

QQQ – Further Pure 1 – Chapter 8 – Numerical Methods (Version 1)

Total Marks: 25

(25 = Platinum, 23 = Gold, 20 = Silver, 17 = Bronze)

1.

$$\frac{dy}{dx} = ye^{x^2}.$$

It is given that $y = 0.2$ at $x = 0$.

- (a)** Use the approximation $\frac{y_1 - y_0}{h} \approx \left(\frac{dy}{dx}\right)_0$, with $h = 0.1$, to obtain an estimate of the value of y at $x = 0.1$. **(2)**

- (b)** Use your answer to part (a) and the approximation $\frac{y_2 - y_0}{2h} \approx \left(\frac{dy}{dx}\right)_1$, with $h = 0.1$, to obtain an estimate of the value of y at $x = 0.2$.
Gives your answer to 4 decimal places. **(3)**

(Total 5 marks)

2.

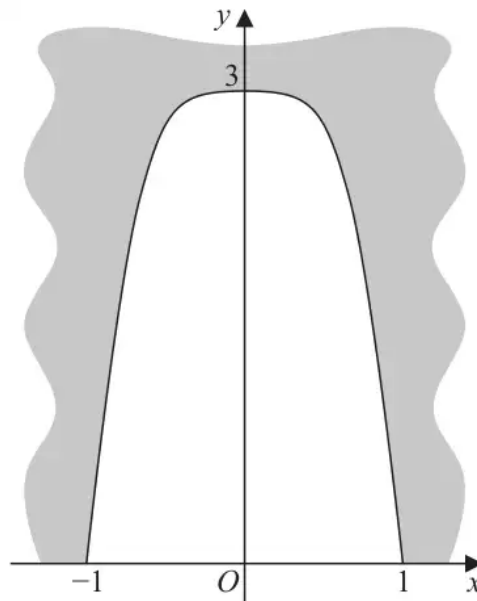


Figure 1

Figure 1 shows a sketch of the vertical cross-section of the entrance to a tunnel. The width at the base of the tunnel entrance is 2 metres and its maximum height is 3 metres.

The shape of the cross-section can be modelled by the curve with equation $y = f(x)$ where

$$f(x) = 3 \cos \left(\frac{\pi}{2} x^2 \right) \quad x \in [-1, 1]$$

A wooden door of uniform thickness 85 mm is to be made to seal the tunnel entrance.

Use Simpson's rule with 6 intervals to estimate the volume of wood required for this door, giving your answer in m^3 to 4 significant figures.

(6)

(Total 6 marks)

3. A population of deer was introduced onto an island.

The number of deer, P , on the island at time t years following their introduction is modelled by the differential equation

$$\frac{dP}{dt} = \frac{P}{5000} \left(1000 - \frac{P(t+1)}{6t+5} \right) \quad t > 0$$

It was estimated that there were 540 deer on the island six months after they were introduced.

Use **two** applications of the approximation formula $\left(\frac{dy}{dx} \right)_n \approx \frac{y_{n+1} - y_n}{h}$ to estimate the number of deer on the island 10 months after they were introduced.

(7)

(Total 7 marks)

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4. The variables x and y satisfy the differential equation

$$\frac{d^2y}{dx^2} = 2y^2 - x - 1$$

where $\frac{dy}{dx} = 3$ and $y = 0$ at $x = 0$

Use the approximations

$$\left(\frac{d^2y}{dx^2} \right)_n \approx \frac{(y_{n+1} - 2y_n + y_{n-1}))}{h^2} \quad \text{and} \quad \left(\frac{dy}{dx} \right)_n \approx \frac{(y_{n+1} - y_{n-1}))}{2h}$$

with $h = 0.1$ to find an estimate for the value of y at $x = 0.2$

(7)

(Total 7 marks)

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