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Class: 9
Subject: Mathematics
Topic: Geometric constructions
No. of Questions: 20

Q1. To construct an angle equal to a given angle.

Sol. Given : Any ∠POQ and a point A.

Required: To construct an angle at A equal to ∠POQ.

Step of Construction:

(i) With O as centre and any (suitable) radius, draw an arc to meet OP at R and OQ at S.

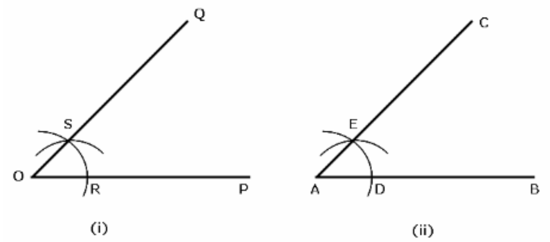
(ii) Though A draw a line AB.

(iii) Taking A as center and same radius (as in step 1), draw arc to meet AB at D.

(iv) Measure the segment RS with compasses.

(v) With d as centre and radius equal to RS, draw an arc to meet the previous arc at E.

(vi) Join AE and Produce it to C, then ∠BAC is the required angle equal to ∠POQ



Q2. To bisect a given angle.

Sol. Given: Any ∠POQ

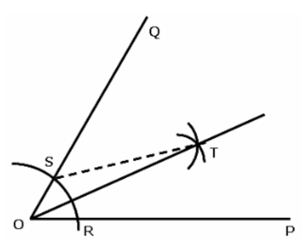
Required: To bisect ∠POQ.

Steps of Constructions:

(i) With O as centre and any (suitable) radius, draw an arc to meet OP at R and OQ at S.

(ii) With R as centre and any suitable radius (not necessarily) equal to radius of step 1 (but $> \frac{1}{2}$ RS), Draw an arc. Also, with S as centre and same radius draw another arc to meet the previous arc at T.

(iii) Join OT and produce it, then OT is the required bisector of ∠POQ.



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Q3. To Construct angles of 60°, 120° , 90°, 45°

Sol. (1.) To construct an angle of 60°

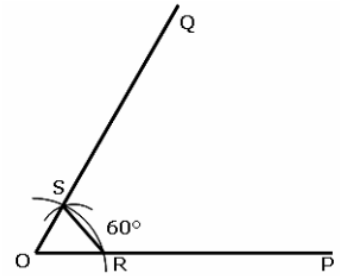
Steps of construction:

(i) Draw any line OP.

(ii) With O as centre and any suitable radius, draw an arc to meet OP at R.

(iii) With R as centre and same radius (as in step 2), draw an arc to meet the previous arc at S.

(iv) Join OS and produce it to Q, then ∠POQ = 60°.

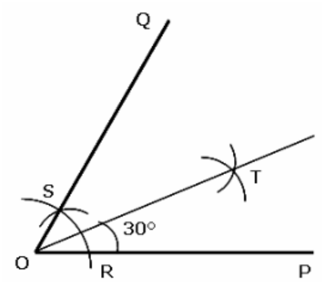


(2.) To construct an angle of 30°

Steps of Construction:

(i) Construct ∠POQ = 60° (as above).

(ii) Bisect ∠ POQ (as in construction 2). Let OT be the bisector of ∠POQ, then ∠POT = 30°



(3.) To construct an angle of 120°

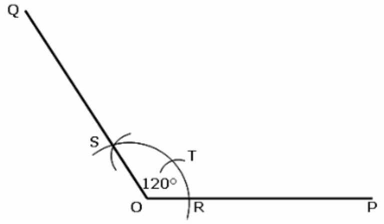
Steps of construction:

(i) Draw any line OP.

(ii) With O as center and any suitable radius, draw an arc to meet OP at R.

(iii) With R as center and same radius (as in step 2), draw an arc to meet the previous arc at T. With T as centre and same radius, draw another arc to cut the first arc at S.

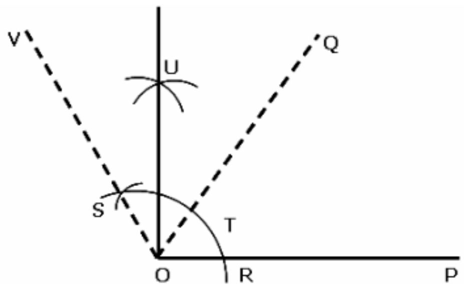
(iv) Join OS and produce it to Q, then ∠POQ = 120°



(4.) To construct an angle of 90°

Step of construction

(i) Construct ∠POQ = 60° (as in construction 3(i)).
(ii) Construct ∠POV = 120° (as above).
(iii) Bisect ∠QOV (as in construction 2). Let OU be the bisector of ∠QOV, then ∠POU = 90°.

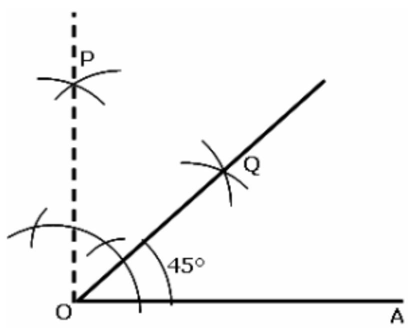


(5.) To construct an angle of 45°

Steps of construction:

(i) Construct ∠AOP = 90° (as above).
(ii) Bisect AOP (as in construction 2).

Let OQ be the bisector of ∠AOP, then ∠AOQ = 45°



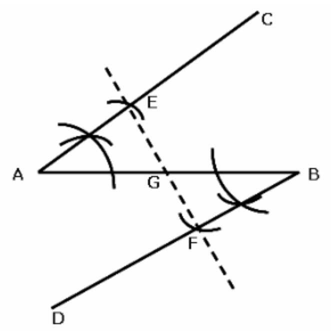
Q4. To bisect a given line segment.

Sol. Given: Any line segment AB.
Required: To bisect line segment AB.
Steps of Construction:
(i) At A, construct any suitable angle BAC.
(ii) AT B, construct ∠ABD = ∠BAC on the other side of line AB.

(iii) With A as centre any suitable radius, draw an arc to meet AC at E.

(iv) From BD, Cut off BF = AE.

(v) Join EF to meet AB at G, then EG is a bisector of the line segment AB and G is mid-point of AB.



Q5. Divided a line segment AB of length 8 cm into 4 equal parts.

Sol. Given: A line segment AB of length 8 cm.

Required: To divide line segment 8 cm into 4 equal parts.

Steps of Construction:

(i) Draw a line segment AB = 8 cm.

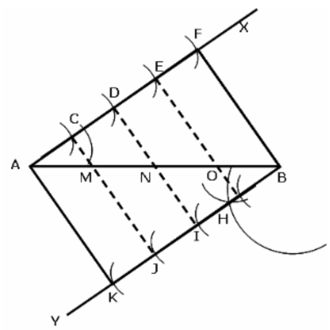
(ii) At A, construct any suitable angle BAX.

(iii) At B, construct ∠ABY = ∠BAX on the other side of the line AB.

(iv) From AX, cut off 4 equal distance at the points C, D, E and F such that AC = CD= DE= EF.

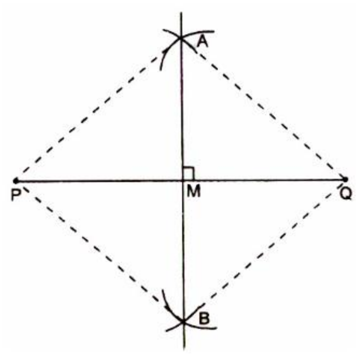
(v) With the same radius H, I, J and K such that BH = HI= IJ= JK.

(vi) Join AK, CJ, DI, EH and FB. Let CJ, DI and EH meet the line segment AB at the points M, N and O respectively. Then, M, N and O are the points of division of AB such that AM = MN = NO = OB.



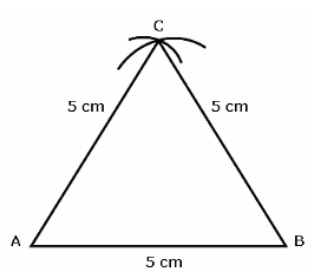
Q6. To draw a perpendicular bisector of a line segment.

Sol. Given: Any line segment PQ.
Required: To draw a perpendicular bisector of line segment PQ.
Steps of construction:
(i) With P as centre and any line suitable radius draw arcs, one on each side of PQ.
(ii) With Q as centre and same radius (as in step 1), draw two more arcs, one on each side of PQ cutting the previous arcs at A and B.
(iii) Join AB to meet PQ at M, then AB bisects PQ at M, and is perpendicular to PQ, Thus, AB is the required perpendicular bisector of PQ.



Q7. To construct an equilateral triangle when one of its side is give.
E.g.: Construct and equilateral triangle whose each side is 5 cm.

Sol. Given: Each side of an equilateral triangle is 5 cm.
Required: To construct the equilateral triangle.
Steps of construction:
(i) Draw any line segment AB = 5 cm.
(ii) With A as centre and radius 5cm draw an arc.
(iii) With B as centre and radius 5 cm draw an arc to cut the previous arc at C.
(iv) Join AC and BC. Then ABC is the required triangle.



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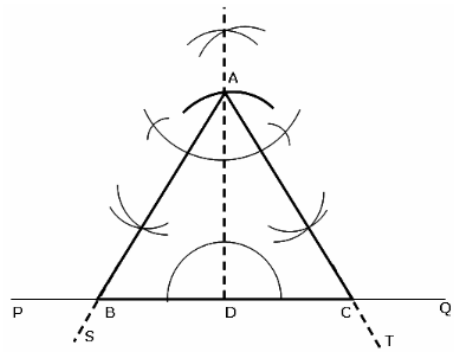
Q8. To construct an equilateral triangle when its altitude is given.
E.G.: Construct an equilateral triangle whose altitude is 4 cm.

Sol. Step of construction:

(i) Draw any line segment PQ.

(ii) Take a point D on PQ and At D, construct perpendicular DR to PQ. From DR, cut off DA = 4 cm.

(iii) At A, construct $\angle DAS = \angle DAT = \frac{1}{2} \times 60° = 30°$ on either side of AD. Let AS and AT meet PQ at points B and C respectively.
Then, ABC is the required equilateral triangle.



Q9. Construct of a triangle, given its Base, Sum of the other two sides and one Base Angle.
E.g. : Construct a triangle with base of length 5 cm, the sum of the other two sides 7 cm and one base angle of 60°

Sol. Given: In ΔABC, base BC = 5 cm, AB+AC = 7 cm and $\angle ABC = 60°$
Required: To construct the ΔABC.
Steps of construction:

(i) Draw BC = 5 cm.

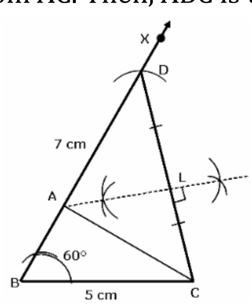
(ii) At B, construct $\angle CBX = 60°$

(iii) From BX, cut off BD = 7 cm.

(iv) Join CD.

(v) Draw the perpendicular bisect of CD, intersecting BD at a point A.

(vi) Join AC. Then, ABC is the required triangle.



Q10. Construction of a triangle, given its Base, Difference of the Other Two Sides and one Base Angle.

E.g. : Construct a triangle with base of length 7.5 cm, the difference of the other two sides 2.5 cm, and one base angle of 45°

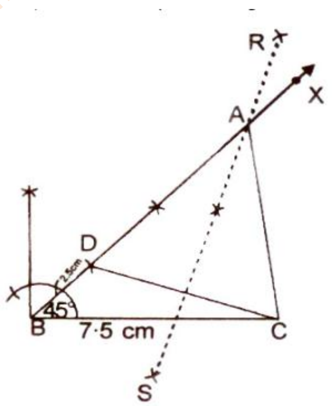
Sol. Given: In ΔABC, base BC = 7.5 cm, the difference of the other two sides, AB-AC or AC – AB = 2.5 cm and one base angle is 45°.

Required: To construct the ΔABC,

CASE 1.

Steps of Construction:

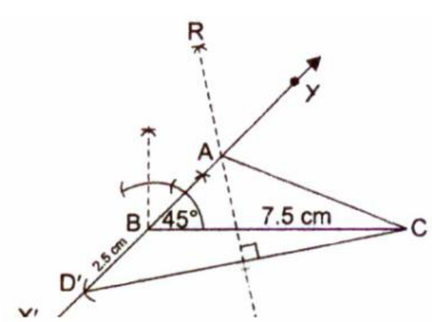
(i) Draw BC = 7.5 cm.
(ii) At B, construct ∠CBX = 45°.
(iii) From BX, Cut off BD = 2.5 cm.
(iv) Join CD.
(v) Draw the perpendicular bisector RS of CD intersecting BX at a point A.
(vi) Join AC. Then, ABC is the required triangle.



CASE 2. (AC- AB = 2.5 cm)

Steps of construction:

(i) Draw BC = 7.5 cm
(ii) At B, construct ∠CB X = 45° and produce XB to form a line XBX'.
(iii) From BX', cut off BD' = 2.5 cm.
(iv) Join CD'.
(v) Draw perpendicular bisector RS of CD' intersecting BX at a point A.
(vi) Join AC. ABC is the required triangle.
(vii) Join AC. Then, ABC is the required triangle.



Q11. Construction of a triangle of given perimeter and base angles. Construct a triangle with perimeter 11.8 cm and base angles 60° and 45°

Sol. Given: In ΔABC, AB+BC+CA = 11.8 cm, ∠B = 60° & ∠C = 45°.

Steps of Construction:

(i) Draw DE = 11.8 cm.

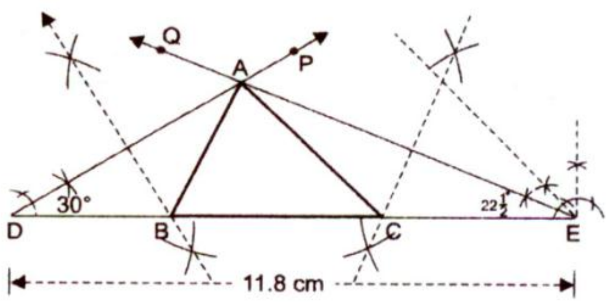
(ii) At D, construct $\angle EDP = \frac{1}{2}$ of $60° = 30°$ and at E, construct $\angle DEQ = \frac{1}{2}$ of $45° = 22\frac{1}{2}°$.

(iii) Let DP and EQ meet at A.

(iv) Draw perpendicular bisector of AD to meet DE at B.

(v) Draw perpendicular bisector of AE to meet DE at C.

(vi) Join AB and AC. Then, ABC is the required triangle.



Q12. Construct a triangle ABC, in which BC = 3.5 cm, ∠B = 30° and AB+AC = 6.4

Sol. Steps of construction:

(i) Draw BC = 3.5 cm

(ii) Draw ∠CBX = 30°

(iii) From ray BX, cut off line segment BD equal to AB+AC i.e., 6.4 cm

(iv) Join CD.

(v) Draw the perpendicular bisector of CD meeting BD at A.

(vi) Join CA to obtain the required triangle ABC.

Hence, ΔABC is the required triangle.

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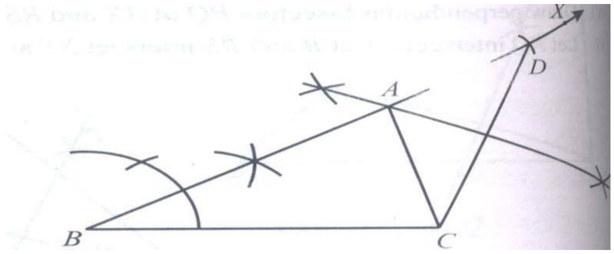


Q13. Construct the angle of the 30 °.

Sol. Steps of construction:

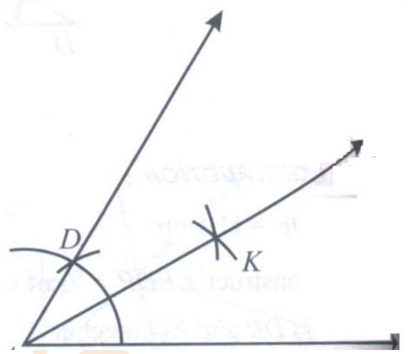
(i) Draw A ray AB of any suitable length.

(ii) Taking A as centre and any suitable radius, draw an arc which intersects ray AB at C.

(iii) Taking C as centre and radius = AC, draw an arc which intersects the previous arc at D.

(iv) Taking C and D as centre and radius > ½ CD draw two arcs intersecting each other at K.

Now ∠BAK = 30°



Q14. Construct an equilateral triangle, given its sides 5 cm and justify the construction.

Sol. Steps of construction:

(i) Draw BC = 5 cm

(ii) Taking B and C as centre and radius of length 5 cm, draw two arcs intersecting each other at A.

(iii) Join AB and AC

∴ ΔABC is the required equilateral triangle.

Justification:

Since the three sides

AB = BC = CA = 5 cm

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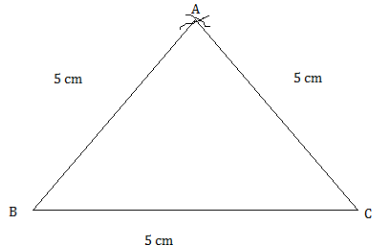
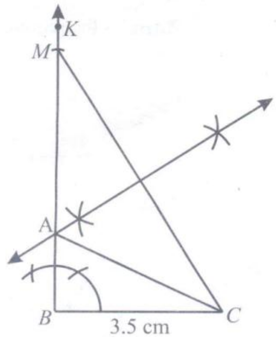
Thus ΔABC is an equilateral triangle.



Q15. Construct a right triangle when one side is 3.5 cm and the sum of the other side and hypotenuse is 5.5 cm

Sol. Steps of construction:

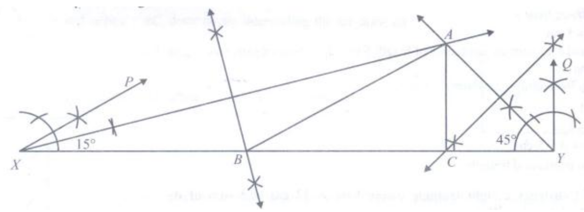
(i) Draw BC of length 3.5 cm.
(ii) At B, construct ∠CBX = 90°
(iii) From BX, cut off BM of length 5.5 cm.
(iv) Join C to M
(v) Draw perpendicular bisector of CM, let the bisector meet BM at A.
(vi) Join A to C.
Thus ΔABC is the required right triangle.



Q16. Construct a right triangle with perimeter 13 cm and one angle of 30°.

Sol. Steps of construction:

(i) Draw XY of length 13 cm
(ii) Draw ∠PXY = 30°
(iii) Draw bisectors of ∠PXY and ∠XYQ meeting each other at A.
(iv) Draw right bisector of AX and AY which meets XY at B and C respectively.
(v) Join AB and AC.
∴ ΔABC is the required triangle.



Q17. Construct an angle of 45° at the initial point of a given ray and justify the construction.

Sol. Step of Construction:

(i) Draw a ray BA

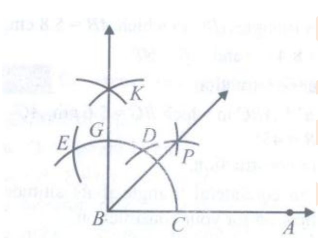
(ii) Take B as centre and any radius, draw an arc which intersecting AB at C.

(iii) Again take C as centre and radius = BC, draw an arc which is intersects the arc drawn in step (ii) at D.

(iv) Again take D as centre and radius as BC, draw an arc intersecting the arc drawn in step (ii) at E.

(v) Now With D and E as centers and radius >1/2 ED, draw two arcs which intersects each other at K. Join KB. Also let BK intersect the arc ED at G.
Now, $\angle ABK = 90°$

(vi) Take G and C as centre and radius >1/2 CG, draw two arcs, which intersecting each other at P.
Join BP.
$\therefore \angle ABP = 45°$



Q18. Construct a perpendicular bisector of a line segment of length 6 cm. Write the steps of construction and also justify your construction.

Sol. Step of Construction:

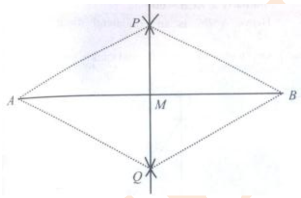
(i) Draw a line segment AB of length 6 cm.

(ii) Taking A and B as centers and radius more than 1/2AB, draw arcs on both sides of the line segment AB (to intersect each other).

(iii) Let these arcs intersect each other at P and Q. Join PQ.

(iv) Let PQ intersect AB at the point M. Then line PMQ is the required perpendicular bisector of AB.

Justification:
Join A and B to both P and Q to form AP, AQ, BP and BQ.
In triangle PAQ and PBQ,
AP = BP (Arcs of equal radii)
AQ = BQ (Arcs of equal radii)
PQ = PQ (common)
Therefore, $\Delta APQ \cong \Delta BPQ$ (SSS rule)
So, $\angle APQ = \angle BPQ$
Or $\angle APM = \angle BPM$ (C.P.C.T.)
Now in triangle PMA and PMB,
AP = BP (As before)
PM = PM (common)
$\angle APM = \angle BPM$ (Proved above)
Therefore, $\Delta PMA \cong \Delta PMB$ (SAS rule)
So, AM = BM and $\angle AMP = \angle BMP$ (C.P.C.T.)
As $\angle AMP + \angle BMP = 180°$ (Linear pair axiom)
We get $\angle AMP + \angle AMP = 180°$
$\Rightarrow \angle AMP = 90°$
Therefore, PM that is PMQ is the perpendicular bisector of AB.

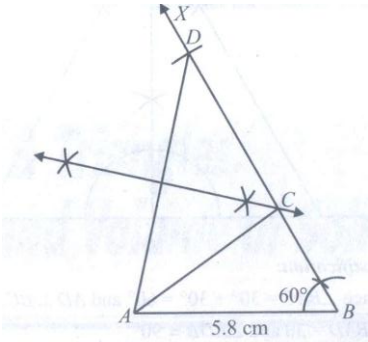


Q19. Construct a triangle ABC in which AB = 5.8 cm, BC+CA = 8.4 cm and $\angle B = 60°$. Justify your construction:

Sol. Step of Construction:
(i) Draw AB = 5.8 cm
(ii) Draw $\angle ABX = 60°$
(iii) From ray BX, cut off line segment BD = BC+CA = 8.4
(iv) Join AD
(v) Draw the perpendicular bisector of AD meeting BD at C.
(vi) Join AC to obtain the required triangle ABC.

Justification:
Clearly, C lies on the perpendicular bisector of AD.
$\therefore$ CA = CD
Now, BD = 8.4 cm
$\Rightarrow$ BC+CD = 8.4 cm

⇒ BC + CA = 8.4 cm
Hence, ΔABC is the required triangle.



Q20. Construct an equilateral triangle if its altitude is 6 cm. Give justifications for your construction.

Sol. Step of Construction:
(i) Draw a line XY.
(ii) Take any point D on this line.
(iii) Construct perpendicular PD on XY.
(iv) Cut a line segment AD from D equal to 6 cm.
(v) Make angles equal to 30° at A on both sides of AD. Say ∠CAD and ∠BAD where B and C lie on XY. Then ABC is the required triangle.
(vi) Draw perpendicular bisector of CD, which intersects XX' at point A. Join A to C.

Justification:
Since ∠BAC = 30°+30° = 60° and AD ⊥ BC. In Δ ABD,
∠BAD = 30 and ∠ADB = 90°
∴ ∠ABD = 60°, i.e. ∠ABC = 60°
Similarly ∠ACB =60°
Hence ΔABC is an equilateral triangle with altitude AD = 6 cm.