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Prelims Paper - I

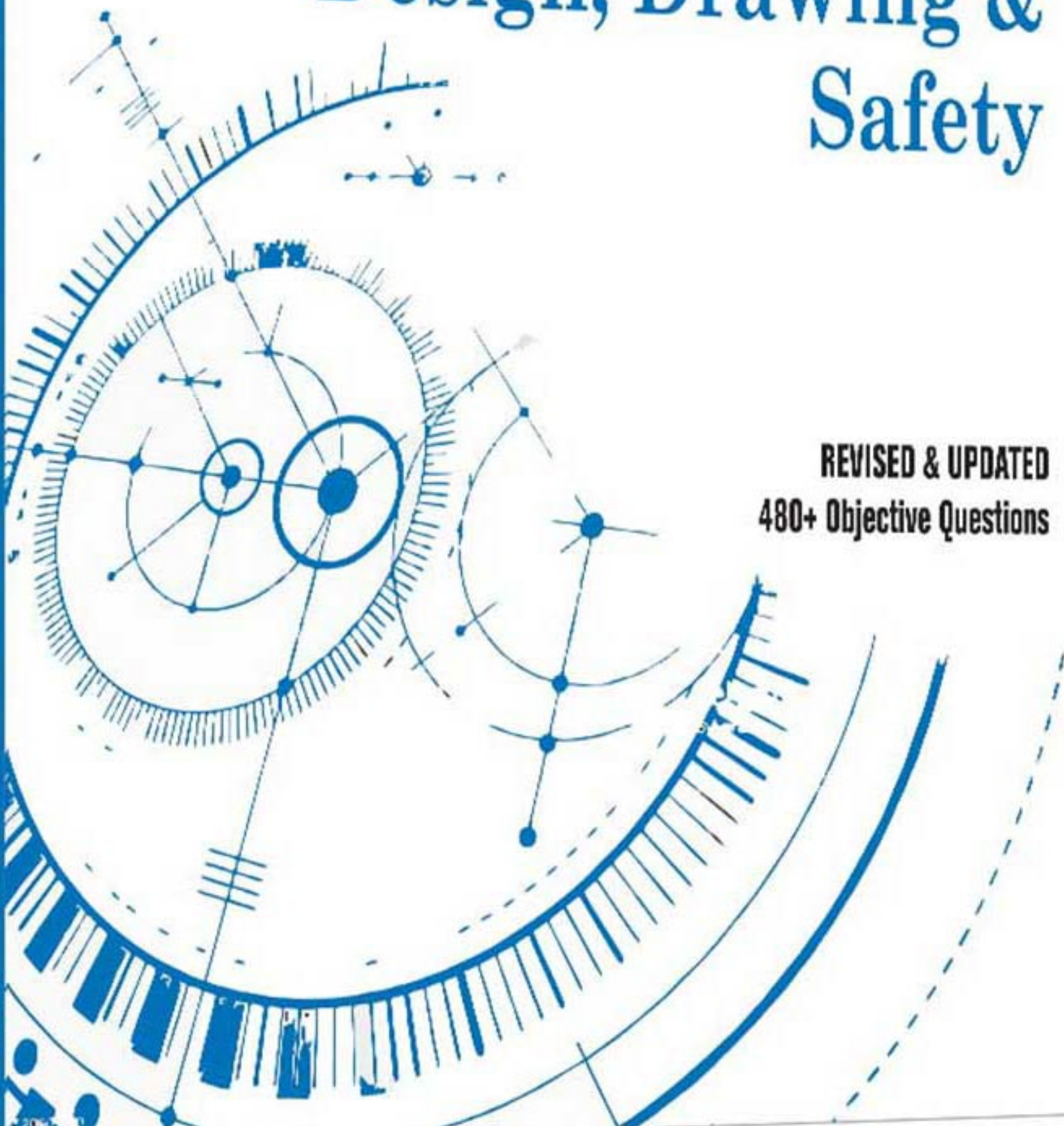


GENERAL PRINCIPLES OF  
**Design, Drawing &  
Safety**

**REVISED & UPDATED**  
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GENERAL PRINCIPLES OF DESIGN, DRAWING & SAFETY

ESE 2019  
Prelims Paper - I



# General Principles of Design, Drawing & Safety

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# PREFACE

Giving life to an engineer's dream for the betterment of society involves **Design, Drawing and Safety**. With the increasing complexities of economy, as well as the ensuing disruption in IT, besides the stringent safety rules, this inter-disciplinary subject has become quite challenging to comprehend from exam point of view.

Looking at the nature of Engineering Services Examination (ESE), and the level of questions being asked, the conventional approach of preparing through theory and examples is not enough to serve the purpose. The revised and updated edition of **General Principles of Design, Drawing and Safety** attempts to provide logical reasoning through mathematical analysis, gives a clear insight into the concepts, and paints a complete picture in front of you. For students to determine the level of their preparation, self-practice questions have been provided at the end of this book.

In their endeavour to give students the best, **Mr. Bipin Thakur** and **Mr. Himadri Shekhar (Aahil)** have brought about this book in an easy-to-grasp language that gives in a complete clarity of thought. As a result, what students get is their collective wisdom that breaks free the constraints of engineering students in appreciating the basics of Design, Drawing and Safety.

As you flip over the pages of this book, you would come across a slew of diagrams, flow charts, mind maps and tables. This book is a delight for every ESE aspirant as it communicates, connects, and builds upon the exam preparedness right up to the standards of the UPSC.

**IES Master Publication**  
**New Delhi, 2018**

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# CHAPTER

# 1

# Introduction to Engineering Drawing

## 1.1 INTRODUCTION

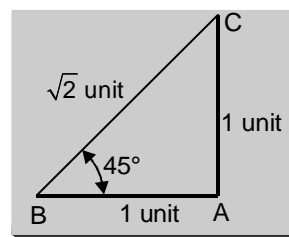
### INSIDE

- 1.1 Introduction
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- 1.3 Drawing Board
- 1.4 Scales
- 1.5 Mini Drafter
- 1.6 T-Square
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- 1.13 Layout of a Drawing Sheet

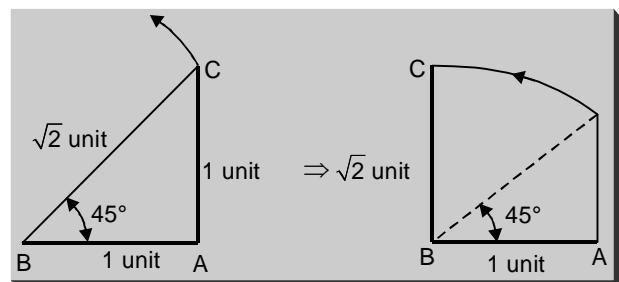
Engineering drawing is a technique of creating graphical representation that contains all necessary information such as dimensions, specifications and notes using which an abstract concept can be transformed into real world object. To realize such concept, basic tools of construction of drawing has to be clearly understood as to what standard has to be followed. There is an international standard on code of practice for drawing which is followed and adopted by Bureau of Indian Standard (BIS). In this chapter, we shall be dealing with drawing instruments and accessories (i.e. drafting tools) which is necessary for engineering drawing.

## 1.2 DRAWING SHEETS : [IS 10711 : 2001]

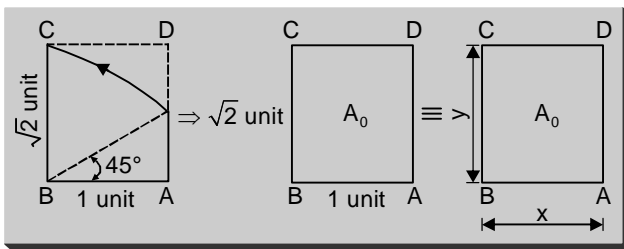
Consider an isosceles triangle ABC of unit length as shown below.



Now rotate BC anticlockwise so that BC becomes perpendicular to AB as shown below.



Now taking AB as one side and BC as another side complete a rectangle ABCD as shown below.



There are two basic principles involved in arriving at the sizes of A<sub>0</sub> sheet

- (i)  $x : y = 1 : \sqrt{2}$ , where,  $x, y \in$  side  
 (ii) Surface area ( $xy$ ) of A<sub>0</sub> sheet is unity i.e.,  $xy = 1$

$$\begin{aligned} \therefore x : y &= \frac{1}{\sqrt{2}} \\ \therefore \frac{x}{y} &= \frac{1}{\sqrt{2}} \\ \Rightarrow y &= x\sqrt{2} \quad \dots (i) \end{aligned}$$

$$\text{Also, } xy = 1 \Rightarrow x \cdot x\sqrt{2} = 1 \text{ from (i)}$$

$$\Rightarrow x^2 = \frac{1}{\sqrt{2}} \Rightarrow x = \frac{1}{\sqrt{\sqrt{2}}} = \frac{1}{1.189}$$

$$\Rightarrow x = 0.841 \text{ m}$$

$$\therefore y = 0.841\sqrt{2} = 1.189 \text{ m}$$

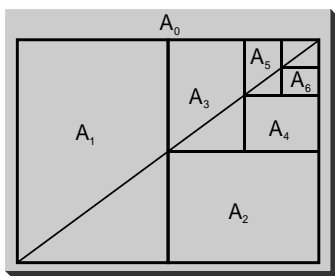
Hence, value of  $x$  and  $y$  is given as

$$x = 0.841 \text{ m} \quad (\text{or}) \quad 841 \text{ mm}$$

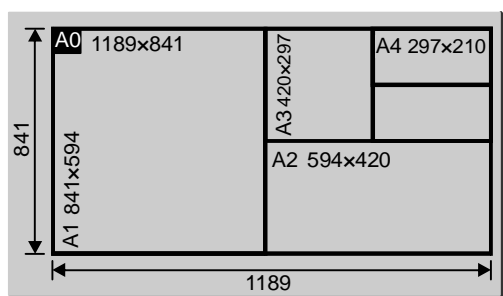
$$y = 1.189 \text{ m} \quad (\text{or}) \quad 1189 \text{ mm}$$

Successive smaller sizes are obtained by halving previous size sheets, with the above constant width to length ratio i.e., ( $x : y = 1 : \sqrt{2}$ )

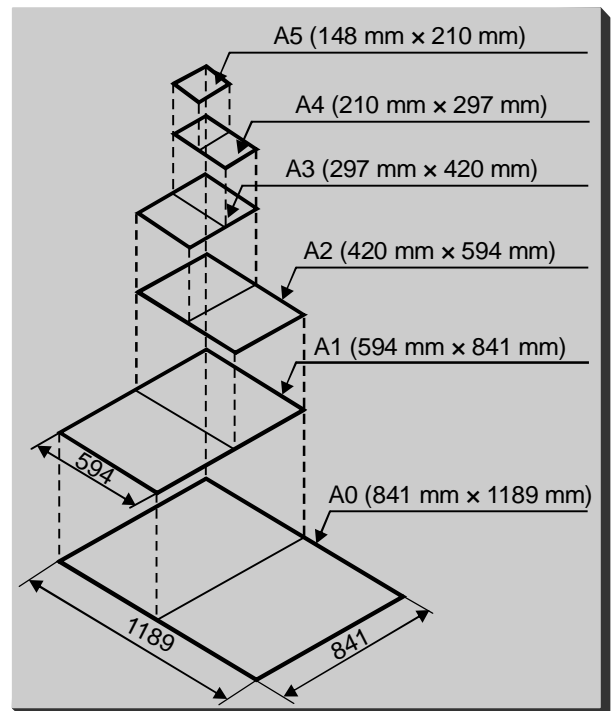
**Example :**



**2-D view**



**3-D view**



**Note:** The ISO 'A' series of sheet is based on a constant width to length ratio of  $1 : \sqrt{2}$ .

**Application**

The relationship of  $1 : \sqrt{2}$  is particularly important for reduction onto microfilm, or reduction and enlargement on photocopiers. All metric equipment including microfilm cameras, microfilm printers, photocopiers and even drawing pen sizes are designed around this ratio.

- Note:** (1) A2 size drawing sheet is preferred for class use.  
 (2) Recommended size and its designation of ISO 'A' series of sheet is given below.

**Table 1.1:** Recommended size of drawing sheets

Drawing Sheet (IS 10711 : 2001)	
Designation	Size (mm) Length × Width
A0	1189 × 841
A1	841 × 594
A2	594 × 420
A3	420 × 297
A4	297 × 210

### 1.3 DRAWING BOARD : [IS 1444 : 1989]

It is generally made from soft wood such as white pine, fir, oak, red cedar etc.

- To prevent warping, the board should be made of narrow strips of wood joined together accurately.



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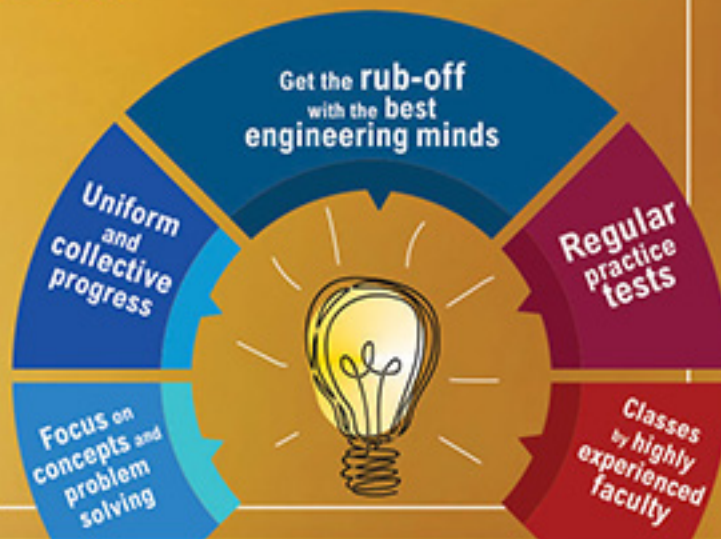
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- Ebony strip fitted to the left side of drawing board provides the guide for the T-square.

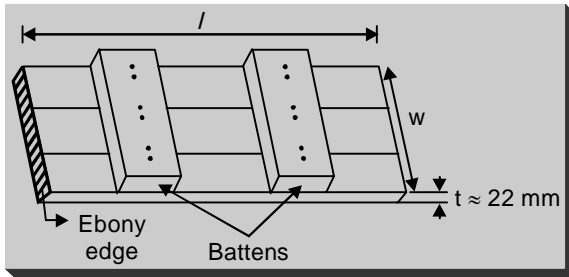


Table 1.2 : Recommended sizes of drawing boards.

Drawing Board (IS 1444 : 1989)		
Designation	Size (mm) Length × Width	Recommended for use with sheet sizes
D0/B0	1270 × 920	A0
D1/B1	920 × 650	A1
D2/B2	650 × 470	A2
D3/B3	500 × 350	A3

**Note:** D2 size drawing board is normally used for class work.

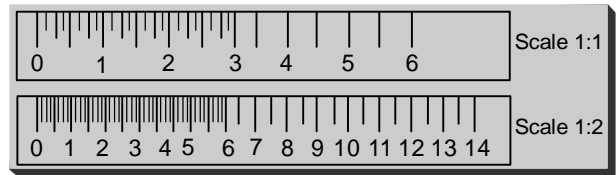
### 1.4 SCALES

The word 'scale' is usually employed for an instrument used for drawing or measuring the length of a straight line. It is also used to represent the proportion in which the drawing is made with respect to the object. It is used to make full size, reduced size or enlarged size drawing conveniently depending upon the size of the object and that of the drawing sheet. As recommended by Bureau of Indian Standards (BIS) there are eight set of scales. These are designated from M1 to M8 as shown in Table 1.3.

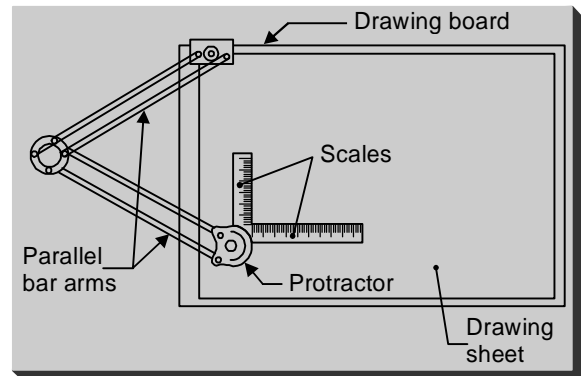
Table 1.3 : Designation and description of Engineer's scale

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

For example, a length designated as 2 cm on a 1 : 2 scale is equal to the length designated as 1 cm on a 1 : 1 scale.

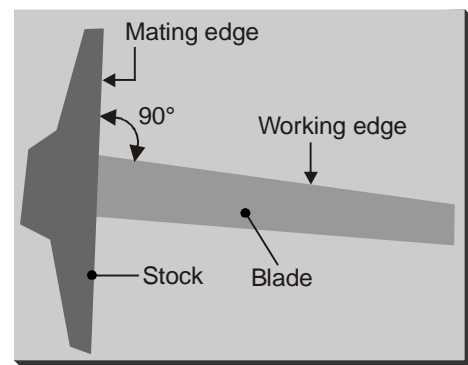


### 1.5 MINI DRAFTER



- It combines the function of a T-square, set square, scales and protractor.
- It is used for drawing horizontal, vertical, inclined, parallel, perpendicular lines along with its measurement.
- It is also used to trace angle.

### 1.6 T-SQUARE



It is a T-shape drawing tool whose mating edge slide along width of drawing board with the help of stock. It is useful in drawing primarily horizontal lines and also used for guiding the set squares while drawing vertical or inclined lines.

### 1.7 SET SQUARE

A pair of right angled triangle is called set squares. A set square has either 45°-45° angle or 30°-60° angle. The 45° set square shown below in fig. (a) is a right-angled triangle having acute angles of 45°. The 30°-



13. Which of the following statements are correct?  
 I. A D2 size drawing board has dimensions of 920 mm x 650 mm.  
 II. A title block is placed at bottom right corner of the drawing frame.  
 (a) only I (b) Only II  
 (c) Both (d) None
14. To draw a circle of diameter 20 mm, the most preferred instrument is  
 (a) large compass  
 (b) bow pencil compass  
 (c) circle template  
 (d) any of the above
15. A French curve is used to draw  
 (a) polygons  
 (b) circles  
 (c) ellipses  
 (d) smooth freeform curves
16. Which of the following is bulletin is the recent publication of Bureau of Indian Standards, contains codes for practice in engineering drawing?  
 (a) IS 696 (b) SP 46  
 (c) BS 8888 (d) ASME Y14.100
17. A device which combines the functions of a T-square, set square, protractor & scale is called  
 (a) fasteners (b) mini drafter  
 (c) templates (d) combination set
18. Paper size 'A0' has an area of  
 (a) 1 m<sup>2</sup> (b) 0.75 m<sup>2</sup>  
 (c) 0.5 m<sup>2</sup> (d) 0.25 m<sup>2</sup>
19. A title block does not provide which of the following information?  
 (a) Name of the legal owner  
 (b) Drawing sheet number  
 (c) Angle of projection used  
 (d) Explanation of symbols used
20. What should appear on the top position after folding the drawing sheet?  
 (a) Revision table (b) Item references  
 (c) Title block (d) Any of these

ANSWER KEY

1. (a)	5. (b)	9. (c)	13. (b)	17. (b)	19. (d)
2. (c)	6. (d)	10. (b)	14. (b)	18. (a)	20. (c)
3. (b)	7. (d)	11. (a)	15. (d)		
4. (c)	8. (a)	12. (c)	16. (b)		

EXPLANATIONS

12. (c)  
 Length of A2 size drawing = 594 mm.  
 Width of A1 size drawing sheet = 594 mm  
 Hence, given statement is true.  
 For technical drawing, three grades of pencils are used. Those are H, 2H, HB. All these are hard grades pencils.
13. (b)  
 A D2 size drawing board has dimensions of 650 mm x 470 mm. The given size in the question is of D1 drawing board.  
 A title block is placed at bottom right corner of the drawing frame and it is divided into two zones.  
 (i) Part identification zone  
 (ii) Additional information zone.
14. (b)  
 Bow compasses are suitable to draw circles or arcs using pencil. To draw a circle of diameter smaller than 25mm bow pencil compass is preferred.
15. (d)  
 French curves is used to draw smooth freedom curves.

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