

# MATHEMATICS

## Class-VI

### Topic-12

#### PRATICAL GEOMETRY



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## TERMINOLOGIES

Construction of circle, construction of line segment, construction of perpendicular lines, perpendicular bisector of line segment, construction of equal angles.

### INTRODUCTION

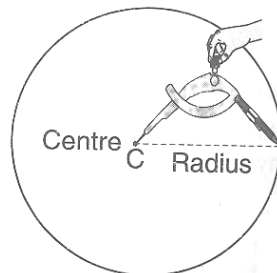
Geometric constructions are made with the aid of a ruler or straight edge and compasses only. Drawings are made with the aid of additional instruments, such as protractor and ruler. In this we learn the method of drawing a line segment of given length, an angle of given measurement etc with the help of the instruments in our geometry box.

## 12.1 CONSTRUCTION

### (a) Construction of a circle when its radius is known

Suppose you are asked to draw a circle of radius 3 cm. do as follows :

**STEP 1.** Mark a point C with your pencil. This point will be the centre of the circle.



**STEP 2.** Open the compass for the required radius, i.e., 3 cm by putting the steel point on C and opening the pencil upto 3 cm.

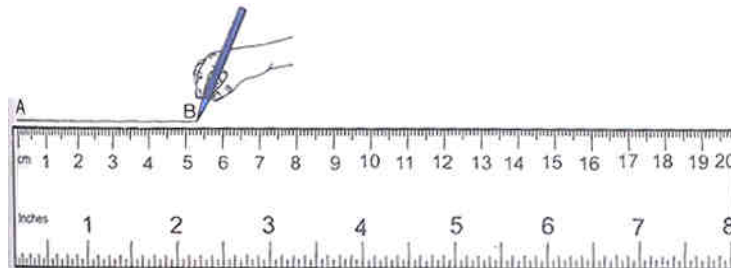
**STEP 3.** Hold the paper with one hand and swing the pencil leg of the compass around to draw a circle.

### (b) Construction of line segment of a given length :

Suppose you have to draw a line segment 5.3 cm long.

#### (i) Method-1 : Using ruler only

1. Mark any point in your exercise book and label it as A.

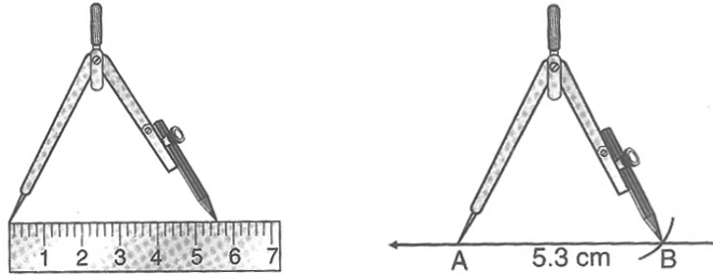


2. Place the ruler in such a way that the zero mark on the ruler coincides with A.
3. Now count 5 complete centimetres and 3 small divisions after the 5 cm mark and mark a point corresponding to this division on the exercise book.
4. Join A to this point as shown.
5. Label the second point as B.  
Then AB is the required segment of length 5.3 cm.

**(ii) Method 2 : Using ruler and compass**

**STEP 1.** Draw any line segment which is longer than 5.3 cm.

**STEP 2.** Mark a point on this line near one end as shown. Label it A.

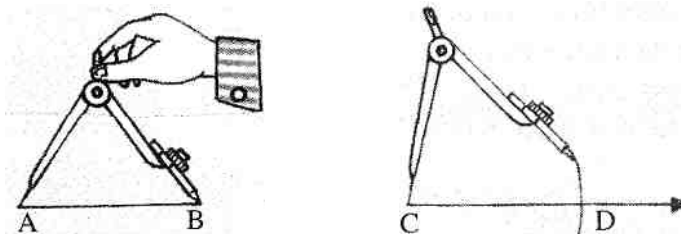


**STEP 3.** Use your compass to measure 5.3 cm on your ruler.

**STEP 4.** Put the point of the compass on the line segment at A and draw an arc to cut the line as shown. Then  $AB = 5.3$  cm.

**(c) To Construct a Line segment Congruent to a given Line Segment AB**

**STEP 1.** Draw a ray through any end point C. Open your compass so that the metal tip is on A and the pencil point is on B.



**STEP 2.** Keep the compass opening same. Put the metal tip on the end point C of the ray and mark off a line CD congruent to AB.

**(d) Perpendicular Lines**

Perpendicular lines are lines that intersect at right angles. The symbol  $\perp$  means “is perpendicular to”.

**(e) Drawing Perpendicular using ruler and a set-square**

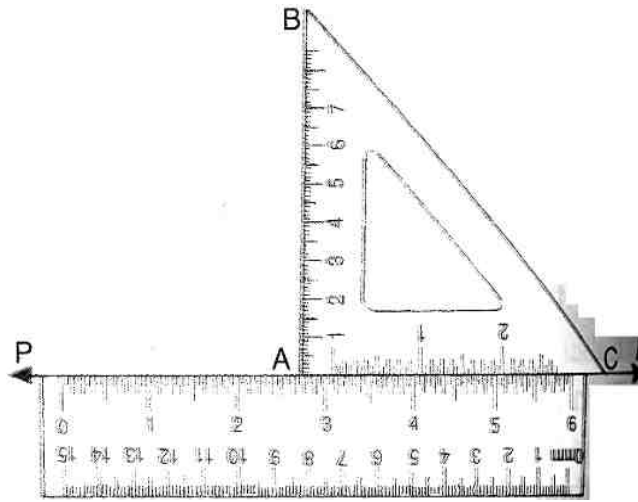
**CASE 1 :** To construct a line perpendicular to a given line l at a point P lying on it.

**STEP 1.**

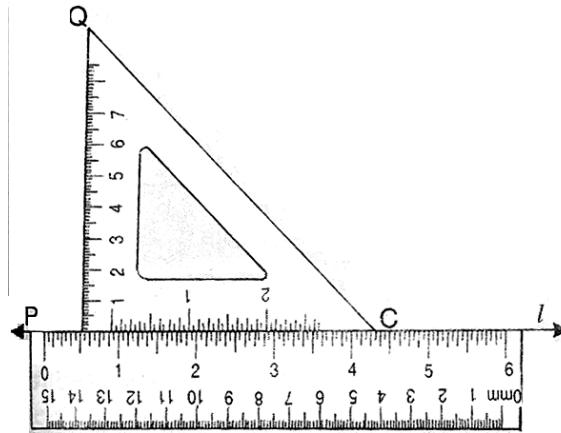
Place a ruler on the paper with one of its long edges lying along the line l.

**STEP 2.**

Holding the ruler fixed, place a set-square ABC with the arm AC of its right angle A in contact with the ruler.



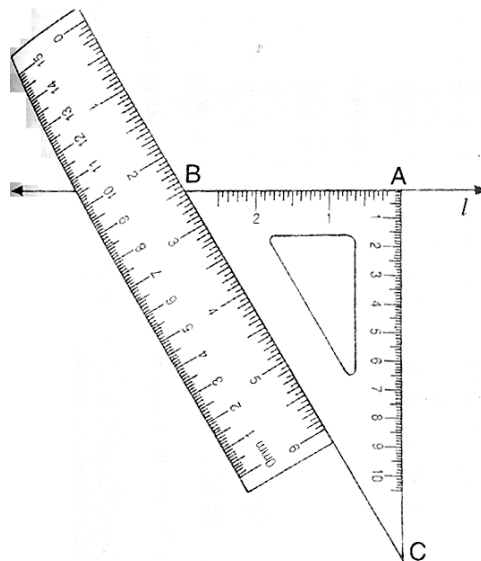
**STEP 3.** Slide the set-square along the edge of the ruler until A coincides with P.



**STEP 4.** Holding the set-square fixed in this position, draw with a sharp pencil a line PQ along the edge AB. Then PQ is the required line perpendicular to the line l.

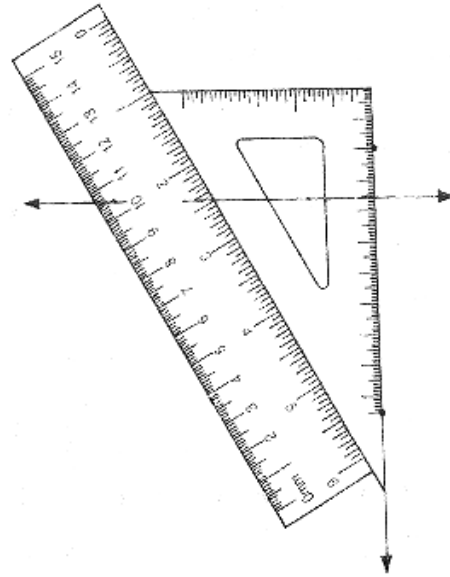
**CASE 2 :** To construct a line perpendicular to a given line l and passing through a given point P lying outside the given line.

**STEP 1.** Place either of the set-squares so that one edge AB of the right angle A lies along l.



**STEP 2.** Now hold the set-square fixed and place a ruler along the edge opposite to the right angle of the set-square.

**STEP 3.** Holding the ruler firmly, slide the set-square along the ruler until the edge AC passes through the given point P.



**STEP 4.** Draw line PQ along the edge AC of the set-square. Then PQ is the required line perpendicular to the given line, l, through the point P not lying on it.

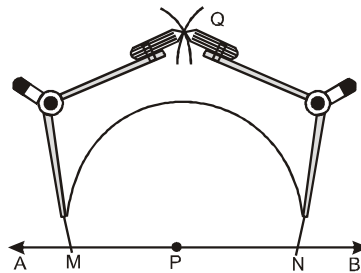
**(ii) To Draw a perpendicular to a Given Line with a Ruler and Compass :**

**CASE 1.** At a point on the line. Let AB be a given line and P be the point on it.

**STEP 1.** With P as centre and any suitable radius draw an arc to cut the line AB at points M and N.

**STEP 2.** With M and N as centres and radius of more than half MN, draw two arcs to cut at Q.

**STEP 3.** Join PQ.



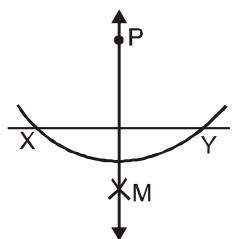
Then ray PQ is the perpendicular to the line AB at P.

**CASE 2.** From a point outside the line. Let l be the given line and P a point outside it.

**STEP 1.** With P as centre and a suitable radius, draw an arc to cut the line l at X and Y.

**STEP 2.** With X and Y as centres and a radius of more than half XY, draw two arcs to cut at M.

**STEP 3.** Join PM. Then  $PM \perp l$ .



**(d) Perpendicular Bisector of a Line Segment**

In a plane, the perpendicular bisector of a segment is the line that is perpendicular to the segment at its midpoint, Line  $l$  is the perpendicular bisector of segment  $AB$ .

**(i) Construction of Perpendicular Bisector of a Segment :**

Using ruler and compass, to construct the perpendicular bisector of a given line segment.

**STEP 1.**

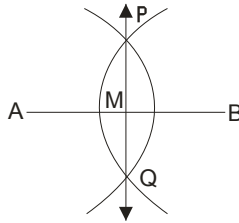
Open the legs of compass to more than half the length of  $AB$ . With  $A$  as centre (i.e., place the metal-tip of compasses at  $A$ ), draw arc 1.

**STEP 2.**

With  $B$  as centre and the same radius (i.e., the same opening of the compass), draw arc 2 to cut the first arc. Name the points of intersections as  $P$  and  $Q$ .

**STEP 3.**

Draw the line through  $P$  and  $Q$  by joining  $P, Q$ . This line bisects the given line segment  $AB$  and is called the bisector of  $AB$ .



Let  $PQ$  cut  $AB$  at  $M$ . Then  $M$  is called the middle point or simple midpoint of  $AB$ . The line  $PQ$  is the perpendicular bisector or the right bisector of  $AB$ .

**(e) To Construct an Angle Equal to a Given Angle ABC**

**STEP 1.** Draw any ray  $QR$ . This ray will become one side of the angle and its end point  $Q$  will become the vertex of the angle.

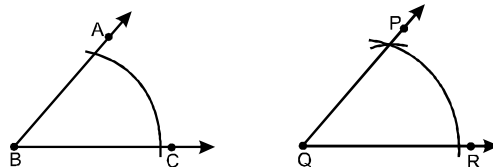
**STEP 2.** Put the metal tip of your compass on the vertex of  $\angle ABC$ . Draw an arc.

**STEP 3.** Without changing the opening of the compass, put the metal tip of the compass on  $Q$ . Draw an arc of sufficient length which crosses the ray as shown.

**STEP 4.** Open the compass so that the metal tip and pencil point are on the points where the arc cuts the arms of  $\angle ABC$ .

**STEP 5.** Without changing the opening of the compass put the metal tip on the point where the arc cuts  $QR$ . Draw another arc that crosses the previous arc at, say,  $P$ .

**STEP 6.** From point  $Q$  draw a ray through the intersection of two arcs, then  $\angle PQR = \angle ABC$ . Check your construction with your protractor.

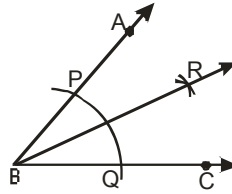

**(i) To Bisect a Given Angle ABC :**

**STEP 1.** With  $B$  as centre and a suitable radius, draw an arc that intersects  $BA$  and  $BC$ . Name the points of intersection as  $P$  and  $Q$ .

**STEP 2.** With  $P$  as centre and a radius greater than half  $PQ$  draw an arc.

**STEP 3.** With Q as centre and the same radius draw another arc to cut the first arc. Name the point of intersection of the two arcs as R.

**STEP 4.** Join BR. Ray BR bisects  $\angle ABC$ . Ray BR is called the angle bisector. Check your result with a protractor.



**(f) Angles of Special Measures**

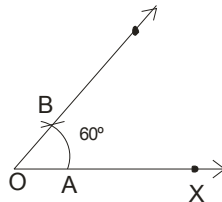
**(i) Angle Of  $60^\circ$  :**

**STEP 1.** Draw a ray OX.

**STEP 2.** With O as centre and any convenient radius draw an arc above OX, and also cutting OX at A.

**STEP 3.** With A as centre and the same radius, draw another arc to cut the first arc at B.

**STEP 4.** Join OB. Then  $\angle AOB = 60^\circ$

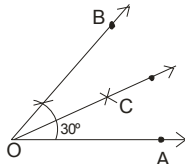


**(ii) Angle Of  $30^\circ$  :**

**STEP 1.** Draw a ray OA.

**STEP 2.** With O as the vertex, construct  $\angle AOB$  of  $60^\circ$ .

**STEP 3.** Bisect  $\angle AOB$ . OC is the bisector. Then,  $\angle AOC = 30^\circ$ ,  $\angle COB = 30^\circ$



**(iii) Angle Of  $120^\circ$  :**

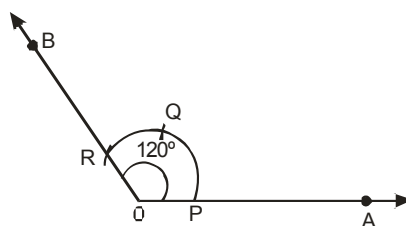
**STEP 1.** Draw a ray OA.

**STEP 2.** With O as centre and any convenient radius draw an arc to cut OA at P.

**STEP 3.** With P as centre and the same radius draw another arc to cut the first arc at Q.

**STEP 4.** With Q as centre and the same radius draw another arc to cut the first arc at R.

**STEP 5.** Draw the ray OB through O and R. then  $\angle AOB = 120^\circ$





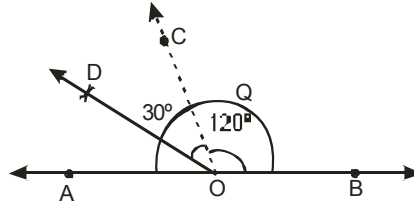
**(iv) Angle Of  $150^\circ$  :**

**STEP 1.** Draw a line AB.

**STEP 2.** With any vertex O on AB, construct  $\angle BOC$  of  $120^\circ$

**STEP 3.** Bisect  $\angle AOC$ . Ray OD is the bisector.

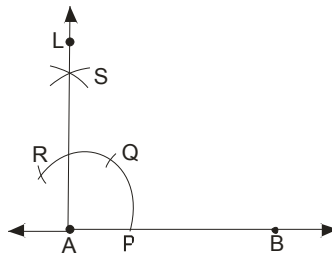
Then  $\angle BOD = 150^\circ$


**(v) Angle Of  $90^\circ$  :**

**STEP 1.** With A as centre and any suitable radius draw an arc cutting AB at P.

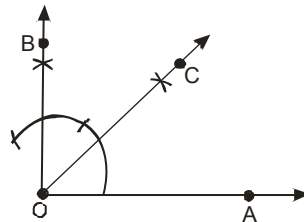
**STEP 2.** With P as centre and the same radius as before cut the arc of Step 1 at Q. With Q as centre and the same radius cut the arc again at R.

**STEP 3.** With Q and R as centres and any convenient radius (same for both) draw arcs cutting at S. Join A to S and produce A to L. Then  $\angle BAL = 90^\circ$ , i.e., AL is perpendicular to AB at A.


**(vi) Angle Of  $45^\circ$  :**

**STEP 1.** Construct an angle AOB of  $90^\circ$  as in the previous construction.

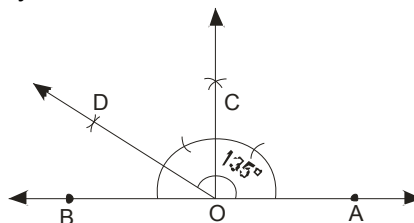
**STEP 2.** Bisect  $\angle AOB$ . Let OC be the angle bisector. Then  $\angle AOC = 45^\circ$ ;  $\angle COB$  is also  $= 45^\circ$


**(vii) Angle Of  $135^\circ$  :**

**STEP 1.** Draw a line AB.

**STEP 2.** With any point O on line AB as vertex, construct  $\angle AOC = 90^\circ$ . Then  $\angle BOC$  is also  $= 90^\circ$ .

**STEP 3.** Bisect  $\angle BOC$ . Ray OD is the bisector. Then,  $\angle AOD = 90^\circ + 45^\circ = 135^\circ$





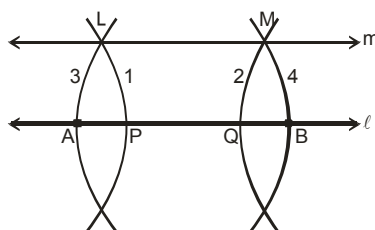
## Ask yourself

1. Draw a circle of radius 6cm
2. Draw a circle of radius 5cm . Let O be the centre. Mark points A, B and C such that OA = 4cm, OB= 5cm, OC = 7cm. Now identify the point which lie  
**(a)** in its exterior region **(b)** in its interior region **(c)** on the circle.
3. Draw a circle having diameter as 7cm, draw AB and CD as two of its diameter.
4. Draw a line segment AB of length 7.9cm using a ruler.
5. Draw a line AB , take a point X on it. Construct a perpendicular XY on it using set square. How many such lines can be drawn ?
6. Draw a line segment of length 9.8cm. Construct its perpendicular bisector.
7. Construct the following angles with the help of ruler and protractor:  
**(a)**  $43^\circ$                       **(b)**  $70^\circ$                       **(c)**  $110^\circ$
8. Construct the following angles with the help of ruler and compass:  
**(a)**  $120^\circ$                       **(b)**  $45^\circ$                       **(c)**  $150^\circ$



## Add your knowledge

- (a)** Draw a line parallel to a given line using Compass.  
 Using Compass
- **To construct a line parallel to a given line.**  
 Let  $\ell$  be the given line. We have to draw a line parallel to  $\ell$ .

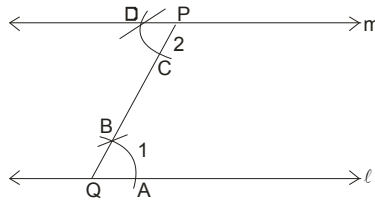


- Step - 1 :** Mark any two points A and B on  $\ell$ .
- Step - 2 :** Draw an arc '1' having A as centre. Mark the point where this arc cuts  $\ell$  as P.
- Step - 3 :** Draw an arc '2' with the same radius and having B as centre.  
 Mark the point where this arc cuts  $\ell$  as Q.
- Step - 4 :** Now, keeping the same radius, draw arc 3 with centre P and arc 4 with centre Q.
- Step - 5 :** Mark as L the point where arc 3 cuts arc 1 and as M the point where arc 4 cuts arc 2.
- Step - 6 :** Join L to M and produce LM on both sides.  
 Then, line LM ( $m$ ) is parallel to the given line  $\ell$ .

- **To construct a line parallel to a given line passing through a given point not lying on it.**

**Given :** A line  $l$  and a point  $P$  not lying on it.

**To construct :** A line parallel to  $l$  through  $P$ .



**Steps of Construction :**

**Step - 1 :** Take any point  $Q$  on line  $l$  and join  $Q$  to  $P$ .

**Step - 2 :** With  $Q$  as centre and a convenient radius, draw an arc 1 cutting  $l$  at  $A$  and  $PQ$  at  $B$ .

**Step - 3 :** Now, with  $P$  as centre and the same radius as in step 2, draw an arc 2 cutting  $PQ$  at  $C$ .

**Step - 4 :** Place the steel point of the compass at  $A$  and adjust the opening so that the pencil point is at  $B$ .

**Step - 5 :** With the same opening as in Step 4 and with  $C$  as centre, draw an arc cutting the arc 2 at  $D$ .

**Step - 6 :** Draw a line  $m$  through  $P$  and  $D$ .

Then  $m$  is the required line parallel to  $l$  and passing through the given point  $P$ .

## Summary

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1. Using ruler and compass , we can construct
  - (a) A circle if its radius is given.
  - (b) A line segment if its length is given.
  - (c) An angle if its measure is given.
  - (d) A line segment equal to a given line segment.
  - (e) An angle equal to a given angle.
  - (f) Perpendicular to a line from a point on the line.
  - (g) Perpendicular to a line from a point outside the line.
  - (h) The bisector of a given angle.
  - (i) Angles of measure such as  $15^\circ$  ,  $30^\circ$  ,  $60^\circ$  ,  $45^\circ$  ,  $90^\circ$  ,  $120^\circ$  ,  $135^\circ$  etc.
2. We can use set squares to draw perpendicular lines.
3. Two lines are said to be perpendicular if one of the angles formed by them is a right angle.
4. Bisector of an angle is its axis of symmetry.
5. Perpendicular bisector of a line segment is the axis of symmetry of the line segment.
6. One and only one perpendicular can be drawn to a line from a point not on the line.
7. One and only one perpendicular can be drawn to a line at a point on it.
8. An unlimited number of circles can be drawn passing through a point.

# EXERCISE 01

## SECTION -A (FIXED RESPONSE TYPE)

### VERY SHORT ANSWER TYPE

1. Draw a circle of radius 3.5 cm.
2. Draw the line segments whose measures are :  
(i) 7.3 cm      (ii) 8.5 cm
3. Construct a line segment of length 10 cm. From this cut a segment AC of length 4.6 cm. Measure the remaining segment.
4. Draw a line segment AB of length 8cm. Draw its perpendicular bisector. Is it its line of symmetry.
5. Use a protractor to draw angles of :  
(a)  $48^\circ$       (b)  $75^\circ$       (c)  $122^\circ$       (d)  $118^\circ$
6. Draw a line segment  $AB = 5.6\text{cm}$  . Draw the perpendicular bisector of AB.

### SHORT ANSWER TYPE

7. Draw a line segment AB of length 8.5cm . From this cut off a line segment XZ of length 4.8cm
8. Draw a line LM and take a point P not lying on it. Using set squares construct a perpendicular from P to the line LM.
9. Draw a line XY. Take a point A on it and construct a perpendicular AB using ruler and compass. Measure  $\angle XAB$ . Is it a right angle?
10. Draw a circle of diameter 7 cm. Draw another diameter perpendicular to the first diameter. What figure is formed by joining the ends of these diameters ?
11. Draw a segment of the length given. Construct its perpendicular bisector.  
(a) 6 cm      (b) 8.7 cm      (c) 98 mm
12. Draw a line segment  $AB = 6\text{cm}$  . Take a point C on AB such that  $AC = 2.5\text{cm}$  . Draw CD perpendicular to AB

### LONG ANSWER TYPE

13. With compass and a ruler, construct each of the following angles :  
(a)  $60^\circ$       (b)  $30^\circ$       (c)  $90^\circ$       (d)  $45^\circ$
14. Draw a circle of radius 4.5 cm. with the same centre, draw two more circles of radii 3.8 cm and 3 cm. What special name do you give to these circles ?
15. Draw a circle of any radius , say 4 cm. Draw any two of its diameters. Join the ends of these diameters. What figure do you obtain ? What figure is obtained if the diameters are perpendicular to each other.

16. Draw a line segment  $AB = 8$  cm. Mark a point  $P$  on  $AB$  such that  $AP = 4.5$  cm. Draw a ray perpendicular to  $AB$  at  $P$  by  
 (i) Using set- squares      (ii) using compass
17. Draw a circle of radius 3.8 cm. Mark any three points  $P, Q, R$  on the circumference. Construct the perpendicular bisectors of  $PQ$  and  $QR$ . Where do the two bisectors meet? Bisect each angle using ruler and compass only.
- (e)  $22 \frac{1}{2}^\circ$       (f)  $75^\circ$       (g)  $135^\circ$       (h)  $150^\circ$   
 (i)  $120^\circ$

## EXERCISE

## 02

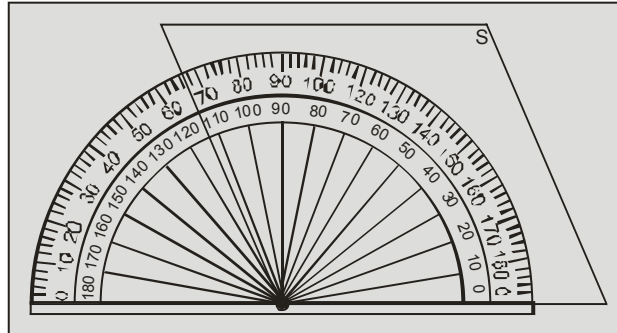
### SECTION -A (COMPETITIVE EXAMINATION QUESTION)

#### MULTIPLE CHOICE QUESTIONS

- The instrument in the geometry box having the shape of a triangle is called a  
 (A) Protractor      (B) Compasses      (C) Divider      (D) Set-square
- The instrument to measure an angle is  
 (A) Ruler      (B) Protractor      (C) Divider      (D) Compass
- The instrument to draw a circle is  
 (A) Ruler      (B) Protractor      (C) Divider      (D) Compass
- Two lines are perpendicular if they intersect each other at  
 (A) acute angle      (B) right angle      (C) obtuse angle      (D) none.
- Perpendicular bisector of a line segment  
 (A) is perpendicular to it      (B) divides it into two equal parts  
 (C) both (A) and (B) true      (D) none
- The angle bisector of an angle divides an angle into  
 (A) two equal angles      (B) two unequal angles  
 (C) infinite angles      (D) none
- In a circle, diameter  
 (A) passes through the centre      (B) does not pass through the centre  
 (C) is less than radius      (D) none
- Perpendicular bisector of a chord of a circle  
 (A) passes through the centre      (B) does not pass through the centre  
 (C) is not a line segment      (D) none
- To construct an angle of  $30^\circ$ , we construct the angle bisector of  
 (A)  $15^\circ$       (B)  $60^\circ$       (C)  $90^\circ$       (D)  $180^\circ$
- To construct an angle of  $45^\circ$ , we construct the angle bisector of  
 (A)  $90^\circ$       (B)  $60^\circ$       (C)  $120^\circ$       (D)  $15^\circ$

# EXERCISE 03

1. A parallelogram is shown below



The measure of angle S to the nearest degree.

(NSTSE 2011)

(A)  $136^\circ$

(B)  $115^\circ$

(C)  $124^\circ$

(D)  $56^\circ$

**ANSWER KEY >>****EXERCISE >> 02****SECTION -A (COMPETITIVE EXAMINATION QUESTION)****MULTIPLE CHOICE QUESTIONS**

Ques.	1	2	3	4	5	6	7	8	9	10
Ans.	D	B	D	B	C	A	A	A	B	A

**EXERCISE >> 03****(PREVIOUS YEAR EXAMINATION QUESTIONS)**

Ques.	1
Ans.	B