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CHAPTER NOTES

Circles Class 9 Notes | CBSE Maths Chapter 5

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Ask me anything from this chapter. A concept, a numerical, or that one doubt you did not want to raise in class. Pick one to start:

Explain Circles simply

What can the board exam ask?

Most important formulas

Quiz me on this chapter

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Circles Class 9 Notes | CBSE Maths Chapter 5

Circles is Chapter 5 of CBSE Class 9 Maths. In the 2026-27 NCERT textbook, Ganita Manjari Part I, it appears under the title "I'm Up and Down, and Round and Round". The chapter defines a circle as a locus, looks at its symmetries, and asks how many circles pass through two points and through three points. It then proves a chain of twelve theorems about chords, their distances from the centre, the angles that arcs subtend, and when four points lie on one circle.

This is a reasoning chapter. School exams ask you to explain why each theorem is true using congruent triangles, isosceles triangles and the Baudhāyana-Pythagoras theorem, and to apply the results: find a chord from the radius and distance, find angles at the centre and on the circle, and solve cyclic quadrilateral problems. Circles is part of Unit IV, Geometry, and the chord and angle facts here are the base for the further results about circles that you study in Class 10.

Quick Answer - Circles in 30 Seconds

A **circle** is the set of points on a plane equidistant from a fixed point. Infinitely many circles pass through two points, but exactly one circle passes through three **non-collinear points**: the circumcircle. Equal chords are equidistant from the centre, and conversely. The perpendicular distance from the centre to a chord of length $2\sqrt{r^2 - d^2}$. The longer chord subtends at the centre is **double** the angle subtended at the circumference. The angle in a semicircle is 90° . Opposite angles of a cyclic quadrilateral are supplementary, and conversely.



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All Key Formulas at a Glance

Result	Rule	Remember
Circles through two points A, B	Infinitely many; centres on the perpendicular bisector of AB	Smallest has radius AB/2
Circle through three points	Exactly one if the points are non-collinear	None if they are collinear
Equal chords and central angles	$AB = DE \Leftrightarrow \angle AOB = \angle DOE$	Proofs: SSS one way, SAS the other
Perpendicular from the centre	$OM \perp AB \Leftrightarrow AM = MB$	It bisects the chord
Chord length	Chord = $2\sqrt{r^2 - d^2}$	
Equal chords and distance	$AB = CD \Leftrightarrow \text{equal distance from O}$	
Arc at centre and on the circle	Angle at centre = angle subtended by the arc at the circumference	
Angle in a semicircle	90°	
Angles in the same segment	Equal	
Cyclic quadrilateral	$\angle A + \angle C = 180^\circ$ $\angle B + \angle D = 180^\circ$	



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Key Concepts

1. What a Circle Is: Centre, Radius, Chord and Diameter

Every circle, big or small, has a centre, and every point on the circle is at the same distance from that centre. NCERT turns this observation into the definition. All figures in this chapter are drawn on a flat sheet, a two-dimensional plane.

Circle: the set of all points on the plane that are equidistant from a given point on that plane.

A set of points that satisfies a given condition is called a **locus**. So a circle is also the **locus of points equidistant from a given point**. The given point is the **centre**, and the distance from the centre to any point on the circle is the **radius**.

- **Chord:** the line segment joining two points B and C on the circle.
- **Angle subtended by a chord at the centre:** if A is the centre, chord BC subtends $\angle BAC$ at the centre.
- **Diameter:** a chord that passes through the centre.
- **Arc:** a connected portion of the circle, formed by two points on the circle and the part along the circle.
- **Minor and major arc:** two points A and B on a circle divide the circle into two arcs. The smaller one is the minor arc, the bigger one is the major arc.
- **Semicircle:** each of the two equal arcs into which a circle is divided by a diameter.

The CBSE course structure also lists two regions of a circle (the region between a chord and one of its arcs, called a segment with the major arc). A sector is the region of a circle bounded by two radii and an arc.

Illustration: in a circle of radius 5 units the longest chord is 10 units, the smallest chord, since a chord can be made as small as we like, is 0 units.

2. Symmetries of a Circle

A circle is perfectly symmetric in two ways:

- **Rotational symmetry:** rotate a circle about its centre by any angle and it will look the same. That is why you cannot tell which way a circle is rotated. NCERT calls this **complete rotational symmetry**.



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- **Reflection symmetry:** fold a paper circle so that the boundaries overlap. The crease passes through the centre, so it is a diameter. **Every diameter is a line of reflection symmetry**, so a circle has infinitely many lines of symmetry.

By comparison, a square has only 4 lines of symmetry, a regular pentagon 5 and a regular hexagon 6.

Rotating a circle carries a chord to another chord of the same length, with the same central angle. The theorems below prove with congruent triangles what this rotation suggests.

3. Circles Through Two Points and Through Three Points

Key fact: the perpendicular bisector of a segment AB is the locus of points equidistant from A and B. Every point on it is equidistant from A and B, and every point equidistant from A and B lies on it.

Two points. The centre O of any circle through A and B lies on the perpendicular bisector of AB. Every point on the perpendicular bisector of AB is the centre of a circle through A and B. **Circles pass through two given points**, and the centres of these circles lie on the perpendicular bisector of AB.

- The smallest such circle has its centre at the midpoint of AB and its radius is half the length of AB.
- Moving the centre away from AB increases the radius.

Theorem 1: There is a unique circle passing through three non-collinear points.

Why: the centre O of such a circle has $OA = OB$ and $OB = OC$, so it lies on the perpendicular bisector of AB and the perpendicular bisector of BC. If A, B, C are not collinear, these two bisectors are not parallel and intersect at a point O. The circle with centre O and radius OA passes through A, B, and C.

If A, B, C are collinear, the perpendicular bisectors of AB and BC are the same line, so they are parallel and never meet. **No circle passes through three collinear points.**

Circumcircle and circumcentre. Three non-collinear points and the circle passing through them. The circle is the **circumcircle**; its centre is the **circumcentre**, where the perpendicular bisectors of the sides of the triangle meet.



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Illustration: in a circle of radius 12 cm, chord AB subtends 60° at the centre O. $\triangle OAB$ has $OA = OB$, so $\angle OAB = \angle OBA = (180^\circ - 60^\circ)/2 = 60^\circ$. The triangle is equilateral and $AB = 12$ cm.

5. The Perpendicular from the Centre to a Chord

Theorem 4: The line joining the centre of a circle and the midpoint of a chord of the circle is perpendicular to the chord.

Given: chord AB of a circle with centre C, M the midpoint of AB. **To show:** $CM \perp AB$.

Why: $CA = CB$, so $\triangle CAB$ is isosceles and $\angle A = \angle B$. Also $AM = BM$. By **SAS**, $\triangle CMA \cong \triangle CMB$, so $\angle CMA = \angle CMB$. These two angles form a linear pair, so $\angle CMA + \angle CMB = 180^\circ$, and each is 90° .

Theorem 5 (converse): The perpendicular from the centre of a circle to a chord of the circle bisects the chord.

Why: now $\angle CMA = \angle CMB = 90^\circ$. In right triangles $\triangle CMA$ and $\triangle CMB$, CA and CB are radii and CM is common. By **RHS**, $\triangle CMA \cong \triangle CMB$.

Consequence: the perpendicular bisector of a chord of a circle passes through the centre. The centre is equidistant from the chord's ends.

The key right triangle. With radius r , distance from centre to chord d , and half-chord AM , the Baudhāyana-Pythagoras theorem in $\triangle CMA$ gives

$$r^2 = d^2 + (AM)^2, \text{ so chord } AB = 2 \times AM = 2\sqrt{r^2 - d^2}$$

6. Distance of Chords from the Centre

The **distance of a chord from the centre** of a circle is the length of the perpendicular from the centre to the chord. By Theorem 5, the foot of that perpendicular is the midpoint of the chord.

Theorem 6: Chords of a circle having the same distance from the centre are equal.

Given: $AB = FG$ in a circle with centre C; E and H are midpoints of AB and FG respectively. NCERT gives two explanations.



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- **Method 1:** $CA = CF$, $CB = CG$ (radii) and $AB = FG$, so $\triangle CAB \cong \triangle CFG$ by SSS. Corresponding altitudes of congruent triangles are equal, so $CE = CH$.
- **Method 2:** $AE = FH$ (halves of equal chords), $\angle CEA = \angle CHF = 90^\circ$ and $CA = CF$ (radii). By RHS, $\triangle CEA \cong \triangle CHF$, so $CE = CH$.

Theorem 7 (converse): Chords of a circle that are equidistant from the centre have equal length. If $CE = CH$, then $AE^2 = r^2 - CE^2 = r^2 - CH^2 = FH^2$, so $AE = FH$ and the full chords are equal.

Theorem 8: Let AB and DE be two chords of a circle with centre C. Suppose $AB > DE$. Then the distance from C to AB is less than the distance from C to DE.

Why: drop perpendiculars CF to AB and CG to DE. $AC = CD$ (radii), so $CF^2 + AF^2 = AC^2 = CD^2 = CG^2 + GD^2$. F and G are midpoints, so $AB > DE$ gives $AF > GD$, so $AF^2 > GD^2$. Then $CF^2 < CG^2$, so $CF < CG$.

In short, the longer the chord, the closer it is to the centre.

- The chord nearest the centre is the one closest to the **longest chord**.
- As a chord is pushed away from the centre, it becomes a single point of length 0.

Distance d from centre ($r = 5$ cm)

0 cm

3 cm

4 cm

5 cm

7. Angles Subtended by an Arc

Angle at the centre. The angle subtended by an arc at the centre is double the angle subtended by it at any point on the circumference. As you move from OA to OB along that arc. A minor arc subtends a reflex angle, more than 180° . An angle subtended by a minor arc at the centre is the angle of the minor arc and the major arc on the same side of the centre.



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Angle at a point on the circle. The angle subtended by arc AXB at a point on the circle outside the arc is $\angle ACB$, where C is any point of the circle not on arc AXB. Its measure does not depend on which such point C you choose.

Theorem 9: The angle subtended by an arc at the centre of the circle is double the angle subtended by the arc at any point on the circle outside the arc.

Proof (case where DC extended meets the arc): let C be the centre, AFB the arc and D a point on the circle outside it. Join DC and extend it to meet arc AFB at E.

- $\triangle DCB$ is isosceles ($CB = CD$), so $\angle CBD = \angle CDB$. $\angle BCE$ is an exterior angle of $\triangle BCD$, so $\angle BCE = \angle CBD + \angle CDB = 2\angle BDC$.
- $\triangle ADC$ is isosceles ($CA = CD$), so $\angle CAD = \angle CDA$. $\angle ACE$ is an exterior angle of $\triangle ADC$, so $\angle ACE = 2\angle CDA$.
- Adding: $\angle BCA = \angle BCE + \angle ECA = 2(\angle BDC + \angle CDA) = 2\angle BDA$.

Other case: if DC extended meets the circle at E, the same angle steps give $\angle ACE = 2\angle ADC$ and $\angle BCE = 2\angle BDC$. So $\angle BCE = 2(\angle ADC - \angle BDC) = 2\angle ADB$.

Angles in the same segment are equal. The angle subtended by an arc at the circumference is $\frac{1}{2}$ (angle of the arc at the centre). So all such angles are equal. This is true for all such points.

Corollary: The angle subtended by a diameter at the circumference is 90° . If D is the midpoint of the arc, the angle subtended by the diameter at the circumference is 90° . This is the **angle in a semicircle**. The radius to the midpoint of the hypotenuse of a right-angled triangle is the midpoint of the hypotenuse.

Illustrations:

- An arc subtends 70° at the centre. At any point on the circumference, it subtends 35° .
- A major arc subtends a reflex angle of 230° at the centre. At any point on the circumference, it subtends 115° .



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8. Concyclic Points and Cyclic Quadrilaterals

Points that lie on the same circle are called **concyclic**. Any three non-collinear points are concyclic (Theorem 1). Four points need a test.

Theorem 10: If a line segment AB joining two points A, B subtends equal angles at two other points C, D that lie on the same side of AB, then the four points lie on a circle.

Why (by contradiction): draw the circle through A, B, C. If D is outside it, AD meets the circle at E, and $\angle ADB < \angle AEB = \angle ACB$ (exterior angle of $\triangle BED$, then same segment), which contradicts $\angle ACB = \angle ADB$. If D is inside, extending AD gives the reverse inequality and the same contradiction. So D lies on the circle.

A quadrilateral whose four vertices are concyclic is a **cyclic quadrilateral**.

Theorem 11: The sum of two opposite angles of a cyclic quadrilateral is 180° .

Why: let ABCD be cyclic with centre O. A is outside arc BAD, so $\angle BCD = \frac{1}{2} (\angle BOD)$. Then make the complete angle at O. So $\angle BAD + \angle BCD = 180^\circ$.

Theorem 12 (converse): If two opposite vertices of the quadrilateral lie on a circle

Why (by contradiction): take the circle through A, B, C. AD meets the circle at E. ABED is cyclic, so $\angle BAD + \angle BED = 180^\circ$. But $\angle BED = \angle BCD$. This contradiction (and a similar one when

Consequences you should know:

- **Exterior angle of a cyclic quadrilateral** is equal to the opposite angle. If E is on CD extended,
- **Rectangle:** the only parallelogram that is cyclic. Opposite angles; cyclic means they add to 180° .



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Formula and Theorem Sheet

No.	Result (NCERT numbering)	Proved using
1	A unique circle passes through three non-collinear points	Perpendicular bisectors of two sides meet at one point
2	Equal chords subtend equal angles at the centre	SSS congruence
3	Chords subtending equal angles at the centre are equal	SAS congruence
4	Line from centre to midpoint of a chord is perpendicular to it	SAS, linear pair
5	Perpendicular from centre bisects it	
6	Equal chords are equidistant from the centre	
7	Chords equidistant from the centre are equal	
8	Of two unequal chords, the longer is nearer the centre	
9	Angle at centre = $2 \times$ angle at circumference subtended by the same arc on the circle outside the arc	
Corollary	Angle subtended by a diameter at the circumference of a circle = 90°	
10	Equal angles on the same side of a line make A, B, C, D concyclic	
11	Opposite angles of a cyclic quadrilateral add to 180°	



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No.	Result (NCERT numbering)	Proved using
12	Opposite angles adding to 180° make a quadrilateral cyclic	Contradiction, Theorem 11
Formula	Chord = $2\sqrt{(r^2 - d^2)}$; $r^2 = d^2 + (\text{chord}/2)^2$	Theorem 5 and Pythagoras

Important Definitions

Term	Definition
Circle	The set of all points on a plane that are equidistant from a given point on that plane
Locus	The set of points
Chord	A line segment
Diameter	A chord passing through the centre
Arc	A connected part of the circumference of a circle or a curve joining two points
Minor arc, major arc	Of the two arcs, the smaller is the minor arc and the bigger is the major arc
Segment	The region between a chord and the minor arc
Sector	The region between two radii and the arc
Circumcircle, circumcentre	The circle through the vertices of a triangle and the point where the perpendicular bisectors of the sides meet
Concyclic points	Points that lie on the same circle
Cyclic quadrilateral	A quadrilateral whose vertices lie on a circle



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Solved Examples (NCERT-Based)

Example 1: Chord from radius and distance (NCERT End-of-Chapter Exercise 1)

In a circle, a chord is 5 cm away from the centre. If the radius of the circle is 13 cm, what is the length of the chord?

Solution: let O be the centre, AB the chord and M the foot of the perpendicular from O. By Theorem 5, M is the midpoint of AB. In right $\triangle OMA$, $OA = 13$ cm and $OM = 5$ cm.

$$AM^2 = OA^2 - OM^2 = 169 - 25 = 144, \text{ so } AM = 12 \text{ cm.}$$

$$AB = 2 \times AM = \mathbf{24 \text{ cm.}}$$

Example 2: Distance of a chord (NCERT End-of-Chapter Exercise 3)

The diameter of a circle is 26 cm. A chord is 12 cm long. Find the distance from the centre of the circle to the chord.

Solution: radius $r = 26/2 = 13$ cm. Half the chord is 6 cm. The perpendicular from the centre bisects the chord.

$$d^2 = r^2 - 12^2 = 169 - 144 = 25, \text{ so } d = \mathbf{5 \text{ cm}}$$

Example 3: Radius from a chord (NCERT Exercise 4)

The distance of a chord of length 16 cm from the centre of a circle is 6 cm. Find the radius of the circle.

Solution: half-chord = 8 cm and $d = 6$ cm.

Example 4: Parallel chords on opposite sides of the centre (NCERT Exercise 5)

Two parallel chords of lengths 6 cm and 8 cm are on opposite sides of the centre of a circle. If the radius of the circle is 5 cm, find the distance between the chords.

Solution: the perpendicular from the centre to the chords bisects them. Because the chords are parallel, both perpendiculars are parallel. The midpoints and O are collinear.



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Chord of 6 cm: $d_1 = \sqrt{(25 - 9)} = 4$ cm. Chord of 8 cm: $d_2 = \sqrt{(25 - 16)} = 3$ cm.

The chords are on opposite sides of O, so the distance between the midpoints = $4 + 3 = 7$ cm.
(On the same side it would be $4 - 3 = 1$ cm.)

Example 5: Parallel chords on the same side (NCERT End-of-Chapter Exercise 18)

Two parallel chords of lengths 10 cm and 24 cm are on the same side of the centre of a circle. The distance between the chords is 7 cm. Find the radius of the circle.

Solution: the longer chord is nearer the centre (Theorem 8). Let its distance from the centre be x cm; the 10 cm chord is then $(x + 7)$ cm away.

From the 24 cm chord: $r^2 = 12^2 + x^2 = 144 + x^2$.

From the 10 cm chord: $r^2 = 5^2 + (x + 7)^2 = 74 + x^2 + 14x$.

Equating: $144 + x^2 = 74 + x^2 + 14x$, so $14x = 70$.

$r^2 = 144 + 25 = 169$, so $r = 13$ cm. Check with Theorem 8.

Example 6: Chord from a central angle

In a circle with centre O, the central angle subtended by a chord AB is 60° . Find the length of the chord AB?

Solution: $OA = OB = 12$ cm, so $\triangle OAB$ is isosceles.

$\angle OAB + \angle OBA = 180^\circ - 60^\circ = 120^\circ$, so each angle is 60° .

All angles are 60° , so $\triangle OAB$ is equilateral and $AB = 12$ cm.

Example 7: Angle at the circle (NCERT Exercise 10.2)

An arc of a circle subtends an angle of 70° at the centre. Find the angle subtended by the arc at a point on the circumference.

Solution: by Theorem 9, the angle at a point on the circumference is $\frac{1}{2} \times 70^\circ = 35^\circ$.



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Example 8: Opposite angles of a cyclic quadrilateral (NCERT End-of-Chapter Exercise 7)

ABCD is a cyclic quadrilateral inscribed in a circle. If $\angle A$ measures 75° , what is the measure of $\angle C$? If $\angle B$ measures 110° , what is the measure of $\angle D$?

Solution: by Theorem 11, opposite angles add to 180° .

$$\angle C = 180^\circ - 75^\circ = \mathbf{105^\circ}. \quad \angle D = 180^\circ - 110^\circ = \mathbf{70^\circ}.$$

Check: $75^\circ + 110^\circ + 105^\circ + 70^\circ = 360^\circ$.

Example 9: Cyclic quadrilateral with algebra (NCERT End-of-Chapter Exercise 8)

Quadrilateral PQRS is inscribed in a circle. If $\angle P = (2x + 10)^\circ$ and $\angle R = (3x - 20)^\circ$, find the value of x and the measures of $\angle P$ and $\angle R$.

Solution: P and R are opposite vertices, so

$$(2x + 10) + (3x - 20) = 180, \text{ so } 5x - 10 = 180$$

$$\angle P = 2(38) + 10 = \mathbf{86^\circ}; \quad \angle R = 3(38) - 20 = \mathbf{94^\circ}$$

Example 10: Can the quadrilateral Theorem 11)

A cyclic quadrilateral has angles measuring $80^\circ, 110^\circ, 100^\circ$ and 70° . Can such a quadrilateral be drawn? Explain why or why not.

Solution: the angles add to $80 + 110 + 100 + 70 = 360^\circ$, so a quadrilateral exists.

$$\text{Opposite pairs: } \angle A + \angle C = 80^\circ + 100^\circ = 180^\circ$$

By Theorem 12, a quadrilateral whose opposite angles add to 180° can be drawn.

Example 11: Area of a cyclic quadrilateral

A cyclic quadrilateral has sides 5, 5, 12, 12. Find its area.



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Solution: take the sides in order: $AB = BC = 5$ and $CD = DA = 12$. Join BD .

$\triangle BAD \cong \triangle BCD$ by SSS ($BA = BC$, $AD = CD$, BD common), so $\angle A = \angle C$.

The quadrilateral is cyclic, so $\angle A + \angle C = 180^\circ$. Hence $\angle A = \angle C = 90^\circ$.

Area = area of $\triangle BAD$ + area of $\triangle BCD = \frac{1}{2} \times 5 \times 12 + \frac{1}{2} \times 5 \times 12 = 30 + 30 = \mathbf{60 \text{ square units}}$.

If the sides are taken in the order 5, 12, 5, 12, the quadrilateral is a parallelogram inscribed in a circle, so it is a 5 by 12 rectangle, and the area is again 60 square units.

Example 12: Regular hexagon in a circle (NCERT End-of-Chapter Exercise 19)

A regular hexagon is inscribed in a circle of radius r . Find the length of the sides of the hexagon and the distance of each side from the centre of the circle.

Solution: the six sides are equal chords, so each angle is $360^\circ/6 = 60^\circ$.

Each side and two radii form an isosceles triangle (see Example 6). **Side = r .**

The perpendicular from the centre bisects the side. The distance is $(\sqrt{3}/2)r$.



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Competency-Based Questions

1. Case-based: Finding the centre

An archaeologist finds a piece of a circular plate on the curved edge and draws the perpendicular from point O . She measures one chord as 30 cm and the distance from O to the chord as 8 cm.

(i) Why is O the centre of the plate? (ii) Find the radius of the plate.

Answer: (i) The perpendicular bisector of the chord passes through the centre. The perpendicular bisectors, and two non-parallel lines meet at a point. 15 cm , $d = 8 \text{ cm}$, $r = \sqrt{(225 + 64)} = \sqrt{289} = 17 \text{ cm}$.

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2. Case-based: A well for three villages

Three villages P, Q and R are not on one straight line. The panchayat wants to dig a well at a point equally far from all three.

(i) Where should the well be? (ii) If the angle at Q in ΔPQR is 90° and $PR = 4$ km, where is the well and how far is it from each village? (iii) Is there such a point if the three villages lie on one straight road?

Answer: (i) At the circumcentre of ΔPQR , where the perpendicular bisectors of PQ and QR meet (Theorem 1). (ii) For a right triangle the circumcentre is the midpoint of the hypotenuse PR. The well is at the midpoint of PR, 2 km from each village. (iii) No. For collinear points the perpendicular bisectors are parallel and never meet.

3. Assertion-Reason

Assertion (A): Infinitely many circles pass through two given points A and B.

Reason (R): The centre of any circle through A and B lies on the perpendicular bisector of AB and every point of that bisector is equidistant from A and B.

- (a) Both A and R are true, and R is the correct explanation of A.
- (b) Both A and R are true, but R is not the correct explanation of A.
- (c) A is true, but R is false.
- (d) A is false, but R is true.

Answer: (a). Each point of the bisector is equidistant from A and B. Hence, there are infinitely many circles passing through A and B.

4. Assertion-Reason

Assertion (A): Three collinear points A, B, and C do not have a unique circle passing through them.

Reason (R): For collinear points A, B, C, the perpendicular bisectors of AB and BC do not have a common point.

- (a) Both A and R are true, and R is the correct explanation of A.
- (b) Both A and R are true, but R is not the correct explanation of A.
- (c) A is true, but R is false.
- (d) A is false, but R is true.

Answer: (d). Both bisectors are perpendicular to the line containing A, B and C. They have a common point. No point is equidistant from A, B and C, so no circle passes through them.



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5. Assertion-Reason

Assertion (A): Two chords of lengths 7 cm each in a circle subtend equal angles at the centre.

Reason (R): The diameter is the longest chord of a circle.

- (a) Both A and R are true, and R is the correct explanation of A.
- (b) Both A and R are true, but R is not the correct explanation of A.
- (c) A is true, but R is false.
- (d) A is false, but R is true.

Answer: (b). A is Theorem 2 (equal chords, equal central angles, by SSS). R is true, but it compares chord lengths and says nothing about central angles, so it does not explain A.

6. Source-based: Completing a proof

A student writes the proof of Theorem 9 with the reasons missing. C is the centre, D is on the circle and DC extended meets arc AFB at I.

Step 1: $\angle CBD = \angle CDB$. Step 2: $\angle BCE = \angle CEA$. Step 3: $\angle ACE = 2\angle CDA$. Step 4: $\angle BCE = 2\angle CDA$. Step 5: $\angle BCA = 2\angle BDA$.

(i) Give the reason for Step 1. (ii) Give the reason for Step 4 to reach Step 5?

Answer: (i) $CB = CD$ (radii), so $\triangle DCB$ is isosceles. $\angle BCE$ is an exterior angle of $\triangle BCD$, and an exterior angle is equal to the sum of the two opposite interior angles. (iii) Add them: $\angle BCE + \angle ECA = \angle BCA$ and $2\angle CDA + 2\angle BDA = 2\angle BDA$.

7. Error analysis: Chord length versus distance from the centre

In a circle, if the distance of chord AB from the centre is 3 cm and AB is 8 cm, find the radius of the circle. If the distance of chord AB from the centre is 4 cm, can we conclude that the radius is 5 cm?

Answer: No. Chord length is $2\sqrt{r^2 - d^2}$, where r is the radius and d is the distance from the centre to the chord. Here, $8 = 2\sqrt{r^2 - 3^2}$, $4 = \sqrt{r^2 - 9}$, $16 = r^2 - 9$, $r^2 = 25$, $r = 5$ cm. If $d = 4$ cm, $8 = 2\sqrt{r^2 - 4^2}$, $4 = \sqrt{r^2 - 16}$, $16 = r^2 - 16$, $r^2 = 32$, $r = \sqrt{32}$ cm, which is not equal to 5 cm. What we can conclude is that the radius is longer (Theorem 8).



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8. Reasoning: The shortest chord through a point (NCERT End-of-Chapter Exercise 23)

A point A is 6 cm from the centre O of a circle of radius 10 cm. Which chord through A is the shortest, and how long is it? Which chord through A is the longest?

Answer: for any chord through A, its perpendicular distance from O is at most OA, because OA is the hypotenuse of the right triangle formed with the foot of the perpendicular. The distance equals OA only when the chord is perpendicular to OA. The farthest chord is the shortest (Theorem 8), so the shortest chord is the one perpendicular to OA. Its length is $2\sqrt{(100 - 36)} = 2 \times 8 = 16$ cm. The longest chord through A is the diameter through A, 20 cm.

Important Questions for Exams

1-Mark Questions

Q1. What is the length of the longest chord

Answer: 10 units, the diameter.

Q2. How many circles pass through three

Answer: None.

Q3. What is the least possible radius of a circle

Answer: $AB/2$, with the midpoint of AB as

Q4. The diameter of a circle is AB. Point C is on the circumference. Find $\angle ACB$?

Answer: 90° , the angle in a semicircle.

Q5. Where does the circumcentre of an obtuse triangle lie?

Answer: Outside the triangle.

2-Mark Questions

Q6. Show that the triangle formed by a chord and the radii to its endpoints is isosceles.

Answer: Let AB be a chord of a circle with centre O. Join OA and OB. The triangle OAB with two equal sides is isosceles,

Q7. A circle has a radius of 15 cm. A chord is drawn perpendicular to the radius at a point 8 cm from the centre. What is the length of the chord?



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to

Answer: Half-chord = $\sqrt{15^2 - 9^2} = \sqrt{(225 - 81)} = \sqrt{144} = 12$ cm. Chord = 24 cm.

Q8. Explain why the perpendicular from the centre of a circle to a chord bisects the chord.

Answer: Let $OM \perp AB$. In right triangles OMA and OMB, hypotenuse $OA = OB$ (radii) and OM is common. By RHS, $\triangle OMA \cong \triangle OMB$, so $AM = BM$.

Q9. Let ABCD be a cyclic quadrilateral and E a point on CD extended. Explain why $\angle CDE = \angle ABC$.

Answer: $\angle CDE + \angle ADC = 180^\circ$ (linear pair). $\angle ABC + \angle ADC = 180^\circ$ (opposite angles of a cyclic quadrilateral). So $\angle CDE = \angle ABC$.

3-Mark Questions

Q10. Prove that the perpendicular bisector of a chord passes through the centre of the circle.

Answer: Let AB be a chord of a circle with centre O. $OA = OB$ (radii), so O is equidistant from A and B. The perpendicular bisector of AB is the locus of all points equidistant from A and B. So O lies on it. (Equivalently: if M is the midpoint of AB, $OM \perp AB$ by Theorem 4, so line OM is the perpendicular bisector, and it contains O.)

Q11. An isosceles triangle ABC is inscribed in a circle. The perpendicular bisector of the base AC passes through the centre of the circle.

Answer: Let AD be the altitude, D on BC. $AB = AC$ (given), AD is common, so $\triangle ADB \cong \triangle ADC$ (RHS) and $BD = DC$. AD passes through its midpoint: AD is the perpendicular bisector of AC. The perpendicular bisector of a chord passes through the centre, so the centre lies on AD.

Q12. Show that rectangle is the only parallelogram that is cyclic.

Answer: Let parallelogram ABCD be inscribed in a circle. Opposite angles are equal: $\angle A = \angle C$. The quadrilateral is cyclic, so $\angle A + \angle C = 180^\circ$. $2\angle A = 180^\circ$, so $\angle A = 90^\circ$. A parallelogram with a right angle is a rectangle.

Q13. In a circle with centre O, chords AB and AC are such that $\angle AOB = \angle AOC$. Prove that the line segment OA bisects the angle BAC.

Answer: Join OA, OB, OC. In $\triangle OAB$ and $\triangle OAC$, OA is common. By SSS, $\triangle OAB \cong \triangle OAC$, so $\angle OAB = \angle OAC$. OA bisects $\angle BAC$.

5-Mark Questions

Q14. Prove that the angle subtended by an arc at the centre is double the angle subtended at any point on the remaining part of the circle. (The angle subtended by a semicircle is 90° .)



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Answer: Let O be the centre, AB the arc and P a point on the circle outside it. Join PO and extend it to meet the arc at Q (in the other case, subtract instead of adding). $OA = OP$, so $\angle OAP = \angle OPA$; $\angle AOQ$ is the exterior angle of $\triangle AOP$, so $\angle AOQ = \angle OAP + \angle OPA = 2\angle OPA$. In the same way, $OB = OP$ gives $\angle BOQ = 2\angle OPB$. Adding, $\angle AOB = \angle AOQ + \angle QOB = 2(\angle OPA + \angle OPB) = 2\angle APB$. For a semicircle, AB is a diameter, the central angle is a straight angle, 180° , so $\angle APB = \frac{1}{2} \times 180^\circ = 90^\circ$.

Q15. Prove that the sum of either pair of opposite angles of a cyclic quadrilateral is 180° . In a cyclic quadrilateral PQRS, $\angle P$ is 40° more than $\angle R$. Find $\angle P$ and $\angle R$.

Answer: Let ABCD be cyclic with centre O. A lies outside arc BCD, so $\angle BAD = \frac{1}{2}$ (reflex $\angle BOD$), the angle swept from OB to OD through C. C lies outside arc BAD, so $\angle BCD = \frac{1}{2} \angle BOD$, swept through A. The two central angles together make one complete turn, 360° . So $\angle BAD + \angle BCD = \frac{1}{2} \times 360^\circ = 180^\circ$. As the angles of a quadrilateral add to 360° , $\angle B + \angle D = 180^\circ$ too. For PQRS: $\angle P + \angle R = 180^\circ$ and $\angle P - \angle R = 40^\circ$. Adding, $2\angle P = 220^\circ$, so $\angle P = 110^\circ$ and $\angle R = 70^\circ$.

Q16. Let AB and DE be two chords of a circle with centre C and $AB > DE$. Prove that AB is nearer to the centre than DE. Use this to justify: "The perpendicular from the centre to a chord bisects the chord."

Answer: Draw $CF \perp AB$ and $CG \perp DE$. By Theorem 10, $AF = AB/2$ and $GD = DE/2$, and $AF > GD$. In right triangles CFE and CGD , $CF^2 + AF^2 = CE^2 = r^2$ and $CG^2 + GD^2 = CD^2 = r^2$. Since $AF^2 > GD^2$, $CF^2 < CG^2$, so $CF < CG$. The perpendicular from the centre to a chord is nearer to the centre than the perpendicular to a longer chord. So the perpendicular from the centre to a chord bisects the chord.



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Common Mistakes and Explanations

1. Using the diameter as the hypotenuse

Halve a given diameter before using r^2 .

2. Forgetting to double the half-chord. Theorem 10 says "The perpendicular from the centre to a chord bisects the chord."

Do not use "AM" as a separate line.

3. Writing Theorem 5 without the reason

Theorem 5 says "The perpendicular from the centre bisects the chord." Do not say "The perpendicular from the centre bisects the chord" as an incomplete step.

4. Mixing up SSS, SAS and RHS. Theorem 5 uses RHS.

Theorem 5 uses RHS. Name the correct congruence criterion.

5. Halving the wrong way. The angle at the circumference is 40° , the central angle is 80° .

Do not halve the central angle. Halve the angle at the circumference.

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6. **Choosing a point on the arc itself.** Theorem 9 needs the point outside the arc. For a major arc, the central angle is reflex (360° minus the minor one), and the angle at a point on the minor arc is half of that.
7. **Adding adjacent angles of a cyclic quadrilateral.** Only opposite angles (A with C, B with D) add to 180° . Check which vertices are opposite from the order of the letters.
8. **Calling every quadrilateral in a figure cyclic.** A quadrilateral is cyclic only if all four vertices lie on the circle, or if a pair of opposite angles is supplementary.
9. **Same side or opposite sides.** For two parallel chords, add the distances when the chords are on opposite sides of the centre and subtract when they are on the same side. Read the question for these words.
10. **Claiming a circle through any three points.** The points must be non-collinear. Always write the word "non-collinear" in Theorem 1.

Quick Revision Points

- A circle is the set (locus) of all points or
- A circle has complete rotational symme
diameter.
- Infinitely many circles pass through two
of the segment joining them.
- Theorem 1: exactly one circle passes th
through three collinear points.
- Circumcentre = meeting point of perpe
midpoint of hypotenuse for right, outsid
- Theorem 2 and 3: equal chords subtenc
- Theorem 4: the line from the centre to t
- Theorem 5: the perpendicular from the
- Chord = $2\sqrt{(r^2 - d^2)}$, from $r^2 = d^2 + (\text{chord})^2$
- Theorem 6 and 7: equal chords are equ
- Theorem 8: the longer chord is nearer t
- Theorem 9: angle at the centre = $2 \times$ ar
- The angle in a semicircle is 90° .



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- Theorem 10: if AB subtends equal angles at C and D on the same side of AB, then A, B, C, D are concyclic.
- Theorem 11: opposite angles of a cyclic quadrilateral add to 180° .
- Theorem 12: if a pair of opposite angles of a quadrilateral add to 180° , it is cyclic.
- The exterior angle of a cyclic quadrilateral equals the interior opposite angle.
- The rectangle is the only parallelogram that can be inscribed in a circle.

Weightage and Exam Pattern

Class 9 has no board exam. Circles is assessed in school exams: periodic tests, the half-yearly exam and the annual exam. In the CBSE Class IX Mathematics course structure for 2026-27, the chapter is part of **Unit IV, Geometry, which carries 25 marks** out of the 80-mark theory paper and is allotted 69 teaching periods. The unit has five chapters: Introduction to Euclid's Geometry, Lines and Angles, Triangles (Congruence), Similar Figures, and Areas and Perimeters. The course structure does not split the 25 marks for internal assessment.

Unit
I. Number System
II. Algebra
III. Coordinate Geometry
IV. Geometry
V. Mensuration
VI. Statistics and Probability

The CBSE question paper design weights understanding, 24% applying, and 22% analysing. The course structure asks students to state whether a statement is true or false, whether a chord and angle theorem is true, and decide which of two statements is correct. The chapter includes items, chord and angle numericals, and "e"



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The chord, arc and cyclic quadrilateral results here are the base for the further results about circles in Class 10.



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