

Practical Geometry

Chapter -XIV

Introduction

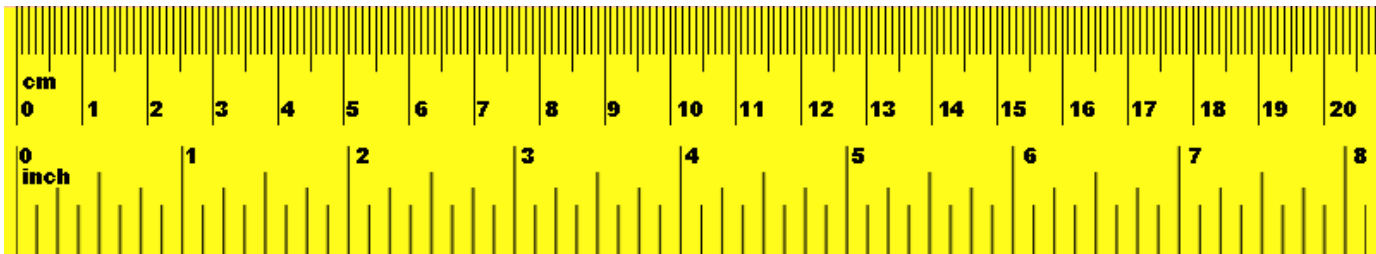
- So far, we have learnt about various geometrical shapes , and their properties. In this chapter we learn how to construct some basic shapes .
- To construct, we need the help of some tools, which are calibrated , and the coming slides will deal about them , in depth .

Tools

- We need the following tools to construct :
 - Ruler
 - Compass
 - Divider
 - Set Squares
 - Protractor

Ruler

- A **Ruler**, sometimes called a rule or line gauge, is an instrument used in geometry, technical drawing, printing and engineering/building to measure lengths and/or to rule straight lines.
- Strictly speaking, the ruler is essentially a **straightedge** used to rule lines, but typically the ruler also contains **calibrated lines** to measure distances, as depicted below :



Compass

- **Compass** , is an instrument used to **mark off equal lengths** , and **construct circles and arcs**.
- It contains '**pen or pencil**' on one side, and **spike** on other end, connected by metallic hinge, that can be adjusted .



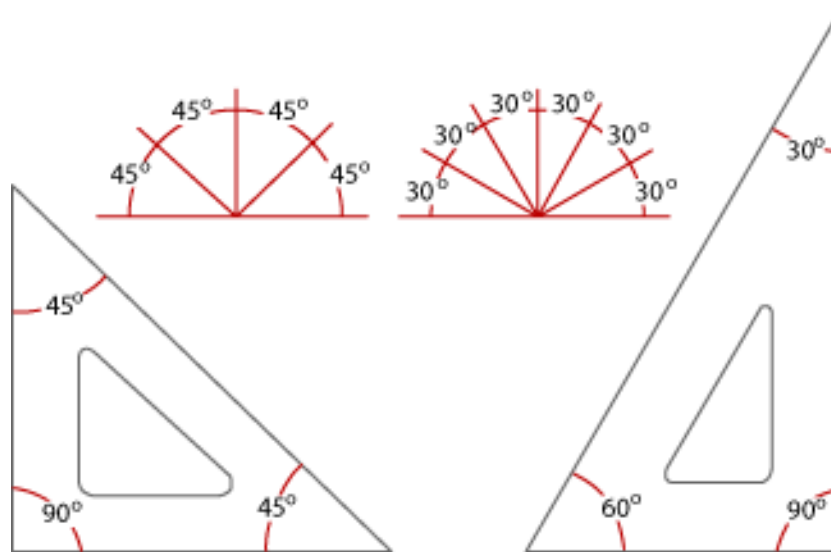
Divider

- **Divider** is an instrument used to **compare lengths** !
- Unlike compass, it has spikes on both sides, used for measuring and comparing lengths .



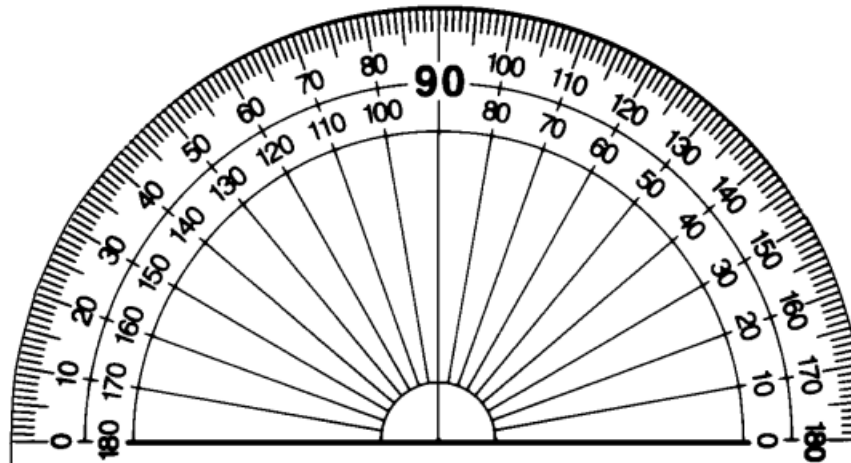
Set Squares

- These are two triangular pieces which are used to **draw perpendicular and parallel lines**.
- One of them has 45° , 45° and 90° angles at the vertices, whereas the other one has 30° , 60° and 90° angles at the vertices.

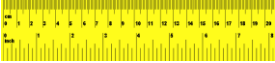


Protractor

- It is a semi-circular device used for **drawing and measuring the angles**.
- It is graduated into 180° degree parts, which start with 0° on left hand side and goes up to 180° on right hand side and vice-versa.

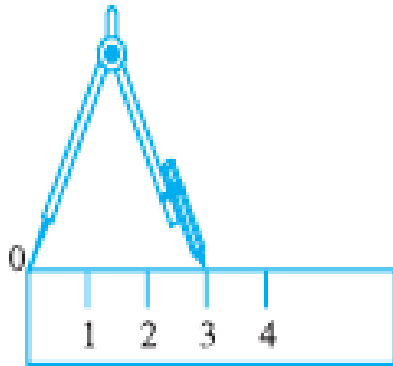


Constructions (using Ruler and Compass)

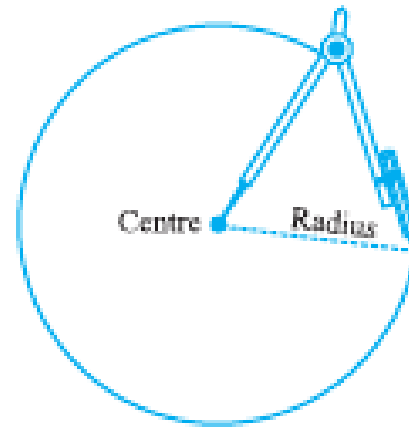
- **Tools needed :** Ruler () and Comp )
- Now we construct the following things using the above tools:
 - Circle with some radius.
 - Line segment of given length .
 - Constructing a copy of given line segment .
 - Perpendiculars of a line, and perpendicular bisectors .

Constructing circle with some radius

- **Step-1:** Open the Compass and mark the required radius (Say 3cms).
- **Step-2:** Mark a center **O**, and keep the spiky edge pressed on the center, and rotate the compass slowly to trace a circle.



Step – 1



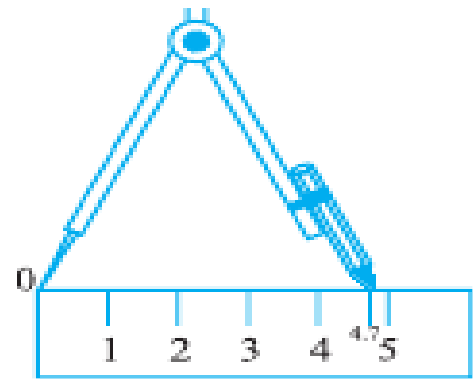
Step-2

Constructing a line segment of given length

- **Step – 1** : Draw a line ‘**l**’ and mark a point ‘**A**’ on it.



- **Step – 2** : Place the spiky edge on zero of the ruler and stretch the legs of compass until the pencil point reaches given length (say 4.7cms).



- **Step – 3** : Place the spiky edge on **A** , and then mark an arc on the line ‘**l**’ and call it as ‘**B**’ and **AB** is the line segment .

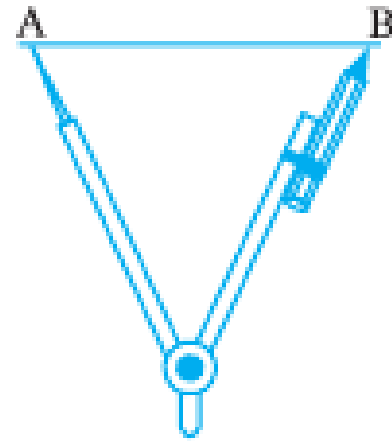


Constructing a copy of given line segment

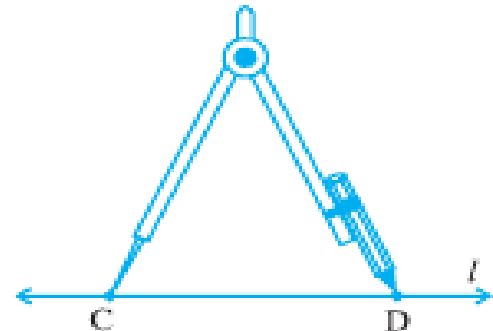
- **Step – 1 :** Consider a line segment **AB** of unknown length.



- **Step – 2 :** Keep the spiky leg of the compass on **A** and keep the pencil point on **B**.

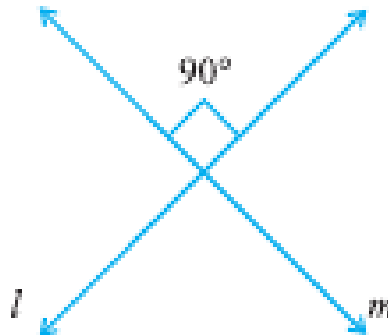


- **Step – 3 :** Draw any line '**l**' and mark a point **C** on it. Without disturbing the compass, keep the spiked leg on **C** and cut an arc on '**l**' and then mark it as **D**. Now **CD** is new line segment of length **A**.



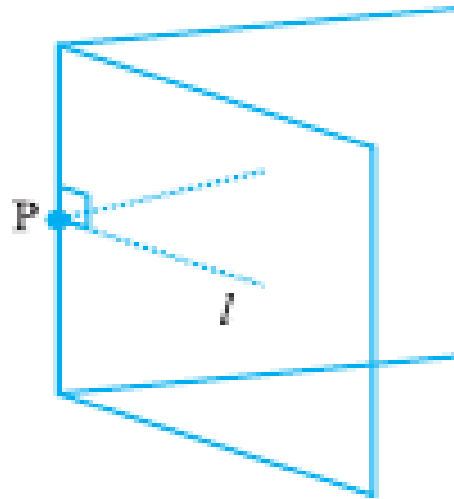
Perpendicular

- Two lines are said to be perpendicular, if they intersect and the angle at their intersection is right angle (i.e. 90°).
- For example, the lines '**l**' and '**m**' are perpendicular to each other (have an angle of 90°).



Perpendicular to a line , given a point on it .

- Tracing paper or any transparent paper could be better for this activity. Let us take such a paper and draw any line ***l*** on it. Let us mark a point ***P*** anywhere on ***l***.
- Fold the sheet such that ***l*** is reflected on itself; adjust the fold so that the crease passes through the marked point ***P***. Open out; the crease is perpendicular to ***l***.

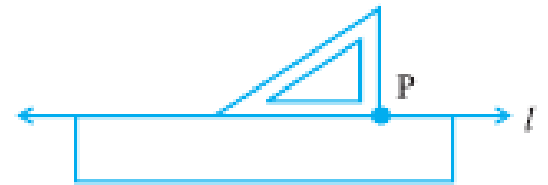
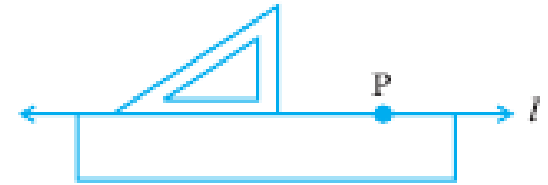


Constructing the perpendicular using Ruler and Compass

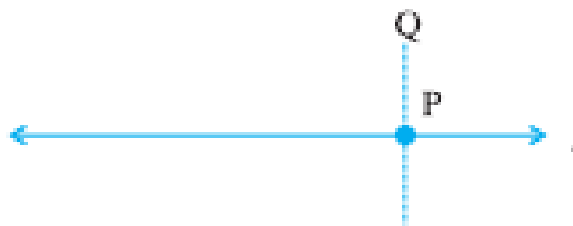
- **Step – 1 :** Consider the given line ' l ' and the point ' P ' on the line, place one edge of the ruler on it, and hold it firmly.



- **Step – 2 :** Place a set square, with one of its edges on already aligned ruler edge, and move it carefully, till the right-angled corner of it coincides with the ' P '.

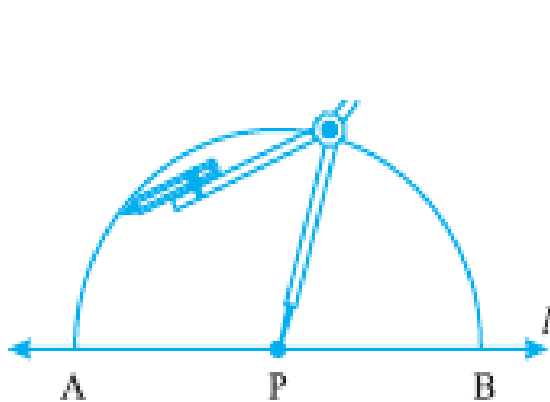


- **Step – 3 :** Hold the set square firmly and then draw PQ along the edge of the set square.

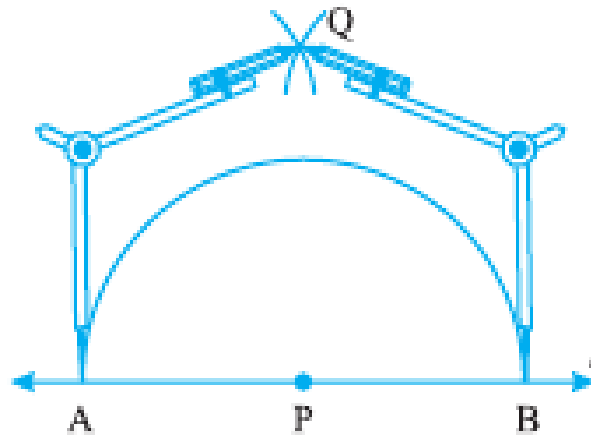


Drawing perpendicular using Ruler and compass

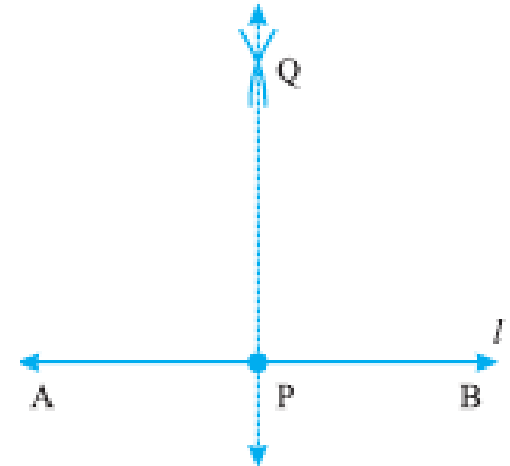
- **Step – 1** : Consider a given line ' l ' and a point ' P ' on it. Take the compass , and with a convenient radius , making ' P ' as center draw an arc intersecting line at two points **A** and **B** .
- **Step – 2** : With **A** and **B** as centers , and with a radius greater than **AP** , draw two arcs which cut each other at **Q**.
- **Step – 3** : Join **PQ** , then **PQ** is the perpendicular to ' l '.



Step – 1



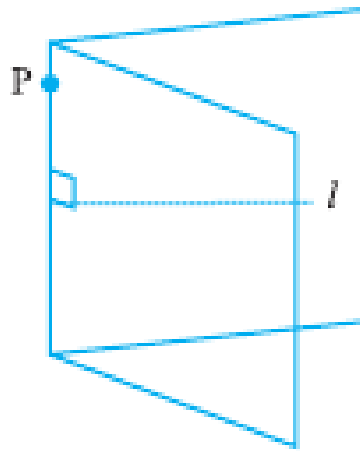
Step – 2



Step – 3

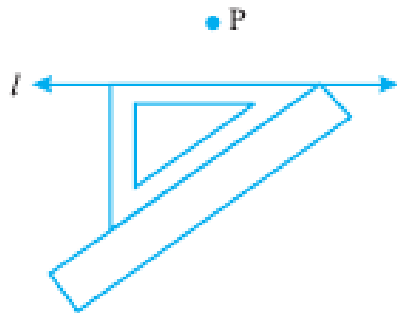
Perpendicular to a line , given a point not on it .

- Draw a line '**l**' and mark a point '**P**' away from '**l**'.
- Fold the sheet such that the crease passes through P.
- The parts of the line **l** on both sides of the fold should overlap each other.
- Open out. The crease is perpendicular to **l** and passes through **P**.

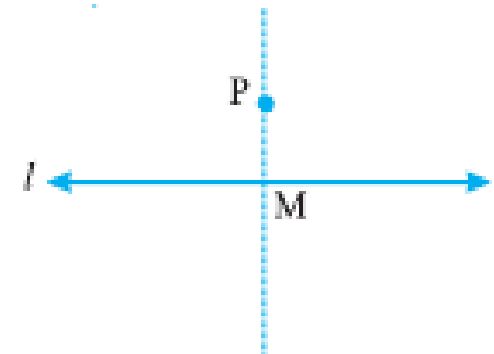
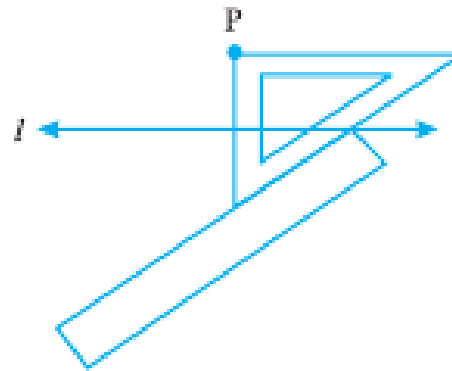


Constructing the perpendicular using Ruler and Compass

- **Step – 1 :** Consider a given line ' l ' with a point ' P ' away from it. Place a set square with one arm of the right angle aligns to the line, and place a ruler opposite to the right angle of the set square.
- **Step – 2 :** Hold the ruler fixed and slide the set square along the ruler till the point P touches the other arm of set square .
- **Step – 3 :** Now draw a line on the side of the set square starting at ' P ' and touching the line at ' l ' at ' M '. Now PM is perpendicular to ' l ' .



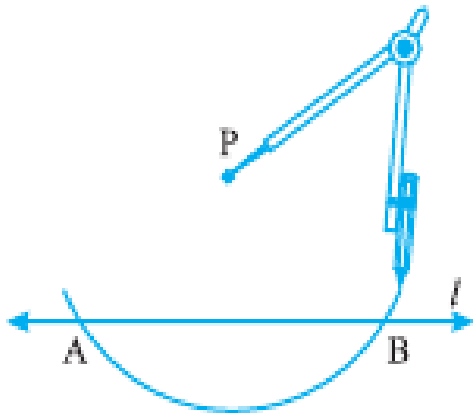
Step – 1



Step – 2

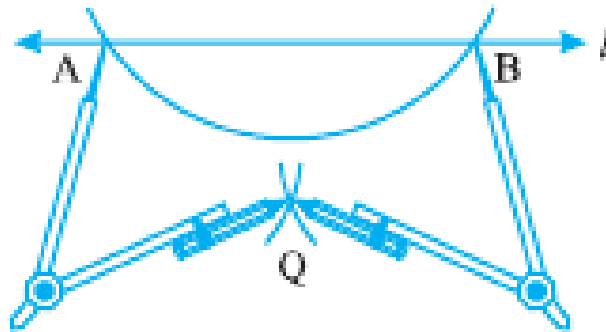
Drawing perpendicular using Ruler and compass

- **Step – 1** : Consider a given line ' l ' and a point ' P ' not on it. Take the compass , and with a convenient radius , making ' P ' as center draw an arc intersecting line at two points **A** and **B** .
- **Step – 2** : With **A** and **B** as centers , and with the same radius , draw two arcs which cut each other at **Q**.
- **Step – 3** : Join **PQ** , then **PQ** is the perpendicular to ' l '.

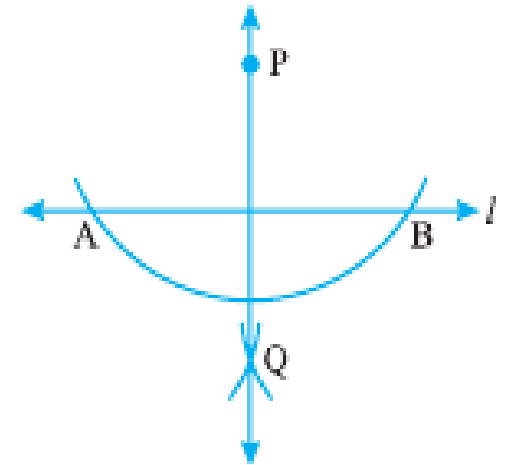


Step – 1

Step – 3

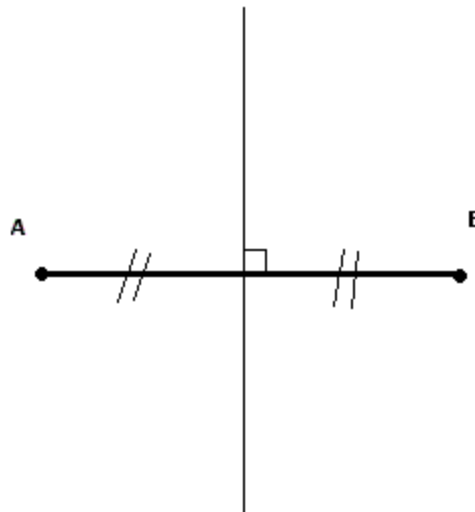


Step – 2



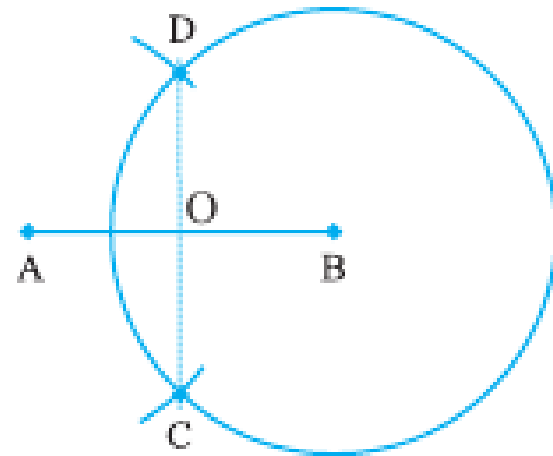
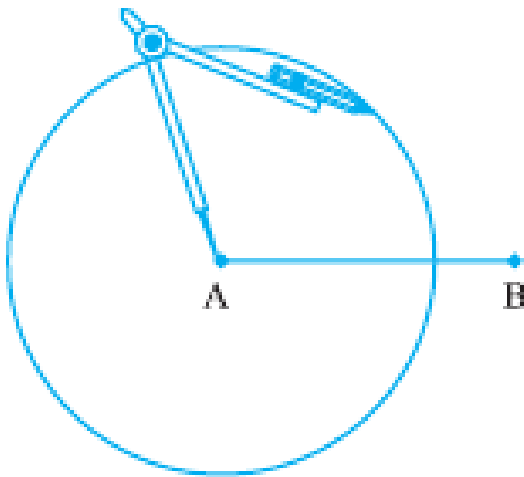
Perpendicular Bisector of a line

- A Perpendicular bisector of a line segment , is a perpendicular of the line segment , that divides the line into two equal parts. The word Bisect means divide into two equal parts.



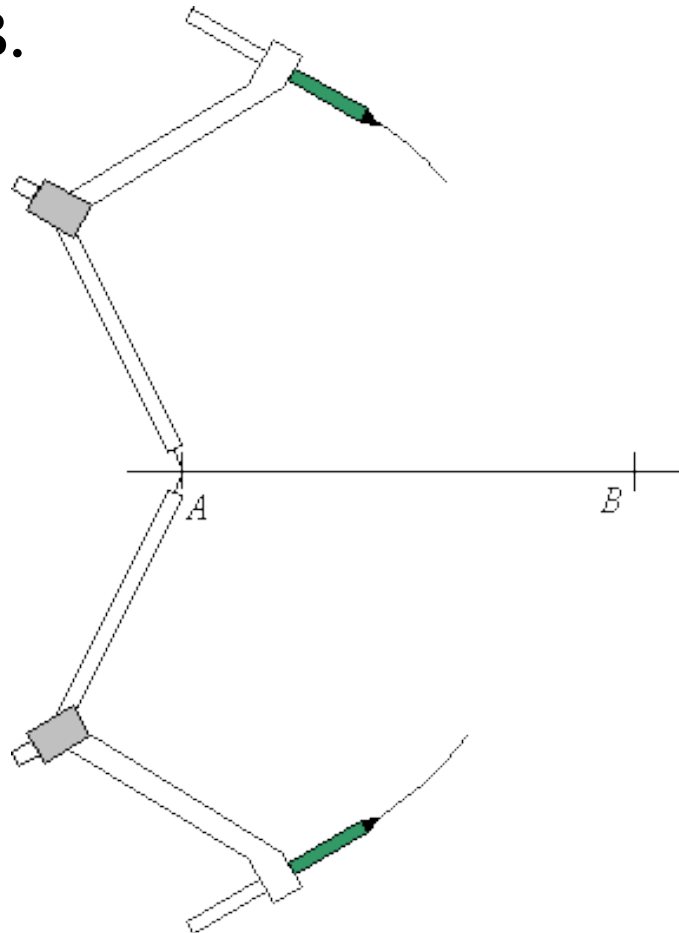
Constructing the perpendicular Bisector using Ruler and Compass

- **Step – 1 :** Consider the line segment **AB** of given length and with **A** as center and radius greater than half of **AB**, draw a circle using compass.
- **Step – 2 :** With same radius, draw another circle with center as **B**, which cuts the previously drawn circle at **C** and **D**. Join **CD**, which cuts **AB** at **O**. Measure lengths **AO** and **OB** using divider and also measure the angle at **O** using protractor . You find that **AO=OB** and angle is 90°



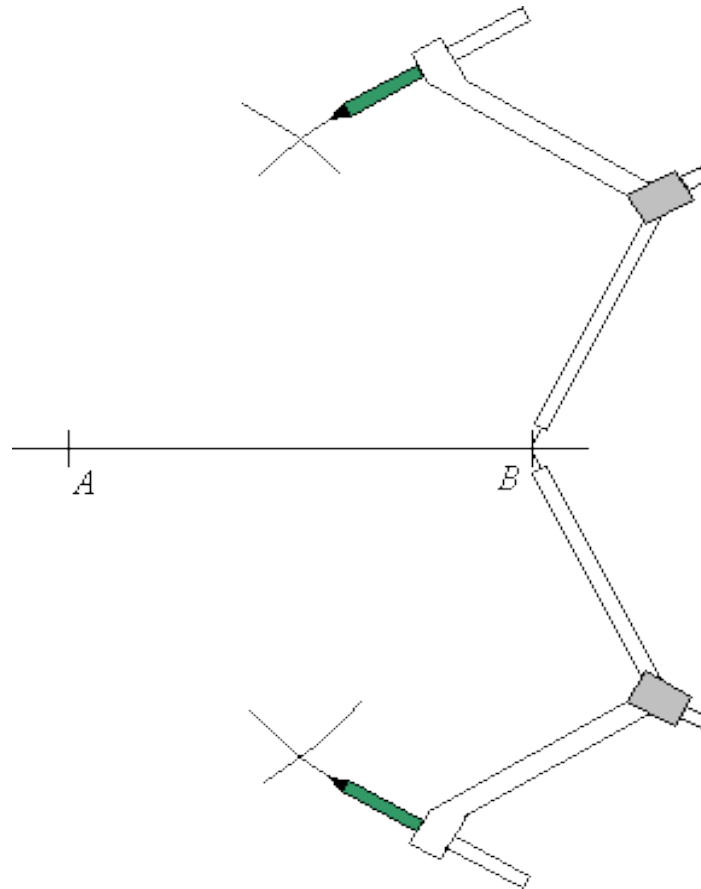
Alternative method for constructing perpendicular bisector

- **Step – 1** : Consider a given line Segment **AB**. With A as center and a radius greater than half of **AB** , draw the arcs on both sides of **AB**.



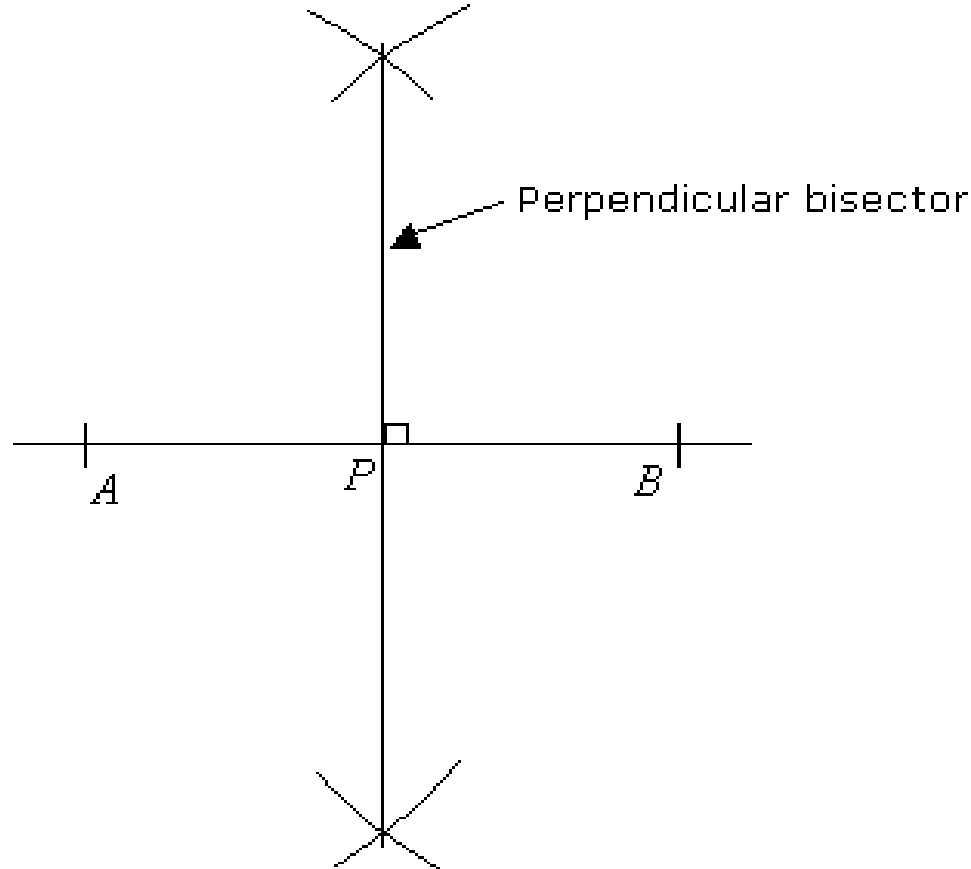
Alternative method for constructing perpendicular bisector

- **Step – 2 :** With **B** as center and with same radius Cut the previously drawn arcs .



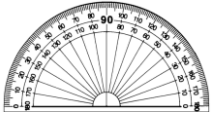
Alternative method for constructing perpendicular bisector

- **Step – 3 :** Draw a line , passing through the intersection points of two arcs and it will give us the perpendicular bisector of line segment **AB**.



Angles

- Tools needed :

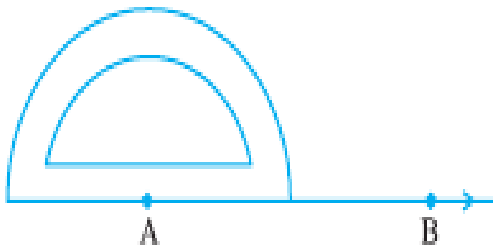
- Protractor ().

- Compass ().

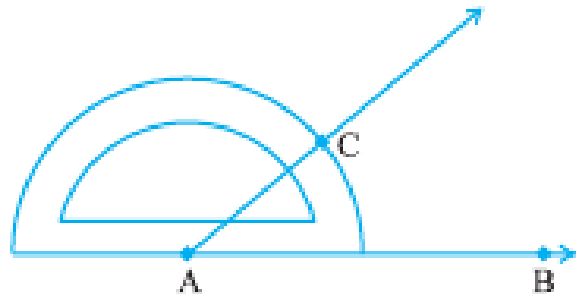
- We do the following tasks :
 - Constructing an angle of known measure.
 - Constructing an angle equal to given angle .
 - Bisecting angle.
 - Constructing angles of special measures.

Constructing an angle of given measure

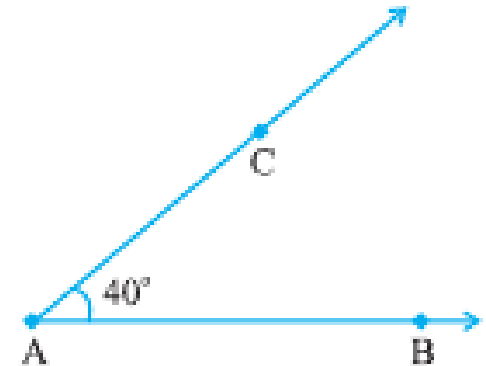
- **Step – 1 :** Draw a ray **AB** of any length and place the protractor at **A** and Zero edge of it along **AB**.
- **Step – 2 :** Start with Zero near **B** and mark a point **C** at 40° (You can find the calibrations on protractor)
- **Step – 3 :** Join **AC** and $\angle \mathbf{BAC}$ is the required angle .



Step – 1



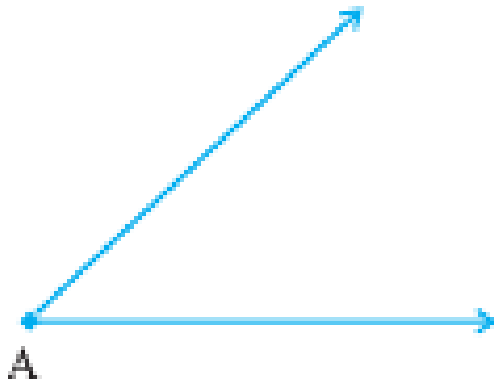
Step – 2



Step – 3

Constructing an angle of unknown measure

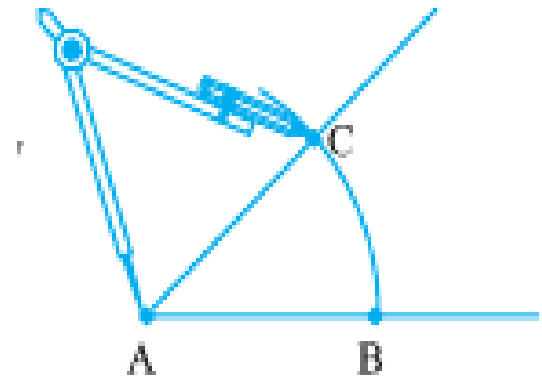
- **Step – 1 :** Consider the figure , and we need to determine the angle at **A**.
- **Step – 2 :** Draw a line and choose a point **P** on the line '**l**'.
- **Step – 3 :** Place the compass at **A** and draw an arc to cut the rays of **A** at **B** and **C** .



Step – 1



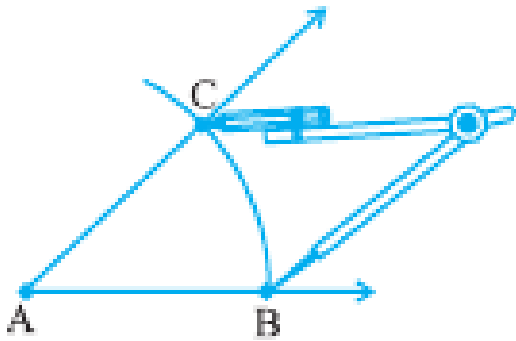
Step – 2



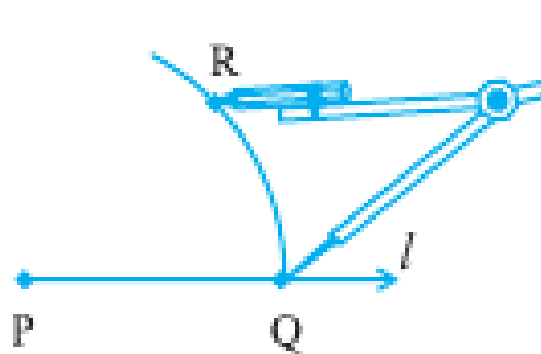
Step – 3

Constructing an angle of unknown measure

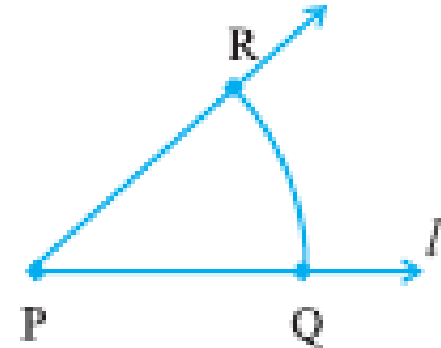
- **Step – 4:** Using the same Compass set, draw an arc with center **P** to cut the line '**l**' at **Q**.
- **Step – 5:** Now set the compass to the length **BC** with **B** as center on the ray **AB**.
- **Step – 6 :** Place the compass at **Q** and without disturbing the radius cut the previously drawn arc at **R**. Join **PR** and now it has the same angle as **A** .



Step – 4



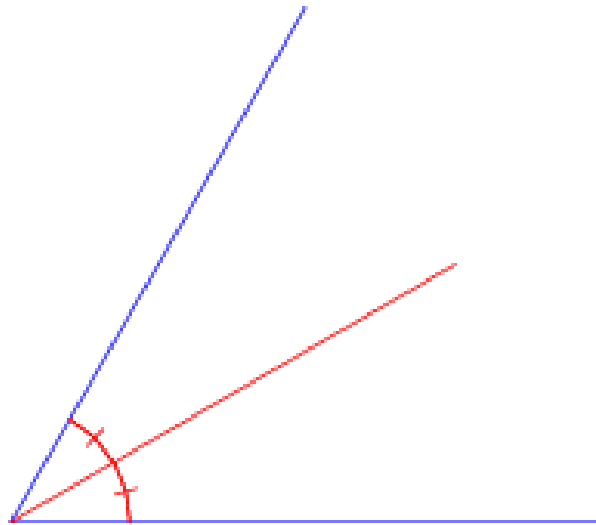
Step – 6



Step – 5

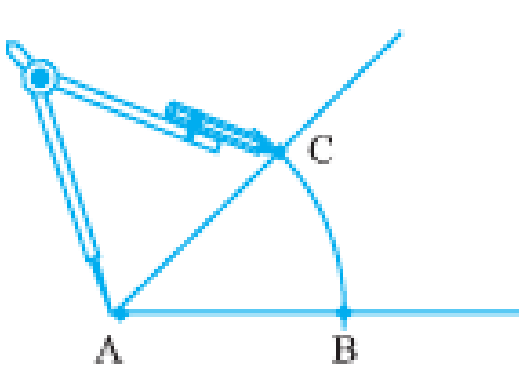
Bisector of an angle

- The Bisector of an angle, is a ray passing through the angle, which divides the angle into two equal parts.

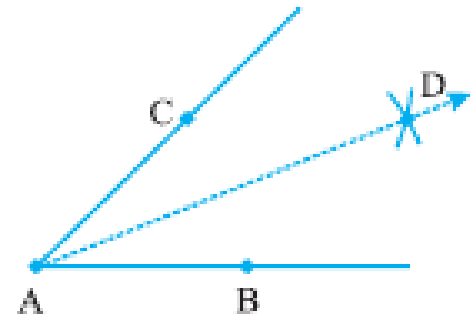
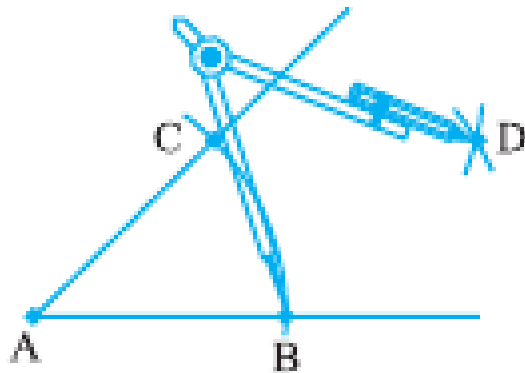


Constructing the Angle bisector using ruler and compass

- **Step – 1** : Consider the figure , and with **A** as center, using compass cut the both rays at **B** and **C**.
- **Step – 2** : With **B** as center and more than half length of **BC** draw an arc interior to the angle **A**.
- **Step – 3** : With same radius, with center as **C** cut the arc at **D** . Join **AD**, and it becomes the angle bisector. Verify $\angle CAD$ and $\angle DAB$ using protractor .



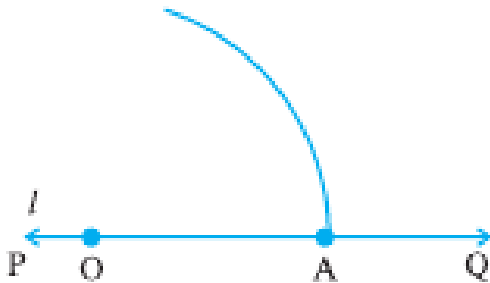
Step – 1
Step – 3



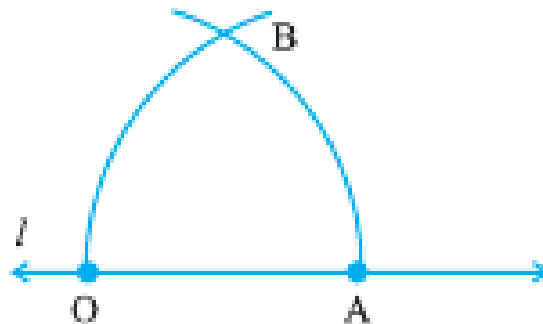
Step – 2

Angles of special measures (Constructing angle of 60°)

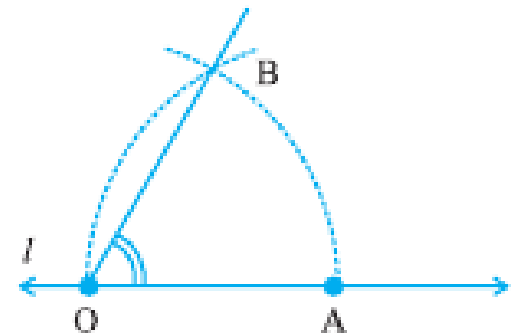
- **Step – 1** : Consider a line segment **PQ** with a point **O** on it. With **O** as center and with convenient radius cut **PQ** at **A**.
- **Step – 2** : With **A** as center and same radius draw an arc to cut the previously drawn arc at **B**.
- **Step – 3** : Join **AB** and we get the measure of $\angle\mathbf{AOB}$ as 60° .



Step – 1



Step – 2



Step – 3

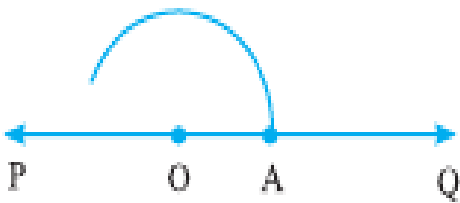
Angles of special measures (Constructing angle of 30°)

Construct an angle of 60° as shown previously and bisect the angle to get the 30°

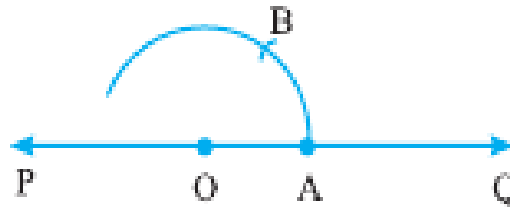


Angles of special measures (Constructing angle of 120°)

- **Step – 1 :** Consider a line **PQ** with a point **O** on it. With **O** as center and with convenient radius cut **PQ** at **A**.
- **Step – 2 :** With **A** as center and without disturbing the radius draw an arc to cut the previously drawn arc at **B**.
- **Step – 3 :** With **B** as center and without disturbing the radius draw an arc to cut the first arc at **C**. Join **CO** and $\angle COA$ is the required angle.



Step – 1



Step – 2

