



Differentiation: Connected Rates of Change - Edexcel Past Exam Questions

1. The volume of a spherical balloon of radius r cm is V cm³, where $V = \frac{4}{3} \pi r^3$.

(a) Find $\frac{dV}{dr}$. (1)

The volume of the balloon increases with time t seconds according to the formula

$$\frac{dV}{dt} = \frac{1000}{(2t+1)^2}, \quad t \geq 0.$$

(b) Using the chain rule, or otherwise, find an expression in terms of r and t for $\frac{dr}{dt}$. (2)

Jan 06 Q7 (edited)

3. At time t seconds the length of the side of a cube is x cm, the surface area of the cube is S cm², and the volume of the cube is V cm³.

The surface area of the cube is increasing at a constant rate of 8 cm² s⁻¹.

Show that

(a) $\frac{dx}{dt} = \frac{k}{x}$, where k is a constant to be found, (4)

(b) $\frac{dV}{dt} = 2V^{\frac{1}{3}}$. (4)

June 06 Q7 (edited)

4.

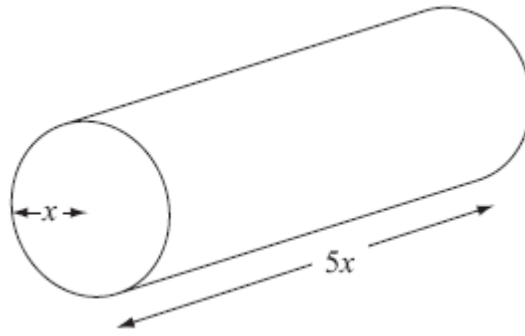
**Figure 2**

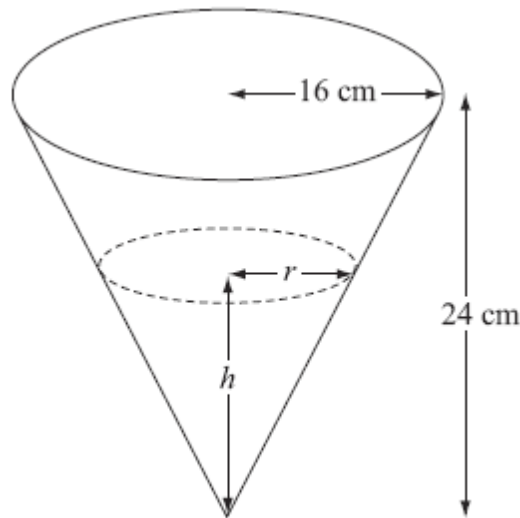
Figure 2 shows a right circular cylindrical metal rod which is expanding as it is heated. After t seconds the radius of the rod is x cm and the length of the rod is $5x$ cm.

The cross-sectional area of the rod is increasing at the constant rate of $0.032 \text{ cm}^2 \text{ s}^{-1}$.

- (a) Find $\frac{dx}{dt}$ when the radius of the rod is 2 cm, giving your answer to 3 significant figures. (4)
- (b) Find the rate of increase of the volume of the rod when $x = 2$. (4)

June 08 Q3

5.


Figure 2

A container is made in the shape of a hollow inverted right circular cone. The height of the container is 24 cm and the radius is 16 cm, as shown in Figure 2. Water is flowing into the container. When the height of water is h cm, the surface of the water has radius r cm and the volume of water is V cm³.

(a) Show that $V = \frac{4\pi h^3}{27}$. (2)

[The volume V of a right circular cone with vertical height h and base radius r is given by the formula $V = \frac{1}{3} \pi r^2 h$.]

Water flows into the container at a rate of $8 \text{ cm}^3 \text{ s}^{-1}$.

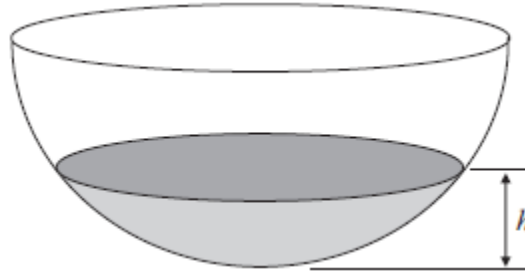
(b) Find, in terms of π , the rate of change of h when $h = 12$. (5)

Jan 09 Q5

6. The area A of a circle is increasing at a constant rate of $1.5 \text{ cm}^2 \text{ s}^{-1}$. Find, to 3 significant figures, the rate at which the radius r of the circle is increasing when the area of the circle is 2 cm^2 . (5)

Jan 10 Q6

7.

**Figure 1**

A hollow hemispherical bowl is shown in Figure 1. Water is flowing into the bowl.

When the depth of the water is h m, the volume V m³ is given by

$$V = \frac{1}{12} \pi h^2 (3 - 4h), \quad 0 \leq h \leq 0.25.$$

(a) Find, in terms of π , $\frac{dV}{dh}$ when $h = 0.1$. (4)

Water flows into the bowl at a rate of $\frac{\pi}{800}$ m³ s⁻¹.

(b) Find the rate of change of h , in m s⁻¹, when $h = 0.1$. (2)

June 11 Q3