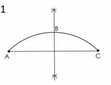
Exercise 13.1

Q1. Divide an arc of any length.

(i) Into two equal parts.



Solution:

Steps of construction:

1. Draw an arc $\overset{\frown}{AC}$.
2. Join A with C
3. Draw the right bisector of $\overline{AC}$ which intersects the arc $\overset{\frown}{AC}$ at point B.
4. Therefore, the given arc $\overset{\frown}{AC}$ has been divided into two equal arcs $\overset{\frown}{AB}$ and $\overset{\frown}{BC}$.

(ii) Into four equal parts



Solution:

Steps of construction:

1. Draw an arc $\overset{\frown}{AC}$.
2. Join A with C
3. Draw the right bisector of $\overline{AC}$ which intersects the arc $\overset{\frown}{AC}$ at point B.
4. Join B with A and C.
5. Draw the right bisectors of $\overline{AB}$ and $\overline{BC}$ which intersect the arc $\overset{\frown}{AC}$ at points D and E respectively.

6. Therefore, the given arc $\overset{\frown}{AC}$ has been divided into four equal arcs $\overset{\frown}{AD}$, $\overset{\frown}{DB}$, $\overset{\frown}{BE}$ and $\overset{\frown}{EC}$.

2. Practically find the centre of an arc ABC.



Solution:

Steps of Construction:

1. Draw an arc $\overset{\frown}{ABC}$.
2. Join A with B and B with C.
3. Draw LM and PQ right Bisectors of AB and BC respectively. LM and PQ intersect at point O.
4. O is the required centre of an arc ABC.

3. (i) If | $\overline{AB}$ | = 3 cm and | $\overline{BC}$ | = 4 cm are the lengths of two chords of an arc, then locate the centre of the arc.



Solution:

Steps of Construction:

1. Draw an arc $\overset{\frown}{ABC}$.
2. Draw | $\overline{AB}$ | = 3 cm and | $\overline{BC}$ | = 4
3. Draw $\overline{LM}$ and $\overline{PQ}$ right bisectors of $\overline{AB}$ and $\overline{BC}$ respectively. $\overline{LM}$ and $\overline{PQ}$ intersect at point O.
4. O is the required centre of an arc ABC.

(ii) If | $\overline{AB}$ | = 3.5 cm and | $\overline{BC}$ | = 5 cm are the lengths of two chords of an arc, then locate the centre of the arc.

Solution:

Steps of Construction:

1. Draw an arc $\overset{\frown}{ABC}$.
2. Draw |AB| = 3.5 cm and |BC| = 5 cm.
3. Draw $\overline{LM}$ and $\overline{PQ}$ right bisectors of $\overline{AB}$ and $\overline{BC}$ respectively. $\overline{LM}$ and $\overline{PQ}$ intersect at pint O.
4. O is the required centre of an arc ABC.



4. For an arc draw two perpendicular bisectors of the chords $\overline{PQ}$ and $\overline{QR}$ of this arc, construct a circle through P, Q and R.



Solution:

Steps of Construction:

1. Draw an arc $\overset{\frown}{PQR}$.
2. Join P with Q and Q with R.
3. Draw $\overline{LM}$ and $\overline{AB}$ right bisectors of $\overline{PQ}$ and $\overline{QR}$

respectively. $\overline{LM}$ and $\overline{AB}$ intersect at point O.

4. O is the required centre of an arc $\overset{\frown}{PQR}$.
5. Draw a circle with radius $\overline{OP}$ = $\overline{OQ}$ = $\overline{OR}$ having centre at O, which is the required circle.

5. Describe circle of radius 5 cm passing through points A and B, 6 cm apart. Also find distance from the centre to the line segment AB.



Solution:

Steps of Construction:

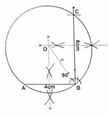
1. We draw a line segment AB of length 6cm
2. We draw right bisector of Ab intersecting it at point C.
3. From points A and B we draw arcs of radius 5cm each, intersecting the bisector at point O.
4. Taking O as centre we draw a circle of radius 5cm passing through the points A and B.

5. To find the distance of centre O from AB we consider right angle OAC.

By Pythagoras theorem.

$$\left(m\overline{OC}\right)^2+\left(m\overline{AC}\right)^2=\left(m\overline{OA}\right)^2$$
$$\left(m\overline{OC}\right)^2+(3)^2=(5)^2$$
$$\left(m\overline{OC}\right)^2=25-9$$
$$\left(m\overline{OC}\right)^2=16$$
$$m\overline{OC}=4\text{cm}$$

6. If | $\overline{AB}$ | = 4 cm and | $\overline{BC}$ | = 6 m, such that $\overline{AB}$ is perpendicular to $\overline{BC}$, construct a circle through points A, B and C. Also measure its radius.



Solution:

Steps of Construction:

1. Draw $\overline{AB}$ = 4 cm and $\overline{BC}$ = 6 m, such that $\overline{AB}$ is perpendicular to $\overline{BC}$.
2. We draw right bisectors of $\overline{AB}$ and $\overline{BC}$, intersecting each other at point O.

3. Taking O as centre we draw a circle of radius $m\overline{OA}$ = $m\overline{OB}$ = $m\overline{OC}$ passing through the points A, B and C.
4. The radius is measured to be 3.6 cm
5. By Pythagoras theorem

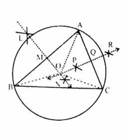
$$r^2=2^2+3^2$$
$$r^2=4+9$$
$$r=\sqrt{13}$$
$$r=3.6cm$$

(i) Circumscribe a circle about a given triangle:

Given:

Triangle ABC.

Steps of Construction:



1. Draw $\overline{LMN}$ as perpendicular bisector of side $\overline{AB}$.
2. Draw $\overline{PQR}$ as perpendicular bisector of side $\overline{AC}$.
3. $\overline{LN}$ and $\overline{PP}$ intersect at point O.
4. With centre O and radius $m\overline{OA} = m\overline{OB} = m\overline{OC}$, draw a circle.

This circle will pass through A, B and C whereas O is the circumcenter of the circumscribed circle.

Remember:

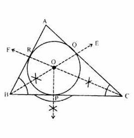
The circle passing through, the vertices of triangle ABC is known as **circumcircle**, its radius as **circumradius** and centre as **circumcenter.**

(ii) Inscribe a circle in a given triangle:

Given:

A triangle ABC.

Steps of Construction:

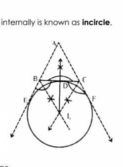


1. Draw $\overrightarrow{BE}$ and $\overrightarrow{CF}$ to bisect the angles ABC and ACB respectively. Rays $\overrightarrow{BE}$ and $\overrightarrow{CF}$ intersect each other at point O.

2. O is the centre of the inscribed circle.
3. From O draw $\overline{OP}$ perpendicular to $\overline{BC}$. With centre O and radius $\overline{OP}$ draw a circle. This circle is the inscribed circle of triangle ABC.

Remember:

A circle which touches the three sides of a triangle internally is known as **incircle**, its radius as **inradius** and centre as **in centre**.



(iii) Escribe a circle to a given triangle:

Given:

A triangle ABC

Steps of Construction:

1. Produce the sides $\overline{AB}$ and $\overline{AC}$ of ΔABC.
2. Draw bisectors of exterior angles ABC and ACB. These bisectors of exterior angles meet at I_1.
3. From I_1 draw perpendicular on side $\overline{BC}$ of ΔABC. Which I_1D intersect BC at D. I_1D is the radius of the escribed circle with centre at I_1.
4. Draw the circle with radius I_1D and centre at I_1 that will touch the side BC of the ΔABC externally and the produced sides AB and AC.

Escribed circle:

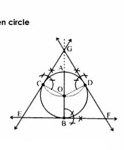
The circle touching one side of the triangle externally and two produced sides internally is called escribed circle (e-circle). The centre of e-circle is called **e-centre** and radius is called **e-radius**.

(iv) Circumscribe an equilateral triangle about a given circle

Given:

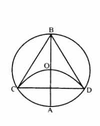
A circle with centre O of reasonable radius.

Steps of Construction:



1. Draw $\overline{AB}$, the diameter of the circle, for locating.
2. Draw an arc of radius $m\overline{OA}$ with centre at A for locating points C and D on the circle.
3. Join O to the points C and D.
4. Draw tangents to the circle at points B, C and D.
5. These tangents intersect at points E, F and G.

(v) Inscribe an equilateral triangle in a given circle.



Given:

A circle with centre at O.

Steps of Construction:

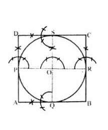
1. Draw any diameter $\overline{AB}$ of the circle.
2. Draw an arc of radius OA from point A. The arc cuts the circle at points C and D.

3. Join the prints B, C and D to form straight line segments $\overline{BC}$, $\overline{CD}$ and $\overline{BD}$. Triangle BCD is the required inscribed equilateral triangle.

(vi) Circumscribe a square about a given circle:

Given:

A circle with centre at O.



Steps of Construction:

1. Draw two diameters $\overline{PR}$ and $\overline{QS}$ which bisect each other at right angle.
2. At points P, Q, R and S draw tangents to the circle.
3. Produce the tangents to meet each other at A, B, C and D. ABCD is the required circumscribed square.

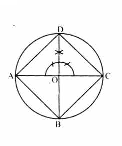
(vii) Inscribe a square in a given circle:

Given:

A circle, with centre at O.

Steps of Construction:

1. Through O draw two diameters AC and BD which bisect each other at right angle.
2. Join A with B, B with C, C with D and D with A. ABCD is the required square inscribed in the circle.

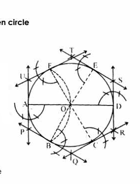


(viii) Circumscribe a regular hexagon about a given circle

Given:

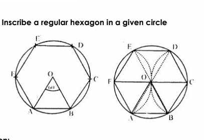
A circle with centre at O.

Steps of Construction:



1. Draw any diameter $\overline{AD}$.
2. From point A draw an arc of radius $\overline{AO}$ (the radius of the circle), which cuts the circle at points B and F.
3. Join B with O and extend it to meet the circle at E.
4. Join F with O and extend it to meet the circle at C.
5. Draw tangents to the circle at points A, B, C, D, E and F intersecting one another at points P, Q, R. S, T and U respectively.
6. Thus, PQRSTU is the circumscribed regular hexagon.

(ix) Inscribe a regular hexagon in a given circle



Given:

A circle, with centre at O.

Steps of Construction:

1. Take any point A on the circle and point with O.
2. From point A, draw an arc of radius $\overline{OA}$ which intersects the circle at point B and F.
3. Join O and A with points B and F.
4. ΔOAB and ΔOAF are equilateral therefore ∠AOB and ∠AOF are of measure 60° i.e., $m\overline{OA} = m\overline{AB} = m\overline{AF}$.
5. Produce $\overline{FO}$ to meet the circle at C. Join B to C. Since in ∠BOC = 60° therefore $m\overline{BC} = m\overline{OA}$.
6. From C and F, draw arcs of radius $\overline{OA}$, which intersect the circle at points D and E.
7. Join C to D, D to E and E to F ultimately. We have $m\overline{OA} = m\overline{OB} = m\overline{OC} = m\overline{OD} = m\overline{OE} = m\overline{OF}$

Thus, the figure ABCDEF is a regular hexagon inscribed in the circle.

Exercise 13.2

1. Circumscribe a circle about a triangle ABC with sides

$|\overline{AB}| = 6$ cm, $|\overline{BC}| = 3$ cm, $|\overline{CA}| = 4$ cm

Also measure its circum radius.

Solution:

Given:

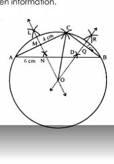
Three sides

$|\overline{AB}| = 6$ cm, $|\overline{BC}| = 3$ cm, $|\overline{CA}| = 4$ cm

Required:

To construct a circumscribed circle about a triangle using given information.

Steps of Construction:



1. Draw a line segment $|AB| = 6$ cm
2. With centre at A, draw an arc of radius 4 cm.
3. With centre at B, draw an arc of radius 3 cm which cuts the previous arc at point C.
4. Join C with A and B.
5. Thus ABC is the required triangle.
6. Draw $\overline{LMN}$ as perpendicular bisector of side $\overline{AB}$.
7. Draw $\overline{PQR}$ as perpendicular bisector of side $\overline{BC}$.
8. $\overline{LN}$ and $\overline{PR}$ intersect at point O.

9. With centre O and radius $m\overline{OA} = m\overline{OB} = m\overline{OC}$, draw a circle.
10. This circle will pass through A, B and C whereas O is circum center of the circumscribed circle

Here $m\overline{OA} = m\overline{OB} = m\overline{OC} = 3.3$ cm.

2. Inscribe a circle in a triangle ABC with sides.

$|\overline{AB}| = 5$ cm, $|\overline{BC}| = 3$ cm, $|\overline{CA}| = 3$ cm. Also measure its in-radius.

Solution:

Given:

Three sides

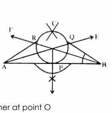
$|\overline{AB}| = 5$ cm, $|\overline{BC}| = 3$ cm, $|\overline{CA}| = 3$ cm

Required:

To construct an inscribed circle about a triangle using given information.

Steps of Construction:

1. Draw a line segment $|\overline{AB}| = 5$cm
2. With centre at A, draw an arc of radius 3 cm.
3. With centre at B, draw an arc of radius 3 cm which cuts the previous arc at point C.



4. Join C with A and B.
5. Thus, ABC is the required triangle.
6. Draw $\overrightarrow{AE}$ and $\overrightarrow{BF}$ to bisect the angles BAC and ABC. Rays $\overrightarrow{AE}$ and $\overrightarrow{BF}$ intersect each other at point O
7. O is the centre of the inscribed circle.

8. From O draw $\overline{OP}$ perpendicular to $\overline{AB}$.
9. With centre O and radius $\overline{OP}$ draw a circle.
10. This circle is the inscribed circle of triangle ABC.

Here $m\overline{OP} = m\overline{OQ} = m\overline{OR} = 1$ cm (approximately).

3. Escribe a circle opposite to vertex A to a triangle ABC with sides

$|\overline{AB}| = 6$ cm, $|\overline{BC}| = 4$ cm, $|\overline{CA}| = 3$ cm. Find its radius also.

Solution:

Given:

Three sides

$|\overline{AB}| = 6$ cm, $|\overline{BC}| = 4$ cm, $|\overline{CA}| = 3$ cm

Required:

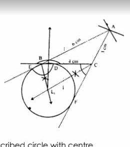
To construct an escribed circle opposite to vertex A to a triangle using given information.

Steps of Construction:

1. Draw a line segment $|\overline{BC}| = 4$ cm.
2. With centre at B, draw an arc of 6 cm.
3. With centre at C, draw an arc of 3cm which cuts

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the previous arc at point A.



4. Join A with B and C.
5. Thus, ABC is the required triangle.
6. Produce the sides AB and BC of ΔABC.
7. Draw bisectors of exterior angles ABC and ACB. These bisectors of exterior angles meet at L.
8. From L, draw perpendicular to side BC of ΔABC which intersects BC at D. LD is the radius of the escribed circle with centre at L.
9. Draw the circle with radius LD and centre at L, that will touch the side BC of the ΔABC externally and the produced sides AB and AC internally.

[redacted]

4. Circumscribe a circle about an equilateral triangle ABC with each side of length 4 cm.

Solution:

Given:

Equilateral triangle ABC with each side of length 4cm.

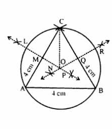
Required:

To construct a circumscribed circle about an equilateral triangle using given information.

Steps of Construction:

1. Draw a line segment $|\overline{AB}| = 4$ cm
2. With centre at A, draw an arc of radius 4 cm.
3. With centre at B, draw an arc of radius 4 cm which cuts the previous arc

at point C.



4. Join C with A and B.
5. Thus $\overline{ABC}$ is the required triangle.
6. Draw $\overline{LMN}$ as perpendicular bisector to of side AC.
7. Draw $\overline{PQR}$ as perpendicular bisector of side $\overline{BC}$.
8. $\overline{LN}$ and $\overline{PQ}$ intersect at point O.
9. With centre at O and radius $m\overline{OA} = m\overline{OB} = m\overline{OC}$, draw a circle.
10. This circle will pass through A, B and C whereas O is circumcenter of the circumscribed circle

5. Inscribe a circle in an equilateral triangle ABC with each side of length 5 cm.

Solution:

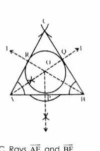
Given:

Equilateral triangle ABC with each side of length 5 cm.

Required:

To construct an inscribed circle about a triangle using given information.

Steps of Construction:



1. Draw a line segment $|\overline{AB}| = 5$cm
2. With centre at A, draw an arc of radius 5cm.
3. With centre at B, draw an arc of radius 5cm which cuts the previous arc at point C.
4. Join C with A and B.
5. Thus ABC is the required triangle.
6. Draw $\overrightarrow{AE}$ and $\overrightarrow{BF}$ to bisect the angles BAC and ABC. Rays $\overrightarrow{AE}$ and $\overrightarrow{BF}$ intersect each other at point O
7. O is the centre of the inscribed circle.
8. From O draw $\overline{OP}$ perpendicular to $\overline{AB}$.
9. With centre O and radius OP draw a circle.
10. This circle is the inscribed circle of triangle ABC.

6. Circumscribe and inscribe circles with regard to a right-angle triangle with sides, 3 cm, 4 cm and 5 cm.

Solution:

Given:

Three sides

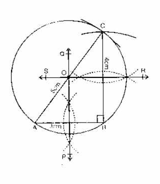
$|\overline{AB}| = 3$ cm, $|\overline{BC}| = 4$ cm, $|\overline{CA}| = 5$ cm.

Required:

To construct an inscribed and circumscribed circle about a triangle using given information.

(i) Circumcircle

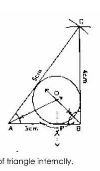
Steps of Construction:



1. Construct a right-angle triangle ABC with sides 3 cm, 4 cm and 5 cm.
2. Draw right bisectors $\overline{PQ}$ and $\overline{RS}$ of each side $\overline{AB}$ and $\overline{BC}$ respectively intersecting each other at point O.
3. Taking O as centre and radius equal to $m\overline{OA}$ or $m\overline{OB}$ or $m\overline{OC}$, we draw a circle passing trough the points A, B and C.
4. This is our required circumcircle whose radius is measured to be 2.5 cm.

(ii) Inscribed Circle

Steps of Construction:



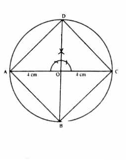
1. Construct a right-angle triangle ABC according to the given conditions.
2. We draw the bisectors of ∠A and ∠B intersecting each other at point O.
3. From point O. we draw $\overline{OP}$ perpendicular to $\overline{AB}$.
4. Taking O as centre and radius equal to $\overline{OP}$, we draw a circle, touching three sides of triangle internally.
5. This is the required incircle whose radius is measured to be 1 cm.

7. In and around the circle of radius 4 cm draw a square.

(i) In a circle of radius 4 cm draw a square:

Solution:

Given:



A circle of radius 4cm.

Required:

Draw a square inside the circle.

Steps of Construction:

1. Draw circle of radius 4cm with O as a centre.
2. Through O draw two diameters $\overline{AC}$ and $\overline{BD}$ which bisect each other at right angle
3. Join A with B, B with C, C with D and D with A.
4. Thus, ABCD is the required square inscribed in the circle.

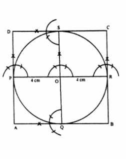
(ii) Around a circle of radius 4 cm draw a square:

Solution:

Given:

A circle of radius 4cm.

Required:



Draw a square around the circle.

Steps of Construction:

1. Draw circle of radius 4cm with O as a centre.
2. Draw two diameters $\overline{PR}$ and $\overline{QS}$ which bisect each other at right angle.
3. At point P, Q, R and S draw tangents to meet each other at A, B, C and D. ABCD is the required circumscribed square.

8. In and around the circle of radius 3.5 cm draw a regular hexagon.

(i) In a circle of radius 3.5 cm draw a hexagon:

Solution:

Given:

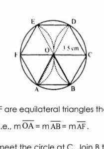
A circle of radius 3.5cm.

Required:

Draw a regular hexagon inside the circle.

Steps of Construction:

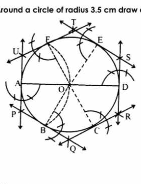
1. Take any point O.
2. Take O as centre of and draw a circle of radius 3.5 cm.
3. Take any point A on the circumference of the circle.
4. From point A, draw an arc of radius $\overline{OA}$ which intersects the circle at point B and F.
5. Join O and A with points B and F.



6. ΔOAB and ΔOAF are equilateral triangles therefore ∠AOB and ∠AOF are of measure 60° i.e., $m\overline{OA} = m\overline{AB} = m\overline{AF}$.
7. Produce $\overline{FO}$ to meet the circle at C. Join B to C, Since in ∠BOC = 60° therefore $m\overline{BC} = m\overline{OA}$.
8. From C and F, draw arcs of radius $\overline{OA}$, which intersect the circle at points D and E.
9. Join C to D, D to E and E to F. Ultimately we have $m\overline{OA} = m\overline{OB} = m\overline{OC} = m\overline{OD} = m\overline{OE} = m\overline{OF}$

Thus, the figure ABCDEF is a regular hexagon inscribed in the circle.

(ii) Around a circle of radius 3.5 cm draw a regular hexagon:



Given:

A circle of radius 3.5 cm.

Steps of Construction:

1. Draw a diameter $\overline{AD} = 7$ cm.
2. From point A draw an arc of radius $\overline{AO} = 3.5$ cm(the radius of the circle), which cuts the circle at points B and F.
3. Join B with O and extend it to meet the circle at E.
4. Join F with O and extend it to meet the circle at C.
5. Draw tangents to the circle at points A, B, C, D, E and F intersecting one another at points P, Q, R, S, T and U respectively.
6. Thus, PQRSTU is the circumscribed regular hexagon.

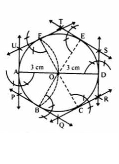
9. Circumscribe a regular hexagon about a circle of radius 3cm.

Given:

A circle of radius 3 cm.

Steps of Construction:

1. Draw a diameter $\overline{AD} = 6$ cm.
2. From point A draw an arc of radius $\overline{AO} = 3$ cm (the radius of the circle), which cuts the circle at points B and F.



3. Join B with O and extend it to meet the circle at E.
4. Join F with O and extend it to meet the circle at C.
5. Draw tangents to the circle at points A, B, C, D, E and F intersecting one another at points P, Q, R, S, T and U respectively.
6. Thus, PQRSTU is the circumscribed regular hexagon.

Exercise 13.3

1. In an arc ABC the length of the chord $|BC| = 5$ cm. Draw a secant $|PBC| = 6$ cm, where P is the point outside the arc. Draw a tangent through point P to the arc.

Steps of Construction:

(i) Draw an arc $\overset{\frown}{ABC}$

(ii) Take a chord $\overline{BC} = 3$cm.

(iii) Produce $\overline{CB}$ towards B and take point P that $\overline{PBC}$ secant in 8cm.

(iv) Find M, the midpoint of $\overline{CP}$.

(v) Take M as centre and draw a semi-circle.

(vi) Draw $\overline{BR} \perp \overline{CP}$ which meets the semi-circle at point Q.

(vii) Take P as centre and draw an arc of radius $\overline{PQ}$, this arc intersects the given arc of 1.

(viii) Join P to T and produce it.

Result:

$\overleftrightarrow{PT}$ is the required tangent.



2. Construct a circle with diameter 8 cm. Indicate a point C, 5 cm away from its circumference. Draw a tangent from point C to the circle without using its centre.

Steps of Construction:

(i) Draw a circle of radius $\frac{8}{2} = 4$ cm with centre at O.

(ii) Take a secant $\overset{\frown}{ABC}$ such that point C is 5cm away from circumference of the circle.

(iii) Find M, the midpoint of $\overline{AC}$.

(iv) Draw a semi-circle of radius $\frac{1}{2}\overline{AC} = r(\overline{CM})$ with centre at M.

(v) Draw a perpendicular at point B which meets the semi-circle at D.

(vi) Draw an arc arc radius $r(\overline{CD})$ with centre at C. This arc cuts the given circle at point E.

(vii) Join C with E.

Result:

$\overline{CE}$ is the required tangent.



3. Construct a circle of radius 2 cm. Draw two tangents making an angle of 45° with each other.

Steps of Construction:

(i) Take a point O.

(ii) Take O as centre and draw a circle with radius 2 cm.

(iii) Draw $\overline{AOB}$ any diameter.

(iv) Draw $m\angle BOT = 90°$



(v) Draw tangents at point A and 3. These are $\overleftrightarrow{AQ}$ and $\overleftrightarrow{TP}$

Result:

$\overleftrightarrow{AQ}$ and $\overleftrightarrow{TP}$ are the required tangents that meet at point P at 45°.

4. Draw two perpendicular tangents to a circle of radius 3cm.

Steps of Construction:

(i) Take a point O.

(ii) Take O as centre and a circle of radius 3 cm.

(iii) Take $\overline{AOB}$ any diameter of the circle.

(iv) Draw $m\angle BOC = 90°$.

(v) Draw tangents at point A, C. These are $\overleftrightarrow{PT}$, $\overleftrightarrow{MQ}$

Result:

$\overleftrightarrow{MQ}$, $\overleftrightarrow{PT}$ are the required tangents that meet at point D at 90°.

5. Two equal circles are of 6 cm apart. Draw two direct common tangents of this pair of circles.

Steps of Construction:

(i) Draw $\overline{OO'} = 6$ cm.

(ii) Draw two circles of equal size on O and O'.

(iii) Draw $\overline{OL} \perp \overline{OO'}$ and produce towards O. $\overline{OL}$ produced meets the circle at C.

(iv) Draw $\overline{O'R} \perp OO'$ and produce it towards O. $\overline{O'R}$ produced meets the circle at D.

(v) Join A with B and produce it both sides.

(vi) Join C with D and produce both sides.

Result:

$\overleftrightarrow{AB}$ and $\overleftrightarrow{CD}$ are the common external tangents.

6. Draw two equal circles of each radius 2.4 cm. If the distance between their centres is 6 cm then draw their transverse tangents.

(i) Draw $m\overline{OO'} = 6$ cm.

(ii) Draw two circles of 2.4 cm radius on O and O'.

(iii) Find M, the midpoint of $\overline{OO'}$.

(iv) Find N, the midpoint of $\overline{MO'}$.

(v) Draw a circle with centre at N and of radius $\overline{NO'}$. This circle intersects the circle of O and P.

(vi) Join P with M and produce towards M. It touches the second circle at Q'.

(vii) Join P with M and produce towards M. $\overline{PM}$ produced touches the second circle at Q. $\overleftrightarrow{PQ}$, $\overleftrightarrow{PQ'}$ are the required tangents.

7. Draw two circles with radii 2.2 cm and 3.2cm if their centres are 6cm apart then draw two direct common tangents.

Steps of Construction:

(i) Draw $\overline{OO'}$ of length 6.2 cm.

(ii) Take O as centre and draw a circle with radius 3 cm.

(iii) Take O' as centre and draw a circle with radius 2.5 cm.

(iv) Take M, mid-point of $\overline{OO'}$. Take M as centre and draw a circle with radius m $\overline{MO'}$.

(v) Cut m$\overline{MO'}$ = 3 - 2.5 = 0.1 cm and take O as centre, draw the circle with radius m$\overline{OB}$. This circle intersects the circle C, at point A, A'.

(vi) Join O with A and produce it to meet the circle O' at point P. Similarly, join O with A' and produce it to meet the circle O' at point Q.

(vii) Draw $\overline{O'P} \perp \overline{OP}$ and $\overline{O'Q'} \perp \overline{OQ}$.

(viii) Join P with P' and Q with Q'.

Result:

$\overleftrightarrow{PP'}$ and $\overleftrightarrow{QQ'}$ are the required tangents.

8. Draw two circles with radii 3.5 cm and 2 cm. If their centres are 6cm apart then draw two transverse common tangents.

Ans. Conclusion:

(i) Take a line segment of measure $\overline{AB} = 6$cm.

(ii) Take O as centre and draw a circle with radius 3.5 cm.

(iii) Take O' as centre and draw a circle with radius 2.5 cm.

(iv) Taking N as centre draw a circle of radius 3.5 + 2 = 5.5 cm.

(v) Bisect the line segment $\overline{AB}$ at point M.

(vi) Take M as centre and draw a circle of radius $\overline{MA}$, which intersects the big circle of points C and D.

(vii) Join A with C and D to produce on both sides. Join B with C and D to meet the inner circle at E and F.

(viii) Draw $\overline{BG} \parallel \overline{AD}$ and $\overline{BF} \parallel \overline{AE}$.

(viii) Join F with Q and produce on both sides. Join F with P and produce on both sides.

Result:

$\overleftrightarrow{EQ}$ and $\overleftrightarrow{FP}$ are the required tangents.

9. Draw two common tangents to two touching circles of radii 2.5 cm and 3.5 cm.

Steps of Construction:

(i) Draw a line segment $\overline{OO'}$ of measure 2.5 + 3.5 = 6.0 cm.

(ii) Take O as centre and draw a circle with radius $r(\overline{OA}) = 3.5$ cm.

(iii) Take O' as centre and draw a circle with radius $r(\overline{O'A}) = 2.5$ cm. These circles touch each other at point M.

(iv) Draw $\overline{AB} \perp \overline{OO'}$.

Result:

$\overleftrightarrow{AB}$ is the required common tangents.

10. Draw two common tangents to two intersecting circle of radii 3 cm and 4 cm.

Steps of Construction:

(i) Take a line segment $\overline{AB}$ that $m\overline{AB} = 3 + 4 = 7$ cm.

(ii) Draw two circles of radii r = 4 cm and r = 3cm with centres at A and B respectively.

(iii) Taking M as centre draw a circle with radius 4 + 3 = 7 cm.

(iv) Bisect the line segment $\overline{AB}$ at point M.

(v) Take M as centre and draw a circle of radius m$\overline{MB}$, this circle intersects circle with radius r.cm of point Q.

(vi) Join A with P and Q and produce $\overline{AP}$, $\overline{AQ}$ to meet the larger circle at T, C.

(vii) Draw $\overline{BT} \perp \overline{AB}$ and $\overline{BC} \perp \overline{AC}$.

(viii) Join D with T and produce both sides.

(ix) Join C with E and produce both sides.

Result:

$\overleftrightarrow{DT}$ and $\overleftrightarrow{CE}$ are the required tangents.

11. Draw circles which touches both the arms of angles.

(i) 45° (ii) 60°

(i) 45°

Steps of Construction:

(i) Draw an angle ABC of 45°.

(ii) Draw $\overleftrightarrow{BP}$ bisector of angle $\angle ABC$.

(iii) Take any point O on $\overleftrightarrow{BP}$.

(iv) Drop $\overline{OM} \perp \overleftrightarrow{BA}$.

(v) Take O as centre and draw a circle with radius m$\overline{OM}$. This circle touches arm $\overleftrightarrow{BC}$ of it also.

(ii) 60°

Steps of Construction:

(i) Draw an angle $\angle ABC$ of 60°.

(ii) Draw $\overleftrightarrow{BP}$ bisector of angle $\angle ABC$.

(iii) Take any point O on $\overleftrightarrow{BP}$.

(iv) Drop $\overline{OM} \perp \overleftrightarrow{BC}$.

(v) Take O as centre and draw a circle with radius m$\overline{OM}$. This circle touches arm $\overleftrightarrow{BC}$ of it also.

Miscellaneous Exercise - 13

Q1. Multiple Choice Questions:

Three possible answers are given for the following questions. Tick (√) the correct answer:

(i) The circumference of a circle is called

(a) chord **(b)** segment **(c)** boundary

(ii) A line intersecting a circle is called:

(a) tangent **(b)** secant **(c)** chord

(iii) The portion of a circle between two radii and an arc is called

(a) sector **(b)** segment **(c)** chord

(iv) Angle inscribed in a semi-circle is

(a) $\frac{\pi}{2}$ **(b)** $\frac{\pi}{3}$ **(c)** $\frac{\pi}{4}$

(v) The length of the diameter of a circle is how many times the radius of the circle

(a) 1 **(b)** 2 **(c)** 3

(vi) The tangent and radius of a circle at the point of contact are

(a) parallel **(b)** not perpendicular **(c)** perpendicular

(vii) Circles having three points in common:

(a) overlapping **(b)** collinear **(c)** non collinear

(viii) If two circles touch each other, their centres and point of contact are

(a) coincident **(b)** non-collinear **(c)** collinear

(ix) The measure of the external angle of a regular hexagon is

(a) $\frac{\pi}{3}$ **(b)** $\frac{\pi}{6}$ **(c)** $\frac{\pi}{2}$

(x) If the incentre and circumcentre of a triangle coincide, the triangle is

(a) an isosceles **(b)** a right triangle **(c)** an equilateral

(xi) The measure of the external angle of a regular octagon is

(a) $\frac{\pi}{4}$ **(b)** $\frac{\pi}{2}$ **(c)** $\frac{\pi}{3}$

(xii) Tangents drawn at the end points of the diameter of a circle are

(a) parallel **(b)** perpendicular **(c)** intersecting

(xiii) The lengths of two transverse tangents to a pair of circles are

(a) unequal **(b)** equal **(c)** overlapping

(xiv) How many tangents can be drawn from a point outside the circle?

(a) 1 **(b)** 2 **(c)** 3

(xv) If the distance between the centres of two circles is equal to the sum of their radii, then the circles will:

(a) intersect **(b)** do not intersect **(c)** touch each other externally

(xvi) If the two circles touch externally, then the distance between their centres is equal to the

(a) difference of their radii **(b)** sum of their radii **(c)** product of their radii

(xvii) How many common tangents can be drawn for two touching circles?

(a) 2 **(b)** 3 **(c)** 4

(xviii) How many common tangents can be drawn for two disjoint circles?

(a) 2 **(b)** 3 **(c)** 4

Answers:

(i)	c	(ii)	b	(iii)	a	(iv)	a	(v)	b
(vi)	c	(vii)	b	(viii)	c	(ix)	b	(x)	c
(xi)	b	(xii)	b	(xiii)	a	(xiv)	b	(xv)	c
(xvi)	b	(xvii)	b	(xviii)	c				

Q2. Write short answers of the following questions:

(i) Define and draw the following geometric figures:

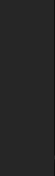
(a) The segment of a circle. (b) The tangent to a circle.

(c) The sector of a circle. (d) The inscribed circle.

(e) The circumscribed circle. (f) The ecribed circle.

(a) The segment of a circle

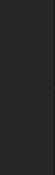
Solution:



The area contained between a chord and the arc which it cuts off is called a segment of the circle.

(b) The tangent to a circle.

Solution:



A line that touch a circle at a single point is called its tangent. $\overline{AB}$ is tangent to the circle with centre O at point P.

(c) The sector of a circle.

Solution:



The area contained between two radii and the arc of the circle which they intercept, is called a sector of the circle.

(d) The inscribed circle.

Solution:

The sides of triangle touch a circle internally, such a circle is called inscribed circle of the triangle.

(e) The circumscribed circle.

Solution:

A circle that passes through the vertices of a triangle is called circumscribed circle of the triangle.

(f) The ecribed circle.

Sol=tion:

A circle that touches two sides of a triangle internally and one side externally is called a escribed circle.

(ii) The length of each side of a regular octagon is 3 cm. Measure its perimeter.

Solution:

Length of side = 3 cm

Number of sides of an octagon = 8

Perimeter = 3 × 8 = 24 cm

(iii) Write down the formula for finding the angle subtended by the ride of a n-sided polygon at the centre of the circle.

Ans.

$$\frac{360^\circ}{n}$$

(iv) The length of the side of a regular pentagon is 5 cm what is its perimeter?

Solution

Length of each side = 5 cm

Number of sides = 5

Perimeter = 5 × 5 = 25 cm

Q3. Fill in the blanks:

1) The boundary of a circle is called _____.

2) The circumference of a circle is called _____ of the circle.

3) The line joining the two points of circle is called _____.

4) The point of intersection of perpendicular bisectors of two non-parallel chords of a circle is called the _____.

5) Circles having three points in common will _____.

6) The distance of a point inside the circle from its centre is _____ than the radius.

7) The distance of a point outside the circle from its centre is _____ than the radius.

8) A circle has only _____centre.

9) One and only one circle can be drawn through three _____ points.

10) Angle inscribed in a semi-circle is a _____ angle.

11) If two circles touch each other, the point of _____ and their _____ are collinear.

12) If two circles touch each other, their point of contact and centres are _____.

13) From a point outside the circle _____ tangents can be drawn.

14) A tangent is _____ to the radius of a circle at its point of contact.

15) The straight line drawn ⊥ to the raius of a circle is called the _____ to the circle.

16) Two circles cannot cut each other at more than _____ points.

17) The ⊥ bisector of a chord of a circle passes through the _____.

18) The length of two direct common tangents to two circles are _____ to each other.

19) The length of two transverse common tangents to two circles are _____ to each other.

20) If the incentre and circum-centre of a triangle coincide the triangle is _____.

21) Two intersecting circles are not _____.

22) The centre of an inscribed circle is called _____.

23) The centre of a circumscribed circle is called _____.

24) The radius of an inscribed circle is called _____.

25) The radius of a circumscribed circle is called _____.

Answer:

1	Circumference	2	Boundary	3	Chord	4	Centre	5	Coincide
6	Less	7	Greater	8	One	9	Non-collinear	10	Right
11	Contact, centres	12	Collinear	13	Two	14	Perpendicular	15	Tangent
16	Two	17	Centre	18	Equal	19	Equal	20	Equilateral
21	Concentric	22	Incentre	23	Circumcentre	24	Inradius	25	Circumradius

Summary

- A circle of any radius can be traced by rotating a compass about fixed point.
- The perpendicular bisectors of two non-parallel chords of a circle intersect at a point which is known as centre of circle.
- A circle can be drawn through given three non-collinear points.
- When a part of circumference of a circle is given, the circle can be completed.
- If a triangle is given, the circumscribed circle, inscribed circle and escribed circle opposite to each vertex can be constructed.
- If a circle is given, then the circumscribed and inscribed equilateral triangles can be constructed.
- For a given circle, the circumscribed and inscribed squares can be drawn.
- For a given circle, the circumscribed and inscribed regular hexagon can be constructed.

- We can draw tangents to a given arc as its midpoint, it's any end point, and a point not on the arc.
- Tangents can be drawn, to a given circle, when a point is on its circumference and from a point outside the circle.
- Tangents to two unequal touching circles can be traced.
- Direct or transverse common tangents of two equal circles or two unequal circles can be drawn.
- We can construct a circle touching the arms of a given angle.
- A circle passing through a given point between two converging lines and touching each of them, can be traced.