DRAUGHTSMAN MECHANICAL

NSQF Level - 5

1st Year (Volume I of II)

TRADE THEORY

SECTOR: Production & Manufacturing

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

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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 Committee 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 **Draughtsman Mechanical, 1st Year (Volume I of II) Trade Theory NSQF Level - 5 in Production & Manufacturing 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 & Entrepreneurship,
Government of India.

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 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 organisation to bring out this IMP **(Trade Theory)** for the trade of **Draughtsman Mechanical** under the **Production & Manufacturing** Sector for ITIs.

MEDIA DEVELOPMENT COMMITTEE MEMBERS

Shri. V. Dhanasekaran	-	Assistant Director of Training (Retd) CTI Guindy Chennai - 32.
Shri. G. Jayaraman	-	Assistant Training Officer (Retd) Govt I.T.I. (North chennai) DET, Tamilnadu.
Shri. G. Michael Johny	-	Assistant Manager Co-ordinator - NIMI - Chennai -32.

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

NIMI also acknowledges with thanks, the invaluable efforts rendered by all other staff who have contributed for the development of this Instructional Material.

NIMI is grateful to all others who have directly or indirectly helped in developing this IMP.

INTRODUCTION

TRADE THEORY

The manual of trade theory consists of theoretical information for the First Semester course of the Draughtsman Mechanical Trade. 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 co-relation 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 on trade practical. The indicating about the corresponding practical exercise are given in every sheet of this manual.

It will be preferable to teach/learn the trade theory connected to each exercise atleast 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.

Module 1	Safety		25 Hrs
Module 2	Basic engineering drawing		50 Hrs
Module 3	Types of curves		75 Hrs
Module 4	Dimensioning and scales		75 Hrs
Module 5	Projections		75 Hrs
Module 6	Free hand sketching		50 Hrs
Module 7	Development of surfaces and solids		50 Hrs
Module 8	Intersection of solids		50 Hrs
Module 9	Types of projection		50 Hrs
	Project work/ Industrial visit	Total	575 Hrs

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 intented to be used in workshop . It consists of a series of practical exercises to be completed by the trainees during the Fourth Semester course of the Electronic Mechanic trade supplemented and supported by instructions/ informations to assist in performing the exercises. These exercises are designed to ensure that all the skills in compliance with NSQF LEVEL - 5

The manual is divided into Eight modules. The distribution of time for the practical in the Eight modules are given below.

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

While developing the practical manual a sincere effort was made to prepare each exercise which will be easy to understand and carry out even by below average trainee. However the development team accept that there is a scope for further improvement. NIMI, looks forward to the suggestions from the experienced training faculty for improving the manual.

CONTENTS

LEARNING / ASSESSABLE OUTCOME

On completion of this book you shall be able to

- **Recognize & comply with safe working pracitces, environment regulation and housekeeping.**
- **Read and apply engineering drawing for different application in the field of work.**
- **Explain energy conservation, global warming and pollution and contribute in day-to-day optimally using available resources.**
- **Understand and apply basic computer working, basic operating system and uses internet services to get accustomed & take benefit of IT developments in the industry.**
- **Construct different Geometrical figures using drawing Instruments.**
- **Draw orthographic Projections giving proper dimensioning with title block and heading using appropriate line type and scale.**
- **Construct free hand sketches of simple machine parts with correct proportions.**
- **Construct plain scale, comparative scale, diagonal scale and vernier scale.**
- **Draw Sectional views showing orthographic projections.**
- **Development of surface and interpenetration of solid in ortho-graphic projection.**
- **Draw isometric projection from orthographic views (and vice - versa) and oblique projection from orthographic views.**

SYLLABUS

1st Year (Volume I of II) **Duration: Six Month**

Week No.	Ref. Learning Outcome	Professional Skills (Trade Practical) with Indicative hours	Professional Knowledge (Trade Theory)
1.	• Recognize &comply with safe working practices, environment regulation and housekeeping.	1. Importance of trade training, List of tools & Machinery used in the trade. (02 hrs) 2. Safety attitude development of the trainee by educating them to use Personal Protective Equipment (PPE). (05 hrs) 3. First Aid Method and basic training. (03 hrs) 4. Safe disposal of waste materials like cotton waste, metal chips/burrs etc. (02 hrs) 5. Hazard identification and avoidance. (02 hrs) 6. Safety signs for Danger, Warning, caution & personal safety message. (02 hrs) 7. Preventive measures for electrical accidents & steps to be taken in such accidents. (05 hrs) 8. Use of Fire extinguishers. (07 hrs)	Importance of safety and general precautions observed in the industry/shop floor. All necessary guidance to be provided to the newcomers to become familiar with the working of Industrial Training Institute system including stores procedures. Soft Skills: its importance and Job area after completion of training. Introduction of First aid. Operation of electrical mains. Introduction of PPEs. Introduction to 5S concept & its application. Response to emergencies e.g. power failure,
2.	• Construct different Geometrical figures using drawing Instruments	Perform assignment using drawing instruments: 9. Draw straight lines of a given length. (01hr) 10. Draw perpendicular, inclined (given angle) and parallel lines. Draw triangles with given sides and angles.(03hrs) 11. Construct regular polygons (up to 8 sides) on equal base. (04hrs) 12. Draw inscribed and circumscribed circles of triangle, pentagon and hexagon. (04hrs) 13. Draw a parallelogram with a given length included angle. (02hrs) 14. Draw an angle bi-sector and a line bi-sector. (08hrs) 15. Divide a line into given equal divisions. (06hrs)	Nomenclature, description and use of drawing instruments & various equipments used in drawing office. Their care and maintenance.
3.	-do-	16. Layout a A3 drawing sheet as per Sp -46 : 2003 with margin and name plate. (05hrs) 17. Draw a sample title block providing details as:	Lay out and designation of a drawing sheet as per Sp -46 : 2003 Recommended scale of engineering drawing as per Sp -46 : 2003

		(i) Title of the drawing (ii) Sheet number (iii)Scale (iv)Symbol, denoting the method of projection (v) Revision with sign (vi) Name of the firm (vii) Initials of staff drawn, checked and approved. (05hrs) 18. Draw different types of lines & write their uses in drawing. (05hrs) 19. Label a drawing views showing most of the types of line.(13hrs)	Types of Lines and their application. Folding of prints for filing Cabinets or binding as per SP: 46-2003
4	-do-	20. Write Block letters & numerals in single & double stroke of ratio 7:4 and 5:4 in drawing sheet. (28hrs)	Type of lettering proportion and spacing of letters and words.
5-6	-do-	21. Construction of ellipse, parabola & hyperbola in different methods. (28hrs) 22. Construction of involutes, cycloid curves, helix & spiral. (28hrs)	Definition of ellipse, parabola, hyperbola, different methods of their construction. Definition & method of drawing involutes cycloid curves, helix & spiral.
7	Draw orthographic Projections giving proper dimensioning with title block using appropriate line type and scale.	21. Construct object drawing with dimensioning in different alignment as per SP-46. (03hrs) 24. Create dimensions in previous assignments. (25hrs)	Terminology – feature, functional feature,functional dimension, datum dimension, principles. Units of dimensioning, System of dimensioning, Method of dimensioning & common features.
8	-do-	25. Draw orthographic projection of points and lines. (10hrs) 26. Draw projection of plane figures (lamina). (18hrs)	Methods of obtaining orthographic view. Position of the object, selection of the views, three views of drawing. Planes and their normal projections.
9-10	-do-	27. Draw orthographic projection of solids- prisms, cylinders, cones, pyramids. (28hrs) 28. Draw orthographic projection of cut section/ frustums of solids- prism, cylinders, cones, pyramids. (28hrs)	Orthographic projection. First angle and third angle projection. Principal of orthographic projection. Projection of solids like prism, cones, pyramids and their frustums.
11	Construct free hand sketches of simple machine parts with correct proportions.	29. Free hand sketch (in proper proportion) of tool post of a Lathe, Bench Vice, Cutting Tools, Bolts, Stud & Nut, gland, Pipe Flange, Hand Wheel, Crane hook, Steel bracket. (28hrs)	Methods of free hand sketching for machine parts.

11	Construct free hand sketches of simple machine parts with correct proportions.	29. Free hand sketch (in proper proportion) of tool post of a Lathe, Bench Vice, Cutting Tools, Bolts, Stud & Nut, gland, Pipe Flange, Hand Wheel, Crane hook, Steel bracket. (28hrs)	Methods of free hand sketching for machine parts.
12	Construct free hand sketches of simple machine parts with correct proportions.	30. Draw plain scales, diagonal scales, comparative scales, venire scale & scale of chords. (28hrs)	Knowledge of different types of scales, scale of cords, their appropriate uses, Principle of R.F, diagonal & vernier.
13-14	Draw Sectional views of orthographic projections.	31. Sketch Conventional sings and symbols. (10hrs) 32. Sketch different types of section lines and abbreviations for different materials as per SP-46:2003. (10hrs) 33. Draw Orthographic drawing of solids (viz., cube, prisms, cone and pyramids) finding out the true shape surfaces cut by oblique planes. (36hrs)	Knowledge of solid section.Types of sectional views & their uses. Cutting plane and its representation. Parts not shown in section. Conventional signs, symbols, abbreviations & hatching for different materials. Solution of problems to find out the true shape of surfaces when solids are cut by different cutting planes.
15-16	Develop surface and interpenetration of solid in orthographic projection.	34. Construct the development of surface of cylinder, prisms, Cone, pyramids and their frustum. (28hrs) 35. Draw development of an oblique cone with elliptical base. (05hrs) 36. Draw the development of a 3-pieces pipe elbow, a pipe hole through it, a bucket and a funnel. (23hrs)	Definition of development, its need in industry & different method of developing the surfaces. Development of surfaces bounded by plane of revolution intersecting each other. Development of an oblique cone with elliptical base etc. Calculation of developed lengths of geometrical solids.
17-18	-do-	37. Construct orthographic projection of interpenetrating solids (cylinder, cones, prism & pyramid) of axes right angle to each other and axes inclined to each other. (36hrs) 38. Generate the curves of intersection of cylinder penetrating through a sphere, cone and a cylinder. (20hrs)	Definition of Intersection & interpenetration curves. Common method to find out the curve of interpenetration. Solution of problems on interpenetration of prism, cones, & pyramids with their axes intersecting at an angle. Intersection of cylinder.
19	Draw isometric projection from orthographic views (and vice-versa) and draw oblique projection from orthographic views.	39. Construct the isometric view of Polygons and circular lamina. (10hrs) 40. Draw isometric view of solid geometrical figures from orthographic views with dimension. (10hrs)	Principle of isometric projection and Isometric drawing. Methods of isometric projection and dimensioning. Isometric scale. Difference between Isometric drawing & Isometric projection.

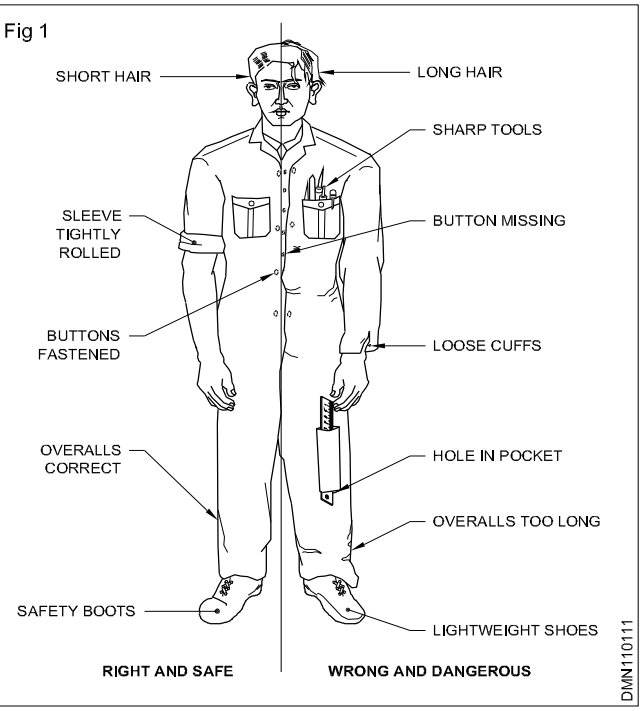
		41. Draw isometric views of truncated cone and pyramid. (08hrs)	
20-21	-do-	39. Construct the isometric view of Polygons and circular lamina. (10hrs) 40. Draw isometric view of solid geometrical figures from orthographic views with dimension. (10hrs) 41. Draw isometric views of truncated cone and pyramid. (08hrs) 43. Construct orthographic views of hanger, bracket & support (10hrs) 44. Draw isometric view of V-block, Angle plate, sliding block. (18hrs) 45. Draw isometric drawing of a simple Journal Bearing. (10hrs.)	Principle of isometric projection and Isometric drawing. Methods of isometric projection and dimensioning. Isometric scale. Difference between Isometric drawing & Isometric projection. orthographic drawings for clear description of the object.
22	-do-	46. Draw oblique projection of circular lamina in receding axis at 30° & 45°. (05hrs) 47. Draw oblique projection of levers and hollow blocks. (23hrs)	Principle and types of oblique projection. Advantage of oblique projection over isometric. Projection.
23-24	**Project work/ on-the-job training:** a. Create solid stepped block by thermocol and represent 1st angle and 3rd angle projection in the co-ordinate planes of paper board and transparent sheet. b. Create solid hexagonal pyramid cut of section by thermocol and represent projection and impression of true shape in the co-ordinate planes of paper board and transparent sheet. c. Prepare by paper cutting of developed surface of prisms, cone and pyramids. d. Prepare the models of interpenetrated solids (by thermocol / plasticine) e. Prepare models of V-block, angle plate, hanger and bracket.		
23 - 25	**Revision**		
26	**Examination**		

Safety

Objectives: At the end of this lesson you shall be able to
- **state the importance of safety**
- **list out the safety precautions to be observed in a machine shop**
- **list out the personal safety precautions to be observed**
- **list out the safety precautions to be observed while working on the machines.**

Generally accidents do not happen; they are caused. Most accidents are avoidable. A good craftsman, having a knowledge of various safety precautions, can avoid accidents to himself and to his fellow workers and protect the equipment from any damage. To achieve this, it is essential that every person should follow safety procedure. (Fig 1)

Fig 1



Safety in a workshop can be broadly classified into 3 categories.

- General safety
- Personal safety
- Machine safety

General safety

Keep the floor and gangways clean and clear.

Walk with care in the workshop, do not run.

Don't leave the machine in running condition when you are not in place .

Don't touch or handle any equipment/ machine unless authorised to do so.

Don't walk under suspended loads.

Don't cut jokes while on work.

Use the correct tools for the job.

Keep the tools at their specified place.

Wipe out splil oil immediately.

Replace worn out or damaged tools immediately.

Never direct compressed air at yourself or at your co-worker.

Ensure adequate light in the workshop.

Clean the machine only when it is in switched off condition.

Sweep away the chips.

Know everything about the machine before you start it.

Personal safety

Wear a one piece overall or boiler suit.

Keep the overall buttons fastened.

Don't use ties mufflers and towels.

Follow up the sleeves tightly above the elbow.

Wear safety shoes or boots or chain.

Cut the hair short &don't wear a finger ring, watch or chain.

Never lean on the machine.

Don't clean hands using coolant fluid.

Don't remove guards when the machine is in running condition.

Don't use cracked or chipped tools.

Don't start the machine until

- the workpiece is securely mounted
- the feed mechanism is in the neutral position
- the work area is cleaned and clear.

Don't adjust clamps or holding devices while the machine is in running condition.

Never touch the electrical equipment with wet hands.

Don't use any faulty electrical equipment.

Ensure that electrical connections are made by an authorised electrician only.

Concentrate on your work.Have a calm attitude.

Do things in a methodical way.

Don't engage yourself in conversation with others while doing on your job.

Don't distract the attention of others.

Don't try to stop a running machine with hands.

Machine safety

Switch off the machine immediately if something goes wrong.

Keep the machine clean.

Replace any worn out or damaged accessories, holding devices, nuts, bolts etc as soon as possible.

Do not attempt operating the machine until you know how to operate it properly.

Do not adjust tool or the workpiece unless the power is off.

Stop the machine before changing the speed.

Disengage the automatic feeds before switching off.

Check the oil level before starting the machine.

Never start a machine unless all the safety guards are in position.

Take measurements only after stopping the machine.

Use wooden planks over the bed while loading and unloading heavy jobs.

Safety is a concept, understand it. Safety is a habit, cultivate it.

Organisation of the industrial training institute

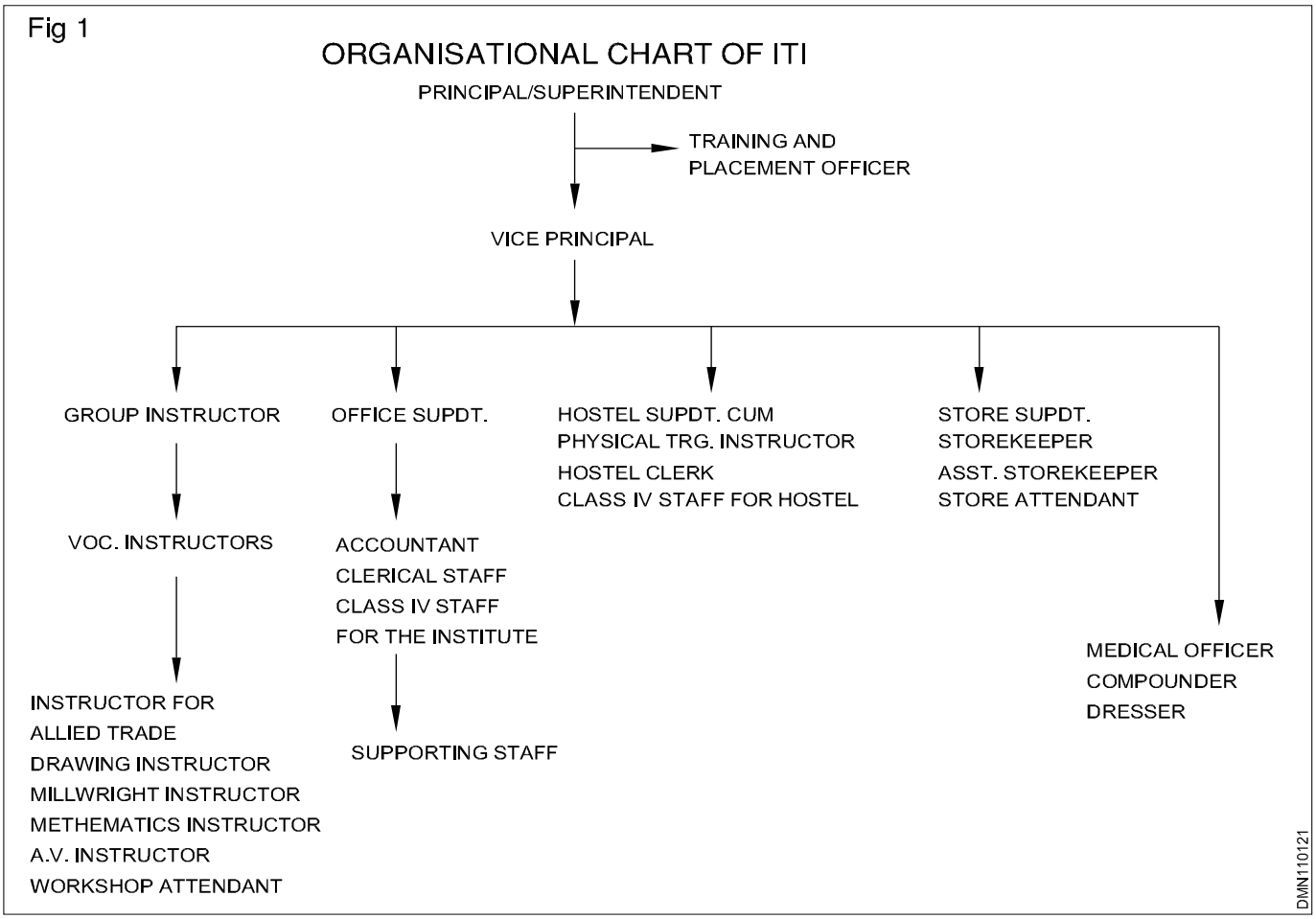
Objectives: At the end of this lesson you shall be able to
- **identify the staff structure of the institute**
- **identify the available trades in the institute and their functions.**

The industrial training institute throughout India follow the same syllabus pattern given by the National Council for Vocational Training (NCVT) Board. In India there are number of Govt. ITIs and Private ITIs. Based on the Govt. of India, Ministry of Labour's Annual report of 2011-2012. The Govt. ITIs in each state work under the Directorate of Employment and Training which is a department under the Labour Ministry in most of the states.

The head of the industrial training institute is the Principal, under whom there is one Vice-Principal, group instructor and a number of trade instructors as shown in the organisation chart of ITI.

Even though there are 62 trades selected for instructional training and 135 trades identified for apprentice training, according to the requirement of industrial needs, area and finance a few selected trades are established under each ITI. The trainees are advised to make a list of the trades available in their ITI, the type of training and the scope of these trades in getting self or job employment in the rural and urban areas.

Fig 1



Road safety

Objectives: At the end of this lesson you shall be able to
- **list three kinds of road sign**
- **describe the marking on the road**
- **describe the various police traffic hand signal and light signal**
- **list the collision causes.**

In older days road locomotive carrying a red flag by day and red lantern by night. Safety is the prime motive of every traffic.

Kinds of road signs

Mandatory

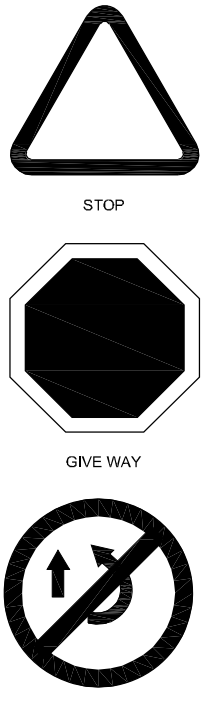
Cautionary and

Informatory

Mandatory sign (Fig 1)

Violation of mandatory sign can lead to penalities. Ex. Stop, give way, limits, prohibited, no parking and compulsory sign.

Fig 1



Cautionary signs (Fig 2)

Cautionary/ warming signs are especially safe. Do's and don'ts for pedestrians, cyclists, bus passengers and motorists.

Information signs (Fig 3)

Information signs as especially benefit to the passengers and two wheelers.

Marking lines on road (Fig 4)

- Marking lines are directing or warn to the moving vehicles, cyclist and pedestrians to follow the law.
- Single and short broken lines with middle of the road allow the vehicle to cross the dotted lines safely overtake whenever required.
- When moving vehicle approaching pedestrian crossing, be ready to slow down or stop to let people cross.
- Do not overtake in the vicinity of pedestrian crossing.

Fig 2

Fig 3

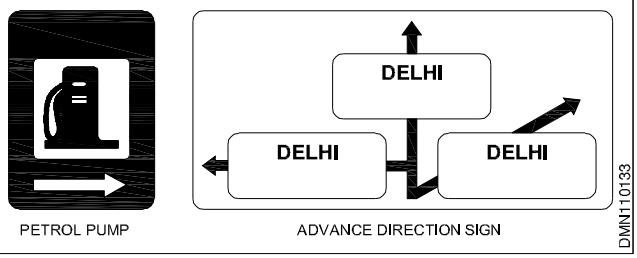
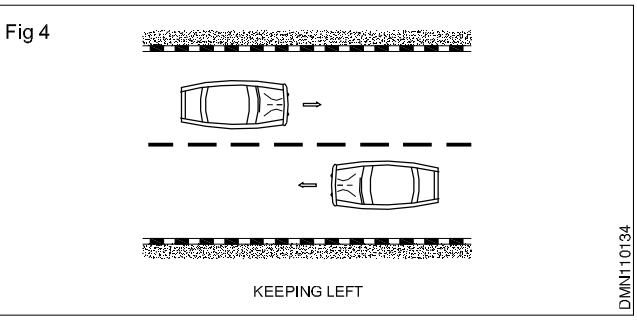


Fig 4



Police signals

To stop a vehicle approaching from behind. Fig 5(1)

To stop a vehicle coming from front. Fig 5(2)

To stop vehicles approaching simultaneously from front and behind. Fig 5(3)

To stop traffic approaching from left and wanting to turn right. Fig 5(4)

To stop traffic approaching from the right to allow traffic from left to turn right. Fig 5(5)

To allow traffic coming from the right and turning right by stopping traffic approaching from the left. Fig 5(6)

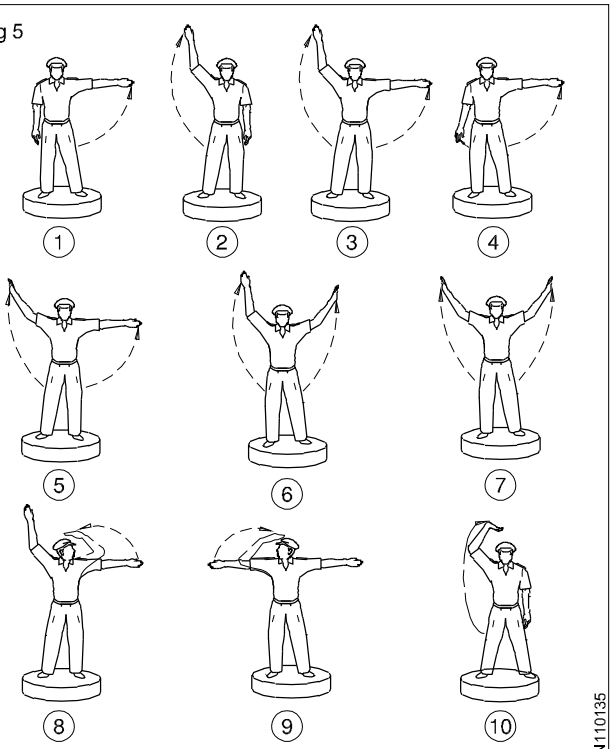
Warning signal closing all traffic. Fig 5(7)

Beckoning on vehicles approaching from left. Fig 5(8)

Beckoning on vehicles approaching from right. Fig 5(9)

Beckoning on vehicles from front. Fig 5(10)

Fig 5

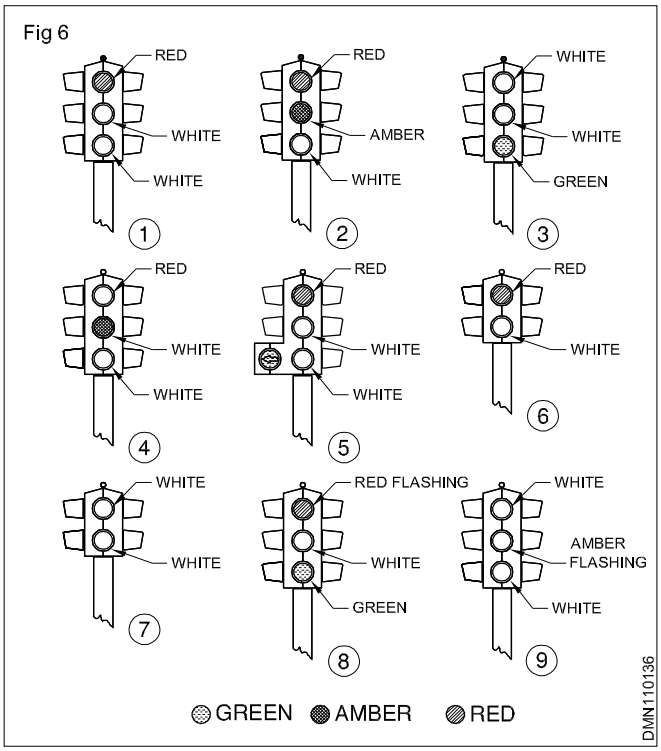


POLICE SIGNALS

Traffic light signals

Red means stop. Wait behind the stop line on the carriage way. Fig 6(1)

Fig 6



Red and amber also means stop. Do not pass through or start until green shows. Fig 6(2)

Green means you may go on if the way is clear. Take special care if you mean to turn left or right and give way to pedestrians who are crossing. Fig 6(3)

Amber means stop at the stop line. you may only go on if the amber appears after you have crossed the stop line or so close to it that to pull up may not be possible. Fig 6(4)

Green arrow means that you may go in the direction shown by the arrow. You may do this whatever other lights may be showing. Fig 6(5)

Pedestrians - do not cross. Fig 6(6)

Pedestrians - cross now. Fig 6(7)

Flashing red means stop at the stop line and if the way is clear proceed with caution. Fig 6(8)

Flashing amber means proceed with caution. Fig 6(9)

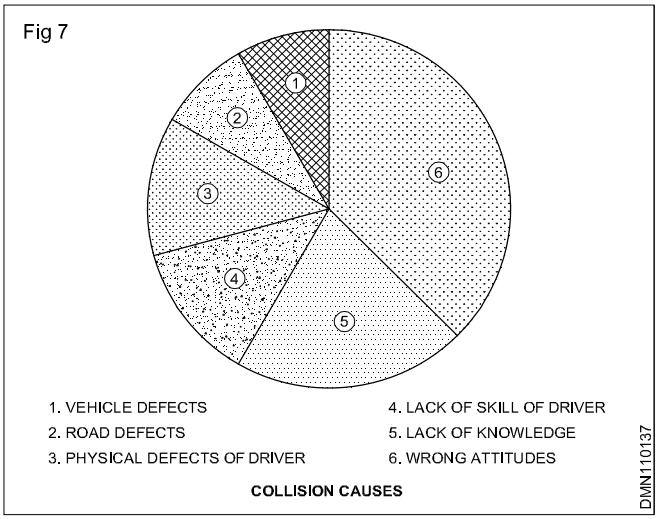
Collision causes

Three factors are responsible for collision

- Roads
- Vehicles and
- Drivers.

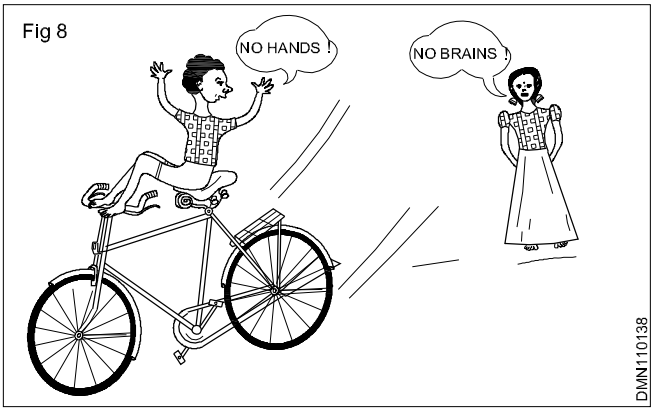
The fig 7 shows approximately proportionate causes of collision. In wrong attitudes such that avoid foolish acts at the wheel. Driving time is not play time.(fig 8)

Fig 7

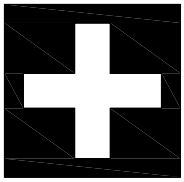


COLLISION CAUSES

Fig 8

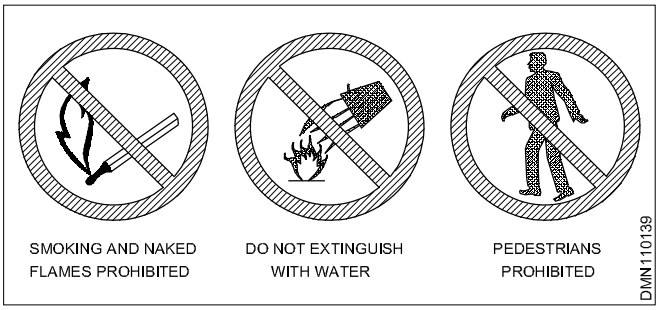


Information signs



SHAPE	Square or oblong.
COLOUR	White symbols on green background.
MEANING	Indicates or gives information of safety provision.
Example	First aid point.

Prohibition signs



Mandatory Signs

Warning Signs

Question about your safety

Do you know the general safety rules that cover your place of work?

Are you familiar with the safety laws that govern your particular job?

Do you know how to do your work without causing danger to yourself, your workmates and the general public?

Are the plant, machinery and tools that you use really safe? Do you know how to use them safely and keep them in a safe condition?

Do you wear all the right protective clothing, and have you been provided with all the necessary safety equipment?

Have you been given all the necessary safety information about the materials used?

Have you been given training and instruction to enable you to do your job safely?

Do you know who is responsible for safety at your place of work?

Do you know who are the appointed 'Safety Representatives'?

Guidelines for good shop floor maintenance

Objectives: At the end of this lesson you shall be able to
- **list the benefits of a shop floor maintanance**
- **state what is 5S**
- **list the benefits of 5S.**

Benefits of a shop floor maintenance

Some of the benefits which may be derived from the utilization of a good Shop Floor Maintenance are as follows:

- Improved Productivity
- Improved operator efficiencies.
- Improved support operations such as replenishment moves and transportation of work in process and finished goods .
- Reduction of scrap
- Better control of your manufacturing process
- More timely information to assist shop floor supervisors in managing their assigned production responsiblities.
- Reduction of down time due to better machine and tool monitoring.
- Better control of Work In Progress inventory, what is is and where it is improved on time schedule performance.

5S Concept

5S is a Japanese methodology for worksplace organisation. In Japanese it stands for seiri (SORT), seiton(SET),seiso (SHINE), seiketsu(STANDARDIZE), and shitsuke (SUSTAIN).

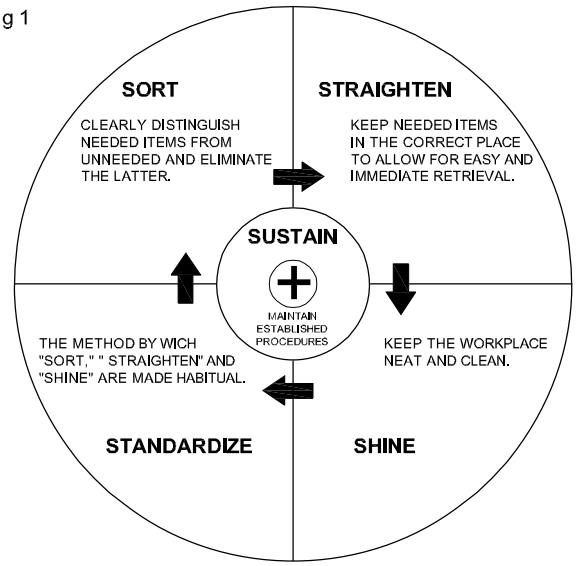
The list describes how to organize a work space for efficiency and effectiveness by identifying and storing the items used, maintaining the area and items, and sustaining the new order. The list describes how to organize a work space for efficiency and effectiveness by identifying and stroing the items used, maintaining the area and items, and sustaining the new order.

5S Wheel

The Benefits of the 5s system

- Increases in productivity
- Increases in quality
- Reduction in cost

Fig 1



5S WHEEL

Basic first-aid

Objectives: At the end of this lesson you shall be able to
- **state what is first aid**
- **list the key aims of first aid**
- **explain the ABC of the first aid**
- **brief how to give first-aid for a victim who need first aid.**

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.

First aid procedure often consists 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.
- **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 cardiopulmonary 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 an 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 organization such as the Red cross and St. John ambulance.

ABC of 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.
- **Breathing:** Breathing if stops, the victim may die soon. Hence means of providing support for breathing is an important next steps. 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.

When providing first aid one needs to follow some rule. There are certain basic norms in teaching and training students in the approach and administrating of first aid to sick and injured.

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 cause one to do wrong procedures. Hence be calm and focus on the given institution. 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 surroundings 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.

Do no harm

Most often over 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 causes more harm.

This does not mean do nothing. It means 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 to do it. Hence moving a trauma victim, especially an unconscious one, needs very careful assessment. Removal 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 problem 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 the time, the more likely the best treatment applied.

Maintain the hygiene

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

Cleaning and dressing

Always clean the wound thoroughly before applying the bandage lightly wash the wound with clean water.

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.

CPR (Cardio-Pulmonary Resuscitation) can be life-sustaining

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 some 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 maneuver 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 use 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 stated and where exactly it is located. If someone has already been injured or is missing, report that as well.
- A life-threatening medical emergency, explain how the incident occurred and what symptoms the person currently displays.

- A car crash - Location, serious nature of injures, vehicle's details and registration, number of people involved etc.

Call emergency service

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 that 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 question as best as 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, gasses, 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 points (wrist, carotid artery, groin)

Avoid moving the victim

Avoid moving the victim unless they are 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 at the accident scene, try to establish breathing before calling for help, and do not leave the victim alone unattended.

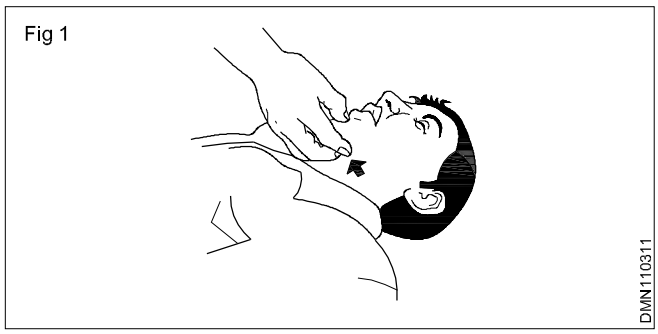
Determine responsiveness

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

If the person remains unresponsive, carefully roll them on 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.(Fig 1)

Fig 1



Look, listen and feel for signs of breathing

Look for the victim's chest to raise 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 colour and check their pulse (the carotid artery is a good option; it is located on either side of the neck, below the jaw bone). 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.

- **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 from 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 colour 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.
- **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.
- **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.

Stay with the victim until help arrives

Try to be a calming presence for the victim until assistance can arrive.

Unconsciousness (COMA)

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.

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)
- Extreme of body temperature (Heat, Cold)
- Cardiac arrest (Heart attack)
- Stroke (Cerbro-vascular accident)
- Blood loss (Haemorrhage)
- Dehydration (Diarrohea & vomiting)
- Diabetes (Low or high sugar)
- Blood pressure (Very low or very 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:

- 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 (palpitation)
- Stupor

First aid

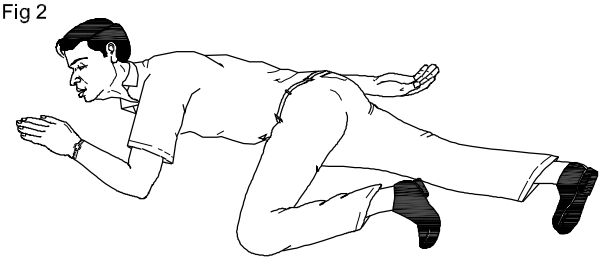
- Call EMERGENCY number.
- Check the person's airway, breathing, and pulse frequently. If necessary, begin rescue breathing and CPR.
- If the person is breathing and lying on the back and after ruling out spinal injury, carefully roll the person onto the side, preferably left side. Bend the top leg so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

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.

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. Never give anything by mouth to an unconscious casualty.

Fig 2



DMN110312

How to diagnose an unconscious injured person

- Consider alcohol: look for signs of drinking, like empty bottles or the smell of alcohol.
- Consider epilepsy: are there signs of a violent seizure, such as saliva around the mouth or a generally dishevelled scene?
- Think insulin: might the person be suffering from insulin shock (see 'How to diagnose and treat insulin shock")?
- Think about drugs: was there an overdose? Or might the person have under dosed - that is not taken enough of a prescribed medication?
- Consider trauma: is the person physically injured?
- Look for signs of infection: redness and/ or red streaks around a wound.
- Look around for signs of Poison: an empty bottle of pills or a snakebite wound.
- Consider the possibility of psychological trauma: might the person have a psychological disorder of some sort?
- Consider stroke, particularly for elderly people.
- Treat according to what you diagnose.

Shock(Fig 3)

A severe loss of body fluid will lead to a drop in blood pressure. Eventually the blood's circulation will deteriorate and the remaining blood flow will be directed to the vital organs such as the brain. Blood will therefore be directed away from the outer area of the body, so the victim will appear pale and the skin will feel ice cold.

Fig 3

DMN110313

Safety practice - fire extinguishers

Objectives: At the end of this lesson you shall be able to
- **state the effects of a fire breakout**
- **state the causes for fire in the workshop**
- **state the conditions required for combustion relevant to fire prevention**
- **state the general precautionary measures to be taken for fire prevention.**

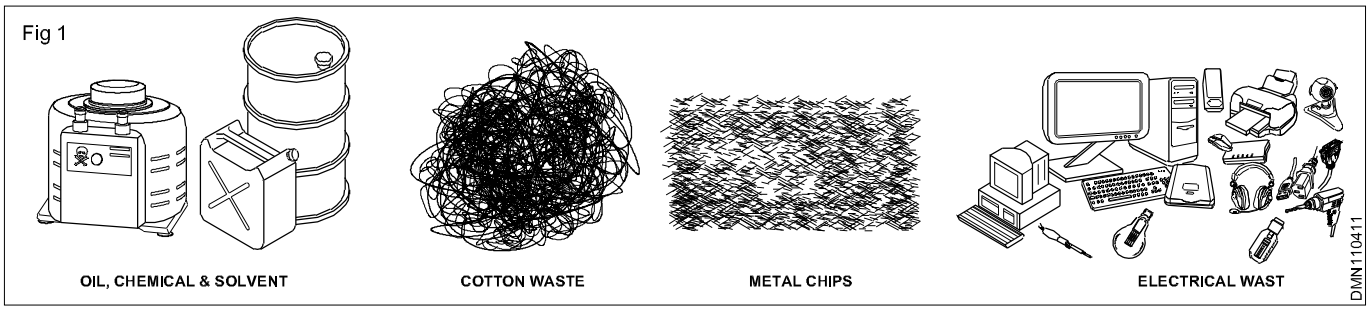
Waste material

Industrial waste is the waste produced by industrial activity, such as that of factories, mills and mines.

List of waste material (Fig 1)

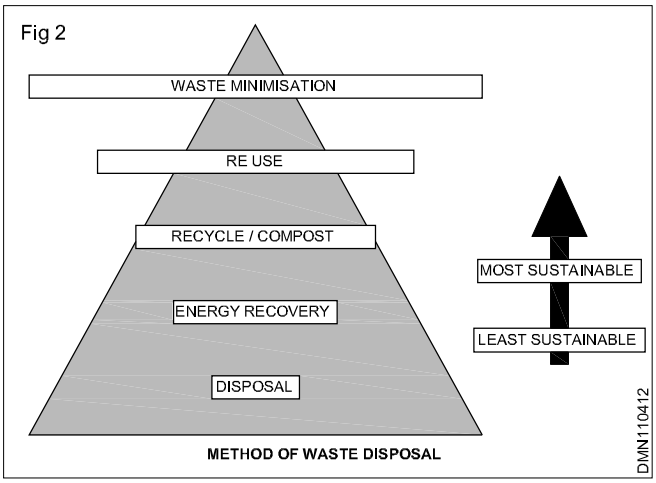
- Cotton waste
- Metal chips of different material.
- Oily waste such as lubricating oil, coolant etc.
- Other waste such as electrical, glass etc.

Fig 1



Methods of waste disposal

Fig 2



Recycling

Recycling is one of the most well known method of managing waste. It is not expensive and can be easily done by you. If you carry out recycling, you will save a lot of energy, resources and thereby reduce pollution.

Composting

This is a natural process that is completely free of any hazardous by-products. This process involves breaking down the materials into organic compounds that can be used as manure.

Landfills

Waste management through the use of landfills involves the use of a large area. This place is dug open and filled with the waste.

Burning the waste material

If you cannot recycle or if there are no proper places for setting up landfills, you can burn the waste matter generated in your household. Controlled burning of waste at high temperatures to produce steam and ash is a preferred waste disposal techinque.

Advantage of waste disposal

- Ensures workshop neat & tidy
- Reduces adverse impact on health
- Improves economic efficiency
- Reduce adverse impact on environment

Colour code for bins for waste segregation

Sl.no.	Waste Material	Color code
1	Paper	Blue
2	Plastic	Yellow
3	Metal	Red
4	Glass	Green
5	Food	Black
6.	Others	Sky blue

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 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.

Draughtsman Mechanical 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, 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.

About the trade

What do draftsman do?

Draftsmen, also called drafters, perform some of the same tasks as desingers and often work with design. Draftsmen, prepare CAD drawings. However, drafting can be applied to many other areas besides production and manufacturing. Drafting can be used to create drawings of circuitry or mechanical designs. A draftsman's CAD drawings include technical details and specifications such as materials, dimensions and procedures. In addition to using CAD, draftsmen also use calculators, tables and technical handbooks.

The type of work a draftsman does depends on his or her area of expertise. For example, drafters produce drawings for new manufacturing projects. They may specialize in or in the type of material used, such as steel, timber design drafters. Mechanical prepare drawings for use in major mechanical projects, such as production.

Draftsmen are responsible for creating technical drawings that accurately represent design ideas. Draftsmen use hand drawing and computer - aided drafting methods to generate precise drawings that meet given specifications and are used by manufacturers and engineers.

Plan and organize assigned work and detect & resolve issues during execution. Demonstrate possible solutions and agree tasks with in the team. Communicate with required clarity and understand technical English. Sensitive to environment, self-learning and productivity.

Job duties and tasks for "Mechanical drafter"

1 Produce drawings using computer assisted drafting systems (CAD) or drafting machines or by hand using compasses, dividers, protractors, triangles and other drafting devices.

2 Draft plans and detailed drawings for structures, installations, and Production projects such as working from sketches or notes.

3 Draw detail parts of machines. Assembly drawing, wiring draw unit limits, fits and trendances.

This course is meant for the candidates who aspire to;

1 Use and maintain in good condition -drawing instruments, slide rule, survey instrument, autolevel, digital theodolite, total station, GPS, computer & drafting software, plotter & printer etc.

2 Plan and draw of elevation-sectional views.

3 Prepare working drawings of all types of machine part line sketches in CAD.

4 Planning, drawing, estimating, and costing production manufacturing. Drawing plans by using CAD. Making of 3D models of mechanical and Giving detail information of work etc.

5 Prepare proposals for drainages and water supply for a given building including preparation of detailed drawings.

6 Plot the longitudinal section and cross - section for a proposed road and calculate the earth work and materials for road work.

7 Draw the parts of R.C.C structures and steel sections. Prepare working drawing of R.C.C structures from the given field data.

8 Draw from sketches or specifications various types and cross - section of roads culverts, bridges, Railways & irrigation structures in CAD.

9 Carry out the surveying by using latest equipments (Auto level, Digital theodolite, total station, GPS).

Options for employment are

Private sector opportunities shall be as Draftsman, CADD operators.

Options for Self- Employment are

The Trainee shall be able to independently undertake mechanical drawing, estimation & costing consultant for production & manufacturing work. He can set up his own office for above work.

Rules and regulation of the institute and trade

- The trainees who are all got admission in I.T.I has to follow same general rates 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 correct in punctuality should be maintained.
- He should be very sincere and faithfull not only to this instructor but also other instructors and staff of 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 his 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)

Employment oppurtunities for traniee for traniee from this trade as draftsman - sr. draughtsman - chief draughtsman - vocational instructor shall be availables in central & state government departments.

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 tracts, 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 Draughtsman Civil .

The name of some public sectors are given below.

- C.P.N.D
- Railways
- Military Engineering
- DET of states
- BEL
- BHEL
- Golden Rock Trichy
- Automic power station

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 D'man Mechanical for each semester

The following are minimum broad learning outcomes after completion of the Draughtsman mechanical course of two years duration:

1. Recognize & comply with safe working practices, environment regulation and housekeeping.
2. Work in a team, understand and practice soft skills, technical english to communicate with required clarity.
3. Demonstrate knowledge of concept and principles of basic arithmetic, algebraic, trigonometric, statistics, co-ordinate system and apply knowledge of specific area to perform practical operations.
4. Understand and explain basic science in the field of study including basic electrical, and hydraulics & pneumatics.
5. Read and apply engineering drawing for different application in the field of work.
6. Understand and explain the concept in productivity, quality tools, and labour welfare legislation and apply such in day-to-day work to improve productivity & quality.
7. Explain energy conservation, global warming and pollution and contribute in day-to-day work for personal & societal growth.
8. Explain personnel finance, entrepreneurship and manage/organize related task in day-to-day work for personal & societal growth.
9. Understand and apply basic operating system and uses internet services to get accustomed & take benefit of IT developments in the industry.

Semester - I

10. Construct different geometrical figures using drawing instruments.
11. Draw orthographic projecions giving proper dimensioning with title block and heading using appropriate line type and scale.
12. Construct free hand sketches of simple machine parts with correct proportions.
13. Construct plain scale, comparative scale, diagonal scale and vernier scale.
14. Draw sectional views showing orthographic projections.
15. Develop surface and interpeneration of solid in orthographic views (and vice - versa) and draw oblique projection from orthographic views.

16 Draw isometric projection from orthographic views (and vice-versa) and draw oblique projection from orthographic views.

Semester - II

17 Draw and indicate the specification of different types of fasteners, welds and locking devices as per SP - 46:2003

18 Acquire basic knowledge on tools and equipment of allied trades viz, fitter, turner, machinist, sheet metal worker, welder, foundry man, electrician and maintenace motor vehicles.

19 Draw different types of gears, couplings and bearing with tolerance dimension and indicating surface finish symbol.

20 Create 2D objects on CAD drawing space using commands from ribbon, menu bar, toolbars and by typing in command prompt.

Semester - III

21 Construct projection views of geometrical figures with dimension and annotation on CAD in model space and viewport in layout space.

22 Draw detail and assembly drawing of machine parts Viz., Pulleys, pipe fittings, gears and cams applying range of cognitive and practical skills.

23 Construct drawing and engine parts with detailed and assembly in template layout applying quality concept in CAD.

24 Create 3D solid by switching to 3D modeling workspace in CAD, generate views, print preview and plotting

Semester - IV

25 Construct detailed and assembled drawing applying conventional sign & symbols.

26 Prepare drawing of machine part by measuring with gauges and measuring instruments

27 Draw a machine shop layout considering process path and ergonomics (human factor).

28 Create and plot assembly and detail views of a machine part with dimension, Annotation, title block and bill of materials in solid works/Auto CAD invertor/ 3D modeling.

29 Create production drawing of machine part.

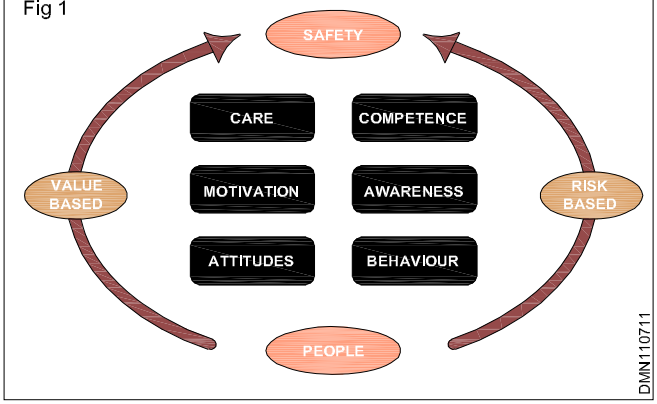
Occupational safety and health

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)

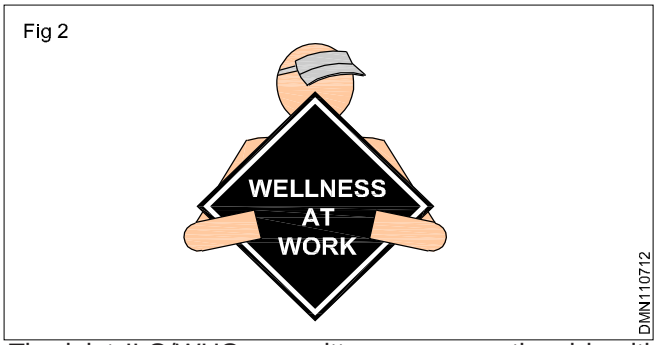
Fig 1



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. (Fig 1)

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

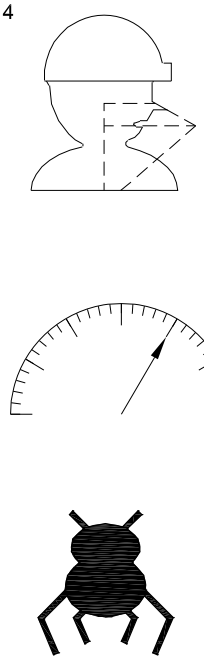
BIOLOGICAL HAZARD

DMN110723

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 4



BIOLOGICAL HAZARD

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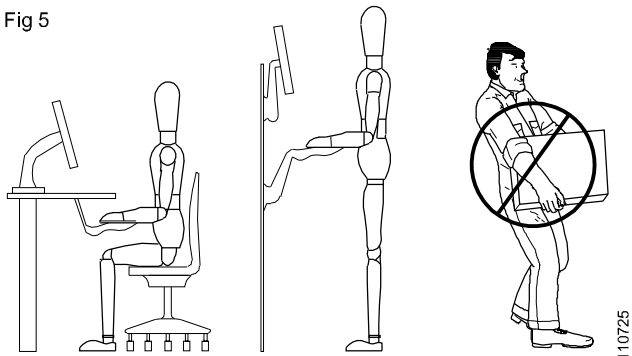
Fig 5



ERGONOMIC HAZARDS

DMN110725

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

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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

DMN110727

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.

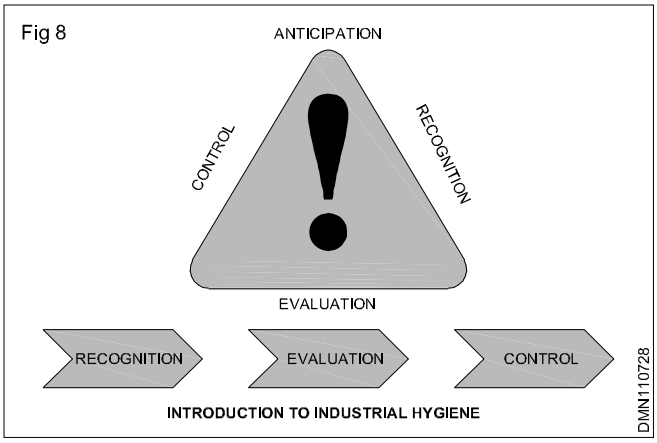
A workplace inspection should include

- 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.

Fig 8



DMN110728

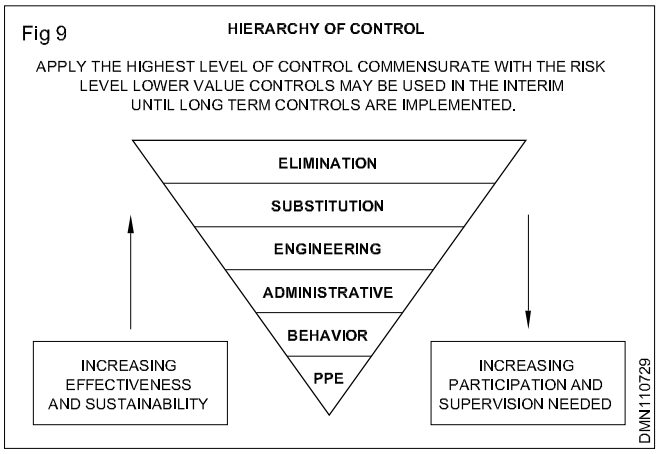
Occupational hygiene uses science and engineering to prevent ill health caused by the environment in which people work. It helps employers and employees to understand the risks and improve working conditions and working practices. (Fig 9)

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 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.

Fire safety

Objectives: At the end of this lesson you shall be able to
- **state different type of fire**
- **state the differemt 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.

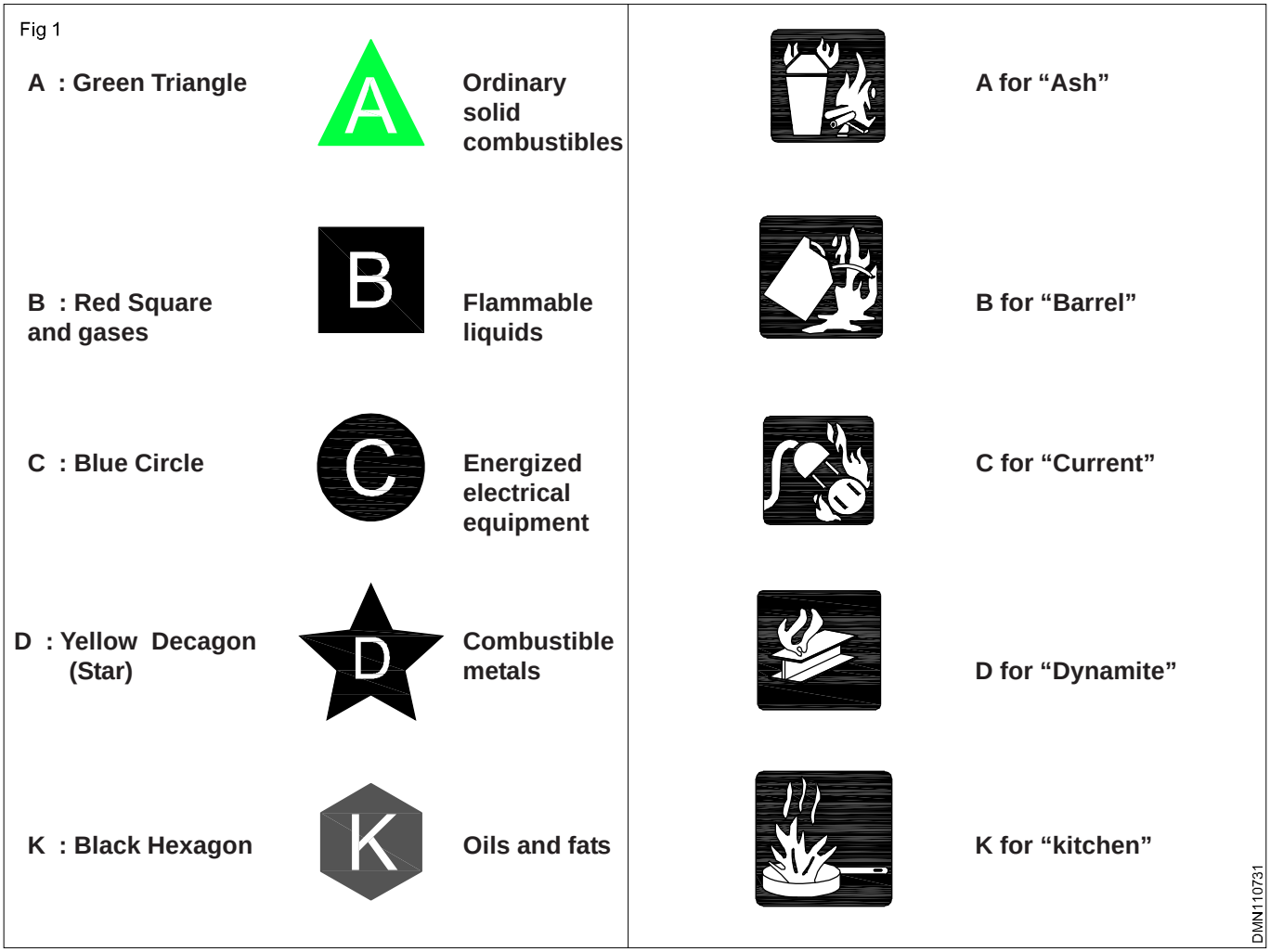
Carbon-dioxide extinguishers contain the expellant gas in a separate cartridge that is punctured prior to discharge, exposing the propellant to the extinguishing agent. This type is not as common, used primarily in areas such as industrial facilities, where they receive higher-than-average use. They 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.

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.

Fig 1



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 basic principle for protective equipment**
- **state the accident prevention technique**
- **describe the controls of accidents & safety measures.**

Basic Principles for Protective Equipment (PPE)

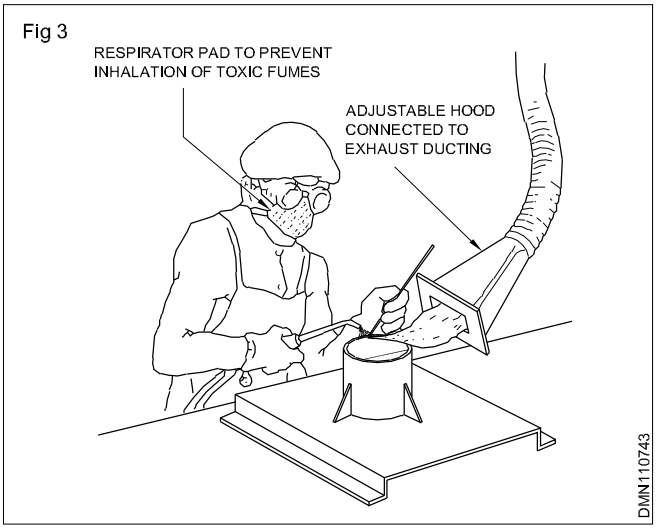
Personal protective equipment, commonly referred to as "PPE", is a equipment worn to minimize exposure to serious workplace injuries and illnesses. (Fig 1) These injuries and illnesses may result from contact with chemical, radiological, physical, electrical, mechanical or other workplace hazards. Personal 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

Fig 3



to use personal protective equipment to know:

- 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.

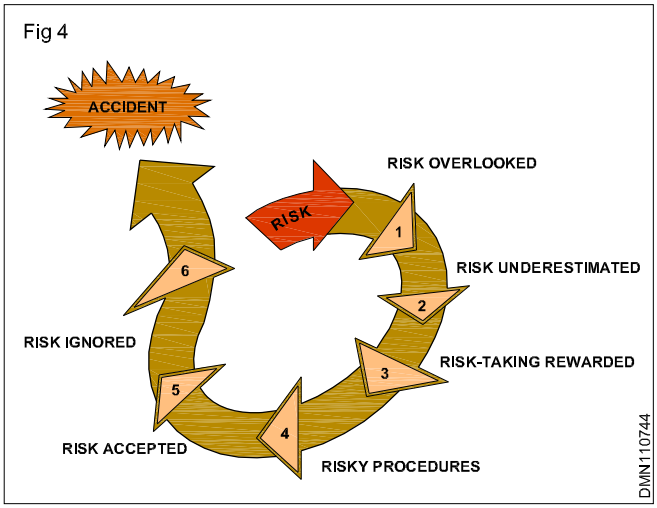
Accident prevention techniques-control of accidents and safety measures

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

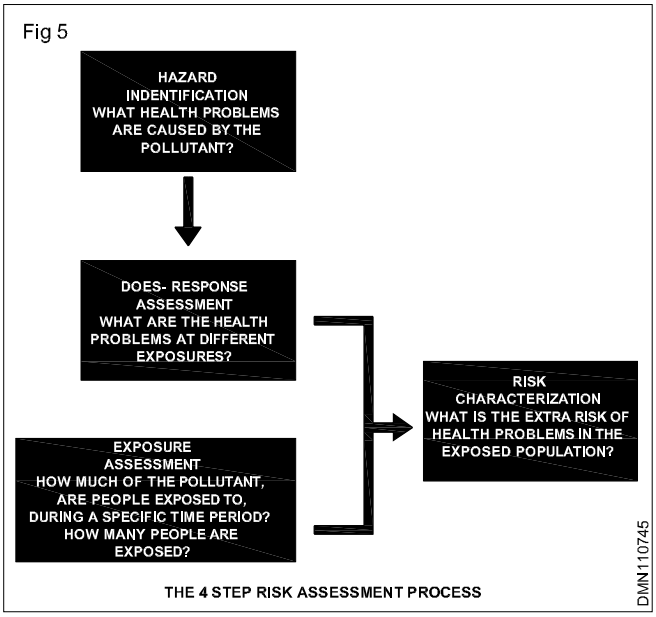


Control of accidents are done by reducing exposure to a hazards through engineering, work practices, administration or protective equipment.

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

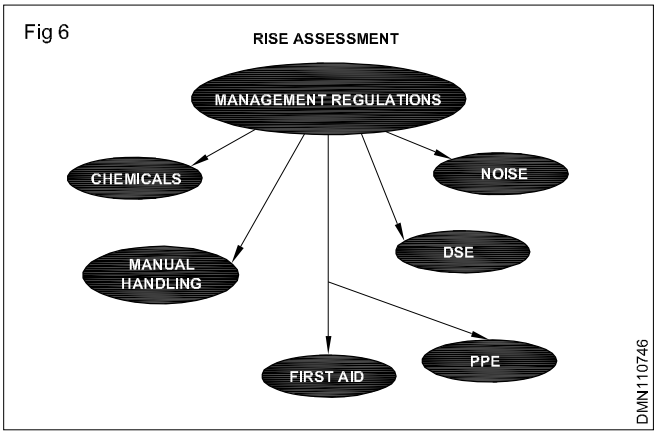


THE 4 STEP RISK ASSESSMENT PROCESS

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.

Fig 6



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 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 the plant work place and medical treatment program.

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

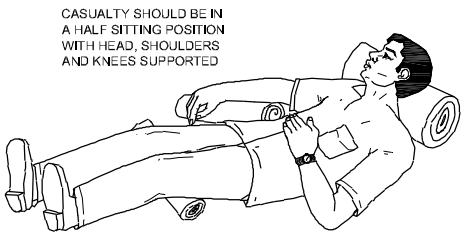
CIRCULATION

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.

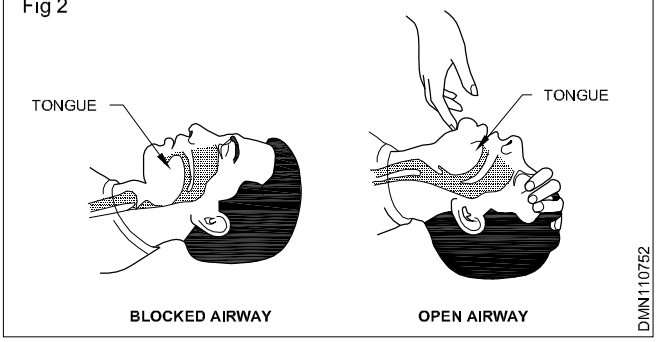
Training : Basic principles, such as knowing to use an adhesive bandage or applying direct pressure on a bleed, are often acquired passively through life experiences. However, to provide effective, life-saving first aid interventions requires instruction and practical training. This is especially true 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

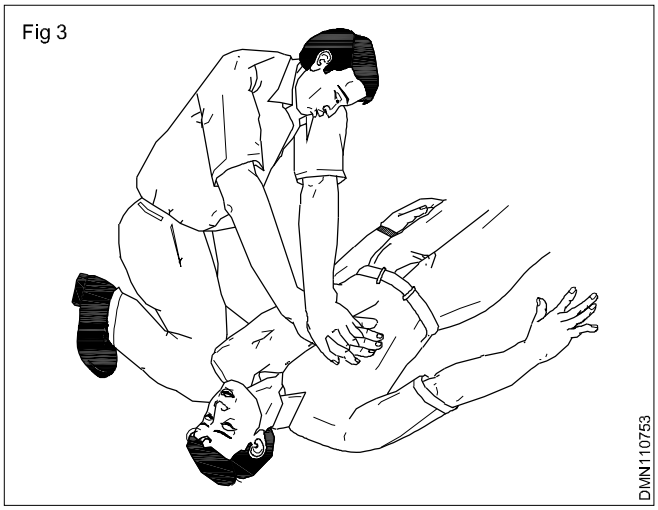
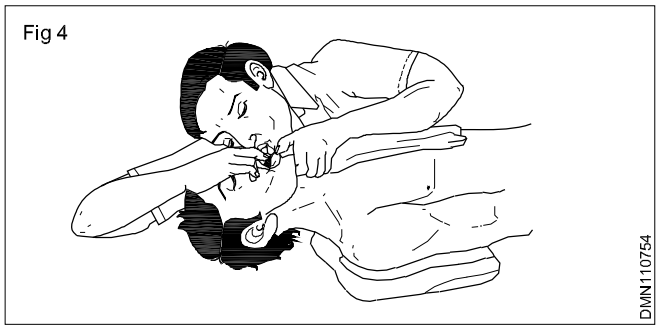


Fig 4



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)

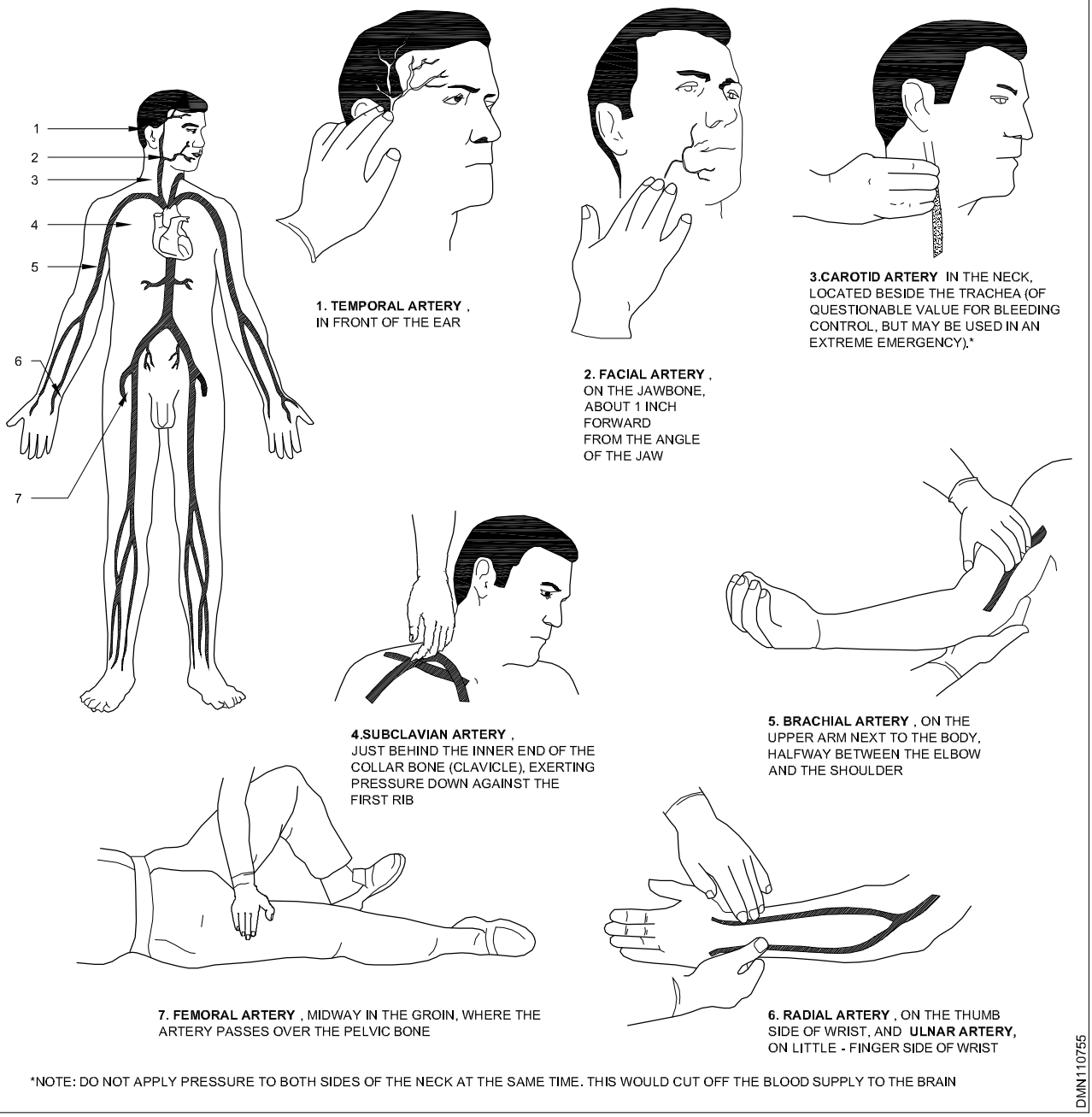
Not to get panic : Panic is one emotion that can make the situation more worse. People often make mistake because they get panic. Panic clouds thinking and causes mistakes. First-aider need calm and collective approach. if the first-aider himself is in a state of fear and panic gross mistakes may result. 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.

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

Fig 5



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.

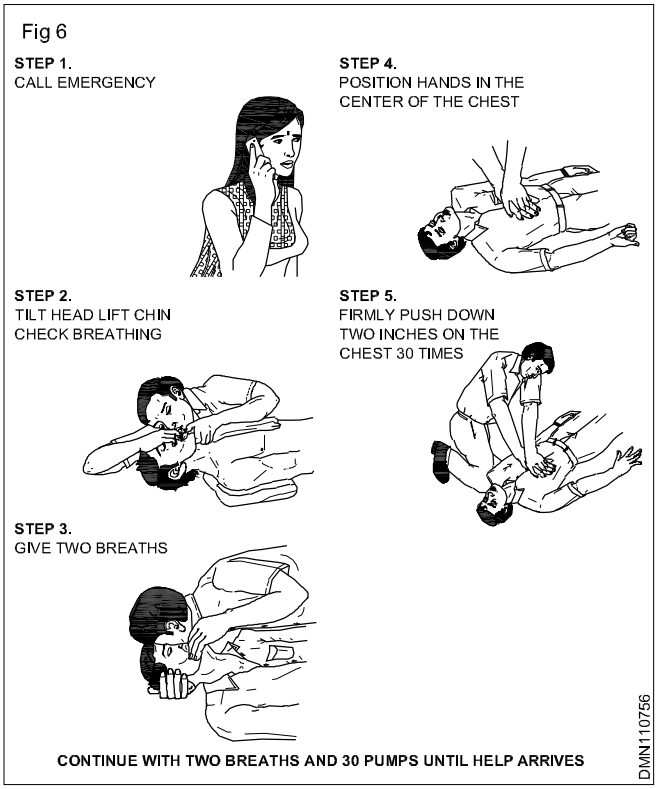
This does not mean do nothing. It mean to make sure that to do something the care givers feel confident through training would make matters safe. If the first-aider is not confident of correct handling it is better not to intervene of do it. Hence moving a trauma victim, especially an unconscious one, 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)

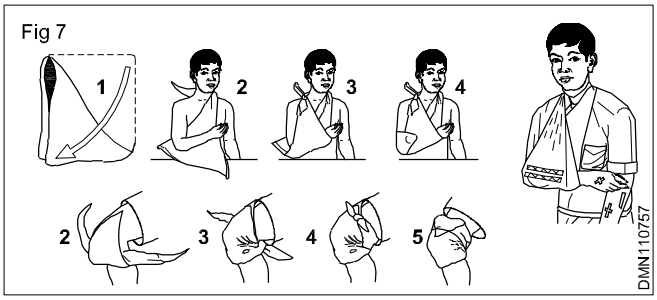
Fig 6



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



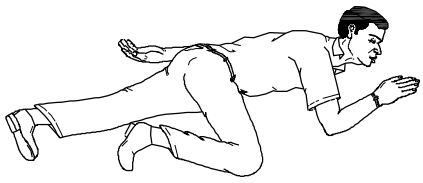
Not to use local medications on cuts or open wounds. They are more irritating to tissue than it is helpful. Simple dry cleaning or with water and some kind of bandage are best.

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)

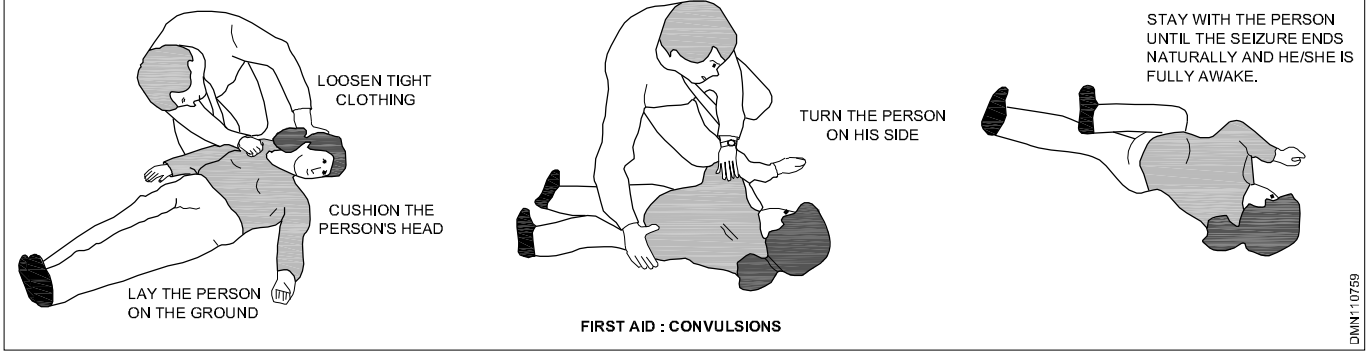
The following symptoms may occur after a person has been unconscious : (Fig 9)

- 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 both hip and knee are at right angles. Gently tilt

Fig 9

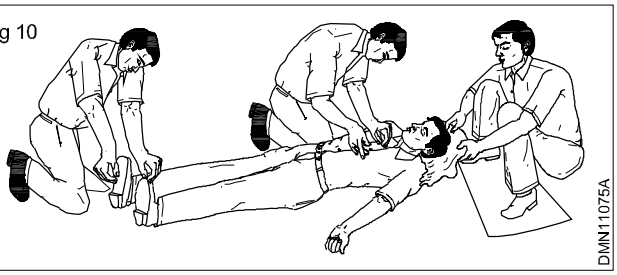


FIRST AID : CONVULSIONS

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 maneuver 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 well.
- 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.

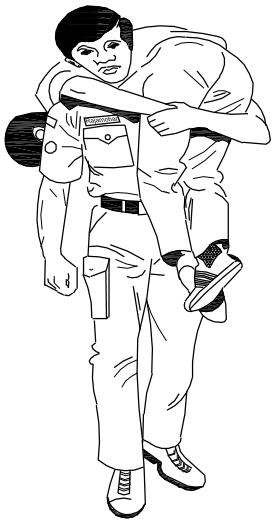
- If the victim is breathing, but unconscious, roll them onto their side, keeping the head and neck aligned with the body. This will help drain the mouth and prevent the tongue or vomit from blocking the airway.

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

DMN11075B

Fig 12

FORE AND AFT METHOD

DMN11075C

- **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

DMN11075D

Fig 14

HUMAN-CRUTCH METHODS

DMN11075E

- **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.

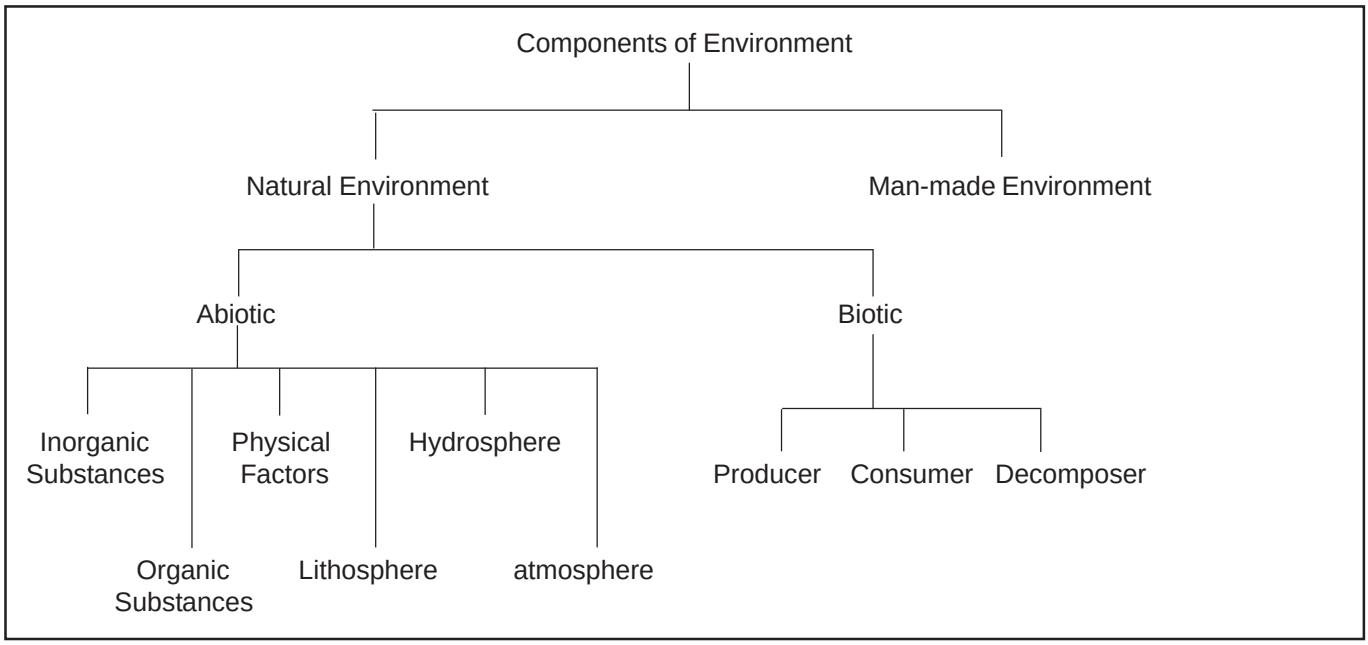
Components of Environment

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.



Billion years ago earth had surroundings which were not suitable for the existence of any kind of life. Then a mass of gaseous-chemical with hot temperature in which the organisms cannot exist. Due to the process of action and reaction of these chemicals after millions of years, the suitable condition of environment came to exist.

Many components together co-ordinated to form a natural environment which helps in substance of life. The natural environment components can be classified into two

1 Abiotic components

2 Biotic components

1 Abiotic components

These components are not living but can support other living organisms. When these components became unbalanced and they cause for total to the living organisms. Some kinds of such organisms are given below:

i) **Inorganic substances :** The elements which are taken up by the plants with the help of sunlight and converted into food. The examples of such inorganic elements are like nitrogen, calcium, phosphorus, hydrogen, carbon di-oxide and oxygen.

ii) **Organic substances :** The substances which are taken in the form of inorganic materials from the food source and are again sent back to the environment after decomposition by decomposers. E.g. Carbohydrates, proteins, fats etc.

iii) **Physical factors :** These factors have direct effect on living organisms, which are climatic conditions like temperature, rainfall, wind, humidity, soil and light energy which is used by the plants for the preparation of food.

iv) **Lithosphere :** The outermost layer of the earth (i.e.) soil or land.

v) **Hydrosphere :** Part of the earth having water resources like oceans, rivers, ponds and lakes.

vi) **Atmosphere :** It is a cover around the earth composed by variety of gases which protects the living organisms from various harmful cosmic radiations.

2 Biotic components of environment

The area in which the life is possible is called as biosphere. All living organism in the biosphere depends upon one another and these organisms exist in the biosphere forming the following community.

i) **Producers :** The green plants presents on earth surface which producers their own food only once by the process of photosynthesis in sunlight, water and carbon dioxide forms food for other organisms. E.g. Sugar, carbohydrates etc.

ii) **Consumer :** This organisms directly (or) indirectly depends upon the green plants for the source of food. E.g. All animals including man.

iii) **Decomposers :** These are micro organisms which decompose the complex compounds in the dead organic matter of plants and animals and again recycle the elements into the environment. E.g. Bacteria's and fungi.

Man-made environment

The man is the highest of all creatures on this earth, who has started modifying the environment according to his own needs and its consequences which he faces every day. The recent developments in the under developed countries lead to more critical conditions.

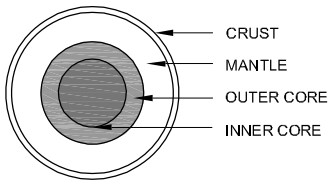
The conditions of the villages are worse because there is no sewerage and sanitation system. The competition in the villagers for the increase in production of agricultural products leads to more and more use which ultimately spoils the environment and alter the composition of natural products.

Atmosphere

The earth is a dynamic planet. It is constantly undergoing changes inside and outside of the earth.

Just like onion, the earth is made up of several concentric layers with one inside (Fig 1)

Fig 1



LAYERS OF THE EARTH

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The uppermost layer over the earth's surface is called the 'crust'. It is the thinnest of all the layers and is about 35km on the continental masses and only 5km on the ocean floors. The main mineral constituents of the continental mass are the **'silica and alumina',** called as **'sial'.** The oceanic crust mainly consists of silica and magnesium, called as **'sima'.**

Just beneath the crust is the mantle which extends upto a depth of **2900km** below the crust.

The innermost layer is the **core** with a radius of about 350km. It is made up of nickel and iron and is called **'nife'.** The central core has very high temperature and pressure.

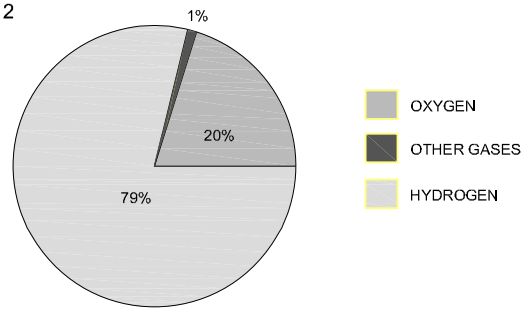
The earth is surrounded by a huge blanket of air called **atmosphere.** All living things on this earth depend on the atmosphere for their survival. It provides the air to breathe and protects from the harmful effects of the sun's rays. It is the mass of air that has made the temperature on the earth liveable.

Atmosphere & its composition

The atmosphere is a thin layer of gases which stays above the earth due to the force of gravitation. It's air is colourless, odourless and tasteless.

The air is actually a mixture of many gases. Nitrogen and oxygen are two major gases of the atmosphere. Carbon dioxide (CO_2), Helium, Ozone, Organ and hydrogen are found in lesser quantities. Apart from these gases, tiny dust particles are also present in the air. The pie chart (Fig 2) shows the percentage of gases in the atmosphere.

Fig 2



APPROXIMATE COMPOSITION OF THE AIR

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Nitrogen is the most plentiful gas in the air. The plants need nitrogen for their survival. But they cannot take nitrogen directly from the air. Bacteria in the soil and roots of same plants take nitrogen from the air and change its form that plants can use it.

Oxygen (O_2) is the second most plentiful gas in the air. Humans and animals take oxygen from the air to breathe.

Green plants produce oxygen during photosynthesis. So oxygen content in the air remains constant.

Carbon dioxide (CO_2) to make their food and release oxygen. Humans or animals release carbon dioxide. The amount of carbon dioxide released by human (or) animals equal to the amount used by the plant make perfect balance.

This balance is upset by burning fuels (coal and oil). They add billions of tons of carbon dioxide into the atmosphere each year. This increased volume of carbon dioxide is affecting the earth's weather and climate.

Sl. No	Name of the gases	Percentage
1	Nitrogen	78.03%
2	Oxygen	20.99%
3	Argon	0.94%
4	Carbon dioxide	0.03%
5	Hydrogen	0.01%
6	Helium	0.0005%
7	Neon	0.0018%
8	Cryptal	0.0001%
9	Zeon	0.000009%
10	Ozone	0.000001%

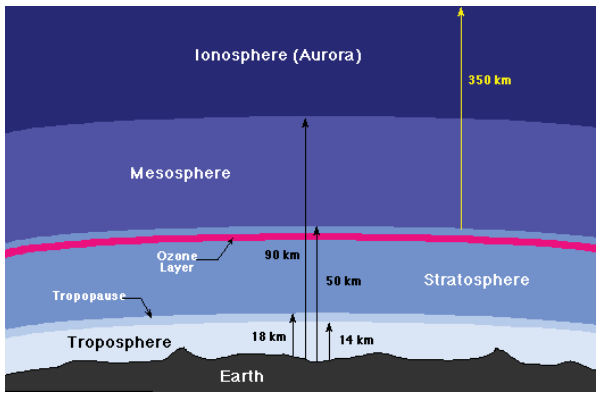
Atmospheric gases

The quantities of various gases.

Structure of the atmosphere

The atmosphere is divided into five layers starting from the earth's surface (Fig 3)

Fig 3



- **Troposphere (0 - 18kms) :** This layer is the most important layer of the atmosphere. The air breath exists here. All the weather like rainfall, fog and hailstorm occur in this layer.

- **Stratosphere (18 - 50kms) :** Above the troposphere lies the stratosphere. It is free from clouds and making continuous most ideal for flying Aeroplanes. It contains a layer of ozone gas, and it protects from the harmful effect of the sun rays.
- **Mesosphere (50 - 85kms) :** It is the third layer of the stratosphere. Temperature drops to about -95˚C.
- **Thermosphere(85 - 500kms) :** In this layer, the temperature rises very rapidly with increasing height. Ionosphere is a part of this layer. It helps in radio transmission.
- **Exosphere(500 - 1600kms) :** The upper most layer of the atmosphere is called as **exosphere.** It is very thin air. Temperature is very high due to direct solar radiation. Light gases like helium and hydrogen float into the space from here.

Relationship between the society and environment

Technological development was an important need of man in the ancient period but after that it became his habit because the facilities received from technology in the initial stage (or) in under developed storage ultra modern technology has affected environment more.

Nature controls pity mistakes of man, concerned with the environment by a self regulatory process and keep live environment in balance.

But continuous changes have attained such proportion that even the self regularly capacity of the nature has not been able to keep lie environmental balance. Due to this environmental problem have come into the force.

In ancient period the man used to collect his food in the form of fruits and roots and took shelter in the caves. This activity did not have any bad effect on the environment because his necessities were limited. When the man learnt to produce fire from the stone, then with the first invention in the field of technology was recognised. For cooking food, the man started making tools for cutting wood. It was the second stage of the advancement of technology in which he used his intellect according to his need.

In order to satisfy the needs for food, the man started propagation of plants which were good for his health. He recognised these plants, the fruits, leaves, stem and roots which were useful to him. The availability of resources at one place lead to increase the population, so people started migrating from one place to another. They cut down the forests for converting them into agricultural land. From this period onwards the process for a continuous change in the man and environment relation started.

For satisfying his economic needs man has developed science and technology to a great extent. To make the resources available in the increasing of population, ultra modern technology was developed. To satisfy his curiosity, the ambitions, man has started moving in the direction of achieving **'victory over nature'.** A change in this outlook has also occurred. He has changed into a **'technology man'.** Aspiring for an ownership over nature, he has started using the natural resources excessively.

The following physical changes for economic and industrial development

- New agriculture practice was adopted for more production crops to use hybrid seeds, and improved methods of irrigation to be adopted
- Use of machines in agriculture, chemical fertilizer are increased.
- Dams were made on the rivers; cannels were dug for irrigation and supply the storage of water.
- Roads and bridges were constructed.
- Construction of underground land and atmospheric explosions under nuclear programmes.

Environment problems created by man

Man has created problems with the nature and the environment which have become danger. Some of them are :

1 Depletion of ozone layer

Many gases are present in the atmosphere. In the upper portion of the stratosphere nearly 25km thick layer of **ozone gas,** known as **ozonosphere** which acts as a safety shield for the living things. Oxygen gas is converted into ozone gas and it forms a thick layer in the atmosphere. **Ozone layer** absorbs the sun rays and protects the flora present on the earth.

Scientist discovered the causes of depletion of ozone gas as follows.

- Man made Chloro - Fluro - Carbon (CFC)
- Excess of nitric oxide (NO) in the atmosphere
- Radiations from the nuclear centres.
- Gases released by explosion of atomic bombs.
- Chlorine gas related in volcano eruptions
- Polar cyclones.

What is CFC?

Chloro Fluro Carbons (CFC) constitute a family of manmade chemical compound. It was invented in the 1930's. They are non toxic and harmless to handle. CFCs are extremely stable and non-flammable. This stability gives them a long life span in the atmosphere allowing its transport to the stratosphere. In stratosphere, ultra violet radiation releases chlorine from the rest of the molecule. A single chlorine atom can destroy thousands of molecules of ozone

The scientist discovered a hole of 40km diameter, in the ozone layer above the South Pole. This ozone layer is affected by **polar cyclones.**

2 Green house effect

It occurs due to increase of the percentage of carbon dioxide in the atmosphere. It absorbs the solar rays and energy of the sun due to which the temperature on the earth increases and natures balance gets disturbed. Our

vehicles and industries are continuously increasing the amount of carbon dioxide in the atmosphere.

Solution to environment problems

By the **"Environment education"** only the environment pollution can be protected. Through the medium of education only human ideology and point of view can be changed. New sources of energy should be encouraged such as **solar energy, wind energy, biogas** and the use of **biodiesel in vehicles.** Such technology must be developed by which the natural sources and resources are used to the minimum and our environment and earth remains clean.

Personal and family responsibility about the environment

Man and his family can play important role in it. Their responsibilities are listed as below

- Educate awareness to prevent increasing of population
- Avoid wastage of water unnecessarily.
- Bio gas and solar cooker should be used in the place of wood as fuel.
- Cutting of trees should be prevented and the planted trees should be protected. Tree plantation on public places should be our goal.
- Insecticides and chemical fertilizers should be used in a limited quantity.
- In order to avoid noise pollution. Volume of T.V. and radio should be kept low.
- Control the use of petrol to vehicles should be used only for external essential tables.
- During festivals instead of electric lights the lamps and candles should be used. Now a days, instead of using filament lamps, CFL (Compact & Florescent Lamp) can be used.
- The domestic waste should not be thrown around. Use dustbin for such purpose.
- Use cloth bags instead of polythene bags.

Natural Disasters

Earth Quakes : The movement of lithosphere plates causes changes on the surface of the earth. When the lithospheric plates move, the surface of the earth vibrates. This vibrations can travel all round the earth. These vibrations are called as **'earth quake'.** It makes greatest damages of the buildings and environment.

The earth quake is measured with a machine called a **'seismograph'.** The magnitude of the earth quake is measured on the **'Richter scale'.**

Effect of destruction caused by earth quakes may be minimized by constructing earth quake resist building and construction project not to be undertaken in the sensitive area.

Volcano : It is a vent (opening) in the certain crust through which molten materials erupts and suddenly come out. It causes for mass disaster over the surface of earth. A volcano is a long narrow depression in the earth crust through which molten lava, ash and gases materials erupt. Tilt meter is one such instrument that can be implemented for volcanic activity.

An earth quake of 2.0 richly or less	little effect
An earth quake of 5.0 falling	Course damage from things
An earth quake more than 6.0	very strong.

Floods : Rivers can carry water according to their capacity only. Due to sudden essential rains and melting of ice the level of rivers suddenly increased. This water breaches the banks of the rivers and spread over the surrounding areas, is called as **'flood'.**

Due to the construction of roads, houses and commercial buildings, the area for flow of water and absorption in the earth reduced on maximum. The dams constructed for preventing the floods and due to digging of rivers undertaken.

Landslides : The process of sliding of the rocks and the soil downwards in the mountains due to the force of gravitation is called as **landslide.** The sudden sliding of rocks and the soil is dangerous. It is difficult to control landslide but its rate can be reduced by proper drainage of surface and ground water.and reducing erosion

Cyclones : Cyclones are a normal occurrence in coastal areas of torrid zone. Cyclones are produced in Torrid zone due to high temperature and humidity. In Atlantic Ocean they are named as **'hurricanes'** In Caribbean and northern eastern Pacific Ocean an **'Typhcon'** and in India occur as they are named as **"hilly willies or tropical cyclones.**

Storms : Storms are caused due to atmospheric depression in geographical area. Heavy storms brings severe calamity to the residential areas as well as in the agricultural fields.

Tsunami : 'Tsunami' is a Japanese word meaning 'harbour waves'. A Tsunami is a wave train or a series of waves generated in a body of water by an impulsive disturbance that vertically displaces the water column. Tsunami is generated when sea floor (Tectonic plates) abruptly crash and vertically displaces the overlying water. **Tectonic earth quakes** are associated with earth crustal deformation.

When these earthquakes occurs beneath the sea, the water above the deformed area is displaced from its equilibrium position. When layer of sea floor is elevated or subsided, Tsunami's are created.

A massive tsunami of 9.0 magnititude struck Indonesia, Southern Thailand, India (Andaman and Nicobar Islands, ECR(East Coast Road) of Tamil Nadu. Srilanka, Andhra, Kerala and Pondichery on **26th December 2004** and killing over 1,50,000 people and other damages.

Eco-system

Objectives: At the end of this lesson you shall be able to
- **state the concept of eco-system**
- **state the components of eco-system**
- **state the factors responsible for environmental degradation**
- **state the meaning of environmental hazards, disasters & its types.**

Concept of Eco-System

In 1935, **A.G. Tansley** defined the eco-system as a physical system in which **biotic** and **abiotic** components are included and the balance between them is rather constant. The term **'Eco'** means environment and **"system"** means internal process and a complex process of interdependence.

The accumulation of components of active abiotic environment in plants and animals is through the mean of interaction by which improvements, changes and development of the eco-system continues to happen. .

"Eco-system is a system involving the interaction between a community of living organisms in a particular area and it's non-living environment."

Components of Eco-system

They are broadly grouped into Abiotic and Biotic components

1 **Abiotic (Nonliving) components:** The abiotic component can be grouped into following three categories:-

i) **Physical factors :** Sun light, temperature, rainfall, humidity and pressure. They sustain and limit the growth of organisms in an ecosystem.

ii) **Inorganic substances :** Carbon dioxide, nitrogen, oxygen, phosphorus, sulphur, water, rock, soil and other minerals.

iii) **Organic compounds :** Carbohydrates, proteins, lipids and humus substances. They are the building blocks of living systems and therefore, make a link between the biotic and abiotic components.

2 Biotic (Living) components

i) **Producers :** The green plants manufacture food for the entire eco-system through the process of photosynthesis. Green plants are called **autotrophs,** as they absorb water and nutrients from the soil,

ii) **Consumers :** They are called heterotrophs and they consume food synthesized by the autotrophs. Based on food preferences they can be grouped into three broad categories.

- Herbivores (e.g. cow, deer and rabbit etc.) feed directly on plants.
- Carnivores are animals which eat other animals (eg. lion, cat, dog etc.)
- Omnivores feed upon both plants and animals e.g. human, bears and crows

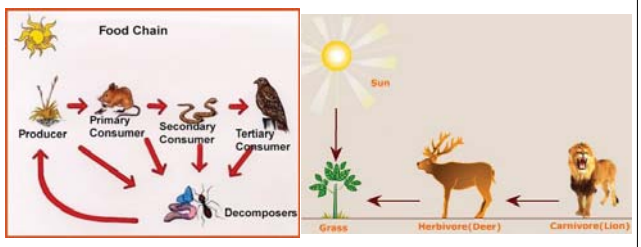
iii) Decomposers

They are also called **saprotrophs.** These are mostly bacteria and fungi that feed on dead decomposed and the dead organic matter of plants and animals by secreting enzymes outside their body on the decaying matter. They play a very important role in recycling of nutrients. They are also called **detrivores** or **detritus feeders.**

Food Chain

"Transfer of food energy from the plants through a series of organisms is referred as "food chain" (Fig 1) If one species in food chain gets affected or becomes extinct, then the species in the subsequent tropical level is also affected.

Fig 1

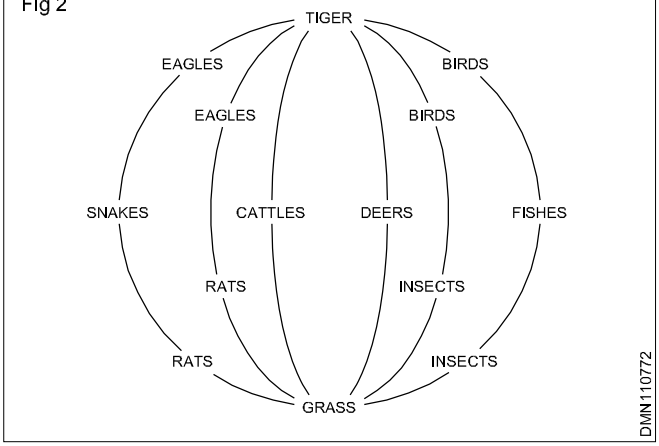


Food Web

"The interlocking pattern of various food chain in an eco-system is known as food web".

In food web, many food chains are interconnected where different types of organism are connected at different tropical level. If one species gets affected, it does not affect other tropical levels so seriously as there are number of options available at each tropic level. (Fig 2)

Fig 2



Environmental degradation

The meaning of environmental degradation is the decline in the quality of the whole environment which is due to the contrary changes caused by the activities of man which has a bad effect on the whole bio community and the human society.

The cause of degradation of the air of the environment can be pollution, natural hazards and calamities. The natural activities may produce crisis and calamity, suddenly (ie) earth quake, flood etc. and may be caused by the human activities (ie) by breaking of the dam, explosion by nuclear bombs etc.

The environment pollution due to the activities of man occur slowly as increase in population or population explosion, urbanization, industrialization, development of the means of transport, establishment of factories are polluting the environment gradually and continuously.

The environment degradation has a direct effect on the ecology by which the balance of the ecology gets disturbed because it causes decline in the quality of the eco-system.

The imbalance in ecology is an indicator of degradation of the environment.

Causes of environmental degradation

The basic causes of the degradation of environment are as follows.

i) **Natural process :** Tremors, earthquake, storms, floods, forest fire, draught and excessive rains etc.The man has no control over these because these processes occur all of a sudden.

ii) **Human activities :** These activities can be controlled. These have a slow and continuous effect of the following causes.

- The development of modern technology.
- Increase in population and its explosion.
- Move pressure by excessive use of natural resources.
- Industrial development and opening of factories.
- Housing problem due to urbanisation and pollution problem.
- Excessive development of economic tasks by man.
- Use of chemical fertilizers and insecticides in the agricultures.

Environmental hazards and disaster

'Environmental Hazard' may be stated as those extreme events caused by natural process (or mains activities which exceeds the tolerance magnitude within or beyond certain time limits, make adjustment difficult, result in losses of property and lives. The seriousness of environmental disaster can be estimated by the loss of life and property of the human society. The decline in the quality of the environment (or) the factors leading to its destruction are called **hazards** or **disasters.**

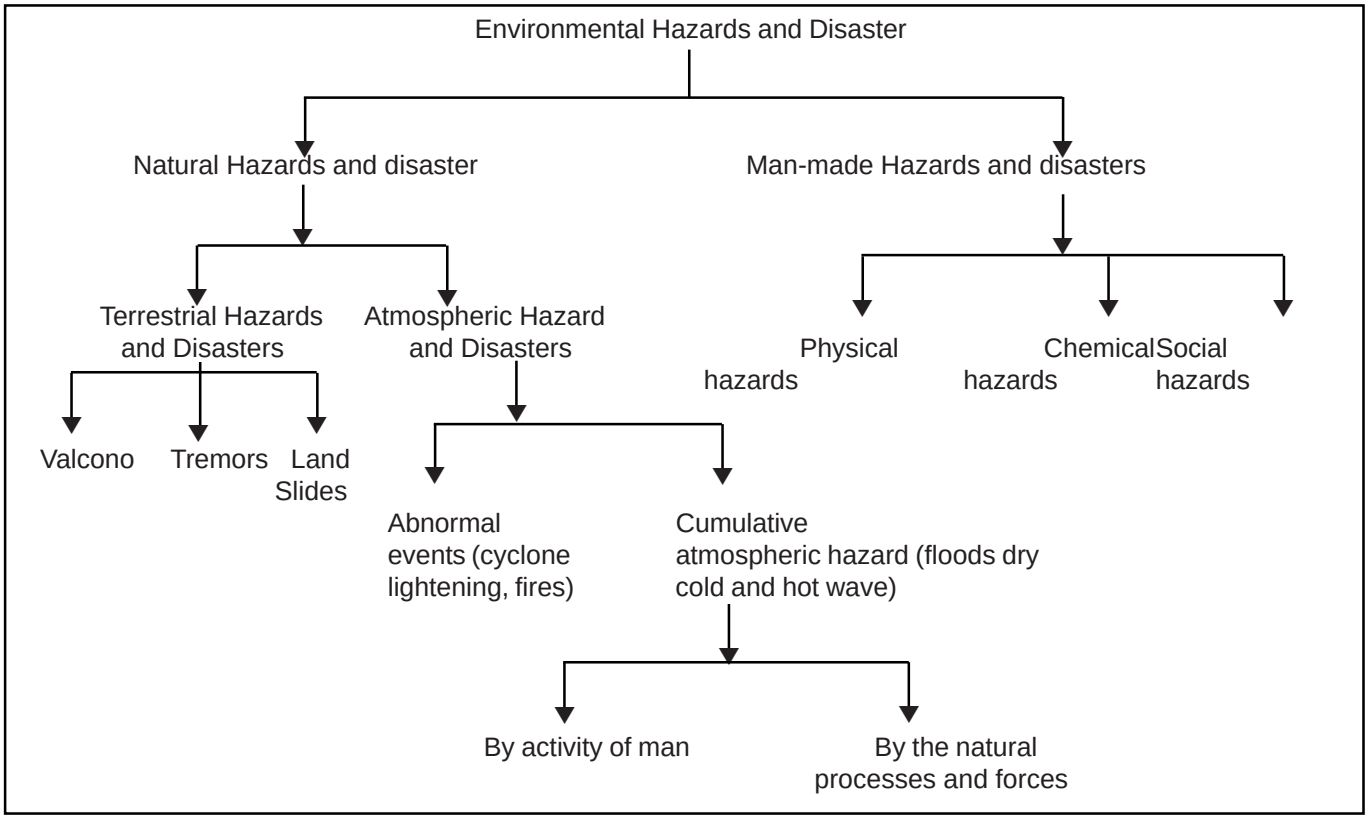
When due to physical process the hazards and disaster happen all of sudden and the human life.

Based on the casual factors, they are also divided into two subgroups

1 Natural hazards

2 Man induced hazards.

Types of environmental Hazards and Disaster



I Natural hazards : These are caused by natural factors. These can be divided into three groups ;

- **Terrestrial hazards :** arises on the surface of the earth (ie) tremors, earthquakes, volcanoes and forest fires etc.
- **Atmospheric hazards :** due to imbalance in the environment (ie) excessive rains, storms, cyclones, typhoon etc.
- **Cumulative atmospheric hazards :** The human activities have immediate effect such as forest fires, demolishing maintains, release of poisonous gases from the factories, nuclear explosion etc. The rivers get flooded due to breach in Dam losts of life, property, the crops and houses are destroyed.

II Man induced hazards and disasters

The environment degradation is also made by the activities of human. The hazards and the damages done by the man cannot be compensated. Man made hazards and disasters by their nature can be spontaneous or deliberate.

They have been divided into three groups

- **Physical hazards :** Tremors, landslides, soil erosion.
- **Chemical hazards :** Release of toxic gases from the tanks in the factories, gases produced by the factories air pollution by vehicles, nuclear experiments, sinking of oil ships in the sea or catching of fire by them.
- **Social hazards :** Increase is population or population explosion, decline of religions valves, giving importance to economic valves, use of nuclear power in war.

Pollution and pollutants

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

- **define the meaning of pollution**
- **list out various kinds of environmental pollution**
- **define the meaning of pollutant**
- **state various type of hazardous waste management**
- **list out the causes of indoor environment pollution and suggestion to keep the environment safe.**

The quality of the environment has declined due to environmental pollution. In industrial and technological progress of man, the chemical and nuclear energy, poisonous gases and other industrial workers have polluted the environment by which the quality for the environment is affected.

Pollution

An undesirable change in the quality of physical, chemical and biotic substances, air, water and soil is called **pollution.** This change is harmful for the health and life of living things. The pollution brings a change in some aspect of the biosphere in a direct or an indirect manner, which leaves a bad effect on the living beings and the humans.

There are mainly two kinds of pollutions. They are

1 Physical pollution

A decline in physical elements of the environment caused by man's activities is called as **physical pollution.** It can be divided into three sub parts

- Air pollution occurs when gases, dust particles, fumes (or smoke) or odour are introduced into the atmosphere in a way that makes it harmful to humans, animals and plant.
- Air pollution can result from both human and natural actions. Natural events that pollute the air include forest fires, volcanic eruptions, wind erosion, pollen dispersal, evaporation of organic compounds and natural radioactivity.

Human activities that result in air pollution include:

- **Emissions from industries and manufacturing activities :** Chimneys of manufacturing plant with lots of smoke and fumes coming out of it. Waste incinerators, Manufacturing industries and power plants emit high levels of carbon monoxide, organic compounds, and chemicals into the air. Petroleum refineries also release lots of hydrocarbons into the air.
- **Burning Fossil Fuels :** Cars, heavy duty trucks, trains, shipping vessels and airplanes all burn lots of fossil fuels to work. Fumes from car exhaust contain dangerous gases such as carbon monoxide, oxides of nitrogen, hydrocarbons and particulates. On their own, they cause great harm to people who breath them. Additionally, they react with environmental gases to create further toxic gases.
- **Household and Farming Chemicals :** Crop dusting, fumigating homes, household cleaning products or painting supplies, over the counter insect/pest killers, fertilizer dust emit harmful chemicals into the air and cause pollution. In many case, when we use these chemicals at home or offices with no or little ventilation, we may fall ill if we breathe them.

Air pollution prevention, monitoring and solution.

Solution efforts on pollution are always a big problem. This is why prevention and interventions are always a better way of controlling air pollution. These prevention methods can either come from government (laws) or by individual actions. In many big cities, monitoring equipment has been installed at many points in the city. Authorities read them regularly to check the quality of air.

- **Government (or community) level prevention**

Governments throughout the world have already taken action against air pollution by introducing green energy. Some governments are investing in wind energy and solar energy, as well as other renewable energy, to minimize burning of fossil fuels, which cause heavy air pollution.

Governments are also forcing companies to be more responsible with their manufacturing activities.

Car manufacturing companies are also building more energy efficient cars, which pollute less than before.

- **Individual Level Prevention**

- Encourage your family to use the bus, train or bike when commuting. If we all do this, there will be less cars on road and less fumes.
- Use energy (light, water, boiler, kettle and fire woods) wisely. This is because lots of fossil fuels are burned to generate electricity, and so if we can cut down the use, we will also cut down the amount of pollution we create.
- Recycle and re-use things. This will minimize the dependence of producing new things. Remember manufacturing industries create a lot of pollution, so if we can re-use things like shopping plastic bags, clothing, paper and bottles, it can help.

Water pollution is the contamination of water bodies (e.g. lakes, rivers, oceans, aquifers and groundwater), very often by human activities. Water pollution is very harmful to humans, animals and water life. The effects can be catastrophic, depending on the kind of chemicals, concentrations of the pollutants and where there are polluted. The effects of water pollution are varied and depend on what chemicals are dumped and in which locations.

Many water bodies near urban areas (cities and towns) are highly polluted. This is the result of both garbage dumped by individuals and dangerous chemicals legally or illegally dumped by manufacturing industries, health centres, schools and market places. Some of the effects of water pollution are:

- **Death of aquatic (water) animals**

The main problem caused by water pollution is that it kills life that depends on these water bodies. Dead fish, crabs, birds and sea gulls, dolphins, and many other animals often wind up on beaches, killed by pollutants in their habitat (living environment).

- **Disruption of food-chains**

Pollution disrupts the natural food chain as well. Pollutants such as lead and cadmium are eaten by tiny animals. Later, these animals are consumed by fish and shellfish, and the food chain continues to be disrupted at all higher levels.

- **Diseases**

Eventually, humans are affected by this process as well. People can get diseases such as hepatitis by eating seafood that has been poisoned. In many poor nations, there is always outbreak of cholera and diseases as a result of poor drinking water treatment from contaminated waters.

- **Destruction of ecosystems**

Ecosystems (the interaction of living things in a place, depending on each other for life) can be severely changed or destroyed by water pollution. Many areas are now being affected by careless human pollution, and this pollution is coming back to hurt humans in many ways.

Prevention of water pollution

Dealing with water pollution is something that everyone (including governments and local councils) needs to get involved with. Here are a few things we can do:

- Never throw rubbish away any where. Always look for the correct waste bin.
- Use water wisely. Do not keep the tap running when not in use.
- Do not throw chemicals, oils, paints and medicines down the sink drain, or the toilet.
- Buy more environmentally safe cleaning liquids for use at home and other public places. They are less dangerous to the environment.
- If you use chemicals and pesticides for your gardens and farms, be mindful not to overuse pesticides and fertilizers. This will reduce runoffs of the chemical into nearby water sources.
- If you live close to a water body, try to plant lots of trees and flowers around your home, so that when it rains, chemicals from your home does not easily drain into the water.

Land pollution is the deterioration (destruction) of the earth's land surfaces, often directly or indirectly as a result of man's activities and their misuse of land resources.

2 Social pollution

Accumulated happenings or crises have a country effect on the social aspects is called social pollution. It can be divided into three subgroups

- Population explosion (or) growth
- Social backwardness
- Economic pollution - poverty

Pollutant

The substance, which causes a decline in the quality of environment or produces pollution in the environment is called as a pollutant. It includes any solid, liquid or gaseous substance, which by its presence (or) excess in the environment is harmful effect on the living beings and man.

Pollutants are residues of the substance which are to be thrown away after use. Water or rivers get polluted by the wastes of the cities and sewage thrown into them.

Some pollutants of the environment are the cause to pollute the air, water and the solid and bring a decline in their quality.

Some of the main pollutants are given below

- Collected substances - dust, smoke, tar etc.
- Gases - Carbon dioxide, Nitrogen and sulphur dioxide.
- Solid wastes - which we thrown away after use
- Radioactive substances
- Noise - excessive noise of the vehicles
- Complex chemicals - ether, benzene, acid etc.
- Metals
- Fluorides
- Photo chemical oxides.
- Agricultural chemical substances

From the above examples the pollutants are broadly categorised into three types

- In the form of solid substances (or) matter
- In the form of liquid substances
- In the form of gases

According to the nature, pollutants can be classified into Non-degradable pollutants and Bio - degradable pollutants.

1 Non -degradable pollutants

Those pollutants which cannot be broken down into simpler, harmless substances in nature, are called non-biodegradable pollutants. DDT, plastics, polythene, bags, insecticides, pesticides, mercury, lead, arsenic, metal articles like aluminium cans, synthetic fibres, glass objects, iron products and silver foils are non-biodegradable pollutants. (Table1)

Table 1

Sl. No.	Pollutant	Effect of human health
1	**Air pollution**	
	• Carbon monoxide	• Headache, hear stress
	• Lead	• Mental and physical improvement
	Water pollution	
	• Sewage pollutant	• Jaundice, cholera, typhoid
	• Methyl mercury	• Affects nerves system, lips and tongue deadness
	• Excess nitrate in drinking water	• Blue body syndrome
	Radioactive pollution	• Cancer, lung, breast, spot skin, genetic disorder
	Noise pollution	• Stress related diseases, eardrum may be damaged
	Ozone depletion	• Cataract, skin diseases, affecting immune system.

v**2 Bio-degradable pollutants**

Hazardous waste

The waste that contains highly toxic and hazardous materials that injurious to all living things and environment are called as hazardous and toxic work.

Hazardous waste management

Following activities are to be followed for hazardous waste management. (Table 2)

Table 2

Sl. No.	Source	Type of hazardous waste
1	Chemical Industries	Acids solvent base
2	Workshop (mechanical)	Metal paints, lead for lead acid battery
3	Leather Industries	Solvent, acid bases
4	Paper industry	Waste - inks, solvents
5	Construction	Waste paints - inflammable
6	Metal Industries	Paint waste, sludges (containing heavy metals)
7	Electronic industries	Solvents, plating and slumping solutions
8	Nuclear power plants	Spent fuel, solvents, radio -active waste

- Reduce waste generation and choose less toxic materials. In Industries, manufacturing process can be altered to eliminate (or) reduce waste production.

- Recycle the solvent and acid to minimize the waste generation.
- Reuse the solvent and acids.

Handling methods of hazardous waste

The safest method to avoid hazardous waste problem is to cut down production of waste in the source itself. The methods of disposal of hazardous wastes are :

- **Physical process :** From this method, main aim is the volume reduction by Sedimentation, Absorption, Aeration, Osmosis, Ione exchange etc.
- **Chemical treatment :** In this method, chemicals are added to connect the hazardous waste into non-hazardous waste. This is suitable to the waste having corrosive and reactive proportion, and its aim to neutralize pH
- **Biological treatment :** This process is generally followed in municipal/corporation waste treatment plant. This process can be used, when the sludge contains high concentration of organic and low concentration of toxic substances.
- **Waste incineration :** This process is suitable if the waste is not subjected to complete decomposition and the waste is combusted for complete destruction.
- **OFF-site disposal :** The residue from thermal process or the untreated sludge have to be disposed in an environment, so that the soil and the ground water do not contaminate.

Indoor environment

Home or a house is such a place where family members live. Every person expects that the place should be pollution free so that he can live their conveniently.The increase in the technology and new domestic machineries and equipment is polluting the indoor environment.

A house has many such materials and appliances which cause pollutions inhouse environment and it affects out health badly but most of the people amongst us are ignorant of this environment.

Causes of the pollution of Indoor environment

There are many things in the house which cause a decline in the quality of the environment. The causes are follows

- Mica, plywood, new wood, varnish and chemical substances are harmful.
- Construction materials such as clay, lime, wood, cement, iron, concrete, plastic paints etc.
- Varnish, paints and fevicol etc. chemical substance used in making furniture's are poisonous and release poisonous gases in the indoor environment.
- The articles made of polythene and plastic has increased greatly, which pollute the air inside the soil.
- When chlorinated water is boiled it releases chlorine which leads pollution
- The kitchen is an important place in house. Where one or the other fuel is used for cooking food such as kerosene oil, petroleum gas etc. In the villages cow dung cakes and wood are burnt which produce harmful gases and smoke, mixer, indoor and juice and other application used in the kitchen also produce noise pollution.
- Many types of enjoyments are used at home which cause environmental pollution. CFC damages the ozone layer of the atmosphere due to which harmful and UV rays from the space and the sum come to the earth.
- Liquid waste water from bathing, washing clothes and utensils, detergents, phenyls, disinfectant, geysers, heated up water etc. when chlorinated water is heated up, it forms chloroform which leads to suffocation and death.
- During technological advertisements various home gadgets also increase in number like. Cooler, heater, blower, refrigerator, washing machines, oven, air containers, VCRs computers, Fax, perfumes release CFCs which deplete the ozone layer of the atmosphere which reflects back to harmful radiations (UV) coming from the outer sphere and sun.

Today the science has given many things of comfort and luxury to man but they leave bad effect on health.

Suggestion for keeping the Indoor environmental safe

For keeping the indoor environment clean and pure following are the suggestion.

- While constructing a house it should be kept in mind that the house is spacious airy and well lighted.
- Material used in the construction should be of good quality.
- Materials of chemical composition must be avoided for the construction of houses.
- Synthetic and non-bio gradable materials should be avoided.
- Kitchen and bathrooms especially be airy and open.
- Waste from houses should be properly utilized.
- The sewage should not be sent to ground water by digging well.
- The electric appliances should be used in accordance with the introduction given on them.
- Proper disposal of excreting products.
- Traditional fuels should be avoided.
- Use of solar energy should be encouraged in houses.
- Elastic light appliance should not be installed in the house more than necessary.
- Excessive brightness should be avoided.
- The volume of various sources of entertainment like Television, tape recorder, stereo etc. should be kept in the house.

- Reduce the use of A.C. coolers, heaters etc. at home.
- The home should be well cleaned properly to avoid dust.
- The use of fragrant substances should be reduced.

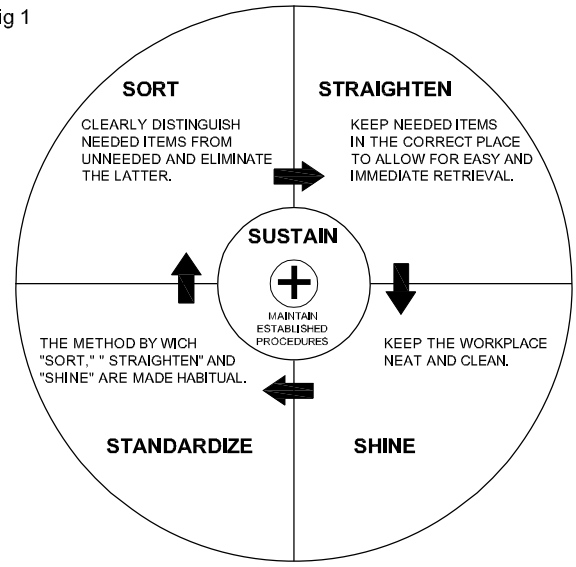
5S Concept

5S is a Japanese methodology for worksplace organization. In Japanese it stands for seiri (SORT), seition (SET), seiso (SHINE), seiketsu (STANDARDIZE), and shitsuke (SUSTAIN).

The list describes how to organize a work space for efficiency and effectiveness by identifying and storing the items used, maintaining the area and items, and sustaining the new order. The list describes how to organize a work space for efficiency and effectiveness by identifying and stroing the items used, maintaining the area and items, and sustaining the new order.

5S Wheel

Fig 1



5S WHEEL

The Benefits of the 5S system

- Increases in productivity
- Increases in quality
- Reduction in cost

Conservation of energy

Objectives: At the end of this lesson you shall be able to
- **define energy and law of conservation of energy**
- **list out and state the difference forms of energy resources**
- **state the importance of conservation of energy**
- **explain the three R's (Reduce, Reuse and Recycle)**
- **state about right attitude towards environment.**

Energy : Energy is defined as capacity to do work. All humans, animal and plant life depend upon energy.

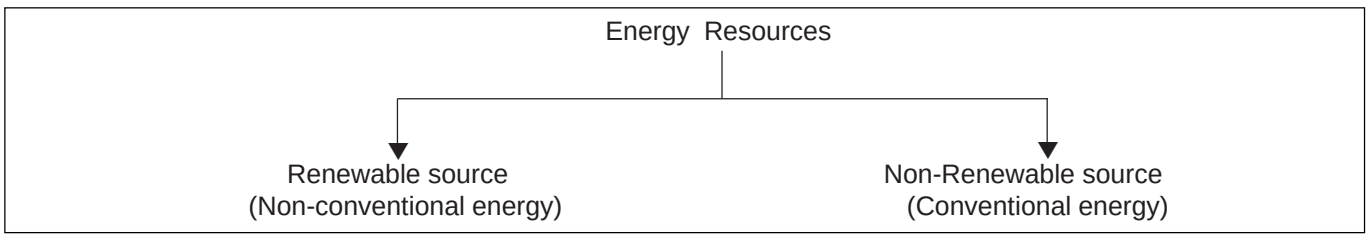
The **law of conservation of energy** states that the energy can neither be created nor destroyed but can be transformed from one form to another, the total energy remain conserved. Energy provides the force to hold structures together, tear them apart and move them from one place to another.

No energy transformation in the present is efficient. The fossil fuel, as it is generally called is expected to exhaust in another 200 years. The energy supply side needs heavy investments and import.

Renewable (Non-Conventional) Energy Source

Renewable energy resources are natural resources which can be regenerated continuously and are inexhaustible. They can be used again and again in an endless manner. Examples are Wood, Solar energy, wind energy, hydropower, tidal energy, geothermal energy etc. These energy resources are pollution free and do not need any fuel and also does not produce any waste.

Solar Energy - The energy that we get directly from the sun is called **solar energy.** Some important solar energy harvesting devices are :



- **Solar (Photovoltaic) cell :** Used in calculator, electronic watches, street lamps, water pumps etc.
- **Solar heat collectors :** Used in cold places where houses are kept in hot condition using solar heat collectors.
- **Solar water heater:**

Wind Energy : The energy recovered from the force of the wind is called **wind energy.** It is available easily in many off-shore, on-shore and remote areas.

Tidal Energy : Energy produced by tides due to gravitational forces of sun and moon is called **tidal energy.** As sea water is inexhaustible, it is completely independent of uncertainity of rain fall.

Geo-thermal energy : The energy harnessed from the high temperature present inside the earth is called **geo-thermal energy.** It is effectively and efficiently used for direct uses such as hot water bath, resorts, aquaculture, green house.

Biomass Energy : Energy produced by organic matter like plants and animals are called **Biomass Energy.** Examples of biomass are wood, crop residues, seeds, cattle dung, sewage, agricultural wastes etc.. Biogas and bio fuel are examples of biomass energy.

Merits of Renewable resources

- Unlimited supply
- Provides energy security
- Fits into sustainable development concept
- Reliable
- decentralized energy production

Non-Renewable (Conventional) Energy Source

Non-Renewable energy resources are natural resources which cannot be regenerated once they are exhausted.. They cannot be used again. Examples are Oil, Coal, petroleum, natural gas, nuclear fuels etc..

Coal : It gives extreme heat, this energy source cannot be renewed. It is used in power houses, factories, industries and fairness.

Petroleum: It includes petrol, diesel, mobil oil and mineral oils which are used in motor vehicles, furnaces and power houses. From the modern technology, it is hoped that 3000 million ton petroleum from the earth and another 1000 million ton from the sea can be obtained.

LPG (Liquified Petroleum Gas) : The petroleum gas obtained during cracking and fractional distillation, can easily be converted into liquid under high pressure as LPG.

Natural gas : Natural gas is formed by the decomposition of dead animal and plants, that are buried under lake and ocean under high pressure and temperature. It is found above the oil in oil well.

Conservational of energy

"Saving of energy is the production of energy" it means that the energy is very essential. In developing country like India, possible effort should be made to serve more and more energy.

The demand for electric energy is increasing at the rate of 10 percent every year. But it is not possible to increase its production at this rate. The consumption of energy is increased by 12.8 percent per year.The production of energy according to the consumption is not possible. So the only selection is that by saving energy, conserve more energy.**14th December** is celebrated as **world energy conservation day.**

Some examples of conservation of electric energy is given below:

Electric motor : Electric motors are strong means of spending energy. By applying modern technologies the expenditure of electric energy can be minimized. So it is essential the strong and quality motors must be used.

Pump : In these pumps, energy is spent through diesel engines and electric motors. Due to diesel engine the popularity of motor pump has increased and it is convenient too. By maintaining the quality diesel engine, more work can be done with less expenditure of energy.

Arrangement of light : The lights are needed in houses and industries. 17.4 percent of the total electricity is consumed for light. This consumption in future would be still more because even now the faculty of electricity is not available to the all population. Excessive use of electricity should be avoided because it is exhaustible source.

Since resources are being exhausted, it is the duty of every individual on this earth to conserve resources in such a way that they must be available for future generation also. Due to advancement and population growth, the present world is facing lot of crises on natural resources.

Measures recommended for conservation of natural resources:

- Switch off lights, fans and other appliances when not in use.
- Use solar cooker for cooking food on sunny day.
- Dry clothes in sunlight instead of driers.
- Grow more trees near the house and get a cool breeze and shade. It will cut off your electricity charges on ACand coolers.
- Use pressure cooker for cooking.
- Ride bicycle or just walk instead of using car or scooter.
- Use minimum water for all domestic purpose.
- Check for water leaks in pipe and repair immediately.
- Plant more trees and protect them.
- Minimise the use of papers and fuel wood.
- Grassing and fishing must be controlled.

The three R's: Reduce, Reuse and Recycle (Fig 1)

Fig 1

These three R's (ie) Reduce, Reuse and Recycle are used to help to cut down on the amount of waste which are thrown out away. They conserve the natural

communities must use to dispose of waste in land fills. All must help to active this goal and save natural resources, energy and money by following the three R's.

Reduce

The best way to manage waste is not to produce it. This can be done by shopping carefully and being aware of few guidelines.

- Buy products in bulk, larger, economic size products or ones in concentrated form use less packaging and usually cost less per ounce.
- Avoid over - packaged goals, especially ones packed with several materials such as foil, paper and plastic.
- Avoid disposable goods, such as paper plates, cups, napkins, razors and lighters.
- Buy durable goods - ones that are well - built or that carry good warranties. They will last longer save money in the long run and same landfill space.
- At work, make two -sided photcopies whenever possible
- Maintain central files rather than using several files for individuals.
- Use electronic mail or main bulletin boards.
- Remove your name from the mailing lists of materials you no longer want to receive.
- Use a dish cloth instead of paper towels.

Reuse

It makes economic and environmental sense to reuse products and it takes creativity.

Reuse products in different ways :

- Use a coffee can to pack a lunch, use plastic mirowave dinner trays as picnic dishes.
- Sell old clothes, appliances, toys and furniture in garage sales or ads or donate them to charities.
- Use reasonable containers rather than plastic wrap.
- Use a ceramic coffee mug instead of paper cup.
- Reuse grocery bags or bring your own cloth bags to the store.
- Do not take a bag from the store unless you need one.

Recycle

The process of changing the waste materials into new products to present waste of potentially useful materials is called as 'recycling'. Recycling is a series of steps that takes a used material and processes, remanufactures and sells it as a new product.

- Begin recycling at home and at work
- Buy products made from recycled materials. Look for the recycling symbol (or) ask store managers or salesman. The recycling symbol means one of two things either the product is made of recycled material or the item can be recycled.
- Many plastic containers have a recycling symbol with a numbered code the identifications means what type of plastic resin it is made from.
- Check collection centres and curb side pickup services to see what they accept, and begin collecting those materials. It includes, metal lens, newspapers, paper products, glass, plastics and oil.
- Consider purchasing recycled materials at work, when purchasing materials for office supply, office equipment (or) manufacturing.
- Speak to store managers and ask for products and packaging that help cut down on waste, such as recycled products and products that are not over packaged.
- Buy products made from material collected recycling.
- Use recycled paper letterhead, copier paper and newsletter.

Right attitude towards environment

Having the right attitude towards environment will help us to improve our efficiency. Creating space in our offices and homes complements the space need in our minds will become clear thinking and focused.

In our home environments are important to help us make the most of ourselves professional. An environment used to be created at home for time to unwind and regroup.

Organising your workspace

- Our work place to be organised most effectively & professionally. Make some time to restore the working space so that it reflects a mind that is calm, focussed and in control with a well managed space where you will have higher productivity.
- Get into the habit of filling things in the correct place.

Create a productive, professional ambiance

- Plants and lights in office space are for promoting calm and productivity. Plants also keep the air oxygenated which will help your thinking process.
- Ensure the plants are healthy. Having dead and dying plants around will drain your energy.
- If your office is dark and gloomy with natural light, you can create the sanction of light and space - glass top desks may be more space enhancing than a dark and dusty oak.
- Make your office ooze with charm, images having clients here with you.
- Having this right attitude to your working environment, treating with care and respect will help the same attitude to your work.

Home is your sanctuary

- Getting a good night's sleep is essential for ensuring that your daily productivity is high.

- Never take your work into the bed room with you. Leave your electronics in another room.
- Create some space away from your laptop and your phone.
- Invert in a comfortable seating area and spend time reading a book.
- By having good night you will be able to function at your maximum potential.

Global warming - Ozone depletion layer

Objectives: At the end of this lesson you shall be able to
- **state the meaning of global warming**
- **state the meaning of green house & its effects**
- **state how to control the green house effect**
- **state ozone gas**
- **state the causes, effects and preventive measures of ozone layer depletion**
- **state acid rain and its effects.**

Global Warming

Increase in average temperature of the earth surface due to green house effect is called as **global warming.** It also refers to the increase in average temperature of the air and sea at earth's surface.

In 1987 **Jean Baptiste Joseph Fourier** a French scientist and mathematician coined the **"Green House Effect"** for trapping of heat in the atmosphere by certain gases.

There are some gases in the earth atmosphere that absorb some of the outgoing long wave radiation or heat energy. These includes Carbon dioxide (CO_2), methane (CH_4), Nitrogen Oxide (NO), Chlora Floro Carbon (CFC), Water vapour.

Effect of Global Warming

- Rising global temperature causes to raise sea level.
- Melting of glaciers, snow mountains and polar ice caps are the important resultant of global warming which leads to increase the sea level.
- The change in rainfall pattern.
- Fresh water bodies will be contaminated with the salty water of sea.
- Migration of human population takes place.
- Forest vegetation will not be able to adapt in the changing pattern of temperature and rainfall.

Meaning of Green House

In the cold countries of the world, houses which is natural that the temperature inside remains higher than outside which will not affect the growth of vegetarian. These type of houses of green glasses are called as "green house".

Carbon dioxide(CO_2) prevents the conversion of solar energy and the solar rays. It acts as a blanket in which the sun rays can enter the heat radiation emitted by the earth cannot go outside.

Now a days, the amount of carbon dioxide is increasing day by day due to Human beings activities such as industrialization and destruction of forest. The increasing of earth's temperature also affects the green house.

Green House Gases (GHG)

The major green house gases are

- Water vapour - causes about 36%-70% of the green house effect.
- Carbon dioxide (CO_2) which causes 9-26%.
- Methane (CH_4) causes 4-9% and ozone (O_3).

The effects of green house and change in climate

Due to green house effect, the following changes takes place in the climate

- Vegetarian and animals are badly affected by it.
- Rains are greatly increased.
- If effects the eco systems balance.
- By increasing of carbon dioxide, the production will increase but the quality of crops is reduced.
- The soil would be less fertile.
- In the cold area, the winter season would become short, and it would be less cold.
- Due to industrialization and destruction of forest, produces impregrenable gases, which results into hot soil.
- The plants would have less amount of nitrogen in them. It is more affected by the insecticides.
- Due to the continuous, increasing of temp of earth, the ocean became warm and the level of the sea water will increase.
- Health of men will be badly affected, due to that the number of diseases will increase (ex. Malaria, respiratory and skin disease).
- The energy sources also will be affected badly.
- Due to scarcity of water the generation of electricity will decrease.

Methods to control line Green House Effect

In 1979, the world environment committee decided that it is very essential to reduce or control the amount of carbon dioxide in the atmosphere.

After 13 years, the earth conference on environment and development was held in 1992 in Riodega-Neiro (Brazil), by 182 countries participants made serious deliberation as given below

- Decreasing the quantity of carbon dioxide in the atmosphere
- Management of forests
- Change of technology
- Bio diversity
- Sustained development
- Financial management to save the world from pollution
- The alternative bio-sources instead of petroleum products should be used.

Climate change is a change which can be related to the activities of man directly or indirectly, which changes the components of global environment and which can be seen in the natural period of time.

Mainly the climate changes can be seen by the total stock of available green house gases in the environment and not by the release of green house gases annually.

Melting of the polar ice

The depletion of ozone is increasing, the temperature of earth's surface is also increasing day by day. Due to the effect of increasing temperature the ice on the poles of the earth has started melting rapidly, then the water level of the sea is rising. By melting of the ice of the poles an imbalance in the eco-system is increasing which is very harmful.

It is essential to control the gases CFC, methane, Nitrous oxide etc. released by industries which harms the ozone layer, and 'melting' ice of the poles destroying animals and vegetation.

Rise in sea water

Due to increase in the temperature of the surface of the earth, the ice on the polar region is rapidly melting, as a result water level of the sea is upto 6cm and by the 21st century level of sea water will rise upto 65cm. So, rise in temperature should be stopped otherwise animals and plants will be affected greatly.

Kyoto conference 1977

In the atmosphere, the carbon-di-oxide is increasing and its temperature is also continuously increasing, causes dangers. So an international conference on climate was held in Dec. 1977 in the city of Kyoto in Japan. 160 countries delegates participated and made a historical agreement for prevention of change in climate due to increase in temperature of the environment of the earth.

The main goal of this conference on climate change was to control the main causes of climate change and trying quality improvement in the world environment from the angle of hygiene and health.

According to this agreement various countries agreed or reducing green house gases.

European organisation - 86%, America - 7%, Japan 6%.

A provision was made in the agreement that the defaulter would be fired and the amount of fine would be voluntarily deposited in the development fund.

Ozone gas

'Ozone' word is originated from Greek word **'Ozo'.** 'Ozo' means **'smell or odour".** This gas was first discovered by a dutch scientist **"Van Marum"**. It has a peculiar odour". Due to this odour only, it is called **ozone gas.** Sun light produces this gas. The oxygen in the atmosphere becomes active in sunlight and changes into ozone gas.

In the environment, this gas is present in a very small quantity. Ozone (O_3) contains 3 atoms of oxygen. This combination of 3 atom of oxygen present in the lower atmosphere is harmful for the human beings, but 'its' presence in the upper atmosphere is very beneficial and essential. This gas is produced itself. When the sun rays strike the upper layer of the atmosphere, then due to high energy radiation, some part of it is converted into ozone. The oxygen gas is converted into ozone by action of electricity clouds, lightening.

At a height of 20-30 km from the surface of the earth in the area of stratosphere of the atmosphere one layer is found. This layer or cover is called as **'ozone gas'.**

This gas acts as a protector of the environment. The part where the ozone gas is found is called as **ozone sphere.**

Ozone Layer Depletion

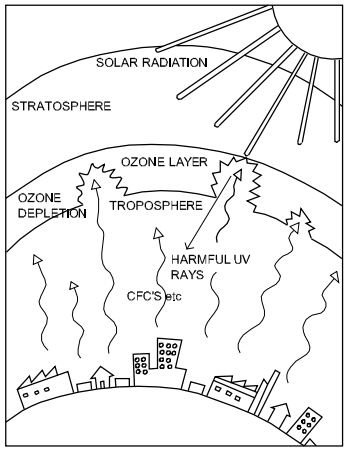
The reduction in the thickness of ozone layer in spring is called as **ozone hole.** This hole is declining in the northern hemisphere on an average rate of **4.1% annually since 1997.**

Causes of the depletion of ozone layer

The reasons for depletion of ozone layer are

- Due to the production of the compound **'Chloro Flouro Carbon'** (CFC) the ozone gas is depleting. When it reaches the stratosphere it attacks the ozone layer and reduces it. (Fig 1)

Fig 1



- The ozone gas layer is affected by polar cyclones.
- The chlorine gas produced by eruption of volcanoes also leaves a bad effect on ozone layer, and it is converted into carbon monoxide.
- Due to excessive amount of Nitrogen oxide in the atmosphere, it affects the ozone layer.
- Radioactive radiation from the nuclear centres has also badly affected the ozone layer.

Effects of ozone depletion

- It produces green house effect and the climate is also changed.
- Ozone depletion results in low production of crops.
- It causes damage to the organs of living things.
- Ultra violet rays harm the plants.
- It causes to spread the skin cancer diseases.
- It increases the smoke in the cities.
- It raises the possibilities of acid rains in the urban areas..
- It increases the temperature of the environment.
- It affects the mental health of man.
- It increases the temperature of atmosphere which has a bad effects on the vegetation.
- The UV rays reaching the earth are harmful to the pregnant women and the infants children also.

Preventive measures for ozone layer depletion

In 1989 limited nations environment and development conference, serious deliberation move alone to put a ban an Chloro Fluro Carbon in a fixed period of time.

- The main cause of formation of ozone hole was the use of Chloro Fluro Carbon (CFC) which is used in refrigerator industry. It harms the ozone layer therefore it should be banned all over the world
- Smoke emitted by the aeroplane should be controlled
- Nuclear explosive strictly banned.
- Use eco-friendly household cleaning products
- Efforts to be made for controlling the smoke emitted by transport vehicles, and in factories.

The ozone layer above India is fortunately completely protected. Because the thickness of ozone layer above the land area of India is 3 times as compared to other countries which are hinge holes in ozone layer.

Acid rain and its effects

When the quantity of acids in the raining water is more than the average, then such rain is called as 'Acid rain'.

or

When the PH of rain water or snow is less than 5.7, it is called as **acid rain.**

or

It is the precipitation of diluted acid from the atmosphere on the earth.

There are two types of depositions of acids in acid rain, they are

- Dry deposition
- Wet deposition

In dry deposition, particles of acid gases like 'NO_2, SO_2' and acid aerosols fall on the earth along with rain. It helps in making acid by dissolving in water in the soil.

In wet deposition, along with acid, water falls on the earth in the form of rain, fog or snow.

Composition of acid rain

Acid rain contains

- Sulphuric acid (H_2SO_4) ' 60% - 70%
- Nitric acid (HNO_3) ' 30% -40%

Nitric acid is formed by dissolving of nitrogen peroxide (NO_2) in water. It is produced in the factories, vehicles, nitrogenous fertilizers factories by the burning of fossil fuel. Sulphuric acid is formed by dissolving sulphur dioxide gas in water. It is produced in volcanoes (67%) and factories (23%).

Due to presence of acid in the rain water, PH values falls. The average PH of rainwater is between 5-6 and 6-5.

The acid rains are the result of the activities if man and the negligence of the industrial units.

The bad effects of acid rain

- By the use of water pollutant with acid rain, man and other living beings are badly affected and the man becomes victims to many types of diseases.
- This rain reduces the lustre of the metals too.
- It decreases the reproduction process of the fishes.
- Wide leaves of the vegetation are harmed by it.
- The nutrients in the soil are badly affected by this rain, ,especially the amount of iron is reduced.
- Water of the rivers, natural resources like wells and ponds gets polluted with acid rain waters. By drinking this water, both man and animals are badly affected.
- It may also causes corrosion in many buildings bridges, monuments, fencing etc.
- With the excessive acid rain, visibility is reduced.
- It decolorizes the leaf pigments.
- It causes irritation in the eyes and skin of human beings.
- Mosquitoes, flies and water insects multiply in this rain.

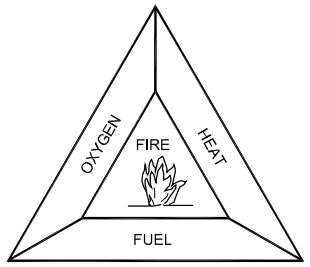
Safety practice - fire extinguishers

Objectives: At the end of this lesson you shall be able to
- **state the effects of a fire breakout**
- **state the causes for fire in the workshop**
- **state the conditions required for combustion relevant to fire prevention**
- **state the general precautionary measures to be taken for fire prevention.**

Fire is the burning of combustible material. A fire in an unwanted place and on an unwanted occasion and in uncontrollable quantity can cause damage or destroy property and materials. Fires injure people, and sometimes, cause loss of life. Hence, every effort must be made to prevent fire. When a fire outbreak is discovered, it must be controlled and extinguished by immediate correct action.

Is it possible to prevent fire? Yes, by eliminating anyone of the three factors that cause fire. (Fig 1)

Fig 1



The factors that must be present in combination for a fire to continue to burn are as follows.

Fuel Any substance, liquid, solid, or gas will burn if given oxygen and high enough temperature.

Heat Every fuel will begin to burn at a certain temperature. Solids and liquids give off vapour when heated and it is this vapour which ignites. Some liquids give off vapour even at normal room temperature say 15°C, eg. petrol.

Oxygen Usually it exists in sufficient quantity in air to keep a fire burning.

EXTINGUISHING OF FIRES

Isolating or removing any of these factors from the combination will extinguish the fire. There are three basic ways of achieving this.

- Starving the fire of fuel by removing the fuel in the vicinity of fire.
- Smothering - i.e. by isolating the fire from the supply of oxygen by blanketing it with foam, sand etc.
- Cooling - i.e. by using water to lower the temperature.

Preventing fires

The majority of fires begin with small outbreaks which burn unnoticed until they become big fires of uncontrollable magnitude. Most of the fires could be prevented with more care and by following some rules of simple common sense.

Accumulation of combustible refuse (cotton waste soaked with oil, scrap wood, paper, etc.) in odd corners are of fire risk. Refuse should be removed to collection points.

The cause of fire in electrical equipment is misuse or neglect. Loose connections, wrongly rated fuses or cables, overloaded circuits cause over heating which may in turn lead to fire. Damage to insulation between conductors in cables also causes fire.

Clothing and anything else which might catch fire should be kept well away from heaters. Make sure the heater is shut off at the end of a working day.

Highly flammable liquids and petroleum mixtures (Thinner, Adhesive solutions, Solvents, Kerosene, Spirit, LPG Gas etc.) should be stored in a separate place called the flammable material storage area.

Blowlamps and torches must not be left burning when they are not in use.

Classification of fires and recommended extinguishing agents.

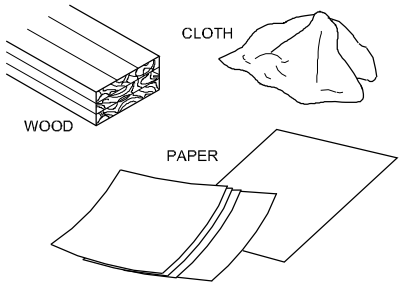
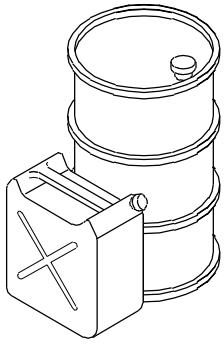
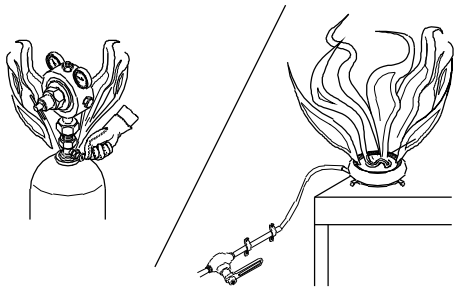
Fires are classified into four types in terms of the nature of fuel.

Different types of fire have to be dealt with different ways and with different extinguishing agents.

An agent is the material or substance used to put out the fire, and is usually (but not always) contained in a fire extinguisher with a mechanism for spraying into the fire.

It is important to know the right type of agent for a particular type of fire; using the wrong one can make things worse.

There is no classification for 'electrical fires' as such, since these are only fires in materials where electricity is present.

Fuel		Extinguishing
CLASS 'A' Fire	Wood, paper, cloth etc. Solid materials. 	Most effective i.e. cooling with water. Jets of water should be sprayed on the base of the fire and then gradually upwards.
CLASS 'B' Fire	Flammable liquids & liquifiable solids 	Should be smothered. The aim is to cover the entire surface of the burning liquid. This has the effect of cutting off the supply of oxygen to the fire. Water should never be used on burning liquids. Foam, dry powder or CO_2 may be used on this type of fire.
CLASS 'C' Fire	Gas and liquified gas 	Extreme caution is necessary in dealing with liquified gases. There is a risk of explosion and sudden spreading of fire in the entire vicinity. If an appliance fed from a cylinder catches fire - shut off the supply of gas. The safest course is to raise an alarm and leave teh fire to be dealt with by trained personnel. Dry powder extinguishers are used on this type of fire. Special powders have now been developed which are capable of controlling and/ or extinguishing this type of fire.
CLASS 'D' Fire	Involving metals 	The standard range of fire extinguishing agents is inadequate or dangerous when dealing with metal fires. Fire on electrical equipment. Carbon dioxide, dry powder and vapourising liquid (CTC) extinguishers can be used to deal with fires in electrical equipment. Foam or liquid (e.g. Water) extinguishers must not be used on electrical equipment under any circumstances.

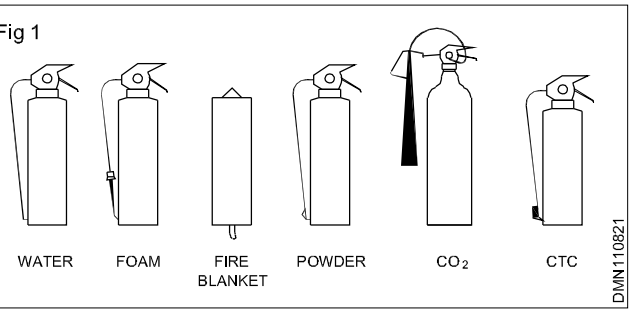
Types of fire extinguishers

Objectives: At the end of this lesson you shall be able to
- **distinguish different types of fire extinguishers**
- **determine the correct type of fire extinguisher to be used based on the class of fire**
- **describe the general procedure to be adopted in the event of a fire.**

A fire extinguisher, flame extinguisher or simply extinguisher is an active fire protection device used to extinguish or control small fires, often in emergency situation. It is not intended for use on an autof control fire.

Many types of fire extinguishers are available with different extinguishing 'agents' to deal with different classes of fires. (Fig 1)

Fig 1

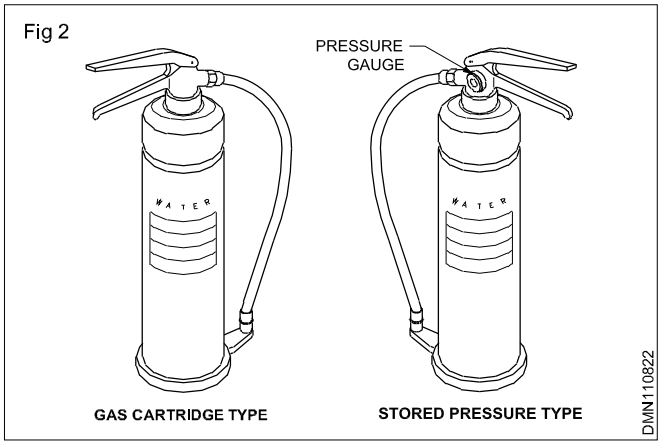


Water-filled extinguishers

There are two methods of operation. (Fig 2)

- Gas cartridge type
- Stored pressure type

Fig 2



With both methods of operation the discharge can be interrupted as required, conserving the contact and preventing unnecessary water damage.

Foam extinguishers (Fig 3)

These may be of stored pressure or gas cartridge types.

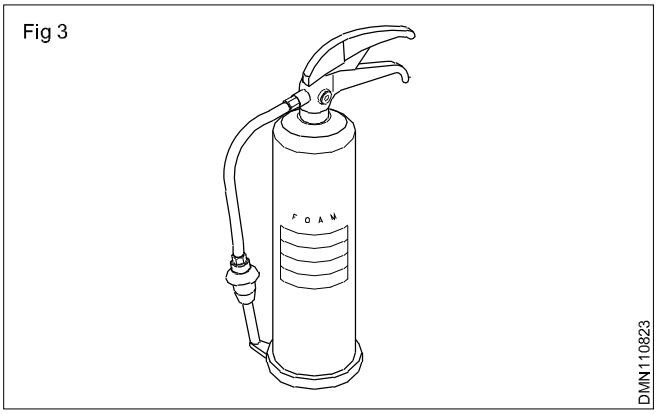
Always check the operating instructions on the extinguisher before use.

Foam extinguishers are most suitable for:

- flammable liquid fires
- running liquid fires

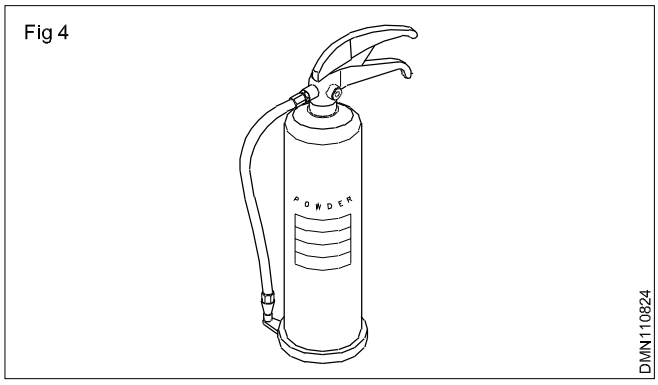
Must not be used where electrical equipment is involved.

Fig 3



Dry powder extinguishers (Fig 4)

Fig 4

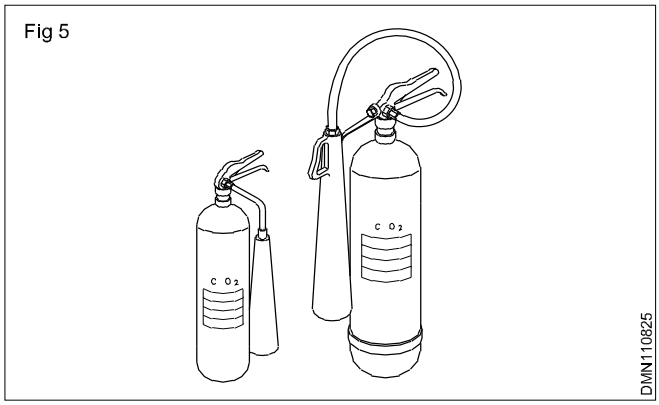


Extinguishers fitted with dry powder may be of the gas cartridge or stored pressure type. Appearance and method of operation is the same as that of the water-filled one. The main distinguishing feature is the fork-shaped nozzle. Powders have been developed to deal with class D fires.

Carbon dioxide (CO_2)

This type is easily distinguished by the distinctively shaped discharge horn. (Fig 5)

Fig 5

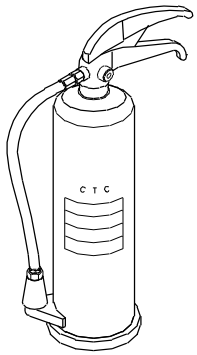


Suitable for class BN fires. Best suited where contamination by deposits must be avoided. Not generally effective in open air.

Always check the operating instructions on the container before use. Available with different gadgets of operation such as - plunger, lever, trigger etc.

Halon extinguishers (Fig 6)

Fig 6



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Theses extinguishers may be filled with carbon tetrachloride and bromochlorodifluoro methene (BCF). They may be of either gas cartridge or stored pressure type.

They are more effective in extinguishing small fires involving pouring liquids. These extinguishers are particularly suitable and safe to use on electrical equipment as the chemicals are electrically non-conductive.

The fumes given off by these extinguishers are dangerous, especially in confined space.

General procedure to be adopted in the event of a fire to be adopted.

- Raise an alarm.
- Turn off all machinery and power (gas and electricity).
- Close the doors and windows, but do not lock or bolt them. This will limit the oxygen fed to the fire and prevent its spreading.
- Try to deal with the fire if you can do so safely. Do not risk getting trapped.
- Anybody not involved in fighting the fire should leave calmly using the emergency exits and go to the designated assembly point. Failure to do this may mean that some person is unaccounted for and others may have to put themselves to the trouble of searching for him or her at risk to themselves.

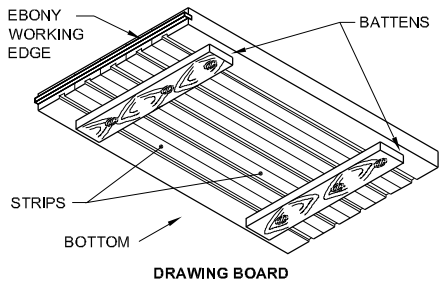
Drawing equipment - drawing board, Mini drafter

Objectives: At the end of this lesson you shall be able to
- **state the construction and use of drawing boards and Mini drafter**
- **state the standard sizes of drawing board as per IS:1444-1989**
- **state the uses of set-squares in drawing work**
- **select the pencil grades for different drawing application**
- **state the purpose of erasing shield.**

The following are the commonly used equipment in a drawing office.

Drawing board (Fig 1)**:** Drawing board is one of the main equipment of Draughtsman. It is used for supporting the drawing paper/tracing paper for making drawings. It is made of well seasoned wood strips of about 25 mm thick or masonite, free from knots and warping. It should be softer enough to allow insertion and removal of drawing pins. Two battens are fastened to the board by screws, in slotted joints. They prevent warping and at the same time permit expansion and contraction of the strips due to the change of moisture in the atmosphere.

Fig 1



One of the shorter edges of the drawing board, is provided with an “ebony edge” (hard wood) fitted perfectly straight.

Standard drawing boards are designated as follows as per IS:1444-1989.

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Standard drawing boards are designated as follows as per IS:1444-1989.

Sl. No.	Designation	Size (mm)
1	D_0	1500 x 1000 x 25
2	D_1	1000 x 700 x 25
3	D_2	700 x 500 x 15
4	D_3	500 x 350 x 15

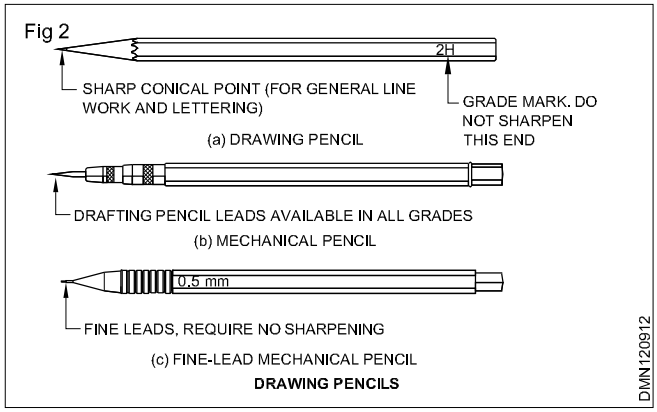
The working edge (ebony) must be straight.

Now-a-days the drawing boards are available with laminated surfaces. The flatness can be checked by placing a straight edge on its surface. If no light passes between them, the surface is perfectly flat.

Pencils, Grade and Selection - Use of Eraser

Pencils (Fig 2)**:** In drawing office, standard pencils (lead encased in wood) and semi-automatic pencils are made use. Pencil leads are made of graphite with kaoline (clay) of varying proportion to get the desired grades. More the kaoline higher the hardness.

Fig 2



Grades of pencils: Pencils are graded according to the hardness or softness of the lead.

Hardest pencil is 9H grade and **softest pencil is 7B grade**. Selection of grade of pencils depends on the type of line work required and paper on which it is used.

Softer lead pencils are used to produce thicker and darker line work, but they wearout quickly. Medium grade of H, 2H are used for general line work as well as for lettering.

Harder grade leads produce lighter and thinner lines. Most construction line work is done with 4H, 5H and 6H pencil leads, producing thin but also sufficiently dark by exerting pressure. Depending upon the individuals touch and the style of writing, right pencil may be selected.

For any drawing on drawing paper or tracing paper, lines should be black, particularly drawings which are to be reproduced. For this purpose, the pencil chosen must be soft enough to produce jet black lines as well hard enough not to smudge easily. The point should not crumble under normal working pressure. The pencils should not be hard and cut grooves on the paper while drawing with normal pressure, Pencils H, 2H or 3H depending upon the paper (quality) and weather conditions are selected.

In summer the pencil leads become softer due to rise in temperature, so slightly harder pencils can be made use of softer grade pencils are used on smooth surfaces for

lettering and arrow head. During rainy season or when humidity is more, the drawing paper expands and wrinkless form, pencil leads become harder. So softer pencils are to be used. Whatever may be grade of pencil you use, always prefer quality pencils/leads viz., Venus, Kohinoor, Apsara etc.

For better line work, i.e., dense black lines, prefer paper which is not having too much teeth (roughness).

Selection of pencils: Pencil grades vary from one brand to another brand. Select the grades of the pencil depending upon the type of line work. For construction lines, you can choose 2H or 3H, for lettering and object lines grade H pencils. In general H, HB and 2H are used.

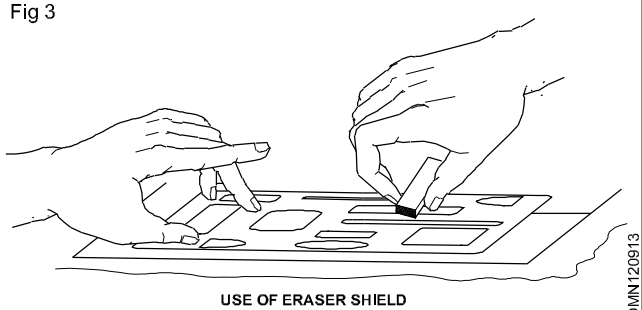
H medium hard
HB medium soft
2H hard

Pencils used for drawing are always hexagonal in cross sections as they do not roll easily even when they are placed on slope surfaces. Its cross section helps in rotating the pencil, while drawing lines, to give uniform line thickness.

Now-a-days automatic (Mechanical) pencils or clutch pencils are available in different sizes (lead dia 0.3, 0.5, 0.7 or 0.9 mm). They are easy to handle as there is no reduction of holding length pencil leads can be replaced, as per required grade of hardness. They produce lines of uniform width without sharpening. (Fig 2)

Erasing shield: When, on a drawing, if a part of a line or some lines among many other lines need to be erased or modified, in normal way of erasing will damage the other nearby lines. In such a situation an erasing shield is effectively useful. It is a thin metallic sheet having small openings of different sizes and shapes. A suitable opening is aligned to the line to be erased and the line is removed by the eraser. (Fig 3)

Fig 3

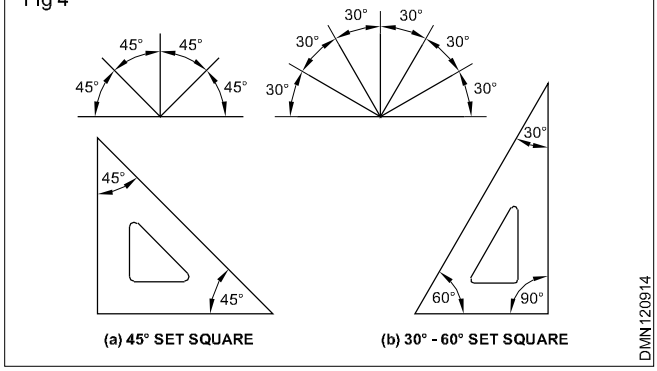


USE OF ERASER SHIELD

DMN120913

Set square (IS:1361-1988)**:** Transparent celluloid / Plastic setsquares are preferred and are commonly used rather ebonite ones. They are two in number, each having one corner with 90°. The setsquare with 60°-30° of 250 mm long and 45° of 200mm long is convenient for use. Setsquares sometimes loose their accuracy due to internal strains. So they should be tested periodically. (Fig 4)

Fig 4



(a) 45° SET SQUARE (b) 30° - 60° SET SQUARE

DMN120914

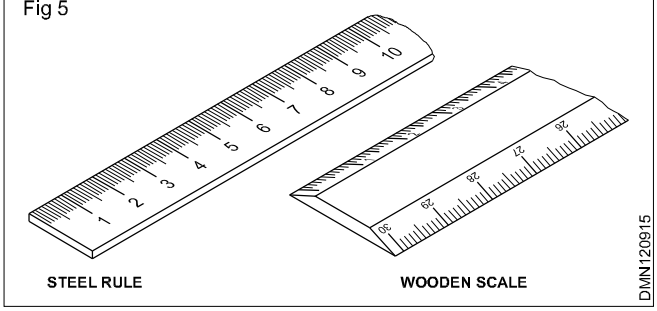
Sometimes set squares have french curves. Set squares are used to draw all straight lines except horizontal lines. It is convenient to draw horizontal lines using Mini drafter.

With the help of Mini drafter and manipulating the 45°, 30°-60° setquares, angular lines in the multiples of 15°; Parallel lines to a given inclined line and perpendicular to can be drawn.

Set squares with graduated, bevel edge and french curve openings are preferable. They are also used to draw smooth curves. Setsquare should never be used as guide for trimming papers.

Scales: Scales are used to transfer and or to measure the dimensions. They are made of wood, steel, ivory, celluloid or plastic, stainless steel scales are more durable. different types of scales used are shown in Figs 1,2 & 3. They are either flat, bevel edged or triangular cross-section. Scales of 15 cm long, 2 cm wide or 30 cm long 3.5 cm wide flat scales are in general use. Thin section or bevel edged scales are preferred over thick flat scales. Parallex error will be nil or least while using thin / tapered edge scales. (Fig 5)

Fig 5



STEEL RULE WOODEN SCALE

DMN120915

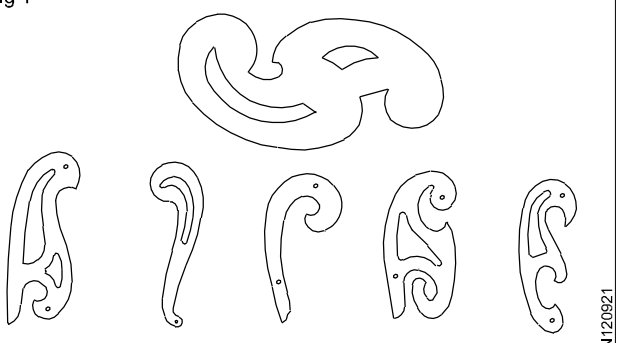
French curves

Objectives: At the end of this lesson you shall be able to
- **state the advantage of french curves**
- **explain the method of applications of french curves.**

These are made in many different shapes, normally come in sets of 6,12,16 etc. French curves are best suited to draw smooth curves/ acres(which cannot be drawn by a compass) with ease. To draw a smooth curve using french curve first set it by trial against a part of the line to be drawn, then shift it to the next portions.

Each new portion should fit atleast three points on the curve just drawn. It should be seen that the curve (radius) is increasing or decreasing smoothly and no corner should be formed on the curve(Fig 6).

Fig 1

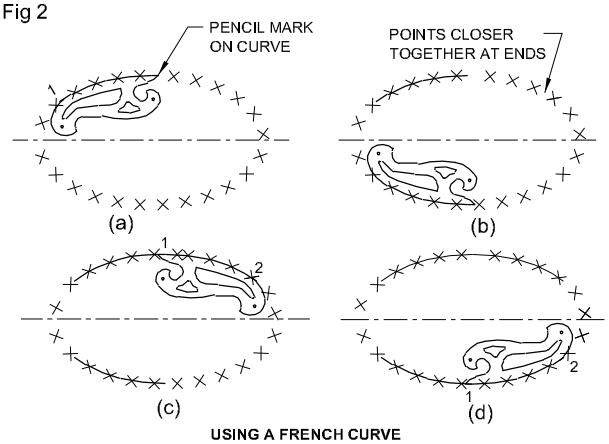


FRENCH CURVES

DMN120921

Fig 7 show how to use the french curve and draw a smooth curves. They are made of transparent celluloid (no bevel edge).

Fig 2



USING A FRENCH CURVE

DMN120922

Drafting machine

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

- **state the funtion of a drafting machine**
- **name the parts of a drafting machine**
- **state the advantages of protractor head**
- **name the types of scales used.**

Drafting in the machine : It serves the functions of a Tee square, set square, protractor and scale. They come in different sizes and a pattern called 'Pantagraph' type. It is fitted on the top left side, edge of the drafting board, mounted on an adjustable frame or table. It requires large area of working place. The angle of the drafting board can be adjusted by pedal operating system. There are two counter weights to balance the angular position of the board and the drafting head. It is more suitable for production drawing office. (Fig 8 to 11).

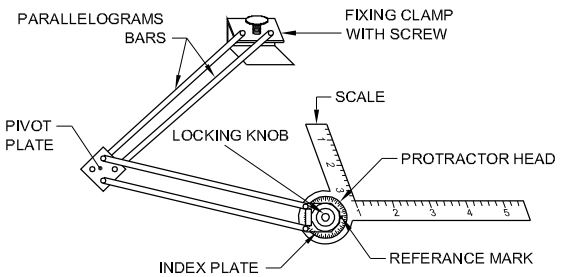
On the other end, a protractor head H with swiveling and locking arrangment is fitted with two scales at right angles.

The protractor head has a spring loaded clutch relieving handle, which rotates and locks at 15^0 intervals automatically. For setting any angle other than multiples of 15^0, the clutch spring is released and by rotating the centre knob, the zero line is set to the required angle and the friction clutch knob is tightened. It is capable of rotating 180^0, thereby any angle can be set.

The scales are bevelled on both sides, graduates to 1:1 & 1:2., They can be reversed with the help of dovetail slide fitting.

There is a fine adjusting mechanism on the drafting head to set the scale parallel to the edge of the board. The scales also can be adjusted if there is any error in measuring 90^0 between them.

Fig 1



PARTS

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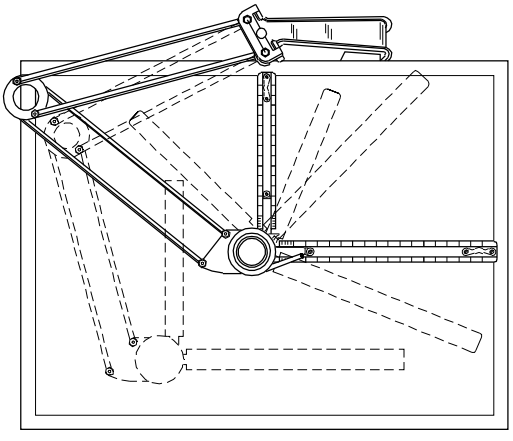
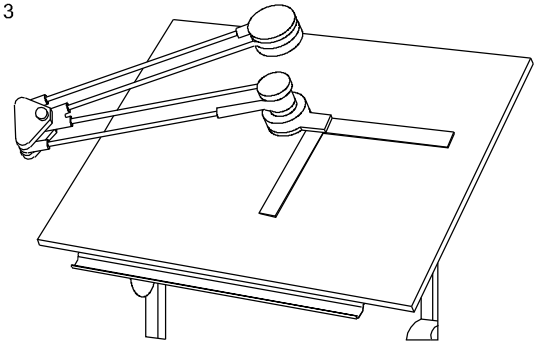
Fig 2



HOW MINI DRAFTER CAN BE ADJUSTED?

DMN120932

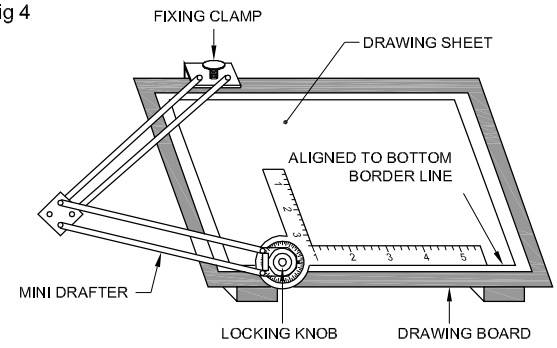
Fig 3



MINI DRAFTER FIXED TO DRAWING BOARD

DMN120933

Fig 4



HOW TO FIX MINI DRAFTER

DMN120934

Drawing Instruments - Features and their uses

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

- **name the contents of an instrument box**
- **state the features and uses of large compass and large divider**
- **state the features and uses of bow instruments, beam compass**
- **state the use of lengthening bar, screw driver, lead case and ruling pen.**

The quality of a good drawing not only depends on the talent of the draftsmen but also on the quality of instruments he uses.

Drawing instruments are generally sold in sets in boxes, but they are also available separately. The main parts of high grade instruments are generally made of Nickel or Brass. They must be rust proof. Tool steel is used for making the blades of the inking pen, bow instruments.

An instrument box contains the following: (Fig 1a to h)

– Large compass (with attachment facility)(a)
– large divider(b)
– Bow compasses, bow divider (c)
– Lengthening bar(d)
– Pen point for attachment(e)
– Screw driver(f)
– Lead case(g)
– Liner(h)

Large compass (Fig 2)**:** It has a knee joint in one leg that permits the insertion of pen or pencil point or attaching lengthening bar with pen or pencil point attached to it. It is used for drawing large circles / arcs also for taking large measurements. The pin on the other leg can be swivelled to vertical position when drawing large circles, while drawing the circles of arcs it should be held in such a way that the needle point leg and pencil point leg should be bent so as to make perpendicular to the paper.

As a rule while drawing concentric circles, small circles should be drawn first before the centre point gets worn.

Large divider: It is used to transfer dimensions and dividing lines into a number of equal parts. Divider with adjustable joints is preferable rather than plain legs. (Fig 3)

Bow instruments: Bow pencil and bow pen compass are used for drawing circles of approximately 25 mm radius. Bow divider is used for marking or dividing smaller spaces. There are two types (i) Integral legs with spring action (4e) (ii) two legs held with a curved spring on top with handle on it.

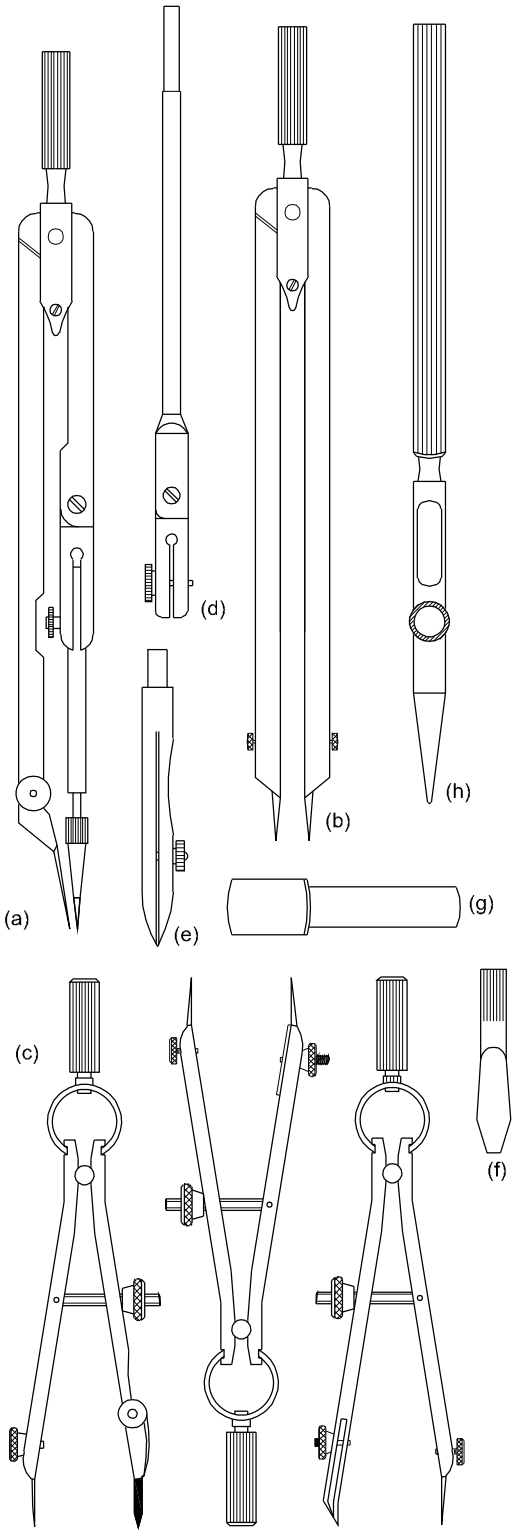
Bow instruments may have adjusting wheel and nut. To draw circles, it is better to mark the required distance separately and set the instruments and check. Then only the circles or arcs should be drawn on the drawing.

Fig 4 shows different types of bow instruments. Adjustment should be made with the thumb and middle finger. The instrument is manipulated by twisting the knurled head between the thumb and finger.

Drop spring bow pencil and pen (Fig 5)**:** Drop spring bow pencil and pen are designed for drawing multiple identical small circles. example rivet holes drilled / reamed holes. The central pin is made to move freely up and down through the tube attached to the pen or pencil unit. It is used by holding the knurled head of the tube between thumb and middle finger while the index finger is placed on the top of the pin. The pin point is placed on the centre point of the circle to be drawn (Fig 5) and pencil or pen is lowered until it touches paper. The instrument is turned clockwise and the circle is drawn.

Beam compass (Fig 6)**:** It consists of a beam made of steel rod or wood . The steel point is used as centre, and by adjusting the compass point (Pencil / Pen), very big circles and arcs are drawn. The divider point and the pencil point are replaceable to the adjustable holders. These pens have provision for varying the thickness of lines.

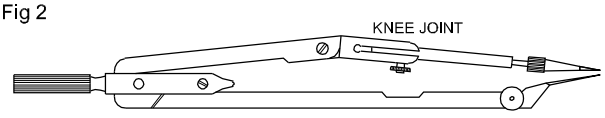
Fig 1



DRAWING INSTRUMENTS

DMN120941

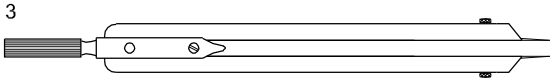
Fig 2



LARGE COMPASS

DMN120942

Fig 3



DIVIDER

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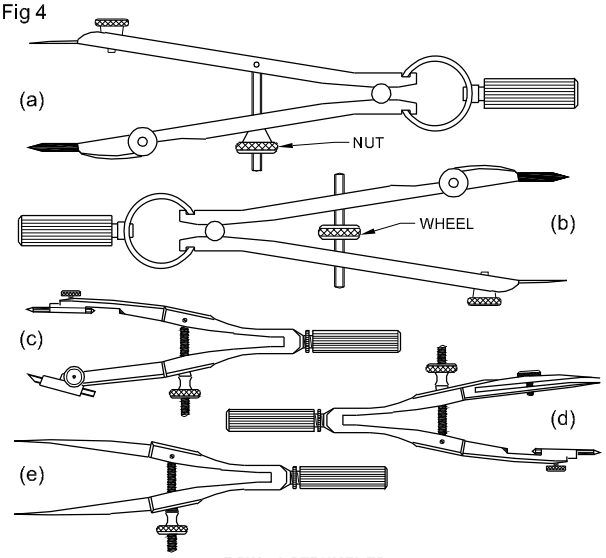
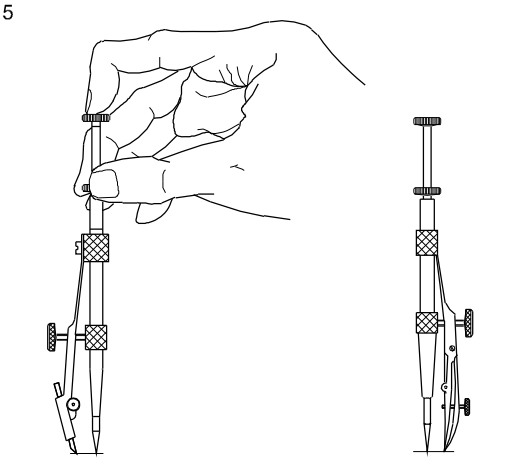
Fig 4



BOW - INSTRUMENTS

DMN120944

Fig 5



DROP SPRING BOW INSTRUMENT

DMN120945

Inking pen or liner or ruling pen (Fig 7)**:** It is used to ink the straight lines drawn with the instruments but never for free hand lines or lettering.

Lengthening bar (Fig 8)**:** To draw larger circles, it is fitted to the compass. The pencil point or pen point is inserted to its end.

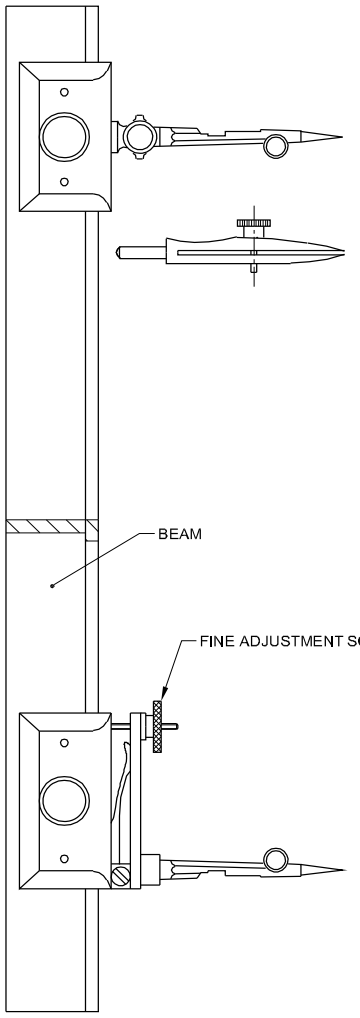
Pencil, pen and needle points are replaceable spares attachable to compass.

Screw driver (Fig 9)**:** Used for adjusting the screws of the instruments.

Lead case (Fig 10)**:** Lead case is the box for holding the pencil leads.

Proportional divider: For enlarging or reducing drawing, dividing a line into a number of equal parts, proportional divider is used. It is best suitable for percentage reduction with the help of graduation marked on the instrument. (Fig 11)

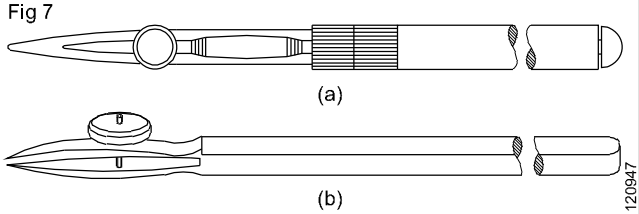
Fig 6



BEAM COMPASS

DMN120946

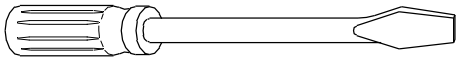
Fig 7



RULING PENS

DMN120947

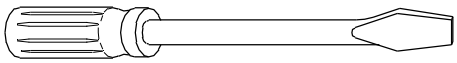
Fig 9



SCREW DRIVER

DMN120949

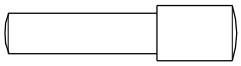
Fig 9



SCREW DRIVER

DMN120949

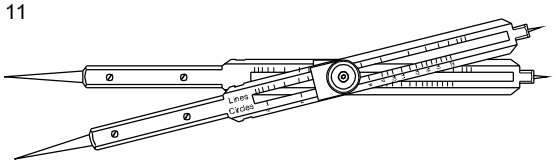
Fig 10



LEAD CASE

DMN12094A

Fig 11



PROPORTIONAL DIVIDERS

DMN12094B

Drawing office materials

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

- **identify man-made and machine-made papers**
- **state the relationship between the sides of standard size sheets**
- **designate and state the length and breadth of standard drawing sheet sizes**
- **interpret the sizes of elongated series in the table**
- **state the method used in arriving at the standard sizes**
- **state the sizes elongated series of sheet sizes.**

Drawing paper: These are of two types:

– Hand-made paper
– Mill-made paper

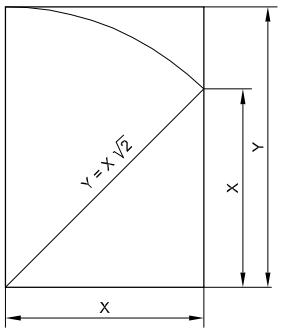
Hand-made papers have rough surfaces, pale in colour and not used for regular work, but meant for charts.

Mill-made papers are most commonly used for regular work, and are available in different sizes and rolls. They are specified by their weight in kg per ream or density in grams per square meter.(GSM)

Size of drawing sheets (in mm)**:** While working or handling, the papers are liable to tear on the edges. So slightly large size (untrimmed) sheets are preferred. They are trimmed afterwards. IS:10811:1983 lays down such as designation of preferred trimmed and untrimmed sizes.

The basic principle involved in arriving at the sizes of the drawing paper is as under. The area of the biggest size (A_0) is $1m^2$ and its length and breadth are in the ratio $1:\sqrt{2}$. Let x and y are the sides of the paper. The surface area of A0 is $1m^2$, then the sides are x = 0.841 m and y = 1.189 m. (Fig 1)

Fig 1



RELATIONSHIP BETWEEN TWO SIDES

DMN120951

Two series of successive sizes are obtained by either halving or doubling along the length. The area of the successive sizes are in the ratio of 1:2.

Designation of sheets: The drawing sheets are designated by symbols such as A_0, A_1, A_2, A_3, A_4 and A_5. A_0 being the largest. Table 1 below gives the length and breadth of the above sizes of sheets. (Trimmed and untrimmed)

The relationship between two sides is same as that of a side of a square and its diagonal.

TABLE 1

Designation	Trimmed size	Untrimmed size
A_0	841 x 1189	880 x 1230
A_1	594 x 841	625 x 880
A_2	420 x 594	450 x 625
A_3	297 x 420	330 x 450
A_4	210 x 297	240 x 330
A_5	148 x 210	165 x 240

For drawings which cannot be accommodated in above sheets, elongated series are used. Elangated series are designated by symbols A_1 x 3; A_2 x 4 etc.

Special elongated series increasing its widths, double, treble etc. are designated as follows A3 x 3, A3 x 4, A4 x 3, A4 x 4, A4 x 5. Please refer Table 2

TABLE 2

Special elongated series	
Designation	**Size**
A_3 x 3	420 x 891
A_3 x 4	420 x 1189
A_4 x 3	297 x 630
A_4 x 4	297 x 841
A_4 x 5	297 x 1051

Exceptional elongated series

Designation	Size
A_0 x 2	1189 x 1682
A_0 x 3	1189 x 2523
A_1 x 3	841 x 1783
A_1 x 4	841 x 2378
A_2 x 3	594 x 1261
A_2 x 4	594 x 1682
A_2 x 5	594 x 2102
A_3 x 5	420 x 1486
A_3 x 6	420 x 1783
A_3 x 7	420 x 2080
A_4 x 6	297 x 1261
A_4 x 7	297 x 1471
A_4 x 8	297 x 1682
A_4 x 9	297 x 1892

A_4 x 3 means the length of A_4 size is retained and the other side is 3 times the width of A_4.

A_4 x 3 = 297 x 630 (210 x 3)

Fig 2 & 3 shows how the sheet sizes are formed by halving / doubling and similarity of format.

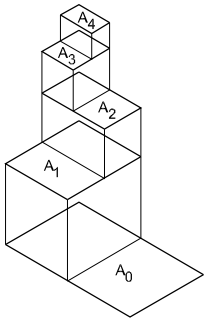
White drawing papers which do not become yellow on exposure to atmosphere are used for finished drawings, maps, charts and drawings for photographic reproductions.

For pencil layouts and working drawings, cream colour papers are best suited.

Quality drawing paper: The drawing papers should have sufficient teeth or grain to take the pencil lines and withstand repeated erasings.

A backing paper is to be placed on the drawing board before fixing drawing / tracing paper, to get uniform lines. Before starting the drawing, the layout should be drawn. (Ref: IS:10711)

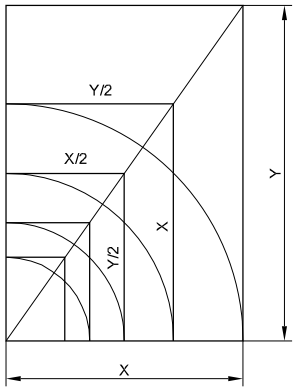
Fig 2



HALVING AND DOUBLING

DMN120952

Fig 3



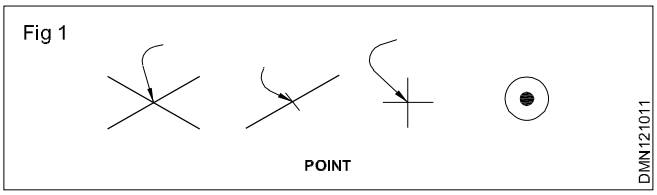
SIMILARITY OF FORMATIONS

DMN120953

Types of lines and angles

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)

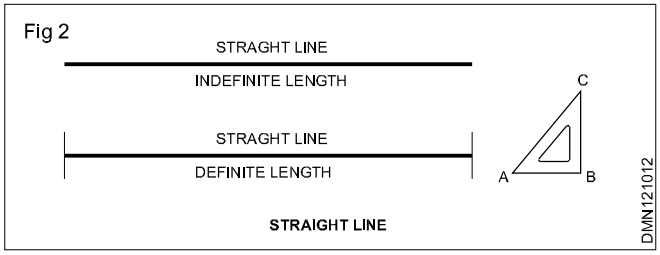


Line is the path of a point when it moves. It has no thickness and are of two types:

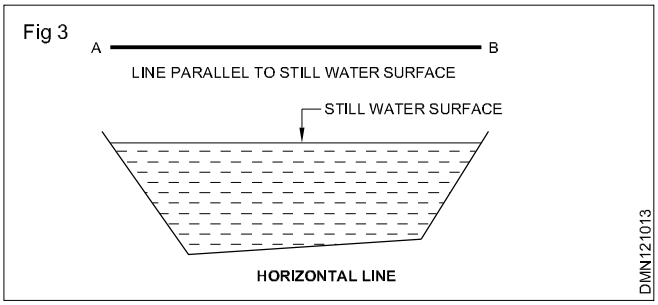
– Straight line

– 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 orientation are classified as Horizontal, Vertical and Inclined or Oblique line.

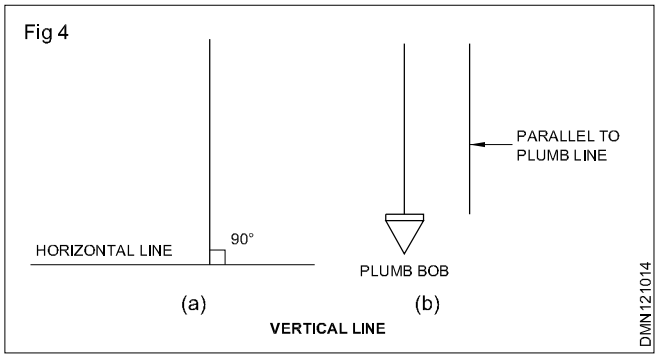


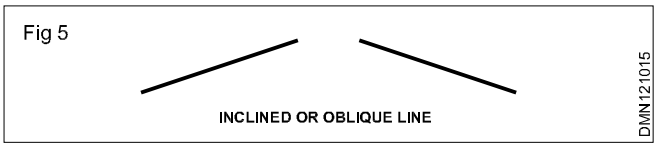
Horizontal line (Fig 2)**:** Horizontal lines are those which are parallel to a horizontal plane. Example of horizontal plane is the surface of a still water. (Fig 3)



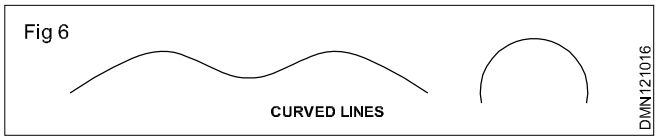
Vertical line (Fig 4a)**:** Lines which are perpendicular to horizontal lines are called vertical lines. It can be treated as a line along the plumb line of the plumb bob or parallel to a plumb line. (Fig 4b)

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

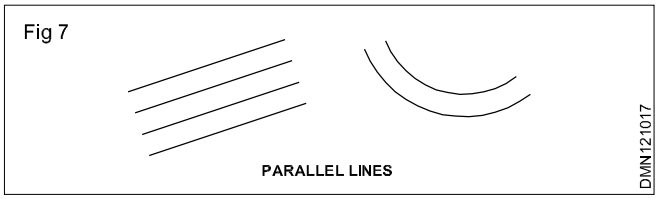




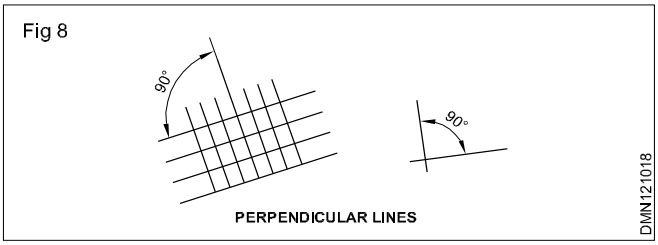
Curved line: It is the path of a point which always changes its direction. Examples of curved lines are shown in Fig 6.



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)



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)



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.(Fig 8)

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 πD or $2\pi D$

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 called as semi-circle.

Tangent of a 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 where the 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 concentric circles. (Fig 2)

Fig 1

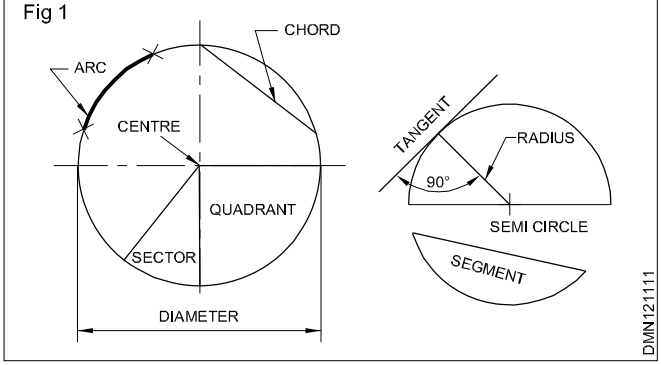
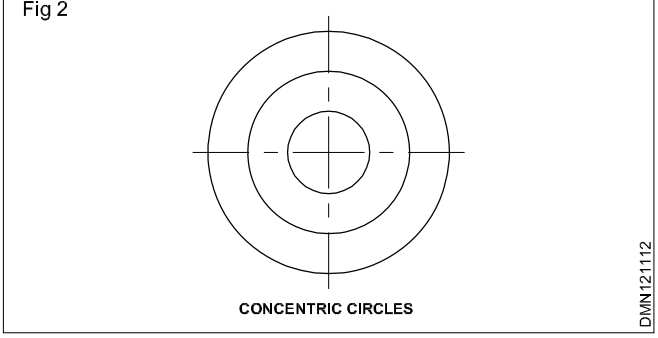
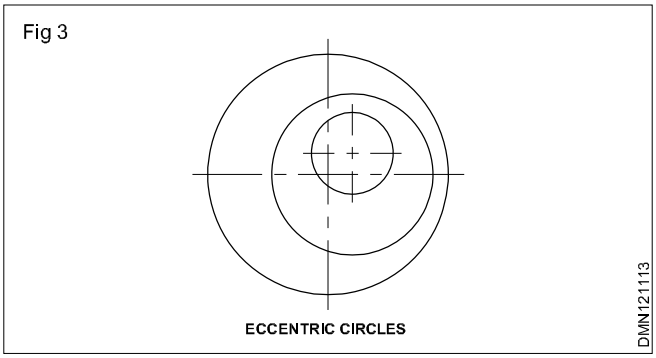


Fig 2



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

Fig 3



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 quadrilaterals.**

Quadrilateral is a plane figure bounded by four sides 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 out of four sides, four angles and two diagonals a minimum of five dimensions are required of which two must be sides. Quadrilaterals are also referred as Trapezoid.

Types of quadrilaterals. (Fig 1)

– Square

– Rectangle

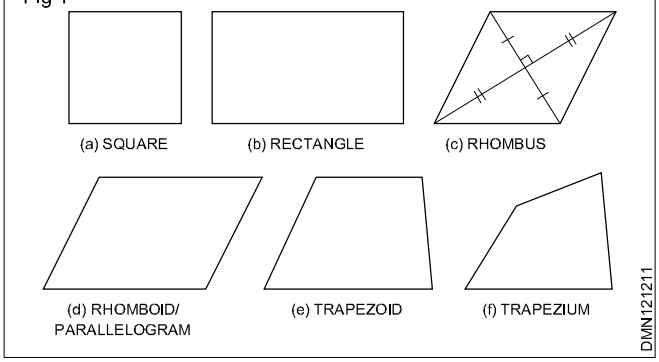
– Rhombus

– Rhomboid/Parallelogram

– Trapezoid

– Trapezium

Fig 1



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

Rectangle (Fig 2)**:** In a rectangle, opposite sides 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

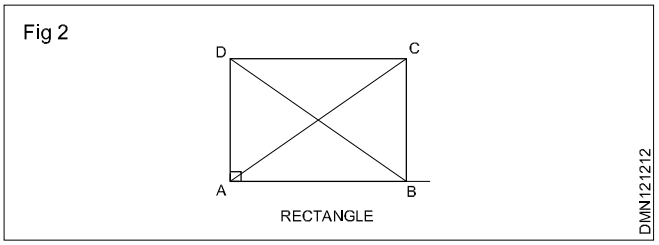


Fig 2 shows a rectangle ABCD. Sides AB = DC and BC = AD. Diagonals AC and BD are equal, bisect but not at right angles.

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.

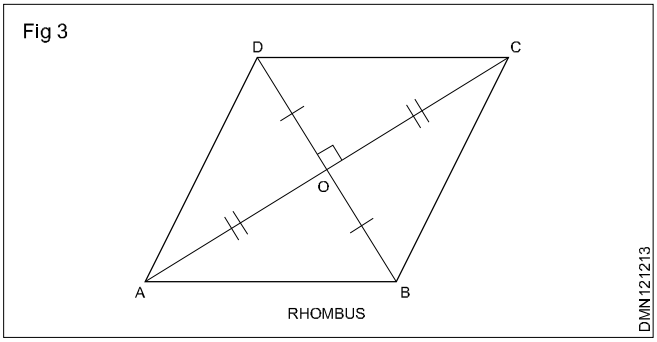
Angle ABC = Angle ADC and Angle BAD = Angle BCD.

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.

Fig 3



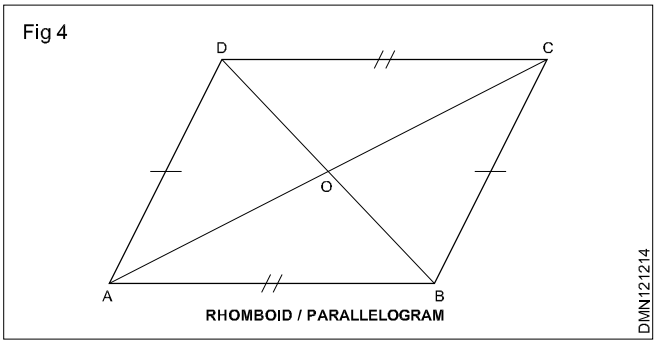
Rhomboid/Parallelogram (Fig 4)**:** In a parallelogram opposite sides are equal and parallel. Opposite angles are also equal. Diagonals are not equal but bisect each other.

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

Fig 4



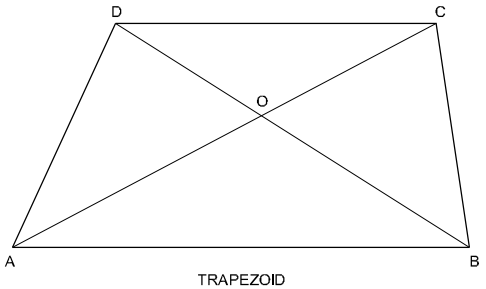
Sides AB,CD and AD, BC are parallel.

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.

ABCD is a trapezoid, sides AB and DC are parallel but not equal.

Fig 5



TRAPEZOID

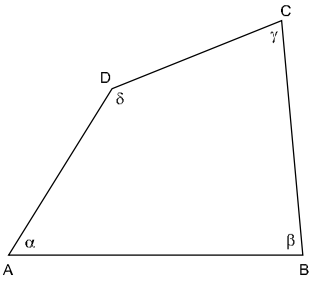
DMN121215

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

Sides AD and BC may sometimes equal.

Trapezium (Fig 6)**:** It is a plane figure of 4 sides, all sides are different and all the four angles also differ.

Fig 6



TRAPEZIUM

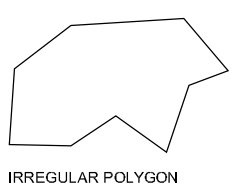
DMN121216

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 a plane figure bounded by many (usually four or more) straight lines. When all the sides and included angles are equal, it is called as a regular polygon. (Fig 1)

Fig 1



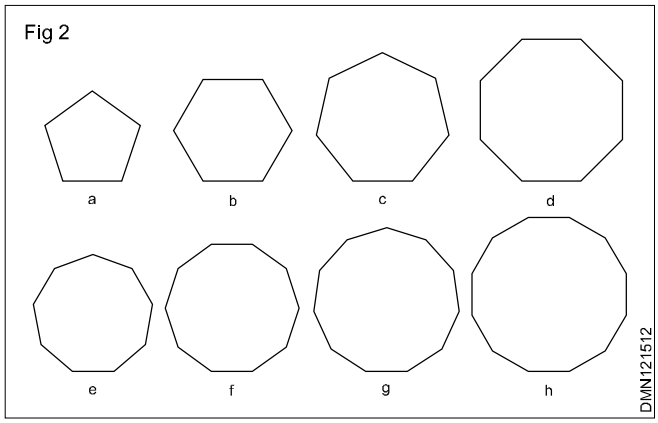
Names of polygons: Polygons are named in terms of their number of sides as given below: (Fig 2)

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

Properties of polygon

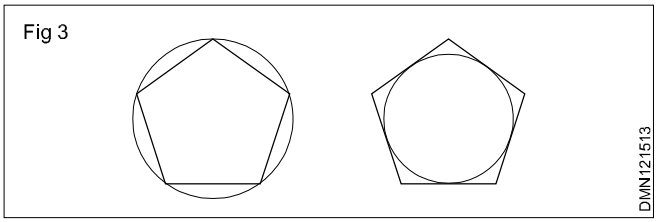
- All corners of a regular polygon lie on the circle. The sides of a regular polygon will be tangential to the circle drawn in side. (Fig 3)

Fig 2



- The sum of the interior angles of a polygon is equal to change as $(2 \times n - 4) \times 90^0$, 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 3



Layout of drawing sheets and title block

Objectives: At the end of this lesson you shall be able to
- **state the measuring of the term `Layout' of drawing sheet**
- **list the different layout styles drawing sheets**
- **explain margin, frame, title block etc.**

Layout: 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 enables 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 20 mm for the sheet sizes A0, A1 and 10 mm for the sheet sizes A2, A3, A4 & A5 for the space for filing. (Refer Figs 1 & 2)

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

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

Fig 2

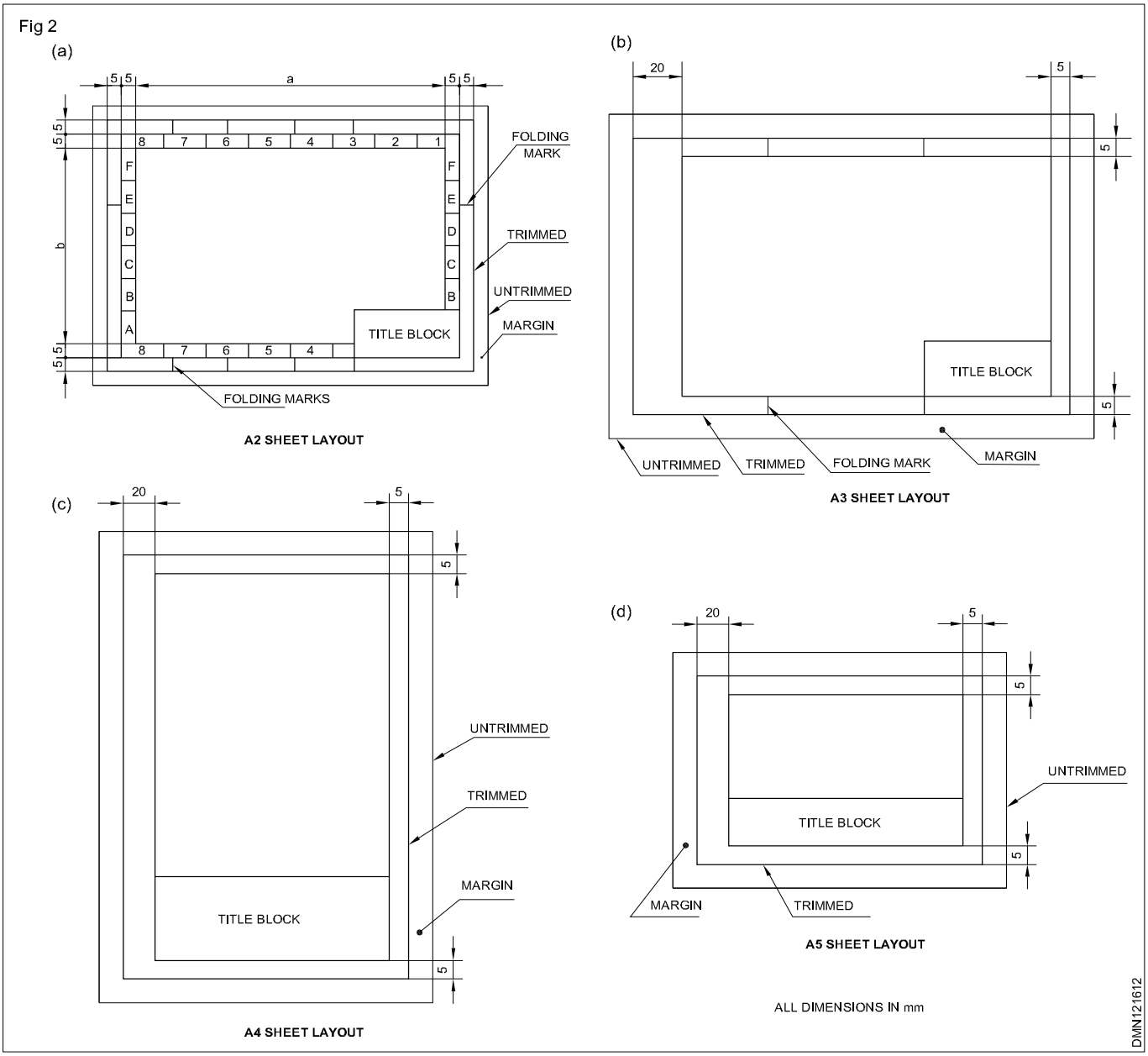
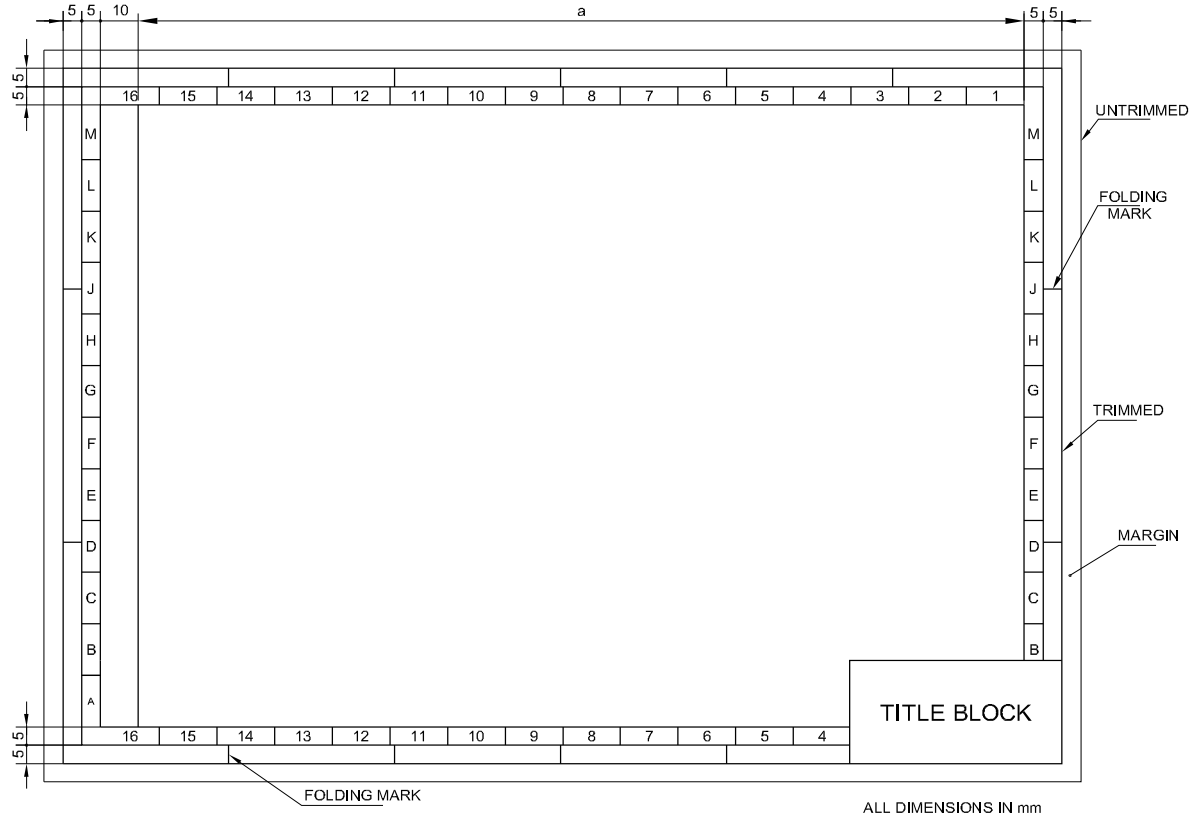


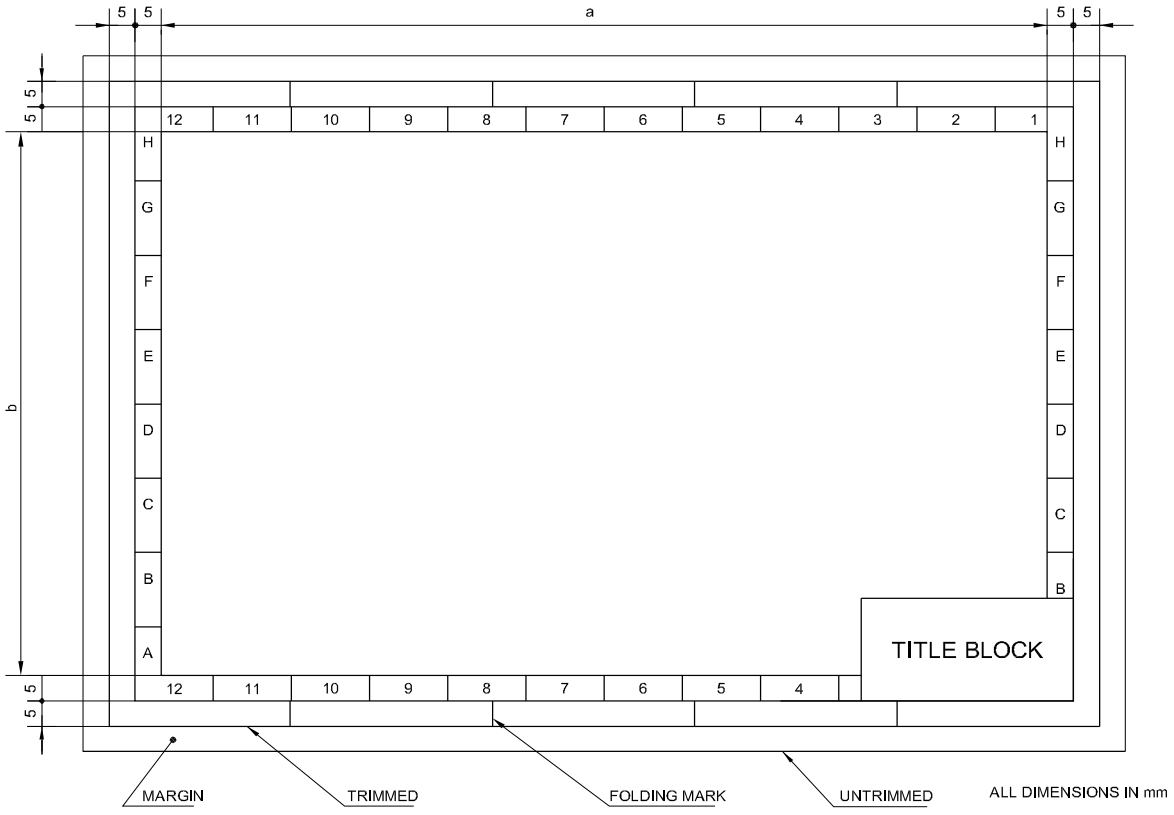
Fig 1

(a)



A0 SHEET LAYOUT

(b)



A1 SHEET LAYOUT

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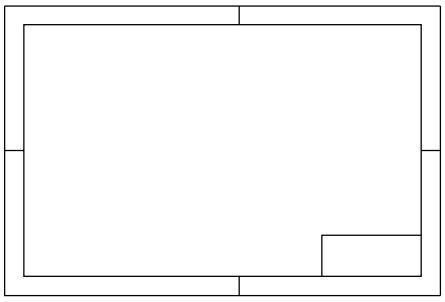
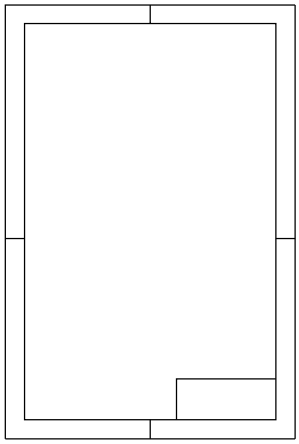
Fig 3



HORIZONTAL SHEET TYPE X

DMN121613

Fig 4



VERTICAL SHEET TYPE Y

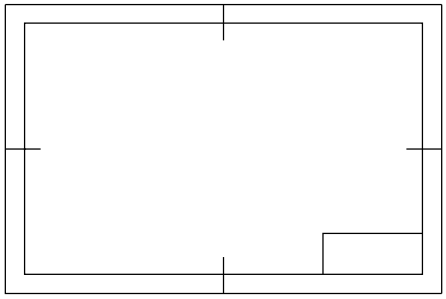
DMN121614

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.

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.

Fig 6

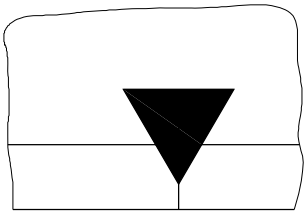


CENTRING MARKS

DMN121616

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

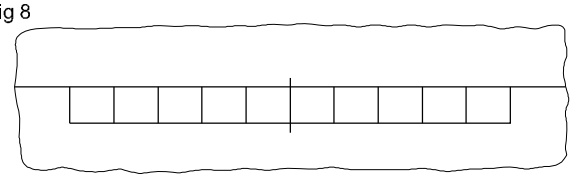


ORIENTATION MARKS

DMN121617

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

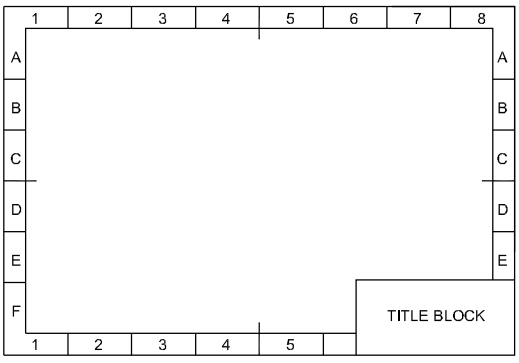


METRIC REFERENCE GRADUATION

DMN121618

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

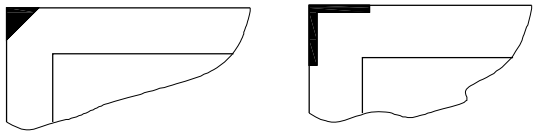


GRID REFERENCE SYSTEM

DMN121619

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

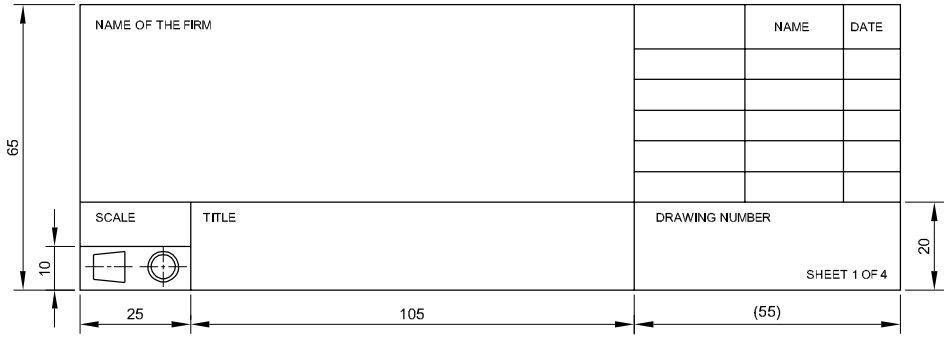
Fig 10

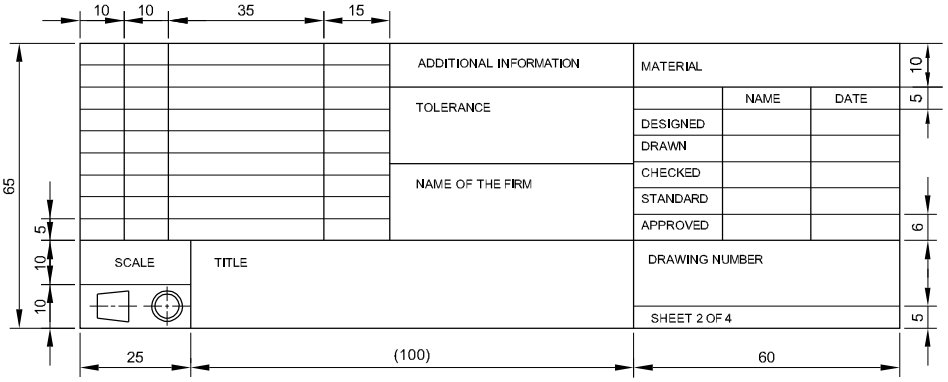


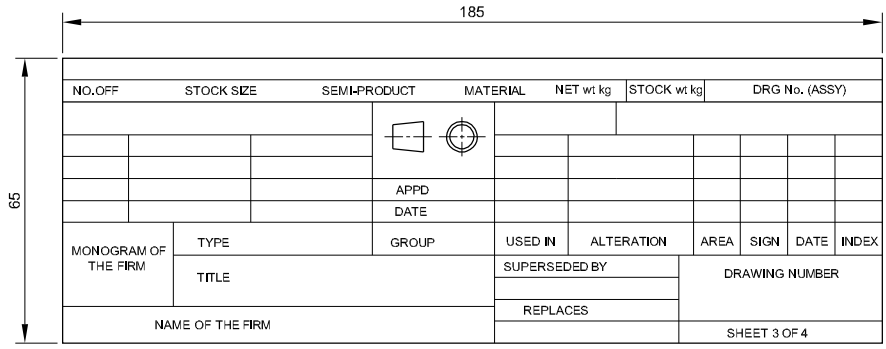
TRIMMING MARKS

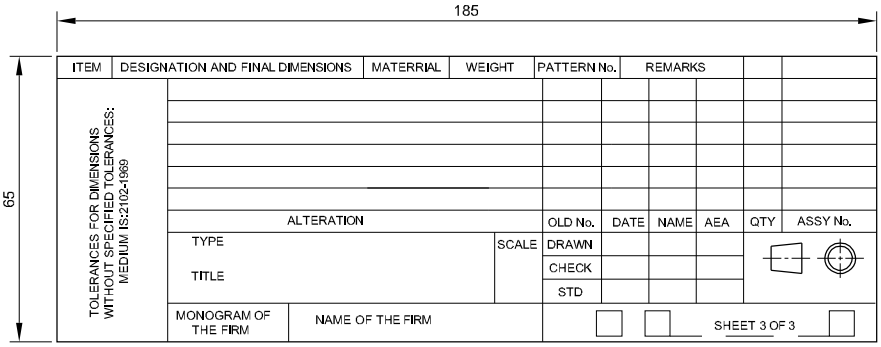
DMN12161A

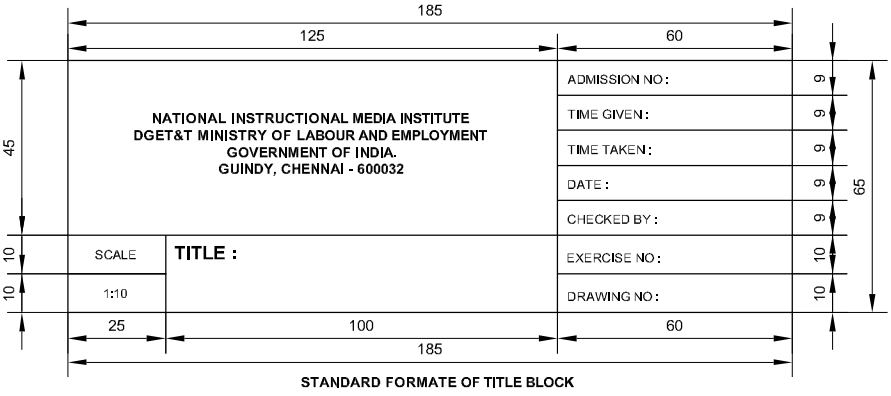
Fig 5











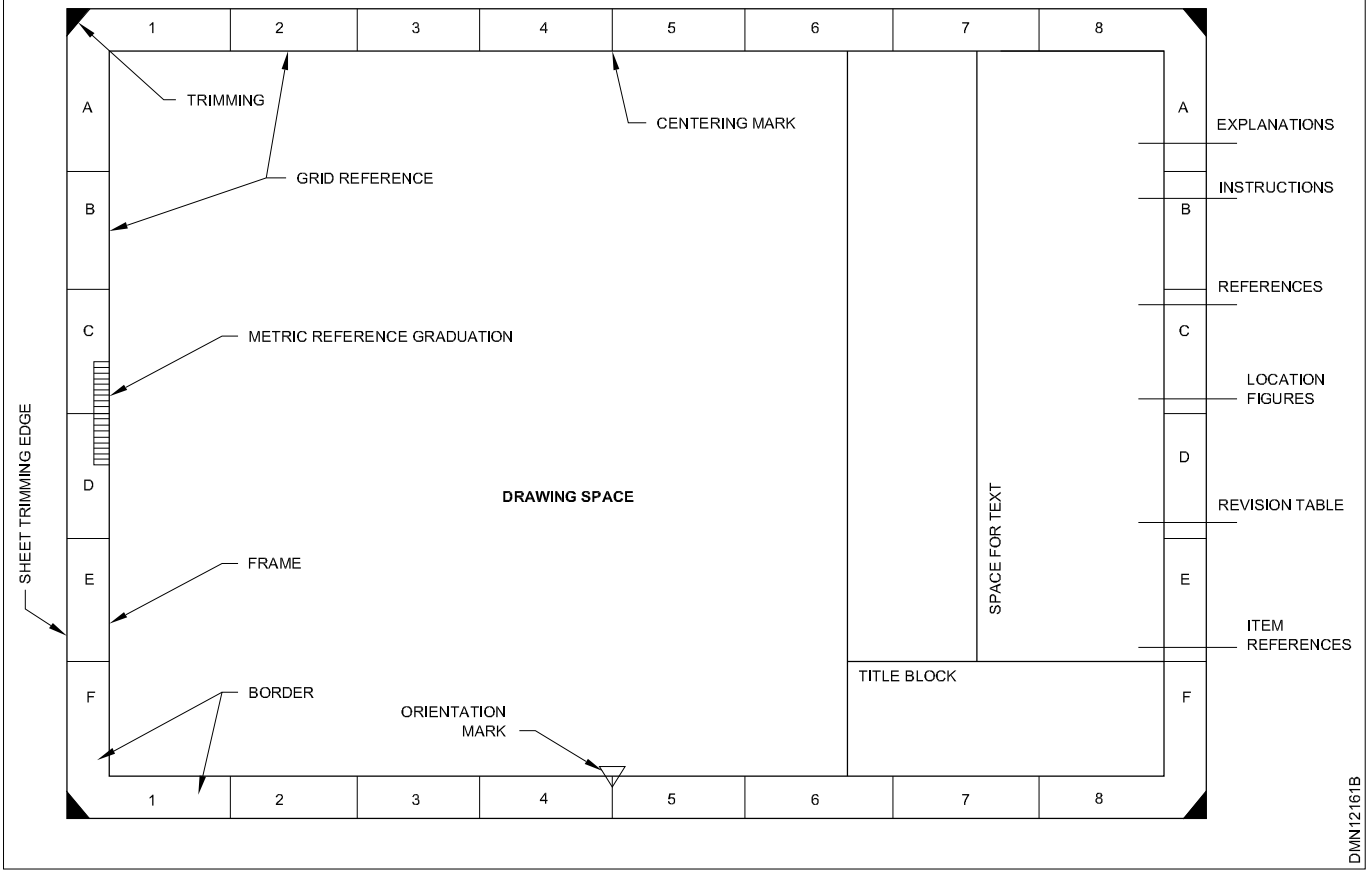
STANDARD FORMATE OF TITLE BLOCK

DMN121615

Spacing Drawing: (Fig.11)

When only one figure is to be drawn on a sheet it should be drawn in the centre of the working space. For more than one figure, the space should be planned and divided into suitable bocks..

Fig 11



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

Folding of Drawing Sheets

Objectives: At the end of this lesson, you shall be able to,
- **state the purpose of folding a drawing sheet**
- **explain the method of folding drawing sheet.**

Introduction

After the completion of the drawing, the drawing should be folded properly according to IS: 11664-1986 recommended by Bureau of Indian Standards, and filed neatly for submission or for future revision / reference. All the maps and plans are folded to final size for convenience of record in office files.

The following proceduredure shall be adopted (Fig.1)

a) Always fold vertically first,

b) Fold horizontally next

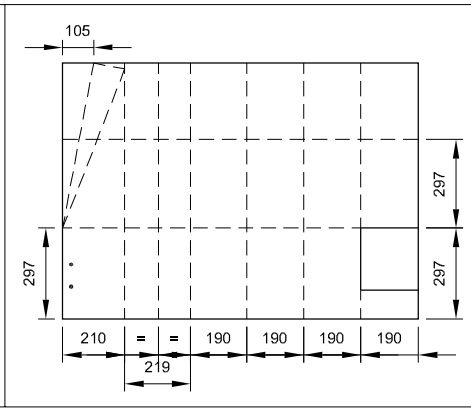
c) Folded drawing to be size of file, and

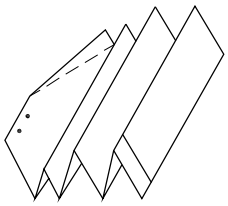
d) It can see that the Title block of all the folded prints appears in topmost position for easy reference.

Fig 1

A0

841 X 1189





DMN121811

Convention of lines

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

- **state the types of line**
- **explain the application of different types of lines.**

Introduction:

The lines on engineering drawing differ in character and thickness to be read easily and to convey different appropriate messages to the trained eye.

Types of lines and their applications

Line	General applications see figure and other relevant figure
A	A1 Visible outlines A2 Visible edges
B	B1 Imaginary lines of intersection B2 Dimension lines B3 Projection lines or extension line B4 Leader lines B5 Hatching B6 Outline of revolved sections in place B7 Short centre lines B8 Thread lines B9 Diagonal line
C	C1 Limits of partial or interrupted views & sections, if the limit is not a chain thin
D	D1 Line (see figure)
E	E1 Hidden outlines E2 Hidden edges
F	F1 Hidden outlines F2 Hidden edges
G	G1 Centre lines G2 Lines of symmetry G3 Trajectors
H	H1 Cutting planes
J	J1 Indication of lines or surfaces to which a special requirement applies
K	K1 Outlines of adacent parts K2 Alternative and extreme positions of movable parts K3 Centroidal lines K4 Initial outlines prior to forming K5 Parts situated in front of the cutting plane.

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**
- **decide 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 figure 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:9609-1983

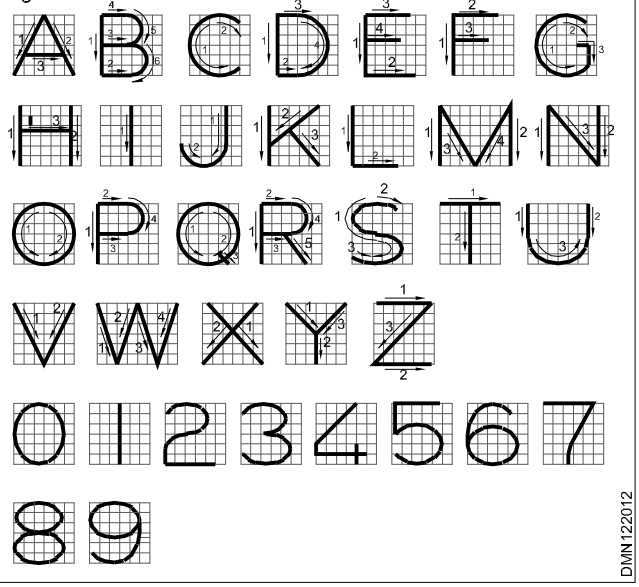
Width (W)	Capital letters
1	I
4	J
5	C,E,F,L
6	B,D,G,H,K,N,O,P,R,S,T,U & Z
7	A,M,Q,V,X,Y
9	W

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



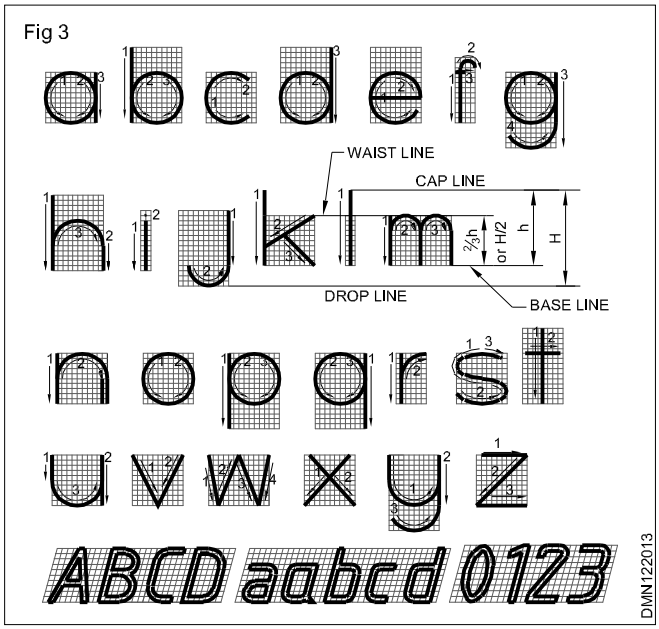
Inclined letters (Fig 3) are drawn at an angle of 15° towards right side, the proportion being the same as of vertical lettering.

Fig 3 shows single stroke / lower case letters.

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.

Fig 3



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

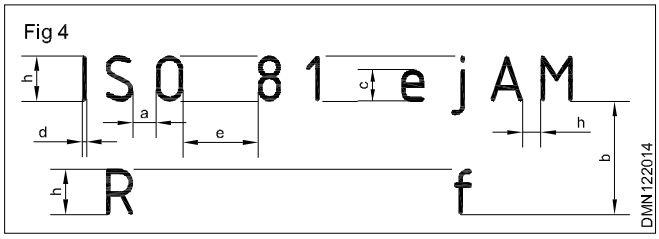


TABLE 1

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 lines	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 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.

Conic sections

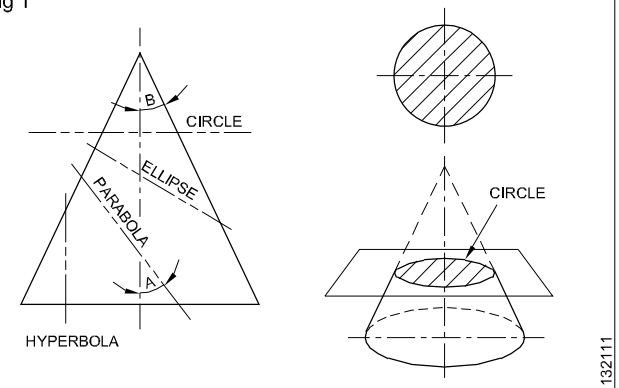
Objectives: At the end of this lesson you shall be able to
- **define a conic section**
- **define an ellipse**
- **identify the elements of an ellipse**
- **state what is eccentricity of an ellipse**
- **state the term tangent and normal as applied to an ellipse**
- **list the methods of constructing an ellipse**
- **state the practical applications of an elliptical curve.**

When a right circular cone is cut by planes at different angles to its axis, depending on the angle of the cutting plan, four different curves are formed. These curves are called "conic sections".

The different conic sections are:

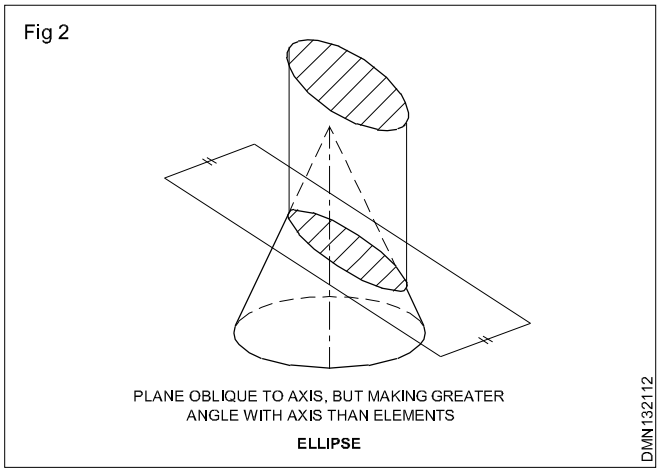
Circle (Fig 1)**:** Cut by a plane perpendicular to the axis.

Fig 1



Ellipse (Fig 2)**:** Cut by a plane making greater angle with axis, more than half of the included angle of the cone.

Fig 2



Parabola (Fig 3)**:** Cut by a plane making the same angle with the axis is parallel to the slant line.

Hyperbola (Fig 4)**:**Cut by a plane making a smaller angle with the axis. (i.e the plane is not parallel to the slant line and passes through the base)

Fig 3

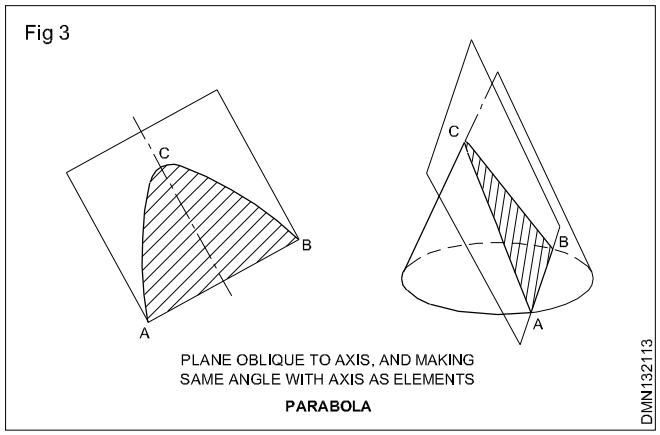
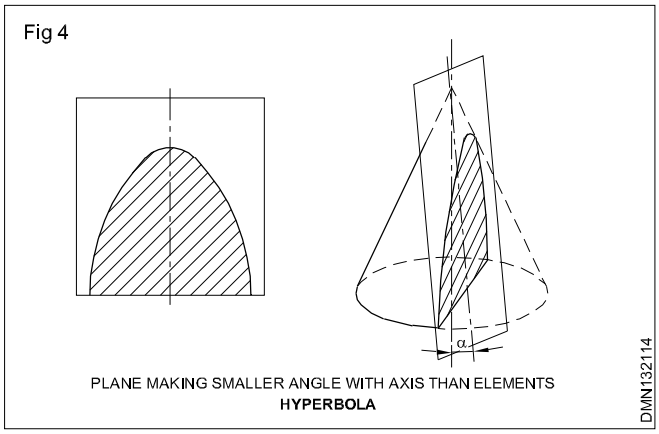
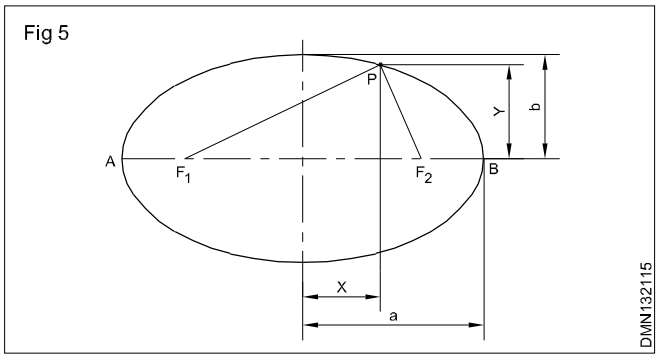


Fig 4



Ellipse (Fig 5)**:** Ellipse in the simplest sense is an elongated circle. However it is defined as a plane curve generated by a point moving so that the sum of its distances from two fixed points F_1 and F_2 called foci, is a constant and equal to the major axis.

Fig 5



P = any point on the curve

F_1,F_2 - focal points (Foci)

AB = major axis

$PF_1 + PF_2 = AB$

Property: If a point 'P' on its curve at distance of X and Y from 0 on X and Y axis respectively,

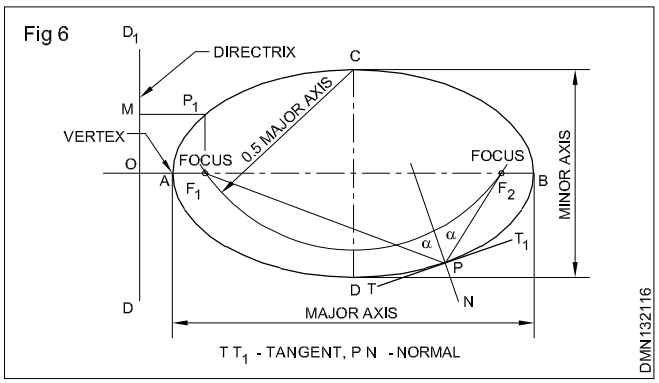
Then, $\frac{X^2}{a^2} + \frac{Y^2}{b^2} = 1$

where a = one half of major axis

b = one half of minor axis

X and Y are co-ordinate of point P.

Elements of an ellipse (Fig 6)



Major axis: It is the longest distance which passes through the ellipse, at right angle to the fixed lines called the directrix. AB is the major axis.

Minor axis: It is the maximum distance which bisects the major axis at right angle. It will be parallel to the directrix. CD is the minor axis.

Directrix: It is a straight line perpendicular to the major axis.

Focus: When an arc is drawn with C or D as centre and radius equal to half the major axis i.e $\frac{AB}{2}$, it is cut at two points F_1 and F_2 on the major axis. F_1 and F_2 are the focal points of an ellipse F_1 or F_2 is the focus. The sum of the distances from F_1, F_2 to any point on the curve i.e., F_1P + F_2P is always constant and equal to the major axis.

Focal radii: The distances from point P on the curve to the focal points F_1 and F_2 are called focal radii. Sum of the focal radii is equal to the major axis.

Eccentricity: The ratio between the distances from the vertex to focus and vertex to the directrix is called the eccentricity and is always less than one.

$AF_1/A0$ is less than one.

It can also be stated as the ratio of the distance from focus onto any point on the curve, say P_1 and the perpendicular distance of P_1 from the directrix. i.e P_1F_1/P_1M is a constant - the eccentricity.

Vertex: The end points of the major axis on the curve are called vertex. (A, B)

Tangent and normal to an ellipse: Normal is the line bisecting the angle F_1PF_2 in Fig 6. Tangents in a line at 90° to the normal and touching the ellipse.

Directrix, axis, focus, vertex and tangent are the elements common to ellipse, parabola and hyperbola.

All ellipse can be constructed in different methods:

- Rectangle method (oblong)
- Concentric circle method
- Arcs method
- String and pins method
- Paper trammel method
- 4 centre method
- Conjugate diameters method
- Eccentricity method

Practical applications: In general, a circle in a pictorial drawing is represented by an ellipse. The use of elliptical shape is rarely used for engineering applications. Ellipse is dealt extensively in mathematical books. Elliptical shape is adopted for better asthetics.

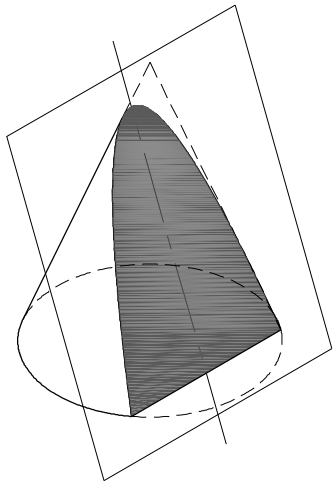
Parabolic curves

Objectives: At the end of this lesson you shall be able to
- **define a parabola**
- **state the properties of parabola**
- **name the elements of the parabola**
- **state the different methods of constructing the parabola**
- **state the practical applications of a Parabolic curve.**

Parabola: It is one of the conic sections.

When the cutting plane is parallel to the generators (slant line) of the cone, (and inclined to the axis) the section obtained is called "Parabola". (Fig 1)

Fig 1



PARABOLA

DMN132121

Properties: Parabola is defined as the locus of a point which moves so that the ratio of its distance from a fixed point F (called the focus) and a directrix bears a constant and equal to 1 (Unity).

In other words if the perpendicular distance of any point on the curve from a fixed line called directrix is equal to its distance from focus, the curve is called "Parabola". (Fig 2)

Elements of Parabola

Axis: It is a line (XX') perpendicular to the directrix and passing through the focus.

Vertex (V)**:** It is the mid point of the perpendicular line drawn from focus to directrix.

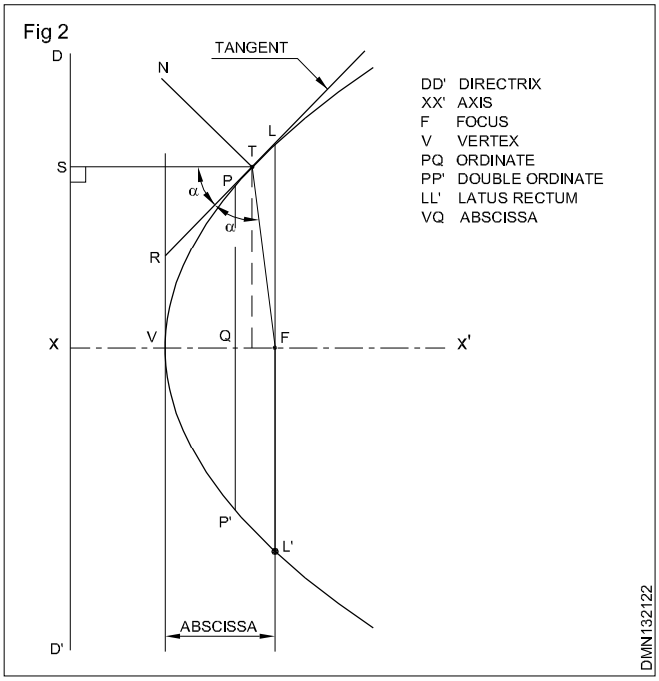
Ordinate: Perpendicular distance of any point P on the curve to the axis line PQ.

Double ordinate: When the ordinate is extended to meet the curve on the other side. Crossing the axis, it is twice the ordinate line P-Q-P' is the double ordinate.

Latus rectum: The double ordinate which passes through the 'Focus' is called latus rectum.

Abscissa: The distance along the axis XX' from vertex (V) and a point through which the double ordinate passes

Fig 2



DMN132122

is called the "Abscissa" VQ is the abscissa corresponding to the ordinate PQ.

Tangent and normal for the point T

– Draw TS perpendicular to directrix

– Draw TF

– Bisect angle STF, it will be tangential to parabola at P.

– Draw TN perpendicular to tangent will be normal at P.

A parabola can be constructed by any one of the following methods:

– ordinate method

– rectangle method

– tangent method

– parallelogram method

– offset method

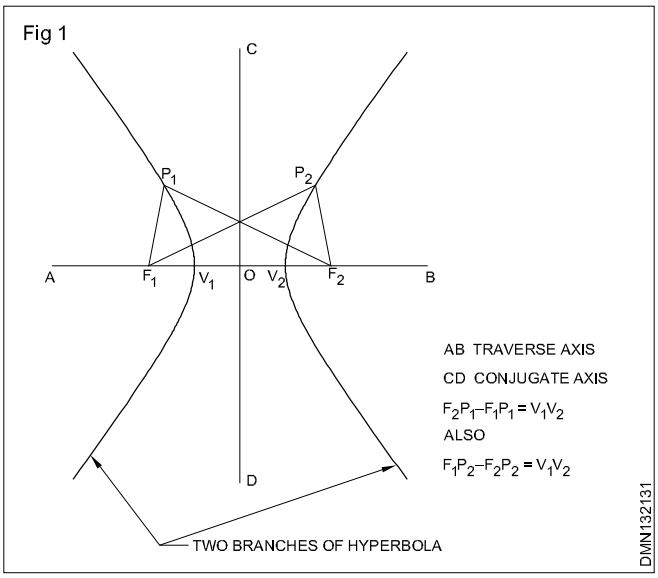
Practical application: Search lights, reflecting surfaces for light and sound, bridge arches, wall brackets and largely used in graphic methods for determining the stress upon beams and girders etc.

Hyperbola

Objectives: At the end of this lesson you shall be able to
- **define a hyperbola**
- **state the elements of hyperbola**
- **name the applications of hyperbolic curves**
- **state the practical applications of a hyperbolic curve.**

Hyperbola (Fig 1)**:** It is a conic section, formed by cutting plane inclined to the axis (not parallel to the generator) and passes through the base. It is the locus of the point which moves so that its distance from a fixed point, the 'Focus' (F) bears a constant ratio (this ratio is called eccentricity and it is always greater than 1) to its perpendicular distance from a straight line called the Directrix.

It is the path of a point moving in such a way that the difference of its distances from the fixed points is a constant and is equal to the distance between the vertices



of the two branches of the hyperbola. This distance is also known as major axis of the hyperbola. (Fig 1)

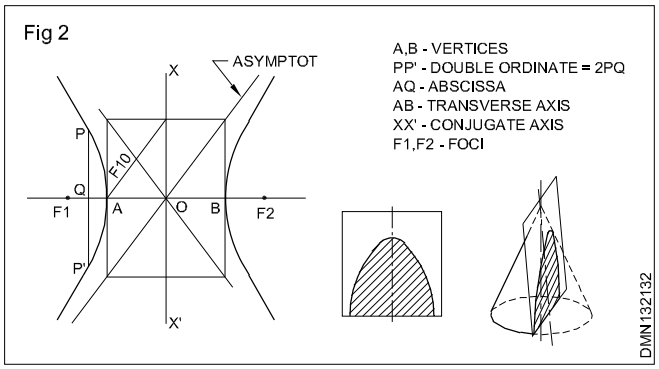
Transverse axis (Fig 1)**:** It is the (horizontal axis) line passing the two vertices (V_1,V_2)of the pair of hyperbola.

FOCI (F_1,F_2)**:** The two fixed points used for defining a hyperbola are called the foci and they lie on the traverse axis.

Ordinate: It is the perpendicular distance from any point on the curve to the transverse axis.

Double ordinate: The distance between the two (similar) points PP' (Fig 2) perpendicular to the axis.

Abscissa: The distance from vertex to the point on the axis where the double ordinate cuts the axis. (AQ in Fig 2)

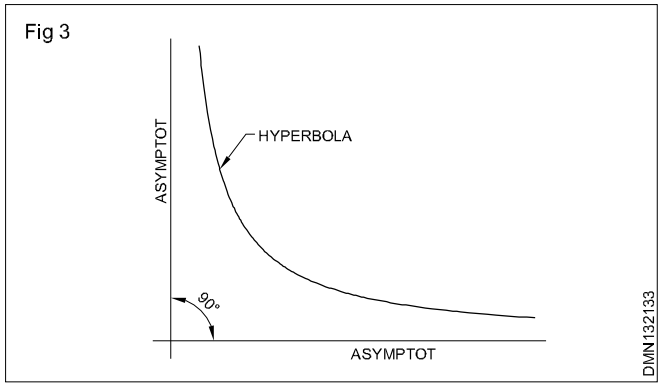


Conjugate axis: It is the perpendicular XX' to the transverse axis passing through the mid point of the transverse axis AB.

Asymptotes: These are lines passing through the center and tangential to the curve at infinity.

Rectangular hyperbola: When the angle between the asymptotes is 90° the curve is called a rectangular or equilateral hyperbola. (Fig 3)

Practical application: Rectangular hyperbola and its application in design of water channels. Further it also represents Boyle's law graphically and in design of Electronic transmitter receiver and Radar antenna.



Involute, helix and spiral curves

Objectives: At the end of this lesson you shall be able to
- **define involute**
- **list the types of involutes**
- **define and explain helix**
- **explain spiral and its terms**
- **list the data required for constructing spiral**
- **state the applications of spiral.**

Involutes (Fig 1)**:** It is yet another geometrical curve. Although they are defined in more than one way, the simplest one is as follows.

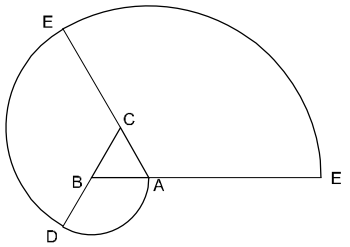
It is the curve traced by a point on a cord as it unwinds (but remains taut) around a circle or polygon.

Alternatively an involute may be defined as the curve traced by a point on a straight line which rolls around a circle or polygon without slip. Depending on the plane shape around which the line rolls, the involutes are named as involute of a triangle, involute of a square, involute of a polygon, involute of a circle etc.

Involutes are not expressed in terms of their basic shape like square etc refers only the involute of a circle.

The most common application of involute is seen in the manufacture of gears. The profile of a gear tooth is the shape of an involute.

Fig 1



(a) INVOLUTE OF TRIANGLE
(INITIAL POINT A)

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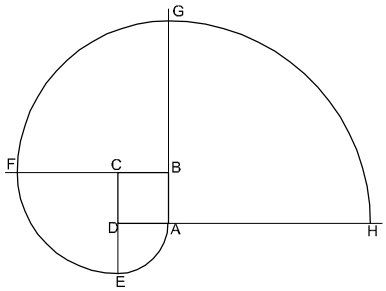
Fig 2



(b) INVOLUTE OF A SQUARE
(INITIAL POINT A)

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When the print on the spiral moves through 360º. It is called one convolution. (not revoution)

Spiral with $1\frac{1}{2}$ and 2 convolutions are shown in Fig 3 & 4.

In order to draw a spiral, the following data are required.

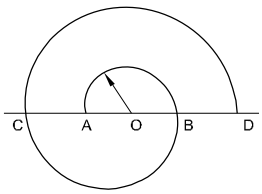
– largest radius
– smallest radius (This is zero if the spiral starts from the pole).
– Number of convolutions.

The difference between the largest and the smallest radii is sometimes referred as the "trowell" of the spiral.

Applications: Scroll plate of lathe chucks, spring of clocks, watches, tooth profile of helical gears and cams etc.

Construction: Refer the procedure in the practical book.

Fig 3



SPIRAL - $1\frac{1}{2}$ CONVOLUTION

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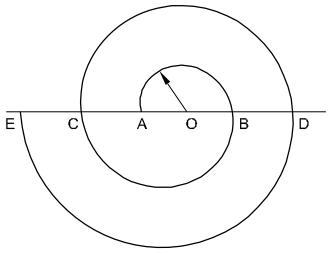
Fig 4



SPIRAL - 2 CONVOLUTIONS

DMN132214

Cycloidal curves

Objectives: At the end of this lesson you shall be able to
- **define a cycloid, epicycloid and hypocycloid curves**
- **define the terms generating circle, baseline or base circle**
- **state the practical applications of a cycloidal curve.**

Cycloidal curves: Cycloidal curves are generated by a point fixed on the circumference of a rolling circle when it rolls without slipping on a straight line or on the outside/ inside of another circle.

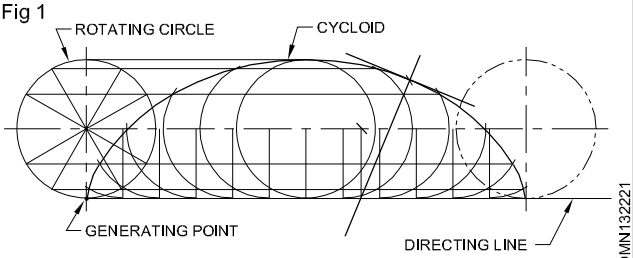
– The rolling circle is called the **generating circle**.

– The fixed straight line on which the rolling circle rolls is called the **directing line** or **base line** and is equal to the circumference of the rolling circle. (πD)

– The circle on which (either outside or inside) the rolling circle rolls is called **directing circle** or **base circle**.

Cycloid (Fig 1)**:** When the generating circle rolls on a straight line, the path of the point is a cycloid.

Fig 1



Epicycloid (Fig 2)**:** When the generating circle rolls on the outside (convex side) of a larger circle, the path of the point is a epicycloid.

Hypocycloid (Fig 3)**:** When the generating circle rolls on the inside (concave side) of a larger circle, the path of the point is a hypocycloid.

Fig 2

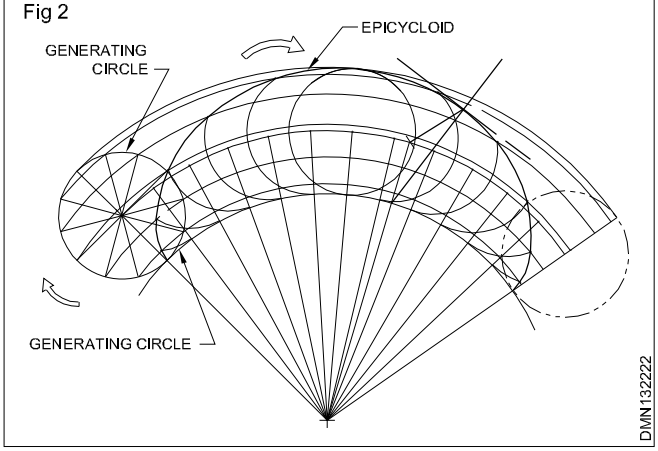
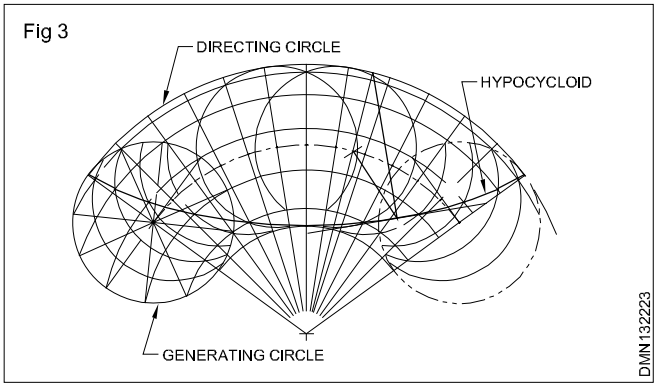


Fig 3



The cycloidal curve has its application in the design of gears and used to form gear teeth outlines.

Helix and spiral curves

Objectives: At the end of this lesson you shall be able to
- **define and explain helix**
- **explain spiral and its terms**
- **list the data required for constructing spiral**
- **state the applications of spiral.**

The fixed distance through which the point moves parallel to the axis for each revolution of the line is called the "Pitch" of the helix. (or lead) (Fig 1)

The helix is called as cylindrical helix when the revolving line is parallel to the axis of revolution.

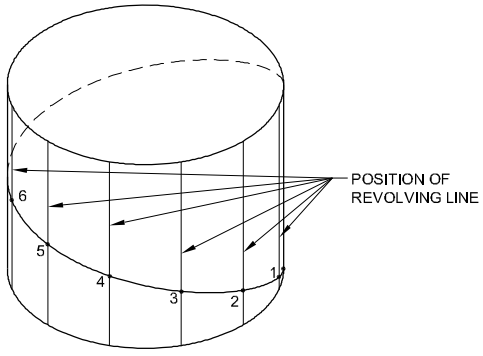
If the revolving line is inclined to the axis of revolution the resulting helix is called conical helix. (Fig 2)

The helix may be either right handed or left handed. The right handed helix climbs from the base towards right side as it rises along the axis.

Practical application: Threads on bolts, screws, nuts, springs, spiral staircase etc have helical curves in them.

Archimedes spiral is a plane curve generated by a point which moves uniformly around and towards or away from a fixed point called the `Pole' or it is the locus of a point which moves away or towards from another fixed point at a uniform linear velocity and uniform angular velocity. (Fig 3)

Fig 1



1,2,3,4 etc POSITION OF THE MOVING POINT

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Fig 2

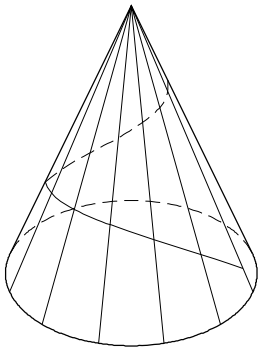

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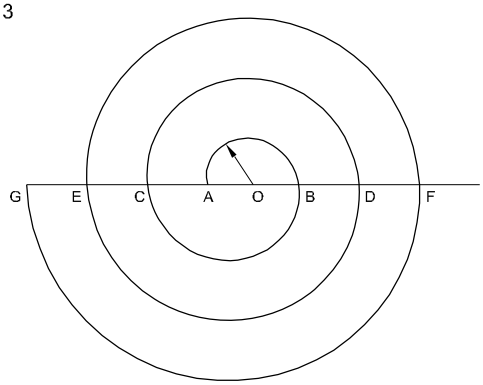
Fig 3



DMN132233

Plain scale, comparative scales and scale of chords

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 and scale of chords.**

Scales (Fig 1)**:** It is difficult to draw the components to their actual sizes, because they may be too large to be accommodated on the drawing sheet or too small to draw and cannot be effectively used in the shop floor. For example, think of making the drawing of a motor car. It is too long and wide to be drawn on the drawing sheet to its original size. Similarly small component like wheel of a wrist watch or its needle (hands) if drawn to its original size will not be legible enough for use in the shop floor.

So depending on the situation drawings are drawn smaller or larger than the actual sizes. When we say that the drawings are smaller or larger, we mean that a given length in the drawing will be smaller or larger than the corresponding length in the object.

The ratio of the length in the drawing to its corresponding length of an object, when both the lengths are in the same unit, it is called the **Representative Fraction** (RF).

Depending on the situation the term scale implies either RF or a measuring device itself made for a particular RF.

RF has two elements of which one of the element is always '1'.

$$RF = \frac{\text{Size of the component in the Drawing}}{\text{Actual size of the component}}$$

Example of RF: 1:5; 1:22; 10:1; 150:1 etc.

First element in the RF always represents the size in the drawing while the second element represents the corresponding size of the object.

Reduction and enlarged scale

Thus RF such as 1:3; 1:100 etc are the reduction scales and the drawings made is smaller than the object.

Similarly RF such as 10:1; 150:1 etc are the enlarged scales and the drawings made are larger than the object.

RF may be written in one of the two ways shown below:

$\frac{1}{120}$ or 1:120 (Reduction scale)

$\frac{15}{1}$ or 15:1 (enlargement scale)

Different reduction scales are recommended by BIS vide IS:10713 are as follows:

Full scale 1:1

Reduction scales:

1:2	1:5	1:10
1:20	1:50	1:100
1:200	1:500	1:1000
1:2000	1:5000	1:10000

The recommended enlarged scales are

50:1	20:1	10:1
5:1	2:1	

Designation of scale: 1:1 for full scale

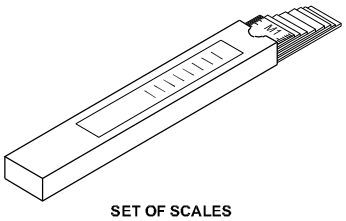
1:X for reduction scale

X:1 for enlargement scale

Recommended length of the scale is 15 or 30 cm but prefer 15 cm.

As a part of trainees tool kit a set of eight scales with designation M1 to M8 of different RF. (Fig 1)

Fig 1



SET OF SCALES

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Types of scales

– Plain scale
– Diagonal scale
– Vernier scale
– Comparative scale
– Scale of chords (for angles)

The diagonal scale and vernier scale will be dealt in the next exercise.

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.

Here RF is expressed as a fraction.

Plain scales (Fig 2)**:** Scales are drawn in the form of rectangle, of length 15 cm (can be upto 30 cm) and width 5 mm. It is divided into suitable number of parts. The first part of the line is sub-divided into smaller 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.

– From 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.

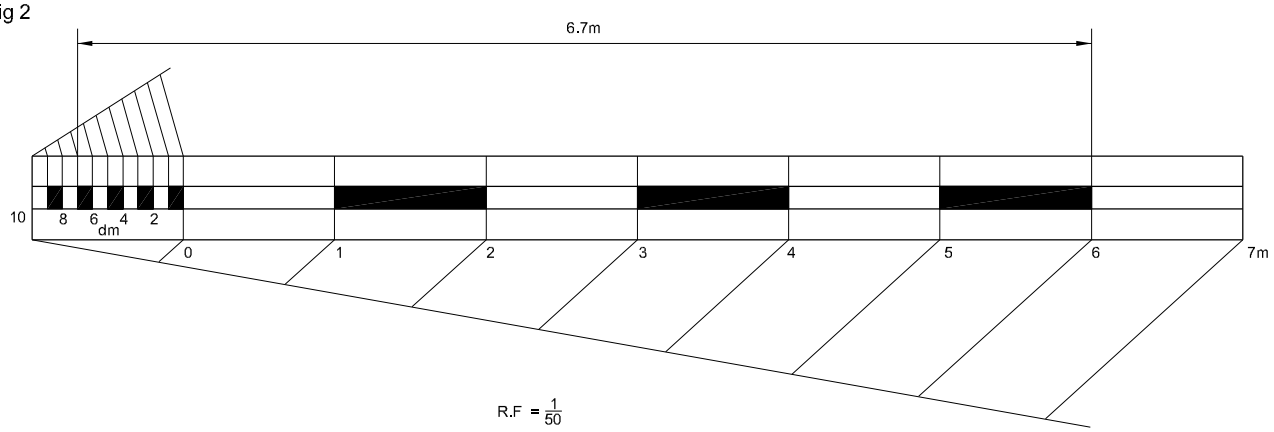
Example of construction of a plain scale to measure metres and decimetres. RF = $\frac{1}{50}$ and to measure upto 8 metres. Minimum standard length of scale = 15 cm.

The length of the scale = RF x maximum length to be measured = $\frac{1}{50}$ x 8 x 100 cm = 16 cm.

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.

Note: A distance of 6.7 m will be shown as in the figure.

Fig 2



Comparative scales (Fig 3)**:** Comparative scale is a graphical device 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 3 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 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

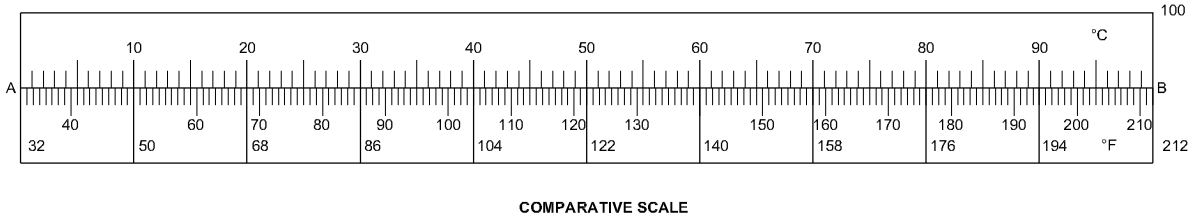
  25°C equivalent reading of F scale = 77°F

For the verification of the conversion using the scale use the following formulae.

$C = (F - 32) \times \frac{5}{9}$

$F = (C \times \frac{9}{5}) + 32$

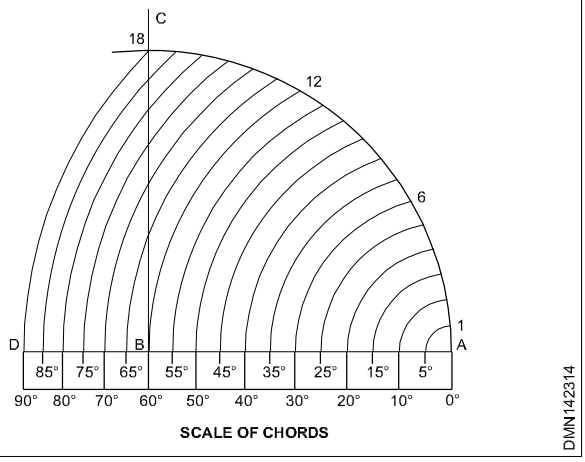
Fig 3



Scale of chords (Fig 4)**:** 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 4 shows the method of constructing the scale of chords.

Fig 4



– Draw a quadrant ABC and extend AB.

– A as centre, AC as radius, draw an arc CD.

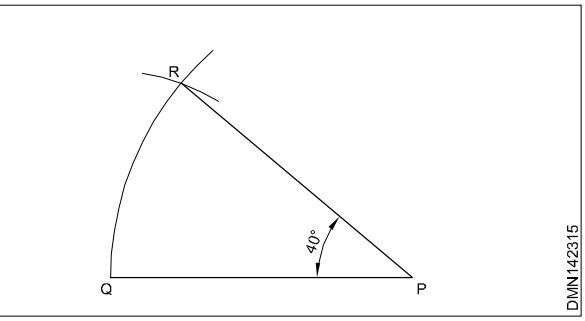
– AD is the chord of arc AC.

– 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°.

Draw an angle 40° using scale of chords (Fig 5)

Fig 5



– Draw a line PQ equal to AB of Fig.4

– P as centre, PQ as radius, draw an arc.

– Set compass to A-40° length.

– Q as centre, A-40° as radius to intersect earlier arc at R.

– Join PR.

– $\angle QPR$ is 40°.

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 0.5 mm. In other words, the smallest measurement that can be taken. Using a plain scale of RF 1:1 is 0.5 mm. If the RF of a plain scale is 1:5, the smallest measurement such a scale can take is 2.5 mm (0.5 mm x 5).

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

– Diagonal scale

– Vernier scale

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

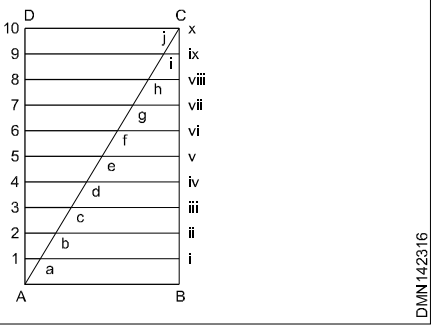
Principle of diagonal scale is based on the principle of similar triangles.

***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 6.

Fig 6



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.

Join one of the diagonal AC.

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

Distance 1 - a is $\frac{1}{10}^{th}$ of AB = 0.1 AB

Distance 2 - b is $\frac{2}{10}^{th}$ of AB = 0.2 AB

Distance a - i is $\frac{9}{10}^{th}$ of AB = 0.9 AB

Distance b - ii is $\frac{8}{10}^{th}$ of AB = 0.8 AB

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

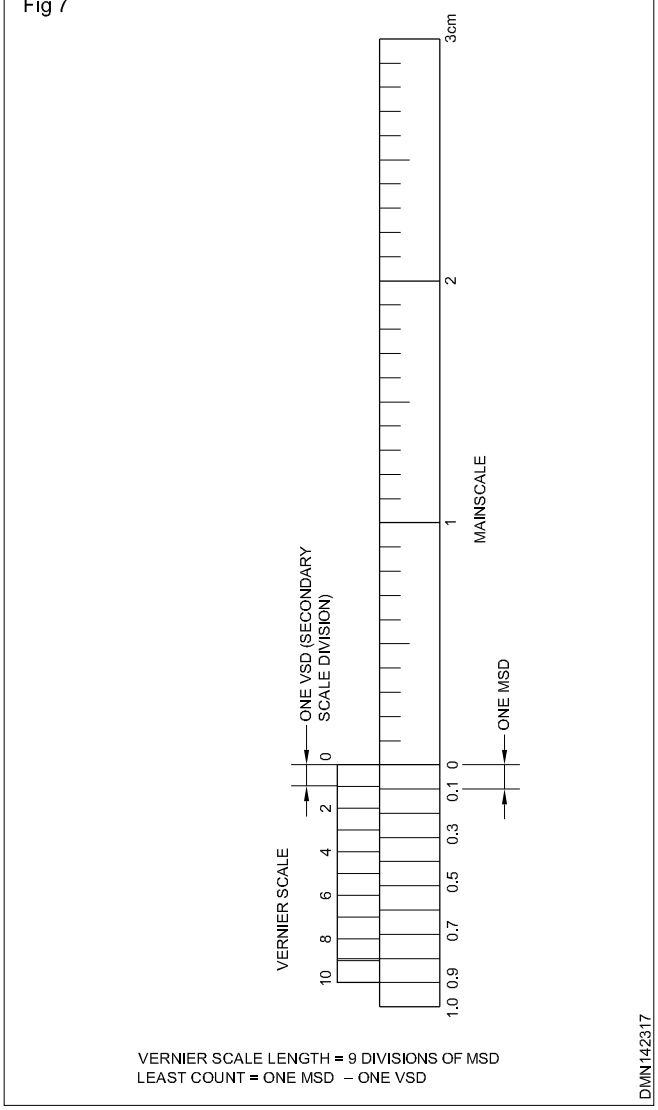
Similarly a - i will be 0.9 mm and c - iii will be 0.7 mm.

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

Vernier scale (Fig 7)**:** 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).

Fig 7



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.

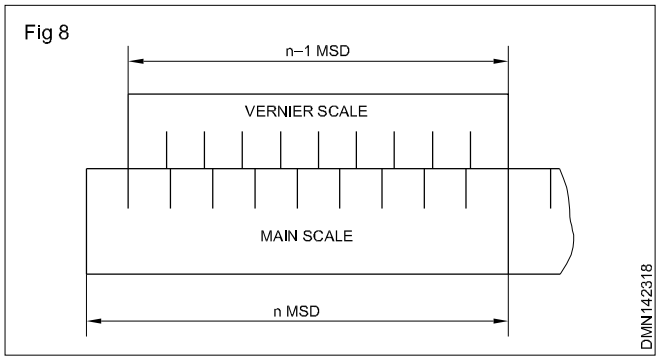
Length of the secondary scale is divided into 'n' equal parts.

Thereby 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.

Direct or forward reading: Vernier scale is the scale constructed having n - 1 numbers of MSD as the secondary scale (vernier) length. (Fig 8)

Fig 8



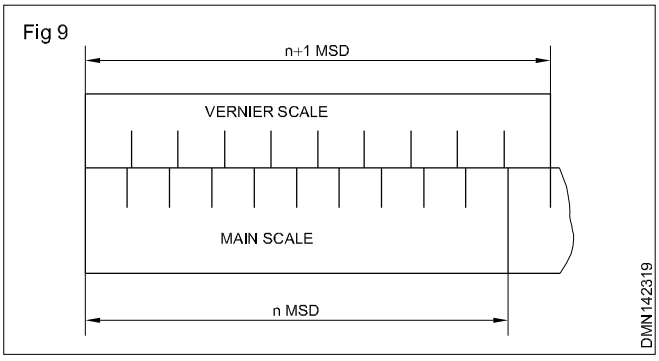
Retrograde or backward reading: Vernier scale is the scale having n + 1 numbers of MSD as the secondary scale (vernier) length. (Fig 9)

According to Direct reading vernier

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

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

Fig 9



According to backward reading vernier

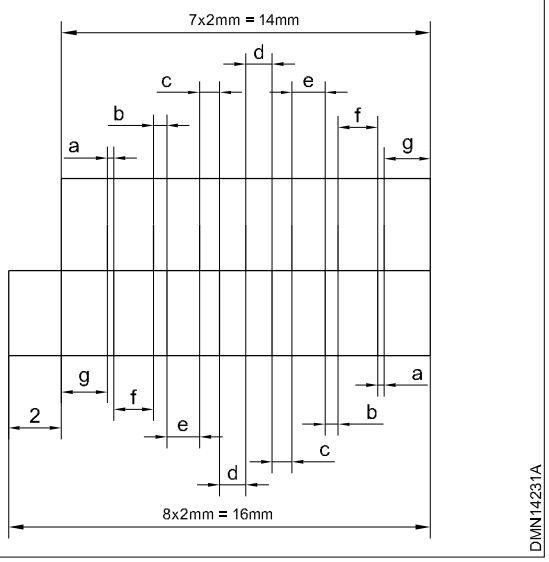
1 Secondary division (vernier) - 1 Main scale division $= \frac{1}{n}\text{MSD}$

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

$\frac{1}{n}$ MSD is the least count of the vernier scale

Example on direct reading vernier scale (Fig 10)**:** Construct a directing reading scale with one MSD = 2 mm, Least count = 0.25 mm.

Fig 10



First find the number of equal parts MSD (n)

$$n = \frac{\text{MSD}}{\text{least count}} = \frac{2\,\text{mm}}{0.25\,\text{mm}} = 8$$

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 (vernier)

1 secondary scale division = $\frac{7 \text{ x } 2\text{mm}}{8} = 1\frac{3}{4}\,\text{mm}$

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

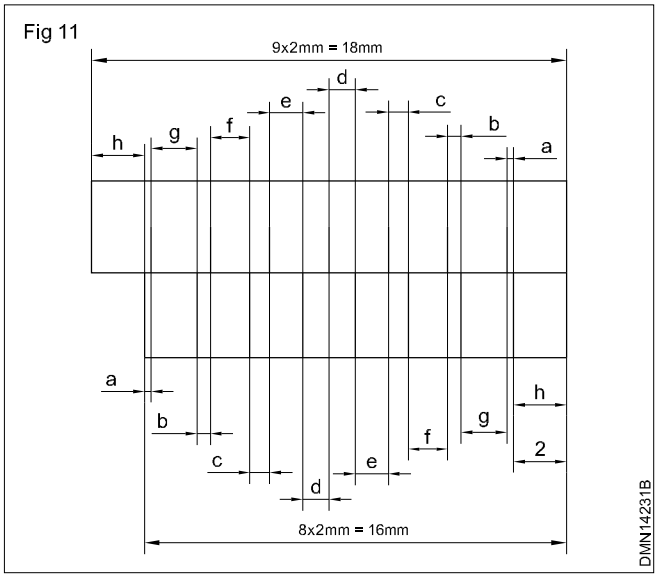
2 mm - $1\frac{3}{4}\,\text{mm} = \frac{1}{4}\,\text{mm}$ = 0.25 mm

It means that the scale can measure upto $\frac{1}{4}$ 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 11 shows a retrograde vernier scale with same least 0.25 mm (1/4 mm) and one MSD = 2 mm.

Fig 11



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

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

1 secondary (vernier) division = $\frac{9 \text{ x } 2\,\text{mm}}{8} = 2\frac{1}{4}\,\text{mm}$

1 VSD - 1 MSD = least count

$2\frac{1}{4}\,\text{mm}\,(2.25\,\text{mm}) - 2\,\text{mm} = \frac{1}{4}\,\text{mm}\,(0.25\text{mm})$

Least count = 0.25 mm

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 principles and application dimensioning**
- **explain the arrangement of dimensioning**
- **state the method of dimensioning and the common features.**

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.

Dimensions are classified according to the following types:

Functional dimension (F)**:** It is a dimension which is essential to the function of the component or space. They are generally shown with limits. (Fig 1)

Non-functional dimension (NF)**:** It is a dimension which is not essential for the function of the component or space. (Fig 1)

Auxiliary or Reference dimension (AUX / REF)**:** It is the dimension given for information only. It is derived from the values given on the drawing or related documents and it does not govern the production or inspection. (Fig 1)

Size dimensions: Give the size of a component, part, hole, slot, depth, width, radius etc.

eg: L1, L3, H, h1, S etc. (Fig 2)

Location dimension: Give or fixes the relationship of the features. viz centre of holes, slots and any significant forms. (Fig 2)

eg: L4, L5, L6

Feature: It is an individual characteristic such as flat surface. Cylindrical surface, shoulder, screw thread, a slot, a curve or profile etc. (Fig 3 & 4)

Fig 1

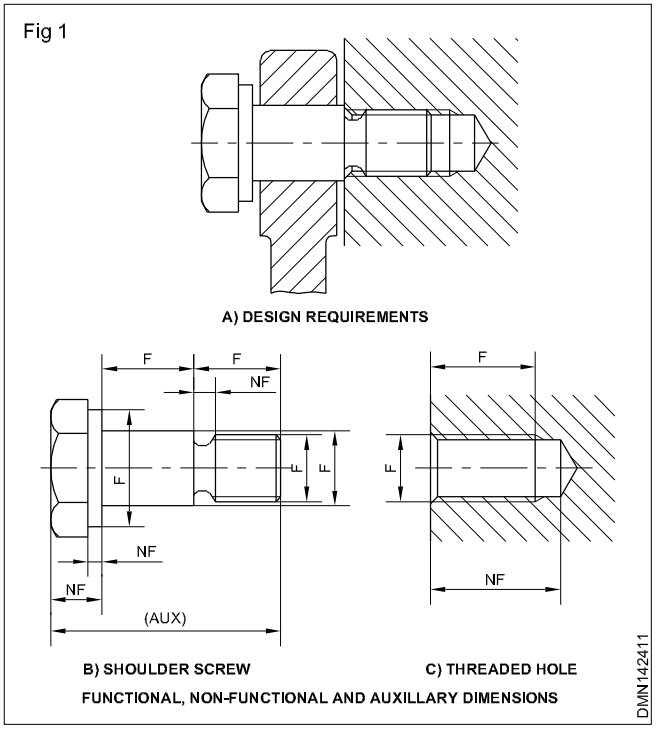


Fig 2

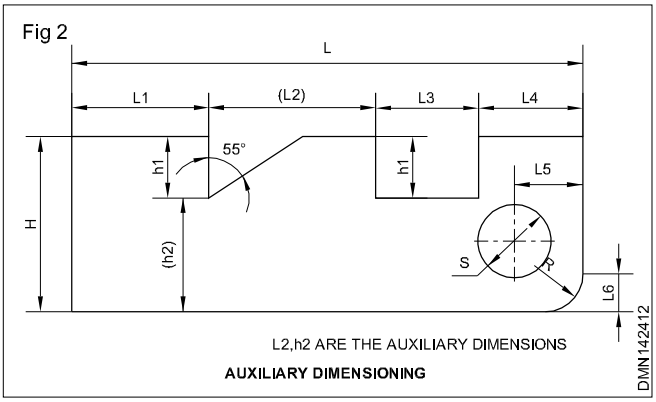


Fig 3

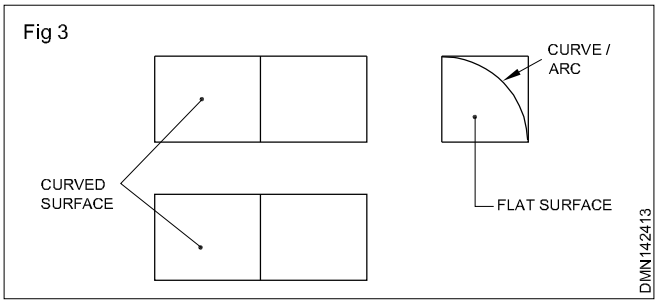
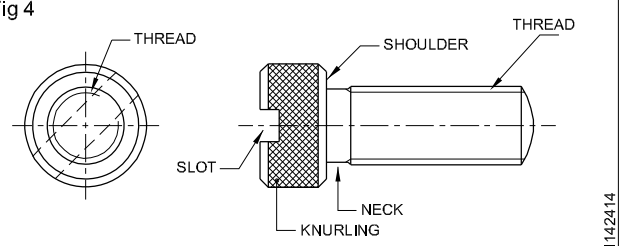


Fig 4



End product: It is a part ready for direct use or assembly or it can be a part ready for further process. e.g a casting, shoulder screw etc. (Fig 4)

The unit of measurement in general, unless or otherwise specified is mm (millimeters). On the dimensions of drawings the abbreviation mm is omitted and a general note is given in an appropriate corner as "All dimensions are in mm".

Elements of dimensioning

– Extension line - a

– Dimension line - b

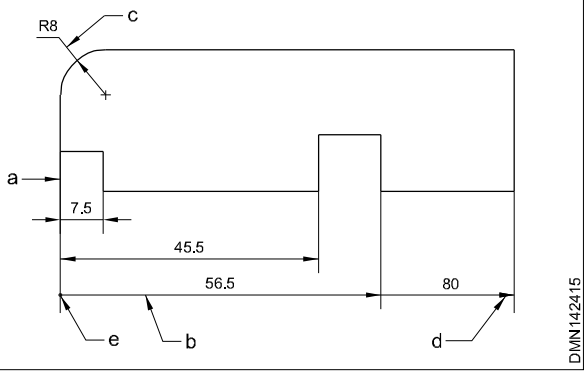
– Leader line - c

– Termination of dimension line (d)

– The original (starting point) indication and the dimension (a).

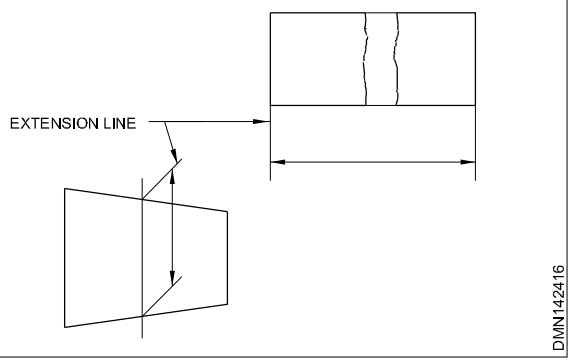
Extension line: It is a thin line projecting from the feature and extending beyond the dimension line. (Fig 6)

Fig 5



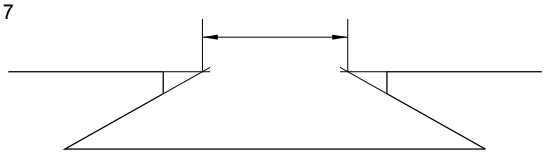
It is normally perpendicular to the feature being dimensioned, but may be drawn obliquely as shown for dimensioning tapers, parallel to each other. (Fig 6)

Fig 6



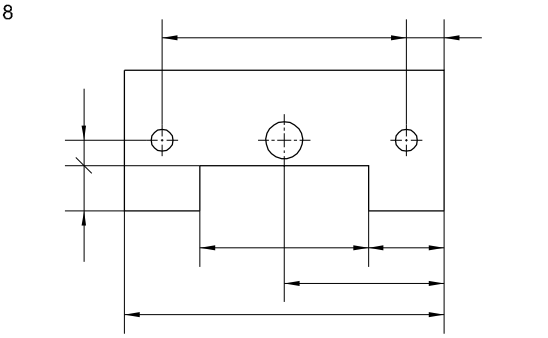
When construction line are required to be shown for practical purposes of the intersecting projection lines extend beyond their point of intersection. (Fig 7)

Fig 7



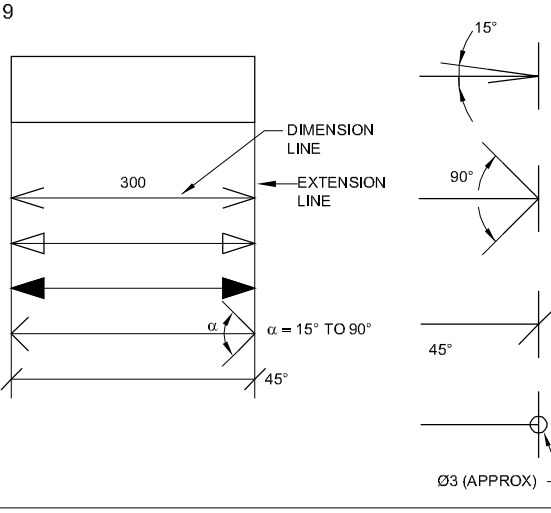
Extension lines (Projection lines) should not cross the dimension lines, but where not possible the lines should not break. (Fig 8)

Fig 8



Dimension line: These are thin continuous lines, terminated at ends by arrow heads, dots or oblique lines touching the extension line. (Fig 9)

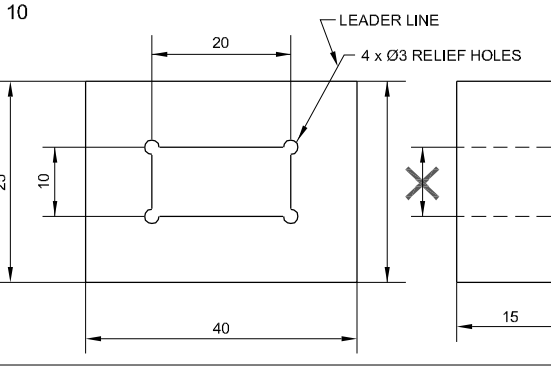
Fig 9



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

Dimensioning hidden lines to be avoided. (Fig 10)

Fig 10



Arrow heads may be placed outside where space is insufficient.

Leader line: It is a thin continuous line. It connects a note or dimension with the features to which it applies. (Fig 10)

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 9)

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

Fig 11

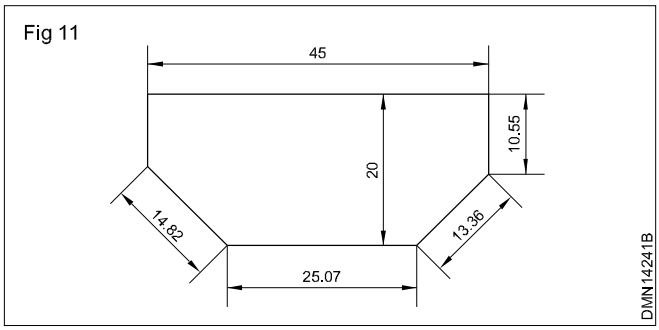
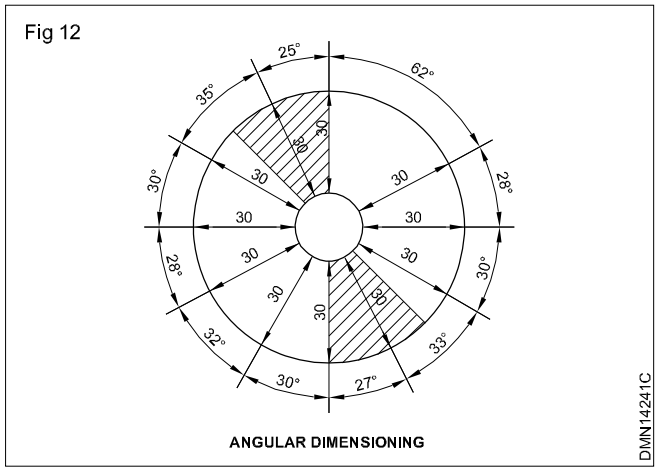


Fig 12



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. (Fig 11 & 12) This method is known as **aligned system** of dimensioning.

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 13 & 14). This method is termed as **unidirectional system** of dimensioning.

Fig 13

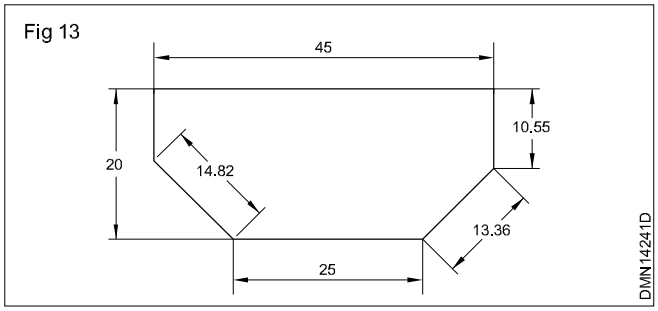
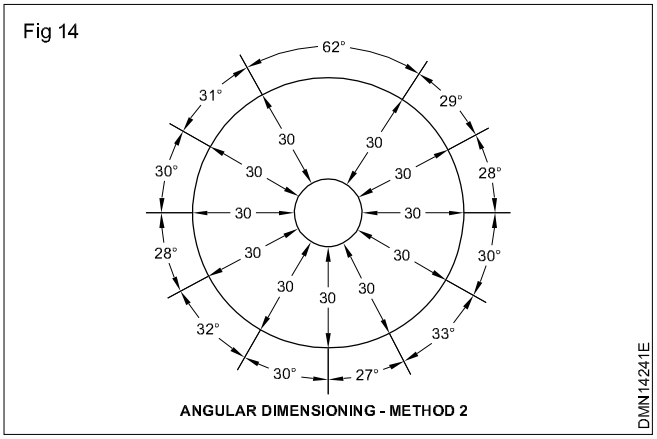


Fig 14



Arrangement and indication of dimensions

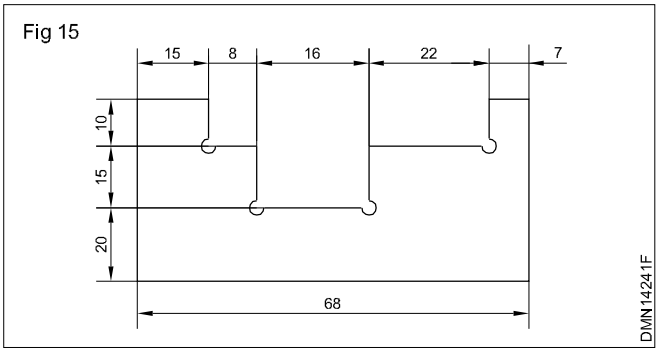
The arrangement of dimensioning on a drawing shall indicate clearly the design purpose.

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 15)

Fig 15

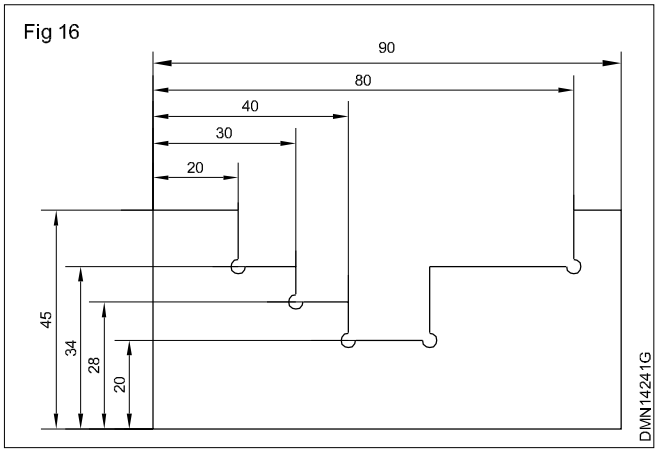


Dimensioning from a common feature is used where a number of dimensions of the same direction relate to a common origin.

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 16.

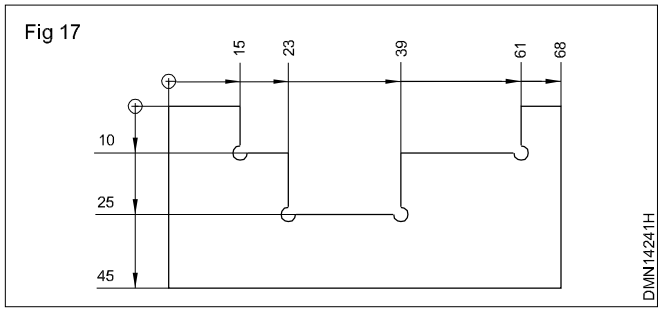
Fig 16



Superimposed running dimensioning (Progressive dimensioning)**:** It is a simplified dimensioning also Cumulative error is controlled. It starts from one origin with arrow heads in one direction only. This may be used where there are space limitations and where no legibility problems would occur.

The origin indication is placed appropriately and the opposite ends of each dimension line shall be terminated only with an arrow head. It may be advantageous to use superimposed running dimensions in two directions. (Fig 17)

Fig 17



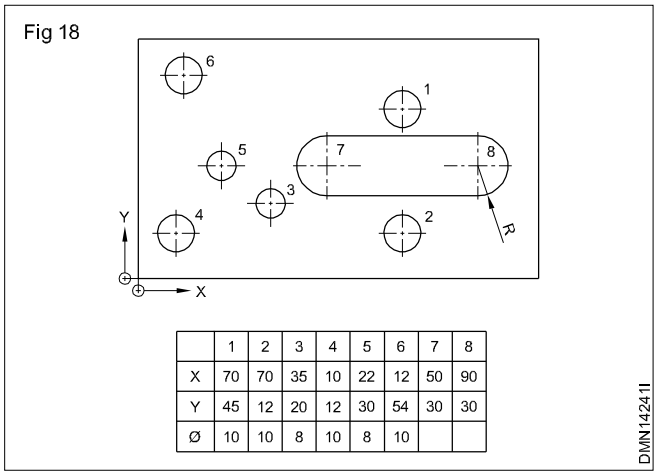
Dimensioning by co-ordinates: This system is much used for components, produced on jig boring machine. Two edges are taken as datum. (references)

Instead of dimensioning in superimposed way, same may be tabulated and given. (Fig 18)

This method is useful in indicating places/positions in country, city and site plans.

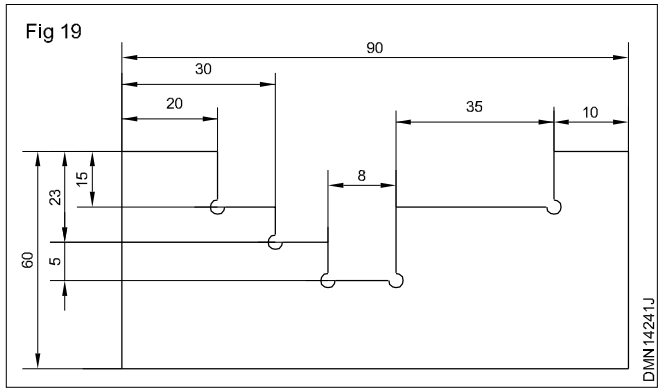
Combined dimensioning: Dimensions are given in chain dimensioning and parallel dimensioning. Common feature is combined. (Fig 19)

Fig 18



	1	2	3	4	5	6	7	8
X	70	70	35	10	22	12	50	90
Y	45	12	20	12	30	54	30	30
Ø	10	10	8	10	8	10		

Fig 19



Methods of dimensioning common features

Dimensioning Tapered parts: When dimensioning tapered part, extension lines be at an angle and parallel to each other. Dimension line be drawn parallel to the feature to be dimensioned. (Figs 20 & 21) They may sometimes be shown with large dia and or MT number.

Fig 20

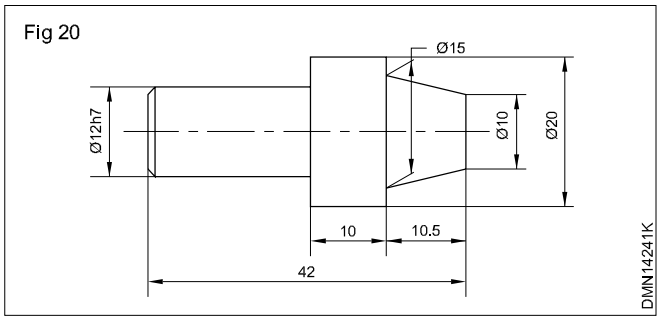
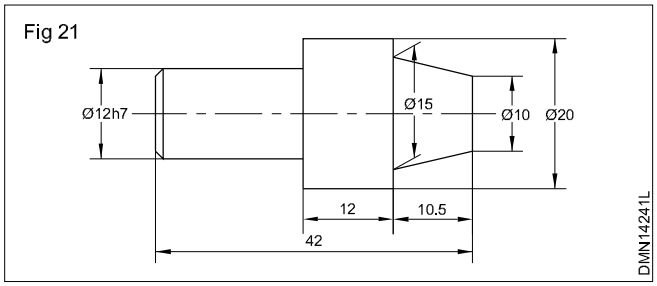


Fig 21



Dimensioning smaller width: Arrow heads are replaced by oblique lines. (Fig 22)

To avoid placing dimensions too far away from feature, dimension lines are drawn closer and not fully. (Fig 23)

Fig 22

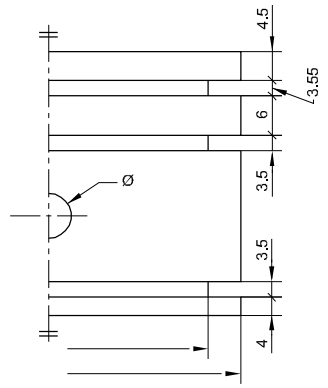
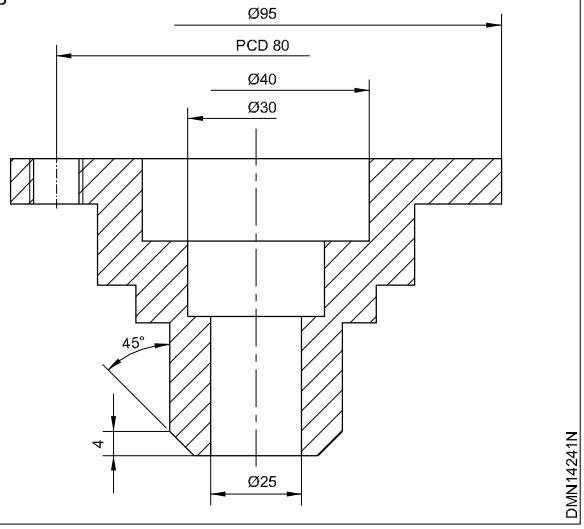


Fig 23

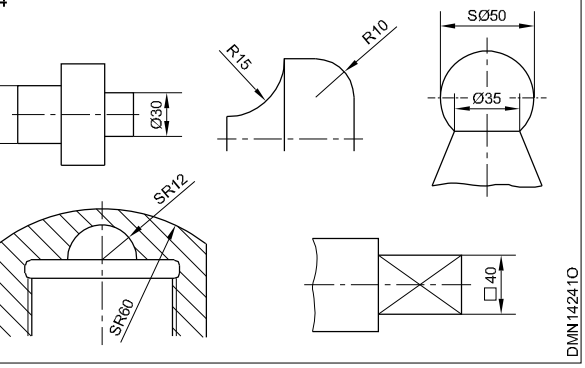


Dimensioning cylindrical and spherical features: Cylindrical features have diameter and length whereas sphere has a diameter only.

Diameter may be indicated by any one of the abbreviation D, Dia, d, dia or ϕ and radius may be indicated by R, r, Rad or rad by square. Any one abbreviation or symbol on a drawing may be indicated by SQ or □.

The length if any required to give alongwith dia, if it is shown as ϕ...x... long. (Fig 24)

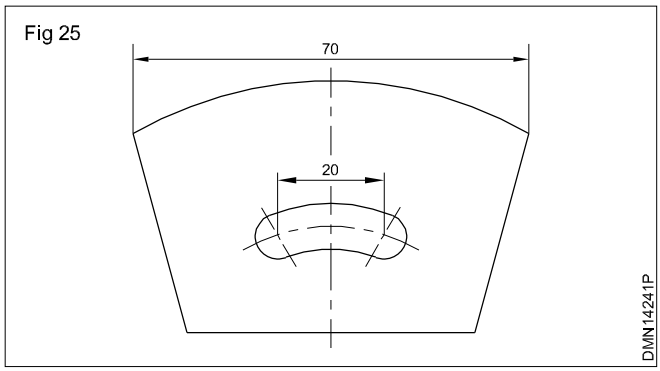
Fig 24



ϕ - Diameter
R - Radius
□ - Square
SR - Spherical radius
Sϕ - Spherical diameter

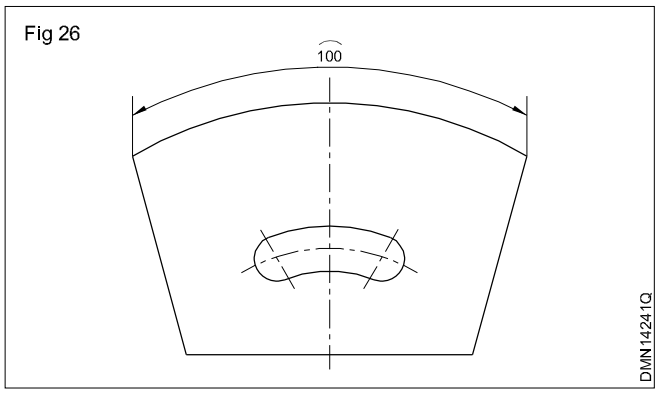
Dimensioning a chord: For dimensioning of chord, refer Fig 25. It is shown as linear size.

Fig 25



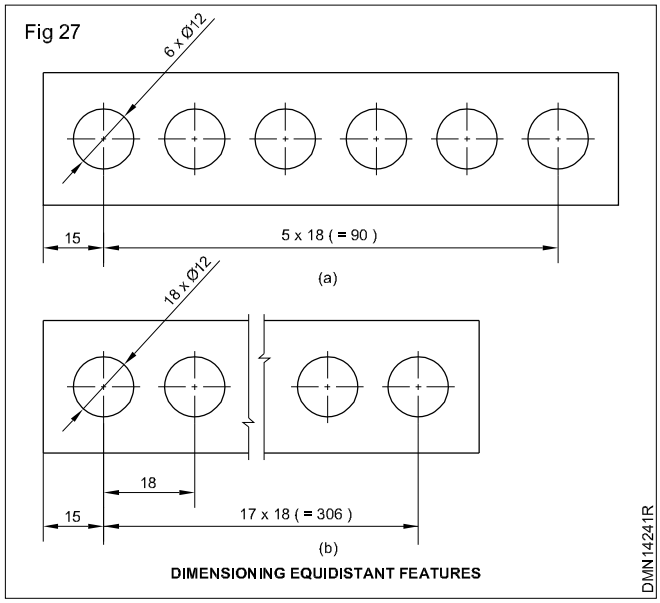
Dimensioning an arc / radius: A small arc is shown over the dimension value, while dimensioning an arc. (Fig 26)

Fig 26



Dimensioning equidistant features: Where equidistant features or uniformly arranged elements are parts of the drawing, specification of the dimensioning may be simplified. Linear spacings may be dimensioned as in Fig 27 a&b.

Fig 27



Dimensioning angles and Angular spacings

Equal angles eg. 4 x 10° = 40°
Equal centre distances eg. 4 x 10 = 40. (Fig 28)

When the drawing is clear, symbols or abbreviation viz. dia, Pcd and angle can be omitted. (Fig 29)

Fig 28

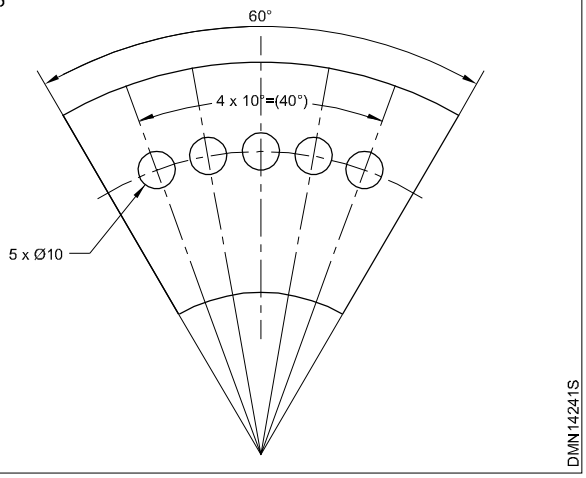
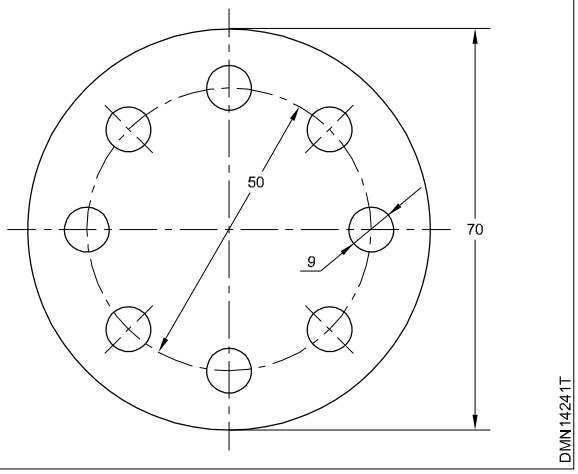
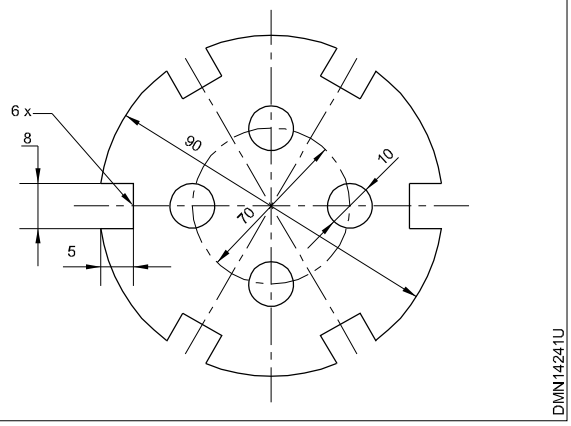


Fig 29



Dimensioning periphery: The features on the periphery can be shown as given in the figure, indicating width, depth and number of slots. (Fig 30)

Fig 30



Dimensioning repeated features: When elements of same size occur, but not of same pitch be shown as in Fig 31.

Countersinks and counterbores (IS:10968-1984)**:** For simplification, the holes are indicated by centre lines and marked by different letters to different type/size of hole. The holes maybe plain, through blind, tapped, countersink of counterbored. (Fig 32)

Fig 31

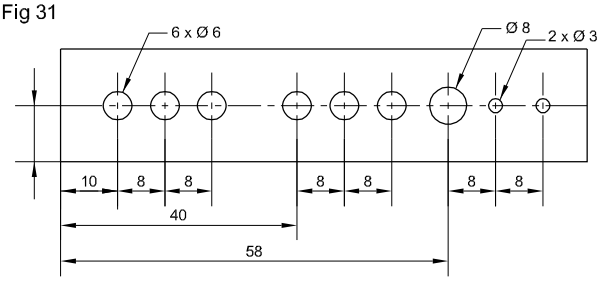
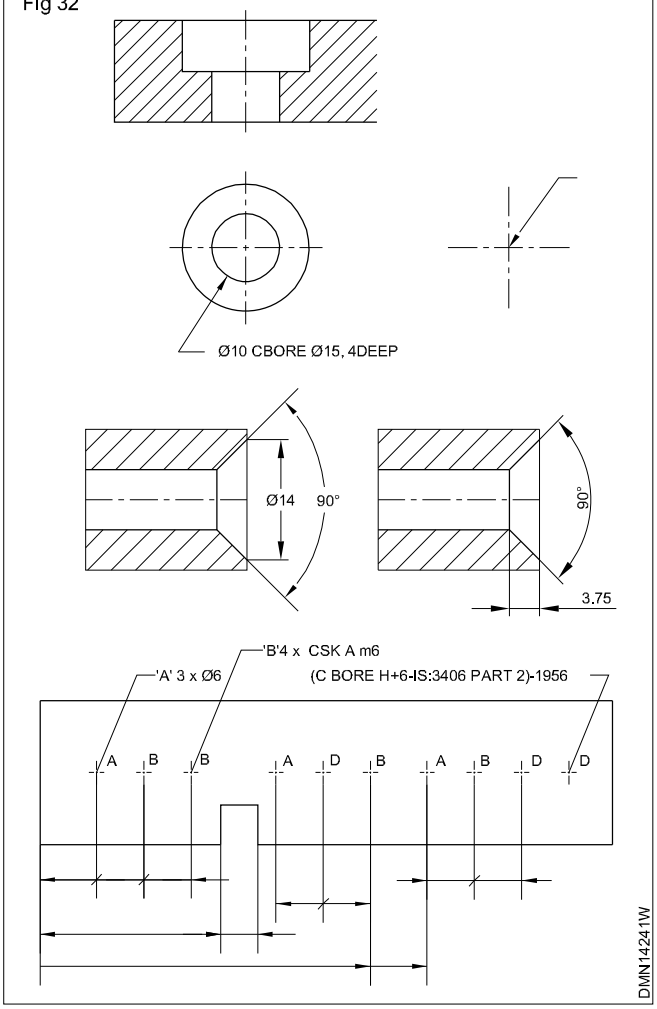


Fig 32



Dimensioning chamfers and undercuts: Chamfer of 45° may be shown by leaderline indicating chamfer width and angle or by dimension line with chamfer width and angle. (Figs 33 & 34)

Fig 33

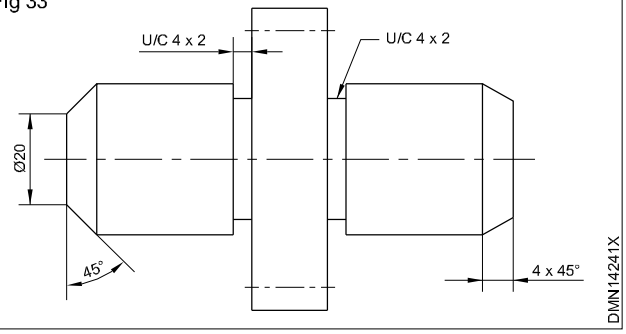
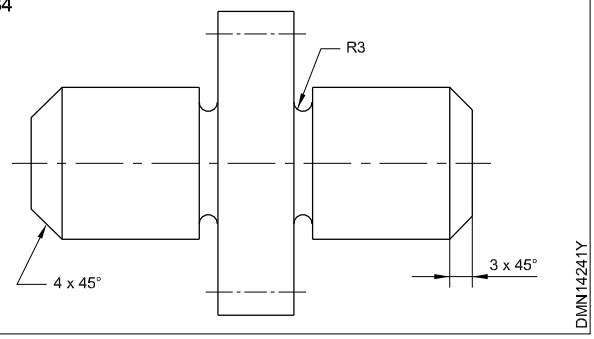


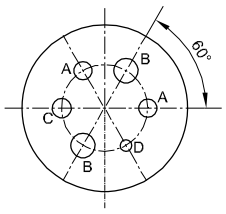
Fig 34



Dimensioning undercut: Dimensioning undercuts are dimensioned either by normal dimensioning the width i.e u/c 4 x 2 or by leader terminating horizontally u/c 4 x 2. (Fig 33)

Other indications: In order to avoid repeating the same dimensional values or to avoid long leader lines, reference letters/numbers may be used in connection with an explanatory table or note. In such cases leader lines may be omitted. (Fig 35)

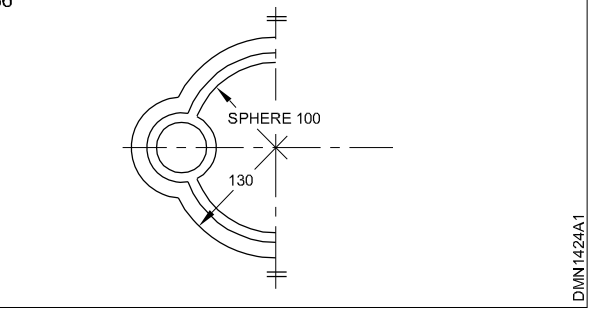
Fig 35



HOLE	No. AND SIZE
A	2 x Ø11.5
B	2 x Ø15
C	Ø 8
D	Ø 5

In partially drawn views and partial sections of symmetrical parts the dimension lines that need not cross the axis of the symmetry are shown extended slightly beyond the axis of symmetry. The second termination is then omitted. (Fig 36)

Fig 36



Where several parts are drawn and dimensioned in an assembly, the groups of dimensioned in an assembly, the groups of dimensions related to each parts should be kept as separate as possible. (Fig 37)

Dimensioning arcs by radius: Only one arrow head termination, with its point on the arc end fo the dimension line shall be used where a radius is dimensioned. The arrow head may be either inside or outside of the feture outline. (Fig 38)

Values for dimensions out of scale: After finalising sizes may require modification. Instead of re-drawing the entire component, the dimension which is changed is marked and a thick line drawn below such size indicating this (feature) size is not to scale (NTS). (Fig 39)

Fig 37

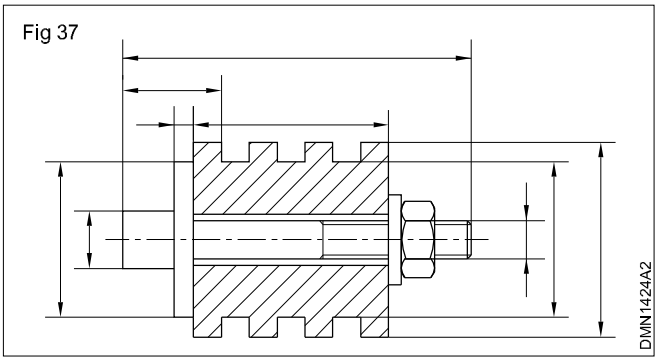


Fig 38

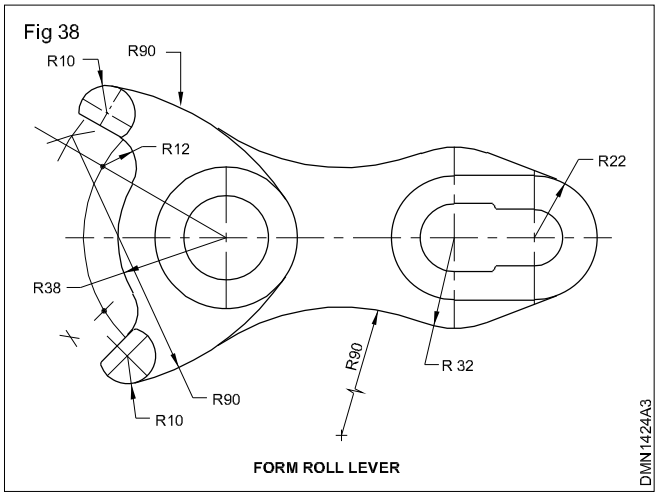
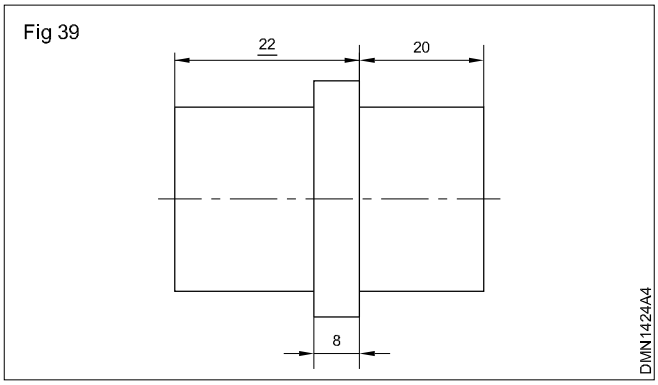


Fig 39

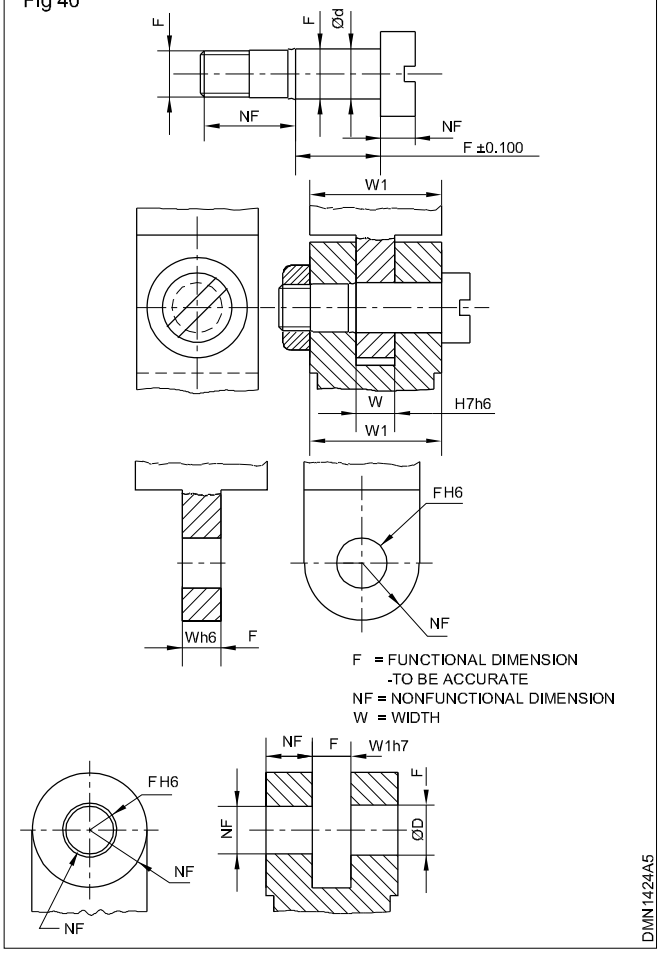


Principles and application of dimensioning: Before proceeding to give dimensions, consider the following steps:

- Mentally visualize the object and divide it into geometrical shapes such as prisms, cones, cylinders, pyramids etc.
- Place the size dimension on each form.
- Consider the relationship mating parts and the process of production, then select the locating (reference or datum) centre lines and surfaces.
- ensure that each geometrical form is located from a centre line and/or a finished surface.
- Place the overall dimensions.
- Add the necessary notes like surface finish, specific operations, material, fit, type of thread etc. (Fig 40)

– All dimensional information necessary to define a part or component clearly and completely shall be shown directly on a drawing unless this information is specified in relevant documents.

Fig 40



– Each feature shall be dimensioned once only on a drawing.

– Dimension shall be placed on the view or section that most clearly shows the features.

Each drawing shall use the same unit (for example, millimetres) for all dimensions but without showing the unit symbol. In order to avoid misinterpretation, the predominant unit symbol on a drawing may be specified in a note.

Where other units have to be shown as part of the drawing specification (for example, N, m for torque or kPa for pressure), the appropriate unit symbol shall be shown with the value.

No more dimensions than are necessary to define a part or an end product shall be shown on a drawing. No feature of a part or an end product shall be defined by more than one dimension in any one direction. Exception may, however be made

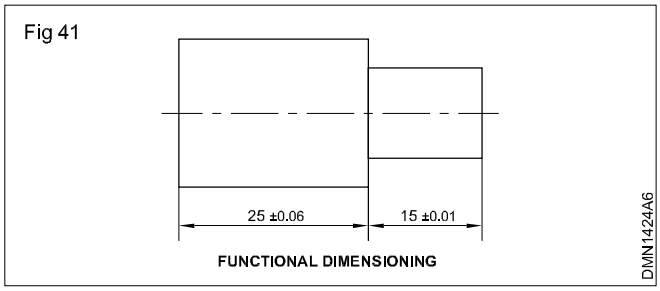
– where it is necessary to give additional dimensions at intermediate stages of production (for example, the size of a feature prior to carburizing and finishing).

– where the addition of an auxiliary dimension would be advantageous.

Production processes or inspection methods should not be specified unless they are essential to ensure satisfactory functioning or interchangeability.

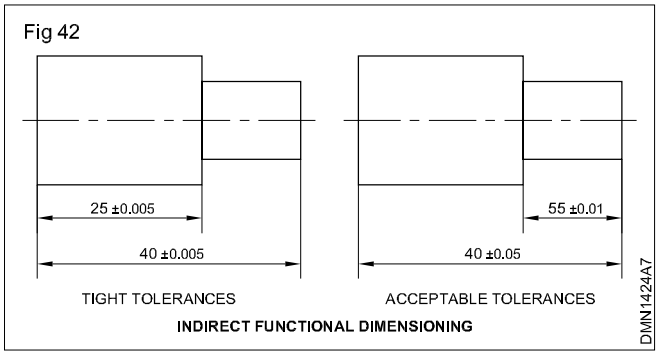
Functional dimensions should be shown directly on the drawing wherever possible. (Fig 41)

Fig 41



Occassionally indirect functional dimensioning is justified or necessary. In such cases, care shall be exercised so that the effect of directly shown functional dimensioning is maintained. Fig 42 shows the effect of acceptable indirect functional dimensioning that maintains the dimensional requirements established by Fig 41.

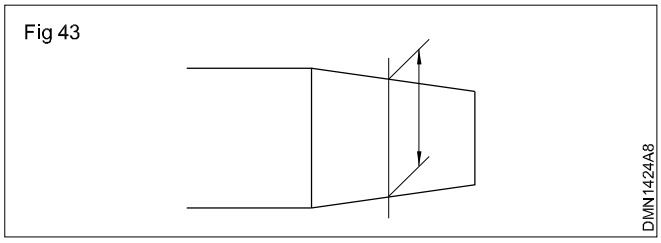
Fig 42



The non-functional dimensions should be placed in a way which is most convenient for production and inspection.

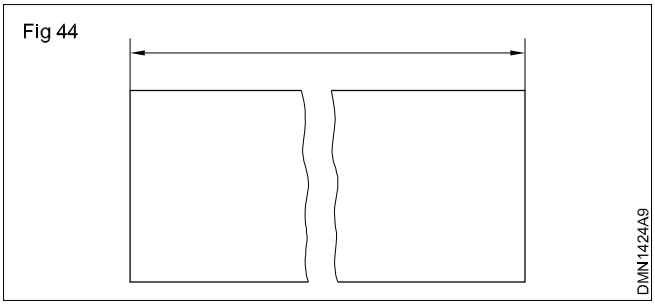
Projection lines should be drawn perpendicular to the feature being dimensioned. Where necessary, however, they may be drawn obliquely, but parallel to each other. (Fig 43)

Fig 43



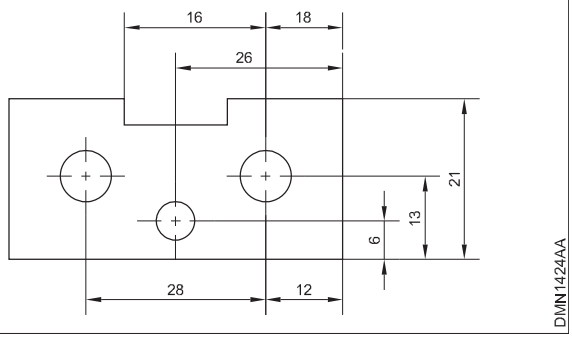
Dimension line shall be shown unbroken where feature to which it refers is shown broken, except in Method 2 (Unindirectional). (Fig 44)

Fig 44



Avoid intersection of projection lines and dimension lines, where unavoidable neither line shall be shown with a break. (Fig 45)

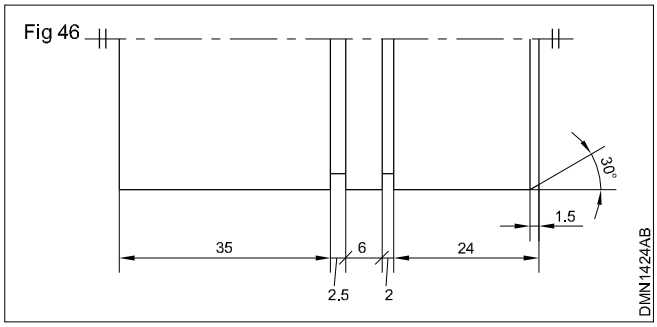
Fig 45



A centre line or the outline of a part shall not be used as a dimension line but may be used in place of a projection line.

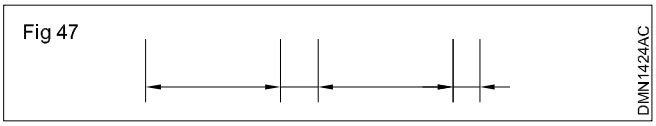
Any one style of arrow head termination shall be used on a single drawing. However, where space is too small for arrow head, oblique stroke or dot may be substituted. (Fig 46)

Fig 46



Arrow head terminations shall be shown within the limits of the dimension line where space is available. Where space is limited, the arrow head termination may be shown outside the intended limits of the dimension line that is extended for that purpose. (Fig 47)

Fig 47



When the feature is seen as a circle, while dimensioning cylindrical jobs or holes, by projections, avoid symbol and or abbreviations D, d or dia etc.

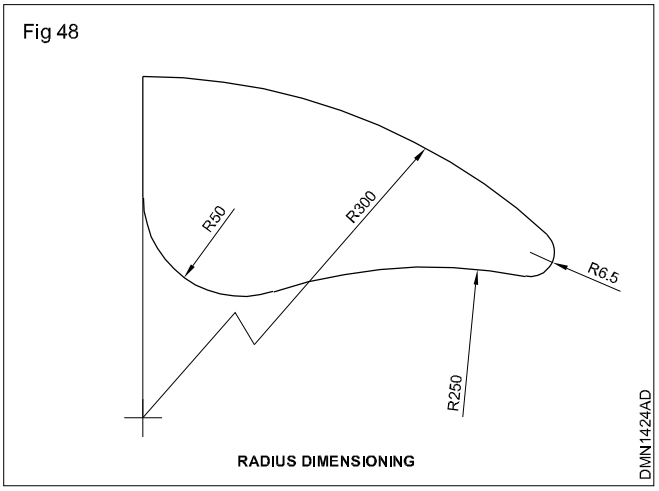
Only one arrow head termination, with its point on the arc end of the dimension line, shall be used where a radius is dimensioned. The arrow head termination may be either on the inside or on the outside of the feature outline for its projection line depending upon the size of the feature. (Fig 48)

Dimensional value should be legible.

Dimension of spherical features should be preceded by S or SR.

Values for dimensions out of scale, except where break lines are used shall be underlined with a straight thick line.

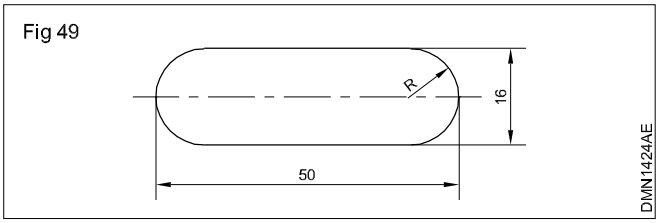
Fig 48



Use chain dimensioning where the possible accumulation of tolerances does not infringe effect on the functional requirements of the part.

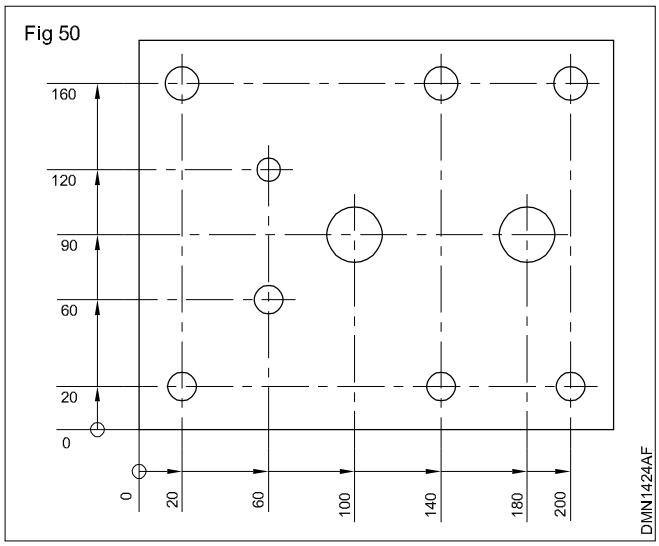
Single dimension, chain dimensioning and dimension line from a common feature may be combined on a drawing if necessary.

Fig 49



Where the size of the radius can be derived from other dimensions, it shall be indicated with a radius arrow and the symbol `R' without an indication of the value. (Fig 49)

Fig 50



It may be advantageous to use superimposed running dimensioning in two directions. In such a case, the origins may be as shown in Fig 50.

If it is possible to define a quantity of elements of the same size so as to avoid repeating the same dimensional value, they may be given as shown in Figs 51 & 52.

Where necessary, in order to avoid repeating the same dimensional value or to avoid long leader lines, reference letters may be used in connection with an explanatory table or note. Leader lines may be omitted. (Fig 53)

In partially drawn views and partial sections of symmetrical parts, the dimension lines that need to cross the axis of symmetry are shown extended slightly beyond the axis of symmetry. The second termination is then omitted. (Fig 54)

Fig 51

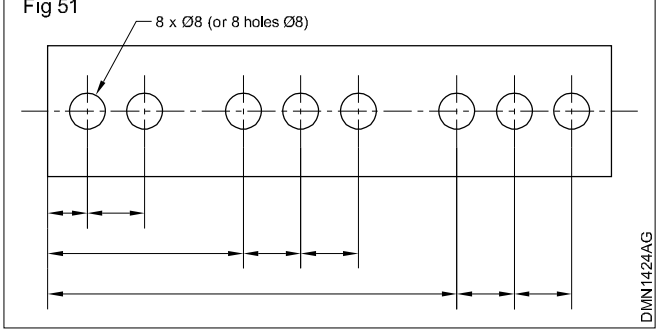


Fig 52

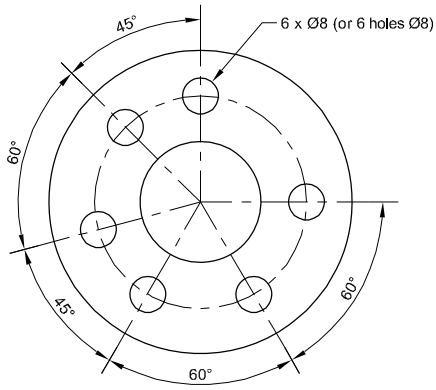


Fig 53

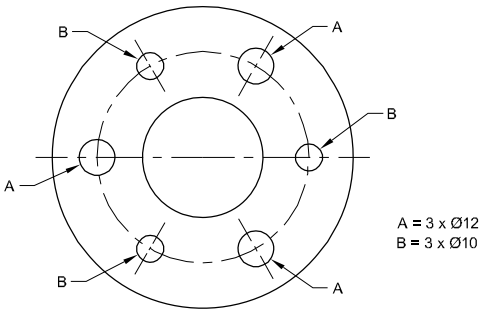
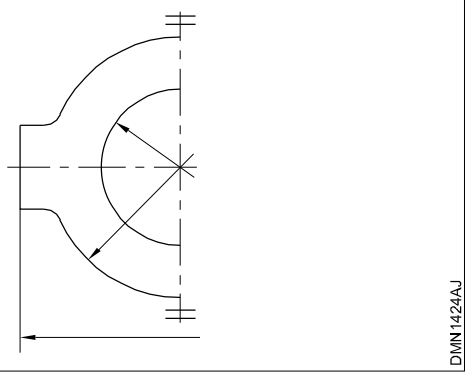


Fig 54



If the special requirement is applied to an element or revolution, the indication shall be shown on one side only. (Fig 55)

Where the location and extent of the special requirement requires identification, the appropriate dimensioning is necessary. However, where the drawing clearly shows the extent of the indication, dimensioning is not necessary. (Fig 56)

Fig 55

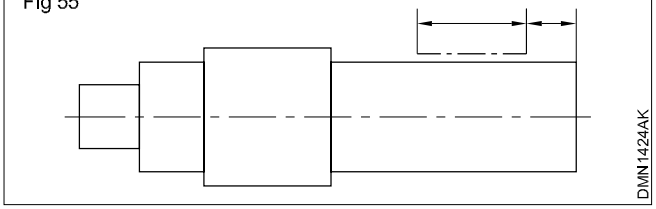
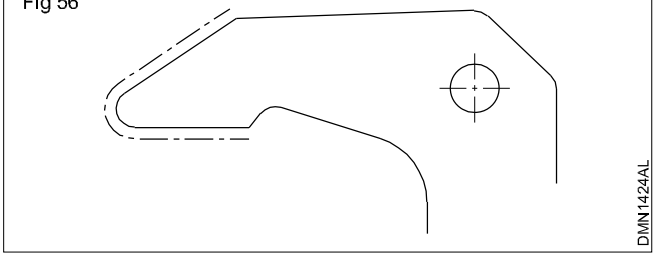


Fig 56



Projection of points and lines

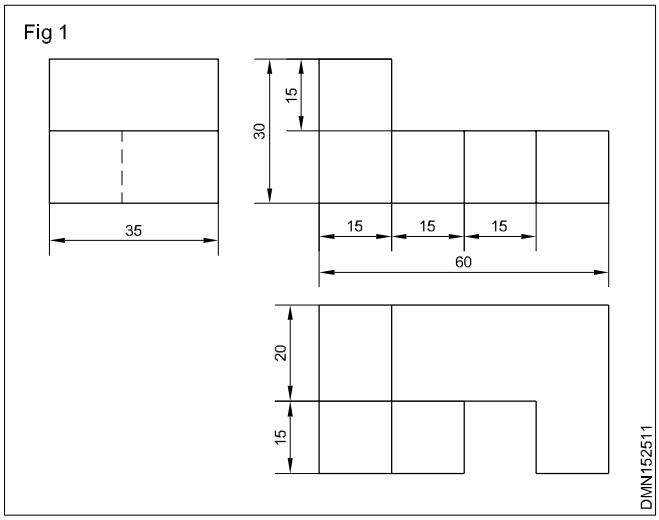
Objectives: At the end of this lesson you shall be able to
- **explain the four dihedral angles**
- **state the meaning of orthographic projection**
- **explain terms plan and elevation as applied to orthographic views**
- **state the relative position of views in first and third angle projection**
-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

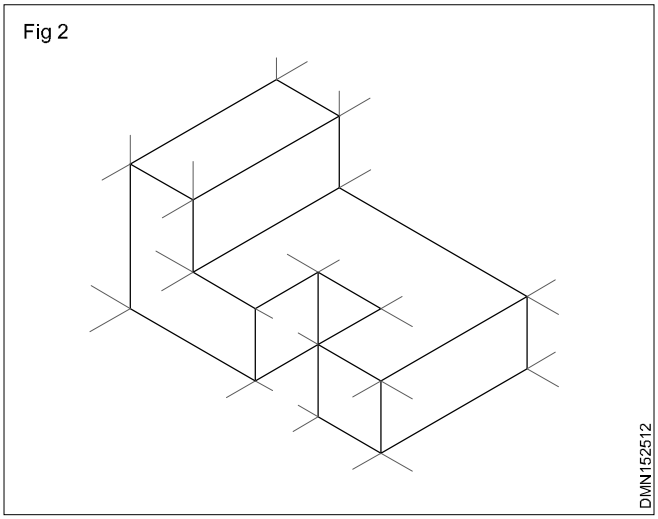
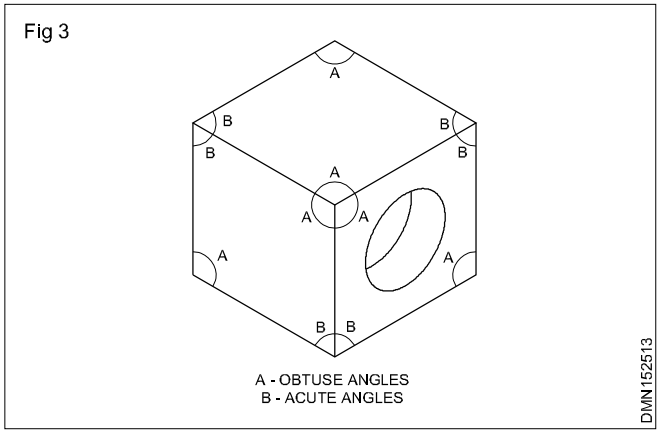


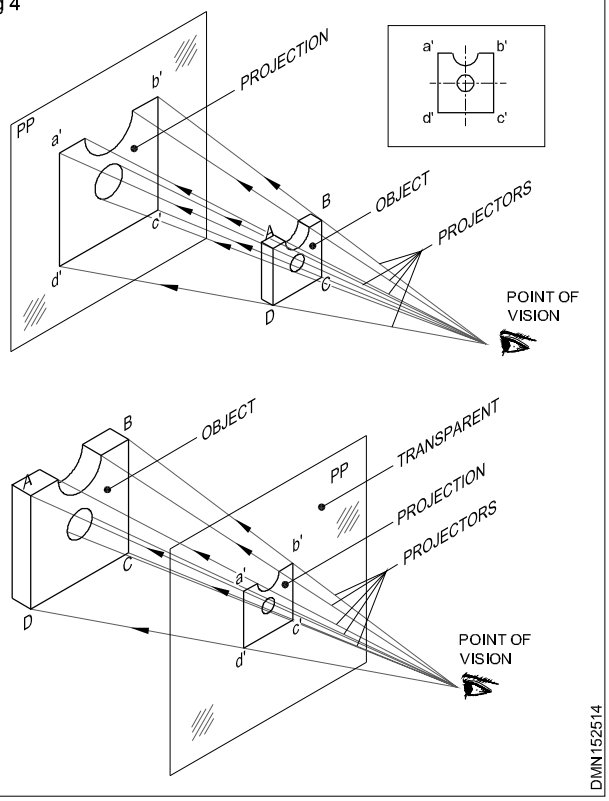
Fig 3



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.

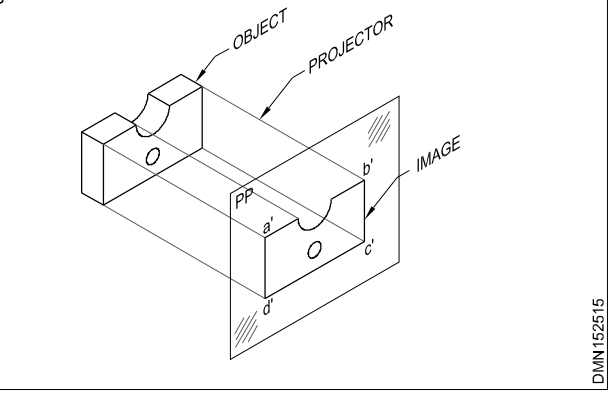
Projection or images can also be formed inbetween the eyes and the object by keeping a transparent plane. (Fig 4)

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

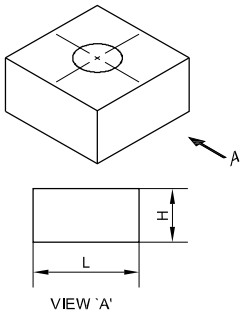


Orthographic projection: The term orthographic is projection derived from the words. Ortho means straight or at right angles and graphic means written or drawn. The projection comes from the Old Latin words PRO means forward and section means to throw. The orthographic projection literally means "Throw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

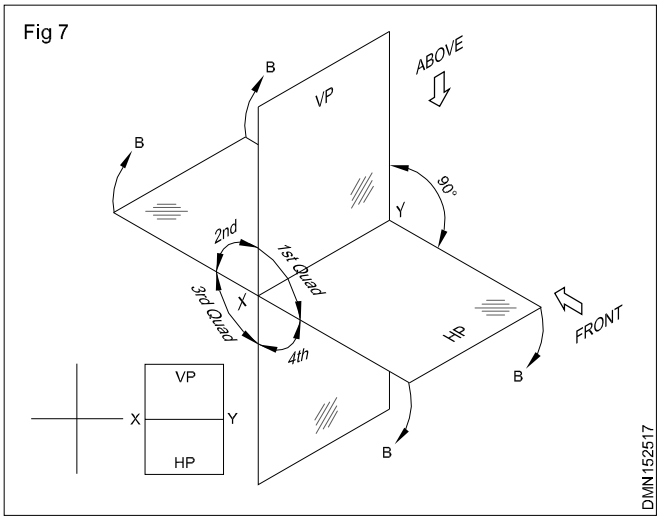


Therefore, it becomes necessary to have an additional view to show the missing dimensions (width). Therefore, we have to make two views to represent the three dimensions of an object.

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 (Plane & 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)

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 8

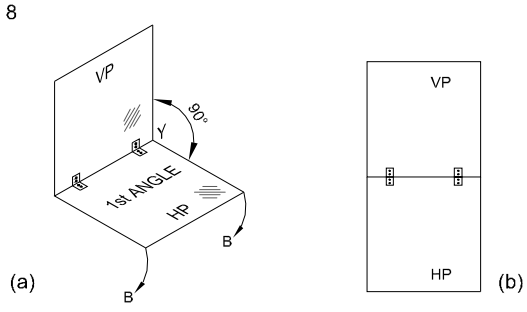


Fig 9

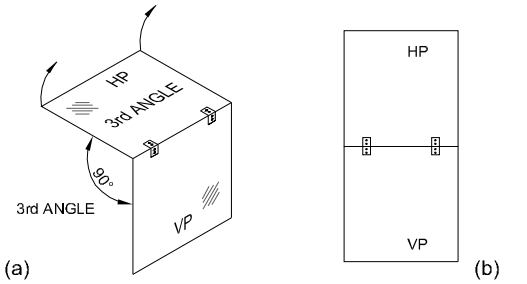


Fig 10

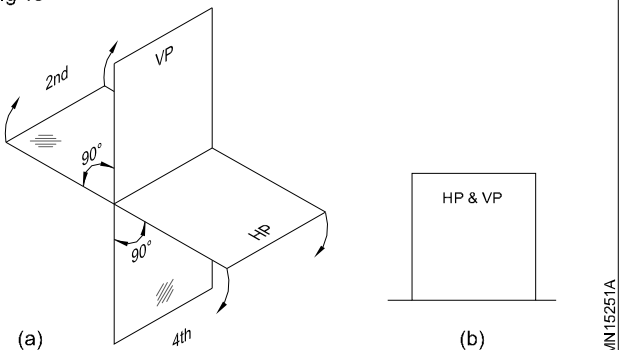


Fig 11

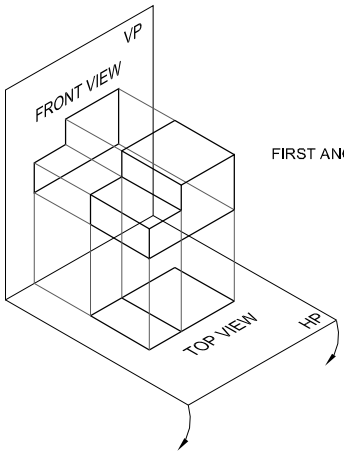


Fig 12

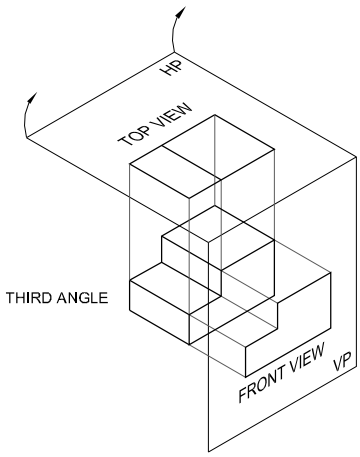


Fig 13

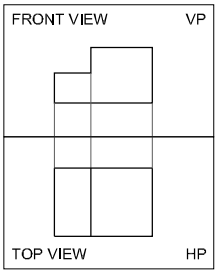
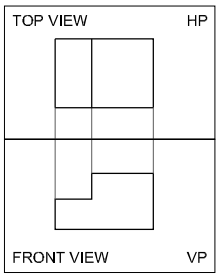


Fig 14



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, & 18 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.

Fig 15

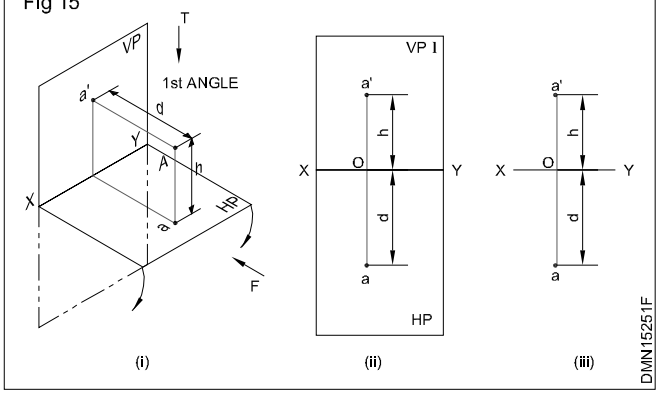


Fig 16

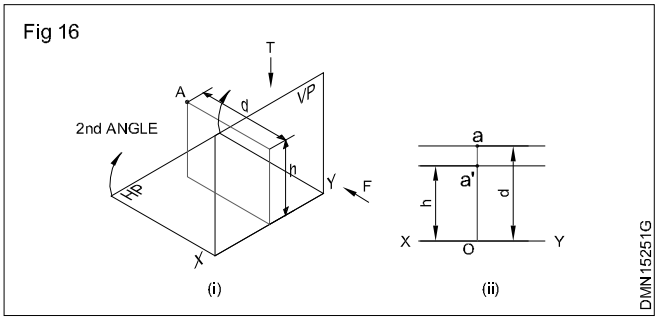
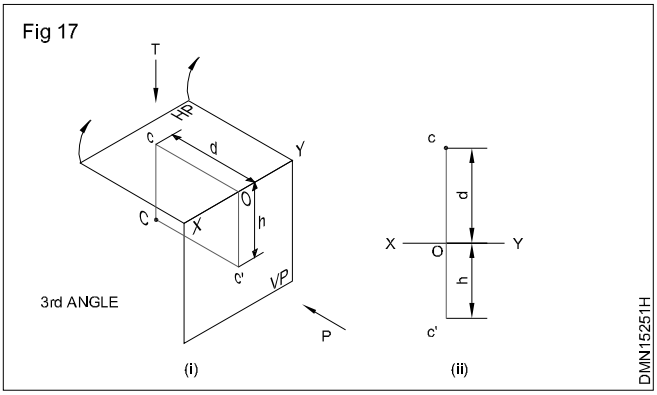


Fig 17



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.

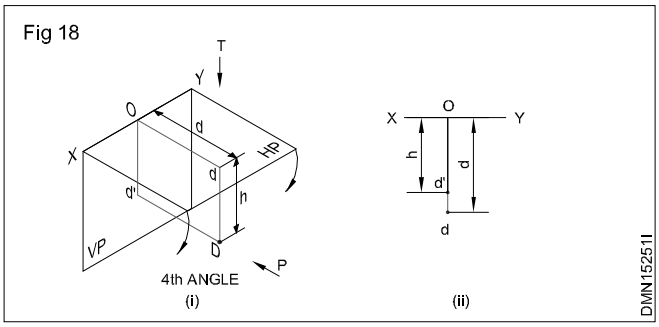
– The point to be projected is marked by capital letters and its projections are marked with corresponding small letters.

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.

Fig 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.

Fig 19

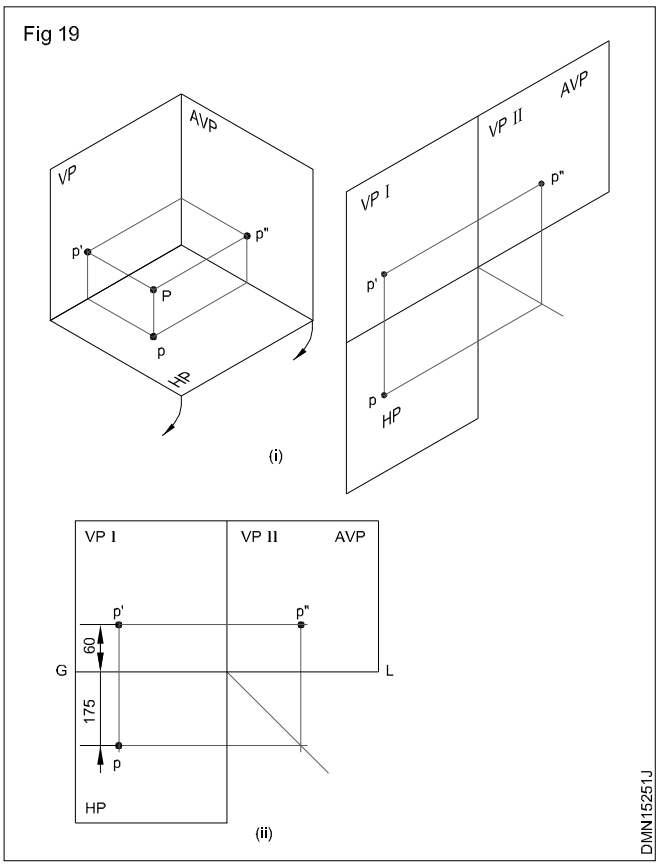
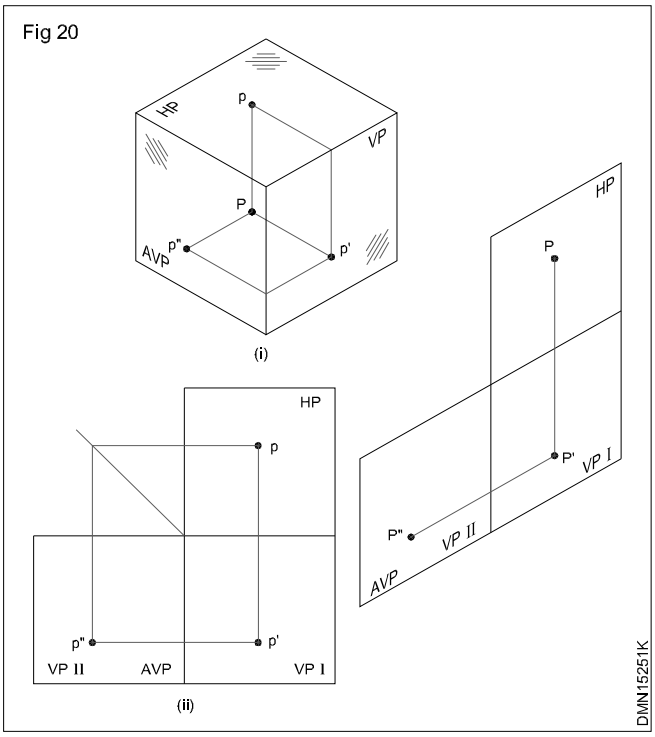
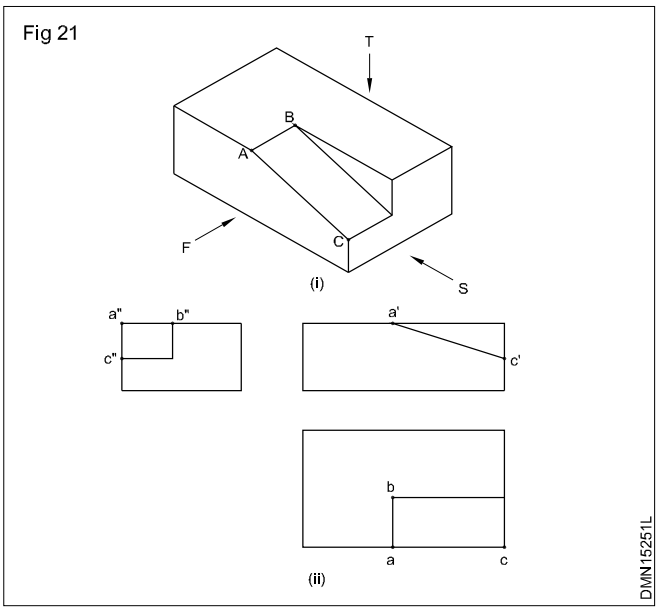


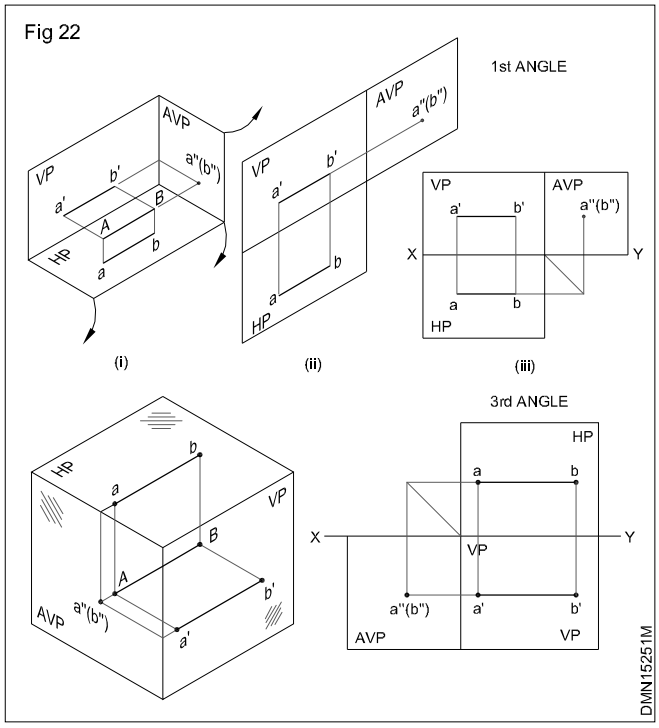
Figure 19 & 20 shows one more plane added to the two planes forming the first angle and third angle (first quadrant and third quadrant) and the projection of a point 'P' on all these planes. The added plane is marked as VPII. VP II and HP are rotated to lie in the same plane (Fig 19 & 20) as VPI. We 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.





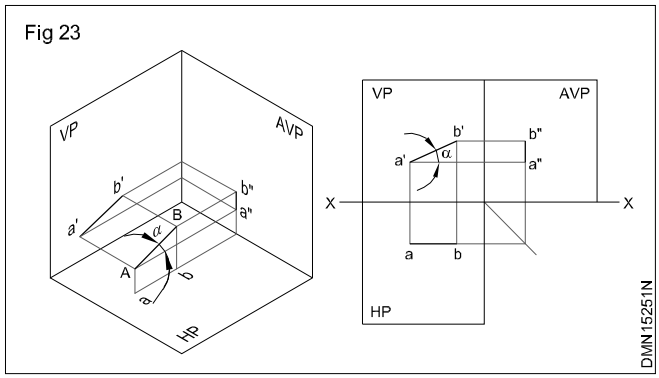
Projection of a line: A straight line connects two points. In otherwords the line has a start point and one end point.

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)

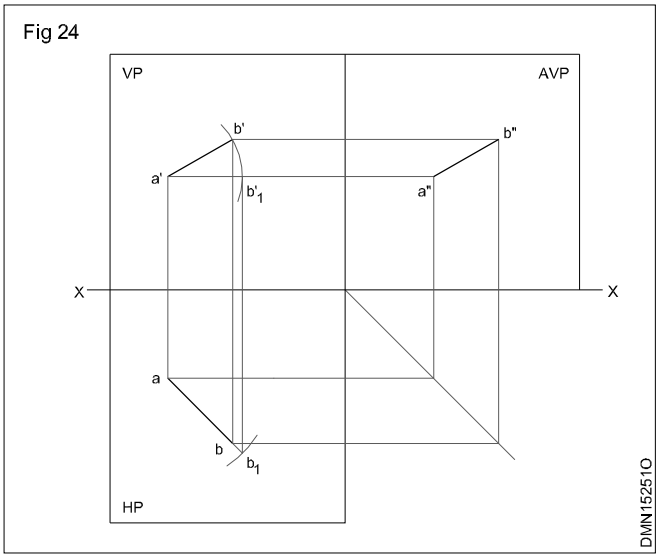
– If a line is perpendicular to the plane of projection, it will be a point.



– 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 of plane figures

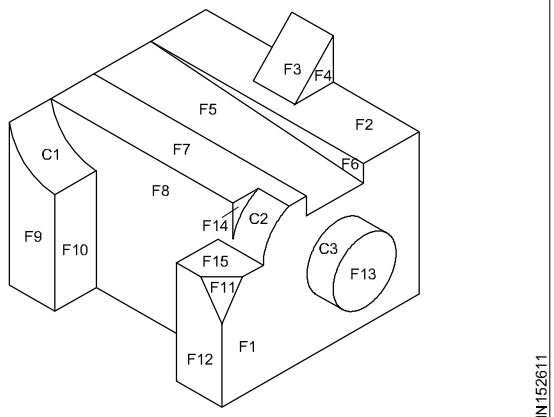
Objectives: At the end of this lesson you shall be able to
- **distinguish between a two dimensional and a three dimensional figure**
- **identify the type of surfaces the object is composed of**
- **explain as to how the projection of a given surface will be on the different planes of projection**
- **state the meaning of the term true shape and the condition to obtain true shape and the views.**

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.

Fig 1



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.

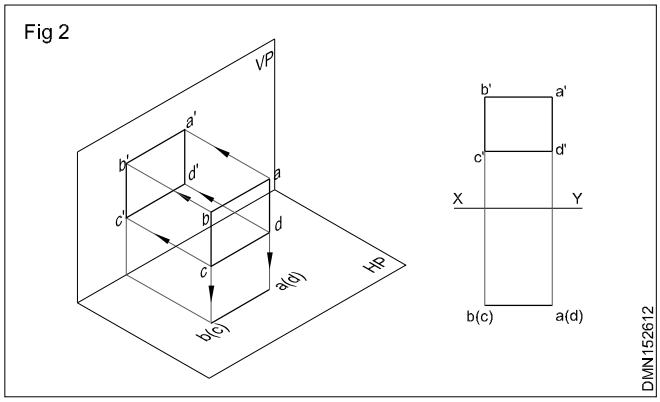
For example in F_3 is rectangular while F_{13} is circular. But surface F_1 is a combination of several plane figure.

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)

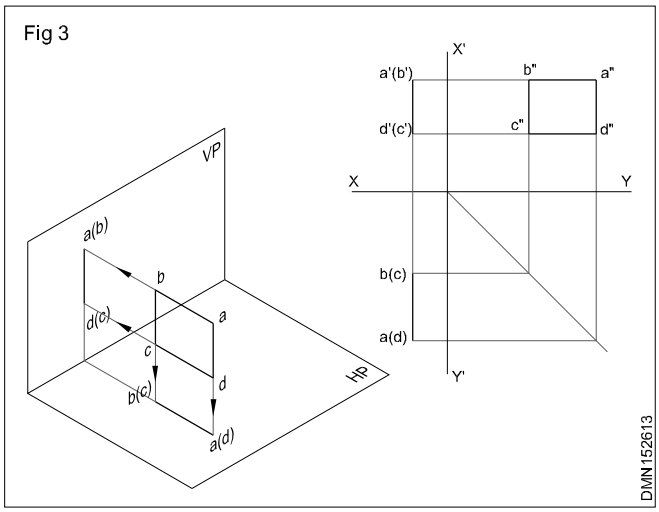
True shape: When the projection of a surface is identical to the surface projected, the projection is said to be of true shape.

Fig 2



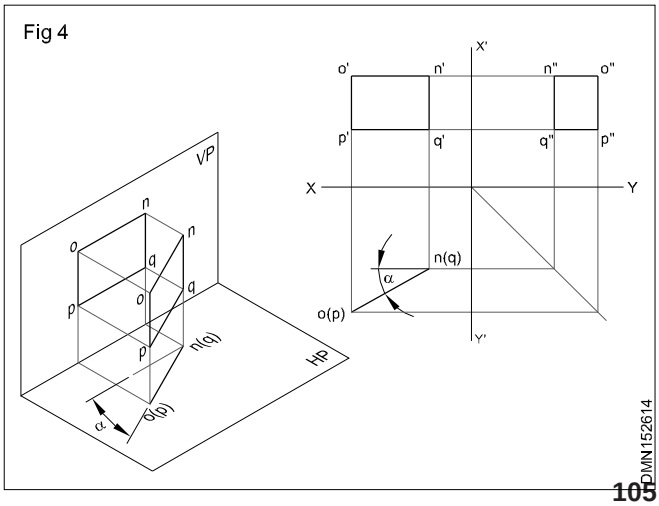
When the surface is perpendicular to the plane of projection, the resulting projection will be a straight line. (Fig 3)

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

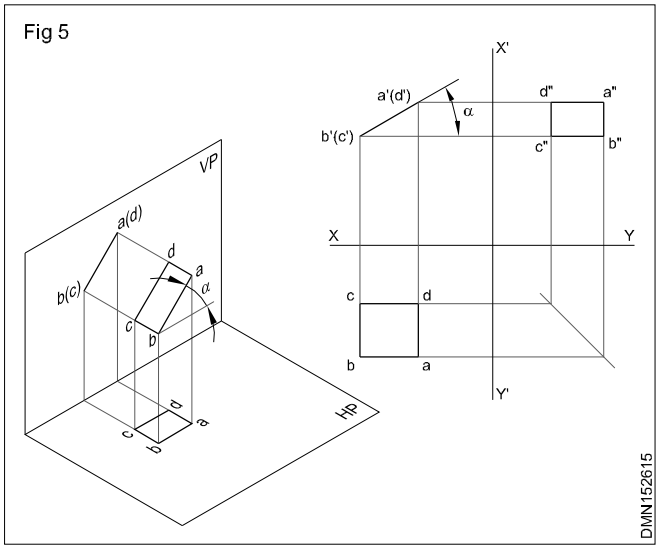


Foreshortened view: Where the projection of a surface is not identical to the surface projected, the projection is said to be foreshortened.

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)

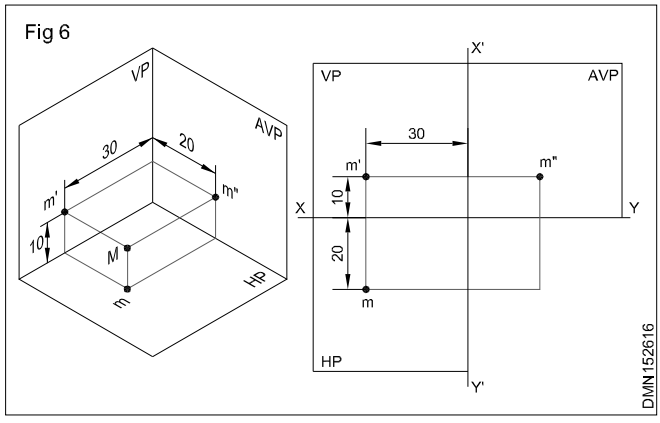
If a surface is inclined to horizontal plane the angle of inclination will be seen on VP and vice-versa. (Fig 5)



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'.

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

Terminology of views/projections: (Fig 6)



– 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.

The distance from XY to a point in the plan and to the corresponding point in the side view from X,Y, is equal to the distance from VP.

The distance from XY to point in the front elevation and to the corresponding point in the side view from XY is equal to the distance of the point from HP.

The distance from X,Y, to a point in the front elevation and the corresponding point in the plan from X,Y, is equal to the distance of the point from AVP.

The above three statements may be summerised as follows:

the distance of a point from one plane will not reflect in the projection on that plane, but it will be reflected in the projections of other planes.

This can be observed in the figure shown.

Point M is 10 mm from HP, 20 mm from VP and 30 mm from AVP.

In the figure B, the projections of point M in the three planes and distances from XY and X,Y, are marked.

Point M is really 10 mm from HP, but the distance of 10 mm is not reflected in HP. Similarly 20 mm is not reflected in VP and 30 mm is not reflected in AVP.

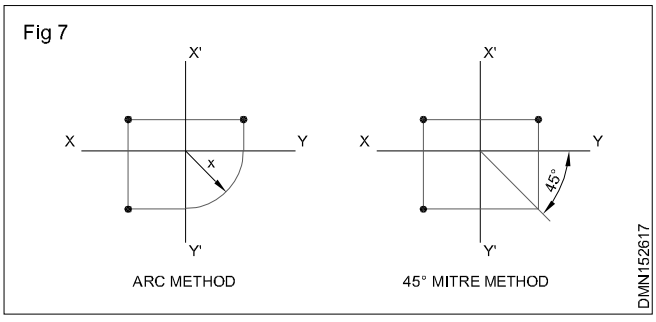
Distance of 10 mm from HP is reflected in front and side views.

Distance 20 mm from VP is reflected in plan and side view.

Distance 30 mm from AVP is reflected in plan and front view.

If we know the projection of point in two planes, its projection to third plane can be obtained by projecting from the given/known two views and transfering distances.

For example, if you draw the front view and side view of a point (Fig 7), plan can be completed by drawing projection from the front view and side view. Transfer of distances from two views to third view may be done either by arc method or by 45° mitre line method.



Following standard conventional markings are to be followed for points, lines and surfaces on plan, front view and side views.

Plan	Final	just an alphabet	(a)
	1st stage		(a1)
	2nd stage		(a2)
Elevation	Final	alphabet with	(a')
	1st stage	a dash	(a1')
	2nd stage		(a2')
Side elevation	Final	alphabet with	(a'')
	1st stage	two dash	(a1'')
	2nd stage		(a2'')

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

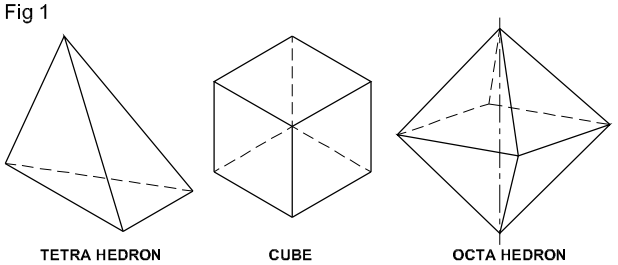
Polyhedra: are solids having (poly-many) more than three flat surfaces called faces. The ends of surfaces meeting with each other are called edges. When the faces are identical to each other, they are called `Regular Polyhedra'. Depending on the number and shape of faces regular polyhedrons are named.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

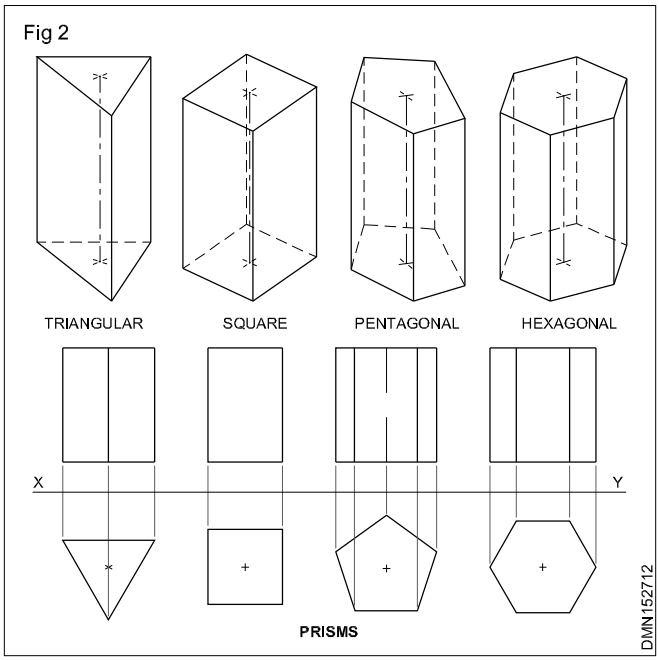
Fig 1



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

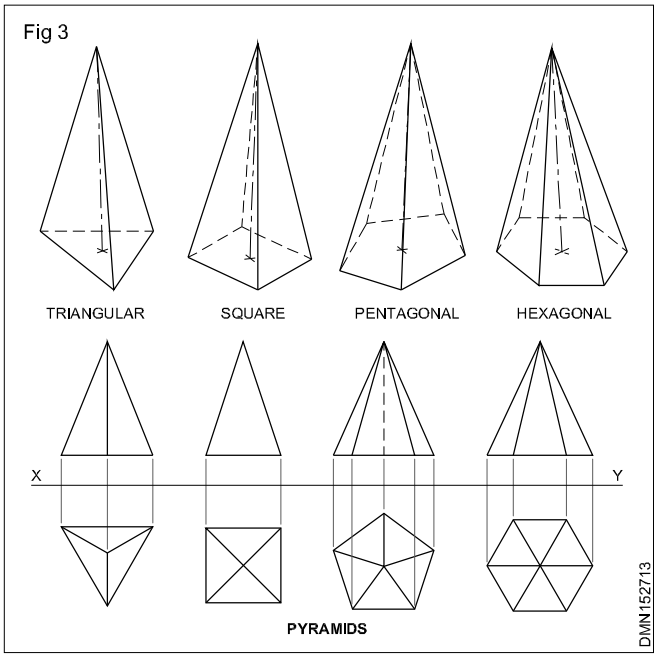
The solid shown in the Fig 4 is formed by the revolution is formed by the revolution of the plane (Fig 4A) abc about the axis ab.

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.

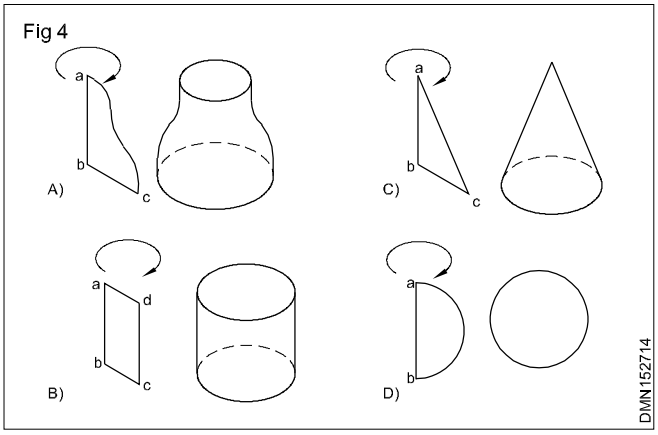
Cylinder has two flat circular faces and a curved surface. (Fig 4B)

Fig 3



PYRAMIDS

Fig 4



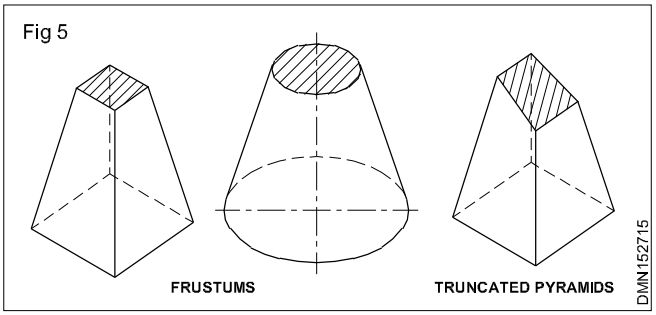
Cone: When a right angled triangle revolves about one of its side forming the right angle, a cone is generated. Cone forming has a circular face and a slant curve surface. (Fig 4c)

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.

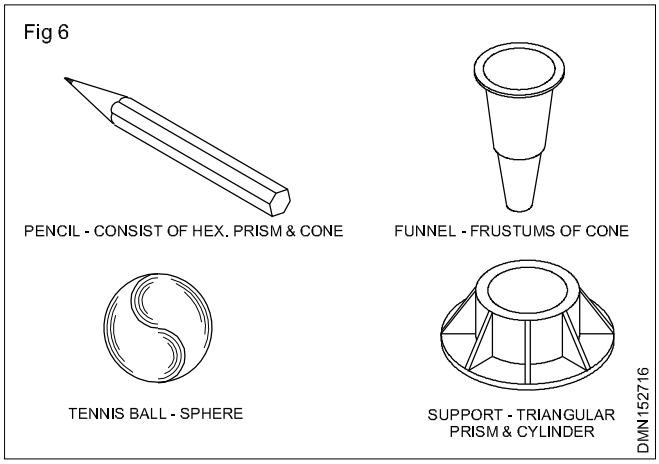
Fig 5



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

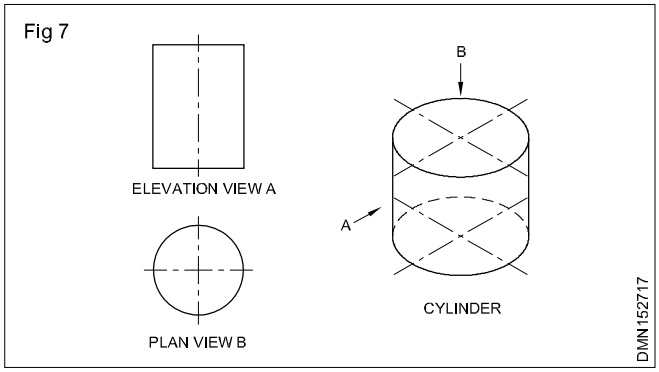


Fig 8

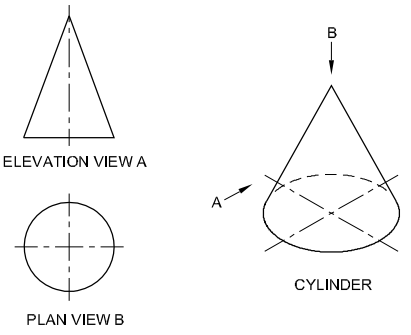


Fig 9

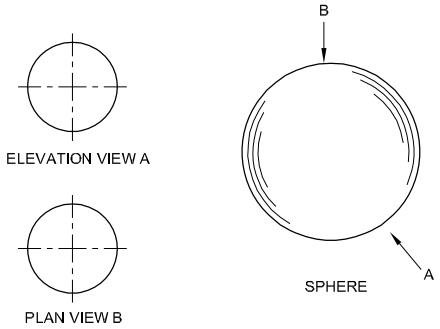


Fig 10

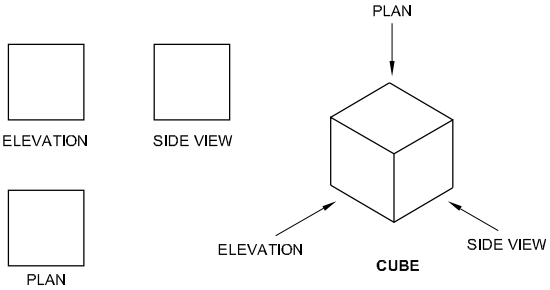
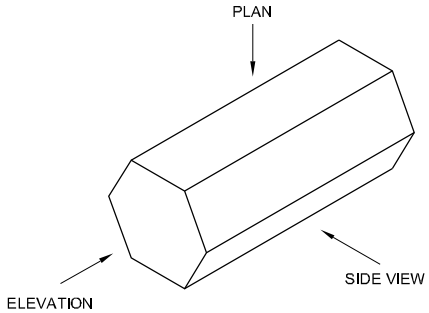


Fig 11



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

Fig 12

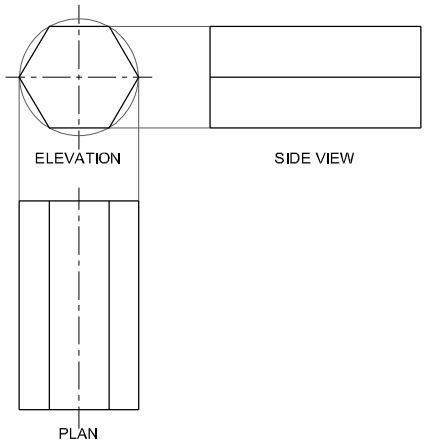


Fig 13

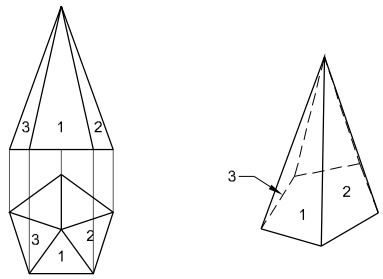


Fig 14

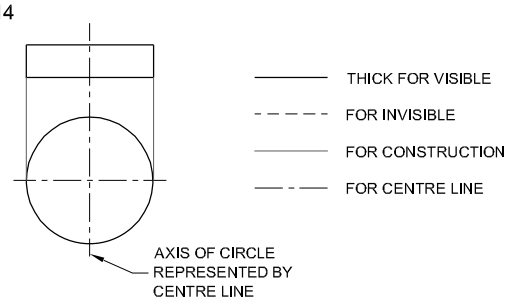


Fig 15

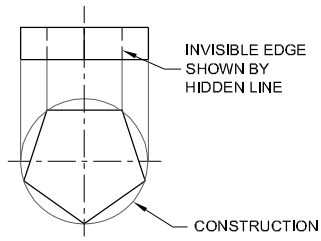
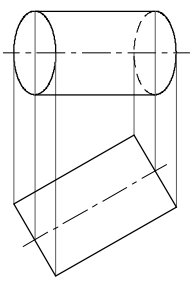


Fig 16



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

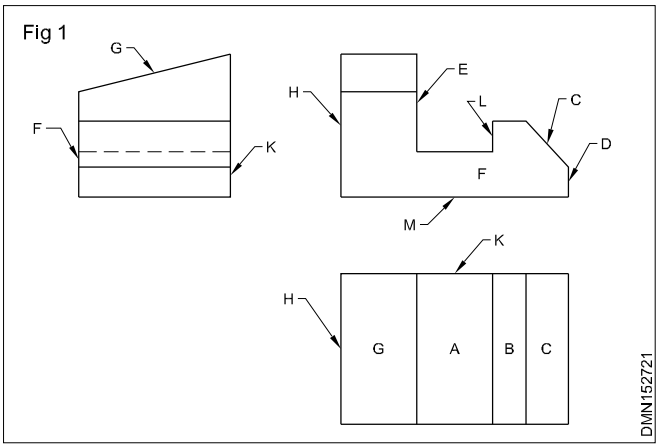


Fig 2

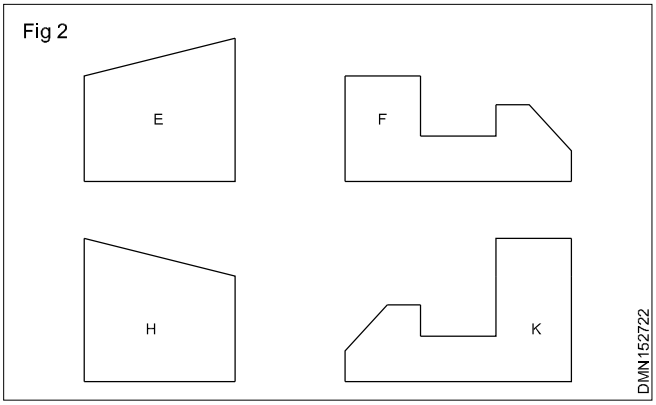
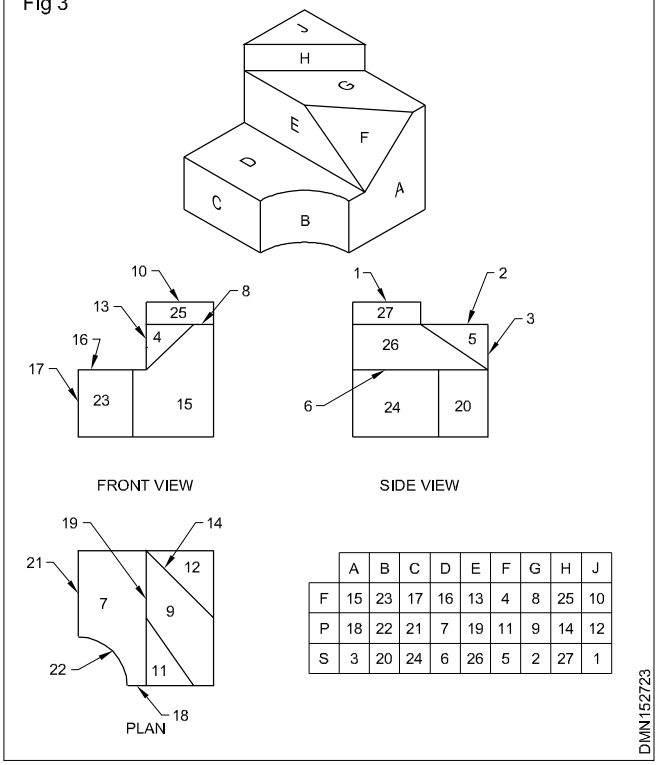


Fig 3



	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.

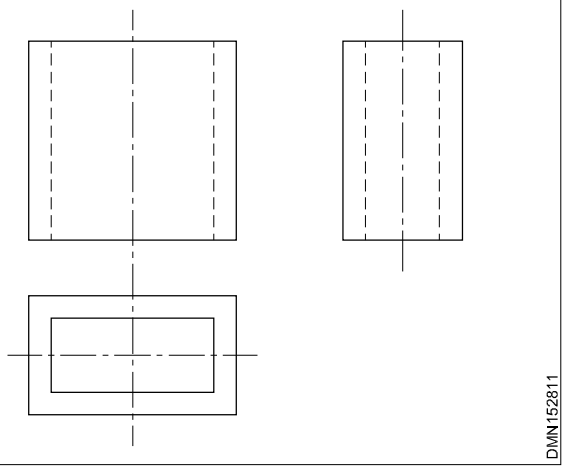
Types of Sectional views

Objectives: At the end of this lesson you shall be able to
- **explain full-section and half-section**
- **describe off-set contiguous and aligned section**
- **explain removed, revolved and local sections**
- **describe hatching methods.**

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.

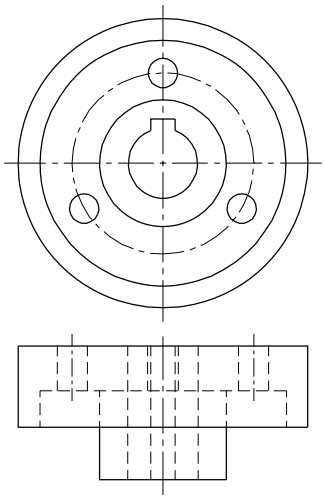
For example in the object shown in figure 1 the hole is invisible in the elevation and side view. Hence it is represented by dotted lines.

Fig 1



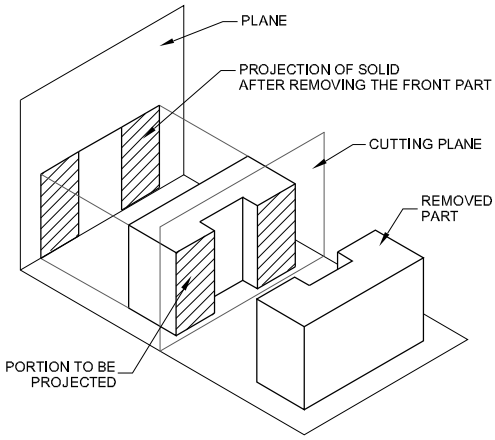
When there are too many dotted lines in a drawing (Fig 2) it is difficult to conceive the details of the object. In such a cases, details can be shown clearly and reading of drawing can be made easier by resorting to what are known as "Sectional views".

Fig 2



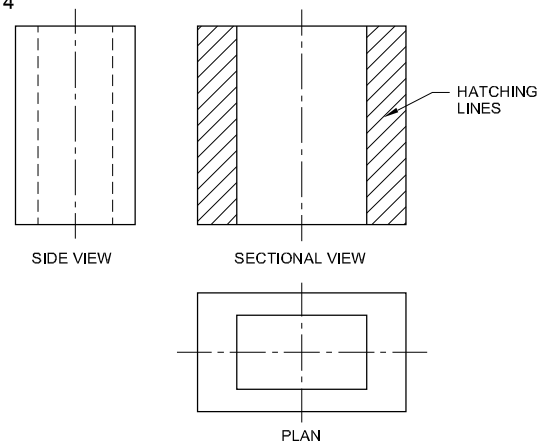
Sectional views: For obtaining sectional views an object it is assumed to be cut by an imaginary plane called cutting plane. The part between the cutting plane and the observer is assumed as removed to reveal the internal details. Then the projection of part left out is projected/ drawn as usual and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

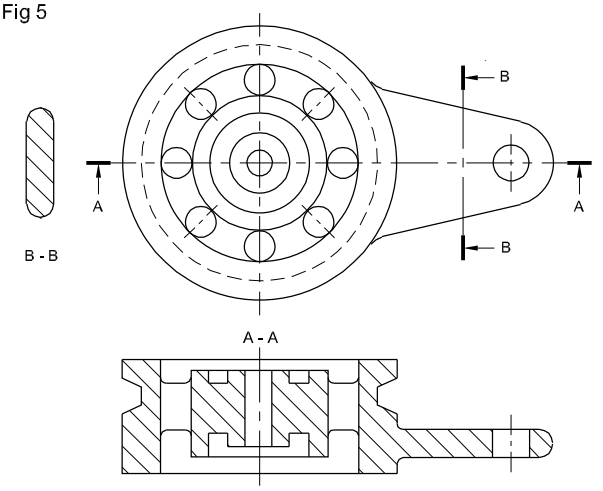


Hatching means filling the surface with equi-distant parallel lines.

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.

Fig 5



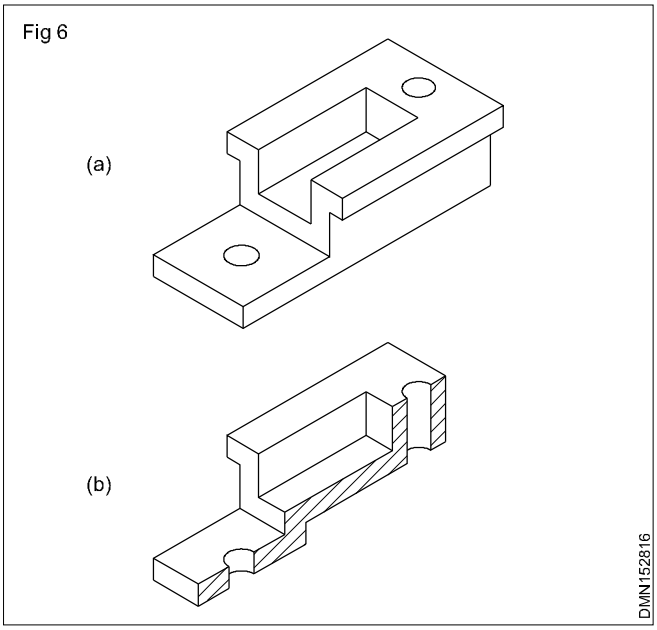
The general rules for the arrangement of the views apply equally when drawing sections.

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

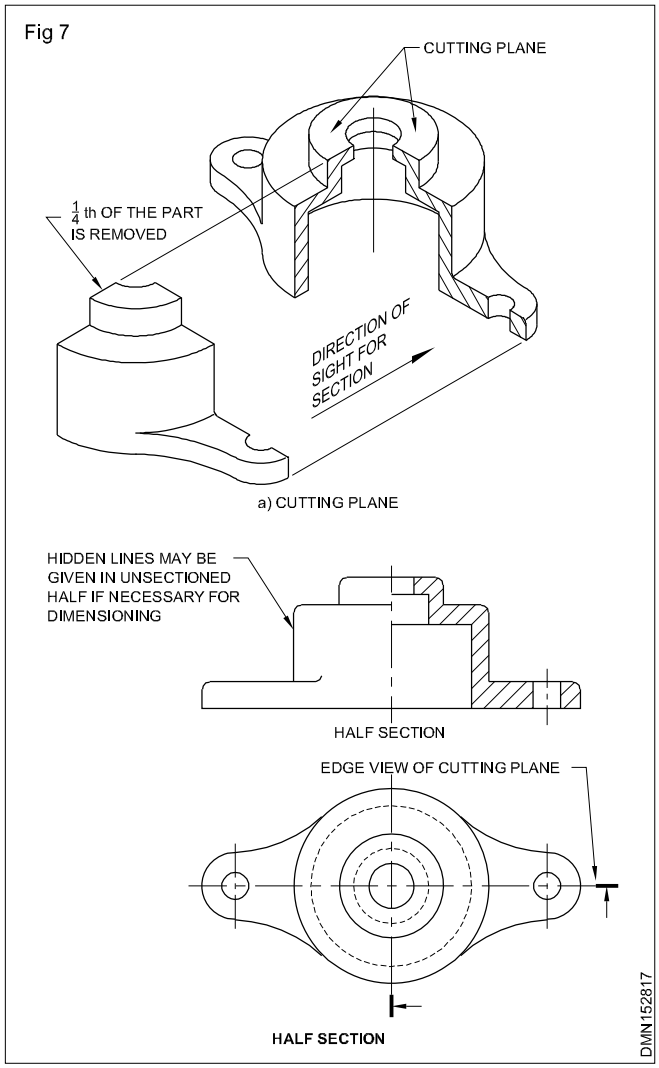


Where the location of a single cutting plane is obvious, no indication of its position is required. Where the locations is not obvious or where it is necessary to distinguish between several cutting planes, the cutting planes shall be indicated by means of thin chain line, thick at ends and change of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

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

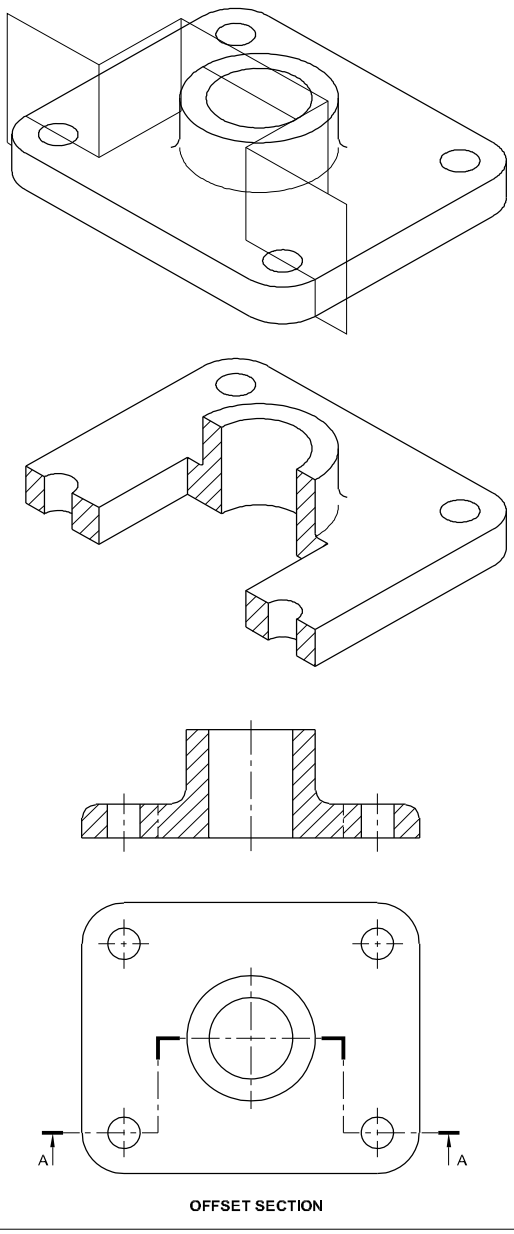
Half section: When a component is symmetrical it is not necessary to draw a full sectional view. In such case one half of the view is drawn in section and the other half is shown as normal view. Thus in one view we show both the external and internal details. For half section, the cutting plane removes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

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.

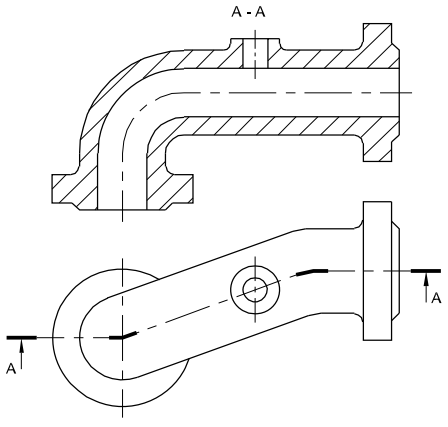
Fig 8



OFFSET SECTION

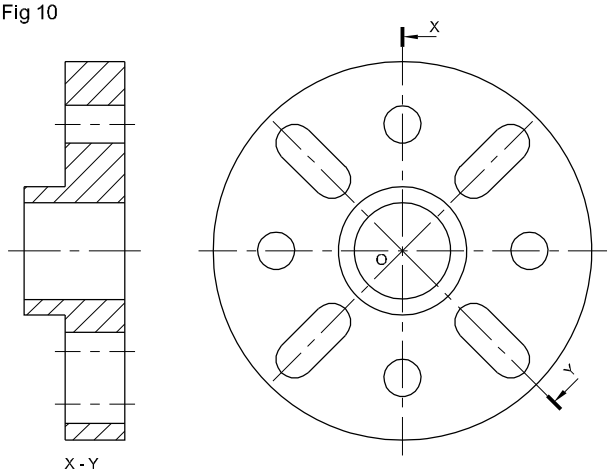
Section in contiguous planes: Certain components such as shown in figure 9 are bent offset at different position. In such cases the cutting plane follow the contour of the part. Here the sectional view is more like a full-section even though the cutting plane is not a single plane. (Fig 9)

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.

Fig 10

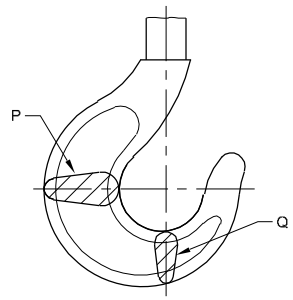


Certain parts like arms, webs are not sectioned. The cutting plane is assumed as passing just outside parallel to it.

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.

Fig 11



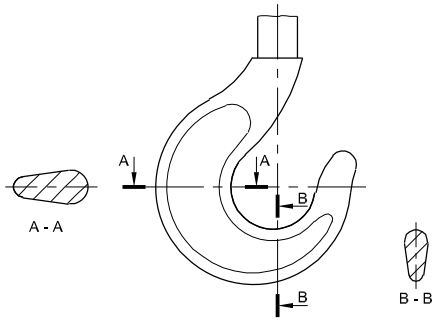
REVOLVED SECTION

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.

The outline of the revolved sections shall be drawn in continuous thin outline.

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

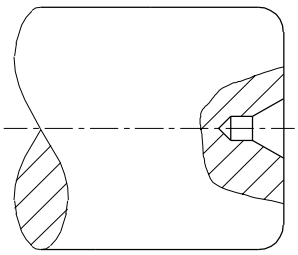


REMOVED SECTION

DMN15281C

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



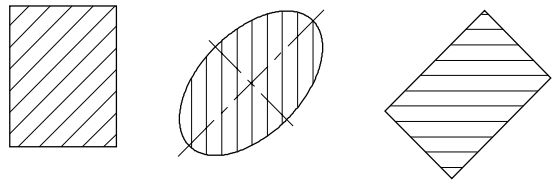
BROKEN SECTION

DMN15281D

Hatching techniques

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)

Fig 1

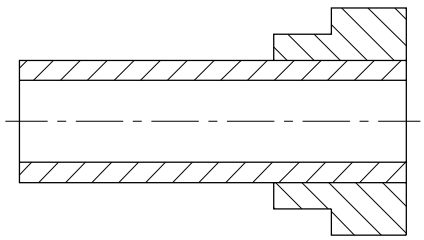


PREFERRED HATCHING ANGLE

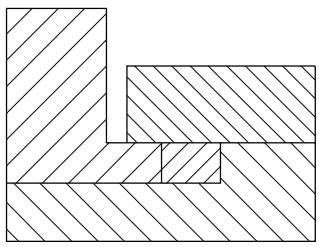
DMN152821

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

Fig 2



a) HATCHING OF ADJACENT COMPONENTS



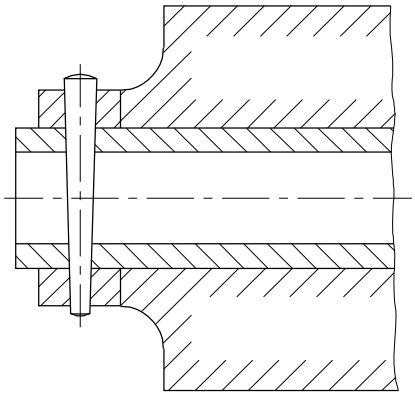
PITCH OF HATCHING LINES IS VARIED TO DISTINGUISH PARTS

b) HATCHING OF MORE THAN TWO ADJACENT COMPONENTS

DMN152822

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)

Fig 3

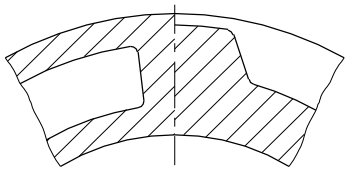


HATCHING OF LARGE AREAS

DMN152823

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 4

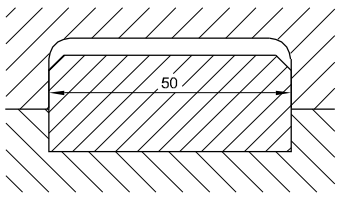


HATCHING OF A PART IN DIFFERET PARRELLEL PLANES

DMN152824

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 5

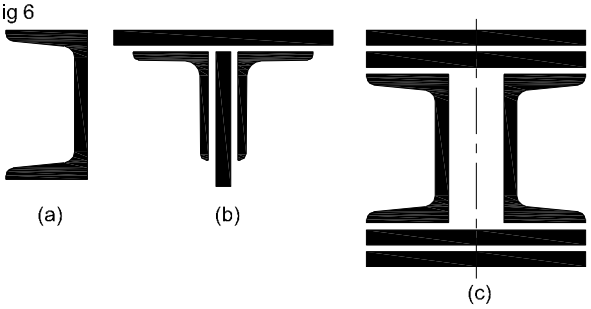


HATCHING INTERUPTED FOR DIMENSION

DMN152825

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

DMN152826

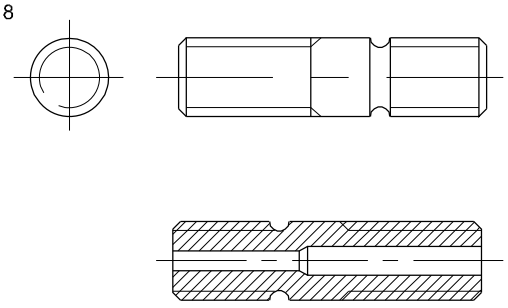
Omission of hatching lines: There are several cases where hatching lines are deliberately omitted even though they are cut by the section plane. For example ribs/webs are not hatched to avoid a false impression of thickness and solidarity. (Fig 7a & b)

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.

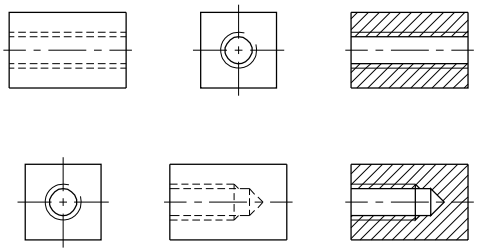
Fig 8



CONVENTION OF EXTERNAL THREAD

DMN152828

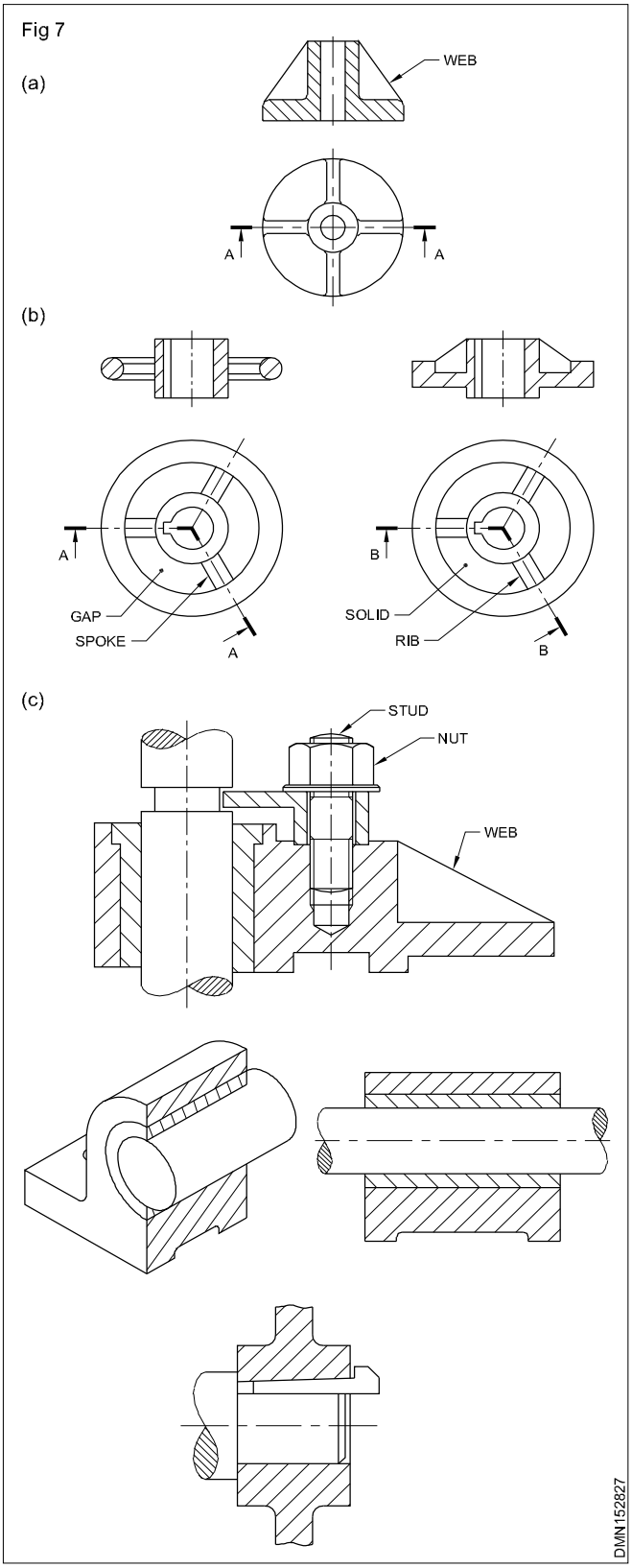
Fig 9



INTERNALTHREAD

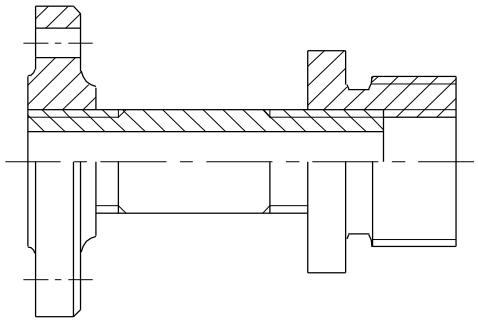
DMN152829

Fig 7



DMN152827

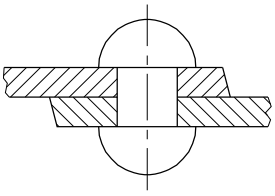
Fig 10



ASSEMBLY OF THREADED PARTS

DMN15282A

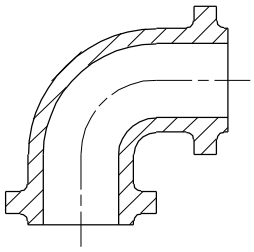
Fig 11



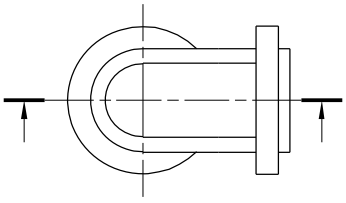
SECTION OF RIVETED JOINT

DMN15282B

Fig 12



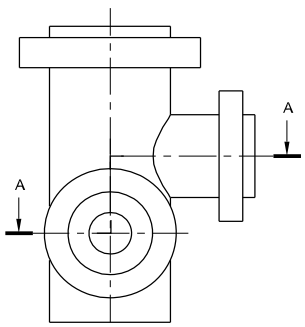
SECTION A-A

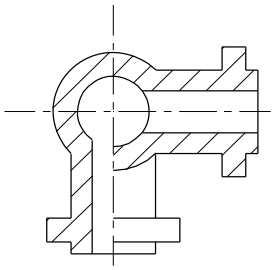


SECTION IN ONE PLANE

DMN15282C

Fig 13

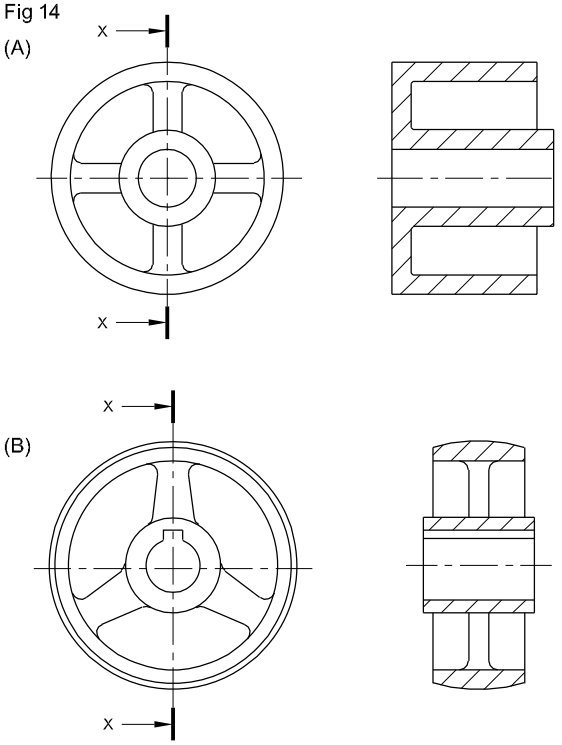




SECTION AA

DMN15282D

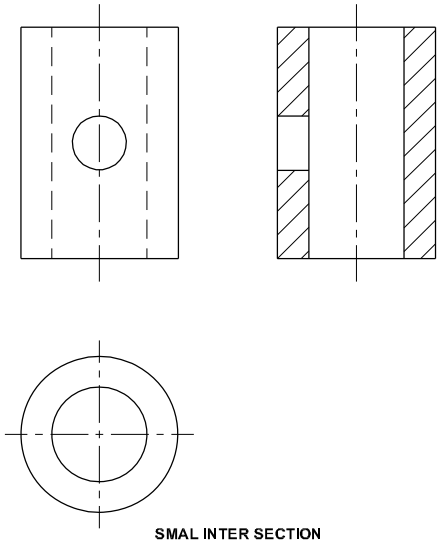
Fig 14



SECTION THROUGH CENTRE A RIBOR WEB

DMN15282E

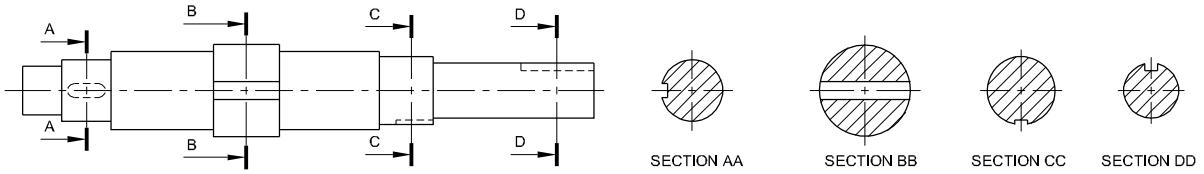
Fig 15



SMAL INTER SECTION

DMN15282F

Fig 16



SUCCESSIVE SECTION

DMN15282G

Free hand sketching

Objectives: At the end of this lesson you shall be able to
- **state the need for free hand sketching**
- **list the situations wherein free hand sketching is useful.**

Need for free hand sketching: Primary duty of draughtsman is to prepare drawings which are required for various purposes. Although several instruments / equipment are available at the disposal of the draughtsman to make perfect scaled drawings. Very often he will also be required to make drawing "free hand" using just a pencil and an eraser.

Here are a few examples of situation wherein free hand sketches will have to be necessarily made.

– On the site sketching for production / maintenance.

– Recording of initial idea of a design.

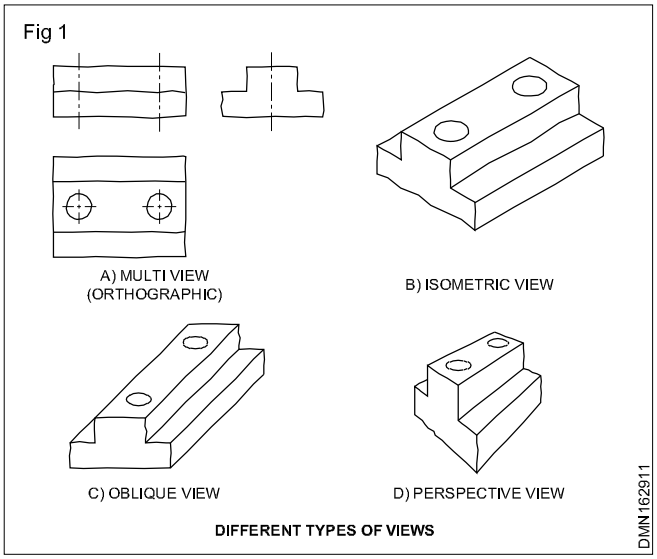
– For quick exchange of ideas among designer, draughtsman.

– Urgency (free hand sketching takes less time)

To make free hand drawings / sketches for the draughtsman has to acquire new skills and one has to have considerable practice to be able to make good free hand sketches. Ability tomake good free hand sketches is an asset to any draughtsman.

Free hand sketches are not usually made to scale. However, they should be as nearly to the proportions as possible. (See Fig 1 for example of free hand sketching)

Fig 1



Materials for free hand sketching: A4 size sheet (preferably a pad instead of loose papers) pencils of soft grade. Example H, HB, F and a good quality eraser are the only materials required. For drawing different darkness, the pencil points should be sharpened to conical shape.

Sketch by free hand

Objectives: At the end of this lesson you shall be able to
- **draw figures involving horizontal, vertical and inclined lines**
- **independently using 'T' square, setsquares, scale, divider and protractor.**

To draw horizontal thick and thin lines. (Fig 1)
- Sketch two vertical thin guide lines AB & CD.
- Mark points on the vertical lines AB & CD, 5 mm intervals approximately.
- Draw the lines by free hand between the two points sketch thick and thin alternatively.

Lengthy lines can be drawn with the forearm motion and short lines are drawn with the wrist motion.

Keep uniform pressure while sketching.

Horizontal lines are drawn from left to right. (Fig 1B)

While sketching straight lines between two points keep your eyes on the point to which the line is to go rather than the point of pencil.

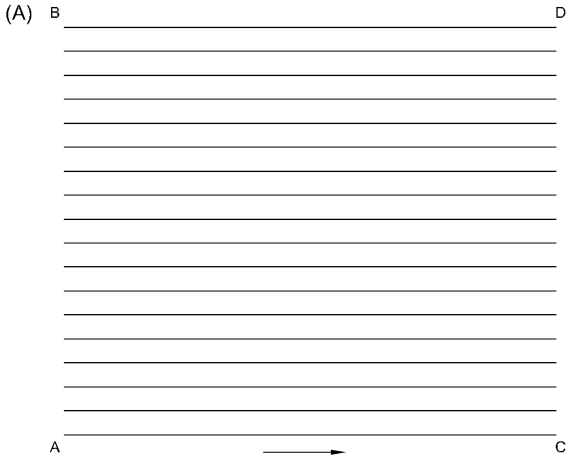
Avoid of drawing whole length of line in one single stroke.

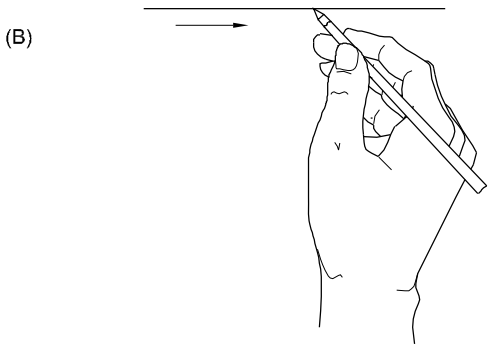
Prevent using eraser often.

Vertical lines are drawn from top to bottom - (Fig 2)

Sketch the inclined lines as shown in figure with thick and thin lines. (Fig 3)
- Sketch two axis AB & CD.
- On the horizontal and vertical axis AB and CD, mark points with 5 mm intervals.
- Draw thick and thin lines in the direction as shown in the figure alternatively.

Fig 1





HORIZONTAL

DMN162921

Inclined lines running upward are drawn left to right i.e bottom to top. (Fig 3B)

The pencil point need not to be too sharp.

Hold the pencil freely and not close to the point.

It is better that the pencil can be hold 30 mm away from the tip of the pencil lead.

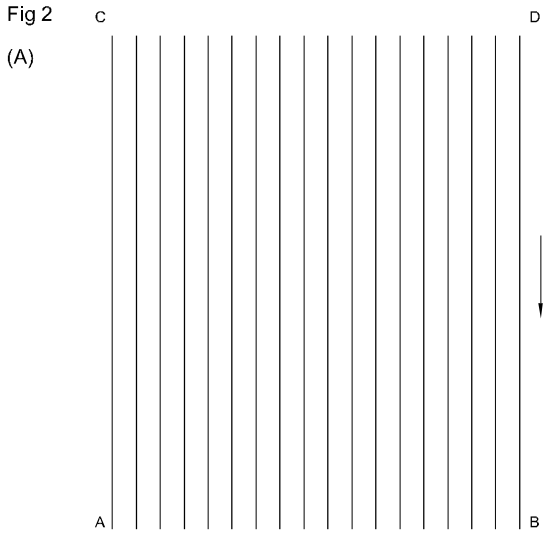
Sketch the given plane figure as shown. (Fig 4)

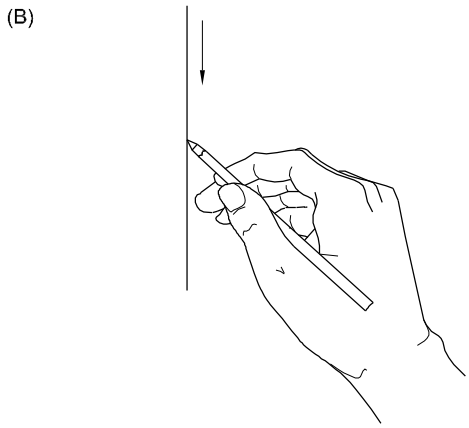
- Draw the horizontal straight line in free hand and mark off 60 mm approximately.
- Draw a vertical straight line of 60 mm long from the base.
- Draw horizontal & vertical parallel lines and form a square box of 60 mm sides.
- Darken the lines of the surfaces in figure using thick line.
- Erase the unwanted lines and complete the plane figure.

Do not place any dimensions in side the figure.

Sketch the plane figure as shown. (Fig 5)

Fig 2





VERTICAL

DMN162922

- Sketch a square box of 30 mm side in thin lines.
- Mark off the dimensions as shown in figure approximately.
- Thick the required lines.
- Erase the unwanted lines and complete the figure.

Sketch the plane figure as given. (Fig 6)

- Form a square box of 30 mm side in thin lines.
- Set of the dimensions and angle as shown in figure.
- Draw the lines and remove the unwanted lines.
- Complete the figure.

Sketch a circle of diameter 50 mm. (Fig 7)

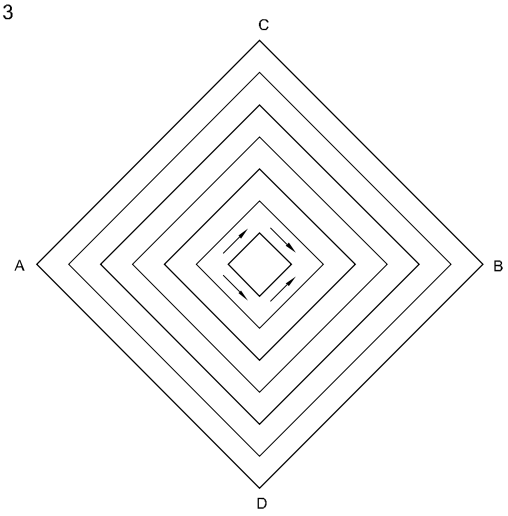
- Sketch a square box of given diameter, mark the mid points and join the mid points of horizontal and vertical sides. (Fig 7A)
- Join the corners (diagonals) of the square box and mark the radius of the given diameter. (Fig 7B)
- Join all the 8 points by a smooth curve and complete the circle. (Fig C)
- Erase the unwanted lines and darken the curve. (Fig 7D)

Side of the square = Diameter of the circle

Radius of circle = Half of the square side.

Fig 3

(A)



(B)

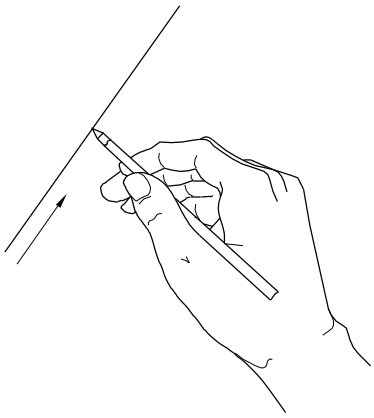


Fig 4

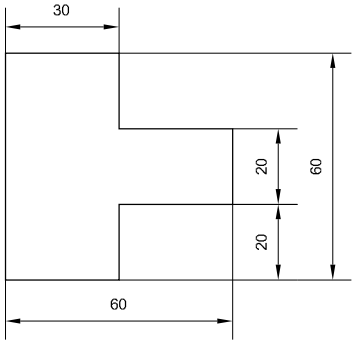


Fig 5

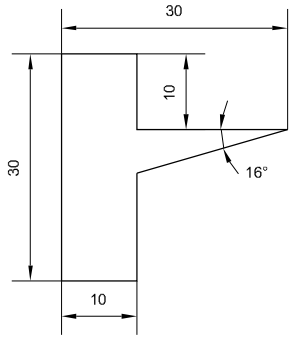


Fig 6

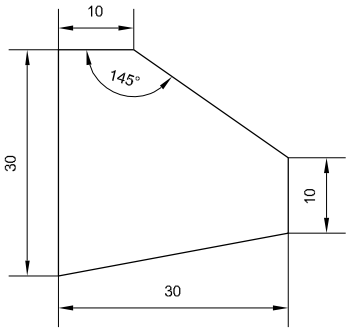


Fig 7

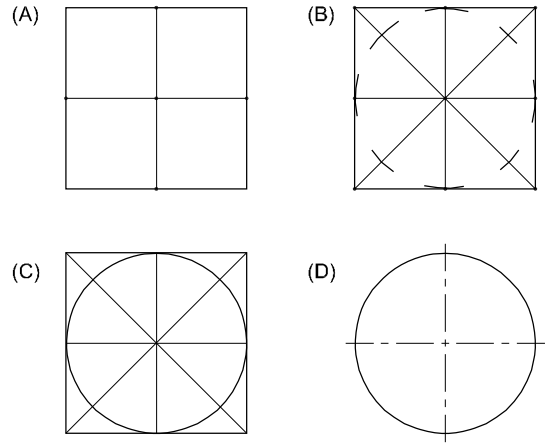
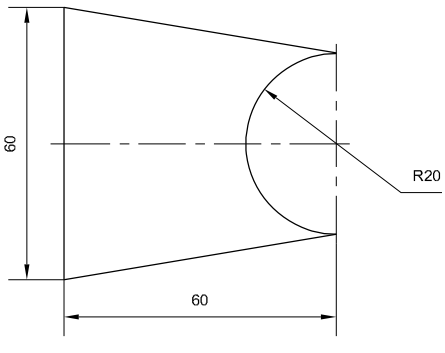


Fig 8



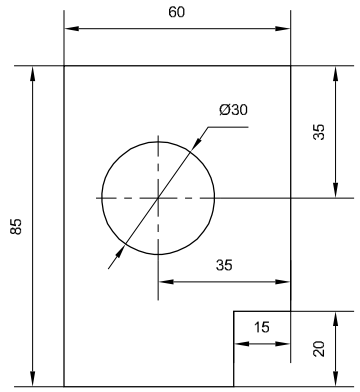
Sketch the template as shown in figure. (Fig 8)

- Sketch a square box of 40 mm side.
- Sketch the semi-circle on right side of the square as shown in figure.
- Darken the lines as in figure and complete the shape of the template.

Sketch the given figure. (Fig 9)

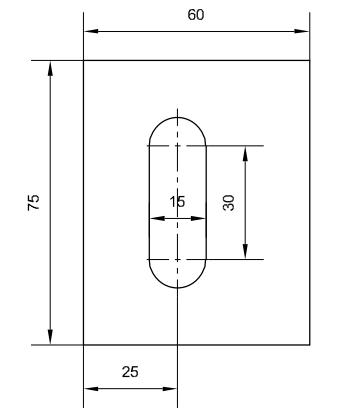
- Sketch a rectangular box of 85 mm x 60 mm.
- Mark of the dimensions as shown in figure.
- Follow the method given in Ex.8.7 and sketch the circle.
- Thick the required lines.
- Erase the unwanted lines and complete the figure.

Fig 9



Sketch the blank shown in figure. (Fig 10)

Fig 10

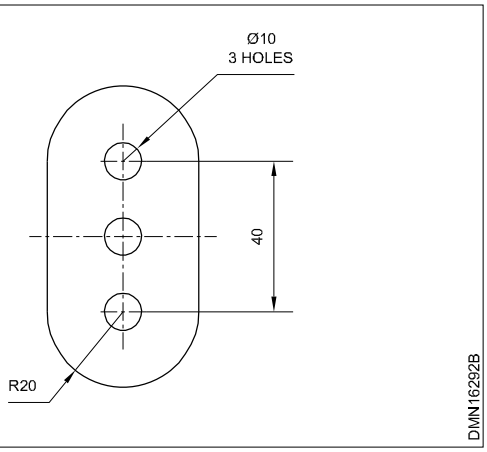


- Sketch a rectangular box of 75 mm x 60 mm as is figure.
- Mark the other dimensions as shown in figure.
- Thick the required lines of the template.
- Erase the unwanted lines and complete the figure.

Sketch the curved shape blank plane figure as given in figure. (Fig 11)

- Draw a vertical straight line and horizontal straight line intersecting each other at right angles.
- Mark off 20 mm on either side of the vertical line from the intersecting point of the straight lines.
- Sketch semi-circle of R 20 mm top and bottom as in figure.
- Join the two semi-circles with vertical lines.
- Sketch the three circles of ϕ 10 mm.
- Darken the lines and complete the figure.

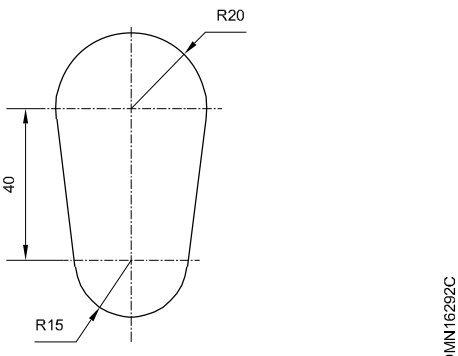
Fig 11



Sketch the template as shown. (Fig 12)

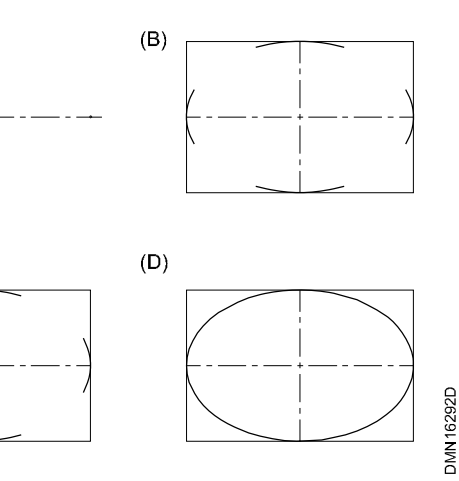
- Draw a vertical straight line.
- Draw two horizontal straight lines intersecting the vertical line keeping 40 mm away.
- Sketch the two curves as in figure and join the curves.
- Erase the unwanted lines and complete the figure.

Fig 12



To sketch an ellipse of given major and minor axis. (Fig 13)

Fig 13



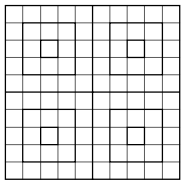
- Draw a horizontal and a vertical line intersecting each other at right angles.
- On the horizontal line mark the half of the major axis on either side of the centre and similarly half of the minor axis on the vertical line.

- Through these points draw horizontal and vertical parallel lines and form a rectangular box.
- Sketch the small arcs with thin lines.
- Join the other portion by smooth curve and complete the ellipse.

Draw the pattern of 50 mm side by free hand. (Fig 14)

- Draw a square by free hand.
- Divide one horizontal and one vertical side into each ten equal parts.
- Draw a thin horizontal and vertical line through the parts marked.
- Darken the squares as per exercise drawing.
- Rub off the thin construction lines and complete the exercise.

Fig 14

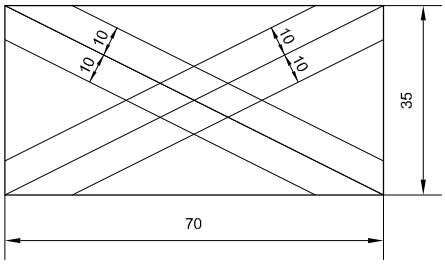


DMN16292E

Draw the pattern of sides 70 mm and 35 mm by free hand proportional to the size. (Fig 15)

- Draw a rectangle proportionately.
- Join the diagonals.
- Draw parallel lines to the diagonals approximately at 10 mm distance from each other as shown in the exercise.

Fig 15

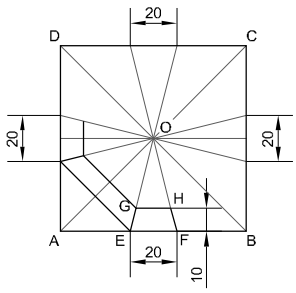


DMN16292F

Draw a square ABCD of side 80 mm approximately by free hand. (Fig 16)

- Join diagonals (thin line).
- Draw the perpendicular bisectors from two adjascent sides (free hand).
- On side AB, mark EF = 20 mm.
- Join E and F to centre of square.
- Draw a line at a distance 10 mm parallel to EF.• The parallel line cuts the inclined lines EO and FO at G and H.
- Join GH, GE and HF.
- Follow the procedure and draw trapeziums similar to EFHG on the remaining three sides.
- Join the lines shown in the Fig 16 and rub off the thin line and finish the drawing.

Fig 16

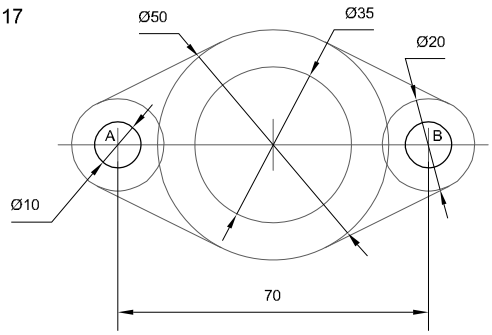


DMN16292G

Sketch the given pattern by free hand. (Fig 17)

- Mark the mid point of the line AB.
- Draw free hand circles of ϕ 35 and ϕ 50 on the mid point of the vertical line.

Fig 17



DMN16292H

- Draw two circles ϕ 20 mm using A and B are the centres.
- Draw two circles of ϕ 10 from points A and B.
- Complete the drawing after removing unwanted lines.

Plane figures for which the procedure are not given follow the constructional methods given in Skill sequences and the Procedures for plane figures and complete them.

Free hand technical sketching of machine parts/components

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 various methods adopted in sketching**
- **multi-views of the object/machine components.**

Importance of technical sketching: The importance of free hand 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 thoughts are expressed first 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 1a shows the `object' for layman's easy understanding 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 obtained only by more practice.

Note: The sketching materials are already explained in earlier lesson of module 1.

Fig 1a

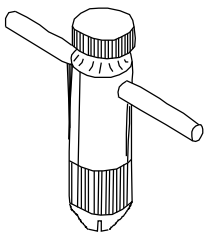
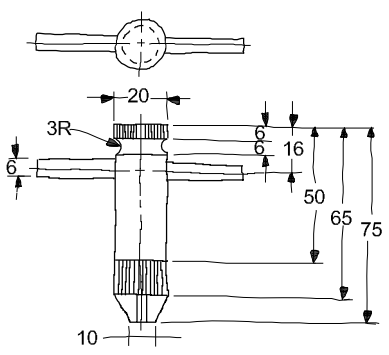


Fig 1b

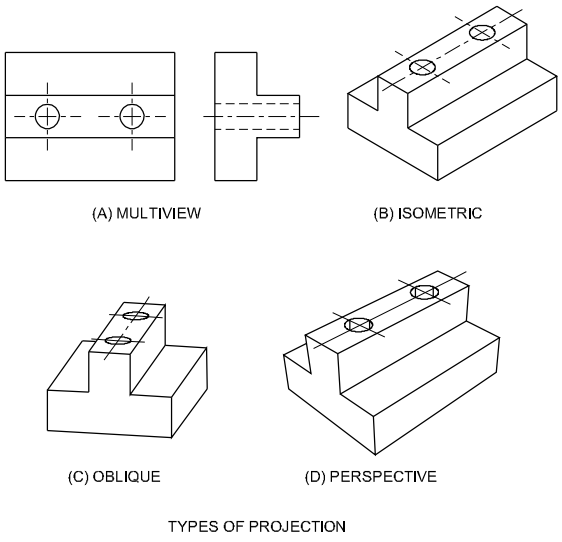


Type of sketches

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)

– Multi-view
– Isometric
– Oblique
– Perspective

Fig 2



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.

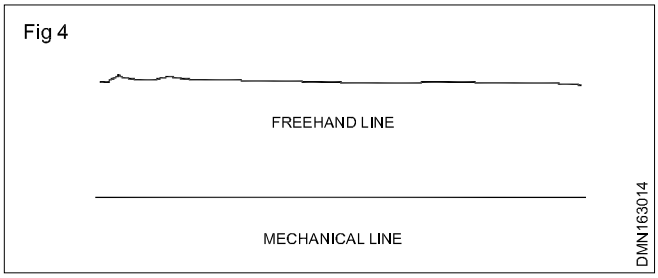
Grid (Cross-section) paper provides a ready scale that may be employed to help in sketching to correct proportions. The size of the sketch depends on the complexity of the object and the size of the paper.

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.

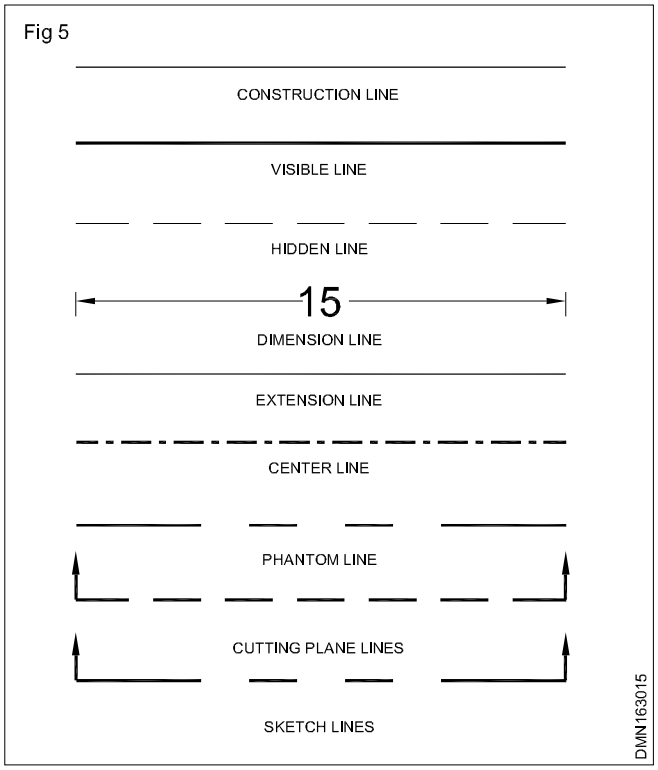
A good and perfect free hand line should not be rigidly straight or perfectly uniform as lines drawn with instruments. The quality of free hand sketch depends in its freedom and variety, whereas drawings done by using instruments lie in exact uniformity. (Fig 4)

Fig 4



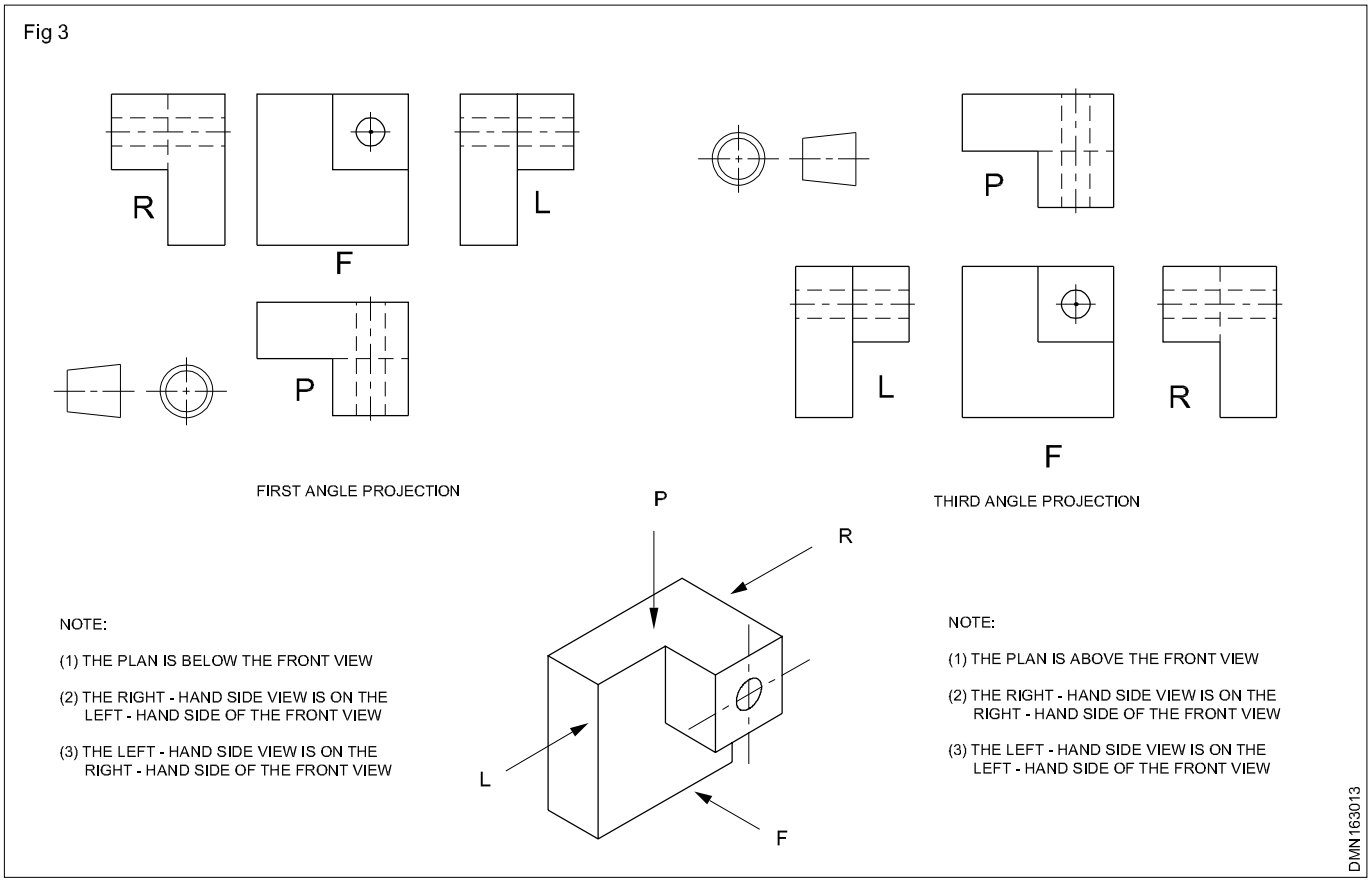
Conventional lines drawn by using instruments are shown in earlier lessons and the corresponding free hand sketches are shown in Fig 5. The free hand construction line is very light rough line in which some strokes may overlap. In free hand technical sketching you should maintain a sharp contrast between 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. The method of drawing pictorial views is explained in this module.

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.

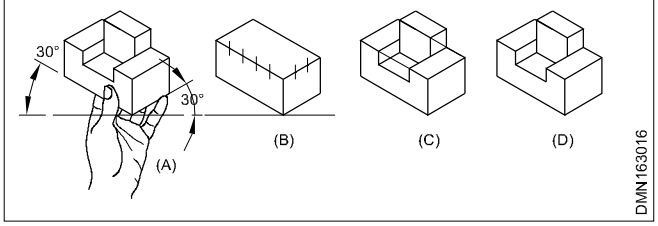
– In this position, the front corner will be vertical and in the other two receding bottom edges will be inclined about 30° to the horizontal.

– 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



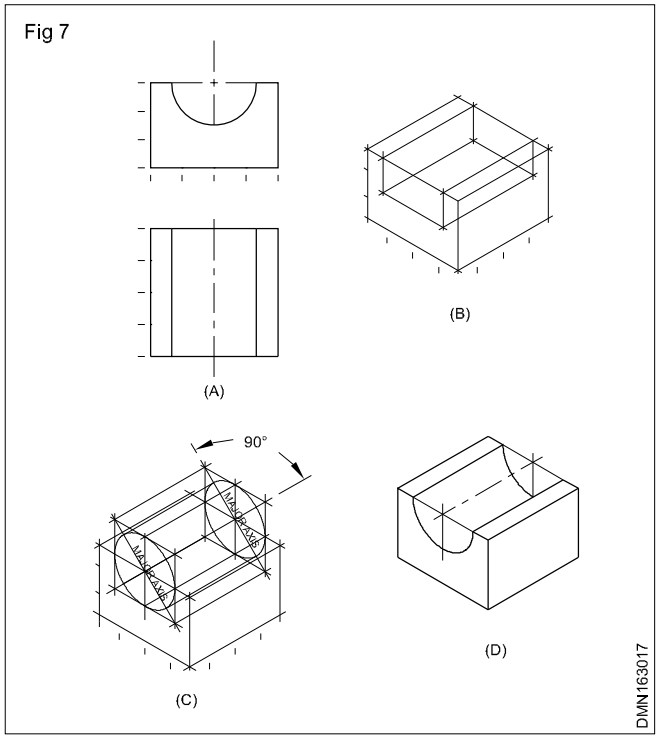
– Sketching an isometric view of a block when two views are given. (Fig 7A)

– 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)

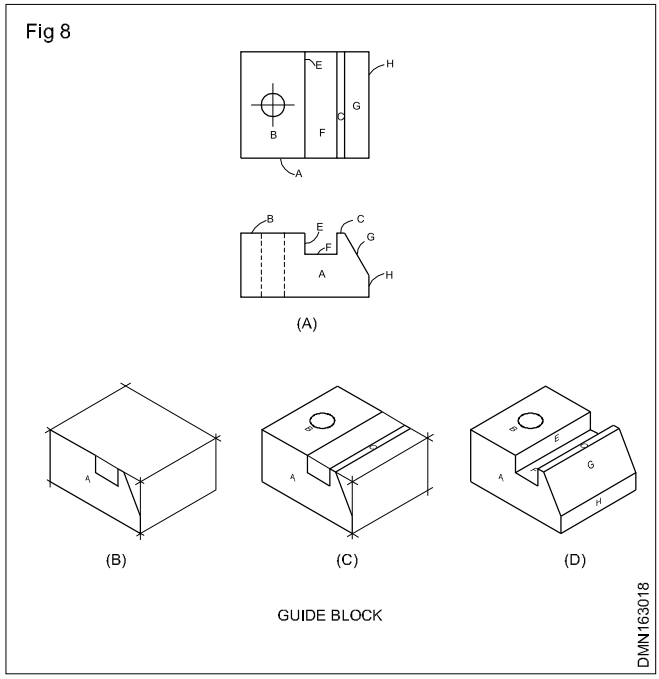
Fig 7



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 given views sketch the enclosing box and also the surface A. (Fig 8B)

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.

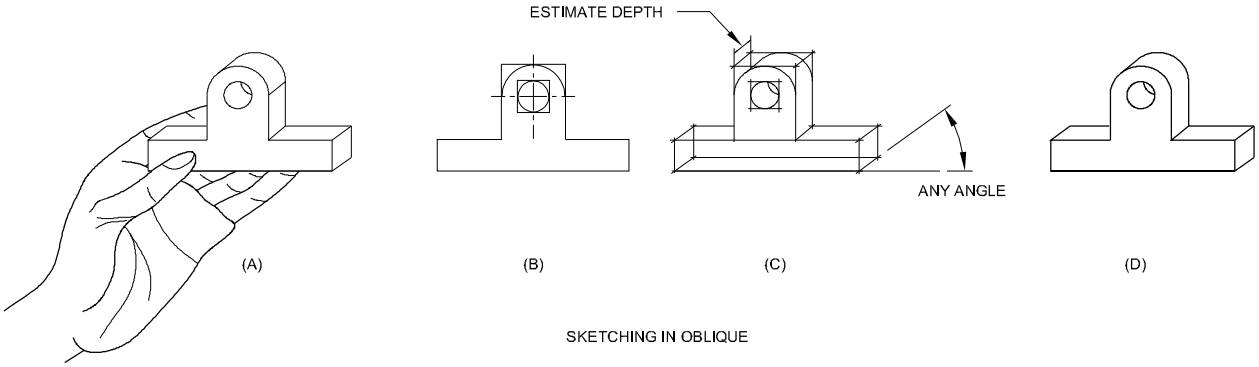
– In this methodthe dimensions are determined by counting the squares.

– The receding lines are drawn at 45° diagonally through the squares.

To sketch in a reduced scale, sketch the receding lines diagonally through half as many squares 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 object on a cross-section paper.

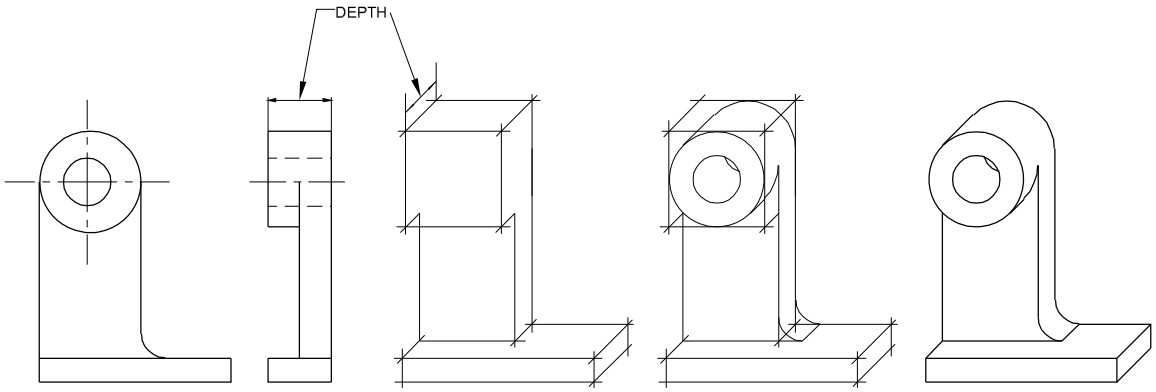
Fig 9



SKETCHING IN OBLIQUE

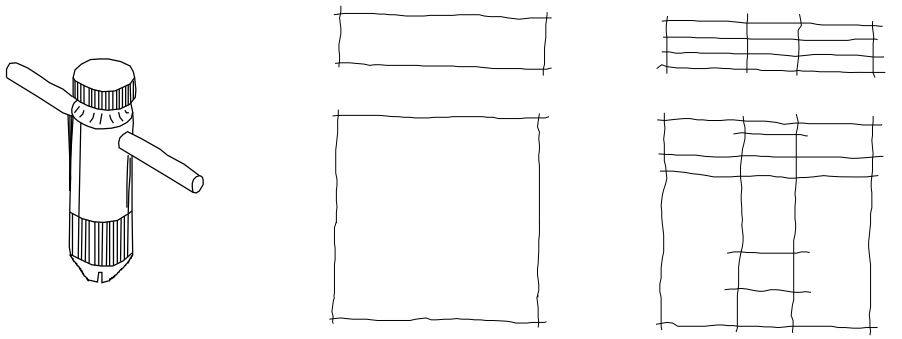
DMN163019

Fig 10



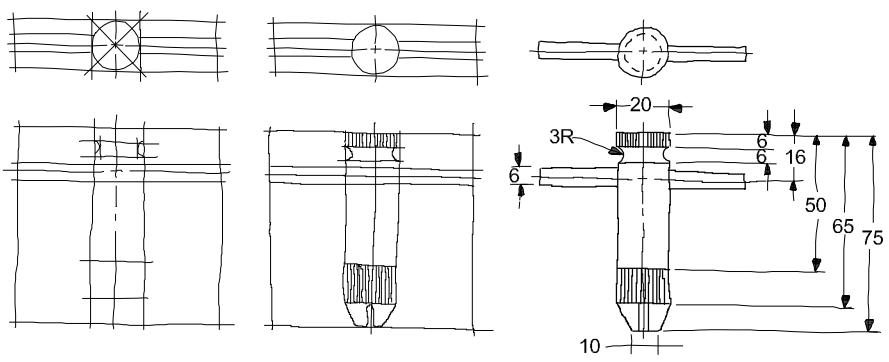
DMN16301A

Fig 11



1. BLOCK IN THE AREA NEEDED FOR EACH VIEW

2. BLOCK IN MAJOR FEATURES TO GET THEM IN PROPER PROPORTION



3. LOCATE CENTER LINES AND DRAW CIRCLES AND ARCS

4. SKETCH STRAIGHT LINES

5. DIMENSIONS

DMN16301B

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.

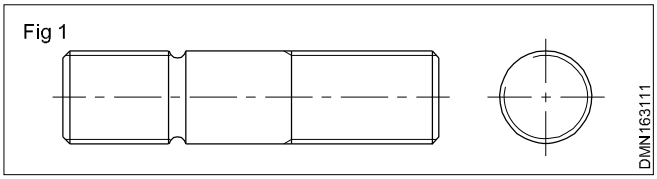
For example a thread on a bolt of M10 and pitch 1.5, it would be very difficult to draw the actual thread profile and is not going to serve any purpose. So a convention to represent the threads is made use of. Similarly gear teeth on gears, a number of holes on a component, spring coils etc are shown 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

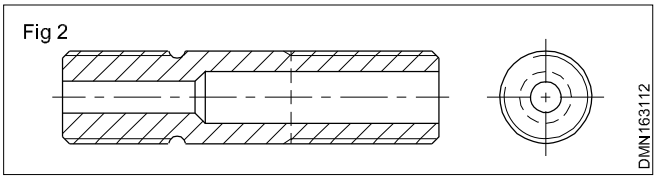
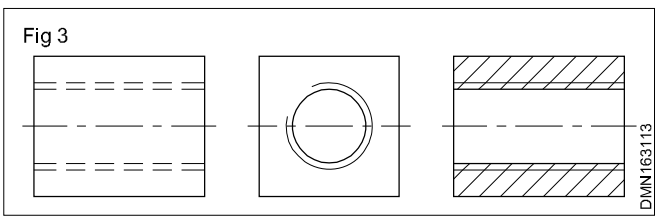


Fig 3



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

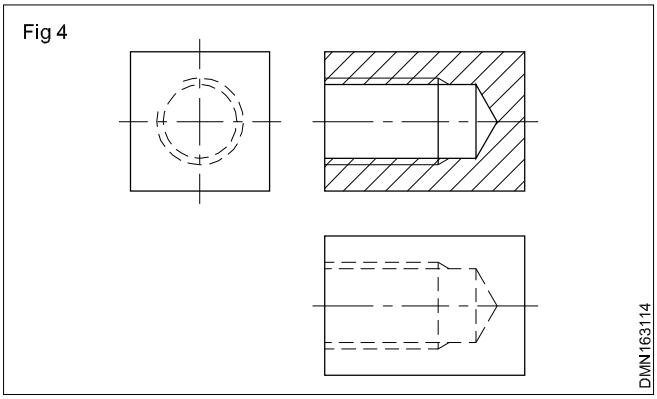
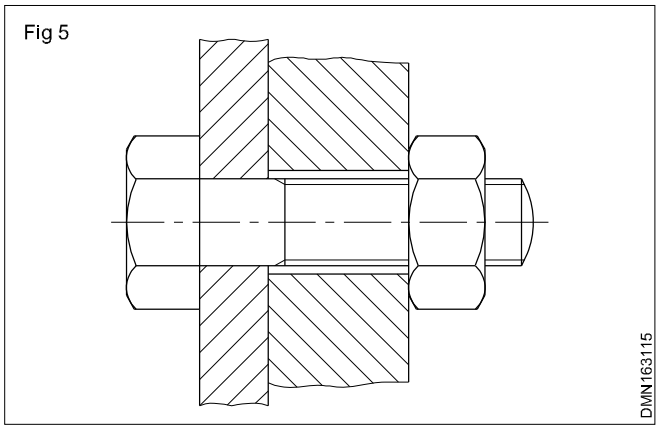
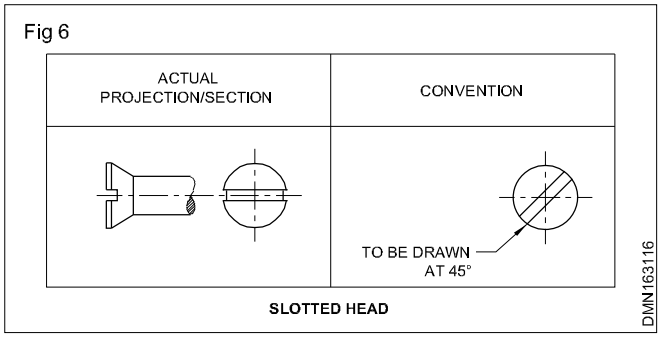


Fig 5



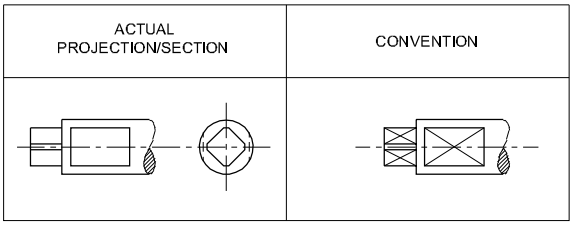
Screwdriver slot: Screwdriver slot on the face of the screw head is always drawn at 45° to the centre line. (Fig 6)

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)

Fig 7

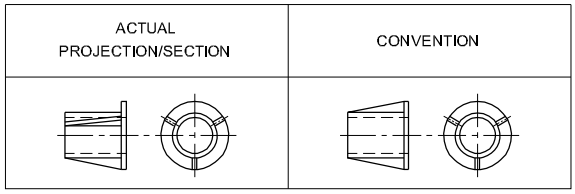


SQUARE END AND FLAT

DMN163117

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 rotated and brought to the centre line and drawn. This gives a symmetrical shape. (Fig 8)

Fig 8

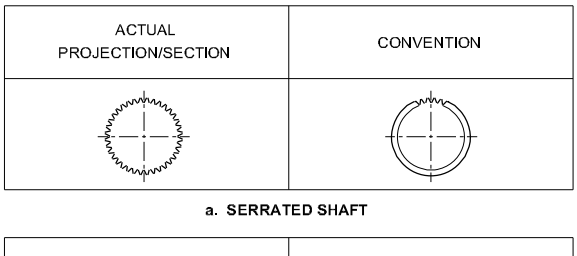


RADIAL RIBS

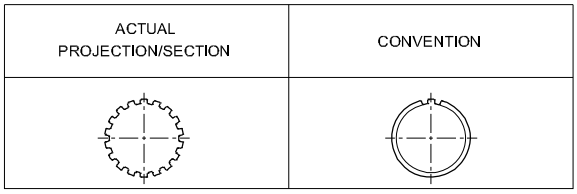
DMN163118

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



a. SERRATED SHAFT

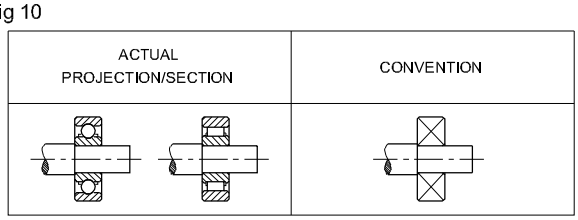


b. SPILINED SHAFT

DMN163119

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

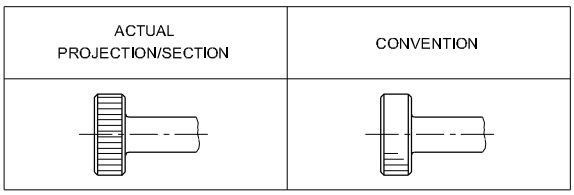


BEARINGS

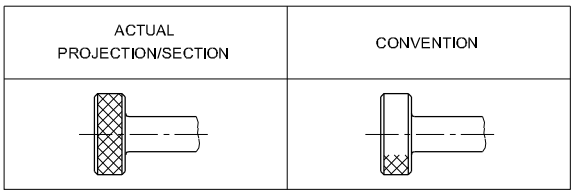
DMN16311A

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



a. STRAIGHT KNURLING

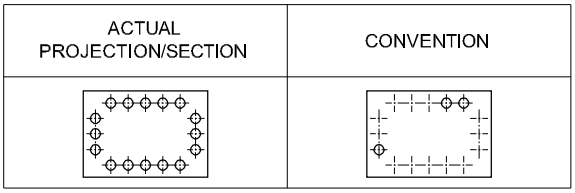


b. DIAMOND KNURLING

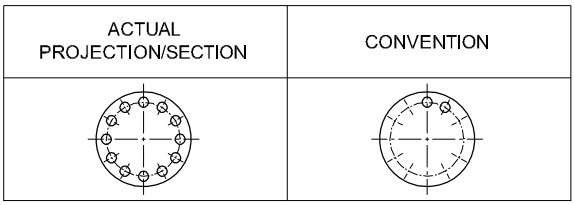
DMN16311B

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



a. HOLES ON A LINEAR PITCH



b. HOLES ON CIRCULAR PITCH

DMN16311C

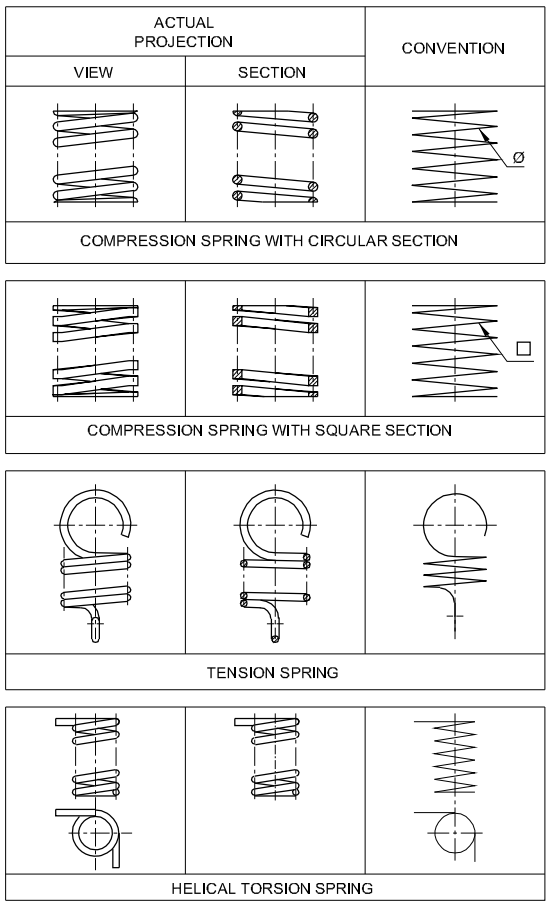
Springs

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.

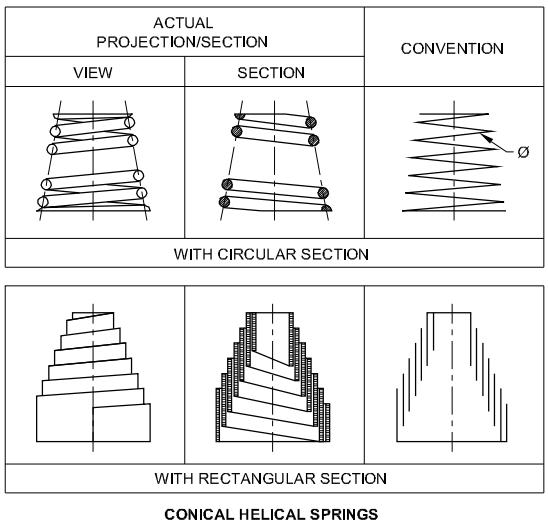
Fig 13



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)

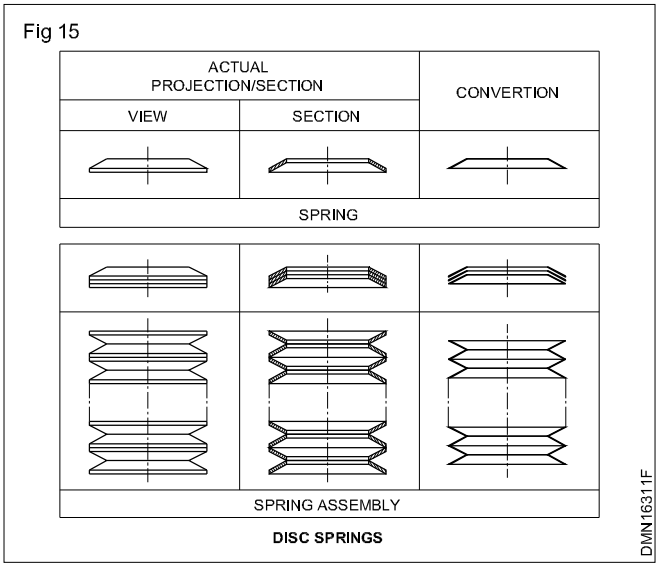
Fig 14



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)

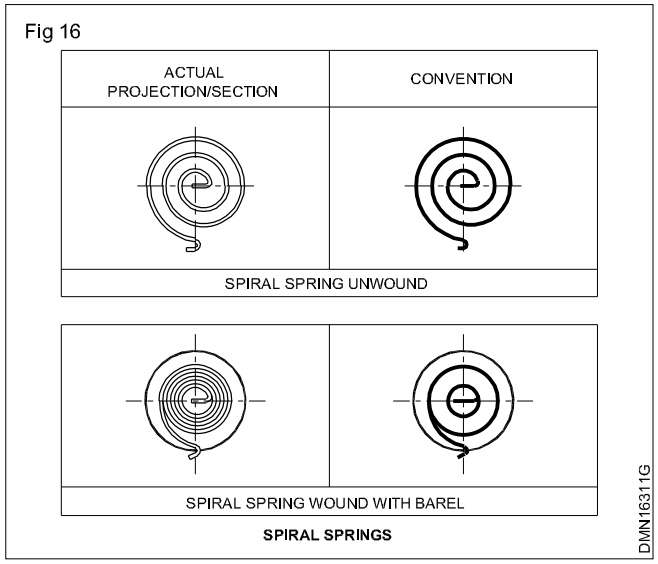
Fig 15



DISC SPRINGS

Spiral springs: These are shown in unwound condition as a spiral with a number of convulsions. The inner end is shown as a straight line and the outer one is shown with a sort of hook. (Fig 16)

Fig 16



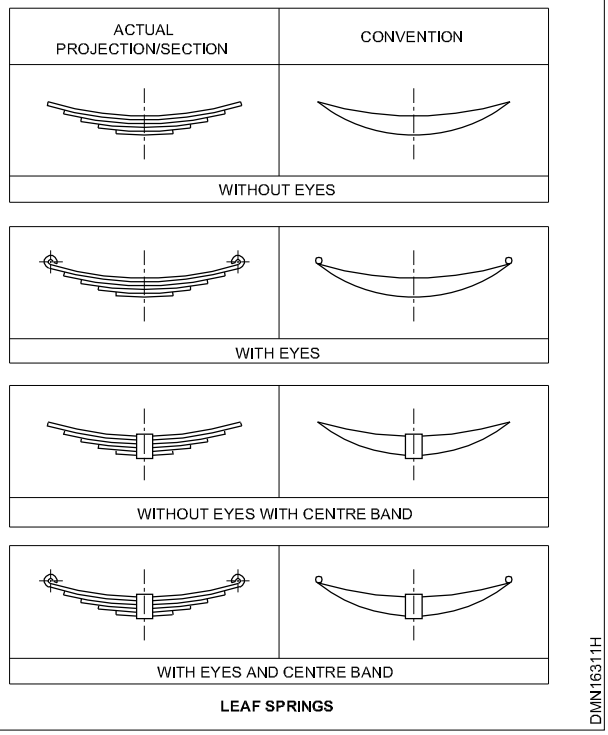
SPIRAL SPRINGS

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

Methods of projection: Two methods of projection are in practice.

– Symbol for 1st angle projection. (Fig 18)
– Symbol for 3rd angle projection. (Fig 19)

Fig 18

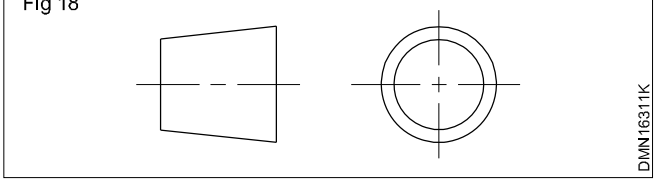
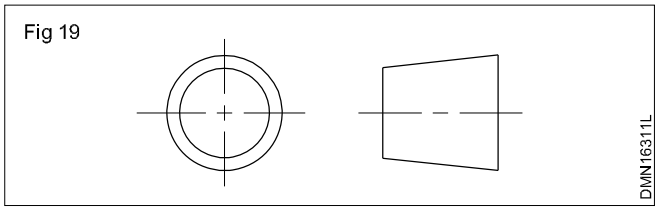


Fig 19



Conventional representation of materials using hatching is shown in Table 1. Conventional representation of gear and gear assemblies are shown in Table 2.

Convention/Symbols concerning other things like conventions used a sectioning etc are dealt during the corresponding exercises.

Material: Convensional representation of materials using hatching is shown in Table 1. Conventional representation of gear assemblies are shown in Table 2.

Conventions/symbols concerning other things like convention used on sectioning etc are dealt during the corresponding exercise.

Table 1

Conversional representation of materials using hatching

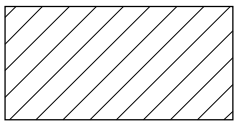
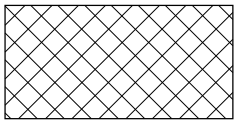
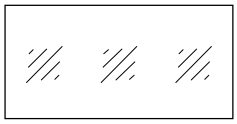
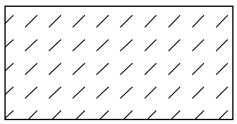
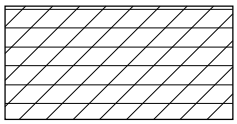
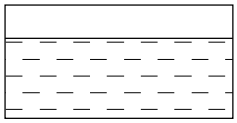
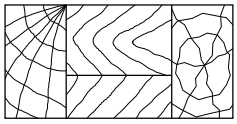
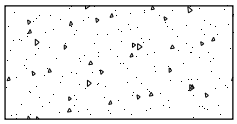
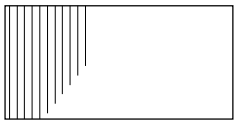
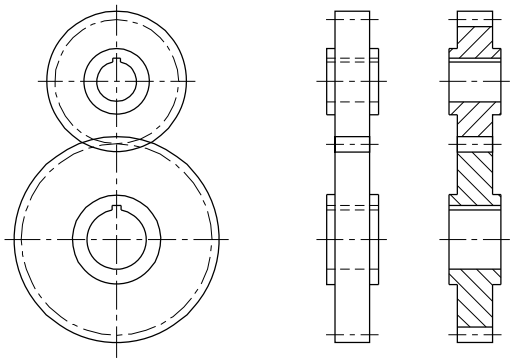
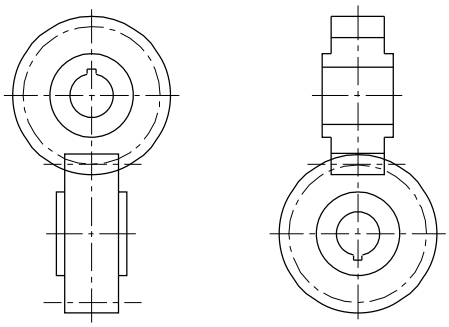
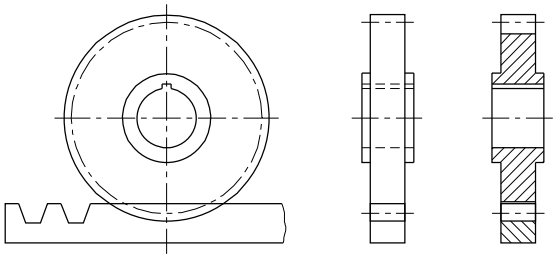
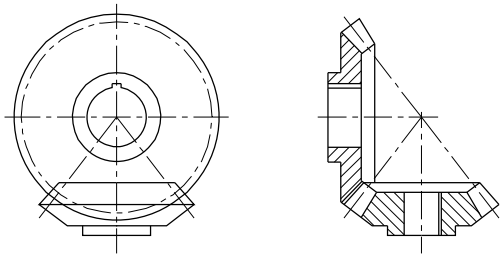
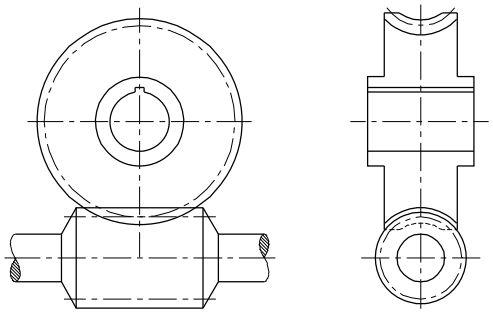
Type	Convention	Material
Metals		Steel, cast iron, copper and its alloys, aluminium and its alloys etc.
		Lead, zinc, tin, white-metal etc.
Glass		Glass
Packing & insulating material		Porcelain, stoneware, marble etc.
		Asbestos, fibre, felt, synthetic resin products, paper, cork, linoleum, rubber leather, wax, insulating and filling materials.
Liquids		Water, oil, petrol kerosene etc.
Wood		Wood, plywood etc.
Concrete		–
Stacked lamination		–

Table 2

Representation of gear assemblies

Title	Conventional representation
Spur/helical gears	Fig 21 
Screw gears	
Rack and pinion	
Bevel gears (Assembly)	
Worm and worm wheel	

Development of surfaces of solids

Objectives: At the end of this lesson you shall be able to
- **state the need for the development of surfaces of solids**
- **state the types of surfaces**
- **state the methods of development of surfaces of solids.**

Development of surfaces - Introduction

In our day-to-day life, we come across a number of objects. eg. Tins of round, square or rectangular shapes, funnels, hoppers, ducts, chimneys, trunk boxes, machine guards, medicine cartons etc are made of sheets of metals and cardboards.

The process of manufacturing these objects involves cutting the flat sheet to the required size and then "folding it" to the final shape. The term development refers to the size and shape of the unfolded sheet or sometimes called as blanks. Development also implies the geometrical process of finding the size and shape of unfolded sheet. Hence, the development of surface plays very important role, such that enabling a machine to cut proper size of the sheet with reference to the development and to fold at proper places to obtain the required shape of the objects, say boilers, boxes, buckets, chimneys, hoppers, ducts etc.

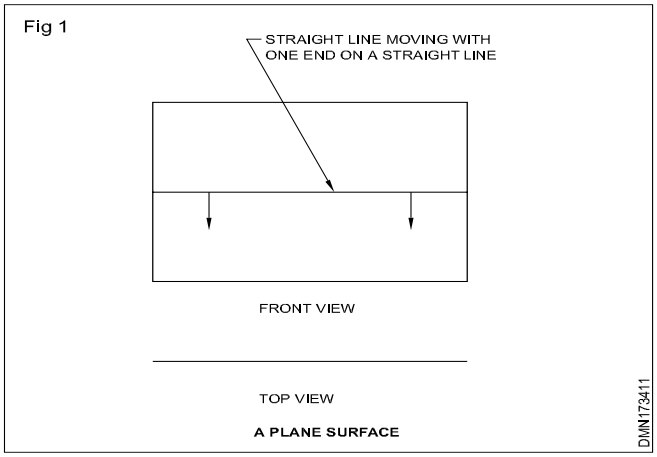
The development of surfaces can be defined as the unrolling or unfolding of all the surfaces of the objects on a plane.

Types of surfaces

All objects are bounded by geometric surfaces, and so developments are made by the application of basic graphic and geometric principles in co-ordination with mathematics. As different shapes has to be joined together in many cases, the principle of intersections of solids are closely related to developments of surfaces.

A geometric surface is formed by the motion of a straight line or curved line, such surface formed by a straight line is identified (Fig 1) as ruled surface. It may be plane, single curved or warped surface. It is ruled surface generated by a straight line moving with one point along a straight line and another point is parallel with the straight line.

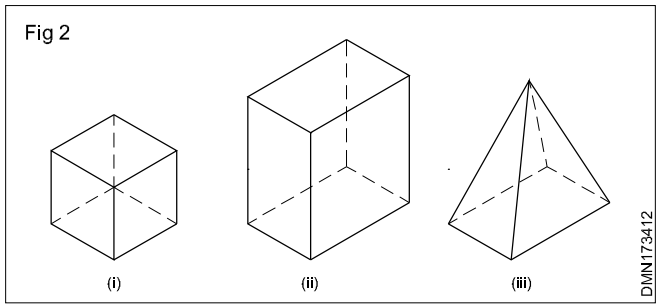
Fig 1



The surfaces may be classified as follows:

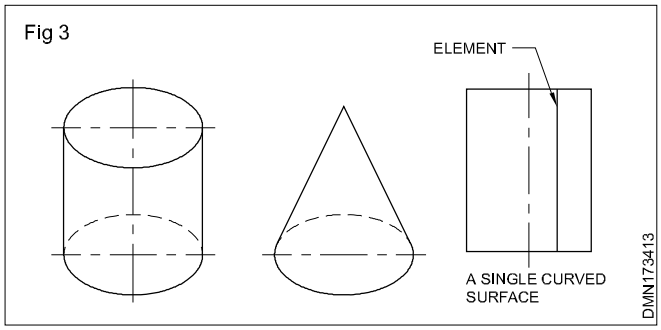
– Solids bounded by plane surfaces. Eg. cube, prism, pyramids etc. (Fig 2)

Fig 2



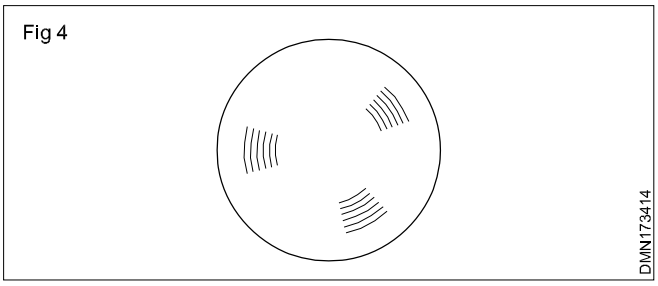
– Solids bounded by single curved surfaces. It can be unrolled to a plane. Eg. cylinder, cone etc. (Fig 3)

Fig 3



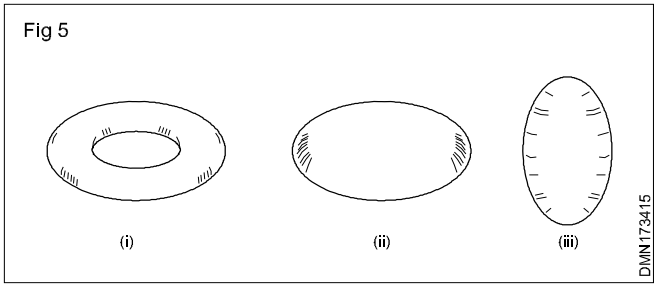
– Solids bounded by double curved surfaces. It is formed by revolving a curve about a straightline. Eg. sphere, paraboloid etc. (Fig 4)

Fig 4



– Solid bounded by warped surfaces. No two adjacent positions of generatix lie in the same plane surface, hyperbolid etc. (Fig 5)

Fig 5



The line that generating the surface is called generatix. Any position of the generatix on a surface is called an element.

Methods of development

Parallel line method (Fig 6i)**:** This is method used for such of those object having parallel elements i.e developing prisms and single curved surfaces like cylinders, in which all the edges/generators of lateral surfaces are parallel to each other.

Radial line development (Fig 6ii)**:** It is used for developing the surfaces of pyramids and also for single curved surfaces like cones, having its apex as centre and the slant edges or generators are taken as radius for drawing its development. Radial line development has the fold lines, coming from a point which is known as apex.

Triangulation method (Fig 6iii)**:** This method is used for developing transition pieces. The word triangulation defines of developing surfaces by breaking into series of triangles. In triangulation method objects having combination of curved and plane surfaces.

Wraped surfaces cannot be laid out flat on a plane, hence they can be developed approximately using a series of triangle.

Parallel line method (Fig 7)

Steps of development of a right prism.

Fig 6

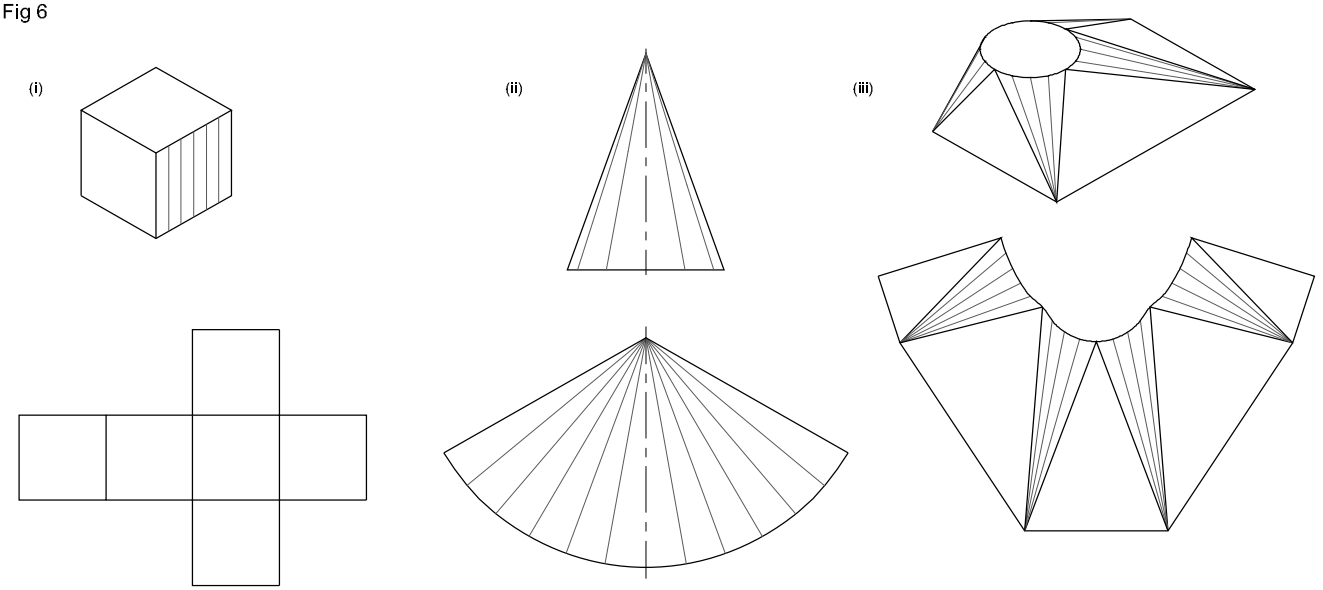
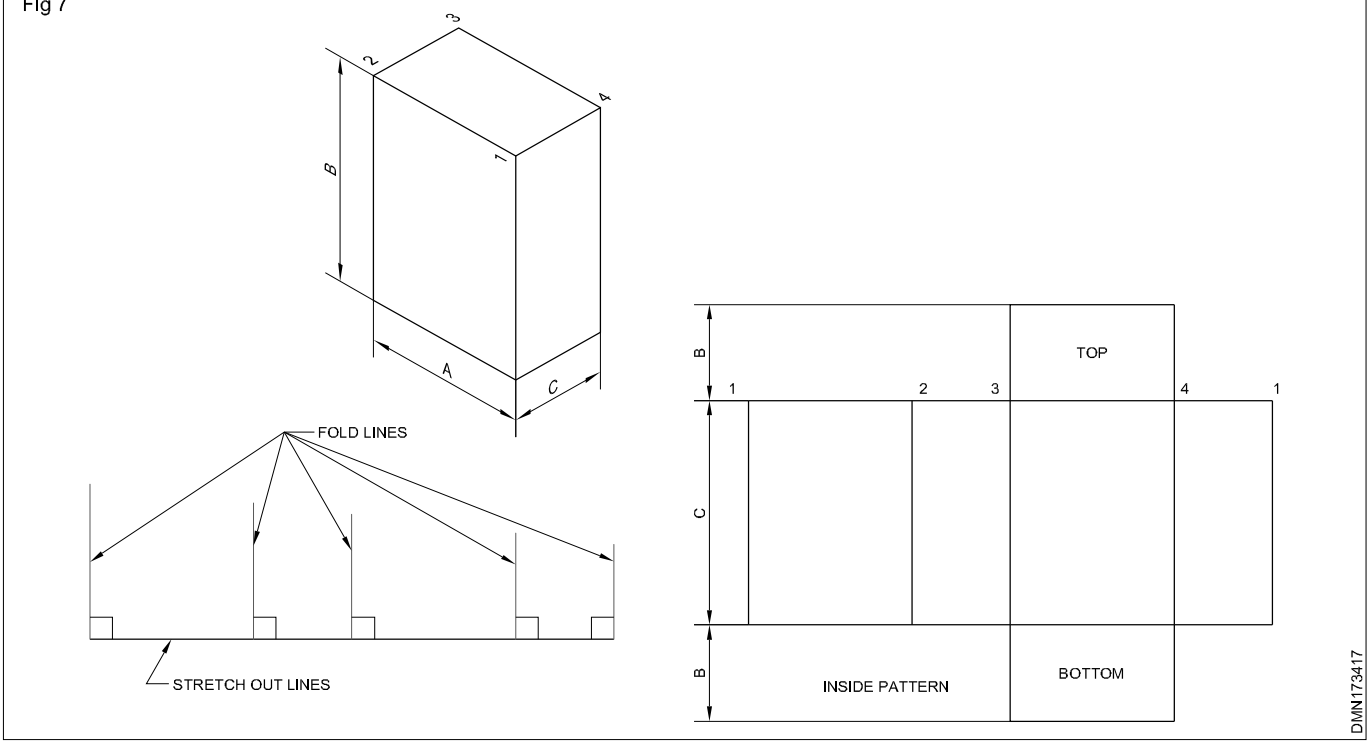


Fig 7



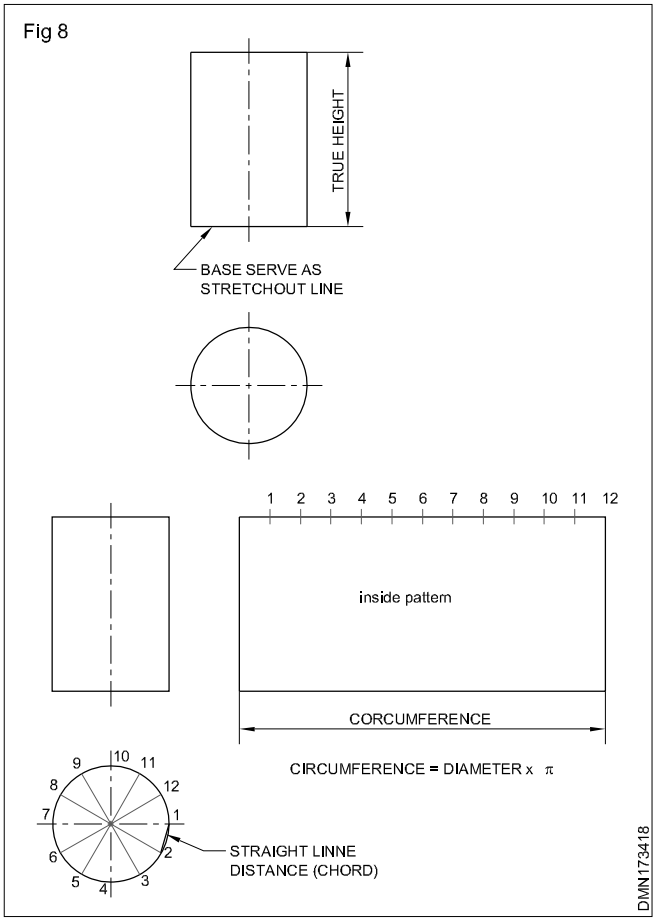
– Draw the stretch out line.
– Length of stretch outline must be equals to the perimeter of the base (i.e the sum of (A + C + A + C) width of the four sides of the prism.
– Mark the distance on the stretch out line.
– Draw the fold lines perpendicular to the stretch outline at each mark equals to the height.
– Draw the top and bottom surface as shown in Fig 7 and complete the development.

The fold lines may be on the developing of the lateral surface, the opening and closing edges should be the same.

Development of a right cylinder (Parallel line method)

– Draw the plan and front view of the cylinder
– Divide the circle into a number of equal parts as shown in Fig 8.
– Draw the stretched line equal to p x d (circumference of the circle) or Layout the straight line distances between each point (chord) in the circle.
– Draw the edges to complete the view.

Fig 8

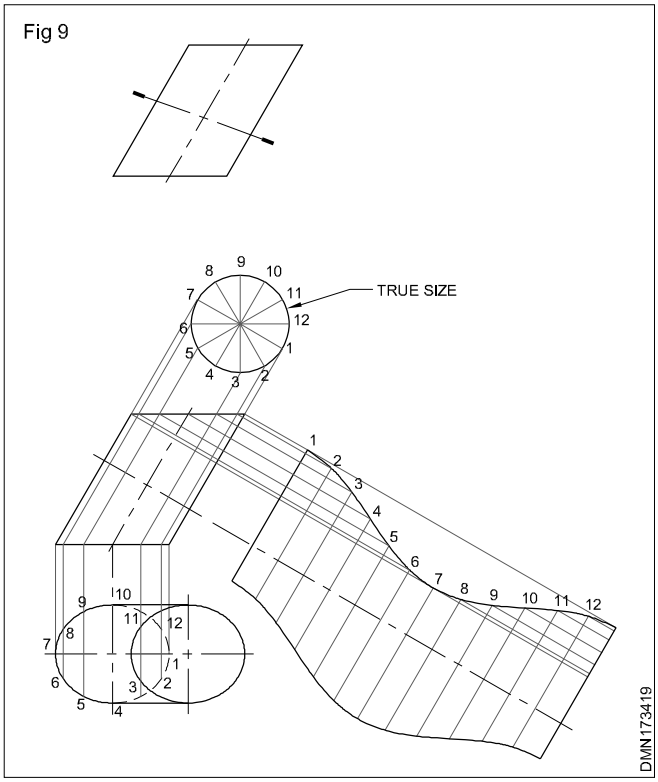


Drawing a development of a truncated right cylinder: A truncated right cylinder is cut by a CP (cutting plane) other than 90° angle with its axis. The development of the lateral surface will be a curved line.

Following are the steps for drawing the development of the surface of the truncated right cylinder.

– Draw the top view and front view
– Draw the cutting plane (CP) perpendicular to the axis of the cylinder in the front view.
– Draw an auxiliary view showing the true size of the cylinder (circle) as shown in the figure 9.

Fig 9



Divide the circle into number of equal parts.

– Project these points to the front view, locating the elements on the cylinder.
– Draw the stretch out line perpendicular to axis of the cylinder.
– Mark each element along the stretchout line by transfering the straight line distances between the points of the auxiliary view.
– Draw the true length of the each element to the development.
– Join all the points by a smooth curve to form the required development.

Radial line method: The geometric forms developed by radial line developments includes pyramids and cones.

Development of a right rectangular pyramid (Fig 10)

Pyramids are composed of several triangles, surfaces and one base. So its development will consists of as many triangles as the sides of the base.

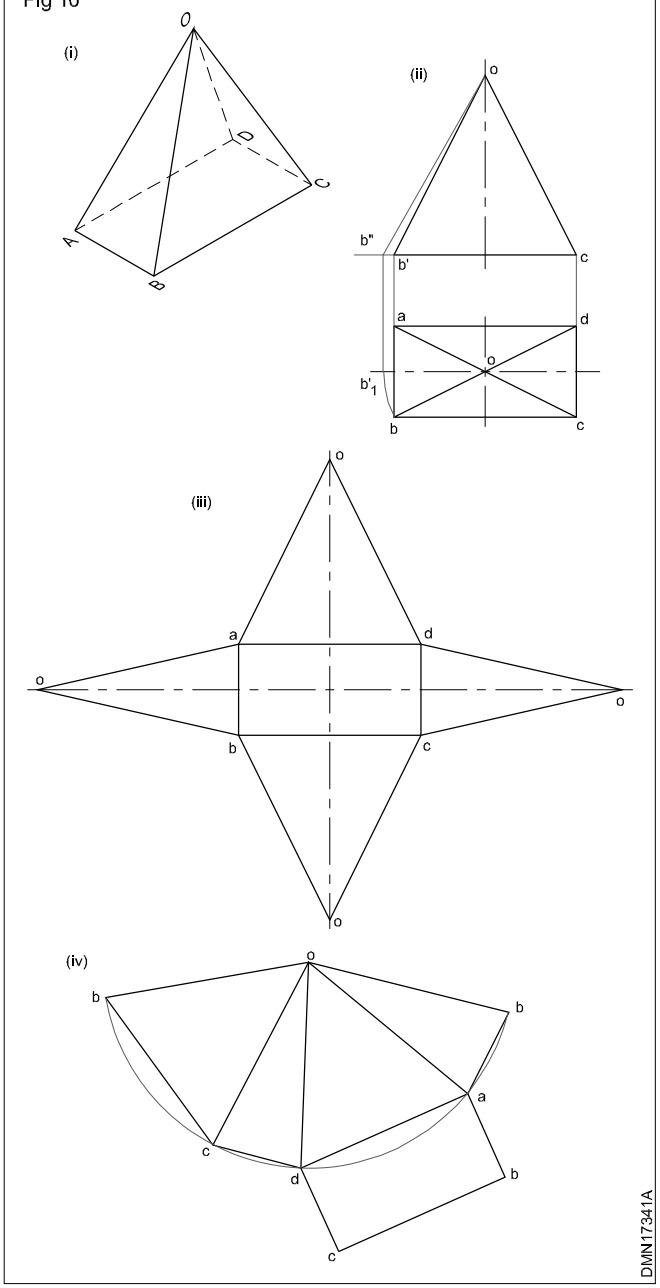
The method of developing a rectangular pyramid is shown in figures. The triangle in the figure are isosceles triangles whose equal sides have length equal to the length of edge OB of pyramid.

Since the length OB is not directly available, it has to be determined by geometrically.

To determine the true length (OB) proceed as follows:

– Draw the plan and elevation of the pyramid and mark the points as shown.
– Set off ob = ob' by drawing an arc with `0' as centre.
– Project b_1 to the elevation and locate the point b'_1.
– Now $o'b'_1$ is the actual length of the edge in plan of the pyramid.
– With `0' as centre and true length $o'b'_1$ as radius draw an arc.
– Set off the sides of the base on the arc as shown.
– Join all the points to O. Add the base rectangle to any one of the side and complete the development. (Fig 10)

Fig 10

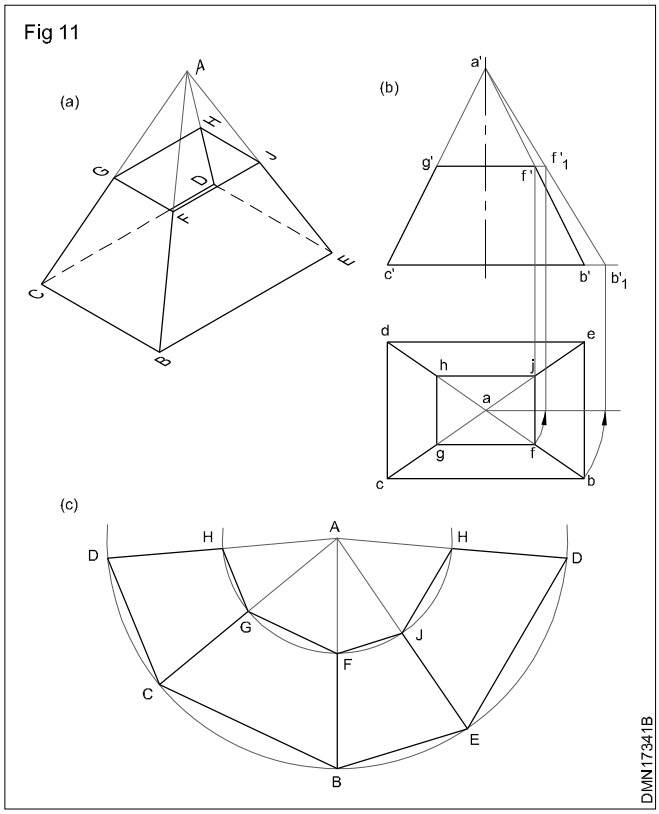


Drawing development of a frustum of a pyramid (Fig 11)

– Draw the plan and front views. Obtain the true length of the line AB between the two faces by drawing arc.
– Find the true length of AF as shown in Figure 6.
– Mark the vertex A of the pyramid.
– With A as centre true length ab as radius describe an arc.
– Set off the sides of the base of the pyramid on the arc.
– This confirms the fold lines of the pyramid converging to the point.
– With A as centre, true length AF as radius, draw an arc intersecting the fold lines in the corner points of the faces.

Join the points to complete the development.

Fig 11



Drawing development of a truncated right cone

A truncated right cone has top cut on an angle other than 90° to its axis.

– Draw the top view (plan) and front view of the cone.
– Divide the base in the plan (circl) into number of equal parts as shown in Fig 12 and mark them.
– Project the points to the base of front view and then join them to the vertex.
– With vertex as centre and slope length has radius draw an arc where the curved length of arc is equals to the circumference of the base.
– This can be obtained by transfering the arc length of each divisions of the base circle or by marking the subtstanded angle. (q)

$$\theta = \frac{360 \text{ x radius of base circle}}{\text{slope length}}$$

– Divide the arc into same number of equal parts of the circle.

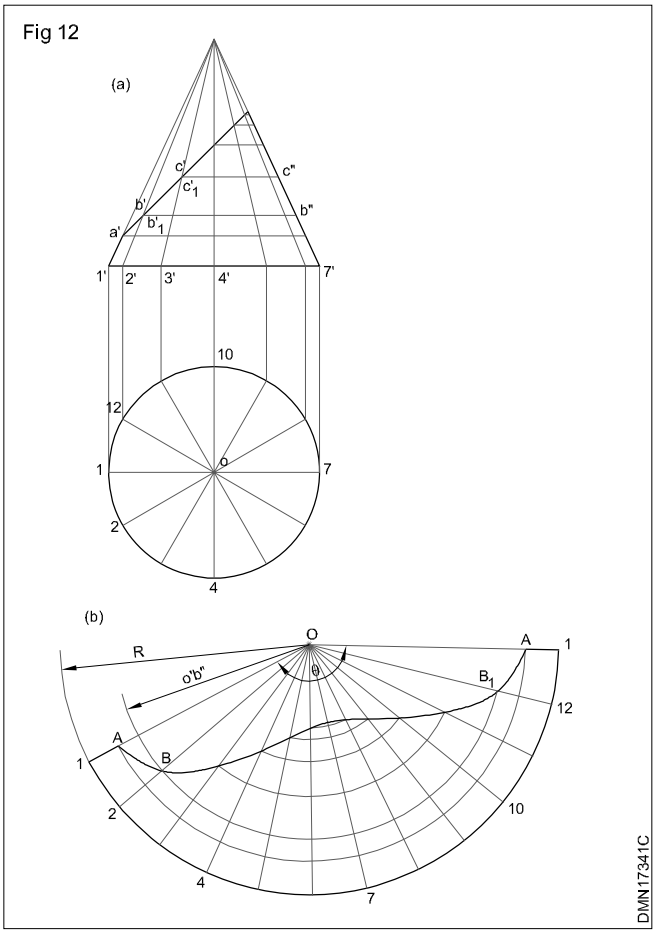
– Join all the points to the vertex.

– Then from the vertex

– Locate the points forming the top plane transfering from the front view, the true lnegths.

– Join all the points by a smooth curve.

Fig 12



For example generator 0'2' and 0'12' in the front view are cut at a point b' & b" which coincide with each other. The true length of o'b' may be obtained by drawing a line through b' parallel to base and cutting 0'7' at b". Now o'b" is the true length of o'b'.

In similar method the other true lengths can be obtained.

Development of an oblique cone by radial line method (Fig 13)

– Draw the front view and top view of the cone.

– Divide the circle into any number of equal parts.

– Project these points to front view and then joint them to vertex.

– Find the true length of each element by revolution method.

– Mark the vertex and draw the one true length element.

– From its end draw an arc, radius equal to the straight line distance between elements.

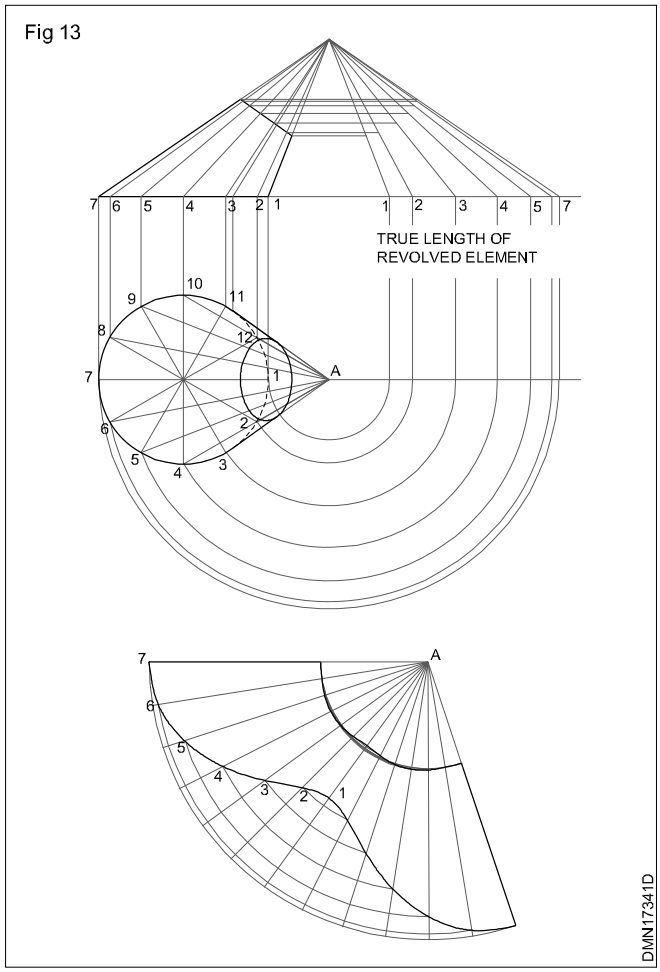
– Draw the next element, the point at which it crosses the arc is a point on the development.

– Proceed the same method till all elements are located.

– From the vertex, mark the points forming the top plane.

– Join the points by a smooth cone for the required development.

Fig 13



Triangulation method

Drawing a development for a rectangular to a circular transition piece. (Fig 14)

– Draw top view and front view.

– Divide the circle into a number of equal parts.

– Join these points to the corners of the rectangular base.

– Draw vertical projectors from these points to the front view.

– Find the true length of each element by revolution.

– As the transition piece is symmetrical, each corner will have the same true length line.

The triangles are drawn to true size by first drawing one edge.

– Edge 1-A is drawn to true length.

– The true length of edge 2-A is as radius draw an arc.

The straight line distance between 1-2 used as radius to draw an arc crossing the arc 2-A.

This forms the triangle 1-A-2

– Draw the development from a point where a seam could be made.

– In this 1-E is taken as starting point.

– Form the each triangle as explained and complete the development.

Warped surface: A warped surface cannot be accurately developed on flat sheet. The object shown in Fig 14 cannot be developed accurately and can be developed approximately by triangularion method.

– Draw the development for a warped surface of a object shown in Fig 15.

– Draw the plan and front views

– Find the true size of the top and bottom openings.

– Divide each top and bottom openings into the same number of equal parts.

– Connect each division in the top with the corresponding point on the bottom such that forming triangles.

– The lines joining the points 1-A are said to be elements and line 1-B is said to be diagonal.

Find the true length of sides of each triangle.

– The true length can be formed by drawing a true length diagram as shown in Fig 15.

– Locate one of the points on the base as the starting of diagram. (Point 1)

– In the top view, measure the horizontal distance from that base point to a point on the top to which it connects. Part `B' is an example.

– Locate point `B' on the diagram and line B is true length.

– Repeat this for each side of each triangle. It is better to draw true length of elements in separate diagram and true length of the diagonal separate diagrams.

– From one end, draw an arc having radius equal to true length of the next side of the triangle.

– Draw the other end by drawing an arc having a radius equal to the straight line distance between the other ends of the triangle.

It is to be measured on a true size view and it forms one triangle.

Continue the same procedure until all triangles are located.

Join the points with an irregular curve, to form the development.

Fig 15 shows the elevation and plan of a oblique cone with elliptical base. Draw the development of the lateral surface of the cone shown as positioned in the figure.

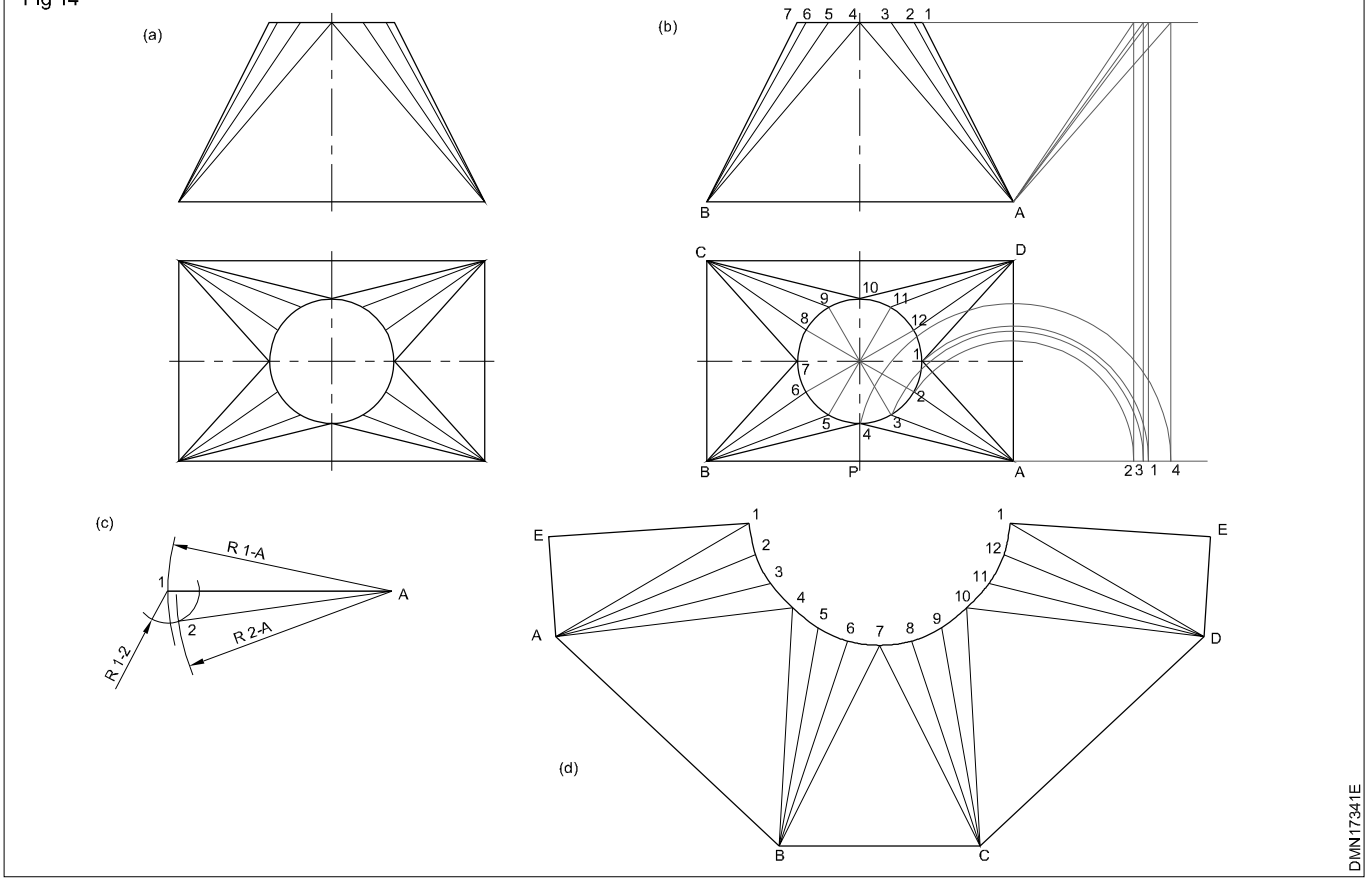
Procedure (Fig 16)

– Draw the elevation of the oblique elliptical cone with major axis (6) as base and vertical height 80 as in Fig 16.

– On the base draw half plan of the cone as shown in Fig 16.

– Divide the circumference of the base into 12 equal parts, whereas it has been shown 6 equal parts.

Fig 14



– From the point `T' appex of the cone draw a perpendicular to the base meeting at `f'.

– Now with `f' as centre, f1 as radius draw an arc to meet the base at 1'.

– Similarly with F2, F3....F5 as radius and `f' as centre, draw arcs and obtain the points 2'3'.....and 5'.

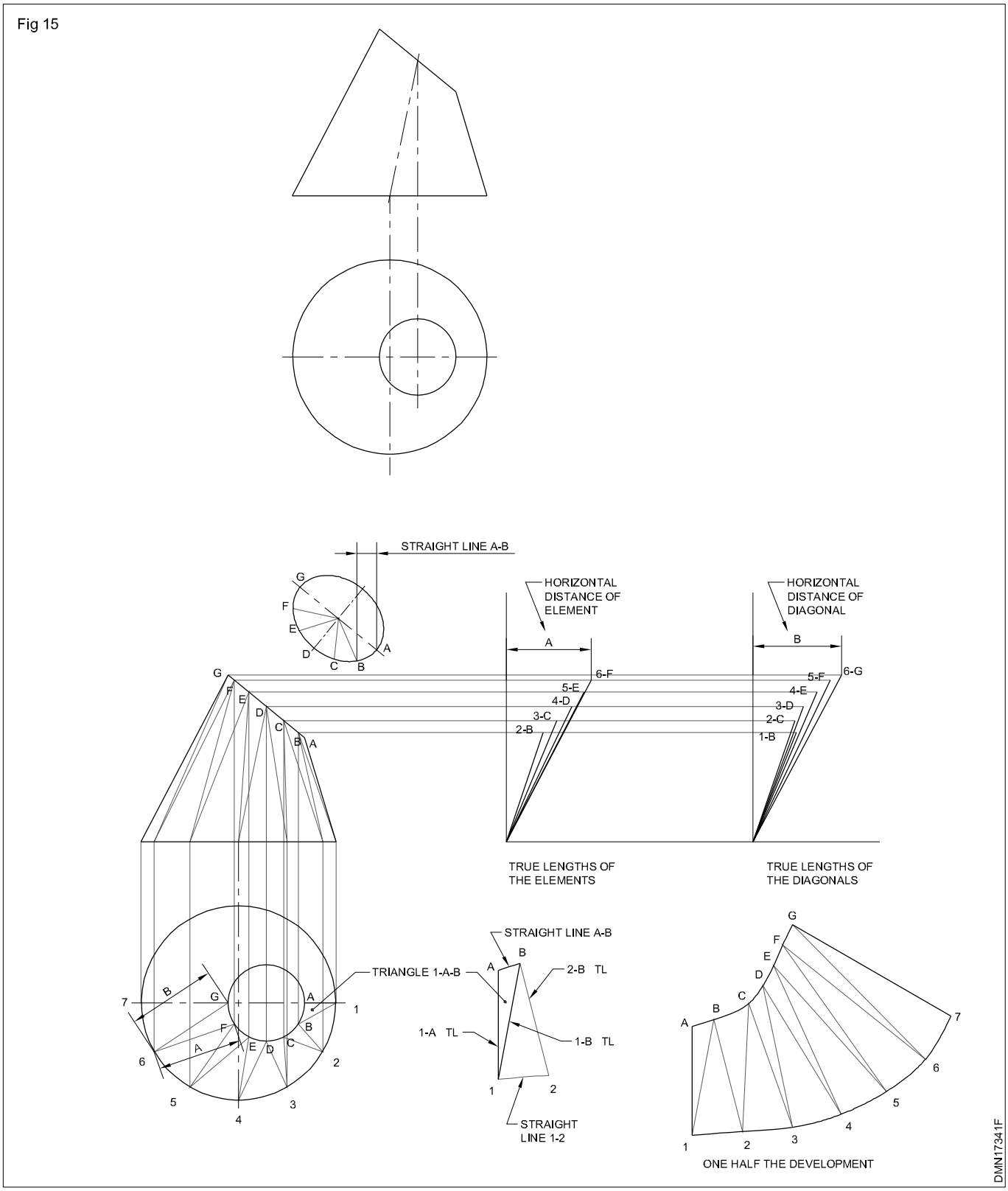
– `T' as centre and T0 as radius swing arc and set off TC and Td as shown in Fig 16.

– In the same procedure swing arcs with `T' as centre and T1', T2', T3', T4', T5' and T6' as radius.

– Set off the points on the arcs with the true length T1', T2'... etcs.

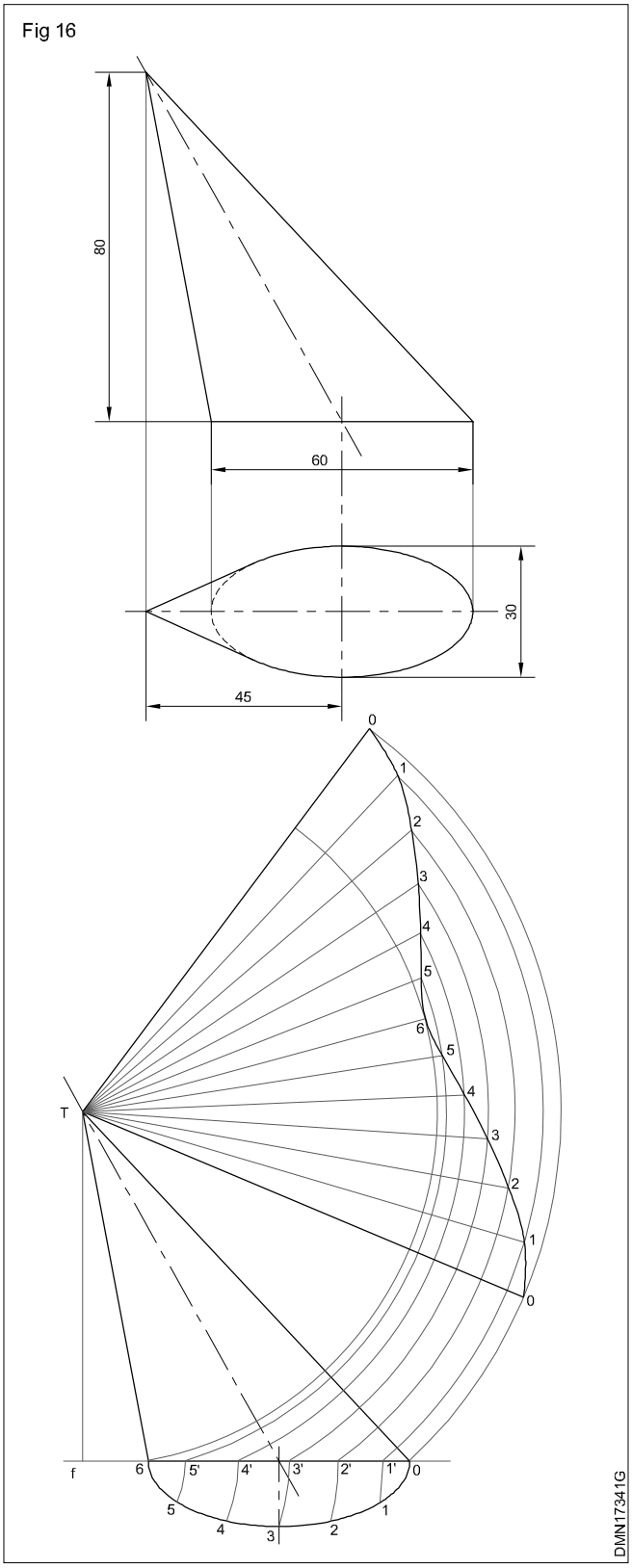
– Join all these points C,1,2,3.... by a smooth curve to obtain the required lateral surface development of the elliptical base oblique cone.

Fig 15



Additional exercise for practice

– Draw the development of the frustum of a hexagonal



pyramid of side of base 40 at the bottom, 15 at the top and height of the frustum being 50.

– A pentagonal pyramid of base 35 side and height 80 stands with its base on XY such that one of the base edges is parallel to the V.P. It is cut by section plane perpendicular to VP and inclined at 30° to the H.P bisecting its axis. Draw the development of the lateral surface of the remaining solid.

– A hexagonal pyramid, of base 40 side and axis 75 long, stands on its base on the ground with one of its base edges perpendicular to the V.P. A hole of 35 diameter is drilled through the solid. The axis of the pyramid at a point 15 below the apex. Draw the development of the lateral surface of the solid.

– Draw the development of a cylinder of 50 diameter and 75 height containing a square hole of 25 sides. The sides of the hole are equally inclined to the base and axis of the hole bisects the axis of the cylinder.

– A semi-circular plate of 120 diameter, a largest hole is made. The plate is folded to form a cone. Draw the two views of the cone showing the line of the hole.

– Draw the development of the lateral surface of a transition piece connecting 40 diameter pipe with a square pipe of 80 x 60 the length of the piece being 60.

– Draw the development of an oblique cylinder the base of which are parallel and 80 apart. The diameter of the base 40 and is inclined at 60° to the XY (base).

– An oblique cylinder of base diameter 50, has an axis 70 long and inclined at 45° to the base. It stands on its base on XY and axis parallel to the V.P. It is cut by a vertical section plane which is perpendicular to V.P and bisecting the axis. Draw the development of the lateral surface of the remaining solid.

– An oblique cone of base 60 diameter and axis 70 rest on its base on XY. The axis of cone is inclined at 60° to XY. It is cut by a horizontal section plane passing through its axis at a distance of 50 from the base. Draw the development of the lateral surface of the remaining part of solid.

– An oblique cone of base 60 diameter and axis 70 rest on its base on XY. The axis of cone is inclined at 60° to XY. It is cut by a horizontal section plane passing through its axis at a distance of 50 from the base. Draw the development of the lateral surface of the remaining part of solid.

– Draw the development of an oblique hexagonal pyramid of base 30 side and axis 100 long. Its axis is inclined at 45° to the base.

– Develop the complete surface of the lateral surface of a cube of 40 side.

– A Pentagonal prism of side of base 30 and axis 60 long rest with its base on XY and an edge of the base is inclined at 45° to V.P. It is cut by a plane perpendicular to VP, inclined at 30° to HP and passing through a point on the axis at a distances of 40 mm from the base. Develop the lateral surface of truncated prism.

– A hexagonal prism, side of base 30 and height 60 rest with its base on H.P and one of its rectangular faces is parallel to V.P. A circular

hole of 40 diameter is drilled through the prism such that the axis of the hole bisects the axis of the prism at right angles and is perpendicular to V.P. Draw the development of the lateral surface of the prism with hole.

– A vertical cylinder of 40 diameter and height 60 rests with its base on XY. A square hole of 20 side is made through it, such that the axis of the hole is parallel to HP and perpendicular to V.P. The faces of the square hole are equally inclined to H.P and its axis of the cylinder. Draw the development of the lateral surface of the solid.

– a two piece elbow consists of two cylindrical pipes, each of diameter 80 joint together such that their axis forming an angle of 90°. Draw the development of the lateral surface of the elbow.

– A triangular pyramid, side of base 30 mm and height 60 mm, rest with its base on XY. It cut by a plane perpendicular to X'Y' (VP), inclined at 40° to XY and passing through a point on the axis at 25 from base. Draw the development of the lateral surface of the truncated pyramid.

– The inside of a hopper of a rice mill is to be lined with a thin tin sheet. The top and bottom of hopper are squares of each side equal to 500 and 400 respectively and the height of the hopper is 300. Draw the shape to which the tin sheet is to be cut as to fit in the hopper. (Select a convenient side)

– The inside of a hopper of a rice mill is to be lined with their tin sheet. The bottom and top of the hopper are circles of 40 and 60 diameters respectively. The height of the hopper is 50. Draw the inside pattern development of the sheet to which the sheet is to be cut to fit in the hopper.

– A cone, base 60 diameter on its axis 70 long rest with the base on XY. A section plane perpendicular to X'Y' and inclined at 45° to XY bisect the axis of the cone. Draw the development of the lateral surface of the remaining part of the cone.

– Draw the development of the lateral surface of the cone of 50 diameter and height 65. It is cut by a cutting plane perpendicular to both XY and X'Y' at a distance of 15 from its axis.

– A right circular cone of base 60 diameter and 70 height stands with its base on HP. A rod of 30 diameter is pierced through the cone. The axis of the rod intersects the axis of cone at right angles at a height of 25 above the base of cone. Draw the development of the cone showing the hole pierced by the rod.

– A bucket made of G.I.sheet has its top 30 diameter and bottom 20 diameter with a circular ring 10 cm wide at the bottom. The total height of the bucket is 40. Develop the complete surface of the bucket.

– Draw the development of the half-point measure shown in figure showing the body, bottom, lip and handle separately.

– An oblique cylinder stands on H.P and its top and bottom circular faces are parallel and of 70 diameter. The axis is 100 long and is inclined at an angle of 45° to the base. Draw the development of the lateral surface of the oblique cylinder.

– An oblique cone, base 50 diameter and height 60, stands with its base on XY. The front and top views are inclined at 45° and 50° respectively to the XY line. Develop the lateral surface of the oblique cone.

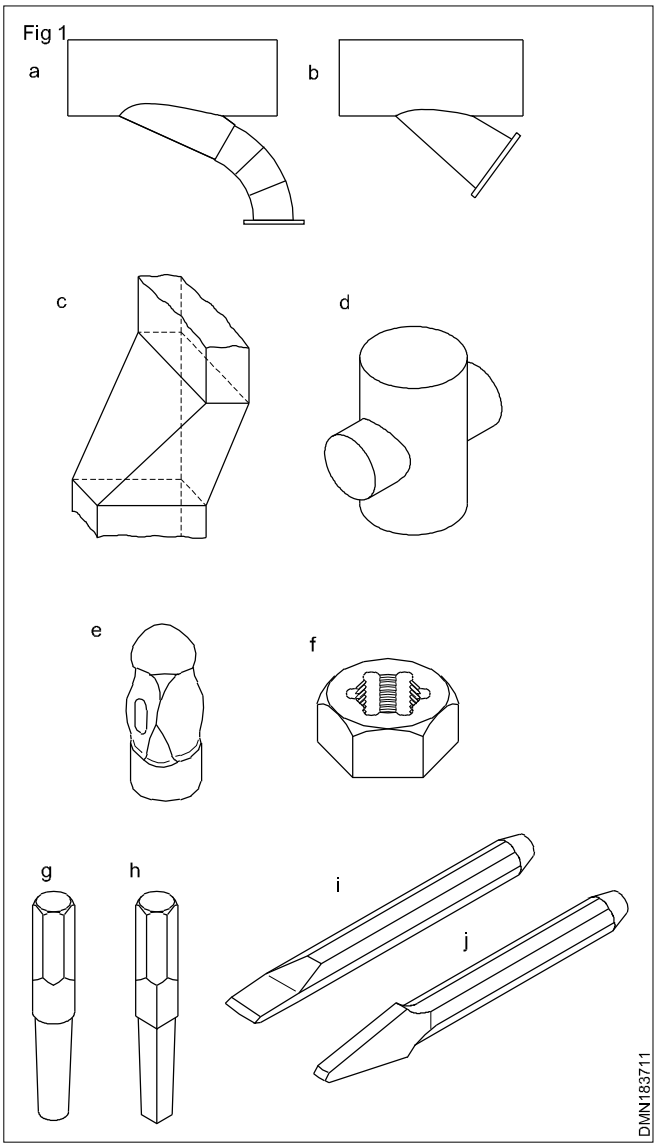
– A circus man rides a motor cycle inside a globe of 6m diameter. Draw the development of the surface of the globe.

Intersection

Objectives: At the end of this lesson you shall be able to
- **state the meaning of intersection**
- **state the importance of drawing lines of intersection**
- **explain the methods of drawing lines of intersection**
- **list the critical points to be noted while drawing lines of intersection.**

Intersection: In the context of engineering drawing, the term intersection refers to the common lines that are formed when two surfaces meet. In fact every edge of a solid is a line of intersection. We are more convinced with the lines of intersection formed when surfaces of two solid meet. The highlighted lines in Fig 1 shows the few examples of lines of intersection.

Fig 1

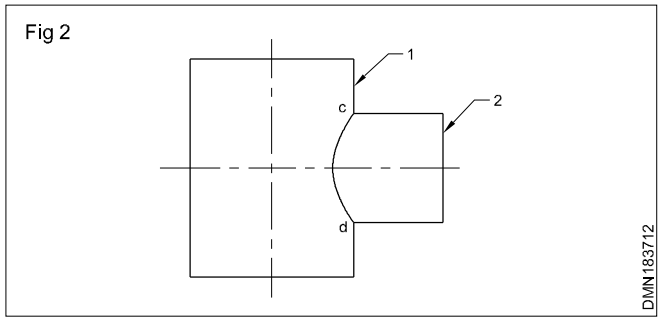


Intersection lines or just intersections are of great importance to both for making drawings and in fabrication work.

When drawing the views of intersecting solids lines of intersection will have to be drawn in order to complete the views. For example Fig 2 shows a solid when two cylinders meet at right angles. Without the line of intersection AB, the view is incomplete. To draw the intersection lines such as AB in its correct form principle of projections have to be followed and this will involve extensive geometrical construction.

In fabrication work, especially in sheet metal fabrication accurate intersection lines are a must for drawing development.

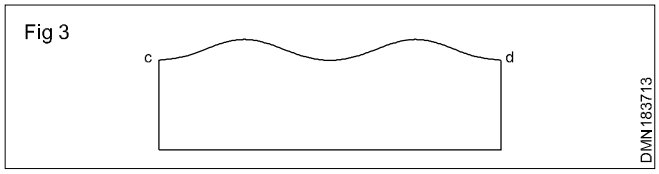
Fig 2



For example, the development of the part 2 in Fig 2 is shown in Fig 3. The accuracy of the fabricated cylinder is much dependent on the accuracy of the curve CD. To plot the line CD, intersection line (Fig 2) has to be drawn accurately.

Depending on the nature of the meeting surfaces, intersection lines may be straight lines or curves. When both the mating surfaces are flat (plain) intersection will be

Fig 3

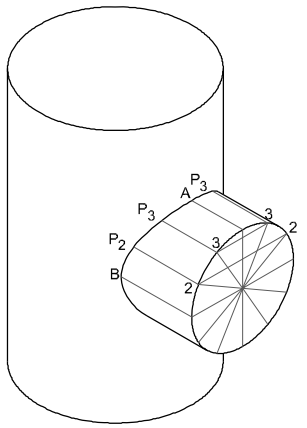


straight lines (Fig 1c). If one or both the mating surfaces are curved, the intersection lines are curved. (Fig 1a,b & c)

Methods of drawing intersection lines: In general intersection lines/curves are drawn by using the method of projection. With a clear understanding of orthographic projection one will feel lost in attempting to draw intersecting curves.

By going through the construction in figure, one can appreciate the principle adopted in drawing the intersection curves. (Fig 1 is a simple example). Our aim here is to draw the curve **cd** (Fig 2), since **cd** is a curve we have to plot it by finding intermediate points such as P_1,P_2,P_3. Actually P_1,P_2,P_3 etc are the projection points lie on the intersection. (Ref. Fig 4)

Fig 4

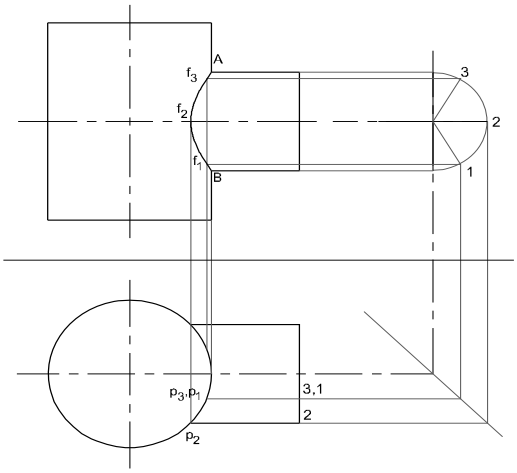


To plot the points required for drawing the intersection curve we can use either the line method or cutting plane method.

Line method (Fig 5)**:** Mark the points 1",2",3" on the circumference of the circle in the side view. (preferably symmetrical)

Project from side view and draw lines such as P_3 - 3/P_1 - 1 and P_2 - 2 in plan. Now these lines P_3 - 3P_1 - 1 and P_2 - 2 are the true lengths of the generators or simply lines drawn from points 3, 1 and 2. These lines will also form the true lengths in the elevation.

Fig 5



Draw projectors of indefinite lengths from points 1",2" & 3" in the side view towards the elevation.

To fix the position of the above projectors, draw projectors vertically from points such as P_3/P_1 and P_2 to intersect with the corresponding lines in the elevation. Mark the intersecting points f_1',f_2',f_3' and draw the required curve.

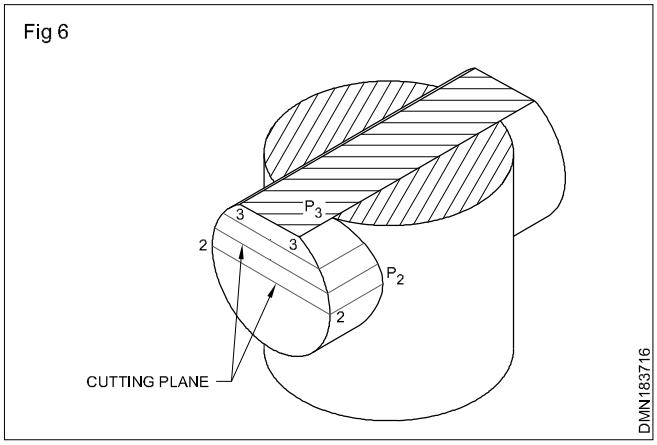
The above step was to simply transfer the true length of generators P_1 - 1, P_2 - 2 from plan to elevation.

Since we have drawn the projection of generators to get the points f_1',f_2',f_3'. This method is called generator method. This is also called as line method.

Cutting plane method (Fig 6)**:** In cutting plane method, we assume that the cylinders are cut by a series of parallel cutting planes passing through such points as 3-3, 2-2 etc. In figure 6, the cylinders are shown after they are cut by a plane passing through 3 - 3. The line f3 - 3 is the same as the generating line f3 - 3 int he front view of figure and hence the rest of the procedure is same as that of line method.

Though both line method and cutting plane method are appearing to be same, they are conceptually different. While any one method can be followed in many cases, but cutting plane method is more useful in solving cases in which none of the projections shows a line view of the surface of a solid.

Fig 6



Critical point or key point (Fig 7)**:** There is no standard shape for intersection curves/lines. The curves/lines may change direction. The point at the direction changes are referred as critical or key point. While drawing generator lines or cutting plane, one of the lines/cutting planes should invariably pass through critical/key point.

Figure 7 shows the point 4 is the critical point, whereas in Fig 8 points m and k are the critical points.

Fig 7

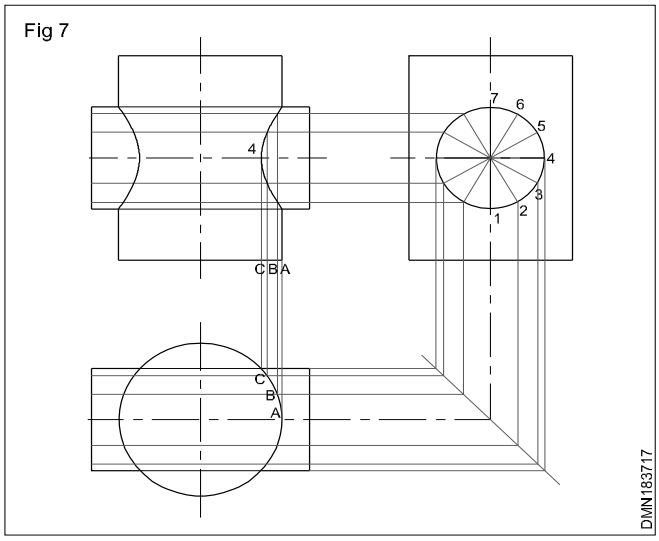
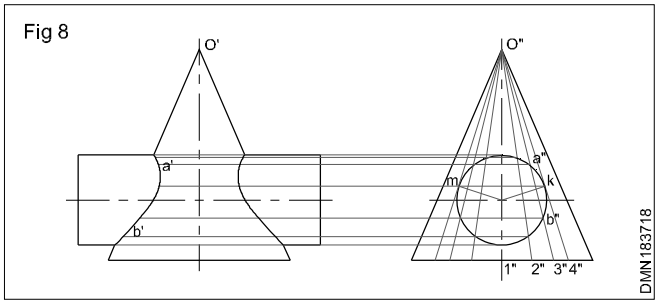


Fig 8



Intersection of surfaces

Objectives: At the end of this lesson you shall be able to
- **state the meaning of intersection**
- **state the importance of drawing lines of intersection**
- **explain the methods of drawing lines of intersection**
- **list the critical points to be noted while drawing lines of intersection.**

Intersection of surfaces

In this chapter, we shall learn about the intersection of planes. These intersecting surfaces may be two planes or two curved surfaces of solids. (The lateral of every solid/ surfaces taken as a whole is a curved surface, may be made of only curved surface as in case cylinders, cones etc. or of plane surfaces as in case of, pyramids etc.) In the former case,'the problem is be on the intersection of surfaces and in the latter it is commonly known as the problem on interpenetra-f solids. It may, however, be noted that when two meet or join or interpenetrate, it is the curved es of the two that intersect each other. The latter is, therefore, on the intersection of surfaces.

intersection:

Engineering practice, objects constructed may have cut parts, the surfaces of which "intersect cne in lines which are called lines of intersection. A fitted on a boiler is one such example. The surface of Dme extends upto the line of intersection only. For the development of the surface of the dome, this line of intersection must be accurately located and shown in two graphic views. The shape of the hole to be cut in the shell is also determined the shape of the same intersection.

From thus, the line of intersection of the two surfaces is a common to both. It is composed of points at which the of one surface intersect those on the other surface, of intersection may be straight or curved, depend upon the nature of intersecting surfaces. Two plane (e.g. faces of prisms and pyramids) intersect in line. The line of the intersection between two curved surfaces (e.g. of cylinders and cones) or between a plane surface and a curved surface is a curve.

When a solid completely penetrates another solid there will be two lines of intersection. These lines are, sometimes, called the lines or curves of interpenetration.

The portion of the penetrating solid which lies hidden within the other solid is shown by the dotted lines

METHODS OF DETERMINING THE LINE OF INTERSECTION BETWEEN SURFACES OF TWO INTERPENETRATING SOLIDS:

(1) Line method: Any number of lateral surface of one of line of intersection. Points. the surface of the other solid will obviously lie on the arc more easily located from the surface of the second solid line). The curve drawn through/the intersection.

(2) Cutting-plane method: The two solids are assumed to be cut by a series of cutting planes. The cutting planes may be vertical (i.e. perpendicular to the H.P) edge -wise (i.e. perpendicular to the V.P) or oblique. The cutting planes are so selected as to cut the surface of one of the solids in straight lines and that of the other in straight lines or circles

Each method is explained in detail while solving ilustrative problems. Sound knowledge of projections of solids in various positions is quite essential while dealing with these problems.

Intersection of two prisms:

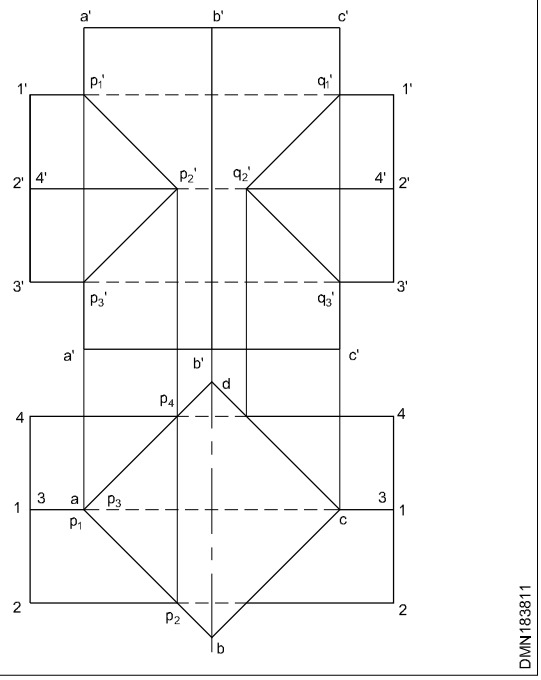
Prisms have planes surfaces as their faces. The line of intersection between two plane surfaces is obtained by locating the positions of points at which the edges of one surface intersect the other surface and then joining the points by a straight line. These points are called vertices (plural of vertex). The line of intersection between two prisms is therefore a closed figure composed of a number of such lines meeting at the vertices. It is determined by locating the points at which edges of one prism intersect edges or faces of the other prism and then joining them in correct sequence.

Problem 1 (Fig.1):

A vertical square prism, base 50mm side, is completely penetrated by a horizontal square prism, base 35 mm side, so that their axes intersect. The axis of the horizontal prism is parallel to the V.P., while the faces of the two prisms are equally inclined to the V.P. Draw the projections of the solids, showing lines of intersection. (Assume suitable lengths for the prisms.)

Draw the projections of the prisms in the required position. The faces of the vertical prism are seen as lines in the top view. Hence, let us first locate the points of intersection in that view. Lines 1-1 and 3-3 intersect the edge of the vertical prism in points p_1 and p_3 (coinciding with a). Lines 2-2 and 4-4 intersect' the faces atp_2 andp_4 respectively. The exact positions of these points along the length of the prism may now be determined by projecting them on correspon-ding lines fn the front view. For example, p_2 is projected to p_z' on the line 2'2'. Note thatp_4' coincides withp_2'. Draw linesp/p/ andp_2'p_3'. Linespi'p_4' andp_3'p_4' coincide with -the front lines. These lines show the line of intersection. Lines g/g_2' and q^cfe' on the other side are obtained in the same manner. Note that the lines for the hidden portion of the edges are

Fig 1

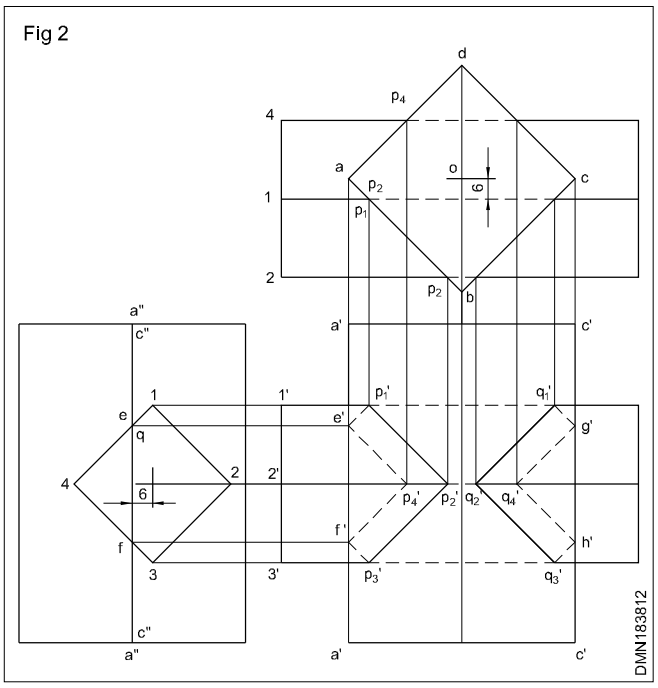


shown!as dashed lines. The portions 'Pi'p_3" and q_l 'q_3' of vertical edges a 'a' and c 'c' do not exist and hence, must be removed or kept fainter.

Problem 2 (Fig 2)

A vertical square prism, base 50mm side is completely penetrated by a horizontal square prism, base 35 mm side so that their axes are 6mm apart. The axis of the horizontal prism is parallel to the V.P., while the faces of both prisms are equally inclined to the V.P. Draw the projections of the prisms showing lines of intersection.

Fig 2

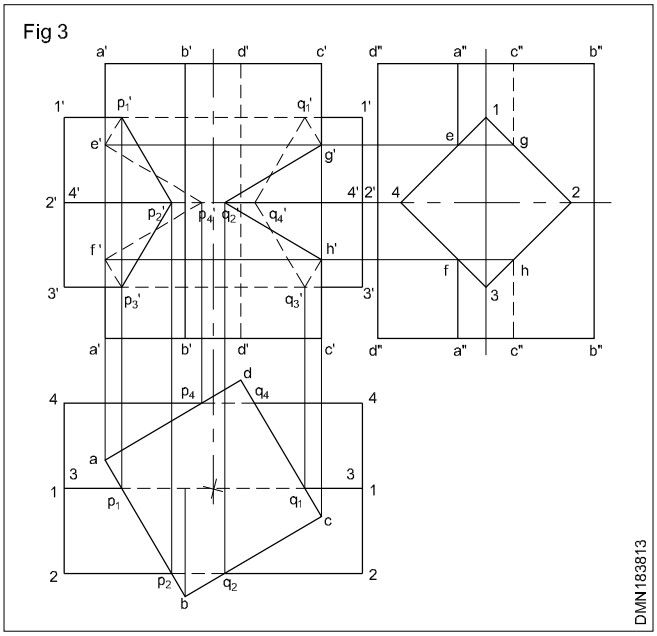


Points PI'...p_4' at which edges of the horizontal prism intersect faces of the vertical prism may be located from the top view. In addition to these points, it will be necessary to find points at which edges, of the vertical prism are cut. They will be the points at which these edges intersect the faces of the horizontal prism. For this purpose, draw the side view. In this view, all faces of the horizontal prism are seen as lines. Mark point and / at which the line a "a" intersects the faces. Project these two points to e' and /' on the line a 'a' in the front view. Join all the points of intersec-tion in correct sequence. Care must be taken to determine visible and hidden links. Only two lines viz. Pi'p_2' and P_2'p_3' are visible. Locate points (on the other side) at which the edges come out anid also the two points g' and h' at which the edge c'c' is cut. Draw lines joining these points. They will be exactly similar to lines P'$_1$ P_2 etc. on the left-hand side.

Problem 3 (Fig. 3)

A vertical square prism, base 50 mm side and height 90 mm has a face inclined at 50° to the V.P. It is completely penetrated by another square prism, base 40 mm side and axis 100 mm long, faces of which are equally inclined to the V.P. The axes of the two prisms are parallel to the V.P. and bisect each other at right angles. Draw the projections showing lines of intersection.

Fig 3



Adopt the same method as explained in problem 2. The edges 1-1 and 3-3 enter one face of the vertical prism and come out of its opposite face. Obtain the points (from the top view) at which all edges intersect the faces and also the four key points (from the side view). Note carefully the lines for visible and hidden edges, shown as full lines and dotted lines respectively. Although the two axes are intersecting, the visible (portions of the lines of intersection, when the penetrating prism enters and comes out differ because the penetrated prism has its faces inclined to the V.P. Linesp/p andp_2!p3' are visible on the left side while g_2 'g' and q_2 'h' are visible on the right side. Edges a 'e' and a'f' are partly hidden, while c'g' and h 'c' are fully visible.

Fig. 3 shows the front view of the vertical prism, when the penetrating prism has been removed. Note that the edges of the back portions of the hole are partly visible.

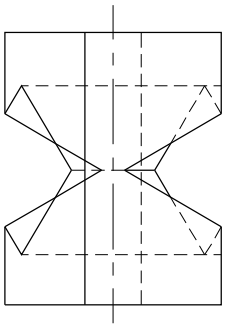
Problem 4 (Fig. 4) :

A square pipe of 50 mm side has a similar branch of 30 mm side. The axis of the main pipe is vertical and is intersected by the axis of the branch at an angle of 45°. All the faces of both the pipes are equally inclined to the V.P. Draw the projections of the pipes, showing lines of intersection. Also develop the surfaces of both the pipes.

The line of intersection between the two pipes is obtained [Fig. 4(;)] in the same manner as shown in pro-blem 1. As the axes are intersecting, the edge a 'a' is cut by the two edges of the branch at points p^ andp_3'. The other two edges of the branch enter the faces of the main pipe at points p_2' andp_4'.

Developments of the surfaces of the two pipes are shown in Fig. 4(;). Heights of all the points are obtained from the front view, e.g. $P_1A=p_l$'a', P_tl =pi'l' etc. The exact position of the pdint P_2 is located from the top view by making AE-= ap_2 and fhen erecting a perpendicular at E. The point P_4 is similarly located.

Fig 4



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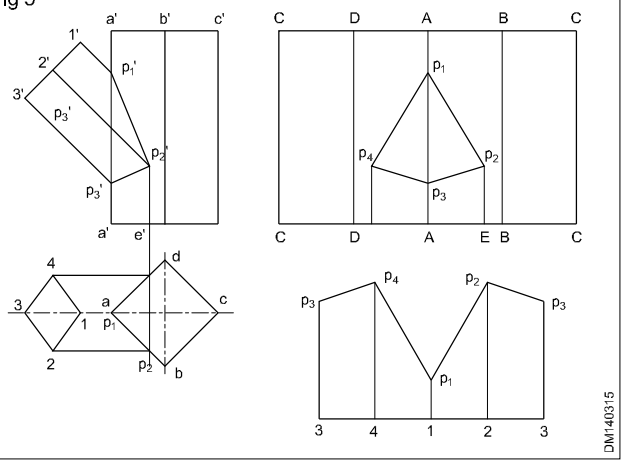
Problem 5 (Fig. 5):

A vertical square prism, base 50 mm side, is intersected by another square prism, base 35 mm side, the axis of which is parallel to the V.P. and inclined at 30° to the H.P. The axes of the two prisms are 6 mm apart and their faces are equally inclined to the V.P. Draw the projections showing the line of intersection.

Obtain points of intersection of the edges of the inclined prism from the top view. For the points at which the edge a'a' of the vertical prism is cut, it will be necessary to pro-ject a view in which faces of the inclined prism will

Fig 5



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be seen as lines. Therefore, project an auxiliary top view on a reference line x_1y_1 drawn perpendicular to the axis of the inclined prism. Mark points e and f at which a "a" is pierced by the faces and project them to points a' and f' on the corresponding .line a'a' in the front view. Draw straight lines joining the six points in correct sequence.

Intersection of cylinder and cylinder:

As cylinders have their lateral surfaces curved, the line of intersection between them will also be curved. Points on this line may be located by any one of the :wo methods. For plotting an accurate curve, certain critical or key points, at which the curve changes direction, must also be located. These are the points at whiph outermost or extreme lines of each cylinder pierce the surface of the other cylinder. In prisms, vertices are the key points.

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 Timetric, Dimetric or Isometric.

Fig 1

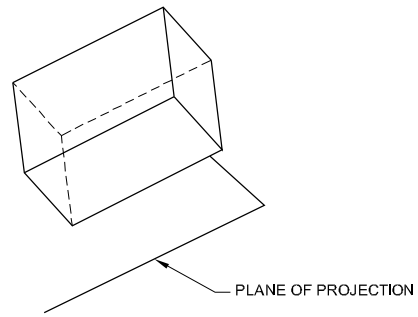
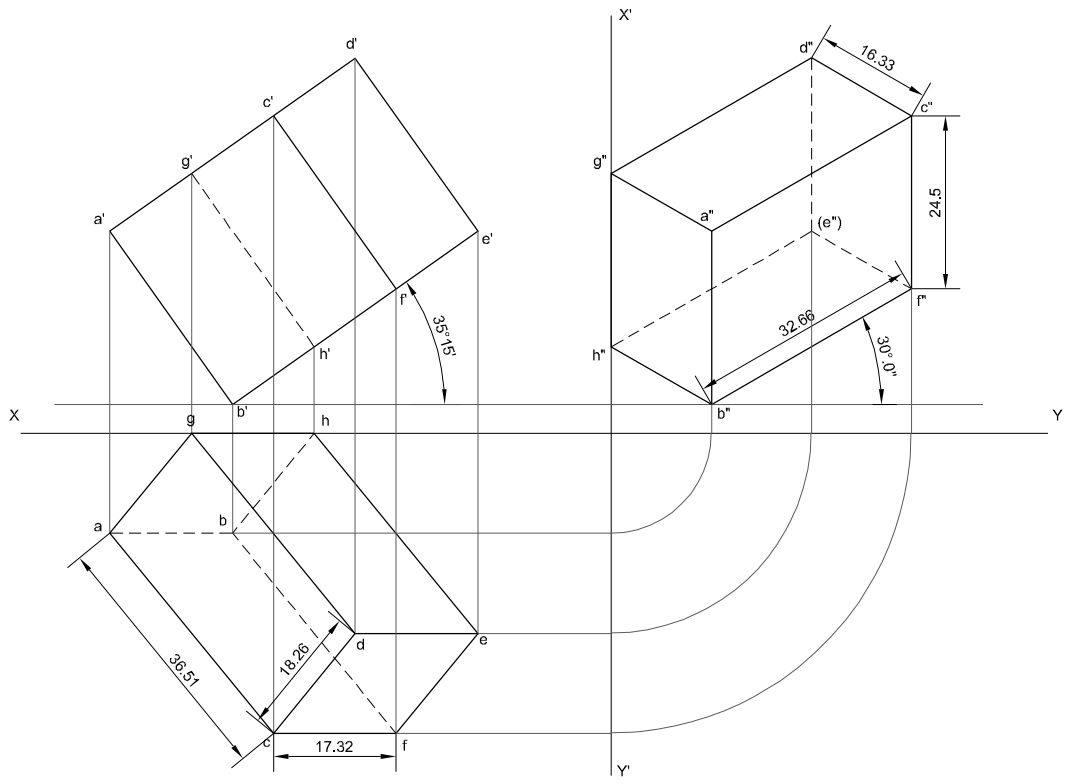
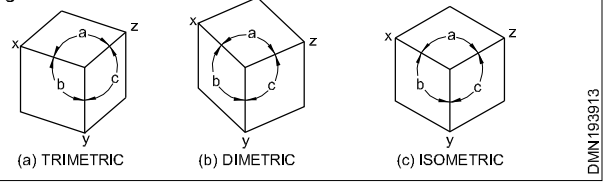


Fig 2



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)

Fig 3



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

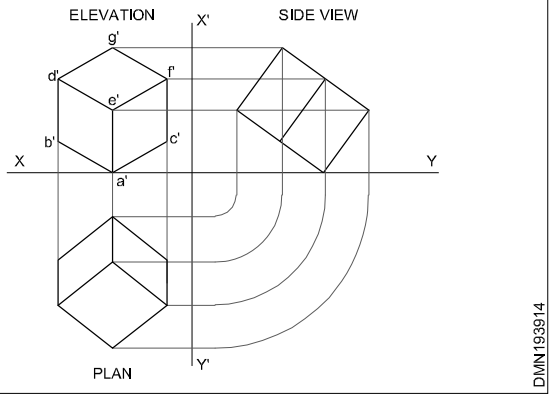
In the three types (trimetric, dimetric and isometric) of pictorial projections mentioned above, because the faces of the object are not parallel to the plane of projection the views will not show the true size and shape of the object. The shapes are distorted and lengths of edges are fore shortened. Referring to Fig 2 it may be seen that the true dimensions of the prims 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 describing 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.

Fig 4

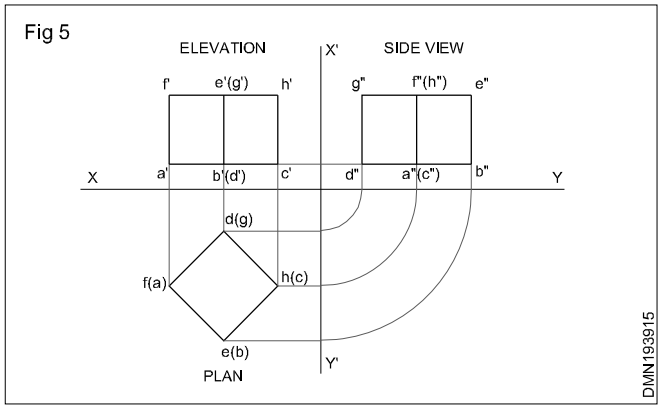


The projection of a cube, the three faces which make equal angles with vertical plane is shown in Fig 4. Here the front view is the isometric projection. Notice that the a'b', a'e', c'f', e'f', c'd', d'g', g'f', b'd', a'c' which represent the various edges of the cube are of equal lengths meaning that 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.

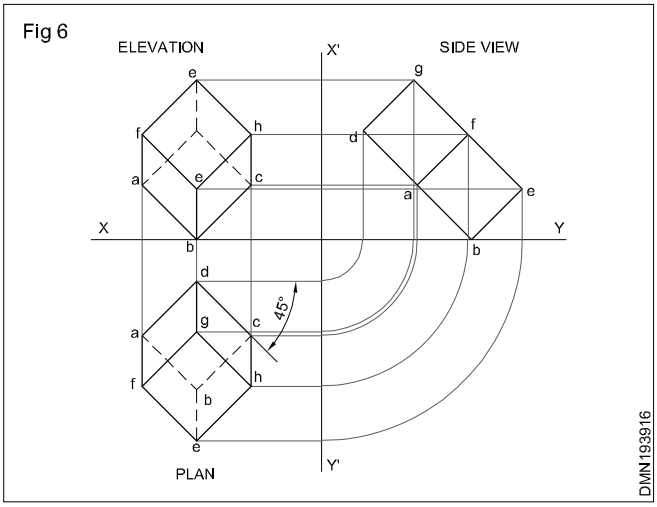
Place the cube on HP such that two of its mutually perpendicular faces make 45° will VP (the plan and side view elevation in the position will be as in Fig 5).

Fig 5



Next tilt the cube towares 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:

Fig 6



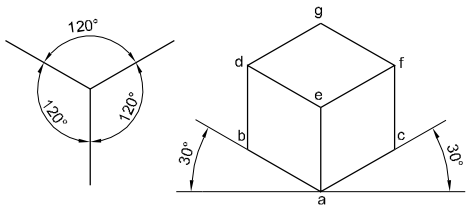
- First reproduce the side view in Fig 5. Such that DE is parallel to XY line.
- Project from the above side view and the plan in Fig 5 shall be reproduced in Fig 6.
- Draw the elevation

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)

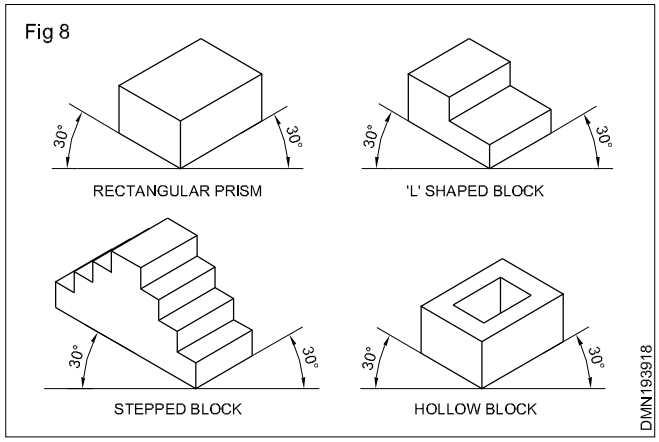
Fig 7



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.

Fig 8



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.

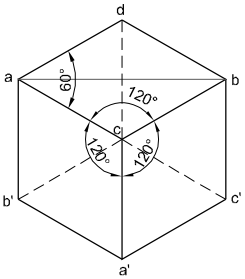
To determine the relationship between the true length and corresponding length in isometric projection, proceed as follows:

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

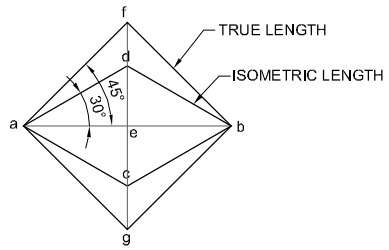
Fig 1



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



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

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

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

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

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

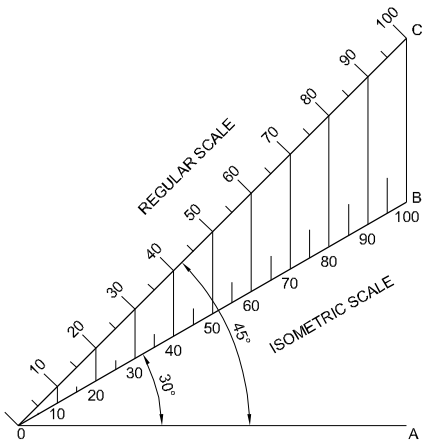
AD = 0.82 AF. This means that the length of a line in isometric projection is 0.82 times of it true length. While drawing an object in isometric projection, the dimensions on or parallel to isometric axes are reduced to this proportion. To make things easier we can construct a scale to the above ratio. 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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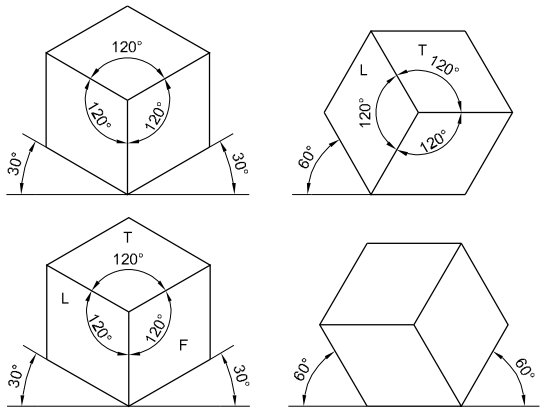
Orientation of isometric axes: While the isometric axes make 120° to each other they may have different orientation as shown in Fig 4. Each of the orientation show3 of the 6 faces (left, right, top, bottom, front and rear) are shown in different combinations.

Fig 4



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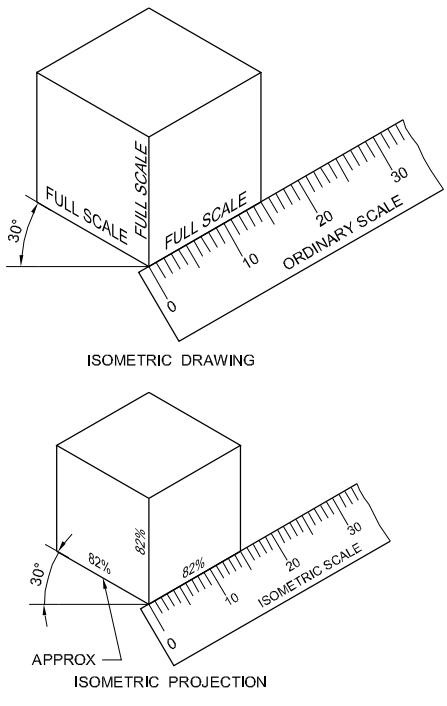
Isometric view and Isometric projection: A drawing is made with true lengths (dimensions) is called isometric view or isometric drawing. Whereas the same drawing made with isometric lengths is termed as isometric projection. (Fig 5)

Fig 5



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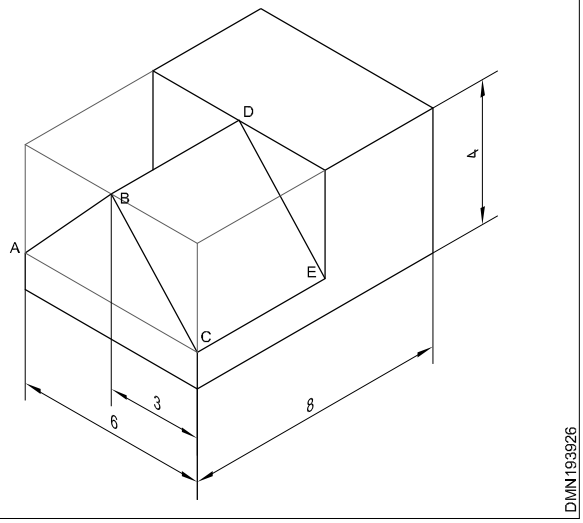
Isometric and non-isometric lines: Fig 6 shows the isometric view of a shaped block. Here all lines except AB, BC and DE are parallel to isometric axis. Lines such as then which are parallel to isometric axes are called isometric lines whereas such as lines AB, BC and DE which are not parallel to isometric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

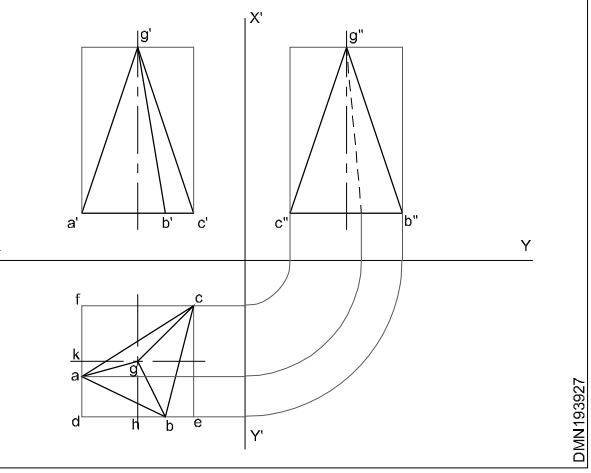
These methods are not only useful for isometric views involving non-isometric lines but also for the isometric views involving isometric lines.

Box method of drawing a pyramid

Example

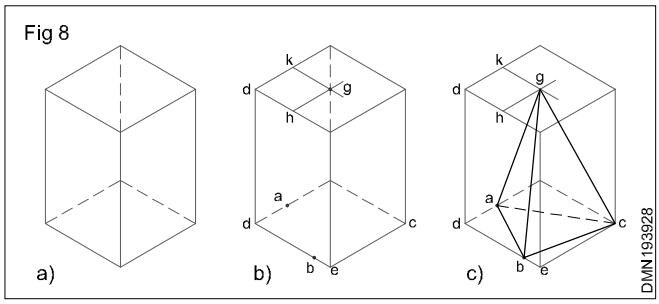
Draw an isometric view for the triangular pyramid shown in Fig 7 using a box method.

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



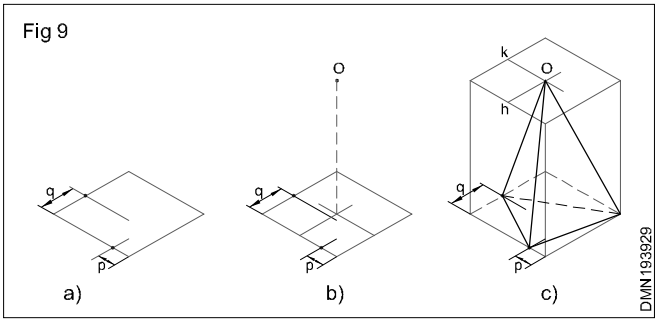
Off-set method of drawing a pyramid

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

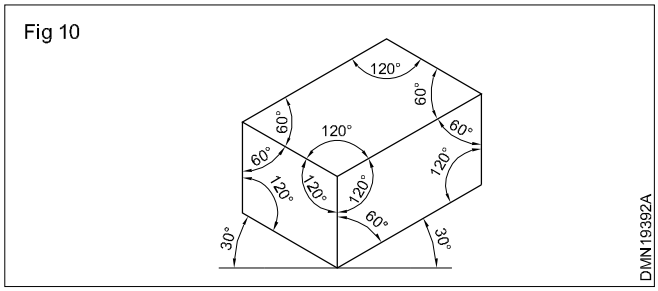


– Join 1-2, 2-3, 1-3, 0-1, 0-2, 0-3 and complete the isometric view of the pyramid. (Fig 9c)

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



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

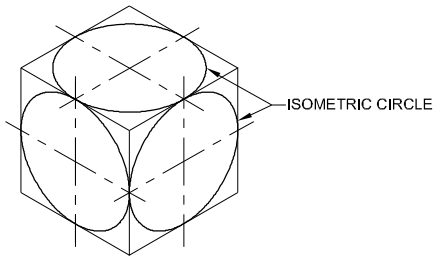
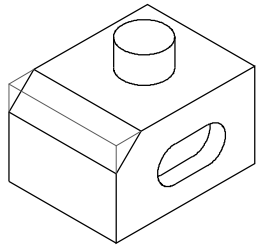


Fig 12



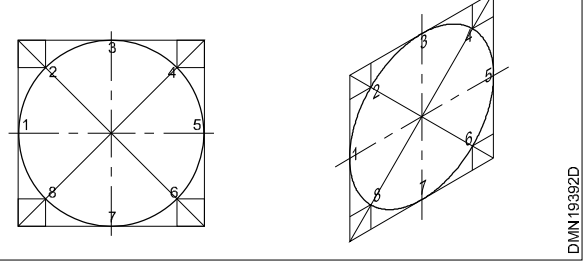
An isometric circle can be drawn either by plotting / offset method or by arc method.

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 view of the square as points 1',2',3'....8'.
- Join these points with a smooth curve to form an ellipse.

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

Fig 13



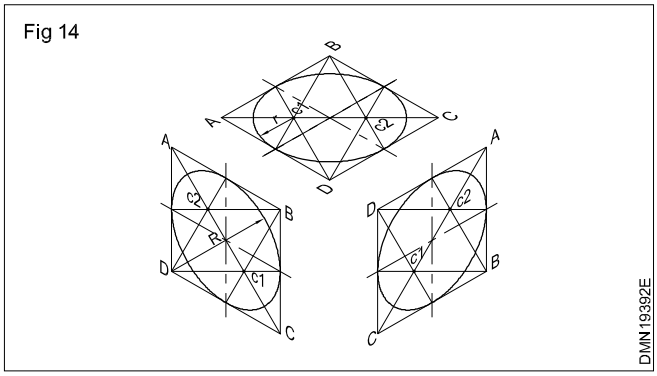
Arc method: Isometric circles drawn by offset method is the ideal method of making isometric circles as the ellipse obtained this way is geometrically true. But by free hand we cannot get a clear line.

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



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

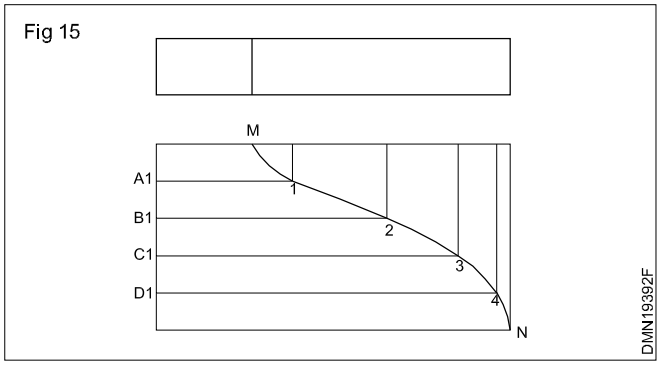
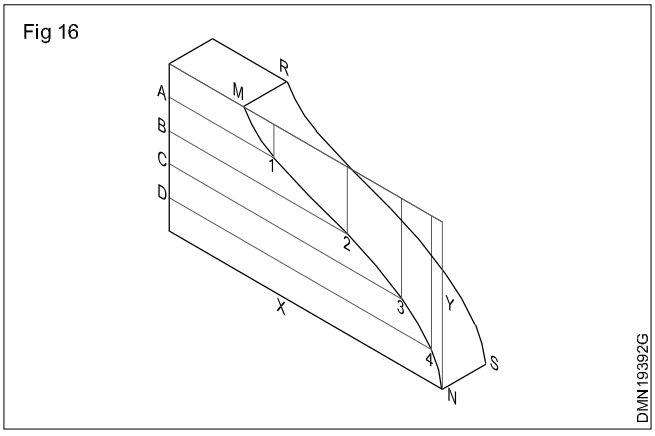


Fig 16



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.

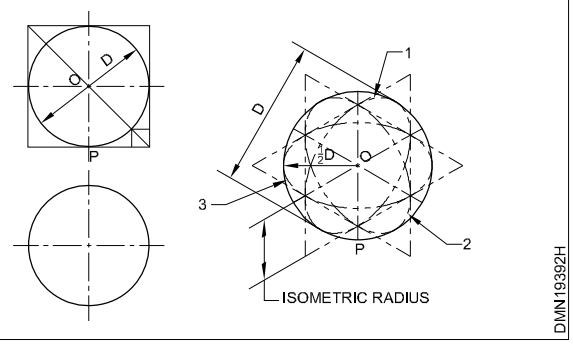
Assume a vertical section the centre of the sphere. Its shape will be a circle of diameter D. The isometric projection of this circle are ellipses 1 & 2 Fig 17(b) drawn in two different vertical positions around the same centre O. The major axis in each case is equal to D. The distance of the point P 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.

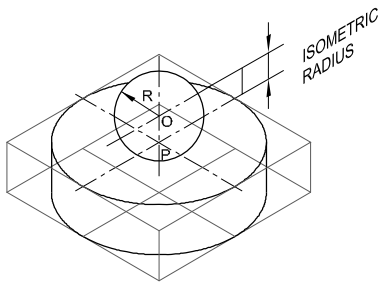
Fig 17



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



Oblique projection

Objectives: At the end of this lesson you shall be able to
- **state what is an oblique view**
- **compare oblique view with isometric view**
- **identify the different types of oblique views**
- **explain various angle used for drawing oblique views**
- **list the hints on positioning and drawing oblique views.**

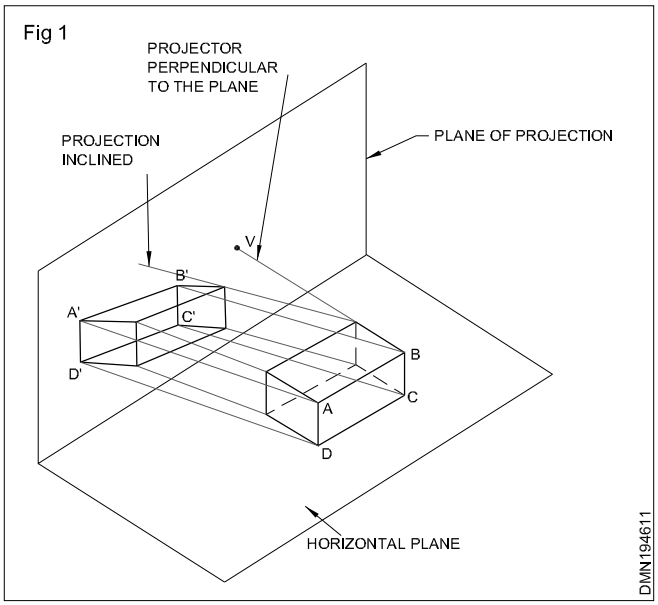
Oblique projections are yet another type of pictorial projections, they differ from isometric projections in two ways.

– In oblique projections, projections are oblique (inclined) to the plane of projection. whereas in isometric projections projectors are perpendicular to the plane of projection. (Fig 1)

– In an oblique projection one of the principal faces of the object is kept parallel to the plane of projection, but in isometric, none of the faces of the object is parallel to the plane of projection.

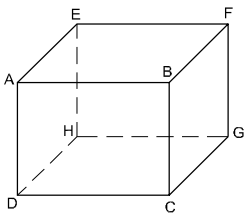
Even though one of face of the object is positioned parallel to the picture plane, we still get a pictorial view and the projections are inclined to both HP and VP.

Fig 1



Because one of the principle faces of the object is parallel to the plane of projection. In the oblique projection, the projection of this face and faces parallel to it will appear in true size and shape. In the oblique projection of a prism is shown in Fig 2, the faces ABCD and EFGH are parallel to the plane of projection and they appear to be true in size and shape. The other four faces which are perpendicular to the plane of projection do not appear in true shape. (all these four faces are seen as parallelogram) However the vertical edges of these faces are parallel to the plane of projection and hence the projection of these edges will measure to their true lengths.

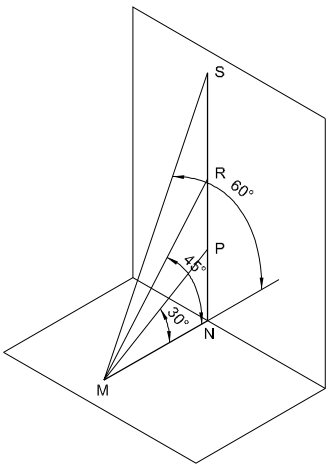
Fig 2



Projection of edges such as AE, DH, BF and CG which are perpendicular to the plane of projection will measure differently depending on the angle of inclination of the projectors. If the inclination of the projectors is 45° the projections of these edges measure to their true lengths. If the angle is less than 45° the projection of such perpendicular edges will measure less than the true length, if the angle of inclination of the projectors is greater than 45°. Projection of such perpendicular edges will measure more than the true length.

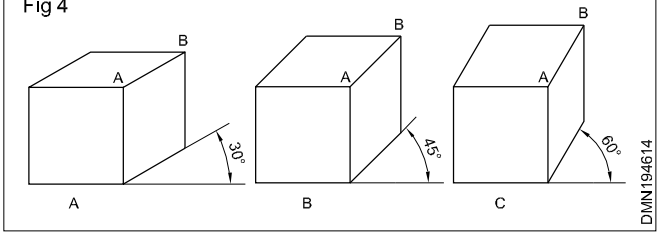
In the Fig 3, a line MN is drawn perpendicular to the plane of projection. NP, NR and NS are its projection when the projectors are 30°, 45° & 60° respectively. NR is equal to MN, NP is less than MN and NS is greater than MN.

Fig 3



Figures 4a,b and c shows the oblique views of a square prism when the angle of the projectors are 30°, 45° & 60°. Because of the variation of the length of edges (AB) which are perpendicular to the plan of projection the views give a rather distorted picture of the prism. This is a disadvantage of oblique projections over isometric projections.

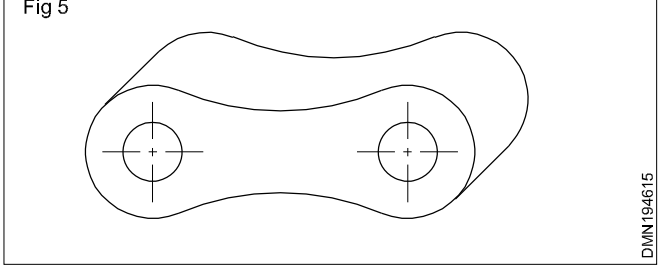
Fig 4



Oblique projections nevertheless have an unique advantage what we want to make pictorial drawings of object having curved features. For making isometric views of a curved feature we have first to draw their orthographic views in order to find out the offsets of points lying on the curve. But this difficult procedure is not necessary in the case of oblique views.

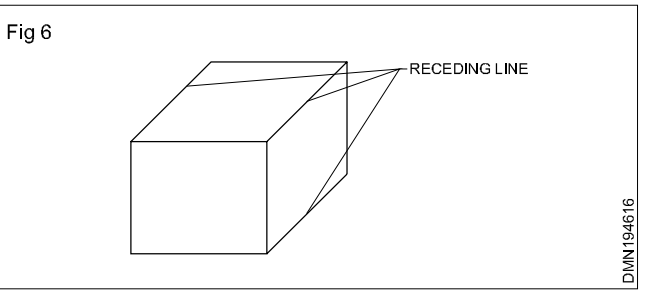
For example the component shown in Fig 5 has several curved features. While drawing oblique view of this component the curved features are drawn to true shape using compass. This is relatively easier method in comparison to the drawing of the same component in isometric view.

Fig 5



Inclination of projectors: While projectors can have any angle of inclination, usually oblique views are drawn to either 45° or 30°. The inclined lines in the oblique drawings are called receding lines (Fig 6) and they are more commonly drawn to 45°. The scale of lines along receding may be 1:1 (true lengths) or 1:2 (half of the true length).

Fig 6



Oblique drawing drawn to 1:1 (Fig 7) are called as cavalier projections and those drawn to 1:2 (Fig 8) are called as cabinet projections. These two terms are of academic interest only and mostly we refer these views as oblique projections/drawings only.

In comparisn a cabinet projection will look less distorted than a cavalier projection.

Fig 7

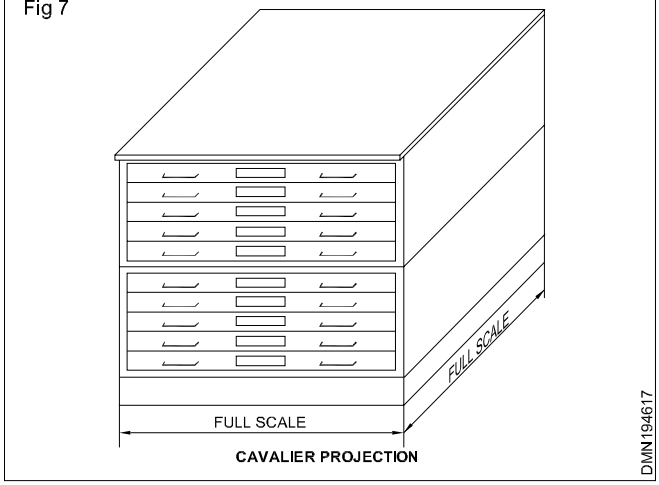
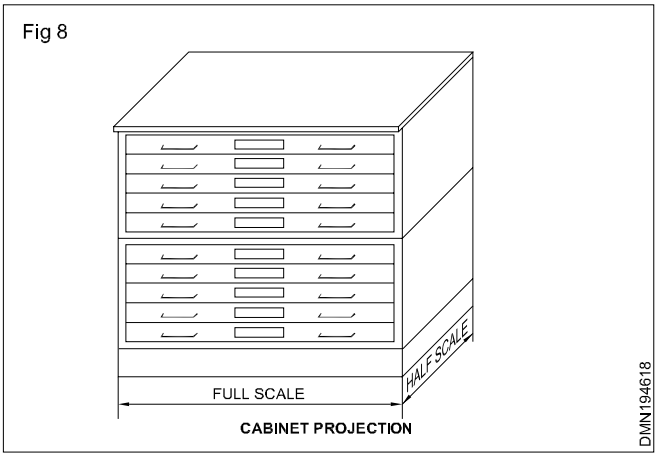
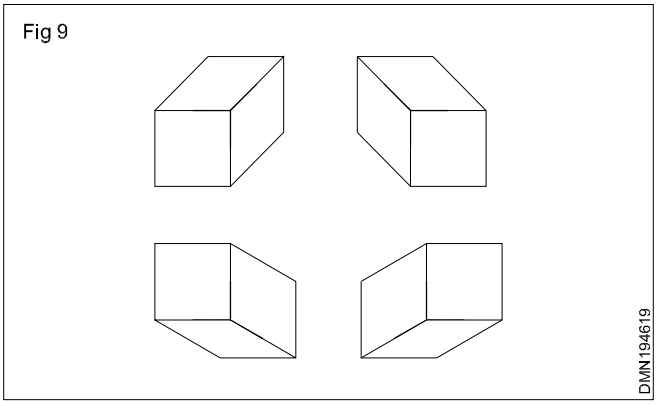


Fig 8



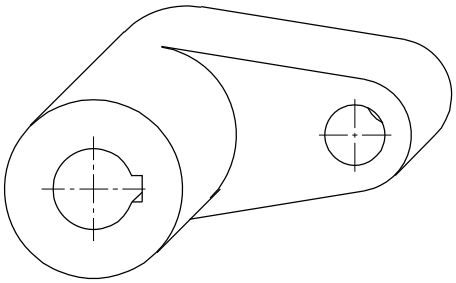
Procedure for drawing oblique views: The procedure for creating oblique drawing is very much similar to that for drawing isometric views. To make isometric view we start from drawing three isometric axes at the desired orientation. In oblique drawing also we start by drawing three axes at the desired orientation. But here two of the axes are perpendicular to each other while the third axis (receding axis). Make 45° or 30° to the horizontal. The orientation of the axes may be any one of the four possibilities given in the figure 9.

Fig 9



Object positioning in oblique drawing: Remember to position the object in such a way as to make best use of the advantage offered by oblique projection. The face that has the maximum curved details should be placed parallel to the plane of projection. See example in Fig 10.

Fig 10



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Another point to note is as far as possible, place the longest dimension parallel to the plane of projection. (Fig 11 a & b)

Fig 11

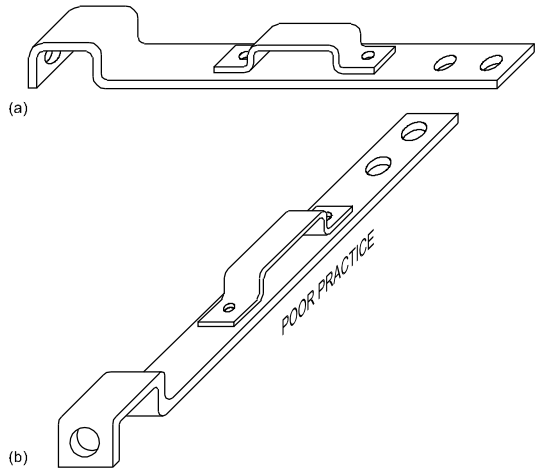

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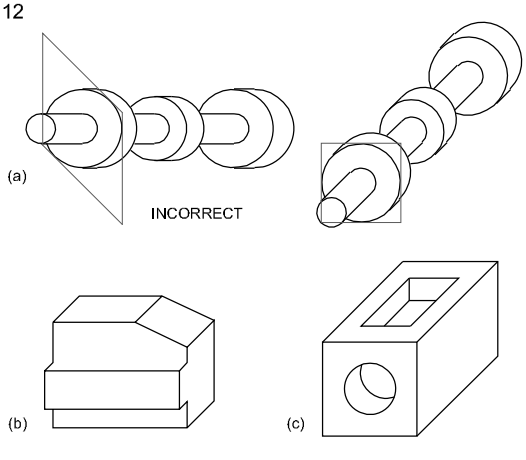
Fig 12



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