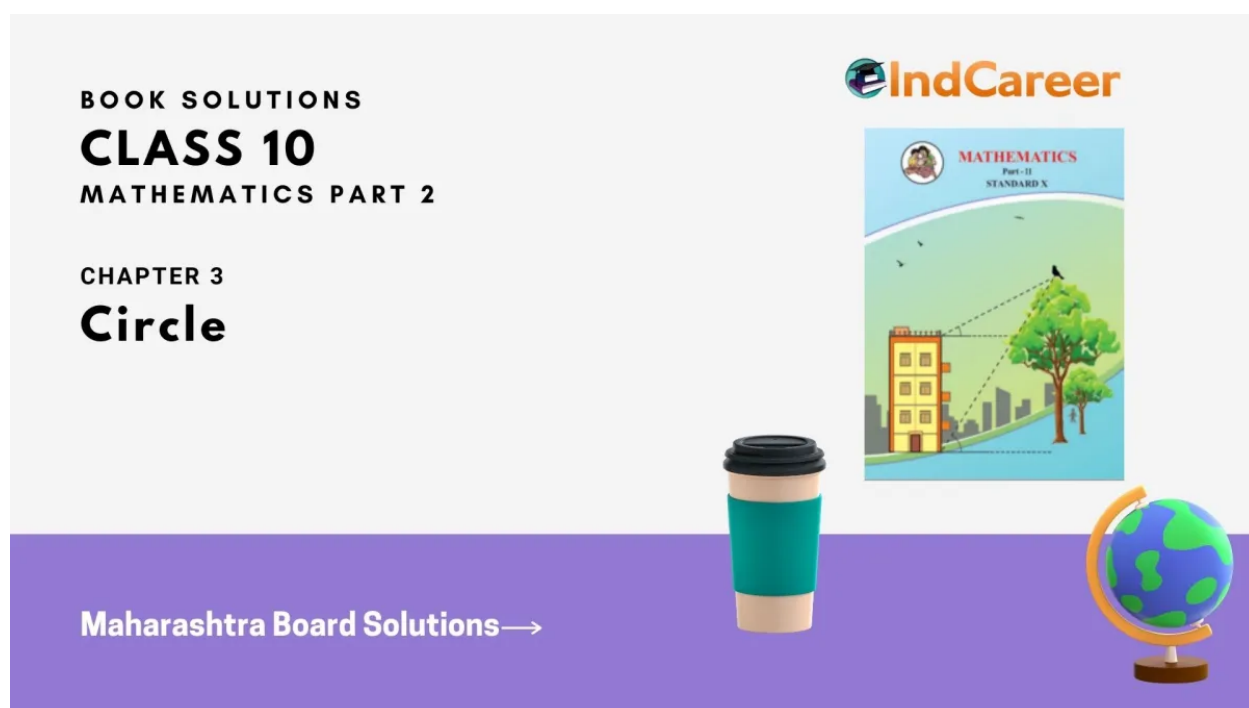


Maharashtra Board Solutions for Class 10-Maths (Part 2): Chapter 3- Circle



For any clarifications or questions you can write to info@indcareer.com

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Maharashtra Board Solutions for Class 10-Maths (Part 2): Chapter 3- Circle

Class 10: Maths Chapter 3 solutions. Complete Class 10 Maths Chapter 3 Notes.

Maharashtra Board Solutions for Class 10-Maths (Part 2): Chapter 3- Circle

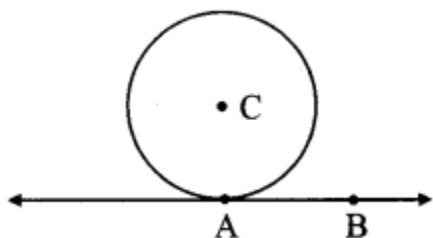
Maharashtra Board 10th Maths Chapter 3, Class 10 Maths Chapter 3 solutions

Practice Set 3.1

Question 1.

In the adjoining figure, the radius of a circle with centre C is 6 cm, line AB is a tangent at A. Answer the following questions.

- What is the measure of $\angle CAB$? Why?
- What is the distance of point C from line AB? Why?
- $d(A, B) = 6$ cm, find $d(B, C)$.
- What is the measure of $\angle ABC$? Why?



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Solution:

i. line AB is the tangent to the circle with centre C and radius AC. [Given]

$\therefore \angle CAB = 90^\circ$ (i) [Tangent theorem]

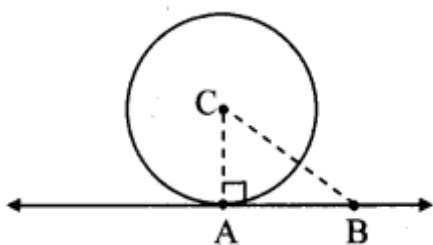
ii. seg CA $\perp$ line AB [From (i)]

radius = l(AC) = 6 cm

$\therefore$ The distance of point C from line AB is 6 cm.

iii. In $\triangle CAB$, $\angle CAB = 90^\circ$ [From (i)]

$\therefore BC^2 = AB^2 + AC^2$. [Pythagoras theorem]



$$= 6^2 + 6^2$$

$$= 2 \times 6^2$$

$\therefore BC = \sqrt{2 \times 6^2}$ [Taking square root of both sides]

$$= 6\sqrt{2} \text{ cm}$$

$\therefore d(B, C) = 6\sqrt{2} \text{ cm}$

iv. In $\triangle ABC$,

AC = AB = 6cm

$\therefore \angle ABC = \angle ACB$ [Isosceles triangle theorem]

Let $\angle ABC = \angle ACB = x$

In $\triangle ABC$,

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$\angle CAB + \angle ABC + \angle ACB = 180^\circ$ [Sum of the measures of angles of a triangle is 180°]

$$\therefore 90^\circ + x + x = 180^\circ$$

$$\therefore 90 + 2x = 180^\circ$$

$$\therefore 2x = 180^\circ - 90^\circ$$

$$\therefore x = 90^\circ / 2$$

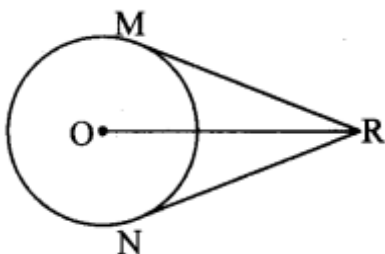
$$\therefore x = 45^\circ$$

$$\therefore \angle ABC = 45^\circ$$

Question 2.

In the adjoining figure, O is the centre of the circle. From point R, seg RM and seg RN are tangent segments touching the circle at M and N. If (OR) = 10 cm and radius of the circle = 5 cm, then

- What is the length of each tangent segment?
- What is the measure of $\angle MRO$?
- What is the measure of $\angle MRN$?

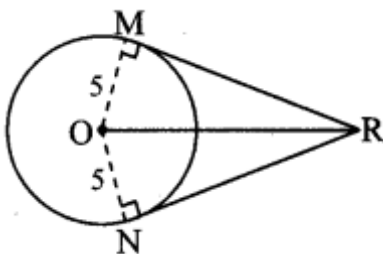


Solution:

seg RM and seg RN are tangents to the circle with centre O. [Given]

$$\therefore \angle OMR = \angle ONR = 90^\circ \text{ [Tangent theorem]}$$

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i. In $\triangle OMR$, $\angle OMR = 90^\circ$

$\therefore OR^2 = OM^2 + RM^2$ [Pythagoras theorem]

$\therefore 10^2 = 5^2 + RM^2$

$\therefore 100 = 25 + RM^2$

$\therefore RM^2 = 75$

$\therefore RM = \sqrt{75}$ [Taking square root of both sides]

$\therefore RM = RN$ [Tangent segment theorem]

Length of each tangent segment is $\sqrt{75}$ cm.

ii. In $\triangle RMO$,

$\angle OMR = 90^\circ$ [Tangent theorem]

$OM = 5$ cm and $OR = 10$ cm

$\therefore OM = \frac{1}{2} OR$

$\therefore \angle MRO = 30^\circ$ (i) [Converse of $30^\circ - 60^\circ - 90^\circ$ theorem]

Similarly, $\angle NRO = 30^\circ$

iii. But, $\angle MRN = \angle MRO + \angle NRO$ [Angle addition property]

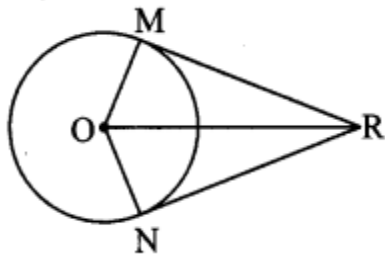
$= 30^\circ + 30^\circ$ [From (i)]

$\therefore \angle MRN = 60^\circ$

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Question 3.

Seg RM and seg RN are tangent segments of a circle with centre O. Prove that seg OR bisects $\angle MRN$ as well as $\angle MON$.

**Solution:**

Proof:

In $\triangle OMR$ and $\triangle ONR$,

seg RM $\cong$ seg RN [Tangent segment theorem]

seg OM $\cong$ seg ON [Radii of the same circle]

seg OR $\cong$ seg OR [Common side]

$\therefore \triangle OMR \cong \triangle ONR$ [SSS test of congruency]

$\therefore \angle MRO \cong \angle NRO$

$\angle MOR \cong \angle NOR$ } [c.a.c.t.]

$\therefore$ seg OR bisects $\angle MRN$ and $\angle MON$.

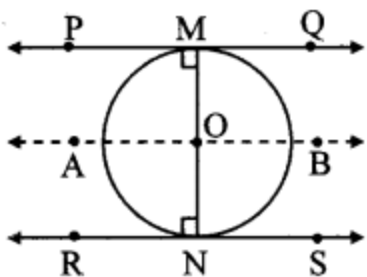
Question 4.

What is the distance between two parallel tangents of a circle having radius 4.5 cm?
Justify your answer.

Solution:

Let the lines PQ and RS be the two parallel tangents to circle at M and N respectively. Through centre O, draw line AB $\parallel$ line RS.

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$$OM = ON = 4.5 \text{ [Given]}$$

line AB $\parallel$ line RS [Construction]

line PQ $\parallel$ line RS [Given]

$\therefore$ line AB $\parallel$ line PQ $\parallel$ line RS

Now, $\angle OMP = \angle ONR = 90^\circ$ (i) [Tangent theorem]

For line PQ $\parallel$ line AB,

$$\angle OMP = \angle AON = 90^\circ \text{ (ii) [Corresponding angles and from (i)]}$$

For line RS $\parallel$ line AB,

$$\angle ONR = \angle AOM = 90^\circ \text{ (iii) [Corresponding angles and from (i)]}$$

$$\angle AON + \angle AOM = 90^\circ + 90^\circ \text{ [From (ii) and (iii)]}$$

$$\therefore \angle AON + \angle AOM = 180^\circ$$

$\therefore \angle AON$ and $\angle AOM$ form a linear pair.

$\therefore$ ray OM and ray ON are opposite rays.

$\therefore$ Points M, O, N are collinear. (iv)

$$\therefore MN = OM + ON \text{ [M - O - N, From (iv)]}$$

$$\therefore MN = 4.5 + 4.5$$

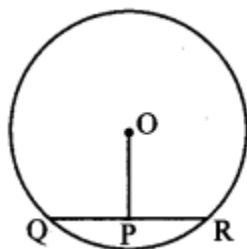
$$\therefore MN = 9 \text{ cm}$$

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∴ Distance between two parallel tangents PQ and RS is 9 cm.

Question 1.

In the adjoining figure, seg QR is a chord of the circle with centre O. P is the midpoint of the chord QR. If $QR = 24$, $OP = 10$, find radius of the circle. To find solution of the problem, write the theorems that are useful. Using them, solve the problem. (Textbook pg. no. 48)

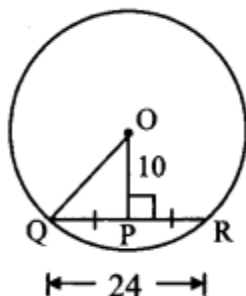


Solution:

Theorems which are useful to find solution:

- The segment joining the centre of a circle and the midpoint of a chord is perpendicular to the chord.
- In a right angled triangle, sum of the squares of the perpendicular sides is equal to square of its hypotenuse.

$QP = 12$ (QR) [P is the midpoint of chord QR]



$$12 \times 24 = 12 \text{ units}$$

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Also, seg $OP \perp$ chord QR [The segment joining centre of a circle and midpoint of a chord is perpendicular to the chord]

In $\triangle OPQ$, $\angle OPQ = 90^\circ$

$\therefore OQ^2 = OP^2 + QP^2$ [Pythagoras theorem]

$$= 10^2 + 12^2$$

$$= 100 + 144$$

$$= 244$$

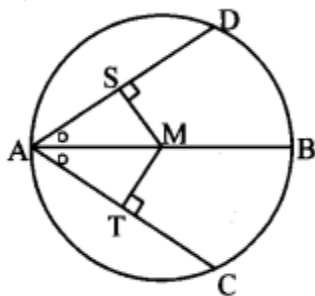
$\therefore OQ = \sqrt{244} = 2\sqrt{61}$ units.

$\therefore$ The radius of the circle is $2\sqrt{61}$ units.

Question 2.

In the adjoining figure, M is the centre of the circle and seg AB is a diameter, seg $MS \perp$ chord AD , seg $MT \perp$ chord AC , $\angle DAB \cong \angle CAB$.

- Prove that: chord $AD \cong$ chord AC .
- To solve this problem which theorems will you use?
 - The chords which are equidistant from the centre are equal in length.
 - Congruent chords of a circle are equidistant from the centre.



- Which of the following tests of congruence of triangles will be useful?
 - SAS
 - ASA
 - SSS
 - AAS
 - Hypotenuse-side test.

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Using appropriate test and theorem write the proof of the above example. (Textbook pg. no, 48)

Solution:

Proof:

i. $\angle DAB \cong \angle CAB$ [Given]

$\therefore \angle SAM \cong \angle TAM$ (i) [A – S – D, A – M – B, A – T – C]

In $\triangle SAM$ and $\triangle TAM$,

$\angle SAM \cong \angle TAM$ [From (i)]

$\angle ASM \cong \angle ATM$ [Each angle is of measure 90°]

seg AM $\cong$ seg AM [Common side]

$\therefore \triangle SAM \cong \triangle TAM$ [AAS [SAA] test of congruency]

$\therefore$ side MS $\cong$ side MT [c.s.c.t]

But, seg MS $\perp$ chord AD [Given]

seg MT $\perp$ chord AC

$\therefore$ chord AD $\cong$ chord AC [Chords of a circle equidistant from the centre are congruent]

ii. Theorem used for solving the problem:

The chords which are equidistant from the centre are equal in length.

iii. Test of congruency useful in solving the above problem is AAS ISAAI test of congruency.

Question 3.

i. Draw segment AB. Draw perpendicular bisector l of the segment AB. Take point P on the line l as centre,

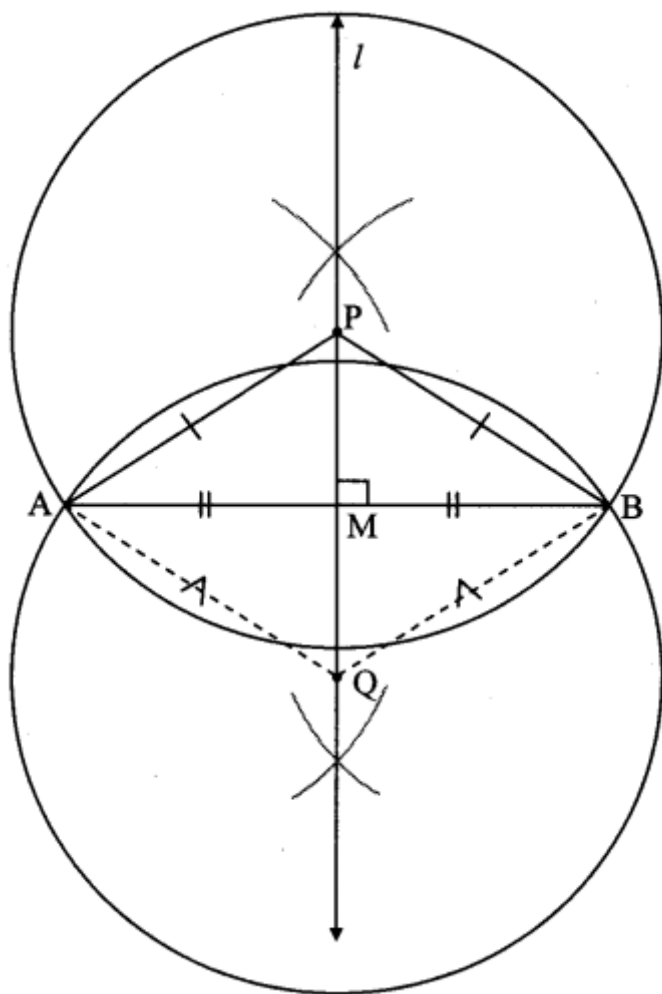
PA as radius and draw a circle. Observe that the circle passes through point B also. Find the reason.

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ii. Taking any other point Q on the line l , if a circle is drawn with centre Q and radius QA , will it pass through B ? Think.

iii. How many such circles can be drawn, passing through A and B ? Where will their centres lie? (Textbook pg. no. 49)

Solution:



i. Draw the circle with centre P and radius PA .

line l is the perpendicular bisector of seg AB .

Every point on the perpendicular bisector of a segment is equidistant from the endpoints of the segment.

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$\therefore PA = PB \dots$ [Perpendicular bisector theorem]

$\therefore PA = PB = \text{radius}$

$\therefore$ The circle with centre P and radius PA passes through point B.

ii. The circle with any other point Q and radius QA is drawn.

$QA = QB = \text{radius} \dots$ [Perpendicular bisector theorem]

$\therefore$ The circle with centre Q and radius QA passes through point B.

iii. We can draw infinite number of circles passing through A and B.

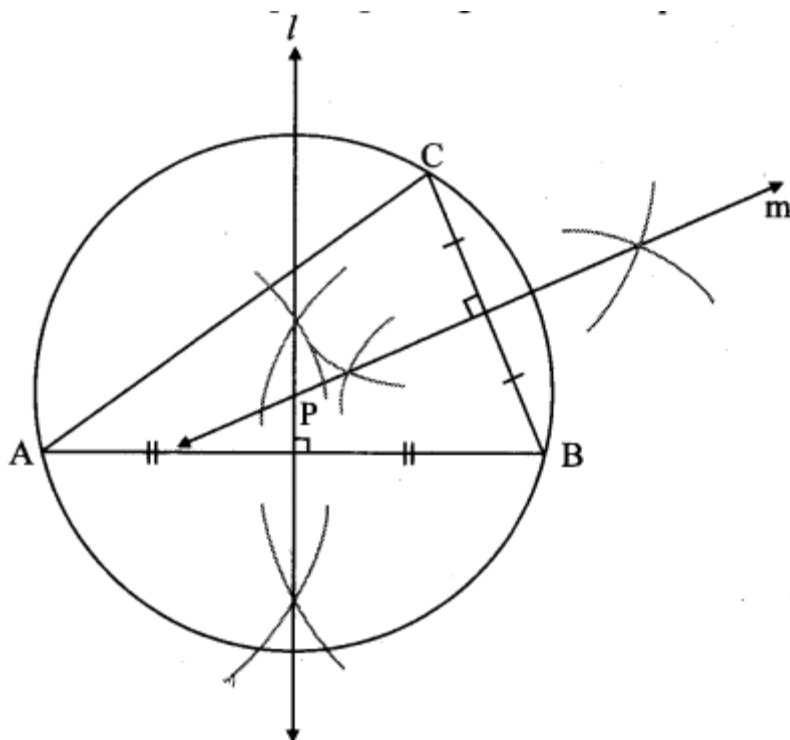
All their centres will lie on the perpendicular bisector of AB (i.e., line l)

Question 4.

i. Take any three non-collinear points. What should be done to draw a circle passing through all these points? Draw a circle through these points.

ii. Is it possible to draw one more circle passing through these three points? Think of it. (Textbook pg. no. 49)

Solution:



i. Let points A, B, C be any three non collinear points.

Draw the perpendicular bisector of seg AB (line l).

$\therefore$ Points A and B are equidistant from any point of line l(i)[Perpendicular bisector theorem]

Draw the perpendicular bisector of seg BC (line m) to intersect line l at point P.

$\therefore$ Points B and C are equidistant from any point of line m(ii) [Perpendicular bisector theorem]

$\therefore$ PA = PB ...[From (i)]

PB = PC ... [From (ii)]

$\therefore$ PA = PB = PC = radius

$\therefore$ With PA as radius the required circle is drawn through points A, B, C.

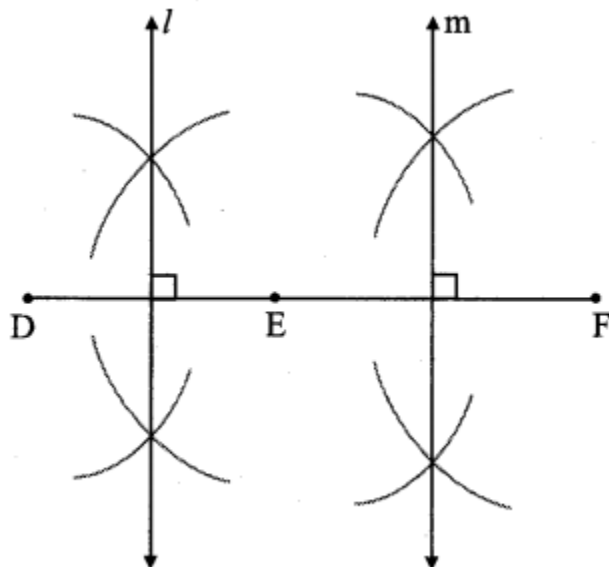
ii. It is not possible to draw more than one circle passing through these three points.

Question 5.

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Take 3 collinear points D, E, F. Try to draw a circle passing through these points. If you are not able to draw a circle, think of the reason. (Textbook pg. no. 49)

Solution:



Let D, E, F be the collinear points.

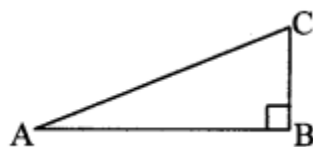
The perpendicular bisector of DE and EF drawn (i.e., line l and line m) do not intersect at a common point.

$\therefore$ There is no single common point (centre of circle) from which a circle can be drawn passing through points D, E and F.

Hence, we cannot draw a circle passing through points D, E and F.

Question 6.

Which theorem do we use in proving that hypotenuse is the longest side of a right angled triangle? (Textbook pg. no. 52)



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Solution:

In $\triangle ABC$,

$$\angle ABC = 90^\circ$$

$$\therefore \angle BAC < 90^\circ \text{ and } \angle ACB < 90^\circ \text{ [Given]}$$

$$\therefore \angle ABC > \angle BAC \text{ and } \angle ABC > \angle ACB$$

$$\therefore AC > BC \text{ and } AC > AB \text{ [Side opposite to greater angle is greater]}$$

$$\therefore \text{Hypotenuse is the longest side in right angled triangle.}$$

We use theorem, If two angles of a triangle are not equal, then the side opposite to the greater angle is greater than the side opposite to the smaller angle.

Question 7.

Theorem: Tangent segments drawn from an external point to a circle are congruent

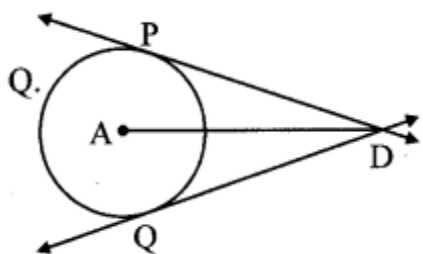
Draw radius AP and radius AQ and complete the following proof of the theorem.

Given: A is the centre of the circle.

Tangents through external point D touch the circle at the points P and Q.

To prove: seg DP $\cong$ seg DQ

Construction: Draw seg AP and seg AQ.

**Solution:**

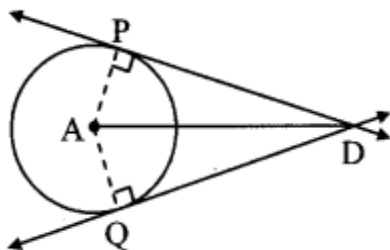
Proof:

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In $\triangle PAD$ and $\triangle QAD$,

seg $PA \cong$ [seg QA] [Radii of the same circle]

seg $AD \cong$ seg AD [Common side]



$\angle APD = \angle AQD = 90^\circ$ [Tangent theorem]

$\therefore \triangle PAD \cong \triangle QAD$ [By Hypotenuse side test]

$\therefore$ seg $DP =$ seg DQ [c.s.c.t]

Practice Set 3.2

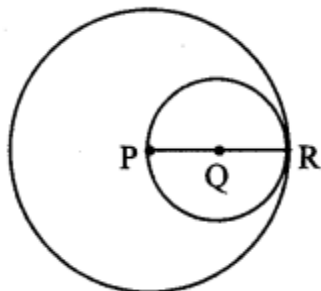
Question 1.

Two circles having radii 3.5 cm and 4.8 cm touch each other internally. Find the distance between their centres.

Solution:

Let the two circles having centres P and Q touch each other internally at point R.

Here, $QR = 3.5$ cm, $PR = 4.8$ cm



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The two circles touch each other internally.

∴ By theorem of touching circles,

$$P - Q - R$$

$$PQ = PR - QR$$

$$= 4.8 - 3.5$$

$$= 1.3 \text{ cm}$$

[The distance between the centres of circles touching internally is equal to the difference in their radii]

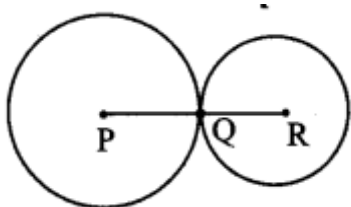
Question 2.

Two circles of radii 5.5 cm and 4.2 cm touch each other externally. Find the distance between their centres.

Solution:

Let the two circles having centres P and R touch each other externally at point Q.

Here, PQ = 5.5 cm, QR = 4.2 cm



The two circles touch each other externally.

∴ By theorem of touching circles,

$$P - Q - R$$

$$PR = PQ + QR$$

$$= 5.5 + 4.2$$

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= 9.7 cm

[The distance between the centres of the circles touching externally is equal to the sum of their radii]

Question 3.

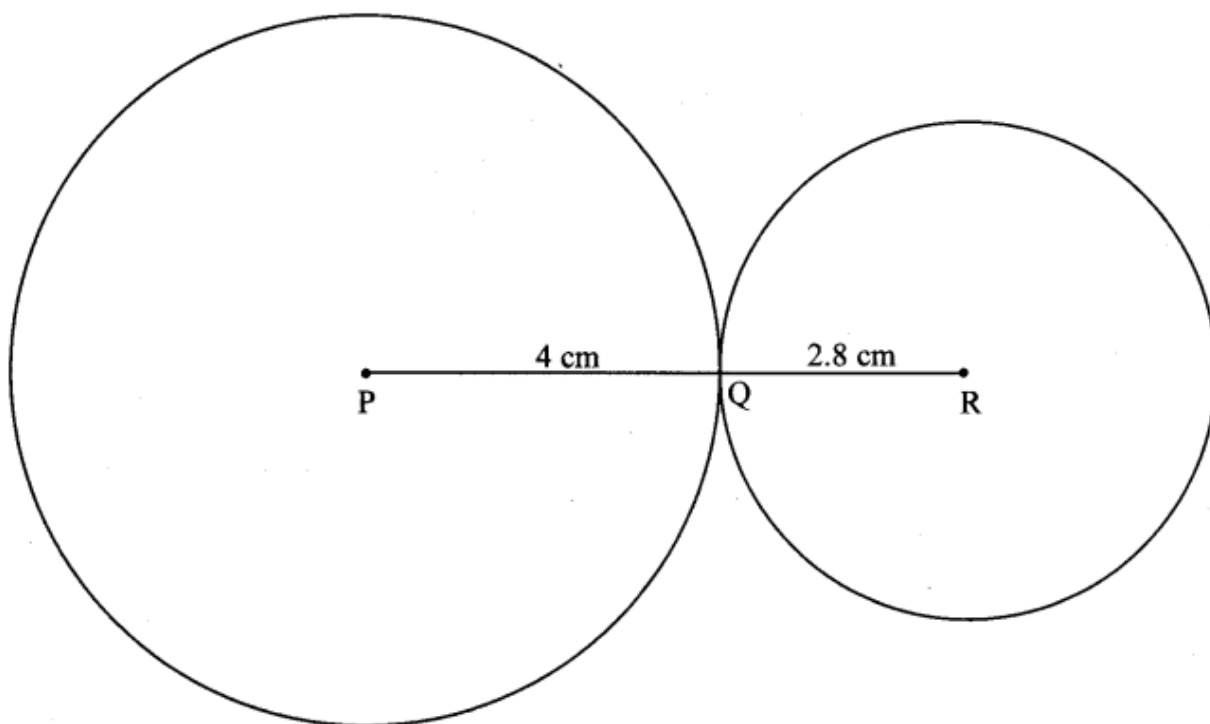
If radii of two circles are 4 cm and 2.8 cm. Draw figure of these circles touching each other

i. externally

ii. internally.

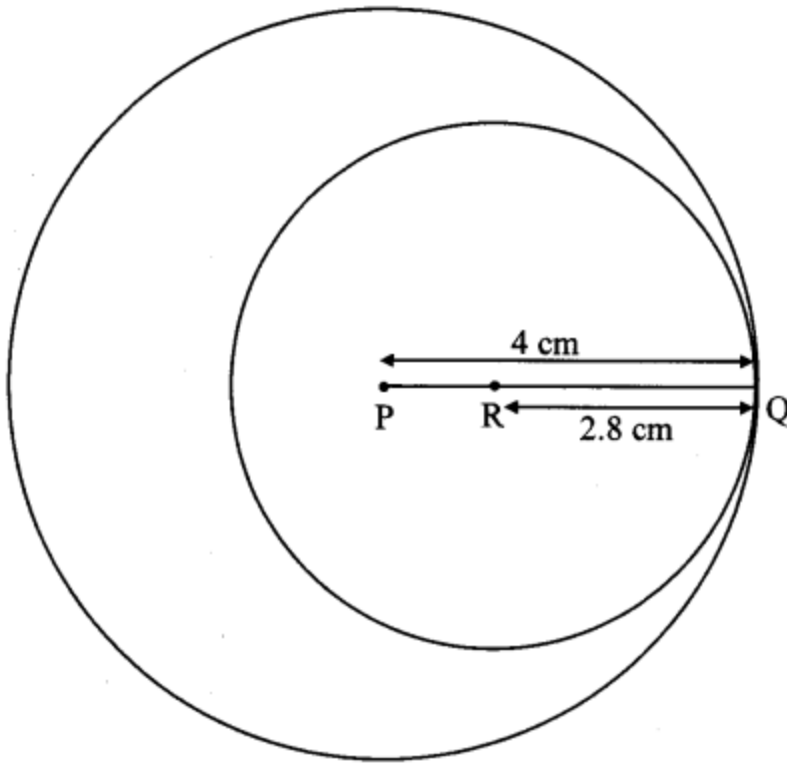
Solution:

i. Circles touching externally:



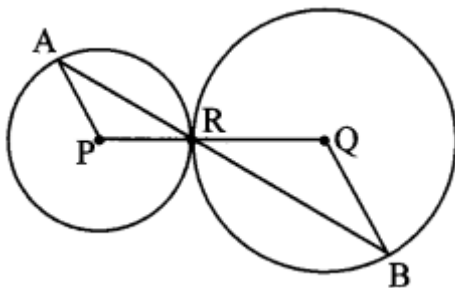
ii. Circles touching internally:

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Question 4.

In the adjoining figure, the circles with centres P and Q touch each other at R. A line passing through R meets the circles at A and B respectively. Prove that –



- i. $\text{seg AP} \parallel \text{seg BQ}$,
- ii. $\triangle APR \sim \triangle RQB$, and
- iii. Find $\angle RQB$ if $\angle PAR = 35^\circ$.

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Solution:

The circles with centres P and Q touch each other at R.

∴ By theorem of touching circles,

$$P - R - Q$$

i. In $\triangle PAR$,

seg PA = seg PR [Radii of the same circle]

∴ $\angle PRA \cong \angle PAR$ (i) [Isosceles triangle theorem]

Similarly, in $\triangle QBR$,

seg QR = seg QB [Radii of the same circle]

∴ $\angle RBQ \cong \angle QRB$ (ii) [Isosceles triangle theorem]

But, $\angle PRA \cong \angle QRB$ (iii) [Vertically opposite angles]

∴ $\angle PAR \cong \angle RBQ$ (iv) [From (i) and (ii)]

But, they are a pair of alternate angles formed by transversal AB on seg AP and seg BQ.

∴ seg AP || seg BQ [Alternate angles test]

ii. In $\triangle APR$ and $\triangle RQB$,

$\angle PAR \cong \angle QRB$ [From (i) and (iii)]

$\angle APR \cong \angle RQB$ [Alternate angles]

∴ $\triangle APR \sim \triangle RQB$ [AA test of similarity]

iii. $\angle PAR = 35^\circ$ [Given]

∴ $\angle RBQ = \angle PAR = 35^\circ$ [From (iv)]

In $\triangle RQB$,

$\angle RQB + \angle RBQ + \angle QRB = 180^\circ$ [Sum of the measures of angles of a triangle is 180°]

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$$\therefore \angle RQB + \angle RBQ + \angle RBQ = 180^\circ \text{ [From (ii)]}$$

$$\therefore \angle RQB + 2 \angle RBQ = 180^\circ$$

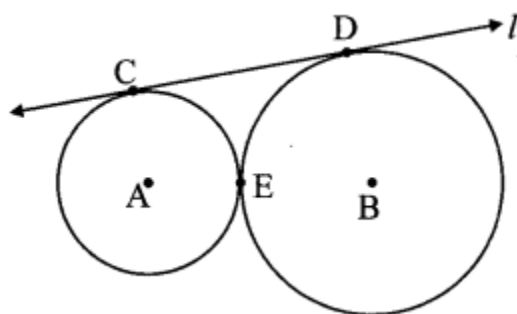
$$\therefore \angle RQB + 2 \times 35^\circ = 180^\circ$$

$$\therefore \angle RQB + 70^\circ = 180^\circ$$

$$\therefore \angle RQB = 110^\circ$$

Question 5.

In the adjoining figure, the circles with centres A and B touch each other at E. Line l is a common tangent which touches the circles at C and D respectively. Find the length of seg CD if the radii of the circles are 4 cm, 6 cm.



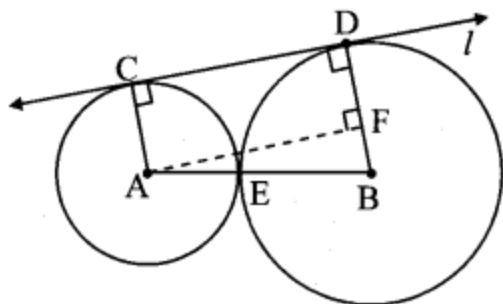
Construction : Draw seg $AF \perp$ seg BD .

Solution:

i. The circles with centres A and B touch each other at E. [Given]

$\therefore$ By theorem of touching circles,

A – E – B



$\therefore \angle ACD = \angle BDC = 90^\circ$ [Tangent theorem]

$\angle AFD = 90^\circ$ [Construction]

$\therefore \angle CAF = 90^\circ$ [Remaining angle of AFDC]

$\therefore$ AFDC is a rectangle. [Each angle is of measure 90°]

$\therefore AC = DF = 4$ cm [Opposite sides of a rectangle]

Now, $BD = BF + DF$ [B – F – C]

$\therefore 6 = BF + 4$ $BF = 2$ cm

Also, $AB = AE + EB$

$= 4 + 6 = 10$ cm

[The distance between the centres of circles touching externally is equal to the sum of their radii]

ii. Now, in $\triangle AFB$, $\angle AFB = 90^\circ$ [Construction]

$\therefore AB^2 = AF^2 + BF^2$ [Pythagoras theorem]

$\therefore 10^2 = AF^2 + 2^2$

$\therefore 100 = AF^2 + 4$

$\therefore AF^2 = 96$

$\therefore AF = \sqrt{96}$ [Taking square root of both sides]

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$$= 16 \times 6 \text{-----} \sqrt{}$$

$$= 4 \sqrt{6} \text{ cm}$$

But, $CD = AF$ [Opposite sides of a rectangle]

$$\therefore CD = 4 \sqrt{6} \text{ cm}$$

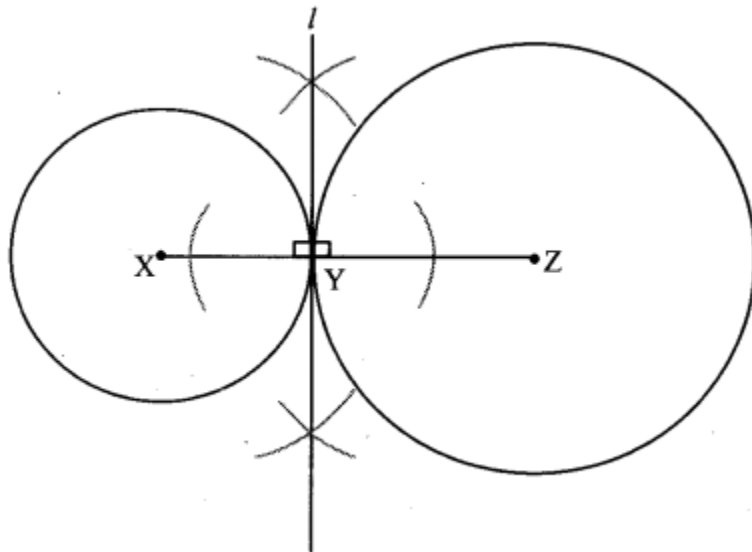
Question 1.

Take three collinear points $X - Y - Z$ as shown in figure.

Draw a circle with centre X and radius XY . Draw another circle with centre Z and radius YZ .

Note that both the circles intersect each other at the single point Y . Draw a line l through point Y and perpendicular to seg XZ . What is line l (Textbook pg. no. 56)

Solution:



Line l is a common tangent of the two circles.

Question 2.

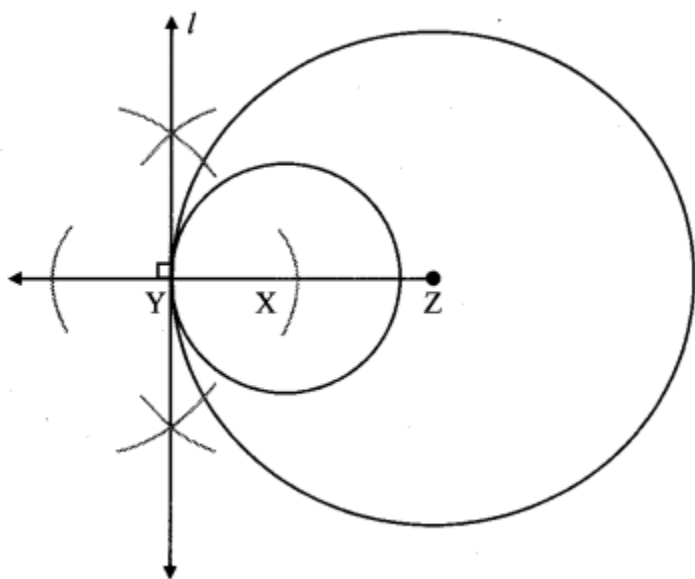
Take points $Y - X - Z$ as shown in the figure. Draw a circle with centre Z and radius ZY .

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Also draw a circle with centre X and radius XY. Note that both the circles intersect each other at the point Y.

Draw a line l perpendicular to seg YZ through point Y. What is line l? (Textbook pg. no. 56)

Solution:



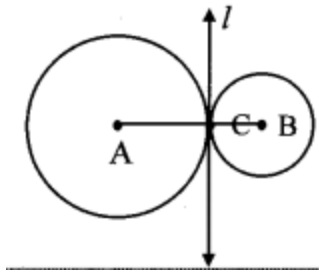
Line l is a common tangent of the two circles.

If two circles in the same plane intersect with a line in the plane in only one point, they are said to be touching circles and the line is their common tangent.

The point common to the circles and the line is called their common point of contact.

1. Circles touching externally:

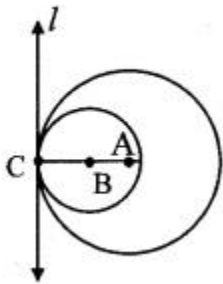
For circles touching externally, the distance between their centres is equal to sum of their radii, i.e. $AB = AC + BC$



2. Circles touching internally:

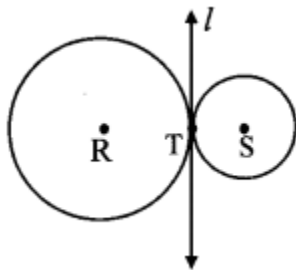
For circles touching internally, the distance between their centres is equal to difference of their radii,

i. e. $AB = AC - BC$



Question 3.

The circles shown in the given figure are called externally touching circles. Why?
(iexthook pg. no. 57)



Answer:

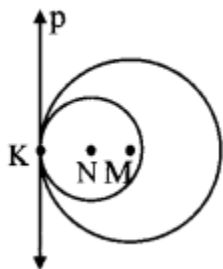
<https://www.indcareer.com/schools/maharashtra-board-solutions-for-class-10-maths-part-2-chapter-3-circle/>

Circles with centres R and S lie in the same plane and intersect with a line l in the plane in one and only one point T [R – T – S].

Hence the given circles are externally touching circles.

Question 4.

The circles shown in the given figure are called internally touching circles, why?
(Textbook pg. no. 57)



Answer:

Circles with centres N and M lie in the same plane and intersect with a line p in the plane in one and only one point T [K – N – M].

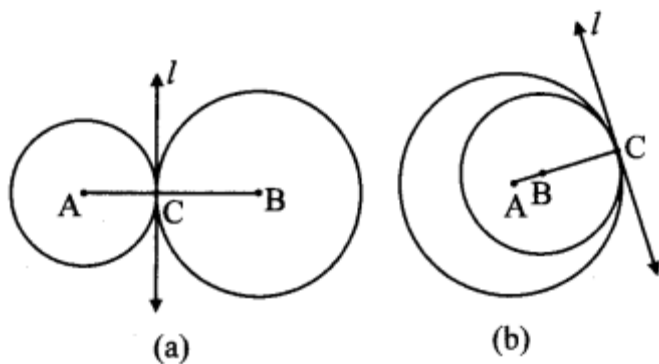
Hence, the given circles are internally touching circles.

Question 5.

In the given figure, the radii of the circles with centres A and B are 3 cm and 4 cm respectively. Find

i. d(A,B) in figure (a)

ii. d(A,B) in figure (b) (Textbook pg. no. 57)



Solution:

i. Here, circle with centres A and B touch each other externally at point C.

$$\therefore d(A, B) = d(A, C) + d(B, C)$$

$$= 3 + 4$$

$$\therefore d(A, B) = 7 \text{ cm}$$

[The distance between the centres of circles touching externally is equal to the sum of their radii]

ii. Here, circle with centres A and B touch each other internally at point C.

$$\therefore d(A, B) = d(A, C) - d(B, C)$$

$$= 4 - 3$$

$$\therefore d(A, B) = 1 \text{ cm}$$

[The distance between the centres of circles touching internally is equal to the difference in their radii]

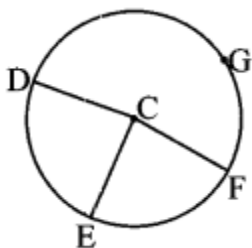
Practice Set 3.3

Question 1.

In the adjoining figure, points G, D, E, F are concyclic points of a circle with centre C.

$\angle ECF = 70^\circ$, $m(\text{arc DGF}) = 200^\circ$. Find $m(\text{arc DE})$ and $m(\text{arc EF})$.

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Solution:

$m(\text{arc EF}) = m\angle ECF$ [Definition of measure of minor arc]

$$\therefore m(\text{arc EF}) = 70^\circ$$

$$\text{i. } m(\text{arc DE}) + m(\text{arc DGF})$$

$$+ m(\text{arc EF}) = 360^\circ \text{ [Measure of a circle is } 360^\circ\text{]}$$

$$\therefore m(\text{arc DE}) = 360^\circ - m(\text{arc DGF}) - m(\text{arc EF})$$

$$= 360^\circ - 200^\circ - 70^\circ$$

$$\therefore m(\text{arc DE}) = 90^\circ$$

$$\text{ii. } m(\text{arc DEF}) = m(\text{arc DE}) + m(\text{arc EF}) \text{ [Arc addition property]}$$

$$= 90^\circ + 70^\circ$$

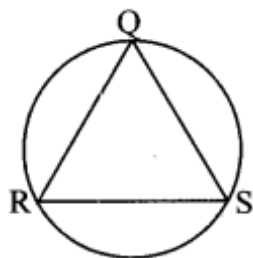
$$\therefore m(\text{arc DEF}) = 160^\circ$$

Question 2.

In the adjoining figure, AQRS is an equilateral triangle. Prove that,

$$\text{i. arc RS} \cong \text{arc QS} \cong \text{arc QR}$$

$$\text{ii. } m(\text{arc QRS}) = 240^\circ.$$

**Solution:**

Proof:

i. $\triangle QRS$ is an equilateral triangle, [Given]

$\therefore \text{seg RS} \cong \text{seg QS} \cong \text{seg QR}$ [Sides of an equilateral triangle]

$\therefore \text{arc RS} \cong \text{arc QS} \cong \text{arc QR}$ [Corresponding arcs of congruent chords of a circle are congruent]

ii. Let $m(\text{arc RS}) = m(\text{arc QS}) = m(\text{arc QR}) = x$

$m(\text{arc RS}) + m(\text{arc QS}) + m(\text{arc QR}) = 360^\circ$ [Measure of a circle is 360° , arc addition property]

$$\therefore x + x + x = 360^\circ$$

$$\therefore 3x = 360^\circ$$

$$\therefore x = 360^\circ \div 3 = 120^\circ$$

$$\therefore m(\text{arc RS}) = m(\text{arc QS}) = m(\text{arc QR}) = 120^\circ \text{ (i)}$$

Now, $m(\text{arc QRS}) = m(\text{arc QR}) + m(\text{arc RS})$ [Arc addition property]

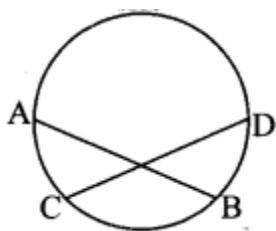
$$= 120^\circ + 120^\circ \text{ [From (i)]}$$

$$\therefore m(\text{arc QRS}) = 240^\circ$$

Question 3.

In the adjoining figure, chord $AB \cong$ chord CD . Prove that, arc $AC =$ arc BD .

<https://www.indcareer.com/schools/maharashtra-board-solutions-for-class-10-maths-part-2-chapter-3-circle/>

**Solution:**

Proof:

chord $AB \cong$ chord CD [Given]

$\therefore$ arc $AB \cong$ arc CD [Corresponding arcs of congruent chords of a circle are congruent]

$\therefore m(\text{arc } AB) = m(\text{arc } CD)$

$\therefore m(\text{arc } AC) + m(\text{arc } BC) = m(\text{arc } BC) + m(\text{arc } BD)$ [Arc addition property]

$\therefore m(\text{arc } AC) = m(\text{arc } BD)$

$\therefore$ arc $AC \cong$ arc BD

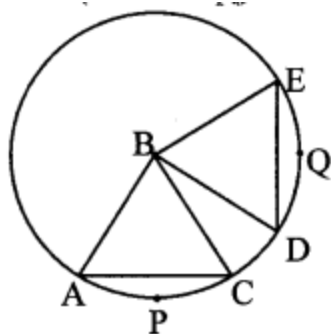
Question 1.

Theorem : The chords corresponding to congruent arcs of a circle (or congruent circles) are congruent. (Textbook pg. no. 61)

Given: B is the centre of circle.

arc $APC \cong$ arc DQE

To prove: chord $AC \cong$ chord DE



Proof:

$m(\text{arc APC}) = \angle ABC$ (i) [Definition of measure of

$m(\text{arc DQE}) = \angle DBE$ (ii) minor arc]

$\text{arc APC} \cong \text{arc DQE}$ (iii) [Given]

$\therefore \angle ABC \cong \angle DBE$ [From (i), (ii) and (iii)]

In $\triangle ABC$ and $\triangle DBE$,

side $AB \cong$ side DB [Radii of the same circle]

side $CB \cong$ side EB [Radii of the same circle]

$\angle ABC \cong \angle DBE$ [From (iii), Measures of congruent arcs]

$\therefore \triangle ABC \cong \triangle DBE$ [SAS test of congruency]

$\therefore \text{chord } AC \cong \text{chord } DE$ [c.s.c.t]

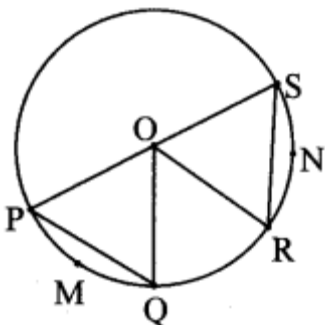
Question 2.

Theorem: Corresponding arcs of congruent chords of a circle (or congruent circles) are congruent (Textbook pg. no. 61)

Given: O is the centre of circle, chord $PQ =$ chord RS

To prove: arc $PMQ =$ arc RNS

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Proof:

In $\triangle POQ$ and $\triangle ROS$,

[side $PO \cong$ side RO

side $OQ \cong$ side OS] [Radii of the same circle]

chord $PQ \cong$ chord RS [Given]

$\therefore \triangle POQ \cong \triangle ROS$ [SSS test of congruency]

$\therefore \angle POQ \cong \angle ROS$ (i) [c.a.c.t.]

$m(\text{arc } PMQ) = \angle POQ$ (ii)

$m(\text{arc } RNS) = \angle ROS$ (iii) [Definition of measure of minor arc]

$\therefore \text{arc } PMQ \cong \text{arc } RNS$ [From (i), (ii) and (iii)]

Question 3.

Prove the two theorems on textbook pg.no.61 for congruent circles. (Textbook pg. no. 62)

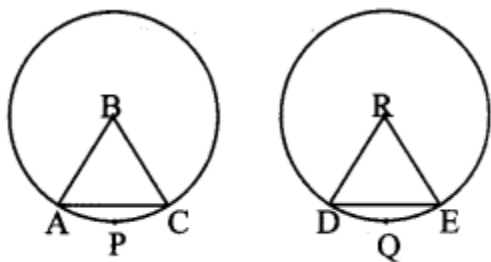
Theorem : The chords corresponding to congruent arcs of congruent circles are congruent

Given: In congruent circles with centres B and R,

arc $APC \cong$ arc DQE

To prove: chord $AC \cong$ chord DE

<https://www.indcareer.com/schools/maharashtra-board-solutions-for-class-10-maths-part-2-chapter-3-circle/>



Proof:

$$[m(\text{arc APC}) = \angle ABC \text{ (i)}]$$

$$m(\text{arc DQE}) = \angle DRE \text{ (ii) [Definition of measure of minor arc]}$$

$$\text{arc APC} \cong \text{arc DQE} \text{ (iii) [Given]}$$

$$\therefore \angle ABC = \angle DRE \text{ (iv) [From (i), (ii) and (iii)]}$$

In $\triangle ABC$ and $\triangle DRE$,

$$[\text{side AB} \cong \text{side DR} \text{ [Radii of congruent circles]}]$$

$$\text{side CB} \cong \text{side ER} \text{ [From (iv)]}$$

$$\angle ABC \cong \angle DRE$$

$$\therefore \triangle ABC \cong \triangle DRE \text{ [SAS test of congruency]}$$

Question 4.

While proving the first theorem of the two, we assume that the minor arc APC and minor arc DQE are congruent. Can you prove the same theorem by assuming that corresponding major arcs congruent? (Textbook pg. no. 62)

Statement:

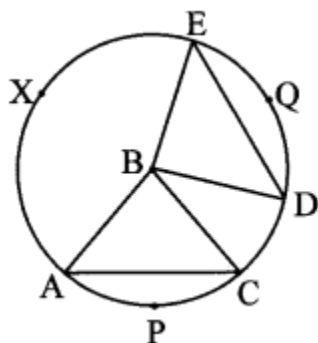
The chords corresponding to congruent major arcs of a circle are congruent.

Given: B is the centre of circle.

$$\text{arc AXC} \cong \text{arc DXE}$$

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To prove: chord $AC \cong$ chord DE



Proof:

$$m(\text{major arc}) = 360^\circ - m(\text{minor arc})$$

$$\therefore m(\text{arc } AXC) = 360^\circ - m(\text{arc } APC) \text{ (i)}$$

$$m(\text{arc } DXE) = 360^\circ - m(\text{arc } DQE) \text{ (ii)}$$

$$m(\text{arc } AXC) = m(\text{arc } DXE) \text{ (iii) [Given]}$$

$$\therefore 360^\circ - m(\text{arc } APC) = 360^\circ - m(\text{arc } DQE) \text{ [From (i), (ii) and (iii)]}$$

$$\therefore m(\text{arc } APC) = m(\text{arc } DQE) \text{ (iv)}$$

$$\therefore m(\text{arc } APC) = \angle ABC \text{ (v) [Definition of measure of minor arc]}$$

$$m(\text{arc } DQE) = \angle DBE \text{ (vi)}$$

$$\therefore \angle ABC = \angle DBE \text{ (vii) [From (iv), (v) and (vi)]}$$

In $\triangle ABC$ and $\triangle DBE$,

[side $AB \cong$ side DB

Side $CB \cong$ side EB] [Radii of the same circle]

$\angle ABC \cong \angle DBE$ [From (vii)]

$\therefore \triangle ABC \cong \triangle DBE$ [SAS test of congruency]

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$\therefore$ chord AC $\cong$ chord DE [c.s.c.t.]

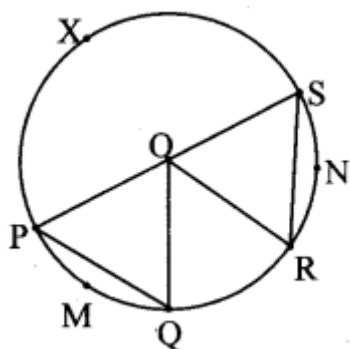
Question 5.

i. In the second theorem, are the major arcs corresponding to congruent chords congruent?

ii. Is the theorem true, when the chord PQ and chord RS are diameters of the circle?
(Textbook pg. no. 62)

Solution:

i. Yes, the major arcs corresponding to congruent chords are congruent.



Proof:

In $\triangle POQ$ and $\triangle ROS$,

seg OP $\cong$ seg OR [Radii of the same circle]

seg OQ $\cong$ seg OS [Radii of the same circle]

seg PQ $\cong$ seg RS [Given]

$\therefore \triangle POQ \cong \triangle ROS$ [SSS test of congruence]

$\therefore \angle POQ \cong \angle ROS$ (i) [c.a.c.t.]

[$m(\text{arc PMQ}) = \angle POQ$ (ii)

$m(\text{arc RNS}) = \angle ROS$] (iii) [Definition of measure of minor arc]

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$$\therefore m(\text{arc PMQ}) = m(\text{arc RNS})$$

$$m(\text{minor arc}) = 360^\circ - m(\text{major arc}) \text{ (iv) [From (i), (ii) and (iii)]}$$

$$m(\text{arc PMQ}) = 360^\circ - m(\text{arc PXQ}) \text{ (v)}$$

$$\text{and } m(\text{arc RNS}) = 360^\circ - m(\text{arc RXS}) \text{ (vi)}$$

$$\therefore 360^\circ - m(\text{arc PXQ}) = 360^\circ - m(\text{arc RXS}) \text{ [From (iv), (v) and (vi)]}$$

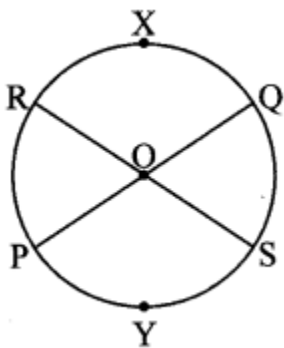
$$\therefore m(\text{arc PXQ}) = m(\text{arc RXS})$$

ii. Yes, the major arcs corresponding to congruent chords (diameters) are congruent.

Given: O is the centre of circle.

seg PQ and seg RS are the diameters.

To prove: arc PYQ $\cong$ arc RYS



Proof:

seg PQ and seg RS are the diameters of the same circle. [Given]

$\therefore$ arc PYQ and arc RYS are semicircular arcs.

$$\therefore m(\text{arc PYQ}) = m(\text{arc RYS}) = 180^\circ \text{ [Measure of a semicircular arc is } 180^\circ]$$

$$\therefore \text{arc PYQ} \cong \text{arc RYS}$$

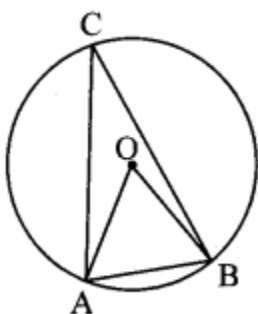
Practice Set 3.4

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Question 1.

In the adjoining figure, in a circle with centre O, length of chord AB is equal to the radius of the circle. Find measure of each of the following.

- i. $\angle AOB$
- ii. $\angle ACB$
- iii. arc AB
- iv. arc ACB.

**Solution:**

i. seg OA = seg OB = radius..... (i) [Radii of the same circle]

seg AB = radius..... (ii) [Given]

$\therefore$ seg OA = seg OB = seg AB [From (i) and (ii)]

$\therefore \triangle OAB$ is an equilateral triangle.

$\therefore m\angle AOB = 60^\circ$ [Angle of an equilateral triangle]

ii. $m\angle ACB = \frac{1}{2} m\angle AOB$ [Measure of an angle subtended by an arc at a point on the circle is half of the measure of the angle subtended by the arc at the centre]

$$= \frac{1}{2} \times 60^\circ$$

$$\therefore m\angle ACB = 30^\circ$$

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iii. $m(\text{arc AB}) = m \angle AOB$ [Definition of measure of minor arc]

$$\therefore m(\text{arc AB}) = 60^\circ$$

iv. $m(\text{arc ACB}) + m(\text{arc AB}) = 360^\circ$ [Measure of a circle is 360°]

$$\therefore m(\text{arc ACB}) = 360^\circ - m(\text{arc AB})$$

$$= 360^\circ - 60^\circ$$

$$\therefore m(\text{arc ACB}) = 300^\circ$$

Question 2.

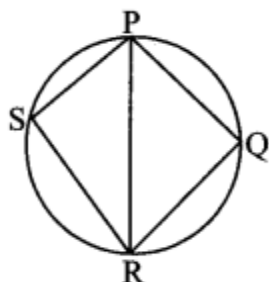
In the adjoining figure, PQRS is cyclic, side $PQ \cong$ side RQ , $\angle PSR = 110^\circ$. Find

i. measure of $\angle PQR$

ii. $m(\text{arc PQR})$

iii. $m(\text{arc QR})$

iv. measure of $\angle PRQ$



Solution:

i. PQRS is a cyclic quadrilateral. [Given]

$\therefore \angle PSR + \angle PQR = 180^\circ$ [Opposite angles of a cyclic quadrilateral are supplementary]

$$\therefore 110^\circ + \angle PQR = 180^\circ$$

$$\therefore \angle PQR = 180^\circ - 110^\circ$$

<https://www.indcareer.com/schools/maharashtra-board-solutions-for-class-10-maths-part-2-chapter-3-circle/>

$$\therefore m \angle PQR = 70^\circ$$

ii. $\angle PSR = 12 m(\text{arcPQR})$ [Inscribed angle theorem]

$$110^\circ = 12 m(\text{arcPQR})$$

$$\therefore m(\text{arc PQR}) = 220^\circ$$

iii. In $\triangle PQR$,

side $PQ \cong$ side RQ [Given]

$$\therefore \angle PRQ = \angle QPR \text{ [Isosceles triangle theorem]}$$

$$\text{Let } \angle PRQ = \angle QPR = x$$

Now, $\angle PQR + \angle QPR + \angle PRQ = 180^\circ$ [Sum of the measures of angles of a triangle is 180°]

$$\therefore \angle PQR + x + x = 180^\circ$$

$$\therefore 70^\circ + 2x = 180^\circ$$

$$\therefore 2x = 180^\circ - 70^\circ$$

$$\therefore 2x = 110^\circ$$

$$\therefore x = 110^\circ / 2 = 55^\circ$$

$$\therefore \angle PRQ = \angle QPR = 55^\circ \dots (i)$$

But, $\angle QPR = 12 m(\text{arc QR})$ [Inscribed angle theorem]

$$\therefore 55^\circ = 12 m(\text{arc QR})$$

$$\therefore m(\text{arc QR}) = 110^\circ$$

iv. $\angle PRQ = \angle QPR = 55^\circ$ [From (i)]

$$\therefore m \angle PRQ = 55^\circ$$

Question 3.

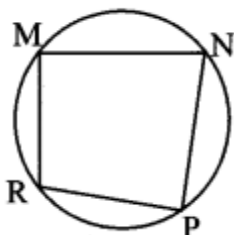
□ **MRPN is cyclic, $\angle R = (5x - 13)^\circ$, $\angle N = (Ax + 4)^\circ$. Find measures of $\angle R$ and $\angle N$.**

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Solution:

□ MRPN is a cyclic quadrilateral. [Given]

∴ $\angle R + \angle N = 180^\circ$ [Opposite angles of a cyclic quadrilateral are supplementary]



$$\therefore 5x - 13 + 4x + 4 = 180$$

$$\therefore 9x - 9 = 180$$

$$\therefore 9x = 189$$

$$\therefore x = 1899$$

$$\therefore x = 21$$

$$\therefore \angle R = 5x - 13$$

$$= 5 \times 21 - 13$$

$$= 105 - 13$$

$$= 92^\circ$$

$$\angle N = 4x + 4$$

$$= 4 \times 21 + 4$$

$$= 84 + 4$$

$$= 88^\circ$$

$$\therefore m\angle R = 92^\circ \text{ and } m\angle N = 88^\circ$$

<https://www.indcareer.com/schools/maharashtra-board-solutions-for-class-10-maths-part-2-chapter-3-circle/>

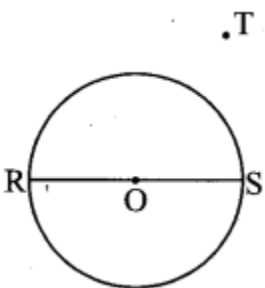
Question 4.

In the adjoining figure, seg RS is a diameter of the circle with centre O. Point T lies in the exterior of the circle. Prove that $\angle RTS$ is an acute angle.

Given: O is the centre of the circle, seg RS is the diameter of the circle.

To prove: $\angle RTS$ is an acute angle.

Construction: Let seg RT intersect the circle at point P. Join PS and PT.



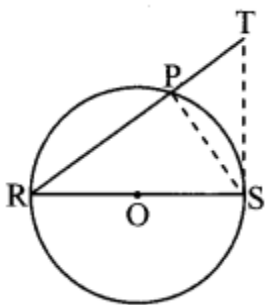
Proof:

seg RS is the diameter. [Given]

$\therefore \angle RPS = 90^\circ$ [Angle inscribed in a semicircle]

Now, $\angle RPS$ is the exterior angle of $\triangle PTS$.

$\therefore \angle RPS > \angle PTS$ [Exterior angle is greater than the remote interior angles]



$\therefore 90^\circ > \angle PTS$

i.e. $\angle PTS < 90^\circ$

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i.e, $\angle RTS < 90^\circ$ [R – P -T]

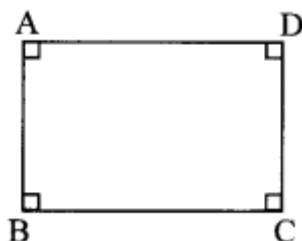
$\angle RTS$ is an acute angle.

Question 5.

Prove that, any rectangle is a cyclic quadrilateral.

Given: ABCD is a rectangle.

To prove: ABCD is a cyclic quadrilateral.



Proof:

ABCD is a rectangle. [Given]

$\therefore \angle A = \angle B = \angle C = \angle D = 90^\circ$ [Angles of a rectangle]

Now, $\angle A + \angle C = 90^\circ + 90^\circ$

$\therefore \angle A + \angle C = 180^\circ$

$\therefore$ ABCD is a cyclic quadrilateral. [Converse of cyclic quadrilateral theorem]

Question 6.

In the adjoining figure, altitudes YZ and XT of $\triangle WXY$ intersect at P. Prove that,

i. $\square WZPT$ is cyclic.

ii. Points X, Z, T, Y are concyclic.

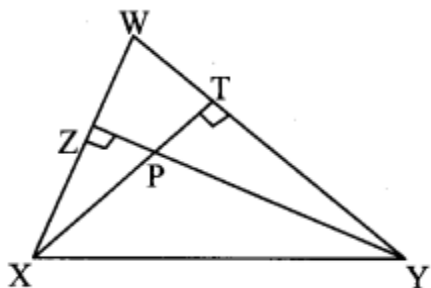
Given: seg YZ $\perp$ side XW

seg XT $\perp$ side WY

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To prove: i. $\square WZPT$ is cyclic.

ii. Points X, Z, T, Y are concyclic.



Proof:

i. $\text{seg } YZ \perp \text{side } XW$ [Given]

$$\therefore \angle PZW = 90^\circ \dots\dots (i)$$

$\text{seg } XT \perp \text{side } WY$ [Given]

$$\therefore \angle PTW = 90^\circ \dots\dots(ii)$$

$$\angle PZW + \angle PTW = 90^\circ + 90^\circ \text{ [Adding (i) and (ii)]}$$

$$\therefore \angle PZW + \angle PTW = 180^\circ$$

$\therefore \square WZPT$ is a cyclic quadrilateral. [Converse of cyclic quadrilateral theorem]

ii. $\angle XZY = \angle YTX = 90^\circ$ [Given]

$\therefore$ Points X and Y on line XY subtend equal angles on the same side of line XY.

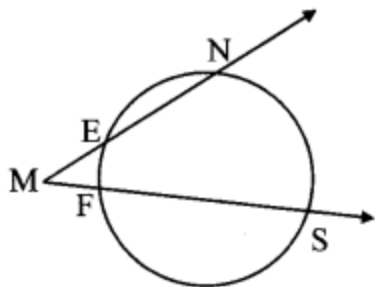
$\therefore$ Points X, Z, T and Y are concyclic. [If two points on a given line subtend equal angles at two distinct points which lie on the same side of the line, then the four points are concyclic]

Question 7.

In the adjoining figure, $m(\text{arc } NS) = 125^\circ$, $m(\text{arc } EF) = 37^\circ$, find the measure of $\angle NMS$.

Solution:

<https://www.indcareer.com/schools/maharashtra-board-solutions-for-class-10-maths-part-2-chapter-3-circle/>



Chords EN and FS intersect externally at point M.

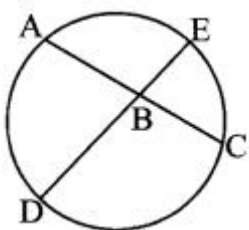
$$m\angle NMS = \frac{1}{2} [m(\text{arc NS}) - m(\text{arc EF})]$$

$$= \frac{1}{2} (125^\circ - 37^\circ) = \frac{1}{2} \times 88^\circ$$

$$\therefore m\angle NMS = 44^\circ$$

Question 8.

In the adjoining figure, chords AC and DE intersect at B. If $\angle ABE = 108^\circ$, $m(\text{arc AE}) = 95^\circ$, find $m(\text{arc DC})$.



Solution:

Chords AC and DE intersect internally at point B.

$$\therefore \angle ABE = \frac{1}{2} [m(\text{arc AE}) + m(\text{arc DC})]$$

$$\therefore 108^\circ = \frac{1}{2} [95^\circ + m(\text{arc DC})]$$

$$\therefore 108^\circ \times 2 = 95^\circ + m(\text{arc DC})$$

$$\therefore 95^\circ + m(\text{arc DC}) = 216^\circ$$

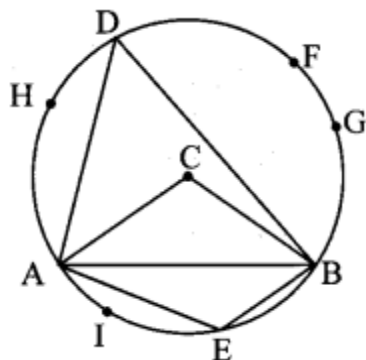
$$\therefore m(\text{arc DC}) = 216^\circ - 95^\circ$$

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$$\therefore m(\text{arc DC}) = 121^\circ$$

Question 1.

Draw a sufficiently large circle of any radius as shown in the figure below. Draw a chord AB and central $\angle ACB$. Take any point D on the major arc and point E on the minor arc.



- Measure $\angle ADB$ and $\angle ACB$ and compare the measures.
- Measure $\angle ADB$ and $\angle AEB$. Add the measures.
- Take points F, G, H on the arc ADB. Measure $\angle AFB$, $\angle AGB$, $\angle AHB$. Compare these measures with each other as well as with measure of $\angle ADB$.
- Take any point I on the arc AEB. Measure $\angle AIB$ and compare it with $\angle AEB$. (Textbook pg, no. 64)

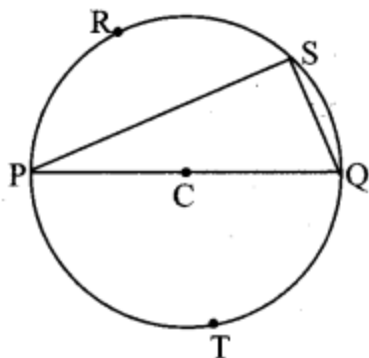
Answer:

- $\angle ACB = 2 \angle ADB$.
- $\angle ADB + \angle AEB = 180^\circ$.
- $\angle AHB = \angle ADB = \angle AFB = \angle AGB$
- $\angle AEB = \angle AIB$

Question 2.

Draw a sufficiently large circle with centre C as shown in the figure. Draw any diameter PQ. Now take points R, S, T on both the semicircles. Measure $\angle PRQ$, $\angle PSQ$, $\angle PTQ$. What do you observe? (Textbook pg. no.65)

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Answer:

$$\angle PRQ = \angle PSQ = \angle PTQ = 90^\circ$$

[Student should draw and verify the above answers.]

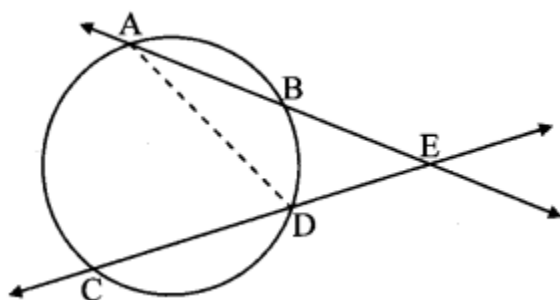
Question 3.

Prove that, if two lines containing chords of a circle intersect each other outside the circle, then the measure of angle between them is half the difference in measures of the arcs intercepted by the angle. (Textbook pg. no. 72)

Given: Chord AB and chord CD intersect at E in the exterior of the circle.

To prove: $\angle AEC = \frac{1}{2} [m(\text{arc AC}) - m(\text{arc BD})]$

Construction: Draw seg AD.



Proof:

$\angle ADC$ is the exterior angle of $\triangle ADE$.

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$$\therefore \angle ADC = \angle DAE + \angle AED \text{ [Remote interior angle theorem]}$$

$$\therefore \angle ADC = \angle DAE + \angle AEC \text{ [C – D – E]}$$

$$\therefore \angle AEC = \angle ADC - \angle DAE \dots\dots(i)$$

$$\angle ADC = 12 \text{ m(arc AC)} \text{ (ii) [Inscribed angle theorem]}$$

$$\angle DAE = 12 \text{ m(arc BD)} \text{ (iii) [A – B – E, Inscribed angle theorem]}$$

$$\therefore \angle AEC = 12 \text{ m(arc AC)} - 12 \text{ m (arc BD)} \text{ [From (i), (ii) and (iii)]}$$

$$\therefore \angle AEC = 12 \text{ m(arc AC)} - \text{m (arc BD)}$$

Question 4.

Angles inscribed in the same arc are congruent.

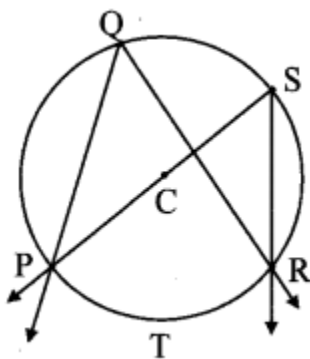
Write ‘given’ and ‘to prove’ with the help of the given figure.

Think of the answers of the following questions and write the proof.

i. Which arc is intercepted by $\angle PQR$?

ii. Which arc is intercepted by $\angle PSR$?

iii. What is the relation between an inscribed angle and the arc intercepted by it? (Textbook: pg. no. 68)



Given: C is the centre of circle. $\angle PQR$ and $\angle PSR$ are inscribed in same arc PTR.

To prove: $\angle PQR \cong \angle PSR$

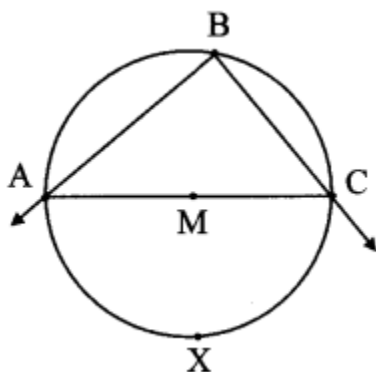
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Proof:

- i. arc PTR is intercepted by $\angle PQR$.
- ii. arc PTR is intercepted by $\angle PSR$.
- iii. $\angle PQR = 12 m(\text{arc PTR})$, and (i) [inscribed angle theorem]
 $\angle PSR = 12 m(\text{arc PTR})$ (ii) [Inscribed angle theorem]
 $\therefore \angle PQR \cong \angle PSR$ [From (i) and (ii)]

Question 5.

Angle inscribed in a semicircle is a right angle. With the help of given figure write 'given', 'to prove' and 'the proof. (Textbook pg. no. 68)



Given: M is the centre of circle. $\angle ABC$ is inscribed in arc ABC.

Arcs ABC and AXC are semicircles.

To prove: $\angle ABC = 90^\circ$

Proof:

$\angle ABC = 12 m(\text{arc AXC})$ (i) [Inscribed angle theorem]

arc AXC is a semicircle.

$\therefore m(\text{arc AXC}) = 180^\circ$ (ii) [Measure of semicircular arc is 180]

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$$\therefore \angle ABC = 12 \times 180^\circ$$

$$\therefore \angle ABC = 90^\circ \text{ [From (i) and (ii)]}$$

Question 6.

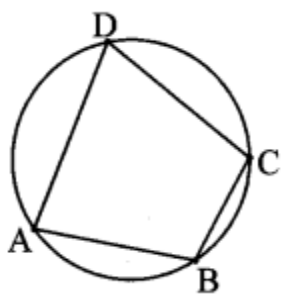
Theorem: Opposite angles of a cyclic quadrilateral are supplementary.

Fill in the blanks and complete the following proof. (Textbook pg. no. 68)

Given: $\square ABCD$ is cyclic.

To prove: $\angle B + \angle D = 180^\circ$

$$\angle A + \angle C = 180^\circ$$



Proof:

arc ABC is intercepted by the inscribed angle $\angle ADC$.

$$\therefore \angle ADC = \frac{1}{2} m(\text{arc ABC}) \text{ (i) [Inscribed angle theorem]}$$

Similarly, $\angle ABC$ is an inscribed angle. It intercepts arc ADC.

$$\therefore \angle ABC = \frac{1}{2} m(\text{arc ADC}) \text{ (ii) [Inscribed angle theorem]}$$

$$\therefore \angle ADC + \angle ABC$$

$$= \frac{1}{2} m(\text{arc ABC}) + \frac{1}{2} m(\text{arc ADC}) \text{ [Adding (i) and (ii)]}$$

$$\therefore \angle D + \angle B = \frac{1}{2} m(\text{arc ABC}) + \frac{1}{2} m(\text{arc ADC})$$

$$\therefore \angle B + \angle D = \frac{1}{2} \times 360^\circ \text{ [arc ABC and arc ADC constitute a complete circle]}$$

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$$= 180^\circ$$

$$\therefore \angle B + \angle D = 180^\circ$$

Similarly we can prove,

$$\angle A + \angle C = 180^\circ$$

Question 7.

In the above theorem, after proving $\angle B + \angle D = 180^\circ$, can you use another way to prove $\angle A + \angle C = 180^\circ$? (Textbook pg. no. 69)

Proof:

Yes, we can prove $\angle A + \angle C = 180^\circ$ by another way.

$$\angle B + \angle D = 180^\circ$$

In ABCD,

$$\angle A + \angle B + \angle C + \angle D = 360^\circ \text{ [Sum of the measures of all angles of a quadrilateral is } 360^\circ \text{.]}$$

$$\therefore \angle A + \angle C + 180^\circ = 360^\circ$$

$$\therefore \angle A + \angle C = 360^\circ - 180^\circ$$

$$\therefore \angle A + \angle C = 180^\circ$$

Question 8.

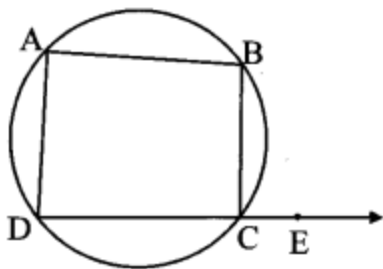
An exterior angle of a cyclic quadrilateral is congruent to the angle opposite to its adjacent interior angle. (Textbook pg. no. 69)

Given: ABCD is a cyclic quadrilateral.

$\angle BCE$ is the exterior angle of ABCD.

To prove: $\angle BCE \cong \angle BAD$

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Proof:

$$\angle BCE + \angle BCD = 180^\circ \dots\dots (i) \text{ [Angles in a linear pair]}$$

ABCD is a cyclic quadrilateral. [Given]

$$\angle BAD + \angle BCD = 180^\circ \dots\dots\dots (ii) \text{ [Opposite angles of a cyclic quadrilateral are supplementary]}$$

$$\therefore \angle BCE + \angle BCD = \angle BAD + \angle BCD \text{ [From (i) and (ii)]}$$

$$\therefore \angle BCE = \angle BAD$$

Question 9.

Theorem : If a pair of opposite angles of a quadrilateral is supplementary, then the quadrilateral is cyclic. (Textbook pg. no. 69)

Given: In ABCD, $\angle A + \angle C = 180^\circ$

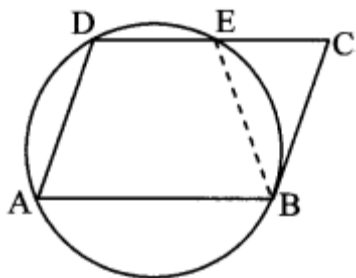
To prove: ABCD is a cyclic quadrilateral.

Proof:

(Indirect method)

Suppose ABCD is not a cyclic quadrilateral.

We can still draw a circle passing through three non collinear points A, B, D.



Case I: Point C lies outside the circle.

Then, take point E on the circle

such that $D - E - C$.

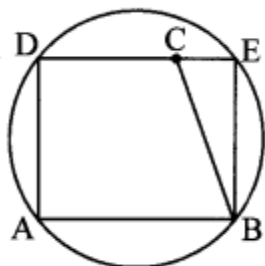
$\therefore$ ABED is a cyclic quadrilateral.

$\angle DAB + \angle DEB = 180^\circ$ (i) [Opposite angles of a cyclic quadrilateral are supplementary]

$\angle DAB + \angle DCB = 180^\circ$ (ii) [Given]

$\therefore \angle DAB + \angle DEB = \angle DAB + \angle DCB$ [From (i) and (ii)]

$\therefore \angle DEB = \angle DCB$



But, $\angle DEB \neq \angle DCB$ as $\angle DEB$ is the exterior angle of $\triangle BEC$.

$\therefore$ Our supposition is wrong.

$\therefore$ ABCD is a cyclic quadrilateral.

Case II: Point C lies inside the circle.

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Then, take point E on the circle such that

$D - C - E$

$\therefore \square ABED$ is a cyclic quadrilateral.

$\angle DAB + \angle DEB = 180^\circ$ (iii) [Opposite angles of a cyclic quadrilateral are supplementary]

$\angle DAB + \angle DCB = 180^\circ$ (iv) [Given]

$\therefore \angle DAB + \angle DEB = \angle DAB + \angle DCB$ [From (iii) and (iv)]

$\therefore \angle DEB = \angle DCB$

But $\angle DEB \neq \angle DCB$ as $\angle DCB$ is the exterior angle of $\triangle BCE$.

$\therefore$ Our supposition is wrong.

$\therefore \square ABCD$ is a cyclic quadrilateral.

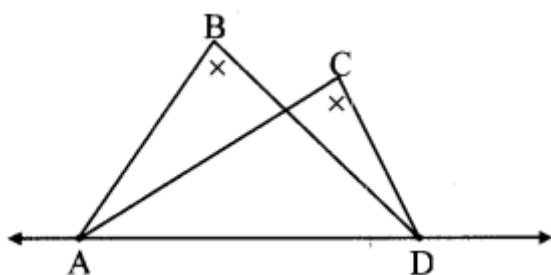
Question 10.

Theorem: If two points on a given line subtend equal angles at two distinct points which lie on the same side of the line, then the four points are concyclic. (Textbook pg. no. 70)

Given: Points B and C lie on the same side of the line AD.

$\angle ABD = \angle ACD$

To prove: Points A, B, C, D are concyclic. i.e., $\square ABCD$ is a cyclic quadrilateral.



Proof:

Suppose points A, B, C, D are not concyclic points.

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We can still draw a circle passing through three non collinear points A, B, D.

Case I: Point C lies outside the circle.

Then, take point E on the circle such that

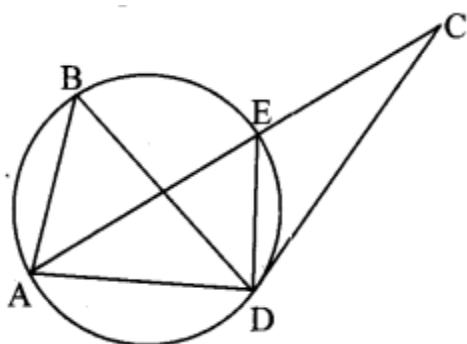
A – E – C.

$\angle ABD \cong \angle AED$ (i) [Angles inscribed in the same arc]

$\angle ABD \cong \angle ACD$ (ii) [Given]

$\therefore \angle AED \cong \angle ACD$ [From (i) and (ii)]

$\therefore \angle AED \cong \angle ECD$ [A – E – C]



But, $\angle AED \cong \angle ECD$ as $\angle AED$ is the exterior angle of $\triangle ECD$.

$\therefore$ Our supposition is wrong.

$\therefore$ Points A, B, C, D are concyclic points.

Case II: Point C lies inside the circle. Then, take point E on the circle such that A – C – E.

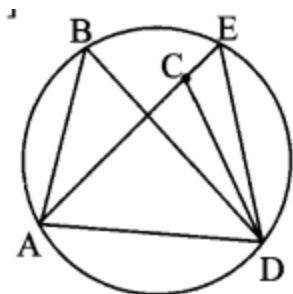
$\angle ABD \cong \angle AED$ (iii) [Angles inscribed in the same arc]

$\angle ABD \cong \angle ACD$ (iv) [Given]

$\therefore \angle AED \cong \angle ACD$ [From (iii) and (iv)]

$\therefore \angle CED \cong \angle ACD$ [A – C – E]

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But, $\angle CED \cong \angle ACD$ as $\angle ACD$ is the exterior angle of $\triangle ECD$.

$\therefore$ Our supposition is wrong.

$\therefore$ Points A, B, C, D are concyclic points.

Question 11.

The above theorem is converse of a certain theorem. State it. (Textbook pg. no. 70)

Answer:

If four points are concyclic, then the line joining any two points subtend equal angles at the other two points which are on the same side of that line.

Practice Set 3.5

Question 1.

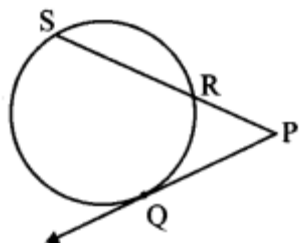
In the adjoining figure, ray PQ touches the circle at point Q. $PQ = 12$, $PR = 8$, find PS and RS.

Solution:

i. Ray PQ is a tangent to the circle at point Q and seg PS is the secant. [Given]

$\therefore PR \times PS = PQ^2$ [Tangent secant segments theorem]

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$$\therefore 8 \times PS = 12^2$$

$$\therefore 8 \times PS = 144$$

$$\therefore PS = 1448$$

$$\therefore PS = 18 \text{ units}$$

$$\text{ii. Now, } PS = PR + RS \text{ [P - R - S]}$$

$$\therefore 18 = 8 + RS$$

$$\therefore RS = 18 - 8$$

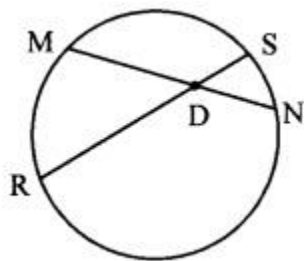
$$\therefore RS = 10 \text{ units}$$

Question 2.

In the adjoining figure, chord MN and chord RS intersect at point D.

i. If RD = 15, DS = 4, MD = 8 find DN

ii. If RS = 18, MD = 9, DN = 8 find DS



Solution:

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i. Chords MN and RS intersect internally at point D. [Given]

$$\therefore MD \times DN = RD \times DS \text{ [Theorem of internal division of chords]}$$

$$\therefore 8 \times DN = 15 \times 4$$

$$\therefore DN = 15 \times 48$$

$$\therefore DN = 7.5 \text{ units}$$

ii. Let the value of RD be x.

$$RS = RD + DS \text{ [R - D - S]}$$

$$\therefore 18 = x + DS$$

$$\therefore DS = 18 - x$$

$$\text{Now, } MD \times DN = RD \times DS \text{ [Theorem of internal division of chords]}$$

$$\therefore 9 \times 8 = x(18 - x)$$

$$\therefore 72 = 18x - x^2$$

$$\therefore x^2 - 18x + 72 = 0$$

$$\therefore x^2 - 12x - 6x + 72 = 0$$

$$\therefore x(x - 12) - 6(x - 12) = 0$$

$$\therefore (x - 12)(x - 6) = 0$$

$$\therefore x - 12 = 0 \text{ or } x - 6 = 0$$

$$\therefore x = 12 \text{ or } x = 6$$

$$\therefore DS = 18 - 12 \text{ or } DS = 18 - 6$$

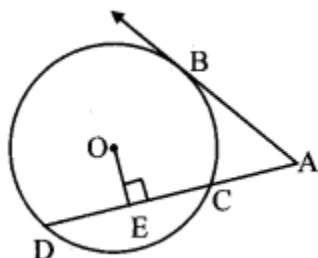
$$\therefore DS = 6 \text{ units or } DS = 12 \text{ units}$$

Question 3.

In the adjoining figure, O is the centre of the circle and B is a point of contact. Seg OE $\perp$ seg AD, AB = 12, AC = 8, find

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- i. AD
- ii. DC
- iii. DE.



Solution:

i. Line AB is the tangent at point B and seg AD is the secant. [Given]

$\therefore AC \times AD = AB^2$ [Tangent secant segments theorem]

$$\therefore 8 \times AD = 122$$

$$\therefore 8 \times AD = 144$$

$$\therefore AD = 1448$$

$$\therefore AD = 18 \text{ units}$$

ii. $AD = AC + DC$ [A – C – D]

$$\therefore 18 = 8 + DC$$

$$\therefore DC = 18 - 8$$

$$\therefore DC = 10 \text{ units}$$

iii. $\text{seg } OE \perp \text{seg } AD$ [Given]

i.e. $\text{seg } OE \perp \text{seg } CD$ [A – C – D]

$\therefore DE = 12 DC$ [Perpendicular drawn from the centre of the circle to the chord bisects the chord]

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$$= 12 \times 10$$

$$\therefore DE = 5 \text{ units}$$

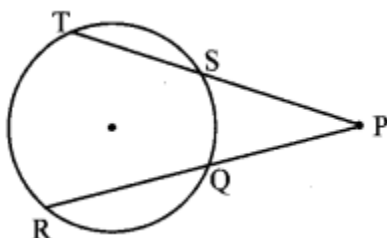
Question 4.

In the adjoining figure, if $PQ = 6$, $QR = 10$, $PS = 8$, find TS .

Solution:

$$PR = PQ + QR \text{ [P-Q-R]}$$

$$\therefore PR = 6 + 10 = 16 \text{ units}$$



Chords TS and RQ intersect externally at point P .

$$PQ \times PR = PS \times PT \text{ [Theorem of external division of chords]}$$

$$\therefore 6 \times 16 = 8 \times PT$$

$$\therefore PT = 6 \times 16 / 8 = 12 \text{ units}$$

$$\text{But, } PT = PS + TS \text{ [P - S - T]}$$

$$\therefore 12 = 8 + TS$$

$$\therefore TS = 12 - 8$$

$$\therefore TS = 4 \text{ units}$$

Question 5.

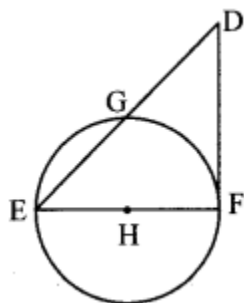
In the adjoining figure, seg EF is a diameter and seg DF is a tangent segment. The radius of the circle is r . Prove that, $DE \times GE = 4r^2$.

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Given: seg EF is the diameter.

seg DF is a tangent to the circle,

radius = r



To prove: $DE \times GE = 4r^2$

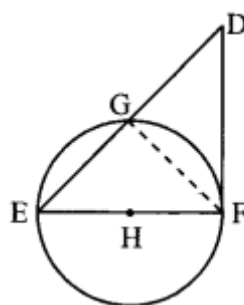
Construction: Join seg GF.

Proof:

seg EF is the diameter. [Given]

$\therefore \angle EGF = 90^\circ$ (i) [Angle inscribed in a semicircle]

seg DF is a tangent to the circle at F. [Given]



$\therefore \angle EFD = 90^\circ$ (ii) [Tangent theorem]

In $\triangle DFE$,

$\angle EFD = 90^\circ$ [From (ii)]

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seg $FG \perp$ side DE [From (i)]

$\therefore \triangle EFD \sim \triangle EGF$ [Similarity of right angled triangles]

$\therefore EFGE = DEEF$ [Corresponding sides of similar triangles]

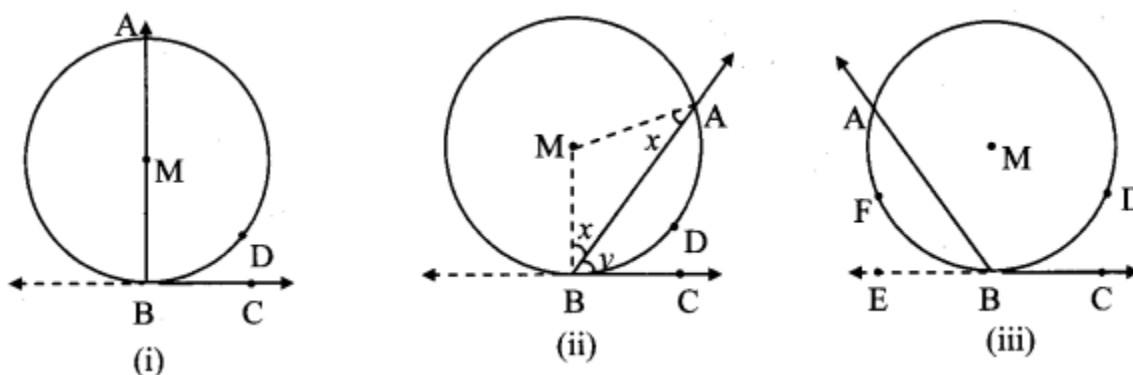
$\therefore DE \times GE = EF^2$

$\therefore DE \times GE = (2r)^2$ [diameter = $2r$]

$\therefore DE \times GE = 4r^2$

Question 1.

Theorem: If an angle has its vertex on the circle, its one side touches the circle and the other intersects the circle in one more point, then the measure of the angle is half the measure of its intercepted arc. (Textbook pg.no. 75 and 76)



Given: $\angle ABC$ is any angle, whose vertex B lies on the circle with centre M .

Line BC is tangent at B and line BA is secant intersecting the circle at point A .

Arc ADB is intercepted by $\angle ABC$.

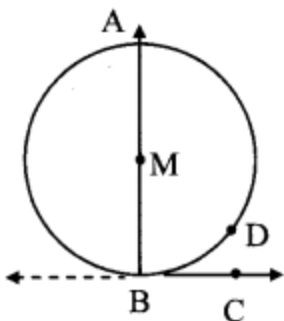
To prove: $\angle ABC = \frac{1}{2} m(\text{arc } ADB)$

Proof:

Case I: Centre M lies on arm BA of $\angle ABC$.

$\angle MBC = 90^\circ$ [Tangent theorem]

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i.e. $\angle ABC = 90^\circ$ (i) $[A - M - B]$

arc ADB is a semicircular arc.

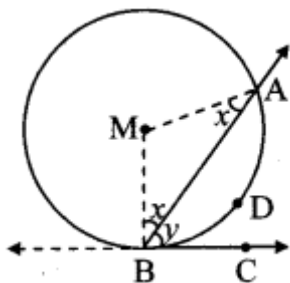
$\therefore m(\text{arc ADB}) = 180^\circ$ (ii) [Measure of a semicircle is 180°]

$\therefore \angle ABC = \frac{1}{2} m(\text{arc ADB})$ [(From (i) and (ii))]

Case II: Centre M lies in the exterior of $\angle ABC$.

Draw radii MA and MB.

$\therefore \angle MBA = \angle MAB$ [Isosceles triangle theorem]



Let, $\angle MBA = \angle MAB = x$, $\angle ABC = y$ In $\triangle ABM$,

$\angle AMB + \angle MBA + \angle MAB = 180^\circ$ [Sum of the measures of all the angles of a triangle is 1800]

$\therefore \angle AMB + x + x = 180^\circ$

$\therefore \angle AMB = 180^\circ - 2x \dots\dots (i)$

Now, $\angle MBC = \angle MBA + \angle ABC$ [Angle addition property]

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$$\therefore 90^\circ = x + y \text{ [Tangent theorem]}$$

$$\therefore x = 90^\circ - y \dots\dots(ii)$$

$$\angle AMB = 180^\circ - 2(90^\circ - y) \text{ [From (i) and (ii)]}$$

$$\therefore \angle AMB = 180^\circ - 180^\circ + 2y$$

$$\therefore 2y = \angle AMB$$

$$\therefore y = \frac{1}{2} \angle AMB$$

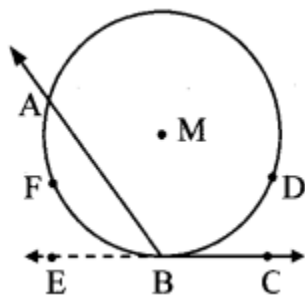
$$\therefore \angle ABC = \frac{1}{2} \angle AMB$$

$$\therefore \angle ABC = \frac{1}{2} m(\text{arc ADB}) \text{ [Definition of measure of minor arc]}$$

Case III: Centre M lies in the interior of $\angle ABC$.

Ray BE is the opposite ray of ray BC.

Now, $\angle ABE = \frac{1}{2} m(\text{arc AFB})$ (i) [Proved in case II]



$$\angle ABC + \angle ABE = 180^\circ \text{ [Angles in a linear pair]}$$

$$\therefore 180 - \angle ABC = \angle ABE$$

$$\therefore 180 - \angle ABC = \frac{1}{2} m(\text{arc AFB}) \text{ [From (i)]}$$

$$= \frac{1}{2} [360 - m(\text{arc ADB})]$$

$$\therefore 180 - \angle ABC = 180 - \frac{1}{2} m(\text{arc ADB})$$

$$\therefore -\angle ABC = -\frac{1}{2} m(\text{arc ADB})$$

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$$\therefore \angle ABC = 12 \text{ m(arc ADB)}$$

Question 2.

We have proved the above theorem by drawing seg AC and seg DB. Can the theorem be proved by drawing seg AD and seg CB, instead of seg AC and seg DB? (Textbook pg. no. 77)

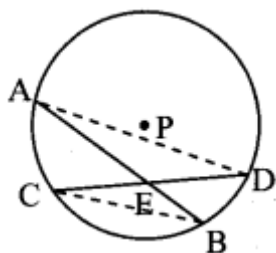
Solution:

Yes, the theorem can be proved by drawing seg AD and seg CB.

Given: P is the centre of circle, chords AB and CD intersect internally at point E.

To prove: $AE \times EB = CE \times ED$

Construction: Draw seg AD and seg CB.



Proof:

In $\triangle CEB$ and $\triangle AED$,

$$\angle CEB = \angle DEA \text{ [Vertically opposite angles]}$$

$$\angle CBE = \angle ADE \text{ [Angles inscribed in the same arc]}$$

$$\therefore \triangle CEB \sim \triangle AED \text{ [by AA test of similarity]}$$

$$\therefore CE/AE = EB/ED \text{ [Corresponding sides of similar triangles]}$$

$$\therefore AE \times EB = CE \times ED$$

Question 3.

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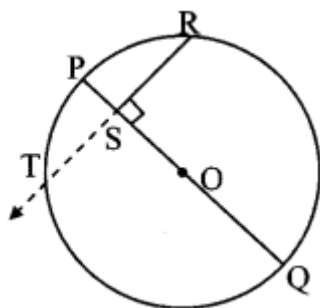
In figure, seg PQ is a diameter of a circle with centre O. R is any point on the circle, seg $RS \perp$ seg PQ. Prove that, SR is the geometric mean of PS and SQ. [That is, $SR^2 = PS \times SQ$] (Textbook pg. no. 81)

Given: seg PQ is the diameter.

seg $RS \perp$ seg PQ

To prove: $SR^2 = PS \times SQ$

Construction: Extend ray RS, let it intersect the circle at point T.



Proof:

seg $PQ \perp$ seg RS [Given]

$\therefore$ seg OS $\perp$ chord RT [R – S – T, P – S – O]

$\therefore$ segSR = segTS (i) [Perpendicular drawn from the centre of the circle to the chord bisects the chord]

Chords PQ and RT intersect internally at point S.

$\therefore$ $SR \times TS = PS \times SQ$ [Theorem of internal division of chords]

$\therefore$ $SR \times SR = PS \times SQ$ [From (i)]

$\therefore$ $SR^2 = PS \times SQ$

Question 4.

Theorem: If secants containing chords AB and CD of a circle intersect outside the circle in point E, then

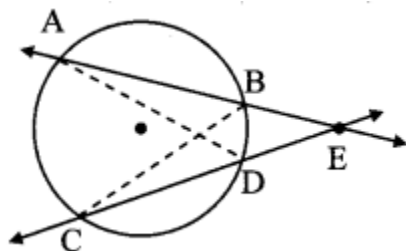
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$AE \times EB = CE \times ED$. (Textbook pg. no. 78)

Given: Chords AB and CD of a circle intersect outside the circle in point E.

To prove: $AE \times EB = CE \times ED$

Construction: Draw seg AD and seg BC.



Proof:

In $\triangle ADE$ and $\triangle CBE$,

$\angle AED = \angle CEB$ [Common angle]

$\angle DAE \cong \angle BCE$ [Angles inscribed in the same arc]

$\therefore \triangle ADE \sim \triangle CBE$ [AA test of similarity]

$\therefore AE/CE = ED/EB$ [Corresponding sides of similar triangles]

$\therefore AE \times EB = CE \times ED$

Question 5.

Theorem: Point E is in the exterior of a circle. A secant through E intersects the circle at points A and B, and a tangent through E touches the circle at point T, then $EA \times EB = ET^2$.

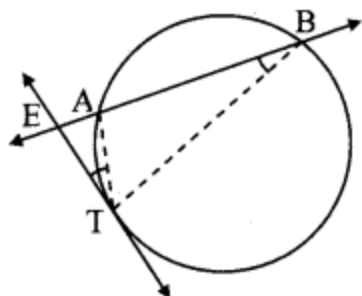
Given: Secant through point E intersects the circle in points A and B.

Tangent drawn through point E touches the circle in point T.

To prove: $EA \times EB = ET^2$

Construction: Draw seg TA and seg TB.

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Proof:

In $\triangle EAT$ and $\triangle ETB$,

$\angle AET \cong \angle TEB$ [Common angle]

$\angle ETA \cong \angle EBT$ [Theorem of angle between tangent and secant, $E - A - B$]

$\therefore \triangle EAT \sim \triangle ETB$ [AA test of similarity]

$\therefore EA \cdot EB = ET^2$ [Corresponding sides of similar triangles]

$\therefore EA \times EB = ET^2$

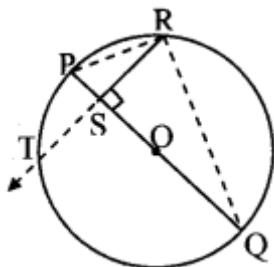
Question 6.

In the figure in the above example, if seg PR and seg RQ are drawn, what is the nature of $\triangle PRQ$. (Textbook pg. no, 81)

Answer:

seg PQ is the diameter of the circle.

$\therefore \angle PRQ = 90^\circ$



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$\therefore \triangle PRQ$ is a right angled triangle. [Angle inscribed in a semicircle]

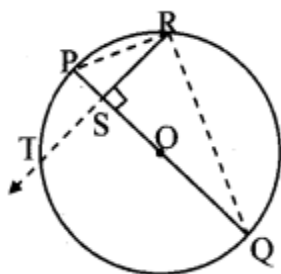
Question 7.

Have you previously proved the property proved in the above example? (Textbook pg. no. 81)

Answer:

Yes. It is the theorem of geometric mean.

$\triangle PSR \sim \triangle RSQ$ [Similarity of right angled triangles]



$\therefore PS \cdot SQ = SR^2$ [Corresponding sides of similar triangles]

$\therefore SR^2 = PS \times SQ$



Maharashtra Board Solutions

Class 10 Maths (Part 2)

- Chapter 1- Similarity
- Chapter 2- Pythagoras Theorem
- Chapter 3- Circle
- Chapter 4- Geometric Constructions
- Chapter 5- Co-ordinate Geometry
- Chapter 6- Trigonometry
- Chapter 7- Mensuration

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About About Maharashtra State Board (MSBSHSE)

The Maharashtra State Board of Secondary and Higher Secondary Education or MSBSHSE (Marathi: महाराष्ट्र राज्य माध्यमिक आणि उच्च माध्यमिक शिक्षण मंडळ), is an **autonomous and statutory body established in 1965**. The board was amended in the year 1977 under the provisions of the Maharashtra Act No. 41 of 1965.

The Maharashtra State Board of Secondary & Higher Secondary Education (MSBSHSE), Pune is an independent body of the Maharashtra Government. There are more than 1.4 million students that appear in the examination every year. The Maha State Board conducts the board examination twice a year. This board conducts the examination for SSC and HSC.

The Maharashtra government established the Maharashtra State Bureau of Textbook Production and Curriculum Research, also commonly referred to as Ebalbharati, in 1967 to take up the responsibility of providing quality textbooks to students from all classes studying under the Maharashtra State Board. MSBHSE prepares and updates the curriculum to provide holistic development for students. It is designed to tackle the difficulty in understanding the concepts with simple language with simple illustrations. Every year around 10 lakh students are enrolled in schools that are affiliated with the Maharashtra State Board.

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