ENGINEERING DRAWING

(NSQF)

1 YEAR

Revised Syllabus - 2022

Group 9

Group 9 CTS Trades Covered
Sheet Metal

Directorate General of Training

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

NATIONAL INSTRUCTIONAL MEDIA INSTITUTE, CHENNAI

Nimi

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Engineering Drawing (NSQF) - 1 Year

Group 9 - Engineering Trade

As per Revised syllabus 2022 under CTS

Rs. /-

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 comprising various stakeholder's 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 **Engineering Drawing 1 Year** NSQF **Group 9 - Engineering Trade** under CTS 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 trainees will also get the opportunities to promote life long learning and skill development. I have no doubt that with NSQF the trainers and trainees of ITIs, and all stakeholders will derive maximum benefits from these 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

SHRI. ATUL KUMAR TIWARI., I.A.S.,
Director General/Addl. Secretary
Ministry of Skill Development & Entrepreneurship,
Government of India.

New Delhi - 110 001

PREFACE

The National Instructional Media Institute(NIMI) was set up at Chennai, by the Directorate General of Training, Ministry of skill Development and Entrepreneurship, Government of India, with the technical assistance from the Govt of the Federal Republic of Germany with the prime objective of developing and disseminating instructional Material for various trades as per prescribed syllabus and Craftsman Training Programme(CTS) under NSQF levels.

The Instructional materials are developed and produced in the form of Instructional Media Packages (IMPs), consisting of Trade Theory, Trade Practical, Test and Assignment Book, Instructor Guide, Wall charts, Transparencies and other supportive materials. The above material will enable to achieve overall improvement in the standard of training in ITIs.

A national multi-skill programme called SKILL INDIA, was launched by the Government of India, through a Gazette Notification from the Ministry of Finance (Dept of Economic Affairs), Govt of India, dated 27th December 2013, with a view to create opportunities, space and scope for the development of talents of Indian Youth, and to develop those sectors under Skill Development.

The emphasis is to skill the Youth in such a manner to enable them to get employment and also improve Entrepreneurship by providing training, support and guidance for all occupation that were of traditional types. The training programme would be in the lines of International level, so that youths of our Country can get employed within the Country or Overseas employment. The **National Skill Qualification Framework (NSQF)**, anchored at the National Skill Development Agency(NSDA), is a Nationally Integrated Education and competency-based framework, to organize all qualifications according to a series of **levels of Knowledge, Skill and Aptitude.** Under NSQF the learner can acquire the Certification for Competency needed at any level through formal, non-formal or informal learning.

The **Engineering Drawing** 1 Year NSQF Group 9 - Engineering Trade under CTS is one of the book developed by the core group members as per the NSQF syllabus.

The **Engineering Drawing** 1 Year NSQF Group 9 - Engineering Trade under CTS as per NSQF) is the outcome of the collective efforts of experts from Field Institutes of DGT, Champion ITI's for each of the Sectors, and also Media Development Committee **(MDC)** members and Staff of **NIMI.** NIMI wishes that the above material will fulfill to satisfy the long needs of the trainees and instructors and shall help the trainees for their Employability in Vocational Training.

NIMI would like to take this opportunity to convey sincere thanks to all the Members and Media Development Committee (MDC) members.

Chennai - 600 032   **EXECUTIVE DIRECTOR**

ACKNOWLEDGEMENT

INTRODUCTION

Theory and procedure along with the related exercises for further practice

This book on theory and procedure along with related exercises contains theoretical information on **1 Year Engineering drawing** NSQF (Revised syllabus 2022 Group 9 - Engineering Trade) and procedure of drawing/ sketching different exercise for further practice are also available. Wherever required, BIS specification has been used.

Exercise for further practice

The practice exercise is given with Theory and procedure for 1st Year book made obsolete as it was felt that, it is very difficult to work in workbook using drawing instruments. It is well known fact that, any drawing is prepared on suitable standard size of drawing sheets only.

The instructor is herewith advised to go through the instructions given below and to follow them in view of imparting much drawing skill in the trainees.

Acquiring the above said ability and doing small drawings is not a simple task. These books will provide a good platform for achieving the said skills.

Time allotment:

Duration of 1st Year : 40 Hrs

Sl. No.	Topic	Exercise No.	Time Allotment
1	Introduction to Engineering Drawing and Drawing Instruments	1.1.01 - 1.1.05	2
2	Lines and Free hand drawing	1.2.06 - 1.2.09	6
3	Drawing	1.3.10 - 1.3.13	8
4	Dimensioning	1.4.14 - 1.4.16	2
5	Concept and Reading of Drawing	1.5.17 - 1.5.19	10
6	Symbolic Representation	1.6.20	4
7	Reading of Job drawing of related trades	1.7.21	8
			40 Hrs

Instructions to the Instructors

It is suggested to get the drawing prepared on A4/A3 sheets preferably on only one side. If separate table and chair facility is available for every trainee then it is preferred to use A3 sheets and if the drawing hall is provided with desks then A4 sheets may be used. However while preparing bigger drawings on A4 sheets suitable reduction scale to be used or multiple sheets may be used for detailed and assembly drawings.

First the border and the title block to be drawn only for the first sheet of the chapter. Eg. for conical sections only first sheet will have the title block whereas the rest of the sheets of that chapter will have only borders.

Serial number of sheet and total no. of sheets to be mentioned on each sheet.

The completed sheet to be punched and filled in a box file/ suitable files and preserved by the trainees carefully after the approval of instructor, VP and Principal of the Institute.

The file may be referred by the authority before granting the internal marks at the end of the Year.

LEARNING / ASSESSABLE OUTCOME

On completion of this book you shall be able to

- **Read and apply engineering drawing for different application in the field of work.**

CONTENTS

SYLLABUS

1 Year   **Group 9 - Revised syllabus 2022**   **Duration: 1 Year**
Engineering trades under CTS

CTS Trades Covered: Mason

S.no.	Syllabus	Time in Hrs
1	Introduction to Engineering Drawing and Drawing Instruments – • Conventions • Sizes and layout of drawing sheets • Title Block, its position and content • Drawing Instrument	2
2	Lines - Types and applications in drawing Free hand drawing of - • Geometrical figures and blocks with dimension • Transferring measurement from the given object to the free hand sketches. • Free hand drawing of hand tools and measuring tools.	6
3	Drawing of - • Angle, Triangle, Circle, Rectangle, Square, Parallelogram, Ellipse & Parabola. • Lettering & Numbering - Single Stroke. • Development of Surfaces	8
4	Dimensioning • Types of arrowhead • Leader line with text • Position of dimensioning (Unidirectional, Aligned)	2
5	Concept and reading of Drawing in • Concept of axes plane and quadrant • Concept of Orthographic and Isometric projections • Method of first angle and third angle projections (definition and difference)	10
6	Symbolic representation - • Different symbols used in the Sheet Metal trade.	4
7	Reading of Job drawing related to Sheet Metal trade.	8
	Total	**40**

Introduction to engineering drawing and drawing instruments

Communication

There are many different ways of communicating ideas, information, instructions, requests, etc. They can be transmitted by signs or gestures, by word of mouth, in writing, or graphically. In an industrial context the graphical method is commonly used with communication is achieved by means of engineering drawings.

If oral and written communicati on only were used when dealing with technical matters, misunderstandings could arise, particularly in relation to shape and size. The lack of a universal spoken language makes communication and understanding even more difficult because of the necessity to translate both words and meaning from one language to another.

However, the universally accepted methods used in graphical communication through engineering drawings eliminate many of these difficulties and make it possible for drawing prepared by a British designer to be correctly interpreted or "read" by, for example, his German, French or Dutch counterparts.

Equally important, the components shown on the drawings could be made by suitably skilled craftsmen of any nationality provided they can "read" an engineering drawing.
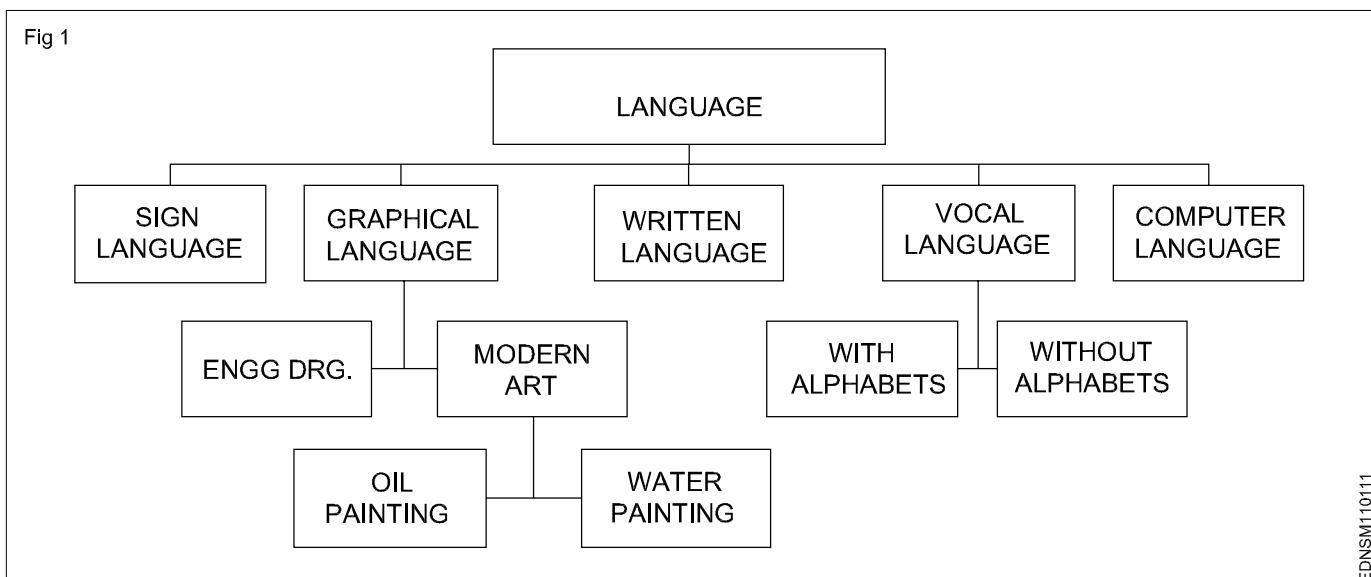
Conventionally prepared engineering drawings provide the main means of communication between the "ideas" men (the designers and draughtsman) and the craftsmen (machinists, fitters, assemblers, etc.). For the communication to be effective, everyone concerned must interpret the drawing in the same way. Only then will the finished product be exactly as the designer envisages it.

To ensure uniformity of interpretation, the British Standards Institution has prepared a booklet entitled BS 308:1972, Engineering Drawing Practice. Now in three parts, this publication recommends the methods which should be adopted for the preparation of drawing used in the engineering industry.

The standards and conventions in most common use and hence those required for a basic understanding of engineering drawing are illustrated and explained in this book.

Language

1   It is the media of communication (Fig 1)

Fig 1

Conclusion

Effective communication is possible when graphical language is supported by written language/vocal language and vice versa.

Engineering drawing is a language that uses both graphical language and written language for effective communication.

Engineering drawing is a graphical language that also uses written language for effective communication.

The importance of Engineering Drawing

The economic success of any country is mainly dependent on its industrial development. Due to globalization, any industry in our country is expected to be of a global market standard. For the above-mentioned reasons, our Indian products require very high quality for their size, dimension, fit, tolerance, and finish etc.

To produce the best standard product, all the technical personnel (Engineers to Craftsman) in an industry must have a sound knowledge of engineering drawing because engineering drawing is the language of engineers. Engineering drawing is a universal language. Different types of lines make up their alphabets. Technical personnel in any industry, including craftsman, are expected to communicate anything concerning a part or a component by means of drawings involving lines, symbols, conventions, abbreviations etc.

With our spoken languages, it is impossible to express the details of a job or a product. Engineering drawing knowledge and practise are a must for designing or producing a component or part. Even a small mistake in the drawing may reflect very badly on the product. Therefore, reading and doing engineering drawings are very essential for craftsmen and engineers.

A drawing is a graphical representation of an object, or part of it, and is the result of creative thought by an engineer or technician. When one person sketches a rough map in giving direction to another, this is graphic communication. Graphic communication involves using visual materials to relate ideas. Drawings, photographs, slides, transparencies, and sketches are all forms of graphic communication. Any medium that uses a graphic image to aid in conveying a message, instructions, or an idea is involved in graphic communication.

One of the most widely used forms of graphic communication is the drawing. Technically, it can be defined as **"a graphic representation of an idea, a concept or an entity which actually or potentially exists in life"**

Drawing is one of the oldest forms of communicating, dating back even farther than verbal communication. The drawing itself is a method of communicating necessary information about an abstract, such as an idea or concept or a graphic representation of some real entity, such as a machine part, house or tools. There are two basic types of drawings: Artistic and Technical drawings.

Technical drawings

Technical drawings allows efficient communication among engineers and can be kept as a record of the planning process. Since a picture is worth a thousand words, a technical drawing is a much more effective tool for engineers than a written plan.

The technical drawing, on the other hand is not subtle, or abstract. It does not require an understanding of its creator, only on understanding of technical drawings. A technical drawing is a means of clearly and concisely communicating all of the information necessary to transform an idea or a concept in to reality. Therefore, a technical drawing often contains more than just a graphic representation of its subject. It also contains dimensions, notes and specifications.

Fields of use

Technical drawing is the preferred method of drafting in all engineering fields, including, but not limited to, civil engineering, electrical engineering, mechanical engineering and architecture.

Purpose of studying engineering drawing

1   To develop the ability to produce simple eng ineering drawing and sketches based on current practice

2   To develop the skills to read manufacturing and construction drawings used in industry.

3   To develop a working knowledge of the layout of plant and equipment.

4   To develop skills in abstracting information from calculation sheets and schematic diagrams to produce working drawings for manufacturers, installers and fabricators.

Main types of Engineering drawing

Regardless of branch of engineering the engineering drawing is used. However based on the major engineering branches, engineering drawing can be classified as follows: (Fig 2)

## Mechanical Engineering drawings

Some examples of mechanical engineering drawings are part and assembly drawings, riveted joints, welded joints, fabrication drawings, pneumatics and hydraulics drawings, pipeline diagrams, keys coupling drawings etc. (Fig 3&4)
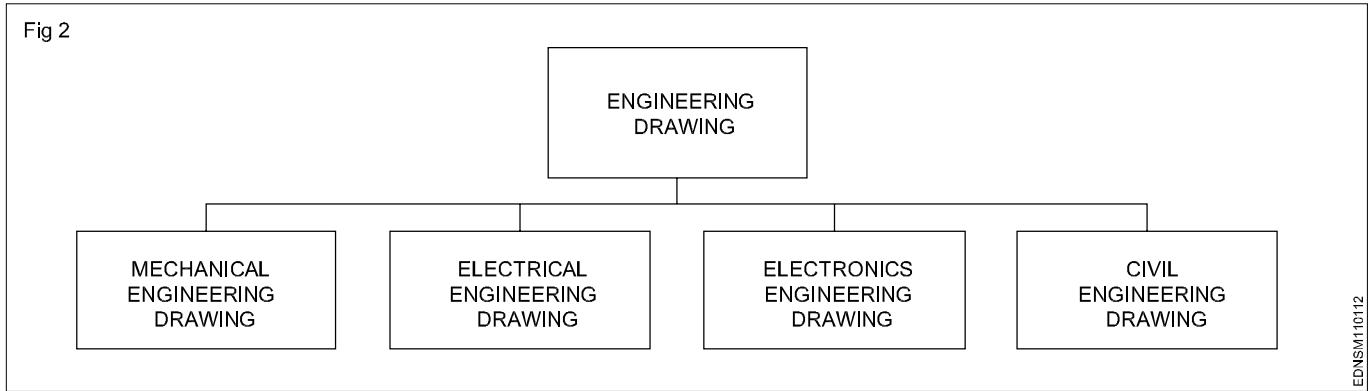
Electrical engineering drawing

Wiring diagrams of home and industries, circuit diagrams, electrical installation drawings etc.
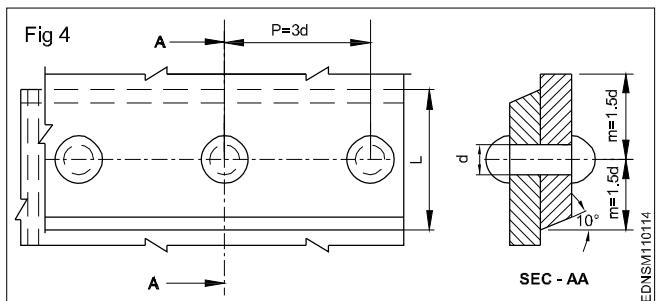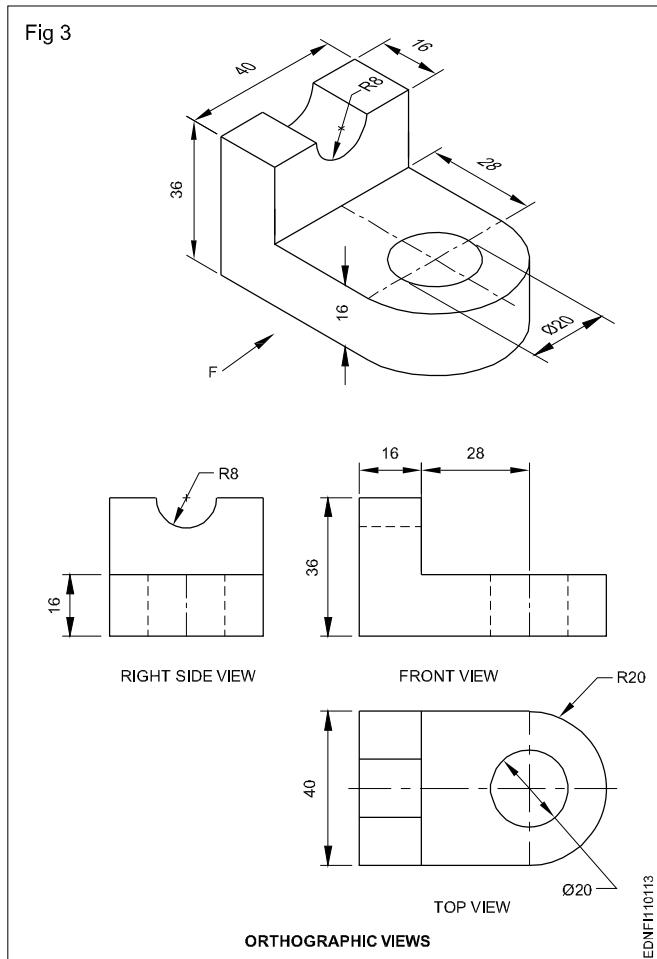
Example

The voltage supply to a filament lamp is 10.8V. The voltage should be 12V. (Fig 5)
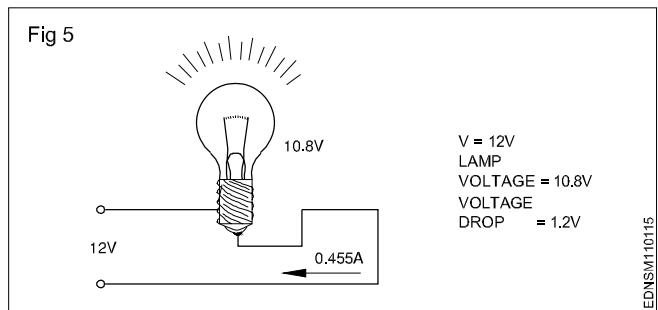
Fig 2
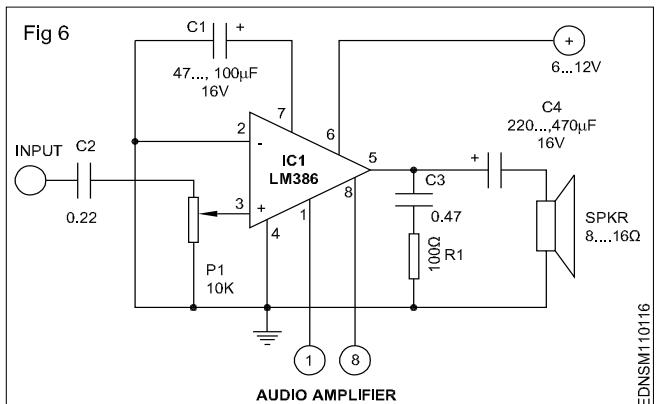
ENGINEERING DRAWING

MECHANICAL ENGINEERING DRAWING — ELECTRICAL ENGINEERING DRAWING — ELECTRONICS ENGINEERING DRAWING — CIVIL ENGINEERING DRAWING

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Mechanical Engineering Drawings (Fig 3&4)

Fig 3

40

16

R8

28

36

16

Ø20

F

RIGHT SIDE VIEW

R8

16

16

28

36

FRONT VIEW

R20

40

Ø20

TOP VIEW

ORTHOGRAPHIC VIEWS

EDNFI110113

Fig 4

A

P=3d

m=1.5d

d

m=1.5d

10°

L

A

SEC - AA

EDNSM110114

Electrical Engineering Drawing (Fig 5)

Fig 5

10.8V

12V

0.455A

V = 12V
LAMP
VOLTAGE = 10.8V
VOLTAGE
DROP   = 1.2V
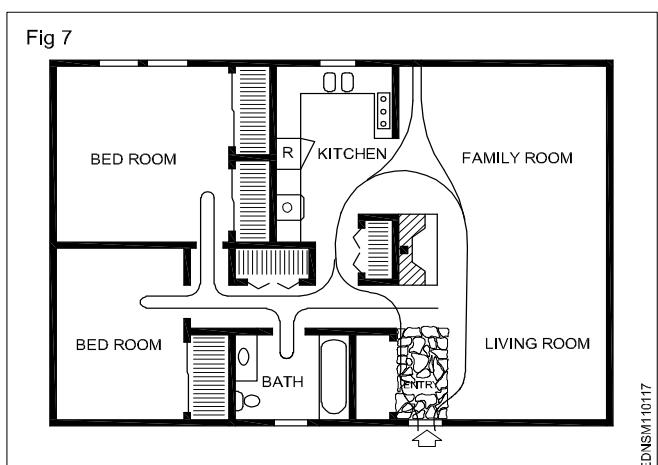
EDNSM110115
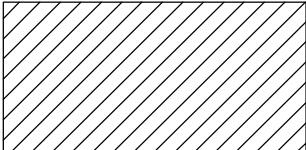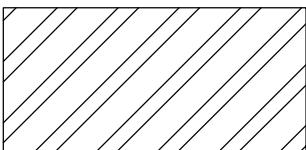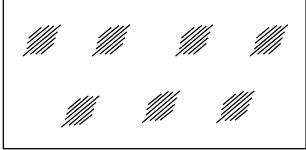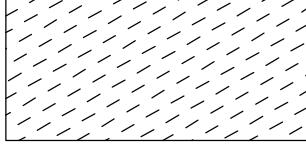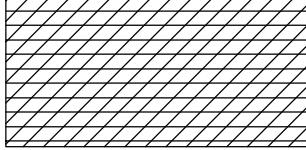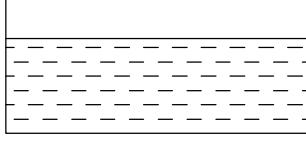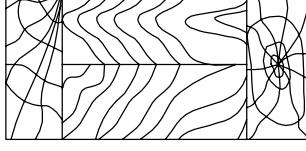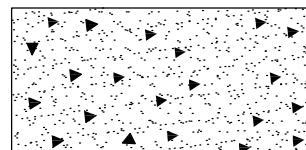
Electronics Engineering Drawing

Audio amplifier (Fig 6)

Fig 6

C1   +

47..., 100μF
16V

INPUT C2

0.22

7

2   6

IC1
LM386

3   5
       8
     1
P1
10K

4

100Ω R1

C3

0.47

+

6...12V

C4
220...,470μF
16V

+

SPKR
8....16Ω

1   8

AUDIO AMPLIFIER

EDNSM110116

Civil Engineering Drawing (Fig 7)

Fig 7

BED ROOM

R KITCHEN

FAMILY ROOM

BED ROOM

BATH

ENTRY

LIVING ROOM

EDNSM110117

3

Conventions

TYPE	CONVENTION	MATERIALS
Metals		Steel, Cast Iron, Copper and its Alloys, Aluminium and its alloy, etc
		Lead, Zinc, Tin, White-metal, etc.
Glass		Glass
Packing and Insulating materials		Porcelain, Stoneware, Marble, Slate etc
		Asbestos, Fibre, Felt, Synthetic resin products, Paper, Cork, Linoleum, Rubber, Leather, Wax, insulating & Filling Materials etc
Liquid		Water, Oil, Petrol, Kerosene etc
Wood		Wood, Plywood etc
Concrete		Concrete

Sizes and layout of drawing sheets

Size of drawing sheets (in mm): While being worked on or handled, the drawing sheets are prone to tear along the edges. So slightly larger(untrimmed) sheets are preferred. They are trimmed afterwards. IS:10811:1983 lays down such as designation of preferred trimmed and untrimmed sizes.

Designation of sheets: The drawing sheets are designated by symbols such as A0, A1, A2, A3, A4 and A5. A0 being the largest and A5 is smallest. 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 between a side of a square and its diagonal.

TABLE 1

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

Special elongated series increasing its widths, double, treble etc. are denoted 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
A3 x 3	420 x 891
A3 x 4	420 x 1189
A4 x 3	297 x 630
A4 x 4	297 x 841
A4 x 5	297 x 1051

Fig 1 & 2 shows how the sheet sizes are formed by halving/ doubling and similarity of format.
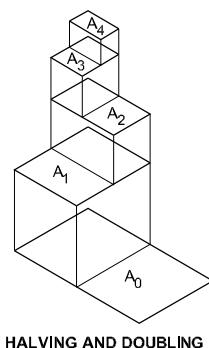
White drawing papers that do not turn yellow on exposure to air are used for finished drawings, maps, charts and drawings for photographic reproductions.

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

Quality drawing paper: The drawing papers should have sufficient teeth or grain to take the pencil lines and withstand repeated erasing.
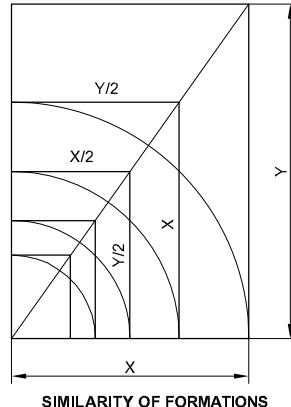
To get uniform lines, backing paper is to be placed on the drawing board before fixing drawing/tracing paper,. Before starting the drawing, the layout should be drawn. (Ref: IS:10711)

Fig 1

HALVING AND DOUBLING

Fig 2

SIMILARITY OF FORMATIONS
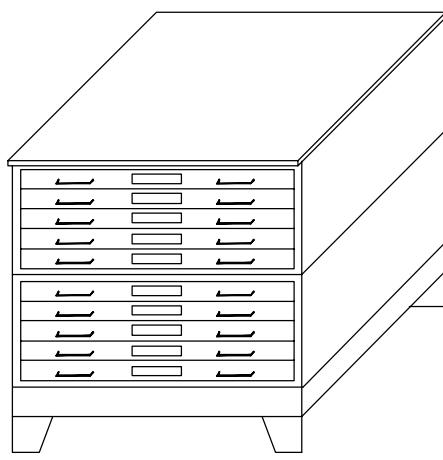
The following is the method of folding printed drawing sheets as recommended by BIS. (Fig 3)

Method of folding of printed drawing sheets as per BIS SP: 46-2003

When drawings sheets are in more numbers, they have to be folded and kept in order to save the trace required for preserving them (Fig 4).

Fig 4

DRAWING CABINET

5
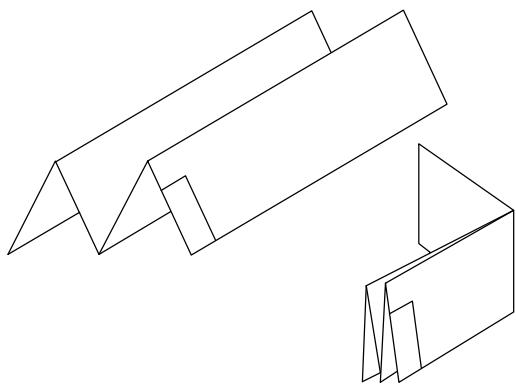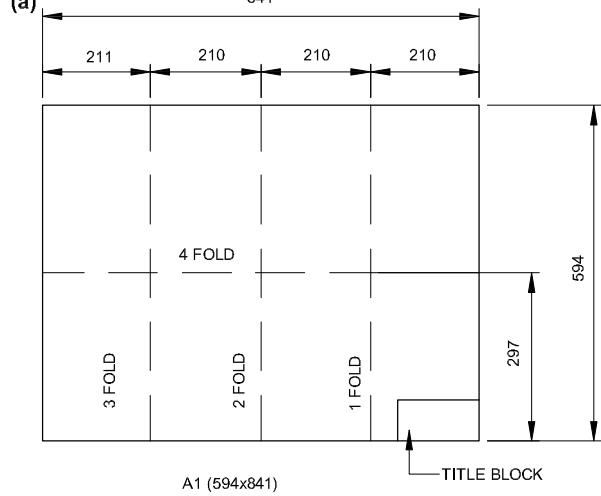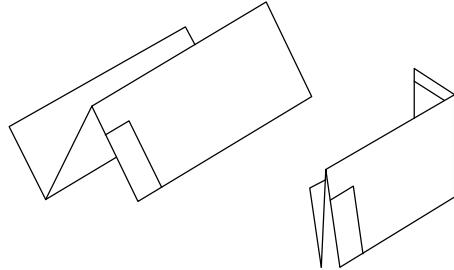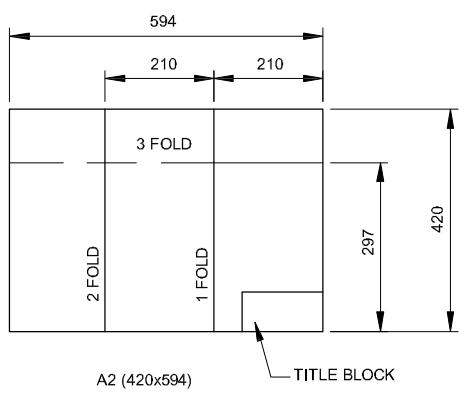
Method of folding printed drawing sheets (Fig 3)
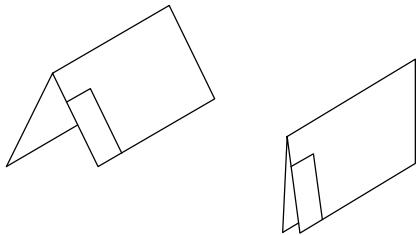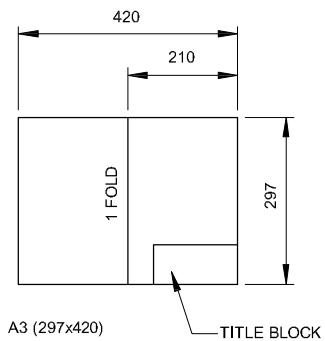
Fig 3
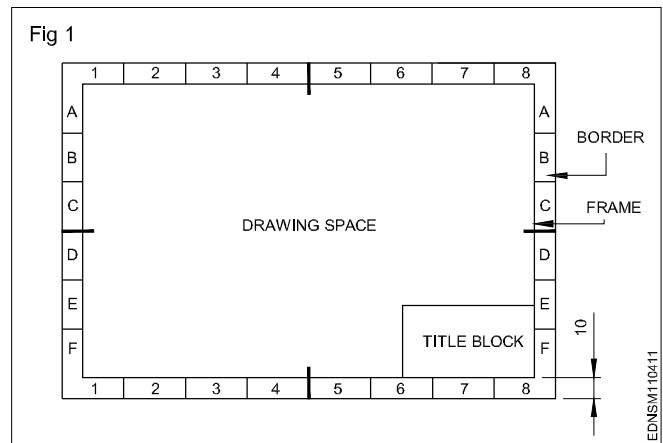
(a)

841

211 | 210 | 210 | 210

4 FOLD

594

297

3 FOLD | 2 FOLD | 1 FOLD

TITLE BLOCK

A1 (594x841)

(b)

594

210 | 210

3 FOLD

420

297

2 FOLD | 1 FOLD

TITLE BLOCK

A2 (420x594)

(c)

420

210

1 FOLD

297

TITLE BLOCK

A3 (297x420)

EDNWL110313

METHOD OF FOLDING OF PRINTED DRAWING SHEETS
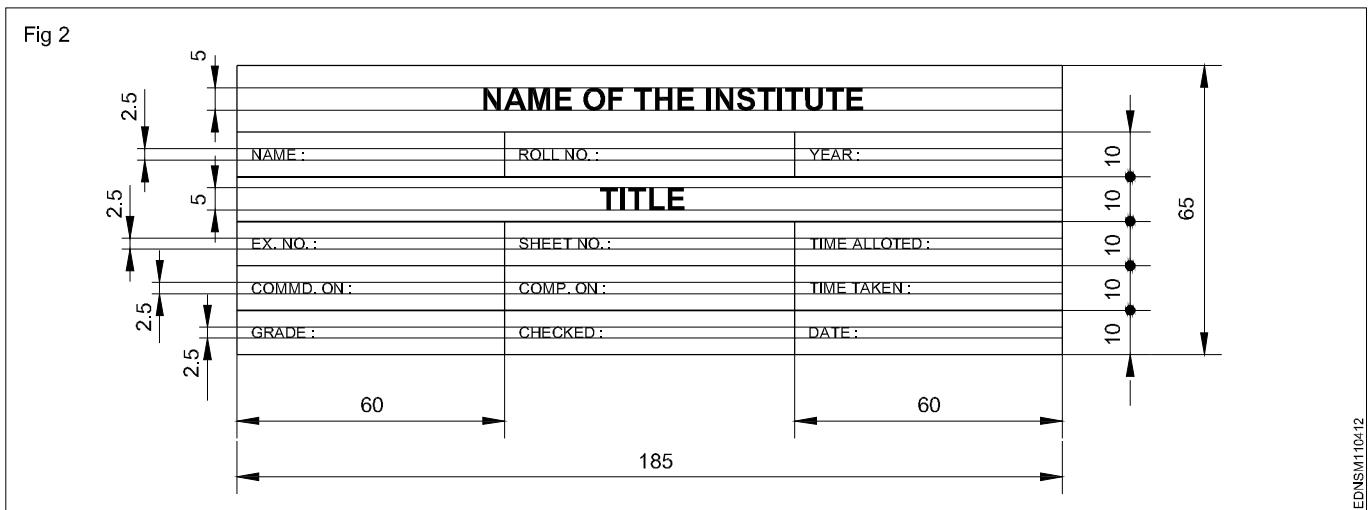
# Title block, its position and content

Layout of drawing sheet:
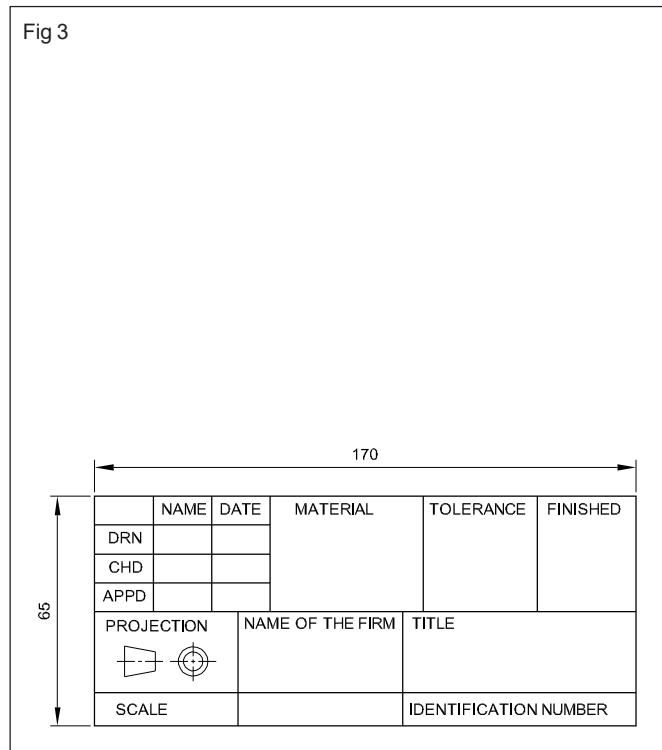
As a standard practice sufficient margins are to be provided on all sides of the drawing sheet. The drawing sheet should have drawing space and title space. A typical layout of a drawing sheet is shown in the (Fig 1 & 2).
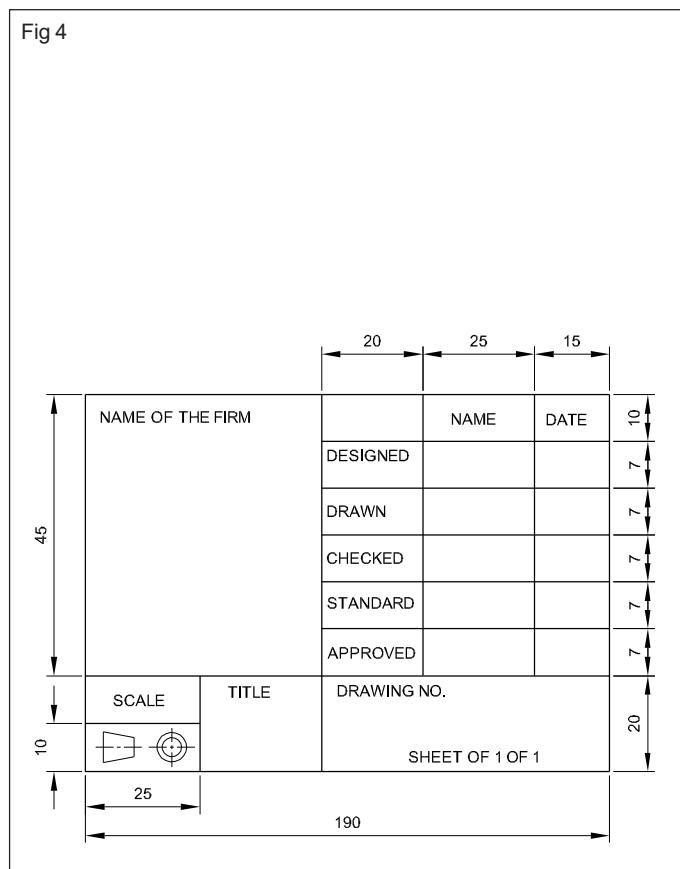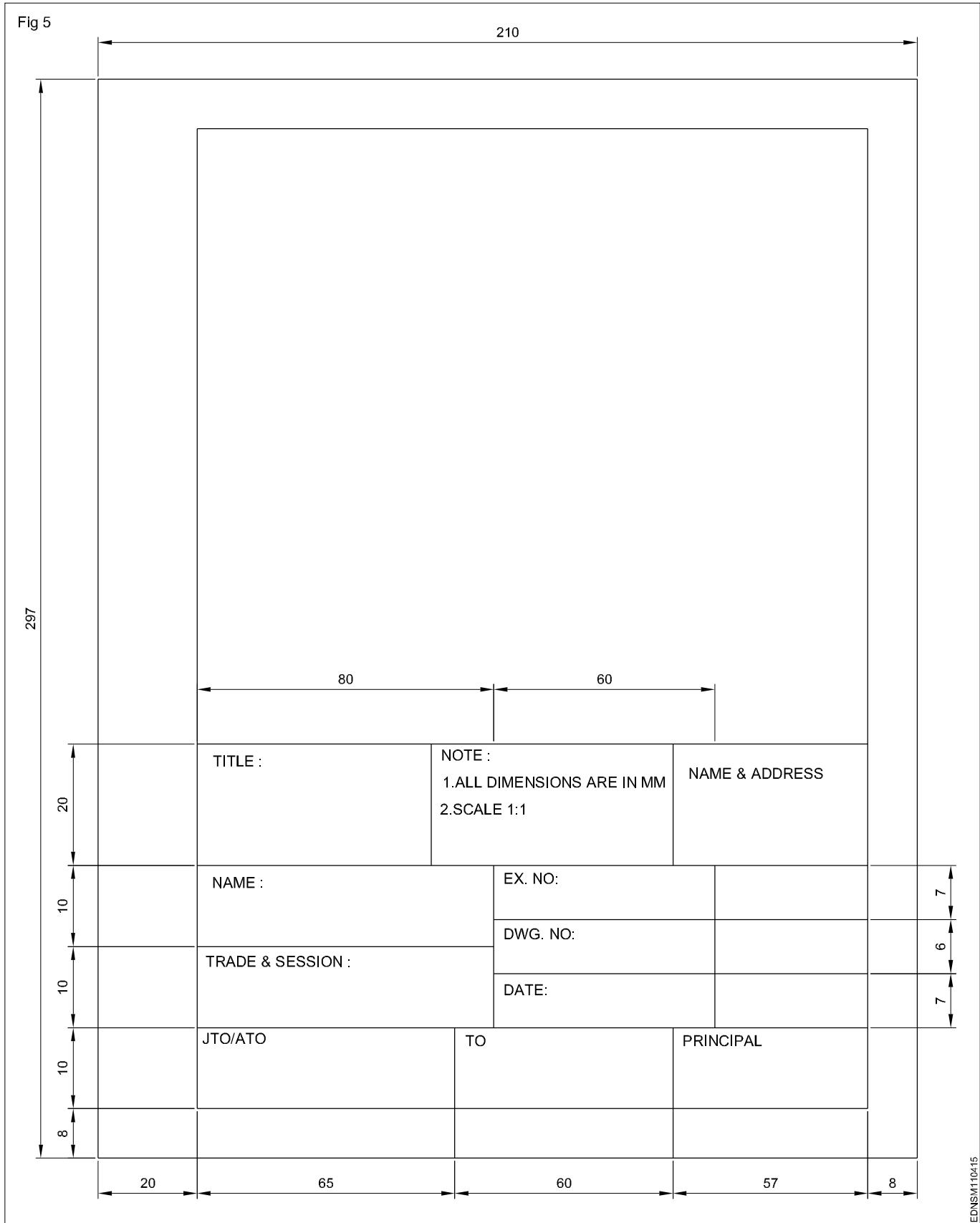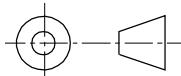
Fig 1

Title Block - 1

Fig 2

Title Block - 2

Fig 3

	NAME	DATE	MATERIAL	TOLERANCE	FINISHED
DRN					
CHD					
APPD					

PROJECTION | NAME OF THE FIRM | TITLE

SCALE | | IDENTIFICATION NUMBER

170
65

Title Block - 3

Fig 4

NAME OF THE FIRM			NAME	DATE	10
		DESIGNED			7
		DRAWN			7
		CHECKED			7
		STANDARD			7
		APPROVED			7

SCALE | TITLE | DRAWING NO.

SHEET OF 1 OF 1

20 25 15
45
10
25
190
20

Title Block - Position and content - 1

Fig 5

TITLE :	NOTE : 1.ALL DIMENSIONS ARE IN MM 2.SCALE 1:1	NAME & ADDRESS
NAME :	EX. NO:	
TRADE & SESSION :	DWG. NO:	
	DATE:	
JTO/ATO	TO	PRINCIPAL

210

297

80

60

20

10

10

10

8

20   65   60   57   8

7

6

7

EDNSM110415

Title Block - Position and content - 2

Fig 6

Item Reference on Drawing Sheet

05	TIGHTENING PIN	01	MILD STEEL	
04	WORK PIECE	01	ANY MATL.	
03	SCREW ROD	01	STD.	
02	"U" CLAMP	01	CAST IRON	
01	"V" BLOCK	01	CAST IRON	
PART NO	DESCRIPTION OF ITEM	QTY/ASSY	MATERIAL	REMARKS
BILL OF MATERIALS				

The drawing sheet on which the drawings to be prepared should be prepared first by following the procedure given below:
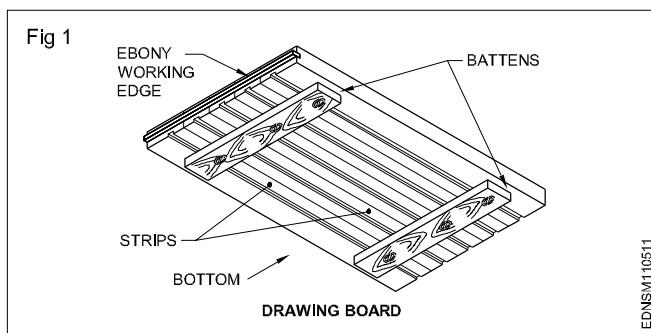
1 Take A4/A3 drawing sheet.

2 Mark the borders and draw the title block as mentioned.

3 Follow the same procedure for A3 drawing sheet where the title block is to be drawn right side bottom corner and the border dimensions remain same.

4 Title block to be drawn whenever the title of the drawing changes. Eg. for the geometrical construction chapter the title block may be drawn in the first sheet only where as on the remaining sheets borders to be drawn before they are used for preparing drawings.

Drawing instruments

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

Drawing board (Fig 1): Drawing board is one of the main item of equipment for 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

DRAWING BOARD

One of the shorter edges of the drawing board is provided with an "ebony edge" (hardwood) fitted perfectly straight.

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

Sl. No.	Designation	Size (mm)
1	D0	1500 x 1000 x 25
2	D1	1000 x 700 x 25
3	D2	700 x 500 x 15
4	D3	500 x 350 x 15

The working edge (ebony) must be straight.

Now-a-days 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.

'T' Square: It is of 'T' shape, made of well-seasoned wood. It has two parts., head/stock and blade. One of the edges of the blade is the working edge. The blade is screwed to this head such that the working edge is at a right angle to the head. (Fig 2a)
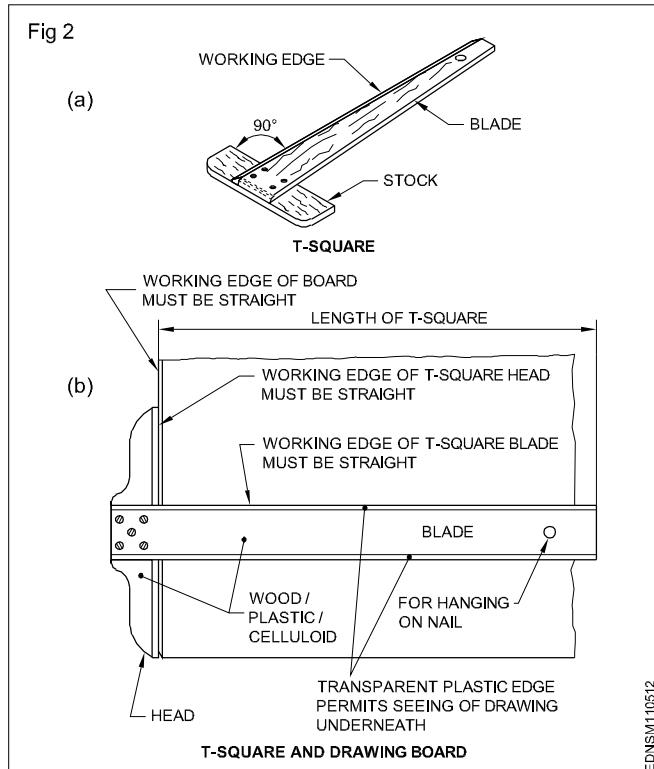
The standard 'T' square is designated as follows with dimensions shown in mm; as per IS:1360-1989.

Sl. No.	Designation	Blade length
1	T0	1500
2	T1	1000
3	T2	700
4	T3	500

The 'T' square is used with its head against the ebony edge of the drawing board to draw horizontal lines, and parallel lines and to guide/hold the set squares, stencils etc.
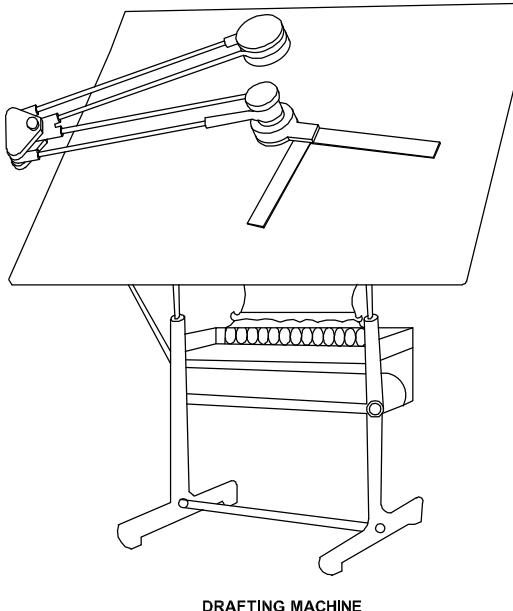
Fig 2b shows how the 'T' square is used.

'T' square should never be used as a hammer or as a guide for trimming papers.

Fig 2

T-SQUARE AND DRAWING BOARD

Drafting in the machine (Fig 3): It serves the functions of a Tee square, set square, protractor and scale. They come in different sizes and have a pattern called the 'Pantograph' type. It is fitted on the top left side, edge of the drafting board, mounted on an adjustable frame or table. It requires a large area of working place. The angle of the drafting board can be adjusted by the pedal operating system. There are two counterweights to balance the angular position of the board and the drafting head. It is more suitable for the production drawing office.

Fig 3

DRAFTING MACHINE

On the other end, a protractor head H with swivelling and locking arrangement is fitted with two scales at right angles.
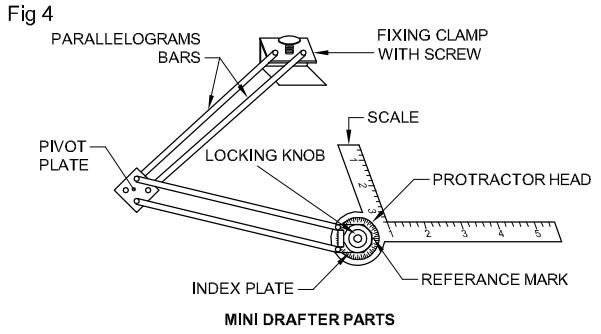
The protractor head has a spring-loaded clutch relieving handle, which rotates and locks at 15° intervals automatically. For setting any angle other than multiples of 15°, the clutch spring is released and by rotating the centre knob, the zero line is set to the required angle and the friction clutch knob is tightened. It is capable of rotating 180°, 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 an error in measuring 90° between them.
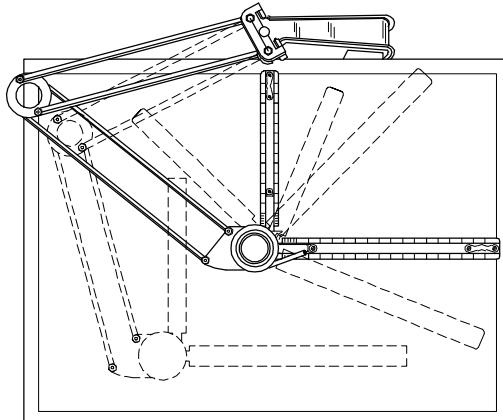
The mini drafter is an important device used for making drawing quickly & accurately. This instrument has the combination of T-square, set square, protractor and scales, it helps to draw the drawings at a faster rate. (Fig 4,5 & 6)

Fig 4

PARALLELOGRAMS BARS
FIXING CLAMP WITH SCREW
SCALE
PIVOT PLATE
LOCKING KNOB
PROTRACTOR HEAD
INDEX PLATE
REFERANCE MARK

MINI DRAFTER PARTS

Fig 5

MINI DRAFTER ADJUSTMENT

Fig 6

FIXING CLAMP
DRAWING SHEET
ALIGNED TO BOTTOM BORDER LINE
MINI DRAFTER
LOCKING KNOB
DRAWING BOARD

FIXING MINI DRAFTER
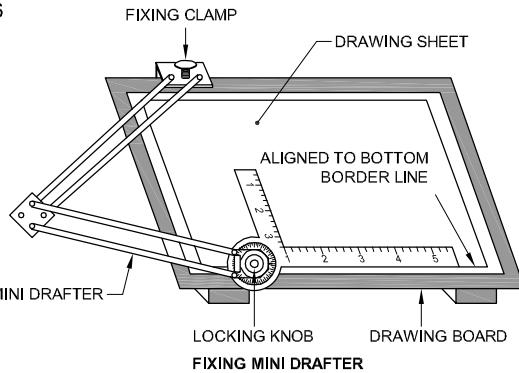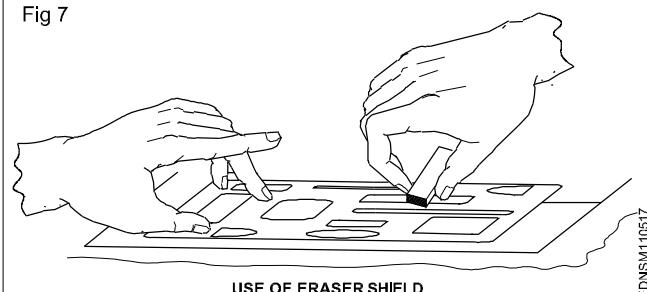
Erasing shield: When, on a drawing, if a part of a line or some lines among many other lines needs to be erased or modified, in a normal way erasing will damage the other nearby lines. In such a situation an erasing shield is effectively useful. It is a thin metallic sheet having small openings of different sizes and shapes. A suitable opening is aligned to the line to be erased and the line is removed by the eraser. (Fig 7)

Fig 7

USE OF ERASER SHIELD
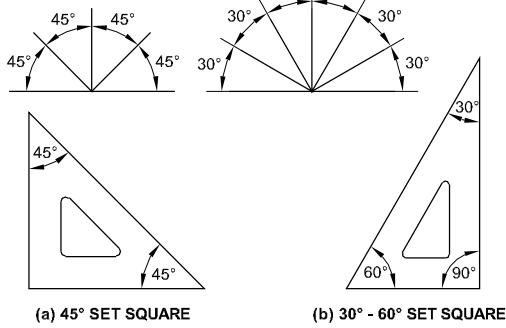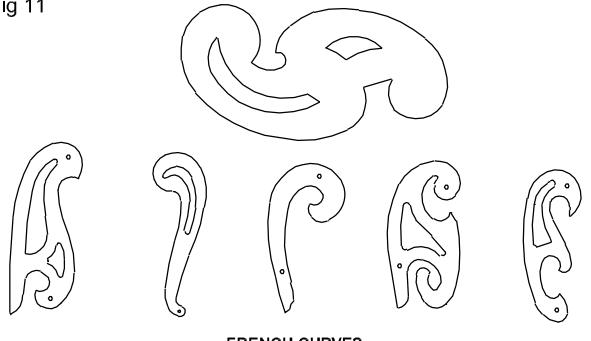
Set square (IS:1361-1988): Transparent celluloid /Plastic set squares are preferred and are commonly used rather than ebonite ones. They are two in number, each having one corner with 90°. The set square with 60° & 30° of 250 mm long and 45° of 200mm long is convenient for use. (Fig 8)

Fig 8

(a) 45° SET SQUARE

(b) 30° - 60° SET SQUARE
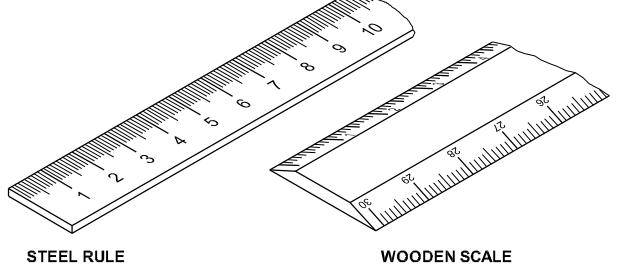
Scales: Scales are used to transfer and or measure the dimensions. They are made of wood, steel, ivory, celluloid or plastic, stainless steel scales are more durable. different types of scales used are shown in Fig 9. They are either flat, bevel-edged or triangular cross-sections. Scales of 15cm long, 2cm wide or 30cm long 3.5cm wide are in general use.

Fig 9

STEEL RULE

WOODEN SCALE
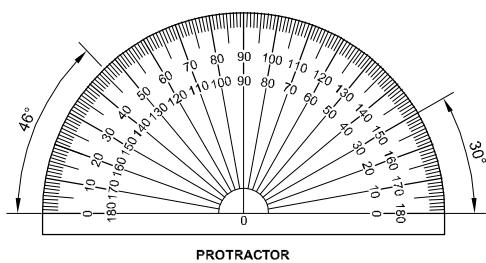
Protractor: A protractor is an instrument for measuring angles. It is semi-circular or circular and is made of a flat celluloid sheet.

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

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

Fig 10

PROTRACTOR
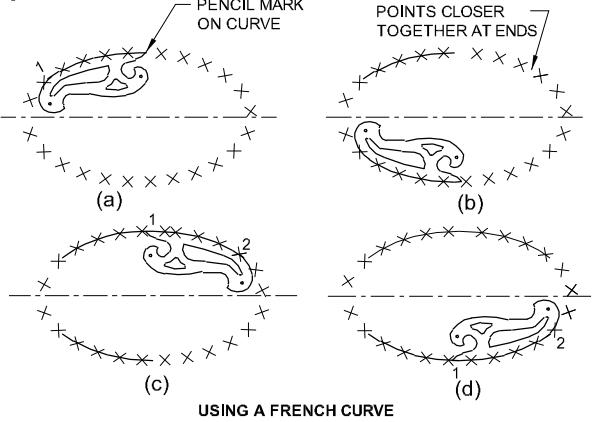
French curves (Fig 11)

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/ arcs (which cannot be drawn by a compass) with ease. To draw a smooth curve using a french curve first set it by trial against a part of the line to be drawn, then shift it to the next portions.

Fig 12 shows how to use the french curve and draw smooth curves. They are made of transparent celluloid (no bevel edge).

Fig 11

FRENCH CURVES

Fig 12

PENCIL MARK ON CURVE

POINTS CLOSER TOGETHER AT ENDS

(a)

(b)

(c)

(d)

USING A FRENCH CURVE
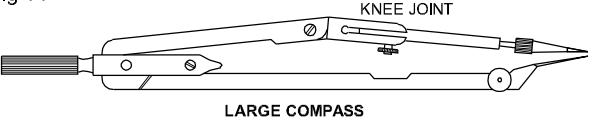
An instrument box contains the following: (Fig 13a to h)

• Large compass (with attachment facility) (a)

• Large divider (b)

• Bow compasses(pencil/ink), bow divider (c)

• Lengthening bar (d)

• Pen point for attachment (e)

• Screwdriver (f)

• Lead case (g)

• Liner (h)

Large compass (Fig 14): It has a knee joint in one leg that permits the insertion of a pen or pencil point or attaching a lengthening bar with a pen or pencil point attached to it. It is used for drawing large circles/arcs and also for taking large measurements.

Fig 14

KNEE JOINT

LARGE COMPASS

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

Large divider: It is used to transfer dimensions and divide lines into several equal parts. Divider with adjustable joints is preferable rather than plain legs. (Fig 15)

Fig 13

DRAWING INSTRUMENTS

Fig 15

DIVIDER

Bow instruments: Bow pencil and bow pen compass are used for drawing circles of approximately 25 mm radius. A bow divider is used for marking or dividing smaller spaces. There are two types (i) Integral legs with spring action (ii) two legs are held with a curved spring on top with a handle on it.
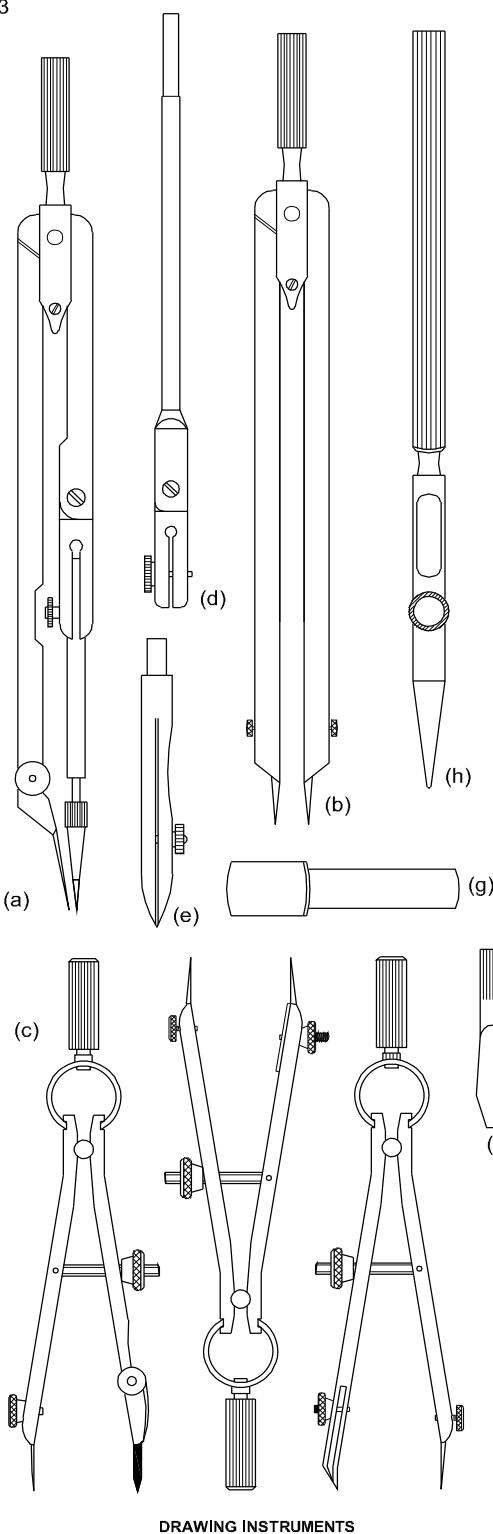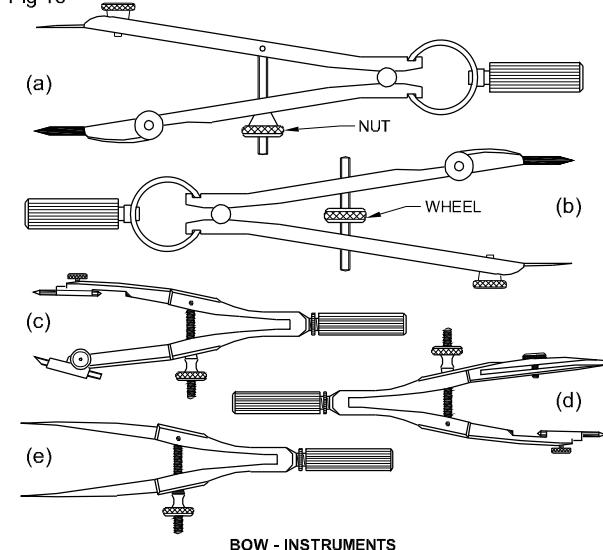
Fig 16 shows different types of bow instruments. Adjustments should be made with the thumb and middle finger.

Fig 16

BOW - INSTRUMENTS
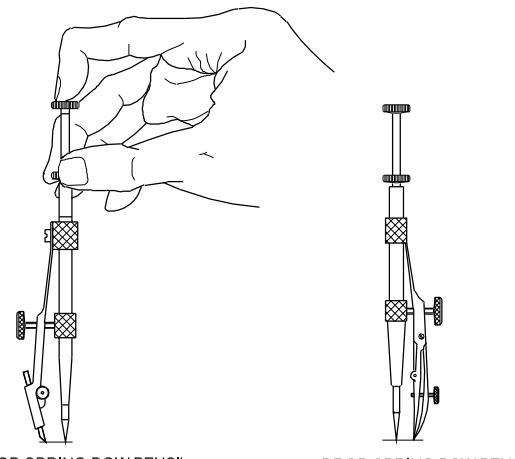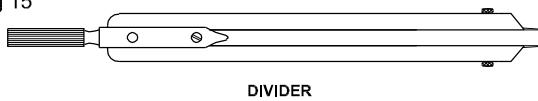
Drop spring bow pencil and pen (Fig 17)**:** Drop spring bow pencil and pen are designed for drawing multiple identical small circles. Example: rivet holes, drilled/reamed holes. The central pin is made to move freely up and down through the tube attached to the pen or pencil unit.

Fig 17

DROP SPRING BOW PENCIL   DROP SPRING BOW PEN

DROP SPRING BOW INSTRUMENT

Inking pen or liner or ruling pen (Fig 18): It is used to ink the straight lines drawn with the instruments but never for freehand lines or lettering.

Fig 18

RULING PENS

Lengthening bar (Fig 19): To draw larger circles, it is fitted to the compass. The pencil point or pen point is inserted into its end.

Fig 19

LENGTHENING BAR

EDNSM11051J

Replaceable spare pencils, pens and needle points for the compass are available in the instrument box.

Screwdriver (Fig 20): Used for adjusting the screws of the instruments.

Fig 20
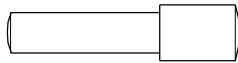
SCREW DRIVER

EDNSM11051K

Lead case (Fig 21): Lead case is the box for holding the pencil leads.

Fig 21
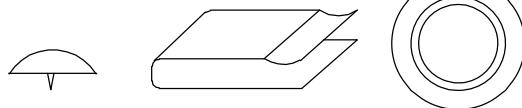
LEAD CASE

EDNSM11051L

Pin, Clip, Cello tape: Drawing sheet should be fastened onto the drawing board firmly temporarily so that it does not shake during preparing the drawing. For this purpose, the pins, clips and cello tapes are used (Fig 22)

Fig 22
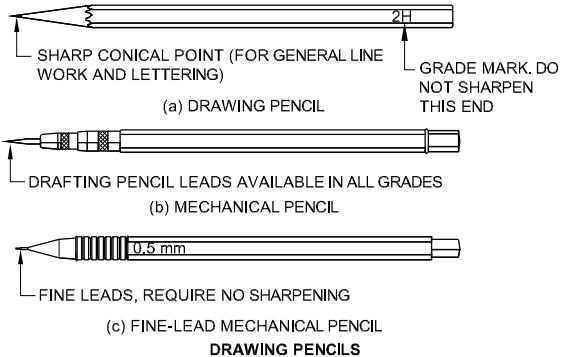
PIN,CLIP AND TAPE

EDNSM11051M

Pencils, Grade and Selection (Fig 23)

Fig 23

SHARP CONICAL POINT (FOR GENERAL LINE WORK AND LETTERING)

2H

GRADE MARK. DO NOT SHARPEN THIS END

(a) DRAWING PENCIL

DRAFTING PENCIL LEADS AVAILABLE IN ALL GRADES

(b) MECHANICAL PENCIL

0.5 mm

FINE LEADS, REQUIRE NO SHARPENING

(c) FINE-LEAD MECHANICAL PENCIL

DRAWING PENCILS

EDNSM11051N

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

The hardest pencil is 9H grade and the softest pencil is 7B grade. The selection of the grade of pencils depends on the type of line work required and the paper on which it is used.

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

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

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). Leads can be replaced as per the required grade of hardness. They produce lines of uniform width without sharpening.

Lines - Types and applications in drawing

Drawings are made up of different types of lines. Just a language with alphabet and grammar.

Lines of different thicknesses and features are used for specific use. (Fig 1 and 2)

Technical drawings are drawn with different types of lines. By proper choice and application of lines, product features can be correctly defined in a drawing. Different types of lines recommended for specific applications are given in Table 1.

Table 1
Types of lines and their application

Lines	Description	General applications See figure and other relevant figure	
Fig 1 A ————————— 0.5 B ————————— 0.2	Continuous thick	A1	Visible outlines
		A2	Visible edges
	Continuous thin (straight)	B1	Imaginary lines of intersection
		B2	Dimension lines
		B3	projection lines or extension line
		B4	Leader lines
		B5	Hatching
		B6	Outlines of revolved sections in place
		B7	Short centre lines
		B8	Thread line
		B9	Diagonal line
C ∿∿∿∿∿ 0.2	Continuous thin free hand	C1	Limits of partial or interrupted views & sections, if the limit is not a chain thin
D ⋀⋁⋀⋁ 0.2	Continuous thin (Straight) with zig-zags	D1	Line (See figures)
E – – – – – 0.3	Dashed thick	E1	Hidden outlines
		E2	Hidden edges
F – – – – – 0.2	Dashed thin	F1	Hidden outlines
		F2	Hidden edges
G –·–·–·– 0.2	Chain thin	G1	Centre lines
		G2	Lines of symmetry
		G3	Trajectories
H —·—·— 0.3	Chain thin, thick at ends & changes of direction	H1	Cutting planes
J —·—·—·— 0.5	Chain thick	J1	Indication of lines or surfaces to which a special requirement applies
K —··—··— 0.2	Chain thin double-dashed	K1	Outlines of adjacent 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

1 This type of line is suited for production of drawings by machines.
2 Although two alternatives are available, it is recommended that on any one drawing, only one type of line be used.

In the above range, for craftsmen, 0.5 is preferred. Table 2 shows the 0.5 line range and other lines under this range.

The numbers on the right side of the lines refer to the line thickness in mm.
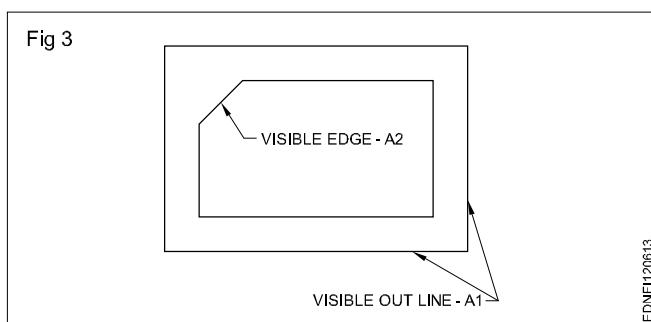
Table 2

Fig 2
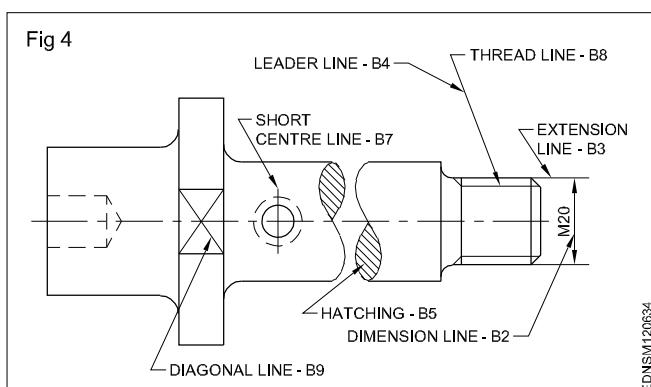
All the views of a component drawn to one particular scale should have the same range of line thickness.

Types of lines: Ten types of lines are used in general engineering drawing as per IS:10714-1983. Which first four types of lines are continuous lines of both thick and thin. (Type A to D)

A continuous thick line (A-type) is used for drawing visible outlines (A1) and visible edges (A2). (Fig 3) These lines are also called object lines

Fig 3
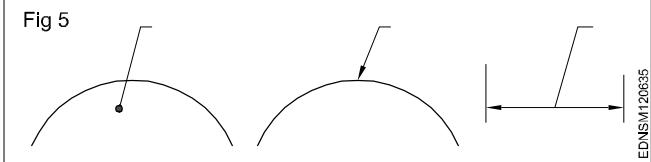
Continuous thin lines (B type): Continues thin lines are used for many applications as stated in Table 1. A few applications of B types of lines are shown in Fig 4.
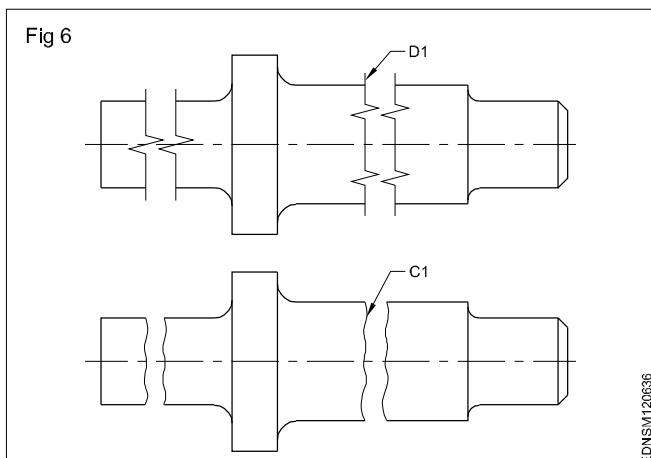
Fig 4

A leader line - B4 (Fig 4)**:** A leader line is a line referring to a feature (dimension, object, outline etc). A leader line should terminate.

• with a dot

• with an arrow head

• without a dot or arrow head (Fig 5)

Fig 5
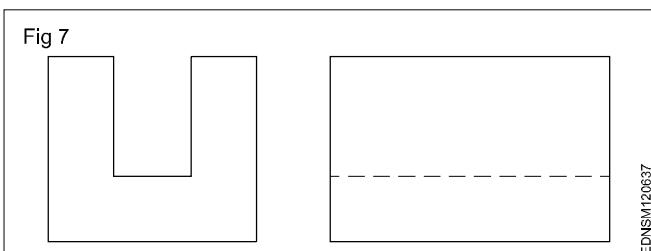
Hatching lines (B5): Hatching lines are the lines inclined parallel lines. The minimum space between these lines should be more than twice the thickness of the heaviest line in the drawing. It is recommended that these spacings should never be less than 0.7 mm. (Fig 4)
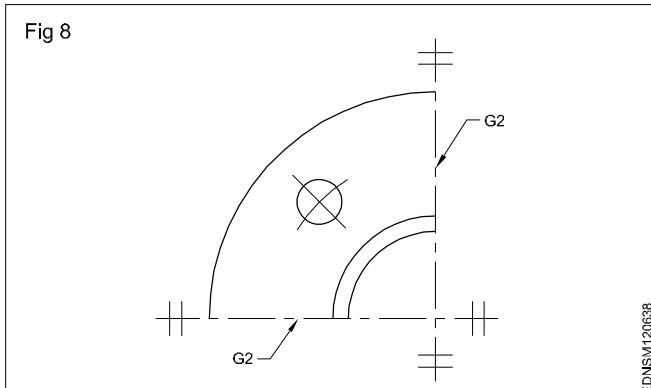
For showing the limits of partial or interrupted views and sections continuous thin freehand lines (C1) or continuous thin straight lines with zig-zag (D1) are used. (Fig 6)

Fig 6

Lines of type E to K in Table 1 are of the non-continuous type. Some of these are thin and some are thick. For hidden lines both thick and thin dashes (E & F type) are available, it is recommended that on anyone drawing, only one type of (Thick or thin) line be used. (Fig 7)

Fig 7
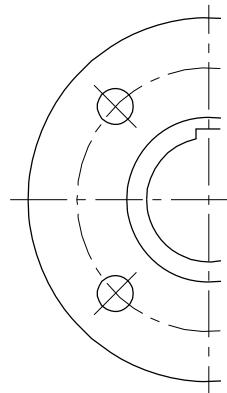
Chain lines (Thin)**:** Chain lines are used for drawing centre lines of circles, cylinders etc. Same lines are also used to show the axis of symmetry in symmetrical objects. The line of symmetry is identified at its ends by two thin short parallel lines drawn at right angles to it. (Fig 8)

Fig 8
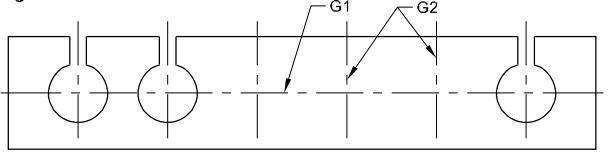
Another method of representing symmetrical shape is to extend the object lines beyond the axis of the symmetry. (Fig 9) In this case, the short parallel lines described above are omitted. The same lines are also used to show the repetitions of features of a component. (Fig 10)

Fig 9
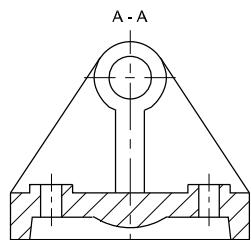
Fig 10

For drawing a sectional view, the plane of cutting is to be shown in another view. The cutting plane (H1) in Table 1 is drawn with a thin chain, thick at the ends and also at the places of direction change. (Figs 11 & 12)

Fig 11
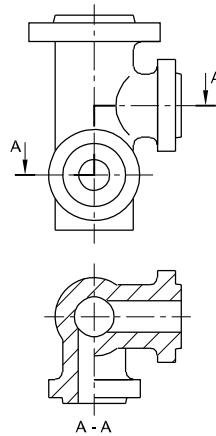
If thick chain lines (J1) in table 1 are drawn on a surface, it indicates some special treatment/application on that surface. (Fig 13)

Chain thin double dashed (K) lines are applied for the following:

K1 - Outlines of adjacent parts (Fig 13)
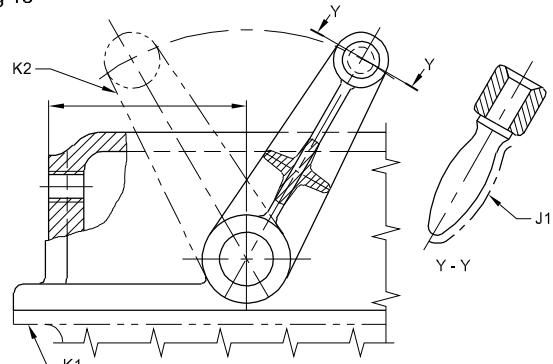
K2 - Alternative and extreme positions of moving parts. (Fig 13)

Fig 12

A - A
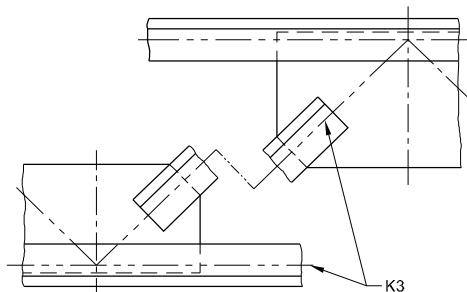
Fig 13

K3 - Centroidal lines (Fig 14)
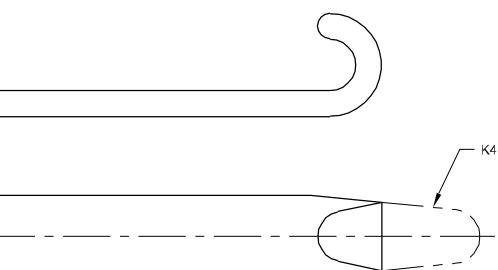
Fig 14

K4 - Initial outlines brefore forming (Fig 15)
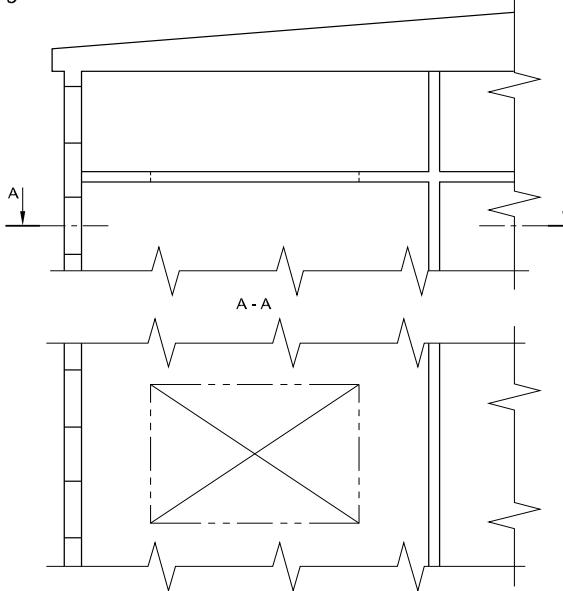
Fig 15

K5 - Parts situated in front of the cutting plane (Fig 16)

Fig 16
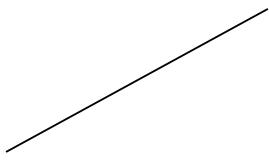
Lines - Drawing lines of a given length (straight, curved), drawing parallel lines, perpendicular lines and methods of division of line segment

There are a lot of ways to define straight and curved lines; the most elaborate way to define them is the following:

• A straight line is a succession of points that are aligned in the same direction. Or in other words, to go from one point to another, we never change direction. (Fig 17)

Fig 17
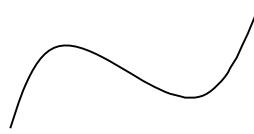
• On the contrary, the points of a curved line do change direction from one point to the next. (Fig 18)

Fig 18
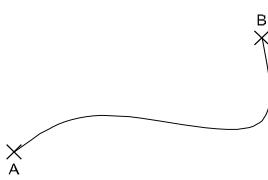
• If there aren't any obstacles, there are plenty of ways to do this…for example: (Fig 19 to 23)
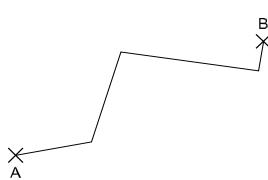
Fig 19
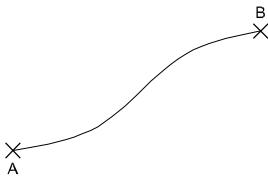
Fig 20
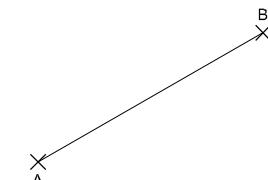
Fig 21
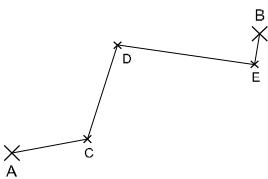
Fig 22
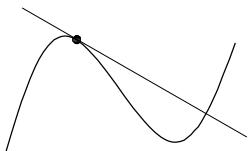
Fig 23

Tangent line (Fig 24)
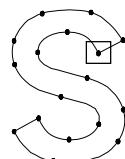
Fig 24

4 Easy ways to draw curved line (Fig 25)

Fig 25

Drawing curved dashed line (Fig 26)

Fig 26
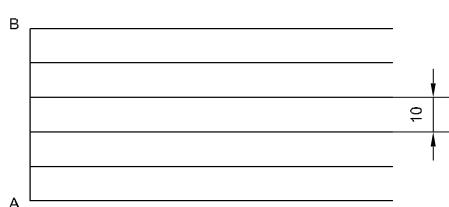
Exercise 1

How to draw six horizontal parallel lines of 50 mm long with 10 mm intervals (Fig 1).

Fig 1

Use a sharpened conical point pencil.

Keep the pencil slightly inclined towards the direction of the movement.
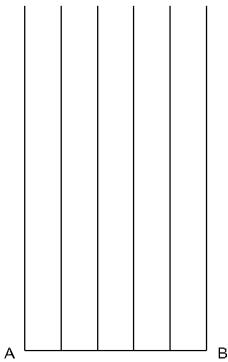
While drawing rotates the pencil to keep the constant thickness.

Maintain uniform pressure on the lead of the pencil.

Exercise 2

How to draw six vertical parallel lines of 50 mm length with 10 mm intervals (Fig 2).

Fig 2
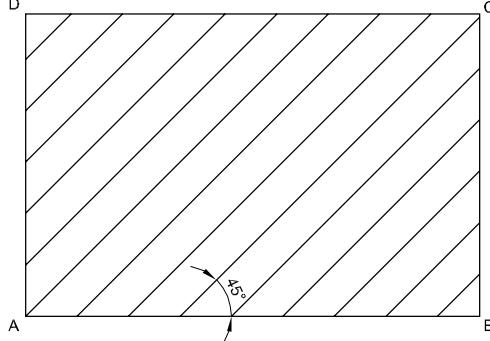
Draw the vertical lines from bottom to top.

Exercise 3

How to draw 45° inclined lines (Fig 3).

Fig 3

Draw lines from bottom to top.
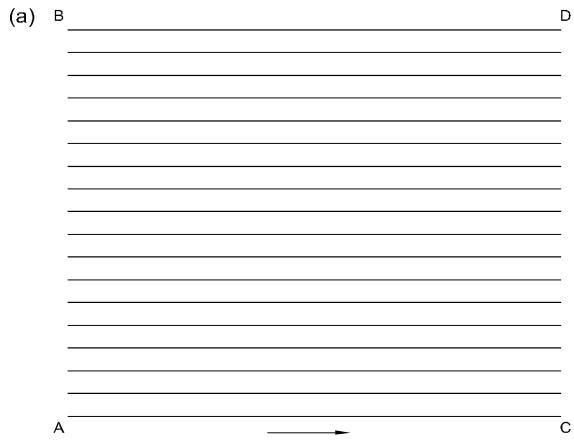
Sketch by free hand

Sketch the following practice No.1 to 3 in A3/A4 sheets.

Practice
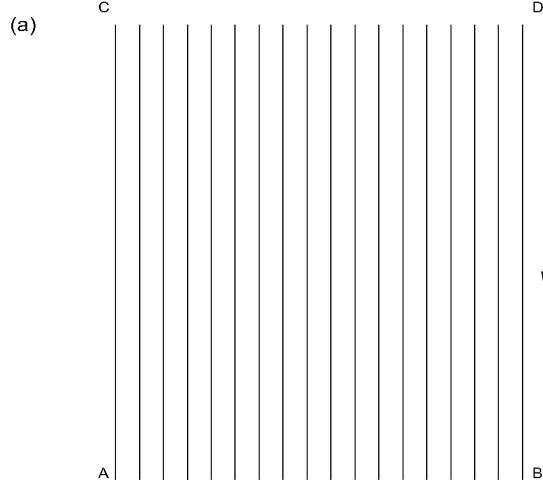
1   To draw horizontal thick and thin lines. (Fig 1)

Fig 1
(a)
(b)

HORIZONTAL
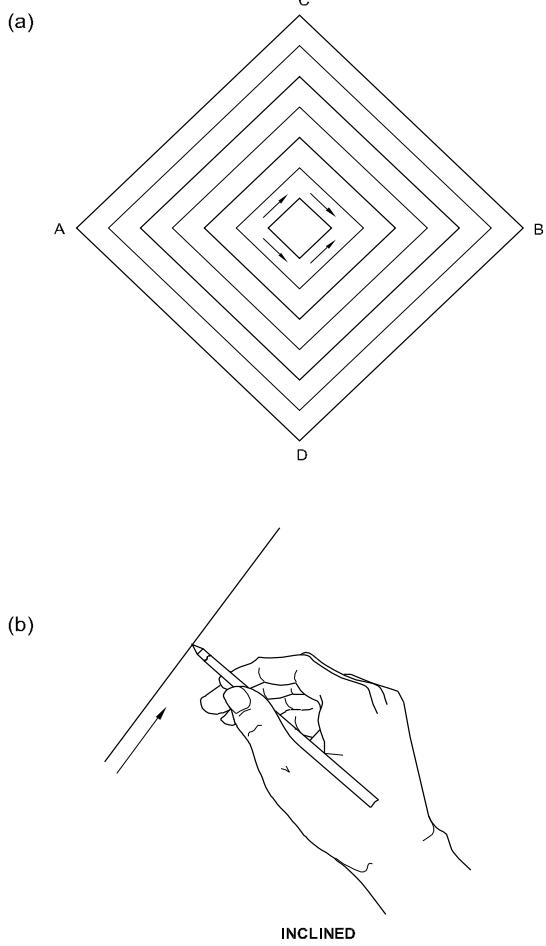
2   To draw vertical thick and thin lines. (Fig 2)

Fig 2
(a)
(b)

VERTICAL

3   Sketch the inclined lines as shown in figure with thick and thin lines. (Fig 3)
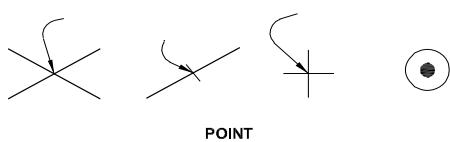
Fig 3
(a)
(b)
INCLINED

Types of lines

A point represents a location in space, having no width or height. It is represented by drawing the intersection of lines or a dot. (Fig 4)

Fig 4
POINT
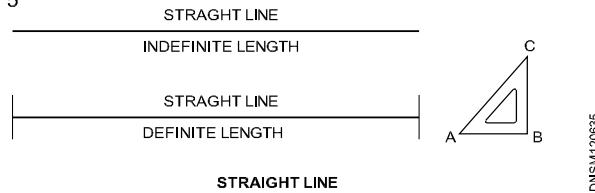
A line is the path of a point when it moves. It has no thickness and is of two types:

i   Straight line and   ii   Curved line
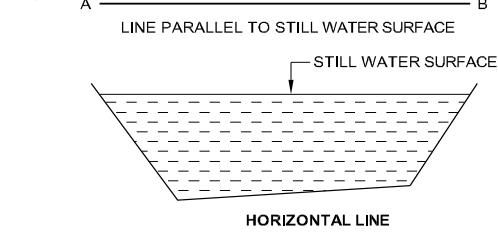
Straight-line: It is the path of a point when it is moving in a particular direction. It has only length and no width. (Fig 5) Also, a straight line is the shortest distance between two points. Straight lines, depending on their orientation are classified as Horizontal, Vertical Inclined or Oblique lines.

Fig 5
STRAGHT LINE
INDEFINITE LENGTH
STRAGHT LINE
DEFINITE LENGTH
STRAIGHT LINE
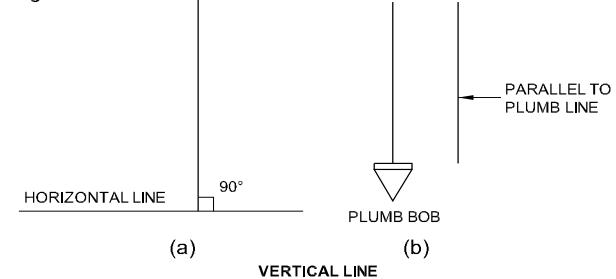
Horizontal line (Fig 6): Horizontal lines are those which are parallel to a horizontal plane. An example of the horizontal plane is the surface of still water. (Fig 6)

Fig 6
A ———— B
LINE PARALLEL TO STILL WATER SURFACE
STILL WATER SURFACE
HORIZONTAL LINE

Vertical line (Fig 7a): Lines that 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 7b)

Fig 7
PARALLEL TO PLUMB LINE
HORIZONTAL LINE
90°
PLUMB BOB
(a)   (b)
VERTICAL LINE

Inclined line or Oblique line: A straight line that is neither horizontal nor vertical is called an inclined line. (Fig 8)

Fig 8
INCLINED OR OBLIQUE LINE
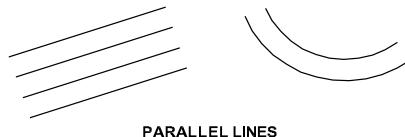
Curved line: It is the path of a point that always changes its direction. Examples of curved lines are shown in (Fig 9).

Fig 9
CURVED LINES
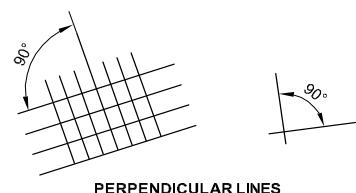
Parallel lines: They are the lines with the same distance between them. They may be straight lines or curved lines Parallel lines do not meet when extended. (Fig 10)

Fig 10
PARALLEL LINES

Perpendicular lines: When two lines meet at 90°, the two lines are said to be perpendicular to each other. One of the lines is called a reference line. (Fig 11)

Fig 11
90°
90°
PERPENDICULAR LINES
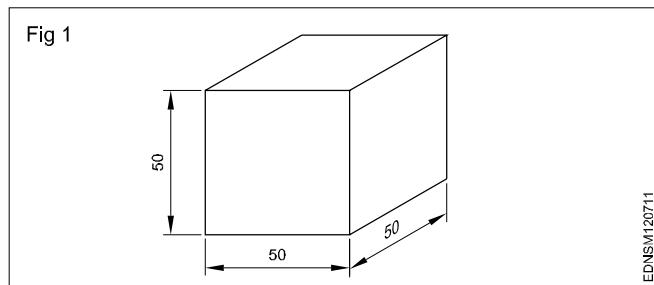
Free hand drawing of - Geometrical figures and block with dimension

Freehand sketching: Apart from making drawing using instruments, often craftsmen will be required to make drawings with their free hand.
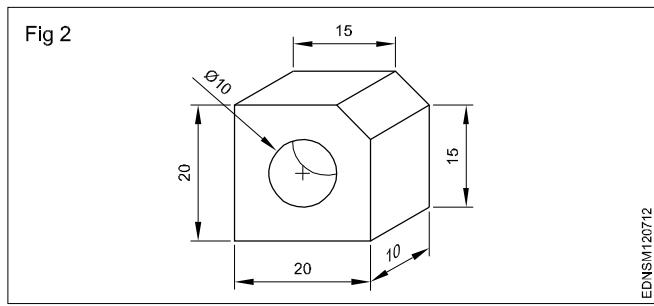
Freehand sketching is the easiest method to express the shape of a piece part or a component by an engineer or craftsman.

Freehand sketches are not usually made to scale. However, they should be as nearly to the proportions as possible.
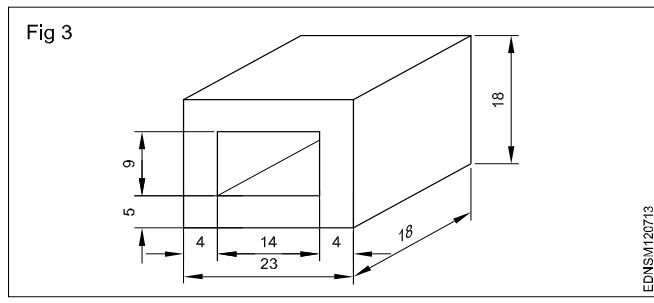
Cube (Fig 1)

Fig 1
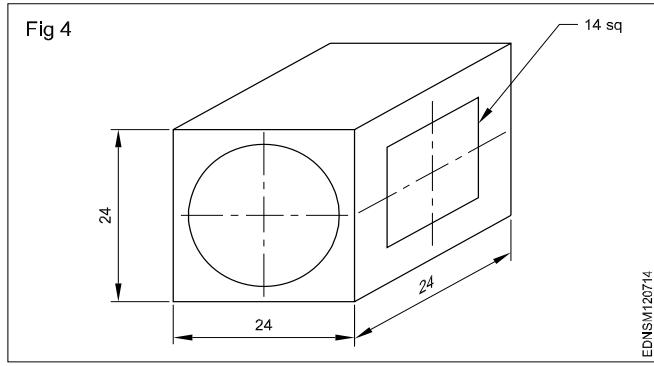
Square block (Fig 2)

Fig 2
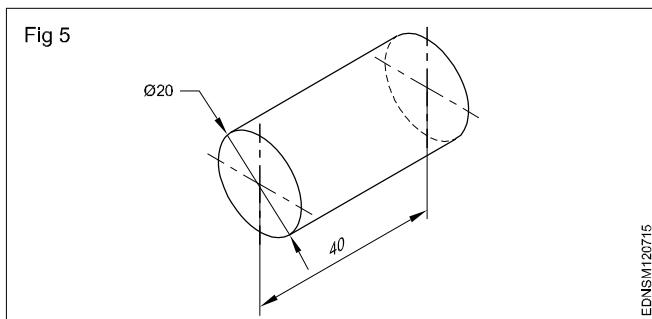
Rectangular block (Fig 3)

Fig 3
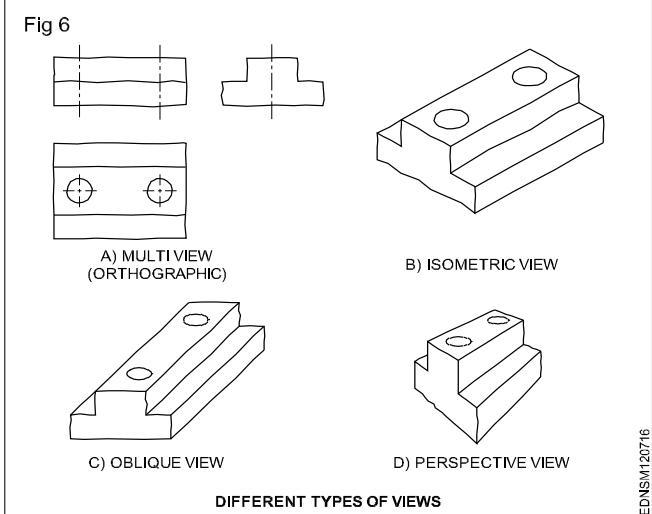
Cube block (Fig 4)

Fig 4

Cylinder (Fig 5)

Fig 5
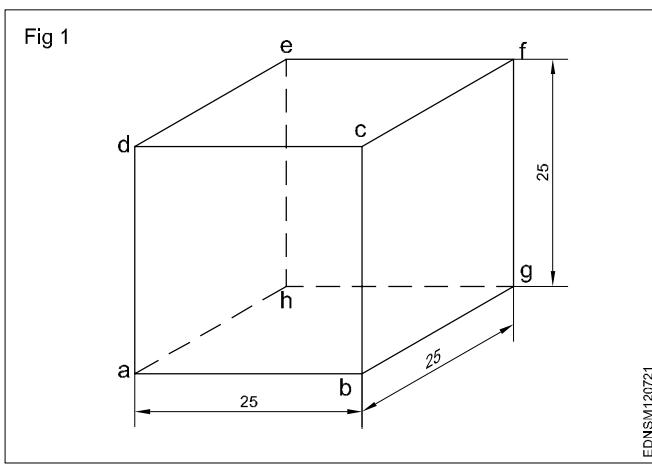
Materials for free hand sketching: A4 size sheet (preferably a pad instead of loose papers) pencils of soft grade. Example H, HB, and a good quality eraser are the only materials required. For drawing different darkness, the pencil points should be sharpened to a conical shape. Fig 6 shows some free hand sketches of different types of views.

Fig 6

A) MULTI VIEW (ORTHOGRAPHIC) B) ISOMETRIC VIEW C) OBLIQUE VIEW D) PERSPECTIVE VIEW

DIFFERENT TYPES OF VIEWS

Procedure

Freehand drawing of solid figures, cubes, cuboids, cone, prism, pyramid, frustum of a cone with dimensions
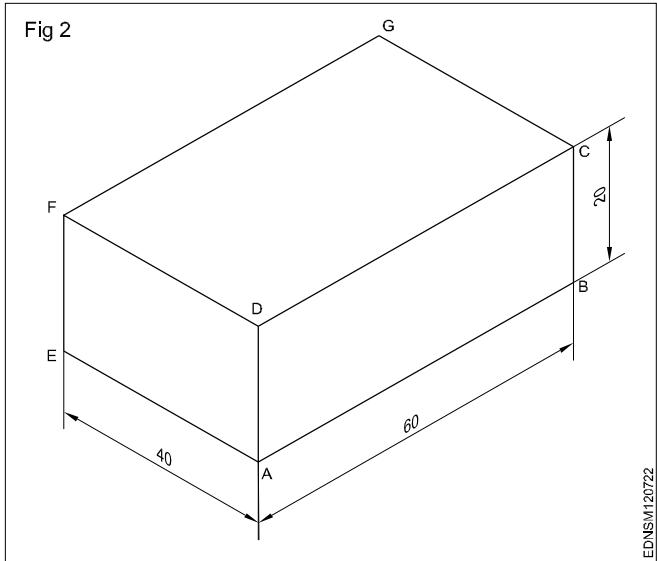
Cube (Fig 1)

Fig 1

- Draw squares of a, b, c and d.

- Draw 30° from points b, c and d for the length of 25mm.

- Mark point g from b, f from c and e from d as shown in the figure.

- Joint all points.

Cuboid (Fig 2)
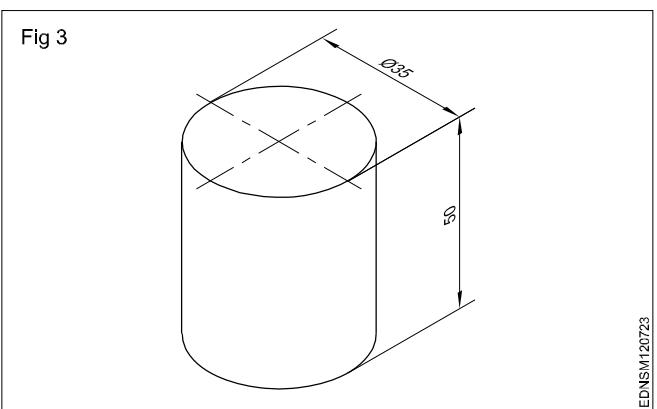
Draw the isometric drawing of a cuboid of base 60 mm x 40 mm and the height of 20 mm. (Fig 2)

Fig 2
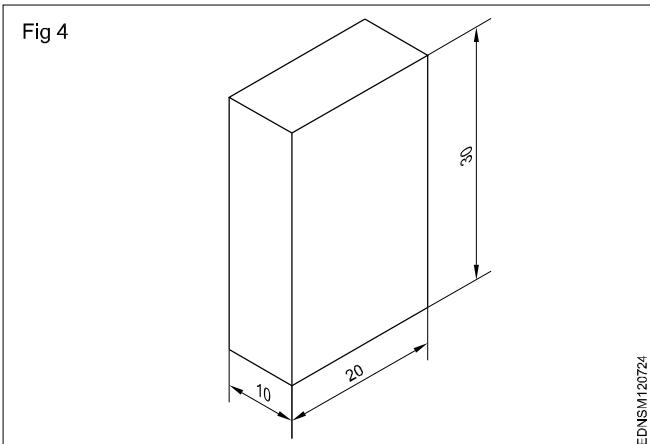
Draw the three isometric axes through the point 'A'.

- Mark AB = 60mm, AE = 40mm and AD= 20mm representing the three sides of cuboid.

- Draw two vertical lines EF and BC parallel to AD from points E and B respectively.

- Similarly, draw two more lines parallel to AB and AE to mark G's interesting point from F and C.

- Draw lines parallel to DC and FG Draw lines parallel to DF and GC.

- Join all the points.

Cylinder (Fig 3)

Fig 3
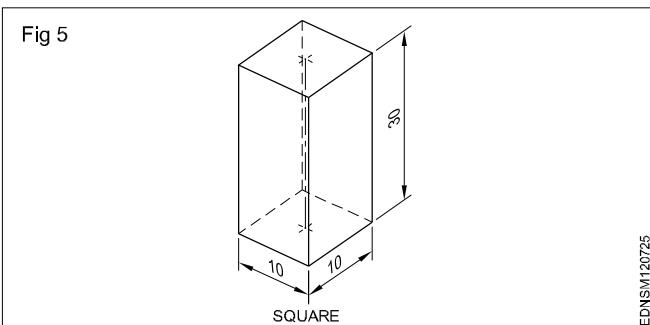
Rectangular prism (Fig 4)
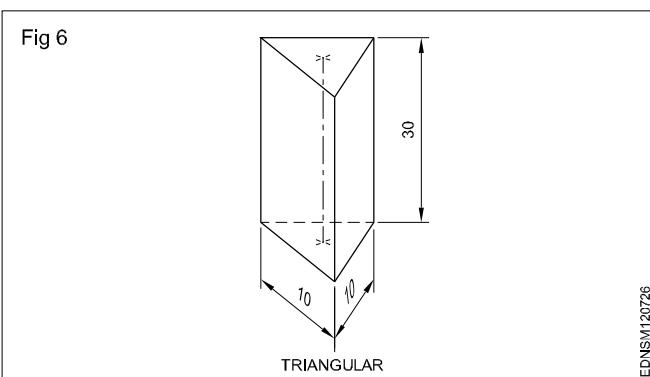
Fig 4

Square Prism (Fig 5)

Fig 5
SQUARE
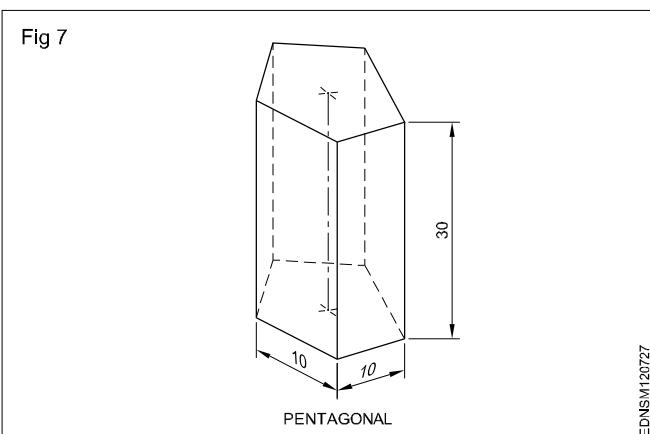
Triangular Prism (Fig 6)

Fig 6
TRIANGULAR
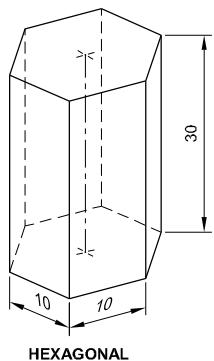
Pentagonal prism (Fig 7)

Fig 7
PENTAGONAL

Hexagonal prism (Fig 8)

Fig 8

HEXAGONAL
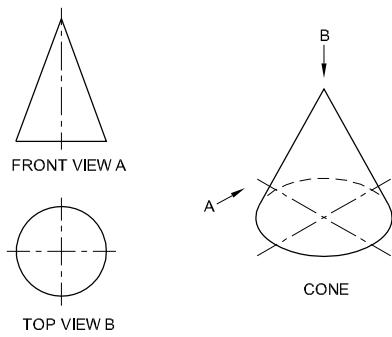
Cone: When a right-angled triangle revolves about one of its sides forming the right angle, a cone is generated. Cone forming has a circular face and a slant curved surface. (Fig 9)

Fig 9

FRONT VIEW A

TOP VIEW B

CONE

Pyramids: Pyramids are polyhedron 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.
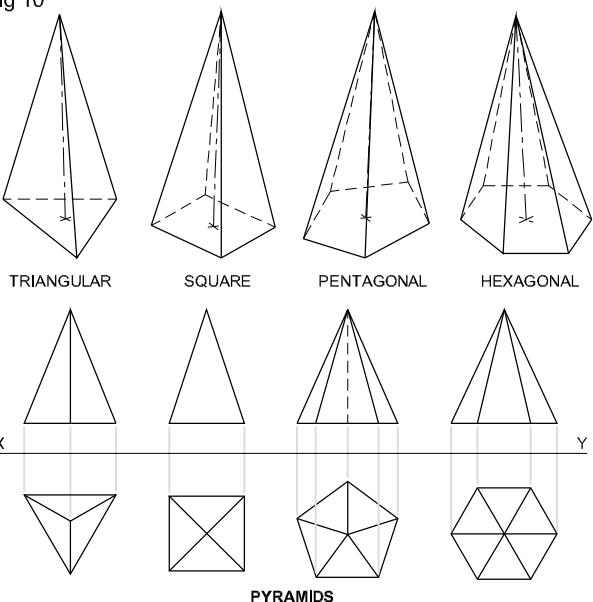
Fig 10 shows some pyramids and their views.

When a semi-circle revolves about its diameter a sphere is generated. A sphere has no flat surface. (Fig 11D)

Frustums: Pyramid/cone is cut parallel to the base and the top portion is removed. The remaining bottom portion is called the frustum of a pyramid/cone.
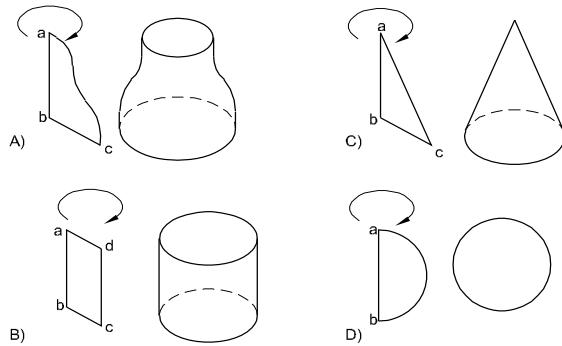
If the cutting plane is at an angle to the axis/base, the pyramids or cones are called "Truncated pyramids or cones".

Fig 10

TRIANGULAR   SQUARE   PENTAGONAL   HEXAGONAL

PYRAMIDS

Fig 11

A)   C)

B)   D)
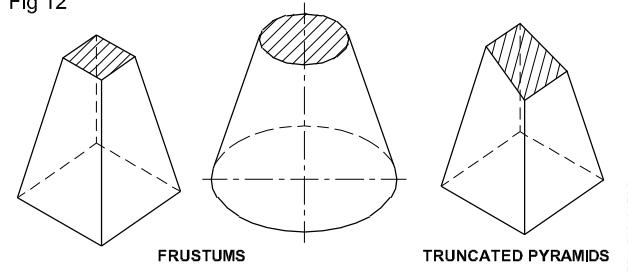
Fig 12 shows frustums and truncated pyramids.

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

Fig 12

FRUSTUMS   TRUNCATED PYRAMIDS
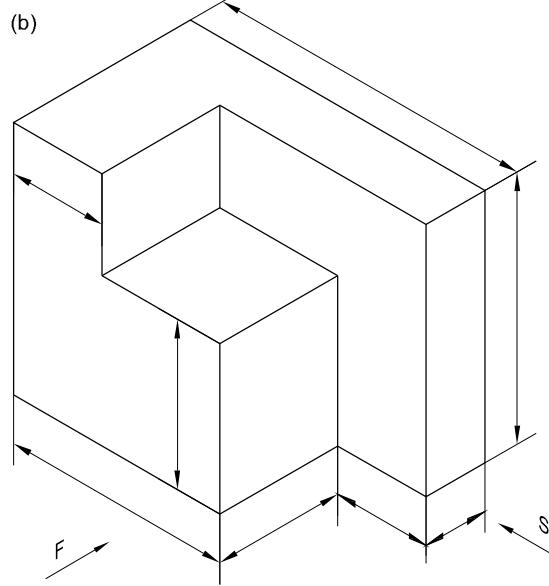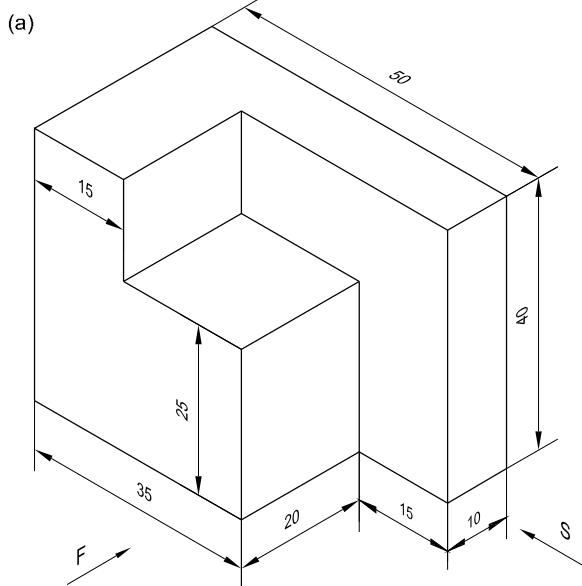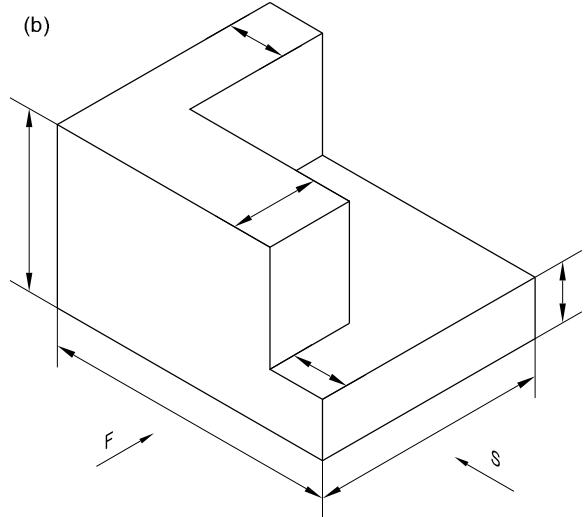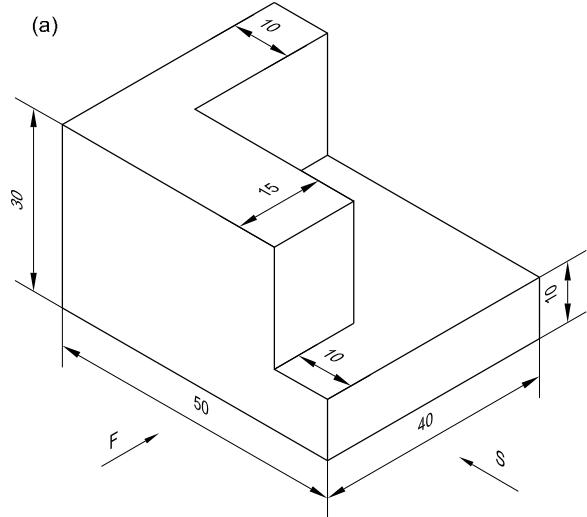
Free hand drawing of - Transferring measurement from the given object to the free hand sketches

Fig 3
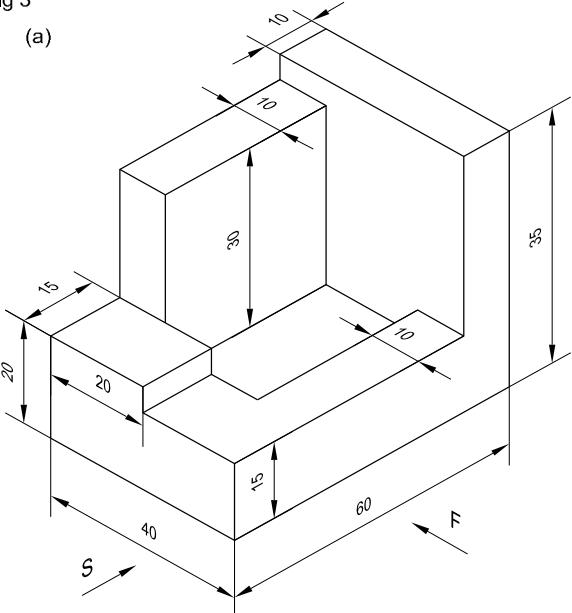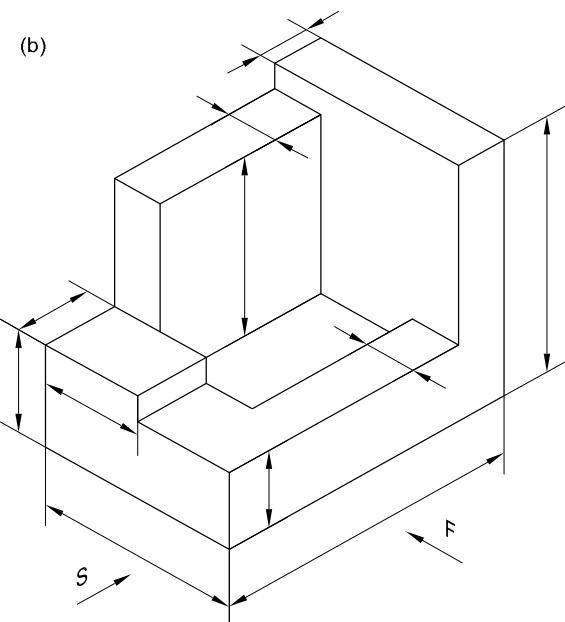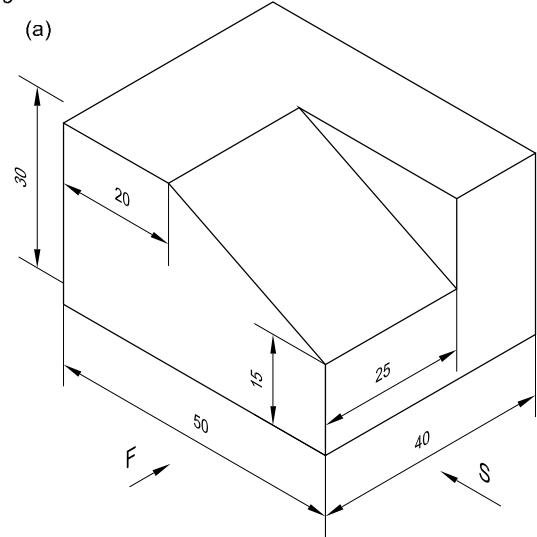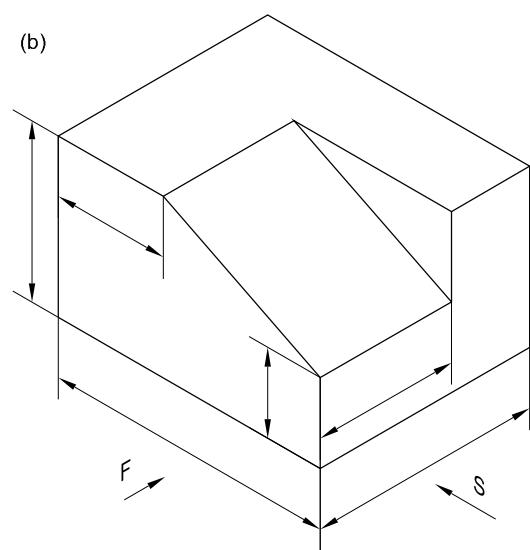
(a)

(b)

Fig 4

(a)

(b)

Fig 5

(a)

(b)

Fig 6

(a)

30

15

20

15

35

F

30

15   15   15

F

(b)

F

F

EDNSM120816

Fig 7

(a)

20

30

25

45
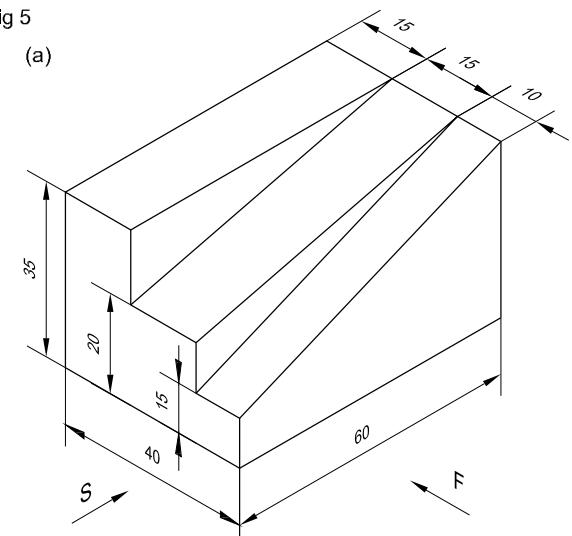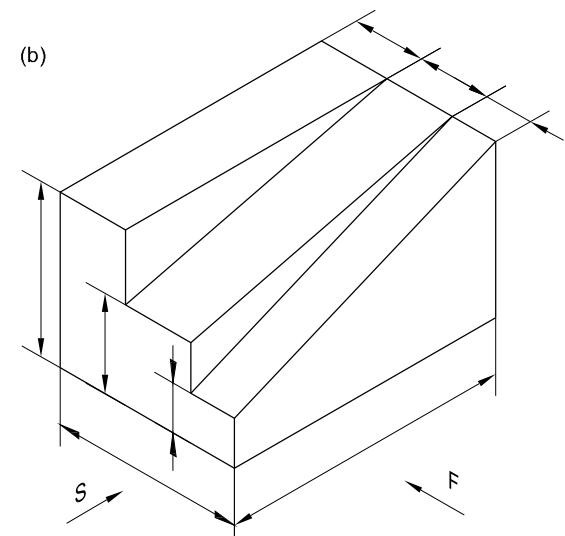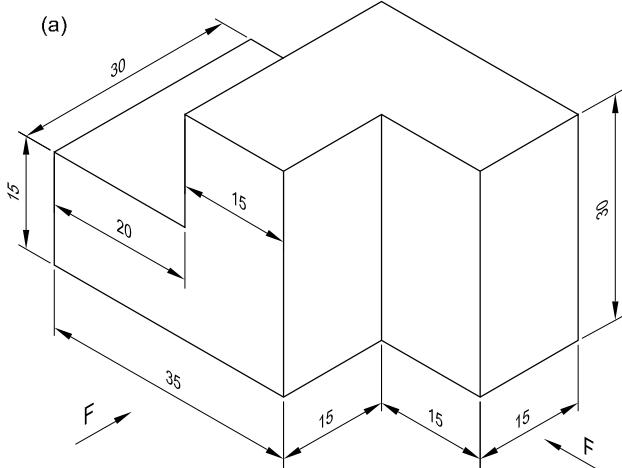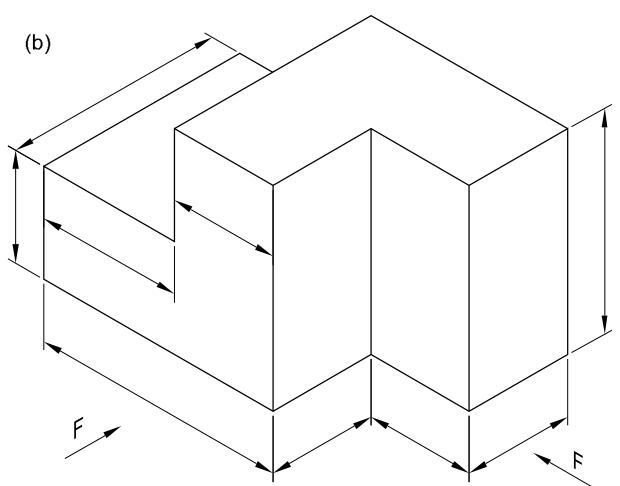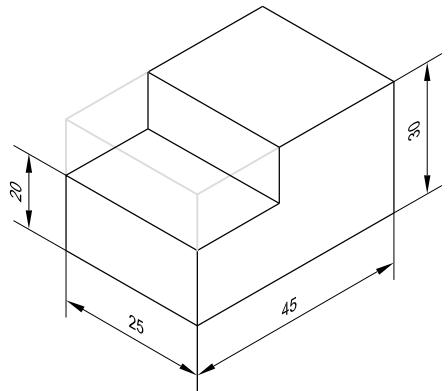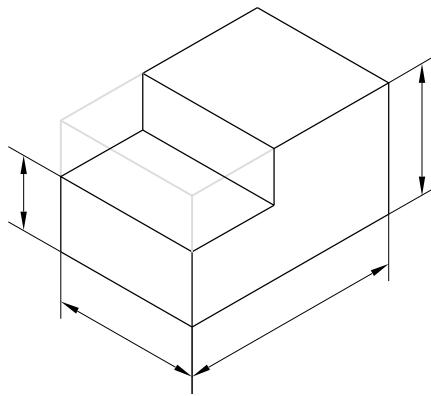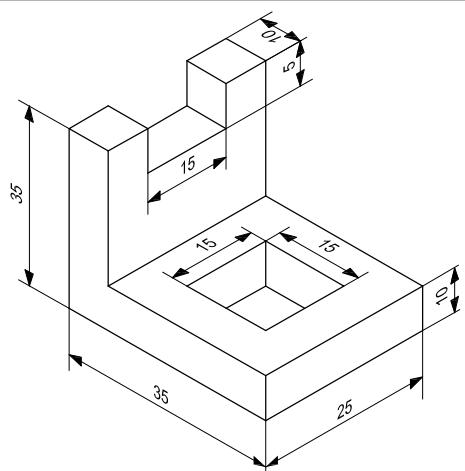
(b)

EDNSM120817

Fig 8

(a)

10

5

35

15

15   15

10

35   25
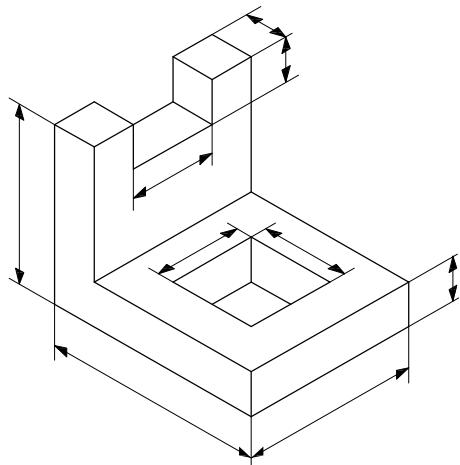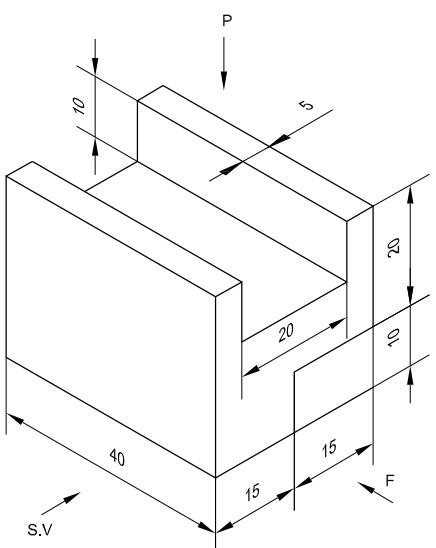
(b)

EDNSM120818

Fig 9

(a)

(b)

Fig 10

(a)

(b)
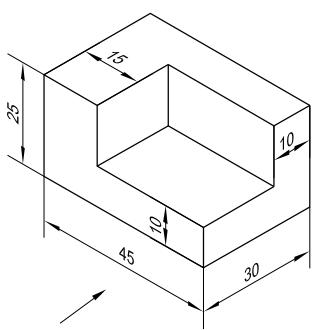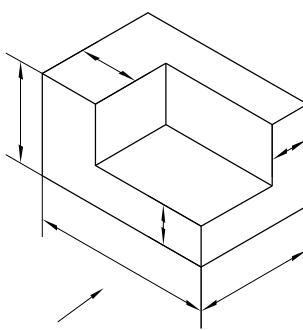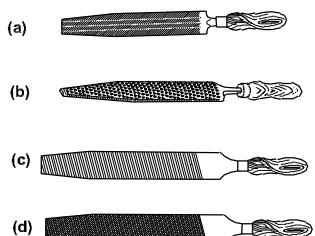
Free hand drawing of hand tools and measuring tools

Hand Tools

Files (Fig 1)
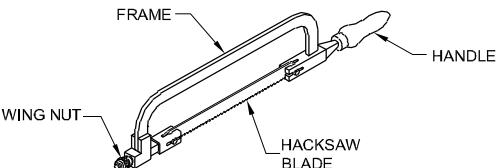
|			
a	Curved cut file	b	Rasp cut file
c	Single cut file	d	Double cut file

Fig 1

Scriber (Fig 2)

Fig 2

Divider (Fig 3)

Fig 3

Outside caliper (Fig 4)

Fig 4

Inside caliper (Fig 5)

Fig 5

Hacksaw (Fig 6)

Fig 6

Ball pein hammer (Fig 7)

Fig 7

Chisel (Fig 8)

Fig 8
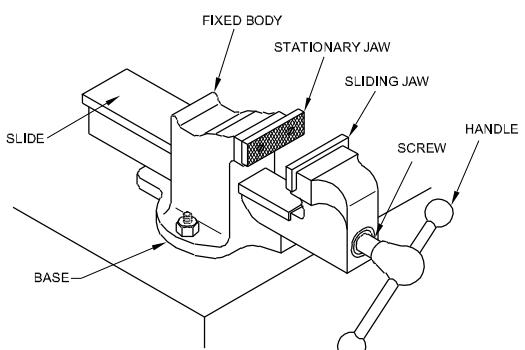
Bench vice (Fig 9)
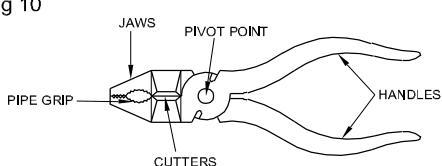
Fig 9

Cutting plier (Fig 10)
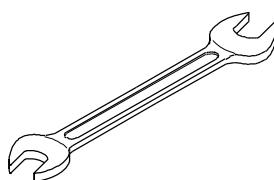
Fig 10

Open end spanner (Fig 11)

Fig 11
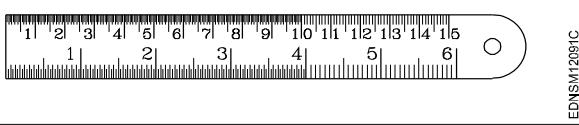
Measuring Tools
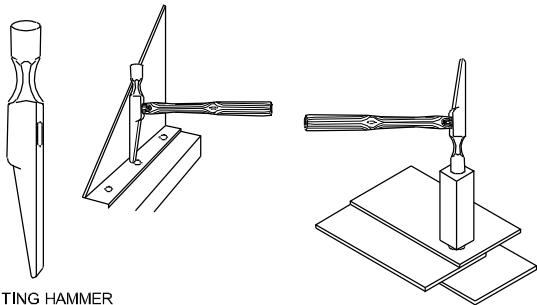
Steel rule (Fig 12)

Fig 12

EDNSM12091C
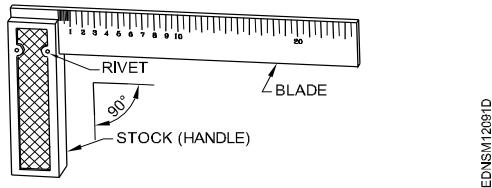
Try square (Fig 13)

Fig 13

RIVET
BLADE
90°
STOCK (HANDLE)

EDNSM12091D

Rawhide mallet (Fig 14)

Fig 14

(a) FACE
BODY
HANDLE
ORDINARY WOODEN MALLET

(b) BOOSING MALLET

(c) END - PACKED MALLET

(d) RAWHIDE MALLET
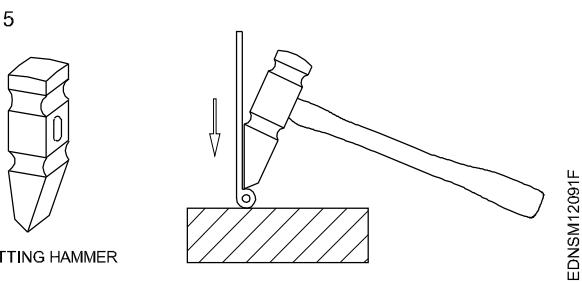
EDNSM12091E

Setting hammer (Fig 15)
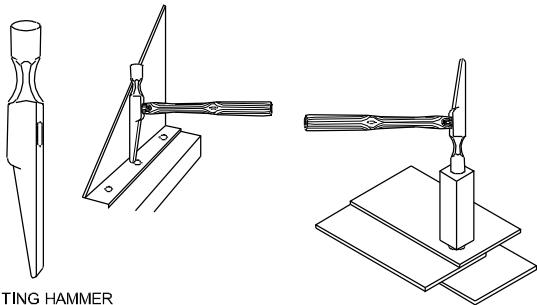
Fig 15

SETTING HAMMER

EDNSM12091F

Riveting hammer (Fig 16)

Fig 16

RIVETING HAMMER
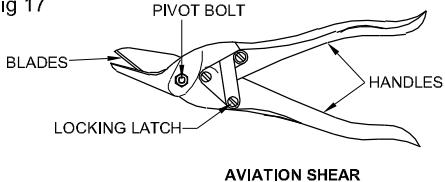
EDNSM12091G

Aviation shear (Fig 17)

Fig 17

PIVOT BOLT
BLADES
HANDLES
LOCKING LATCH
AVIATION SHEAR
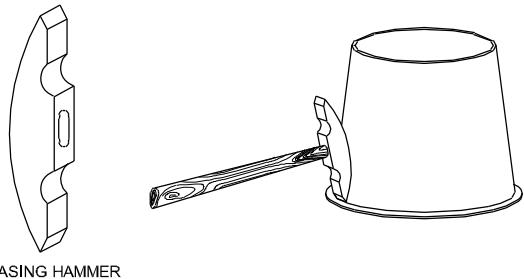
EDNSM12091H

Creasing hammer (Fig 18)

Fig 18

CREASING HAMMER
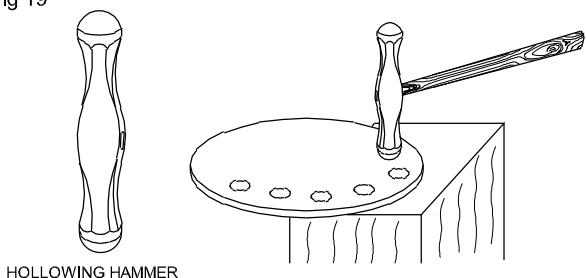
EDNSM12091I

Hollowing hammer (Fig 19)

Fig 19

HOLLOWING HAMMER
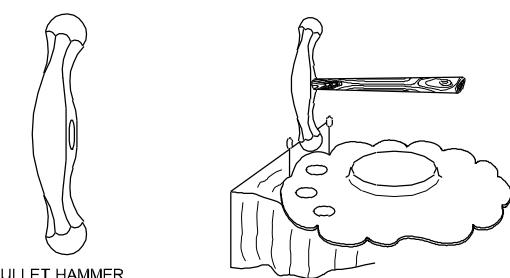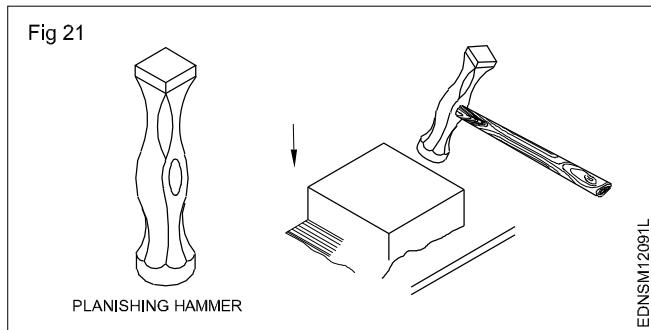
EDNSM12091J

Bullet hammer (Fig 20)

Fig 20

BULLET HAMMER

EDNSM12091K

Planishing hammer (Fig 21)

Fig 21

PLANISHING HAMMER

EDNSM12091L

Bench shear (Fig 22)

Fig 22

BENCH SHEAR

EDNSM12091M

Straight snip (Fig 23)

Fig 23

BLADE

HANDLES

STOPPER

FACE OF BLADE — PIVOT

OVER ALL LENGTH

STRAIGHT SNIP

EDNSM12091N

Bend snip (Fig 24)

Fig 24

STOPPER

HANDLE

BLADE

RIVET

BEND SNIP

EDNSM12091O

Hawk-billed shear (Fig 25)

Fig 25

HAWK-BILLED SHEAR

EDNSM12091P

Double-cutting shear (Fig 26)

Fig 26

DOUBLE CUTTING SHEAR

EDNSM12091Q

Round bottom stake (Fig 27)

Fig 27

FACE OR HEAD OR HORN

SHANK OR BODY

HEEL

ROUND BOTTOM STAKE

EDNSM12091R

Half moon stake (Fig 28)

Fig 28

HALF MOON STAKE

EDNSM12091S

Beak or bickiron (Fig 29)

Fig 29

BEAK

BEAK OR BICKIRON

EDNSM12091T

Creasing iron (Fig 30)

Fig 30

CREASING IRON

EDNSM12091U

Tinman's horse (Fig 31)

Fig 31

TINMAN'S HORSE

EDNSM12091V

Heads (Fig 32)

Fig 32

A

B

C

D

E

A - ROUND BOTTOM
B - ANVIL
C - ANVIL

D - HALF MOON
E - ROUND HEAD

HEADS

EDNSM12091W

Tinman's anvil (Fig 33)

Fig 33

TINMAN'S ANVIL

EDNSM12091X

Penning hammer (Fig 34)

Fig 34

PEENING HAMMER

EDNSM12091Y

Universal stake holder (Fig 35)

Fig 35

UNIVERSAL STAKE HOLDER

EDNSM12091Z

Square edge (Fig 36)

Fig 36

1

2

1 SQUARE EDGE
2 CURVED EDGE

EDNSM12091Z1

Hand seamer (Fig 37)

Fig 37

KNURLED SCREW

LOCK

HAND SEAMER

EDNSM12091Z2

Hollow punch (Fig 38)

Fig 38

TUBULAR BODY

SHAFT

MACHINED END

HOLLOW PUNCH

EDNSM12091Z3

Folding bars (Fig 39)

Fig 39

LEGS OF FOLDING BARS

FOLDING BARS

EDNSM12091Z4

Revolving bench plate (Fig 40)

Fig 40

REVOLVING BENCH PLATE

EDNSM12091Z5

Blind rivetting equipment (Fig 41)

Fig 41

RIVETTING PLIERS

LEVER HAND TOOL

LAZY TONGS

PNEUMATIC HAND
TOOL WITH AUTOMATIC FEED

PNEUMATIC BLIND
RIVETTER

BLIND RIVETTING EQUIPMENT

EDNSM12091Z6

Solid punch (Fig 42)

Fig 42

SOLID PUNCH

EDNSM12091Z7

Iron hand punch (Fig 43)

Fig 43

IRON HAND PUNCH

EDNSM12091Z8

Hand riveter (Fig 44)

Fig 44

HAND RIVETER

EDNSM12091Z9

Size of groove & seam (Fig 45)

Fig 45

GROOVER

6mm

GROOVED
SEAM WIDTH

SIZE OF GROOVE & SEAM

EDNSM12091ZA

Tinner's hand punch (Fig 46)

Fig 46

TINNER'S HAND PUNCH
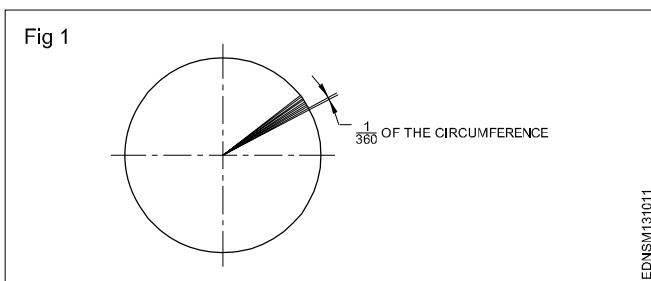
EDNSM12091ZB
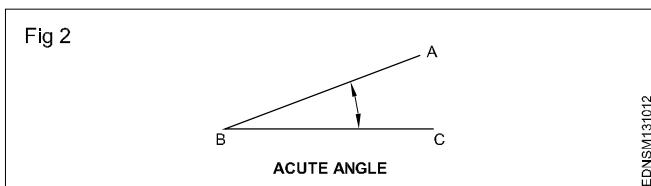
Drawing of angle & triangle

Angles: Angle is the inclination between two straight lines meeting at a point or meeting when extended. AB and BC are two straight lines meeting at B. The inclination between them is called an angle. The angle is expressed in degrees or radians.
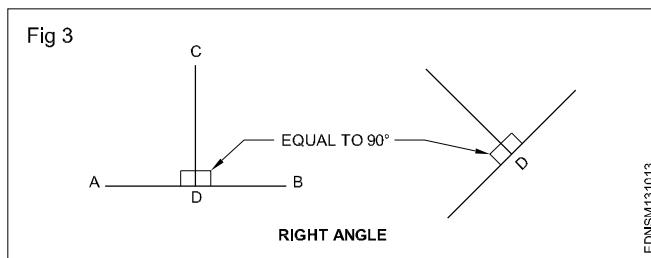
Concept of a degree: When the circumference of a circle is divided into 360 equal parts and radial lines are drawn through these points, the inclination between the two adjacent radial lines is defined as one degree. Thus a circle is said to contain 360°. (Fig 1)

Fig 1

$\frac{1}{360}$ OF THE CIRCUMFERENCE
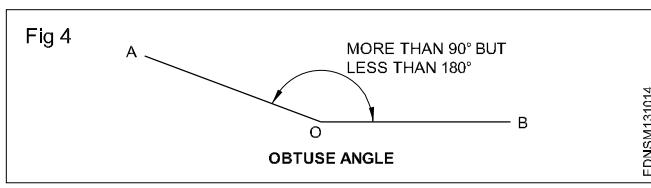
Acute angle: An angle that is less than 90° is called an acute angle. (Fig 2)

Fig 2

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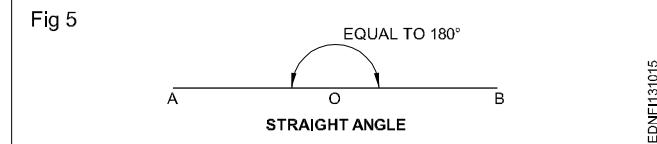
Right angle: The angle between a reference line and a perpendicular line is called a right angle. (Fig 3)

Fig 3

EQUAL TO 90°
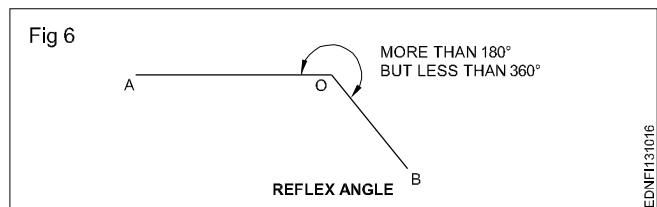
RIGHT ANGLE

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

Fig 4

MORE THAN 90° BUT LESS THAN 180°

OBTUSE ANGLE
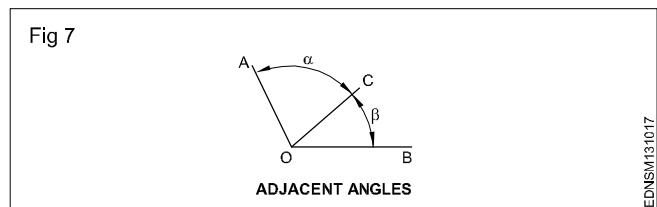
Straight angle: This refers to an angle of 180°. This is also called the angle of a straight line. (Fig 5)

Fig 5

EQUAL TO 180°

STRAIGHT ANGLE
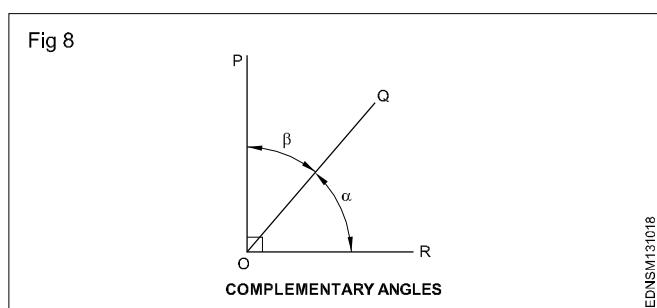
Reflex angle: It is the angle that is more than 180°, but less than 360°. (Fig 6)

Fig 6

MORE THAN 180° BUT LESS THAN 360°

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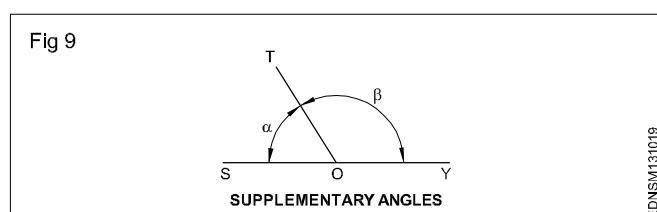
Adjacent angles: These are the angles lying on either side of a line. (Fig 7)

Fig 7

ADJACENT ANGLES

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

Fig 8

COMPLEMENTARY ANGLES

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

Fig 9

SUPPLEMENTARY ANGLES

Triangle - different types

Triangle is a closed plane figure having three sides and three angles. The sum of the three angles always equals to 180°.
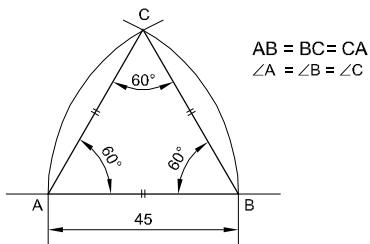
To define a triangle, we need to have a minimum of three measurements as follows:

• 3 sides or

• 2 sides and one angle or

• 2 angles and one side

Types of triangles

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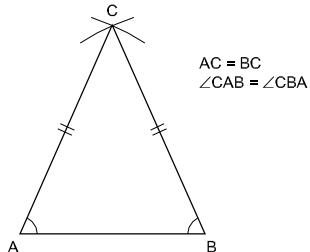
Fig 1

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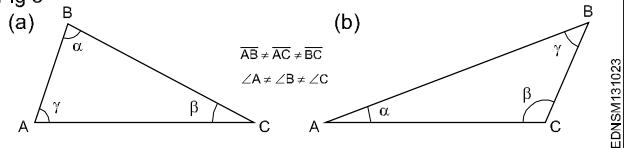
Fig 2

3 Scalene triangle has all three sides unequal in length. All three angles are also unequal. (Fig 3)

Fig 3

4 A right-angled triangle is one in which one of the angles is equal to 90° (Right angle). The side opposite the right angle is called the hypotenuse. (Fig 4)
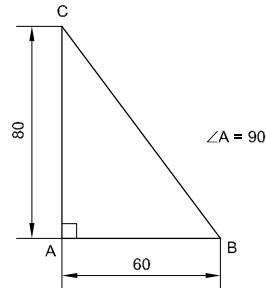
5 An Acute angled triangle is one in which all the three angles are less than 90°. (Fig 5)

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

The sum of the three angles in any triangle is equal to 180°.
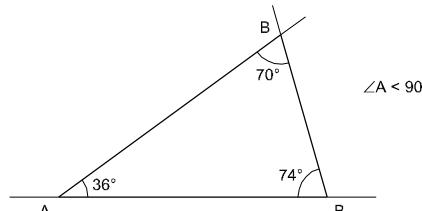
The sum of any two sides is more than the third side.

Fig 4
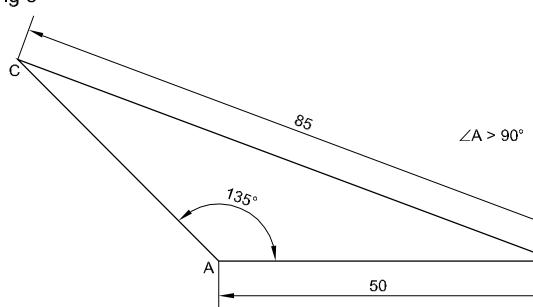
Fig 5
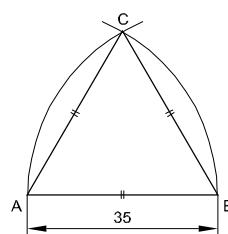
Fig 6

Procedure to draw the triangle

1 Equilateral triangle (Fig 1) AB = BC = CA = 35 mm.

• Draw a line and mark AB 35 mm side of the triangle.

• Draw radius from centre A and B, arcs cutting mark at C (Fig 1).

• Join CA and CB.

• ABC is a required triangle.

Fig 1
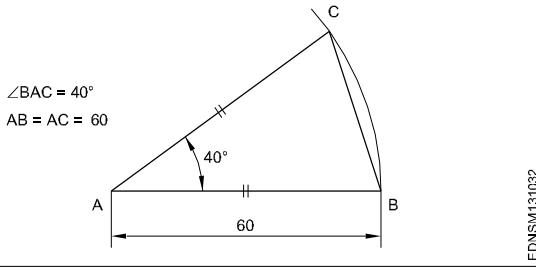
2 Isosceles triangle : AB = AC = 60 mm & $\angle$BAC = 40°.
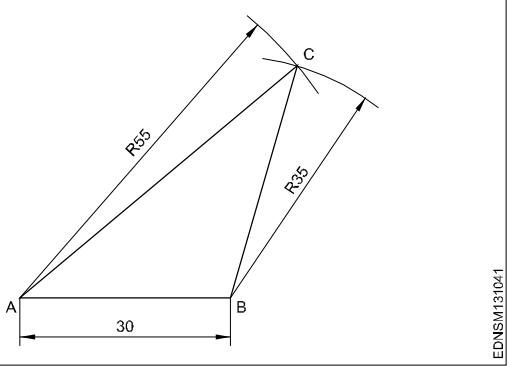
• Draw the side AB equal to 60 mm. `A' as the centre, draw an arc of radius AB.

• Draw a line AC at 40° to AB.

• Join BC to form the triangle ABC. (Fig 2)

Fig 2

∠BAC = 40°
AB = AC = 60

40°

A
60
B

C

EDNSM131032

Exercise

1   **Scalene triangle: AB = 30 mm, AC = 55 mm & BC= 35 mm. (Fig 1)**

Fig 1

R55
R35
A
30
B
C
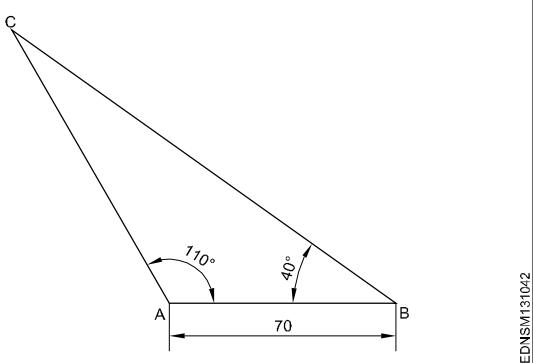
EDNSM131041

2   **Scalene triangle: AB = 70 mm. (Fig 2)**

∠ABC = 40° & ∠BAC = 110°

Fig 2

C

110°   40°
A
70
B
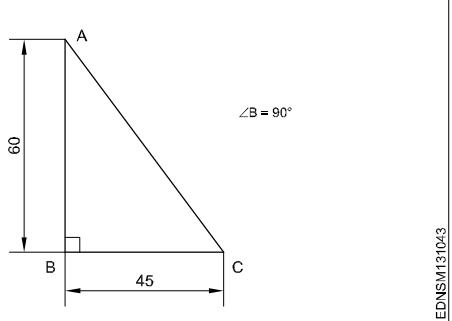
EDNSM131042
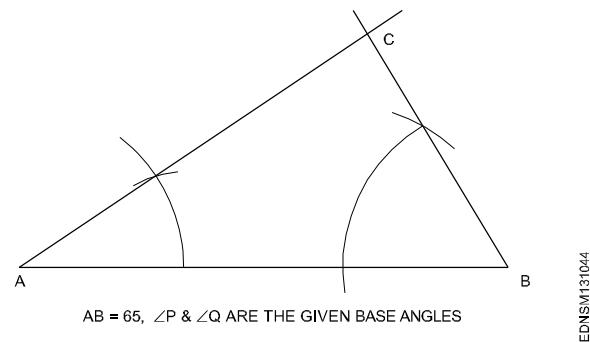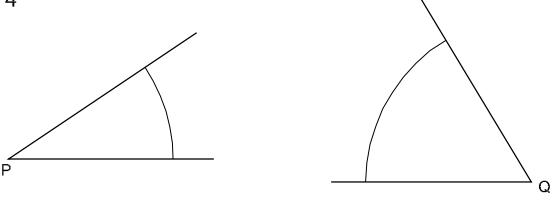
3   **Right angled triangle: AB = 60 mm, BC = 45 mm. (Fig 3)**

Fig 3

A

∠B = 90°

60

B
45
C

EDNSM131043
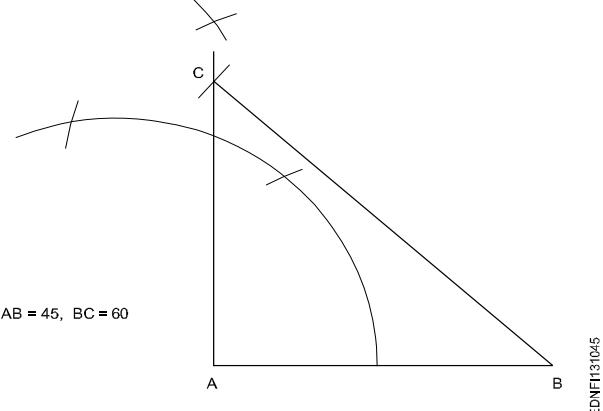
4   Draw a triangle when one side and 2 angles being given in Fig 4.

Fig 4

P

Q

C

A
B

AB = 65, ∠P & ∠Q ARE THE GIVEN BASE ANGLES

EDNSM131044
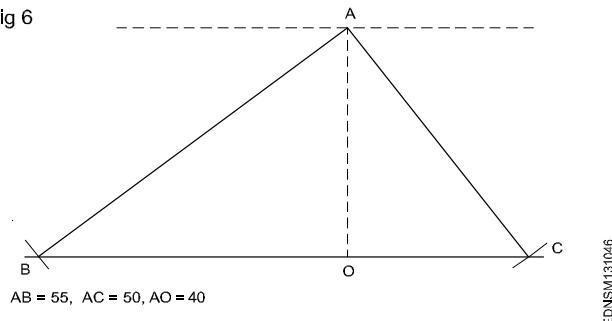
5   Draw a right angled triangle when the base and hypotenuse being given in Fig 5.

Fig 5

C

AB = 45, BC = 60

A
B

EDNFI131045

6   Draw a triangle with the altitude and two sides being given in Fig 6.

Fig 6

A

B
O
C

AB = 55, AC = 50, AO = 40

EDNSM131046

Drawing of circle

Circle: Circle is a plane figure bounded by a curve, formed by the locus of a point which moves so that it is always at a fixed distance from a stationary 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.

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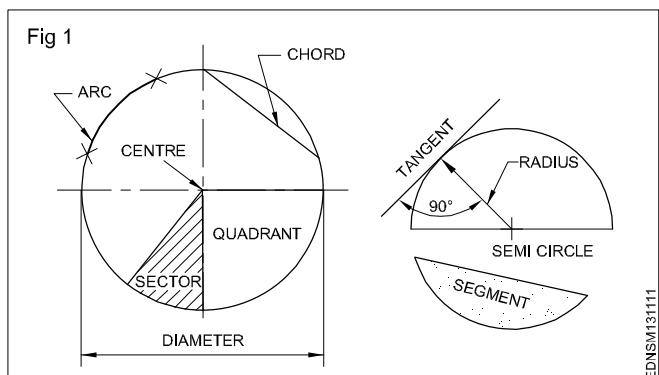
Sector: It is the part of a circle bounded by two radii (plural of radius) meeting at an angle and an arc.

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 a semi-circle.

Tangent: The 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.
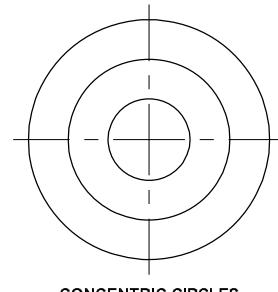
Fig 1 shows all the above elements.

Fig 1

Concentric circles: When two or more circles (drawn) have a common centre, they are called concentric circles. Ball-bearing is the best example of concentric circles. (Fig 2)
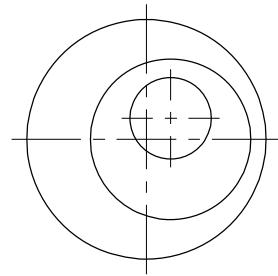
Eccentric circles: Circles within a circle but with different centres are called eccentric circles. (Fig 3)

Fig 2

CONCENTRIC CIRCLES

Fig 3

ECCENTRIC CIRCLES
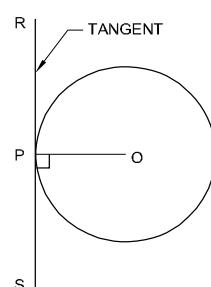
Circle and Arcs

Exercise

1   **Draw a tangent to a given circle of ϕ 50 mm at any point `P' on it. (Fig 1)**
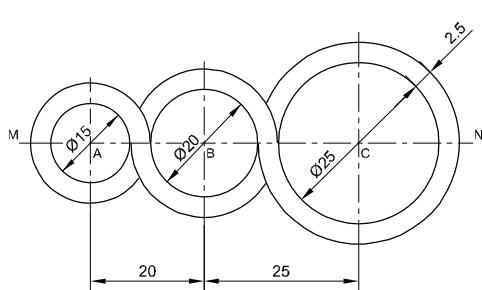
Fig 1

2   **Draw a loop of 3 circles pattern. (Fig 2)**
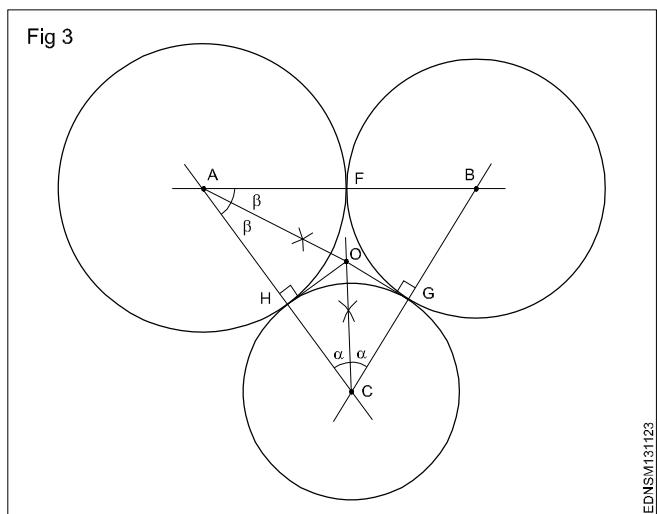
Draw any line MN and mark points A,B and C. So that AB = 20 mm and BC = 25 mm.
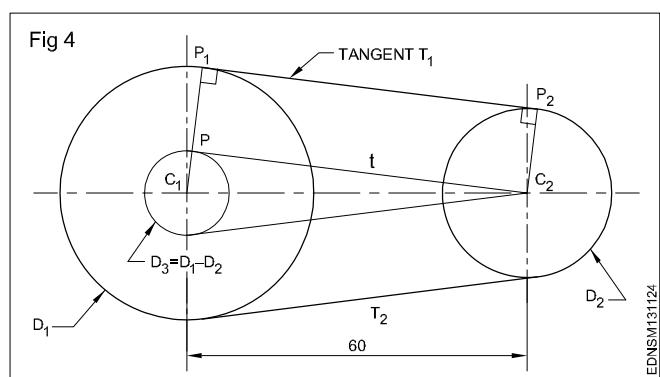
Fig 2

3 3   Draw three circles tangential to each other if centres A, B & C are given. (Fig 3)
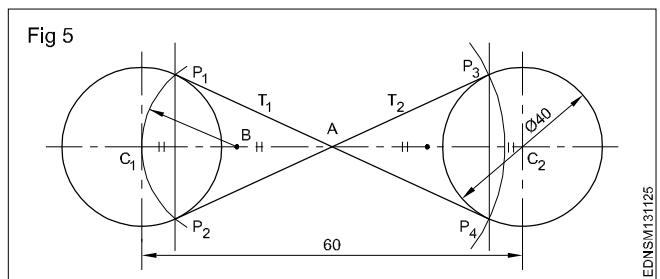
Fig 3

4   Draw external tangents to circles of dia 40 and 30 and centre distance 60 mm. (Fig 4)

Fig 4

5   Draw internal tangents to circles of the same diameter 40 each and a centre distance of 60 mm. (Fig 5)
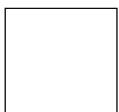
Fig 5

Drawing of square, rectangle and parallelogram

A quadrilateral is a plane figure bounded by four sides and four angles. The sum of the four angles in a quadrilateral is (interior angles) 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 besides. Quadrilaterals are also referred as Trapezium. (Fig 1)
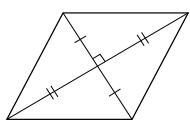
Fig 1
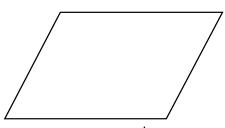
(a) SQUARE   (b) RECTANGLE

(c) RHOMBUS   (d) RHOMBOID / PARALLELOGRAM

Types of quadrilaterals (Fig 1)
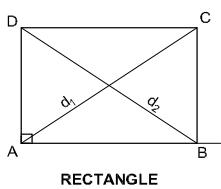
*   Square
*   Rectangle
*   Rhomboid / Parallelogram

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

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

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

Fig 2
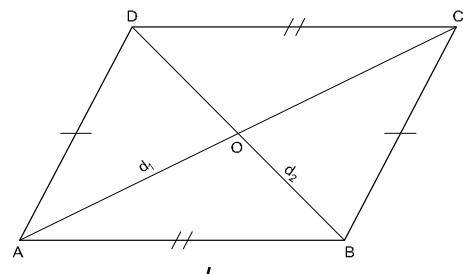
RECTANGLE

Rhomboid/Parallelogram (Fig 3): In a parallelogram, opposite sides are equal and parallel. Opposite angles are also equal. Diagonals are not equal but bisect each other.

Fig 3

RHOMBOID / PARALLELOGRAM
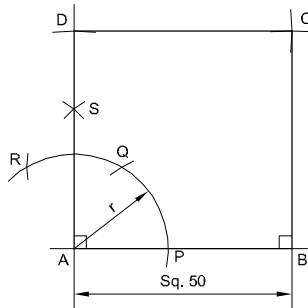
Procedure to draw the square, rectangle and parallelogram

Square

1   **1st method** (Fig 1)**:** A square of side 50 mm by erecting perpendicular.

Fig 1

Sq. 50
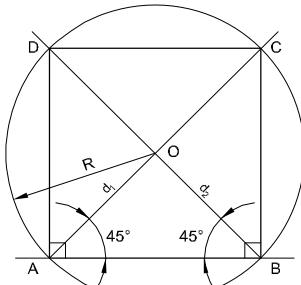
2   **2nd method (Fig 2): A square of side 60 mm using 45° setsquare and compass.**

Fig 2

$d_1 = d_2$

45°   45°
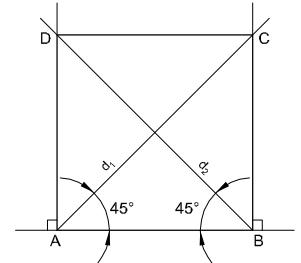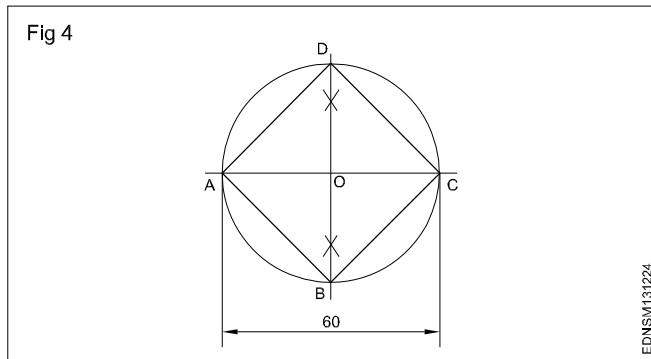
3   **3rd method (Fig 3): A square of side 60 mm long by erecting perpendicular and also using 45° setsquare.**

Fig 3

$d_1 = d_2$

45°   45°
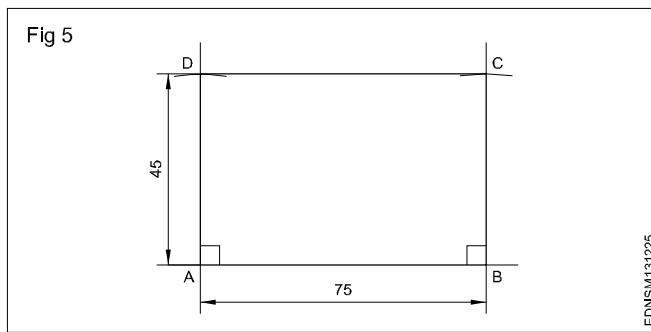
4 Square having diagonal 60 mm (Fig 4)

Fig 4

5 Rectangle (Fig 5)
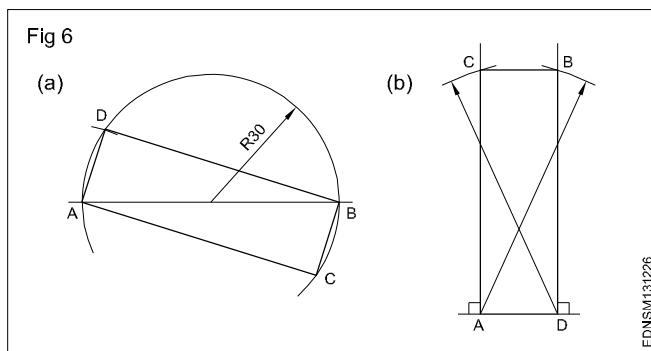
Side AB = 75 mm, side AD = 45 mm using setsquare and compass.

Fig 5

6 Rectangle - Diagonal - 60 mm and one side 20 mm
1st method (Fig 6a)

2nd method (Fig 6b)
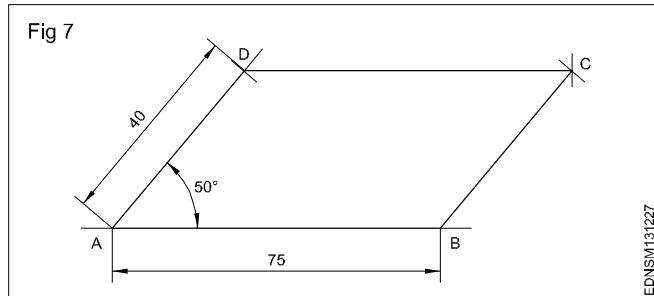
ADBC is the required rectangle of side 20 mm and diagonal 60 mm.

Fig 6

7 Parallelogram (Fig 7)

Sides = 75 mm and 40 mm
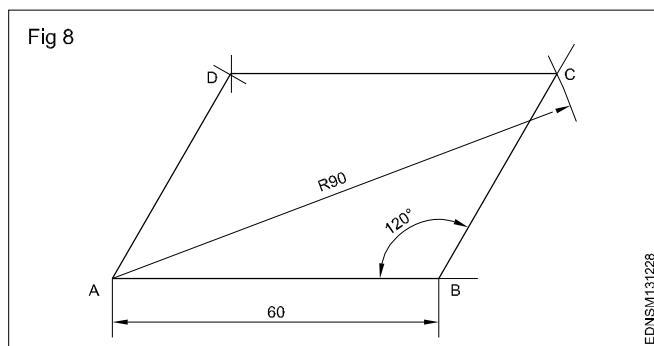
Angle between them: 50°

Fig 7

8 Parallelogram (Fig 8)
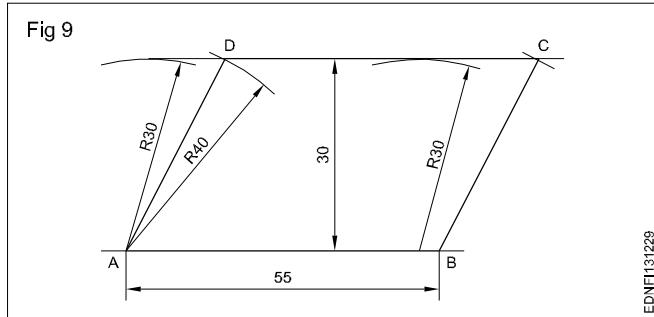
Parallelogram - Side AB = 60 mm

Diagonal AC = 90 mm ∠ABC = 120°

Fig 8

9 Parallelogram (Fig 9)

Sides AB = 55 mm, BC = 40 mm and vertical height = 30 mm.

Fig 9
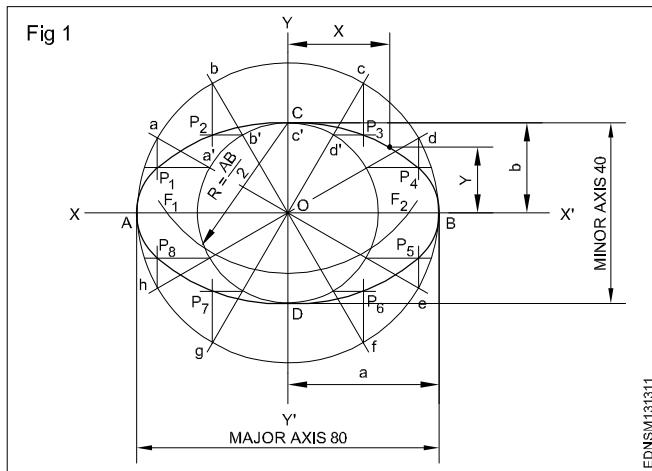
Drawing of ellipse & parabola

Ellipse

1   Construct an ellipse by concentric circle method. Major axis 80 mm. Minor axis 40 mm. (Fig 1)

   •   Draw the major axis AB (80 mm) and minor axis CD (40 mm), bisecting at right angle at 0.

   •   '0' as centre OA and OC as radius, draw two concentric circles.

   •   Draw a number of radial lines through '0' (say 12) cutting the two circles.

   •   Mark the points on the outer circle as a,b,c.

   •   Similarly mark the corresponding intersecting points on inner circle as a',b',c'.

   •   From points such as a,b,c... draw lines parallel to minor axis.

   •   From points such as a', b',c'.... draw lines parallel to the major axis to intersect with the corresponding vertical lines at points P_1, P_2, P_3.... etc.

   •   Join all these points with a smooth curve by free hand or using "french curve" and form the ellipse.

   •   To find the 'Foci' - with half the major axis (a) as radius and with 'C' on the minor axis as centre, draw an arc cutting the major axis, at two points, mark them as $F_1 F_2$ the focus points of the ellipse.

Fig 1
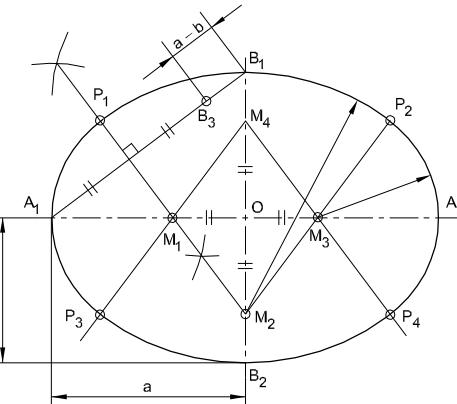
2   Construct an ellipse by four centre method - Major axis = 80 mm and Minor axis = 40 mm - Type A. (Fig 2)

   •   Draw the major axis $A_1 A_2$ and minor axis $B_1 B_2$.

   •   Set off $B_1 M_2$ and $B_2 M_4$ equals to $A_1 B_1$.

   •   Join $A_1 B_1$ and set off $B_1 B_3$ equal to a-b (a = OA_1, b = OB_1)

   •   Draw a bisector on $A_1 B_3$ which intersects $A_1 A_2$ at M_1.

   •   Similarly obtain M_3. M_2 & M_4 as centres and $B_1 M_2$ as radius, draw arcs $P_1 P_2$ & $P_3 P_4$.

   • $M_1 M_3$ as centres and $M_1 P_1$ as radius, draw arcs $P_1 P_3$ & $P_2 P_4$ and complete the ellipse.
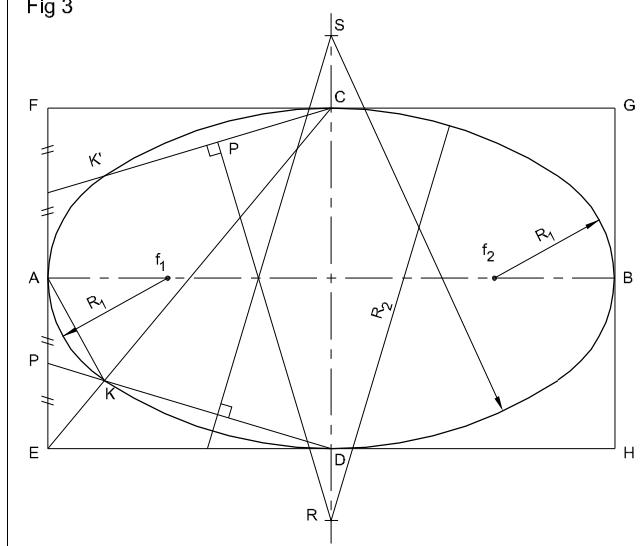
Fig 2

3   Construct an ellipse by four centre method - Major axis = 80 mm and Minor axis = 40 mm - Type B. (Fig 3)

Fig 3

   •   Draw the rectangle EFGH (80 x 40) and draw AB & CD represent major and minor axis.

   •   Join EC

   •   Bisect AE and mark P the mid-point.

   •   Join DP meeting EC at K.

   •   Draw perpendicular bisectors of KD and extend DC and locate point `S'.

   •   'S' as centre SD as radius draw the arc KD.

   •   Similarly get the point 'R'.

- Join AK and draw perpendicular bisector on it, and meet AB at f_1.

- 'f_1' as centre, Af_1 as radius, draw an arc KK'.

- Mark centre 'f_2' so that $Bf_2 = Af_1$.

- Now R, S, F_1 & F_2 are the four centres of the ellipse.
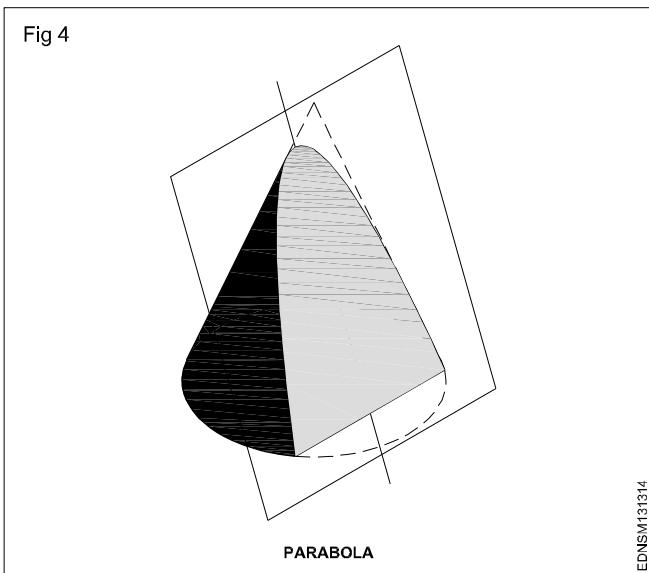
Similar to the procedure followed for drawing curves KD and KK_1 and complete the ellipse.

Follow the procedures given below and construct parabolic curves in the work book.

4 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 4)

Fig 4

PARABOLA

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 5)

Elements of Parabola

Axis: It is a line (XX') perpendicular to the directrix and passing through the focus.
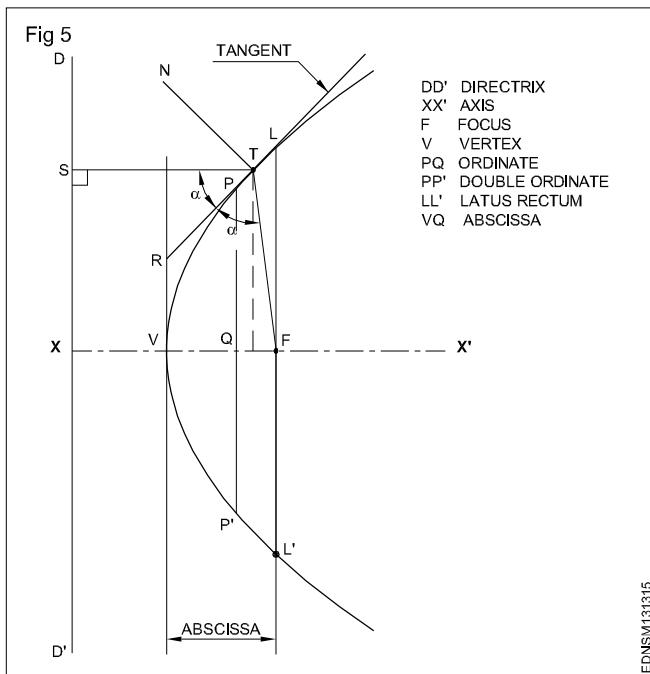
Vertex (V)**:** It is the mid point of the perpendicular line drawn from focus to directrix.

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[1] is the double ordinate.

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

5 Abscissa: The distance along the axis XX' from vertex (V) and a point through which the double ordinate passes is called the "Abscissa" VQ is the abscissa corresponding to the ordinate PQ (Fig 5).

Fig 5

DD'	DIRECTRIX
XX'	AXIS
F	FOCUS
V	VERTEX
PQ	ORDINATE
PP'	DOUBLE ORDINATE
LL'	LATUS RECTUM
VQ	ABSCISSA

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.
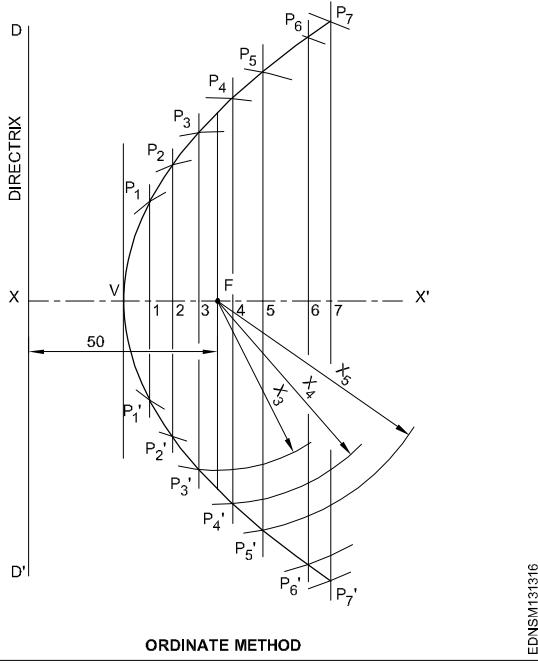
6 Parabola

Construct a Parabola from a given focus is at 50 mm from the directrix. (Fig 6) - Ordinate method.

- Draw a vertical line D-D[1] the directrix.

- Draw horizontal line XX[1], the axis through any point X on the directrix.

- Mark the focus 'F' on XX[1] = 50 mm from X (on the directrix).

- Mark the mid point of XF, as V.

- Mark a number of points from V towards right side on the axis as 1,2,3,4.....

- Draw vertical lines through these points as shown, forming double ordinates.

- Point 'F' as centre, X-1 as radius, draw arcs on the co-ordinates (vertical lines) passing through 1, mark points P_1 & P_1'.

- X-2 as radius, F as centre, draw arcs on the 2nd ordinate, mark P_2 & P_2'.

- Similarly get point P_3, P_4.... P_3', P_4' etc. on the axis as above.

- Join all the points with a smooth curve, by free hand and form the parabola curve.

Fig 6
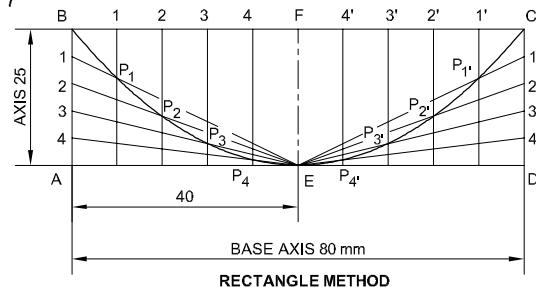
ORDINATE METHOD

7 Construct a Parabola given the base and axis of a rectangle; base 80 mm, axis 25 mm - Rectangle method. (Fig 7)

- Draw a rectangle ABCD of sides 80 mm & 25 mm.

- Mark centre points of AD and BC, as E and F, join EF.

- Divide AB & CD and into any number of equal parts say 5. Also divide AE and ED into the same number of equal parts and number them as shown.

- From point E on AD, draw lines to the divisions on AB & CD.

- From the points on AED, draw parallel lines to EF.

- Mark the intersecting points P_1, P_2, P_3, P_4 on either side of axis.

- Form the parabola by joining the points BEC and intersecting with a smooth curve, passing through P_1, P_2 .....

Fig 7
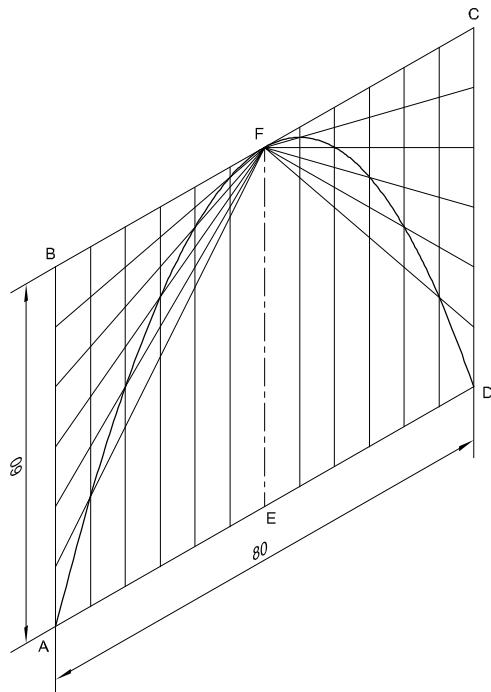
RECTANGLE METHOD

8 Parabolic curve of sides 80 and 60 making 60°/120° Parallelogram method. (Fig 8)

- Procedure is similar to the exercise (11) rectangle method of drawing a Parabolic curve.

Fig 8

PARALLELOGRAM METHOD
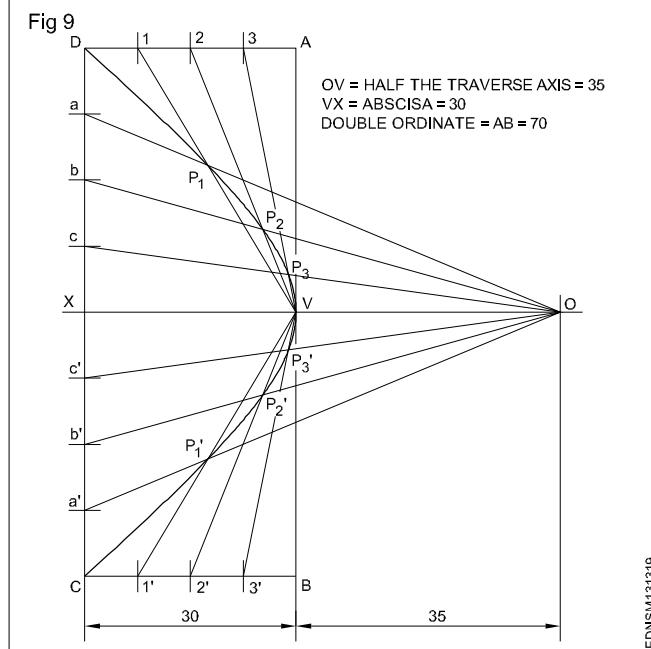
9 Given the double ordinate, abscissa and distance between vertices (Fig 9)

- Draw a hyperbola with double ordinate 70 mm and abscissa 30 mm (rectangle method) and the transverse axis 70 mm.

- Draw the rectangle ABCD 70 x 30 mm.

- Mark the mid points V, X on AB and CD.

- Join VX and extend it outside to '0' 35 mm (70/2) from V.

- Divide AD and BC into 4 equal parts. Mark them as $1,2,3,1^1,2^1,3^1$.

- Join these points to V by straight lines.

- Divide DX;XC into 4 equal parts, each mark them as a,b,c,c^1,b^1,a^1.

- Join '0' to these points by straight lines.

- Mark the intersecting points as P_1, P_2 etc as shown.

- Join V-D-C with a smooth curve through P_1, P_2, P_3 etc.

Fig 9

OV = HALF THE TRAVERSE AXIS = 35
VX = ABSCISA = 30
DOUBLE ORDINATE = AB = 70

EDNSM131319

Drawing of lettering and numbering - Single stroke

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

Fig 1

GOTHIC ALL LETTERS HAVING THE ELEMENTARY STROKES OF EVEN WIDTH ARE CLASSIFIED AS GOTHIC

ROMAN ALL LETTERS HAVING THE ELEMENTARY STROKES "ACCENTED" OR CONSISTING OF HEAVY AND LIGHT LINES ARE CLASSIFIED AS ROMAN

ITALIC ALL SLANTING LETTERS ARE CLASSIFIED AS ITALIC. THESE MAY BE FURTHER DESIGNATED AS ROMAN-ITALICS, GOTHIC-ITALICS, TEXT-ITALICS

TEXT THIS TERM INCLUDES ALL STYLES OF OLD ENGLISH, GERMAN TEXT. BRADELY TEXT OF OTHERS OF VARIOUS TRADE NAMES. TEXT STYLES ARE TOO ILLEGIBLE FOR COMMERCIAL PURPOSES

Standard heights/Width: The standard heights recommended by BIS SP: 46-2003 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, 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.

Lowercase means small letters, as opposed to capital **letters**. The word yes, is for example, is in **lowercase**, while the word YES is in **upper case**. For many programmes, this distinction is very important. Programmes that distinguish between **uppercase** and **lowercase** are said to be case sensitive

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:
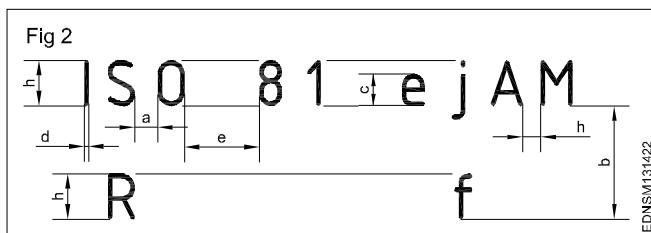
Uppercase Lettering BIS SP: 46-2003

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
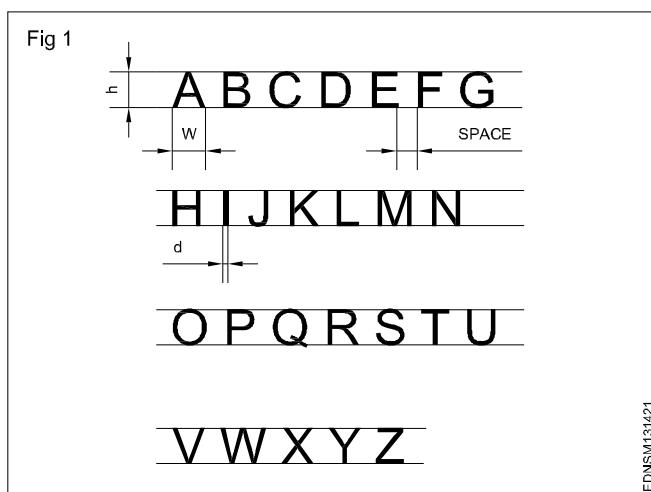
Spacing of letters: Recommended spacing between characters, a minimum spacing of baselines and minimum spacing between words as per BIS SP: 46-2003 are given below in Fig 2.

Fig 2

Lettering

Procedure

1 Print 10 mm single stroke capital letters and numerals in vertical style using either scale or set-square and by freehand. (Fig 1)

Fig 1

• Draw horizontal parallel lines (thin lines) of 10 mm distance.

10 mm distances denote the height of the letter.

• Mark the width of the letters recommended by BIS (IS:9609-1983)

The width of different letters in terms of `d' is as follows: `d' indicates stroke thickness i.e d: h/10.

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

For curved letters use a smooth freehand curve.

Print straight line letters using either scale or set-squares.

To maintain the uniform thickness of the line, use a conical point soft grade pencil and avoid too much sharpness.

Guidelines of both top and bottom should always be drawn with a sharp pencil.

Numerals 2.1 (Fig 2)
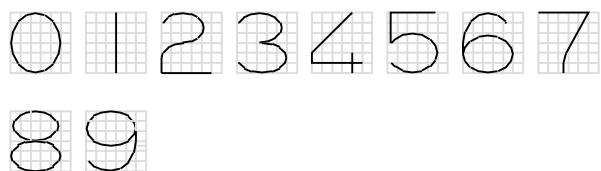
Fig 2

• Follow the same procedure of letters.

• `h' is height of numerals and `d' is the stroke thickness.

• Width of numerals in terms of `d' is as follows shown in square grid (Fig 3).

Fig 3

2 Print 10 mm single stroke capital letters and numerals in inclined style (Fig 4).

Fig 4

Practice the following lettering exercises in A3/A4 paper as per the given ratio

1   Single stroke inclined letters of ratio 7:6, 7:5, 7:4, 7:3, 7:1 (Fig 5)
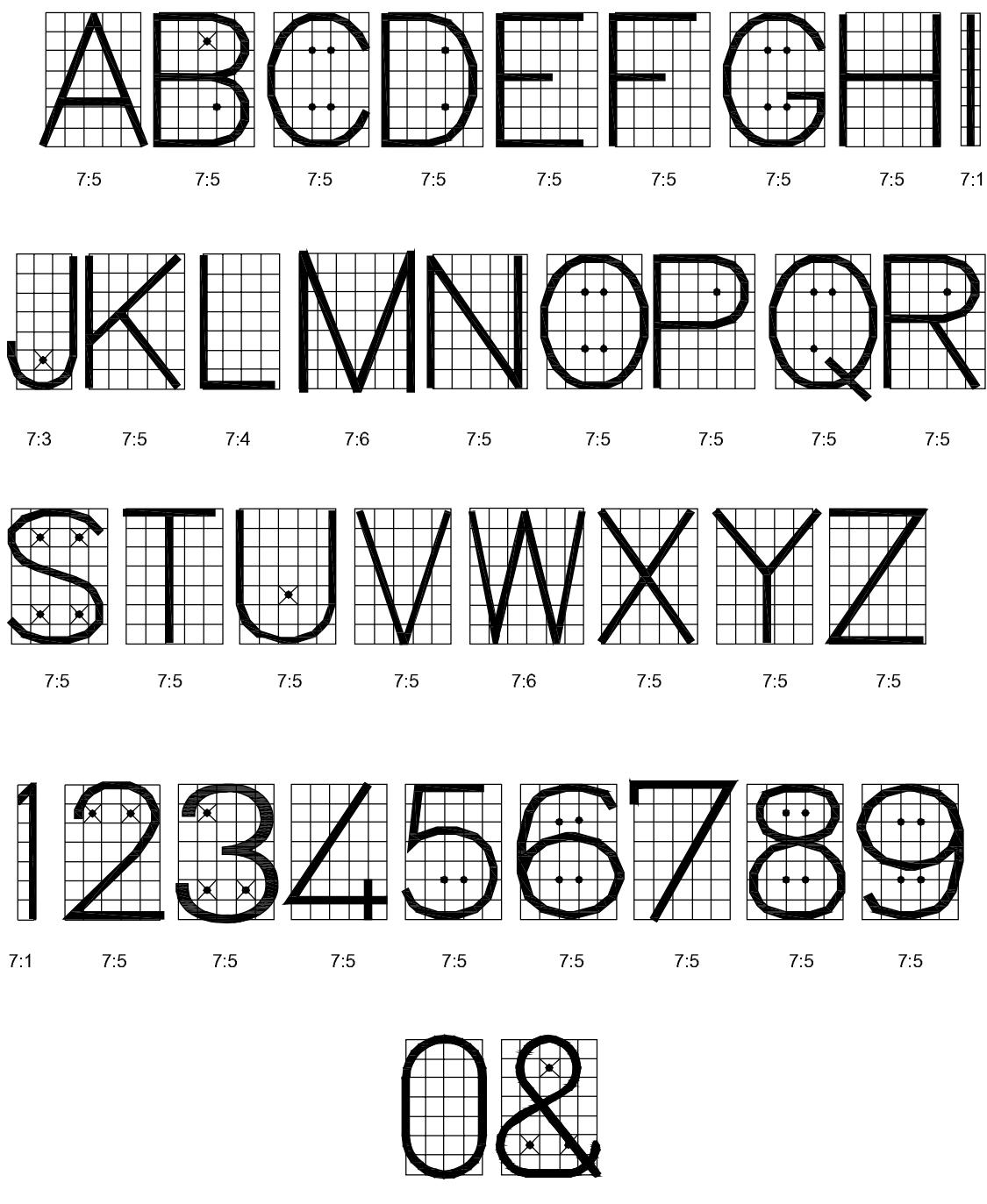
Fig 5

SINGLE STROKE INCLINED LETTERS

2 Single stroke vertical letters of ratio 7:6, 7:5, 7.4, 7:3, 7:1 (Fig 6)

Fig 6

SINGLE STROKE VERTICAL LETTERS
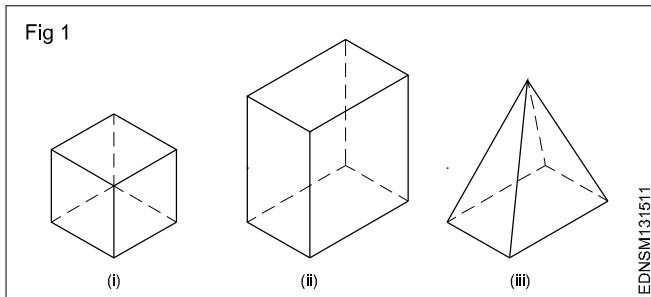
Drawing of development of surfaces - Introduction

Surface develpoment of prism, pyramid, cylinder projection & development, cone projection & development
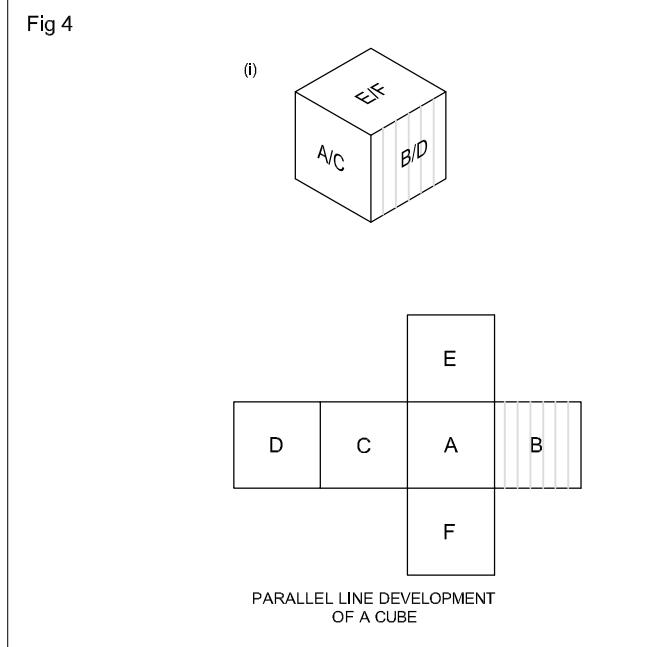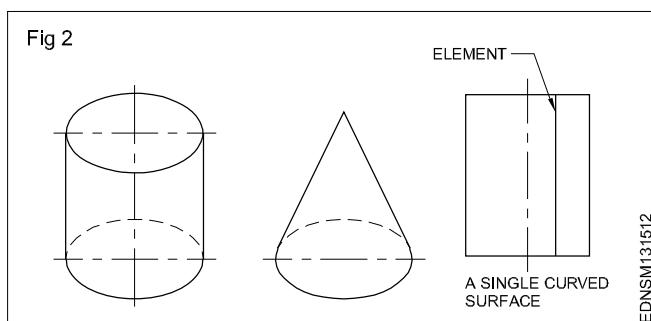
Development of surface - Introduction

The surfaces may be classified as follows:
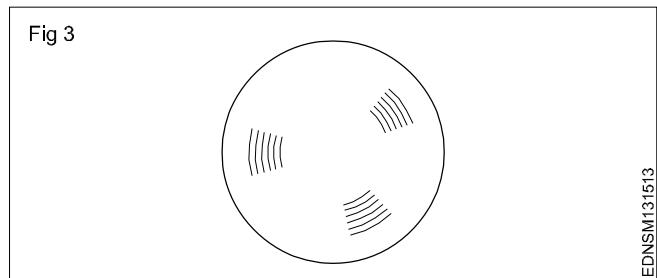
*   Solids bounded by plane surfaces. Eg. cube, prism, pyramids etc. (Fig 1)

Fig 1

(i)   (ii)   (iii)

*   Solids bounded by single curved surfaces. It can be unrolled to a plane. Eg. cylinder, cone etc. (Fig 2)

Fig 2

ELEMENT

A SINGLE CURVED SURFACE

*   Solids bounded by double curved surfaces. It is formed by revolving a curve about a straightline. Eg. sphere, paraboloid etc. (Fig 3)

Fig 3
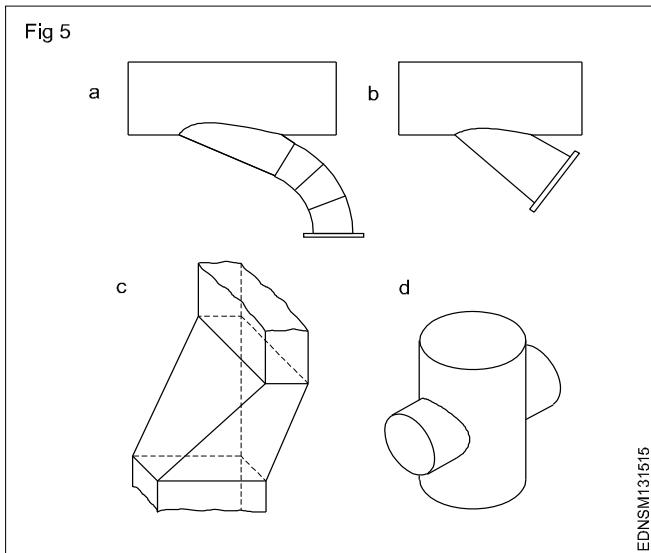
Methods of development

Parallel line method (Fig 4i)**:** 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 4ii): 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.

Fig 4

(i)

E/F
A/C B/D

E
D C A B
F

PARALLEL LINE DEVELOPMENT
OF A CUBE

(ii)

RADIAL LINE DEVELOPMENT
OF A CONE
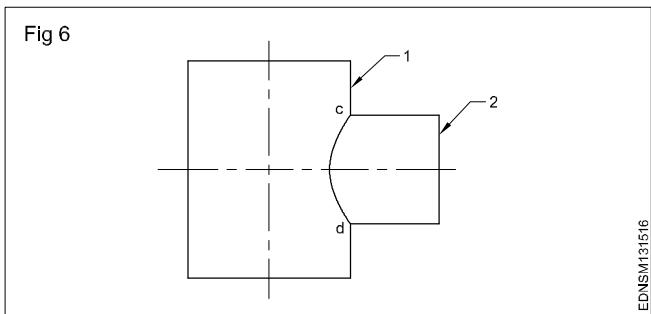
Intersection: We are more convinced with the lines of intersection formed when surfaces of two solid meet. Fig 5 shows the few examples of lines of intersection.

Fig 5
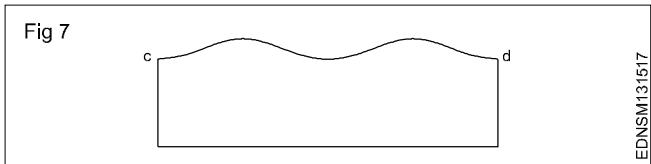
Intersection lines or just intersections are of great importance to both for making drawings for fabrication work.

When drawing the views of intersecting solids, lines of intersection will have to be drawn in order to complete the views. For example Fig 6 shows a solid when two cylinders meet at right angles. Without the line of intersection cd, the view is incomplete. To draw the intersection lines in its correct form, principle of projections have to be followed and this will involve extensive geometrical construction.

Fig 6

In fabrication work, especially in sheet metal fabrication accurate intersection lines are a must for drawing development.
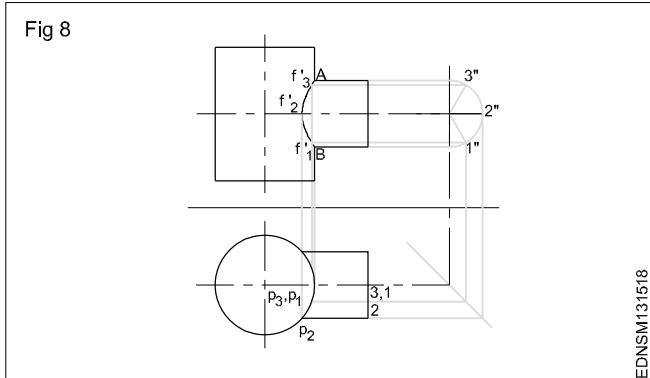
For example, the development of the part 2 of Fig 6 is shown in Fig 7. The accuracy of the fabricated cylinder is much dependent on the accuracy of the curve cd. To plot the line cd, intersection line cd (Fig 6) has to be drawn accurately.

Fig 7

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 straight lines (Fig 5c). If one or both the mating surfaces are curved, the intersection lines are curved. (Fig 5a,b & d)

To plot the points required for drawing the intersection curve we can use either the line method or cutting plane method.

Line method (Fig 8)**:** Mark the points 1",2",3" on the circumference of the circle in the side view. (preferably symmetrical)

Fig 8

Project from side view and locate points P_2; P_1/P_3 in plan. Now these lines P_3 - 3, P_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.

Draw projectors of indefinite lengths from points 1",2" & 3" in the side view towards the elevation.
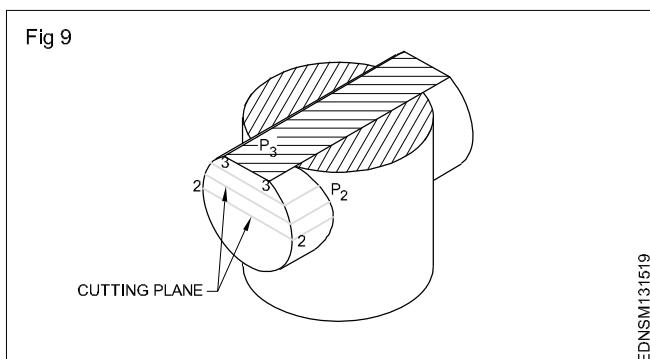
To fix the position of the above projectors, draw projectors vertically from points such as P_3/P_1 and P_2 to intersect with the corresponding lines in the elevation. Mark the intersecting points f_1',f_2',f_3' and draw the required curve.

Note: 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 9)**:** 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 9, 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" in the front view of figure and hence the rest of the procedure is same as that of line method.

Fig 9
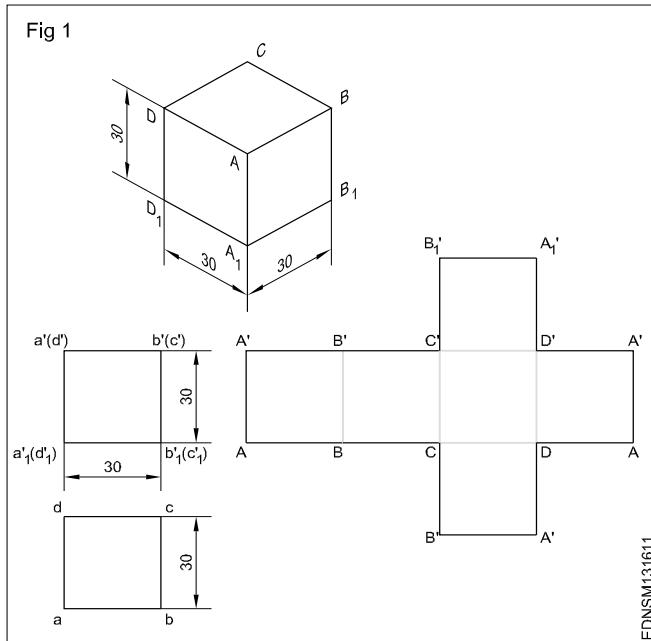
Note: Though both line method and cutting plane method are appearing to be same, they are conceptually different. While any one method can be followed in many cases, but cutting plane method is more useful in solving cases in which none of the projections shows a line view of the surface of a solid.

Drawing of development of surfaces - Procedure

Practice of Surface development of prism, pyramid, cylinder projection & development, cone projection & development

Procedure

1   Draw the development of the surfaces of a cube of side 30 mm. (Fig 1)


Fig 1
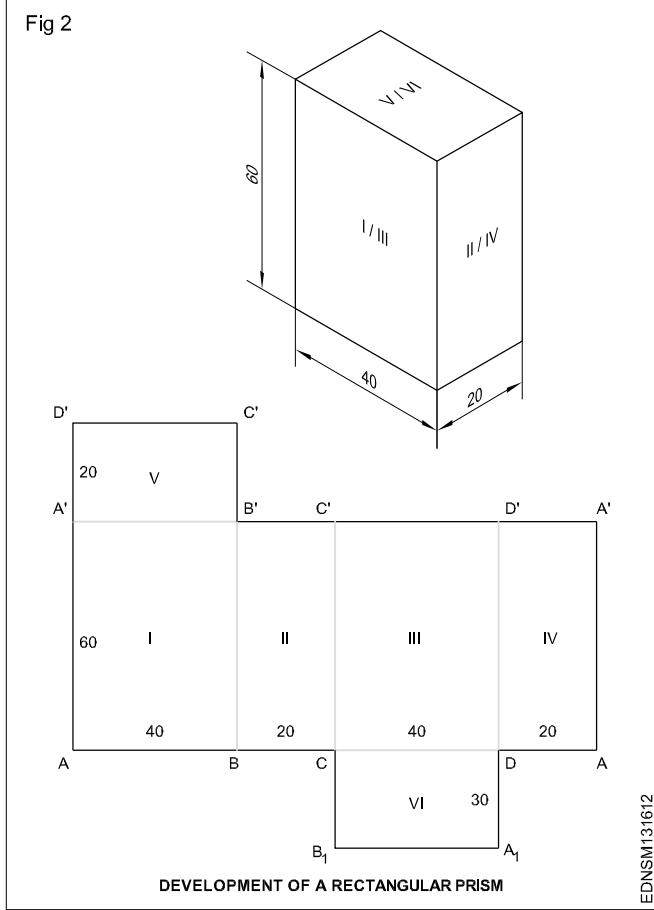
- Draw the elevation and plan of the cube.

- From the front view stretch out (Project) the line AA & A'A' from points b'_1 b' horizontally.

- Set off AB, BC, CD & DA equal to 30 mm each. (side of square)

- From C & D draw perpendiculars and mark off/CB' & DA' equals to 30 mm.

- Similarly erect perpendiculars from points C' & D' such that C'B'$_1$ & D'A'$_1$ equals to 30 mm.

- Darken the lines as shown in Fig 1 to get the required development of the cube.
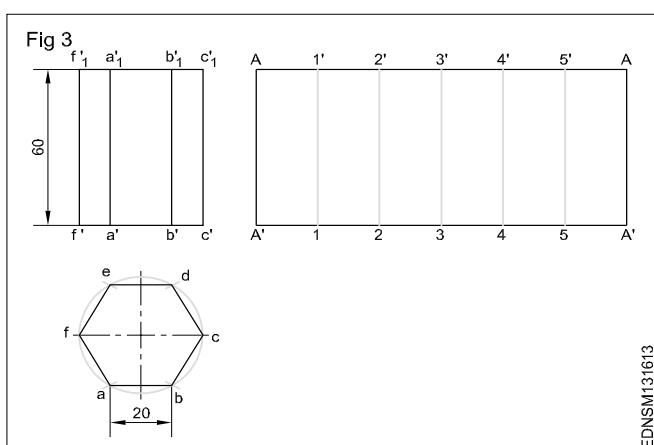
2   Draw the development of the surface/a rectangular prism of size 40 mm x 20 mm and height 60 mm by parallel line method. (Fig 2)

- Draw a rectangle of length equals to the perimeter of the prism. Length = 2 (l + b) = 120 mm and height equals to the height of prism (60 mm).

- Mark AB; BC; CD and DA equals to 40, 20, 40 & 20 mm respectively.

- Draw perpendiculars from the points A,B,C,D and mark as A', B', C', D'.

- Draw a rectangle A'B'C'D' on A'B' of size 40 x 20 mm.

- Draw another rectangle CD A$_1$B$_1$ on CD of size to 40 x 20 mm, the end faces of the prism. Figure obtained is the development of the total prism.

DEVELOPMENT OF A RECTANGULAR PRISM
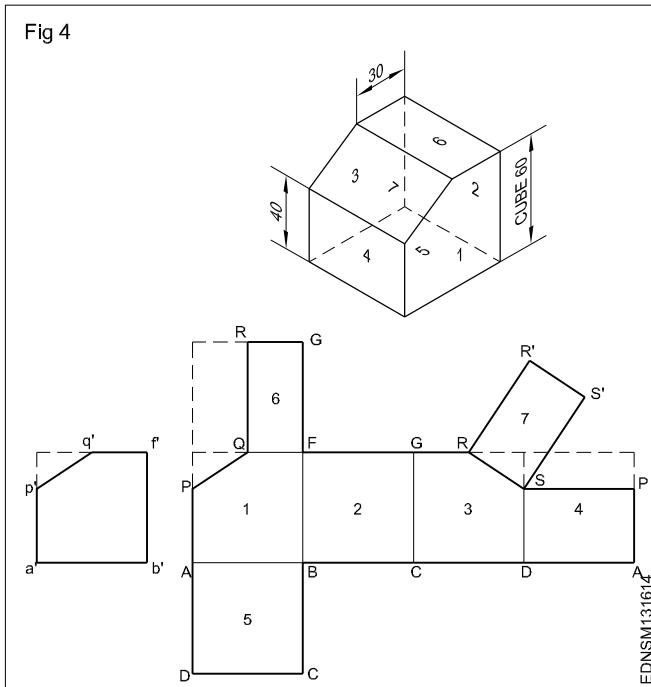
3   Draw the development of the lateral surface of a open hexagonal prism of side 20 mm and height 60 mm. (Fig 3)

Fig 3

- Draw the elevation and plan of the hexagonal prism.

- Project A'A' & AA from the elevation C'C'$_1$ shall be equal to 6 x 20 = 120 mm.

- On A'A' set of A'1, 1-2, 2-3 etc. equal to the side of the hexagon.

- Through A', 1,2,3 etc, draw vertical lines meet at AA, 1',2',3' etc to complete the required lateral surface development of the hexagonal prism.
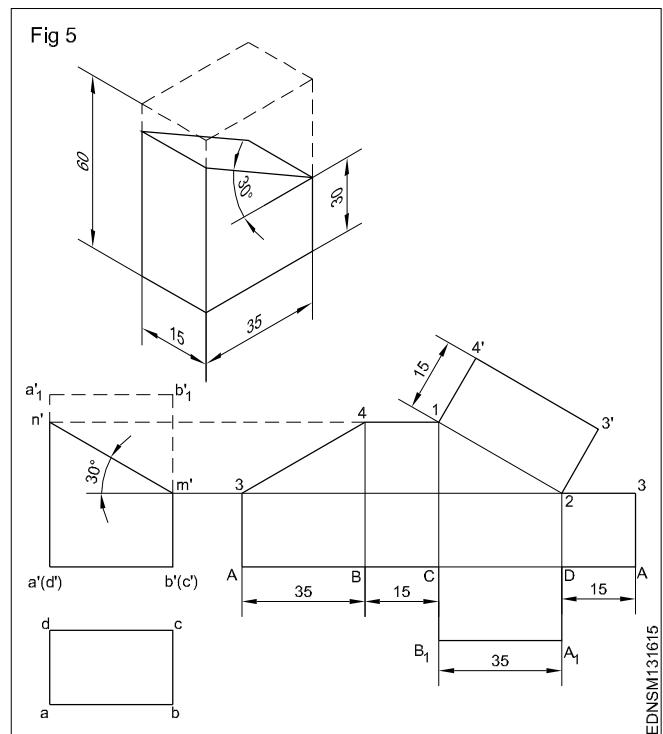
4   Draw the development of surfaces of the box. (Fig 4)

Fig 4

- Assume there is no slope surface and draw the development of cube of side 60 mm as given in Fig4.

- Draw lines PQ and RS in the surfaces 1 and 3 in the basic development equivalent the shape shown in the isometric view of the box.

- Similarly join a rectangle of size equal to the surface 7 shown in isometric view with line RS or PQ and complete the development after erasing the construction lines.

5   Draw the development of a rectangular prism as stated under and as shown in Figure. Prism is cut by a cutting plane at 30°, 30 mm from base on width side. (Fig 5)

- Draw the top view and front view of the rectangular prism.

- Mark 30 mm on front view from b' (c') to meet the line b'b'$_1$ at m'

- At m' make an angle of 30° such that the cutting plane meet the line a'-a'$_1$, at n'.

- Project b', m', n' horizontally and mark of AB = 35, BC = 15, CD = 35 & DA = 15 mm.

- From A,B,C,D,A of the front view, draw vertical lines and mark points 3, 4,1,2 & 3.

- Draw 1-4' and 2-3' perpendiculars to 1-2 equals to 15 mm and draw CB$_1$ & DA$_1$ perpendicular to CD and equals to 15 mm.

- Darken the lines throughout the development of the given prism.

Fig 5
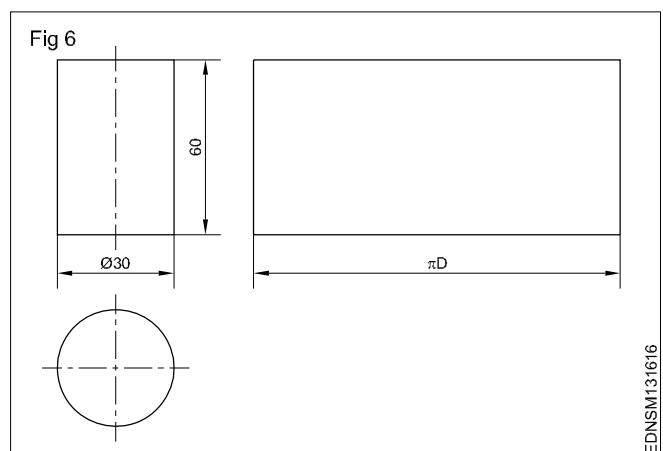
6   Draw the development of the lateral surface of an open cylindrical drum of dia 30 mm and height is 60 mm. (Fig 6)

- Draw the plan and elevation of the drum as stated.

- Project the front view and draw the side view to a length of circumference of the base of the cylinder.

Circumference = π D = π x 30 mm = 94.26 or 94.3

Rectangle thus formed is the development of cylinder.

Fig 6

7   Draw the development of a cone of base 60 mm and height 40 mm. (Fig 7)

- Draw the plan and elevation of the cone.

- Divide the plan circle into number of equal parts (say 12 parts) and mark.
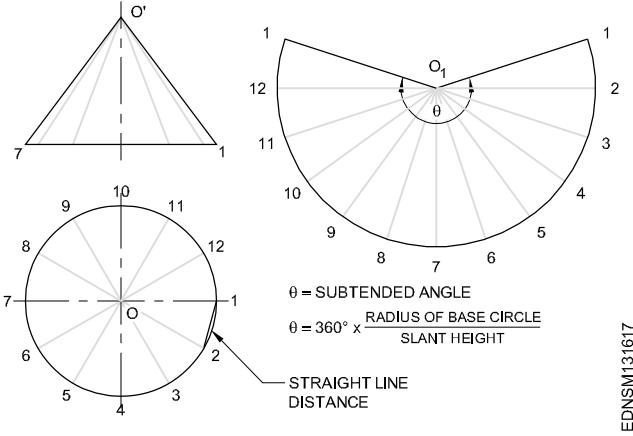
Development is more accurate if the number of equal parts are more.

- Project these parts to the base of the cone.

- Join these points to the vertex of the cone.

- Locate O_1 vertex for the development of cone.

- Draw an arc from the vertex as centre and length of slope as radius.

- Set divider on the straight distance between two consecutive points on the plan.

- Transfer the distance along the arc as many times according to the divisions on the plan.

- Join points 1 O_1 1and complete the development.

> **This method is only an approximate method. The straight line distance taken is slightly smaller than the arc length. More accurate method is by calculating actual circumference and dividing it into number of segments.**

Fig 7

θ = SUBTENDED ANGLE

$\theta = 360° \times \dfrac{\text{RADIUS OF BASE CIRCLE}}{\text{SLANT HEIGHT}}$

STRAIGHT LINE DISTANCE

9 Draw the development of the lateral surface of the cone as positioned. (Fig 8)
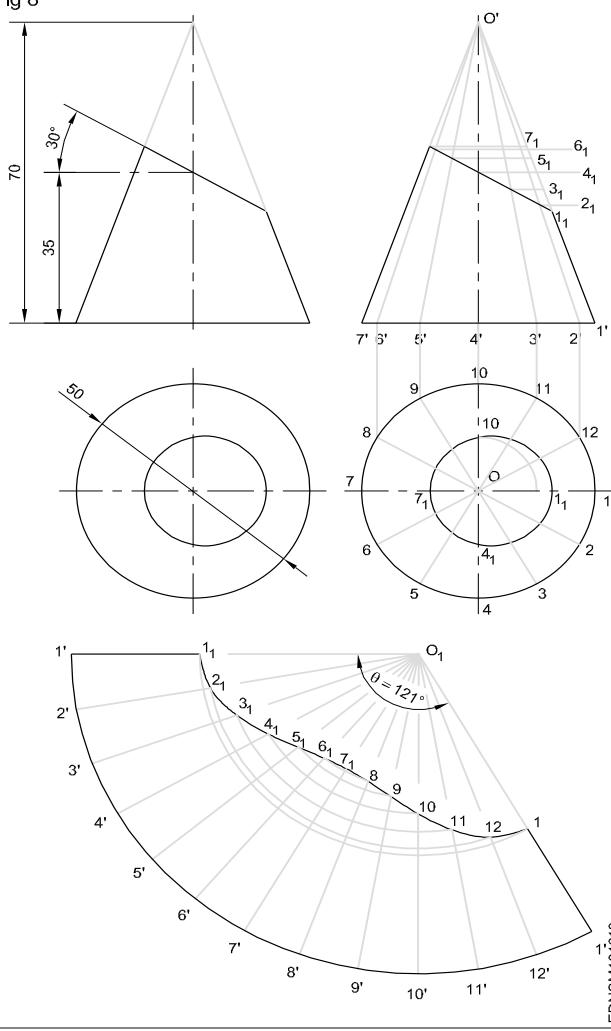
- Draw the views of the cone and cutting plane on it.

- Divide the base into any number of equal parts, say 12 and mark them.

- Project the points on to FV and join to the apex.

- Mark the points on the cutting plane and draw lines parallel to base, touching the generator at $1_1, 2_1....7_1$. These are the true lengths from 0'.

- Draw the sector with slope as radius.

$$\text{Sector angle } \theta = \frac{\text{radius of cone base circle}}{\text{Slant height length (s)}} \times 360°$$

- Mark O_1 and set angle θ.

- Transfer the true lengths on the cone on to the sectors and join by smooth curve.

The area between this curve and the arc is the development of the lateral surface.
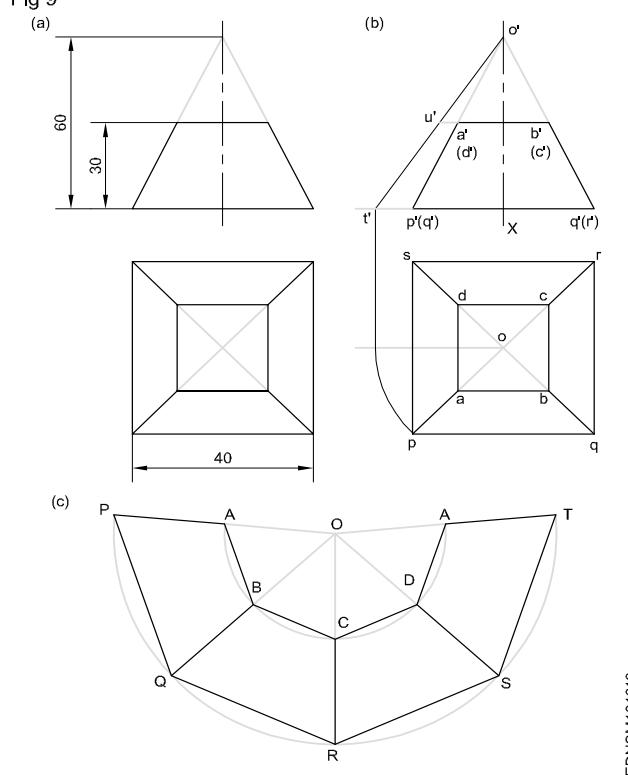
Fig 8

12 Draw the development of the lateral surface of the frustum of a square pyramid as positioned. (Fig 9a)
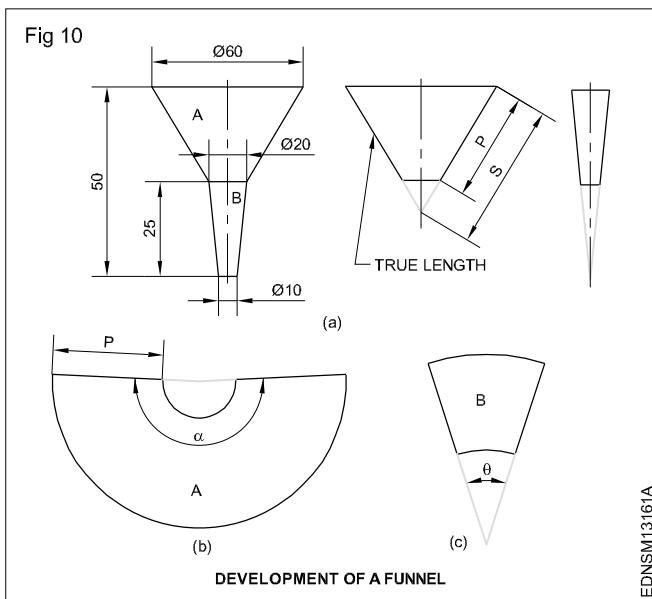
Fig 9

- Draw the front view and plan of the pyramid. (Fig 9b) None of lines in these views show the true length of slant edge.

- Transfer OP in plan to xt in front view. Join o't' by straight line. o't' is the true length of slant edge.

- With `O' as centre draw the development of whole pyramid. (Follow the steps of the exercise 10)

- With `O' as centre set off OA, OB, OC, OD & OA equal to O'U' in front view. (Fig 9c)

- Join AB, BC, CD, DA. Surface bounded by ABCDATSRQP is the development.

10 Draw the development of the lateral surface of a funnel as positioned. (Fig 10)

DEVELOPMENT OF A FUNNEL

EDNSM13161A
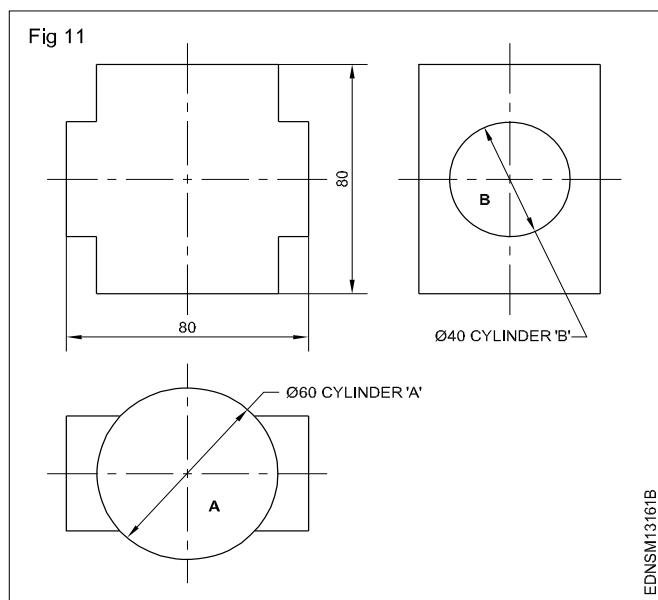
- The parts (A & B)of the funnel are in the shapes of frustum of cones.

- Development of cone and frustum of cone are already dealt in earlier exercises. Follow the previous procedures and draw the developments of both parts A and B.
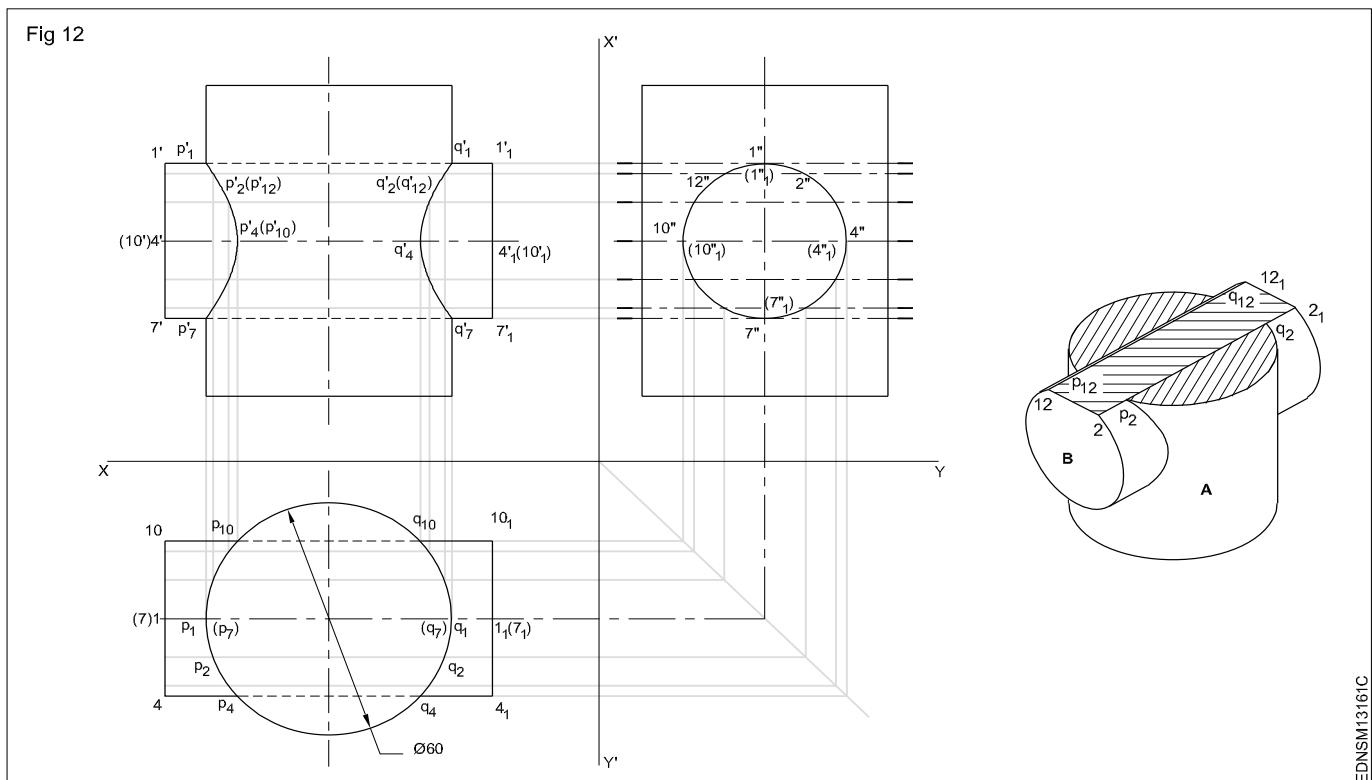
Formula for finding angle

$$\alpha = \frac{\text{Radius of base cone circle}}{\text{Slant height}} \times 360°$$

11 The cylinders A & B are positioned as shown, (Fig 11) intersects each other at right angles. Draw the plan, elevation, side view and show the curve of intersection.

EDNSM13161B

12 Draw the three views of cylinder `A' as shown in position. (Fig 12)

EDNSM13161C

- Draw the side view of the cylinder `B', as circle of diameter equals to 40 mm, such that its centre is the mid-point of the axis of cylinder `A'.

- Divide the circle into 12 equal parts and number them.

- Draw the front view and top view of cylinder `B' projecting from the side view of the horizontal cylinder.

Note: Consider that a number of horizontal section planes passing through the generators of the horizontal cylinder to cut both cylinders. For all the horizontal sectional planes, the sectional top view will always be a circle of `n' diameter. Also the sectional top view of the vertical cylinder will be a circle of `m' diameter.
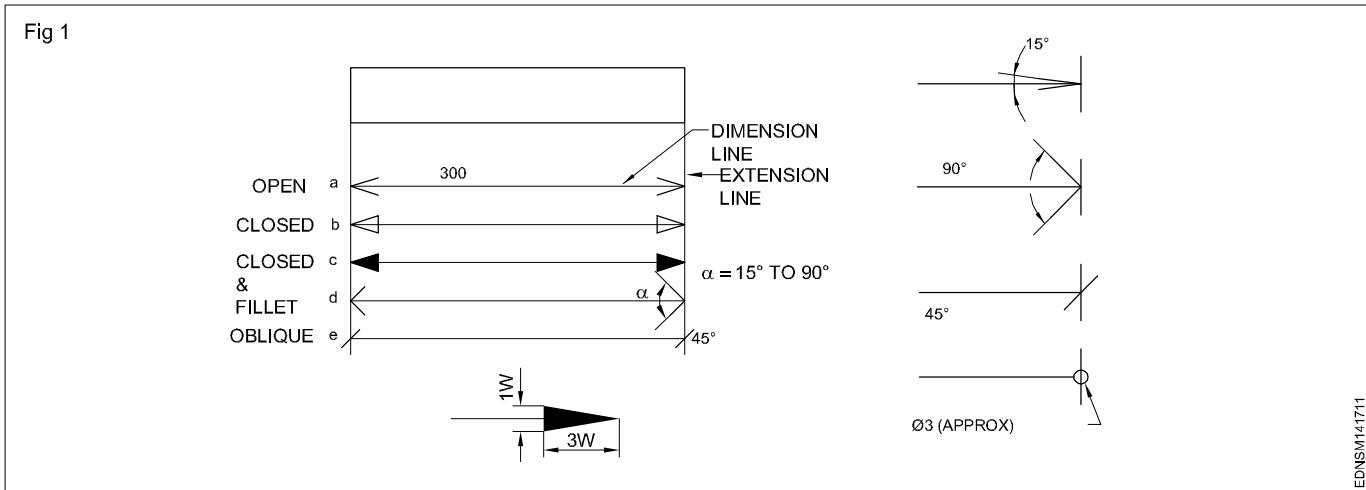
- Draw series of cutting planes on the end view of cylinder `B'.

- Draw horizontal projectors on to the vertical cylinder (A).

- The line $1 - 1_1$ in top view intersects the circle at p_1 & q_1.

- Draw vertical projectors from these intersection points P_1 & q_1 to intersect the line $1'1'$, in front view at p'_1 and q'_1 respectively.

- Considering the second horizontal plane $2\,2_1$ in top view, obtain the corresponding point in the front view $P'_2\ (p'_{12}, q'_{12})$ and q'_2.

- Repeat the same procedure for other series of section planes passing through generators, obtain intersection points in front view.

Join the obtained intersection points in the front view by a smooth curve, which is the curve of intersection of cylinders A & B as stated.
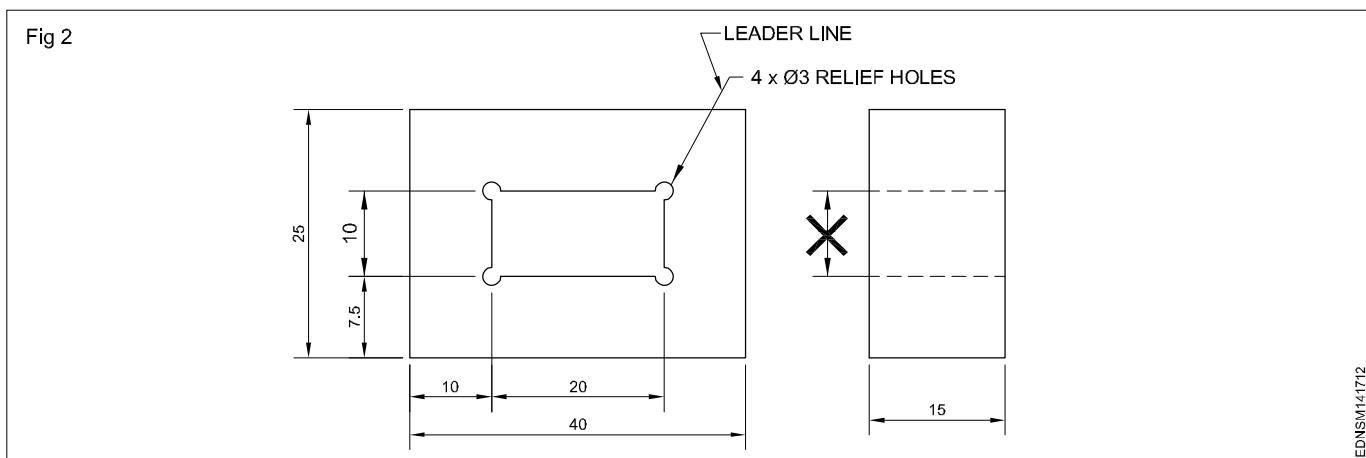
Dimensioning - Types of arrow heads and leader line with text

Dimension line: These are thin continuous lines, terminated at ends by arrowheads, dots or oblique lines touching the extension line. (Fig 1)

Fig 1

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

Dimension to the hidden lines be avoided. (Fig 2)

Fig 2

Arrowheads 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 2)

Termination and Origin indication: The size of the terminations (arrowheads/oblique strokes) shall be proportional to the size of the drawing. Only one style of arrowhead shall be used on a single drawing. However, where the space is too small for the arrowheads, it may be substituted by a dot or by an oblique line. Arrowheads 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 are drawn as short lines inclined at 45°. (Fig 1)

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.
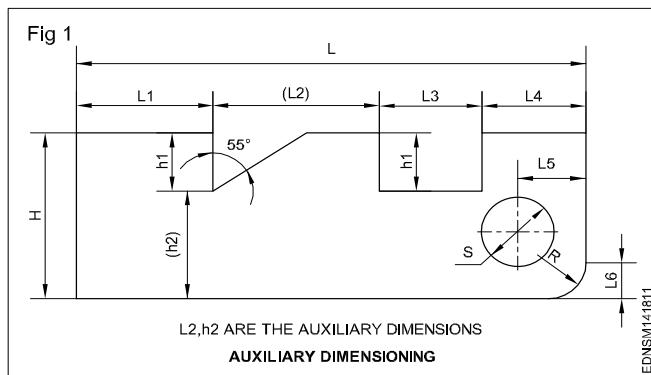
Dimensioning - Position of dimensioning (aligned, unidirectional)

Definitions related to dimensioning

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

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

eg: L1, L3, H, h1, S etc. (Fig 1)

L2, h2 ARE THE AUXILIARY DIMENSIONS

AUXILIARY DIMENSIONING
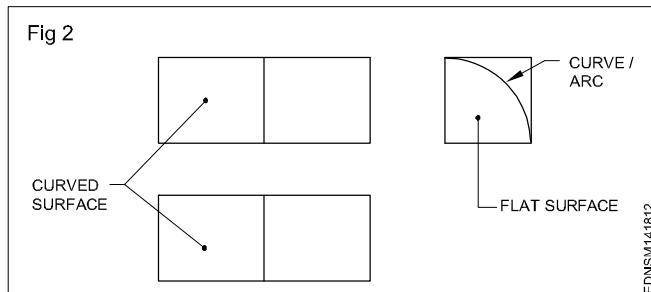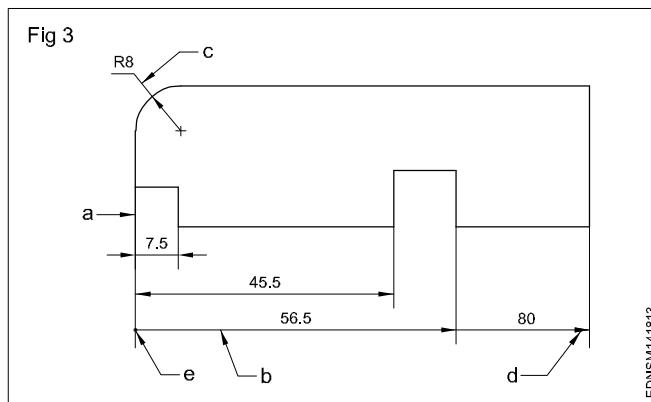
Location dimension: Gives or fixes the relationship of the features. viz centre of holes, slots and any significant forms. (Fig 1)

eg: L4, L5, L6

Feature: It is an individual characteristic such as a flat surface. Cylindrical surface, shoulder, screw thread, a slot, a curve or profile etc. (Fig 2)

Extension line: It is a thin line projecting from the feature and extending beyond the dimension line. (Fig 3)
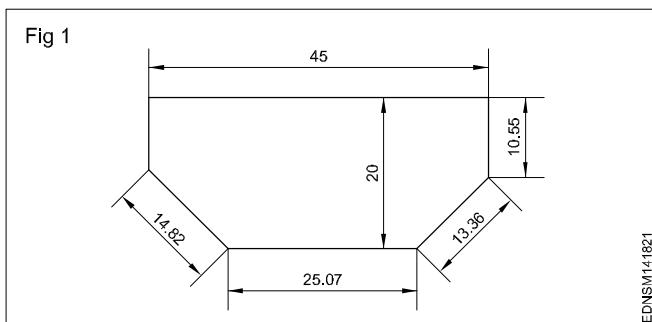

Methods of indicating values

Methods of indicating values: There are two methods used for indicating the values. Only one method should be used on anyone drawing.
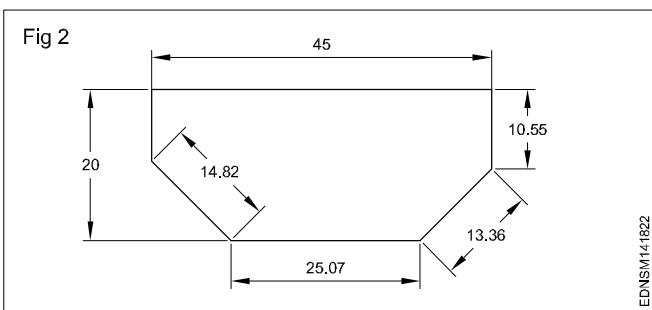
Method 1 Aligned system

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 the bottom of the the right-hand side of the drawing. Dimension lines should not be broken. Dimensioning of angles is also given in the same way. (Fig 1) This method is known as an **aligned system** of dimensioning.

Method 2 Unidirectional system

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 2). This method is termed a **unidirectional system** of dimensioning.
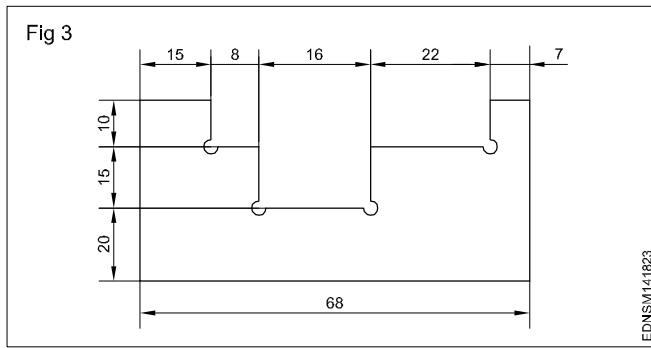

Arrangement and indication of dimensions

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.
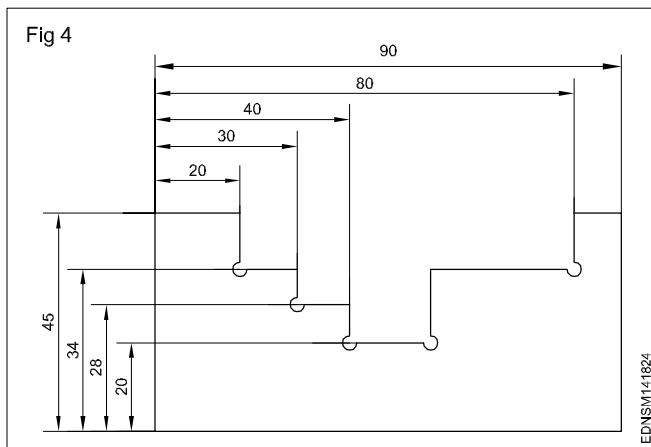
Chain dimensioning: It is used where the possible accumulation of tolerances does not infringe (effect) on the functional requirement of the component. (Fig 3)


Fig 3
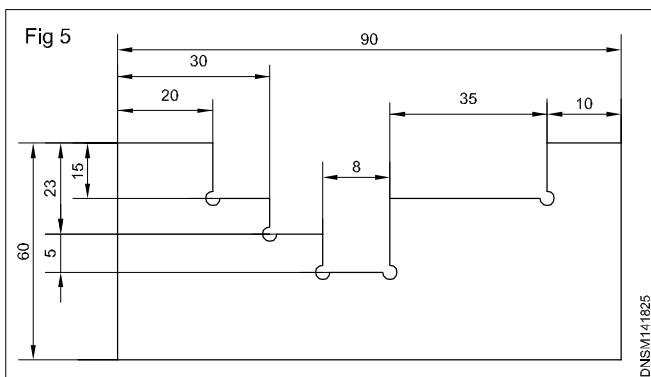
Dimensioning from a common feature is used where several dimensions of the same direction relate to a common origin.

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 another and placed so that the dimensional values can easily be added in Fig 4.


Fig 4
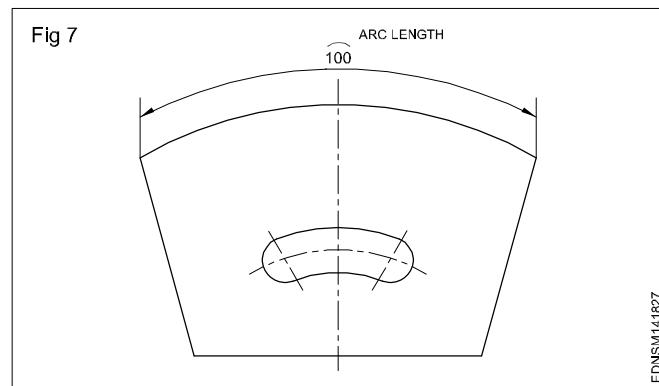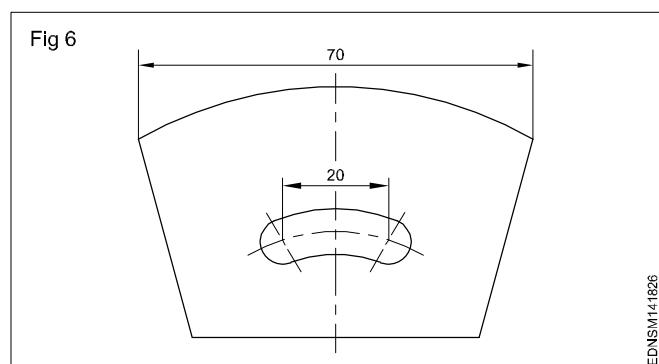
Combined dimensioning: Dimensions are given in chain dimensioning and parallel dimensioning. The common feature is combined. (Fig 5)


Fig 5
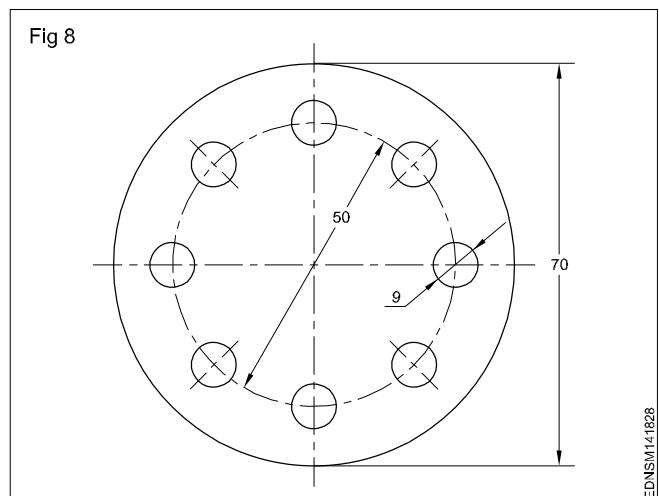
**Dimensioning a chord:** For dimensioning of the chord, refer Fig 6. It is shown as linear size.
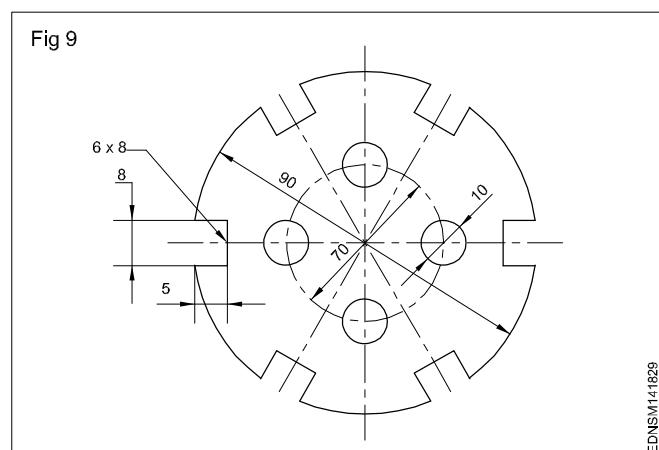
Dimensioning an arc/radius: A small arc is shown over the dimension value, while dimensioning an arc. (Fig 7)

Fig 6

Fig 7

When the drawing is clear, symbols or abbreviation viz. dia, Pcd and angle can be omitted. (Fig 8)


Fig 8
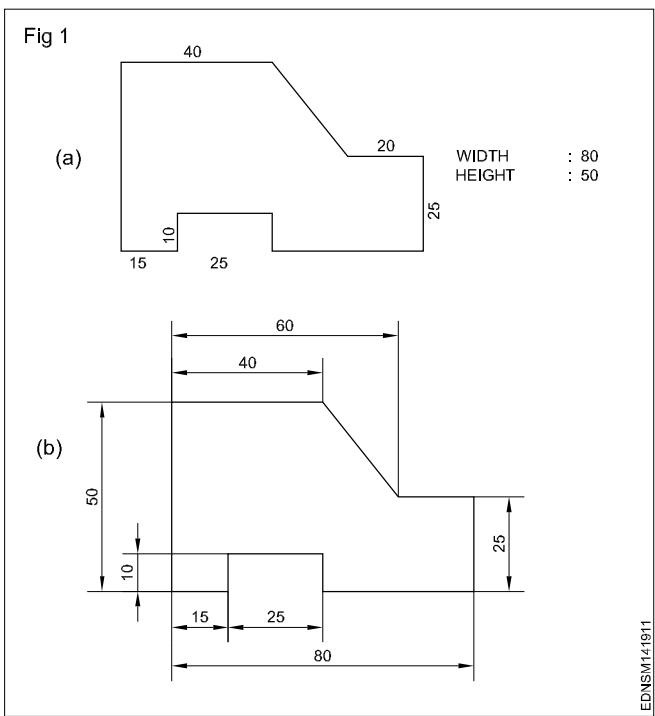
Dimensioning periphery: The features on the periphery can be shown as given in the figure, indicating width, depth and number of slots. (Fig 9)


Fig 9

Practice of dimensioning
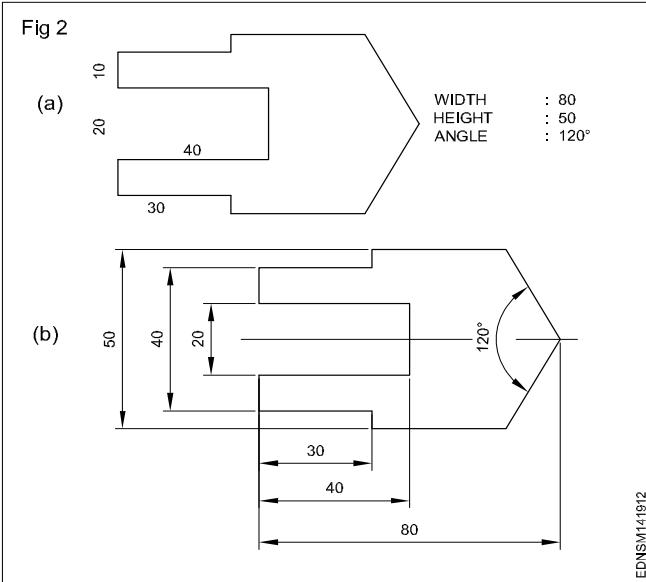
1 To the given drawing of the profile sheet metal as shown in Fig 1, place the dimensions in the aligned system. (Fig 1a)

• Draw the drawing of the sheet metal to 1:1 scale.

• Draw the extension lines in continuation of outlines.

• Draw the dimension lines. (Fig 1b)

• Place the dimension value near the middle and above the dimension line to be read from "bottom and right hand side" of the drawing.

Fig 1
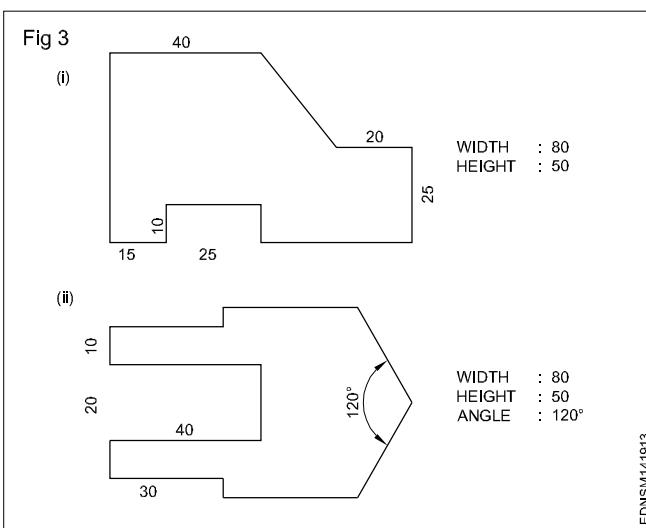
2 To the given drawing of the profile sheet metal as shown in Fig 2a, give the dimensions in the unidirectional system. (Fig 2b)

• Place the horizontal dimensions above and middle of the dimension line without break.

• Break the dimension in the middle of all non-horizontal dimension lines. (Fig 2b)

Fig 2

3 Draw the two sheet metal templates to full scale with appropriate lines use 0.5 range line thickness. (Fig 3)

• Draw a rectangular block of length 80 mm and width 50 mm in thin lines.

• Incorporate the features of the template as per the given dimension.

• Draw by thick lines all visible outlines.

• Give dimensions and maintain the line thickness as per the line range (0.5).

• Complete the figure and remove the unwanted lines.

Fig 3
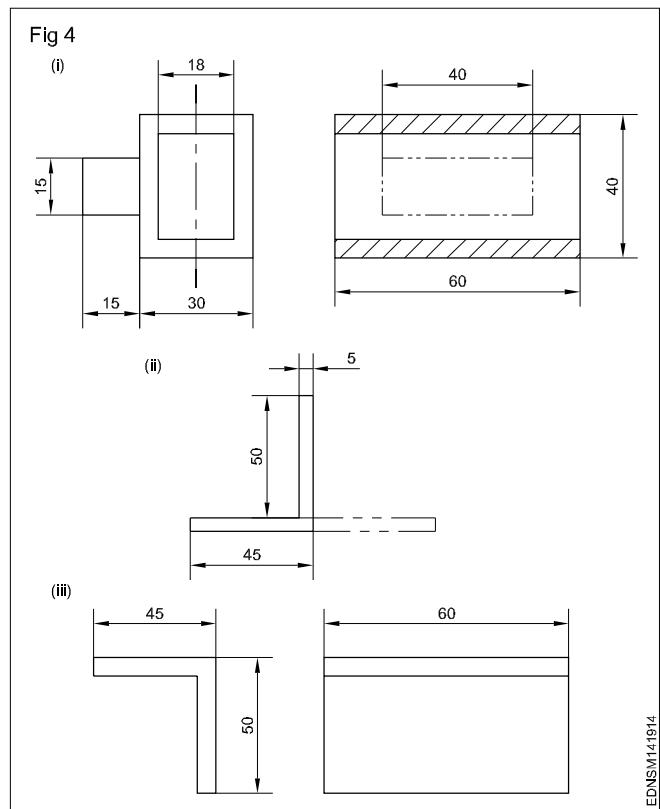
4   Draw the figures given. Maintain the types of lines as per the B.I.S and choose correct line thickness. (Fig 4)

   •   According to the given dimensions, draw the figures given in Fig 4.

   •   Select the appropriate lines and maintain uniformity.

   •   Remove (erase) unwanted lines, arcs and complete the drawing.
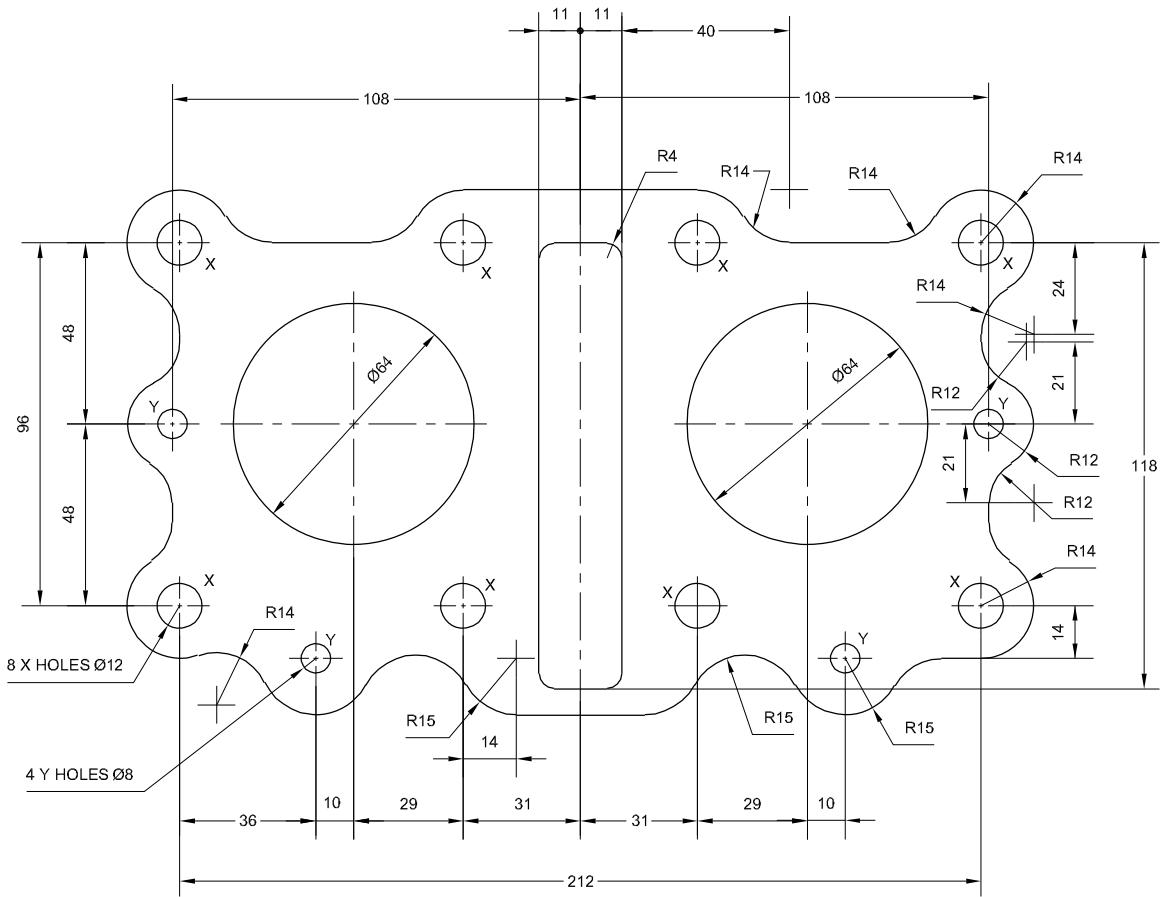
   **Note: Draw the dimension line terminations as per IS:11669-1986.**

5   The motor cycle engine gasket is shown in figure 5. There are some mistakes in dimensioning. Reproduce the same in the A3/A4 sheet provided and correct the mistakes according to the aligned system of dimensioning. (Fig 5)

Fig 4
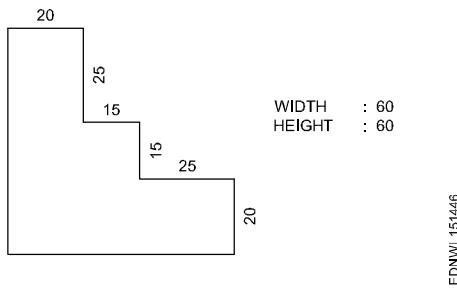
Fig 5
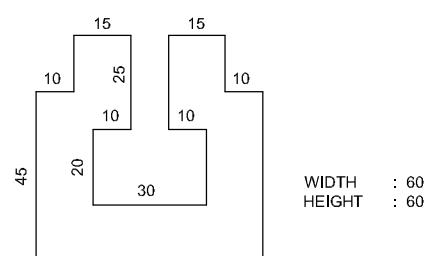
6   Draw the given cover plate and give the dimensions in the aligned system. (Fig 6)

Fig 6

20

25

15

15

25

20

WIDTH   : 60
HEIGHT   : 60

EDNWL151446
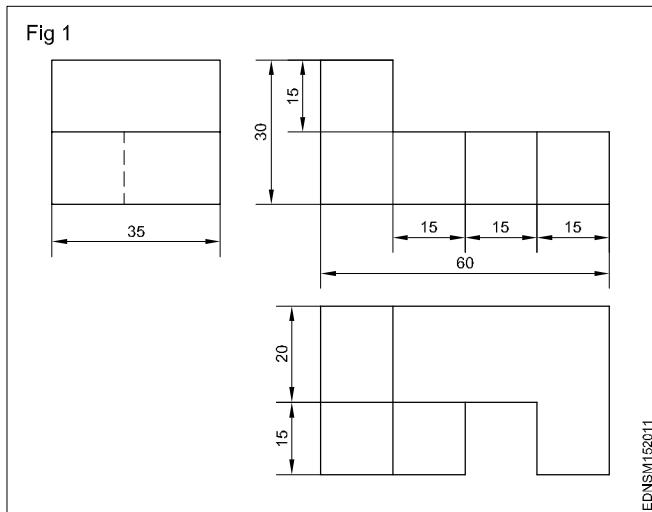
7   Draw the cover plate given in the figure and place the dimensions in the unidirectional system. (Fig 7)

Fig 7

15   15

10   25   10

10   10

45   20

30

WIDTH   : 60
HEIGHT   : 60

EDNWL151447

Concept and reading of drawing in - Concept of axes plane and quadrant

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 way and the shape is easily understood even by a layman.


Fig 2
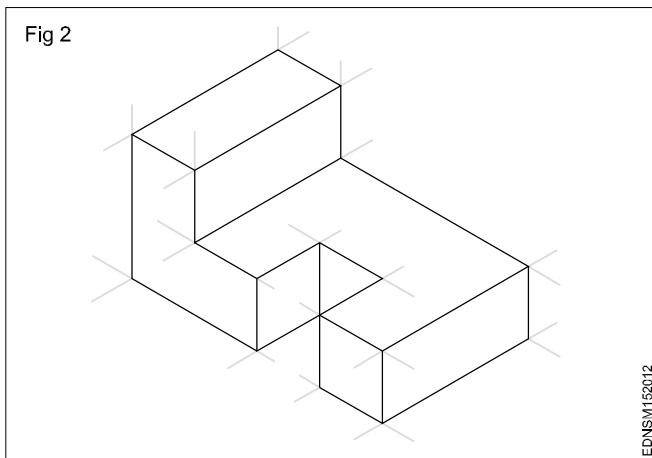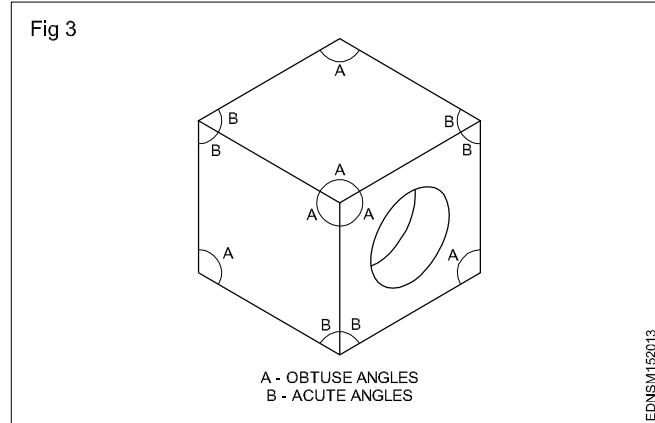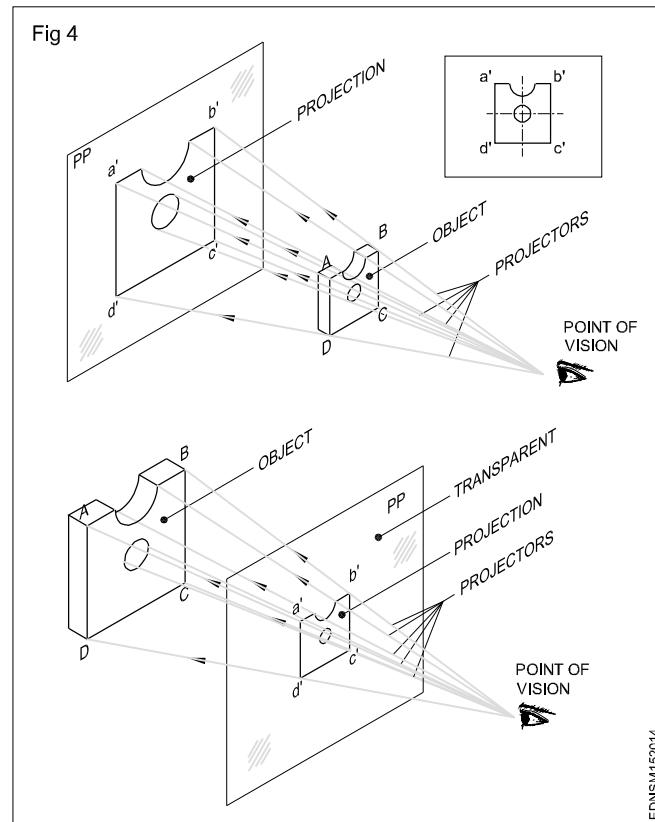
Figure 1 is called a Multiview drawing or Orthographic drawing and figure 2 is called a pictorial drawing.

Fig 3, wherein a cube with a circular hole is represented pictorially. We know that all corners of the cube are 90°. But in the pictorial drawing in Fig 3, the same 90° is represented at some places by acute angles and some other places by obtuse angles.


Fig 3

A - OBTUSE ANGLES
B - ACUTE ANGLES

Projection: Projection is a commonly used term in draughtsman's vocabulary. In the context of engineering drawing, projectors mean images.
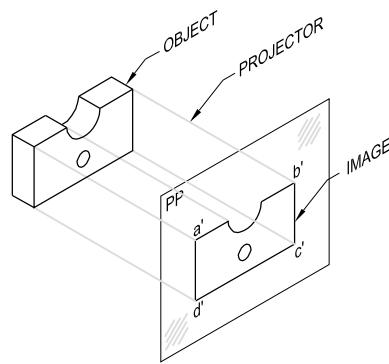
Projections or images can also be formed in between the eyes and the object by keeping a transparent plane. (Fig 4)


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 the image is formed is called the plane of projection. In orthographic projection, the projectors are perpendicular to the plane of projection. (Fig 5)
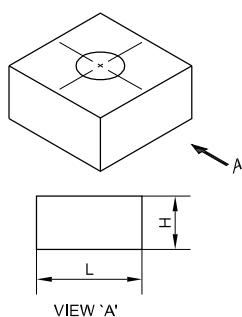
Fig 5

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 a 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 alone.


Fig 6
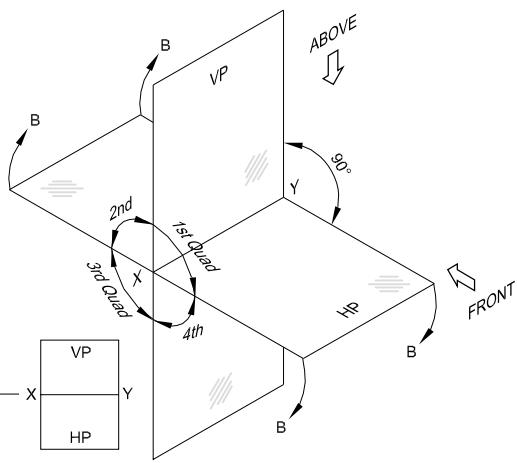
Therefore, it becomes necessary to have an additional view to show the missing dimensions (width). Hence, we have to make two views to represent the three dimensions of an object.

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)

All 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.
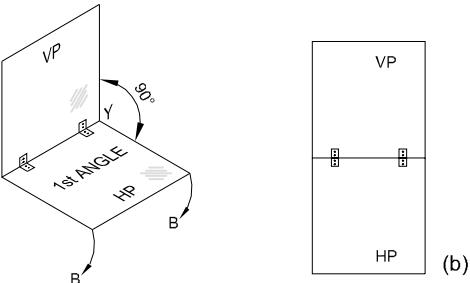

Fig 7

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 top and front view are projected to the respective planes.
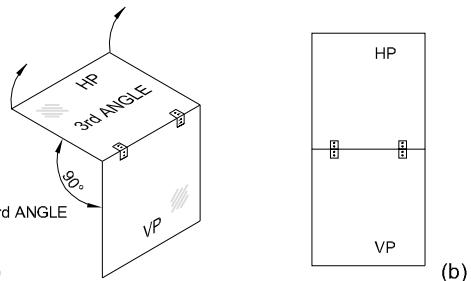
Now to make it possible to draw the two views (Front & Top view) in one plane i.e the plane of the drawing paper, the horizontal plane is assumed to be unfolded in a clockwise direction through 90° (Fig 8b & 9b). We proceed this way when the views are made. When the object is placed in the 2nd or fourth quadrant the front and top will get superimposed (one upon the other) (Fig 10a & b).

Fig 8
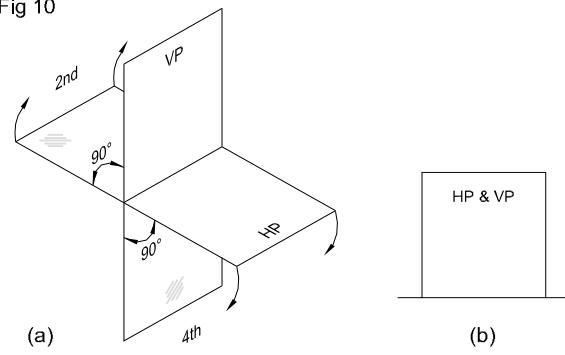
Fig 9
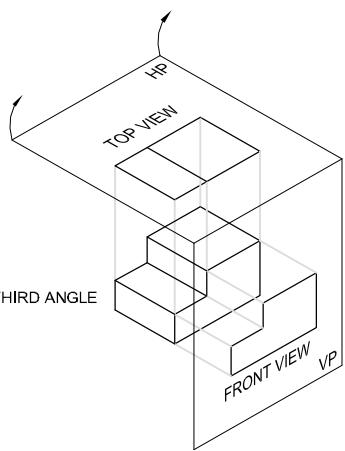
Due to this reason, the 2nd and 4th angles are not used for making engineering drawings as the three dimensions cannot be easily identified. Hence for representing the three dimensions of the object, we assume the object is placed either in the 1st angle or in the 3rd angle (Fig 11&12) respectively.

Fig 10
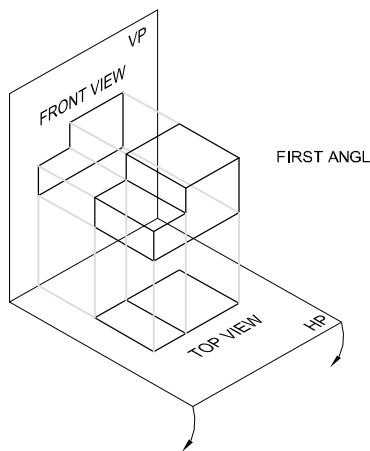
(a)   (b)

VP

2nd

90°

90°

4th

HP

HP & VP

EDNSM15201A

Fig 11

VP

FRONT VIEW

FIRST ANGLE

TOP VIEW

HP

EDNSM15201B

Fig 12

HP

TOP VIEW

THIRD ANGLE

FRONT VIEW   VP
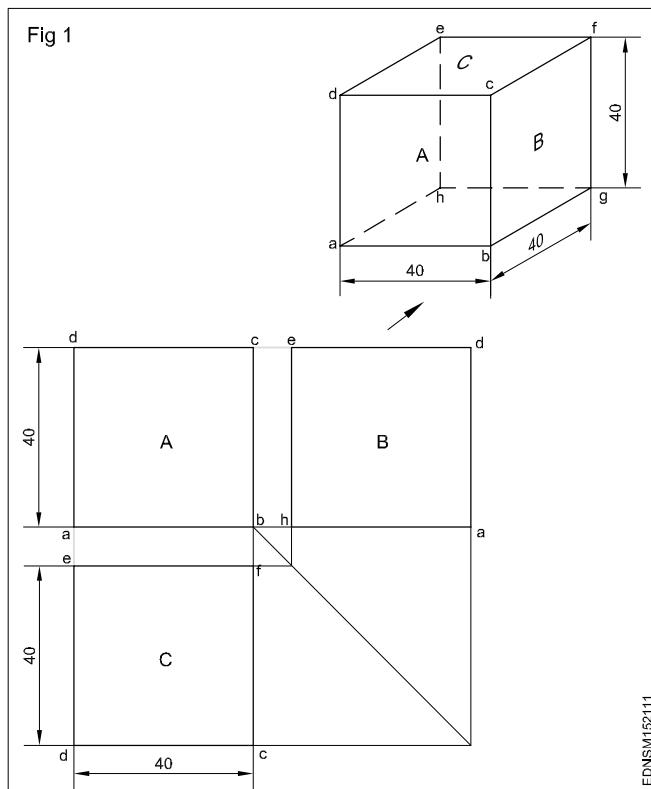
EDNSM15201C

Concept and reading of drawing in - Concept of orthographic projection and isometric projection

Concept of Orthographic projection

Method 1

Draw the orthographic projection (front, top and side views) of the square sheet (40 mm side) kept perpendicular to HP and parallel to VP. (I angle) (Fig 1)

Fig 1
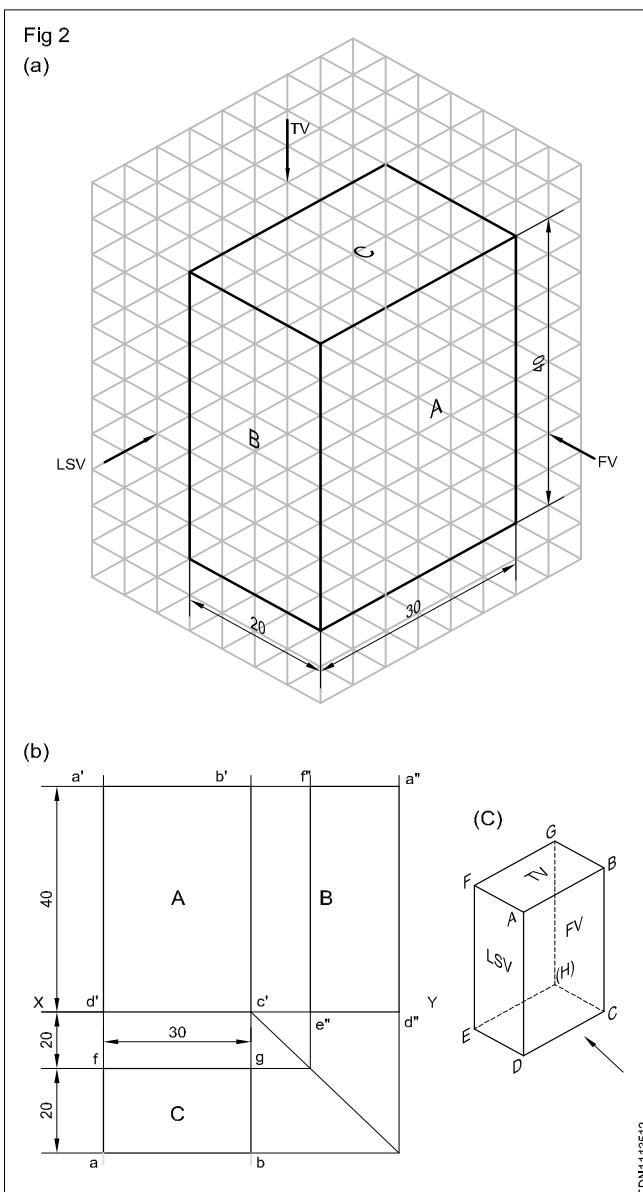
- Draw the XY line.

- Draw the square with its centre 40 mm above the XY line and one edge parallel to the XY line.

- Mark the corners of the figure a', b', c' & d'. This will be the front of the square.

- Draw the vertical projectors from a'b' downward beyond the XY line.

- Draw a horizontal line dc at a distance of 20 mm below the XY line. Line dc will be the plan.

- Draw a X'Y' line at a convenient distance from b'c', intersecting the XY line at `0'.

- Project the top to the X Y line meeting at e.

- By arc method transfer Oe to XY and mark the point `f' at a" and d" respectively. Now the line a"d" is the side view.

Method 2: Rectangular prism

Draw the Top, Front and side views of the rectangular prism of base 30 x 20 mm and height 40 mm. (Fig 2A)

In this exercise, the faces of the prism are parallel to the planes of projection. Therefore all the line's orthographic projections are vertical and horizontal only.

Visualise the shape of the object and imagine the shape description of views. Surface ABCD (Fig 2B) is only visible from the elevation. At the same time, all four sides of ABCD are isometric lines. Therefore in the elevation, a rectangle of 40 x 30 mm is seen.


Fig 2
(a)

(b)

(C)
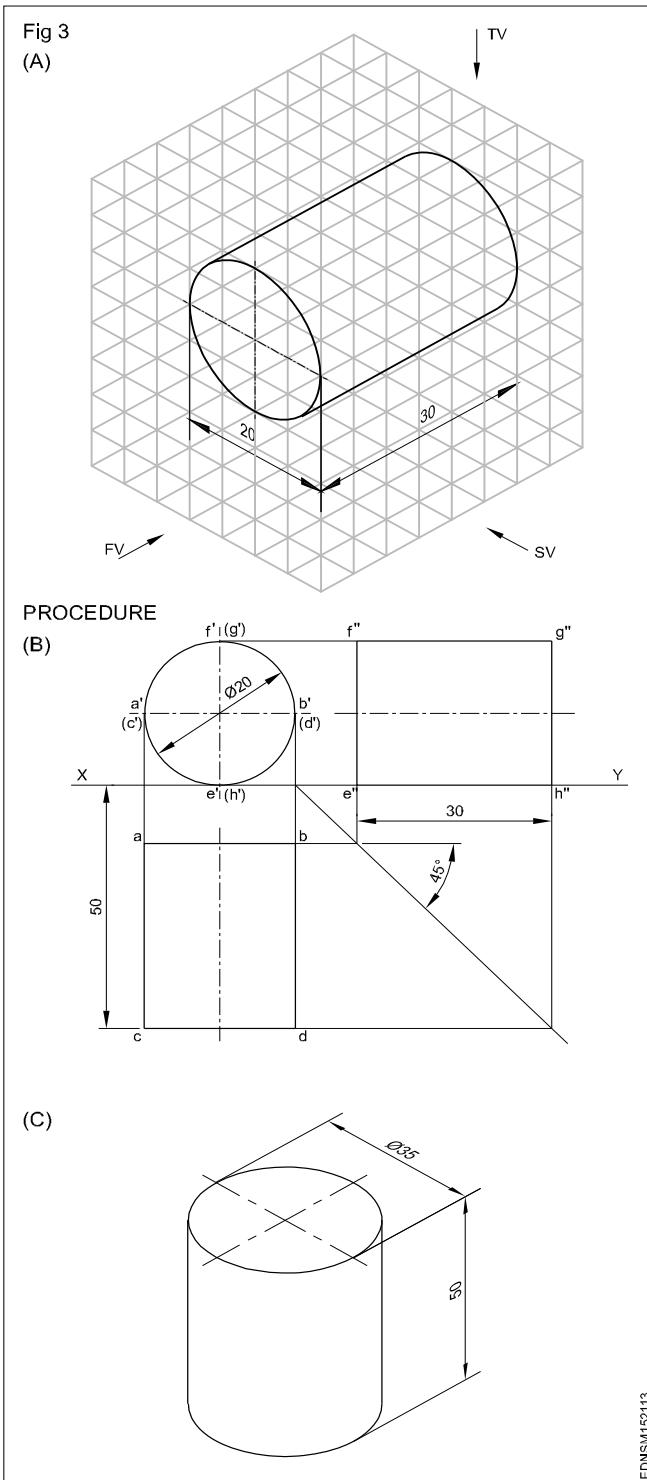
- Draw XY line of convenient length. (Fig 2B)

- Draw a rectangle a'b'c'd' on the XY line. This will be the front view of the prism.

- Project the vertical sides of the front view (a'd' and b'c') downwards beyond the XY line.

- Draw a horizontal line fg approximately 20 mm below the XY line.

- Draw a rectangle fgba of 30 x 20 mm size. This will be the plan of the prism.

- Project points b' and c' horizontally a convenient length to the right side of the elevation.

- Transfer the width of the top view GB by the arc and locate points e"d" on the XY line.

- Project e"d" vertically up and locate points f"a"d"e" is the left side view of the prism.

Method 3 : Cylinder

Draw the top, front and side view of a cylinder of diameter 20 mm and length of 30 mm. (Fig 3A)

Fig 3 (A)

PROCEDURE (B)

(C)
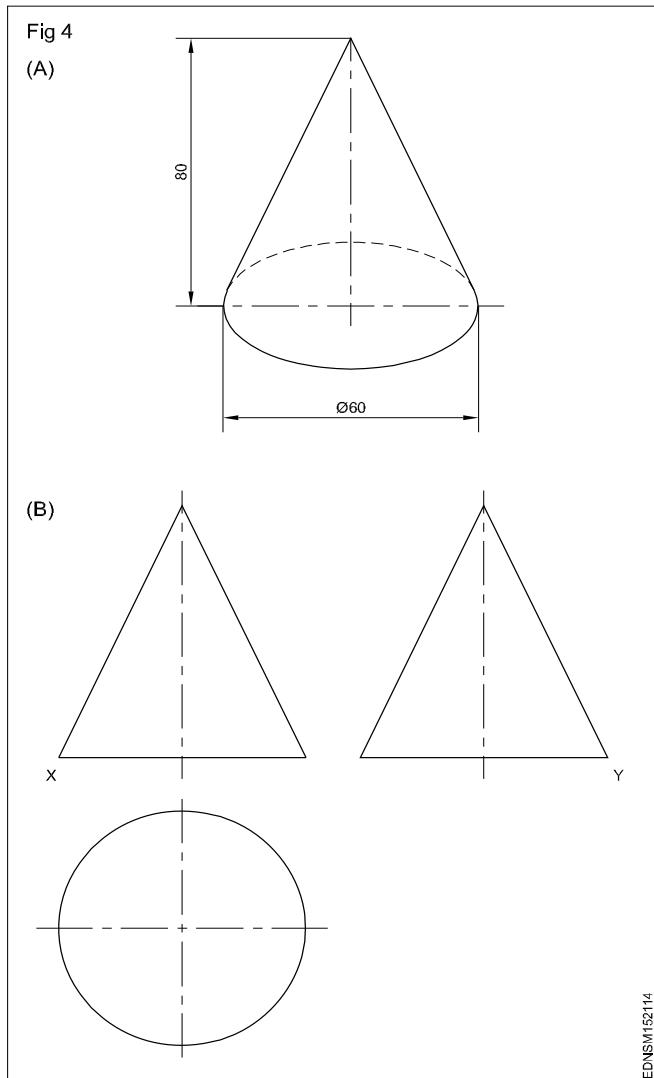
In this problem, the circular faces are parallel to VP. Therefore the front is a circle resting on the XY line. Plan and end views are rectangles of size 30 mm x 20 mm.

- Draw the circle of diameter 20 mm touching the XY line. (Fig 3B)

- Draw the plan projecting it from the elevation.

- Draw the end view by drawing a projection on it, from the plan and elevation.

- Draw the top, front and side views of a cylinder whose base diameter is 35 mm and height 50 mm when its position is as shown in Fig 3C.

Method 4: Cone

Draw the multi-views of the cone shown in Fig 4A. Follow the procedures of the earlier exercises and draw the multi-views. (Fig 4B)


Fig 4 (A)

(B)
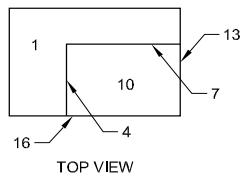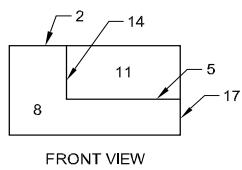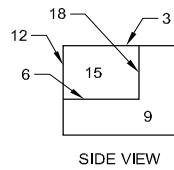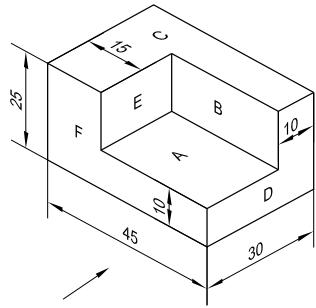
Method 5

Identify the surfaces of the block shown in the isometric view with the corresponding multi-views and fill the numerals in the given tabulation column. (Fig 5)

The surfaces are parallel and perpendicular to the plane of projection.

- Study the isometric view and the corresponding multi-views carefully.

Fig 5

SIDE VIEW

FRONT VIEW

TOP VIEW

	F	S	P
A	5	6	10
B			
C			
D			
E			
F			

- You may observe that the surfaces seen in one view are represented by lines in the other two views.

- In this exercise, the surface `A' shown in the isometric view is seen as a line in the front elevation and numbered as `5' in the front view of the corresponding multi-views.

- The same surface `A' in the side view is seen as a line and numbered `6' in the side view of the multi-views.

- Similarly, the surface `A' seen from the top of the isometric views is numbered as `10' in the plan of the multi-views, whereas the full surface area is visible.

When a surface is parallel or perpendicular to the plane of projection vice-versa in a multi-views drawing, the full area of the surface will be seen in anyone the three views (plan, elevation and side view) and in the other two views, the corresponding line of the surface will be seen.

Method 6

Draw the isometric view (Fig 6) and also draw the three views in the workbook.

The orthographic projection shows the shape of a component by drawing several views each looking at a different side of the component.

A minimum of two views are required to represent a component. To clarify the internal and external details a minimum of three views are to be drawn. They are:
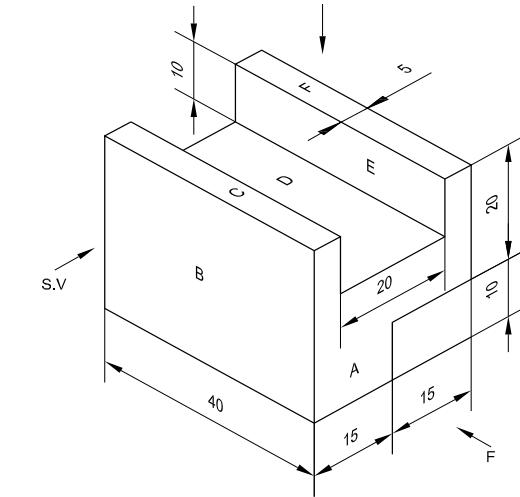
- Elevation or Front view or Front elevation. (F)

- Plan or Top view. (P)

- Side view or side elevation or end elevation. (S)

In Fig 6, surface `A' is only seen when looking at the front of the figure. All the lines in the isometric view are isometric. Therefore in the orthographic projection, the front view will be like this. (Fig 7)

In the plan surfaces `C', `D' and `F' are visible and the bottom surface will not visible. The line joining the two surfaces will not be visible. The line joining the surfaces will appear in the plan as a hidden line. (Fig 8)
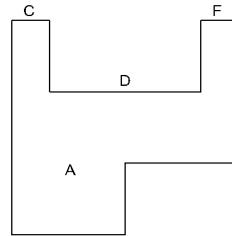
In the side view surface `B' is visible and surfaces `E' and back bottom surfaces are invisible. Due to this reason the line joining `D' and `E', also the line joining back bottom surfaces are appearing in the side view by a hidden line. (Fig 9)


Fig 6
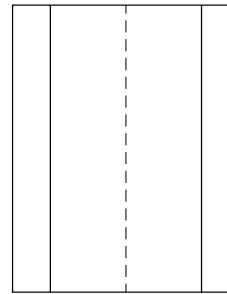
Fig 7

Fig 8

Fig 9

Pictorial drawing (isometric drawing)

Pictorial drawing: Even a common man can understand easily the shape of an object quickly by a picture or by a pictorial drawing. It is also called three-dimensional drawing.
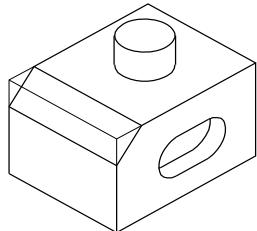
Pictorial drawings are very useful for describing the shape of a piece part or component, even though they have a distorted look.

Three types of pictorial drawings are (Fig 1)
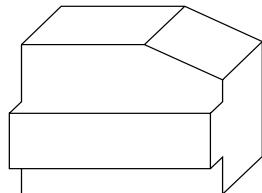
• Isometric drawing

• Oblique drawing

• Perspective drawing

Out of the above three types, isometric drawings are very much preferred by machine shops and metalworking trades groups. But perspective drawings are popular in the civil engineering group of trades.
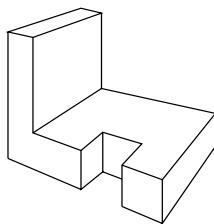
Fig 1

ISOMETRIC

OBLIQUE

PERSPECTIVE
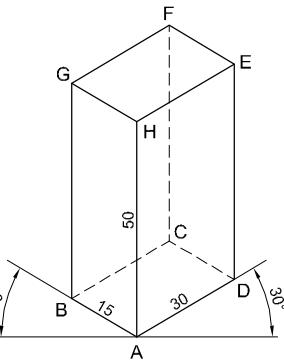
Isometric drawing

Procedure

1 Rectangular prism

Draw the isometric drawing of a rectangular prism of base 15 mm x 30 mm and the height of 50 mm. (Fig 1)

• Draw the three isometric axes through point `A'.

• Mark AB = 15 mm, AD = 30 mm and AH = 50 mm representing the three sides of prism.
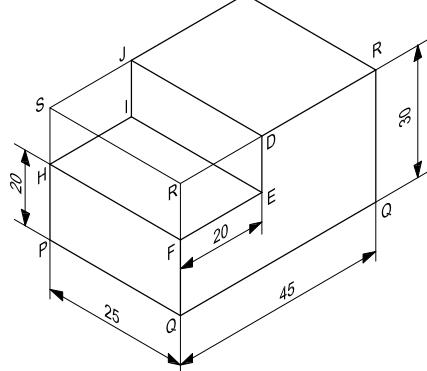
Fig 1

• Draw two vertical lines parallel to the line AH through points B and D.

• Similarly draw two more lines parallel to AB and AD through point H.

• Mark G and E the intersecting points.

• Draw lines parallel to GH and HE through points G and E intersecting point is F.

• Draw lines parallel to AB & AD through points D and B respectively intersecting at C.

• Join CB & CD with dash lines.

• Join F and C also with dash lines.

• Rub off the construction lines and complete the prism.

2 Stepped block - 1

Draw the isometric view of the stepped block given in Fig 2.

Fig 2

• Draw the isometric view of a rectangular prism of dimensions equal to the overall size of the block 45 x 25 x 30 mm.

• Draw the lines JD, DE, EF, FH, HI and IJ using the measurements given in the figure.

• Rub off SR, RD, SJ, SH and RF.

• Darken the remaining lines of the stepped block.
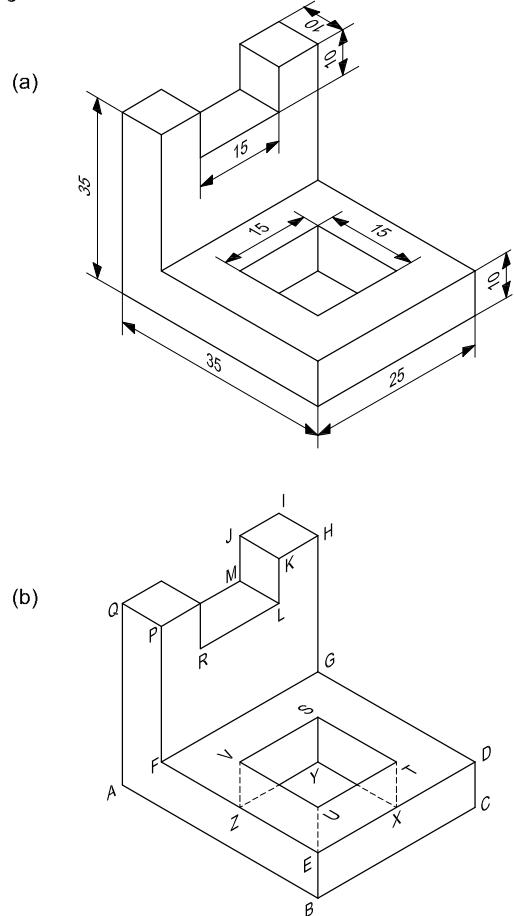
3 Stepped block - 2

Draw the isometric view of the components shown. (Fig 3)

• Draw the stepped block as per dimension. Follow the procedure given in the previous Ex. No.2.

• Mark points to UTSV as per dimension on the top of the surface EDGF (Fig 3b)

• Join points UTSV.

• Project vertically downwards from the points UTSV and obtain the point WXYZ at the bottom surface such that UW, TX, SY & VZ are equal to 10 mm. Join the point WXYZ and draw the thick lines which are all visible and dotted lines that are not visible

> **All construction lines should be in thin lines. After completion of the isometric views, in each case erase the unwanted lines and construction lines.**

Fig 4

(a)

(b)

With the experiences gained in previous exercises of drawing isometric views, draw the following exercises 4 & 5 and complete the same.

Practice 1 to 3 (Figs 4,5 &6)

Fig 4
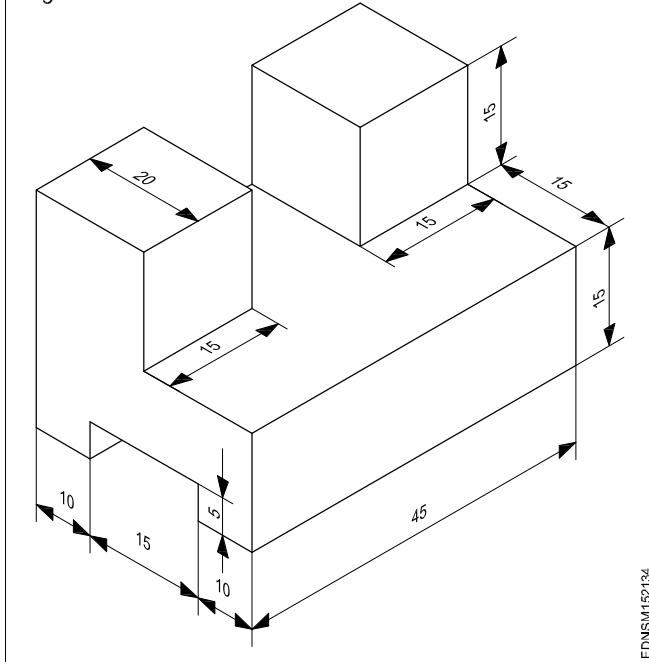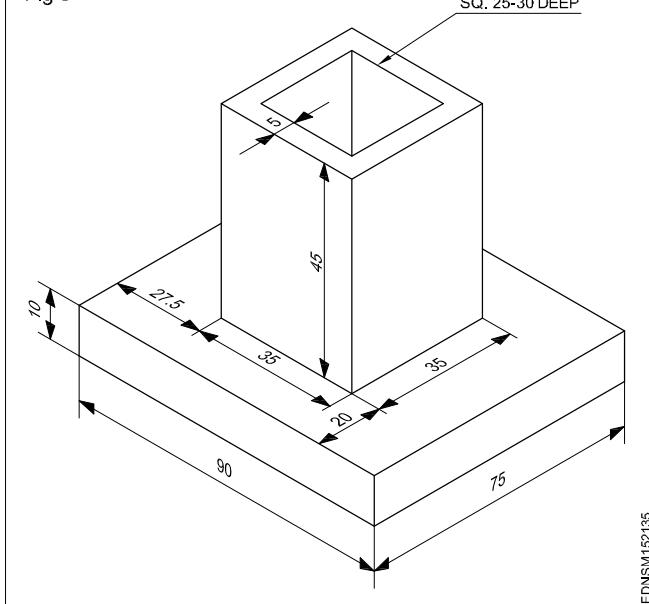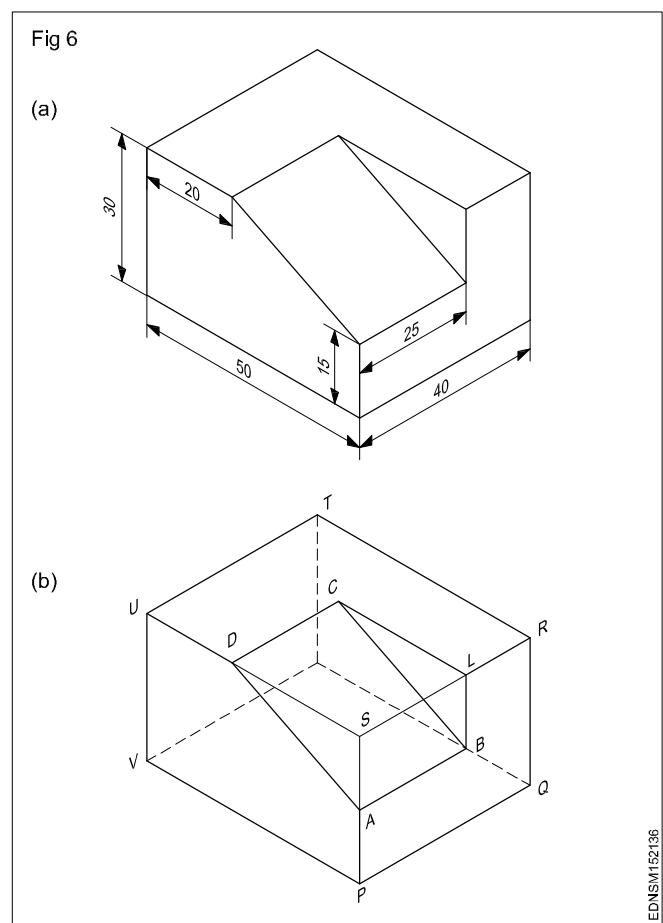
Fig 5
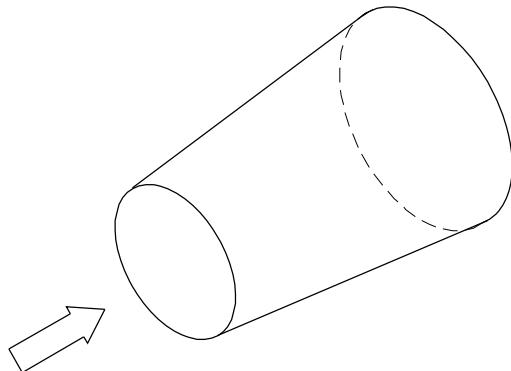
Draw the isometric view of the machined block having non-isometric lines. (Fig 6)

Fig 6

(a)

(b)
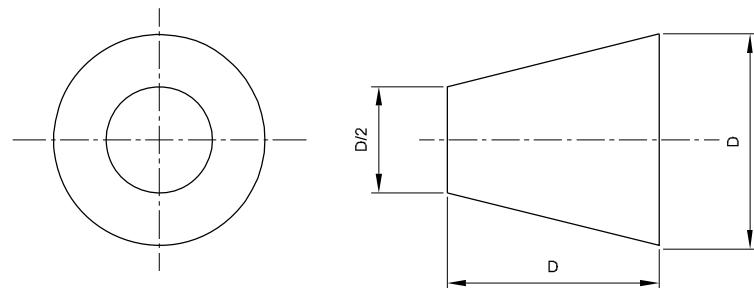
Method of 1st angle and 3rd angle projections (Definition and difference)

Symbol of 1st angle and 3rd angle projection as per IS specification
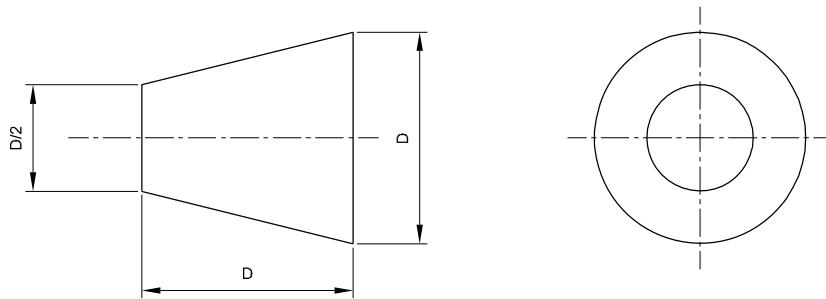
PROPORTION OF PROJECTION SYMBOLS

SYMBOL FOR THIRD ANGLE

SYMBOL FOR FIRST ANGLE
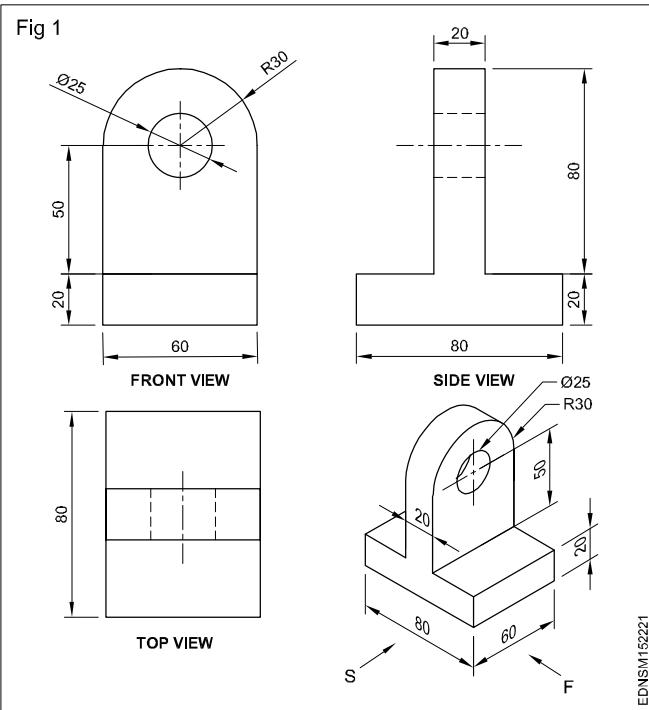
EDNSM152211

1 a Draw the symbol for 1st angle projection as per IS specification, if bigger dia D is 50 mm.

   b Draw the symbol for 3rd angle projection as per IS specification, if bigger dia D is 40 mm.
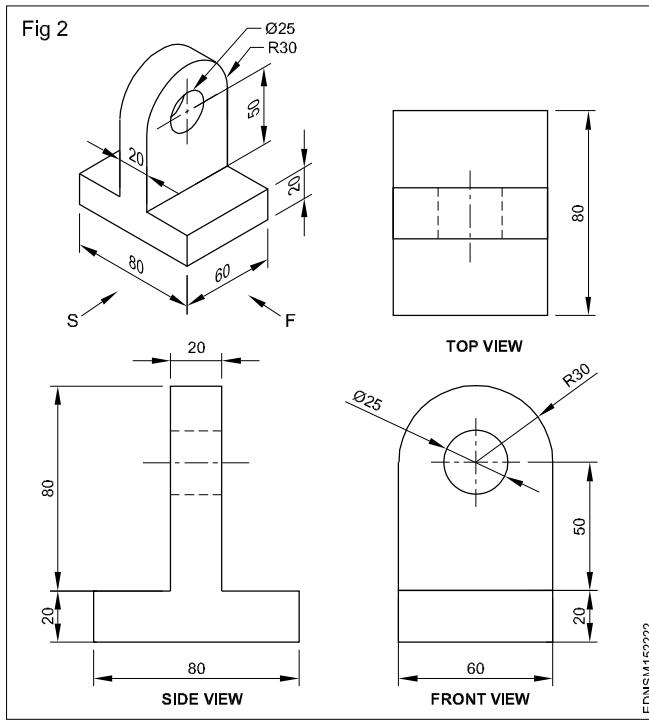
2 a Draw the symbol for 1st angle projection as per IS specification, if smaller dia D/2 is 20 mm.

   b Draw the symbol for 3rd angle projection as per IS specification, if smaller dia D/2 is 15 mm.

Method of 1ˢᵗ angle and 3ʳᵈ angle projections

1ˢᵗ Angle projection (Fig 1)
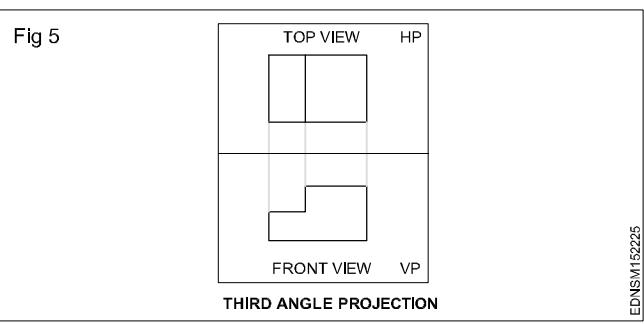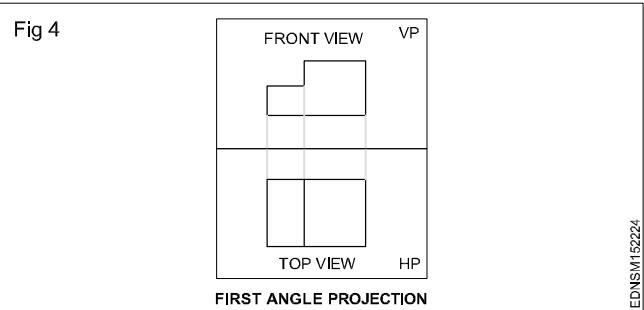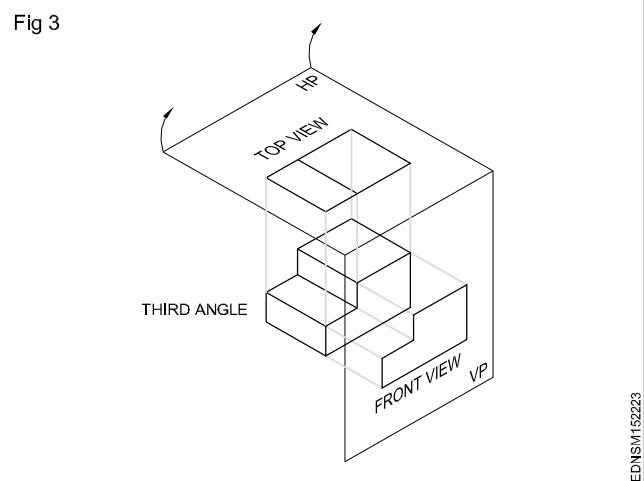
Fig 1

FRONT VIEW
SIDE VIEW
TOP VIEW

3ʳᵈ Angle projection (Fig 2)


Fig 2

SIDE VIEW
TOP VIEW
FRONT VIEW

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.

The placement of the front and top views when the horizontal plane is unfolded will be different in these two systems. It may be observed in Fig 3, that the first angle projection plan (top views) will be directly below the front view (Fig 4), whereas in 3ʳᵈ angle projection top view lies directly above the elevation. (Fig 5)

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.


Fig 3

Fig 4

FIRST ANGLE PROJECTION

Fig 5

THIRD ANGLE PROJECTION

Symbolic representaion - Different symbols used in the sheet metal trade

Fig 1

SLITTING TABS BENT OVER THE FLANGE

TABS

FLANGE

A

B

PLAIN DOVETAIL SEAM.

EDNSM162311

Fig 2

(A) FLANGE-BUTT SEAM

(B) BUTT

EDNSM162312

Fig 3

1 x T MINIMUM

FOLD SIZE

T

EDGE FOLDS

EDNSM162313

Fig 4

FLANGE DOVETAIL SEAM

PLAIN DOVETAIL SEAM

BEADED DOVETAIL SEAM

EDNSM162314

Fig 5

(A) PLAIN LAP

(B) SUNK LAP

(C) INSIDE LAP

(D) OUTSIDE LAP

EDNSM162315

Fig 6

A & D

LOCKED GROOVED SEAM 4mm

B

LAP JOINT SOLDERED

C & E

LAP JOINT SOLDERED

F

PANED DOWN AND SOLDERED

G

2 mm HEM

H

3 mm HEM

EDNSM162316

Fig 7

KNOCKED UP JOINT

EDNSM162317

Fig 8

G

T

W

LOCKED GROOVED SEAM

EDNSM162318

Fig 9

C

T

W

W

DOUBLE GROOVED SEAM

EDNSM162319

Fig 10

W

T

P

PANED DOWN SEAM

EDNSM16231A

Fig 11

STORAGE BINS

BOTTOM AND SIDES IN
ONE PIECE ADD ENDS

PITTSBURGH SEAM

EDNSM16231B

Fig 13

CURVED FLANGE

EDNSM16231D

Fig 12

DOUBLE HEMMING

EDNSM16231C

Fig 14

DOUBLE HEMMING SECOND FOLD

EDNSM16231E

Different operations of bend by press brake (Fig 15)

Fig 15

(a)   (b)   (c)

(d)   (e)

(f)   (g)   (h)

(i)   (j)   (k)   (l)   (m)

EXAMPLES OF BEND BY PRESS BRAKE

EDNSM16231F

Practice on snap locked seam (Fig 16)

Fig 16

MALE SECTION

FEMALE SECTION

10

2

1

1

2

SNAP LOCK AT ALL CORNERS
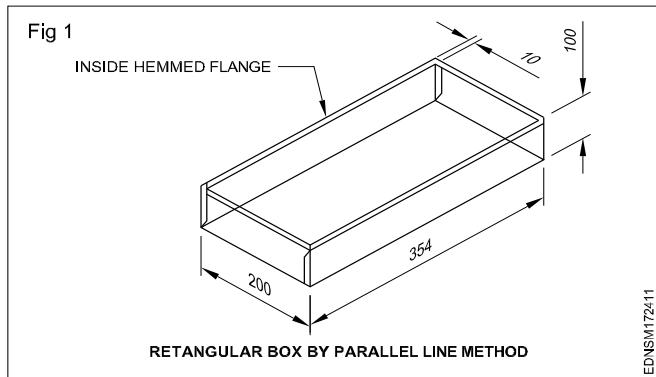
EDNSM16231G

Reading of job drawing related to sheet metal trade
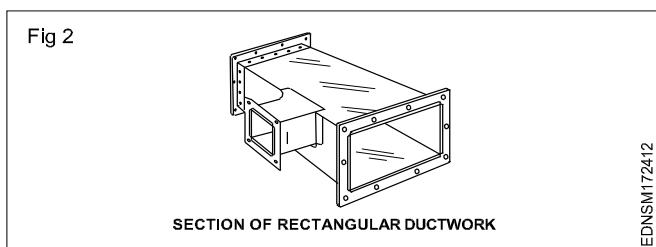
Read and write the following. (Fig 1)

1   Which type of notch used for making rectangular box?

2   What is the name of joining?

3   What is the purpose of notch?

Fig 1

INSIDE HEMMED FLANGE

100

10

354

200

EDNSM172411

RETANGULAR BOX BY PARALLEL LINE METHOD
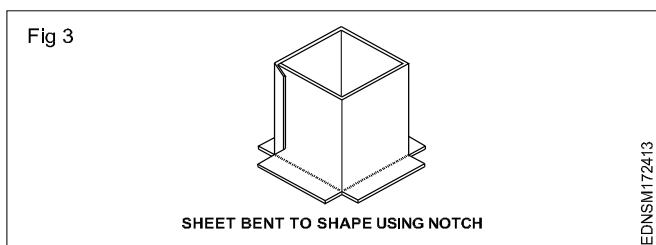
Read and write the following. (Fig 2)

1   What are the joints are in Duct work?

2   What are the folding in the ducting and write the name?

3   What are the bending in duct and write the name?

4   What is the use of duct?

Fig 2

EDNSM172412

SECTION OF RECTANGULAR DUCTWORK
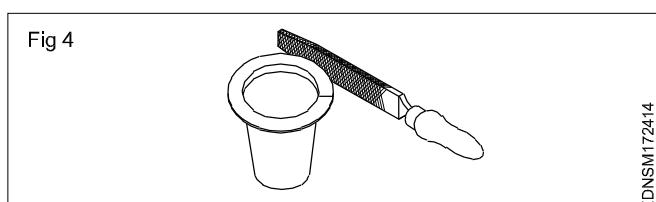
Read and write the following. (Fig 3)

1   What is the types of notch?

Fig 3

EDNSM172413

**SHEET BENT TO SHAPE USING NOTCH**
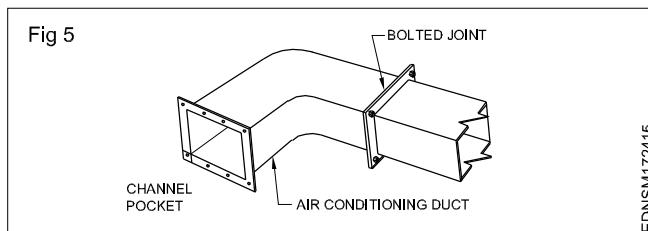
Read and write the following. (Fig 4)

1   What type of notch used in the Fig 4?

2   What is thename of acitivity?

Fig 4

EDNSM172414

Read and write the following. (Fig 5)

1   What is the name of Duct?

Fig 5

BOLTED JOINT

CHANNEL POCKET

AIR CONDITIONING DUCT

EDNSM172415
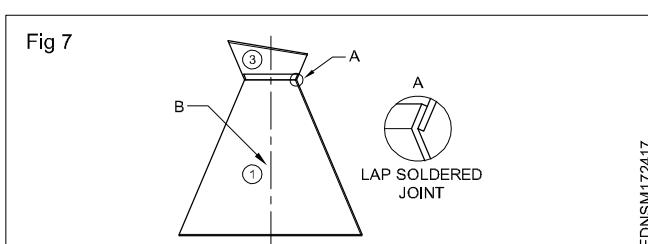
Read and write the following. (Fig 6)

1   Where rectangular duct used?

2   Why the ridges are provided in the duct?

Fig 6

B

EDNSM172416

**B - DIAMOND - BREAK STIFFENING OF DUCT WALLS
SLIGHT DIAGONAL FOLD FROM CORNER TO CORNER**
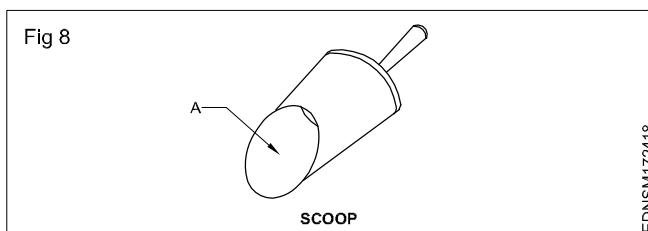
Read and write the following. (Fig 7)

1   What is the name of joint 'A'?

2   What is the name of joint 'B'?

Fig 7

③

A

A

B

①

**LAP SOLDERED
JOINT**

EDNSM172417

Read and write the following. (Fig 8)

1   What is the name of the joint 'A'?

Fig 8

A

EDNSM172418

SCOOP

Read and write the following. (Fig 9)
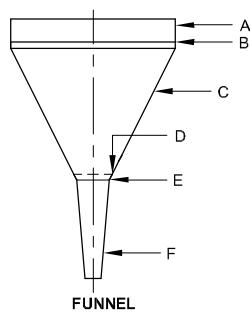
1   Write the name of 'A'?

2   Write the name of 'B'?

3   Write the name of 'C'?

4   Write the name of 'D'?

5   Write the name of 'E'?

6   Write the name of 'F'?


Fig 9

FUNNEL
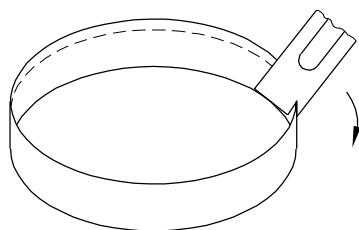
EDNSM17241 9

Read and write the following. (Fig 10)

1   Why G.I wire to be inserted?

Fig 10
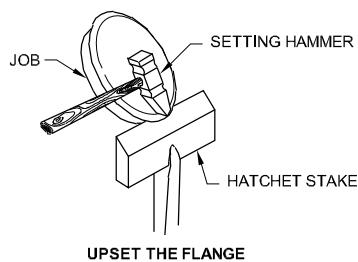
CURVED EDGE TO BE FIXED USING A GAUGE

EDNSM17241A

Read and write the following. (Fig 11)

1   What is the name of activity?

Fig 11

JOB

SETTING HAMMER

HATCHET STAKE
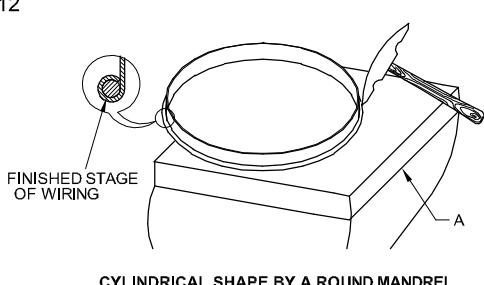
UPSET THE FLANGE

EDNSM17241B

Read and write the following. (Fig 12)

1   What is the name of hammer?

2   What is the name of tool 'A'?

Fig 12
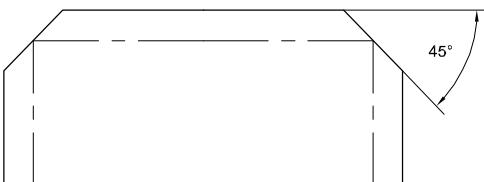
FINISHED STAGE OF WIRING

A

CYLINDRICAL SHAPE BY A ROUND MANDREL

EDNSM17241C

Read and write the following. (Fig 13)

1   What is the angle of slant notch?

Fig 13

45°

NOTCH CUT AFTER MARKING

EDNSM17241D
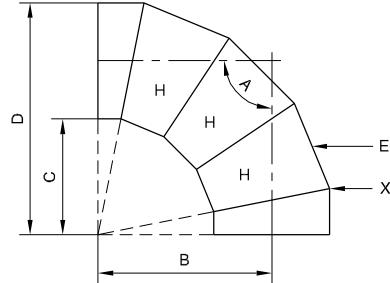
Read and write the following. (Fig 14)

1   What is the name of 'C'?

2   What is the name of 'D'?

3   What does X refers?

Fig 14

D

C

B

H

H

H

A

E

X
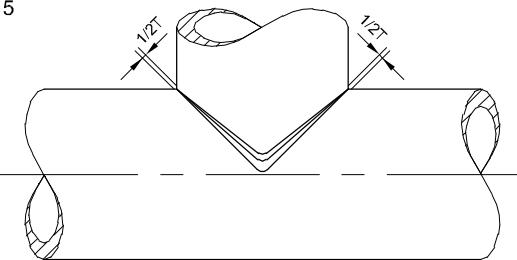
EDNSM17241E

Read and write the following. (Fig 15)

1   What is the name of joint?

2   What does ½T refers?

Fig 15

½T

½T
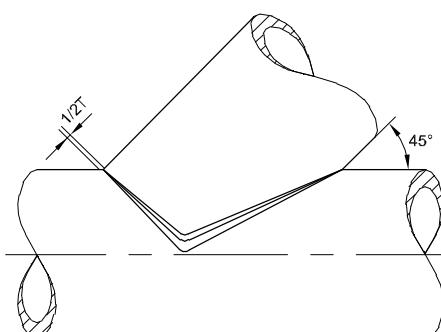
EDNSM17241F

Read and write the following. (Fig 16)

1   What is the name of joint?

2   What is the angle of 'A'?

Fig 16

½T

45°
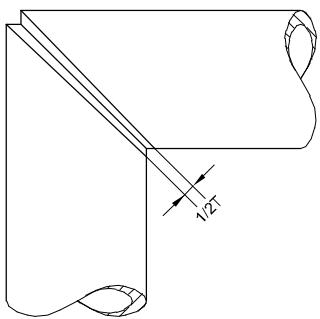
EDNSM17241G

Read and write the following. (Fig 17)

1   What is the name of joint?

2   What is the angle of joint?

Fig 17
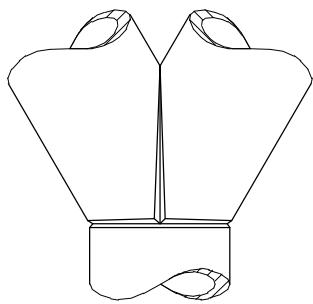
Read and write the following. (Fig 18)

1   What is the name of joint?

Fig 18
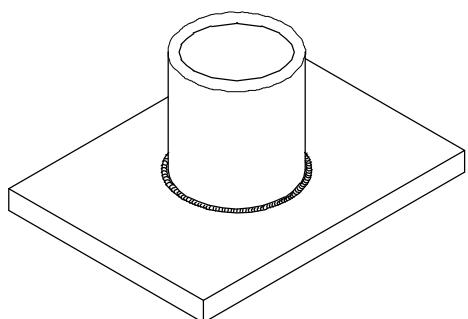

Read and write the following. (Fig 19)

1   What is the meaning of flange joint?

Fig 19
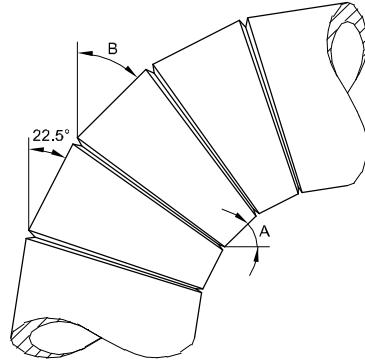
Read and write the following. (Fig 20)

1   What is the name of bend?

2   What is the angle of 'A'?

3   What is the angle of 'B'?

Fig 20

**Engineering Drawing : (NSQF - Revised 2022) 1 Year Group 9 : Exercise 1.7.24**
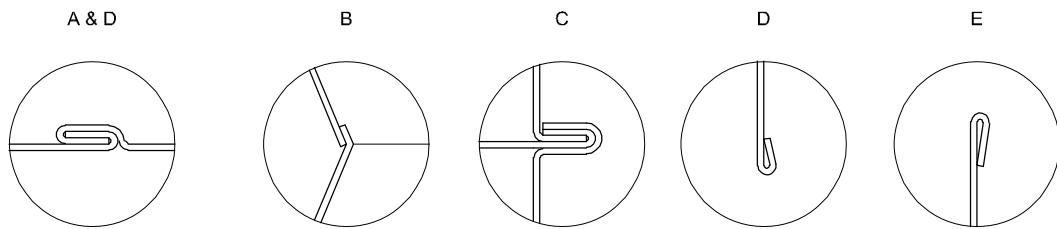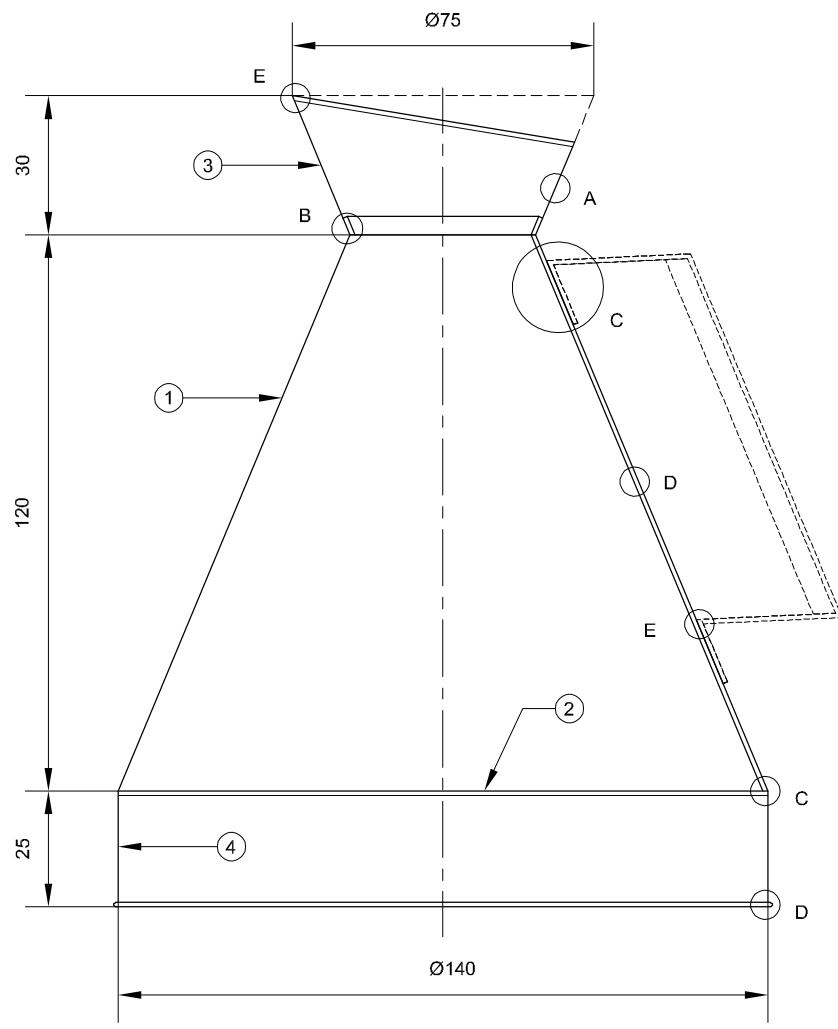
Read and write the following. (Fig 21)

1 What is the name of joints 'A'?

2 What is the name of joints 'B'?

3 What is the name of joints 'C'?

4 What is the name of joints 'D'?

5 What is the name of joints 'E'?

Fig 1