A Level · Edexcel · Further Maths

30 mins 3 questions

5.1 Volumes of Revolution

5.1.1 Volumes of Revolution / 5.1.2 Modelling with Volumes of Revolution

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Total Marks **/30**

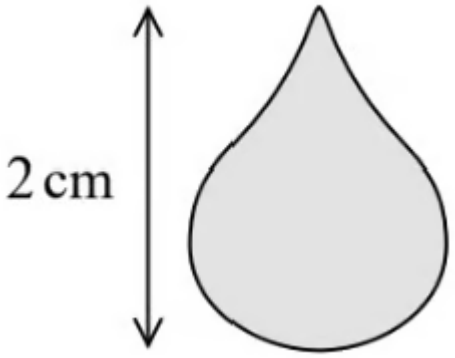

Figure 1

1 (a) Figure 1 shows the image of a gold pendant which has height 2cm. The pendant is modelled by a solid of revolution of a curve C about the y-axis. The curve C has parametric equations

$$x = \cos\theta + \frac{1}{2}\sin 2\theta,\ y = -(1+\sin\theta) \qquad 0 \leq \theta \leq 2\pi$$

(a) Show that a Cartesian equation of the curve C is

$$x^2 = -(y^4 + 2y^3)$$

(4 marks)

(b) (b) Hence, using the model, find, in cm^3, the volume of the pendant.

(4 marks)

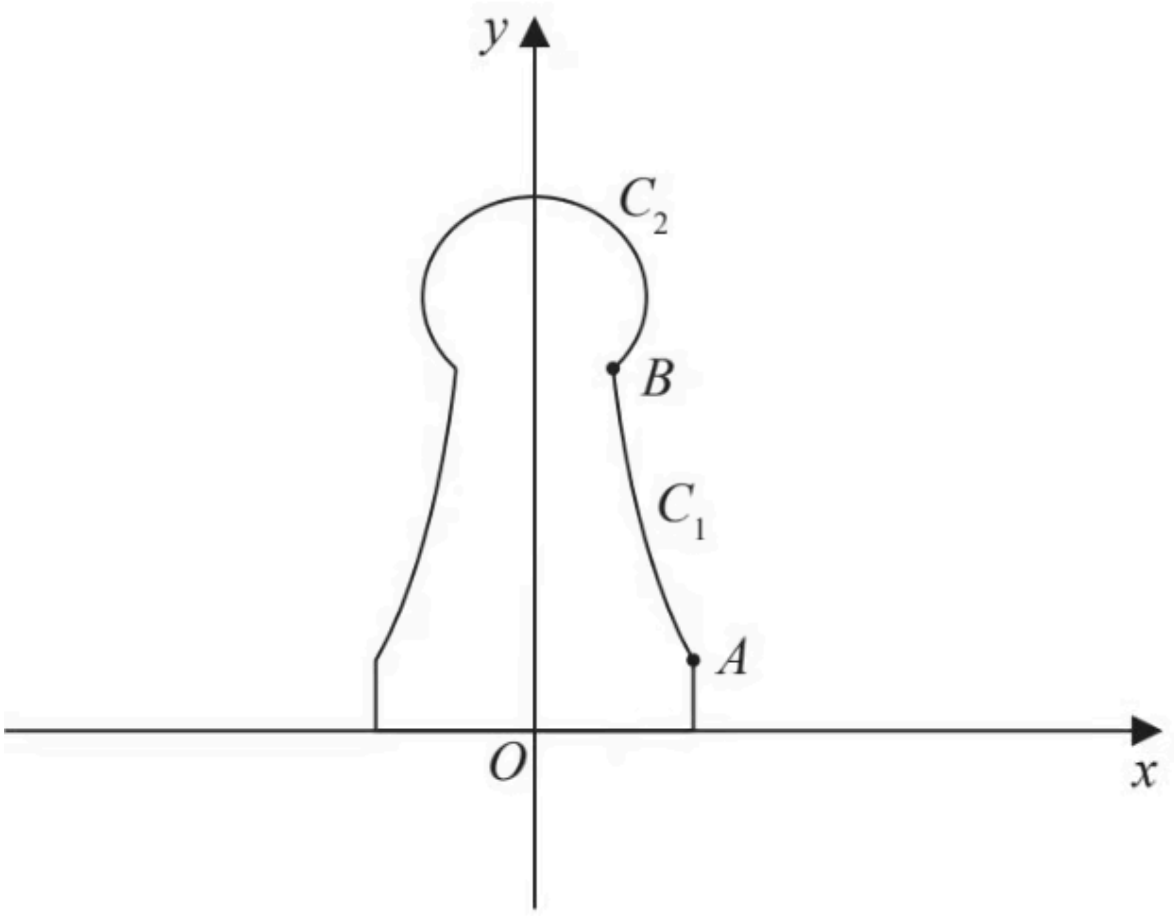

Figure 1

2 (a)

A student wants to make plastic chess pieces using a 3D printer. Figure 1 shows the central vertical cross-section of the student's design for one chess piece. The plastic chess piece is formed by rotating the region bounded by the y-axis, the x-axis, the line with equation $x = 1$, the curve C_1 and the curve C_2 through 360° about the y-axis.

The point A has coordinates (1, 0.5) and the point B has coordinates (0.5, 2.5) where the units are centimetres.

The curve C_1 is modelled by the equation

$$x = \frac{a}{y + b} \qquad 0.5 \leq y \leq 2.5$$

a) Determine the value of a and the value of b according to the model.

(2 marks)

(b) The curve C_2 is modelled to be an arc of the circle with centre (0, 3).

(b) Use calculus to determine the volume of plastic required to make the chess piece according to the model.

(9 marks)

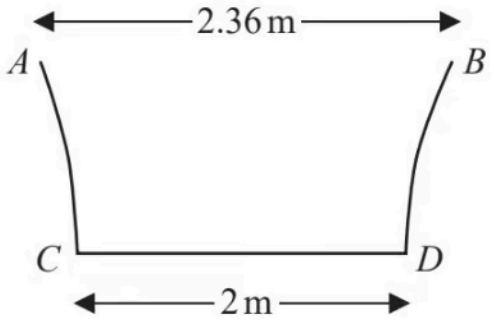

Figure 1

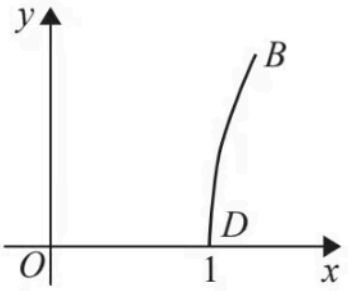

Figure 2

3 (a) Figure 1 shows the central vertical cross section $ABCD$ of a paddling pool that has a circular horizontal cross section. Measurements of the diameters of the top and bottom of the paddling pool have been taken in order to estimate the volume of water that the paddling pool can contain.

Using these measurements, the curve BD is modelled by the equation

$$y = \ln(3.6x - k) \qquad 1 \leq x \leq 1.18$$

as shown in Figure 2.

(a) Find the value of k.

(1 mark)

(b) (b) Find the depth of the paddling pool according to this model.

(2 marks)

(c) The pool is being filled with water from a tap.

(c) Find, in terms of h, the volume of water in the pool when the pool is filled to a depth of h m.

(5 marks)

(d) Given that the pool is being filled at a constant rate of 15 litres every minute,

(d) find, in cm h^{-1}, the rate at which the water level is rising in the pool when the depth of the water is 0.2 m..

(3 marks)