ENGINEERING DRAWING

(NSQF)

1st YEAR

(For 2 Year Trades)

(As per Revised Syllabus July 2022)

Group 21

Group 21 CTS Trades Covered

Instrument Mechanic (Chemical Plant), Attendant Operator (Chemical Plant), Laboratory Attendant (Chemical Plant), Maintenance Mechanic (Chemical Plant)

कौशलं बलम्
Directorate General of Training

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

Nimi

NATIONAL INSTRUCTIONAL MEDIA INSTITUTE, CHENNAI

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

Engineering Drawing (NSQF) 1st Year (For 2 Year Trades)

Group 21 Engineering Trades

As per Revised syllabus July 2022 under CTS

Developed & Published by

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FOREWORD

The Government of India has set an ambitious target of imparting skills one out of every four Indians, 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 1st Year (For 2 Year Trades)** NSQF **Group 21 Engineering Trades (Revised 2022)** 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 Director General, Executive Director & Staff of NIMI and members of Media Development Committee deserve appreciation for their contribution in bringing out this publication.

Jai Hind

ATUL KUMAR TIWARI, *I.A.S*
Secretary
Ministry of Skill Development & Entrepreneurship,
Government of India.

December 2023
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** 1st Year (For 2 Year Trades) NSQF Group 21 - Engineering Trades (Revised 2022) under CTS is one of the book developed by the core group members as per the NSQF syllabus.

The **Engineering Drawing** 1st Year (For 2 Year Trades) NSQF Group 21 - Engineering Trades under (Revised 2022) 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

The National Instructional Media Institute (NIMI) sincerely acknowledge with thanks the co-operation and contribution of the following Media Developers to bring this IMP for the course **Engineering Drawing 1st Year (For 2 Year Trades) Group 21 - Engineering Trades** as per NSQF Revised 2022.

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Shri. G. Michael Johny	-	Manager, NIMI, Chennai - 32.

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

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

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 **1st Year Engineering drawing** NSQF (For 2 Year Revised syllabus July 2022 Group 21 - Engineering Trades) 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 - 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	Free hand drawing	1.2.06 - 1.2.08	6
3	Drawing of Geometrical Figures	1.3.09 - 1.3.12	4
4	Dimensioning Practice	1.4.13	2
5	Symbolic Representation	1.5.14	4
6	Reading of Chemical Plant Circuit Diagram	1.6.15	14
7	Reading of Chemical Plant Layout Drawing	1.7.16	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.

CONTENTS

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.**

SYLLABUS

1st Year **Group 21 - Revised syllabus July 2022** **Duration: 1 Year**

2 Year Engineering trades under CTS

CTS Trades Covered: Instrument Mechanic (Chemical Plant), Attendant Operator (Chemical Plant), Laboratory Attendant (Chemical Plant), Maintenance Mechanic (Chemical Plant)

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 Instruments	2
2	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 Geometrical figures: • Angle, Triangle, Circle, Rectangle, Square, Parallelogram. • Lettering & Numbering - Single Stroke.	4
4	Dimensioning Practice • Types of arrowhead	2
5	Symbolic representation - • Different symbols used in the related trades.	4
6	Reading of chemical plant Circuit Diagram	14
7	Reading of Chemical plant Layout drawing	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 communication 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.

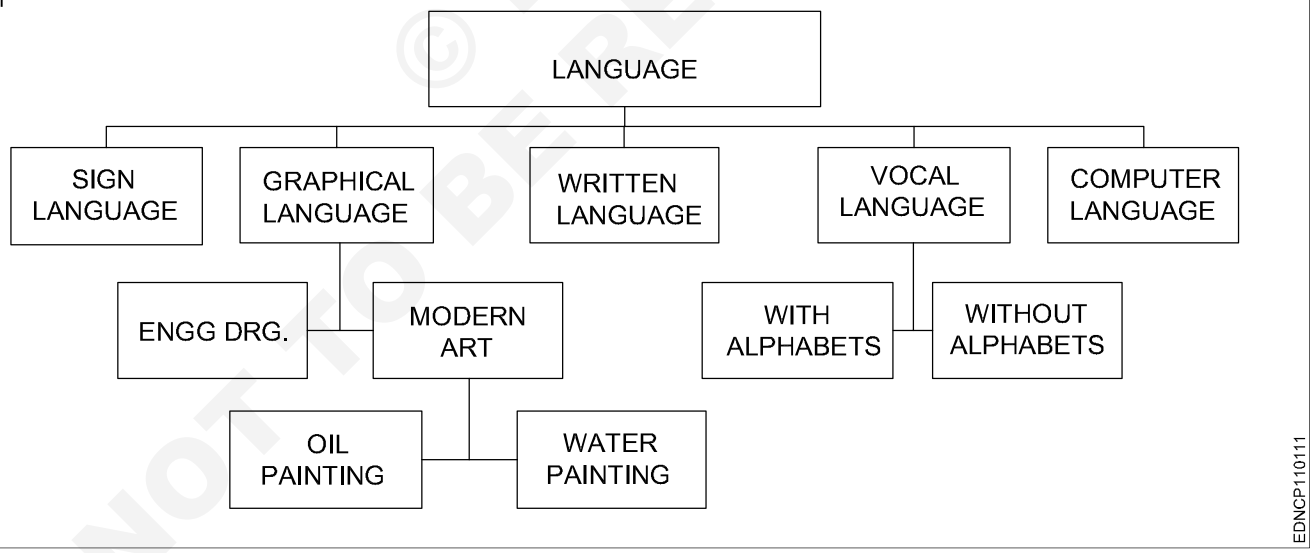
To ensure uniformity of interpretation, the British Standards Institution has prepared a booklet entitled BS 308:1972, Engineering Drawing Practice. Now in three parts, this publication recommends the methods which should be adopted for the preparation of drawing used in the engineering industry.

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 engineering 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)

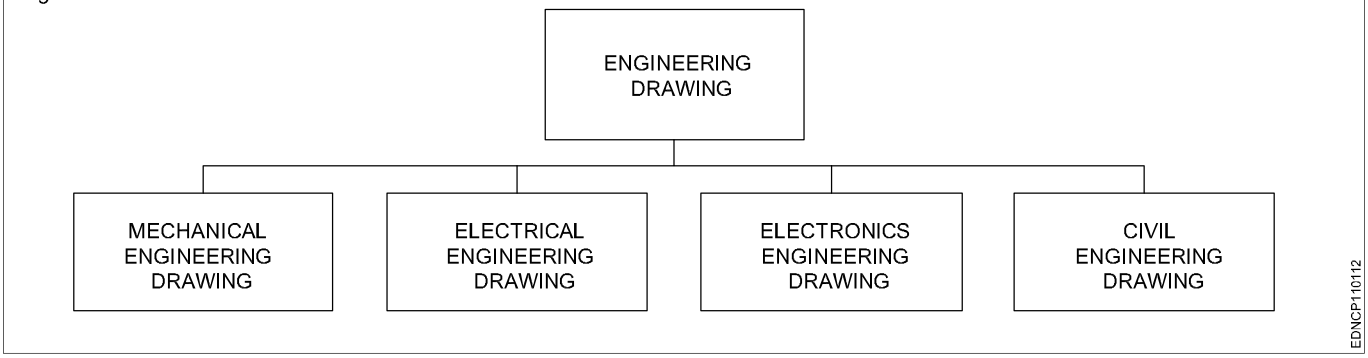
Electrical engineering drawing

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



Mechanical Engineering Drawings (Fig 3&4)

Fig 3

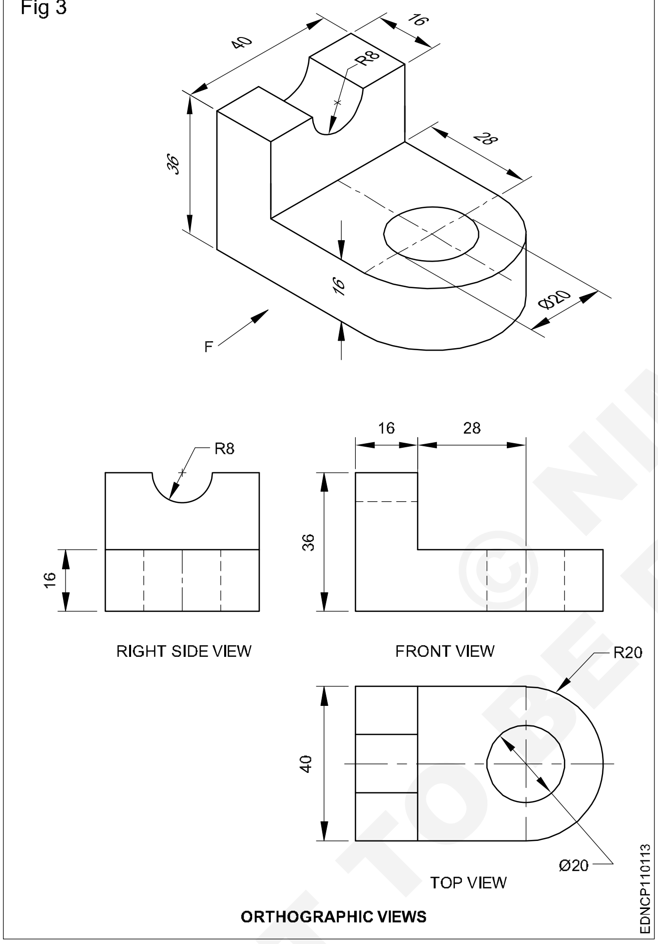
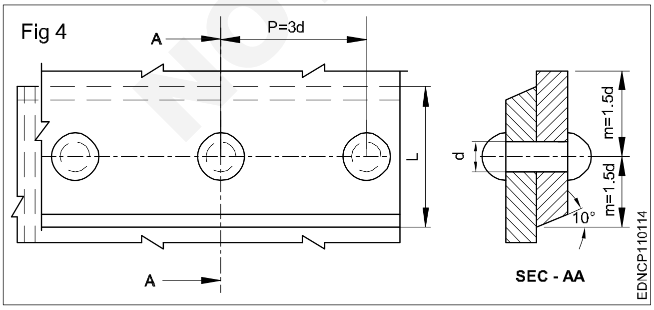
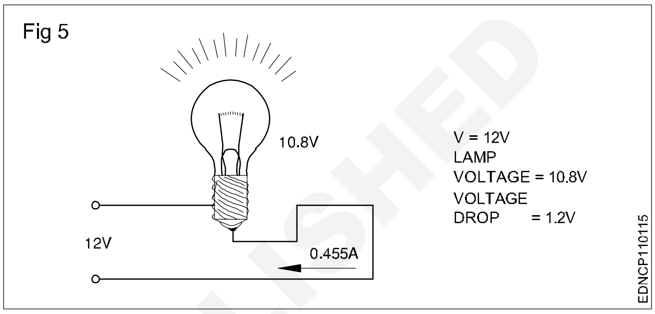


Fig 4



Electrical Engineering Drawing (Fig 5)

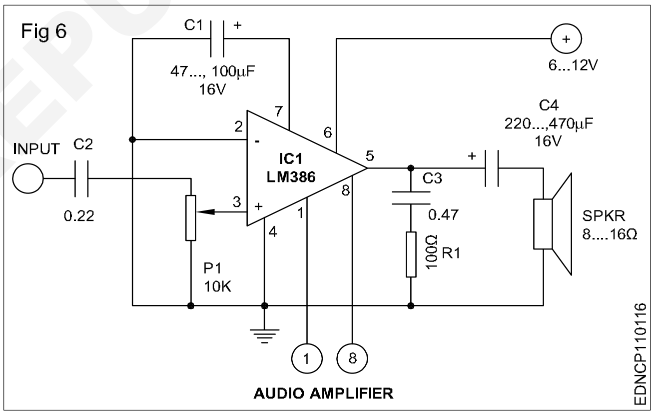
Fig 5



Electronics Engineering Drawing

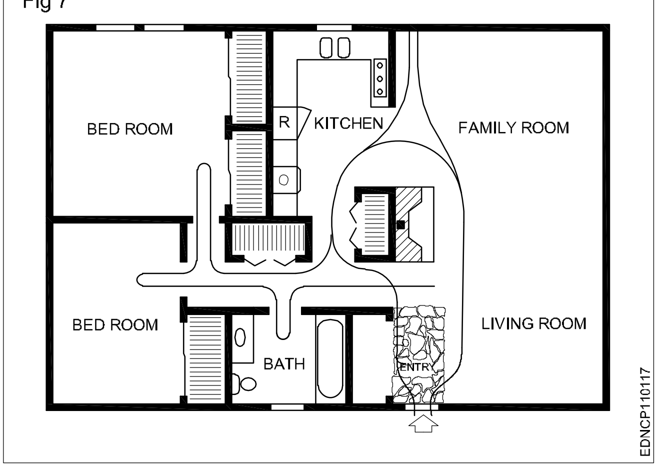
Audio amplifier (Fig 6)

Fig 6

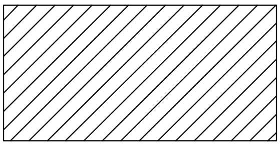
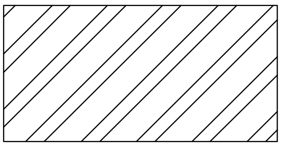
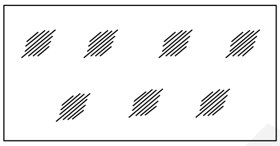
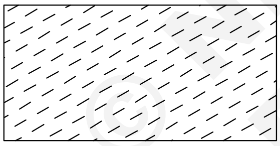
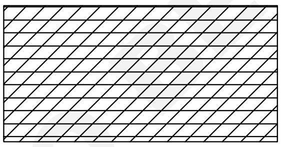
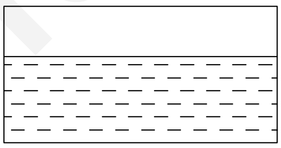
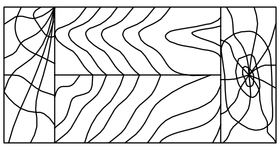
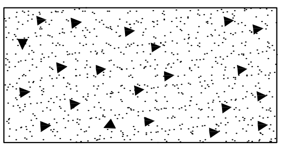


Civil Engineering Drawing (Fig 7)

Fig 7



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.

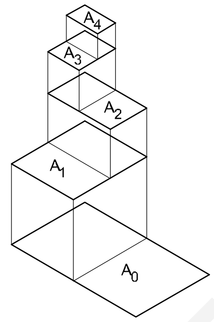
White drawing papers that do not turn yellow on exposure to air are used for finished drawings, maps, charts and drawings for photographic reproductions.

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.

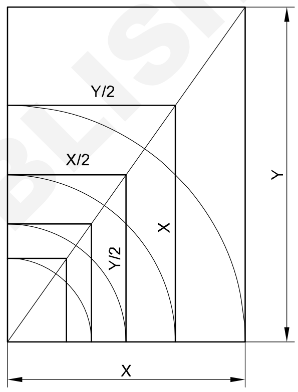
To get uniform lines, backing paper is to be placed on the drawing board before fixing drawing/tracing paper,. Before starting the drawing, the layout should be drawn. (Ref: IS:10711)

Fig 1



HALVING AND DOUBLING

Fig 2



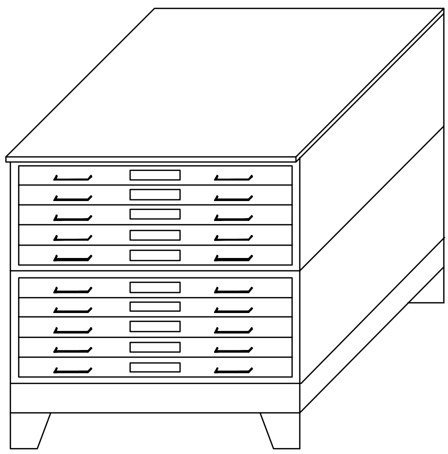
SIMILARITY OF FORMATIONS

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).

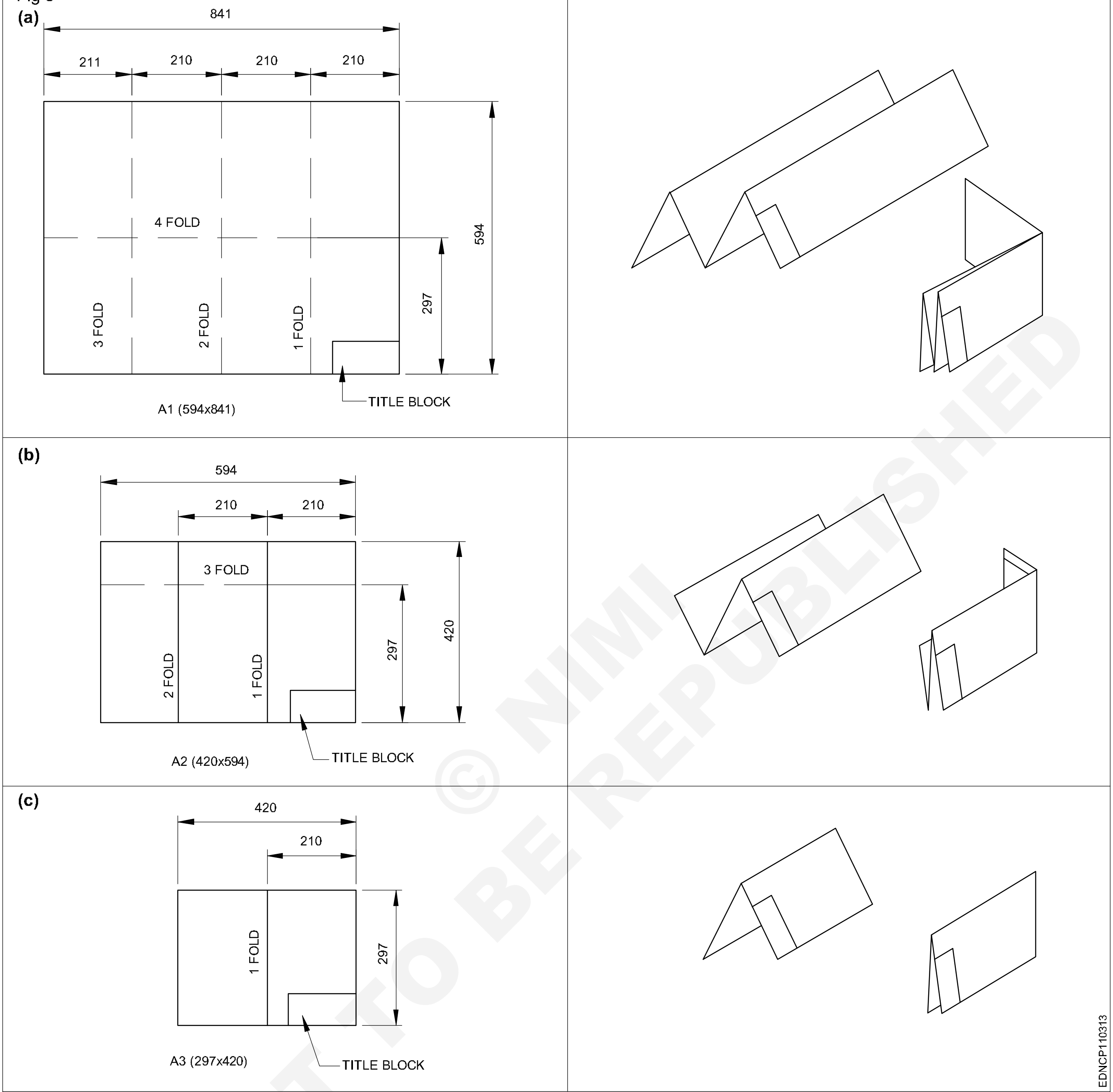
Fig 4



DRAWING CABINET

Method of folding printed drawing sheets (Fig 3)

Fig 3



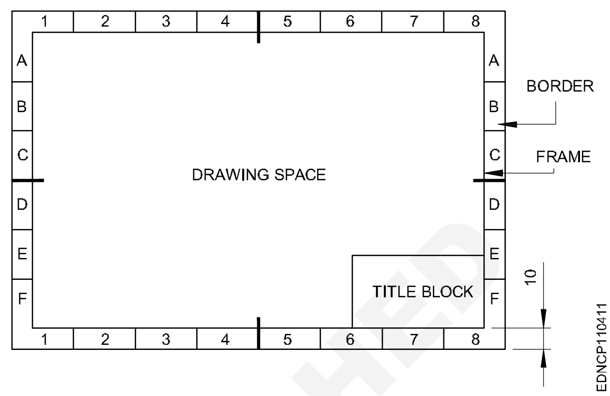
METHOD OF FOLDING OF PRINTED DRAWING SHEETS

Title block, its position and content

Layout of drawing sheet

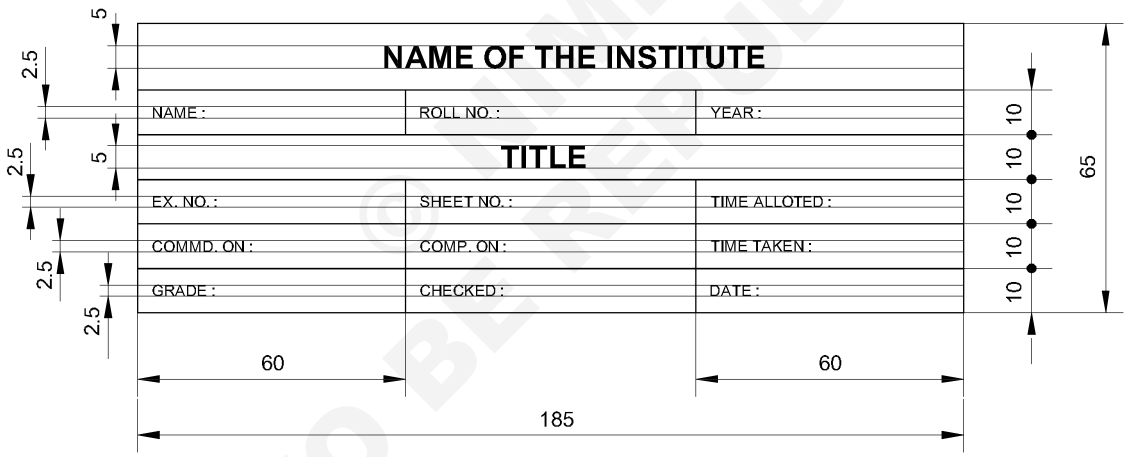
As a standard practice, sufficient margins are to be provided on all sides of the drawing sheet. The drawing sheet should have drawing space and title space. A typical layout of a drawing sheet is shown in the (Fig 1 & 2).

Fig 1



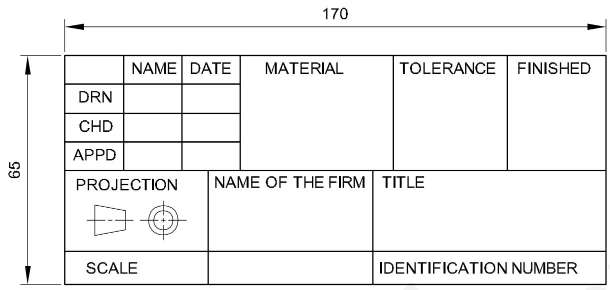
Title Block - 1

Fig 2



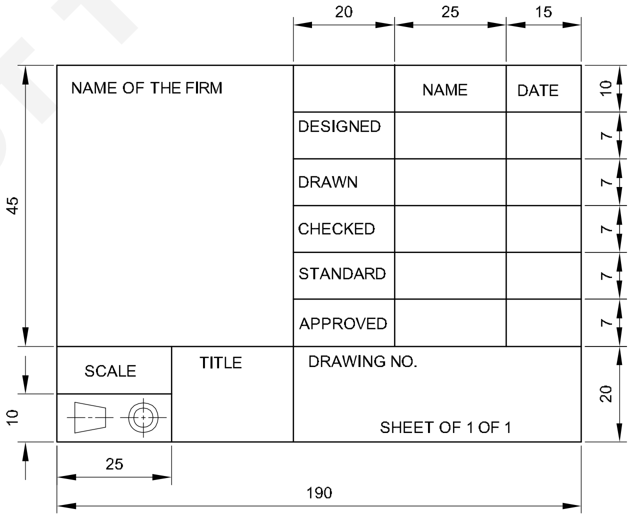
Title Block - 2

Fig 3



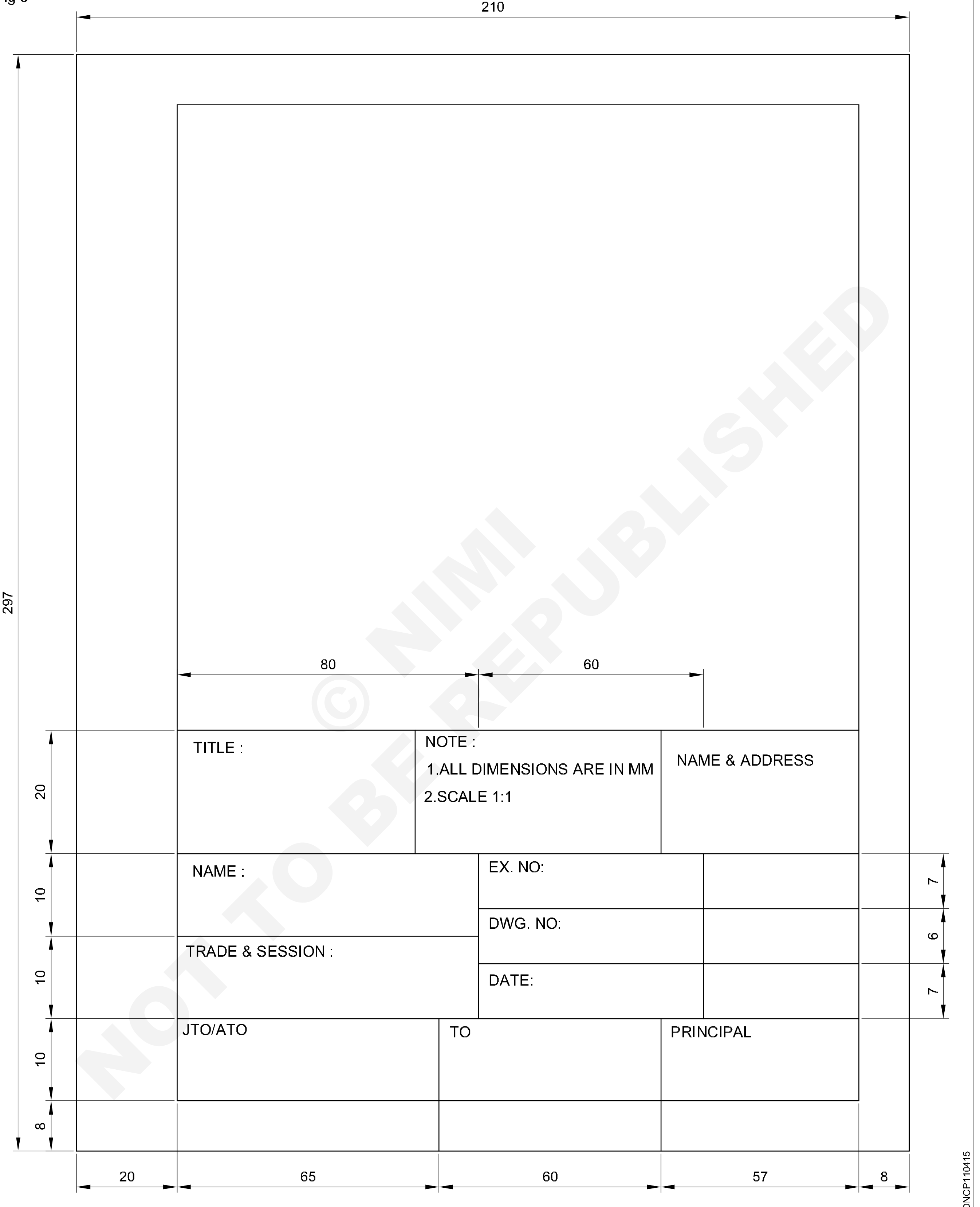
Title Block - 3

Fig 4



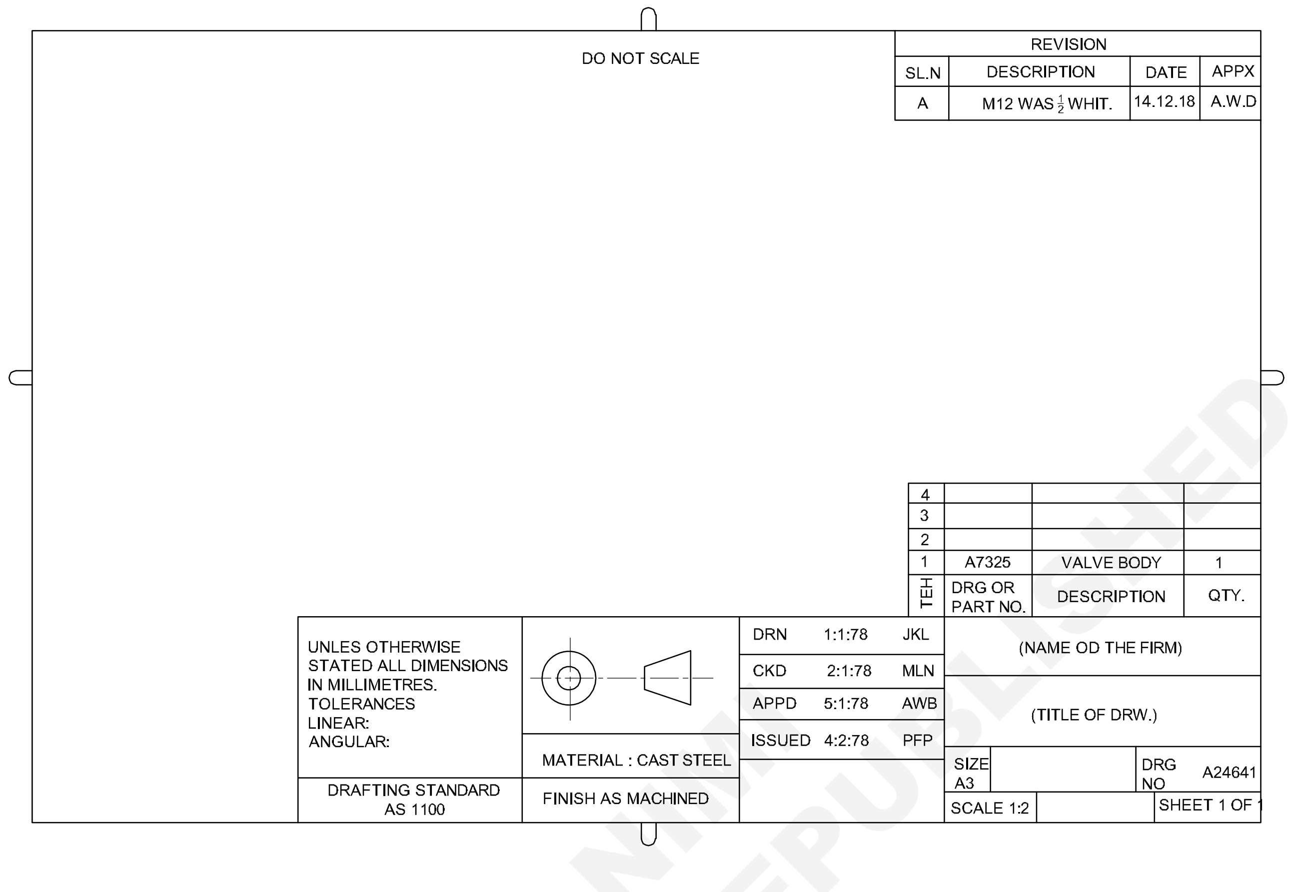
Title Block - Position and content - 1

Fig 5



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.

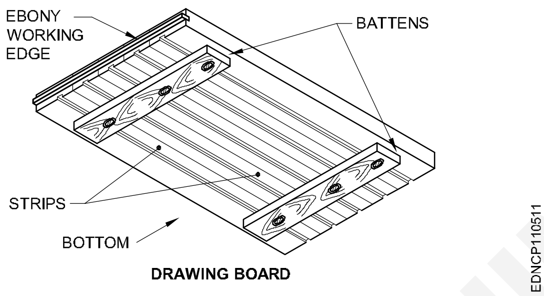
4 Title block to be drawn whenever the title of the drawing changes. Eg. for the geometrical construction chapter the title block may be drawn in the first sheet only where as on the remaining sheets borders to be drawn before they are used for preparing drawings.

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



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.

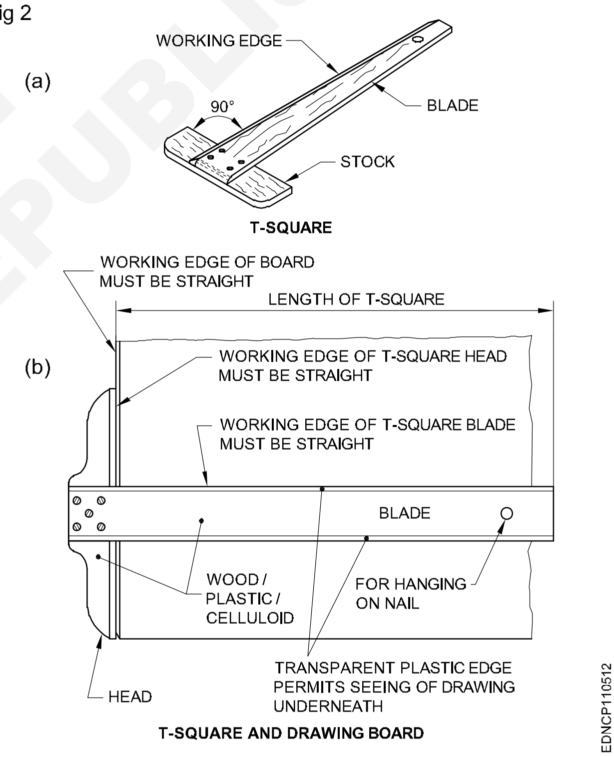
Sl. No.	Designation	Blade length
1	T0	1500
2	T1	1000
3	T2	700
4	T3	500

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.

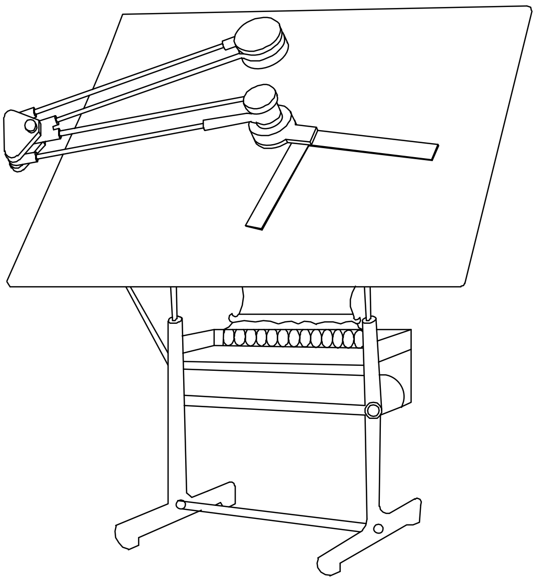
'T' square should never be used as a hammer or as a guide for trimming papers.

Fig 2



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.

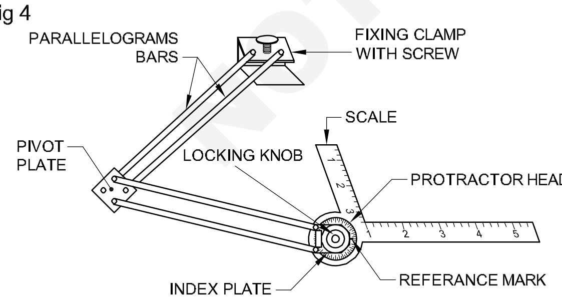
The protractor head has a spring-loaded clutch relieving handle, which rotates and locks at 15° intervals automatically. For setting any angle other than multiples of 15°, the clutch spring is released and by rotating the centre knob, the zero line is set to the required angle and the friction clutch 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.

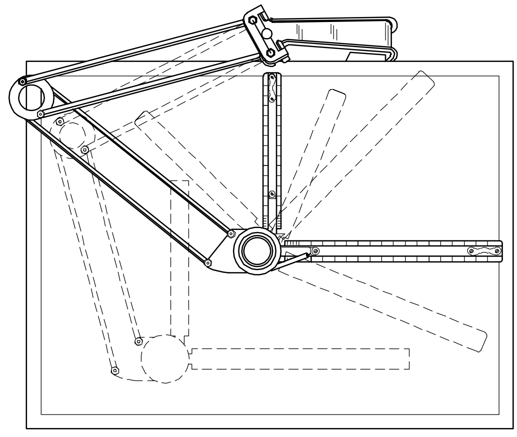
The mini drafter is an important device used for making drawing quickly & accurately. This instrument has the combination of T-square, set square, protractor and scales, it helps to draw the drawings at a faster rate. (Fig 4,5 & 6)

Fig 4



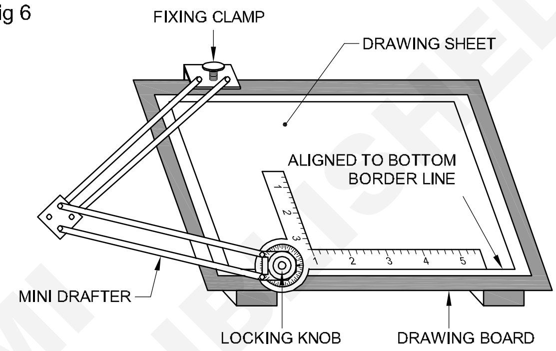
MINI DRAFTER PARTS

Fig 5



MINI DRAFTER ADJUSTMENT

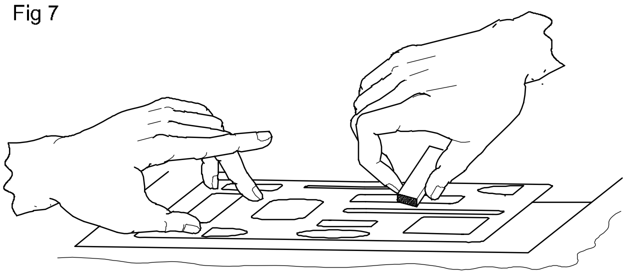
Fig 6



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)

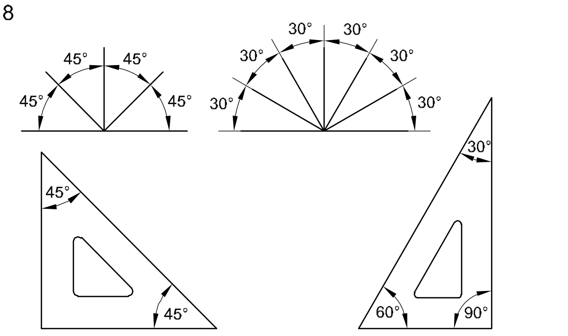
Fig 7



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)

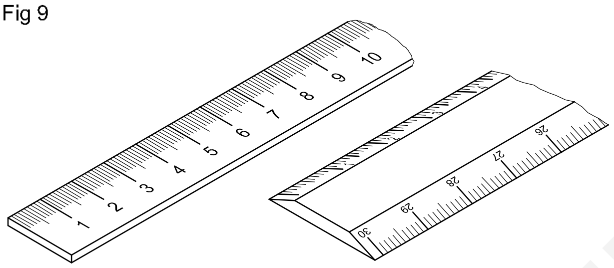
Fig 8



(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



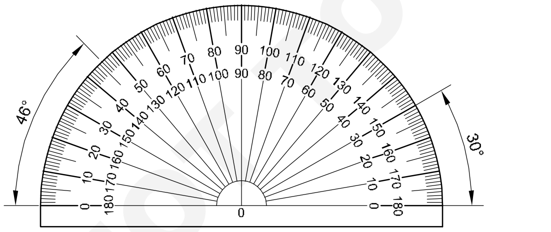
STEEL RULE WOODEN SCALE

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



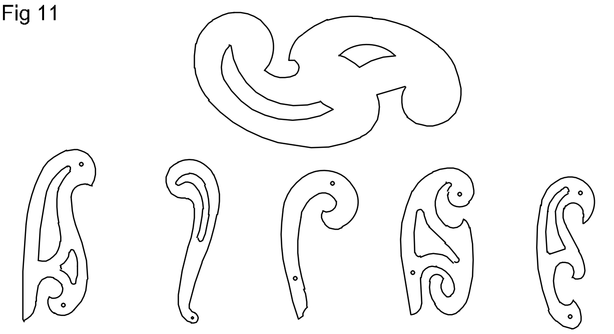
PROTRACTOR

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.

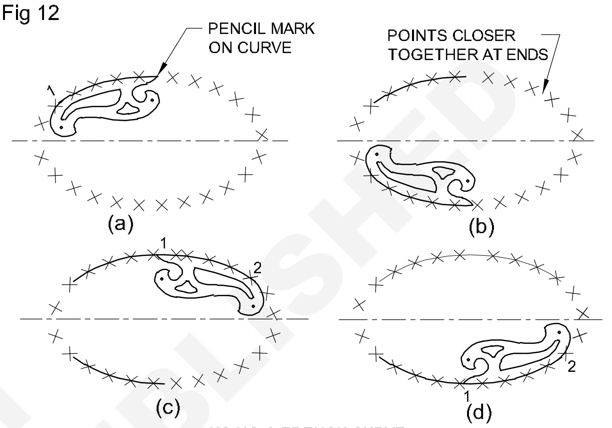
Fig 12 shows how to use the french curve and draw smooth curves. They are made of transparent celluloid (no bevel edge).

Fig 11



FRENCH CURVES

Fig 12



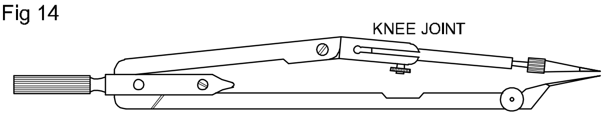
USING A FRENCH CURVE

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

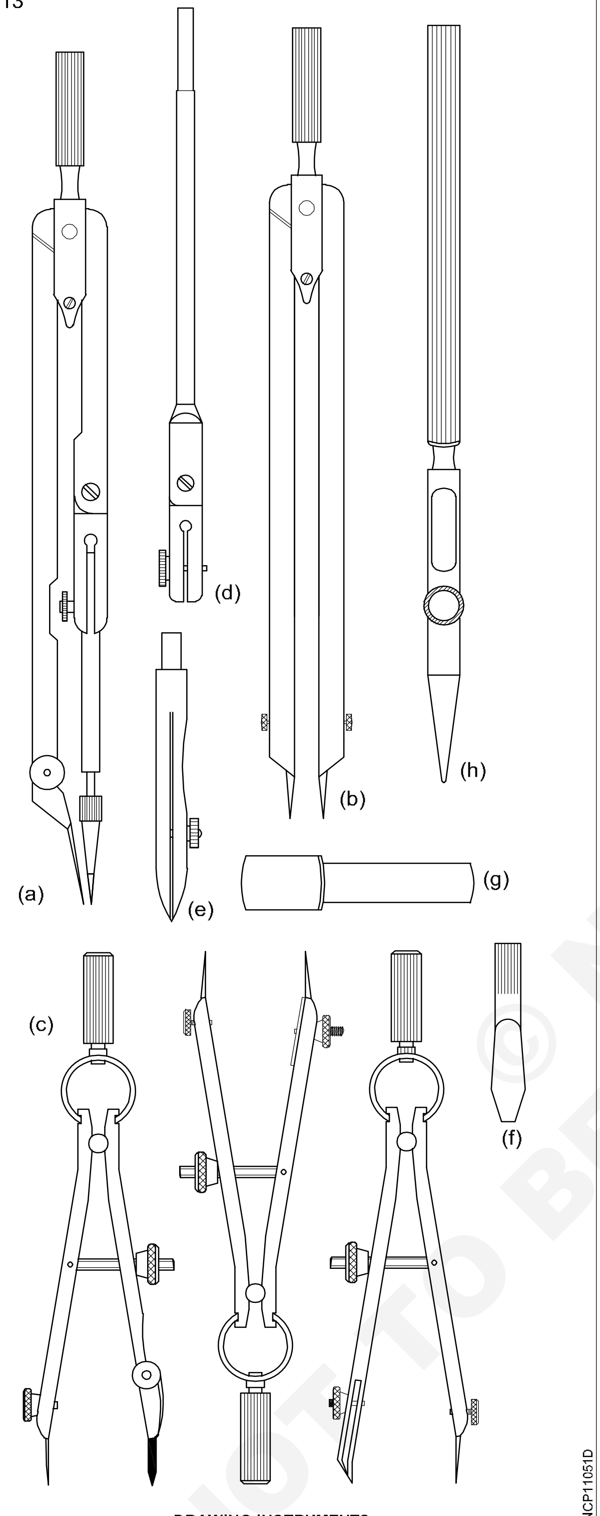


LARGE COMPASS

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

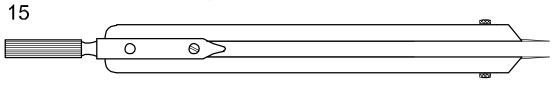
Large divider: It is used to transfer dimensions and divide lines into several equal parts. Divider with adjustable joints is preferable rather than plain legs. (Fig 15)

Fig 13



DRAWING INSTRUMENTS

Fig 15

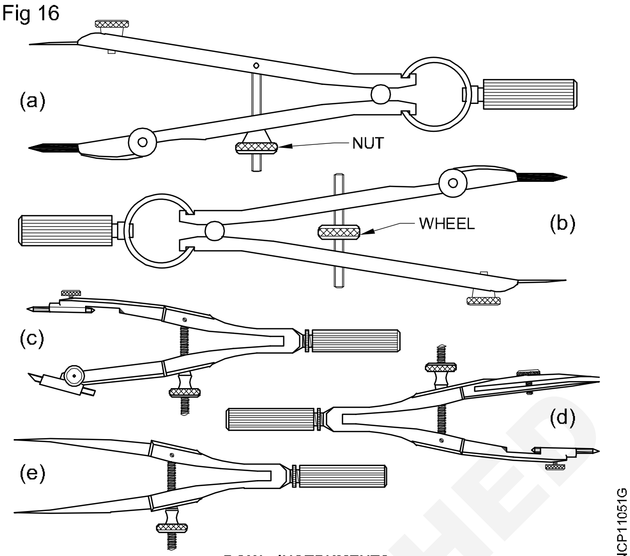


DIVIDER

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.

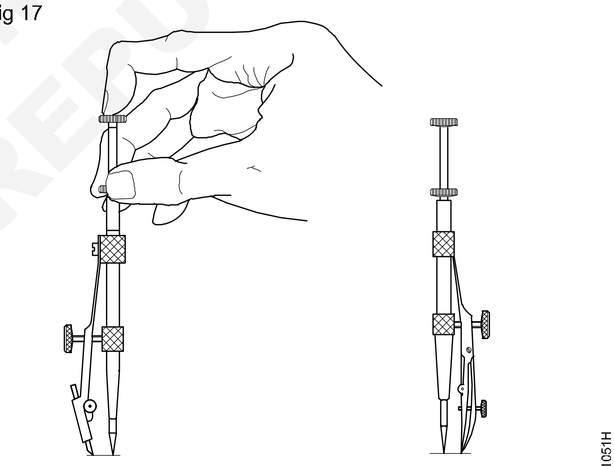
Fig 16



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.

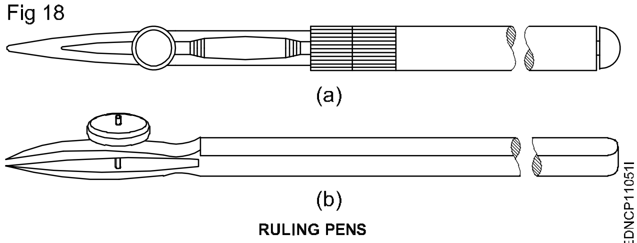
Fig 17



DROP SPRING BOW 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.

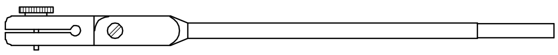
Fig 18



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

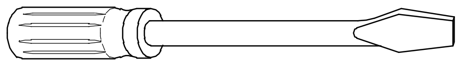


LENGTHENING BAR

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.

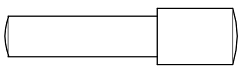
Fig 20



SCREW DRIVER

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

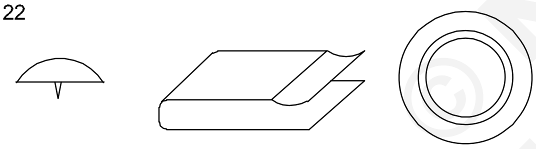
Fig 21



LEAD CASE

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)

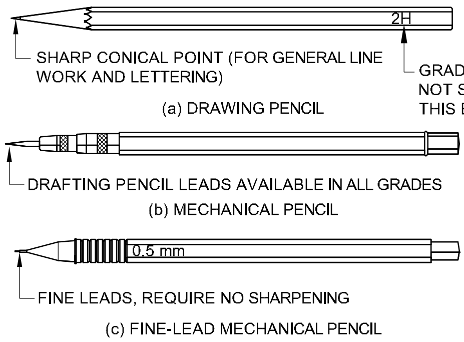
Fig 22



PIN,CLIP AND TAPE

Pencils, Grade and Selection (Fig 23)

Fig 23



DRAWING PENCILS

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.

Free hand drawing of - Geometrical figures and blocks with dimension

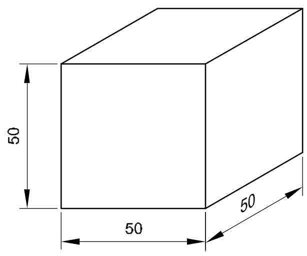
Freehand sketching: Apart from making drawing using instruments, often craftsmen will be required to make drawings with their free hand.

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.

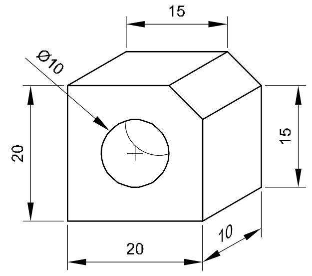
Cube (Fig 1)

Fig 1



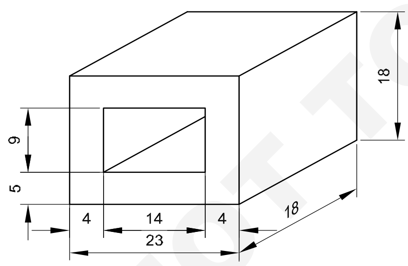
Square block (Fig 2)

Fig 2



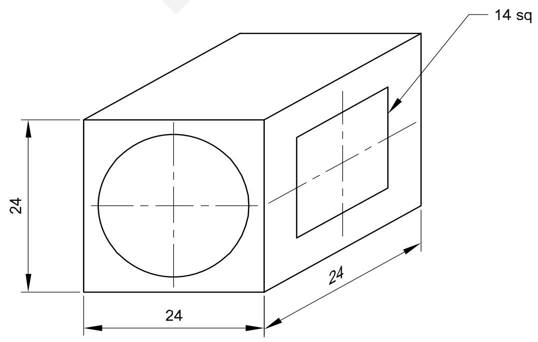
Rectangular block (Fig 3)

Fig 3



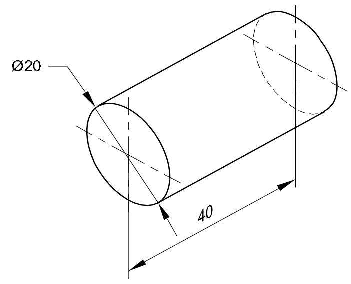
Cube block (Fig 4)

Fig 4



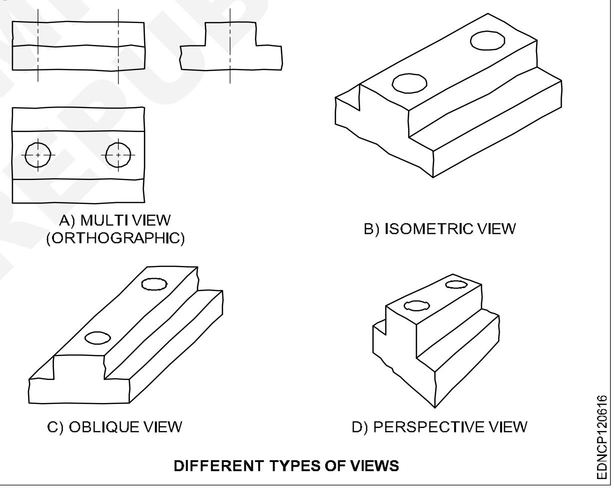
Cylinder (Fig 5)

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

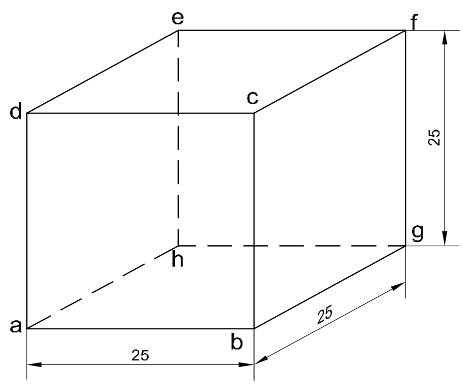


Procedure

Freehand drawing of solid figures, cubes, cuboids, cone, prism, pyramid, frustum of a cone with dimensions

Cube (Fig 1)

Fig 1

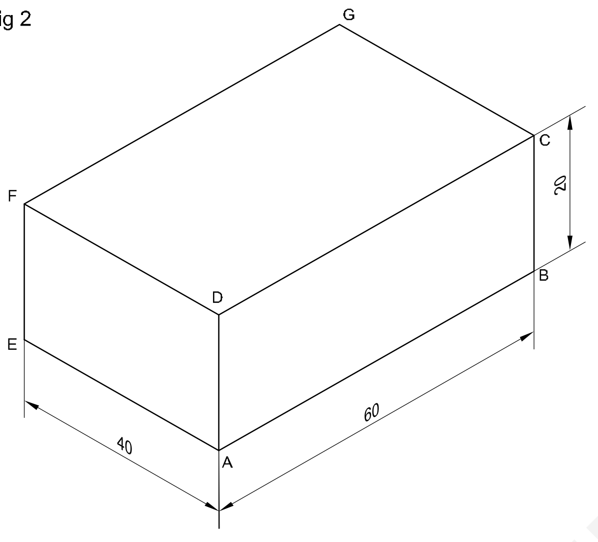


- Draw squares of a, b, c and d.
- Draw 30° from points b, c and d for the length of 25mm.
- Mark point g from b, f from c and e from d as shown in the figure.
- Joint all points.

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

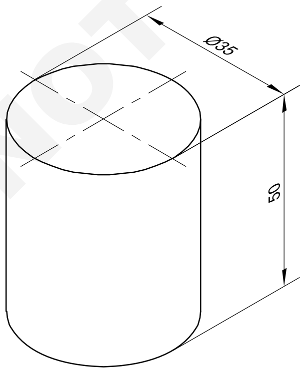


Draw the three isometric axes through the point 'A'.

- 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.

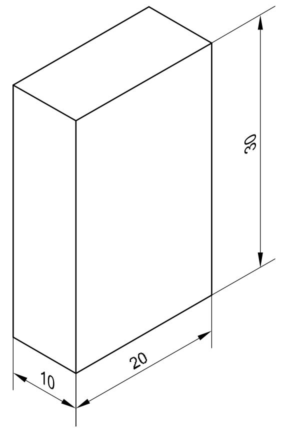
Cylinder (Fig 3)

Fig 3



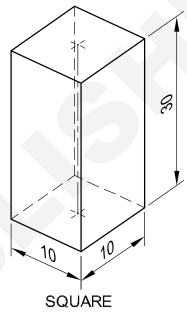
Rectangular prism (Fig 4)

Fig 4



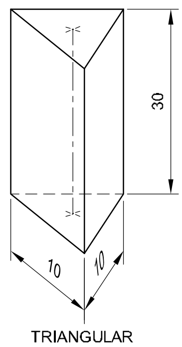
Square Prism (Fig 5)

Fig 5



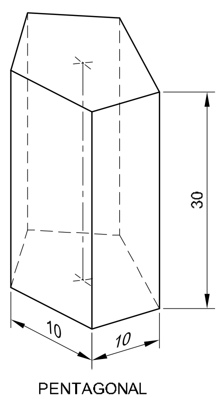
Triangular Prism (Fig 6)

Fig 6



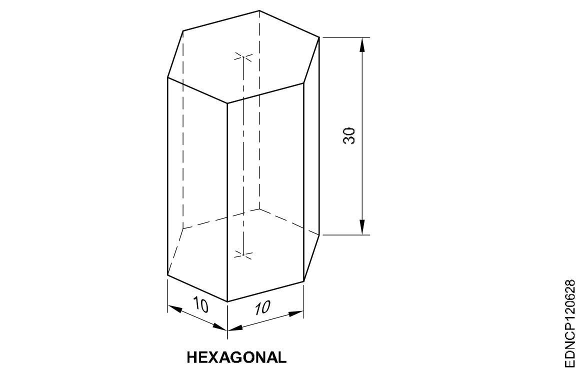
Pentagonal prism (Fig 7)

Fig 7



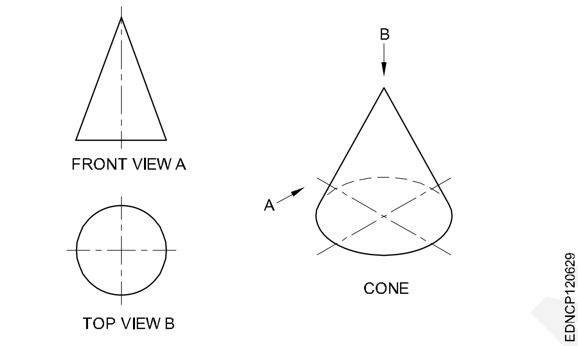
Hexagonal prism (Fig 8)

Fig 8



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



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

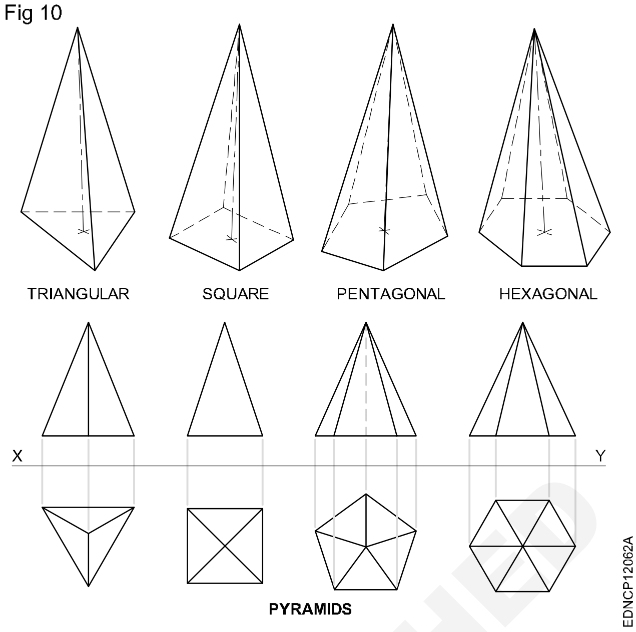


Fig 11

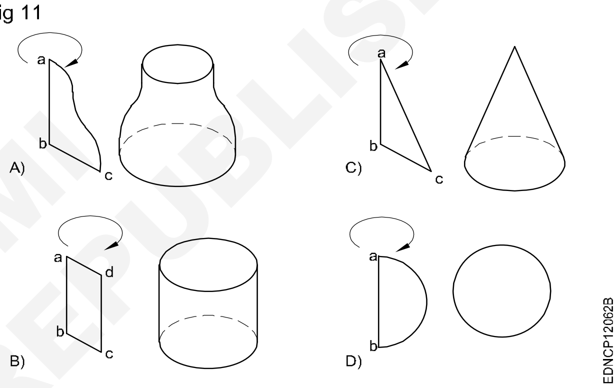
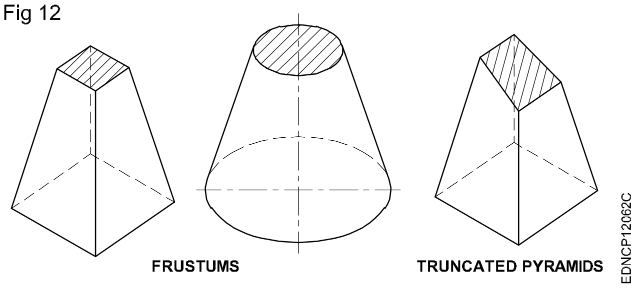


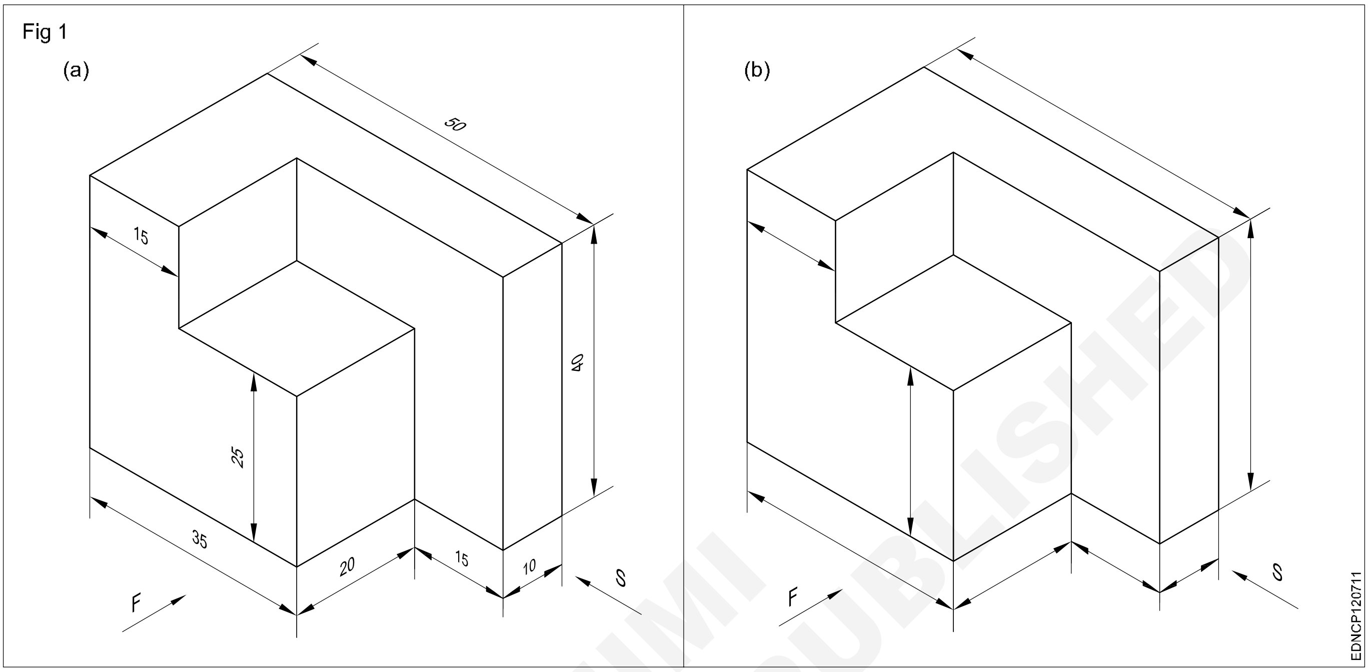
Fig 12 shows frustums and truncated pyramids.

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

Fig 12



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



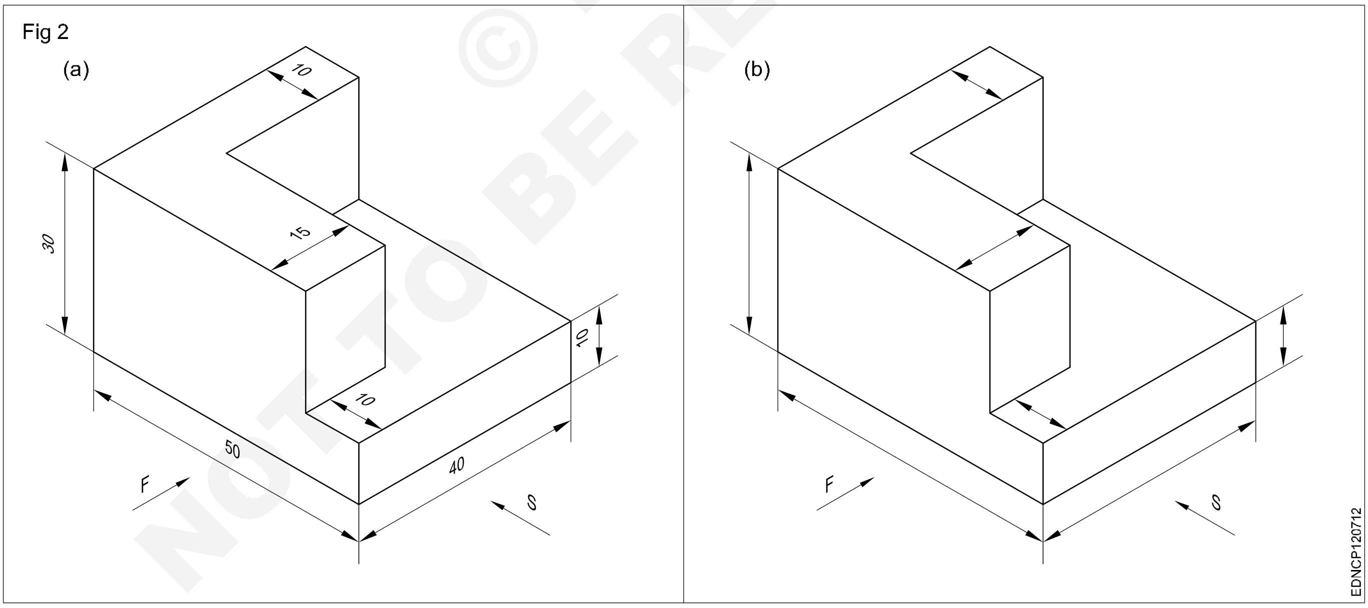


Fig 3

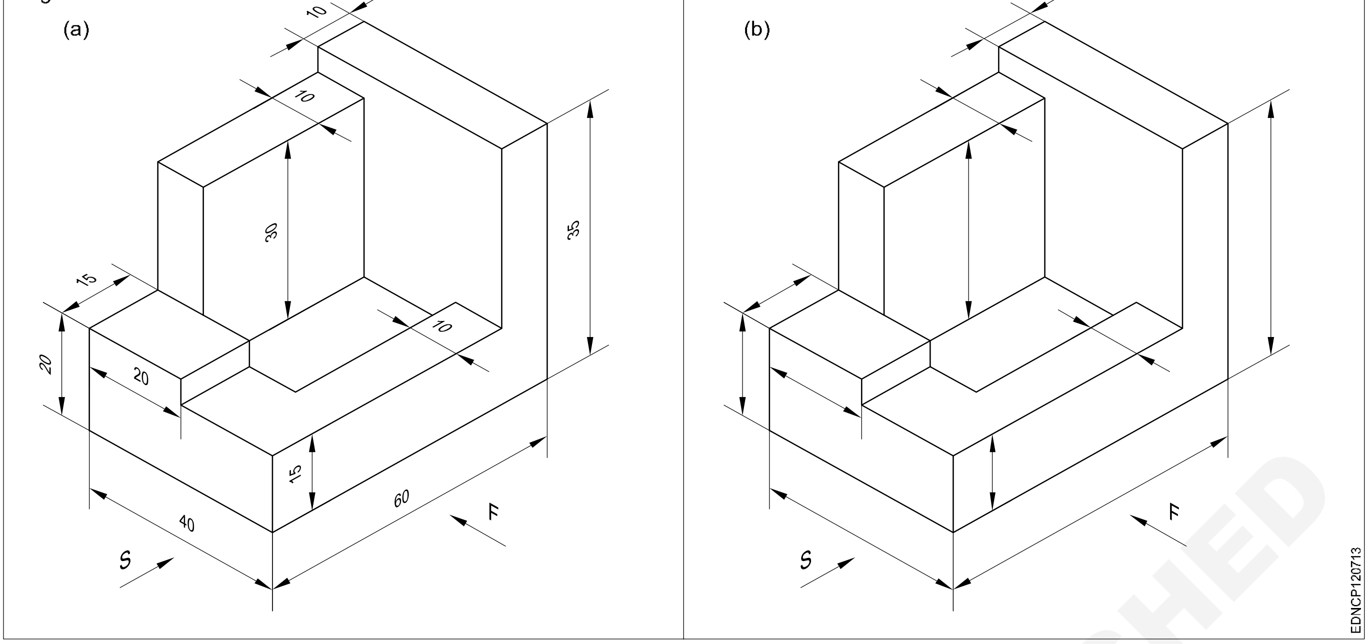


Fig 4

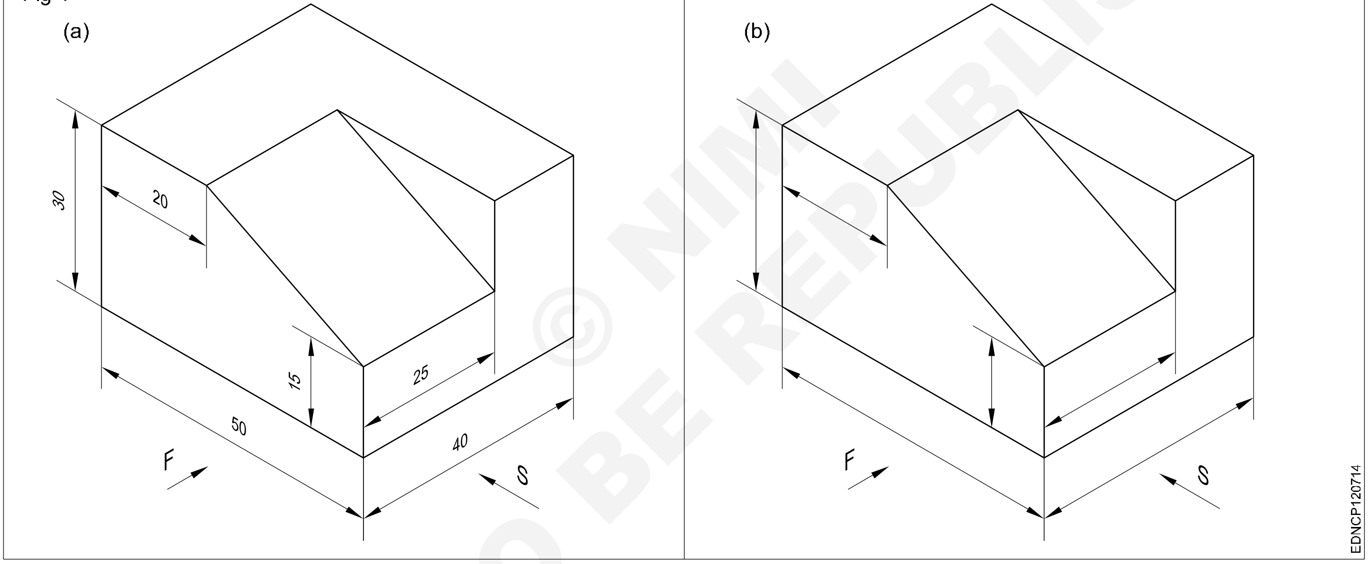


Fig 5

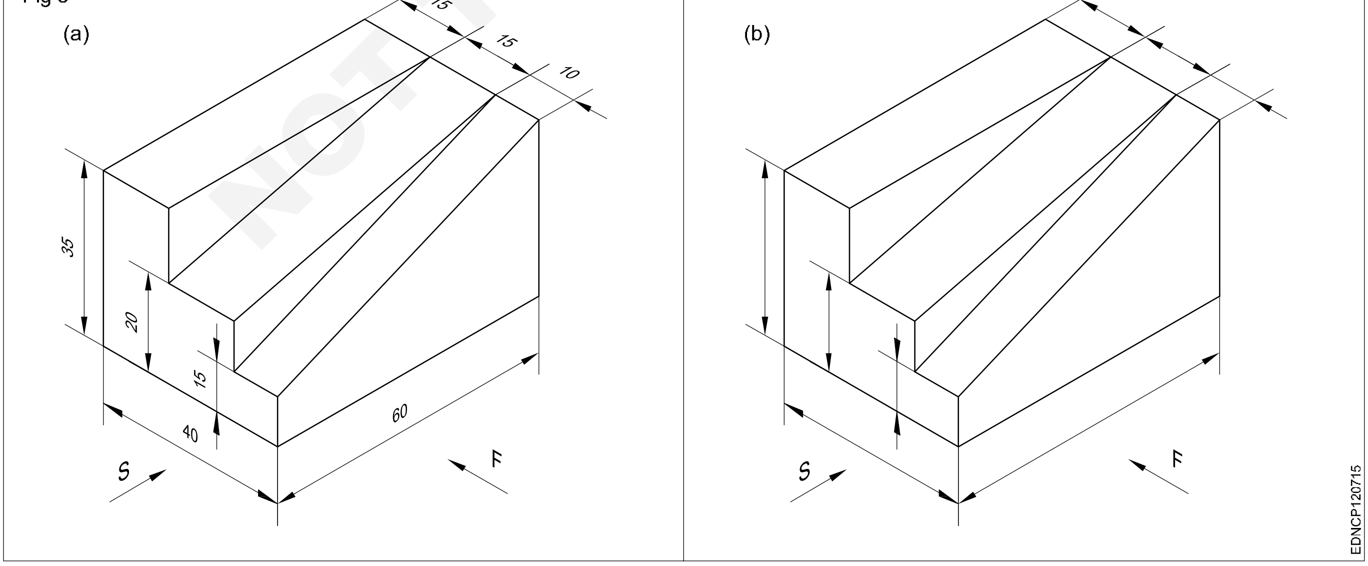


Fig 6

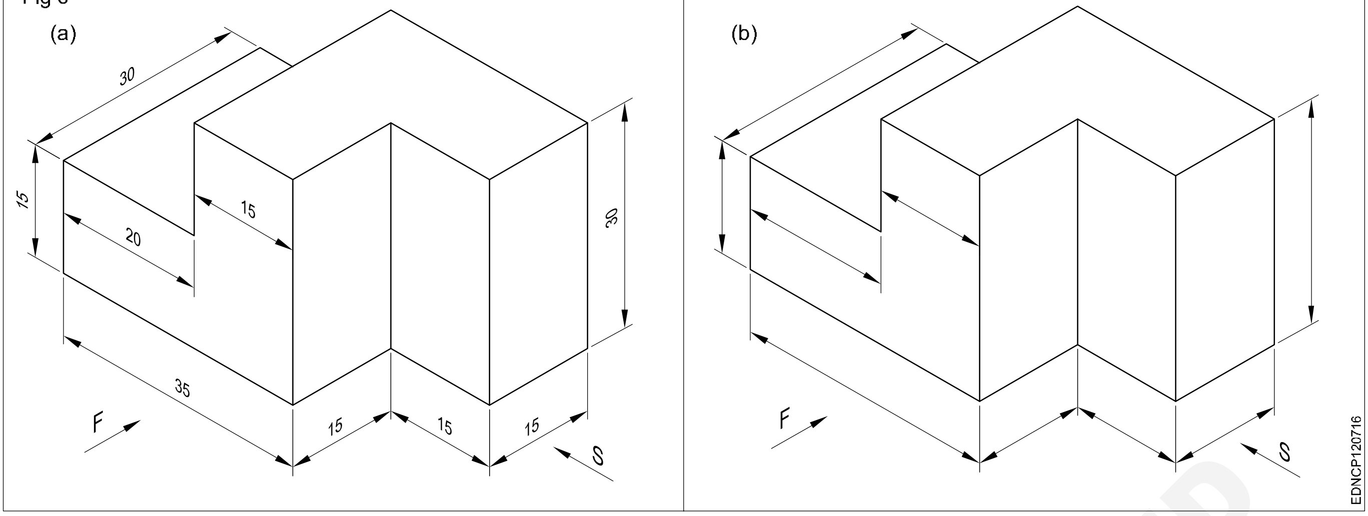


Fig 7

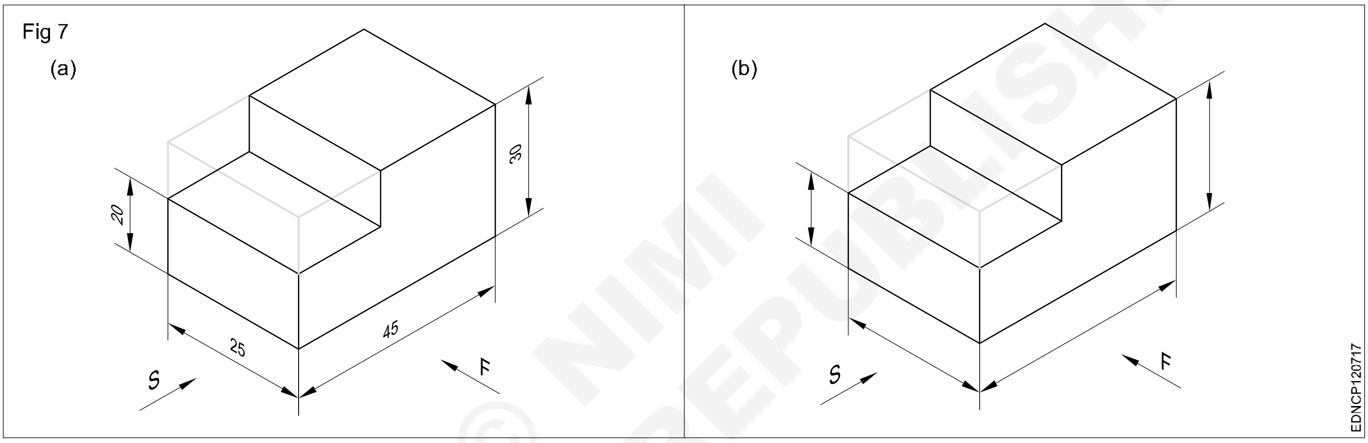


Fig 8

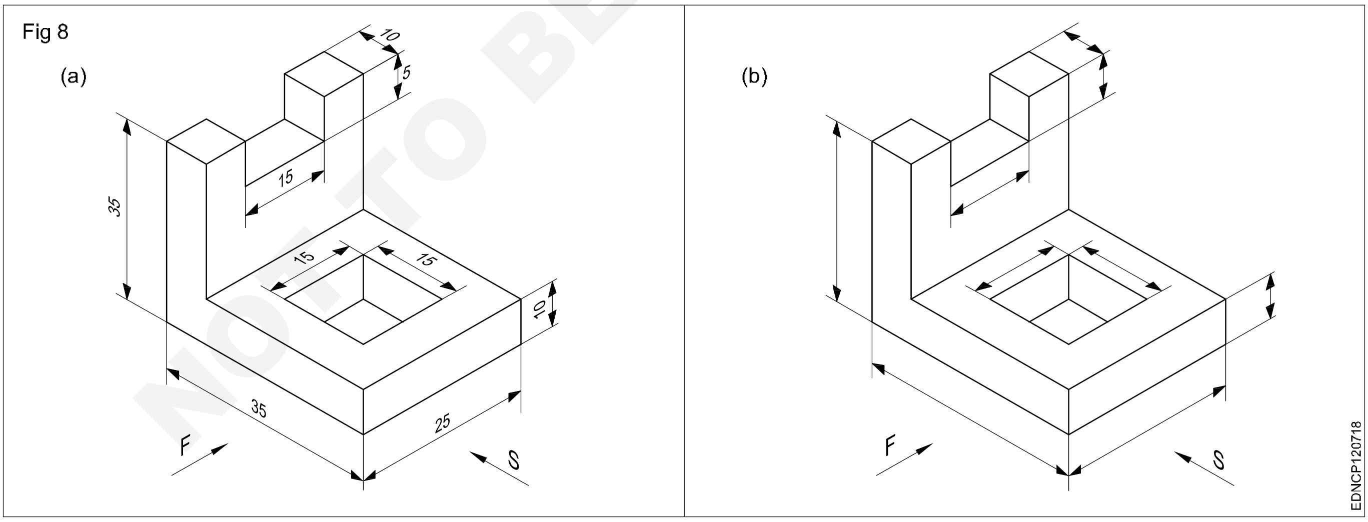


Fig 9

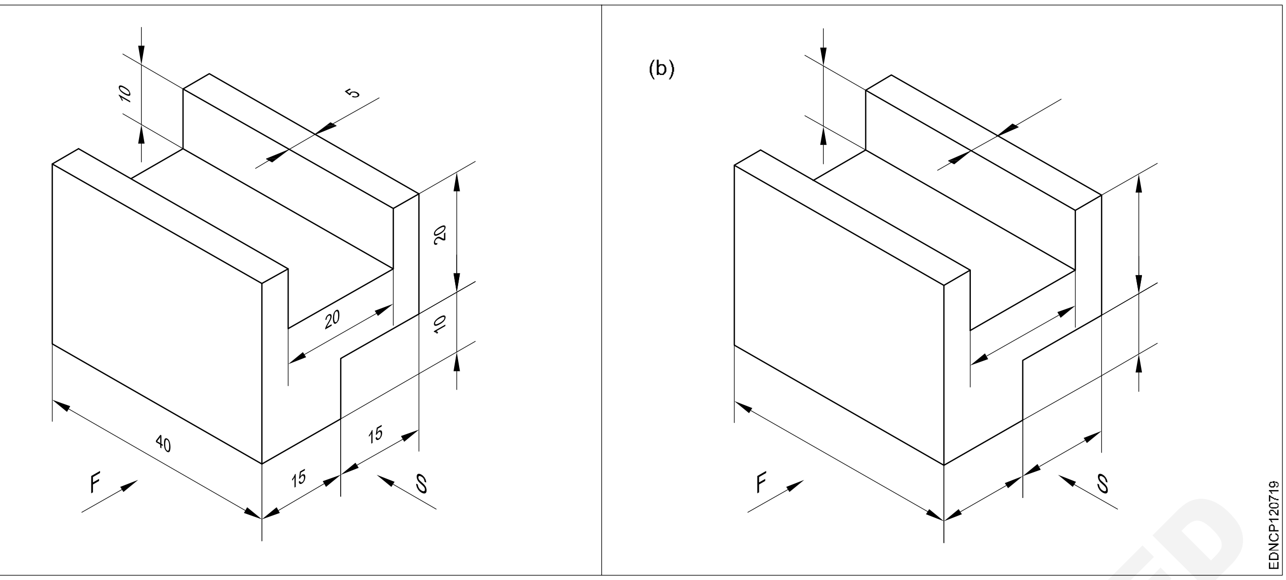
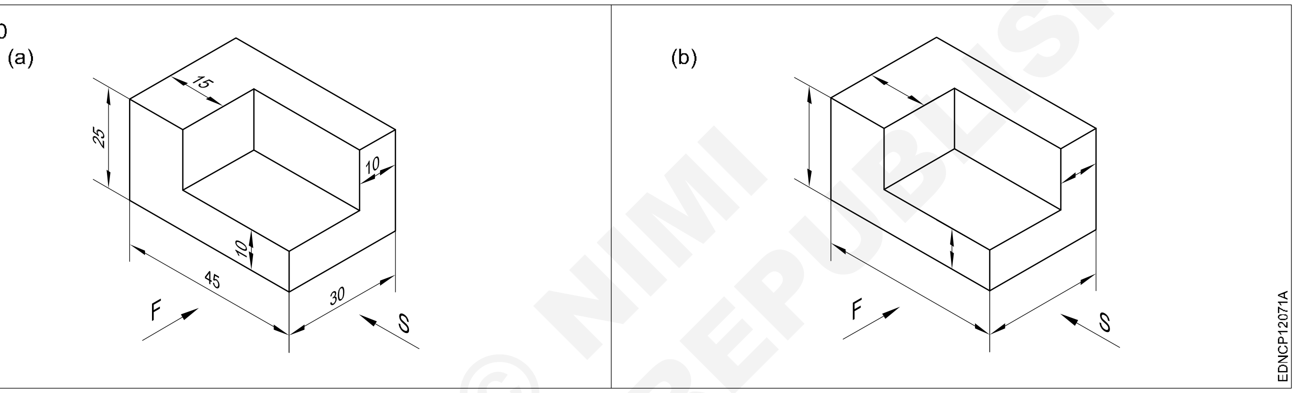

(a)
10
5
20
20
10
40
15
15
F
S
(b)
F
S
EDNCP120719

Fig 10


(a)
15
25
10
10
45
30
F
S
(b)
F
S
EDNCP12071A

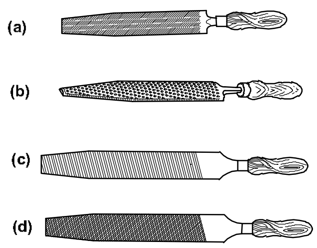
Free hand drawing of hand tools and measuring tools

Hand Tools

Files (Fig 1)

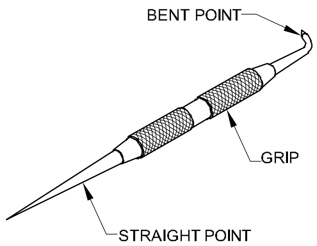
- a Curved cut file
- b Rasp cut file
- c Single cut file
- d Double cut file

Fig 1



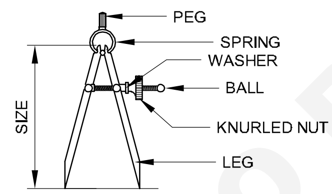
Scriber (Fig 2)

Fig 2



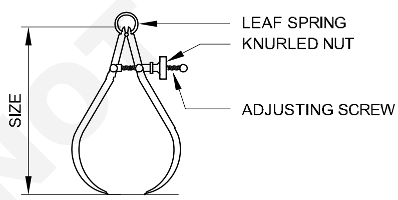
Divider (Fig 3)

Fig 3



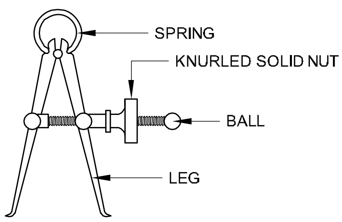
Outside caliper (Fig 4)

Fig 4



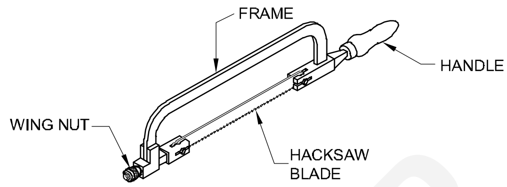
Inside caliper (Fig 5)

Fig 5



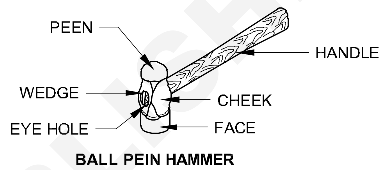
Hacksaw (Fig 6)

Fig 6



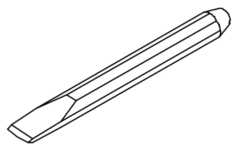
Ball pein hammer (Fig 7)

Fig 7



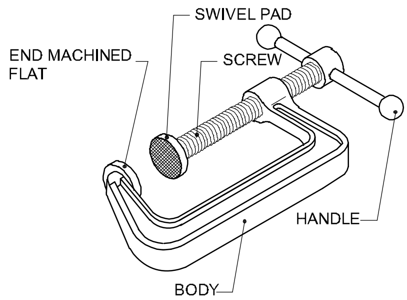
Chisel (Fig 8)

Fig 8



'C' clamp (Fig 9)

Fig 9

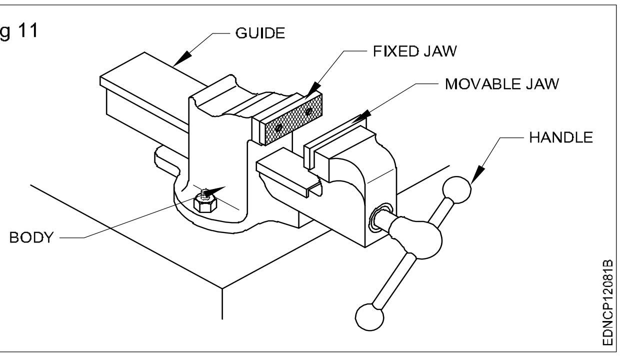


Screw driver (Fig 10)

Fig 10

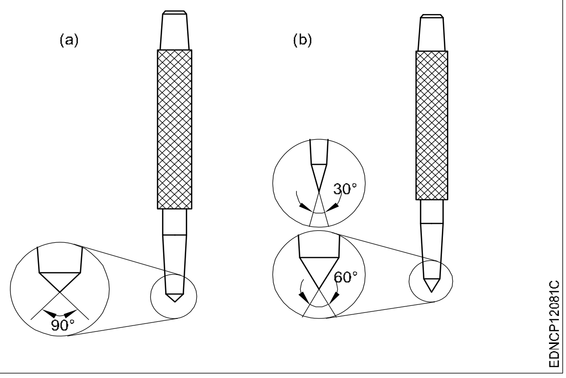
Bench vice (Fig 11)

Fig 11



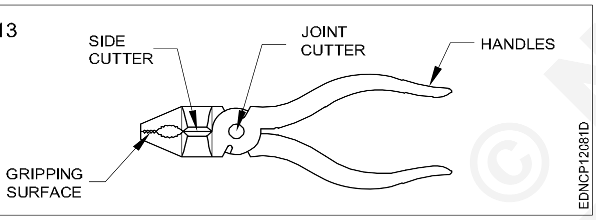
Centre punch (Fig 12)

Fig 12



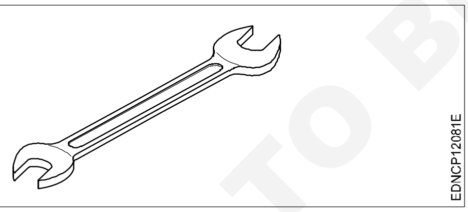
Cutting plier (Fig 13)

Fig 13



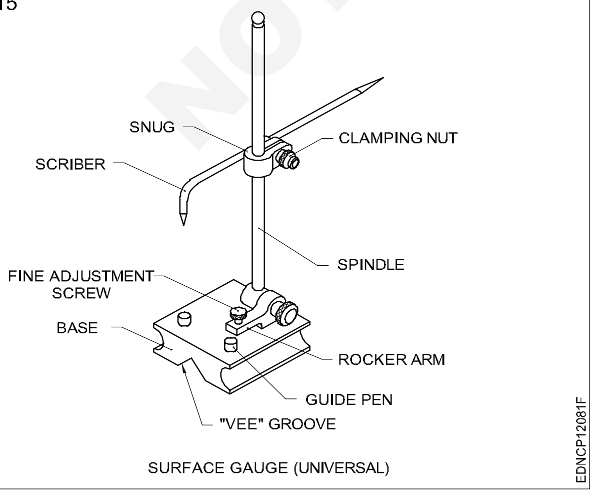
Open-end spanner (Fig 14)

Fig 14



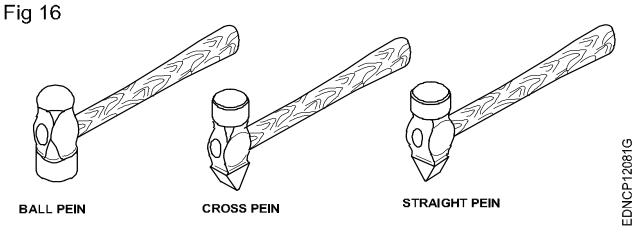
Surface gauge (Fig 15)

Fig 15



Hammers (Fig 16)

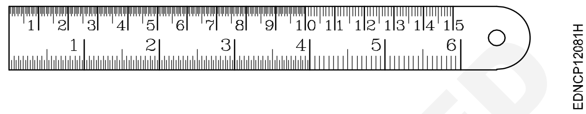
Fig 16



Measuring Tools

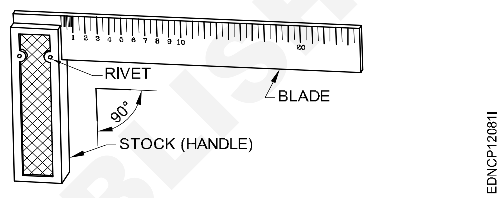
Steel rule (Fig 17)

Fig 17



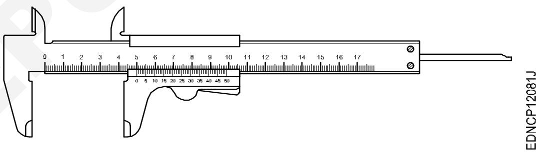
Try square (Fig 18)

Fig 18



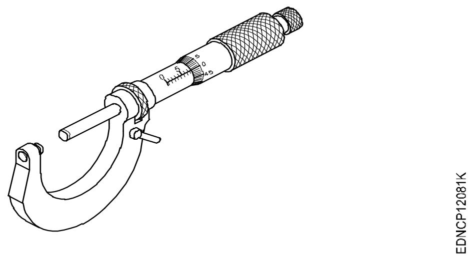
Vernier caliper (Fig 19)

Fig 19



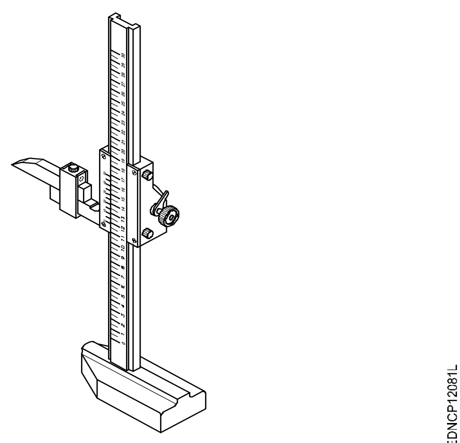
Micrometer (Fig 20)

Fig 20



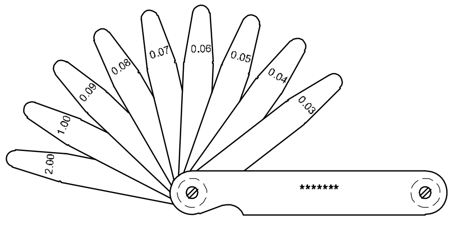
Vernier height gauge (Fig 21)

Fig 21



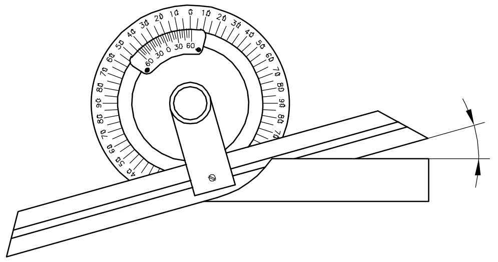
Feeler gauge (Fig 22)

Fig 22



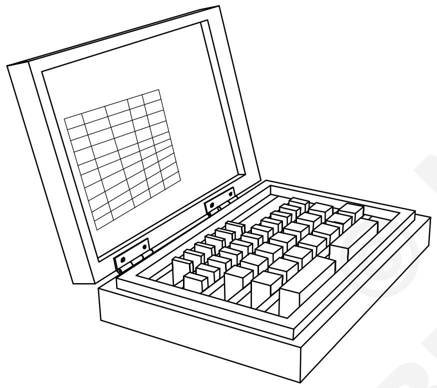
Bevel protractor (Fig 23)

Fig 23



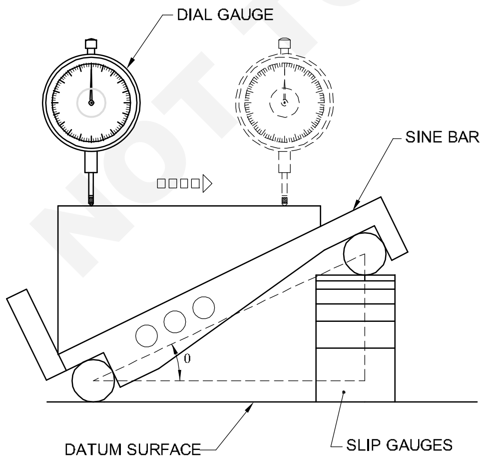
Slip gauge box (Fig 24)

Fig 24



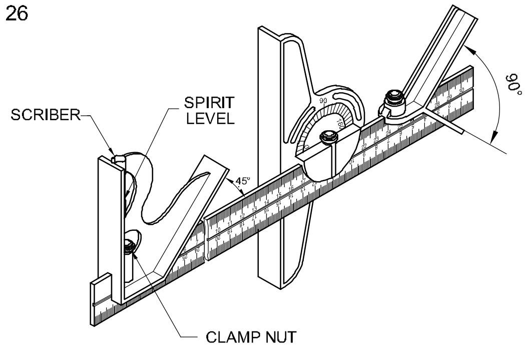
Sine bar with dial gauge (Fig 25)

Fig 25



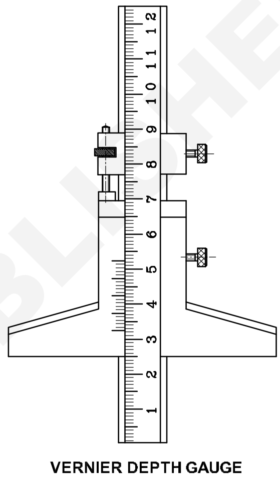
Combination set (Fig 26)

Fig 26



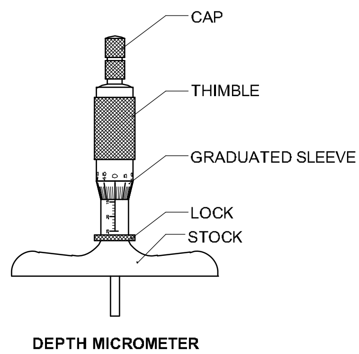
Vernier depth gauge (Fig 27)

Fig 27



Depth micrometer (Fig 28)

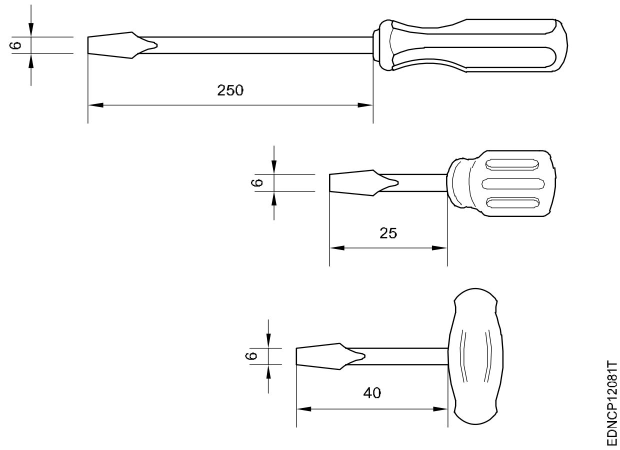
Fig 28



Hand Tools

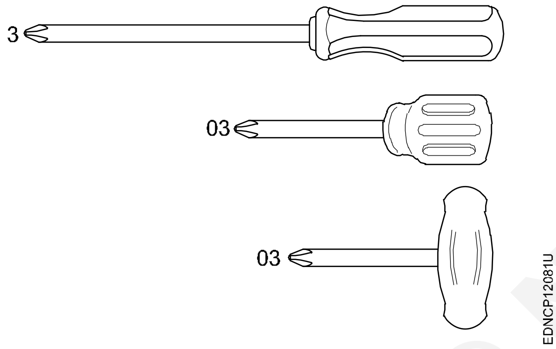
Screwdriver (Fig 29)

Fig 29



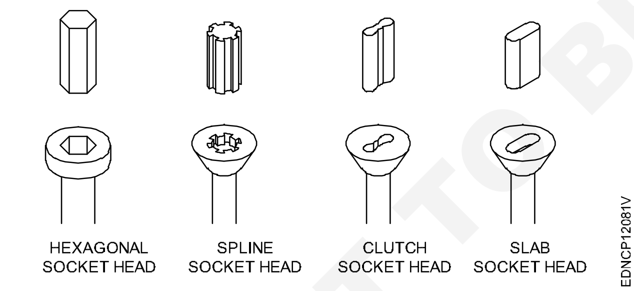
Screwdriver with cross-type tips (Fig 30)

Fig 30



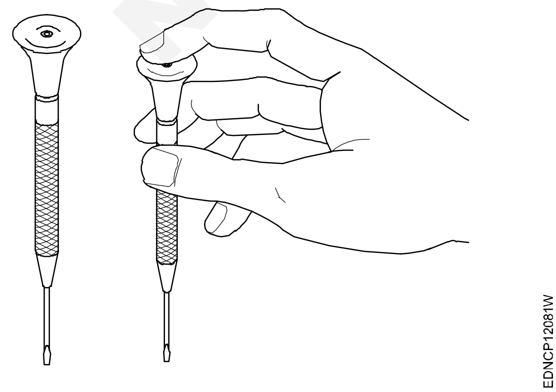
Screw tips aided screw heads (Fig 31)

Fig 31



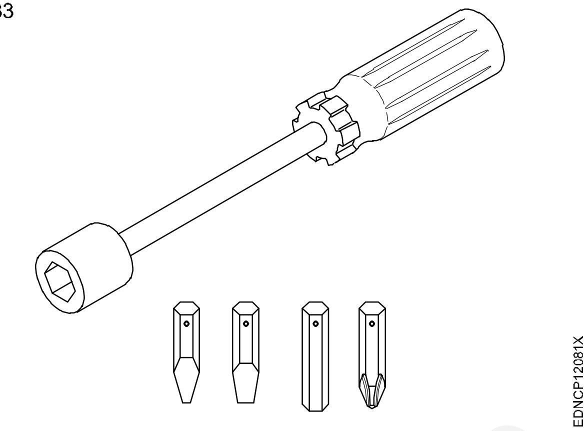
Instrument screwdriver (Fig 32)

Fig 32



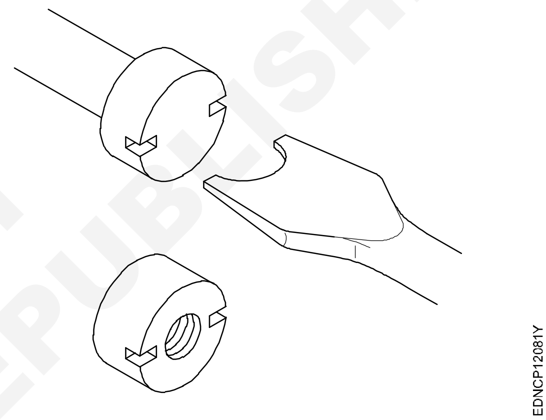
Screwdriver interchangeable tips (Fig 33)

Fig 33



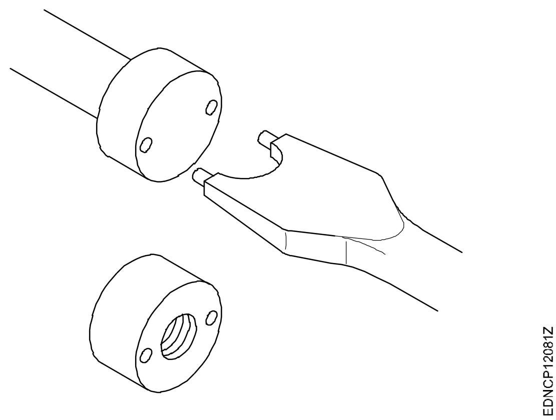
Special type screwdriver (two rectangular recesses) (Fig 34)

Fig 34



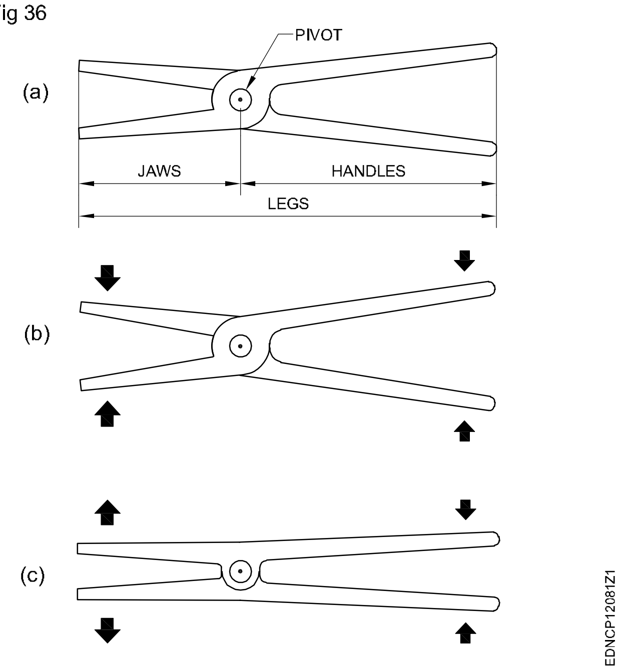
Special type screwdriver (two round recesses) (Fig 35)

Fig 35



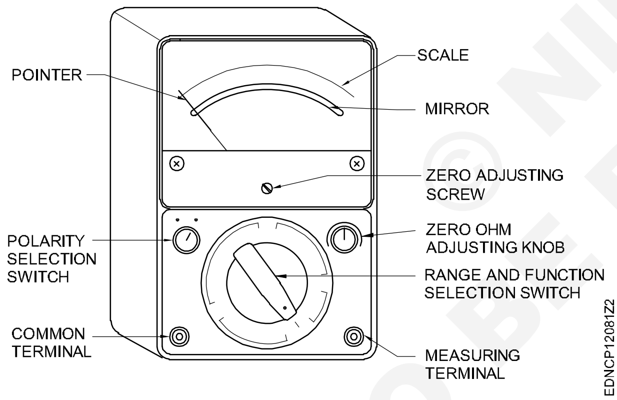
Pliers (Fig 36)

Fig 36



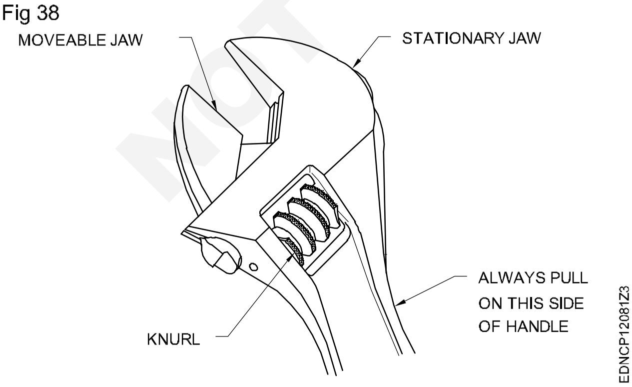
Analog multimeter (Fig 37)

Fig 37



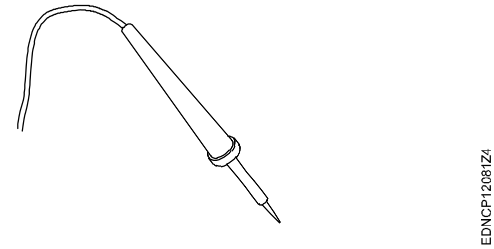
Adjustable spanner (Fig 38)

Fig 38



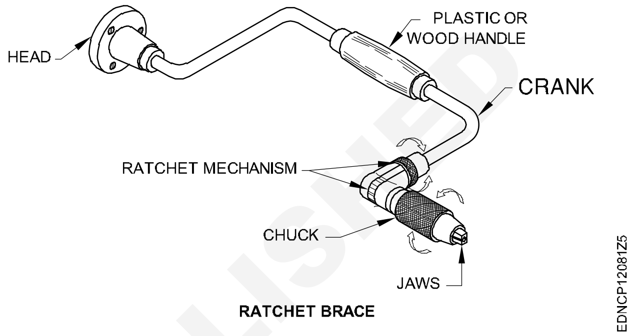
Soldering iron (Fig 39)

Fig 39



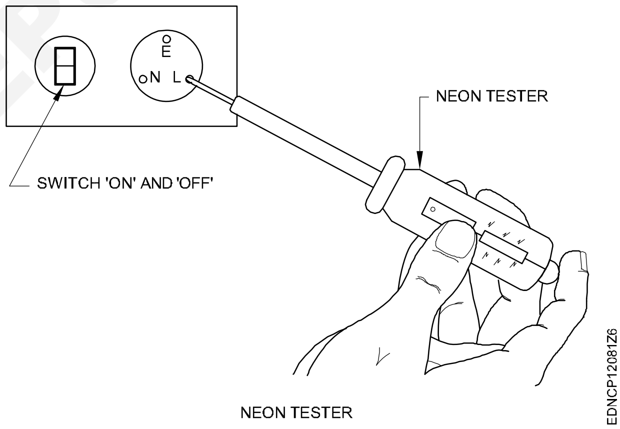
Ratchet brace (Fig 40)

Fig 40



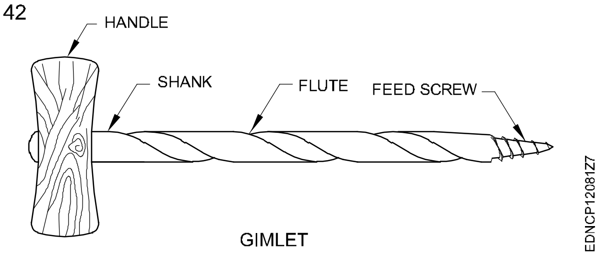
Neon Tester (Fig 41)

Fig 41



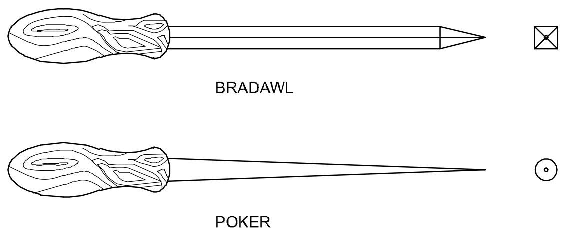
Gimlet (Fig 42)

Fig 42



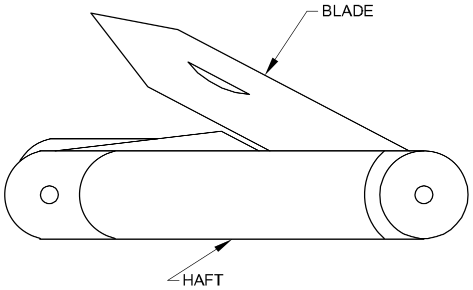
Bradawl & poker (Fig 43)

Fig 43



Electrician's knife (Fig 44)

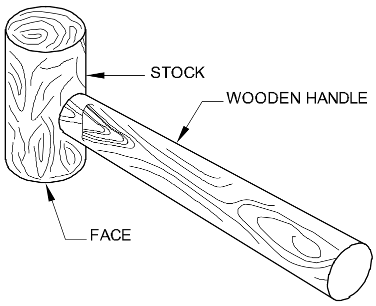
Fig 44



ELECTRICIAN'S KNIFE

Mallet (Fig 45)

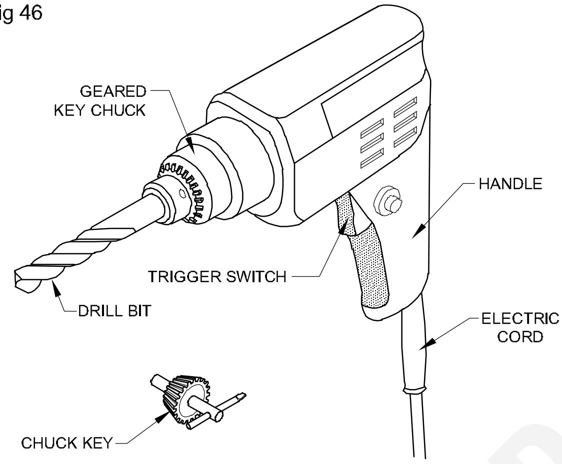
Fig 45



MALLET

Electric drilling machine (Fig 46)

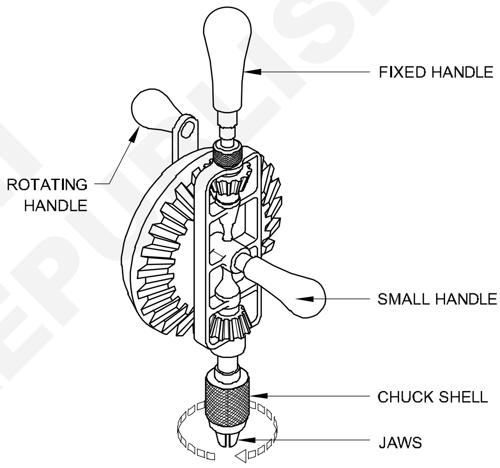
Fig 46



ELECTRIC DRILLING MACHINE

Hand drill (Fig 47)

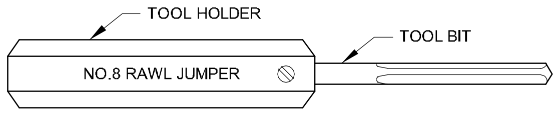
Fig 47



HAND DRILL

Rawl plug tool (Fig 48)

Fig 48



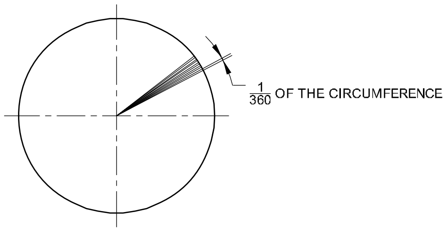
RAWL PLUG TOOL

Drawing of geometrical figures - 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.

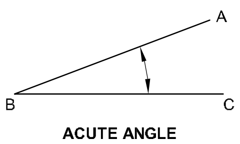
Concept of a degree: When the circumference of a circle is divided into 360 equal parts and radial lines are drawn through these points, the inclination between the two adjacent radial lines is defined as one degree. Thus a circle is said to contain 360°. (Fig 1)

Fig 1



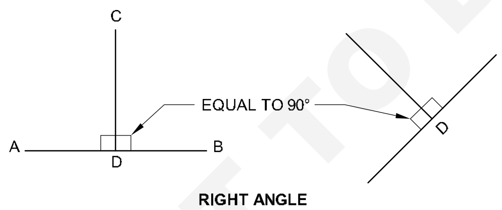
Acute angle: An angle that is less than 90° is called an acute angle. (Fig 2)

Fig 2



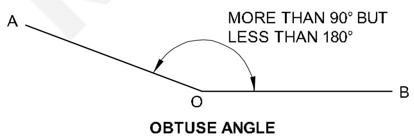
Right angle: The angle between a reference line and a perpendicular line is called a right angle. (Fig 3)

Fig 3



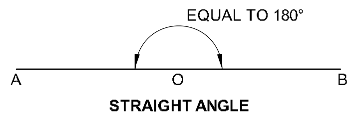
Obtuse angle: This refers to an angle between 90° and 180°. (Fig 4)

Fig 4



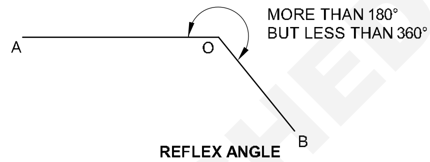
Straight angle: This refers to an angle of 180°. This is also called the angle of a straight line. (Fig 5)

Fig 5



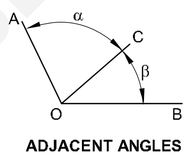
Reflex angle: It is the angle that is more than 180°, but less than 360°. (Fig 6)

Fig 6



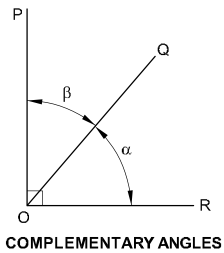
Adjacent angles: These are the angles lying on either side of a line. (Fig 7)

Fig 7



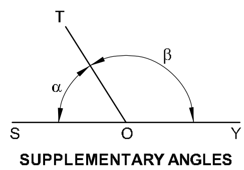
Complementary angles: When the sum of the two angles is equal to 90°, angle POQ + angle QOR = 90° angle POQ and angle QOR are complementary angles to each other. (Fig 8)

Fig 8



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



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°.

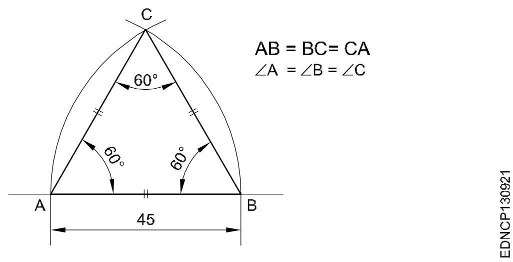
To define a triangle, we need to have a minimum of three measurements as follows:

- 3 sides or
- 2 sides and one angle or
- 2 angles and one side

Types of triangles

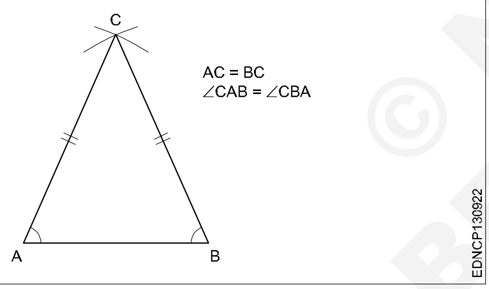
1 **Equilateral triangle** is a triangle having all the three sides equal. Also all the three angles are equal (60°). (Fig 1)

Fig 1



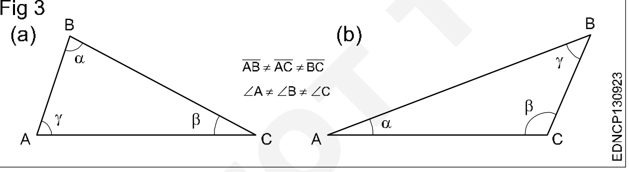
2 **Isosceles triangle** has two of its sides equal. The angles opposite the two equal sides are also equal. (Fig 2)

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

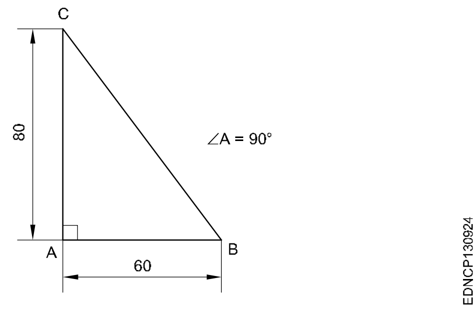


Fig 5

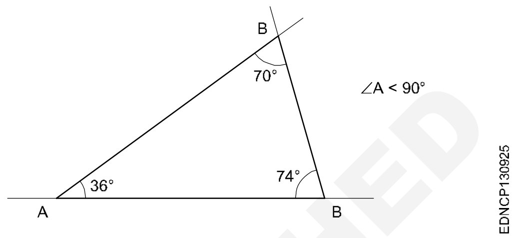
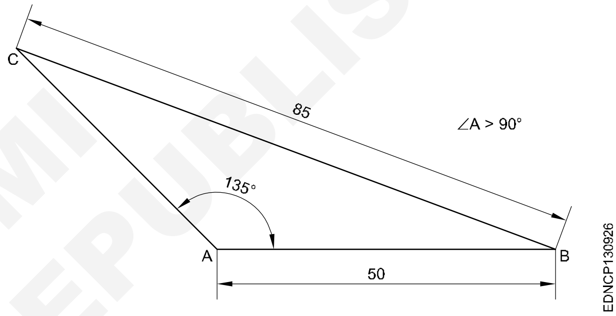


Fig 6

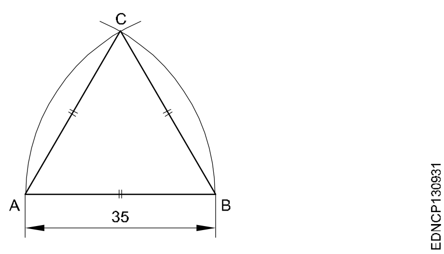


Procedure to draw the triangle

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.

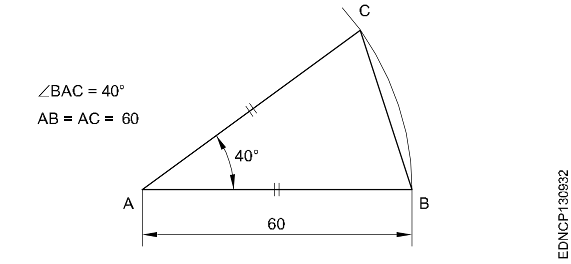
Fig 1



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)

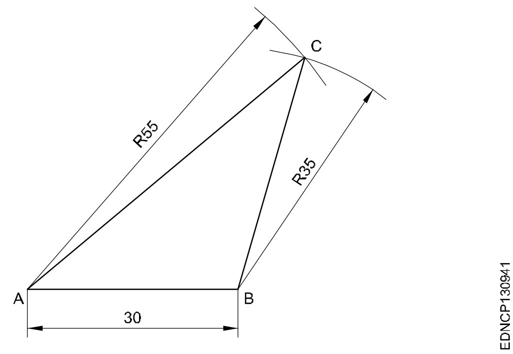
Fig 2



Exercise

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

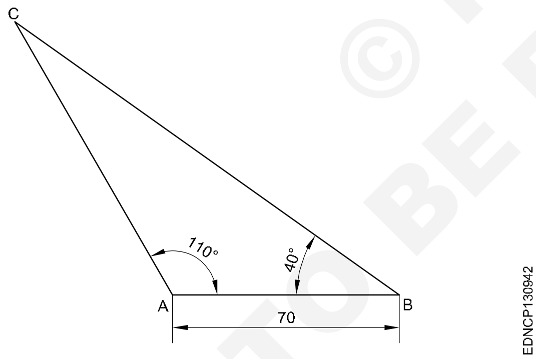
Fig 1



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

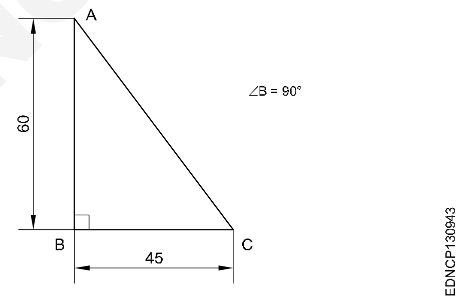
$\angle ABC = 40^\circ$ & $\angle BAC = 110^\circ$

Fig 2



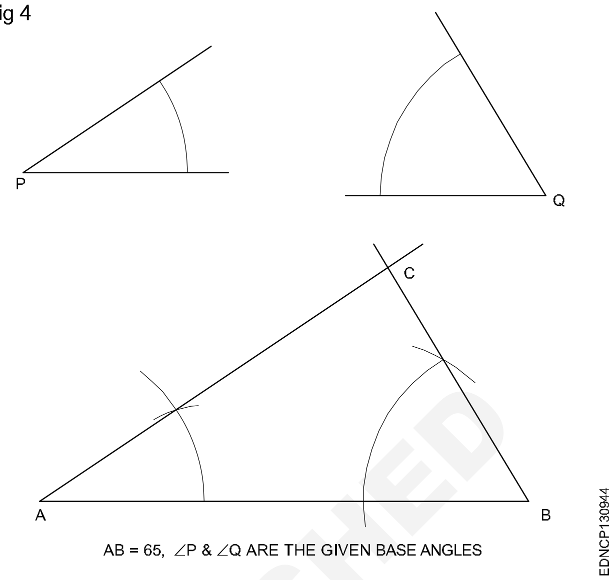
3 **Right angled triangle: AB = 60 mm, BC = 45 mm. (Fig 3)**

Fig 3



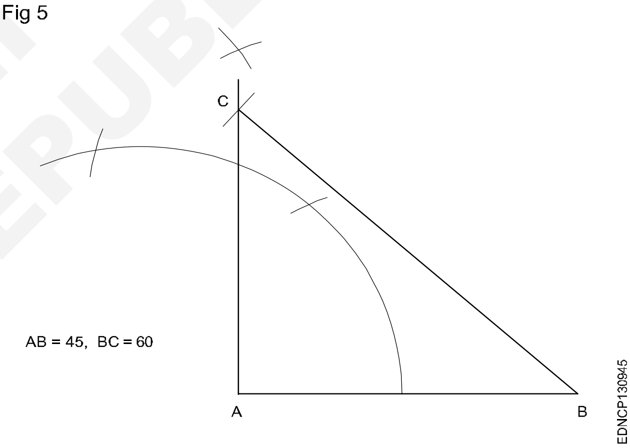
4 Draw a triangle when one side and 2 angles being given in Fig 4.

Fig 4



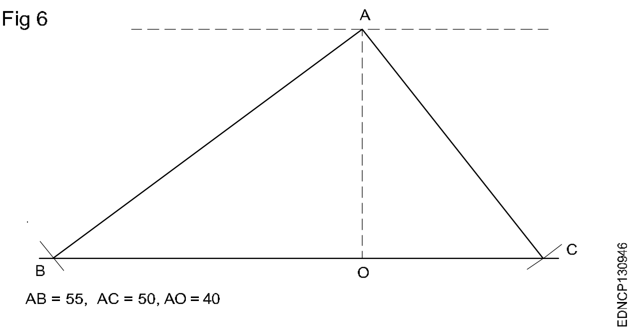
5 Draw a right angled triangle when the base and hypotenuse being given in Fig 5.

Fig 5



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

Fig 6



Drawing of geometrical figures - 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.

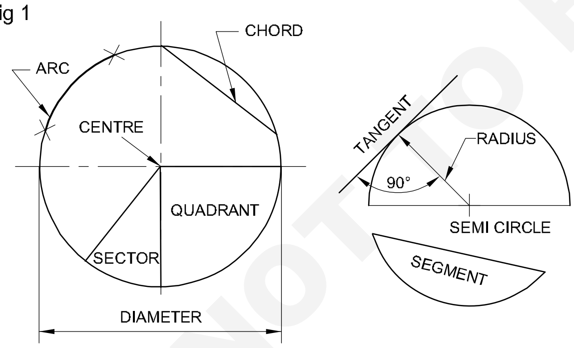
Quadrant: Part of a circle with radii making 90° with each other is a quadrant (one-fourth of the circle).

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

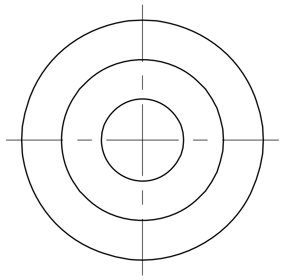


EDNCP131011

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)

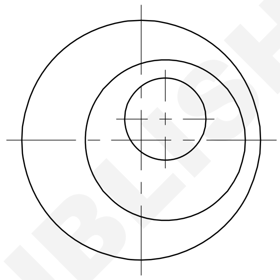
Fig 2



CONCENTRIC CIRCLES

EDNCP131012

Fig 3



ECCENTRIC CIRCLES

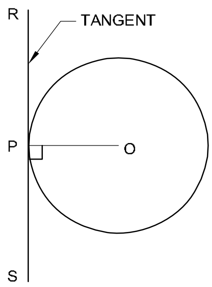
EDNCP131013

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

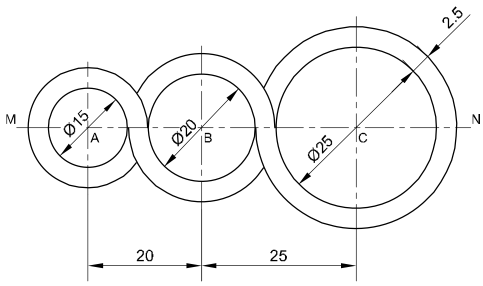


EDNCP131021

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.

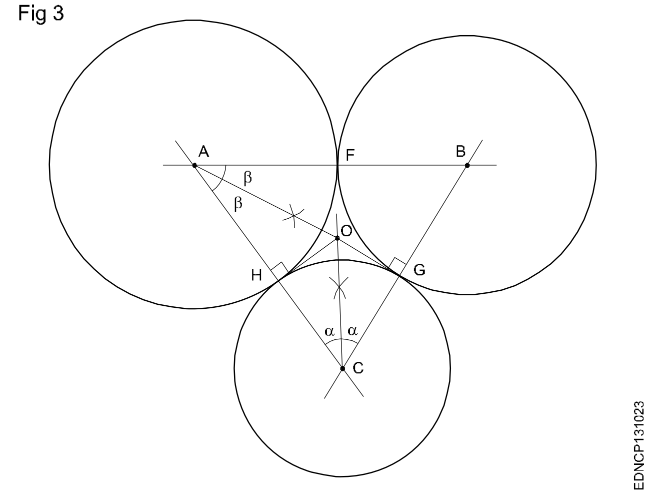
Fig 2



EDNCP131022

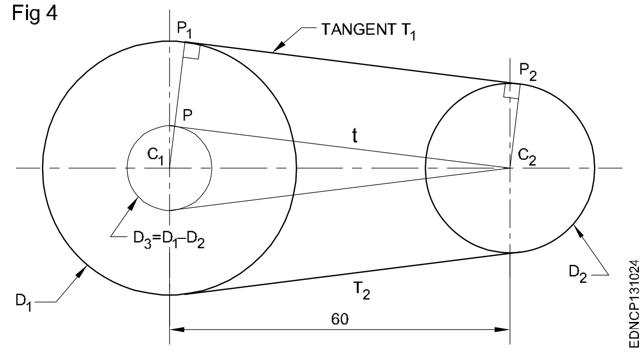
3 3 **Draw three circles tangential to each other if centres A, B & C are given. (Fig 3)**

Fig 3



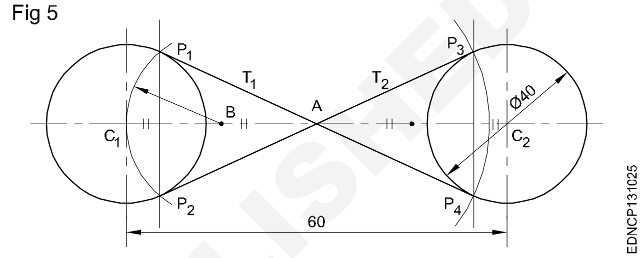
4 **Draw external tangents to circles of dia 40 and 30 and centre distance 60 mm. (Fig 4)**

Fig 4



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

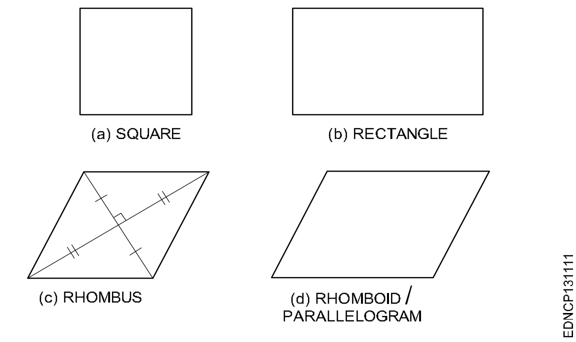
Fig 5



Drawing of geometrical figures - 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



Types of quadrilaterals (Fig 1)

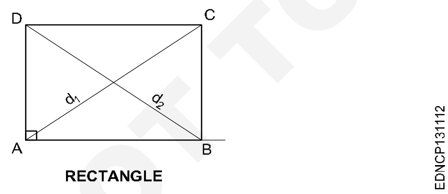
- Square
- Rectangle
- Rhomboid / Parallelogram

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.

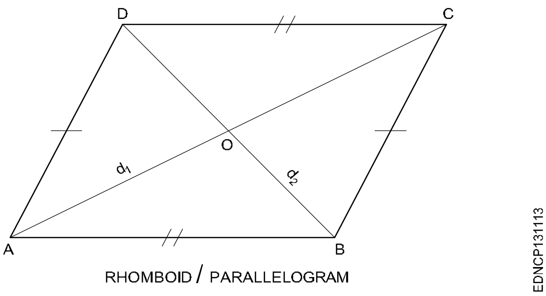
Fig 2 shows a rectangle ABCD, Sides AB = DC and BC = AD. Diagonals AC and BD are equal. Diagonals are not bisected at right angles.

Fig 2



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



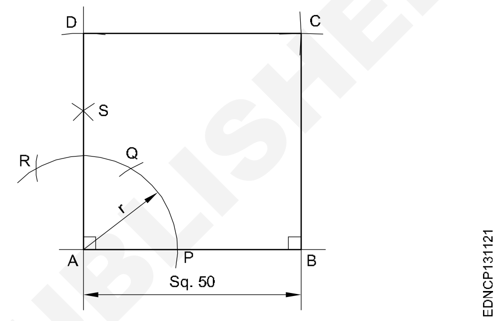
Procedure to draw the square, rectangle and parallelogram

Square

1 **1st method** (Fig 1)**:** A square of side 50 mm by erecting perpendicular using compass and 45° set square.

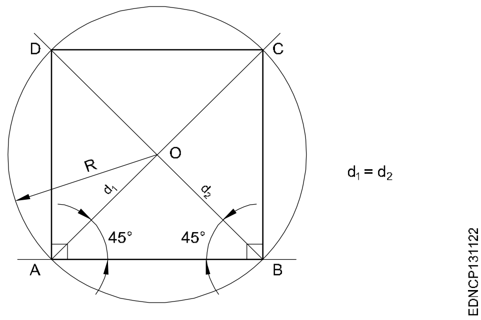
Draw a line 50mm. 'A' as centre draw an arc of convenient radius. Same arc cut and mark as PQR. Draw a line perpendicular, mark 50mm and make a square as shown in figure.

Fig 1



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

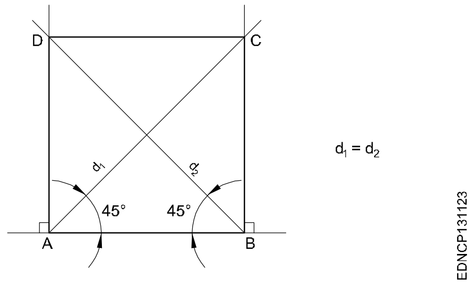
Fig 2



Draw a horizontal line AB = 60 mm. From point 'A' & 'B' using 45° setsquare draw diagonal and circle of radius OA with centre 'O'. Join points AD, DC & CB to complete the required square.

3 **3rd method (Fig 3):** A square of side 60 mm long by erecting perpendicular and also using 45° setsquare. Mark AD, BC and join ABCD to get the required square.

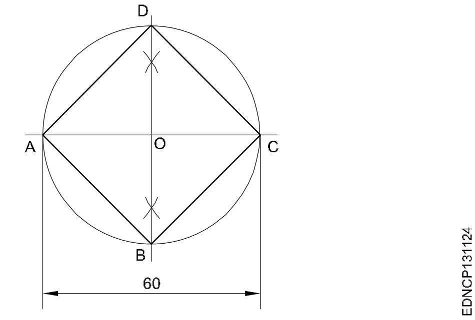
Fig 3



4 Square having diagonal 60 mm (Fig 4)

Draw horizontal and vertical centre lines intersect at 'O' and make a circle. Join all the points ABC&D to get the required square.

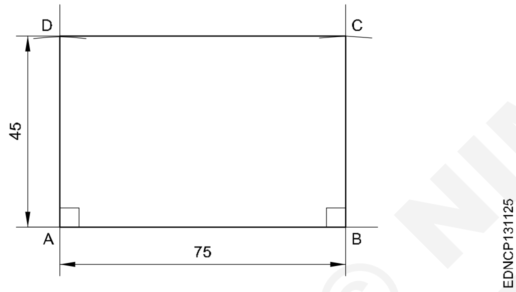
Fig 4



5 Rectangle (Fig 5)

Draw AB = 75 mm and side AD = 45 mm using setsquare and compass. Draw BC = 45 mm using setsquare and compass. Join ABCD to get the required rectangle.

Fig 5

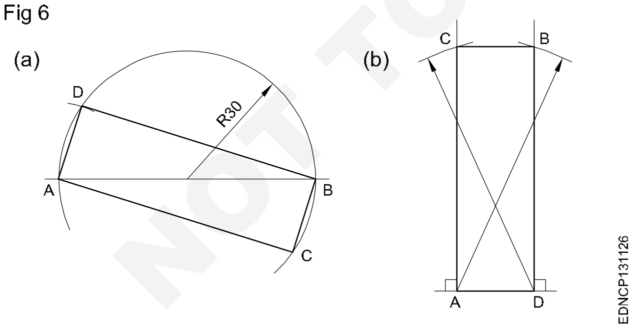


6 Rectangle - Diagonal - 60 mm and one side 20 mm 1st method (Fig 6a)

2nd method (Fig 6b)

ADBC is the required rectangle of side 20 mm and diagonal 60 mm by using setsquare and compass.

Fig 6

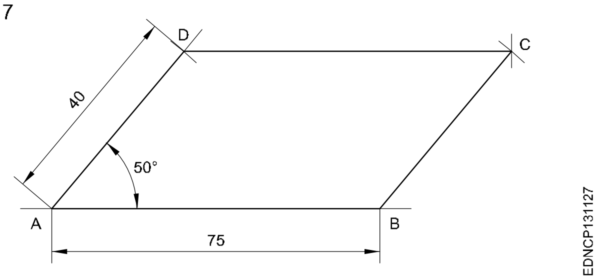


7 Parallelogram (Fig 7)

Sides = 75 mm and 40 mm, angle 50°

- Draw line AD equal to 40 mm and 50° angle to AB.
- 'D' as centre, draw an arc of radius equal to AB.
- 'B' as centre, draw an arc of radius equal at AD, upwards such that they meet at a point 'C'. Join ABCD to get the required parallelogram.

Fig 7



8 Parallelogram (Fig 8)

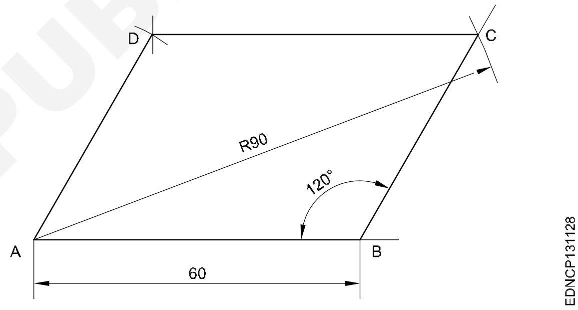
Parallelogram - Side AB = 60 mm

Diagonal AC = 90 mm ∠ABC = 120°

- Draw a line AB = 60 mm. Draw a line from B to an angle 120° to AB.
- 'A' as centre with radius 90 mm, draw an arc cutting 120° line from 'B' at 'C'.
- 'C' as centre, radius = AB, draw an arc.
- 'A' as centre and BC as radius, draw another arc, both arcs meet at 'D'. Join AD and DC.

  ABCD is the required parallelogram.

Fig 8



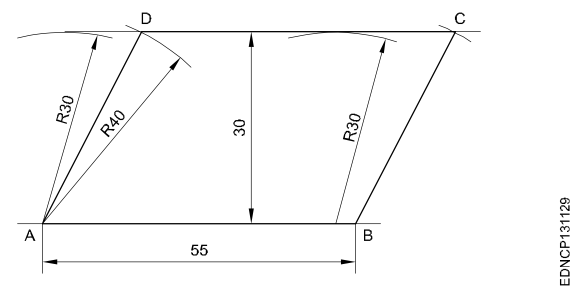
9 Parallelogram (Fig 9)

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

- Draw the line AB = 55 mm long.
- 'A' and 'B' as centres and radius (R) 30 mm, draw arcs above the line.
- Draw a parallel tangential line to AB touching the arcs.
- 'A' and 'B' as centres, draw an arc of 40 mm radius cutting the line at 'D' and 'C'.

  ABCD is the required parallelogram.

Fig 9



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

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,I	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

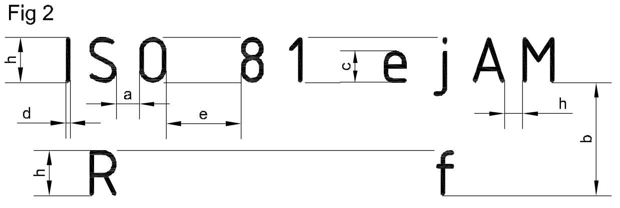
Width (W)	Capital letters
1	I
4	J
5	C,E,F,L
6	B,D,G,H,K,N,O,P,R,S,T,U & Z
7	A,M,Q,V,X,Y
9	W

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

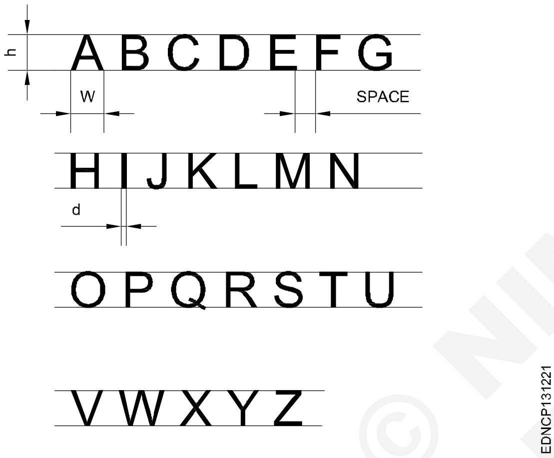


Lettering

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.

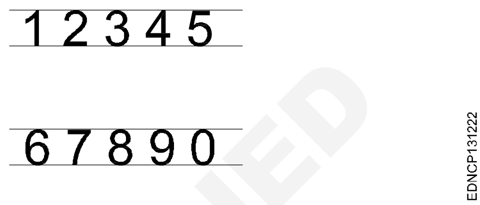
Print straight line letters using either scale or set-squares.

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.

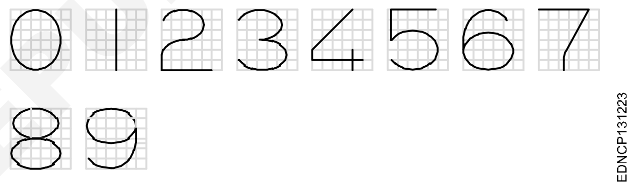
Numerals 2.1 (Fig 2)

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)

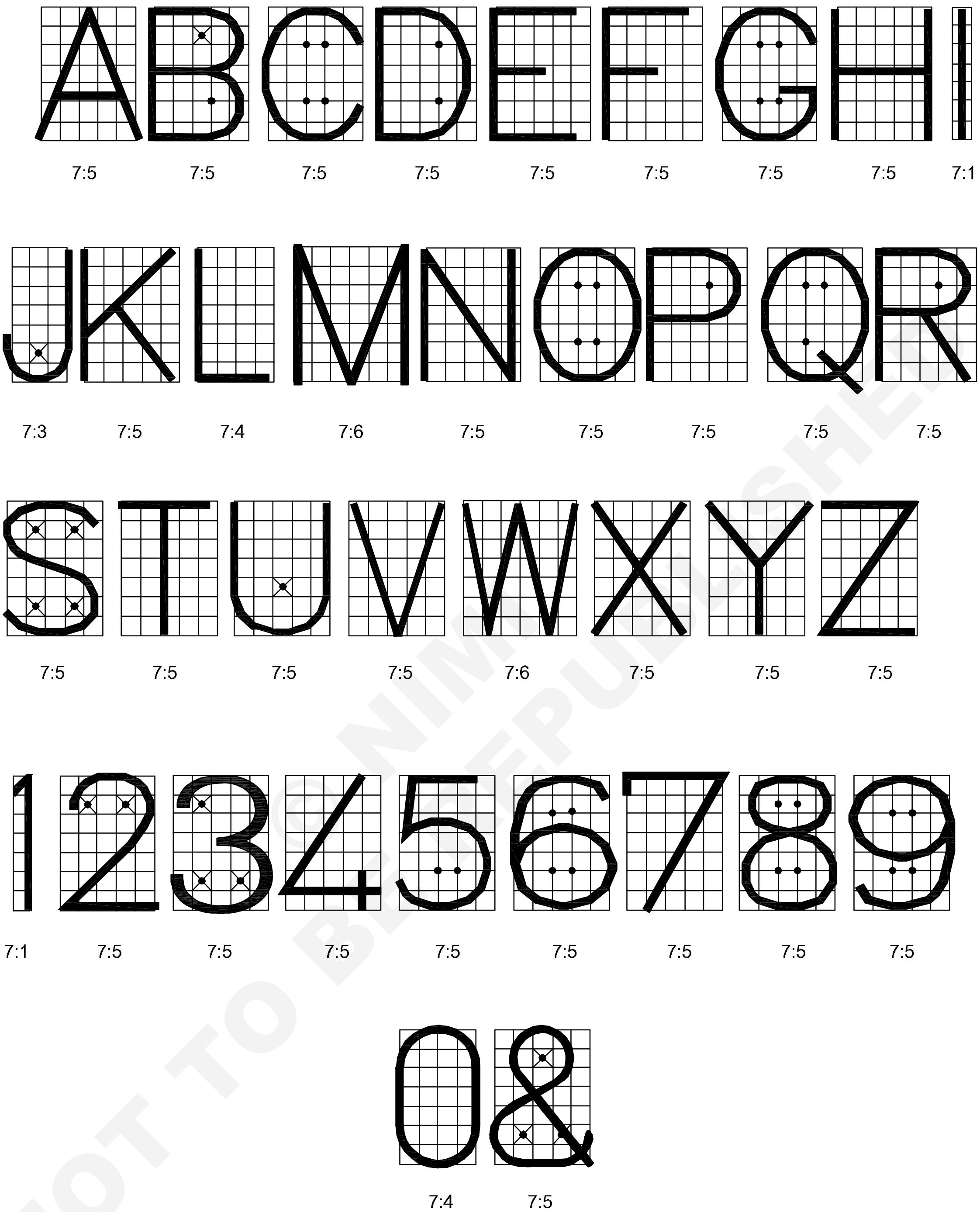
Fig 5

SINGLE STROKE INCLINED LETTERS

EDNCP131225

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

Fig 6



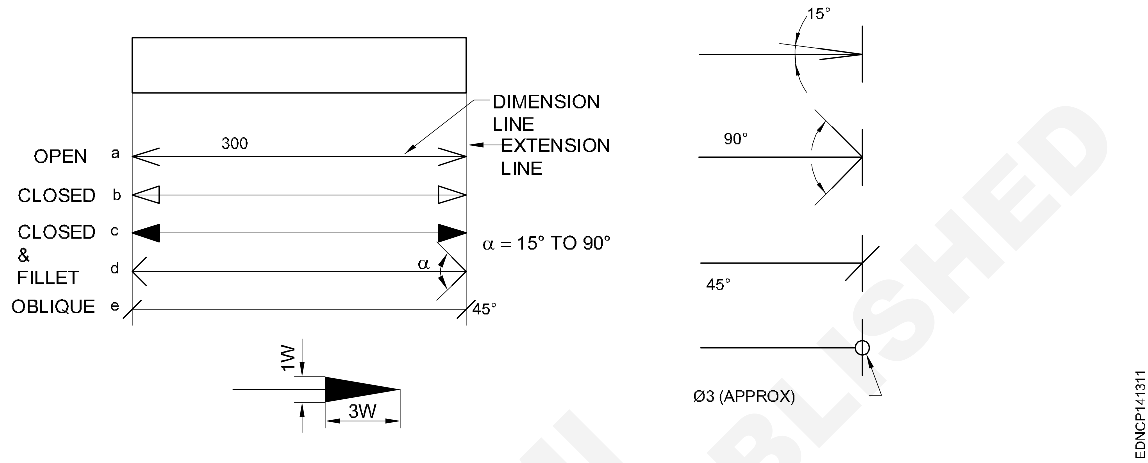
SINGLE STROKE VERTICAL LETTERS

EDNCP131226

Dimensioning Practice - Types of arrow heads

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

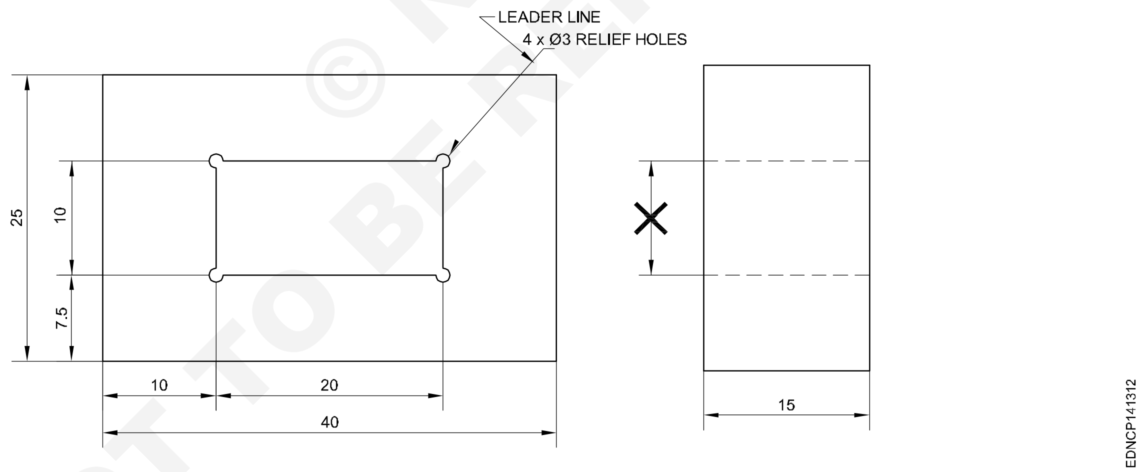
Fig 1



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)

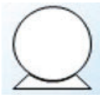
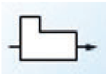
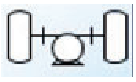
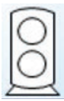
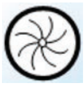
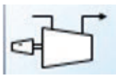
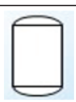
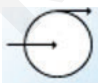
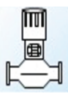
Termination and Origin indication: The size of the terminations (arrowheads/oblique strokes) shall be proportional to the size of the drawing. Only one style of arrowhead shall be used on a single drawing. However, where the space is too small for the arrowheads, it may be substituted by a dot or by 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)

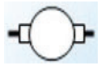
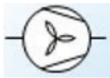
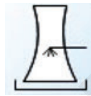
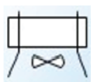
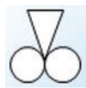
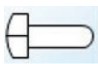
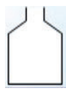
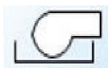
Indicating dimensional values on drawings: All dimensional values shall be shown on drawings in characters of sufficient size to ensure complete legibility on the original drawings as well as on reproductions made from micro-filming.

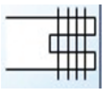
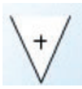
They shall be placed in such a way that they are not crossed or separated by any other line on the drawing.

Symbolic representation – Different symbols used in the related trades

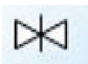
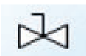
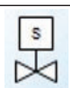
Equipments

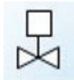
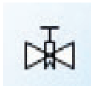
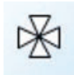
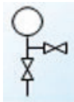
Sl.No.	Symbol	Description
1		Compressor
2		Reciprocating compressor
3		Compressor silencers
4		Centrifugal
5		Rotary compressor
6		Liquid ring compressor
7		Centrifugal compressor
8		Mixing
9		Mixing reactor
10		Vertical vessel
11		Column
12		Pump
13		Centrifugal pump
14		Vertical pump
15		Rotary gear pump

Sl.No.	Symbol	Description
16		Vacuum pump
17		Screw pump
18		Turbine pump
19		Selectable fan
20		Cooling tower 2
21		Heat exchanger
22		Heater
23		Cooler
24		Air-blown cooler
25		Reboiler heat exchanger
26		Spiral heat exchanger
27		Briquetting machine
28		U-tube heat exchanger
29		Boiler
30		Oil burner
31		Fired heater

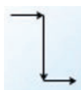
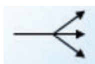
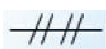
Sl.No.	Symbol	Description
32		Condenser
33		Tank
34		Wastewater treatment
35		Furnace
36		Crusher

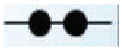
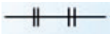
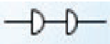
Valves

Sl.No.	Symbol	Description
1		Gate valve, Hand-operator
2		Globe valve Hand-operator
3		Needlel valve
4		Control valve
5		Plug or cock valve
6		Check valve
7		Butterfly valve
8		Flanged valve
9		Relief valve
10		Ball
11		Diaghragm
12		Solenoid valve
13		Hydraulic valve

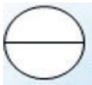
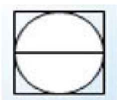
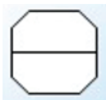
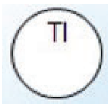
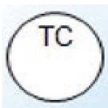
Sl.No.	Symbol	Description
14		Powered valve
15		Float-operator valve
16		Needle valve
17		Four-way valve
18		Gauge
19		Bleeder valve

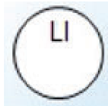
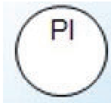
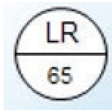
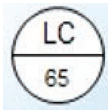
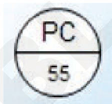
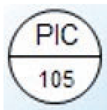
Piping and Connection Shapes

Sl.No.	Symbol	Description
1		Major pipeline
2		Connect pipeline
3		Major straight line
4		Process connection
5		Side by side
6		One-to-ma...
7		Electrical signal
8		Sonic signal
9		Nuclear
10		Pneumatic
11		Hydraulic signal line
12		Butt weld

Sl.No.	Symbol	Description
13		Mechanical link
14		Soldered solvent
15		Flange
16		End caps
17		Breather

Instruments

Sl.No.	Symbol	Description
1		Indicator
2		Indicator 3
3		Shared Indicator
4		Computer Indicator
5		Temp Indicator
6		Temp Controller
7		Flow Indicator
8		Flow Recorder
9		Flow Controller

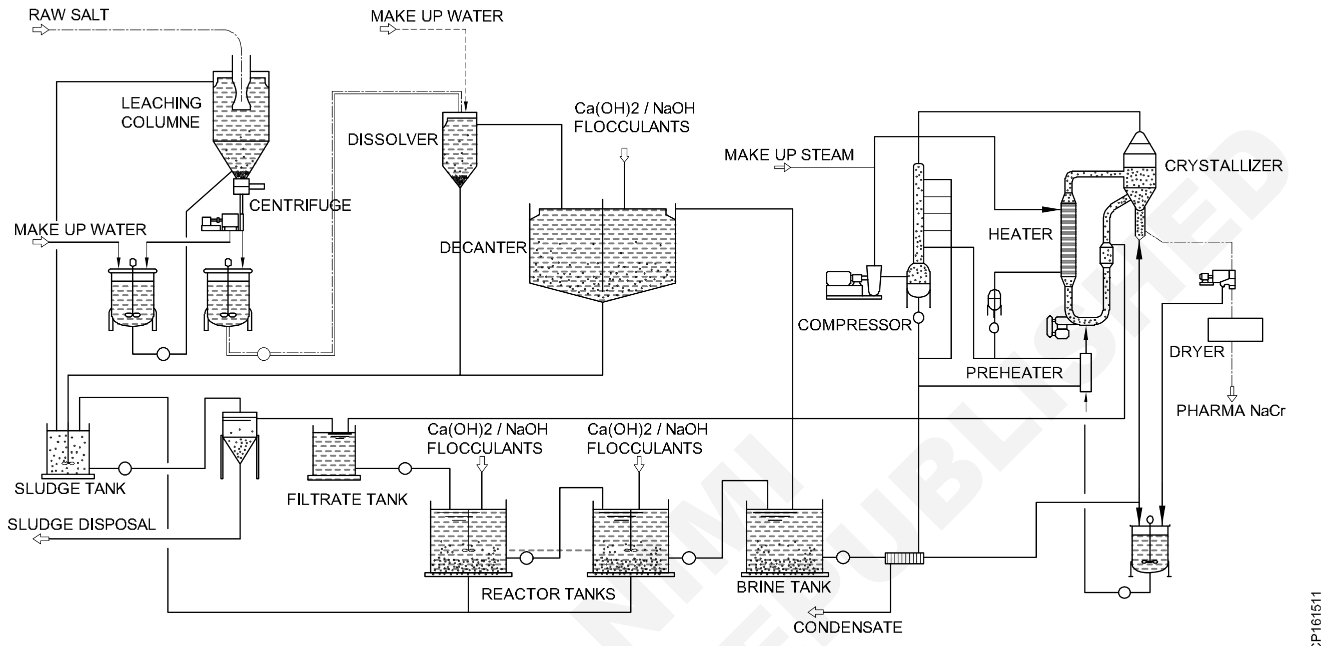
Sl.No.	Symbol	Description
10		Level Indicator
11		Pressure Indicator
12		Level Recorder
13		Level Controller
14		Pressure Recorder
15		Pressure Controller
16		Pressure Indicating
17		Level Alarm

Reading of chemical plant circuit diagram

Sodium chloride (Fig 1)

Sodium chloride for pharmaceutical applications must fulfill high purity requirements, as excipients or active pharmaceutical ingredients (API). In addition to the chemical purity, bacteriological limits must also be observed.

Fig 1



SODIUM CHLORIDE

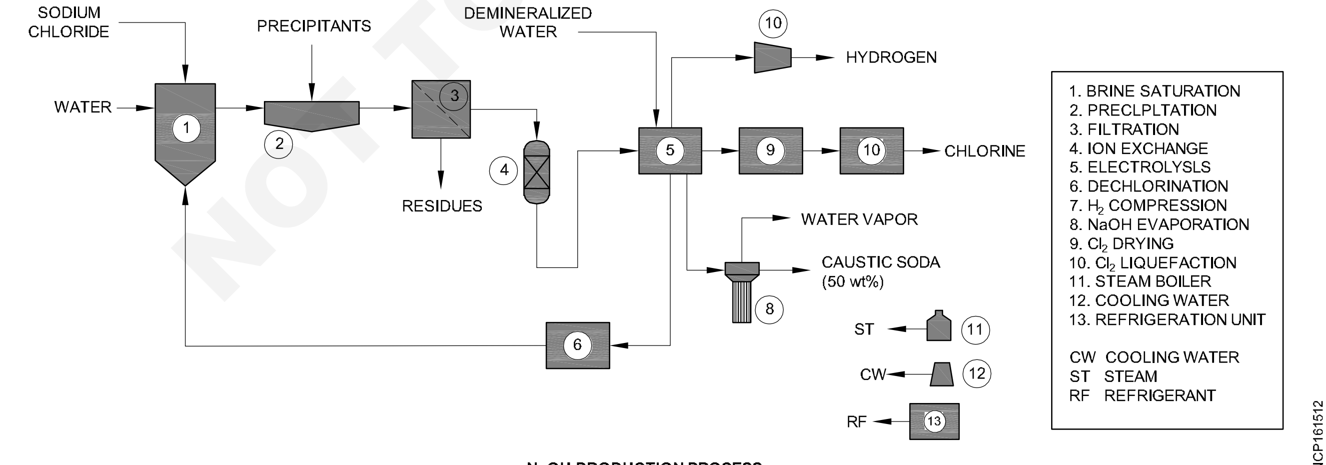
Sodium hydroxide (Fig 2)

NaOH production process

The production of NaOH from sodium chloride (NaCl) comprises three major sections: (1) brine purification; (2) electrolysis; and (3) product recovery.

The diagram shown here depicts the industrial production process for NaOH. (Fig 2)

Fig 2



NaOH PRODUCTION PROCESS

Brine purification: Initially, recycled depleted brine is mixed with water and re-saturated with fresh NaCl. Heavy metal ions (for example, Ca^{2+} and Mg^{2+}) present in the brine would be harmful to the membranes. So the brine is treated with precipitants in such a way that the metals precipitate, forming a sludge, which is removed by settling in a clarifier. Subsequently, the clarified solution is filtered and then purified by ion-exchange resins to remove residual hardness and achieve acceptable levels.

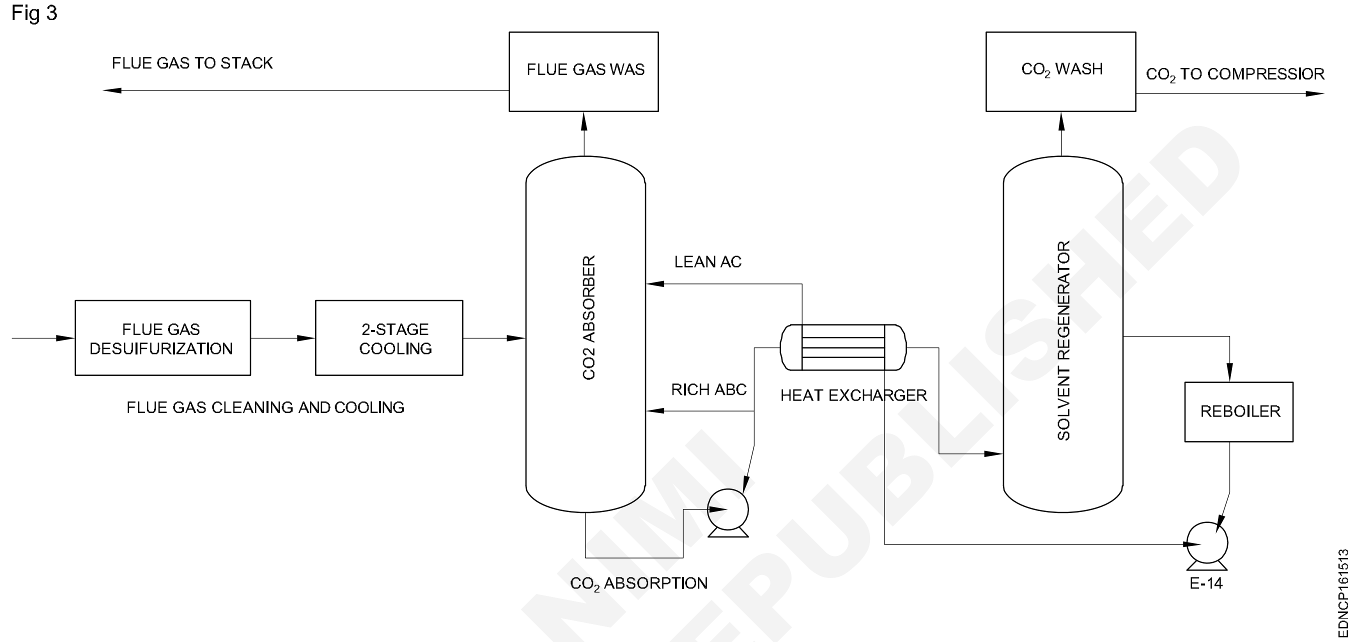
Electrolysis: The ultrapure brine and electricity are the main inputs to the electrolysis area. The brine is fed into the anolyte compartments of the cells, separated from the catholyte by cation-exchange membranes.

Products recovery: Hydrogen from the electrolysis process is compressed and directed to consumers. The caustic soda solution is concentrated to a saturated 50 wt.% NaOH solution - the commercialized form. The chlorine gas produced is sent to a drying system, consisting of drying towers, where concentrated sulfuric acid circulates as a dehydrating agent. The dry chlorine gas is compressed and then liquefied before being send to storage vessels.

Ammonium chloride (Fig 3)

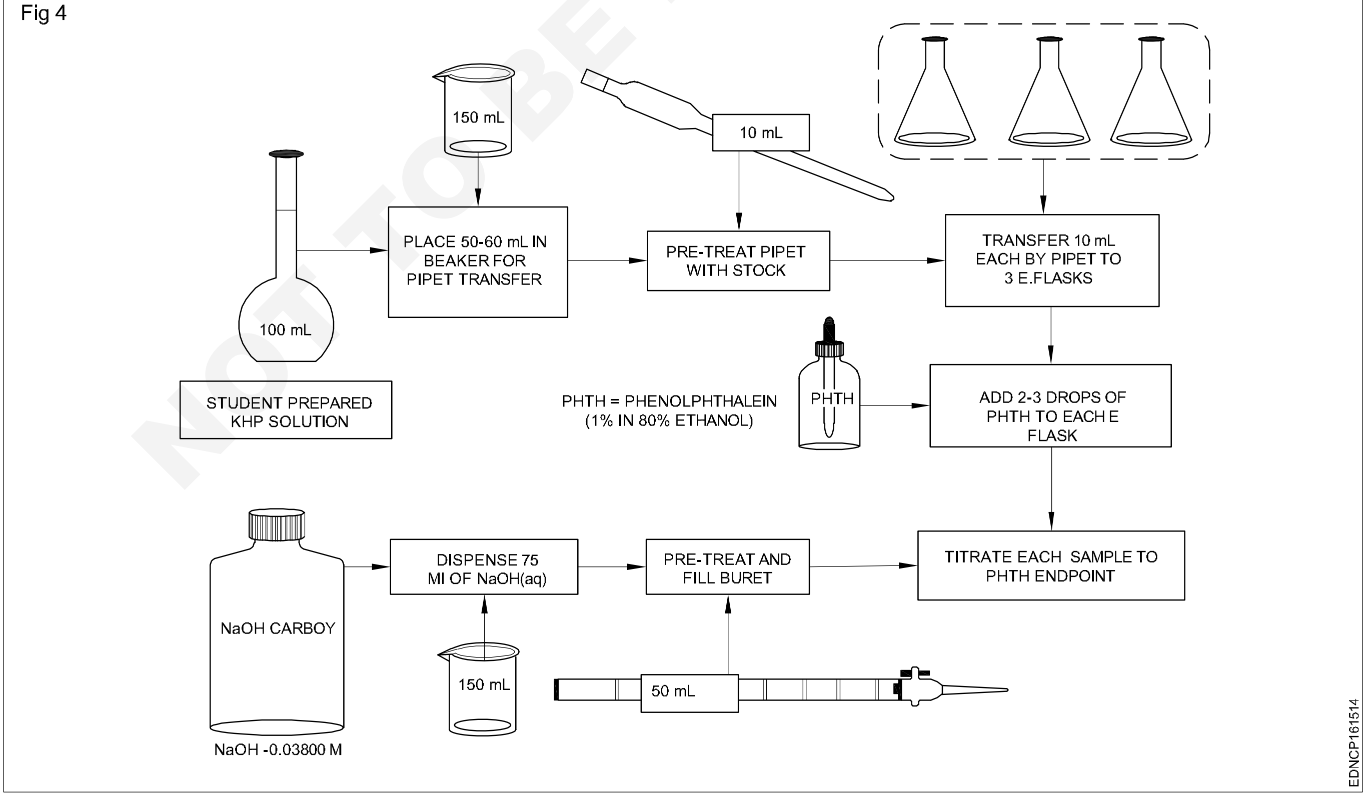
In this study, a relevant literature has been reviewed focusing on the carbon dioxide capture technologies in general, such as amine-based absorption as conventional carbon dioxide capturing technology, aqueous ammonia-based absorption, membranes, and absorption material (e.g., zeolites, and activated carbons).

Fig 3



Preparation of titration (Fig 4)

Fig 4



Titrate standard solution (Fig 5)

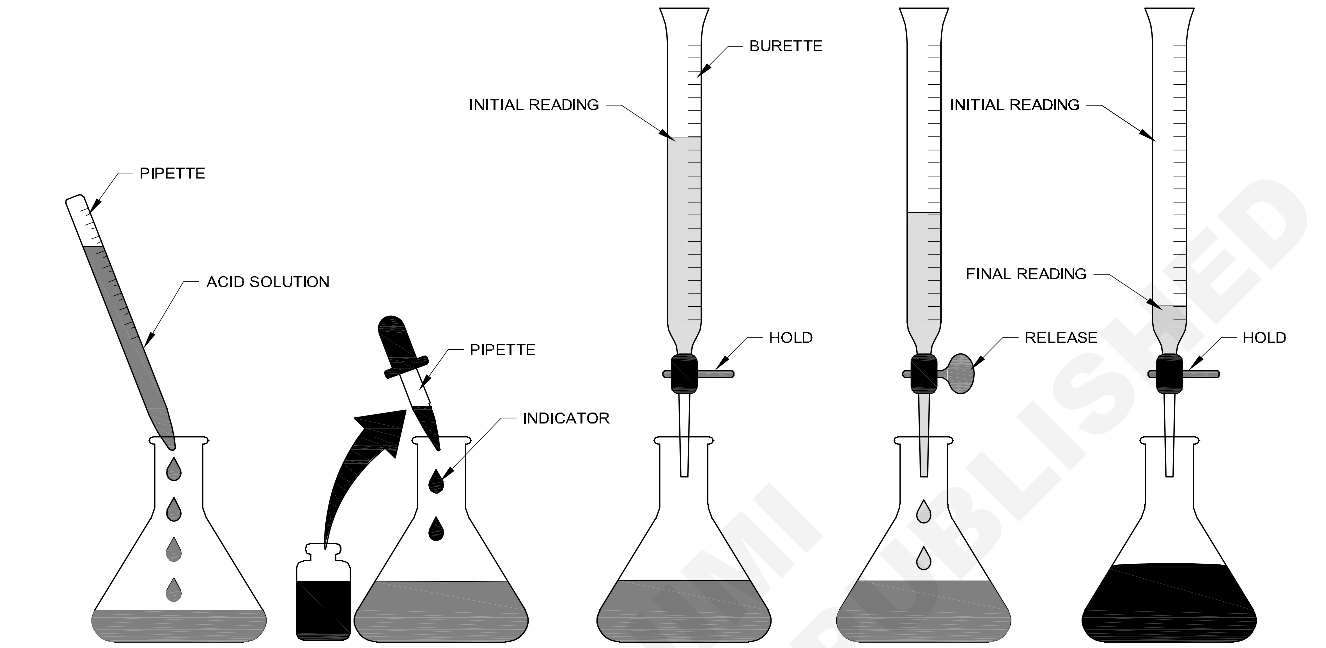
Titration is a way of measuring the concentration of something, usually the concentration of a substance in a solution. For example, you can use it to find the concentration of a solution of an acid.

Titration is a type of chemical analysis. We consider it to be analysis because we use it to make a measurement.

Titration can also be described as a volumetric method of analysis, because it involves measuring the volume of a reagent required to react.

There are many uses for titration - it can be used to find the concentration of many different substances.

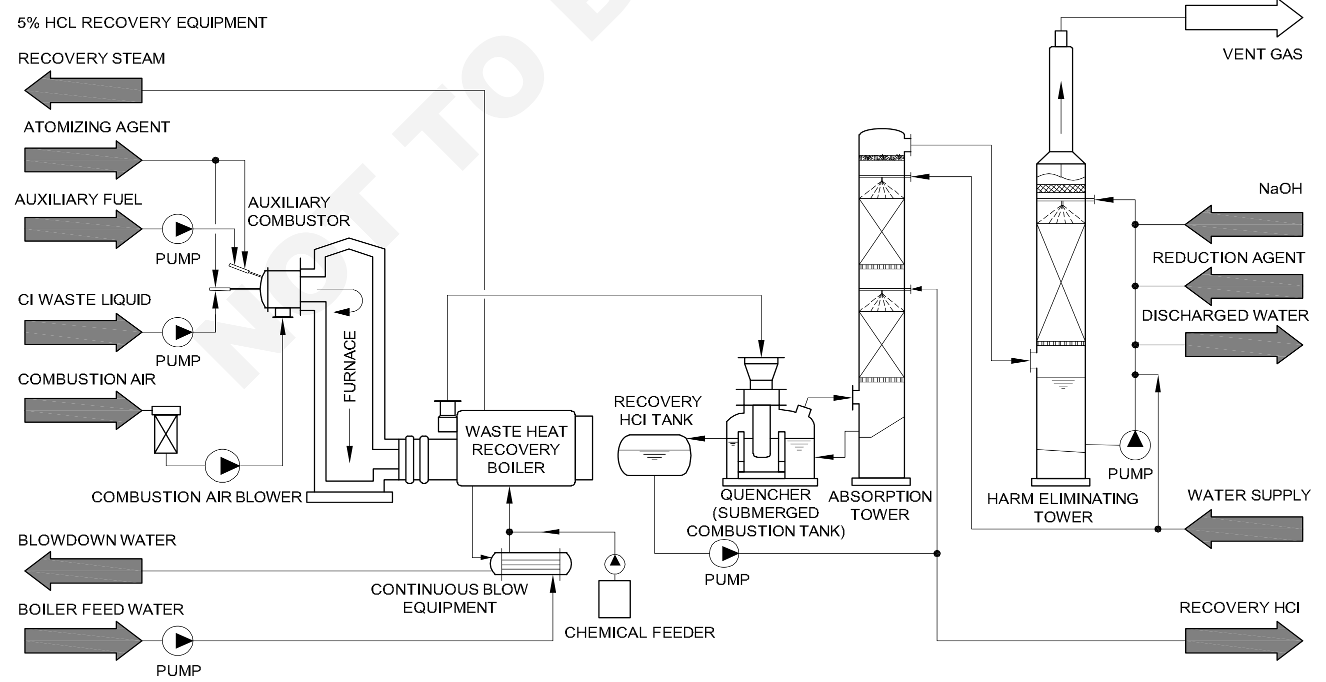
Fig 5



Hydrochloric acid (Fig 6)

When there is a large amount of chlorine in the waste liquid or gas (particularly in PVC manufacturing processes), hydrochloric acid may be collected as a byproduct. The collected hydrochloric acid has a concentration around between 5% and 33%. That grade can be used in a variety of ways depending on the level, ranging from industry level to the level used in food additives.

Fig 6



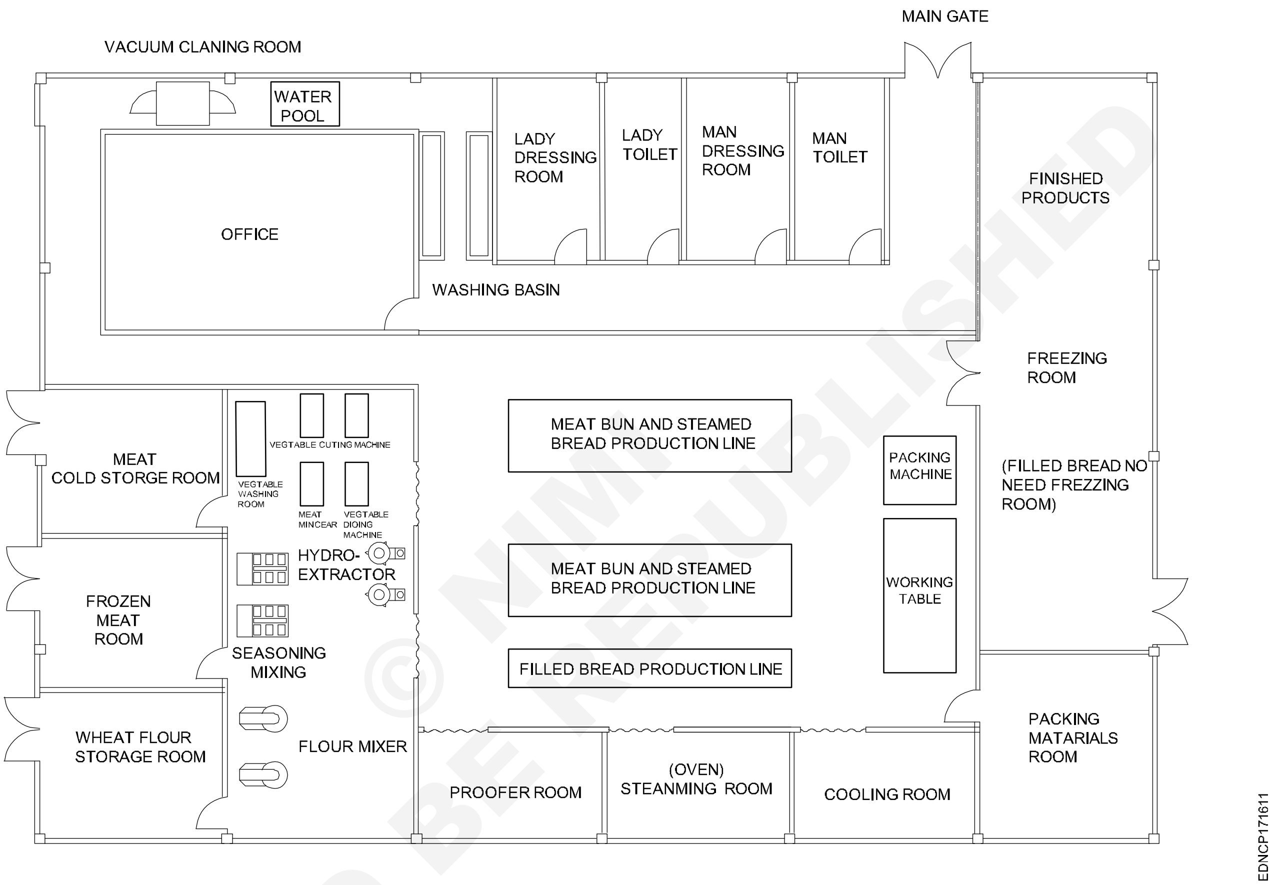
Reading of chemical plant layout drawing

Plant layout diagram

Plant layout drawing may have a general arrangement, equipment location, equipment arrangement, plant of instruments etc.

The chemical process engineer must know and understand plant layout in order to be able to perform calculations accordingly and address that to PFD and P&ID. (Fig 1)

Fig 1



Laboratory Space and Office space (Fig 2&3)

The companies modern laboratories readily serve most general chemical R&D needs, with specific labs designed to optimally support activities such as organic synthesis, instrumental analysis, process development or intermediate scale-up work.

Fig 2

Office Space (Fig 3)

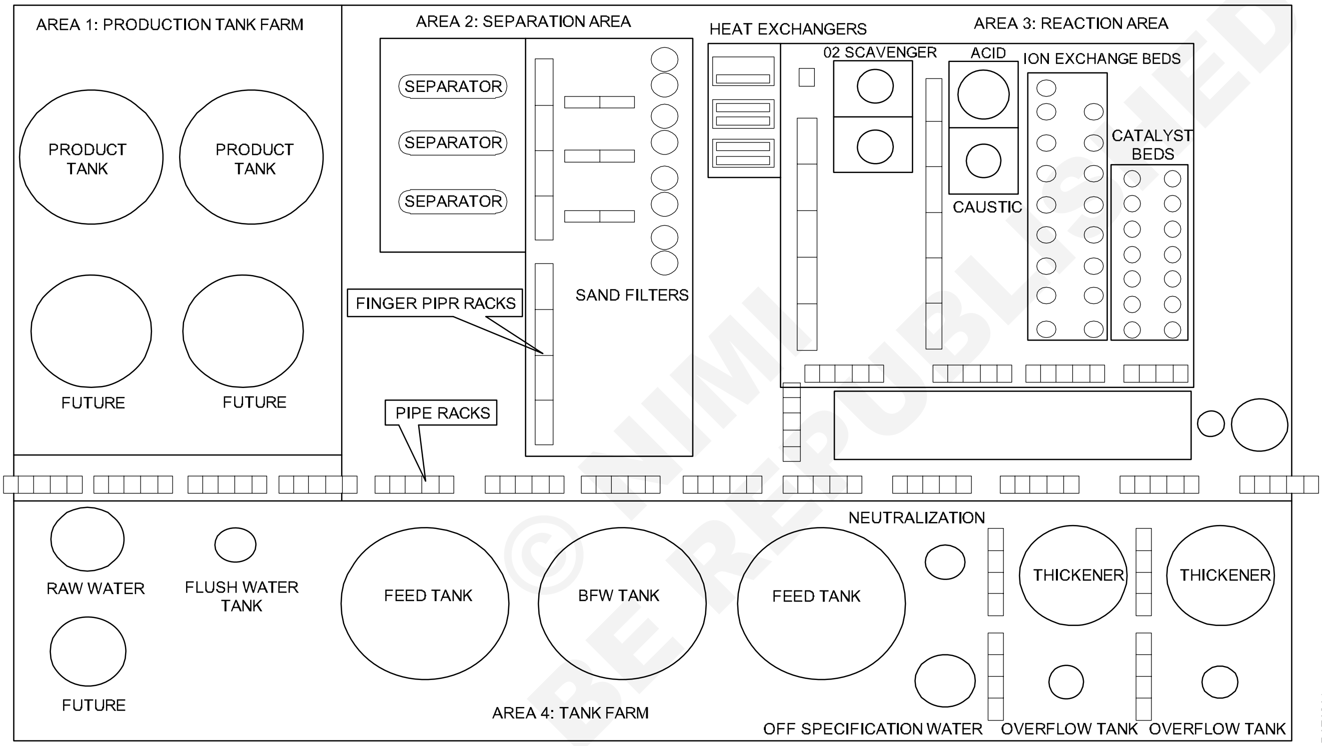
Fig 3

Plot plan (Fig 4)

Plot plan design: process requirements: it is important to conceptualize plant layout in terms of both ideal location and optimal geographical positioning of equipment components.

Engineers seek to identify the optimal location for the plant. Generally speaking, a chemical process industries (CPI) plant should be in a location that allows it to easily receive raw materials and have access to utilities, such as water and power. Other key considerations are related to access to the infrastructure needed, such as roads, rail lines and shipping options, to enable both the shipment of products (and side-products) and the disposal of waste streams.

Fig 4



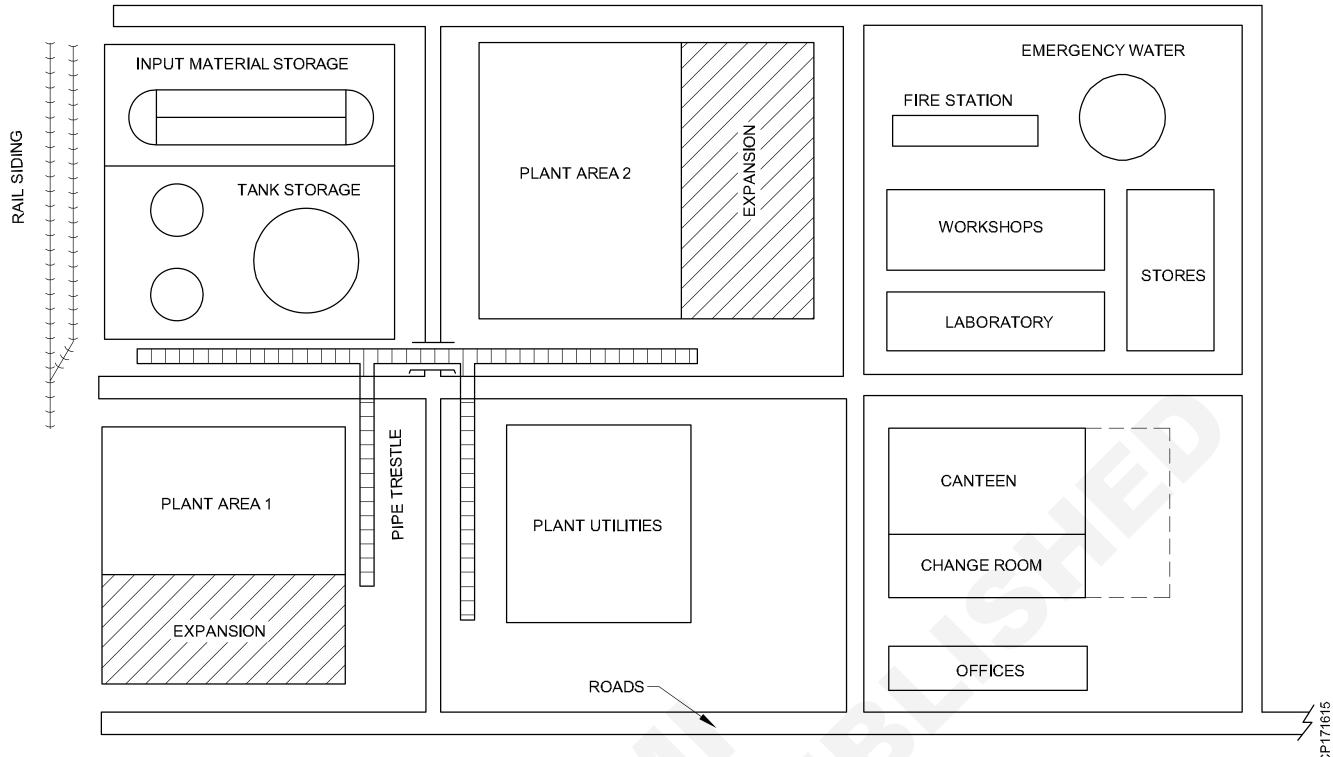
Other than material resources, any CPI facility also needs access to a good supply of human resources. When plants are established in desirable locations, they have access to a broad pool of qualified, skilled people for operation, maintenance and management of the plant.

During the development and design of a plot plan, requirements and limitations are identified and decisions are made with regard to the following considerations:

- Process requirements, such as the need to support equipment
- Suitable performance
- Safety requirements, such as the need to ensure the proper distance between the furnace and oil-storage tanks
- Construction requirements, such as the need to provide enough access area to allow construction equipment (such as cranes and lifts) to maneuver around the equipment
- Operation, inspection and maintenance requirements, to ensure easy accessibility for operators to reach each component, system or monitoring console
- Logistics requirements, to ensure easy accessibility for service companies and their vehicles, including chemical-delivery trucks

A simple typical plant layout (Fig 5)

Fig 5



A SIMPLE TYPICAL PLANT LAYOUT

Site selection and plant layout

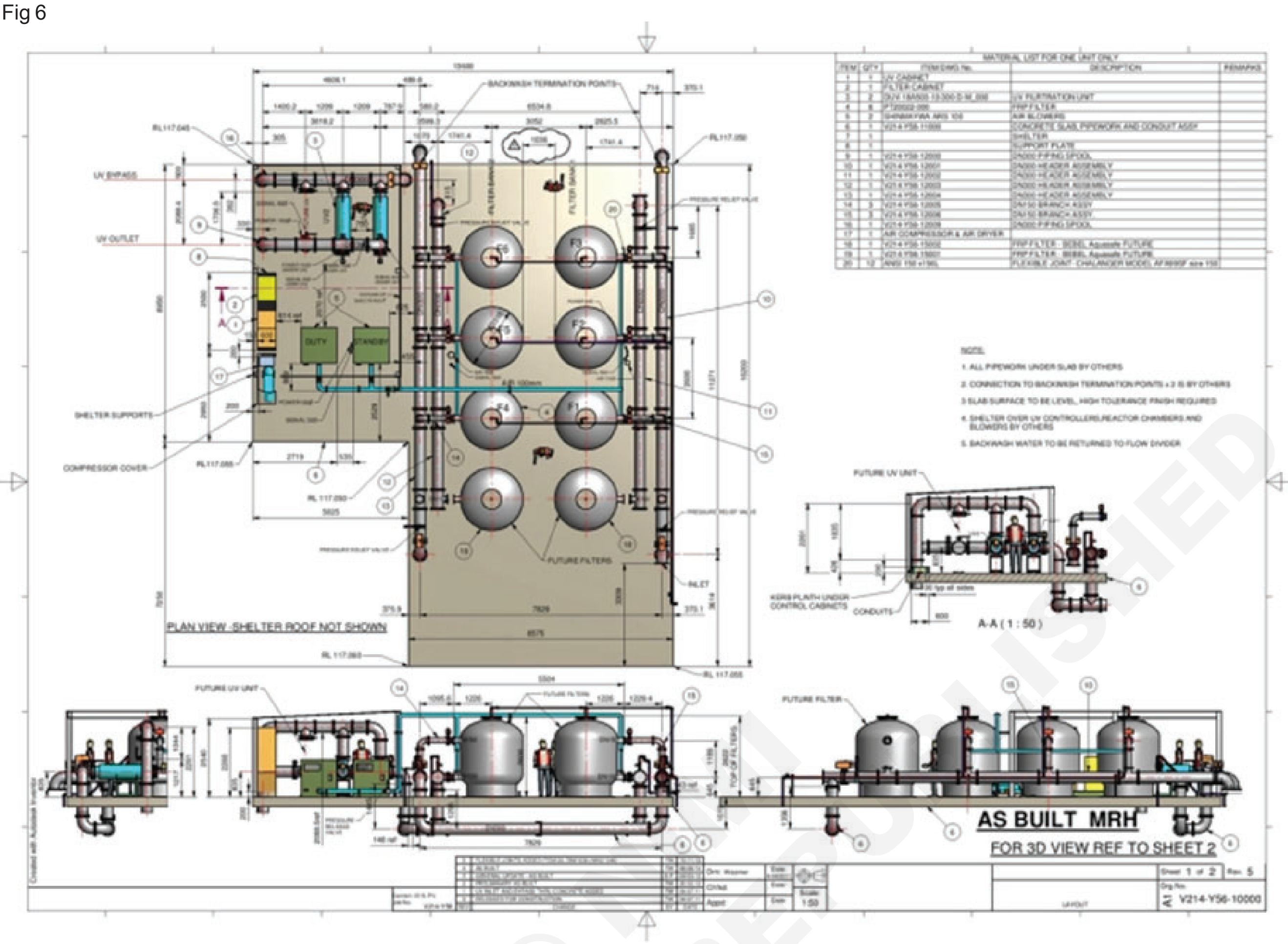
Factors affecting the selection of the plant location

Proper layout includes arrangement of processing areas, and handling areas in efficient co-ordination and with regard to such factors as:

- New site development or addition to previously developed
- Site type and quantity of the product to be produced
- Type of process and product control
- Operational convenience and accessibility
- Economic distribution of utilities and services like water, process steam and power
- Type of building and building and building code requirements
- Health and safety considerations including possible hazards of fire, explosion and fumes.
- Waste disposal problems
- Auxiliary equipment
- Space available and space require
- Roads and rail roads
- Posiible future expansion
- Sensible use of floor and elevation space

Chemical process (Fig 6)

Fig 6



During the initial phase of a project, you will develop or be involved with at least three documents; process flow diagram (PFD), piping and instrumentation diagram (P&ID) and Plant Layout.

Process Flow Diagram is a deliverable developed by the chemical process engineer. It is the representation of heat and material balance in a drawing. It will give the inputs for most of the specifications developed during plant design.

The piping and instrumentation diagram will make possible the development of the system where the heat and material balance takes place. Its main purpose is to address piping, instruments, equipment, control etc to the design team. Industrial plants, generally speaking, are built based on P&ID.

Layout drawing of various Chemical plants (Fig 7 to 9)

Fig 7

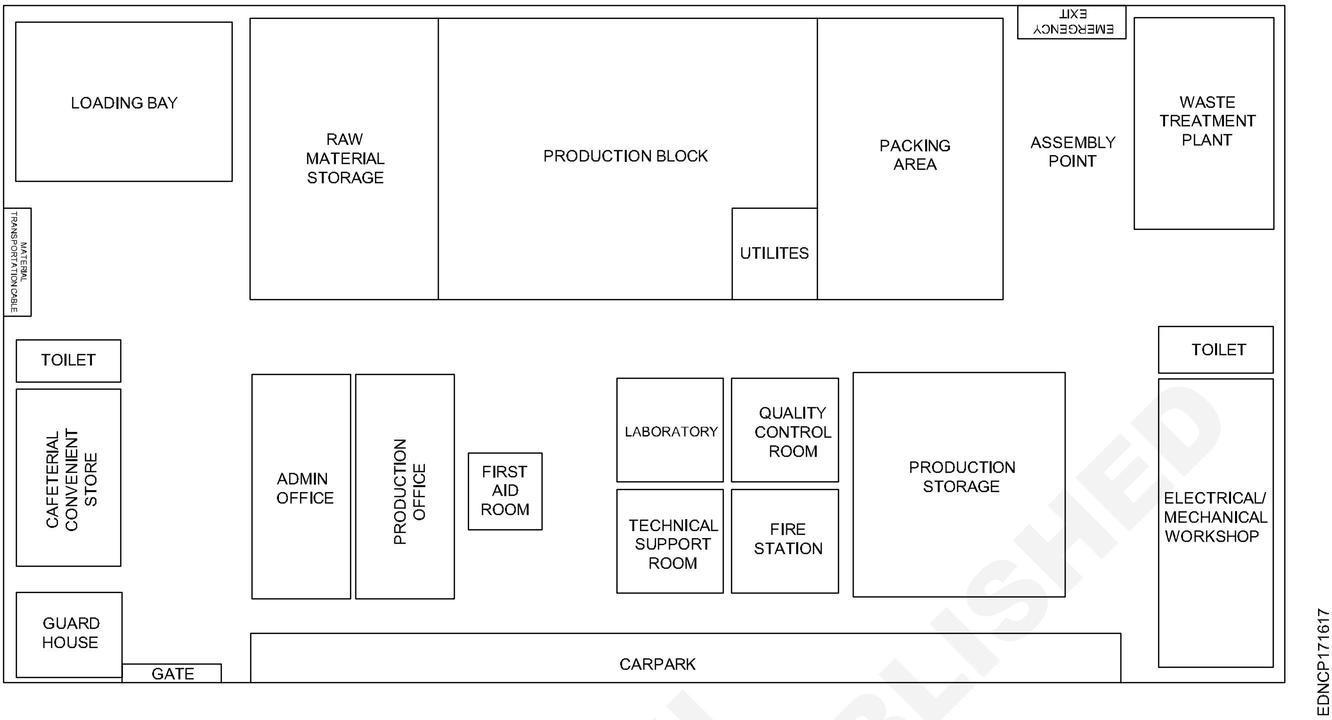


Fig 8

Fig 9