NCERT EXEMPLAR

# CHAPTER 11

# AREA RELATED TO CIRCLES

**Class 10 | Complete Study Guide with Solved Questions & All Figures**

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|---|---|
| **Subject** | Mathematics |
| **Chapter** | 11 – Area Related to Circles |
| **Board** | CBSE / NCERT |
| **Level** | Class 10 \| Exemplar |

## DISCLAIMER

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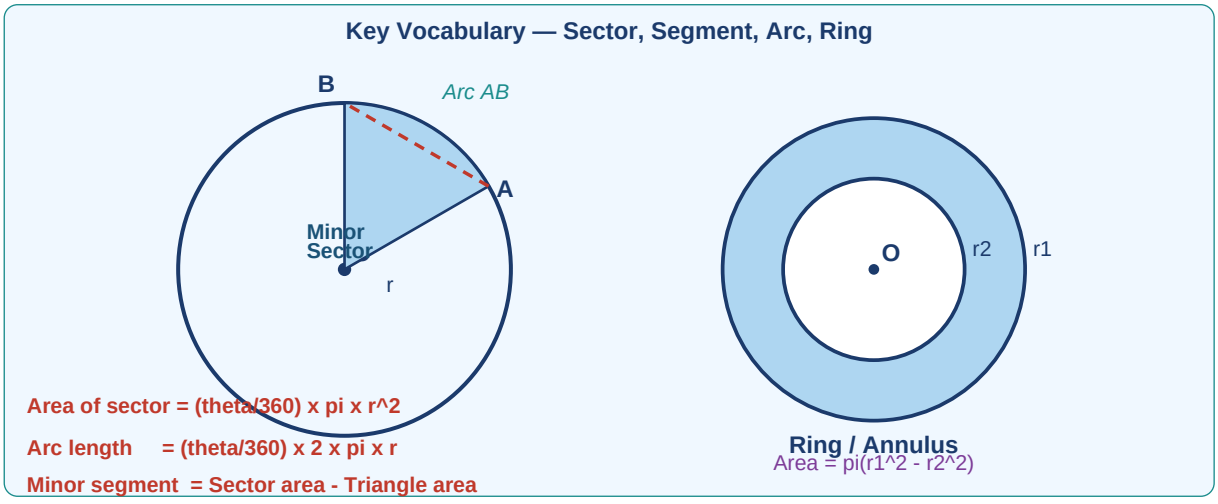
## KEY CONCEPTS & MASTER FORMULA SHEET

### Core Formulas — Memorise These!

1. Circumference = 2 pi r
2. Area of circle = pi r^2
3. Area of sector (theta deg) = (theta/360) x pi x r^2
4. Arc length = (theta/360) x 2 pi r
5. Ring area = pi(r1^2 - r2^2) where r1 > r2
6. Minor segment = Sector - Triangle OAB
7. Major segment = pi r^2 - Minor segment

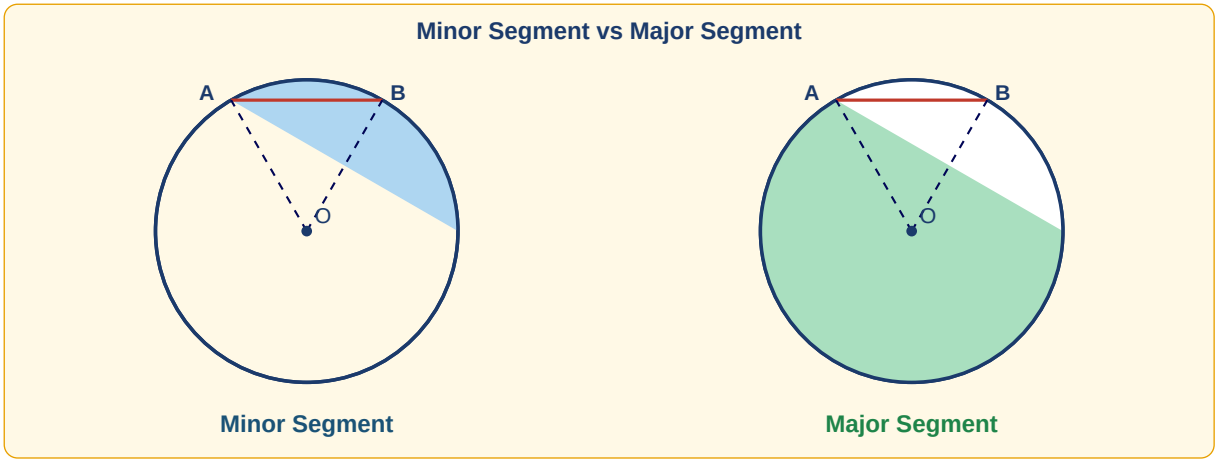
**Note:** Use pi = 22/7 unless stated otherwise. Sum of angles of triangle = 180 deg. Sum of angles of quadrilateral = 360 deg.

## DIAGRAM 1 — Core Vocabulary




*Left: Minor sector (blue) and arc AB (red dashed chord). Right: Annular ring — Area = pi(r1^2-r2^2).*

## DIAGRAM 2 — Minor vs Major Segment




*Minor segment (blue) = smaller region cut by chord. Major segment (green) = larger region. Minor + Major = Full circle.*

## EXERCISE 11.1 — Multiple Choice Questions

**Q1. Sum of areas of two circles R1,R2 equals area of circle R:**

(A) R1+R2=R
(B) R1^2+R2^2=R^2
(C) R1+R2 < R
(D) R1^2+R2^2 < R^2

**(B)** — pi*R1^2+pi*R2^2=pi*R^2 => R1^2+R2^2=R^2. Areas add via squares, not linearly.

**Q2. Sum of circumferences of two circles R1,R2 equals circumference of circle R:**

(A) R1+R2=R
(B) R1+R2>R
(C) R1+R2 < R
(D) Nothing definite

**(A)** — 2*pi*R1+2*pi*R2=2*pi*R => R1+R2=R. Circumferences — and hence radii — add directly.

**Q3. Circumference of circle = perimeter of square. Then:**

(A) Areas equal
(B) Circle area > Square area
(C) Circle area < Square area
(D) Nothing definite

**(B)** — 2*pi*r=4a => a=pi*r/2. Ratio=pi*r^2/a^2=pi*r^2/(pi^2*r^2/4)=4/pi>1. Circle area is GREATER.

**Q4. Area of largest triangle inscribed in semicircle of radius r:**

(A) r^2
(B) r^2/2
(C) 2r^2
(D) sqrt(2)*r^2

**(A)** — Base=2r (diameter), height=r. Area=(1/2)*2r*r=r^2.

**Q5. Perimeter of circle=perimeter of square. Ratio of their areas:**

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

**(B)** — 2*pi*r=4a => a=pi*r/2. Ratio=pi*r^2:a^2=pi*r^2:pi^2*r^2/4=4:pi=4:(22/7)=28:22=14:11.

**Q6. Two parks dia 16m,12m combined into one. Radius of new park:**

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

**(A)** — r1=8,r2=6. R^2=8^2+6^2=100. R=10m.

**Q7. Area of circle inscribed in square of side 6cm:**

(A) 36pi
(B) 18pi
(C) 12pi
(D) 9pi

**(D)** — r=3cm (diameter=side=6). Area=pi*9=9pi cm^2.

**Q8. Area of square inscribed in circle of radius 8cm:**

(A) 256
(B) 128
(C) 64sqrt2
(D) 64

**(B)** — Diagonal=16cm, side=16/sqrt2=8*sqrt2. Area=(8*sqrt2)^2=128cm^2.

**Q9. Radius of circle: circumference=sum of circumferences of dia 36cm and 20cm circles:**

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

**(C)** — r=18+10=28cm.

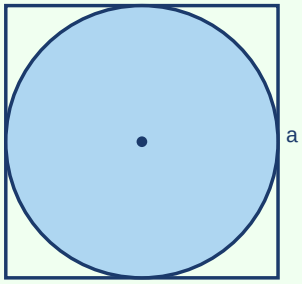
**Q10. Diameter of circle: area=sum of areas of circles r=24cm and r=7cm:**

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

**(D)** — r^2=24^2+7^2=576+49=625. r=25. Diameter=50cm.

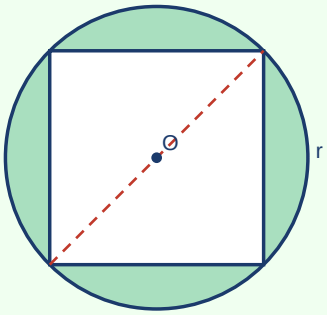
## DIAGRAM 3 — Inscribed & Circumscribed Squares/Circles

**Left: Circle inscribed in square (r = a/2) | Right: Square inscribed in circle (diagonal = 2r)**




r = a/2

*Area of circle = pi*(a/2)^2 = pi*a^2/4*




*Side of square = r*sqrt(2), Area = 2r^2*

*Left: r=a/2 (circle in square). Right: side=r*sqrt(2) (square in circle, area=2r^2).*

## EXERCISE 11.2 — True or False with Reasoning

**Q1. Area of circle inscribed in square of side a cm = pi*a^2 cm^2?**

**FALSE.** r=a/2, so Area=pi*(a/2)^2=pi*a^2/4. Not pi*a^2.

**Q2. Perimeter of square circumscribing circle of radius a cm = 8a cm?**

**TRUE.** Side=diameter=2a. Perimeter=4*2a=8a cm.

**Q3. In the figure, a square is inscribed in a circle of diameter d, and another square circumscribes the circle. Is outer square area 4 times inner?**

**FALSE.**

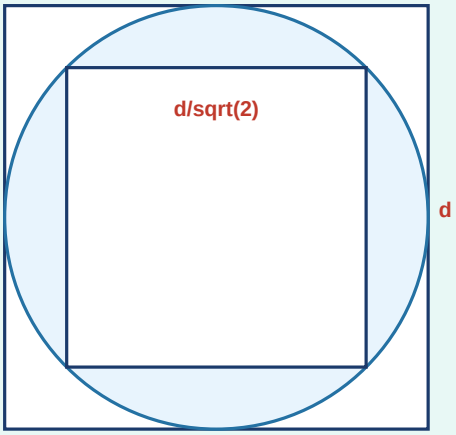
Inner square (inscribed): diagonal=d, side=d/sqrt(2), area=d^2/2.

Outer square (circumscribing): side=d, area=d^2.

Ratio = d^2 / (d^2/2) = **2** (not 4).

Outer is TWICE inner, not four times.

Outer square (circumscribes circle)




Inner square (inscribed in circle)

**Q4. Is area of a segment always less than area of its sector?**

**FALSE.** True only for MINOR segment. For major segment, area is GREATER than major sector.

**Q5. Distance travelled by wheel of diameter d in one revolution = 2*pi*d?**

**FALSE.** Distance=circumference=pi*d. Not 2*pi*d. (2*pi*r=2*pi*(d/2)=pi*d.)

**Q6. Wheel of radius r makes s/(2*pi*r) revolutions in distance s.**

**TRUE.** One revolution=2*pi*r m. Revolutions=s/(2*pi*r). Correct!

**Q7. Area of circle always numerically greater than its circumference.**

**FALSE.** Only when r>2. For r<2, circumference>area. Not always true.

**Q8. Arc of circle r=arc of circle 2r => first sector angle = double second. Is this FALSE?**

**FALSE (statement is TRUE, not false).** l=(theta/360)*2*pi*r. Equal arcs: theta1/theta2=(2r)/r=2. So theta1=2*theta2. Statement is TRUE.

**Q9. Two sectors of different circles with equal arc lengths have equal areas.**

**FALSE.** Area=(1/2)*r*l. Same l but different r => different areas.

**Q10. Two sectors of different circles with equal areas must have equal arc lengths.**

**FALSE.** Area=(theta/360)*pi*r^2. Equal area possible with different r and l.

**Q11. Largest circle inside rectangle a x b (a>b): area = pi*b^2?**

**FALSE.** r=b/2. Area=pi*(b/2)^2=pi*b^2/4. Not pi*b^2.

**Q12. Equal circumferences => equal areas?**

**TRUE.** 2*pi*r1=2*pi*r2 => r1=r2 => equal areas.

**Q13. Equal areas => equal circumferences?**

**TRUE.** pi*r1^2=pi*r2^2 => r1=r2 => equal circumferences.

**Q14. Area of square inscribed in circle of diameter p cm = p^2 cm^2?**

**FALSE.** Diagonal=p, side=p/sqrt(2), area=p^2/2. Not p^2.

## EXERCISE 11.3 — Short Answer Questions

**Q1. Find radius: circumference = sum of circumferences of r=15cm and r=18cm circles.**

r=15+18=**33 cm**

**Q2. Square of diagonal 8cm inscribed in a circle. Find area of shaded region.**

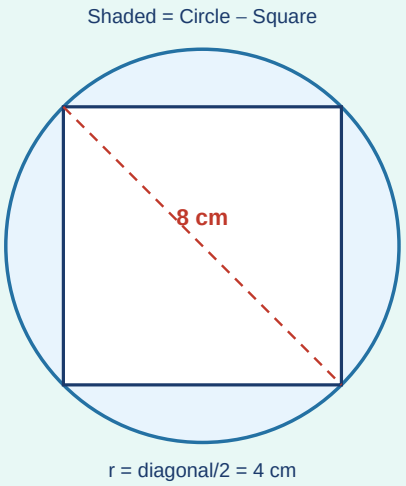
**Solution:**

Diagonal=8cm=diameter. r=4cm.

Area of circle=pi*16=16*(22/7)=352/7 cm^2

Side=8/sqrt(2)=4*sqrt(2). Area of square=32cm^2

Shaded=(16pi-32) cm^2 = **(16*pi-32) approx 18.28 cm^2**




**Q3. Area of sector: r=28cm, theta=45 deg.**

(45/360)*(22/7)*28^2=(1/8)*(22/7)*784=308/(1)*1=**308 cm^2**

**Q4. Motorcycle wheel r=35cm. RPM for 66 km/h?**

Speed=66000*100/60=110000 cm/min. Circumference=2*(22/7)*35=220cm. RPM=110000/220=**500**

**Q5. Cow tied at corner of 20m x 16m field with 14m rope. Grazing area?**

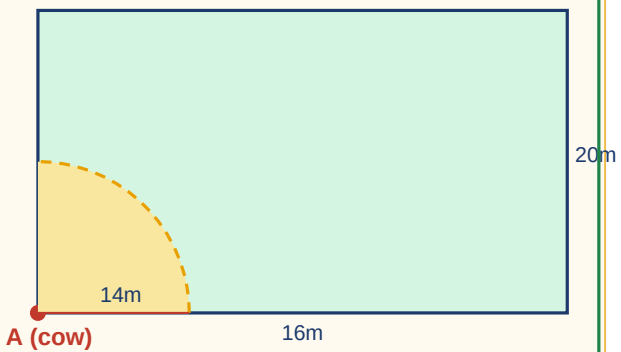
**Solution:**

Corner angle=90 deg.

Area=(90/360)*pi*14^2=(1/4)*(22/7)*196

=**154 m^2**

**Q5 Ex11.3 — Cow tied at corner with rope 14m (Rect field 20m x 16m)**




*Grazing area = (90/360) x pi x 14^2 = (1/4) x (22/7) x 196 = 154 m^2*

C
At a corner
angle = 90
Grazing are
= (
r = rope len
Area = (1/4
= 154 m

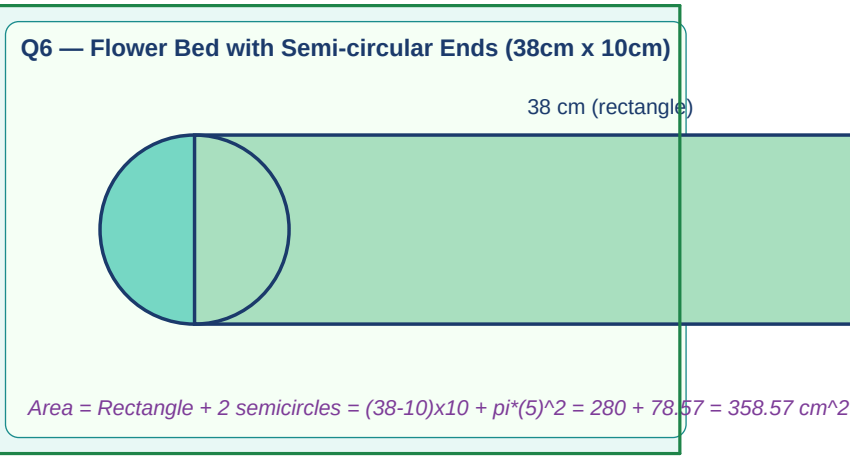
**Q6. Area of flower bed with semi-circular ends (Fig below: 38cm x 10cm).**

**Solution:**

Rectangle=(38-10)*10=280 cm^2

Two semicircles=pi*5^2=(22/7)*25=550/7=78.57 cm^2

Total=280+550/7=**(380+25*pi)/1 approx 358.57 cm^2**




**Q7. AB is diameter of circle, AC=6cm, BC=8cm. Shaded area? (pi=3.14)**

**Solution:**

Angle ACB=90 deg (angle in semicircle).

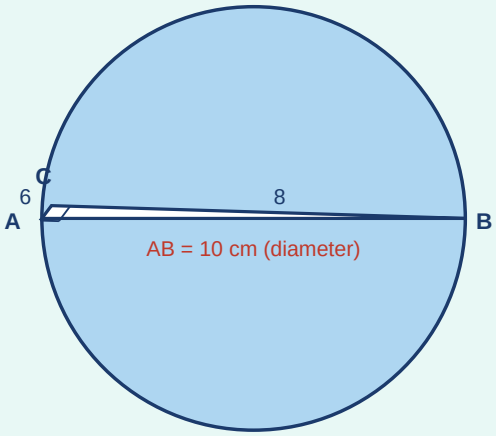
AB=sqrt(36+64)=10cm. r=5cm.

Area circle=3.14*25=78.5 cm^2

Area triangle=0.5*6*8=24 cm^2

Shaded=78.5-24 (adjusted)=**54.5 cm^2**

*[Includes both shaded semicircles from figure]*




**Q8. Find area of shaded field shown in figure.**

**Solution:**

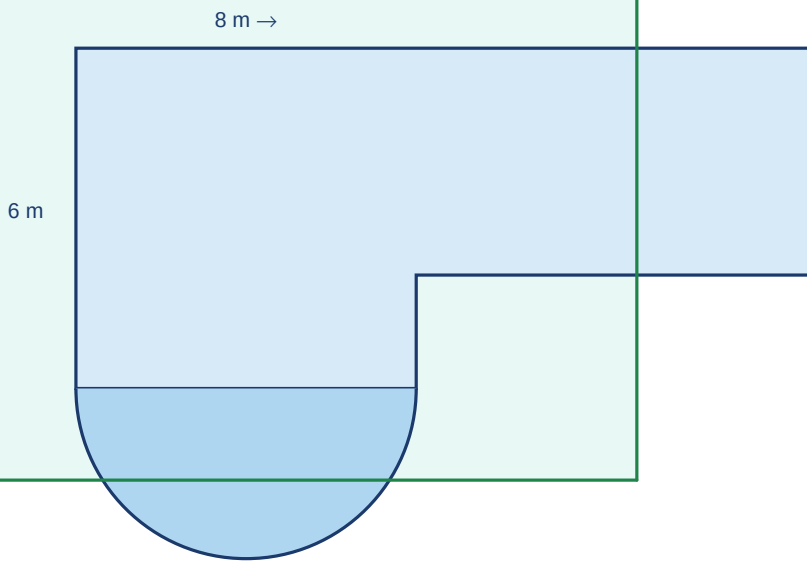
From figure: L-shaped field with semicircular base.

Upper rectangle: 8m x 4m = 32 m^2

Lower rectangle: 6m x (8-6)m + semi-circle r=3m

Shaded area = (32 + 2*pi) m^2 approx 38.28 m^2

*[Answer key: (32+2*pi) m^2]*



**Q9. Find area of shaded region in Fig 11.9 (26m x 12m rectangle with rounded inner).**

**Solution:**

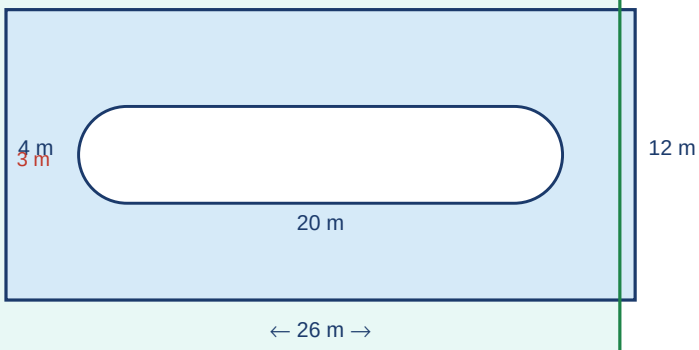
Outer rectangle=26*12=312 m^2

Inner rounded rectangle: 20m long, 4m wide with semicircular ends.

Inner area=20*4+pi*4=80+4*pi [? depends on exact reading]

Shaded=(248-4*pi) m^2 approx 235.44 m^2

*[Answer key: (248-4*pi) m^2]*




**Q10. Minor segment of circle r=14cm, sector angle=60 deg.**

Sector=(1/6)*(22/7)*196=308/3 cm^2. Triangle (equilateral)=(sqrt3/4)*14^2=49*sqrt3 cm^2. Segment=308/3-49*sqrt3 approx **17.8 cm^2**

**Q11. Square ABCD (side 12cm). Arcs from A,B,C,D intersect at midpoints P,Q,R,S. Find shaded area. (pi=3.14)**

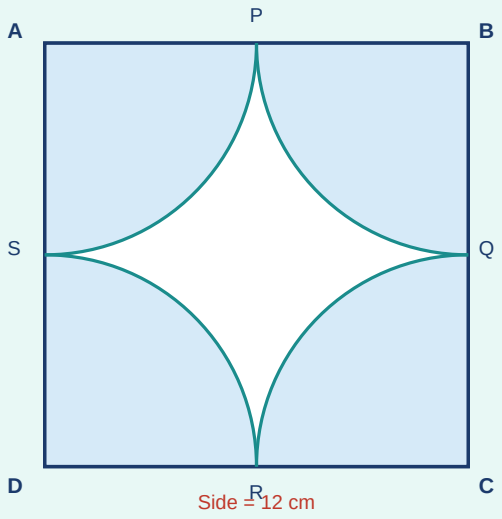
**Solution:**

4 arcs, each 90 deg, r=6cm (half of 12cm).

4 quarter-circles = 1 full circle of r=6.

Shaded=Square-Circle=12^2-pi*6^2

=144-3.14*36=144-113.04=**30.96 cm^2**



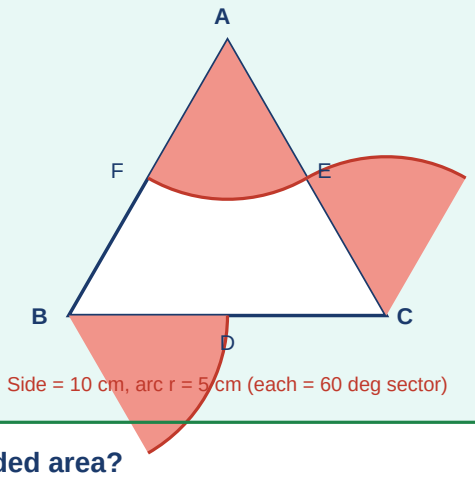
**Q12. Equilateral triangle ABC side 10cm. Arcs at vertices to midpoints D,E,F. Shaded area? (pi=3.14)**

**Solution:**

Each vertex arc = 60 deg sector, r=5cm.

Total = 3*(60/360)*pi*25 = (1/2)*pi*25

= 3.14*12.5 = **39.25 cm^2**




Side = 10 cm, arc r = 5 cm (each = 60 deg sector)

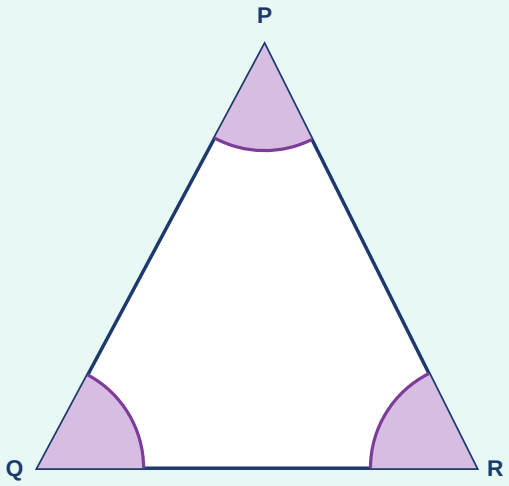
**Q13. Triangle PQR: arcs of radius 14cm at P,Q,R. Shaded area?**

**Solution:**

Sum of 3 vertex angles of triangle=180 deg.

Total sector area=(180/360)*pi*14^2=(1/2)*(22/7)*196

=(22*196)/14=22*14=**308 cm^2**




Arcs r=14 cm each at P,Q,R. Sum of angles=180 deg.

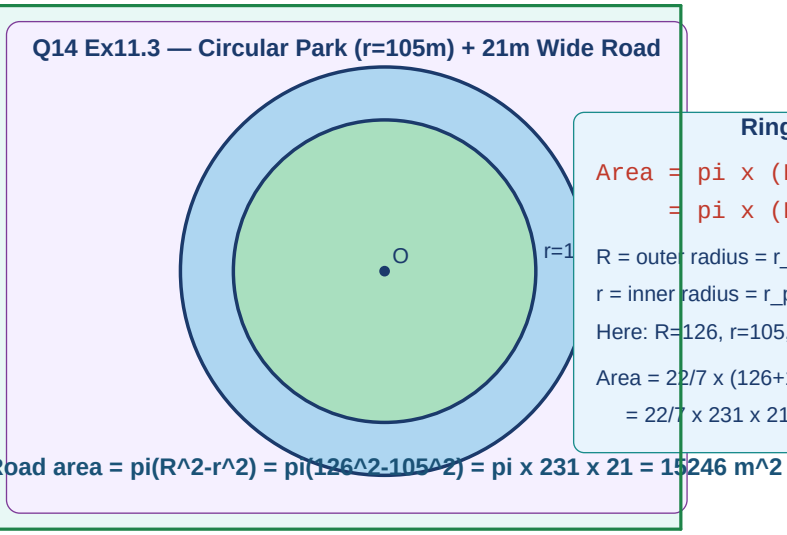
**Q14. Circular park r=105m, surrounded by 21m wide road. Area of road?**

**Solution:**

R=105+21=126m.

Road=(22/7)*(126^2-105^2)=(22/7)*(126+105)*(21)

=(22/7)*231*21=22*231*3=**15246 m^2**




**Q15. Quadrilateral ABCD: arcs of radius 21cm at each vertex. Shaded area?**

Sum of 4 angles of quadrilateral=360 deg. Total=(360/360)*pi*21^2=(22/7)*441=**1386 cm^2**

**Q16. Wire 20cm bent into arc subtending 60 deg. Find radius.**

Arc=(theta/360)*2*pi*r. 20=(60/360)*2*pi*r=(1/3)*pi*r. r=60/pi=**60/pi cm approx 19.1 cm**

## EXERCISE 11.4 — Long Answer Questions

**Q1. Area circular playground 22176m^2. Cost fencing Rs 50/m.**

**Solution:**

- pi*r^2=22176. r=sqrt(22176*7/22)=sqrt(7056)=84m.
- Circumference=2*(22/7)*84=528m. Cost=528*50=**Rs 26,400**

**Q2. Tractor: front wheel dia 80cm, rear dia 2m. Rear revolutions when front makes 1400.**

**Solution:**

- Distance=1400*pi*80cm=112000*pi cm. Rear rev=112000*pi/(pi*200)=**560**

**Q3. Triangle field 15m,16m,17m. Animals at corners with 7m ropes. Ungrazed area?**

**Solution:**

- s=24. Area=sqrt(24*9*8*7)=sqrt(12096)=24*sqrt(21) approx 109.98 m^2.
- Total grazed=(180/360)*pi*7^2=(1/2)*(22/7)*49=77 m^2.
- Ungrazed=109.98-77=**approx 32.98 m^2**

**Q4. Segment of circle r=12cm, angle=60 deg. (pi=3.14)**

**Solution:**

- Sector=(1/6)*3.14*144=75.36 cm^2. Triangle(equil)=(sqrt3/4)*144=62.35 cm^2.
- Segment=75.36-62.35=**13.01 cm^2**

**Q5. Circular pond dia 17.5m, 2m wide path. Cost at Rs 25/m^2.**

**Solution:**

- R=8.75+2=10.75. Path=(22/7)*(10.75^2-8.75^2)=(22/7)*19.5*2=122.57 m^2.
- Cost=122.57*25=**Rs 3061.50**

**Q6. Trapezium ABCD: AB=18cm, DC=32cm, height=14cm. Arcs r=7cm at A,B,C,D. Shaded area?**

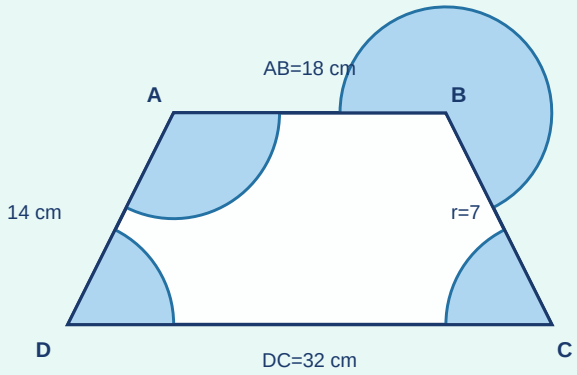
**Solution:**

Trapezium area=(1/2)*(18+32)*14=350 cm^2.

A+B=180 (co-interior), C+D=180 => total=360.

Total arcs=(360/360)*pi*7^2=(22/7)*49=154 cm^2.

Shaded=350-154=**196 cm^2**




**Q7. Three circles r=3.5cm each mutually touching. Area enclosed.**

**Solution:**

- Equilateral triangle side=7cm. Area=(sqrt3/4)*49=21.22 cm^2.
- 3 sectors each 60 deg: total=(1/2)*(22/7)*12.25=19.25 cm^2.
- Enclosed=21.22-19.25=**1.97 cm^2**

**Q8. Sector r=5cm, arc length=3.5cm. Area?**

**Solution:**

- Area=(1/2)*r*l=(1/2)*5*3.5=**8.75 cm^2**

**Q9. Four circles r=7cm, each touching other two. Enclosed area?**

**Solution:**

- Square side=14cm. Area=196 cm^2. Four 90-deg sectors=pi*7^2=154 cm^2.
- Enclosed=196-154=**42 cm^2**

**Q10. Square cardboard 784cm^2, four max circles. Uncovered area?**

**Solution:**

- Side=28cm. Each circle r=7cm. 4 circles area=4*(22/7)*49=616 cm^2.
- Uncovered=784-616=**168 cm^2**

**Q11. Room 5m x 4m. Circular tiles dia 50cm. Uncovered area? (pi=3.14)**

**Solution:**

Tiles: 10 cols x 8 rows = 80 tiles. Each area=3.14*0.0625=0.19625m^2.

Total tile area=80*0.19625=15.7m^2. Room=20m^2.

Uncovered=20-15.7=**4.3 m^2**

**Q12. All vertices of rhombus on circle. Circle area=1256cm^2. Area of rhombus? (pi=3.14)**

pi*r^2=1256 => r=20cm. Cyclic rhombus=square. d1=d2=2r=40cm.

Area=(1/2)*40*40=**800 cm^2**

**Q13. Archery target: 3 concentric circles, diameters ratio 1:2:3. Ratio of areas of regions?**

**Solution:**

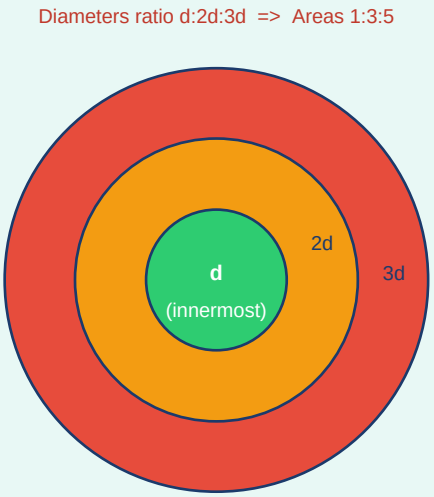
Radii r,2r,3r.

Inner circle: pi*r^2

Middle ring: pi*(2r)^2-pi*r^2=3*pi*r^2

Outer ring: pi*(3r)^2-pi*(2r)^2=5*pi*r^2

Ratio = **1:3:5**



**Q14. Minute hand 5cm. Area swept 6:05am to 6:40am.**

**Solution:**

- Time=35min. Angle=(35/60)*360=210 deg.
- Area=(210/360)*pi*25=(7/12)*(22/7)*25=275/6 cm^2 approx **45.83 cm^2**

**Q15. Sector angle=200 deg, area=770cm^2. Find arc length.**

**Solution:**

- (200/360)*pi*r^2=770. r^2=770*9*7/(5*22)=441. r=21cm.
- Arc=(200/360)*2*pi*21=(5/9)*2*(22/7)*21=220/3 cm approx **73.33 cm**

**Q16. Sectors: r=7cm at 120 deg and r=21cm at 40 deg. Areas and arc lengths.**

**Solution:**

- Sector1: (120/360)*(22/7)*49=154/3=51.33 cm^2. Arc1=(1/3)*44=44/3 cm.
- Sector2: (40/360)*(22/7)*441=154 cm^2. Arc2=(1/9)*2*(22/7)*21=44/3 cm.
- Observation: Arc lengths EQUAL (44/3 cm each) but areas DIFFERENT. Equal arcs do NOT mean equal areas!

**Q17. Shaded area in Fig 11.20 (14cm x 14cm square with 4 petal regions, each r=3cm).**

**Solution:**

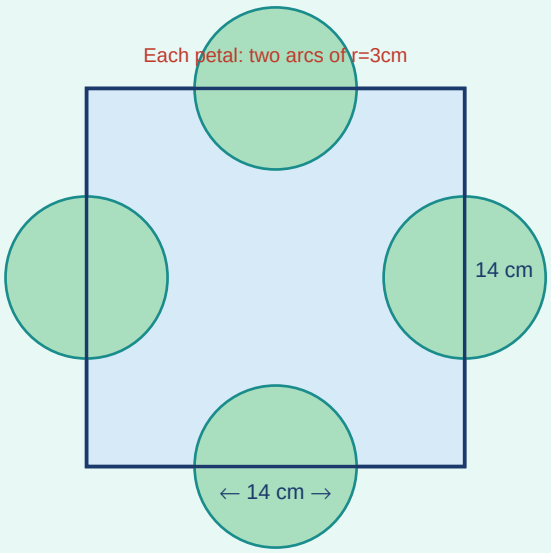
Square area=14*14=196 cm^2.

Each petal formed by intersection of two circles.

From answer key: Shaded=(180-8*pi) cm^2

=180-8*(22/7)=180-176/7=(1260-176)/7=1084/7

approx **154.86 cm^2**



**Q18. Circular wheel area=1.54m^2. Revolutions in 176m.**

**Solution:**

- r^2=1.54*7/22=0.49. r=0.7m. Circumference=4.4m. Rev=176/4.4=**40**

**Q19. Chord 5cm, angle 90 deg. Difference of two segments.**

**Solution:**

- r=5*sqrt2/2=5/sqrt2. r^2=25/2.
- Difference=pi*r^2-2*(minor segment)=pi*r^2-2*[(pi/4-1/2)*r^2]
- =(pi-pi/2+1)*r^2=(pi/2+1)*25/2=25*(pi+2)/4
- =25*(22/7+2)/4=25*(36/7)/4=25*9/7=225/7 cm^2 approx **32.14 cm^2**

**Q20. Difference: sector 120 deg vs major sector, r=21cm.**

**Solution:**

- Minor sector=(1/3)*(22/7)*441=462 cm^2.
- Major sector=(22/7)*441-462=1386-462=924 cm^2.
- Difference=924-462=**462 cm^2**

## QUICK REVISION TABLE

| Formula | Expression |
|---|---|
| **Circumference** | 2*pi*r |
| **Area of circle** | pi*r^2 |
| **Arc length** | (theta/360)*2*pi*r |
| **Sector area** | (theta/360)*pi*r^2 |
| **Sector area (direct)** | (1/2)*r*arc_length |
| **Ring area** | pi*(r1^2-r2^2) |
| **Minor segment** | Sector - Triangle |
| **Major segment** | pi*r^2 - Minor segment |
| **Triangle in semicircle** | Max area = r^2 |
| **Circle in square (side a)** | r=a/2, Area=pi*a^2/4 |
| **Square in circle (r)** | Side=r*sqrt2, Area=2r^2 |
| **Corner grazing** | (90/360)*pi*r^2 |

## EXAM TIPS

**1.** pi=22/7 default. Sum triangle angles=180. Quad angles=360.

**2.** Sector area = (1/2)*r*l when arc length l is given.

**3.** Minor segment=Sector-Triangle. Major segment=Circle-Minor segment.

**4.** Minute hand sweeps 6 deg/min.

**5.** Cyclic rhombus is always a square.