



MATHEMATICS • CLASS 12

6

CHAPTER

# Applications of Derivatives

NCERT SOLUTIONS

## AREA RATE WITH RESPECT TO RADIUS – EXERCISE 6.1 Q1

Q. Find the rate of change of a circle's area with respect to radius  $r$  at (a)  $r = 3$  cm and (b)  $r = 4$  cm.

Answer:

The area of a circle of radius  $r$  is

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

Differentiate  $A$  with respect to  $r$  using the power rule:

$$\frac{dA}{dr} = 2\pi r.$$

This gives the rate of change of the area with respect to the radius  $r$ .

(a) At  $r = 3$  cm, the rate of change is

$$\left. \frac{dA}{dr} \right|_{r=3} = 2\pi(3) = 6\pi \text{ cm}.$$

(b) At  $r = 4$  cm, the rate of change is

$$\left. \frac{dA}{dr} \right|_{r=4} = 2\pi(4) = 8\pi \text{ cm}.$$

The unit of  $\frac{dA}{dr}$  is  $\text{cm}^2$  per cm, which is equivalent to cm.

Hence, (a)  $6\pi$  cm; (b)  $8\pi$  cm.

## CUBE SURFACE AREA FROM VOLUME RATE – EXERCISE 6.1 Q2

Q. A cube's volume grows at  $8 \text{ cm}^3/\text{s}$ . How fast does its surface area grow when its edge is  $12 \text{ cm}$ ?

Answer:

Let the edge of the cube be  $a$ . Then its volume and surface area are

$$V = a^3 \quad \text{and} \quad S = 6a^2.$$

Differentiate both with respect to time  $t$ .

$$\frac{dV}{dt} = 3a^2 \frac{da}{dt} \quad \text{and} \quad \frac{dS}{dt} = 12a \frac{da}{dt}.$$

We are given that the volume is increasing at  $8 \text{ cm}^3/\text{s}$ , so

$$\frac{dV}{dt} = 3a^2 \frac{da}{dt} = 8.$$

When  $a = 12 \text{ cm}$ , we get  $\frac{da}{dt} = \frac{8}{3 \times 12^2} = \frac{8}{3 \times 144} = \frac{1}{54} \text{ cm/s}$ .

Now, the rate of change of the surface area is  $\frac{dS}{dt} = 12a \frac{da}{dt}$ .

At  $a = 12 \text{ cm}$ , substitute  $\frac{da}{dt} = \frac{1}{54}$  to get  $\frac{dS}{dt} = 12 \times 12 \times \frac{1}{54} = \frac{144}{54} = \frac{8}{3} \text{ cm}^2/\text{s}$ .

Hence, Surface area increases at  $\frac{8}{3} \text{ cm}^2/\text{s}$ .

## EXPANDING CIRCLE AREA – EXERCISE 6.1 Q3

Q. A circle's radius grows at 3 cm/s. Find the area growth rate when  $r = 10$  cm.

Answer:

Let  $r$  be the radius of the circle at time  $t$  and  $A$  be the area of the circle at time  $t$ .

The area of a circle is given by

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

Differentiate both sides with respect to time  $t$ . Using the chain rule, we get

$$\frac{dA}{dt} = 2\pi r \cdot \frac{dr}{dt}.$$

We are given that the radius grows at 3 cm/s, so

$$\frac{dr}{dt} = 3 \text{ cm/s}.$$

At the instant when  $r = 10$  cm, substitute  $r = 10$  and  $\frac{dr}{dt} = 3$  in the above formula:

$$\begin{aligned}\frac{dA}{dt} &= 2\pi \times 10 \times 3 \\ &= 60\pi \text{ cm}^2/\text{s}.\end{aligned}$$

Hence,  $\frac{dA}{dt} = 60\pi \text{ cm}^2/\text{s}.$

## CUBE VOLUME GROWTH – EXERCISE 6.1 Q4

Q. A cube's edge grows at 3 cm/s. How fast is its volume growing when the edge is 10 cm?

Answer:

If the edge of the cube is  $a$ , its volume is given by

$$V = a^3.$$

Differentiating both sides with respect to time  $t$  and using the chain rule, we get

$$\frac{dV}{dt} = 3a^2 \frac{da}{dt}.$$

It is given that the edge grows at 3 cm/s, so

$$\frac{da}{dt} = 3.$$

When the edge is 10 cm, i.e.  $a = 10$ , the rate of change of volume is

$$\begin{aligned}\frac{dV}{dt} &= 3(10)^2(3) = 3 \times 100 \times 3 \\ &= 900.\end{aligned}$$

Hence, Volume increases at 900 cm<sup>3</sup>/s.

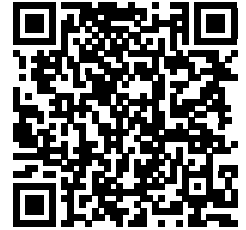


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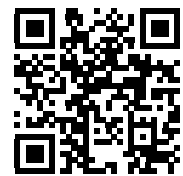


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