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3. A curve  $C$  has equation

$$y = x^2 e^x.$$

(a) Find  $\frac{dy}{dx}$ , using the product rule for differentiation.

(3)

(b) Hence find the coordinates of the turning points of  $C$ .

(3)

(c) Find  $\frac{d^2y}{dx^2}$ .

(2)

(d) Determine the nature of each turning point of the curve  $C$ .

(2)

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5. The functions  $f$  and  $g$  are defined by

$$f : x \mapsto \ln(2x - 1), \quad x \in \mathbb{R}, x > \frac{1}{2},$$

$$g : x \mapsto \frac{2}{x - 3}, \quad x \in \mathbb{R}, x \neq 3.$$

- (a) Find the exact value of  $fg(4)$ . (2)
  
- (b) Find the inverse function  $f^{-1}(x)$ , stating its domain. (4)
  
- (c) Sketch the graph of  $y = |g(x)|$ . Indicate clearly the equation of the vertical asymptote and the coordinates of the point at which the graph crosses the  $y$ -axis. (3)
  
- (d) Find the exact values of  $x$  for which  $\left| \frac{2}{x - 3} \right| = 3$ . (3)

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**Question 5 continued**

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7. (a) Prove that

$$\frac{\sin \theta}{\cos \theta} + \frac{\cos \theta}{\sin \theta} = 2 \operatorname{cosec} 2\theta, \quad \theta \neq 90n^\circ.$$

(4)

(b) On the axes on page 20, sketch the graph of  $y = 2 \operatorname{cosec} 2\theta$  for  $0^\circ < \theta < 360^\circ$ .

(2)

(c) Solve, for  $0^\circ < \theta < 360^\circ$ , the equation

$$\frac{\sin \theta}{\cos \theta} + \frac{\cos \theta}{\sin \theta} = 3,$$

giving your answers to 1 decimal place.

(6)

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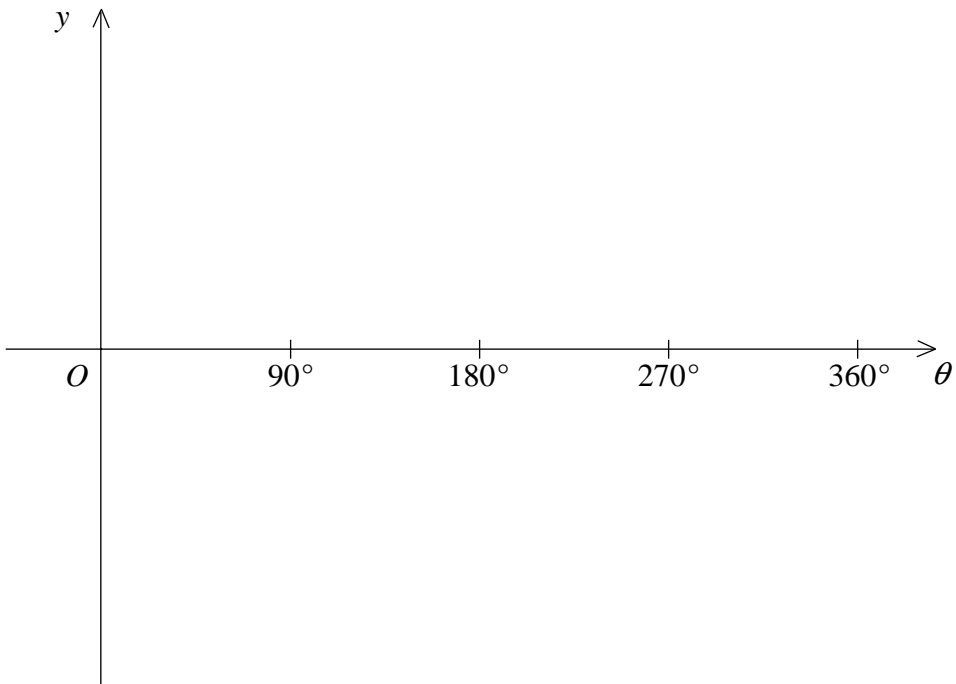
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Question 7 continued



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8. The amount of a certain type of drug in the bloodstream  $t$  hours after it has been taken is given by the formula

$$x = De^{-\frac{1}{8}t},$$

where  $x$  is the amount of the drug in the bloodstream in milligrams and  $D$  is the dose given in milligrams.

A dose of 10 mg of the drug is given.

- (a) Find the amount of the drug in the bloodstream 5 hours after the dose is given. Give your answer in mg to 3 decimal places. (2)

A second dose of 10 mg is given after 5 hours.

- (b) Show that the amount of the drug in the bloodstream 1 hour after the second dose is 13.549 mg to 3 decimal places. (2)

No more doses of the drug are given. At time  $T$  hours after the second dose is given, the amount of the drug in the bloodstream is 3 mg.

- (c) Find the value of  $T$ . (3)

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**Question 8 continued**

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(Total 7 marks)

**TOTAL FOR PAPER: 75 MARKS**

**END**

**Q8**

