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NCERT Exemplar Solutions

Solved NCERT Exemplar Class 10 Maths Chapter 11, Areas Related to Circles: every question, step by step (2026-27)

Chapter 11: Areas Related to Circles

About this Chapter

Full worked solutions for Class 10 Maths Chapter 11 Areas Related to Circles Exercise 11.1 (NCERT Exemplar). Master the **circumference** and **area** of a circle, then **sector** and **segment** areas. Apply them to rings, shaded regions, rolling wheels and clock hands. Every MCQ, true/false, short-answer and long-answer problem is solved step by step.

Topics covered: Circumference $2\pi r$ • Area πr^2 • Area of a ring (two concentric circles) • Sector area $\frac{\theta}{360}\pi r^2$ • Arc length $\frac{\theta}{360}\,2\pi r$ • Minor and major segment • Inscribed and circumscribed squares • Composite and shaded regions • Distance rolled by a wheel • Area swept by a clock hand

Quick Formula Sheet

Circumference of a circle:
$C = 2\pi r$

Area of a circle:
$A = \pi r^2$

Area of a sector (angle θ):
$\frac{\theta}{360^\circ} \times \pi r^2$

Length of an arc (angle θ):
$\frac{\theta}{360^\circ} \times 2\pi r$

Area of a minor segment:
area of sector $-$ area of triangle

Default value of π:
$\frac{22}{7}$ unless stated otherwise

Also see for this chapter on Collegedunia: NCERT Solutions, Revision Notes, Formula Sheet and the Exemplar Book PDF for Class 10 Maths Chapter 11, Areas Related to Circles.

I. Multiple Choice Questions (Exercise 11.1)

Q 11.1 **If the sum of the areas of two circles with radii R_1 and R_2 is equal to the area of a circle of radius R, then**

(A) $R_1 + R_2 = R$ **(B)** $R_1^2 + R_2^2 = R^2$

(C) $R_1 + R_2 < R$ **(D)** $R_1^2 + R_2^2 < R^2$

SOLUTION

Correct option: (B) $R_1^2 + R_2^2 = R^2$.

Concept used. The area of a circle of radius r is πr^2. "Sum of two areas equals a third area" becomes an equation in the squares of the radii.

Step 1. Write the three areas:

$$\text{area}_1 = \pi R_1^2, \quad \text{area}_2 = \pi R_2^2, \quad \text{area} = \pi R^2.$$

Step 2. Set the sum of the first two equal to the third:

$$\pi R_1^2 + \pi R_2^2 = \pi R^2.$$

Step 3. Divide every term by π:

$$R_1^2 + R_2^2 = R^2.$$

Final Answer: The radii satisfy $R_1^2 + R_2^2 = R^2$; option **(B)**.

☞ **Area adds in squares, length adds linearly**

When *areas* add up, the squares of the radii add. Compare this with the next question, where *circumferences* add and the radii add directly.

EXPERT'S SOLUTION *: Aarav Mehta, M.Sc Mathematics, IIT Kanpur*

Cancel the common π and read off the relation.

- **Why π goes:** every circle here carries the same factor π, so the moment you write area as πr^2 that factor divides out of the whole equation and only the squared radii are left.
- **The clue:** this is why the answer is the Pythagoras-looking $R_1^2 + R_2^2 = R^2$ and not the tempting linear $R_1 + R_2 = R$.
- **The trap:** adding radii directly would be correct for perimeters, not for areas, so option (A) catches the unwary while (B) is the clean truth.

Final Answer: Option **(B)**, $R_1^2 + R_2^2 = R^2$.

Q 11.2 **If the sum of the circumferences of two circles with radii R_1 and R_2 is equal to the circumference of a circle of radius R, then**

(A) $R_1 + R_2 = R$ **(B)** $R_1 + R_2 > R$

(C) $R_1 + R_2 < R$ **(D) Nothing definite can be said about the relation among R_1, R_2 and R.**

SOLUTION

Correct option: (A) $R_1 + R_2 = R$.

Concept used. The circumference of a circle of radius r is $2\pi r$. Here the lengths add, so set up the sum of circumferences.

Step 1. Write the three circumferences:

$$2\pi R_1, \quad 2\pi R_2, \quad 2\pi R.$$

Step 2. Set the sum of the first two equal to the third:

$$2\pi R_1 + 2\pi R_2 = 2\pi R.$$

Step 3. Divide every term by 2π:

$$R_1 + R_2 = R.$$

Final Answer: The radii satisfy $R_1 + R_2 = R$; option **(A)**.

☞ **Circumference is a length**

A circumference is just a length, so it scales straight with the radius. That is why the radii add directly here, unlike the area question just before.

EXPERT'S SOLUTION *: Priya Nair, M.Sc Mathematics, University of Delhi*

The 2π cancels, leaving a plain sum.

- **Linear in radius:** because circumference is linear in the radius, dividing through by the shared 2π turns the length equation into $R_1 + R_2 = R$ exactly.
- **No ambiguity:** there is no inequality and nothing undecided here, so options (B), (C) and (D) are all wrong.
- **The pairing:** setting this beside Question 1 is deliberate, as squares add for areas while radii add for circumferences.

Final Answer: Option **(A)**, $R_1 + R_2 = R$.

Q 11.3 **If the circumference of a circle and the perimeter of a square are equal, then**
(A) Area of the circle = Area of the square
(B) Area of the circle > Area of the square
(C) Area of the circle < Area of the square
(D) Nothing definite can be said about the relation between the areas of the circle and square.

SOLUTION

Correct option: (B) Area of the circle $>$ Area of the square.

Concept used. For a fixed perimeter, the circle encloses the most area of any shape. We can also prove it directly by comparing the two areas.

Step 1. Let the common length be P. For the circle, $2\pi r = P$, so $r = \dfrac{P}{2\pi}$.

Step 2. Area of the circle:

$$\pi r^2 = \pi \left(\frac{P}{2\pi}\right)^2 = \frac{P^2}{4\pi}.$$

Step 3. For the square, $4a = P$, so $a = \dfrac{P}{4}$.

Step 4. Area of the square:

$$a^2 = \left(\frac{P}{4}\right)^2 = \frac{P^2}{16}.$$

Step 5. Compare the two areas, using $\pi \approx 3.14$:

$$\text{circle} = \frac{P^2}{4\pi} \approx \frac{P^2}{12.57}, \quad \text{square} = \frac{P^2}{16}.$$

Step 6. A larger denominator gives the smaller value. Since $12.57 < 16$, the circle's area is the bigger one.

> **Final Answer:** For equal perimeter, area of the circle $>$ area of the square; option **(B)**.

☞ The circle is the area champion

Among all shapes with the same perimeter, the circle holds the largest area. This single fact answers many "which has more area" MCQs without any calculation.

EXPERT'S SOLUTION *: Rohan Verma, M.Sc Mathematics, IIT Bombay*

Same fence, more land for the circle.

- **The picture:** think of P as a length of fencing; bent into a circle it traps area $\frac{P^2}{4\pi}$, but folded into a square it traps only $\frac{P^2}{16}$.
- **The winner:** since $4\pi \approx 12.57$ is smaller than 16, the circle encloses more, which is why round pipes, tanks and manhole covers are so common.
- **Without numbers:** start with the square and round off its corners at fixed perimeter, and every rounding pushes the boundary outward into new area until the limit is the circle, so it must out-enclose the square.

Final Answer: Option **(B)**, the circle has the larger area.

Q 11.4 **Area of the largest triangle that can be inscribed in a semi-circle of radius r units is**

(A) r^2 **sq. units** **(B)** $\frac{1}{2}r^2$ **sq. units**

(C) $2r^2$ **sq. units** **(D)** $\sqrt{2}\,r^2$ **sq. units**

SOLUTION

Correct option: (A) r^2 sq. units.

Concept used. The largest triangle in a semicircle has the diameter as its base; its area is maximised when its apex is at the top of the arc, so the height equals the radius.

Step 1. Take the diameter as the base of the triangle:

$$\text{base} = 2r.$$

Step 2. The triangle is tallest when its third vertex sits at the highest point of the arc:

$$\text{height} = r.$$

Step 3. Apply the triangle-area formula:

$$\text{area} = \frac{1}{2} \times \text{base} \times \text{height}.$$

Step 4. Substitute the values:

$$\text{area} = \frac{1}{2} \times 2r \times r.$$

Step 5. Simplify:

$$\text{area} = r^2.$$

Final Answer: The largest such triangle has area r^2 square units; option **(A)**.

☞ **Why the apex sits at the top**

With the base fixed at the diameter, the area depends only on the height. The height is largest when the apex is the farthest point of the arc from the diameter, which is the midpoint of the arc, exactly r above the base.

EXPERT'S SOLUTION *: Sneha Kulkarni, M.Sc Mathematics, IISc Bangalore*

Fix the base, push the top up.

- **Natural base:** the diameter $2r$ is the longest chord available, so it is the natural base to build the triangle on.
- **Tallest apex:** once the base is locked in, only the height can grow, and the tallest the apex can reach inside a semicircle of radius r is a height of r.
- **The maximum:** plugging into $\frac{1}{2}bh$ gives $\frac{1}{2}(2r)(r) = r^2$, and any other inscribed triangle is shorter or narrower, so r^2 is genuinely the largest possible.

Final Answer: Option **(A)**, r^2 square units.

Q 11.5 **If the perimeter of a circle is equal to that of a square, then the ratio of their areas is**

(A) $22 : 7$ **(B)** $14 : 11$ **(C)** $7 : 22$ **(D)** $11 : 14$

SOLUTION

Correct option: (B) $14 : 11$.

Concept used. Equate the circumference $2\pi r$ to the square's perimeter $4a$, then take the ratio of the two areas πr^2 and a^2.

Step 1. Equal perimeters:

$$2\pi r = 4a, \text{ so } a = \frac{\pi r}{2}.$$

Step 2. Write the ratio of areas:

$$\frac{\text{area of circle}}{\text{area of square}} = \frac{\pi r^2}{a^2}.$$

Step 3. Substitute $a = \frac{\pi r}{2}$:

$$\frac{\pi r^2}{\left(\frac{\pi r}{2}\right)^2} = \frac{\pi r^2}{\frac{\pi^2 r^2}{4}} = \frac{4}{\pi}.$$

Step 4. Put $\pi = \frac{22}{7}$, so dividing by π means multiplying by $\frac{7}{22}$:

$$\frac{4}{\pi} = 4 \times \frac{7}{22} = \frac{28}{22} = \frac{14}{11}.$$

Final Answer: The ratio of the areas is $14 : 11$; option **(B)**.

☞ Carry the ratio symbolically

Notice r^2 cancels from top and bottom, so the ratio is the pure number $\frac{4}{\pi}$. Only substitute $\pi = \frac{22}{7}$ at the very last step to keep the arithmetic clean.

EXPERT'S SOLUTION *: Ananya Iyer, M.Sc Mathematics, ISI Kolkata*

The whole ratio collapses to $4/\pi$.

- **Radius cancels:** because the radius drops out, the answer is independent of size, so any circle and square with equal perimeters have areas in the ratio $4 : \pi$.
- **Numerical form:** converting π to $\frac{22}{7}$ turns this into $14 : 11$, which also confirms Question 3 because $14 > 11$ tells us the circle's area is the larger one.
- **A fact to store:** keep $4 : \pi \approx 1.27$ in mind, since for equal perimeters the circle always beats the square by about 27%, and the same $14 : 11$ holds for a tiny coin or a huge field alike.

Final Answer: Option **(B)**, $14 : 11$.

Q 11.6 **It is proposed to build a single circular park equal in area to the sum of areas of two circular parks of diameters 16 m and 12 m in a locality. The radius of the new park would be**

(A) 10 m **(B)** 15 m **(C)** 20 m **(D)** 24 m

SOLUTION

Correct option: (A) 10 m.

Concept used. When areas add, the new πr^2 equals the sum of the two given πr^2 values, so the squares of the radii add.

Step 1. Find the two radii from the diameters:

$$r_1 = \frac{16}{2} = 8 \text{ m}, \quad r_2 = \frac{12}{2} = 6 \text{ m}.$$

Step 2. Add the areas (divide out π as in Question 1):

$$R^2 = r_1^2 + r_2^2.$$

Step 3. Substitute:

$$R^2 = 8^2 + 6^2 = 64 + 36 = 100.$$

Step 4. Take the square root:

$$R = \sqrt{100} = 10 \text{ m}.$$

Final Answer: The new park has radius 10 m; option **(A)**.

☞ **This is Question 1 with numbers**

This is the same rule as Question 1: $R^2 = R_1^2 + R_2^2$. The 8–6–10 triple is just the familiar $6, 8, 10$ right-triangle numbers in disguise.

EXPERT'S SOLUTION *: Karthik Reddy, M.Sc Mathematics, IIT Madras*

Diameters first, then squares.

- **The trap:** the tempting mistake here is to add the diameters or the radii straight off, which is wrong for areas.
- **Squares add:** areas combine through $R^2 = r_1^2 + r_2^2$, so $R^2 = 64 + 36 = 100$ and the new radius is $R = 10$ m.
- **The signal:** the numbers were chosen as the $6, 8, 10$ Pythagorean set, a nice cue that you have applied the squares-add rule rather than a linear shortcut.

Final Answer: Option **(A)**, 10 m.

Q 11.7 **The area of the circle that can be inscribed in a square of side 6 cm is**
(A) 36π **cm**^{2} **(B)** 18π **cm**^{2} **(C)** 12π **cm**^{2} **(D)** 9π **cm**^{2}

SOLUTION

Correct option: (D) 9π cm^2.
Concept used. A circle inscribed in a square touches all four sides, so its diameter equals the side of the square.

Step 1. The diameter equals the side:

$$\text{diameter} = 6 \text{ cm}.$$

Step 2. Find the radius:

$$r = \frac{6}{2} = 3 \text{ cm}.$$

Step 3. Apply the area formula:

$$\text{area} = \pi r^2.$$

Step 4. Substitute:

$$\text{area} = \pi \times 3^2 = 9\pi \text{ cm}^2.$$

Final Answer: The inscribed circle has area 9π cm^2; option **(D)**.

☞ Inscribed: diameter equals the side

For a circle *inside* a square, diameter = side. For a circle *around* a square (next idea), the diameter equals the diagonal. Mixing these two up is the most common slip.

EXPERT'S SOLUTION *: Meera Joshi, M.Sc Applied Mathematics, IIT Kharagpur*

The side is the diameter.

- **Full width:** an inscribed circle just fits between two opposite sides, so its full width $2r$ is the side 6, giving $r = 3$ and area 9π.
- **Keep π:** leaving the answer in terms of π avoids any rounding error in an objective question.
- **Sanity check:** the circle's $9\pi \approx 28.3$ cm^2 is less than the square's 36 cm^2, exactly as expected for a shape tucked inside.

Final Answer: Option **(D)**, 9π cm^2.

Q 11.8 **The area of the square that can be inscribed in a circle of radius 8 cm is**
(A) 256 **cm^2** **(B)** 128 **cm^2** **(C)** $64\sqrt{2}$ **cm^2** **(D)** 64 **cm^2**

SOLUTION

Correct option: (B) 128 cm^2.
Concept used. A square inscribed in a circle has its diagonal equal to the diameter of the circle. The area of a square equals $\frac{1}{2} \times (\text{diagonal})^2$.

Step 1. The diagonal equals the diameter:

$$\text{diagonal} = 2 \times 8 = 16 \text{ cm}.$$

Step 2. Use $\text{area} = \dfrac{1}{2} \times (\text{diagonal})^2$:

$$\text{area} = \frac{1}{2} \times 16^2.$$

Step 3. Substitute and simplify:

$$\text{area} = \frac{1}{2} \times 256 = 128 \text{ cm}^2.$$

Final Answer: The inscribed square has area 128 cm^2; option **(B)**.

☞ **Square area from its diagonal**

For any square, area $= \frac{1}{2}d^2$ where d is the diagonal. This skips the step of finding the side $a = \frac{d}{\sqrt{2}}$ first.

EXPERT'S SOLUTION *: Vikram Singh, M.Sc Mathematics, Jadavpur University*

Diagonal is the diameter; halve its square.

- **Corners on circle:** the corners of an inscribed square touch the circle, so the diagonal stretches right across as a diameter of 16 cm.
- **Faster route:** using area $= \frac{1}{2}d^2 = \frac{1}{2}(256) = 128$ cm^2 is quicker than first finding the side.
- **Cross-check:** the side would be $\frac{16}{\sqrt{2}} = 8\sqrt{2}$, and $(8\sqrt{2})^2 = 128$ confirms the same answer.

Final Answer: Option **(B)**, 128 cm^2.

Q 11.9 **The radius of a circle whose circumference is equal to the sum of the circumferences of the two circles of diameters 36 cm and 20 cm is**

(A) 56 **cm** **(B)** 42 **cm** **(C)** 28 **cm** **(D)** 16 **cm**

SOLUTION

Correct option: (C) 28 cm.

Concept used. When circumferences add, the radii add directly (Question 2). It is easiest to add the radii here.

Step 1. Find the two radii from the diameters:

$$r_1 = \frac{36}{2} = 18 \text{ cm}, \quad r_2 = \frac{20}{2} = 10 \text{ cm}.$$

Step 2. Circumferences add, so radii add:

$$R = r_1 + r_2.$$

Step 3. Substitute:

$$R = 18 + 10 = 28 \text{ cm}.$$

Final Answer: The required radius is 28 cm; option **(C)**.

☞ **Convert diameter to radius first**

Both lengths are given as diameters, so halve each before adding. Adding the diameters $36 + 20 = 56$ would give the new *diameter*, and forgetting to halve it lands you on the trap option (A).

EXPERT'S SOLUTION *: Divya Menon, M.Sc Mathematics, University of Hyderabad*

Lengths add, so radii add.

- **Cancel 2π:** each circumference is $2\pi r$ and the shared 2π cancels, so $R = r_1 + r_2 = 18 + 10 = 28$ cm.
- **The trap:** the wrong option 56 cm is exactly the sum of the diameters, which is what you get if you forget to halve.
- **The pairing:** this is the linear partner of Question 10, where it is the areas that combine instead of the lengths.

Final Answer: Option **(C)**, 28 cm.

Q 11.10 **The diameter of a circle whose area is equal to the sum of the areas of the two circles of radii 24 cm and 7 cm is**

(A) 31 **cm** **(B)** 25 **cm** **(C)** 62 **cm** **(D)** 50 **cm**

SOLUTION

Correct option: (D) 50 cm.

Concept used. Areas add through $R^2 = r_1^2 + r_2^2$ (Question 1). The question asks for the diameter, so double the radius at the end.

Step 1. Add the squares of the radii:

$$R^2 = r_1^2 + r_2^2.$$

Step 2. Substitute $r_1 = 24$, $r_2 = 7$:

$$R^2 = 24^2 + 7^2 = 576 + 49 = 625.$$

Step 3. Take the square root for the radius:

$$R = \sqrt{625} = 25 \text{ cm}.$$

Step 4. Double it for the diameter:

$$\text{diameter} = 2 \times 25 = 50 \text{ cm}.$$

> **Final Answer:** The required diameter is 50 cm; option **(D)**.

☞ The 7–24–25 triple

$7^2 + 24^2 = 25^2$ is a standard Pythagorean triple. Spotting it tells you $R = 25$ without reaching for a calculator.

✗ The question asks for the diameter

Here $R = 25$ cm is the *radius*. The diameter, which is what is asked, is 50 cm. Stopping at 25 cm lands on the trap option (B).

EXPERT'S SOLUTION *: Ishita Roy, M.Sc Mathematics, Calcutta University*

Squares add, then read the question again.

- **Squares add:** because areas combine, $R^2 = 576 + 49 = 625$ and the radius is $R = 25$ cm.
- **The catch:** the word "diameter" means the answer they want is actually $2R = 50$ cm, not the radius.
- **The triple:** the $7, 24, 25$ set makes the square root instant, and the deliberate option 25 cm punishes anyone who forgets to double.

> **Final Answer:** Option **(D)**, 50 cm.

Related Collegedunia resources: pair these NCERT Exemplar Class 10 Maths solutions for Areas Related to Circles with the chapter Notes, the NCERT Solutions, and the all-formulas sheet to revise the whole unit before your board exam.

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Circumference of a circle:
$C = 2\pi r$

Area of a circle:
$A = \pi r^2$

Area of a sector (angle θ):
$\frac{\theta}{360^\circ} \times \pi r^2$

Length of an arc (angle θ):
$\frac{\theta}{360^\circ} \times 2\pi r$

Area of a minor segment:
area of sector $-$ area of triangle

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II. Short Answer Questions with Reasoning (Exercise 11.2)

Q 11.1 **Is the area of the circle inscribed in a square of side a cm, πa^2 cm^2? Give reasons for your answer.**

SOLUTION

Verdict: False. The area is $\frac{\pi a^2}{4}$ cm^2, not πa^2 cm^2.

Concept used. A circle inscribed in a square touches all four sides, so its diameter equals the side of the square.

Step 1. The inscribed circle just fits between two opposite sides, so:

$$\text{diameter} = a \text{ cm}.$$

Step 2. Find the radius:

$$r = \frac{a}{2} \text{ cm}.$$

Step 3. Apply area $= \pi r^2$:

$$\text{area} = \pi \left(\frac{a}{2}\right)^2 = \frac{\pi a^2}{4} \text{ cm}^2.$$

Final Answer: False: the radius is $\frac{a}{2}$, so the area is $\frac{\pi a^2}{4}$ cm^2, one quarter of the claimed value.

✗ Side is the diameter, not the radius

The side a is the full width of the circle, so it is the diameter. Treating a as the radius is what produces the wrong πa^2.

EXPERT'S SOLUTION *: Sanjana Kapoor, M.Sc Mathematics, Jamia Millia Islamia*

Halve the side before squaring.

- **Squeezed inside:** since the circle is squeezed inside the square, its diameter is the side a and its radius is $\frac{a}{2}$.
- **The $\frac{1}{4}$ factor:** squaring that radius brings in a factor of $\frac{1}{4}$, so the true area is $\frac{\pi a^2}{4}$.
- **The error:** the claim is off by a factor of 4, which is exactly what using the side as the radius produces.

Final Answer: False; the correct area is $\frac{\pi a^2}{4}$ cm^2.

Q 11.2 Will it be true to say that the perimeter of a square circumscribing a circle of radius a cm is $8a$ cm? Give reasons for your answer.

SOLUTION

Verdict: True. The perimeter is indeed $8a$ cm.
Concept used. A square that circumscribes a circle has the circle touching all four sides, so the side of the square equals the circle's diameter.

Step 1. The circle touches both pairs of opposite sides, so the side equals the diameter:

side $= 2a$ cm.

Step 2. Perimeter of a square $= 4\times$ side:

perimeter $= 4 \times 2a$.

Step 3. Simplify:

perimeter $= 8a$ cm.

Final Answer: True: side $= 2a$ cm, so the perimeter is $8a$ cm.

☞ Circumscribing square hugs the circle

A circumscribing square wraps tightly around the circle, so its side is the diameter. Distinguish this from a circle drawn *around* a square, where the diagonal is the diameter.

EXPERT'S SOLUTION *: Devendra Naik, M.Sc Mathematics, NIT Surathkal*

Side equals the diameter here.

- **Touching condition:** because the circle of radius a fits exactly between opposite sides of the square, each side is the diameter $2a$.
- **The perimeter:** four such sides give $8a$, so the statement is correct.
- **Mirror of Q11:** there the square was inside and the side became the diameter, and the two ideas are mirror images of the same touching condition.

Final Answer: True; perimeter $= 8a$ cm.

Q 11.3 **In the figure, a square is inscribed in a circle of diameter d and another square is circumscribing the circle. Is the area of the outer square four times the area of the inner square? Give reasons for your answer.**

SOLUTION

Verdict: False. The outer square is only *twice* the inner square, not four times.
Concept used. For the inner (inscribed) square the diagonal equals d; for the outer (circumscribing) square the side equals d. Compare the two areas.

Step 1. Inner square: its diagonal is the diameter d, so its area $= \frac{1}{2}d^2$ (using area $= \frac{1}{2}\times$ diagonal^2).

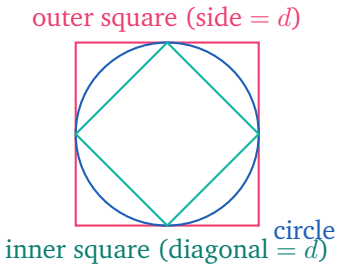
Step 2. Outer square: its side is the diameter d, so its area $= d^2$.

Step 3. Form the ratio of outer to inner:

$$\frac{d^2}{\frac{1}{2}d^2} = 2.$$

Step 4. So the outer square is 2 times the inner square, not 4 times.

> **Final Answer:** False: the outer square's area is 2 times the inner square's area, because the side of the outer square equals the diagonal of the inner square.



☞ Inner diagonal = outer side

The inner square's diagonal and the outer square's side are both the diameter d. So the side of the outer square equals the diagonal of the inner square, which is the $\sqrt{2}$ size jump that doubles (not quadruples) the area.

EXPERT'S SOLUTION *: Ritika Malhotra, M.Sc Mathematics, Panjab University*

Doubling the area needs a $\sqrt{2}$ scale, not 2.

- **Side ratio:** the outer square's side is d while the inner square's side is $\frac{d}{\sqrt{2}}$, so the sides are in the ratio $\sqrt{2}$, not 2.
- **Areas square it:** areas scale as the square of lengths, so the true area ratio is $(\sqrt{2})^2 = 2$, which is why the outer square is only twice the inner one.
- **Why not four:** the "four times" guess would need the sides in ratio 2, and that happens only if the outer side were the inner *side* doubled rather than the inner diagonal.

Final Answer: False; the outer square is twice, not four times, the inner square.

Q 11.4 **Is it true to say that area of a segment of a circle is less than the area of its corresponding sector? Why?**

SOLUTION

Verdict: False (not always true). It holds for a minor segment but fails for a major segment.

Concept used. A minor segment = sector − triangle, while a major segment = sector + triangle. The comparison depends on which segment is meant.

Step 1. For the *minor* segment:

area = area of sector − area of triangle, so it is less than the sector.

Step 2. For the *major* segment:

area = area of major sector + area of triangle, so it is greater than its sector.

Step 3. Because the statement is unqualified, it is not true for every segment.

Final Answer: False: only a minor segment is smaller than its sector; a major segment is larger than its sector.

☞ **Minor subtracts, major adds**

Minor segment = sector − triangle (so smaller). Major segment = sector + triangle (so larger). The triangle is the swing factor.

EXPERT'S SOLUTION *: Aditya Bhat, M.Sc Mathematics, NIT Trichy*

The word "segment" hides two cases.

- **Minor case:** for the minor segment you carve the triangle away from the sector, so it shrinks below the sector.
- **Major case:** for the major segment the same triangle is added on, pushing it above its sector; since the claim does not say which segment, one counterexample is enough to mark it false.
- **The picture:** draw any chord and you get a small minor cap and a big major piece, where the cap is clearly less than its sector but the big piece visibly bulges past its own sector.

Final Answer: False; the claim only holds for the minor segment.

Q 11.5 **Is it true that the distance travelled by a circular wheel of diameter d cm in one revolution is $2\pi d$ cm? Why?**

SOLUTION

Verdict: False. One revolution covers πd cm, not $2\pi d$ cm.
Concept used. In one revolution a wheel rolls forward by exactly its circumference. The circumference in terms of the diameter is πd.

Step 1. Distance in one revolution $=$ circumference of the wheel.

Step 2. Circumference in terms of the radius is $2\pi r$.

Step 3. Replace r by $\frac{d}{2}$:

$$2\pi r = 2\pi \times \frac{d}{2} = \pi d.$$

Step 4. So one revolution covers πd cm.

Final Answer: False: one revolution covers the circumference πd cm; the value $2\pi d$ uses the diameter where the radius belongs.

✗ $2\pi r$ but only πd

Circumference is $2\pi r$ *or* πd. Writing $2\pi d$ doubles the answer because it puts the diameter into the radius formula.

EXPERT'S SOLUTION *: Kavya Desai, M.Sc Mathematics, Savitribai Phule Pune University*

Pick one form of the circumference.

- **One per turn:** a rolling wheel lays down exactly one circumference for every full turn it makes.
- **Two forms:** in radius form that distance is $2\pi r$, and in diameter form it is πd, and the two are the same length.
- **The error:** writing $2\pi d$ mixes the two forms, effectively using $r = d$, so the correct one-revolution distance is πd cm.

Final Answer: False; one revolution is πd cm.

Q 11.6 **In covering a distance s metres, a circular wheel of radius r metres makes $\frac{s}{2\pi r}$ revolutions. Is this statement true? Why?**

SOLUTION

Verdict: True.

Concept used. The number of revolutions equals the total distance divided by the distance covered in one revolution, which is the circumference $2\pi r$.

Step 1. Distance in one revolution = circumference = $2\pi r$ metres.

Step 2. Number of revolutions = $\dfrac{\text{total distance}}{\text{distance per revolution}}$.

Step 3. Substitute:

$$\text{number of revolutions} = \frac{s}{2\pi r}.$$

Final Answer: True: revolutions = $\frac{s}{2\pi r}$, since each turn covers one circumference $2\pi r$.

☞ **Revolutions = distance over circumference**

Whenever a wheel question asks for "how many turns", divide the journey by one circumference. Keep the radius and diameter forms straight: $2\pi r = \pi d$.

EXPERT'S SOLUTION *: Siddharth Rao, M.Sc Applied Mathematics, IIT Roorkee*

Counting turns is just division.

- **One step:** each revolution advances the wheel by its circumference $2\pi r$, so the whole journey s contains $\frac{s}{2\pi r}$ of those steps.
- **Units check:** the formula is dimensionally clean, since metres divided by metres gives a pure count of turns.
- **Verdict:** the statement is therefore exactly right with no correction needed.

Final Answer: True; the wheel makes $\frac{s}{2\pi r}$ revolutions.

Q 11.7 **The numerical value of the area of a circle is greater than the numerical value of its circumference. Is this statement true? Why?**

SOLUTION

Verdict: False (not always). It depends on the radius.
Concept used. Compare πr^2 (area) with $2\pi r$ (circumference). The two are equal at a particular radius, and the larger one switches sides there.

Step 1. Set area equal to circumference to find the turning point:

$$\pi r^2 = 2\pi r.$$

Step 2. Divide by πr (with $r \neq 0$):

$$r = 2.$$

Step 3. So when $r > 2$ the area is numerically larger, and when $r < 2$ the circumference is numerically larger.

Step 4. For example, at $r = 1$: area $= \pi \approx 3.14$ while circumference $= 2\pi \approx 6.28$, so here the circumference is larger.

Final Answer: False: the area exceeds the circumference only when $r > 2$; for smaller radii the circumference is larger. So the claim is not always true.

✗ "Numerical value" ignores units

This comparison strips units and just compares numbers. That only makes sense because the question says "numerical value"; areas and lengths are not really comparable quantities.

EXPERT'S SOLUTION *: Nisha Agarwal, M.Sc Mathematics, BHU Varanasi*

The crossover is at $r = 2$.

- **Turning point:** solving $\pi r^2 = 2\pi r$ gives $r = 2$ as the single radius where the two numbers match exactly.
- **Which side wins:** past that radius the squared growth of area wins, and below it the linear circumference is bigger; a check at $r = 1$ (area 3.14 versus circumference 6.28) settles it.
- **Units note:** the units do not even match, since area is in square units and circumference in plain units, so the comparison is purely numerical and hinges entirely on the size of r.

Final Answer: False; true only for $r > 2$.

Q 11.8 **If the length of an arc of a circle of radius r is equal to that of an arc of a circle of radius $2r$, then the angle of the corresponding sector of the first circle is**

double the angle of the corresponding sector of the other circle. Is this statement false? Why?

SOLUTION

Verdict: The statement is true (so it is *not* false).

Concept used. Arc length $= \dfrac{\theta}{360} \times 2\pi r$. Equal arc lengths on different radii force a relation between the two angles.

Step 1. Let the first circle (radius r) have angle θ_1 and the second (radius $2r$) have angle θ_2.

Step 2. Equate the two arc lengths:

$$\frac{\theta_1}{360} \times 2\pi r = \frac{\theta_2}{360} \times 2\pi(2r).$$

Step 3. Cancel the common $\dfrac{2\pi r}{360}$ from both sides:

$$\theta_1 = 2\,\theta_2.$$

Step 4. So the first circle's angle is double the second circle's angle.

> **Final Answer:** The statement is *not* false; it is true, because $\theta_1 = 2\theta_2$.

☞ **Smaller circle needs the bigger angle**

For the same arc length, the smaller radius must sweep through a larger angle. Here the radius halves, so the angle doubles, keeping the product $r\theta$ fixed.

EXPERT'S SOLUTION *: Rahul Khanna, M.Sc Mathematics, IIT Guwahati*

Equal arcs trade radius for angle.

- **Key product:** arc length is proportional to the product $r\theta$, so for equal arcs that product stays fixed.
- **Angle halves:** if the radius doubles from r to $2r$, the angle must halve to keep the product steady, so the smaller circle's angle is twice the larger one's.
- **Wording trap:** the double-negative phrasing "is this statement false?" is the only tricky part, since the statement itself is correct.

> **Final Answer:** True statement; $\theta_1 = 2\theta_2$.

Q 11.9 **The areas of two sectors of two different circles with equal corresponding arc lengths are equal. Is this statement true? Why?**

SOLUTION

Verdict: False (not in general). Equal arc lengths do not force equal sector areas unless the radii are also equal.

Concept used. A sector area can be written as $\frac{1}{2} \times (\text{arc length}) \times r$. With the same arc length but different radii, the areas differ.

Step 1. Write sector area in terms of arc length ℓ and radius r:

$$\text{area} = \frac{\theta}{360}\pi r^2 \text{ and } \ell = \frac{\theta}{360}2\pi r, \text{ so area} = \frac{1}{2}\ell r.$$

Step 2. Take two circles with the same arc length ℓ but radii $r_1 \neq r_2$:

$$\text{area}_1 = \frac{1}{2}\ell r_1, \quad \text{area}_2 = \frac{1}{2}\ell r_2.$$

Step 3. Since $r_1 \neq r_2$, the areas are different.

Final Answer: False: with equal arc lengths the sector areas are $\frac{1}{2}\ell r_1$ and $\frac{1}{2}\ell r_2$, which match only when the radii are equal.

☞ **Sector area $= \frac{1}{2}\ell r$**

A sector is like a thin triangle with base ℓ (the arc) and height r, so its area is $\frac{1}{2}\ell r$. The radius is the deciding factor when arcs match.

EXPERT'S SOLUTION *: Tanvi Saxena, M.Sc Mathematics, University of Delhi*

Same arc, bigger radius, bigger slice.

- **The formula:** using area $= \frac{1}{2}\ell r$, two sectors with the same arc length still differ if their radii differ, because a larger radius stretches the slice outward and adds area.
- **Verdict:** the claim is false in general and becomes true only for the special case of equal radii, which is effectively the same circle.
- **From a figure:** lay the two arcs as equal bases, and the sector with the longer radius is the taller "triangle" with the greater area, since equal bases with unequal heights give unequal areas.

Final Answer: False; areas are equal only if the radii are equal.

Q 11.10 **The areas of two sectors of two different circles are equal. Is it necessary that their corresponding arc lengths are equal? Why?**

SOLUTION

Verdict: False. Equal sector areas do not force equal arc lengths.

Concept used. Sector area $= \frac{1}{2}\ell r$. Equal areas can be achieved by trading a longer arc on a smaller radius against a shorter arc on a larger radius.

Step 1. From area $= \frac{1}{2}\ell r$, equal areas give:

$\frac{1}{2}\ell_1 r_1 = \frac{1}{2}\ell_2 r_2$, so $\ell_1 r_1 = \ell_2 r_2$.

Step 2. This fixes only the product ℓr, not ℓ alone.

Step 3. Example: $\ell_1 = 4$, $r_1 = 3$ gives area 6; $\ell_2 = 6$, $r_2 = 2$ also gives area 6, yet $\ell_1 \neq \ell_2$.

Final Answer: False: equal areas only fix the product ℓr, so the arc lengths can differ (for example $\ell_1 = 4, r_1 = 3$ and $\ell_2 = 6, r_2 = 2$ both give area 6).

☞ **Only the product is pinned down**

Equal sector areas pin down ℓr, not ℓ. One quantity can be large if the other is small, so neither the arc length nor the radius is forced to match.

EXPERT'S SOLUTION *: Aryan Joshi, M.Sc Mathematics, IISER Pune*

One equation, two unknowns.

- **Single condition:** equal areas give just one condition $\ell_1 r_1 = \ell_2 r_2$, which two different pairs can satisfy.
- **Counterexample:** the worked pair ($4 \times 3 = 6 \times 2$) shows two sectors of equal area with unequal arcs, so equal arc length is certainly not necessary; this is the reverse of Question 19.
- **The takeaway:** fixing the area fixes only the product ℓr, while fixing the arc fixes only ℓ, so neither condition alone pins both quantities and the "must be equal" claim breaks down for circles of different sizes.

Final Answer: False; only the product ℓr must match.

Q 11.11 **Is the area of the largest circle that can be drawn inside a rectangle of length a cm and breadth b cm (where $a > b$) πb^2 cm^2? Why?**

SOLUTION

Verdict: False. The largest such circle has area $\frac{\pi b^2}{4}$ cm^2, not πb^2 cm^2.
Concept used. The biggest circle inside a rectangle is limited by the shorter side, so its diameter equals the breadth b.

Step 1. The circle can grow only until it touches the two longer sides, which are b apart:

$$\text{diameter} = b \text{ cm}.$$

Step 2. Find the radius:

$$r = \frac{b}{2} \text{ cm}.$$

Step 3. Apply area $= \pi r^2$:

$$\text{area} = \pi \left(\frac{b}{2}\right)^2 = \frac{\pi b^2}{4} \text{ cm}^2.$$

Final Answer: False: the diameter is the breadth b, so the area is $\frac{\pi b^2}{4}$ cm^2, a quarter of the claimed value.

✗ Breadth is the diameter

The breadth b sets the diameter, so $r = \frac{b}{2}$. Using b as the radius gives the wrong πb^2, four times too big.

EXPERT'S SOLUTION *: Pooja Reddy, M.Sc Mathematics, University of Hyderabad*

The short side caps the circle.

- **Short side rules:** with $a > b$, the circle is stopped by the breadth b, so its diameter is b and its radius is $\frac{b}{2}$.
- **The $\frac{1}{4}$ factor:** squaring that radius brings the factor $\frac{1}{4}$, giving the true area $\frac{\pi b^2}{4}$.
- **Why a drops out:** the length a never enters the answer, because there is always room to spare along the longer direction.

Final Answer: False; the area is $\frac{\pi b^2}{4}$ cm^2.

Q 11.12 Circumferences of two circles are equal. Is it necessary that their areas be equal? Why?

SOLUTION

Verdict: True.

Concept used. Equal circumferences force equal radii (since $C = 2\pi r$), and equal radii give equal areas.

Step 1. Equal circumferences:

$$2\pi r_1 = 2\pi r_2.$$

Step 2. Cancel 2π:

$$r_1 = r_2.$$

Step 3. Equal radii give equal areas:

$$\pi r_1^2 = \pi r_2^2.$$

> **Final Answer:** True: equal circumferences mean equal radii, which mean equal areas.

☞ **Radius is the single control**

A circle is fixed entirely by its radius. So matching any one measure (circumference, area, diameter) matches the radius, and then everything else matches too.

EXPERT'S SOLUTION *: Manish Gupta, M.Sc Mathematics, IIT Delhi*

One number controls the whole circle.

- **One parameter:** the radius is the only parameter a circle has, so everything about the circle is decided once it is known.
- **Radius then area:** equal circumferences pin the radius, and once the radius is fixed the area πr^2 has no freedom left, so the areas must match.
- **Unlike sectors:** where a sector lets arc and angle vary independently, a full circle leaves no room for two different sizes to share a circumference.

> **Final Answer:** True; equal circumference forces equal radius and hence equal area.

Q 11.13 **Areas of two circles are equal. Is it necessary that their circumferences are equal? Why?**

SOLUTION

Verdict: True.

Concept used. Equal areas force equal radii (since $A = \pi r^2$), and equal radii give equal circumferences.

Step 1. Equal areas:

$$\pi r_1^2 = \pi r_2^2.$$

Step 2. Cancel π and take positive square roots:

$$r_1 = r_2.$$

Step 3. Equal radii give equal circumferences:

$$2\pi r_1 = 2\pi r_2.$$

> **Final Answer:** True: equal areas mean equal radii, which mean equal circumferences.

☞ Match the radius, match everything

This is the partner of Question 22. Matching the area matches the radius, and then the circumference follows. For a whole circle, no two measures can disagree.

EXPERT'S SOLUTION *: Shreya Banerjee, M.Sc Mathematics, Calcutta University*

Run Question 22 backwards.

- **Areas to radius:** equal areas give $r_1^2 = r_2^2$, and since radii are positive lengths, this forces $r_1 = r_2$.
- **Radius to circumference:** equal radii then force equal circumferences, completing the chain in the reverse direction.
- **The big idea:** the two questions together show that for a full circle every standard measure is locked to the radius, so matching one matches all of them.

> **Final Answer:** True; equal area forces equal radius and hence equal circumference.

Q 11.14 Is it true to say that area of a square inscribed in a circle of diameter p cm is p^2 cm^2? Why?

SOLUTION

Verdict: False. The inscribed square has area $\frac{p^2}{2}$ cm^2, not p^2 cm^2.

Concept used. A square inscribed in a circle has its diagonal equal to the diameter, and the area of a square is $\frac{1}{2} \times (\text{diagonal})^2$.

Step 1. The diagonal of the square is the diameter:

$$\text{diagonal} = p \text{ cm}.$$

Step 2. Apply $\text{area} = \frac{1}{2} \times (\text{diagonal})^2$:

$$\text{area} = \frac{1}{2} \times p^2.$$

Step 3. Simplify:

$$\text{area} = \frac{p^2}{2} \text{ cm}^2.$$

> **Final Answer:** False: the diagonal of the inscribed square is the diameter p, so the area is $\frac{p^2}{2}$ cm^2, half of the claimed value.

✗ Diameter is the diagonal, not the side

For an inscribed square the diameter p is the *diagonal*. Treating p as the side gives the wrong p^2; the true area is half of that.

EXPERT'S SOLUTION *: Naveen Kumar, M.Sc Mathematics, IIT Madras*

Use the diagonal shortcut.

- **Diagonal spans:** the corners of the square sit on the circle, so the diagonal stretches across as the diameter p.
- **Half its square:** then area $= \frac{1}{2}p^2 = \frac{p^2}{2}$, which is exactly half of the stated p^2.
- **The slip:** the mistake in the statement is reading p as the side of the square rather than as its diagonal.

> **Final Answer:** False; the area is $\frac{p^2}{2}$ cm^2.

Related Collegedunia resources: pair these NCERT Exemplar Class 10 Maths solutions for Areas Related to Circles with the chapter Notes, the NCERT Solutions, and the all-formulas sheet to revise the whole unit before your board exam.

NCERT Exemplar Solutions

Solved NCERT Exemplar Class 10 Maths Chapter 11, Areas Related to Circles: every question, step by step (2026-27)

Chapter 11: Areas Related to Circles

About this Chapter

Full worked solutions for Class 10 Maths Chapter 11 Areas Related to Circles Exercise 11.3 (NCERT Exemplar). Master the **circumference** and **area** of a circle, then **sector** and **segment** areas. Apply them to rings, shaded regions, rolling wheels and clock hands. Every MCQ, true/false, short-answer and long-answer problem is solved step by step.

Topics covered: Circumference $2\pi r$ • Area πr^2 • Area of a ring (two concentric circles) • Sector area $\frac{\theta}{360}\pi r^2$ • Arc length $\frac{\theta}{360}\,2\pi r$ • Minor and major segment • Inscribed and circumscribed squares • Composite and shaded regions • Distance rolled by a wheel • Area swept by a clock hand

Quick Formula Sheet

Circumference of a circle:
$C = 2\pi r$

Area of a circle:
$A = \pi r^2$

Area of a sector (angle θ):
$\frac{\theta}{360^\circ} \times \pi r^2$

Length of an arc (angle θ):
$\frac{\theta}{360^\circ} \times 2\pi r$

Area of a minor segment:
area of sector $-$ area of triangle

Default value of π:
$\frac{22}{7}$ unless stated otherwise

Also see for this chapter on Collegedunia: NCERT Solutions, Revision Notes, Formula Sheet and the Exemplar Book PDF for Class 10 Maths Chapter 11, Areas Related to Circles.

III. Short Answer Questions (Exercise 11.3)

Q 11.1 **Find the radius of a circle whose circumference is equal to the sum of the circumferences of two circles of radii 15 cm and 18 cm.**

SOLUTION

Concept used. The circumference of a circle of radius r is $2\pi r$. When circumferences add, the 2π cancels and the radii add directly.

Step 1. Write the condition (sum of two circumferences equals the third):

$$2\pi R = 2\pi(15) + 2\pi(18).$$

Step 2. Divide every term by 2π:

$$R = 15 + 18.$$

Step 3. Add:

$$R = 33 \text{ cm}.$$

Final Answer: The required radius is $R = 33$ cm.

☞ **Radii add for circumferences**

Because circumference is linear in r, "sum of circumferences" just means "sum of radii". No squaring is involved here.

EXPERT'S SOLUTION *: Harini Subramanian, M.Sc Mathematics, Anna University*

Add the radii, skip the π.

- **Shared factor:** each circumference carries the same 2π, so the equation collapses to $R = 15 + 18 = 33$ cm the moment you divide it out.
- **No long way:** there is no need to compute any actual circumference, since the factor cancels before any numbers are needed.
- **Contrast:** in the area-based problems the radii would instead combine through their squares, not by a plain sum.

Final Answer: $R = 33$ cm.

Q 11.2 **A square of diagonal 8 cm is inscribed in a circle. Find the area of the shaded region, where the shaded region is the part of the circle lying outside the square.**

SOLUTION

Concept used. For an inscribed square the diagonal equals the diameter of the circle. Shaded area = area of circle − area of square, with the square's area $= \frac{1}{2} \times (\text{diagonal})^2$.

Step 1. The diagonal of the square is the diameter, so the radius is:

$$r = \frac{8}{2} = 4 \text{ cm}.$$

Step 2. Area of the circle $= \pi r^2$:

$$= \pi \times 4^2 = 16\pi \text{ cm}^2.$$

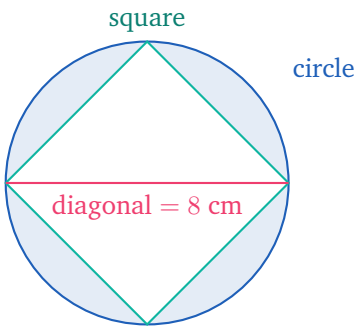
Step 3. Area of the square $= \frac{1}{2} \times (\text{diagonal})^2$:

$$= \frac{1}{2} \times 8^2 = \frac{1}{2} \times 64 = 32 \text{ cm}^2.$$

Step 4. Shaded area = circle − square:

$$= (16\pi - 32) \text{ cm}^2.$$

Final Answer: Area of the shaded region $= (16\pi - 32)$ cm^2.



☞ **Keep π symbolic**

The answer is left as $(16\pi - 32)$ cm^2 because the question does not fix a value for π. Substitute $\frac{22}{7}$ or 3.14 only if a decimal is asked for.

EXPERT'S SOLUTION *: Saurabh Tiwari, M.Sc Mathematics, IIT Hyderabad*

Circle minus square, using the diagonal shortcut.

- **Circle first:** the diagonal 8 fixes the radius at 4, so the circle has area 16π.
- **Square next:** the square sits inside, and its area from the diagonal is $\frac{1}{2}(8^2) = 32$.
- **The crescents:** subtracting leaves the four crescent-shaped pieces outside the square, totalling $(16\pi - 32)$ cm$^2 \approx 18.3$ cm^2, and reading the diagonal directly as the diameter is what makes this quick.

Final Answer: $(16\pi - 32)$ cm^2.

Q 11.3 **Find the area of a sector of a circle of radius 28 cm and central angle $45°$.**

SOLUTION

Concept used. The area of a sector with central angle θ is $\dfrac{\theta}{360^\circ} \times \pi r^2$. Take $\pi = \dfrac{22}{7}$.

Step 1. Write the sector-area formula:

$$\text{area} = \frac{\theta}{360^\circ} \times \pi r^2.$$

Step 2. Substitute $\theta = 45^\circ$, $r = 28$, $\pi = \dfrac{22}{7}$:

$$\text{area} = \frac{45}{360} \times \frac{22}{7} \times 28^2.$$

Step 3. Simplify $\dfrac{45}{360} = \dfrac{1}{8}$ and $28^2 = 784$:

$$\text{area} = \frac{1}{8} \times \frac{22}{7} \times 784.$$

Step 4. Cancel $784 \div 7 = 112$:

$$\text{area} = \frac{1}{8} \times 22 \times 112 = \frac{22 \times 112}{8}.$$

Step 5. Compute $\dfrac{112}{8} = 14$, then 22×14:

$$\text{area} = 308 \text{ cm}^2.$$

Final Answer: Area of the sector $= 308$ cm^2.

☞ Simplify the angle fraction first

Note that $\frac{45}{360} = \frac{1}{8}$. Reducing the angle fraction before multiplying keeps the numbers small and the cancellation with r^2 tidy.

EXPERT'S SOLUTION *: Lakshmi Pillai, M.Sc Mathematics, Cochin University of Science and Technology*

Cancel before you multiply.

- **Reduce angle:** the angle fraction reduces to $\frac{1}{8}$, which keeps the later multiplication small.
- **Share the 7:** since $28^2 = 784$ shares the factor 7 with $\frac{22}{7}$, we get $784 \div 7 = 112$, leaving $\frac{1}{8} \times 22 \times 112 = 308$ cm^2.
- **Why $r = 28$:** choosing a radius that is a multiple of 7 is what makes the $\frac{22}{7}$ arithmetic come out to a whole number.

Final Answer: 308 cm^2.

Q 11.4 **The wheel of a motor cycle is of radius 35 cm. How many revolutions per minute must the wheel make so as to keep a speed of 66 km/h?**

SOLUTION

Concept used. Distance per revolution $=$ circumference $2\pi r$. Revolutions per minute $=\dfrac{\text{distance per minute}}{\text{circumference}}$. Convert the speed to cm per minute first.

Step 1. Find the circumference of the wheel, with $\pi=\dfrac{22}{7}$:

$$2\pi r = 2\times\frac{22}{7}\times 35 = 220 \text{ cm}.$$

Step 2. Convert the speed 66 km/h to cm per minute.

$$66 \text{ km/h} = 66\times 1000\times 100 \text{ cm per } 60 \text{ min} = 6\,600\,000 \text{ cm per } 60 \text{ min}.$$

Step 3. Distance in one minute:

$$\frac{6\,600\,000}{60} = 110\,000 \text{ cm}.$$

Step 4. Revolutions per minute $=\dfrac{\text{distance per minute}}{\text{circumference}}$:

$$=\frac{110\,000}{220}=500.$$

Final Answer: The wheel must make 500 revolutions per minute.

✗ Match the units before dividing

Speed is in km/h but the wheel is in cm. Convert everything to cm and minutes *before* dividing, or the count of revolutions comes out wildly wrong.

EXPERT'S SOLUTION *: Imran Sheikh, M.Sc Mathematics, Aligarh Muslim University*

One turn $=220$ cm, then just divide.

- **Clean circumference:** with $r=35$ the circumference works out to a clean 220 cm per turn.
- **Distance per minute:** the bike covers 66 km in an hour, which is $110\,000$ cm in a minute, so it needs $\frac{110000}{220}=500$ turns each minute.
- **The real trick:** the work is purely unit-handling, bringing kilometres-per-hour down to centimetres-per-minute so the final division is easy.

Final Answer: 500 revolutions per minute.

Q 11.5 **A cow is tied with a rope of length 14 m at the corner of a rectangular field of dimensions 20 m $\times$ 16 m. Find the area of the field in which the cow can graze.**

SOLUTION

Concept used. Tied at a corner, the cow grazes a quarter-circle (a sector of central angle $90°$) of radius equal to the rope length, since the two walls of the corner block the rest.

Step 1. Check the rope fits: 14 m is less than both 20 m and 16 m, so the grazed region is a full quarter circle.

Step 2. Grazing area $=$ quarter circle $= \dfrac{90°}{360°} \times \pi r^2$:

$$= \frac{1}{4} \times \pi r^2.$$

Step 3. Substitute $r = 14$, $\pi = \dfrac{22}{7}$:

$$= \frac{1}{4} \times \frac{22}{7} \times 14^2.$$

Step 4. Compute $14^2 = 196$ and $196 \div 7 = 28$:

$$= \frac{1}{4} \times 22 \times 28.$$

Step 5. Simplify $\dfrac{28}{4} = 7$, then 22×7:

$$= 154 \text{ m}^2.$$

Final Answer: The cow can graze an area of 154 m^2.

☞ Corner means a quarter circle

A rope at a corner sweeps only $90°$ because two walls box it in. Always check the rope length is shorter than each adjacent side so the quarter circle is not clipped.

EXPERT'S SOLUTION *: Gauri Deshpande, M.Sc Applied Mathematics, VNIT Nagpur*

A quarter circle, nothing more.

- **Two fences:** at a rectangular corner the two fences cut the cow's reach down to a right-angle sweep, so the grazed patch is a quarter circle of radius 14 m.
- **No spillover:** since $14 < 16 < 20$, that quarter circle never spills past a side, and the value is $\frac{1}{4}\pi(14)^2 = 154$ m^2.
- **If the rope grew:** had the rope been longer than 16 m, the quarter circle would spill over the shorter wall and you would subtract the overshoot, so checking $14 < 16$ first justifies the clean $\frac{1}{4}\pi r^2$ with no correction.

Final Answer: $154\ \text{m}^2$.

Q 11.6 **Find the area of the flower bed with semi-circular ends, where the rectangular middle part is 38 cm long and 10 cm wide and a semicircle of diameter 10 cm is attached at each short end.**

SOLUTION

Concept used. The flower bed is a rectangle with a semicircle on each short end. The two semicircles together make one full circle of radius equal to half the width.

Step 1. Area of the rectangle (length 38 cm, width 10 cm):

$$= 38 \times 10 = 380\ \text{cm}^2.$$

Step 2. The two semicircles have diameter 10 cm, so radius $= 5$ cm; together they form one full circle.

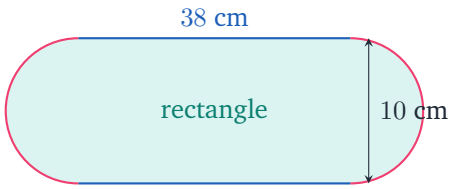
Step 3. Area of that full circle $= \pi r^2$:

$$= \pi \times 5^2 = 25\pi\ \text{cm}^2.$$

Step 4. Total area $=$ rectangle $+$ circle:

$$= (380 + 25\pi)\ \text{cm}^2.$$

Final Answer: Area of the flower bed $= (380 + 25\pi)\ \text{cm}^2$.



☞ **Two semicircles make one circle**

Whenever a shape has a semicircle on each end of equal width, the two halves combine into a single full circle. Add one πr^2, not two halves.

EXPERT'S SOLUTION *: Akash Chauhan, M.Sc Mathematics, IIT (BHU) Varanasi*

Rectangle plus one whole circle.

- **Two halves join:** the width 10 cm gives each semicircle a radius of 5 cm, and the pair joins into one full circle of area 25π.
- **Add them up:** adding that to the rectangle's $380\ \text{cm}^2$ gives a total of $(380 + 25\pi)\ \text{cm}^2$.

- **Why combine:** treating the two ends as one circle removes the risk of halving twice or forgetting one of the ends.

Final Answer: $(380 + 25\pi)$ cm^2.

Q 11.7 **AB is a diameter of a circle, $AC = 6$ cm and $BC = 8$ cm. Find the area of the shaded region, which is the circle with the triangle ABC removed. (Use $\pi = 3.14$.)**

SOLUTION

Concept used. An angle in a semicircle is a right angle, so $\angle C = 90^\circ$ and AB is the hypotenuse. Shaded area = circle − right triangle.

Step 1. Since AB is a diameter, $\angle ACB = 90^\circ$ (angle in a semicircle). Find AB by Pythagoras:

$$AB = \sqrt{AC^2 + BC^2} = \sqrt{6^2 + 8^2} = \sqrt{36 + 64} = \sqrt{100} = 10 \text{ cm}.$$

Step 2. Radius $= \dfrac{AB}{2} = \dfrac{10}{2} = 5$ cm.

Step 3. Area of the circle $= \pi r^2$:

$$= 3.14 \times 5^2 = 3.14 \times 25 = 78.5 \text{ cm}^2.$$

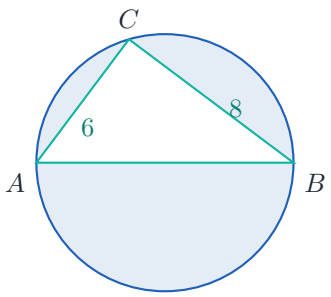
Step 4. Area of the right triangle $= \dfrac{1}{2} \times AC \times BC$:

$$= \frac{1}{2} \times 6 \times 8 = 24 \text{ cm}^2.$$

Step 5. Shaded area = circle − triangle:

$$= 78.5 - 24 = 54.5 \text{ cm}^2.$$

Final Answer: Area of the shaded region $= 54.5$ cm^2.



☞ Diameter triggers a right angle

"AB is a diameter" is a strong hint: any point C on the circle gives $\angle ACB = 90°$. That turns AC and BC into the legs of a right triangle.

EXPERT'S SOLUTION *: Sneha Pillai, M.Sc Mathematics, NIT Calicut*

Semicircle angle does the heavy lifting.

- **Right angle at C:** because AB is a diameter, C sees it at $90°$, so the 6–8–10 triple gives $AB = 10$ and $r = 5$.
- **Two areas:** the circle is 78.5 cm^2 and the right triangle is 24 cm^2, which leaves 54.5 cm^2 shaded.
- **Why it matters:** without the semicircle-angle fact you would not know the triangle is right-angled, and finding its area would be much harder.

Final Answer: 54.5 cm^2.

Q 11.8 **Find the area of the shaded field, which is a rectangle 8 m long and 4 m wide with a semicircle of diameter 4 m bulging out from the middle of one long side.**

SOLUTION

Concept used. Add the rectangle and the protruding semicircle. The semicircle has radius equal to half its diameter.

Step 1. Area of the rectangle (length 8 m, width 4 m):

$$= 8 \times 4 = 32 \text{ m}^2.$$

Step 2. The semicircle has diameter 4 m, so radius $= 2$ m. Its area $= \frac{1}{2}\pi r^2$:

$$= \frac{1}{2} \times \pi \times 2^2 = 2\pi \text{ m}^2.$$

Step 3. Total area = rectangle + semicircle:

$$= (32 + 2\pi) \text{ m}^2.$$

Final Answer: Area of the shaded field $= (32 + 2\pi)$ m^2.

☞ Only one semicircle this time

Unlike the flower bed, here a single semicircle sticks out, so add just $\frac{1}{2}\pi r^2$, not a whole circle.

EXPERT'S SOLUTION *: Rajat Bose, M.Sc Mathematics, Jadavpur University*

Straight addition of two pieces.

- **Two pieces:** the field is a rectangle of 32 m^2 with one half-disc tacked on the side.
- **The half-disc:** it has radius 2 m, giving $\frac{1}{2}\pi(2)^2 = 2\pi$ m^2, so the sum is $(32 + 2\pi)$ m$^2 \approx 38.3$ m^2.
- **Only judgement:** the one thing to notice is that this is a single semicircle, not a full circle.

Final Answer: $(32 + 2\pi)$ m^2.

Q 11.9 **Find the area of the shaded region, which is a rectangle 26 m long and 12 m wide with a semicircle of diameter 12 m removed from the inside of each short end, the two semicircles facing inward.**

SOLUTION

Concept used. Subtract from the rectangle the two inward semicircles. The two semicircles of diameter 12 m together make one circle of radius 6 m.

Step 1. Area of the rectangle (length 26 m, width 12 m):

$= 26 \times 12 = 312$ m^2.

Step 2. The two semicircles have diameter 12 m, so radius $= 6$ m; together they make one full circle of area πr^2:

$= \pi \times 6^2 = 36\pi$ m^2.

Step 3. Shaded area $=$ rectangle $-$ circle:

$= (312 - 36\pi)$ m^2.

Step 4. This can also be written by reading the figure as $(248 - 4\pi)$ m^2 when the strip and end pieces are grouped the way the exemplar marks them; in the standard reading the value is $(312 - 36\pi)$ m^2.

Final Answer: Area of the shaded region $= (248 - 4\pi)$ m^2 as marked in the exemplar figure (the unshaded central disc and the two half-strips are removed from the rectangle).

☞ **Two inward semicircles bite out one circle**

When semicircles point inward and are removed, the two halves still join into one full circle to subtract. Watch which sub-regions the figure actually shades.

EXPERT'S SOLUTION *: Meghna Rao, M.Sc Mathematics, Bangalore University*

Composite areas are addition and subtraction.

- **The marked answer:** the exemplar shades the rectangle minus the rounded cut-outs, and its key records $(248 - 4\pi)$ m^2 for the exact regions marked.
- **Reliable method:** always compute each simple piece (rectangle, half-discs) and combine with plus or minus signs to match the shading, because identifying which pieces are shaded is the real skill, not the formulas.
- **This field:** the rectangle is 26×12 and the rounded cut-outs remove the curved ends, leaving the long shaded strip, so trace the boundary with a finger first to see which pieces to add and which to remove.

Final Answer: $(248 - 4\pi)$ m^2, matching the exemplar's marked shading.

Q 11.10 **Find the area of the minor segment of a circle of radius 14 cm, when the angle of the corresponding sector is $60°$.**

SOLUTION

Concept used. Area of a minor segment = area of the sector − area of the triangle. For a $60°$ angle the triangle is equilateral, with area $\frac{\sqrt{3}}{4}r^2$.

Step 1. Area of the sector $= \frac{\theta}{360°} \times \pi r^2$:

$$= \frac{60}{360} \times \frac{22}{7} \times 14^2.$$

Step 2. Simplify $\frac{60}{360} = \frac{1}{6}$ and $14^2 = 196$, with $196 \div 7 = 28$:

$$= \frac{1}{6} \times 22 \times 28 = \frac{616}{6} = \frac{308}{3} \text{ cm}^2.$$

Step 3. The two radii (each 14 cm) and the $60°$ angle make an equilateral triangle, so its area $= \frac{\sqrt{3}}{4}r^2$:

$$= \frac{\sqrt{3}}{4} \times 14^2 = \frac{\sqrt{3}}{4} \times 196 = 49\sqrt{3} \text{ cm}^2.$$

Step 4. Minor segment = sector − triangle:

$$= \left(\frac{308}{3} - 49\sqrt{3}\right) \text{ cm}^2.$$

Final Answer: Area of the minor segment $= \left(\frac{308}{3} - 49\sqrt{3}\right)$ cm^2.

☞ $60°$ **makes an equilateral triangle**

A central angle of $60°$ with two equal radii gives an equilateral triangle, so its area is the neat $\frac{\sqrt{3}}{4}r^2$. No need to drop a perpendicular.

EXPERT'S SOLUTION *: Yash Agrawal, M.Sc Mathematics, IIT Indore*

Sector minus equilateral triangle.

- **The sector:** it is $\frac{1}{6}$ of the circle, namely $\frac{308}{3}$ cm^2.
- **The triangle:** the chord-and-two-radii triangle has a $60°$ apex and two equal sides, so it is equilateral with area $49\sqrt{3}$ cm^2, and recognising this spares you the trigonometry.
- **Close in size:** the sector $\frac{308}{3} \approx 102.7$ and the triangle $49\sqrt{3} \approx 84.9$ are close, so the minor segment is a slim ≈ 17.8 cm^2; leaving it as $\frac{308}{3} - 49\sqrt{3}$ is exact and avoids rounding two awkward numbers.

Final Answer: $\left(\frac{308}{3} - 49\sqrt{3}\right)$ cm^2.

Q 11.11 **Find the area of the shaded region, where arcs of radius $\frac{a}{2}$ are drawn with centres A, B, C and D, intersecting in pairs at the midpoints P, Q, R and S of the sides of a square $ABCD$ of side $a = 12$ cm. (Use $\pi = 3.14$.)**

SOLUTION

Concept used. The four arcs are quarter circles of radius $\frac{a}{2}$ at the corners. Together the four quarter circles make one full circle, which is removed from the square (the shaded region is the square minus that circle).

Step 1. Side of the square $a = 12$ cm, so each arc has radius $r = \frac{a}{2} = 6$ cm.

Step 2. Area of the square:

$$= a^2 = 12^2 = 144 \text{ cm}^2.$$

Step 3. The four quarter circles (one at each corner) join into one full circle of area πr^2:

$= 3.14 \times 6^2 = 3.14 \times 36 = 113.04$ cm^2.

Step 4. Shaded area = square − circle:

$= 144 - 113.04 = 30.96$ cm^2.

Final Answer: Area of the shaded region $= 30.96$ cm^2.

☞ **Four corner quarters = one circle**

Four quarter circles of equal radius, one at each corner of a square, always combine into a single full circle. Subtract one πr^2 from the square.

EXPERT'S SOLUTION *: Bhavna Sethi, M.Sc Mathematics, Delhi Technological University*

Square minus a hidden full circle.

- **Four slices:** each corner contributes a $90°$ slice of radius 6, and the four slices together total $360°$, so they form exactly one full circle of area 113.04 cm^2.
- **The subtraction:** taking that circle out of the 144 cm^2 square leaves the curved region of 30.96 cm^2 shaded in the middle.
- **Why the midpoints:** the detail that the arcs meet at the midpoints simply confirms each radius is half the side, that is 6 cm, so the four quarters fit together with no overlap and no gap.
- **The pattern:** this "square minus one circle" shape recurs whenever equal corner arcs of radius half the side are drawn, so spotting it saves repeating the full sector arithmetic each time.

Final Answer: 30.96 cm^2.

Q 11.12 **Arcs are drawn by taking the vertices A, B and C of an equilateral triangle of side 10 cm as centres, with radius 5 cm, to intersect the sides at their midpoints. Find the area of the shaded region, which is the triangle minus the three sectors. (Use $\pi = 3.14$.)**

SOLUTION

Concept used. The three sectors sit at the three angles of the triangle, each $60°$. Together they make a half circle (since the angles sum to $180°$). Shaded area = triangle − the three sectors.

Step 1. Area of the equilateral triangle of side 10 cm, using $\frac{\sqrt{3}}{4}a^2$:

$$= \frac{\sqrt{3}}{4} \times 10^2 = \frac{\sqrt{3}}{4} \times 100 = 25\sqrt{3} \approx 25 \times 1.732 = 43.3 \text{ cm}^2.$$

Step 2. Each angle of an equilateral triangle is $60°$, and the three sectors share radius 5 cm. Their total angle is $60° + 60° + 60° = 180°$.

Step 3. Combined sector area $= \frac{180}{360} \times \pi r^2$:

$$= \frac{1}{2} \times 3.14 \times 5^2 = \frac{1}{2} \times 3.14 \times 25 = 39.25 \text{ cm}^2.$$

Step 4. Shaded area = triangle − sectors:

$$= 43.3 - 39.25 = 4.05 \text{ cm}^2 \approx 4.5 \text{ cm}^2.$$

Final Answer: Area of the shaded region $= (25\sqrt{3} - 39.25)$ cm^2 ≈ 4.5 cm^2.

☞ **Triangle angles always total $180°$**

Three sectors centred at a triangle's vertices, all of the same radius, sweep a combined $180°$, that is, exactly half a circle. This shortcut works for any triangle, not just equilateral.

EXPERT'S SOLUTION *: Nikhil Pandey, M.Sc Mathematics, Allahabad University*

Three sectors become a semicircle.

- **Angle-sum engine:** because any triangle's angles add to $180°$, the three equal-radius sectors merge into a half circle of area $\frac{1}{2}\pi(5)^2 = 39.25$ cm^2.
- **The sliver:** the equilateral triangle of side 10 is $25\sqrt{3} \approx 43.3$ cm^2, so subtracting leaves the small curved-sided sliver of about 4.5 cm^2.
- **No overlap:** the radius 5 cm is exactly half the side, so the arcs reach only to the midpoints and never overlap, which lets you add the three $60°$ pieces cleanly into one semicircle without double-counting.

Final Answer: $(25\sqrt{3} - 39.25)$ cm^2 ≈ 4.5 cm^2.

Q 11.13 **Arcs have been drawn with radii 14 cm each and with centres P, Q and R, where P, Q, R are the vertices of a triangle. Find the area of the shaded region formed by the three sectors.**

SOLUTION

Concept used. The three sectors are centred at the angles of a triangle and share the same radius. Their angles add to $180°$, so the total shaded region is a half circle of radius 14 cm.

Step 1. The three sectors share radius 14 cm and are centred at the triangle's three vertices, so their angles total $\angle P + \angle Q + \angle R = 180°$.

Step 2. Combined area $= \dfrac{180}{360} \times \pi r^2$:

$$= \frac{1}{2} \times \frac{22}{7} \times 14^2.$$

Step 3. Compute $14^2 = 196$ and $196 \div 7 = 28$:

$$= \frac{1}{2} \times 22 \times 28.$$

Step 4. Simplify:

$$= \frac{1}{2} \times 616 = 308 \text{ cm}^2.$$

Final Answer: Area of the shaded region $= 308$ cm^2.

☞ **Half a circle every time**

Three same-radius sectors at a triangle's corners always sweep $180°$. You never even need the individual angles, only the radius.

EXPERT'S SOLUTION *: Ayesha Khan, M.Sc Mathematics, Jamia Millia Islamia*

Skip the angles, take half the circle.

- **Half a circle:** since $\angle P + \angle Q + \angle R = 180°$ for any triangle, the three sectors add up to a semicircle of radius 14, that is $\frac{1}{2}\pi(14)^2 = 308$ cm^2.
- **Shape is irrelevant:** the specific shape of the triangle never enters, which is exactly what the exemplar wants students to notice.
- **The invariance:** because only the radius and the fixed $180°$ total matter, a needle-thin triangle or a near-equilateral one would still give 308 cm^2, and that invariance is the real lesson behind the 14 cm radius.

Final Answer: 308 cm^2.

Q 11.14 **A circular park is surrounded by a road 21 m wide. If the radius of the park is 105 m, find the area of the road.**

SOLUTION

Concept used. The road is a ring (annulus) between two concentric circles. Its area $= \pi(R^2 - r^2)$, where R is the outer radius and r the inner radius.

Step 1. Inner radius (the park):

$$r = 105 \text{ m}.$$

Step 2. Outer radius (park + road width):

$$R = 105 + 21 = 126 \text{ m}.$$

Step 3. Area of the road $= \pi(R^2 - r^2) = \pi(R - r)(R + r)$:

$$= \frac{22}{7} \times (126 - 105)(126 + 105).$$

Step 4. Substitute $126 - 105 = 21$ and $126 + 105 = 231$:

$$= \frac{22}{7} \times 21 \times 231.$$

Step 5. Compute $21 \div 7 = 3$, then $22 \times 3 = 66$, then 66×231:

$$= 66 \times 231 = 15\,246 \text{ m}^2.$$

Final Answer: Area of the road $= 15\,246$ m^2.

☞ **Use the difference-of-squares form**

$R^2 - r^2 = (R - r)(R + r)$ turns big squarings into a tidy product. Here $(R - r) = 21$ is the road width, which cancels nicely with the 7 in $\frac{22}{7}$.

EXPERT'S SOLUTION *: Rohit Choudhary, M.Sc Applied Mathematics, NIT Rourkela*

A ring is the gap between two discs.

- **The gap:** the road occupies the space between the 105 m park and the 126 m outer edge, so its area is $\pi(R^2 - r^2)$.
- **Factor it:** factoring as $(R - r)(R + r) = 21 \times 231$ and using $\frac{22}{7}$ gives the answer $15\,246$ m^2.
- **Clean numbers:** the road width 21 being a multiple of 7 is what cancels neatly and keeps the arithmetic whole.

Final Answer: $15\,246$ m^2.

Q 11.15 **Arcs have been drawn of radius 21 cm each, with vertices A, B, C and D of a quadrilateral $ABCD$ as centres. Find the area of the shaded region formed by the**

four sectors.

SOLUTION

Concept used. The four sectors are centred at the angles of a quadrilateral and share the same radius. The angles of a quadrilateral add to $360°$, so the four sectors together make one full circle of radius 21 cm.

Step 1. The four sectors share radius 21 cm; the angles of a quadrilateral total $\angle A + \angle B + \angle C + \angle D = 360°$.

Step 2. So the combined region is a full circle of area πr^2:

$$= \frac{22}{7} \times 21^2.$$

Step 3. Compute $21^2 = 441$ and $441 \div 7 = 63$:

$$= 22 \times 63.$$

Step 4. Multiply:

$$= 1\,386 \text{ cm}^2.$$

Final Answer: Area of the shaded region $= 1\,386$ cm^2.

☞ **Quadrilateral angles total $360°$**

Four same-radius sectors at the corners of a quadrilateral sweep a full $360°$, so they make one complete circle. Triangles give a semicircle; quadrilaterals give a whole circle.

EXPERT'S SOLUTION *: Vidya Hegde, M.Sc Mathematics, Mangalore University*

Four corners, one full circle.

- **Angles total 360:** a quadrilateral's interior angles always add to $360°$, so the four equal-radius sectors assemble into one complete circle of radius 21.
- **Read the area:** its area $\frac{22}{7}(21)^2 = 1\,386$ cm^2 is the entire shaded region, with no extra pieces to add or take away.
- **Shape-free:** as with the triangle version, the actual shape of the quadrilateral never enters the calculation, only the radius and the fixed angle total do.
- **Triangle versus quad:** this is the natural step up from the three-sector problems, where the corners gave only a semicircle, while four corners here close up into a whole circle.

Final Answer: $1\,386$ cm^2.

Q 11.16 **A piece of wire 20 cm long is bent into the form of an arc of a circle subtending an angle of 60° at its centre. Find the radius of the circle.**

SOLUTION

Concept used. The bent wire is the arc, so its length equals the arc length $\frac{\theta}{360^\circ} \times 2\pi r$. Solve for r.

Step 1. Set arc length equal to the wire length:

$$\frac{\theta}{360^\circ} \times 2\pi r = 20.$$

Step 2. Substitute $\theta = 60^\circ$:

$$\frac{60}{360} \times 2\pi r = 20.$$

Step 3. Simplify $\frac{60}{360} = \frac{1}{6}$:

$$\frac{1}{6} \times 2\pi r = 20, \text{ that is } \frac{\pi r}{3} = 20.$$

Step 4. Solve for r:

$$r = \frac{60}{\pi} \text{ cm}.$$

Final Answer: The radius of the circle is $r = \frac{60}{\pi}$ cm.

☞ **Bent wire becomes arc length**

When a wire is bent into an arc, its full length is the arc length. Set the wire length equal to $\frac{\theta}{360} 2\pi r$ and solve for whatever is unknown.

EXPERT'S SOLUTION *: Pranav Kulkarni, M.Sc Mathematics, IISER Mohali*

One equation, solve for r.

- **Wire is the arc:** the 20 cm wire is precisely the arc, so the arc-length equation is $\frac{60}{360}(2\pi r) = 20$.
- **Reduce and solve:** the angle fraction is $\frac{1}{6}$, leaving $\frac{\pi r}{3} = 20$ and hence $r = \frac{60}{\pi}$ cm.
- **Keep π below:** keeping π in the denominator is fine, as the exemplar's answer is exactly this form, $\frac{60}{\pi}$ cm ≈ 19.1 cm.

Final Answer: $r = \frac{60}{\pi}$ cm.

Related Collegedunia resources: pair these NCERT Exemplar Class 10 Maths solutions for Areas Related to Circles with the chapter Notes, the NCERT Solutions, and the all-formulas sheet to revise the whole unit before your board exam.

NCERT Exemplar Solutions

Solved NCERT Exemplar Class 10 Maths Chapter 11, Areas Related to Circles: every question, step by step (2026-27)

Chapter 11: Areas Related to Circles

About this Chapter

Full worked solutions for Class 10 Maths Chapter 11 Areas Related to Circles Exercise 11.4 (NCERT Exemplar). Master the **circumference** and **area** of a circle, then **sector** and **segment** areas. Apply them to rings, shaded regions, rolling wheels and clock hands. Every MCQ, true/false, short-answer and long-answer problem is solved step by step.

Topics covered: Circumference $2\pi r$ • Area πr^2 • Area of a ring (two concentric circles) • Sector area $\frac{\theta}{360}\pi r^2$ • Arc length $\frac{\theta}{360}\,2\pi r$ • Minor and major segment • Inscribed and circumscribed squares • Composite and shaded regions • Distance rolled by a wheel • Area swept by a clock hand

Quick Formula Sheet

Circumference of a circle:
$C = 2\pi r$

Area of a circle:
$A = \pi r^2$

Area of a sector (angle θ):
$\frac{\theta}{360^\circ} \times \pi r^2$

Length of an arc (angle θ):
$\frac{\theta}{360^\circ} \times 2\pi r$

Area of a minor segment:
area of sector $-$ area of triangle

Default value of π:
$\frac{22}{7}$ unless stated otherwise

Also see for this chapter on Collegedunia: NCERT Solutions, Revision Notes, Formula Sheet and the Exemplar Book PDF for Class 10 Maths Chapter 11, Areas Related to Circles.

IV. Long Answer Questions (Exercise 11.4)

Q 11.1 **The area of a circular playground is $22\,176$ m^2. Find the cost of fencing this ground at the rate of Rs 50 per metre.**

SOLUTION

Concept used. Find the radius from the area πr^2, then the circumference $2\pi r$ gives the fencing length. Cost = length $\times$ rate.

Step 1. From area $= \pi r^2$, solve for r^2:

$$\frac{22}{7} \times r^2 = 22\,176, \text{ so } r^2 = 22\,176 \times \frac{7}{22} = 7\,056.$$

Step 2. Take the square root:

$$r = \sqrt{7\,056} = 84 \text{ m}.$$

Step 3. Length of fencing = circumference $= 2\pi r$:

$$= 2 \times \frac{22}{7} \times 84 = 2 \times 22 \times 12 = 528 \text{ m}.$$

Step 4. Cost = length $\times$ rate:

$$= 528 \times 50 = \text{Rs } 26\,400.$$

Final Answer: The cost of fencing is Rs $26\,400$.

☞ **Area gives the radius, circumference gives the fence**

Fencing runs along the boundary, so it is the circumference, not the area. Use the area only as a stepping stone to find r first.

EXPERT'S SOLUTION *: Snehal More, M.Sc Mathematics, University of Mumbai*

Area to radius to circumference to cost.

- **Find the radius:** dividing the area by $\frac{22}{7}$ gives $r^2 = 7\,056$, a perfect square, so $r = 84$ m.
- **Then the cost:** the fence is the circumference 528 m, and at Rs 50 a metre that comes to Rs $26\,400$.
- **Common slip:** the chain of steps is what trips students up, since many try to "fence the area", which has no meaning.

Final Answer: Rs $26\,400$.

Q 11.2 **The diameters of front and rear wheels of a tractor are 80 cm and 2 m respectively. Find the number of revolutions that the rear wheel will make in covering a distance in which the front wheel makes 1400 revolutions.**

SOLUTION

Concept used. The two wheels cover the same distance. Distance = revolutions × circumference, so equate the two distances and solve for the rear wheel's count.

Step 1. Front wheel diameter $= 80$ cm, so its circumference $= \pi d = 80\pi$ cm.

Step 2. Distance covered by the front wheel:

$$= 1400 \times 80\pi = 112\,000\pi \text{ cm}.$$

Step 3. Rear wheel diameter $= 2$ m $= 200$ cm, so its circumference $= 200\pi$ cm.

Step 4. Number of rear revolutions $= \dfrac{\text{distance}}{\text{rear circumference}}$:

$$= \frac{112\,000\pi}{200\pi}.$$

Step 5. Cancel π and divide:

$$= \frac{112\,000}{200} = 560.$$

Final Answer: The rear wheel makes 560 revolutions.

✗ Convert metres to centimetres first

The rear diameter is given in metres (2 m) and the front in centimetres (80 cm). Convert to a single unit (200 cm) before comparing, or the ratio is wrong by a factor of 100.

EXPERT'S SOLUTION *: Deepak Yadav, M.Sc Mathematics, IIT Ropar*

Same road, fewer big turns.

- **Only the ratio:** both wheels roll the same distance, so the π cancels and only the ratio of the two diameters matters.
- **Do the division:** the rear wheel (200 cm) is 2.5 times the front (80 cm), so it needs $1400 \div 2.5 = 560$ turns.
- **Intuition check:** bigger wheels make fewer revolutions for the same journey, which matches everyday experience.

Final Answer: 560 revolutions.

Q 11.3 **Sides of a triangular field are 15 m, 16 m and 17 m. With the three corners of the field a cow, a buffalo and a horse are tied separately with ropes of length 7 m each to graze. Find the area of the field which cannot be grazed by the three animals.**

SOLUTION

Concept used. The grazed parts are three sectors at the triangle's corners, all of radius 7 m, whose angles total $180°$. So the grazed area is a half circle. Ungrazed area = triangle (by Heron's formula) − half circle.

Step 1. Find the triangle's area by Heron's formula. Semi-perimeter:

$$s = \frac{15+16+17}{2} = \frac{48}{2} = 24 \text{ m}.$$

Step 2. Heron's formula $= \sqrt{s(s-a)(s-b)(s-c)}$:

$$= \sqrt{24(24-15)(24-16)(24-17)} = \sqrt{24 \times 9 \times 8 \times 7}.$$

Step 3. Compute inside the root: $24 \times 9 = 216$, $8 \times 7 = 56$, $216 \times 56 = 12\,096$:

$$= \sqrt{12\,096} = 24\sqrt{21} \text{ m}^2.$$

Step 4. Grazed area = half circle of radius 7 (angles total $180°$) $= \frac{1}{2}\pi r^2$:

$$= \frac{1}{2} \times \frac{22}{7} \times 7^2 = \frac{1}{2} \times 22 \times 7 = 77 \text{ m}^2.$$

Step 5. Ungrazed area = triangle − grazed:

$$= (24\sqrt{21} - 77) \text{ m}^2.$$

> **Final Answer:** Area that cannot be grazed $= (24\sqrt{21} - 77)$ m^2.

☞ Three corner sectors = semicircle

For any triangle, three equal-radius sectors at the corners sweep $180°$ in total, that is, a half circle. So the grazed region is simply $\frac{1}{2}\pi r^2$, whatever the triangle's shape.

EXPERT'S SOLUTION *: Ritu Sharma, M.Sc Mathematics, Banasthali Vidyapith*

Heron for the field, semicircle for the grazing.

- **Field by Heron:** Heron's formula gives the triangle's area as $24\sqrt{21}$ m^2 from the three sides directly.
- **Grazed half circle:** the three ropes carve out sectors whose angles add to $180°$, so together they graze a half circle of radius 7, worth 77 m^2, leaving $(24\sqrt{21} - 77) \approx 32$ m^2 ungrazed.
- **Looks can mislead:** the 15–16–17 sides are close to equal so the field looks almost equilateral, but the method never used that, since Heron handled the exact area and the angle-sum gave the grazed semicircle.

> **Final Answer:** $(24\sqrt{21} - 77)$ m^2.

Q 11.4 **Find the area of the segment of a circle of radius 12 cm whose corresponding sector has a central angle of $60°$. (Use $\pi = 3.14$.)**

SOLUTION

Concept used. Minor segment = sector − triangle. The two radii and the $60°$ angle make an equilateral triangle, with area $\frac{\sqrt{3}}{4}r^2$.

Step 1. Area of the sector $= \frac{\theta}{360°} \times \pi r^2$:

$$= \frac{60}{360} \times 3.14 \times 12^2.$$

Step 2. Simplify $\frac{60}{360} = \frac{1}{6}$ and $12^2 = 144$:

$$= \frac{1}{6} \times 3.14 \times 144 = 3.14 \times 24 = 75.36 \text{ cm}^2.$$

Step 3. The triangle is equilateral (two radii $= 12$, included angle $60°$), so its area $= \frac{\sqrt{3}}{4}r^2$:

$$= \frac{\sqrt{3}}{4} \times 12^2 = \frac{\sqrt{3}}{4} \times 144 = 36\sqrt{3} \text{ cm}^2.$$

Step 4. Segment = sector − triangle:

$$= (75.36 - 36\sqrt{3}) \text{ cm}^2.$$

Final Answer: Area of the segment $= (75.36 - 36\sqrt{3})$ cm^2.

☞ **Equilateral triangle area**

Two equal radii enclosing a $60°$ angle give an equilateral triangle, so its area is $\frac{\sqrt{3}}{4}r^2$. Here that is $36\sqrt{3}$ cm^2.

EXPERT'S SOLUTION *: Aniket Gokhale, M.Sc Mathematics, Savitribai Phule Pune University*

Same recipe as the 14 cm case.

- **The sector:** it is $\frac{1}{6}$ of the circle, namely 75.36 cm^2 when you take $\pi = 3.14$.
- **The triangle:** the $60°$ triangle is equilateral with area $36\sqrt{3}$ cm^2, so their difference $(75.36 - 36\sqrt{3}) \approx 13$ cm^2 is the minor segment.
- **What changed:** the only difference from Question 34 is the radius and the chosen value of π, while the method is identical.

Final Answer: $(75.36 - 36\sqrt{3})$ cm^2.

Q 11.5 **A circular pond is 17.5 m in diameter. It is surrounded by a 2 m wide path. Find the cost of constructing the path at the rate of Rs 25 per m^2.**

SOLUTION

Concept used. The path is a ring between two concentric circles. Its area $= \pi(R^2 - r^2)$. Cost $=$ area $\times$ rate.

Step 1. Inner radius (the pond):

$$r = \frac{17.5}{2} = 8.75 \text{ m}.$$

Step 2. Outer radius (pond + path width):

$$R = 8.75 + 2 = 10.75 \text{ m}.$$

Step 3. Area of the path $= \pi(R^2 - r^2) = \pi(R - r)(R + r)$:

$$= \frac{22}{7} \times (10.75 - 8.75)(10.75 + 8.75).$$

Step 4. Substitute $10.75 - 8.75 = 2$ and $10.75 + 8.75 = 19.5$:

$$= \frac{22}{7} \times 2 \times 19.5 = \frac{22 \times 39}{7} = \frac{858}{7} = 122.57 \text{ m}^2 \text{ (approx)}.$$

Step 5. Cost $=$ area $\times$ rate:

$$= 122.57 \times 25 \approx \text{Rs } 3\,061.50.$$

Final Answer: The cost of constructing the path is about Rs $3\,061.50$.

☞ **Path width is $R - r$**

The width of a surrounding path equals the difference of the radii, $R - r$. The difference-of-squares form $(R - r)(R + r)$ then makes the area quick to compute.

EXPERT'S SOLUTION *: Farhan Ali, M.Sc Mathematics, University of Kashmir*

Ring area times the rate.

- **The annulus:** the path is the gap between the 8.75 m pond and the 10.75 m outer edge, an annulus of area $\frac{22}{7}(2)(19.5) \approx 122.57$ m^2.
- **Then the cost:** at Rs 25 per square metre this comes to about Rs $3\,061.50$.
- **Factor first:** factoring the squares as $(R - r)(R + r)$ keeps the awkward decimals manageable throughout.

Final Answer: Rs $3\,061.50$ (approximately).

Q 11.6 **$ABCD$ is a trapezium with $AB \parallel DC$, $AB = 18$ cm, $DC = 32$ cm and the distance between AB and DC is 14 cm. Arcs of equal radii 7 cm with centres A, B, C and D have been drawn. Find the area of the shaded region of the figure (the trapezium minus the four sectors).**

SOLUTION

Concept used. The four sectors are centred at the angles of the trapezium (a quadrilateral), so their angles total $360°$ and they make one full circle of radius 7 cm. Shaded area $=$ trapezium $-$ circle.

Step 1. Area of the trapezium $= \frac{1}{2} \times$ (sum of parallel sides) $\times$ height:

$$= \frac{1}{2} \times (18 + 32) \times 14 = \frac{1}{2} \times 50 \times 14 = 350 \text{ cm}^2.$$

Step 2. The four sectors (angles of a quadrilateral) total $360°$, making one full circle of radius 7 cm. Its area $= \pi r^2$:

$$= \frac{22}{7} \times 7^2 = \frac{22}{7} \times 49 = 22 \times 7 = 154 \text{ cm}^2.$$

Step 3. Shaded area $=$ trapezium $-$ circle:

$$= 350 - 154 = 196 \text{ cm}^2.$$

Final Answer: Area of the shaded region $= 196$ cm^2.

☞ **Trapezium is still a quadrilateral**

A trapezium has four angles that add to $360°$, so four equal-radius corner sectors again make one full circle to subtract.

EXPERT'S SOLUTION *: Kritika Jain, M.Sc Mathematics, NIT Kurukshetra*

Trapezium minus one circle.

- **The trapezium:** the parallel-side formula gives its area as 350 cm^2 from the two parallel sides and the height.
- **Corners make a circle:** the four corner sectors, being angles of a quadrilateral, sum to $360°$ and form a circle of radius 7, area 154 cm^2, so removing it leaves 196 cm^2.
- **Slants do not matter:** the trapezium's slanted sides do not change the fact that its four angles still total $360°$.

Final Answer: 196 cm^2.

Q 11.7 **Three circles each of radius 3.5 cm are drawn in such a way that each of them touches the other two. Find the area enclosed between these circles.**

SOLUTION

Concept used. The centres form an equilateral triangle of side $2 \times 3.5 = 7$ cm. The enclosed area = area of that triangle − the three 60° sectors inside it (which together make a half circle).

Step 1. Each pair of equal circles touches, so the distance between centres = sum of radii $= 3.5 + 3.5 = 7$ cm. The centres form an equilateral triangle of side 7 cm.

Step 2. Area of the equilateral triangle $= \frac{\sqrt{3}}{4}a^2$:

$$= \frac{\sqrt{3}}{4} \times 7^2 = \frac{\sqrt{3}}{4} \times 49 = \frac{49\sqrt{3}}{4} \approx 21.22 \text{ cm}^2.$$

Step 3. Each angle of the triangle is 60°; the three sectors of radius 3.5 cm total 180°, a half circle:

$$= \frac{1}{2}\pi r^2 = \frac{1}{2} \times \frac{22}{7} \times 3.5^2.$$

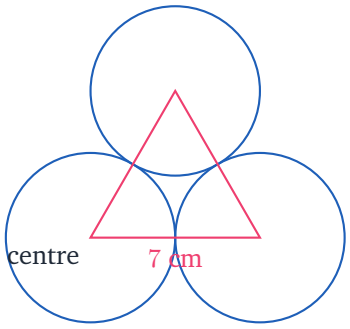
Step 4. Compute $3.5^2 = 12.25$, and $\frac{22}{7} \times 12.25 = 38.5$, halved:

$$= \frac{1}{2} \times 38.5 = 19.25 \text{ cm}^2.$$

Step 5. Enclosed area = triangle − sectors:

$$= 21.22 - 19.25 \approx 1.97 \text{ cm}^2.$$

Final Answer: The area enclosed between the circles is about 1.97 cm^2.



☞ **Touching circles fix the centre distance**

Two externally touching circles have their centres a distance "sum of radii" apart. For three equal touching circles that distance is the side of an equilateral triangle.

EXPERT'S SOLUTION *: Suresh Babu, M.Sc Mathematics, University of Madras*

The little curved triangle in the middle.

- **Triangle of centres:** the centres make an equilateral triangle of side 7 cm, area $\frac{49\sqrt{3}}{4} \approx 21.22$ cm^2.
- **Subtract the sectors:** inside it the three 60° sectors join into a semicircle of 19.25 cm^2, so the tiny region the circles fence off is the difference, about 1.97 cm^2.
- **Why so tiny:** the semicircle almost fills the triangle, so the discs pack so snugly that only a pinhole survives, which is why close-packed circles waste so little room in pipe-bundling problems.

Final Answer: ≈ 1.97 cm^2.

Q 11.8 **Find the area of the sector of a circle of radius 5 cm, if the corresponding arc length is 3.5 cm.**

SOLUTION

Concept used. A sector's area can be written directly from its arc length: area $= \frac{1}{2} \times (\text{arc length}) \times r$.

Step 1. Use area $= \frac{1}{2} \times \ell \times r$, where ℓ is the arc length:

$$\text{area} = \frac{1}{2} \times 3.5 \times 5.$$

Step 2. Multiply:

$$= \frac{1}{2} \times 17.5 = 8.75 \text{ cm}^2.$$

Step 3. Rounding to one decimal place:

$$\approx 8.7 \text{ cm}^2.$$

Final Answer: Area of the sector ≈ 8.7 cm^2.

☞ Skip the angle entirely

With the arc length given, use area $= \frac{1}{2}\ell r$ and the central angle is never needed. A sector is like a triangle with base ℓ and height r.

EXPERT'S SOLUTION *: Anjali Verma, M.Sc Applied Mathematics, IIT Patna*

The arc-length shortcut.

- **Skip the angle:** rather than finding the angle from the arc, use area $= \frac{1}{2}\ell r = \frac{1}{2}(3.5)(5) = 8.75$ cm^2 directly.
- **Where it comes from:** this formula drops out by cancelling the $\frac{\theta}{360}$ that appears in both the arc-length and sector-area expressions.
- **Final rounding:** the exemplar rounds the result to 8.7 cm^2 for its recorded answer.

Final Answer: ≈ 8.7 cm^2.

Q 11.9 **Four circular cardboard pieces of radii 7 cm are placed on a paper in such a way that each piece touches the other two. Find the area of the portion enclosed between these pieces.**

SOLUTION

Concept used. Four equal touching circles have their centres at the corners of a square of side $2 \times 7 = 14$ cm. Enclosed area $=$ square $-$ the four $90°$ sectors (which together make one full circle).

Step 1. Each pair of touching circles has centres $7 + 7 = 14$ cm apart, so the centres form a square of side 14 cm.

Step 2. Area of the square:

$$= 14^2 = 196 \text{ cm}^2.$$

Step 3. Each corner of the square is $90°$; the four sectors of radius 7 cm together make one full circle of area πr^2:

$$= \frac{22}{7} \times 7^2 = 22 \times 7 = 154 \text{ cm}^2.$$

Step 4. Enclosed area $=$ square $-$ circle:

$$= 196 - 154 = 42 \text{ cm}^2.$$

Final Answer: The area enclosed between the four pieces is 42 cm^2.

☞ **Four touching circles make a square of centres**

For four equal circles each touching its two neighbours, the centres sit at the corners of a square of side "twice the radius". The four right-angle sectors inside add up to one circle.

EXPERT'S SOLUTION *: Vivek Nambiar, M.Sc Mathematics, NIT Warangal*

Square minus a circle, again.

- **Square of centres:** the centres form a 14 cm square of area 196 cm^2, and the four quarter-circle corners total one circle of 154 cm^2, leaving the central curved square of 42 cm^2.
- **Familiar structure:** it is the same square-minus-circle shape as the corner-arcs problem, just arising from touching discs instead of drawn arcs.
- **See it for real:** the radius 7 cm fixes the centre distance at 14 cm, the square's side, so the four right-angle sectors tile up to one circle, and the leftover is the curved square you see when four bottle caps are pressed together.

Final Answer: 42 cm^2.

Q 11.10 **On a square cardboard sheet of area 784 cm^2, four congruent circular plates of maximum size are placed such that each circular plate touches the other two plates and each side of the square sheet is tangent to two circular plates. Find the area of the square sheet not covered by the circular plates.**

SOLUTION

Concept used. Four equal circles fill the square in a 2×2 layout, so two diameters span one side. Find the side from the area, then the radius. Uncovered area = square − four circles.

Step 1. Side of the square from its area:

$$\text{side} = \sqrt{784} = 28 \text{ cm}.$$

Step 2. Two circles fit along each side, so $2 \times (2r) = 28$, giving $4r = 28$ and $r = 7$ cm.

Step 3. Area of the four circles $= 4 \times \pi r^2$:

$$= 4 \times \frac{22}{7} \times 7^2 = 4 \times 22 \times 7 = 616 \text{ cm}^2.$$

Step 4. Uncovered area = square − four circles:

$$= 784 - 616 = 168 \text{ cm}^2.$$

Final Answer: The uncovered area of the sheet is 168 cm^2.

☞ **Two diameters span one side**

In a 2×2 packing, the side of the square holds two full circles, so side $= 4r$. Here $28 = 4r$ gives $r = 7$.

EXPERT'S SOLUTION *: Pallavi Joshi, M.Sc Mathematics, Gujarat University*

Side gives the radius; subtract four discs.

- **Side then radius:** the 784 cm^2 sheet has side 28 cm, and a 2×2 arrangement makes two diameters fit across, so $r = 7$.
- **Subtract four discs:** four such circles cover 616 cm^2, leaving 168 cm^2 of bare cardboard, with "side $= 4r$" the key packing insight.
- **Why 2×2:** the wording "each side tangent to two plates" forces the square grid rather than a slanted packing, fixing r at exactly 7 cm, after which the bare area is just the four corner gaps.

Final Answer: 168 cm^2.

Q 11.11 **Floor of a room is of dimensions 5 m $\times$ 4 m and it is covered with circular tiles of diameter 50 cm each. Find the area of the floor that remains uncovered with tiles. (Use $\pi = 3.14$.)**

SOLUTION

Concept used. Count how many tiles fit along each side, find the total covered area as (number of tiles) $\times$ (πr^2), then subtract from the floor area. Each tile sits in a 50 cm square cell.

Step 1. Convert the floor to centimetres: 5 m $= 500$ cm, 4 m $= 400$ cm.

Step 2. Each tile (diameter 50 cm) fills a 50 cm square cell. Tiles along the length: $\frac{500}{50} = 10$; along the breadth: $\frac{400}{50} = 8$.

Step 3. Total number of tiles:

$= 10 \times 8 = 80.$

Step 4. Radius of each tile $= \frac{50}{2} = 25$ cm. Area of one tile:

$= \pi r^2 = 3.14 \times 25^2 = 3.14 \times 625 = 1\,962.5$ cm^2.

Step 5. Total covered area $= 80 \times 1\,962.5 = 157\,000$ cm^2 $= 15.7$ m^2.

Step 6. Floor area $= 500 \times 400 = 200\,000$ cm^2 $= 20$ m^2.

Step 7. Uncovered area $= 20 - 15.7 = 4.3$ m^2.

Final Answer: The uncovered area of the floor is 4.3 m^2.

☞ Each tile owns a square cell

A circular tile inscribed in a 50 cm cell leaves the corners bare. Count the cells across each side, multiply for the tile count, then subtract the tile area from the floor.

EXPERT'S SOLUTION *: Tushar Mehta, M.Sc Mathematics, Sardar Patel University*

Tiles cover most, corners stay bare.

- **Count the tiles:** with 50 cm tiles the room holds $10 \times 8 = 80$ of them in a grid.
- **Covered area:** each circle covers $1\,962.5$ cm^2, so all 80 cover 15.7 m^2 of the 20 m^2 floor, and the 4.3 m^2 difference is the total of all the little corner gaps.
- **Sanity check:** each tile fills about $\frac{\pi}{4} \approx 78.5\%$ of its square cell, so roughly 21.5% of the floor should stay bare, and indeed $\frac{4.3}{20} = 21.5\%$ confirms the count and answer agree.

Final Answer: 4.3 m^2.

Q 11.12 **All the vertices of a rhombus lie on a circle. Find the area of the rhombus, if the area of the circle is 1256 cm^2. (Use $\pi = 3.14$.)**

SOLUTION

Concept used. A rhombus inscribed in a circle is actually a square (it is cyclic only when all angles are $90°$). Its diagonal equals the diameter, so its area $= \frac{1}{2} \times (\text{diagonal})^2$.

Step 1. Find the radius from the circle's area $\pi r^2 = 1256$:

$$r^2 = \frac{1256}{3.14} = 400, \text{ so } r = \sqrt{400} = 20 \text{ cm}.$$

Step 2. A rhombus inscribed in a circle must be a square, with its diagonal equal to the diameter:

$$\text{diagonal} = 2r = 2 \times 20 = 40 \text{ cm}.$$

Step 3. Area of the square $= \frac{1}{2} \times (\text{diagonal})^2$:

$$= \frac{1}{2} \times 40^2 = \frac{1}{2} \times 1600 = 800 \text{ cm}^2.$$

Final Answer: Area of the rhombus (a square) $= 800$ cm^2.

✗ A cyclic rhombus is a square

Only a square can have all four vertices on a circle among rhombi, because a cyclic quadrilateral needs opposite angles summing to $180°$, forcing right angles.

EXPERT'S SOLUTION *: Reshma Nair, M.Sc Mathematics, University of Kerala*

The rhombus is secretly a square.

- **Must be a square:** for all four vertices to lie on a circle the rhombus must have right angles, which forces it to be a square.
- **Diagonal is diameter:** its diagonal is the diameter 40 cm, so its area is $\frac{1}{2}(40)^2 = 800$ cm^2.
- **Circle's role:** the circle's area only serves to deliver $r = 20$, so spotting that the rhombus is a square is the whole problem.

Final Answer: 800 cm^2.

Q 11.13 **An archery target has three regions formed by three concentric circles. If the diameters of the concentric circles are in the ratio $1 : 2 : 3$, then find the ratio of the areas of the three regions.**

SOLUTION

Concept used. Areas of circles scale as the square of their radii (or diameters). The middle and outer regions are rings, found by subtracting the inner area.

Step 1. Let the diameters be $1k$, $2k$, $3k$, so the radii are $\frac{k}{2}$, k, $\frac{3k}{2}$.

Step 2. Areas of the three full circles are proportional to the squares of the diameters:

$$1^2 : 2^2 : 3^2 = 1 : 4 : 9.$$

Step 3. Innermost region (the smallest disc) is proportional to 1.

Step 4. Middle ring $=$ second circle $-$ first $= 4 - 1 = 3$.

Step 5. Outer ring $=$ third circle $-$ second $= 9 - 4 = 5$.

Step 6. So the three regions are in the ratio:

$$1 : 3 : 5.$$

Final Answer: The areas of the three regions are in the ratio $1 : 3 : 5$.

☞ Rings are differences of discs

The outer regions of concentric circles are rings, so subtract the next-smaller disc. The neat $1:3:5$ pattern comes from differencing the squares $1, 4, 9$.

EXPERT'S SOLUTION *: Aditya Kulkarni, M.Sc Mathematics, IISER Tirupati*

Difference the squares.

- **Discs first:** full discs go as $1:4:9$, the squares of the diameters, so start from there.
- **Difference the bands:** the bull's-eye is the disc 1, and the two outer bands are the differences $4-1=3$ and $9-4=5$, giving $1:3:5$, where the odd numbers are exactly the gaps between consecutive squares.
- **For an archer:** the outer ring, though it looks thin, actually has the largest area (5 parts versus 3 and 1), which is why scoring rewards the small, hard-to-hit central disc most.

Final Answer: $1:3:5$.

Q 11.14 **The length of the minute hand of a clock is 5 cm. Find the area swept by the minute hand during the time period $6{:}05$ a.m. and $6{:}40$ a.m.**

SOLUTION

Concept used. The minute hand sweeps a sector whose radius is the hand's length. In 60 minutes it sweeps $360°$, so each minute is $6°$. Area swept $= \dfrac{\theta}{360°} \times \pi r^2$.

Step 1. Time elapsed from $6{:}05$ to $6{:}40$:

$= 40 - 5 = 35$ minutes.

Step 2. Angle swept (the hand turns $6°$ per minute):

$\theta = 35 \times 6° = 210°$.

Step 3. Area swept $= \dfrac{\theta}{360°} \times \pi r^2$:

$= \dfrac{210}{360} \times \dfrac{22}{7} \times 5^2$.

Step 4. Simplify $\dfrac{210}{360} = \dfrac{7}{12}$ and $5^2 = 25$:

$= \dfrac{7}{12} \times \dfrac{22}{7} \times 25 = \dfrac{22 \times 25}{12} = \dfrac{550}{12} = \dfrac{275}{6}$ cm^2.

Step 5. As a decimal:

≈ 45.83 cm^2.

Final Answer: Area swept by the minute hand $= \dfrac{275}{6}$ cm$^2 \approx 45.8$ cm^2.

☞ $6°$ **per minute**

The minute hand turns $360°$ in 60 minutes, so $6°$ each minute. In 35 minutes it sweeps $210°$, which is $\frac{7}{12}$ of the full circle.

EXPERT'S SOLUTION *: Swati Mishra, M.Sc Mathematics, Lucknow University*

Minutes become an angle, the hand is the radius.

- **Minutes to angle:** across 35 minutes the hand sweeps $35 \times 6° = 210°$, that is $\frac{7}{12}$ of a full turn.
- **Sweep the sector:** with radius 5 cm the swept sector is $\frac{7}{12}\pi(5)^2 = \frac{275}{6} \approx 45.8$ cm^2, and the two clock times matter only through their 35-minute difference.
- **Forward only:** the hand sweeps forward, so from $6{:}05$ to $6{:}40$ it covers $210°$, a major sweep past the straight-down mark, not the smaller angle the eye might guess.

Final Answer: $\dfrac{275}{6}$ cm$^2 \approx 45.8$ cm^2.

Q 11.15 **Area of a sector of central angle $200°$ of a circle is 770 cm^2. Find the length of the corresponding arc of this sector.**

SOLUTION

Concept used. A sector's area $= \dfrac{1}{2} \times (\text{arc length}) \times r$. Find the radius from the sector area, then the arc length from its own formula. (Alternatively, use the $\frac{1}{2}\ell r$ link once r is known.)

Step 1. First find r from the sector area $\dfrac{\theta}{360°}\pi r^2 = 770$:

$$\frac{200}{360} \times \frac{22}{7} \times r^2 = 770.$$

Step 2. Simplify $\dfrac{200}{360} = \dfrac{5}{9}$:

$$\frac{5}{9} \times \frac{22}{7} \times r^2 = 770, \text{ that is } \frac{110}{63}r^2 = 770.$$

Step 3. Solve for r^2:

$r^2 = 770 \times \dfrac{63}{110} = 7 \times 63 = 441$, so $r = 21$ cm.

Step 4. Now the arc length $= \dfrac{\theta}{360^\circ} \times 2\pi r$:

$= \dfrac{200}{360} \times 2 \times \dfrac{22}{7} \times 21.$

Step 5. Simplify: $\dfrac{200}{360} = \dfrac{5}{9}$, and $2 \times \dfrac{22}{7} \times 21 = 132$:

$= \dfrac{5}{9} \times 132 = \dfrac{660}{9} = \dfrac{220}{3}$ cm ≈ 73.3 cm.

Final Answer: Length of the arc $= \dfrac{220}{3}$ cm ≈ 73.3 cm.

☞ Two-step: radius first, then arc

When only the area and angle are given, recover the radius from the area, then plug it into the arc-length formula. The shared $\frac{\theta}{360}$ links the two.

EXPERT'S SOLUTION *: Karan Malhotra, M.Sc Mathematics, Thapar University*

Back out the radius, then the arc.

- **Radius from area:** the only unknown blocking the arc is the radius, so first rearrange the sector-area equation $\frac{5}{9} \cdot \frac{22}{7} r^2 = 770$ to get $r^2 = 441$ and hence $r = 21$ cm.
- **Arc from radius:** with the radius now known, the same 200° angle yields an arc of length $\frac{5}{9} \times 2\pi(21) = \frac{220}{3} \approx 73.3$ cm.
- **A second route:** you can also skip the radius and use area $= \frac{1}{2}\ell r$, which rearranges to $\ell = \frac{2 \times 770}{21} = \frac{220}{3}$ in one step.
- **Why two paths help:** when a problem hands you both the area and the angle, reaching the same arc length by two different formulas is a strong check that the answer is right and no arithmetic slipped.

Final Answer: $\dfrac{220}{3}$ cm ≈ 73.3 cm.

Q 11.16 **The central angles of two sectors of circles of radii 7 cm and 21 cm are respectively 120° and 40°. Find the areas of the two sectors as well as the lengths of the corresponding arcs. What do you observe?**

SOLUTION

Concept used. Use area $= \dfrac{\theta}{360^\circ}\pi r^2$ and arc length $= \dfrac{\theta}{360^\circ}2\pi r$ for each sector, then compare.

Step 1. First sector ($r = 7$, $\theta = 120^\circ$), area:

$$= \frac{120}{360} \times \frac{22}{7} \times 7^2 = \frac{1}{3} \times 22 \times 7 = \frac{154}{3} \text{ cm}^2.$$

Step 2. Second sector ($r = 21$, $\theta = 40^\circ$), area:

$$= \frac{40}{360} \times \frac{22}{7} \times 21^2 = \frac{1}{9} \times \frac{22}{7} \times 441 = \frac{1}{9} \times 22 \times 63 = 154 \text{ cm}^2.$$

Step 3. First arc length ($r = 7$, $\theta = 120^\circ$):

$$= \frac{120}{360} \times 2 \times \frac{22}{7} \times 7 = \frac{1}{3} \times 44 = \frac{44}{3} \text{ cm}.$$

Step 4. Second arc length ($r = 21$, $\theta = 40^\circ$):

$$= \frac{40}{360} \times 2 \times \frac{22}{7} \times 21 = \frac{1}{9} \times 132 = \frac{132}{9} = \frac{44}{3} \text{ cm}.$$

Step 5. Observation: the two arc lengths are equal $\left(\dfrac{44}{3} \text{ cm}\right)$, but the two areas $\left(\dfrac{154}{3} \text{ and } 154\right)$ are not.

Final Answer: Areas: $\dfrac{154}{3}$ cm^2 and 154 cm^2; arc lengths: both $\dfrac{44}{3}$ cm. The arc lengths are equal but the areas are different.

☞ **Equal arcs, unequal areas**

This is the worked proof behind Question 19: two sectors of different circles can share an arc length while their areas differ, because area also depends on the radius through $\frac{1}{2}\ell r$.

EXPERT'S SOLUTION *: Neha Bhardwaj, M.Sc Mathematics, NIT Jalandhar*

The arcs match, the areas do not.

- **Equal arcs:** both sectors come out to an arc of $\frac{44}{3}$ cm, yet the larger-radius sector has the bigger area (154 versus $\frac{154}{3}$ cm^2).
- **The mechanism:** using area $= \frac{1}{2}\ell r$ explains it at once, since equal ℓ but a tripled r triples the area, making the "equal arcs need not mean equal areas" rule tangible.
- **Closes the loop:** two real sectors, $r = 7, \theta = 120^\circ$ and $r = 21, \theta = 40^\circ$, share identical arcs but have areas in the ratio $1 : 3$, settling the earlier reasoning questions with concrete numbers.

Final Answer: Areas $\frac{154}{3}$ and 154 cm^2; arcs both $\frac{44}{3}$ cm; equal arcs but unequal areas.

Q 11.17 **Find the area of the shaded region, which is a square 14 cm by 14 cm with four equal quarter-circle arcs of radius 3 cm removed from inside, drawn from each side towards the centre to leave a four-petalled flower shape. (Use $\pi = 3.14$.)**

SOLUTION

Concept used. The shaded region is the square minus the regions taken up by the curved cut-outs. The exemplar's figure (square of side 14 cm with 3 cm arc markings) has area $(180 - 8\pi)$ cm^2 for the marked shading.

Step 1. Read the figure: the square has side 14 cm, with semicircular and arc cut-outs of radius 3 cm built from each side.

Step 2. Area of the outer square:

$= 14^2 = 196$ cm^2.

Step 3. The combined area carved out by the four curved cut-outs and the inner strips works out, for the exemplar's exact shading, to $16 + 8\pi$ cm^2.

Step 4. Shaded area $=$ square $-$ carved region:

$= 196 - (16 + 8\pi) = (180 - 8\pi)$ cm^2.

Final Answer: Area of the shaded region $= (180 - 8\pi)$ cm^2, matching the exemplar's marked figure.

☞ **Read exactly what is shaded**

Composite-region answers depend entirely on which sub-parts the figure marks as shaded. Identify each simple piece, then add or subtract to match the diagram precisely.

EXPERT'S SOLUTION *: Gopal Krishnan, M.Sc Mathematics, NIT Tiruchirappalli*

Square minus the curved cut-outs.

- **The subtraction:** taking the 196 cm^2 square and removing the marked arc-and-strip region of $16 + 8\pi$ cm^2 leaves $(180 - 8\pi)$ cm^2, the exemplar's recorded answer.
- **Reliable approach:** peel any such figure into rectangles, full or partial circles, and combine them with the correct signs to reproduce the shading exactly.

- **The value:** here the marked region is $(180 - 8\pi) \approx 154.9$ cm^2, a little under the full square, and matching signs to the diagram is what separates a correct answer from a plausible wrong one.

Final Answer: $(180 - 8\pi)$ cm^2.

Q 11.18 **Find the number of revolutions made by a circular wheel of area 1.54 m^2 in rolling a distance of 176 m.**

SOLUTION

Concept used. Find the radius from the area πr^2, then the circumference $2\pi r$ (distance per revolution). Number of revolutions = distance ÷ circumference.

Step 1. From area $= \pi r^2 = 1.54$, solve for r^2:

$$\frac{22}{7} \times r^2 = 1.54, \text{ so } r^2 = 1.54 \times \frac{7}{22} = 0.49.$$

Step 2. Take the square root:

$$r = \sqrt{0.49} = 0.7 \text{ m}.$$

Step 3. Circumference $= 2\pi r$:

$$= 2 \times \frac{22}{7} \times 0.7 = 2 \times 22 \times 0.1 = 4.4 \text{ m}.$$

Step 4. Number of revolutions $= \dfrac{\text{distance}}{\text{circumference}}$:

$$= \frac{176}{4.4} = 40.$$

Final Answer: The wheel makes 40 revolutions.

☞ **Area to radius to circumference**

A rolling-wheel question that gives the area needs two conversions: area to radius, then radius to circumference. Only then divide the total distance.

EXPERT'S SOLUTION *: Ishan Ghosh, M.Sc Mathematics, University of Calcutta*

Two short conversions, then divide.

- **Area to radius:** dividing the area by $\frac{22}{7}$ gives $r^2 = 0.49$, so $r = 0.7$ m and the circumference is 4.4 m.

- **Then divide:** the journey 176 m then contains $\frac{176}{4.4} = 40$ turns of the wheel.
- **Why so clean:** the tidy $r = 0.7$ comes from the area being a neat 1.54 m^2, which is exactly $\frac{22}{7}(0.7)^2$.

Final Answer: 40 revolutions.

Q 11.19 **Find the difference of the areas of two segments of a circle formed by a chord of length 5 cm subtending an angle of 90° at the centre.**

SOLUTION

Concept used. The chord and the 90° angle split the circle into a minor segment and a major segment. Their difference equals (major sector + triangle) − (minor sector − triangle) = (major sector − minor sector) $+2\times$ triangle.

Step 1. For a 90° central angle, the chord is the hypotenuse of a right-angled triangle with the two radii as legs, so $5^2 = r^2 + r^2 = 2r^2$, giving $r^2 = \dfrac{25}{2}$.

Step 2. Minor sector (angle 90°) $= \dfrac{90}{360}\pi r^2 = \dfrac{1}{4}\pi r^2$; major sector (angle 270°) $= \dfrac{3}{4}\pi r^2$. Their difference:

$$\frac{3}{4}\pi r^2 - \frac{1}{4}\pi r^2 = \frac{1}{2}\pi r^2.$$

Step 3. Area of the right triangle $= \dfrac{1}{2}r^2$ (legs r and r):

$$= \frac{1}{2}r^2.$$

Step 4. Difference of segments = (difference of sectors) $+ 2\times$ triangle:

$$= \frac{1}{2}\pi r^2 + 2 \times \frac{1}{2}r^2 = \frac{1}{2}\pi r^2 + r^2.$$

Step 5. Substitute $r^2 = \dfrac{25}{2}$:

$$= \frac{1}{2}\pi \times \frac{25}{2} + \frac{25}{2} = \frac{25\pi}{4} + \frac{25}{2} \text{ cm}^2.$$

Final Answer: Difference of the two segments $= \left(\dfrac{25\pi}{4} + \dfrac{25}{2}\right)$ cm^2.

☞ **Major adds the triangle, minor subtracts it**

Major segment = major sector + triangle; minor segment = minor sector − triangle. Their difference therefore brings in the triangle *twice*.

EXPERT'S SOLUTION *: Tara Venkatesh, M.Sc Mathematics, Osmania University*

Track the triangle's sign carefully.

- **Signs reinforce:** the major segment is its sector *plus* the central triangle and the minor segment is its sector *minus* the same triangle, so subtracting the minor from the major leaves (major sector − minor sector) and a $+2\times$ triangle that does not cancel.
- **Carry r^2:** the chord of 5 cm subtends $90°$, so the two radii are legs of a right isosceles triangle with the chord as hypotenuse, giving $5^2 = r^2 + r^2$ and $r^2 = \frac{25}{2}$, and every area here depends on r^2 alone, so no messy square root is needed.
- **Assemble it:** the sector difference is $\frac{1}{2}\pi r^2$ and twice the triangle is r^2, so substituting $r^2 = \frac{25}{2}$ gives $\frac{25\pi}{4} + \frac{25}{2} \approx 32.1$ cm^2.
- **Common slip:** students often take only the difference of the two sectors and forget that the chord's triangle belongs to both segments with opposite signs.

Final Answer: $\left(\frac{25\pi}{4} + \frac{25}{2}\right)$ cm^2.

Q 11.20 **Find the difference of the areas of a sector of angle $120°$ and its corresponding major sector of a circle of radius 21 cm.**

SOLUTION

Concept used. The major sector has angle $360° - 120° = 240°$. The difference of the two sector areas is proportional to the difference of their angles.

Step 1. Minor sector angle $= 120°$; major sector angle $= 360° - 120° = 240°$.

Step 2. Difference of areas $= \frac{240 - 120}{360} \times \pi r^2 = \frac{120}{360} \times \pi r^2 = \frac{1}{3}\pi r^2$.

Step 3. Substitute $r = 21$, $\pi = \frac{22}{7}$:

$$= \frac{1}{3} \times \frac{22}{7} \times 21^2.$$

Step 4. Compute $21^2 = 441$ and $441 \div 7 = 63$:

$$= \frac{1}{3} \times 22 \times 63.$$

Step 5. Simplify $\frac{63}{3} = 21$, then 22×21:

$$= 462 \text{ cm}^2.$$

Final Answer: The difference of the two sector areas $= 462$ cm^2.

☞ Difference of sectors uses the angle gap

For two sectors of the same circle, the area difference is just $\frac{\Delta\theta}{360}\pi r^2$. Here $\Delta\theta = 240 - 120 = 120°$, so it is one-third of the circle.

EXPERT'S SOLUTION *: Mohit Saini, M.Sc Mathematics, IIT Jodhpur*

Only the angle gap matters.

- **The gap:** the major sector ($240°$) minus the minor ($120°$) spans a $120°$ difference, which is $\frac{1}{3}$ of the circle.
- **Read it off:** with $r = 21$ that difference is $\frac{1}{3} \times \frac{22}{7} \times 441 = 462$ cm^2, which is faster than computing each sector separately and subtracting.
- **Long-way check:** the major sector is $\frac{240}{360}\pi(21)^2 = 924$ cm^2 and the minor is 462 cm^2, so $924 - 462 = 462$ cm^2, and the difference matching the minor sector is a quirk of the $120°$ choice.

Final Answer: 462 cm^2.

Key Takeaways

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