Affiliated to CBSE, New Delhi (Affiliation No. 1030642)

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CLASS X · MATHEMATICS STANDARD (041) · CBSE BOARD EXAMINATION 2027

CHAPTER 11

Areas Related to Circles

Answer Booklet · Full worked solutions with CBSE-style step marks

Every question of the Standard booklet | Step marks shown line by line | MCQ keys with working

INSIDE THIS BOOKLET

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HOW TO USE THE ANSWERS

1. Solve the question in your notebook **first**. Open this booklet only to check.
2. The orange number beside each line is the **step mark** an examiner gives for that line, as in the CBSE marking scheme.
3. Give yourself marks line by line. A right final answer without the working can lose step marks.
4. In every question, first write the fraction $\frac{\theta}{360^\circ}$ in its simplest form.
5. Copy every wrong answer to the My Mistakes page of your booklet.

READ THIS FIRST

Marking Guide

Full worked solutions to every question in the chapter booklet, set out the way a CBSE examiner marks them.

HOW MARKS ARE GIVEN IN AREAS RELATED TO CIRCLES ANSWERS

1. **1-mark MCQ / assertion–reason:** only the correct option scores. The working here is for your understanding.
2. **2-mark sector question:** formula with the correct fraction $\frac{\theta}{360}$ 1 · answer with unit 1.
3. **3-mark segment question:** sector area 1 · triangle area 1 · segment (and major segment) 1.
4. **Shaded region:** area of each shape 1 each · shaded area with unit 1.
5. Lines with no number are working that earns no separate mark but must be shown.

PART A · SOLUTIONS

A NCERT Practice – Solutions

Worked solutions with step marks for every question in Part A.

Sectors and arcs

Q	Answer	Working / reason
A1	**(d)** $\frac{\theta}{360} \times \pi R^2$	A sector is the fraction $\frac{\theta}{360}$ of the circle's area πR^2.

A2. Find the area of a sector of a circle of radius 7 cm with central angle 72°. [2]

$\frac{72}{360} = \frac{1}{5}$, so area $= \frac{1}{5} \times \frac{22}{7} \times 7^2$ — 1

$= \frac{154}{5} = 30.8$ cm² — 1

A3. The circumference of a circle is 88 cm. Find the area of a quadrant of the circle. [2]

$2 \times \frac{22}{7} \times r = 88$, so $r = 14$ cm — 1

Quadrant $= \frac{1}{4} \times \frac{22}{7} \times 14^2 = 154$ cm² — 1

A4. The minute hand of a clock is 7 cm long. Find the area swept by it in 15 minutes. [2]

In 15 minutes it turns $15 \times 6^\circ = 90^\circ$ — 1

Area $= \frac{1}{4} \times \frac{22}{7} \times 7^2 = 38.5$ cm² — 1

A5. A circle has radius 42 cm. For a central angle of 60°, find (i) the arc length, (ii) the area of the sector, (iii) the area of the minor segment. (Use $\sqrt{3} = 1.73$.) **[3]**

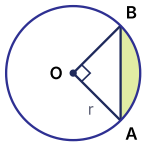
(i) Arc $= \frac{1}{6} \times 2 \times \frac{22}{7} \times 42 = 44$ cm — 1

(ii) Sector $= \frac{1}{6} \times \frac{22}{7} \times 42^2 = 924$ cm² — 1

(iii) Equilateral $\triangle OAB = \frac{\sqrt{3}}{4} \times 42^2 = 762.93$ cm²; segment $= 924 - 762.93 = 161.07$ cm² — 1

Segments (60° and 90°)

A6. A chord of a circle of radius 21 cm subtends a right angle at the centre. Find the areas of the minor and major segments. **[3]**



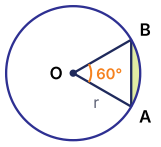
θ = 90°: △OAB = ½r²

Sector $OAB = \frac{1}{4} \times \frac{22}{7} \times 21^2 = 346.5$ cm² — 1

$\triangle OAB = \frac{1}{2} \times 21 \times 21 = 220.5$ cm², so minor segment $= 346.5 - 220.5 = 126$ cm² — 1

Circle $= \frac{22}{7} \times 21^2 = 1386$ cm², so major segment $= 1386 - 126 = 1260$ cm² — 1

A7. A chord of a circle of radius 10 cm subtends an angle of 60° at the centre. Find the areas of the minor and major segments. (Use $\pi = 3.14$, $\sqrt{3} = 1.73$.) **[3]**



θ = 60°: △OAB = (√3/4)·r²

Sector $OAB = \frac{1}{6} \times 3.14 \times 10^2 \approx 52.33$ cm² — 1

Equilateral $\triangle OAB = \frac{\sqrt{3}}{4} \times 100 = 43.25$ cm²; minor segment $= 52.33 - 43.25 = 9.08$ cm² — 1

Major segment $= 314 - 9.08 = 304.92$ cm² — 1

Sectors in daily life

A8. A cow is tied with a 7 m rope at one corner of a square field of side 20 m. Find (i) the area of the field it can graze, (ii) the increase in this area if the rope were 14 m long. **[3]**

(i) The cow grazes a quadrant of radius 7 m: $\frac{1}{4} \times \frac{22}{7} \times 7^2 = 38.5$ m² — 1

(ii) With a 14 m rope: $\frac{1}{4} \times \frac{22}{7} \times 14^2 = 154$ m² — 1

Increase $= 154 - 38.5 = 115.5$ m² — 1

A9. A wire wheel of diameter 42 cm has a rim and 3 diameters that divide it into 6 equal sectors. Find (i) the total length of wire used, (ii) the area of each sector. **[3]**

Rim $= \frac{22}{7} \times 42 = 132$ cm — 1

(i) Wire $= 132 + 3 \times 42 = 258$ cm — 1

(ii) Each sector $= \frac{1}{6} \times \frac{22}{7} \times 21^2 = 231$ cm² — 1

A10. An umbrella has 10 equally spaced ribs. Treating it as a flat circle of radius 42 cm, find the area between two consecutive ribs. **[2]**

Angle between ribs $= \frac{360^\circ}{10} = 36^\circ$, a fraction $\frac{1}{10}$ of the circle — 1

Area $= \frac{1}{10} \times \frac{22}{7} \times 42^2 = 554.4$ cm² — 1

A11. A car has two wipers that do not overlap. Each blade is 21 cm long and sweeps through 100°. Find the total area cleaned in one sweep. **[3]**

Fraction $= \frac{100}{360} = \frac{5}{18}$ — 1

One wiper $= \frac{5}{18} \times \frac{22}{7} \times 21^2 = 385$ cm² — 1

Both wipers $= 2 \times 385 = 770$ cm² — 1

A12. A lighthouse sends a warning light over a sector of 72° up to a distance of 10 km. Find the area of sea covered. (Use $\pi = 3.14$.) **[2]**

Area $= \frac{72}{360} \times 3.14 \times 10^2 = \frac{1}{5} \times 314$ — 1

$= 62.8$ km² — 1

A13. A circular table mat of radius 28 cm has 6 equal designs, as shown. Each design is a segment cut off by a chord that subtends 60° at the centre. Find the total area of the designs and the cost of embroidering them at ₹0.50 per cm². (Use $\sqrt{3} = 1.73$.) **[3]**

$\triangle OAB$ for each design is equilateral: area $= \frac{\sqrt{3}}{4} \times 28^2 = 196 \times 1.73 = 339.08$ cm² — 1

Six designs = circle − six triangles $= \frac{22}{7} \times 28^2 - 6 \times 339.08 = 2464 - 2034.48 = 429.52$ cm² — 1

Cost $= 429.52 \times 0.50 =$ ₹214.76 — 1

B

PART B · SOLUTIONS

Exemplar Practice – Solutions

Worked solutions with step marks for every question in Part B.

Multiple choice

Q	Answer	Working / reason
B1	**(b)** 14 : 11	$2\pi r = 4a$ gives $a = \frac{\pi r}{2}$. Ratio $= \pi r^2 : \frac{\pi^2 r^2}{4} = 4 : \pi = 14 : 11$.
B2	**(a)** 154 cm²	Its radius is half the side, 7 cm: $\frac{22}{7} \times 49 = 154$ cm².
B3	**(d)** 2 units	$2\pi r = \pi r^2$ gives $r = 2$.
B4	**(d)** 500	Circumference $= 220$ cm; $110000 \div 220 = 500$.
B5	**(c)** 30°	$11 = \frac{\theta}{360} \times 132$ gives $\theta = 30^\circ$.
B6	**(a)**	$\frac{1}{4} \times 616 = 154$. R gives the formula used, so R explains A.
B7	**(c)**	Perimeter $= 7 + 7 + 11 = 25$ cm, so A is true. R is false: the two radii are also part of the perimeter.
B8	**(b)**	A is true (6° per minute). R is also true but it is about the hour hand, so it does not explain A.

Short answer with reasons

B9. Find the perimeter of a quadrant of a circle of radius 14 cm. **[2]**

$\text{Arc} = \frac{1}{4} \times 2 \times \frac{22}{7} \times 14 = 22$ cm — 1

$\text{Perimeter} = 22 + 14 + 14 = 50$ cm — 1

B10. Find the area of the ring between two concentric circles of radii 21 cm and 7 cm. **[2]**

$\text{Area} = \pi(R^2 - r^2) = \frac{22}{7} \times (441 - 49)$ — 1

$= \frac{22}{7} \times 392 = 1232$ cm² — 1

B11. Is the area of a sector of angle 60° of a circle of radius 6 cm equal to the area of a circle of radius $\sqrt{6}$ cm? Give reasons. **[2]**

$\text{Sector} = \frac{1}{6} \times \pi \times 6^2 = 6\pi$ cm² — 1

$\text{Circle} = \pi \times (\sqrt{6})^2 = 6\pi$ cm². Yes, they are equal — 1

B12. $ABCD$ is a square of side 14 cm. Quadrants of radius 7 cm are drawn at its four corners. Find the area of the shaded region. **[3]**

$\text{Square} = 14^2 = 196$ cm² — 1

The four quadrants make one circle of radius 7 cm: $\frac{22}{7} \times 7^2 = 154$ cm² — 1

$\text{Shaded} = 196 - 154 = 42$ cm² — 1

B13. The wheels of a car have diameter 70 cm. How many complete turns does each wheel make in 10 minutes when the car moves at 66 km/h? **[3]**

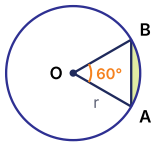
Distance in 10 minutes $= 66 \times \dfrac{10}{60} = 11$ km $= 1100000$ cm — 1

Circumference $= \dfrac{22}{7} \times 70 = 220$ cm — 1

Turns $= 1100000 \div 220 = 5000$ — 1

Long answer

B14. A chord AB of a circle of radius 14 cm subtends $60°$ at the centre O. Find (i) the length of the arc AB, (ii) the area of the minor segment, (iii) the perimeter of the minor segment, (iv) the area of the major segment. (Use $\sqrt{3} = 1.73$.) **[5]**



(i) Arc $AB = \dfrac{1}{6} \times 2 \times \dfrac{22}{7} \times 14 = \dfrac{44}{3} \approx 14.67$ cm — 1

θ = 60°: △OAB = (√3/4)·r²

Sector $OAB = \dfrac{1}{6} \times \dfrac{22}{7} \times 14^2 = \dfrac{308}{3} \approx 102.67$ cm² — 1

(ii) Equilateral $\triangle OAB = 49 \times 1.73 = 84.77$ cm²; minor segment $= 102.67 - 84.77 = 17.90$ cm² — 1

(iii) Chord $AB = OA = 14$ cm, so perimeter $= 14.67 + 14 = 28.67$ cm — 1

(iv) Major segment $= 616 - 17.90 = 598.10$ cm² — 1

B15. $ABCD$ is a square of side 14 cm. Semicircles are drawn inside it on each side as diameter, forming four petals. Find the area of the shaded petals. **[3]**

Each petal = two $90°$ segments of radius 7 cm. One segment $= 38.5 - 24.5 = 14$ cm² — 1

One petal $= 2 \times 14 = 28$ cm² — 1

Four petals $= 4 \times 28 = 112$ cm² — 1

C

PART C · SOLUTIONS

Board Pattern Practice – Solutions

Worked solutions with step marks for every question in Part C.

Sector area, arc length, clock hands and wheels

Q	Answer	Working / reason
C1	**(b)** 11 cm	$\frac{1}{8} \times 2 \times \frac{22}{7} \times 14 = 11$ cm.
C2	**(c)** 12 cm	$\frac{75}{360}\pi r^2 = 30\pi$ gives $r^2 = 144$, $r = 12$ cm.
C3	**(a)** 6 cm	Area $= \frac{1}{2}lr$: $12\pi = \frac{1}{2} \times 4\pi \times r$, so $r = 6$ cm.
C4	**(d)** 45°	1.5 hours $\times 30^\circ = 45^\circ$.
C5	**(b)** 90°	$22 = \frac{\theta}{360} \times 88$ gives $\theta = 90^\circ$.
C6	**(c)** 1000	Circumference $= 2 \times \frac{22}{7} \times 35 = 220$ cm; $220000 \div 220 = 1000$.
C7	**(a)**	$r = 7$ cm, circle $= 154$ cm², quadrant $= 38.5$ cm². R explains A.

C8. A sector of a circle of radius 21 cm has an arc of length 33 cm. Find the area of the sector. [2]

Area $= \frac{1}{2} \times$ arc $\times r$ (or $\theta = \frac{33}{132} \times 360^\circ = 90^\circ$) — 1

$= \frac{1}{2} \times 33 \times 21 = 346.5$ cm² — 1

C9. The perimeter of a sector of a circle of radius 10.5 cm is 32 cm. Find the area of the sector. [2]

Arc $= 32 - 2 \times 10.5 = 11$ cm — 1

Area $= \frac{1}{2} \times 11 \times 10.5 = 57.75$ cm² — 1

C10. The minute hand of a clock is 14 cm long. Find the area swept by it from 6:05 to 6:25. [2]

20 minutes: $\theta = 20 \times 6^\circ = 120^\circ$, a fraction $\frac{1}{3}$ — 1

Area $= \frac{1}{3} \times \frac{22}{7} \times 14^2 = \frac{616}{3} \approx 205.33$ cm² — 1

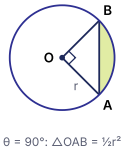
Segments and shaded regions

C11. Find the area of the minor segment of a circle of radius 7 cm cut off by a chord that subtends 90° at the centre. [2]

Sector $= \frac{1}{4} \times \frac{22}{7} \times 7^2 = 38.5$ cm²; $\triangle OAB = \frac{1}{2} \times 7 \times 7 = 24.5$ cm² — 1

Minor segment $= 38.5 - 24.5 = 14$ cm² — 1

C12. A chord of a circle of radius 20 cm subtends a right angle at the centre. Find (i) the minor segment, (ii) the major sector, (iii) the major segment. (Use $\pi = 3.14$.) **[3]**



θ = 90°: △OAB = ½r²

(i) Sector $= \frac{1}{4} \times 3.14 \times 400 = 314$ cm²; $\triangle OAB = \frac{1}{2} \times 20 \times 20 = 200$ cm²; minor segment $= 114$ cm² — 1

(ii) Circle $= 3.14 \times 400 = 1256$ cm², so major sector $= 1256 - 314 = 942$ cm² — 1

(iii) Major segment $= 1256 - 114 = 1142$ cm² — 1

C13. $OABC$ is a square of side 7 cm and OAC is a quadrant of a circle with centre O. Find the area of the shaded region. **[2]**

Square $= 49$ cm²; quadrant $= \frac{1}{4} \times \frac{22}{7} \times 7^2 = 38.5$ cm² — 1

Shaded $= 49 - 38.5 = 10.5$ cm² — 1

C14. Two concentric circles with centre O have radii 14 cm and 7 cm. OA and OB make an angle of 60°, as shown. Find the area of the shaded region $ABDC$. **[3]**

Outer sector $OAB = \frac{1}{6} \times \frac{22}{7} \times 14^2 = \frac{308}{3}$ cm² — 1

Inner sector $OCD = \frac{1}{6} \times \frac{22}{7} \times 7^2 = \frac{77}{3}$ cm² — 1

Shaded $= \frac{308}{3} - \frac{77}{3} = \frac{231}{3} = 77$ cm² — 1

C15. A chord AB of a circle of radius 12 cm subtends 60° at the centre. Find (i) the arc length AB, (ii) the area of the sector, (iii) the area of $\triangle OAB$, (iv) the areas of the minor and major segments. (Use $\pi = 3.14$, $\sqrt{3} = 1.73$.) **[5]**

(i) Arc $= \frac{1}{6} \times 2 \times 3.14 \times 12 = 12.56$ cm — 1

(ii) Sector $= \frac{1}{6} \times 3.14 \times 144 = 75.36$ cm² — 1

(iii) Equilateral triangle: $\frac{\sqrt{3}}{4} \times 144 = 36 \times 1.73 = 62.28$ cm² — 1

(iv) Minor segment $= 75.36 - 62.28 = 13.08$ cm² — 1

Circle $= 3.14 \times 144 = 452.16$ cm², so major segment $= 452.16 - 13.08 = 439.08$ cm² — 1

PART D · SOLUTIONS

D Case-Based Questions – Solutions

Worked solutions with step marks for every question in Part D.

D1. Case Study · Pizza Slices [4]

(i) Find the angle at the centre of each slice. **[1]**

$\frac{360^\circ}{8} = 45^\circ$ 1

(ii) Find the length of the crust (arc) of one slice. **[1]**

$\frac{1}{8} \times 2 \times \frac{22}{7} \times 14 = 11 \text{ cm}$ 1

(iii) Find the area and the perimeter of one slice. **[2]**

$\text{Area} = \frac{1}{8} \times \frac{22}{7} \times 14^2 = 77 \text{ cm}^2$ 1

$\text{Perimeter} = 14 + 14 + 11 = 39 \text{ cm}$ 1

OR

(iii) Three slices are eaten. Find the area of pizza left and the angle at the centre of the part left. **[2]**

5 slices are left: $\frac{5}{8} \times 616 = 385 \text{ cm}^2$ 1

$\text{Angle} = 5 \times 45^\circ = 225^\circ$ 1

D2. Case Study · Garden Sprinkler [4]

(i) Find the area of the lawn that is watered. **[1]**

$\frac{1}{4} \times \frac{22}{7} \times 14^2 = 154 \text{ m}^2$ 1

(ii) Find the length of the curved edge of the watered part. **[1]**

$\frac{1}{4} \times 2 \times \frac{22}{7} \times 14 = 22 \text{ m}$ 1

(iii) Find the area of the lawn that is not watered. **[2]**

$\text{Lawn} = 20 \times 16 = 320 \text{ m}^2$ 1

$\text{Not watered} = 320 - 154 = 166 \text{ m}^2$ 1

OR

(iii) The sprinkler is moved to the middle of side AB and set to turn through 180° with a reach of 7 m. Find the area it now waters and the length of its curved edge. **[2]**

A semicircle: $\frac{1}{2} \times \frac{22}{7} \times 7^2 = 77 \text{ m}^2$ 1

$\text{Curved edge} = \frac{1}{2} \times 2 \times \frac{22}{7} \times 7 = 22 \text{ m}$ 1

D3. Case Study · Clock Tower [4]

(i) Through what angle does the minute hand turn in 20 minutes? **[1]**

$20 \times 6^\circ = 120^\circ$ 1

(ii) How far does the tip of the minute hand move in 20 minutes? **[1]**

$\text{Arc} = \frac{1}{3} \times 2 \times \frac{22}{7} \times 21 = 44 \text{ cm}$ 1

(iii) Find the area swept by the minute hand in 20 minutes. **[2]**

$\text{Fraction} = \frac{120}{360} = \frac{1}{3}$ 1

$\text{Area} = \frac{1}{3} \times \frac{22}{7} \times 21^2 = 462 \text{ cm}^2$ 1

OR

(iii) Find the area swept by the hour hand from 1:00 to 4:00. **[2]**

$3 \text{ hours} \times 30^\circ = 90^\circ$ 1

$\text{Area} = \frac{1}{4} \times \frac{22}{7} \times 14^2 = 154 \text{ cm}^2$ 1

D4. Case Study · Rangoli in a Circle [4]

(i) What is $\angle AOB$? Give a reason. **[1]**

90°: the diagonals of a square bisect each other at right angles 1

(ii) Find the area of the square. **[1]**

$\text{Diagonal} = 28 \text{ cm}$, so $\text{area} = \frac{1}{2} \times 28^2 = 392 \text{ cm}^2$ 1

(iii) Find the total coloured area and the area of one coloured segment. **[2]**

$\text{Coloured} = \frac{22}{7} \times 14^2 - 392 = 616 - 392 = 224 \text{ cm}^2$ 1

$\text{One segment} = \frac{224}{4} = 56 \text{ cm}^2$ 1

OR

(iii) Find the perimeter of one coloured segment. (Use $\sqrt{2} = 1.414$.) **[2]**

$\text{Arc } AB = \frac{1}{4} \times 88 = 22 \text{ cm}$ 1

$\text{Chord } AB = \sqrt{14^2 + 14^2} = 14\sqrt{2} \approx 19.80 \text{ cm}$, so perimeter $\approx 41.80 \text{ cm}$ 1

E

PART E · SOLUTIONS

Challenge Questions – Solutions

Worked solutions with step marks for every question in Part E.

E1. [3]

An arc AB of a circle with centre O and radius 21 cm subtends $60°$ at O. The tangents at A and B meet at P. Find the area of the shaded region between the arc and the tangents. (Use $\sqrt{3} = 1.73$.)

OP bisects $\angle AOB$, so $\angle AOP = 30^\circ$ and $PA = OA \tan 30^\circ = \frac{21}{\sqrt{3}} = 7\sqrt{3} \text{ cm}$ 1

$\text{Area of } OAPB = 2 \times \frac{1}{2} \times 21 \times 7\sqrt{3} = 147\sqrt{3} = 254.31 \text{ cm}^2$ 1

$\text{Sector } OAB = \frac{1}{6} \times \frac{22}{7} \times 21^2 = 231 \text{ cm}^2$, so shaded $= 254.31 - 231 = 23.31 \text{ cm}^2$ 1

E2. The minute and hour hands of a clock are 14 cm and 7 cm long. Find the total distance moved by their tips from 12:00 to 3:00. **[3]**

Minute hand: 3 full turns $= 3 \times 2 \times \dfrac{22}{7} \times 14 = 264$ cm — 1

Hour hand: 90°, so $\dfrac{1}{4} \times 2 \times \dfrac{22}{7} \times 7 = 11$ cm — 1

Total $= 264 + 11 = 275$ cm — 1

E3. A chord of a circle of radius 7 cm is $7\sqrt{2}$ cm long. Find the area of the minor segment it cuts off. **[3]**

$OA^2 + OB^2 = 49 + 49 = 98 = AB^2$, so $\angle AOB = 90^\circ$ (converse of Pythagoras) — 1

Sector $= 38.5$ cm²; $\triangle OAB = 24.5$ cm² — 1

Segment $= 38.5 - 24.5 = 14$ cm² — 1

E4. A chord of length 20 cm subtends 60° at the centre of a circle. Find the area of the minor segment. (Use $\pi = 3.14$, $\sqrt{3} = 1.73$.) **[3]**

$OA = OB$ and $\angle AOB = 60^\circ$, so $\triangle OAB$ is equilateral and $r = 20$ cm — 1

Sector $= \dfrac{1}{6} \times 3.14 \times 400 \approx 209.33$ cm²; $\triangle OAB = \dfrac{\sqrt{3}}{4} \times 400 = 173$ cm² — 1

Segment $= 209.33 - 173 = 36.33$ cm² — 1

E5. Two circles touch each other externally. The sum of their areas is 130π cm² and the distance between their centres is 14 cm. Find their radii. **[3]**

$r_1 + r_2 = 14$ and $r_1^2 + r_2^2 = 130$ — 1

$2r_1r_2 = 14^2 - 130 = 66$, so $r_1r_2 = 33$ — 1

r_1, r_2 are the roots of $x^2 - 14x + 33 = 0$: radii 11 cm and 3 cm — 1

E6. A wire in the shape of a circle of radius 28 cm is bent into a square. Which shape encloses more area, and by how much? **[3]**

Wire $= 2 \times \dfrac{22}{7} \times 28 = 176$ cm, so side of square $= 44$ cm — 1

Circle $= \dfrac{22}{7} \times 28^2 = 2464$ cm²; square $= 44^2 = 1936$ cm² — 1

The circle encloses more, by $2464 - 1936 = 528$ cm² — 1