

GCE Examinations  
Advanced Subsidiary

## Core Mathematics C4

Paper L

Time: 1 hour 30 minutes

### *Instructions and Information*

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Candidates may use any calculator EXCEPT those with the facility for symbolic algebra, differentiation and/or integration.

Full marks may be obtained for answers to ALL questions.

Mathematical formulae and statistical tables are available.

This paper has seven questions.

### *Advice to Candidates*

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You must show sufficient working to make your methods clear to an examiner.  
Answers without working may gain no credit.



*Written by Shaun Armstrong*

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1. The number of people,  $n$ , in a queue at a Post Office  $t$  minutes after it opens is modelled by the differential equation

$$\frac{dn}{dt} = e^{0.5t} - 5, \quad t \geq 0.$$

- (a) Find, to the nearest second, the time when the model predicts that there will be the least number of people in the queue. **(3)**
- (b) Given that there are 20 people in the queue when the Post Office opens, solve the differential equation. **(4)**
- (c) Explain why this model would not be appropriate for large values of  $t$ . **(1)**

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2. A curve has the equation

$$3x^2 + xy - 2y^2 + 25 = 0.$$

Find an equation for the normal to the curve at the point with coordinates  $(1, 4)$ , giving your answer in the form  $ax + by + c = 0$ , where  $a$ ,  $b$  and  $c$  are integers. **(8)**

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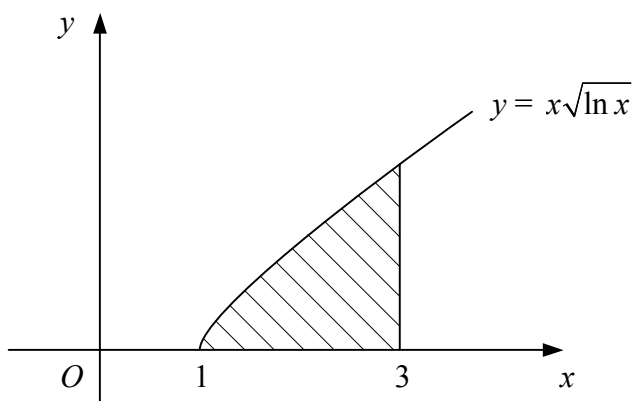
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4.



**Figure 1**

Figure 1 shows the curve with equation  $y = x\sqrt{\ln x}$ ,  $x \geq 1$ .

The shaded region is bounded by the curve, the  $x$ -axis and the line  $x = 3$ .

- (a) Using the trapezium rule with two intervals of equal width, estimate the area of the shaded region. (4)

The shaded region is rotated through  $360^\circ$  about the  $x$ -axis.

- (b) Find the exact volume of the solid formed. (7)

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5. 
$$f(x) = \frac{5-8x}{(1+2x)(1-x)^2}$$

- (a) Express  $f(x)$  in partial fractions. **(5)**
- (b) Find the series expansion of  $f(x)$  in ascending powers of  $x$  up to and including the term in  $x^3$ , simplifying each coefficient. **(6)**
- (c) State the set of values of  $x$  for which your expansion is valid. **(1)**

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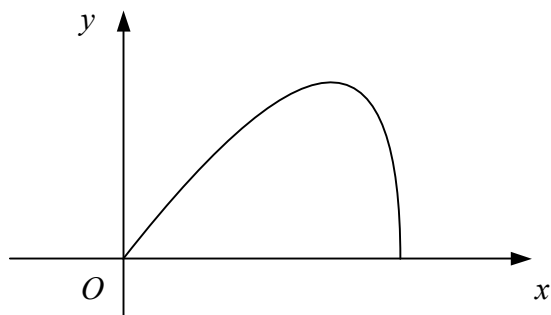
**Figure 2**

Figure 2 shows the curve with parametric equations

$$x = t + \sin t, \quad y = \sin t, \quad 0 \leq t \leq \pi.$$

- (a) Find  $\frac{dy}{dx}$  in terms of  $t$ . **(3)**
- (b) Find, in exact form, the coordinates of the point where the tangent to the curve is parallel to the  $x$ -axis. **(3)**
- (c) Show that the region bounded by the curve and the  $x$ -axis has area 2. **(6)**

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7. The line  $l_1$  passes through the points  $A$  and  $B$  with position vectors  $(3\mathbf{i} + 6\mathbf{j} - 8\mathbf{k})$  and  $(8\mathbf{j} - 6\mathbf{k})$  respectively, relative to a fixed origin.

- (a) Find a vector equation for  $l_1$ . (2)

The line  $l_2$  has vector equation

$$\mathbf{r} = (-2\mathbf{i} + 10\mathbf{j} + 6\mathbf{k}) + \mu(7\mathbf{i} - 4\mathbf{j} + 6\mathbf{k}),$$

where  $\mu$  is a scalar parameter.

- (b) Show that lines  $l_1$  and  $l_2$  intersect. (4)

- (c) Find the coordinates of the point where  $l_1$  and  $l_2$  intersect. (2)

The point  $C$  lies on  $l_2$  and is such that  $AC$  is perpendicular to  $AB$ .

- (d) Find the position vector of  $C$ . (6)

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