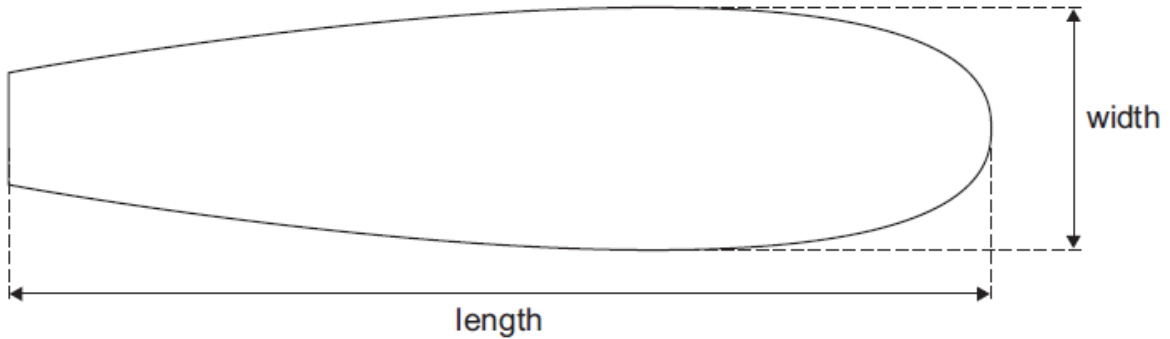## Differentiation – A2 Mathematics P3

1. June/2022/Paper_7357/03/No.6

A design for a surfboard is shown in **Figure 1**.
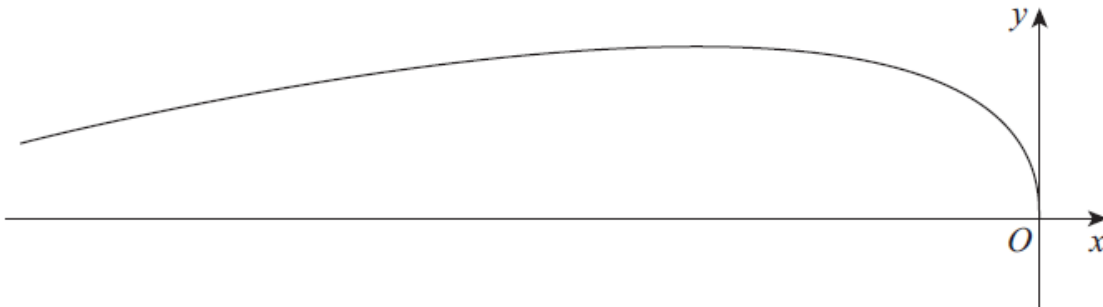
Figure 1

The curve of the **top half** of the surfboard can be modelled by the parametric equations

$$x = -2t^2$$

$$y = 9t - 0.7t^2$$

for $0 \leq t \leq 9.5$ as shown in **Figure 2**, where x and y are measured in centimetres.

Figure 2

(a) Find the length of the surfboard.

[2 marks]

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(b) (i) Find an expression for $\dfrac{\mathrm{d}y}{\mathrm{d}x}$ in terms of t.

[3 marks]

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(b) (ii) Hence, show that the width of the surfboard is approximately one third of its length.

[4 marks]

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2. June/2022/Paper_7357/03/No.8

Water is poured into an empty cone at a constant rate of $8\,\text{cm}^3/\text{s}$

After t seconds the depth of the water in the inverted cone is $h\,\text{cm}$, as shown in the diagram below.

When the depth of the water in the inverted cone is $h\,\text{cm}$, the volume, $V\,\text{cm}^3$, is given by

$$V = \frac{\pi h^3}{12}$$

(a)   Show that when $t = 3$

$$\frac{\mathrm{d}V}{\mathrm{d}h} = 6\sqrt[3]{6\pi}$$

[4 marks]

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(b)   Hence, find the rate at which the depth is increasing when $t = 3$

Give your answer to three significant figures.

[3 marks]

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