3)

B.B of CD = F.B of CD - 180^0

= 203^0 30' - 180

= 23^0 30'

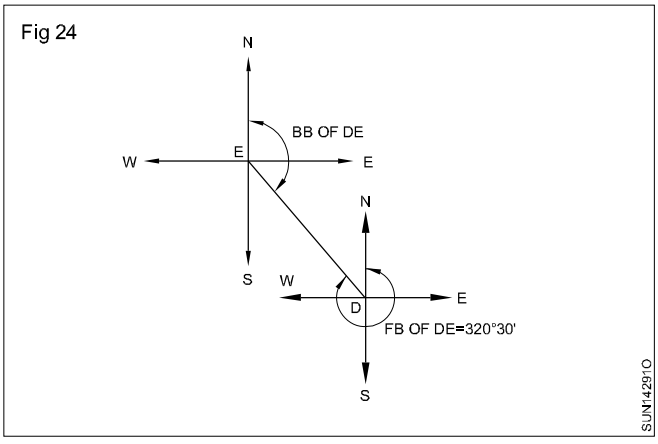


iv) F.B of DE = 320^0 30' (Fig 4)

B.B of DE = F.B of DE - 180^0

= 320^0 30' - 180

B.B of DE = 140^0 30'



Example :

The fore bearing of the lines are as follows.
AB : N32^0 30' E
BC : S 43^0 30' E
CD : S 26^0 30'W

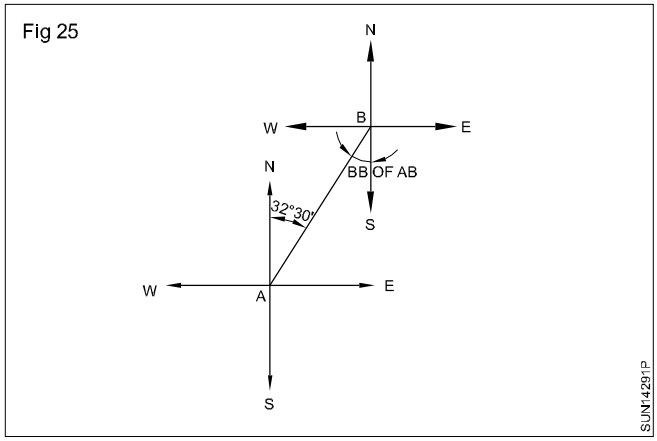
DE : N 65^0 35'W

Find their back bearings

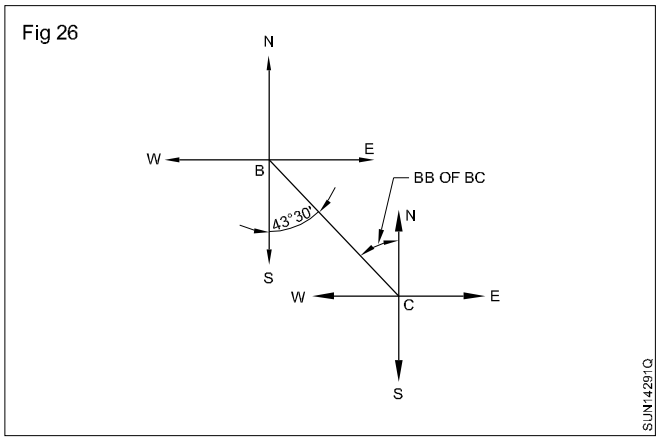
Solution:

When bearings are expressed on the quadrantal systems, the back bearings of a line is numerically equal to its fore bearings but with opposite letters. Therefore

i) F.B of AB = N 32^0 30' E (Fig 1)
∴ B.B of AB = S 32^0 30' W

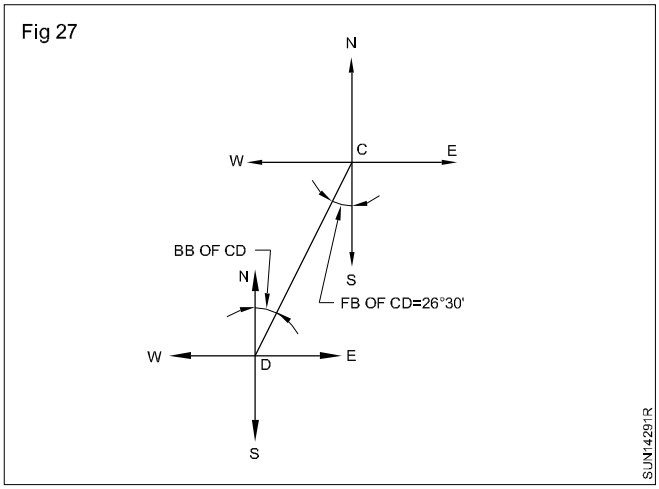


ii) F.B of BC = S 43^0 30'E (Fig 2)
B.B of BC = N 43^0 30'W



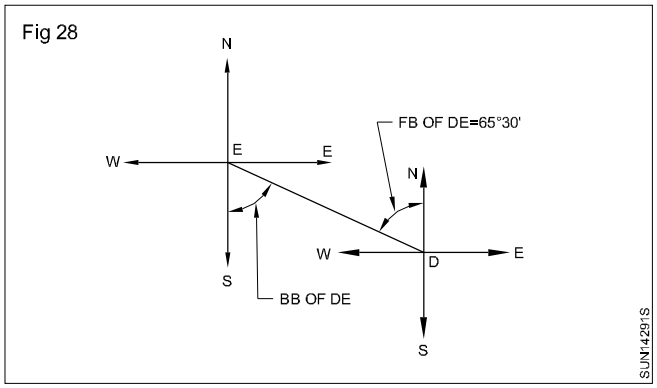
iii) F.B of CD = S 26^0 30'W (Fig 3)
B.B of CD = N 26^0 30' E

Fig 27



iv) F.B of DE = N 65^0 30'W (Fig 4)
∴ B.B of DE = S 65^0 30' E

Fig 28



Exercise

1 The following are the observed Fore bearing of the lines : AB = 88^0 30' ; BC = 142^0 30' ; CD = 209^0 00' ; DE = 324^0 30' Find their back bearing.

2 The fore bearings of the lines are as follows:

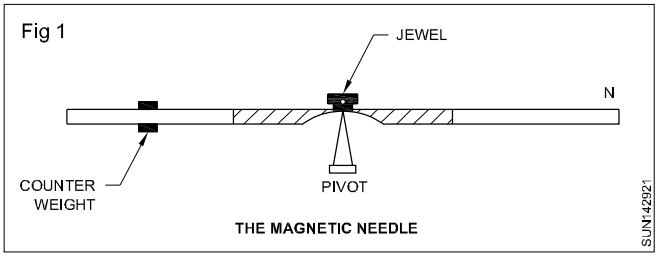
AB = N 26^0 30' E; BC = S 78^0 30' E; CD = S 69^0 0'W; DE = N32^0 30'W, Find their back bearings.

Magnetic declination

Objectives: At the end of this lesson you shall be able to
- **define the dip of the magnetic needle**
- **state the magnetic declination and variations**
- **calculate true bearings**
- **state local attraction and its elimination**
- **explain about errors and its limits**
- **state the testing the prismatic compass.**

Dip of the Magnetic Needle: Before Magnetisation, the needle remains in the horizontal position if it is properly balanced, but after being magnetised, it cannot remain in the same position due to the magnetic influence of the earth. One end of the needle deflects downward towards the magnetic pole. In northern hemisphere the north end of the needle is deflected downward, and in the southern hemisphere the south end points downward. This inclination of the needle with the horizontal is known as the dip of the needle. (Fig 1)

Fig 1



THE MAGNETIC NEEDLE

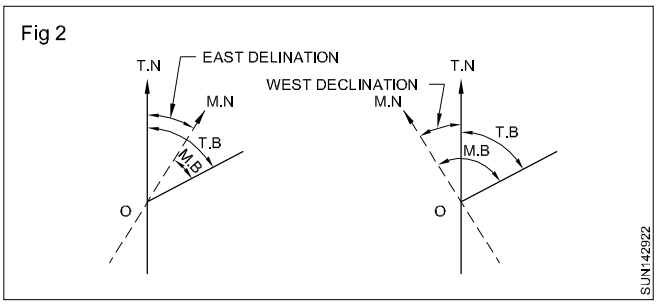
The amount of the dip is not uniform, but it varies in different parts of the earth. It varies from 0^0 to 90^0 (zero at equator and 90^0 at the poles)

To keep the needle in the horizontal position, it is balanced by placing a brass sliding weight or rider at a suitable point over the higher end of the needle.

Magnetic declination: In certain places, the magnetic meridian at a place does not coincide with the true meridian at that place. The horizontal angle which the magnetic meridian makes with the true meridian is known as magnetic declination or declination.

When the needle is deflected towards east of the true meridian it is called east declination and west declination when it is deflected towards west of the true meridian. (Fig.2)

Fig 2



The magnetic meridian differs from time to time on the earth's surface.

Calculation of True bearings:

Rule 1

True bearing of a line = Magnetic bearing of the line ± declination.

Use + sign when the declination is east
Use - sign when the declination is west

Rule 2

Magnetic bearing of a line = True bearing of the line ± declination

Use + sign when the declination is west
Use - sign when the declination is east

Variations in Declination: The declination is not constant for any places, but it changes from time to time and place to place.

The variations may be regular or irregular.

1 **Regular variations:** This variations may itself be analysed into several components of different periods and amplitudes. They are (i) Secular (ii) annual and (iii) diurnal or daily

   – **Secular variation:** The magnetic meridian swings like a pendulum. It swings in one direction for a long period and gradually comes to rest and then swings in the opposite direction.

   – **Annual variation:** It has a period of one year and therefore it is known as annual variations. The amount of variation is in difficult places 0 to ±12 minutes, but it is not remain constant at any place.

   – **Diurnal or daily variation:** It is an oscillation of the needle from its mean position during the day. The amount of this variation varies from 1 minute to about 12 minutes at different places.

2 **Irregular variations:** These are occured by magnetic storms such as earth quakes or volcanic erruptions and their amount may be even 1^0 or 2^0 at a time. It may occured at anytime. It cannot be prediteted.

Calculate true bearing problems on magnetic declination:

Example 1

The magnetic bearing of line is 197^0. Find its true bearing, if the magnetic declination is 3^0 W

Solution (Fig 3)

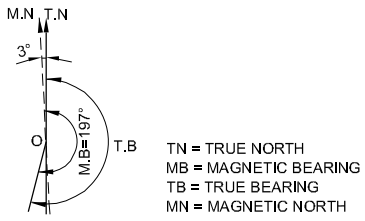
Using Rule 1

True bearing of the line = Magnetic bearing of the line ± declination.

Use - sign because the declination is west.

True bearing of the line = Magnetic bearing of the line - declination.
$= 197^0 - 3^0$
$= 194^0$

Fig 3



Example 2

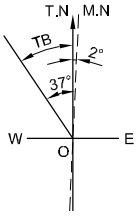
If the magnetic bearing of the line is N 37^0 W and the magnetic declination is 2^0 E Find the true bearing.

Solution (Fig 4)

From Rule I

True bearing of a line = Magnetic bearing of line ± declination
$= N(37^0 - 2^0)$ W
$= N\ 35^0$ W

Fig 4

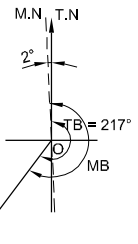


Example 3

True bearing of a line is 217^0 and magnetic declination is 2^0 w. Find the magnetic bearing.

Solution (Fig 5)

Fig 5



In Fig 5 Magnetic bearing of the line = True bearing of line + declination.
$= 217^0 + 2^0$
$= 219^0$

Use + sign declination in west.

Example 4

The magnetic and true bearing of a line are 327^0 14' and 324^0 37' respectively. Find the value of the magnetic declination at the place of observations.

If the annual change is 3' West what would be the magnetic and True bearing of the line four years since the date of the above measurement.

Solution (Fig 6)

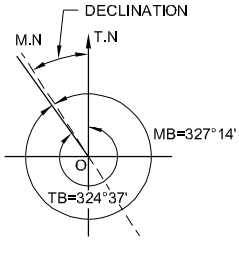
Magnetic bearing of the line = 327^0 14'
True bearing of the line = 324^0 37'

$\therefore$ Declination = 327^0 14' - 324^0 37' = $2^0$37'

From Fig 6,
declination is west, ie 2^0 37'
Annual variation = 3' west
Variation in 4 years = 4 x 3' = 12' W
Total declination after 4 years = 2^0 37' + 12'
= 2^0 49' W

True bearing of a line after 4 years = 324^0 37'
(Same as above)
magnetic bearing after 4 years = 324^0 37' + 2^0 49'
= 327^0 26'

Fig 6



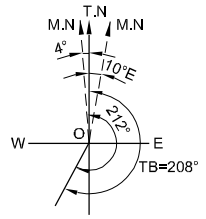
Example 5

A line was drawn as its magnetic bearing 212^0 on an old map when the magnetic declination was 4^0W. To what bearing should if be set now if the present declination is 10^0E

Solution (Fig 7)

When the declination was 4^0W.
True bearing of the line = Magnetic bearing of the line - declination
$= 212^0 - 4^0$
$= 208^0$
When declination is 10^0 East,
Magnetic bearing of the line = True bearing of the line - declination.
$= 208^0 - 10^0$
$= 198^0$
$\therefore$ To set the line now to the bearing of 198^0

Fig 7



Example 6

Find the magnetic declination if the magnetic bearing of the sun at noon is
1 185^0
2 354^0

Solution (Fig 8)

Fig 8(i)

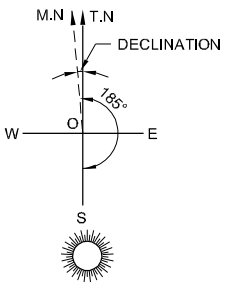
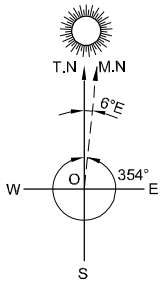


Fig 8(ii)



i Magnetic Bearing of the line - 185^0 (Fig 8(i))

At noon the sun is exactly on the True meridian. Since the magnetic bearing of the sun is 185^0 it is at south pole
Magnetic declination = $185^0 - 180^0 = 5^0$ W.

ii Magnetic bearing of the line is 354^0 (Fig. 8(ii))
The magnetic bearing of the True north is 354^0
Magnetic declination = $360^0 - 354^0$
$= 6^0$ to the east of the true meridian.
Magnetic declination = 6^0 E

Exercise

1 The magnetic bearing of a line AB is 125^0. Find its true bearing if the magnetic declination at A is (a) 9^0 0'W (b) 5^0 30'E

2 The true bearing of a line CD is 138^0 30' Find its magnetic bearing if the magnetic declination at c is (a) 5^0 30'W (b) 3^0 15'E

3 A line has a true bearing of 255^0 . The declination is 3^0 30' E. Calculate the magnetic bearing on whole circle and reduced bearing systems.

4 Find the magnetic declination if magnetic bearings of the sun at noon, are, a) 182^0 00' b) 178^0 30' c) 359^0 0'

5 The true bearing of a line is N 30^0 30'E compute the magnetic bearing of the line if the magnetic declination is a) 4^0 15'E and b) 5^0 30'W.

Local attraction: A magnetic meridian of a place is established by the magnetic needle which is not attracted by other attractive forces. Always the magnetic needle pointing to the magnetic north.

If the compass is placed under the external attractive forces, like magnetic rock, iron ore, and also by steel structures, rails, electric cables, conveying electric current iron pipes. Iron lamp post etc. may affect the magnetic needle of the compass. Due to these external attractive forces, we can't able to find the normal position of the magnetic meridian. Such a disturbing force is known as local attraction.

Detection of Local attraction: The local attraction at a particular place can be detected by observing the fore and back bearings of each line and finding its difference. If it differs exactly by 180^0 there is no local attraction at both stations, provided instrumental and observational errors are eliminated. But if the difference is not equal to 180^0 then local attraction exists there either one or both stations.

Elimination of Local attraction

If there is local attraction at a station all the bearings measured at that place will be incorrect. The amount of error will be equal in all the bearings. There are two methods for eliminating the effects of local attraction.

First method

The amount and direction of error due to local attraction at each of the affected station is to be calculated.

If the observed bearings are in the **whole circle system**, then the correction applied by using the following rule after finding the nature of error.

Rule: If at a station, observed bearing of a line is more than that of its correct one, the error at this station is +ve and the correction is -ve and if the error is -ve at this station, the correction is +ve.

If the observed bearings are in the quadrantal system the corrections must be applied in proper direction.

In I and III quadrants the numerical value of bearings increased in clockwise direction and II and IV quadrants they increase in anticlocked wise direction. Hence +ve corrections are applied for clockwise and -ve corrections applied for anticlockwise directions.

Example 1

The following bearing was observed in running a closed transverse

Line	FB	BB
AB	75^0 00'	254^0 30'
BC	115^0 30'	296^0 30'
CD	165^0 30'	345^0 30'
DE	225^0 00'	44^0 00'
EA	304^0 30'	125^0 00'

Find the error due to local attraction. Determine the correct bearings.

Solution

Line	FB	BB	Error
AB	75^0 00'	254^0 30'	$0^0$30'
BC	115^0 30'	296^0 30'	1^0 00'
CD	165^0 30'	345^0 30'	NIL
DE	225^0 00'	44^0 00'	1^0 00'
EA	304^0 30'	125^0 00'	0^0 30'

From the above calculation we came to know that the stations C and D are free from local attraction and all other stations are having local attractions. Hence the observed bearings at the stations C and D are correct.

Commencing from the fore bearing of 'DE' all other incorrect bearings can be calculated as follows.

Observed F.B of DE = 225^0 00'
Deduct = 180^0 00'

Corrected B.B of DE 45^0 00'
Observed B.B of DE = 44^0 00'

Error at station E (-) 1^0 00'

Observed FB of EA = $304^0$30'
Correction at station E = (+) 1^0 00'

Corrected FB of EA = 305^0 30'
Deduct 180^0 00'

Correct B.B of EA = 125^0 30'
Observed B.B of EA = 125^0 00'

Error at station A (-) 0^0 30'

Solution (Fig 4)

Observed F.B of AB = 75^0 00'
Correction at station A (+) 0^0 30'

Corrected FB of AB = 75^0 30'
Add 180^0 00'

Corrected BB of AB = 255^0 30'
Observed BB of AB 254^0 30'

Error at station 'B' (-) 1^0 00'

Observed F.B of BC = 115^0 30'
Correction at station 'B' = (+) 1^0 00'

Corrected FB of BC = 116^0 30'
Add 180^0 00'

Corrected B.B of BC 296^0 30'

Observed B.B of BC' = 296.30

Hence OK

Line	F.B	B.B	Correction	Corrected FB	Corrected BB
AB	75^0 00'	254^0 30'	(+) 0^0 30' at 'A'	75^0 30'	255^0 30'
BC	115^0 30'	296^0 30'	(+) 1^0 00' at 'B'	116^0 30'	296^0 30'
CD	165^0 30'	345^0 30'	Nil at 'C'	165^0 30'	345^0 30'
DE	225^0 00'	44^0 00'	Nil at 'D'	225^0 00'	45^0 00'
EA	304^0 30'	125^0 00'	(+) 1^0 00' at 'E'	305^0 30'	125^0 30'

Example 2

The following bearings were taken in traversing with a compass in a place where local attraction was suspected.

Line	F.B	B.B
AB	N 46^0 00'E	S 46^0 00'W
BC	S 60^0 30'E	N 61^0 30'W
CD	S 10^0 30'E	N 9^0 00'W
DA	N 79^0 00'W	S 79^0 30'E

At what station do you suspect local attraction? Determine the correct bearings of each line.

Solution

If the numerical value of Fore and back bearings of a line is same there is no local attraction. Examining the above problem the station A and B are free from local attraction. The stations C and D are having local attraction and to be corrected.

Fore and Back bearings of AB are correct

Fore bearing of BC = S 60^0 30'E
Corrected B.B of BC = N 60^0 30' W
Observed B.B of BC = N 61^0 30' W
Difference = (+) 1^0 00' error at 'c'

Observed F.B of CD = S 10^0 30'E
Correction at C' = (-) 1^0 00'

Corrected FB of CD = S 9^0 30'E
Corrected B.B of CD = N 9^0 30'W
Observed B.B of CD = N 9^0 00' W

Difference (-) 0^0 30' error at D

Observed F.B of DA = N 79^0 00'W
Correction at D = (+) 0^0 30'

Corrected F.B of DA = N 79^0 30'W
Corrected B.B of DA = S 79^0 30'E

Observed BB of DA = S79^0 30' E

Hence error at A is N

Line	Corrected F.B	Corrected B.B	Remarks	Observed FB	Observed BB	Correction
AB	N 46^0 00'E	S 46^0 00'W	NIL at 'A'	N 46^0 00' E	S 46^0 00' W	
BC	S 60^0 30'E	N 61^0 30'W	NIL at 'B'	S 60^0 30' E	N 60^0 30' W	
CD	S 10^0 30'E	N 9^0 00'W	-1^0 00' at C	S 9^0 30' E	N 9^0 30' W	
DA	N 79^0 00'W	S 79^0 30'E	+ 0^0 30' at D	N 79^0 30' W	S 79^0 30' E	

Example 3

The following bearings were recorded for a closed compass transverse

Line	F.B	B.B
AB	74^0 30'	256^0 00'
BC	107^0 00'	286^0 30'
CD	224^0 30'	44^0 30'
DA	308^0 00'	127^0 00'

Which stations are affected by local attraction. Determine the correct bearings. Find the true bearings if the declination was 2^0 00' west

Solution

Fore and Back bearings of the line CD differ exactly by 180^0, therefore stations C and D are free from local attraction. Consequently bearings taken at these stations are correct.

Fore and back bearings of CD are correct
F.B of DA = 308^0 00'
Subtract = 180^0 00'

Corrected B.B of DA = 128^0 00'
Observed B.B of DA = 127^0 00'

Difference (-) 1^0 00' error at A

Observed F.B of AB = 74^0 30'
Correction = (+) 1^0 00'

Corrected F.B of AB = 75^0 30'
Add = 180^0 00'

Corrected B.B of AB 255^0 30'
Observed B.B of AB 256^0 00'

Difference (+) 0^0 30' error at 'B'

Observe F.B of BC = 107^0 00'
Correction at B = (-)0^0 30'

Corrected F.B of BC = 106^0 30'
Add = 180^0 00'

Corrected B.B of BC = 286^0 30'
Observed B.B of BC = 286^0 30'
Hence O.K

Which agrees to the given B.B of BC observed at the station C which is free from local attraction. Having corrected the bearings of the lines, their true bearings may be determined by subtracting 2^0 00' from the corrected bearings of the lines, since the magnetic declination is west. The results may be tabulated as follows.

Line	Observer		Correction	Corrected		Decli	True		Remarks
	F.B	B.B		F.B	B.B	nation	F.B	B.B	
AB	74^0 30’	256^0 00’	(+) 1^0 at A	75^0 30’	255^0 30’	Declination being 2’00’W T,B of line = MB -2°	73^0 30’	253^0 30’	Stations C and D are free from local attraction.
BC	107^0 00’	286^0 30’	(-) 0^0 30’ at B	106^0 30’	286^0 30’		104^0 30’	284^0 30’	
CD	224^0 30’	44^0 30’	0^0 at C	224^0 30’	44^0 30’		222^0 30’	42^0 30’	
DA	308^0 00’	127^0 00’	0^0 at D	308^0 00’	128^0 00’		306^0 00’	126^0 00’	

Second method

In this method the included angles for all stations are computed from the observed bearings and check it with the sum of theoritical angles and correct the angles. Then commencing from the unaffected line and using these included angles the correct bearings of the successive lines are computed.

Example 4

The observed bearings of the lines AB, BC, CD and DA are as follows, Find which station is free from local attraction and workout the correct bearings.

Line	F.B	B.B
AB	46^0 00’	226^0 00’
BC	119^0 30’	299^0 00’
CD	170^0 00’	351^0 00’
DA	280^0 00’	99^0 30’

Solution

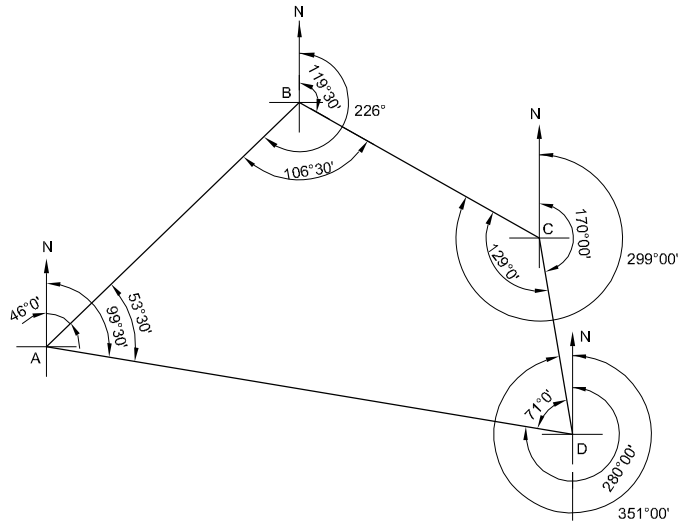
On examining the values of the observed bearings of the lines, it will be seen that fore and back bearings of the line AB only differ by 180^0. Stations A and B are therefore both free from local attraction and the observed fore and back bearings of AB are correct. Now the true included angles between the lines are computed from the observed bearings of the lines.

From the Fig 9

$\angle A = 99^0\,30' - 46^0\,00 = 53^0\,30'$
$\angle B = 226^0\,00' - 119^0\,30' = 106^0\,30'$
$\angle C = 299^0\,00' - 170^0\,00' = 129^0\,00'$
$\angle D = 351^0\,00 - 280^0\,00 = 71^0\,00'$

$\angle A = 53^0\,30'$ Theoretical Check
$\angle B = 106^0\,30'$ $(2n - 4)\,90^0$

Fig 9



SUN142929

ĐC = 129°.00	(2x 4 - 4) 90°
∠D = 71^0 00'	4 x 90^0 = 360^0
Total 360^0 00'	

Fore bearing of AB	= 46^0 00'
Add	= 180^0 00'
B.B of AB	= 226^0 00'
Subtract ∠B	= 106^0 30'
Fore bearing of BC	= 119^0 30'
Add	= 180^0 00'
Corrected B.B of BC	= 299^0 30'
Subtract ∠C	= 129^0 00'
Corrected fore bearing of CD	= 170^0 30'
Add	= 180^0 00'
Corrected B.B of CD	= 350^0 30'
Subtract ∠D	= 71^0 00'
Corrected fore Bearing of DA	= 279^0 30'
Subtract	180^0 00'
Corrected B.B of DA	99^0 30'
Subtract ∠A	53^0 30'
Check	
Fore bearing of AB	= 46^0 00'

which agrees to the given FB of AB observed at station A, which is free from local attraction.

Exercise 1

The following bearings were observed on a compass traverse

Line	F.B	B.B
AB	80^0 30'	260^0 00'
BC	130^0 30'	311^0 30'
CD	240^0 30'	60^0 30'
DA	290^0 30'	11^0 00'

make correction for local attraction and declination of 1^0 30'W and calculate true bearings.

Exercise 2

The following are the bearings taken on a closed compass traverse

Line	F.B	B.B
AB	S$37^0$30'E	N$37^0$30'W
BC	S$43^0$15'W	N$44^0$15'E
CD	N$73^0$00'W	S$72^0$15'E
DE	N$12^0$45'E	S$13^0$15W
EA	N$60^0$00'E	S$59^0$00'W

Compute the interior angles and correct them for observational errors.

Permissible Error in compass surveying: The Permissible Error should not exceed 7½ minute. But due to magnetic changes and variations of declination the error should not exceed 10minutes.

Plotting of a campass traverse

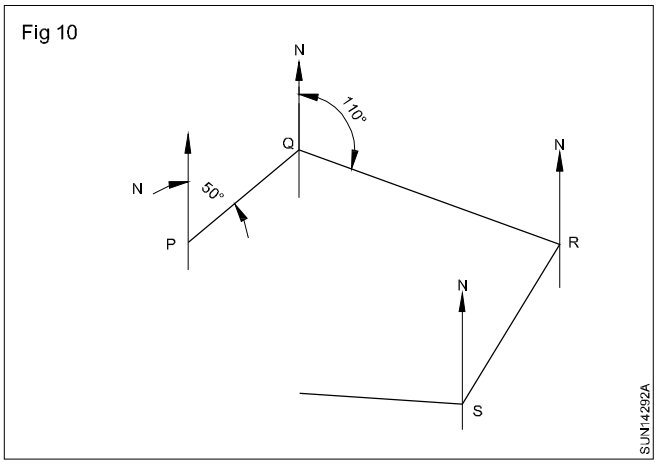
Before plotting a traverse survey on the drawing sheet, first to draw a rough sketch on the paper.

From this we can able to know the size and shape of the plan and also the best way to arrange it on the drawing sheet.

From the observed bearings, corrected bearings are calculated before plotting.

The following methods are used for plotting a traverse survey.

By parallel meridian through each station (Fig. 10)



First fix the position of the starting point P on the paper.

From this point P draw the magnetic meridian.

Plot the bearing of the line PQ with the protractor.

Cut the length of the line PQ with suitable scale.

Now the station point Q is fixed.

From Q, draw a line which is parallel P to magnetic meridian.

Plot the bearing of the line QR and cut off the length of the line QR.

Repeat the same process until all the lines are drawn.

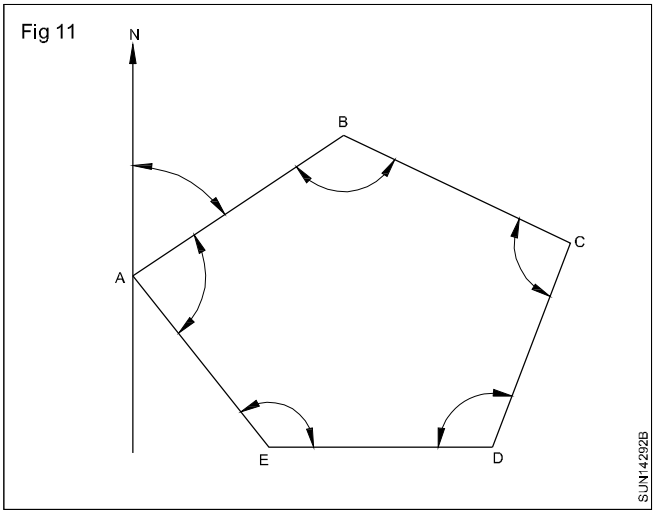
If the traverse is a closed one the last line must coincise with the starting station P.

If not the error is called as closing error.

By included angle method (Fig. 11)

Before plotting the included angle method of the corrected bearings are calculated first, from the observed bearings.

From the corrected bearings, the included angles are calculated.



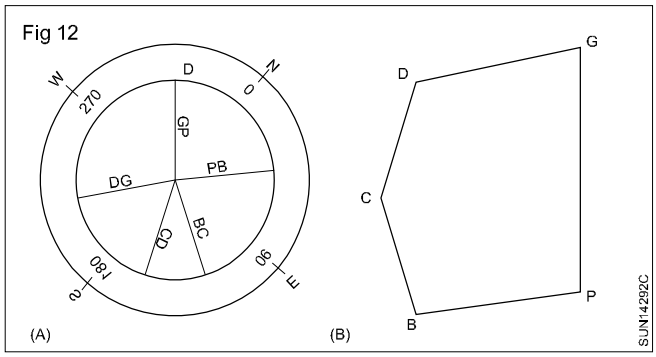
From the starting station A, draw a line representing the magnetic meridian.

From A, draw the bearing of the line AB, and cut off the length AB according to scale, thus fixing of the station 'B'.

From B draw the included angle ABC.

The same process may be repeated at each successive stations.

By paper protractor (Fig. 12)



First mark any point 'O' on the paper and draw the bearing of each line with reference to the magnetic meridian by using large circular paper protector is shown in Fig. (a).

Transfer the direction of all the lines to their proper positions and taking length of each line is shown in Fig. (b).

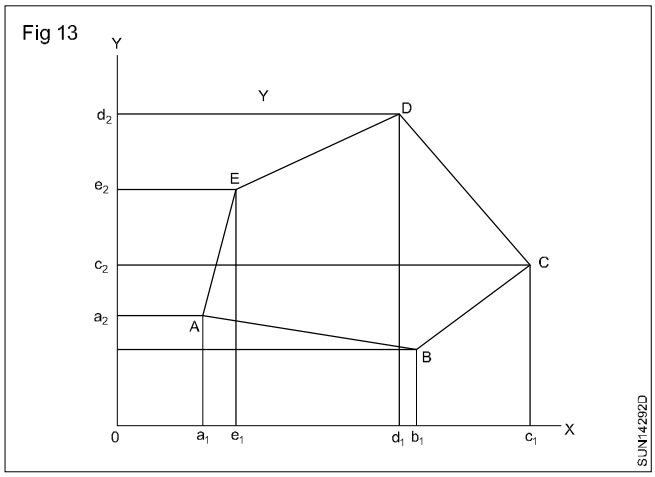
By rectangular co-ordinate method (Fig. 13)

Firstly, the points of the traverse are plotted by their coordinates with respect to x-axis and y-axis. The x axis and y axis are intersecting at 'O'.

- The line OX is representing the magnetic meridian.
- Every point is plotted independently with reference to the axes.

Firstly, the co-ordinates of each point are calculated.

This method is mainly used in plotting of traverse by using Theodolite instrument.



- It is more accurate method of plotting.
- In this method the errors are not accumulate.

Closing Error And its graphical Adjustments: While plotting a closed traverse the starting and the ending points will coincide otherwise if the ending points fails to meet with the starting one is called the closing error or error of closure.

The closing error occurs due to wrong measurement of lengths and bearing of lines in the field and due to faulty plotting.

When the closing error exceeds permissible limit, the field work is repeated. But the error is found to be within the permissible value, the traverse may be adjusted.

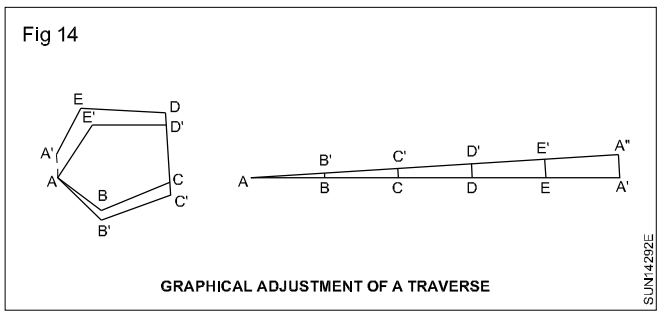
When the angular and linear measurements are of equal precision graphical adjustment of the traverse may be used. This method is based on the Bowditch's rule.

The correction may be applied both lengths as well as to bearings of the lines in proportion to their lengths.

The adjustment of a compass traverse graphically, may be made as under.

Procedure (Fig 14)

Let ABCDEA' be a closed traverse as plotted from the observed magnetic bearings and linear measurments of the traverse lengths. A is the starting station and A' is the location of the station A as plotted. Hence, A'A is the closing error.



Introduction of CAD

Objectives : At the end of this lesson, you shall be able to

- **define the computer and CAD**
- **describe history of computer**

Introduction

Computer are increase singly of a becoming a part of everyday life computers calculates our electricity and telephone bill find its useful applications in the field of medicine and medication assists various business organization system to keep their accounts and other basic jobs up to date its also provides the facility of playing games and surfing over the internet so as to gain the information on different filed in day time.

Definition

Computers are electronic devices which are used to perform arithmetic and logic operation at a very high speed. The applications of computers in different fields and areas is successful and economically justified.

A brief history of computers and software

The first computers were developed in the 1950s, shortly after the transistor was invented. In the mid 1960 s General Motors, Boeing and IBM began developing CAD programs, but the development was slowed by the high cost of computer hardware and programming.

In 1971, Ted Hoff developed the first microprocessor. All circuitry of the central processing unit (CPU) was now on one chip. This started the era of the personal computer (PC). In the 1980s, additional improvements to the microprocessor changed the mainframe computers to powerful desktop models.

Of course, computer software was advancing along with the computer hardware. CAD started as a simple drafting tool and has now evolved into a powerful design tool. CAD has progressed from two-dimensional (2-D) to three-dimensional (3-D), to surface modelling and to solid modelling with animation. Each generation has become more powerful and more user friendly.

Autocad

AutoCAD is the leading computer -aided design and drafting (CAD) program in the world. Since its original introduction in November, 1982, AutoCAD has grown in sales and functionality to become the standard PC-based CAD program against which all other similar programs complete and against which they are judged. Over the years, AutoCAD has kept pace with developments in the computer industry. The program has grown from its original command line driven DOS-based roots to become a fully compatible windows application.

Enlarging or Reducing Diagrams

CADD allows you to enlarge or reduce diagrams in a convenient manner. To enlarge or reduce diagrams, you need to select the objects and enter a scale factor. The scale factor determines by how much the diagrams are to be reduced or enlarged.

Mainframe computers have a lot of data processing power and their size is quite big. A single mainframe computer performs all the data processing and is accessed via terminals connected to it. Minicomputers are smaller versions of mainframe computers. Microcomputers (PCs0 are the desktop or laptop computers of today and are used for individual computing needs.

There are two main categories of computer software:

- **System software**
- **Application program**

The system software manages the internal operations of the computer. The application programs are tools that help you accomplish your work, such as CADD.

CADD HARDWARE

The following are the main hardware components of CADD

- System unit
  - Central processing unit
  - Memory
  - Hard disk, CD-ROM pen drive
- External storage devices
- Monitor
- Printers and plotters
- Keyboard
- Digitizer, puck and mouse

System Unit

The system unit is the computer that is used for all data processing. The main components of the system units are the central processing unit (CPU) and memory. In mainframe and minicomputers CPU and memory are usefully separate compartments that house thousands of devices. In today's PCs, however, they all fit in a small box commonly known as a desktop computer. Most desktop computers today come equipped with a hard disk, and CD ROM. Let us have a look at the components of a system unit:

- Central processing unit
- Memory
- Hard disk, CD-ROM

External storage devices

There are a number of external storage devices available such as magnetic tapes, zip drives and removable hard disks. They are commonly used to keep backup copies of electronic files for safekeeping.

Magnetic tapes are quite common for storing large volumes of data. A magnetic tape that looks like a small videocassette can store thousands of megabytes of data. However, they are quite slow and require a lot of time to store or retrieve data.

The new option for data storage is the removable hard disk. You can remove the entire hard disk from your computer and use it on another computer. This approach is commonly used when you need to work on different computers and you want the same information to be available instantly.

Computer Aided Design (CAD): is simply, design and drafting with the aid of a computer. Design is creating a real product from an idea. Drafting is the production of the drawings that are used to document a design. CAD can be used to create 2D or 3D computer models. A CAD drawing is a file that consists of numeric data in binary form that will be saved onto a disk.

Why should you use CAD?

Traditional drafting is repetitious and can be inaccurate. It may be faster to create a simple "rough" sketch by hand but larger more complex drawings with repetitive operations are drawn more efficiently using CAD.

Why use AutoCAD?

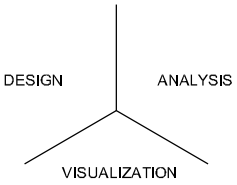
AutoCAD is a computer aided design software developed by Autodesk Inc. AutoCAD was first introduced in 1982. By the year 2000,it is estimated that there were over 4 million AutoCAD users worldwide.

What this means to you is that many employers are in need of AutoCAD operators. In addition, to learning AutoCAD will give you the basics for learning other CAD packages because many commands, terms and concepts are used universally.

Learning to use a CAD system is similar to learning a new language. It is necessary to begin with the basic alphabet and learn how to use it correctly and effectively through practice. This will require learning some new concepts and skills as well as learning a different vocabulary. Today, the majority of the Mechanical CAD systems are capable of creating three-dimensional solid models. Nonetheless, all CAD systems create designs using basic geometric entities and many of the constructions used in technical designs are based upon two-dimensional planar geometry. The method and number of operations that are required to accomplish the basic planar constructions are different from one system to another.

In general, a Computer Aided Design (CAD) package has three components: a) Design, b) Analysis, and c) Visualization, as shown in the sketch. A brief description of these components follows.

Fig 1



COMPONENTS OF COMPUTER AIDED DESIGN

DC2601E1

Hardware and Software Overview

There are two parts of a computer system, hardware and software, and a CADD system in no exception. Computer hardware is the physical components of the computer such as system unit, monitor and plotter. Computer software is the program that determines the application of a system.

There are three main categories of computers with respect to hardware:

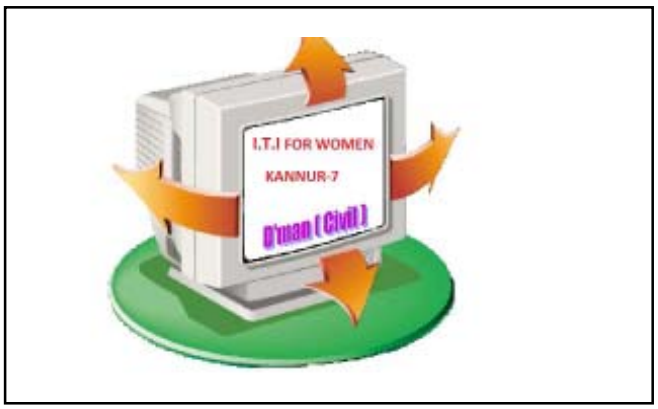
- Mainframe
- Minicomputer
- Microcomputers, for example personal computers (PCs)

The Monitor

The monitor is the computer screen and is used to display information. A good monitor is very important for CADD in order to display fine graphics. A colour monitor is essential because many CADD drawing techniques are

based on colours. Monitors are available in various sizes ranging from 13" to 30" or more. Today, average monitors have the ability to display millions of colours.

The main factor that determines the quality of a monitor is the resolution. The term resolution refers to sharpness of an image displayed on the screen. Resolution is measured by the number of picture elements (pixels) that a screen can display. The more pixels and the closer they are the sharper the image. The distance between pixels is called the "dot-pitch". The smaller the dot-pitch, the sharper the image. A.26 or smaller dot-pitch monitor is recommended for CADD applications.



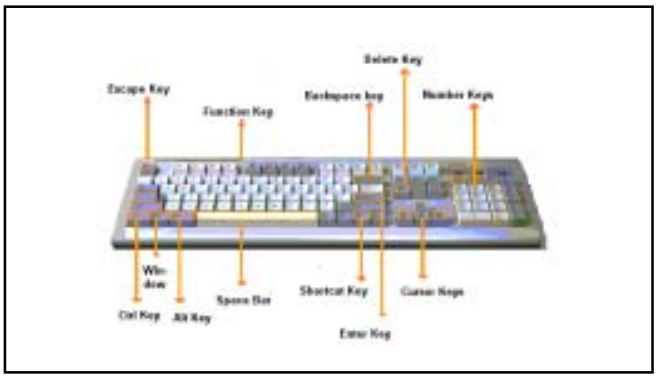
Printers and Plotters

CADD drawings are printed using fine-quality printers and plotters. Drawings are neat and clean and as accurate as the naked eye can see. You can print drawings at as much as 1200-dpi (dots per inch) accuracy. This means 1200 dots are printed in a non-inch-long line! All the text dimensions and other graphics are printed highly accurate, neat and crisp. You can print drawings with a lot of variations; for example, drawings can be printed with different sizes, line types, text fonts and colours.

There are a variety of printers and plotters available in the computer industry. They work on different principles and their prices very significantly. There are many types of pen plotters, ink-jet printers, laser printers and plotters, electrostatic printers, etc.

Key board

Key board - This is an input devices. Which contains keys to feed information in to the computer.



Type writer key: Used for letters, numbers and punctuation symbol.

Function Keys: F1 to F12 performs depend on the software use.

Cursor control keys: To move the cursor to the left, right, up, or down.

Page up and Down key: To move the preceding page and to move the text page.

Home Key: To the top of the Document

End Key: To end of the Document

Num Lock Key: Numeric 0-9, pressing any of them, a number gets displayed on the screen.

Caps Lock Key: By pressing, type letters will appear in the small or capital.

Shift Key: To appear the upper symbol, if Hold Down this key.

Ctrl & Alt Key: Often used in combination with other keys to carry out special actions. By pressing Ctrl, Alt 7 Delete keys simultaneously, the machine automatically Restart.

Enter Key: In alert PC that finish given instruction to execute the Instructions.

Tab Key: Move the cursor along the line to a preset point and also to move from one option to another in a menu.

ESC KEY: To cancel or to ignore the entry or command that just Entered.

Delete Key: Erase the character to the place to the right side of the Blinking cursor.

Back Space Key: Erase the character to the left side of the blinking curser, also it moves the cursor back.

Digitizer, Puck and Mouse

The digitizer (also known as a graphic tablet) and the puck are the data input devices most commonly used in CADD systems. These devices allow you to enter point locations on the screen and to make selections from the menus. As the puck is moved over the surface of the digitizer, it moves the indicator (cursor) on the screen relatively. To enter a point, you need to position the cursor at the appropriate position on the screen and then press the "Enter" button on the puck.

Digitizers are available in many sizes and styles. A number of commands are printed on the digitizer surface. To enter a command, place the puck over the desired command and press the "Enter" button. The selected command is instantly entered. The puck buttons are configured to perform many other tasks. For example, one button is used to make selections, another to enter the data, another to return to the previous menu and another to cancel the last command.

A mouse is another pointing device that can be used with CADD. Like the puck, the mouse allows you to control the position of the cursor on the screen by rolling it across a flat surface, but it does not require a digitizer. Some programs support working with a mouse only, while others support both the mouse and the digitizer. A mouse is much cheaper than a digitizer or puck, but provides only limited data entry options.

CADD Software

A CADD program contains hundreds of functions that enable you to accomplish specific drawing tasks. A task may involve drawing an object, editing and existing drawing, displaying a view of the drawing, printing or saving it, or controlling any other operation of the computer. The functions contain a number of commands that enable you to specify exactly what you want to do and how you want to do it.

The functions are organized into modules that provide easy access to all the commands. The program is divided into modules such as draw, edit, data output, function control, data storage and management. A program may also have a number of specialized functions such as layers, database and 3D. Let s have a look at the CADD modules:

- Draw
- Edit
- Data output
- System control
- Data storage and management
- Special features

Draw

The draw module provides access to all the drawing functions of CADD. Whenever you need to draw something this group of functions is used. The draw module enables you to draw lines, arcs, circles, ellipses, text, dimensions, symbols, borders and many other drawing components.

Draw is CADD s most frequently used module because all drawing work is accomplished using it.

Edit

The edit module lets you change existing drawing elements and manipulate them in a number of ways. You can move, copy or erase drawing components. You can enlarge or reduce the sizes of diagrams or change the colour and line type of drawing components. You can also change the size and style of text and dimensions, as well as edit a dimension to show different units of measurement. A good CADD program is designed to change the appearance of all drawing elements created with CADD.

The edit functions also act as convenient drawing-aid tools. They enable you to join missing corners of lines, trim drawing components along a line, stretch them to fit a new shape, etc. The list of editing capabilities goes on and on. The edit functions make CADD a dynamic drawing tool.

Data Output

The data output module enables you to display drawings on the screen and then print them on paper. There are two separate sets of functions that help accomplish this:

- **View - display functions**
- **Print/plot functions**

The view-display functions allow you to display different views of a drawing on the screen. These functions are used quite often, because every time you need to draw something or edit something, you need to focus on that portion of the drawing. With the help of view-display functions, you can zoom in on a specific portion of the drawing.

The print and plot functions allow you to print drawings using a printer or a plotter. You can control many aspects of printing and plotting. You can print the same drawingin different sizes by applying the appropriate scale

factor. You can plot the drawings with specific colours, pen thickness, and line types.

Data storage and Management

The data storage and management module allows you to store and manage drawing data. Through the use of the functions in this module, you can store drawings as files on the hard disk. You can manage the files in directories and sub-directories, and move, copy or delete them as needed.

CADD data management functions also let you translate drawings created by other CADD programs. These functions convert drawing data to a generic format that can be read by any CADD program. Data exchange format (DXF) is one of the common data translation formats used by CADD program. There are a number of data exchange formats available.

System Control

The system control module (also known as system defaults) allows you to control how CADD works. CADD programs are designed for a broad range of professionals, including architects, designers, engineers and surveyors. With the help of system control functions, you can set the working environment of CADD to suit your needs.

Example: You can set the type of units that you will be using, the accuracy of the units, a style for dimensions and text, colours, layers, line type in a drawing, etc. Additionally, you can customize screen menus, the display of colours on the screen, resolution of the screen, size, the speed of the cursor, etc.

You can also specify whether the selected defaults should apply to a single drawing, to a specific project, or to all the projects in a specific category. The defaults can be set on a temporary or permanent basis.

Special Features

CADD programs usually offer a number of special features that make working with CADD easier and allow you to automate many drawing tasks. For example, you can create layers in a drawing that allow you to segregate drawing components. You can develop spreadsheets and databases that can be used to create many types of project reports. You can create three-dimensional (3D) drawings, such as isometrics and perspectives, with the help of 3D functions. You can also accomplish many other automated tasks with the help of macros.

The number of special features a CADD program has or how elaborate they are various from one program to another. Some vendors sell specialized features as separate packages, while others include them in a single package. It all depends how a program is written, how big or small it is, and how it is sold.

CADD User Interface

CADD user interface provides the environment and the tools that allow you and the computer to communicate. Each CADD program establishes an environment that best suits its purpose. The goal is to make working with CADD efficient. Most programs use a Graphic User Interface (GUI) to communicate with the user. The GUI provides visual aids for quick data entry. You are given tools to select functions, enter textual or mathematical data, locate points in the drawing window, select objects in the drawing window, etc.

Computer Aided drafting and designs

Objectives : At the end of this exercise, you shall be able to

- **define CAD**
- **enumerate System requirement for CAD,2015**
- **explain starting up CAD 2015**

Introduction - Computer Aided Design the ideas of a designer can be represented as mathematical and graphical models in a computer. Further, it involves the use of a computer to develop analysis or modify an engineering design. The designs process is an iterative procedure which involves the following four steps.

i Geometric modelling
ii Engineering analysis
iii Design review and evaluation
iv Automated drafting

Definition : Auto CAD is the most popular computer Aided Designs and Drafting software from Auto desk, a leading U.S based company Auto CAD 2015 is the latest version of Auto CAD series.

System requirements for AutoCAD 2015	
Operating System	Microsoft windows 8/8.1 Microsoft windows 8/8.1 pro Microsoft windows 8/8.1 Enterprise Microsoft windows 7 Enterprise Microsoft windows 7 Ultimate Microsoft windows 7 Professional Microsoft windows 7 Home Premium
CPU	Type: For 32-bit AutoCAD 2015: 32-bit Intel Pentium 4 or AMD Athlon Dual Core, 3.0 GHz or higher with SSE2 technology For 64 -bit AutoCAD 2015: AMD Athlon 64 with SSE2 technology AMD Opteron with SSE2 technology Intel Xeon with Intel EM64T support with SSE2 technology Intel Pentium 4 with Intel EM64T support with SSE2 technology
Network	Development via Deployment Wizard. The license server and all workstations that will run application dependent on network licensing must run TCP/IP protocol. Either Microsoft or Novell TCP/IP protocol stacks are acceptable. Primary login on workstations may be Netware or Windows. In Addition to operating systems supported for the application, the license server will run on the windows Server 2012, windows Server 2012 R2, Win dows Server 2008, Windows 2008 R2 Server editions. Citrix XenApp 6.5 FP1, Citrix Xen Desktop 5.6

System requirements of AutoCAD 2015	
Memory	2GB (8 GB recommended)
Display Resolution	1024x768 (1600x1050 or higher recommended) with True Colour
Display Card	Windows display adapter capable of 1024x768 with True Colour capabilities. DirectX 9 or DirectX 11 compliant card recommended but not required.
Disk space	Installation 6.0 GB
Pointing Device	Ms-Mouse compliant device
Digitizer	WINTAB support
Plotter/Printer	Same as AutoCAD 2013-2014 - System printer and HDI support
Media (DVD)	Download and installation from DVD
Browser	Windows internet Explorer 9.0 (or later)
Side-by-side Install	Supported
Tool Clips Media Player	Adobe Flash Player v10 or up
.NET Framework	.NET Framework Version 4.5

Additional requirements for large datasets, point clouds, and 3D modelling

CPU Type	Intel Pentium 4 processor or AMD Athlon, 3.0 GHz or higher with SSE2 tech nology; Intel or AMD Dual Core processor, 2.0 GHz or higher(minimum).

Techniques for greater comfort

- The computer monitor must be set at such an angle that it is at or lower than eye level.
- Adopt correct techniques, good work habits. Proper posture and suitable equipment.
- Sitting rigidly for long periods is unhealthy.
- Never rest your wrists white typing.
- Raise the back edge of the Keyboard enabling easier use of the device.
- Avoid resting your arms or wrist on the Keyboard. Instead, rests them in your lap or on the armrest while taking a break.
- Tap lightly on the Keyboard rather than pounding on it and use a font size that is comfortable to the eye.
- A larger font size is always better.
- Hold the mouse lightly.
- Reduce unnecessary usage of computer.
- Adequate lighting is required in computer room.
- Switch off the monitor and UPS as per procedure when go for break.
- Please do a task only when you are sure, otherwise it may cause system problems. If you have any doubt consults your master.
- Do not try anything on your own. You may accidentally perform a task that might cause system problem.

Applications of CAD

CAD is used in various fields as listed below

1. Preparing architectural drawing
2. Interior design and modelling
3. Tool and fixture design
4. Production planning and control
5. Preparation of assembly lists and bill of materials
6. Computer aided inspection
7. Preparation of programs for CNC machines
8. Circuit layout and panel design
9. Mapping, building drawing
10. Communication network
11. Piping and instrumentation design
12. Automotive industries and
13. Computer aided manufacturing

CAD packages

Some of the commonly used CAD packages are:

1. Auto CAD
2. Electrical CAD
3. 3 DS-MAX
4. STAAD
5. PRO-Engineer
6. IDEAS
7. Mechanical desktop
8. REVIT
9. Architectural Destop

Differentitate Between Manual and Machine Drafting

Traditional drafting	Computer aided design
1. Uses traditional drafting board and usual skill.	1. Uses a larger digitizer and plotter tools for design
2. Designs cannot be reproduced since there is no means of storage.	2. Designs can be stored in computer memory and cab be retrieved at any time.
3. Accuracy and design are not consistent.	3. Designs such as straight lines, smoothing curves and lines at proper angles can be done.
4. Text formatting facility is not allowed.	4. Allowed.
5. Cross hatching is done manually.	5. Automated cross hatching design is allowed.
6. Hollow section is done manually and inaccurate.	6. Automated hollow section is done and is accurate.
7. Cannot view in different dimensions	7. Dimensions can be changed as per user's wise.
8. Sweeping of images is impossible	8. Done automatically.
9. Image and designs cannot be viewed in different angles	9. Can be viewed in different angles and dimensions
10. Application designs consume more time and hinders productions.	10. Application designs are faster and favourably production.

Traditional draughting	Auto CAD Draughting
1 Scale For all the drawing we want to choose separate scales like full size scale (eg.1:1), reduced scale (eg.1:100) or enlarged scale (eg.100:1)	Scaling is not necessary. Enter all the dimensions in real size (1=1)
2. Paper size First select a drawing sheet according to the size of the drawing i.e A1, A2 ,A3, A4 etc.	In any size paper we can take print out after completing the drawing.
3. Unit Select any one of the unit like meter, Centimetre, millimetre, feet, Inch etc. According to the importance of each are drawing.	We can set units simply by using command UNITS, select appropriate unit from the unit dialogue box.
4. Drawing instruments It requires many instruments like T-square, set squares, pen, pencil, eraser, protractor, etc.	User interface provides many tools which makes the drawing process more easily
5. Drawing board A good quality drawing board is necessary for accurate drawing work.	It is not required.
6. Drawing process It is very difficult to make alterations in the drawing and much time consumes.	It is very easy to make and alter different types of drawings.

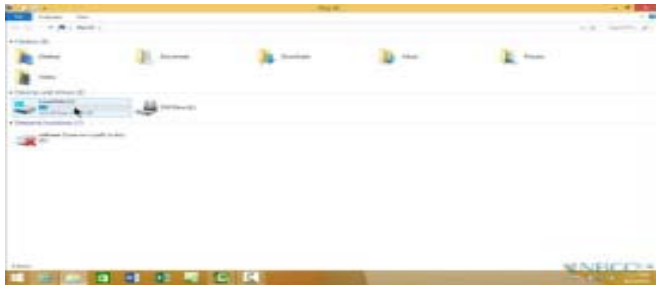
Installation Auto CAD

1. Switch on the computer wait for few minutes to do the process of ROM. Now we see the monitor screen as shown fig.

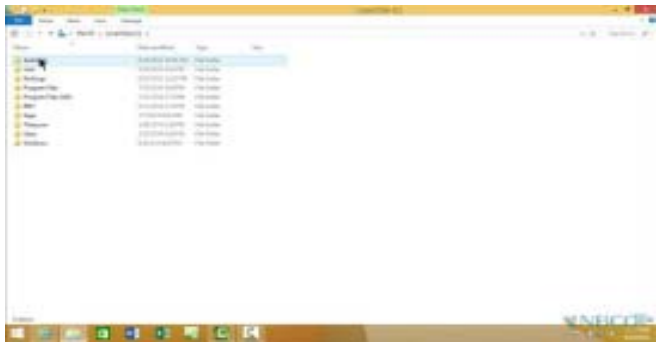
Insert the Auto CAD CD in to CD-ROM drives; double click on My Computer icon then a display as follow.

Open file explorer

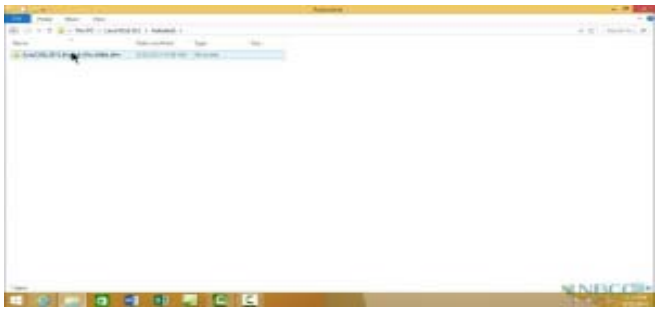
Open local disk(C)



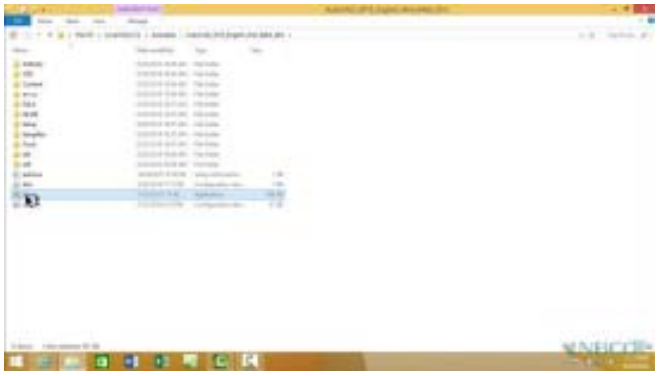
Open Autodesk



Open Autocad_2015



Run setup

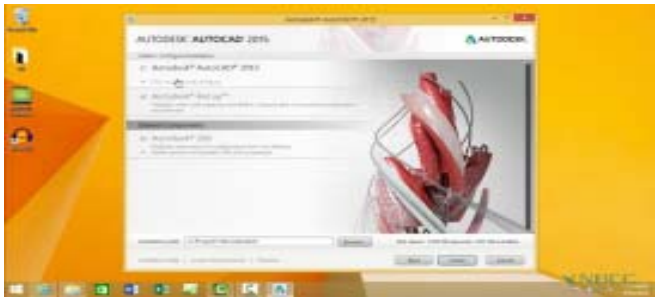


The installer will start once setup is clicked. Please click on install

Change country to India, and accept the license terms, Now click next.

Select your language preference, stand alone licence, and input and product key that you made note of while downloading the software. Now click next.

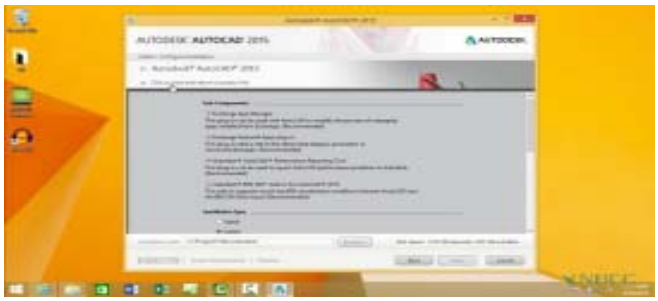
Click on Autodesk AutoCad 2015 to open and configure the options.



Under installation type select custom then make sure you place a green check mark next to feature. This will ensure all components get installed.

Scroll down a bit further and you will see on option for including service packs. Click include service packs and then click the download button. Wait for the service pack to download. Note that this step requires an internet connection.

Go back to the top and click on the “Click to close and return to product list” banner.

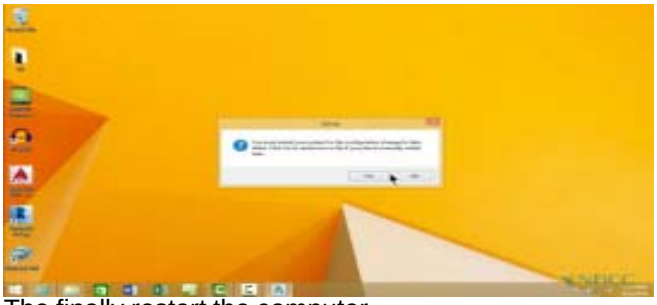


Now click install

The install will take some time. Please be patient.

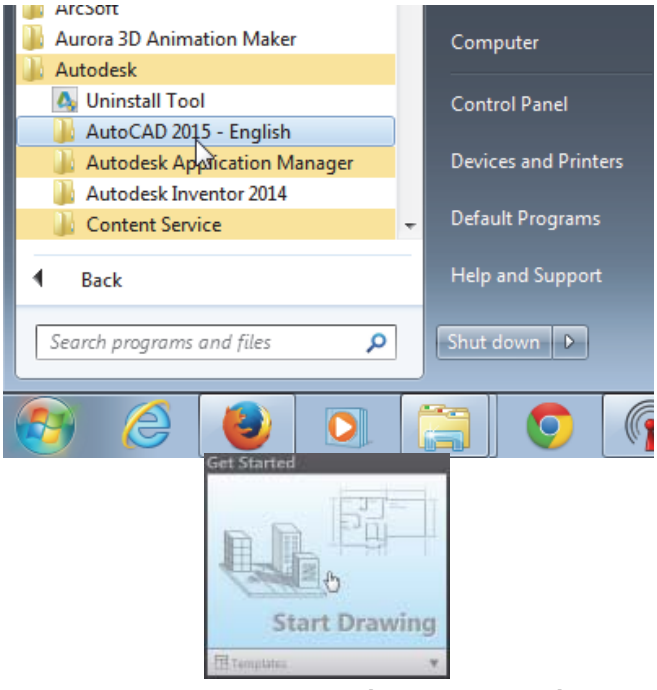
Once the install is complete you should see this message. Press finish to complete the install.

Your system may ask to reboot once the install has finished. Click yes to reboot your system. You have now successfully installed AutoCAD 2015.



The finally restart the computer.

1. Select the AutoCAD 2015 option on the program menu or select the AutoCAD 2015 icon on the Desktop. Click Start Drawing to start a new drawing.



Starting up AutoCAD

When you start auto cad, the start dialog box is displayed. The dialog box provides you with four ways to start a drawing. You can

(i) Open an existing drawing

(ii) Start a drawing from scratch.

(iii) Start a drawing base on a template.

(iv) Use wizards to help you set up your drawing.

To start Auto CAD:

1. From the start menu choose programs. Then choose Auto cad from the menu.

2. In the start dialog box, choose one of the following.

Open a drawing:

Opens a drawing you select from a list of the four most recently opened drawing also, display the browse button that you choose the look for another file.

Start from scratch: Open a new Drawing based on the measurement system you choose-English (Inches) or Metric (Millimetres.)

Use a template: Open a new drawing. Based on template you select from a list. The list display template file that exist in the drawing template file location of specified in the option dialog box. Temple file store all the setting for a drawing and can also include predefined layers, dimension style and views.

Use a Wizard: Open a new drawing that you set up using either the quick setup wizard or the advanced setup wizard.

The setup dialog box is displayed when you first start Auto CAD. Whenever you start a new drawing during your Auto Cad session, the create New Drawing dialog box is displayed. After you use AutoCAD for a while, you may want to turn off display of these dialog boxes. If you them off, choosing File New automatically creates a new drawing based on your last start from scratch selection (English or a Metric) Choosing File open displays the select File dialog box, where you can select Auto Cad drawing and templates.

To turn off display of the Start up dialog box:

In the Start up dialog box, clear show start up Dialog.

To display the Start up dialog box.

1. From the tools menu choose options.

2. In the option dialog box choose the system tab.

3. Under general option, select show start up Dialog.

Choose OK.

Starting a Drawing from scratch

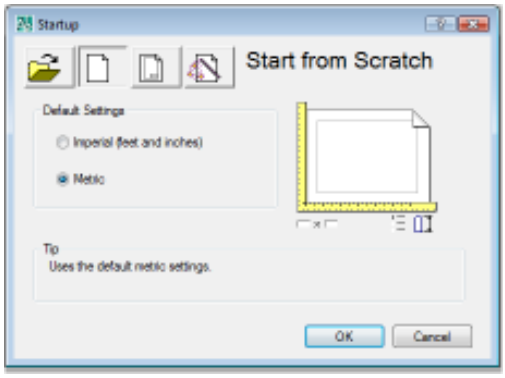
Starting a drawing from scratch is a quick way to begin a new drawing. When you select this drawing start up method, you can select this drawing startup method, you can select one of two measurement system on which to base the new drawing.

English: Creates a new drawing based on the Imperial measurement system. The drawing is based on the acad.dwt, template, and the default drawing boundary, called the drawing limit is 12 x 9 inches.

Metric : Creates a new drawing based on the metric measurement system. The drawing based on the acadiso. Dwt template, and the default drawing boundary is 429x297 millimeters.

To create a new drawing using Start from Scratch:

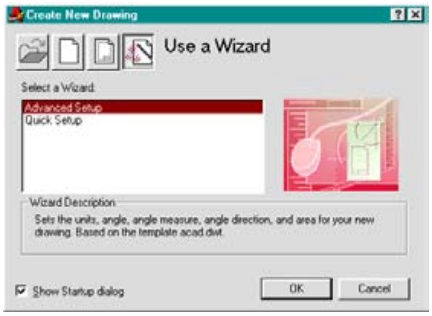
1. In the startup dialog box, choose Start from Scratch
2. Select English or Metric, and then choose OK. The drawing open based on the English (acad.dwt) or metric (acadiso.dwt) template and with the name drawing 1 dwg.
3. From the file menu, choose save as.
4. In the Save Drawing as dialog box under file name enter a name for the drawing and choose save. Auto CAD automatically appends the drawing extension.(.dwg.) to the new file name.



Starting Drawing With Setup wizards:

Auto Cad setup wizard start with the same setting used when you start a drawing from scratch, that is, English or Metric, then customize other setting depending on the wizard our choose.

The quick setup wizard: sets the Drawing unit and drawing area. Choices for drawing unit include Decimal. Engineering. Architectural Fractional. And scientific. You also specify the width and length of the drawing area to establish the drawing boundary, or limit the -al plotted sheet size.



The start a drawing using a wizard:

1. In the startup a dialog box, choose use a wizard.
2. Under select a wizard, Quick setup or Advance setup and choose OK.
3. Complete the wizard pages using the next and back buttons to move forward and backward.
4. On the last pages finish.

The wizard starts your drawing session.

Starting Drawing using Templates

To start a drawing using templates:

1. In the startup dialog box, choose a template.
2. Under select a template, select a templates from the list or choose browse to select another file.

   A preview image of the template appears at the right and a description appears near the bottom of the dialog box.
3. Choose OK.

Auto CAD opens the drawing as drawing. Drg. Creating a template:

If you need to create several drawing with similar requirement, you can save time by saving one of the drawings as a template, add a border and title block if needed, and then erase all existing objects.

To create a templates:

1 From the file menu, choose open

2 In the open dialog box, select the file you want to use as a template and choose OK.

3 If you want to delete the existing file content, from the modify menu, choose Erase.

4 At the select object prompt, enter all, and then select the border and title block (if you want to remove them) and enter (remove)

5 From the file menu, choose Save As.

6 In the save drawing As dialog box under Save files as type, select the drawing template file type.

7 Under file name, enter a name for the template. Choose OK.

8 In the template Description dialog box, enter a brief description of the template. This description is displayed whenever you select this template in the Create New drawing dialog box.

9 Choose OK.

To Open a Drawing

1 In the startup dialog box, choose open a drawing, and the choose browse. (if Auto CAD is already started, from the file menu, choose open)

2 In the select file dialog box, select one and more file and choose open.

You can also enter the drawing menu under file name and choose open, or double click file name in the list of files.

To open a drawing Using drawing browser

1 From the file menu, choose open.

2 In the select file dialog box, choose find file.

3 On the browse tab in the browse/search dialog box, select the drive and directory containing the files you want to view.

4 Under list of type. Select a file type to list.

5 To open a file, either double click its image or select its image and choose open.

To Save a Drawing

When you are working on a drawing, you should save it frequently. If you want to create a new version of a drawing without affecting the original drawing, you can save it under another name.

To save a drawing

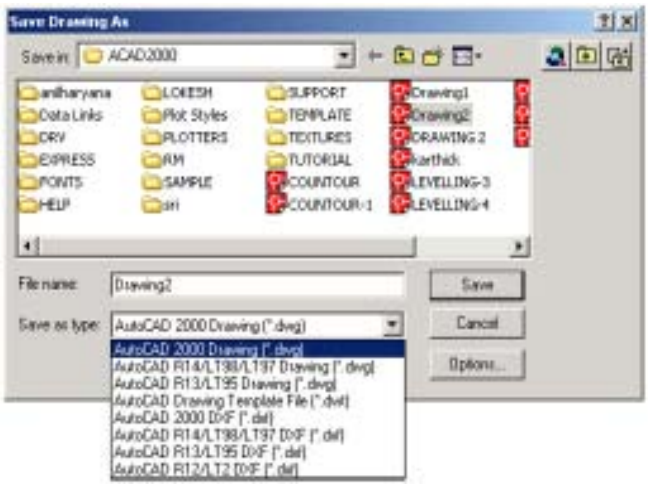
1 From the file menu, choose the save.

2 In the save drawing as dialog box under file name, enter the new drawing name(the file extension is not required)

3 Choose save.

Command line SAVE saves the drawing. SAVES saves a copy of the current drawing under the name you specify.

System variables SAVE TIME sets the time interval at which Auto CAD automatically saves your work. RASTER PREVIEW controls whether BMP preview images are saved with the drawing.



Graphical user interface (GUI)

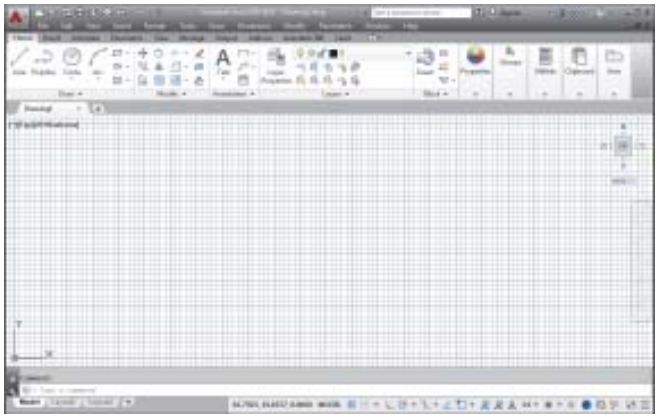
Objectives : At the end of this exercise, you shall be able to

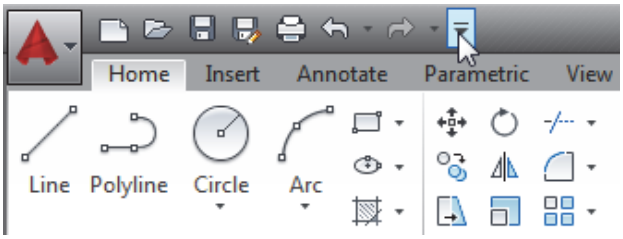
- **describe graphical interface of Auto CAD**
- **explain key board function keys.**

Introduction

Note that AutoCAD automatically assigns generic name, Drawing X, as new drawings are created. In our example, Auto CAD opened the graphics window using the default system units and assigned the drawing name Drawing1.

Graphical user interface (GUI) OF Auto CAD





Quick Access Toolbar

1 Click on one of the following icons for quick access to commands QNEW, OPEN, SAVE, PLOT, and UNDO/ REDO.

Right- click the Quick toolbar and click Customize Quick Access Toolbar. The Customize User Interface dialog opens and displays the list of commands available.

Drag commands you want to add from the command list pane in the Customize User Interface dialog box to the Quick Access toolbar.

By click on the down arrow in the quick access bar and can select show menu bar to display the autocad menubar. The menubar provides access to all autocad commands.

Info Center

Quickly search for a variety of information sources, access product updates and announcements, and save topics with info Center.

Ribbon

The ribbon provides a single, compact placement for operations that are relevant to the current workspace. It eliminates the need to display multiple toolbars, reducing clutter in the application window. The ribbon maximizes the area available for work using a single compact interface.

The ribbon can be displayed horizontally, vertically, or as a floating palette. The horizontal ribbon is displayed at the top of the drawing window by default when you create or open a drawing.

You can create your own panels to display on the ribbon; you can also modify the commands and controls on existing ribbon panels.

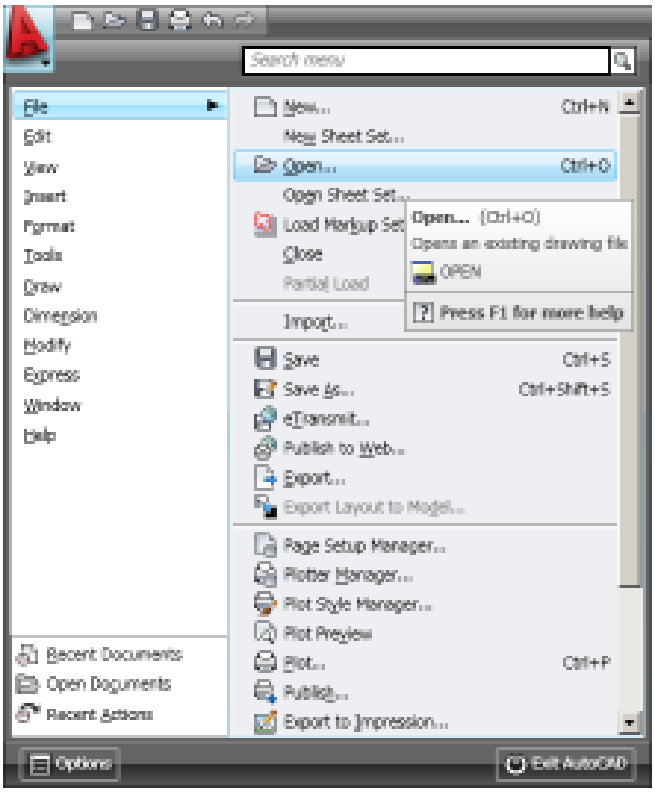
Menus and Colours

Menu Browser

1 Click on the A icon in the upper left corner of the drawing area.

2 Click the desired pulldown menu.

3 Click on the command to be executed from the pulldown.



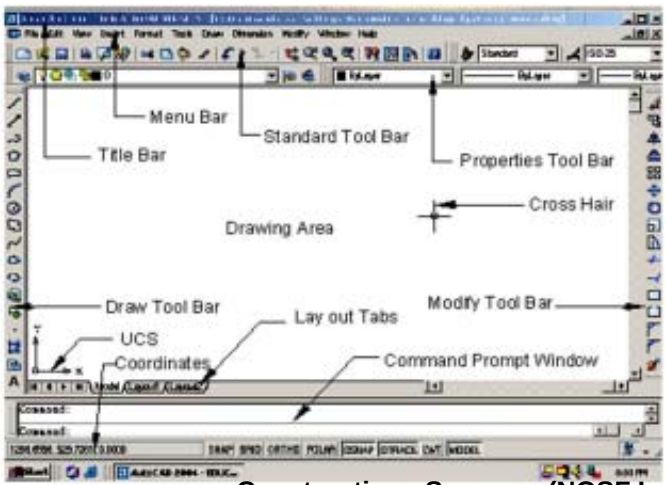
Workspaces

You can switch between the workspaces from the menu browser.

1 Click the Workspace switching icon in the lower left corner of the screen.

2 Click on one of the following workspace options.

AutoCAD classic workspace



Title bar : This shows the name of drawing which is currently used.

Menu bar : This menu bar help us quicker way to access the general controls and setting for AutoCAD. The main commands and functions are available in this menu bar it has the following facilities.

1 It gives a command that requires key board or drawing input.

2 It displays additional menus choice with > symbol, in this menu called cascading menus.

3 It displays a dialogue box that contains settings which have changing options.

Standard tool bar : This tool bar contains the standard functions of commands which is used for getting information's and modifications.

Properties tool bar : This tool bar have the properties of the entity such as thickness of line, colour, layer type of line etc. We can change the properties of the entity by using this tool bar.

Draw tool bar : This tool bar contains the group of drawing commands such as line, arc, circle etc.

Modify tool bar : This tool bars are used to do the modifications in the entities such as erase, trim etc.

Draw area : This is a black space to draw the drawings. This area has formed as grids, we can increase or decrease the area by using boundary limit command.

UCS: UCS (User Coordinate system is an indication to the use of for which plane the drawing is drawn. We can change any plane according to our wish to draw the drawing in views.

Command prompt window : This window is used to give commands by typing in key board.

Cross hair : This is the pointer used to draw, select and to locate.

Layout tabs : These tabs are used to select the particular lay out of the drawing.

Function tabs : Below the command prompt window drawing function tabes are available. These tabs show us the position of grid, ortho, o snap etc. The functional keys are used for effective function of the drawing.

Key board Function Keys

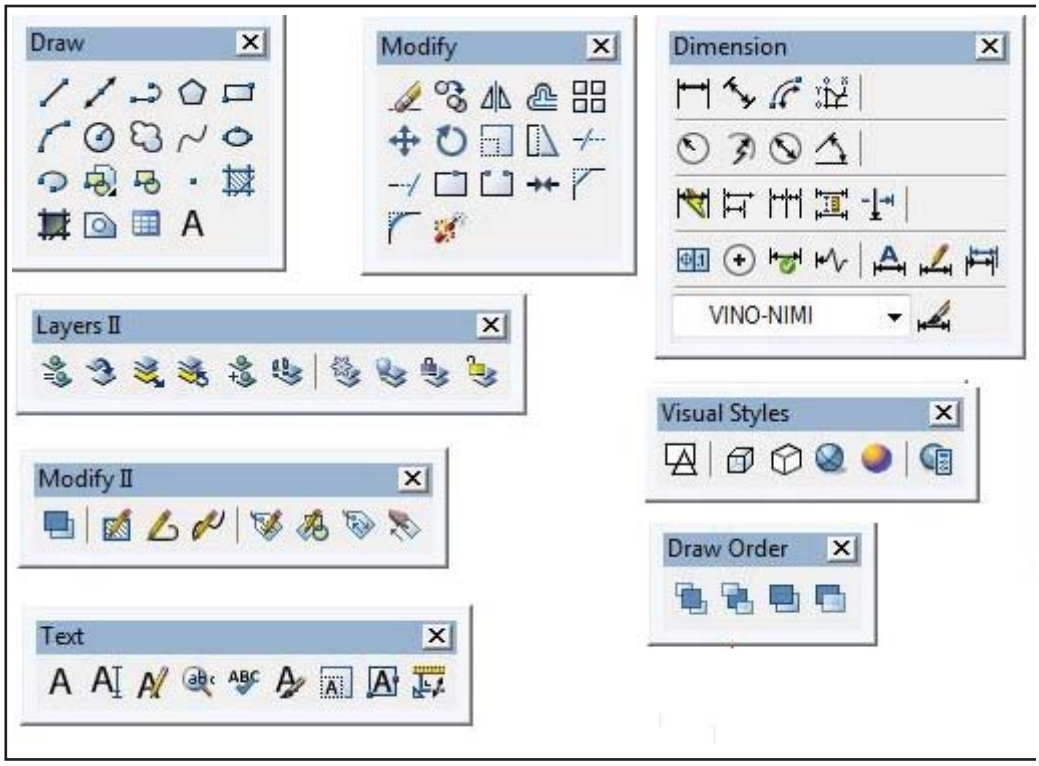
There are some function keys in the keyboard for quick access to certain commands. These keys are pressed for the following purposes.

Key	Function Defined
F1	Online Help
F2	Toggles between Command Window On and Off
F3	Toggles between OSNAP On and Off
F4	Toggles between Tablet On and Off
F5	Switches among Isoplanes Top, Right and Left
F6	Toggles between Coordinates On and Off
F7	Toggles between Grid On and Off
F8	Toggles between Ortho Mode On and Off
F9	Toggles between Snap Mode On and Off
F10	Toggles between Polar Tracking On and Off
F11	Toggles between Objects Snap Tracking On and Off
F12	Save as

You can disable the group selection quickly by pressing FUNCTION KEYS (Ctrl + Key) combination to quickly toggle some of the modes and invoke some of the commands.

Function keys used in Auto CAD

Key Strokes	Function Defined
Ctrl+Z	Undo
Ctrl+C	Copy Clip
Ctrl+E	Osoplane Top/Right /Left
Ctrl+G	Grid On/Off
Ctrl+L	Ortho On/Off
Ctrl+O	OPEN command
Ctrl+S	QSAVE command
Ctrl+U	Polar Tracking ON/Off
Ctrl+W	Object Snap Tracking ON/Off
Ctrl+Y	Redo
Ctrl+2	ADCENTER command
Ctrl+F6	Switch between open drawings
Ctrl+B	Snap On/Off
Ctrl+D	Coordinate Display ON/Off
Ctrl+F	Osnap Setting Dialog



box $\angle A = \angle C = \angle D$

Ctrl+K	HYPERLINK command
Ctrl+N	NEW command
Ctrl+P	PRINT command
Ctrl+T	Tablet On /Off
Ctrl+V	Paste
Ctrl+X	Delete
Ctrl+1	Object Properties window On/Off
Ctrl+6	DBCONNECT command
Ctrl + Tab	Switch between open Drawings.?

The functionality of these Ctrl + Key combination depends on the settings done on the User Preferences tab on the option dialog box.

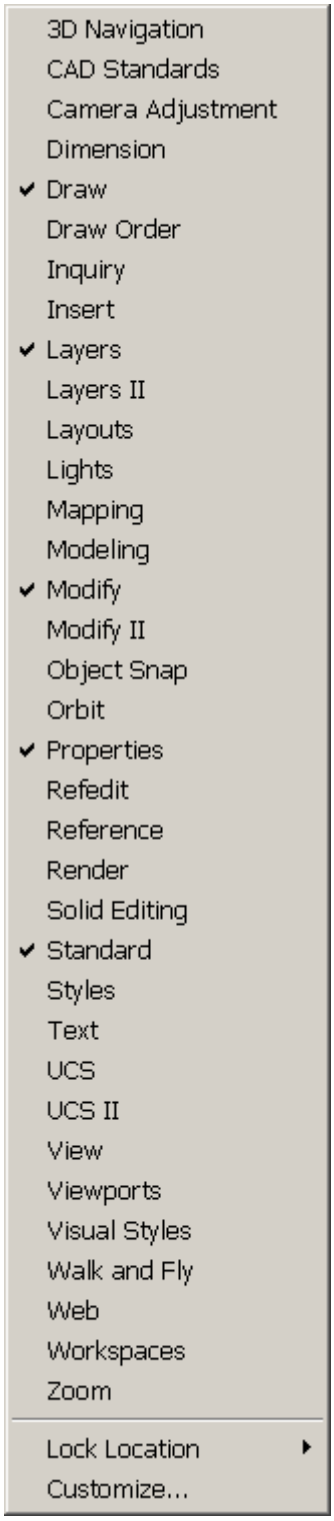
Example:

That is to say Ctrl+ C works for COPYCLIP command, if the check box is cleared, Ctrl + C works for the CANCEL command.

Text edit keys

The following accelerator keys, which are effective within the Multilane Text Editor, dialog box.

Key Strokes	**Function Defined**
Ctrl+A	Select all text in the Multiline Text Editor
Ctrl+B	Applies or removes bold format for selected text
Ctrl+C	Copies selected text to the Clip board
Ctrl+1	Applies or removes italic format for selected text
Ctrl+Shift+L	Converts selected text to lower case
Ctrl+Shift+U	Converts selected text to upper case
Ctrl+U	Applies or removes underline format for selected text
Ctrl+V	Pastes Clipboard contents to cursor location
Ctrl+X	Cuts selected text to the Clipboard
Ctrl+SPACE	Removes character formatting in selected text.



Loading Toolbars

Right- clicking on an icon in any toolbar

This will show a list of all available toolbars.

Practice on AutoCAD

Objectives : At the end of this exercise, you shall be able to

- **explain practice on CAD**
- **explain method of giving commands**
- **explain drawing area set up**
- **explain drawing & settings.**

Practice on Auto cad

Introduction

Already we have studied fundamental of computers. Basic Auto CAD and came to know the importance of these in modern drafting world.

Now it is necessary to study the sequence of commands, their operation to prepare the 2D Drawing knowledge of their tools will assist to create better design.

Before entering into the details of actual drafting, it would be desirable to study creating terms related to computer drafting.

Entity : A drawing element like line, arc and circle is called an entity.

Command : The instruction to be input into a drafting software for making a drawing, modifying, copying, saving, etc. Are called commands. Command can be typed on the keyboard. It may be picking from a menu or table or selected from a bar like standard toolbar and modify toolbar by using a mouse.

Prompt : Drafting software gives textual indication the type of instruction to be fed into it at different stages. Such indication is called prompt. For example, after the issue of LINE command, AutoCAD gives a prompt "from point". After having received instructions about from point, the software shows the prompt "To point:"

Options: Different alternative procedures are available for drawing an entity or solid. These alternative procedures are known as options.

File : A file is a collection of data pertaining to a drawing or set of related drawings.

Directory or folder : A collection of files is called a directory or folder.

User: The person operating the computer to perform tasks is said to be the user.

Programmer: The person who writes computer program is called a programmer.

Default : Default value or default option denotes the value or option that is retained by the software. Default is denoted by <> or <current>. The 'default' is also called the 'current'. The default or current value can be used as such by just pressing the Enter key. The default value can be altered by typing the required value. Radius<1.000>:2 Enter means that the default value for Radius is 1. But you have selected a value of 2 for Radius instead of 1.000.

Dialog box: The user- graphic interface that appears on the screen as response to certain commands is called dialog box. It has check boxes, buttons to click on for alternative options.

There are boxes for OK, apply, cancel and so on. Click on OK will return the user to the usual user interface.

To start with, Auto CAD it would be desirable to study that user-system graphic interface.

Show a typical user-system graphic interface. If consists of menu bar, standard toolbar, draw toolbar, modify toolbar, status bar, vertical scroll bar, horizontal scroll bar, drawing area and command area. Command area is generally a three-line area.

The menu bar has as set of text items like file, edit and draw. Standard toolbar and modify toolbar have a number of window like graphic symbols each representing one feature like line and circle. Items like copy, fillet and chamfer are also represented in the relevant toolbar by graphic images which will depict copying, filleting, etc. These graphic images are called icons.

The menu bar and the toolbars enable the user to select commands quickly. For example, if the user want to send in command for drawing a polygon, the moves such that the cursor point is on 'draw' in the menu bar and presses the left button. A sub-menu listing different entities like line, arc, polygon and circle appears on the screen as a string of texts under the highlighted draw heading. The cursor is than taken onto 'polygon' by using mouse and than the left button is pressed. Now, the software gives prompts in the command area to complete drawing the required polygon ultimately.

Picking Point by Using Cursor

If you move the mouse, you can see a cursor in the form of cross hairs with square appears to move within the drawing area. This is drawing cursor. It is standard cursor. This cursor tells you that Auto CAD is waiting for instructions. When the drawing cursor moves, the co-ordinate display in the status line change i.e. it tells the cursor location it shows the co-ordinates in an x,y format.(x,y axis)

Place the cursor in any point of the drawing area and do left clicking. Now you have just picked a point. If you move the cursor in any direction rectangle follow.

Like this move the cursor a bit and do left clicking, the rectangle disappears. (try picking several more points in the drawing area.)

If the cursor if you move the arrow cursor over the draw option given in the draw tool bar and do clicking on any command (for example, clicking on line command), the cursor appears as cross

Hairs (+). This is point selection cursor; it can also appear in conjunction with a rubber banding line. This tells Auto CAD expects point input.

When we are selecting an object, the drawing cursor changes into a small square. This is object selection cursor. It tells you must select objects.

In the DOS based R-10 and R-11, the cursor control keys on key board, control the screen cursor, By attaching a mouse with the computer system, we can control the screen cursor with may be used to select Auto CAD command from the screen menu and the pull down menu.

Methods of giving command

There are three ways, to enter commands for constructing or editing a drawing.

I Directly from key board : Commands may be entered (typed) in directly from the key board against the command: prompt. The entered command may be cancelled by pressing ESC key.

II From the screen menu : There is a menu displayed at the right side of the drawing screen, this menu is known as screen menu. Moving the arrow, the curser to the screen menu, high lighting the required command and doing left clicking may select commands.

III From pull down menu : There is a menu bar displayed at the top or side of the screen. This menu is known as pull down menu. In this menu bar, the commands are shown in the form of symbols. Moving the arrow cursor over the required command and doing left clicking may select the commands.

Command, Unit : Format, Units:- Auto CAD does not use a predefined system of unit measure such as meters or inches. For example, a distance of one unit may represent one centimetre.

One foot, or one mile in real-world units. Before you begin drawing, decide what distance one unit will represent, and then create your drawing with that convention.

Command line: Units (or 'units for transparent use)

Defines the Length and Angle formats.

Length: Specifies the current unit of measurement and the precision for the current units.

Type: Sets the current format for units of measure. The values include Architectural, Decimal, Engineering, Fractional, and Scientific. The Engineering and Architectural formats produce feet-and -inches display and assume that each drawing unit represents one inch. The other formats can represent any real-world unit.

Precision: Sets the number of decimal places or fractional size displayed for linear measurements.

Angle: Specifies the current angle format and the precision for the current angle display.

Type: Sets the current angle format.

Precision:- Sets the precision for the current angle display.

AutoCAD uses the following conventions for the various angle measures:

Decimal degrees appear as decimal numbers, grads appear with a lowercase g suffix, and radians appear with a lowercase r suffix. The degrees/minutes/seconds format uses d for degrees, 'for minutes, and "for seconds, for example: 123d45'56.7"

Surveyor's units show angles as bearings, using N or S for north or south, degrees/minutes/seconds for how far east or west the angle is from direct north or south, and E or W for east or west, for example: N 45d0'0" E

The angle is always less than 90 degrees and is displayed in the degrees/minutes/seconds format. If the angle is precisely north, south, east, or west, only the single letter representing the compass point is displayed.

Clockwise : Calculates positive angles in the clockwise direction. The default direction for positive angles is counterclockwise.

When AutoCAD prompts for an angle, you can point in the desired direction or enter an angle regardless of the setting specified for clockwise.

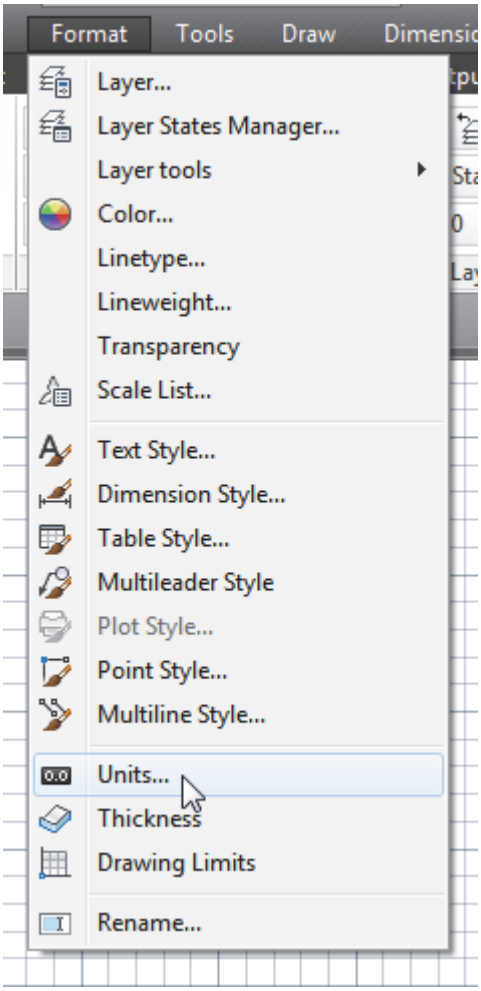
Drawing Units Setup :

Every object we construct in a CAD system is measured in units. We should determine the system of units within the CAD system before creating the first geometric entities.

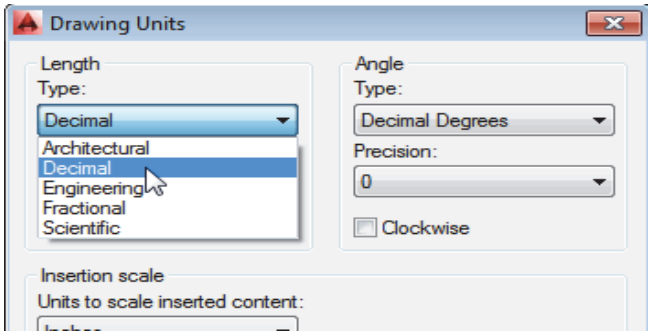
In the Menu Bar select :

[Format]->[Units]

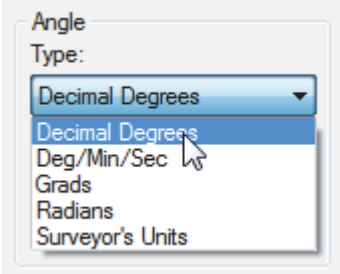
The AutoCAD Menu Bar contains multiple pull-down menus, where all of the AutoCAD commands can be accessed. Note that many of the menu items listed in the pull-down menus can also be accessed through the Quick Access toolbar and /or Ribbon panels.



Click on the Length Type option to display the different types of length units available. Confirm the Length Type is set to Decimal.

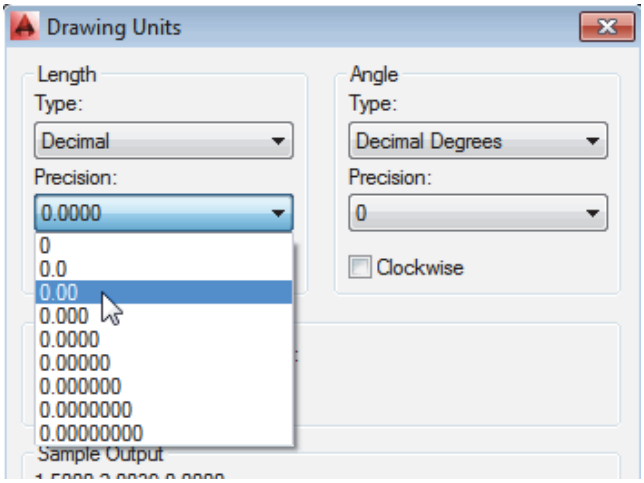


On your own, examine the other settings that are available.

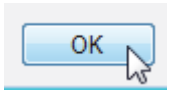


In the drawing Units dialog box, set the Length Type to Decimal. This will set the measurement to the default English units, inches.

Set the Precision to two digits after the decimal point as shown in the above figure.



Pick OK to exit the Drawing Units dialog box.



Command Drawing limits

Format:- Drawing Limit

One of the big advantages in using Auto CAD is that you can draw your drawing at full scale. The size of the drawing area is established by the Auto CAD variables know as minimum and maximum co-ordinates.

The initial limits are minimum co-ordinates (lower-left corner) =0'-0", 0'.0"

Maximum co-ordinate (upper right corner) = 1'-0",9" (or) 420,297

The value of these co-ordinate may be changed using limit command if desired.

Command:- Limits

Reset model space limits:

Specify lower left corner or (ON/OFF)<0.000,0.000>! Use one of the point fixing methods or enter an option.

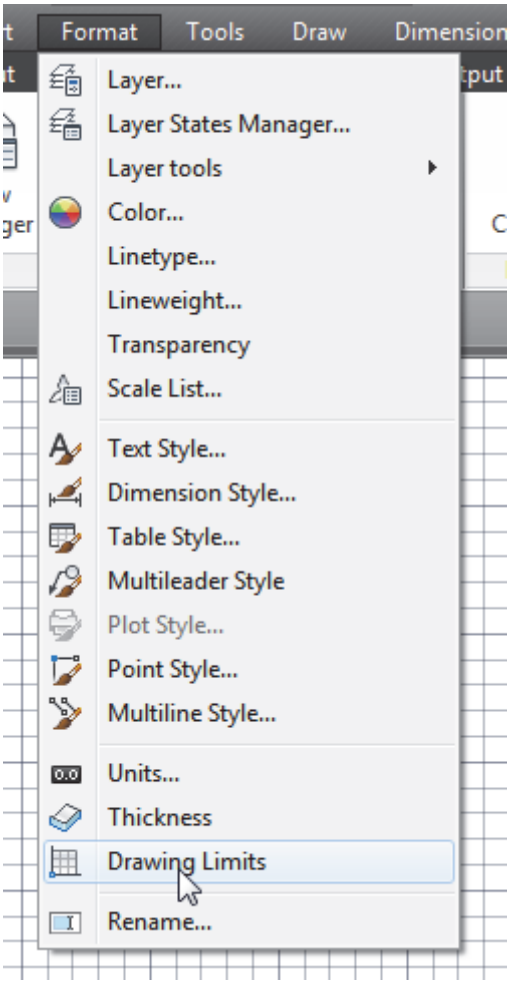
Specify upper right corner <420.000,297.000>: Use one of the point fixing methods.

Drawing Area Setup

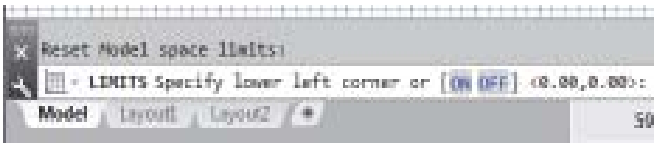
Next, we will set up the Drawing Limits by entering a command in the command prompt area. Setting the Drawing Limits controls the extents of the display of the grid. It also serves as a visual reference that marks the working area. It can also be used to prevent construction outside the grid limits and as a plot option that defines an area to be plotted / printed. Note that this setting does not limit the region for geometry construction.

1. In the Menu Bar select:

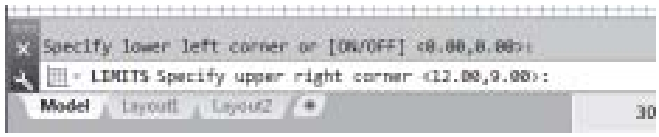
[Format]'[Drawing Limits]



2. In the command prompt area, the message "Reset Model space Limits: specify lower left corner or [On/Off] <0.00,0.00>:" is displayed. Press the ENTER key once to accept the default coordinates <0.00,0.00>.



3. In the command prompt area, the message "Specify upper right corner <12.00,9.00>:" is displayed. Press the ENTER key again to accept the default coordinates<420.000,297.000>



ON

Turns on limits checking. When limits checking is on, Auto CAD rejects attempts to enter points outside the drawing limits. Because limits checking test only points that you enter, portions of objects such as circles can extend outside the limits.

OFF

Turns of limits checking but maintains the values for the next time when you turn on limits checking.

Snap X Spacing:- Specifies the snap spacing in the X direction. The value must be a positive real number. (SNAPUNIT system variable)

Snap Y Spacing:- Specifies the snap spacing in the Y direction. The value must be a positive real number. (SNAPUNIT system variable)

Angle: Rotates the snap grid by the angle specified. (SNAPUNIT system variable)

X Base: Specifies a X base coordinate point for the grid. (SNAPUNIT system variable)

Y Base: Specifies a X base coordinate point for the grid. (SNAPUNIT system variable)

MVSETUP = MultiView Setup

MVSETUP offers two different setup options depending on whether you are in Model Space or in a Layout (Paper Space).

In model space- you set the units type, drawing scale factor, and paper size at the command prompt using MVSETUP. Using the settings you provide, a rectangular border is drawn at the grid limits.

In Paper Space - you can insert one of several predefined title blocks into the drawing and create a set of layout viewports within the title blocks. You can specify a global scale as the ratio between the scale of the title block in the layout and the drawing on the Model tab. The model tab is most useful for plotting multiple views of a drawing within a single border.

MVSETUP commands

No (to not create a new layout tab - we will do this in another lesson)

A (Metric units)

48 (Scale factor - common arch, scale factor is 1:1)

24 Width- see table below for paper size.

(example 210 x 297) Since we are printing in “land scape “ mode, we enter the bigger number of the paper size first.

18 Length - Smaller number from the list below

Once MVSETUP is finished, it will show a rectangle. This is the area where your grid will show up if you have the grid on. This box is pretty much useless so just erase it. You will not need it.

From here, set up dimensions styles, text styles. layer...

If these settings will used in other drawings here are two suggestions, the first of which is recommended because it is less error prone.

1. After creating the desired settings, do a save-as and save t as a . dwt. All of the settings that you created will be saved.

2. After using this drawing, open it and erase all objects. The settings will remain but you will have to hunt down the objects that need to be erased in layouts.

Polar Spacing: Controls the Polar Snap increment distance.

Polar Distance: Sets the snap increment distance when Polar Snap is selected under Snap Type & Style. If this value is 0, the Polar Snap distance assumes the value for Snap X Spacing. The Polar Distance setting is used in conjunction with polar tracking and/or object snap tracking. If neither tracking feature is enabled, the Polar Distance setting has no effect. (POLARDIST system variable)

Grid On: Turns the grid dots on or off. You can also turn grid dots mode on off by clicking Grid on the status bar, by pressing F7, or by using the GRIDMODE system variable.

Grid: Controls the display of a dot grid that helps you visualize distances.

Note: The limits of the dot grid are controlled by the LIMITS command.

Grid X Spacing: Specifies the dot spacing in the X direction. If this value is 0, the grid assumes the value set for Snap X Spacing. (GRIDUNIT system variable)

Grid Y Spacing: Specifies the dot spacing in the Y direction. If this value is 0, the grid assumes the value set for Snap Y Spacing. (GRIDUNIT system variable)

Snap Type & Style: Controls Snap mode settings.

Grid Snap: Sets the snap type to Grid. (SNAPTYPE system variable)

i Rectangular Snap: Sets the snap style to standard Rectangular snap mode.

When the snap type is set to Grid snap and Snap mode is on, the cursor snaps to a rectangular snap grid. (SNAPTYPE system variable)

ii Isometric Snap: Sets the snap style to Isometric snap mode. When the snap type is set to Grid snap and Snap mode is on, the cursor snaps to an isometric snap grid. (SNAPSTYL system variable)

Polar Snap: Sets the snap increment distance when Polar Snap is selected under Snap Type & Style. If this value is 0, the Polar Snap distance assumes the value for Snap X Spacing. This value is also controlled by the POLARDIST system variable. The Polar Distance Setting is used in conjunction with polar tracking and /or object snap tracking. If neither tracking feature is enabled, the Polar Distance setting has no effect.

Polar Tracking Tab (Drafting Setting dialog Box) :

Controls the Auto Track settings

Polar Tracking On: Turns Polar tracking on and off. You can also turn polar tracking on or off by pressing F10 or by using the AUTOSNAP system variable

Polar Angle Settings: Sets the angles used with polar tracking.

Increment Angle: Sets the polar increment angle used to display polar tracking alignment paths. You can enter any angle, or select a common angle of 90, 45,30,22.5,18,15,10, and 5 degrees from the list (POLARANG system variable)

Additional Angles: Makes any additional angles in the list available for polar tracking. The additional Angles check box is a also controlled by the POLARMODE system variable, and the list of additional angles is also controlled by the POLARADDANG system variable.

Note Additional angles are absolute, not incrementa

New: Adds up to 10 additional polar tracking alignment angles.

Track Using All Polar Angle Settings: Permits the cursor to track along any polar angle tracking path for acquired osnap points when object snap tracking is on while specifying points. This setting is also controlled by the POLARMODE system variable.

Note Clicking Polar and Otrack on the status bar also turns polar tracking and object snap tracking on and off.

Polar Angle Measurement: Sets the basis by which polar tracking alignment angles are measured.

Absolute: Bases polar tracking angles on the current uses coordinate system (UCS).

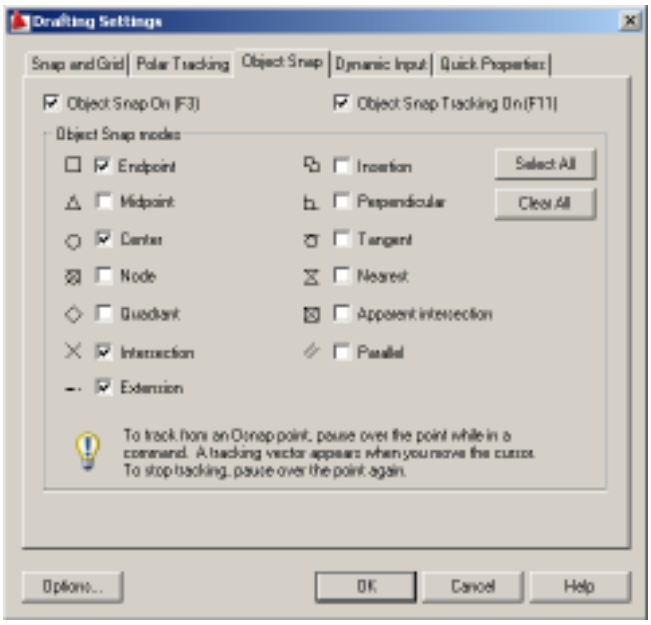
Relative to Last Segment: Bases polar tracking angles on the last segment drawn.

Object Snap Tab (Drafting Setting Dialog Box) :Controls running object snap settings. With running object snap settings, also called Osnap, you can specify a snap point at an exact location on an object. When more than one option is selected, AutoCAD applies the selected snap modes to return a point closest to the center of the aperture box. Press TAB to cycle through the options.

Object Snap On:- Turns running object snaps on and off. The object snaps selected under Object Snap Modes are active while object snap is on. (OSMODE system variable)

Object Snap Tracking On: Turns object snap tracking on and off. With object snap tracking, the cursor can track along alignment paths based on other object snap points when specifying points in a command. To use object snap tracking you must turn on one or more object snaps. (AUTOSNAP system variable)

Object snap Modes: Specifies the running object snap modes. Select one or more options.



Endpoint : Snaps to the closest endpoint of an arc, elliptical arc, line, multiline polyline segment, spline, region, or ray, or to the closest corner of a trace, solid or 3D face.

Mid point : Snaps to the midpoint of an arc, ellipse, elliptical arc, Line, multiline polyline segment, region, Solid, Spline, or Xline.

Center: Snaps to the center of an arc, circle,ellipse, or elliptical arc.

Node: Snaps to a point object, dimension definition point, or dimension text origin.

Quadrant : Snaps to a quadrant point of an arc, circle, ellipse, or elliptical rc.

Intersection: Snaps to the intersection of an arc, circle, ellipse, elliptical arc, line, multiline, polyline, ray, region, spline, or xline.

Intersection and Extended Intersection work with edges of regions and curves but not with edges or corners of 3D solids.

Extension: Causes a temporary extension line to display when you pass the cursor over the endpoint of objects, so you can draw objects to and from point on the extension line.

Insertion: Snaps to the insertion point of an attribute, a block, a shape, or text.

Perpendicular: Snaps to a point perpendicular to an arc, circle, ellipse, elliptical arc, line, multiline, polyline, ray region, solid, spline, or xline. AutoCAD automatically turns on Deferred Perpendicular snap mode when the object you are drawing requires that you complete more than one perpendicular snap. You can use a line, arc, circle, polyline, ray, xline, multiline, or 3D solid edge as an object from which to draw a perpendicular line. You can use deferred perpendicular to draw perpendicular lines between such objects.

Tangent : Snaps to the tangent of an arc, circle, ellipse, elliptical arc, or spline AutoCAD automatically turns on Deferred Tangent snap mode when the object you are drawing requires that you complete more than one tangent snap.

When you use the From option in conjunction with the Tangent snap mode to draw objects other than lines from arcs or circles, the first point drawn is tangent to the arc or circle in relation to the last point selected in the drawing area.

Nearest : Snaps to the nearest point on an arc, circle, ellipse, elliptical arc, line multiline, point, polyline, ray, spline, or xline.

Apparent Intersection: Apparent Intersection includes two separate snap modes: Apparent intersection and Extended Apparent Intersection. You can also locate intersection and Extended Intersection snap points while running Apparent Intersection object snap mode is on. Apparent Intersection snaps to the apparent intersection of two objects (arc, circle, ellipse, elliptical arc, line, multiline, polyline, ray, spline, or xline) That do not intersect in 3D space but may appear to intersect in the current view.

You might get varying results if you have both the intersection and Apparent Intersection running object snaps turned on at the same time.

Parallel : Draws a vector parallel to another object whenever AutoCAD prompts you for the second point of a vector. After specifying the first point of a vector, if you move the cursor over a straight line segment of another object, AutoCAD acquires the point. When the path of the object you create is parallel to the line segment, AutoCAD displays an alignment path, which you can use to create the parallel object.

Select All: Turns on all object snap modes.

Clear All: Turns off all object snap modes

Options: Displays the drafting tab in the option dialog box you cannot access the option dialog box from the drafting setting dialog box if you are running DSETTINGS transparently.

Command: grid : The grid is for visual reference only. It is not plotted, and it is not part of the drawing. You can turn the grid display on and off with the grid button on the status bar. Or press Key button F7,

Specify grid spacing(x) or [ON/OFF/Aspect] <current>:

Grid Spacing(X): Sets the grid to the specified value. Entering x after the value sets the grid spacing to the specified value multiplied by the snap interval.

On turns on the grid using the current spacing.

Off turn off the Grid

Aspect Changes the grid spacing in the X and Y directions.

Specify the horizontal spacing(x) <current>: Enter a value or press ENTER

Specify the vertical spacing (Y) <current>: Enter a value or press ENTER

Entering X following either value defines it as a multiple of the snap interval rather than the drawing units.

The Aspect option is not available when the current snap style is isometric.

Command Line: Snap specify snap spacing or

[ON/OFF/Aspect/Rotate/Style/Type] <current>:

Snap spacing Activates Snap mode with the value you specify

On: Activates Snap mode using the current resolution, rotation, and style of the snap grid.

Off: Turns off Snap mode but retains the current settings

Aspect : Specifies different spacing in the X and Y directions. This option is no available if the current snap style is Isometric.

Specify horizontal spacing <current>: Specify a distance, or press ENTER

Specify vertical spacing<current>: Specify a distance, or press ENTER

Specifies the horizontal and vertical spacing of these snap, grid seperately.

Rotate: Sets the origin and rotation of the snap grid. The rotation angle is measured relative to the current UCS. You can specify a rotation angle between-90 and 90 degrees. A positive angle rotates the grid counterclockwise about its base point. A negative angle rotates the grid clockwise.

Isometric

Isometric: Sets an isometric grid, in which the grid points are initially at 30 degree and 150-degree angles. Isometric snap can be rotated but cannot have different Aspect values.

Specify vertical spacing <current>: Specify a distance or press ENTER

ISOPLANE determines whether the crosshairs lie in the top isometric plane (30 and 150-degree angles), the left isoplane (90-and 150-degree angles), or the right isoplane (30-and 90-degree angles).

Type: Specifies the snap type.

Polar: Sets the snap to polar tracking angles that are set in the POLARANG system variable.

Grid: Set of Snap to Grid

Correcting Mistakes : AutoCAD keeps track of all the commands you use and the changes you market. If you change your mind or make a mistake, you can undo, or reverse, the last action or several previous actions. You can also redo the last action that you reversed.

The Undo and Redo buttons on the Standard toolbar provide the easiest means to undo or redo the previous action.

To undo the most recent action, use one of the following methods:

- On the Standard toolbar, click Undo
- From the Edit menu, choose Undo
- At the command line, type U and then press ENTER
- Press the CTRL-Z shortcut key combination
- Right-click to display the shortcut menu, and then choose Undo

You can also use the UNDO command to reverse several actions at once. To undo a specific number of actions:

1 At the command prompt, type UNDO.

2 On the command line, enter the number of actions to undo, and then press ENTER. For example, to reverse the last five actions, type 5.

If you erase one or more objects by mistake, you can use the OOPS command to restore them to the drawing.

To redo an active, do one of the following:

- On the Standard toolbar, click Redo
- From the Edit menu, Choose Redo
- At the command line, types REDO and then press ENTER
- Press the CTRL-Y shortcut key combination
- Right -click to display the shortcut menu, and then choose Redo

The REDO command reverse the action of the last U or UNDO command. To redo something, you must use the REDO command Immediately after using the U or UNDO command.

Zoom/Pan

Effective zooming can dramatically increase your speed one single command will give you the versatility to move around your drawing. This is the ZOOM command. Another useful command is PAN. These are both quicker than using the scroll bars on the side of the drawing area, unless you have a very short distance to move your drawing (and can make your scroll bars obsolete and thereby create more drawing space).

Start Zoom command by typing Z<ENTER>. When you do this, you will see the following options on the command line:

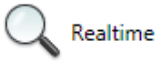
Command: Z <ENTER> ZOOM

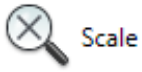
Specify corner of window, enter a scale factor (nx or nxp), or [All/Center/Dynamic/Extents/previous/Scale/Window/Object] <real time>:

I generally use them in conjunction with each other. I'll do a zoom extents to see what state the drawing is at, then perform a zoom window to get to the area I need to work in, then do a zoom Extents when I am done in that area. In between, I may need to use a combination of Zoom Window and Zoom Previous.

Additionally, using your mouse wheel to zoom can be very fast for moving in and out of an area - practice this technique as well.

The zoom command can also be invoked transparently. This means that you can start it up in the middle of a command. For example, if you are in the trim command and want to see a bit more of your drawing, just type 'Z (note the apostrophe) at the command line and you can then zoom using any of the available options. Press <ENTER> to get back to your command.

Command option	Icon		Description
Zoom Extents	Extents		This option will display all the graphics that are contained in the drawing (referred to as the drawing extents) with the largest image possible.
Zoom window	Window		This option (also a 'hidden' default) prompts the user to pick two corners of a box on the existing view in order to enlarge that area to fill the display.
Zoom Previous	Previous		This option restores the displayed view prior to the current one. For the purpose of this option. Up to 10 views are saved so that the last ten views can be recalled. This option includes every time you use the scroll bar, which is one reason to avoid the scroll bars for panning a lot in your drawing.
Zoom Real-time	Realtime		Zoom Realtime provides interactive Zooming capability. Pressing <ENTER> (after entering Zoom) on the command line automatically places you in Realtime mode. Hold the left mouse button down at the midpoint of the drawing and move the cursor vertically to the top (positive direction) of the window to zoom in up to 100% (2xmagnification). Hold the left mouse button down at the midpoint of the drawing and move the cursor vertically to the bottom (negative direction) of the window to zoom out to 100% (5 x magnifications). You cannot zoom out beyond the extents of the current view. When you release the pick button, zooming stops. You can release the pick button, move the cursor to another location in the drawing, and then press the pick button again and continue zooming from that location. To exit Realtime zoom mode, press <ENTER> or <ESC>.
Zoom All	All		This option causes AutoCAD to display the whole drawing as far as its drawing limits or drawing extents (whichever is the greater of the two).
Zoom Dynamic	Dynamic		This is a very useful Zoom option once it is understood. It permits very quick movement around the drawing. Once selected, this option redraws the graphics area of the screen and displays two rectangles. The larger box shows the extents of the current drawing. The smaller box shows the current view with an "X" in the middle. This moves with the mouse. This view box should be positioned so that its lower left corner is at the lower left corner of the view required. By pressing the left button on the mouse, the "X" is replaced by an ">" pointing to the right side of the view box. This allows you to change the magnification. As the mouse is moved, the view box shrinks and expands so that the size of the required view can be set. The left mouse button toggle between PAN "X" and ZOOM">" mode so that fine adjustments can be achieved. When the view required has been selected, press <ENTER> or right click to cause AutoCAD to display it.

Command option	Icon	Description
Zoom Scale	Scale 	This is a 'hidden' default option. You do not have to type "S" to choose this option. It simply requires the entry of a number that represents a magnification factor. Note that the factor is applied to the entire drawing (as defined by the drawing's limits). Numbers less than 1 will reduce the displayed size of the drawing, while numbers greater than 1 will enlarge it. If "X" is inserted after the number (e.g.0.8x) then the factor is applied to the current view. If "XP" is inserted after the scale factor, then the view is scaled relative to paper space. This is useful for zooming a view within a paper space viewport to a specific scale, for example, "1/48XP" will produce a view of model space at a scale of ¼"=1' relative to paper space.
Zoom Center	Center 	This option requires two things: a point that is to be the center of the new display and a value to be its new height in drawing units. The existing height is the default for the new height to allow for panning across the drawing. If the new height value is followed by "X" (e.g..2x), then it is taken as a magnification factor relative to the current height. If followed by "XP", then it is taken as a scale factor relative to paper space and can be used for scaling the contents of paper space viewports.
Aerial view command	Obsolete in 2010 and newer	Aerial view is a zooming tool that displays a view of the drawing in a separate window so that you can quickly move to that area. If you keep the Aerial View window open as you work, you can zoom and pan without choosing a menu option or entering a command. You can change the view by creating a new view box in the Aerial view window. To zoom in to the drawing, make the view box smaller by left clicking a rectangle. To zoom out of the drawing, make the view box larger. As you zoom in or out of the drawing, a real-time view of the current zoom location is displayed in the graphics area. The screenshot shows how the view box looks. Right click in the box and you can move the box to where you want to zoom to.
Zoom object	Object 	This option asks you to select an object or objects, then press <ENTER> and the screen will zoom to those objects only. This is great for when you want to work on object.
Zoom In	In 	Clicking this icon will zoom in to the drawing by about 50%. This option is only available as an icon and cannot be invoked by the command line.
Zoom Out	Out 	Similar to 'Zoom In' - this icon will zoom out of your drawing and allow you to see about 50% more of your drawing space.

Command option	Icon	Description
Mouse scroll	NO Icon	If you have a scrolling wheel on your mouse, you can use it to zoom in and out of your drawing. Scroll towards you to zoom out and away from you to zoom in. You have a option to change the amount of zoom per wheel click with the Zoomfactor system variable. Keep in mind that you will zoom in and out using your mouse location as a 'center point'
PAN	Pan 	Panning allows you to quickly move around the drawing area at the same magnification you currently have set. Type in PAN (or P) <ENTER. And a hand will appear on the screen. Left click and hold to move around your drawing.
Use the Zoom> Previous option to return to where you were.		

CAD basics

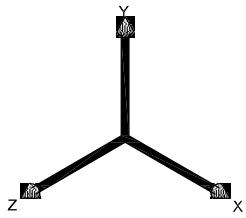
Objectives : At the end of this exercise, you shall be able to

- **explain user co-ordinate system**
- **enumerate AutoCAD commands.**
- **express line & Erase commands**

The CAD Database and the User Coordinate System

Designs and drawings created in a CAD system are usually defined and stored using sets of points in what is called world space. In most CAD systems, the world space is defined using a three-dimensional Cartesian coordinate system. Three mutually perpendicular axes, usually referred to as the X-, Y-, and Z-axes, define this system. The intersection of the three coordinate axes forms a point called the origin. Any point in world space can then be defined as the distance from the origin in the X-, Y- and Z- directions. In most CAD systems, the directions of the arrows shown on the axes identify the positive sides of the coordinates.

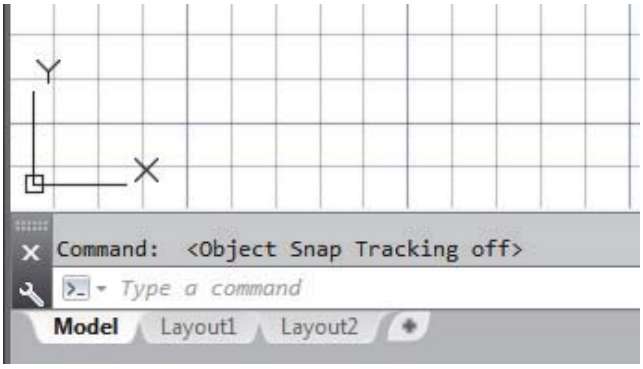
Fig 1



USER COORDINATE SYSTEM

SUN1533211

A CAD file, which is the electric version of the design, contains data that describes the entities created in the CAD system. Information such as the coordinate values in world space for all endpoints, center points, etc., along with the descriptions of the types of entities are all stored in the file. Knowing that AutoCAD stores designs by keeping coordinate data helps us understand the inputs required to create entities.



The icon near the bottom left corner of the default AutoCAD graphics window shows the positive X-direction and positive Y-direction of the coordinate system that is active. In AutoCAD, the coordinate system that is used to create entities is called the user coordinate system (UCS). By default, the user coordinate system is aligned to the world coordinate system (WCS). The world coordinate system is a coordinate system used by AutoCAD as the basis for defining all objects and other coordinate systems defined by the users. We can think of the origin of the world coordinate system as a fixed point being used as a reference for all measurements. The default orientation of the Z-axis can be considered as positive values in front of the monitor and negative values inside the monitor.

AutoCAD uses points to determine where an object is located. There is an origin where it begins counting from. This point is (0,0). Every object is located in relation to the origin. If you were to draw a line straight out to the right from the origin, this would be considered the positive X-axis. If you were to draw a line straight up, this would be the positive Y-axis. The picture above shows a point located at (9,6). This means that the point is 9 units over in the X-axis and 6 units up in the Y-axis. When you are working with points, X always comes first. The other point shown is (-10-4). This means that the point is 10 units in the negative X-axis (left) and 4 units in the negative Y-axis(down)

A line has two points, a start point and an end point. AutoCAD works with the points to display the line on the screen. Move your cursor over the picture above and you will see line drawn from the absolute points of (-10-4) to (9,6).

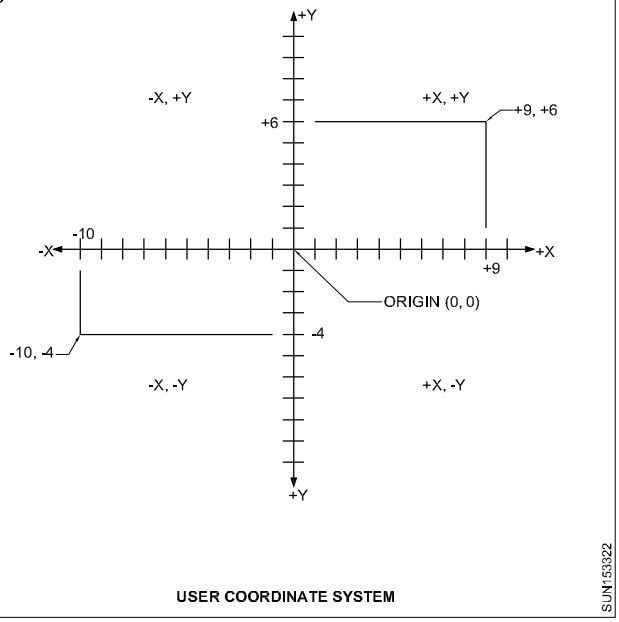
Most of the time you will not have an indication of where the origin is. You may need to draw a line from the endpoint of an existing line. To do this you use relative points. These work the same way, but you have to add the @ symbol (shift+2) to tell AutoCAD that this next point is relative from the last point entered.

To review:

ABSOLUTE POINTS are exact points on the drawing space.

RELATIVE POINTS are relative to an OBJECT on the drawing space.

Fig 2



USER COORDINATE SYSTEM

Its simple system, but mastering it is the key to working with AutoCAD and is explained in more detail further below. In order to work effectively with AutoCAD, you have to work with this system. Until you are comfortable and familiar with it, learning AutoCAD will be more of a chore. My experience in teaching is that the better a student is with coordinates, the faster they will learn.

Entering Points in AutoCAD

You can enter points directly on the command line using three different systems. The one you use will depend on which is more applicable for the situation. The first assignment will get you used to this. The three systems are as follows:

Absolute co-ordinates: Using this method, you enter the points as they relate to the origin of the WCS. To enter a point just enter in the exact point as X,Y.

Relative co-ordinates : This allows you to enter points in relation to the first point you have entered. After you've entered one point, the next would be entered as @ X,Y. This means that AutoCAD will draw a line from the first point to another point X units over and Y units up relative to the previous point.

Polar co-ordinates: You would use this system if you know that you want to draw a line a certain distance at a particular angle. You would enter this as @ D<A. In this case, D is the distance and A is the angle. Example: @10<90 will draw a line 10 units straight up from the first point.

The three ways of entering coordinates shown above are the ONlY way AutoCAD accepts keyboard input. First decide which style you need to use, and then enter as shown. Remember that X is always before Y (alphabetical). Don't forget the '@' symbol when you are entering relative points. Any typing error or omission will give you results you don't want. If you make a mistake and need to see what you typed, Press F2 to bring up the text screen and check your typing. (press F2 to get back to your drawing.)

Key Terms

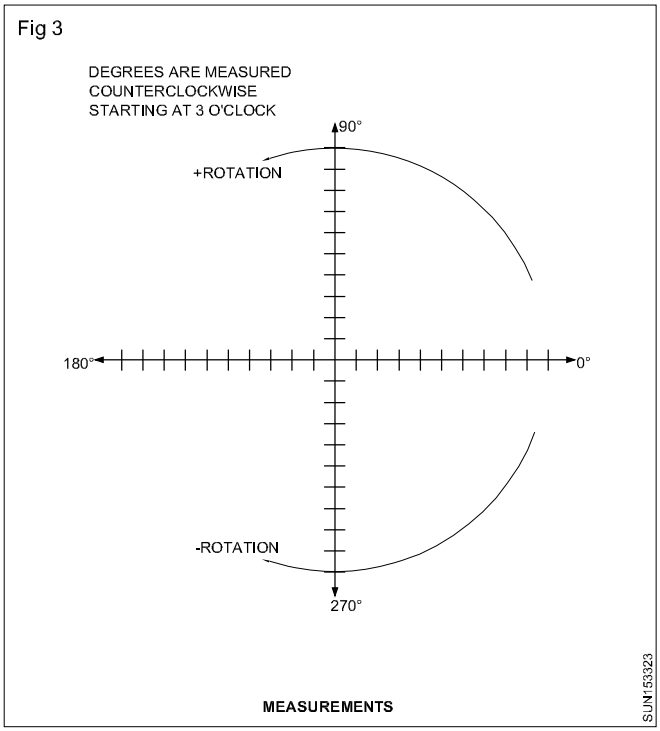
Term	Description
Absolute coordinates	Distance measured from a fixed reference point.
Aperture	Effective diameter of the cursor on the screen.
Cartesian coordinates	A rectangular system of measurement to locate points in the drawing area.
Object snaps	A method for indicating point locations using existing drawing objects as a reference.
Origin point	The 0,0 location of the coordinate system.
Polar coordinates	A system to locate of the coordinate system.
Prototype drawing	A template drawing that has a last location of the cursor.
Relative coordinates	Distance measured from the last location of the cursor
User-defined co-ordinates System	A mode of measurement that allows the user to set up a customized coordinate system.

Angular Measurement

AutoCAD measures angles in a particular way also. Look at the diagram below and then place your mouse on it to see how this is

Degrees are measured counterclockwise starting at 3 O'CLOCK

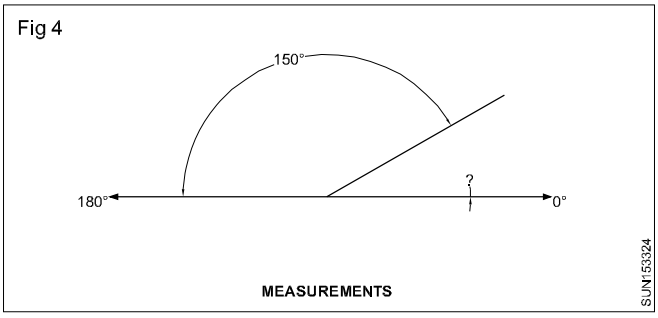
Fig 3



When drawing lines at an angle, you have to begin measuring the angle from 0 degrees, Which is at the 3 O'clock position. If you drew a line at 90 degrees, it would go straight up. The example above (When you move your mouse over it) shows a line drawn at+300 degrees (270+30), or-60 degrees.

You might not always have an obvious reference point for 0 degrees. Look at the example below and place your mouse on the image to find out the angle in question.

Fig 4



In this example, you are given information about the lines, but not the angle AutoCAD needs to draw the line from the start point. What you are given though, is (a) the knowledge that 0°is at the 3 o'clock position (b) the knowledge that180° is at the 9 o'clock position and (c) the angle between 180° and the line you want to draw is 150°. With this information, you can figure out what angle you need. Here is a fool-proof way of getting the angle you need:

1.) Start at the 0° position and measure counter-closkwise (+) to 180°

2.) From 180°, measure clockwise 150°(-)

3.) Consider that you just went+180-150 and use that as an equation:+180-150=30

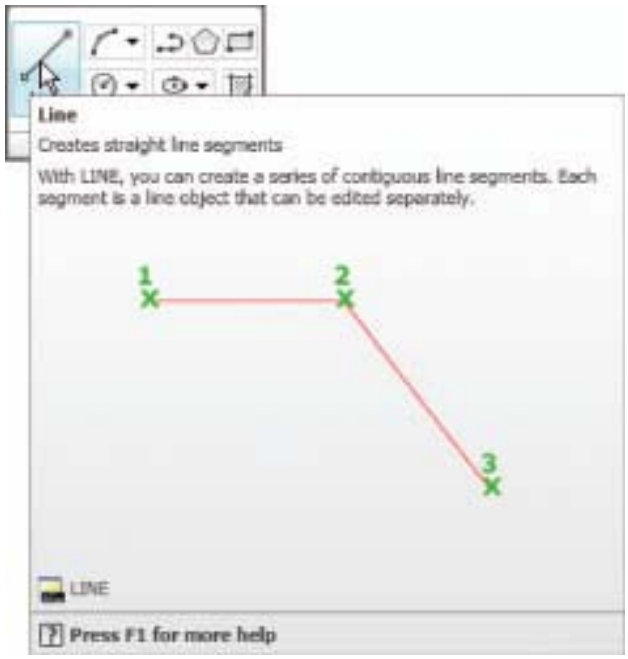
4.) Now you can draw your line using polar coordinates (discussed below)

There are many ways to do things in most windows programs. AutoCAD is no exception. Everyone will develop a way that works best for him or her. In this course, we will primarily be working with the keystroke commands. The reason for this is because they will work in most AutoCAD versions (including DOS versions), and in some other CAD programs. The icons work well, but as you will see, icons can be placed anywhere on the screen and can be difficult to find quickly. You may be working on another employee's computer that is set up differently than what you're used to. The pulldown menus will access almost all commands, but are a slower way of doing things. Icons in AutoCAD 2010 are found on the ribbon, divided into panels-just click on the appropriate tab to open thepanel you need.

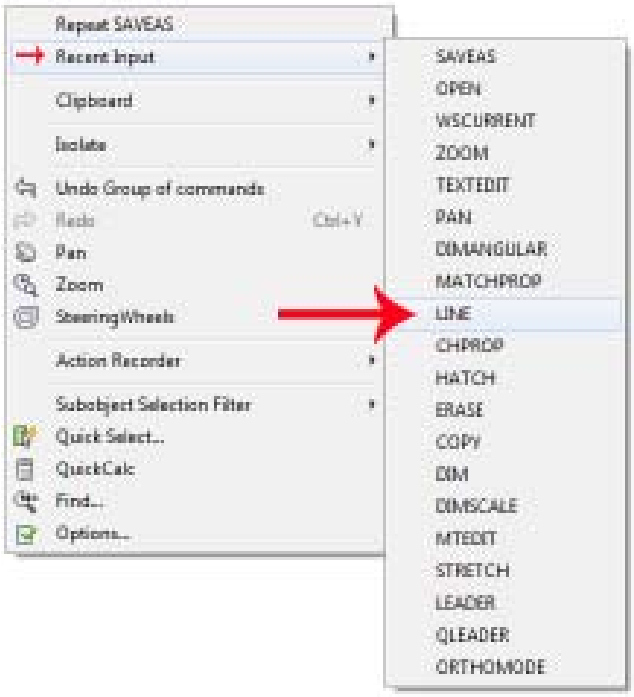
Example: If you want to draw a line, you can do it a few ways:

At the command line type: LINE (or) L and press the ENTER key.

Select the line icon from the DRAW Panel.



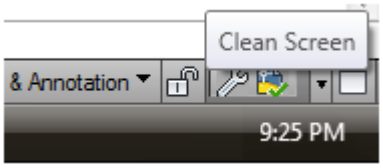
Another way is to Right-Click on the drawing space and choose "Recent Input" from the menu. This will give a list of the most recent command that you have used.



All three approaches will do the same thing: prepare AutoCAD to draw a line where you tell it.

AutoCAD is a popular program because it can be customized to suit an individual's needs. The toolbars are a good example of this. You can have the toolbars you use most often on the screen all the time. You can easily make them go away so that you have more drawing space. You can also customize them so you have the most common commands on one toolbar. For example, the dimensioning toolbar is one that you will not want taking up space on your screen while drawing, but is very handy when you're dimensioning your drawing.

To remove the ribbon and have the most drawing space available, click on the "Clean Screen" icon in the bottom right corner of the screen (or press CTRL+O[letter O]. To go back the to the standard display, click again on the same icon.



Symbol	Command	Purpose
	Erase	Delete object
	Move	Move object one place to other place
	Copy	Create one or more copies of object
	Stretch	Stertch, shorte, or move object
	Trim	Shorten object using other object
	Extend	Lengthen object using object
	Mirror	Creates a mirror image of objects.
	Rotate	Rotate objects around a specified point.
	Offset	Create a new object at a specified distance from an existing object or through a specified point.
	Array	Each object in an array can be manipulated independently.

Auto CAD Drawing Commands

Symbol	Command	Major option	Toolbar button	Draw menu
	Line	Start, End Point	Line	Line
	Mline	Justification, Scale Style	None	Multiline
	Pline	Vertices	Polyline	Polyline
	Polygon	Number of sides, Inscribed / Circumscribed	Polygon	Polygon
	Rectangle	Two Corner	Rectangle	Rectangle
	Arc	Various methods of definition	Arc	Arc, submenu for definition methods
	Circle	Three point, two point, Tangent	Circle	Circle submenu for definition methods
	Donut	Inside, Outside Diameters	None	Donut
	Spline	Convert polyline or Create new	Spline	Spline
	Ellipse	Arc, center, axis	Ellipse	Ellipse, submenu for denifition methods
	Revcloud	Arc Length	Revcloud	Revision cloud

Line Command

Create single straight line segments

1 Choose draw, Line

(or)

2 Click the Line icon. 

(or)

3 Type LINE from the command prompt command: LINE or L

4 Press Enter

5 Pick From point: (point)

6 Pick Specify next point or [Close/Undo]: (point)

7 Pick Specify next point or [Close/Undo]: (point)

8 Press ENTER to end line sequence

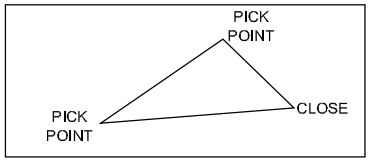
(or)

9 Type U to undo the last segment To point: U (undo)

(or)

10 Type C to create a closed polygon To point: C (close)

Fig 5



SUN153325

LINE COMMAND

Erase and Selection Sets

Erasing Objects

1 Choose Modify, Erase

Or

2 Click The Erase icon 

Or

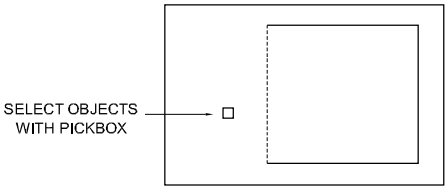
3 Type ERASE at the command prompt.
Command: ERASE or E

4 Pick Object at the select object prompt.

5 Press ENTER when you are done choos ing objects.

Select objects: ENTER

Fig 6



SUN153326

ERASE COMMAND

Basic commands - I

Objectives : At the end of this exercise, you shall be able to

- **circle, arch**
- **ellipse, polygon**

Introduction

AutoCAD allows you to have across to a large number of commands; a general rule is that you use 20% of the commands 80% of the time. I will start by introducing you to the most common drawing commands. When you combine these with the basic modify commands, you will be able to make elaborate drawings quite quickly. In other words, most of the commands you will use while using AutoCAD.

The important thing to remember is that AutoCAD will expect you give it information in a very particular order. The most frustrating thing when you begin using this program is that you will try to do something, but AutoCAD will not work. In most cases, it means that you are trying to input information at the wrong time. This is why it is very important to be in the habit of looking at the command line.

The command line tells you what information AutoCAD requires to continue.

Your first drawing alignment will be to use the drawing commands in conjunction with the co-ordinate system it is very important to understand how to give the program accurate information. You will use the following commands.

Drawing Arcs and Circles

CADD provides many ways to draw arcs and circles. There are a number of advanced techniques available for drawing arcs and circles, which can simplify many geometrical drawing problems. You can draw an arc by specifying circumference and radius, radius and rotation angle, chord length and radius, etc.

Circles

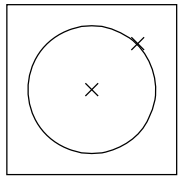
Circle Command

1	Choose	Draw, Circle.
		Or
2	Click	the Circle icon.
		Or
3	Type	CIRCLE at the command prompt.
4	Type	One of the following options:
		3P/2P/TTR/<<center point>>:
		Or
5	Pick	A center point
6	Type	A radius or diameter.
		Or
7	Pick	A radius or diameter
		Diameter/<<radius>>:

TIPS

- To create circles that are the same size, press ENTER when asked for the circle radius.
- When selecting a circle with a pick box, be sure to select the circumference of the circle.

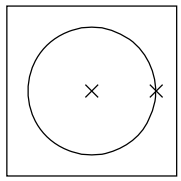
Fig 1



CIRCLE COMMAND

SUN153331

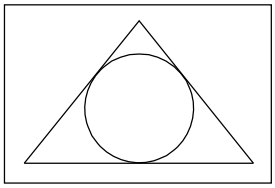
Fig 2



CIRCLE COMMAND

SUN153332

Fig 4



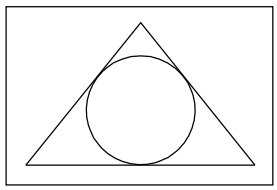
CIRCLE COMMAND

SUN153334

Arc Command

1	Choose	Draw, Arc.
		Or
2	Click	the Arc icon.
		Or
3	Type	ARC at the command prompt Command: ARC
4	Draw	One of the arcs.

Fig 4

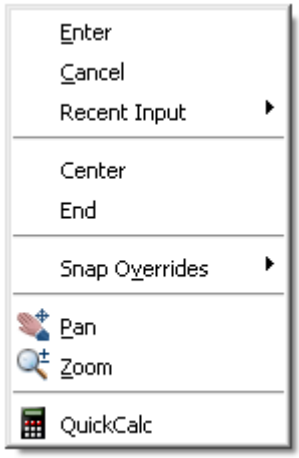


CIRCLE COMMAND

SUN153334

TIPS

- Except for 3 point arcs, arcs are drawn in a COUNTERCLOCKWISE direction.
- While in the arc command, press the right mouse button to select the following options for arcs:



Arc Examples

3 point arc

Start, centre, chord length

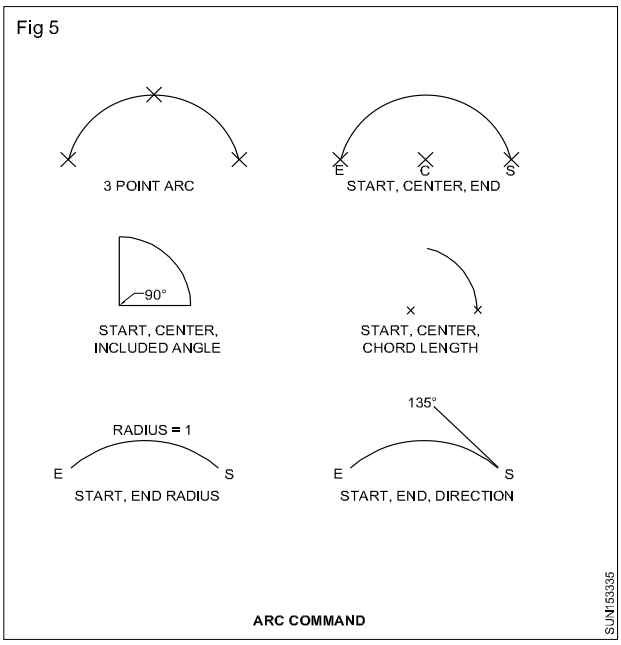
Start, centre, end

Start, end, radius

Start, centre, included angle

Start, end direction

Fig 5



ARC COMMAND

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Drawing Ellipses and Elliptical Arcs

Ellipses are much easier to draw with CADD than on a drawing board. On a drawing board, you need to find the right size template or draw a series of arcs individually to draw an ellipse. With CADD, all you need to do is specify the size of the ellipse.

The following are two basic methods for drawing ellipses:

- Length and width
- Axis and rotation angle

Ellipse

Creates an ellipse or an elliptical arc;

1 **Choose** Draw, Ellipse.

Or

2 **Choose** the Ellipse or Partial Ellipse icon

Or 

3 **Type** ELLIPSE at the command prompt

Command: ELLIPSE

4 Type One of the following options:

Arc/Center/Isocircle/<Axis endpoint1>:

Ellipse options

Axis endpoint 1: Defines the first axis by two specified endpoints. The angle of the first axis determines the angle of the ellipse. The first axis can define either the major or the minor axis of the ellipse.

Axis endpoint 2: <Other axis distance>/Rotation: Specify a point or enter a distance

Arc : Creates an elliptical arc. The angle of the first axis determines the angle of the elliptical arc. The first axis can define either the major or the minor axis of the elliptical arc.

Center : Creates the ellipse by a specified center point.

Isocircle : Creates an isometric circle in the current isometric drawing plane.

Rotation : The major axis is now treated as the diameter of a circle that will be rotated a specified amount around the axis. You enter an angle between 0 and 89.4 degrees.

Polygon

1 Choose Draw, Polygon. 

Or

2 Click The polygonicon.

Or

3 Type Polygon at the command prompt.

Command: POLYGON

4 Type The number of sides for the polygon (31024)

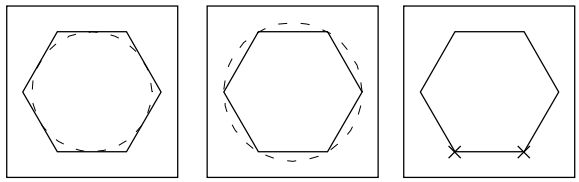
5 Pick The center of the polygon.Edge/ <Center of Polygon>: pick

Or

6 Type E to define the polygon by two edges.

7 Type I or C to place the polygon inside or outside of an imaginary circle.Inscribed in circle/ Circumscribed about circle (IC):

Fig 6



POLYGON COMMAND

SUN 53336

Basic commands - II

Objectives : At the end of this exercise, you shall be able to

- **express move, copy, offset, rotate, trim, on, fillet, array, straiten, lengthen**

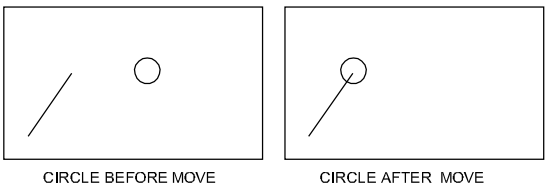
The previous lesson dealt with drawing commands. This lesson will introduce some common modifying commands. In AutoCAD, you may actually use modifying commands more often than drawing commands. Now that you know the basics, here's some more commands to add to your collection. Three commands, Trim, Extend and Offset are used often in 2D AutoCAD work.

Command	Keystroke	Location	Result
Rectangle	RECTANGLE/ REC	Home>Draw>Rectangle	Draws a rectangle after you enter one corner and then the second.
Trim	TRIM/TR	Home>Modify>Trim	Trims objects to a selected cutting edge.
Extend	EXTEND/EX	Home>Modify>Extend	Extends objects to a selected boundary edge.
Offset	OFFSET/O	Home>Modify>Offset	Offsets an object (parallel) by a set distance.
Object snaps	OSNAP/OS/F3	Tools>Object Snap Settings	Brings up the OSNAP dialog box.
Move	Move/M	Home>Modify>Move	Moves an object or objects
Copy	Copy/CP	Home>Modify>Copy	Copies object(s) once or multiple times
Stretch	Stretch/S	Home>Modify>Stretch	Stretches an object after you have selected a portion of it
Mirror	Mirror/MI	Home>Modify>Mirror	Creates a mirror image of an object or selection set
Rotate	Rotate/RO	Home>Modify>Rotate	Rotates objects to a certain angle.
Fillet	Fillet/F	Home>Modify>Fillet	Creates a round corner between two lines
Chamfer	Chamfer/CHA	Home>Modify>Chamfer	Creates an angled corner between two lines
Array	Array/AR	Home>Modify>Array	Creates a repeating pattern of the selected objects

Move Command

1	Choose	Modify, Move. Or
2	Click	The Move icon or 
3	Type	MOVE at the command prompt com mand: MOVE or M
4	Pick	Objects to move Select objects: (se lect)
5	Pick	A point to move from Base point or displacement: (pick point)
6	Pick	A point to move to second point of dis placement: (pick point)

Fig 1



TIP

To move an object a specified distance, type a distance at the second point of displacement prompt:@1<0

Moving Drawing Objects

CAD drawing allows you to move drawing objects within a drawing in a convenient manner. Unlike on a drawing board, you don't need to first erase and then redraw in a new place. You can simply rearrange the existing drawing objects, as you like. This is a very useful tool for analyzing design alternatives and making quick adjustments to drawings.

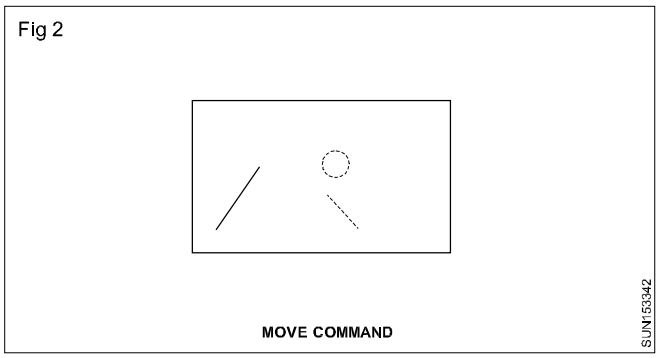
Previous Selection

Places selected objects in the previous selection set

1	Choose	Modify, Move.
		Or
2	Click	the Move icon.
		Or
3	Type	MOVE at the command prompt.
		Command: MOVE or M
4	Pick	Objects to move.
		Select objects :(P)

Previous Selection set Highlighted

Fig 2



TIP

AutoCAD requires that objects be selected in order to be processed. The Select Objects prompt occurs after many commands, including the SELECT command itself.

Copying Drawing Objects

CAD drawing allows you to make quick and easy copies of existing drawing objects. You can copy individual drawing objects or the entire drawing all at once. You can even make multiple copies of drawing objects within seconds.

Using the copy function is quite similar to the way the move function is used. First, you need to select objects using any of the methods described earlier. Then you need to indicate a base point and a relocation (or destination) point. The copied objects are placed according to the relocation point.

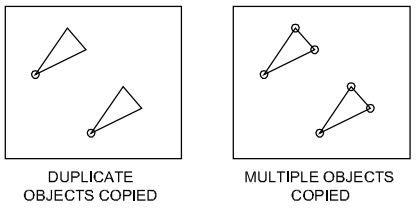
Making Multiple Copies in a Rectangular Fashion

There are separate functions available in CADD that allow you to make multiple copies in a linear or rectangular fashion (commonly known as a rectangular array). You can make hundreds of copies within seconds. You don't need to enter a base point and a destination point. You just need to select the objects, specify how many rows and columns you need and the distance between them.

Copy Command

1	Choose	Modify, copy.
		Or
2	Click	the Copy icon 
		Or
3	Type	COPY at the command prompt.
4	Pick	Objects to copy.
		Select objects: (select)
5	Pick	A point to move from.
		Base point or displacement /Multiple: (pick point).
6	Pick	A point to copy to.
		Second point of displacement: (Pick point)
		Or
7	Type	A point to copy to.
		Second point of displacement: @1<0

Fig 3



COPY COMMAND

SUN153343

TIP

To copy many objects in the same copy command, type M for Multiple at the "Base point or displacement/Multiple" option.

Offset Command

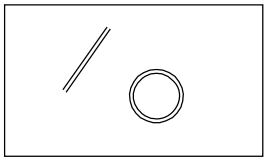
Offset Distance

To offset a specified distance:

1	Choose	Modify, Offset. Or
2	Choose	the Offset icon.  Or
3	Type	OFFSET at the command prompt. Command: OFFSET or O
4	Type	The distance to offset. Offset distance or <Through point>: (number)
5	Pick	The object to offset. Select object to offset: (select object)
6	Pick	A side to offset object to. Side to offset: (pick side)
7	Pick	Another object to offset Select object to offset: (Pick side) Or
8	Press	Enter to end the command.

Offsetting objects by specifying a distance

Fig 4



OFFSET COMMAND

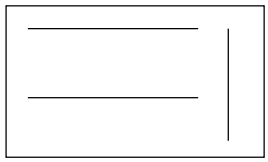
SUN153344

Offset Through Point

To offset through point

1	Type	OFFSET at the command prompt Command: OFFSET
2	Type	T to specify a through point Offset distance or <Through point>: (T)
3	Pick	A point to offset through (HINT: use object snaps) Select object to offset: (pick) through point: (select object)

Fig 5



OFFSET COMMAND

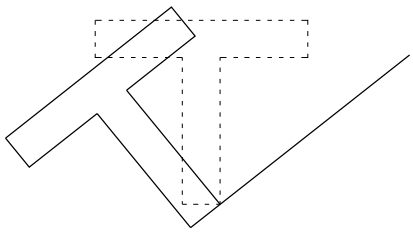
SUN153345

Offset through a point

Rotate command

1	Choose	Modify, Rotate Or
2	Click	the Modify icon.  Or
3	Type	ROTATE at the command prompt Command: ROTATE
4	Pick	Objects to rotate: Select objects: (select)
5	Pick	A pivot point to rotate around Base point: (point)
6	Type	A rotation angle<Rotation angle>/Reference: (number) Or
7	Pick	A rotation angle<Rotation angle>/Reference: (point)

Fig 6



ROTATE COMMAND

SUN153346

Rotating the Drawings

CAD drawing allows you to rotate selected drawing objects to a specified angle. To rotate, you need to select the drawing objects, enter a reference point (or base point) and the rotation angle. The base point acts as a pivot point around which the objects are rotated. The rotation angle determines by how much the objects will be rotated and in which direction.

Reference Angle Rotation

A positive angle causes counterclockwise rotation, and a negative angle produces clockwise rotation. If you respond to the last prompt with r, you can specify the current rotation and the new rotation you want. AutoCAD prompts

1	Type	R for a rotation angle<Rotation angle>/ Reference: (R)
2	Choose	An existing rotation angle Rotation angle: (number or points)
3	Choose	A new rotation angle New angle: (number or points)

TIP

You can show AutoCAD the reference angle (by pointing to the two endpoints of a line to be rotated), and then specify the new angle. You can specify the new angle by pointing or by dragging the object.

Trim

The TRIM command allows you to trim objects in a drawing so they end precisely at a cutting edge defined by one or more other objects in the drawing.

1	Choose	Modify, Trim 
		Or
2	Click	the Trim icon.
		Or
3	Type	Trim at the command prompt
		Command: Trim
		Select cutting edge(s)
4	Pick	The CUTTING edge to extend to
		Select objects: (select)
5	Press	Enter to accept the cutting edge
		Select objects: (press enter)
6	Pick	Objects to trim
		<Select object to trim>/Project/Edge/ Undo:
		Select an object, enter an option, press enter
7	Press	ENTER when youare done choosing objects
		Select object to trim/Undo: (press enter)

Fig 7

TRIM COMMAND

SUNT53347

TIP : Hold the SHIFT key to interactively extend instead of trim.

Cutting drawing objects along an edge

CADD allows you to erase drawing objects along a selected edge (this technique is often called trimming).When you use this function, you are prompted to select the drawing object that is to be used as the cutting edge and then select the objectgs that are to be erased along that edge.

Making Sharp and Rounded Corners

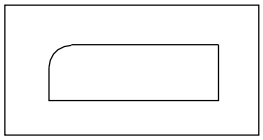
CADD allows you to make fine corners of any two lines or arcs. This technique, often called filleting, is the quickest way to join the missing corners of lines and arcs. With this function active, to make a corner all you need to do is select the lines or arcs that have missing corners. CADD automatically extends or shortens the selected objects to form a corner. You can also specify whether you want a sharp corner or a rounded corner.

Fillet

1	Choose	Modify, Fillet. 
		Or
2	Click	the fillet icon.
		Or
3	Type	FILLET at the command prompt. Command: FILLET
4	Pick	First object to fillet. Polyline/Radius/ Trim<Select two objects>: Select first object.
5	Pick	Second object to fillet.
		Select second object: select second object.
		Or
6	Type	One of the following options:

P	Fillets a nentire Polyline
R	Sets the filletradius.
T	Sets the trimmode (trim cuts the fillet corner and no trim keeps the fillet cor ner).

Fig 8



FILLET COMMAND

SUNT53348

TIP

You can also fillet PARALLEL lines as well as PLINES with LINES

Type a radius of Zero (0) to create a clean 90 degree corner.

Chamfer

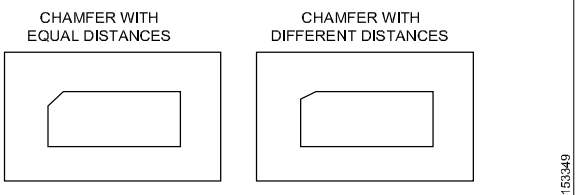
1	Choose	Modify, Chamfer. 
		Or
2	Click	the Chamfer icon.
		Or
3	Type	CHAMFER at the command prompt.
		Command: CHAMFER
4	Pick	First object to chamfer. Polyline/ Distance/Angle/Trim/ Method<Select first line>: select first object.
5	Pick	Second object to chamfer.
		Select second object: select second object.
		Or
6	Type	One of the following options:

P	Chamfers entire Polyline.
D	Sets chamfer distances.
A	Uses a distance and angle method in stead of two distances.
T	Sets the trim mode
M	Sets the method to distance or angle.

Chamfer with equal distances

Chamfer with different distances

Fig 9



CHAMFER COMMAND

Making Chamfered Corners

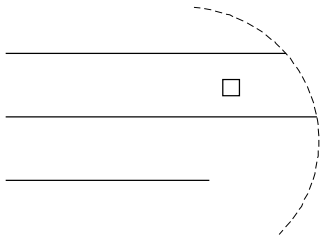
CADD allows you to make a chamfered corner between two lines. It works quite like the fillet command. When you enter the chamfer command, you are prompted to select the lines that are to be chamfered and enter a chamfer distance. The chamfer distance determines the size of the chamfer.

Extend command

1	Choose	Modify, Extend, 
		Or
2	Click	the extend icon.
		Or
3	Type	EXTEND at the command prompt command: EXTEND
		Select boundary edge (s)...
4	Pick	The BOUNDARY edge to extend to select objects: (select)
5	Press	ENTR to accept the boundary edge select objects: (press enter)
6	Pick	The object to extend
		<Select object to extend> / Project/ Edge/ Undo: Select an object, enter an option, or press enter: (select)
7	Press	ENTER when you are done choos ing objects

Lines Extended to an Arc (Arc is boundary edge)

Fig 10



EXTEND COMMAND

TIP

- use the object selection option FENCE to choose multiple objects

Extending Drawing Objects to an Edge

CADD allows you to extend lines to a selected drawing object. Often you need to extend lines to construct a drawing and to fix any graphical errors. To extend lines, you need to select an edge to which the lines should extend and then select the lines to be extended.

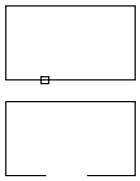
Dividing an Object into Equal Parts

CADD allows you place dividing marks on a drawing object such as a line, arc, ellipse or spline. To use this command, you need to select an object and specify how many divisions are required. This function places markers at equal distances on the drawing object.

Break

1	Choose	Modify, Break. 
		Or
2	Click	the Break icon.
		Or
3	Type	BREAK at the command prompt. Command: BREAK
4	Pick	Object to break.
		Select object: (select one object)
5	Pick	A second break point. Enter second point: (point)
6	Type	F to choose a different break point Enter second point (or F for first point): (F)

Fig 11

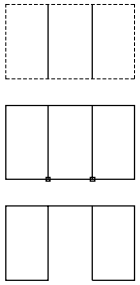


BREAK COMMAND

SUN15334B

7	Pick	The first break point on the object
		Enter first point: (point)
8	Pick	A second break point

Fig 12



BREAK COMMAND

SUN15334C

TIP:

You can also type coordinates instead of picking a break point. Enter second point (or F for first point): @3'<0

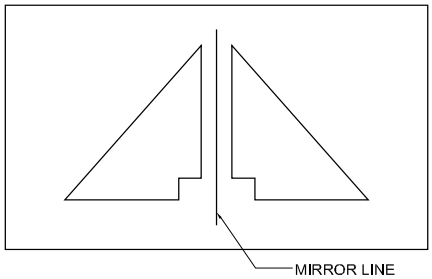
If you break a circle, it changes to an arc by deleting the portion from the first point to the second, going counter-clockwise.

Breaking a polyline with nonzero width will cause the ends to be cut square.

Mirror command

1	Choose	Modify, Mirror. 
		Or
2	Click	the Mirror icon
		Or
3	Type	MIRROR at the command prompt.
		Command: MIRROR
4	Pick	Objects to mirror. Select objects: (Se lect)
5	Pick	First point of mirror line: (point)
6	Pick	Second point: (Point)
7	Type	Yes to delete the original objects and No to keep them.
		Delete old objects? Y or N

Fig 13



MIRROR COMMAND

SUN15334D

Mirroring Drawings

CADD allows you to create mirror images of drawings. This capability is very useful when you want to draw something that is symmetrical on both sides. You need to draw only one half of the drawing; the rest of the drawing can be completed using the mirror function. To make a mirror image, you need to select the objects to be mirrored and indicate a mirror axis. The mirror axis is an imaginary line along which the diagram is mirrored.

Array commands

Rectangular Array

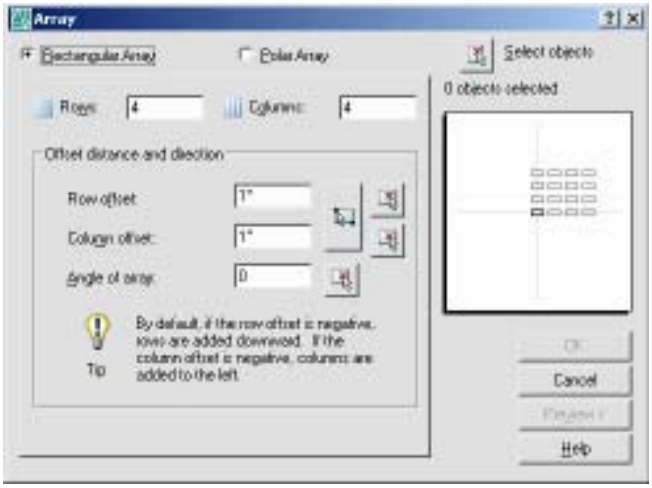
To draw rectangular array:

1	Choose	Modify, Array.
		Or
2	Click	the Array icon. 
		Or
3	Type	ARRAY at the command prompt. Command: ARRAY Objects to array. Select
4	Pick	Objects to array. Select
		Objects: (select)
5	Type	The number of rows top to bottom. Number of rows (----) <1>: (number)
6	Type	The number of columns left to right. Number of columns (III) <1>:(num ber)

7 Type The unit cell distance between items in each row. Distance between rows: (+number=up, number = down)

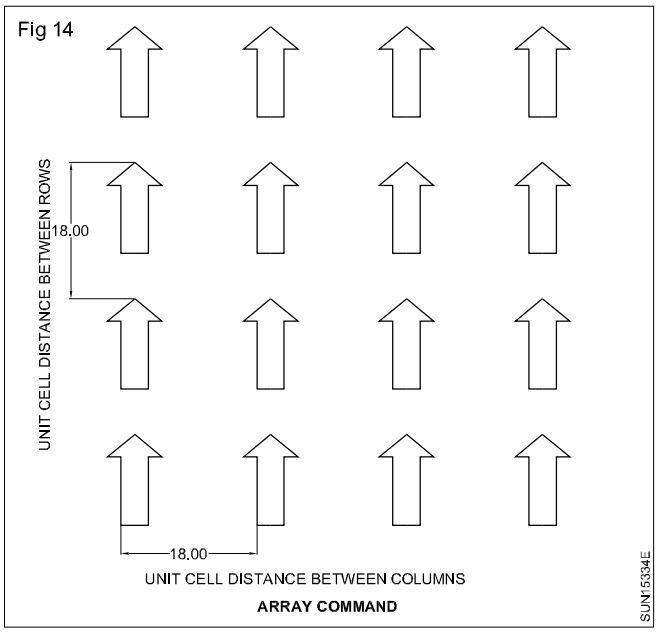
8 Type The unit cell distance between items in each column.

Distance between columns: (+ number = right, -number = left)



Creating an Array of objects

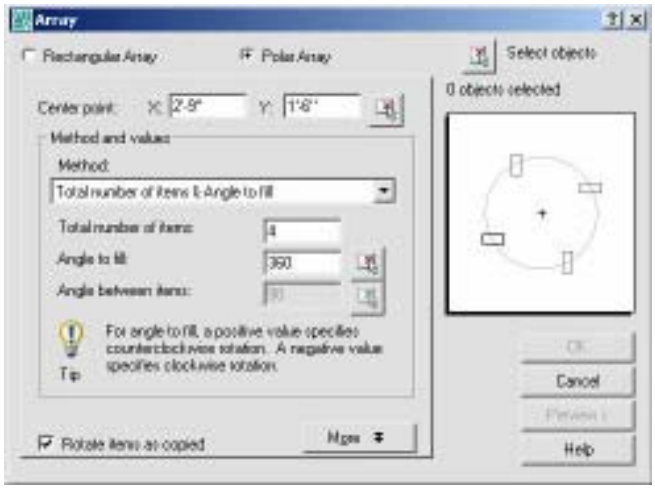
The array command in AutoCAD is used to make multiple copies of objects. Although you can use the copy command to duplicate objects, the array command is more flexible and precise. One advantage of using the array command is that it allows you to copy objects in a defined angle and exact number of copies. Therefore, you can create array in various pattern. For example, you can show multiple objects in a row, column, or irregular pattern such as a spiral. Let's look at a few examples below:

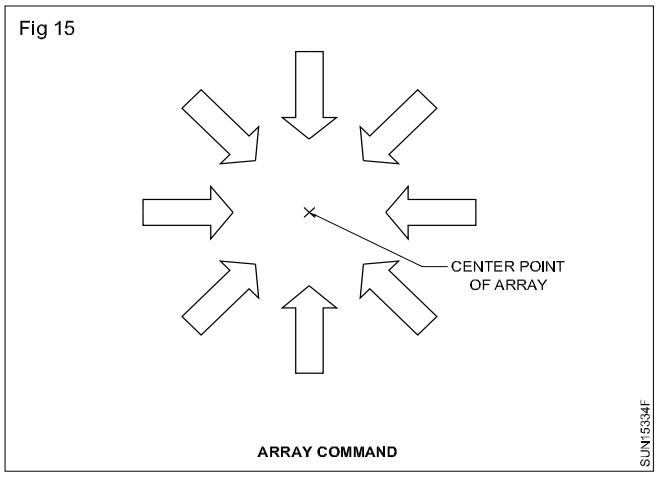


Polar Array

To draw a polar array:

1 Choose Modify, ARRAY.
Or
2 Click The Array icon. Or
3 Type ARRAY at the command prompt. Com mand: ARRAY
4 Pick Objects to array. Select Objects: (select)
5 Type P to draw a polar array. Rectangular or Polar array (R/P):P
6 Pick A center point for the array. Center point of array. Pick point
7 Type The TOTAL number of items in the ar ray. Number of items: number
8 Type The number of degrees to rotate the objects. Degrees to fill (+=CCW, -+CW) <360>:
Number
9 Type Yes No to rotate objects. Rotate objects as they are copied? <y> Y or N

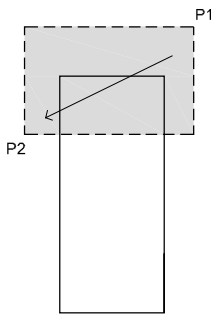




Stretch

1	Choose	Modify, stretch
		Or
2	Click	the stretch icon.
3	Type	STRETCH at the command prompt. Command: STRETCH Select objects to stretch by window.
4	Type	C to choose CROSSING window Select objects: C
5	Pick	A first corner to stretch. First corner: (point)
6	Pick	The opposite corner to window the ob jects to stretch.
		Other corner: (point)
7	Press	ENTER to accept objects to stretch
8	Pick	A base point to stretch from Base point: (point)

Fig 16



STRETCH COMMAND

SUN15334G

Stretching Diagrams

CADD allows you to quickly change the size of diagrams by stretching lines, arcs, splines, etc. This function is very helpful to make quick alterations to drawings. To use the stretch function, you need to select the drawing objects to be stretched and specify the distance and direction of stretching.

9	Pick	A point to stretch to New point: (point)
10	Type	A distance to stretch. New point: @ 1<0

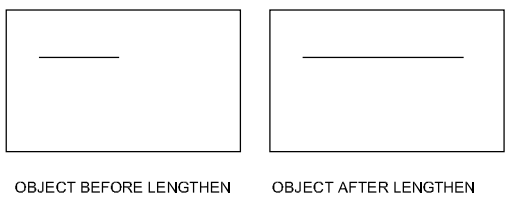
TIP

The Stretch command must use a CROSSING window or a CROSSING POLYGON window.

Lengthen

1	Choose	Modify, LENGTHEN.
		Or
2	Type	LENGTHEN at the command prompt. Command:_ lengthen
		Select an object or [DElta/Percent/Total/ Enter delta length or [Angle]<0.0000>:2
		Select an object to change or [Undo]: pick object
		Object before lengthen Object after lengthen

Fig 17



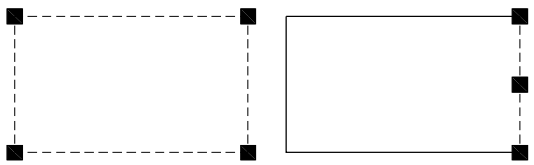
LENGTHEN COMMAND

SUN15334H

Explode Command

1	Choose	Modify, Explode.
		Or
2	Pick	the explode icon.
3	Type	EXPLODE at the command prompt.
		Command: EXPLODE
		Or
4	Pick	The object to explode. Select objects: (pick)

Fig 18



EXPLODE COMMAND

SUN15334I

4.3 OOPS commands

Reinserts the last erased set of objects or block even if it was not the last command issued. Otherwise Oops acts like UNDO.

1	Type	OOPS at the command prompt to rein sert erased objects
		Command: OOPS

Other CAD commands

Objectives : At the end of this exercise, you shall be able to

- **points, rectangle, poliline, spline, multilines, construction line**
- **adding patterns to drawings.**

Introduction

Drawing Multiple Parallel Lines

CADD allows you draw parallel lines simultaneously just by indicating a starting point and an end point. These lines can be used to draw something with heavy lines or double lines. For example, they can be used to draw the walls of a building plan, roads of a site map, or for any other presentation that requires parallel lines.

Most programs allow you to define a style for multiple parallel lines. You can specify how many parallel lines you need, at what distance and if they are to be filled with a pattern or solid fill.

A number of add-on programs use multiple lines to represent specific drawing features. For example, an architectural program has a special function called "wall". When you use this option, it automatically draws parallel lines representing walls or specified style and thickness.

Drawing Flexible Curves

CADD allows you to draw flexible curves (often called splines) that can be used to draw almost any shape. They can be used to create the smooth curves of a sculpture, contours of a landscape plan or roads and boundaries of a map.

To draw a flexible curve, you need to indicate the points through which the curve will pass. A uniform curve is drawn passing through the indicated points. The sharpness of the curves, the roughness of the lines and the thickness can be controlled through the use of related commands.

Adding Hatch Patterns to Drawings

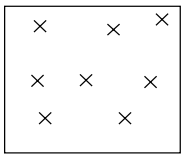
The look of CADD drawings can be enhanced with the hatch patterns available in CADD. The patterns can be used to emphasize portions of the drawing and to represent various materials, finishes, and spaces. Several ready-made patterns are available in CADD that can be instantly added to drawings.

Hatch patterns are quite easy to draw. You don't need to draw each element of a pattern one by one. You just need to specify an area where the pattern is to be drawn by selecting all the drawing objects that surround the area. The selected objects must enclose the area completely, like a closed polygon. When the area is enclosed, a list of available patterns is displayed. Select a pattern, and the specified area is filled.

Point Command

1 Choose Draw, Point, Single or Multiple Point
Or
2 Click the Point icon
Or
3 Type POINT at the command prompt
Command: POINT
4 Pick A point on the drawing

Fig 1



POINT COMMAND

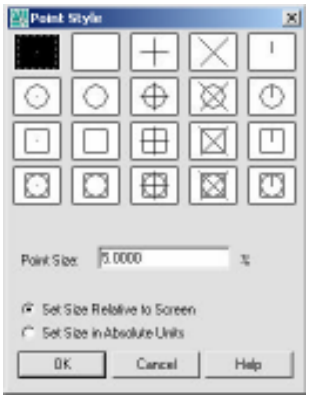
SUN153351

Point (point)

Point Styles 21.1

Changes the appearance of points and point sizes.

1 Choose Format, Point Style...
Or
2 Type DDPTYPE at the command prompt.
Command: DDPTYPE

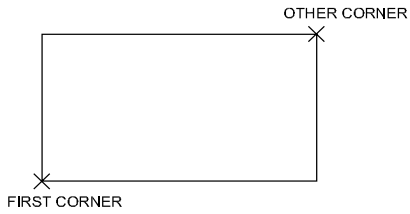


Rectangle 2

1 Choose Draw, Rectangle.
Or
2 Click the Rectangle icon
Or

3	Type	Rectangle at the command prompt Com mand: RECTANG chamfer/Elevation/ Fillet/Thickness/Width/<First corner>
4	Pick	first corner
5	Pick	other corner or type coordinates (i.e. @ 4,2)

Fig 2



RECTANGLE COMMAND

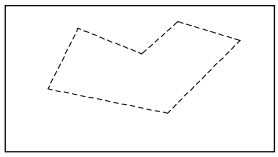
SUN153352

Pline Command

A polyline is a connected sequence of line segments created as a single object. You can create straight line segments, arc segments, or a combination of the two.

1	Choose	Draw, Polyline. Or
2	Pick	the Pline icon.
3	Type	PLINE at the command prompt Com mand: PLINE or PL
4	Pick	A Point on the drawing to start the polyline Form point: (select)
5	Type	One of the following options Arc/Close/ Halfwidth/Length/Undo/Width/<endpoint of line>: Or
6	Pick	A point to continue drawing Arc/Close/ Halfwidth/Length/Undo/Width/<endpoint of line>: (pick point)

Fig 3



PLINE

SUN153353

PLINE options:

Arc : Toggles to arc mode and you receive the following: Angle/CEnter/CLose/Direction/Halfwidth/Line/Radius/ Second Pt/Undo/Width/<enter of arc>:

Close : Closes a polyline as it does in the line command.

Halfwidth : Specifies the halfwidth of the next polyline segments. Can be tapered.

Length : Specifies the length to be added to the polyline in the current direction.

Undo : Undoes the previous pline segment as with the line command.

Width : Specifies the width of the next polyline segments. Can be tapered.

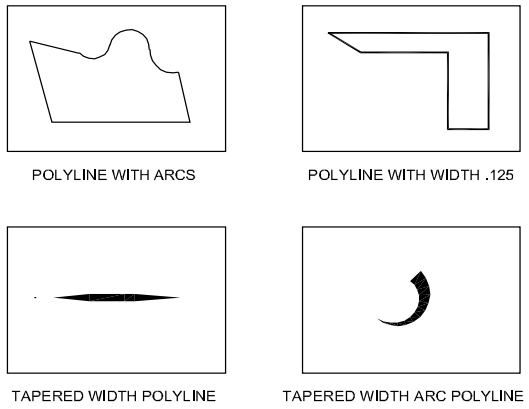
Polyline with arcs

Polyline with width 125

Tapered width polyling

Tapered width arc polyline

Fig 4



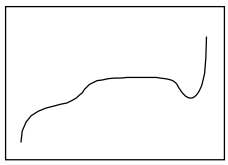
PLINE

SUN153354

Convert PLINE to Spline

1	Draw	A PLINE.
2	Type	PEDIT to edit the polyline as a spline.
3	Choose	Draw, Spline
4	Type	Object at the command prompt.
5	Click	Once on the polyline to turn it into a spline.

Fig 5



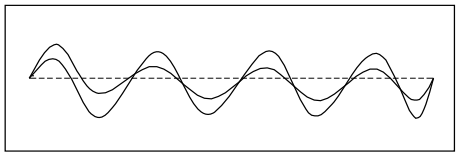
PLINE TO SPLINE

SUN153355

Spline

The SPLINE command creates a particular type of spline known as a non uniform rational B-spline (NURBS) curve. A NURBS curve produces a smooth curve between control points.

Fig 6



SPLINE

SUN153356

1. Choose Draws, Spline.

Or

2. Click the Spline icon

Or

3. Type SPLINE at the command prompt Command: SPLINE

4. Pick A start point for the spline Object /<Enter first point> (pick point)

5. Pick Points until you are done drawing splines Enter point: (pick points)

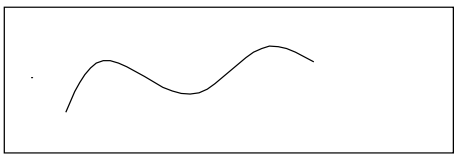
6. Press Enter or close to complete the spline

7. Pick Starting tangent point for the spline Enter start tangent (pick point)

8. Pick Ending tangent point for the spline

Enter end tangent: (pick point)

Fig 7



SPLINE

SUN153357

Spline options

Object Convers 2D or 3D spline-fit polylines to equivalent Splines

Points Points that defines the spline

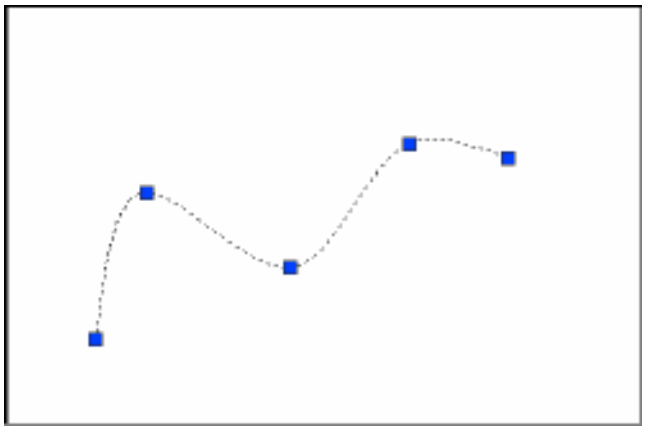
Close Closes a spline

Fit Tolerance Allows you to set a tolerance value that creates a smooth spline.

TIP: Refer to AutoCAD online help topic for more information on spline options.

Editing Splines

1. Choose Modify, Object, Spline.



TIP:

Drawings containing splines use less memory and disk space than those containing spline-fit polylines of similar shape.

Multilines1

MLINE Command

1. Choose Draw, Multiline.

Or

2. Type MLINE at the command prompt Command: MLINE

3. Pick A point to start the multiline.

Justification/Scale/Style/<From point>: pick point

4. Pick A second point to continue the multiline. <To point>: Pick point

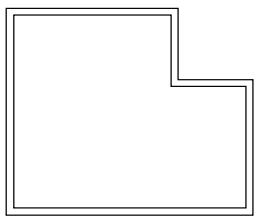
5. Pick The next point to continue drawing Multilines. Undo/<To point>: pick point

6. Press ENTER to end the multiline

Close/Undo/<To point>: press enter or

7. Type C to close the multiline back to the first point. Close/Undo/<To point:C

Fig 8



MULTILINES

SUN153358

Multiline Styles

1. Choose Format, Multiline Style..

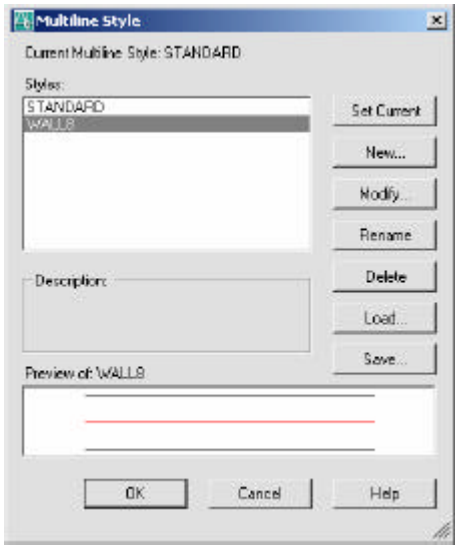
2. Type MLSTYLE at the command prompt.

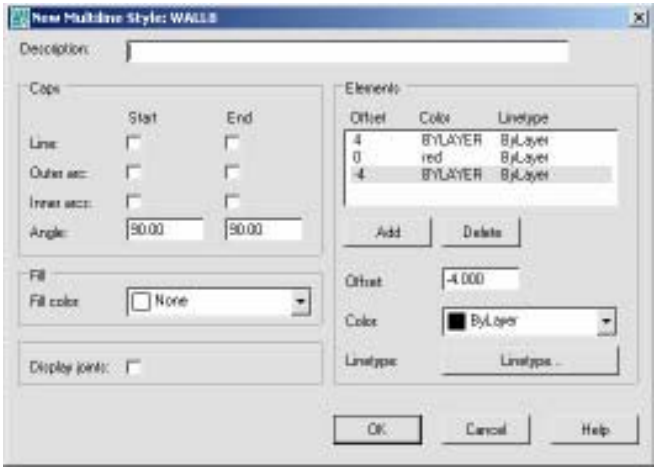
   Command: MLSTYLE

3. Rename The existing style called STANDARD to your new style.

4. Choose Element Properties to change the ap pearance of the Multilines.

5. Choose ADD to create the new multiline.





Editing Multilines 1

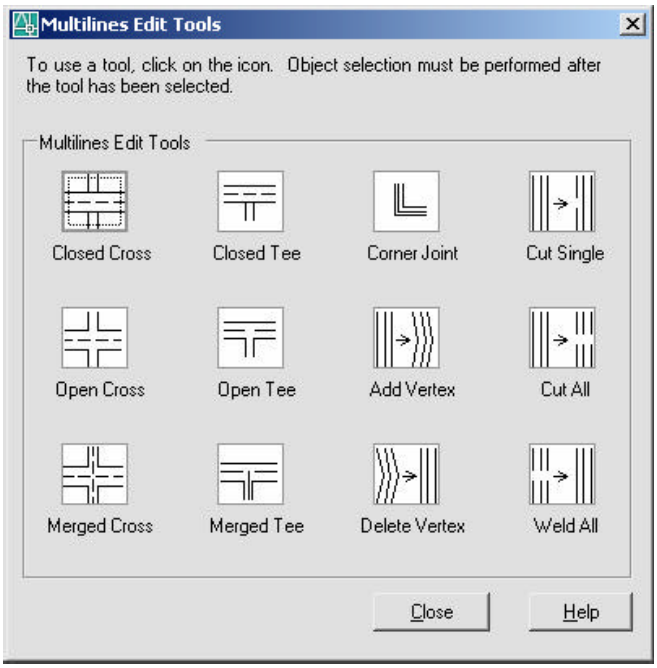
1. Choose Modify, Multiline...

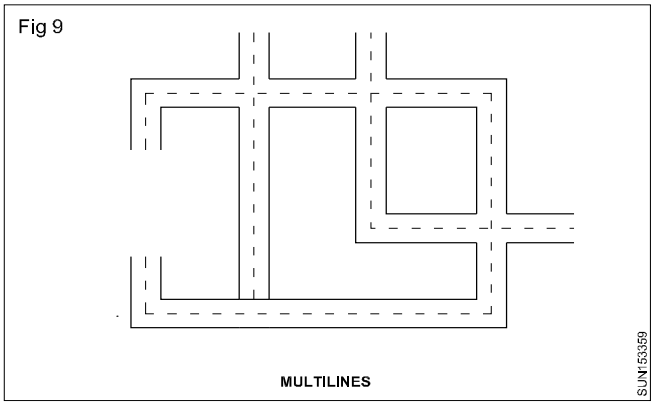
   Or

2. Type MLEDIT at the command prompt

   Command: MLEDIT

3. Choose from one of the mledit options:





Construction Line

Creates an infinite line.

1. Choose Draw, Construction Line

   Or

2. Choose the XLINE icon.

   Or

3. Type XLINE at the command prompt. Com mand: XLINE

Specify a point or [Hor/Ver/Ang/Bisect/Offset]:

XLINE Options

HOR Creates a horizontal xline passing through a specified point

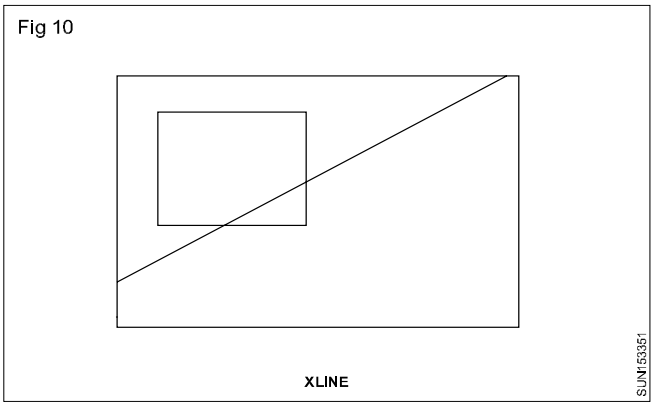
VER Creates a vertical xline passing through a specified point

ANG Creates an xline at a specified angle.

BISECT Creates an xline that passes through the selected angle vertex and bisects the angle between the first and second line

OFFSET Creates an xline parallel to another object.

Fig 10



Ray Command

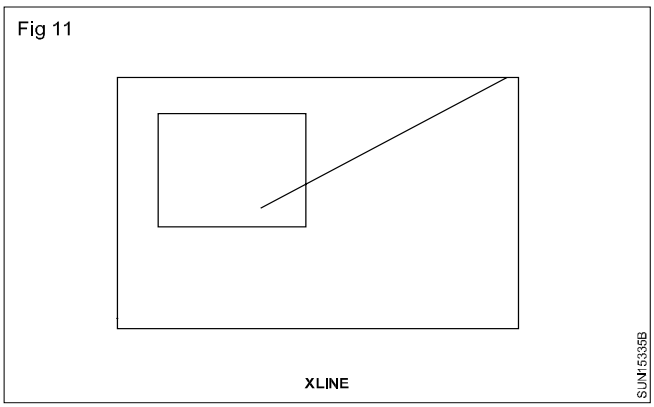
Creates an infinite line in one direction

1. Choose Draw, RAY

   Or

2. Type RAY at the command prompt. Com mand: RAY Specify a point: (pick through point)

Fig 11



BHATCH Command

1. Choose Draw, Hatch...

   Or

2. Click the Hatch icon.

   Or

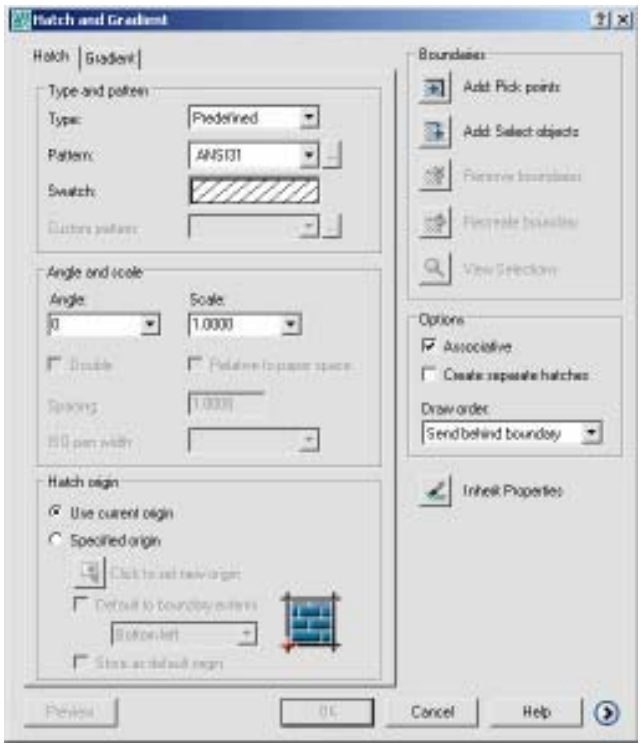
3. Type BHATCH at the command prompt Com mand: BHATCH

BHATCH options

Pattern Type: Sets the current pattern type by using AutoCAD's Predefined patterns or user defined patterns.

Pattern Properties: Sets the current pattern, scale, angle, and spacing, Controls if hatch is double spaced or exploded.

Pick Points: Constructs a boundary from existing objects that form an enclosed area.



Select Objects: Selects specific objects for hatching. The Boundary Hatch dialog box disappears and AutoCAD prompts for object selection.

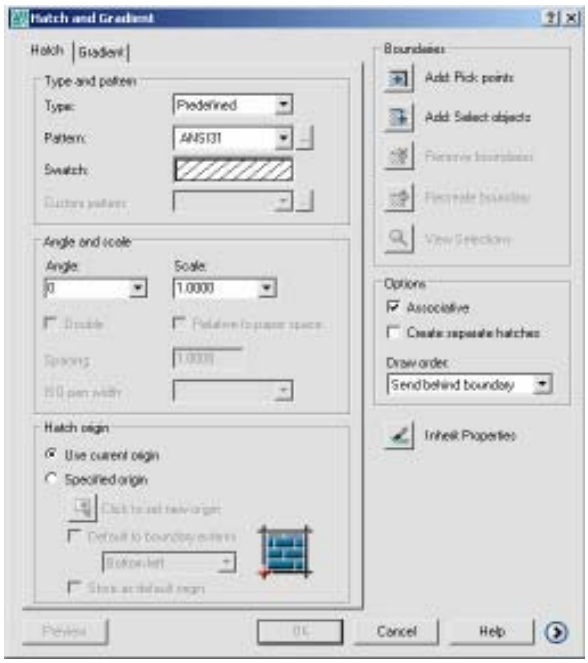
Inherit Properties: Applies the properties of an existing associative hatch to the current Pattern Type and Pattern Properties options.

Preview Hatch: Displays the hatching before applying it. AutoCAD removes the dialog box and hatches the selected areas.

Associative: Controls associative hatching.

Apply: Crates the crosshatching in the boundary.

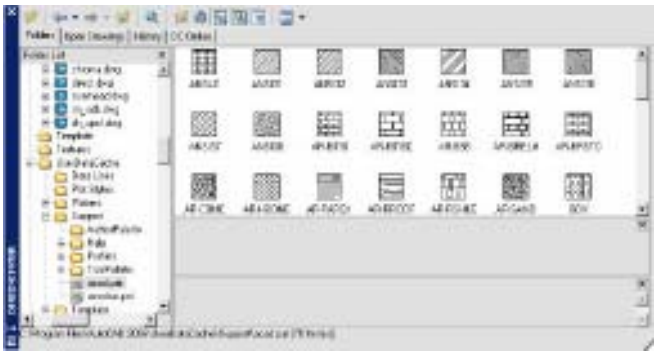
Annotative Hatch



Hatching from the Design Center 20.3

1. Choose: A cross hatch pattern from the following AutoCAD directly\AutoCADxxxx\Support\acad.pat or \AutoCADxxxx\Backup

2. Drag: and drop a pattern into a drawing.



TIP:

Be sure the HPSCALE is set before dropping a hatch pattern into a drawing.

Text & dimensions

Objectives : At the end of this exercise, you shall be able to

- **define text & dimensioning**
- **explain adding text to drawing**
- **explain common methods of dimensioning**

Introduction

Defining a Text Style

As discussed, there are a number of factors that control the appearance of text. It is time-consuming to specify every parameter each time you need to write text. CADD allows you to define text styles that contain all the text information such as size, justification and font. When you need to write text, simply select a particular style and all the text thereafter is written with that style. CADD offers a number of ready-made text styles as well.

Adding Text to Drawings

CADD allows you to add fine lettering to your drawings. You can use text to write notes, specifications and to describe the components of a drawing. Text created with CADD is neat, stylish and can be easily edited. Typing skills are helpful if you intend to write a lot of text.

Writing text with CADD is as simple as typing it on the keyboard. You can locate it anywhere on the drawing, write it as big or as small as you like and choose from a number of available fonts.

Drawing Dimensions

CADD's dimensioning functions provide a fast and accurate means for drawing dimensions. To draw a dimension, all you need to do is to indicate the points that need to be dimensioned. CADD automatically calculates the dimension value and draws all the necessary annotations.

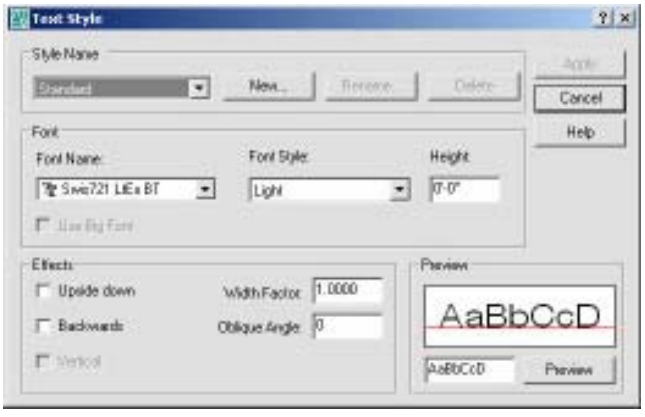
The annotations that form a dimension are: dimension line, dimension text, dimension terminators and extension lines (see fig.) you can control the appearance of each of these elements by changing the dimensioning defaults.

The following are the common methods for drawing dimensions:

- Drawing horizontal and vertical dimensions
- Dimensioning from a base line
- Dimensioning arcs and circles

Test Style Command

1	Choose	Format, Text Style...
		Or
2	Type	STYLE at the command prompt. Command: STYLE
3	Pick	The Text Style icon from the Text Toolbar.
4	Choose	a style from the menu or create a NEW style
5	Choose	a font file.
6	Type	a height for the text (set to zero to vary heights)
7	Type	a width factor for each character. Width fac tor<1>: (enter)
8	Type	an obliquing (slant) angle.
		Obliquing angle <0>: (angle or enter)
9	Type	Yes or No to place characters backwards. Backwards? (Y or N)
10	Type	Yes or No to draw characters upside down. Upside down? (Y or N)
11	Type	Yes or



Font Files

AutoCAD supports the following font types:

.SHX	AutoCAD Fonts
.PFB	Adobe Type I Fonts
.PFA	
.TTF	Windows True Type Fonts

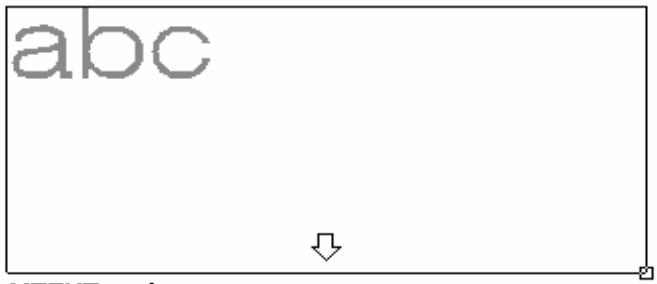
TIP:

To replace the font globally in a drawing, type style at the command prompt and keep the same style name but replace the font file with the new font. When AutoCAD regenerates, it will replace all text drawn with that style with the new font.

Multiline Text

Mtext Command

1	Choose	Draw, Text, Multiline Text...
		Or
2	Pick	the Mtext icon.
		Or
3	Type	MTEXT at the command prompt. Command: MTEXT
4	Type	One of the following options height/Justify/Rotation/Style /Width:
5	Pick	2 points to define the text window.
6	Type	text or change an MTEXT setting.



MTEXT options:

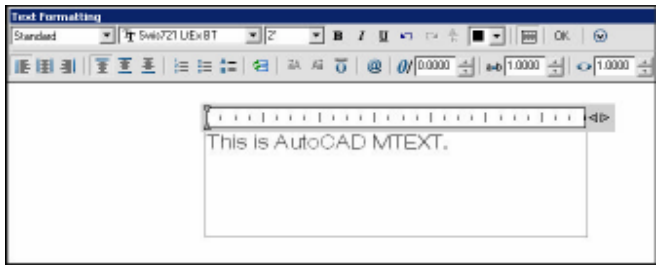
Rotation : Controls the rotation angle of the text boundary.

Style : Specifies the text style to use in paragraph text.

Height : Specifies the height of uppercase text

Direction : Specifies whether text is vertical or horizontal

Width : Specifies the width of the text boundary.

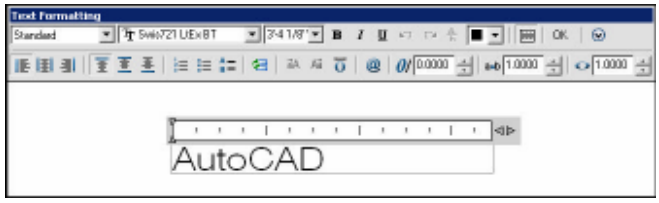


Editing Text

DDEDIT

1	Choose	Modify, Text...
		Or
2	Click	the Edit Text icon from the Text toolbar.
		Or
3	Type	DDEDIT at the command prompt. Command: DDEDIT or ED
4	Pick	The text to edit.
5.	Pick	Additional text or ENTER to end the Command.
		Select objects: ENTER

Text Edit Dialog Box for TEXT and DTEXT commands.



Linear Dimensions

1 Choose Dimension, Liner.

Or

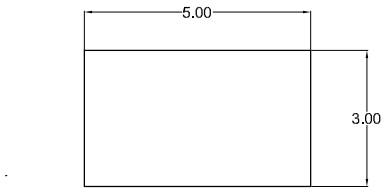
2 Click the Linear Dimension command from the toolbar.

or

3 Type DIM at the command prompt. Com mand: DIM

Dim: HOR or VER

Fig 1



LINEAR DIMENSIONS

SUN153361

Aligned Dimensions

1 Choose Dimension, Aligned.

Or

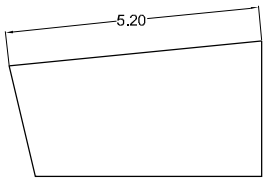
2 Click the Aligned Dimension command from the toolbar.

3 Type DIM at the command prompt.

Command: DIM

Dim: ALIGNED

Fig 2



ALIGNED DIMENSIONS

SUN153362

Radial Dimensions

1 Choose Dimension, Radius or Diameter.

Or

2 Click the Radial Dimensions command from the toolbar.

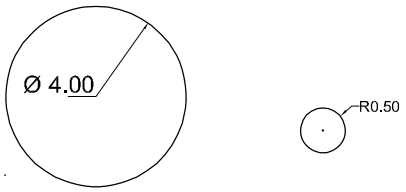
or

3 Type DIM at the command prompt.

Command: DIM

DIM: RADIUS or DIAMETER

Fig 3



RADIAL DIMENSIONS

SUN153363

Angular Dimensions

1 Choose Dimension, Angular.

Or

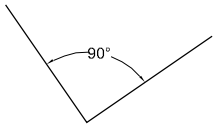
2 Click the Angular Dimensions command from the toolbar

3 Type DIM at the command prompt.

Command: DIM

Dim: ANGULAR

Fig 4



ANGULAR DIMENSIONS

SUN153364

Continued and Baseline Dimensions

1 Choose Dimension, Continue or Baseline.

Or

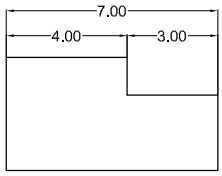
2 Click the Continue or baseline Dimensions command from the toolbar.

3 Type DIM at the command prompt.

Command: DIM

Dim: CONTINUE or BASELINE

Fig 5



CONTINUED AND BASELINE DIMENSIONS

SUN153365

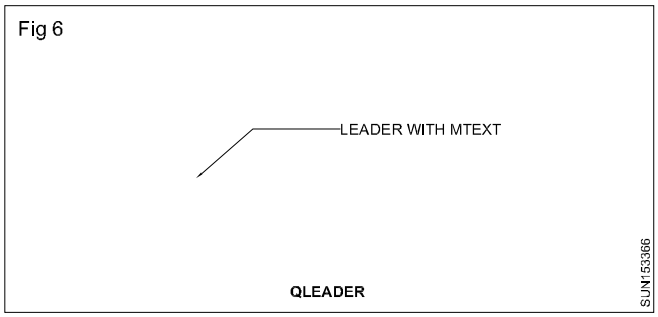
Leaders

1 Choose Dimension, Leader... or

2 Click the Leader icon from the Dimension toolbar. or

3 Type QLEADER at the command prompt. Command: QLEADER

Fig 6

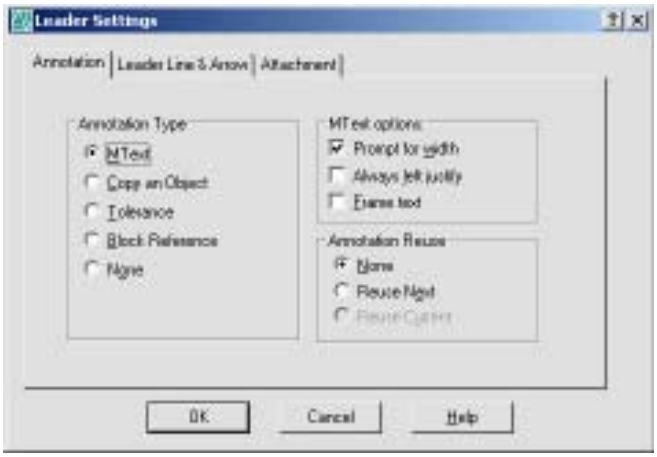


Leader Settings

1 Type QLEADER at the command prompt. Command: QLEADER

2 Type "S" at the QLEADER prompts to change the leader settings.

3 Choose a setting from the following dialog box.



Quick Dimensions

Quickly creates dimension arrangements from the geometry you select.

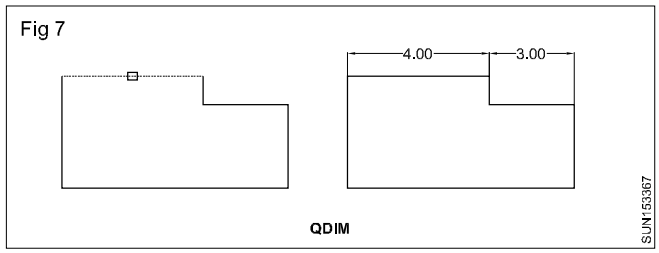
1 Choose Dimension, QDIM or

2 Click the Quick Dimension icon from the Dimensions toolbar. Or

3 Type QDIM at the command prompt. Command: QDIM

4 Pick the objects to dimension.

Fig 7

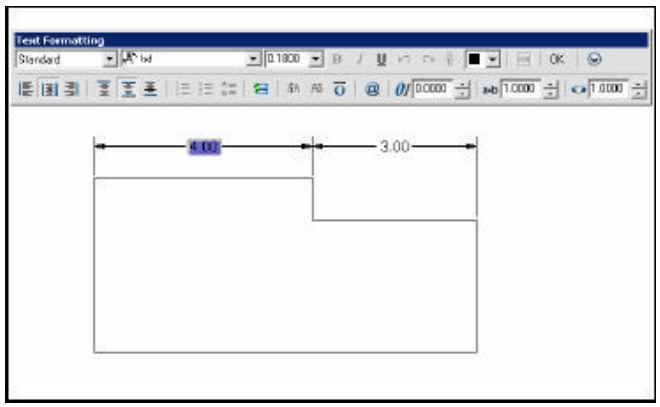


Modifying Dimensions

DDEDIT

1 Choose Modify, Object, Text.

2 Choose the dimension text to modify.



TIP: The actual dimension is placed in brackets <>. Text can be placed in front of or behind these brackets. If text is placed between the brackets, the dimension loses its associative properties.

Stretching Dimensions

1 Choose Modify, Stretch.

2 Choose a crossing window around the area to stretch. Be sure to include the dimension endpoints.

DIMTEDIT

Moves and rotates dimension text

1. Choose Dimension, Align Text. Or
2. Type DIMTEDIT at the command prompt.
   Command: DIMTEDIT
   Select dimension: select object
   Enter text location (Left/Right /Angle):

Dimension Edit Commands

HOMetext : Moves the dimension text back to its home (default) position.

NEWtext : Modifies the text of the Dimensions.

Rotate : Rotates dimension text.

Oblique : Sets the obliquing angle of Dimension extension lines.

Over ride : Overrides a subset of the Dimension variable settings.

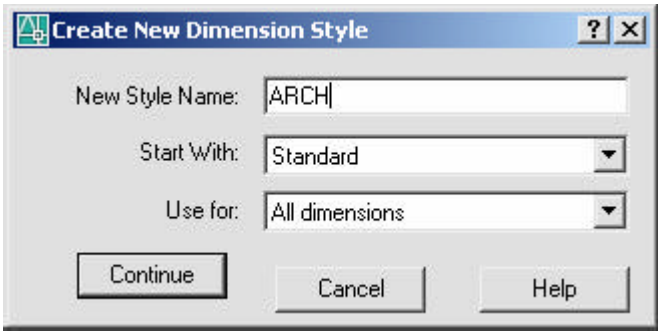
Update : Redraws the Dimensions as directed by the current settings of all dimensioning variables.

Ordinate Dimensions

1 Choose Dimension, Ordinate or
2 Type DIMORDINATE at the command prompt. Command: Dimordinate

Creating Dimension Styles

1 Choose Format, Dimension Style... or
2 Choose Dimension, Style. or
3 Choose Dimension Style icon from the Diameter Style toolbar.
4 Type DDIM at the command prompt
Command: DDIM
5 Choose New...From the dialog box.
6 Create a new style from the existing styles.
7 Click the Continue button.



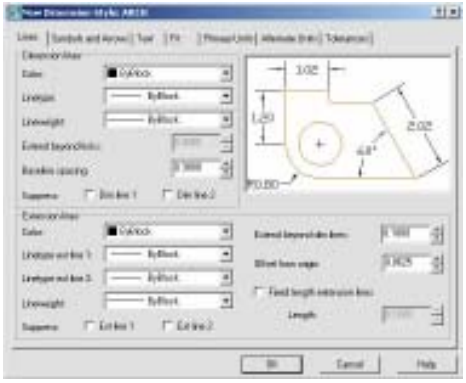
TIP:

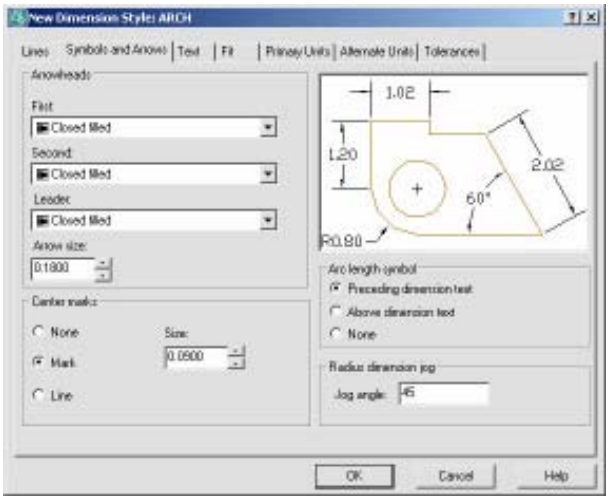
All dimension variables except for DIMSHO and DIMASO can be saved as a style.

Lines and Arrows

Edits Dimension Lines, Extension Lines, and Arrows.

1 Pick : the Lines and Arrows tab from the Dimension variables and Styles dialog box.

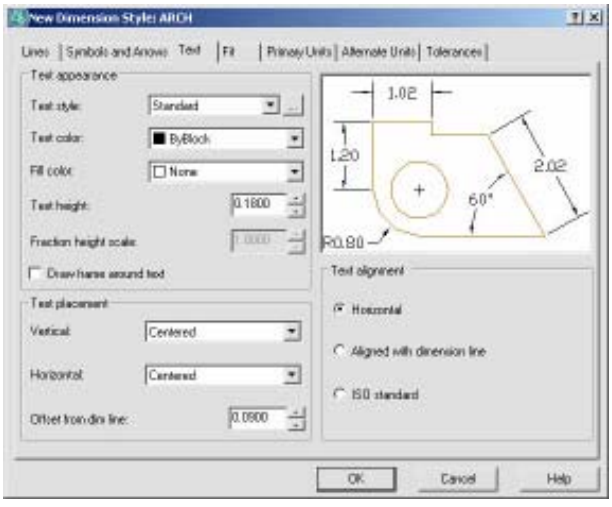




Text

Edits Text Appearance, Text Placement and Text Alignment.

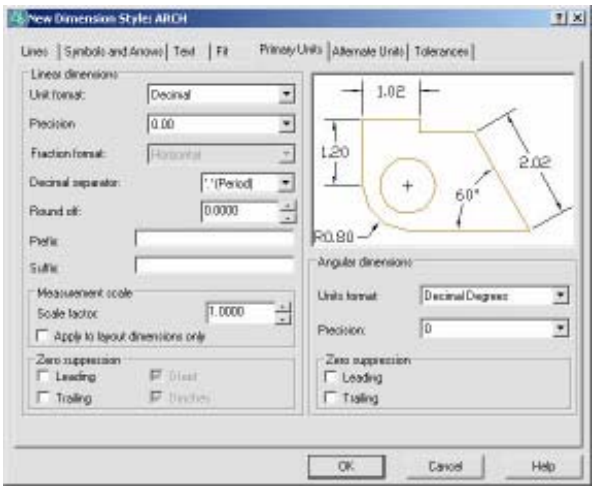
1 Pick the Text tab from the Dimension Variables and Styles dialog box.



Primary Units

Edits Unit options for dimension's primary units.

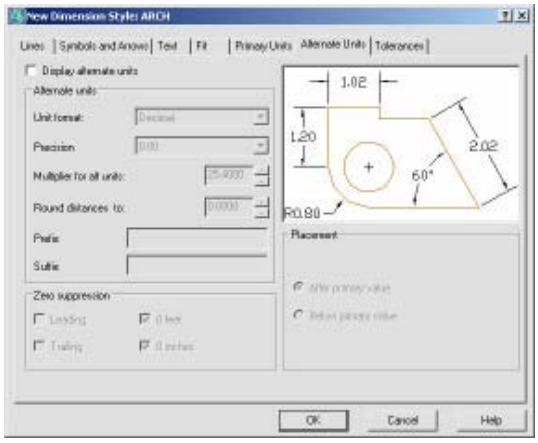
1 Pick : the PRIMARY UNIT tab from the Dimension variables and Styles dialog box.



Alternate Units

Edits Unit options for dimension's alternate units.

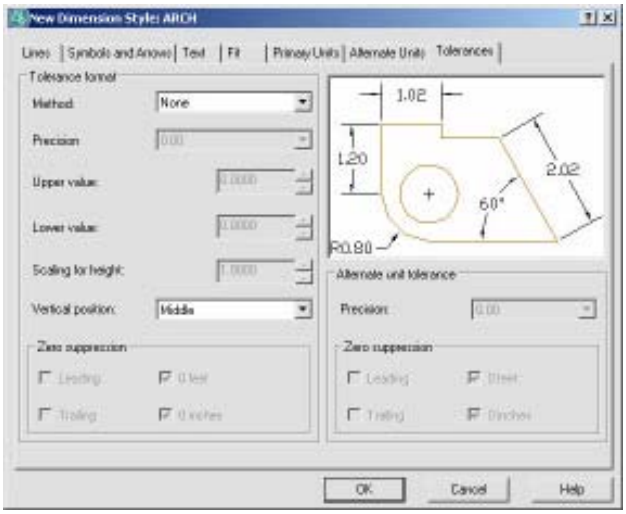
1 Pick : the ALTERNTE UNIT tab from the Dimension Variables and Styles dialog box.



Tolerances

Edits Unit options for tolerances.

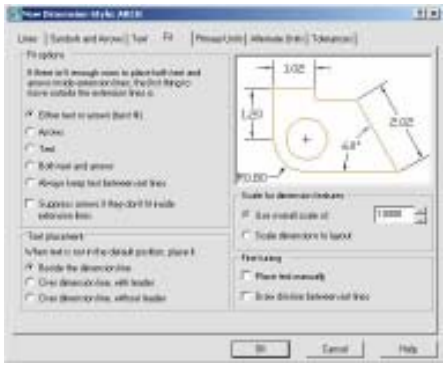
1 Pick : the TOLERANCES tab from the Dimension Variables and Styles dialog box.



Fit

Edits Unit options for fitting dimensions and dimension scales.

1. Pick the FIT tab from the Dimension Variables and Styles dialog box.



Dimension Override

1	Choose	Dimension, Override.
2	Type	a dimension setting to change (i.e. DIMSE1 which suppresses the first ex tension line). Command:_dimoverride Enter dimension variable name to over ride or [Clear overrides]: dimse 1
3	Set	The new value.
4	Press	enter.
5	Pick	the dimension to override.

Printing & plotting

Objectives : At the end of this exercise, you shall be able to

- **state printing & plotting**
- **illustrate setting a scale for drawing**
- **explain steps to plotting & printing.**

The Printing and Plotting Process

CADD drawings are printed using a printer or a plotter. The process of printing is as simple as selecting the print or plot function from the menu. This action sends data from the computer to a printer or plotter, which produces the final drawing. The drawings are neat, clean and, depending on the quality of the printer, highly accurate.

You can specify a number of parameters to control the size and the quality of a plot. You can plot a drawing to any size by applying an appropriate scale factor. You can specify line thickness and colours for different drawing objects. You can make a number of other adjustments as well, including rotating a plot, printing only selected areas of a drawing, or using specific fonts for text and dimensions.

The following are the important considerations for plotting:

- Selecting a scale for drawings
- Composing a drawing layout
- Selecting text and dimension heights
- Choosing pens colours and line weights.

Selecting a Scale for Drawings

When working on a drawing board, you use a specific scale to draw diagrams. For example, when you need to draw a plan of a building or a township, you reduce the size of the diagrams to 1/1000 of its actual size, that is, you use a 1:100 or 1:1000 scale. When you need to draw a small machine part, you draw it many times larger than its actual size. CADD uses the same principles to scale the drawings; however, a different approach is taken.

Term	**Description**
Plotting scale	To proportionally reduce or enlarge diagrams for plotting.
Plotting scale factor	A degree to which drawings are proportionally reduced or enlarged.

Composing a Drawing Layout

CADD provides a number of special functions to compose a drawing layout. You can arrange diagrams on a sheet as you like and apply any scale factor. Different programs use different protocols to accomplish this task.

The following table shows some of the standard sheet sizes (in inches):

ANSI		ISO		Architectural	
Mark	Size	Mark	Size	Mark	Size
A	8.5 x11	A4	8.3 x11.7	A	9 x12
B	11x17	A3	11.7x16.5	B	12x18
C	17x22	A2	16.5x23.4	C	18x24
D	22x34	A1	23.4x33.1	D	24x36
E	34x44	A0	33.1x46.8	E	36x48

Selecting Text and Dimension Heights

As diagrams are enlarged or reduced by applying scale factor, the size of text, dimensions, patterns and symbols is also changed. When you place different scale diagrams on the same sheet, you may get different sized text for each diagram. This is generally not acceptable for professional drawings. It is better to have consistently sized text on the drawings regardless of their scale.

For details on this topic refer to CADD PRIMER.

Choosing Pens, Colors and Line Weights

CADD allows you to work with a variety of colors and line weights depending upon the plotter. In most CADD programs, the colors you use on-screen are configured with a specific line weight in the plotter. For example, the objects drawn with red color on-screen may be printed with.5mm line weight; the objects drawn with blue color may be printed with .2mm line weight. These are called pen assignments.

For details on this topic refer to CADD PRIMER.

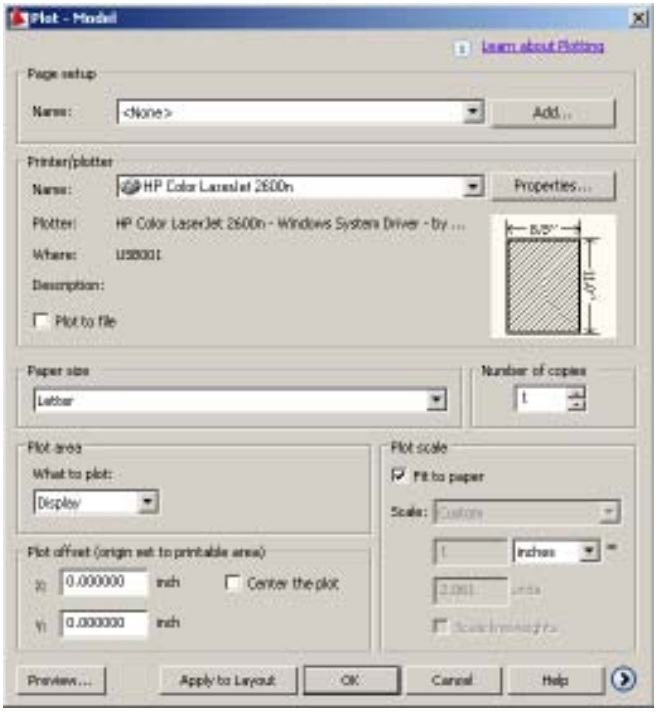
Steps to Plotting

The following are the basic steps to plotting.

Step	Action
1	Set up the plotter according to the manufacturer is specifications and configure it with your CADD program.
2	Place paper in the plotter and run a self test to ensure that the paper path is clear and the pens or cartridges are in good working condition.
3	Display the drawing to be plotted on the screen and choose the plot function.
4	Respond to the specific prompts of your CADD program. In general, a CADD program will require the following information to plot the drawing. **Plotting area :** You can plot a part of the drawing or the entire drawing. You will be able to indicate the plotting area by indicating a window (an imaginary rectangle formed by two diagonal points) or by selecting a specific view for plotting. **Plotting scale factor :** Enter a scale factor based on how big or small you want to print the drawing and the sheet size used. (See topic selecting a Scale for Drawing.) **Plotting origin :** The plotting origin is a point that allows you to align the drawing shown on the screen with the paper in the plotter (see Fig.8.2). You can place the diagrams on the paper anywhere by entering the exact coordinates of the plotting origin.

Plot Command

1	Choose	File, Plot. Or
2	Click	the Plotter icon. Or
3	Type	PLOT at the command prompt. Command: PLOT or PRINT Or
4	Press	CTRL + P



Plot Settings

1	Choose	the Plot Settings tab.
2	Choose	the appropriate paper size based on the chosen plotter.
3	Choose	the paper units (inches or mm).
4	Choose	the drawing orientation (Portrait, Land scape, Upside down).
5	Choose	the plotting area.
6	Choose	the plot scale.
7	Choose	plot to center or specify an x or y offset.
8	Click	OK.

Layers

Objectives : At the end of this exercise, you shall be able to

- **define layer**
- **enumerate key Terms in layer**
- **explain making a layer correct**
- **explain setting layers.**

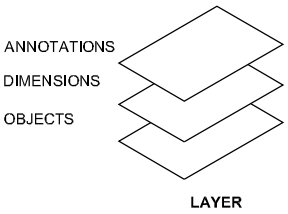
Introduction

A layer is like a transparency. Have you ever used an overhead light projector? Remember those transparencies that are laid on top of the light projector? You could stack multiple sheets but the projected image would have the appearance of one document. Layers are basically the same. Multiple layers can be used within one drawing.

The explain, on the right, shows 3 layers. One for annotations (text). One for dimensions and one for objects.

It is good "drawing management" to draw related objects on the same layer. For example, in an architectural drawing, you could have the walls of a floor plan on one layer and the Electrical and Plumbing on two other layers. These layers can then be Thawed (ON) or Frozen (OFF) independently. If a layer is Frozen, it is not visible. When you draw the layer it becomes visible again. This will allow you to view or make plots with specific layers visible or invisible.

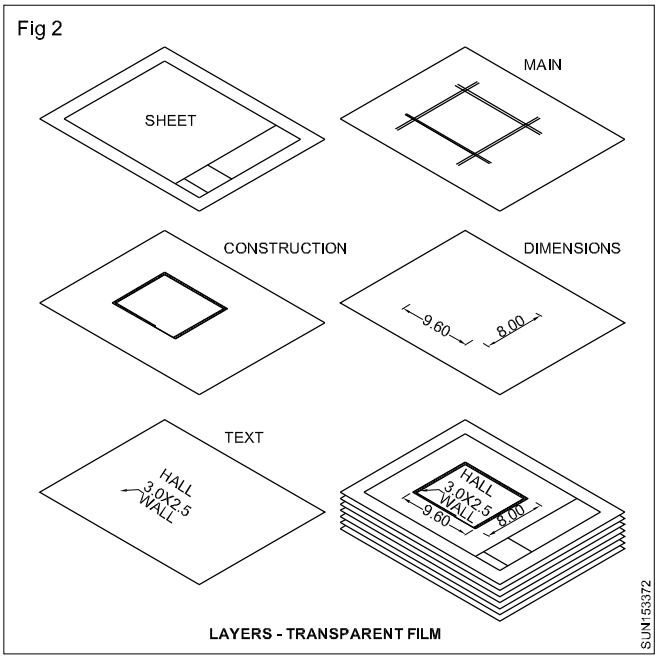
Fig 1



Key Terms in this Chapter

Term	Description
Composite drawing	A drawing that contains multiple drawings created with the help of CADD layers.
Layer or level	A transparent surface created within a drawing.
Layer or level	A color assigned to a layer.
Layer off	Making the drawing objects on a layer invisible.
Layer on	Making the drawing objects on a layer visible.
Layer line type	A line type assigned to a layer.
Locking a layer	Making the drawing objects on a layer permanent and non-editable.
Macro	A recorded set of instructions that can be used to repeat a task.

Fig 2



LAYERS - TRANSPARENT FILM

Introduction to Layers and Layer Dialog Box 1

1	Choose	Format, Layer.
		Or
2	Type	LAYER at the command prompt.
		Command: LAYER (or LA)
		Or
3	Pick	the layers icon from the Layer Control box on the object properties toolbar.

Layer Options

?	Lists layers, with states, colors and linetypes.
Make	Creates a new layer and makes it current.
Set	Sets current layer.
New	Creates new layers.
ON	Turns on specified layers.
OFF	Turns off specified layers.
Ltype	Assigns linetype to specified layers.
Freeze	Completely ignores layers during regenera tion.
Thaw	Unfreezes specified layers Ltype.
Lock	Makes a layer read only preventing entities from being edited but available visual refer ence and osnap functions.
Unlock	Places a layer in read write mode and avail able for edits.
Plot	Turns a Layer On for Plotting
No Plot	Turns a Layer Off for Plotting
LWeight	Controls the line weight for each layer.

TIP

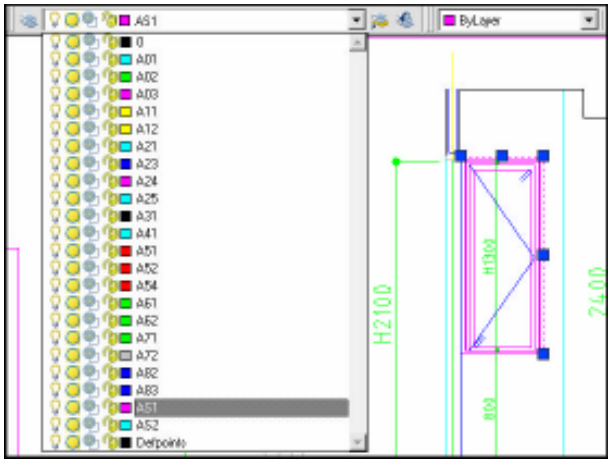
Layers can be set using the command line prompts for layers. To use this, type- LAYER or -LA at the command prompt

1	Type	command:-LAYER or LA\
2	Type	One of the following layer options?/ Make/Set/New/ON/OFF/Color/Ltype/ Freeze/Thaw:

Layer Shortcuts

Changing the Layer of an Object

1	Click	Once on the object to change.
2	Select	the desired layer from the Layer Control Box dropdown.
		AutoCAD will move the object to the new layer.



Making a Layer Current

1 Click Once on the Make Object's Layer Cur rent icon.

2 Select Object whose layer will become current.

Match Properties

1 Choose Modify, Match Properties.

Or

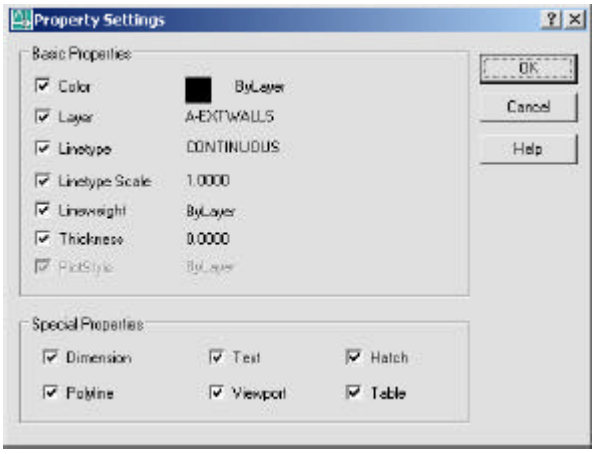
2 Click the Match Properties Icon from the Stan dard toolbar.

or

3 Type Command: MATCHPROP or MA

4 Select the object whose properties you want to copy (1).

5 Select the objects to which you want to apply the properties (2).



Layer Previous

1 Open an AutoCAD drawing with layers.

2 Turn Layers on/off.

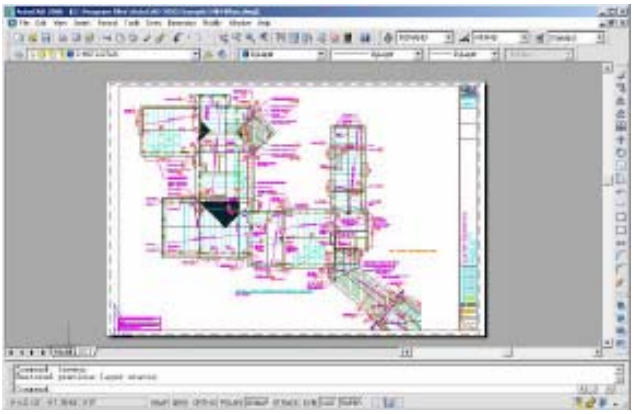
3 Zoom or perform any AutoCAD Command.

4 Type LAYERP at the command prompt.

Command: LAYERP

Or

5. Click the Layer Previous icon.



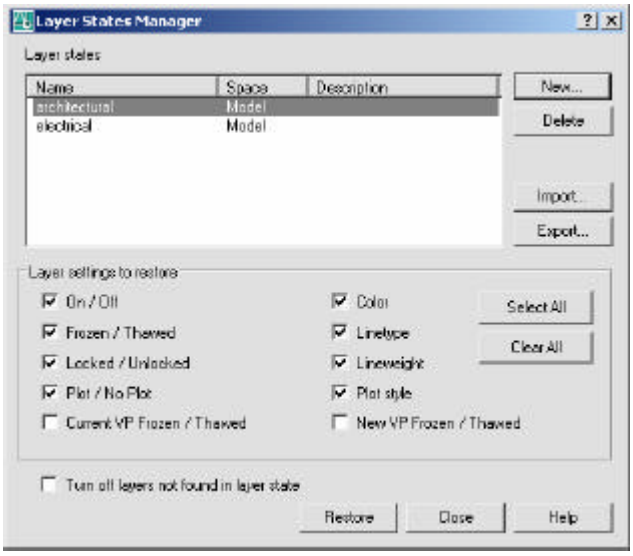
Layer States

1 Choose the layer icon.

2 Select Various layers to be ON, OFF, FROZEN, LOCKED, etc.

3 Choose the Save State button.

4 Choose Restore State to restore the layer settings.



Color Command

1 Choose Format, Color.

Or

2 Type DDCOLOR at the command prompt.

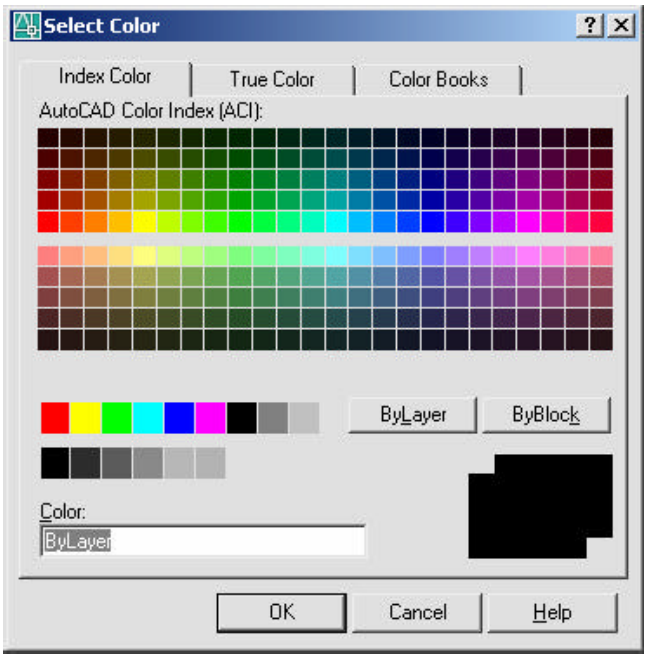
Command: DDCOLOR or COL

Or

3 Choose Color on the Object Properties toolbar and then select a color from the list or select Other to display the Select Color dialog box.

TIP:

These Settings ignore the current layer settings for color.



By Layer

If you enter by layer, new objects assume the color of the layer upon which they are drawn.

ByBlock

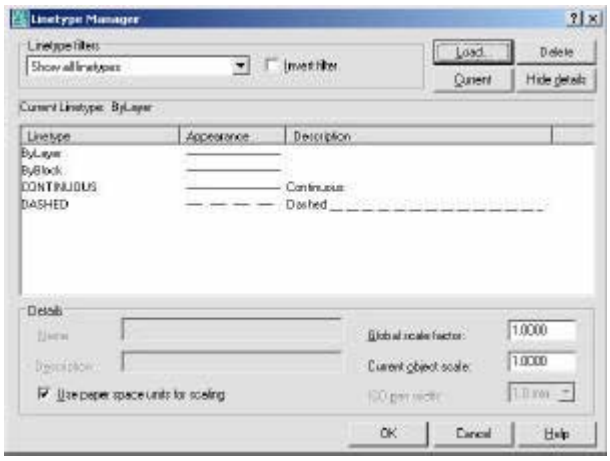
If you enter by block, AutoCAD draws new objects in the default color (white or black, depending on your configuration) until they are grouped into a block. When the block is inserted in the drawing, the objects in the block inherit the current setting of the COLOR command.

Line types

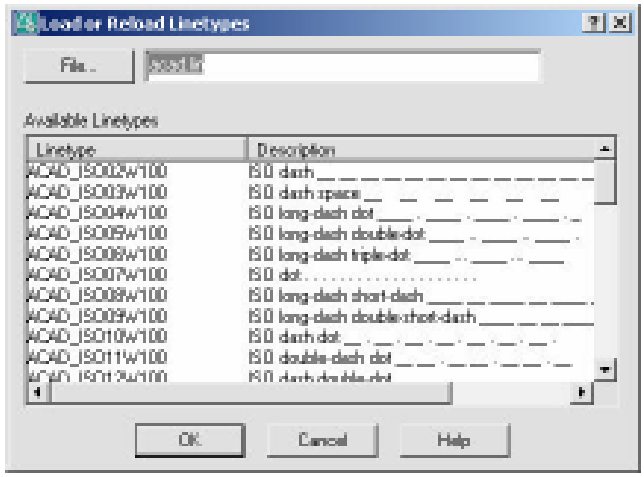
Loading and Changing Line types

1 Choose Format, Linetype...
Or
2 Type DDLTYPE at the command prompt.
Command: DDLTYPE or LT

3 Choose Load... to see a list of available linetypes.



4 Choose the desired linetype to assign.



5 Click OK.

Properties and blocks

Objectives : At the end of this exercise, you shall be able to

- **express line weights.**
- **state object properties**
- **inserting blocks**
- **explain settings of O snap**
- **state redraw & regain, measuring distance**

Introduction

Line weights

You can differentiate objects in your drawing by controlling their lineweights both in the drawing display and in plotting. For example, Sectioned objects should read heavier than objects in elevation and all object lines should be heavier than dimension lines, which in turn should be heavier than hatch pattern lines.

1. Object properties

You can organize objects in your drawing and control how they are displayed and plotted by changing their properties, which include layer, linetype, linetype scale, color, Lineweight, thickness, and plot style.

Every object you draw has properties. Some properties are general and apply to most objects; for example, layer, color, linetype, and plot style. Other properties are object-specific; for example, the properties of a circle include radius and area, and the properties of a line include length and angle.

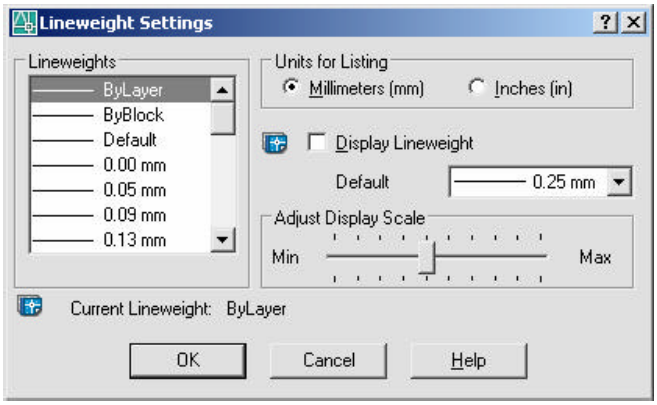
Creating block attribute

A block attribute is a tag or label that attaches information to a block. The information is mapped as a column in a database table. It can be anything, for example room numbers, equipment tags, drawings numbers in a set etc... the advantage of using block attribute is that you can always extract the information into a spreadsheet or database to produce a list.

Line weights

Loading and Changing Line weights

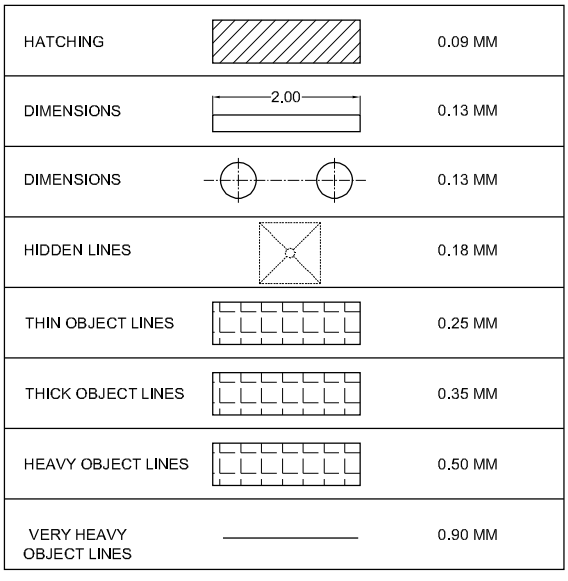
1 Choose	Format, Lineweight...
	or
2 Type	LINEWEIGHT at the command prompt.
	Command: LINEWEIGHT or LWEIGHT
	Or
4 Pick	a lineweight to make current from the ob ject properties menu.



TIPS

- Lineweights can also be assigned to layers.
- The display Lineweights feature can be turned on/off on the status bar to show or not show lineweights in the drawing, thus making regenerations faster.
- Lineweights are displayed using a pixel width in proportion to the real-world unit value at which they plot. If you are using a high-resolution monitor, you can adjust the lineweight display scale to better display different lineweight widths.

Fig 1

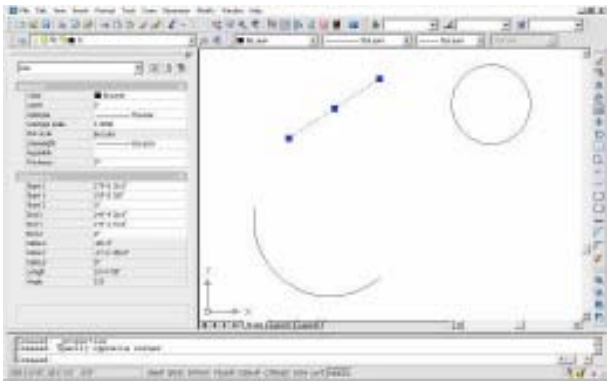


ALPHABET OF LINEWEIGHTS

his graphic depicts a sample set of line weights for various types of entities in a drawing. The actual line widths are being approximated in this image due to the conversion to a raster image. See sample drawing for a more accurate depiction of the lineweights.

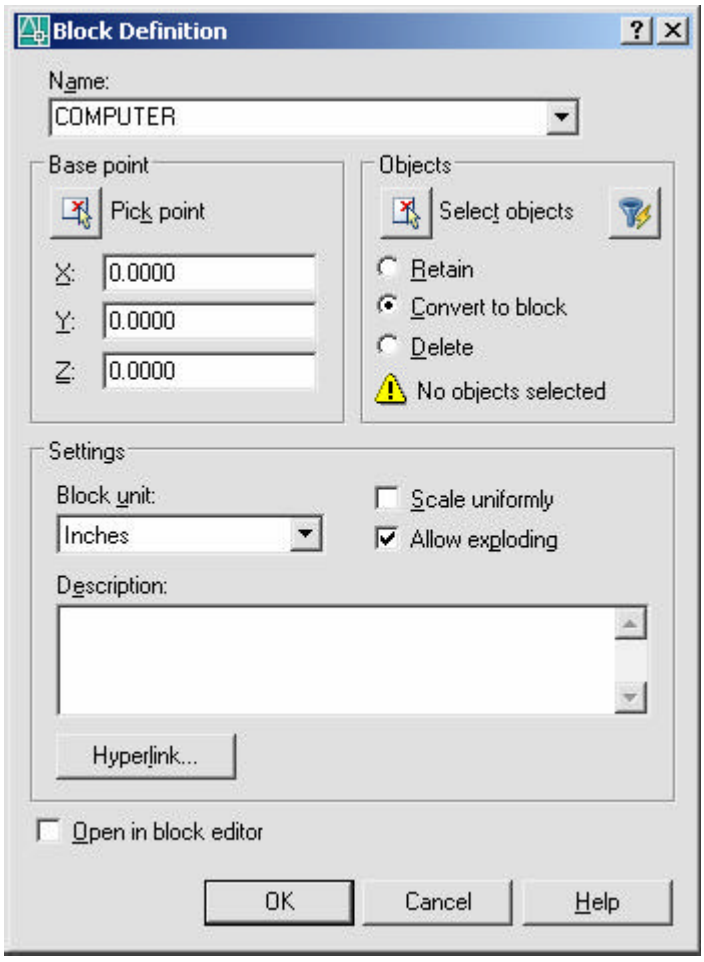
Object Properties

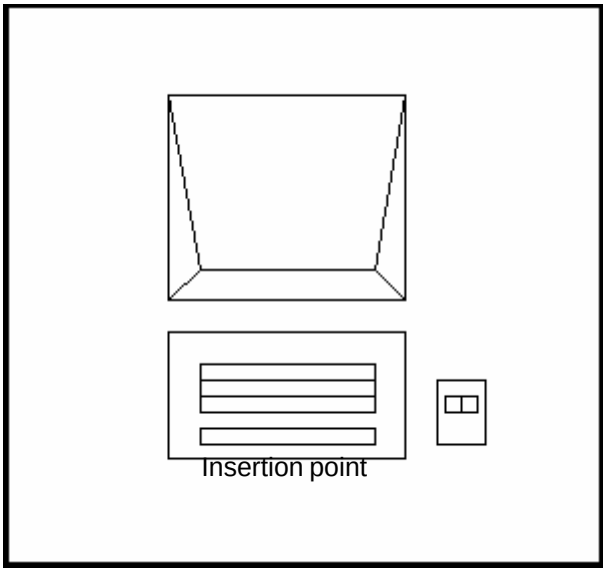
1 Choose Modify, Properties.
Or
2 Click the Properties icon. 
Or
3 Type DDCHPROP or DDMODIFY at the com mand prompt.
Command: DDCHPROP (CH) or DDMODIFY (MO)
4 Pick Objects whose properties you want to change Pick a window for DDMODIFY.
Select objects: (select)
5 Press ENTER to accept objects.
Select objects: (press enter)
6 Choose One of the following properties to change.



Creating Local Blocks (BMAKE)

1 Choose Draw, Block, Make.
Or
2 Click the make block icon. 
Or
3 Type BMAKE at the command prompt.
Command: BMAKE or BLOCK
4 Type the name of the block.
5 Pick an insertion point.
6 Select objects to be included in the block definition.
7 Click OK.

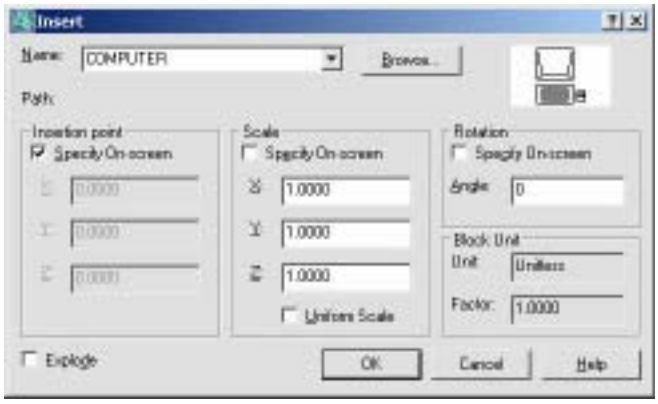




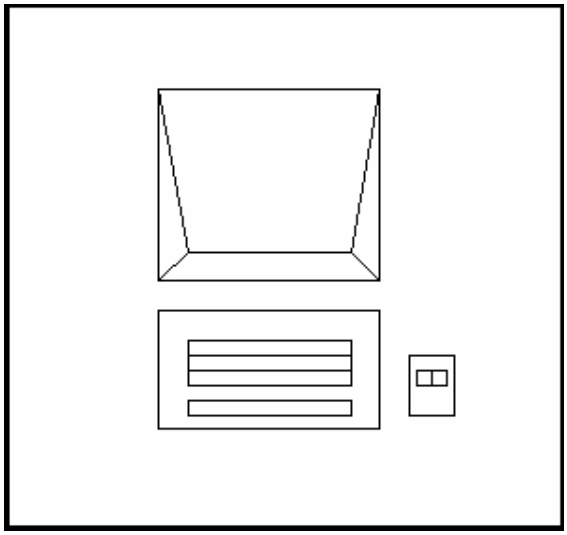
You cannot use DIRECT, LIGHT, AVE_RENDER,RM_SDB, SH_SPOT, and OVERHEAD as valid block names.

Inserting Blocks

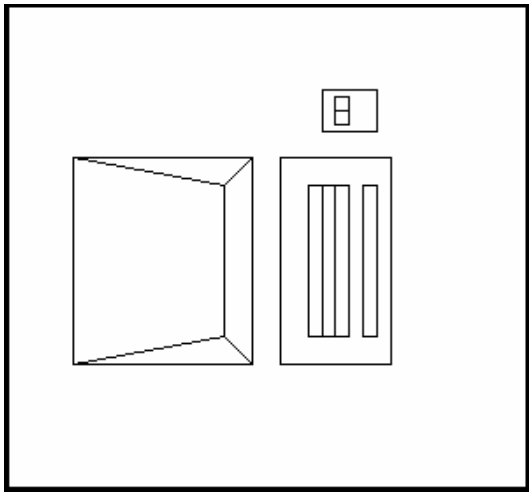
1	Choose	Insert, Insert Block
		Or
2	Click	the insert icon from the INSERT toolbar.
3	Type	INSERT at the command prompt.
		Command: INSERT
4	Choose	the insertion point, scale, and rotation of the block.
5	Choose	the insertion point, scale, and rotation of the block



Block Inserted with a zero degree rotation angle



Block Inserted with a ninety degree rotation angle.



Typing Insert (-INSERT)

1	Type	-INSERT at the command prompt. Com mand:-INSERT
2	Type	Block name to insert.
		Insert block name or (?) type name
3	Pick	An insertion point. Insertion point: pick point
4	Press	ENTER to keep the same x scale factor
		as the original block. X scale factor <1> Corner /XYZ:
5	Press	ENTER to keep the same x scale factor as the original block.
		Y scale factor (default= X):
6	Press	ENTER to keep a rotation angle or zero. Rotation angle <0>:
7	Pick	A rotation angle.

Control the Colour and Line type of Blocks

The objects in an inserted block can retain their original properties, can inherit properties from the layer on which they are inserted, or can inherit the properties set as current in the drawing.

You have three choices for how the colour, linetype, and lineweight properties of objects are treated when a block reference is inserted.

- Objects in the block do not inherit colour, linetype, and lineweight properties from the current settings. The properties of objects in the block do not change regardless of the current settings.

- For this choice, it is recommended that you set the color, linetype, and lineweight properties individually for each object in the block definition: do not use BYBLOCK or BYLAYER color, linetype, and lineweight settings when creating these objects.

- Objects in the block inherit color, linetype, and lineweight properties from the color, linetype, and lineweight assigned to the current layer only.

- For this choice, before you create objects to be included in the block definition, set the current layer to 0, and set the current color, linetype, and lineweight to BYLAYER.

- Objects inherit color, linetype, and lineweight properties from the current color, linetype, and lineweight that you have set explicitly, that is, that you have set to override the color, linetype, or lineweight assigned to the current layer. If you have not explicitly set them, then these properties are inherited from the color, linetype, and lineweight assigned to the current layer.

- For this choice, before you create objects to be included in the block definition, set the current color or linetype to BYBLOCK.

If you want objects in a block to	Create objects on these layers	Create objects with these properties
Retain original properties	Any but 0 (zero)	Any but BYBLOCK or BYLAYER
Inherit properties from the current layer	0 (zero)	BYLAYER
Inherit individual properties first, then layer properties	Any	BYBLOCK

Wblock Command

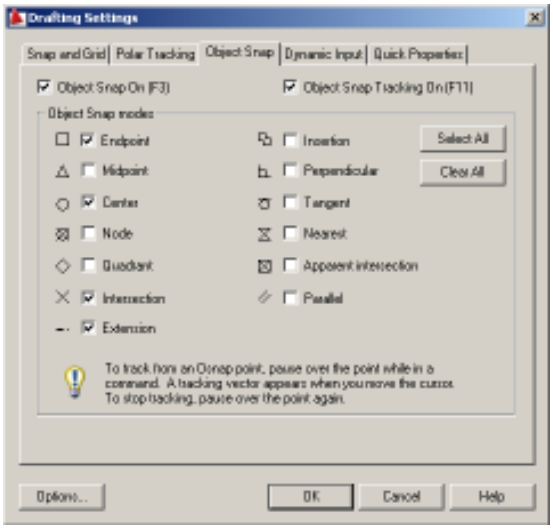
Writes objects to a new drawing file.

1	Type	WBLOCK at the command prompt Com mand: WBLOCK
2	Type	A drawing name (and location).
3	Type	A block name if a local block already exists. Block name: name or
4	Press	ENTER to create a block.
5	Pick	An insertion point on the object Insertion base point: pick a point
6	Pick	Objects to create the block. Select objects: pick objects
7	Press	ENTER to end the selection set.

Running Object Snaps

An object snap mode specifies a snap point at an exact location on an object. OSNAP specifies running object snap modes, which remain active until you turn them off.

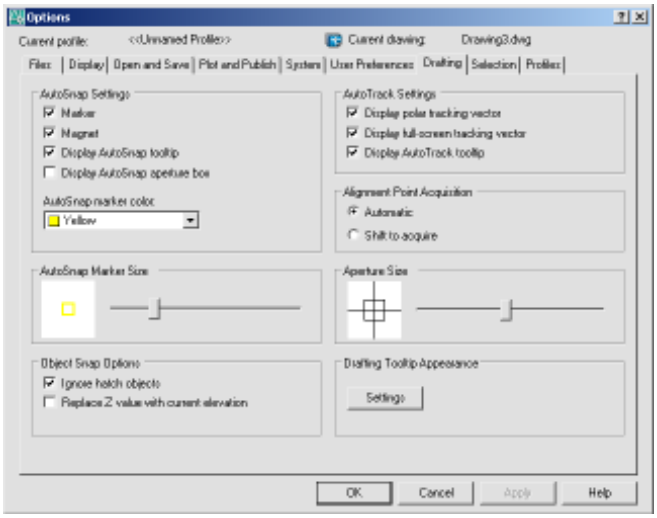
1	Choose	Tools, Drafting Settings....
		Or
2	Type	DDOSNAP at the command prompt command: DDOSNAP
		Or
3	Click	OSNAP on the Status Bar.
4	Right Click	The Object Snap TAB.
5	Choose	an object snap to turn ON/OFF from the dialog box.



Osnap Settings

When you use any of the object snap settings, AutoSnap displays a marker and a Snap tip when you move the cursor over a snap point.

1	Choose	Tools, Options...
2	Select	the Drafting tab in the Options dialog box.
3	Change	settings and Choose OK.



The following are object snap modes:

CENter	Center of Arc or Circle
ENDpoint	Closest endpoint of Line/Arc
INSertion	Insertion point of Text/Block/Shape/Attribute
INTersection	Intersection of Lines/Arcs/Circles
MIDpoint	Midpoint of a line/Arc or midpoint
NEAerst	Nearest point on a Line/Arc/Circle/Point
APParent Int	Finds where two entities would intersect
NODe	Nearest point entity (or Dimension definition point)
PERpendicular	Perpendicular to a Line/Arc/Circle
QUAdrant	Quadrant point on an Arc/Circle
QUIck	Quick mode (first find, not closest).
TANgent	Tangent to Arc or Circle

5.3 Redraw and Regen

Redraw refreshes the current view.

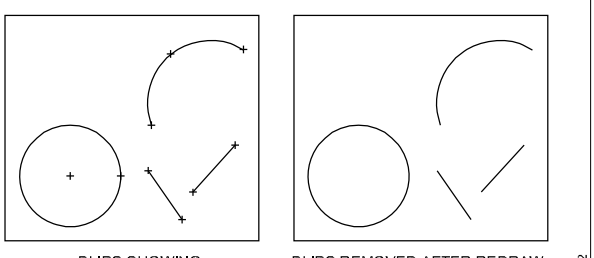
1 Type — Redraw at the command prompt
Command: Redraw or R

REGEN regenerates the entire drawing and recomputes the screen coordinates for all objects. It also re-indexes the drawing database for optimum display and object selection performance.

1. Type — REGEN at the common prompt.
Command: REGEN or RE

TIP: When BLIPMODE is on, marker blips left by editing commands are removed from the current viewport

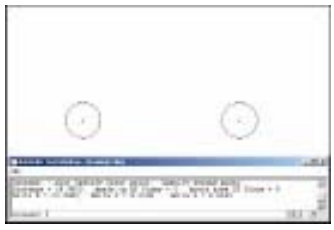
Fig 2



REDRAW AND REGEN

Measuring Distances

1 Choose — Tools, Inquiry, and Distance.
Or
2 Click — the Distance icon from the Inquiry Toolbar.
Or
3 Type — DIST at the command prompt
Command: DIST
4 Pick — The first point to measure from First point: Pick point
5 Pick — The second point to measure to Second point: pick point
Distance Between Circle Centers



TIP

Be sure to use Object Snaps with the MEASURE command.

Divide

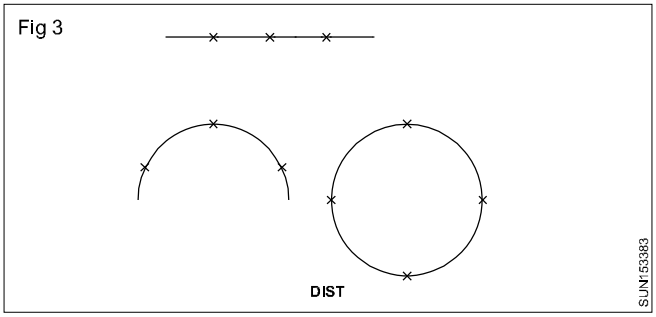
1 Choose — Draw, Point, and Divide.
Or
2 Type — DIVIDE at the command prompt
Command: DIVIDE
3 Pick — Object to divide

Select object to divide: (pick one object)
You can select a single Line, Arc, Circle, or polyline. If you enter a segment count between 2 and 32,767, Point entities will be placed along the object to divide it into that number of equal segments.

4. Type — The number of equal segments to divide the object into <Number of segments>/ Block: (number)

Objects divided using points

Fig 3



Isoplane

Objectives : At the end of this exercise, you shall be able to

- **state Isometric views**
- **explain Isometric Drawing Aids**
- **illustrate Isometric commands & keys.**

Introduction

Isometric views

Isometric views are more realistic than oblique views. The object appears to be tilted at a 30° angle on both sides. An isometric is defined by three planes called isoplanes: top isoplane, right isoplane and left isoplane.

On a drawing board, we use a 30° triangle to draw the three planes of an isometric. The same principle is applied in CADD with the help of various functions. The right isoplane is drawn with 30° and 90° angles, the left isoplane with 150° and 90° angles and the top plane with 30°and 150°angles. All distances are measured using 1:1 scale (actual size) to show depth, width and height. You can use simple 2D functions and draw lines at specific angles to complete an isometric. Polar coordinates are particularly helpful to measure distance along an angle.

Steps to Draw an Isometric

Isometric Drawing - Aid Functions

The following are some of the important CADD functions that simplify isometric drawing. These topics are described with the help of illustrates in CADD

Isoplane(Command)

Specifies the current plane for 2D isometric drawing.

The ISOPLANE command has been superseded by the ISODRAFT command. The primary advantage of ISODRAFT is that when it is turned is turned on or off, all related settings are automatically changed as well.

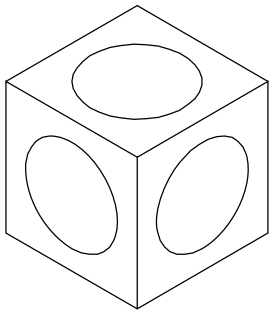
ISOPLANE invokes the following settings and modes when drawing 2D isometric representations of 3D models:

- Ortho directions
- Snap orientation
- Grid orientation and style (dotted)
- Polar tracking angles
- Orientation of isometric circles

This isometric plane affects the cursor movement only when the snap style is set to Isometric in the Drafting Settings dialog box, regardless of whether snap is turned on. If the snap style is Isometric, Ortho mode uses the appropriate axis pair from 30,90, and 150 degrees.

The current isometric plane also determines the orientation of isometric circles created with the Isocircle option of the ELLIPSE command.

Fig 1



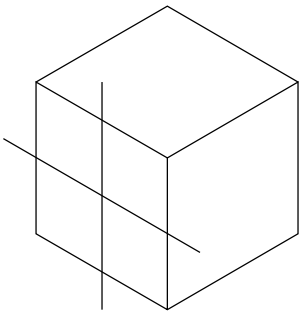
ISOPLANE

SUN153391

Tip: You can quickly cycle through the isometric planes by pressing Ctrl+E or F5. The following prompts are displayed.

Left

Fig 2



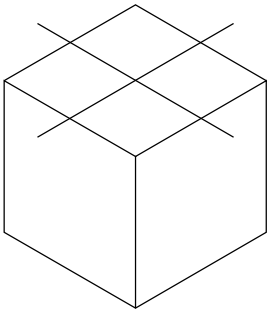
ISOPLANE LEFT

SUN153392

Specifies creating left-facing planes, defined by the 90-degree and 150-degree axis pair.

Top

Fig 3



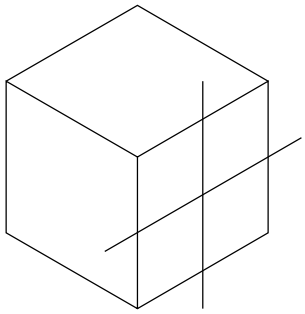
ISOPLANE TOP

SUN153393

Specifies creating top-facing planes, defined by the 30-degree and 150-degree axis pair.

Right

Fig 4



ISOPLANE RIGHT

SUN153394

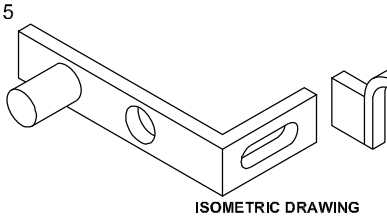
Specifies creating right-facing planes, defined by the 90-degree and 30-degree axis pair.

Isometric drawing in CAD

I've never had a guest writer on my blog-but one of my favourite coworkers - Dieter Schlaepfer, who is a principal learning Content Developer for Autodesk, and an excellent writer-kindly volunteered! Dieter is an enthusiastic fan of the Isodraft command, so here is his take on this awesome new addition to AutoCAD 2015.

With the addition of the new ISODRAFT command in AutoCAD and LT 2015, creating 2D isometric drawings became a whole lot easier and faster. While I'm a total enthusiast for 3D solid modelling, I do have to admit that it makes sense to use isometric drawing when all you need is some simple isometric views for design concepts, presentations, catalogs, illustrations, and assembly instructions.

Fig 5

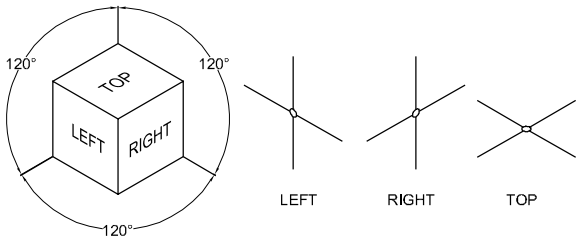


ISOMETRIC DRAWING

SUN153395

The Isodraft command supersedes the Isoplane command. The primary advantage of Isodraft is that when it is turned is turned on or off, all the related settings are automatically changed as well, so they line up with the isometric axes and corresponding isoplanes and their cursors, left, Right, and Top.

Fig 6



ISOPLANE

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Click the isodraft icon on the status bar to turn on isometric drawing. When You're done, click it again to return to orthographic drawing.

Everyone has their favourite methods and preferences for drawing with AutoCAD, and I'm no exception. But before I show you how I would create the bracket illustrated above, let's take an inventory of the feature and tools that I use the most for isometric drawing.

Useful Features

- Polar tracking - Guides your cursor along the isometric angles. I use Ortho in crowed areas.

- Direct distance entry - why use anything else when you know the dimensions?

- Object snap tracking - Super useful for locating points offset from other points along isometric angles. I leave the MID object snap turned on so i can easily locate centres of rectangular areas. If i run into any difficulties, i create construction geometry using another color, and when iam not too lazy, on a separate refreance layer.

- Line weight - lets you add emphasis.

Commands and keys

- Isodraft- access this command quickly from the status bar. To cycle through the isoplanes make the F5 key your friend. Incidentally, sometimes F12, dynamic input, can be helpful depending on the circumstances. Sometimes i use it and sometimes i turn it off.

- Ellipse/isocircle- this lets you create the apperance of circles and arcs in the current isoplane orientation. Don't forget to choose the isocircle option. If you create a lot of isocircles, you might want to consider creating a macro, or perhaps even a button.

- Line, move, copy, trim, extend, erase, fillet (radius=0)- These are the primary command sthat you'll use the most, I use offset all the time in orthographic drawing, but not in isometric drawing.