

GCE Examinations  
Advanced Subsidiary

## Core Mathematics C4

Paper J

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 eight 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.



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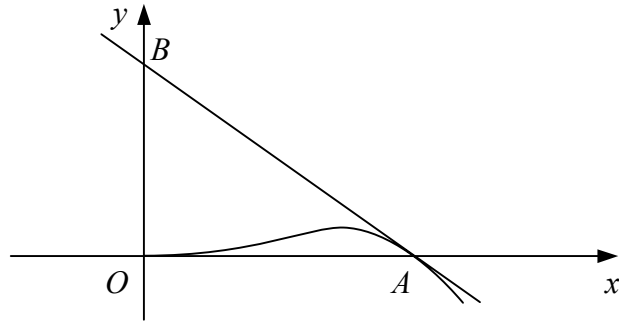








4.



**Figure 1**

Figure 1 shows the curve with parametric equations

$$x = a\sqrt{t}, \quad y = at(1 - t), \quad t \geq 0,$$

where  $a$  is a positive constant.

- (a) Find  $\frac{dy}{dx}$  in terms of  $t$ . (3)

The curve meets the  $x$ -axis at the origin,  $O$ , and at the point  $A$ . The tangent to the curve at  $A$  meets the  $y$ -axis at the point  $B$  as shown.

- (b) Show that the area of triangle  $OAB$  is  $a^2$ . (6)

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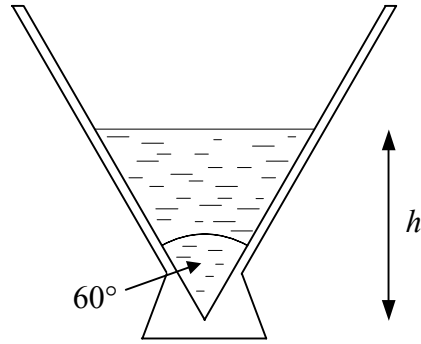




5. continued

Lined area for writing the answer to question 5.

6.



**Figure 2**

Figure 2 shows a vertical cross-section of a vase.

The inside of the vase is in the shape of a right-circular cone with the angle between the sides in the cross-section being  $60^\circ$ . When the depth of water in the vase is  $h$  cm, the volume of water in the vase is  $V$  cm<sup>3</sup>.

(a) Show that  $V = \frac{1}{9} \pi h^3$ . (3)

The vase is initially empty and water is poured in at a constant rate of  $120 \text{ cm}^3 \text{ s}^{-1}$ .

(b) Find, to 2 decimal places, the rate at which  $h$  is increasing

(i) when  $h = 6$ ,

(ii) after water has been poured in for 8 seconds. (7)

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8.

$$f(x) = \frac{x(3x-7)}{(1-x)(1-3x)}, \quad |x| < \frac{1}{3}.$$

(a) Find the values of the constants  $A$ ,  $B$  and  $C$  such that

$$f(x) = A + \frac{B}{1-x} + \frac{C}{1-3x}. \tag{4}$$

(b) Evaluate

$$\int_0^{\frac{1}{4}} f(x) \, dx,$$

giving your answer in the form  $p + \ln q$ , where  $p$  and  $q$  are rational. **(5)**

(c) Find the series expansion of  $f(x)$  in ascending powers of  $x$  up to and including the term in  $x^3$ , simplifying each coefficient. **(5)**

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