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Other names

Pearson Edexcel
Level 3 GCE

Centre Number

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Candidate Number

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Mathematics

Advanced

Paper 1: Pure Mathematics 1

Sample Assessment Material for first teaching September 2017

Time: 2 hours

Paper Reference

9MA0/01

You must have:

Mathematical Formulae and Statistical Tables, calculator

Total Marks

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Candidates may use any calculator permitted by Pearson regulations. Calculators must not have the facility for algebraic manipulation, differentiation and integration, or have retrievable mathematical formulae stored in them.

Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions and ensure that your answers to parts of questions are clearly labelled.
- Answer the questions in the spaces provided
– *there may be more space than you need.*
- You should show sufficient working to make your methods clear. Answers without working may not gain full credit.
- Answers should be given to three significant figures unless otherwise stated.

Information

- A booklet 'Mathematical Formulae and Statistical Tables' is provided.
- There are 15 questions in this question paper. The total mark for this paper is 100.
- The marks for **each** question are shown in brackets
– *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.
- If you change your mind about an answer cross it out and put your new answer and any working out underneath.

Turn over ►

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Answer ALL questions. Write your answers in the spaces provided.

1. The curve C has equation

$$y = 3x^4 - 8x^3 - 3$$

(a) Find (i) $\frac{dy}{dx}$

(ii) $\frac{d^2y}{dx^2}$

(3)

(b) Verify that C has a stationary point when $x = 2$

(2)

(c) Determine the nature of this stationary point, giving a reason for your answer.

(2)

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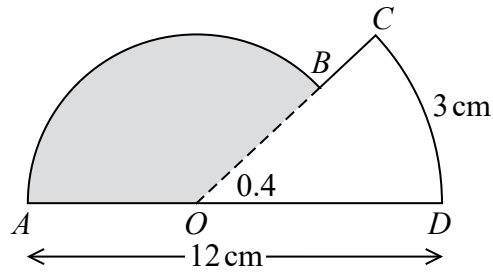
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Question 1 continued

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(Total for Question 1 is 7 marks)

2.

**Figure 1**

The shape $ABCDOA$, as shown in Figure 1, consists of a sector COD of a circle centre O joined to a sector AOB of a different circle, also centre O .

Given that arc length $CD = 3$ cm, $\angle COD = 0.4$ radians and AOD is a straight line of length 12 cm,

(a) find the length of OD , (2)

(b) find the area of the shaded sector AOB . (3)

(Total for Question 2 is 5 marks)

4. Given that a is a positive constant and

$$\int_a^{2a} \frac{t+1}{t} dt = \ln 7$$

show that $a = \ln k$, where k is a constant to be found.

(4)

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(Total for Question 4 is 4 marks)

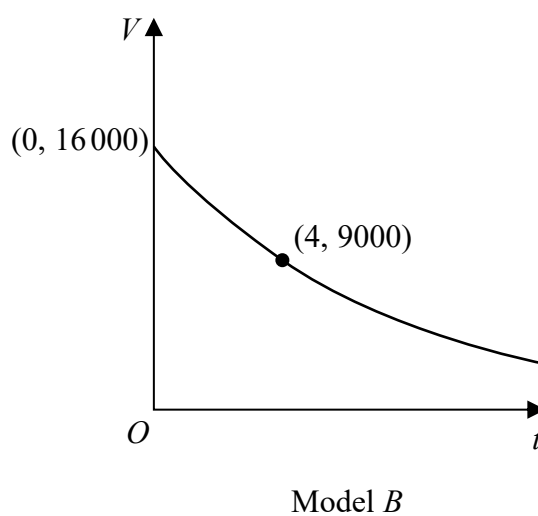
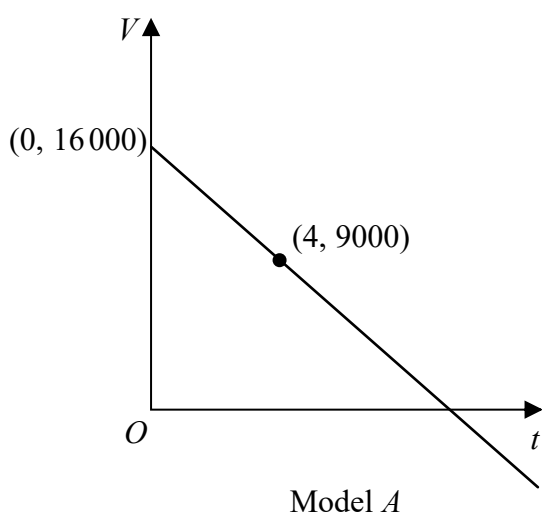
6. A company plans to extract oil from an oil field.

The daily volume of oil V , measured in barrels that the company will extract from this oil field depends upon the time, t years, after the start of drilling.

The company decides to use a model to estimate the daily volume of oil that will be extracted. The model includes the following assumptions:

- The initial daily volume of oil extracted from the oil field will be 16 000 barrels.
- The daily volume of oil that will be extracted exactly 4 years after the start of drilling will be 9 000 barrels.
- The daily volume of oil extracted will decrease over time.

The diagram below shows the graphs of two possible models.



- (a) (i) Use model A to estimate the daily volume of oil that will be extracted exactly 3 years after the start of drilling.
- (ii) Write down a limitation of using model A . (2)
- (b) (i) Using an exponential model and the information given in the question, find a possible equation for model B .
- (ii) Using your answer to (b)(i) estimate the daily volume of oil that will be extracted exactly 3 years after the start of drilling. (5)

Question 6 continued

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(Total for Question 6 is 7 marks)

7.

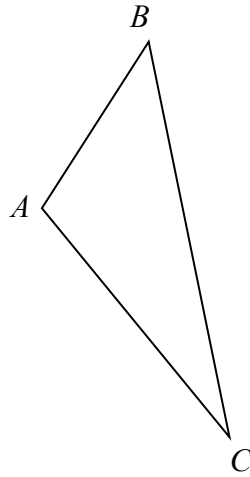


Figure 2

Figure 2 shows a sketch of a triangle ABC .

Given $\vec{AB} = 2\mathbf{i} + 3\mathbf{j} + \mathbf{k}$ and $\vec{BC} = \mathbf{i} - 9\mathbf{j} + 3\mathbf{k}$,

show that $\angle BAC = 105.9^\circ$ to one decimal place.

(5)

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Question 7 continued

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(Total for Question 7 is 5 marks)

9. (a) Prove that

$$\tan \theta + \cot \theta \equiv 2\operatorname{cosec}2\theta, \quad \theta \neq \frac{n\pi}{2}, n \in \mathbb{Z}$$

(4)

(b) Hence explain why the equation

$$\tan \theta + \cot \theta = 1$$

does not have any real solutions.

(1)

(Total for Question 9 is 5 marks)

11. An archer shoots an arrow.

The height, H metres, of the arrow above the ground is modelled by the formula

$$H = 1.8 + 0.4d - 0.002d^2, \quad d \geq 0$$

where d is the horizontal distance of the arrow from the archer, measured in metres.

Given that the arrow travels in a vertical plane until it hits the ground,

- (a) find the horizontal distance travelled by the arrow, as given by this model. (3)
- (b) With reference to the model, interpret the significance of the constant 1.8 in the formula. (1)
- (c) Write $1.8 + 0.4d - 0.002d^2$ in the form

$$A - B(d - C)^2$$

where A , B and C are constants to be found. (3)

It is decided that the model should be adapted for a different archer.

The adapted formula for this archer is

$$H = 2.1 + 0.4d - 0.002d^2, \quad d \geq 0$$

Hence or otherwise, find, for the adapted model

- (d) (i) the maximum height of the arrow above the ground.
- (ii) the horizontal distance, from the archer, of the arrow when it is at its maximum height. (2)

12. In a controlled experiment, the number of microbes, N , present in a culture T days after the start of the experiment were counted.

N and T are expected to satisfy a relationship of the form

$$N = aT^b, \quad \text{where } a \text{ and } b \text{ are constants}$$

- (a) Show that this relationship can be expressed in the form

$$\log_{10} N = m \log_{10} T + c$$

giving m and c in terms of the constants a and/or b .

(2)

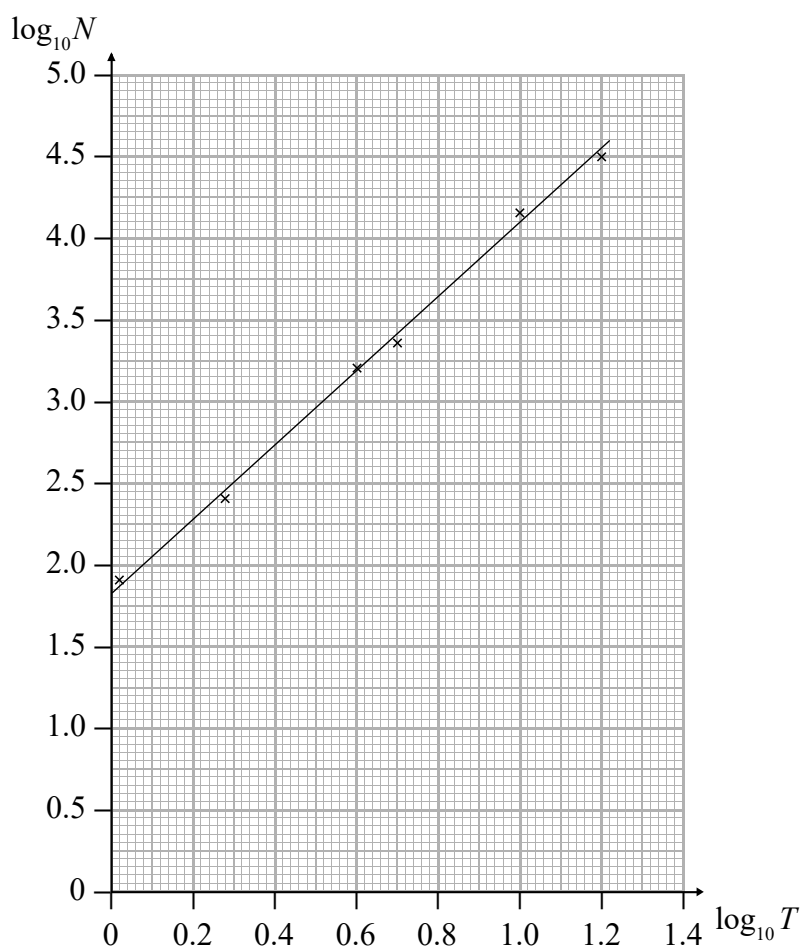


Figure 3

Figure 3 shows the line of best fit for values of $\log_{10} N$ plotted against values of $\log_{10} T$

- (b) Use the information provided to estimate the number of microbes present in the culture 3 days after the start of the experiment.
- (c) Explain why the information provided could not reliably be used to estimate the day when the number of microbes in the culture first exceeds 1 000 000.
- (d) With reference to the model, interpret the value of the constant a .

(4)

(2)

(1)

Question 12 continued

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Question 12 continued

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(Total for Question 12 is 9 marks)

13. The curve C has parametric equations

$$x = 2 \cos t, \quad y = \sqrt{3} \cos 2t, \quad 0 \leq t \leq \pi$$

- (a) Find an expression for $\frac{dy}{dx}$ in terms of t . (2)

The point P lies on C where $t = \frac{2\pi}{3}$

The line l is the normal to C at P .

- (b) Show that an equation for l is

$$2x - 2\sqrt{3}y - 1 = 0 \quad (5)$$

The line l intersects the curve C again at the point Q .

- (c) Find the exact coordinates of Q .

You must show clearly how you obtained your answers. (6)

Question 13 continued

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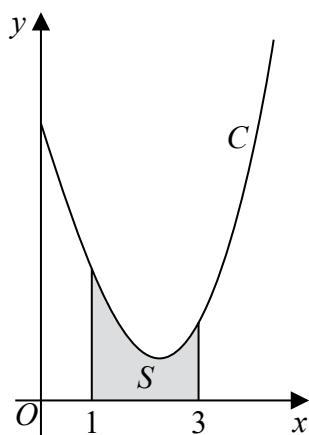


Figure 4

Figure 4 shows a sketch of part of the curve C with equation

$$y = \frac{x^2 \ln x}{3} - 2x + 5, \quad x > 0$$

The finite region S , shown shaded in Figure 4, is bounded by the curve C , the line with equation $x = 1$, the x -axis and the line with equation $x = 3$

The table below shows corresponding values of x and y with the values of y given to 4 decimal places as appropriate.

x	1	1.5	2	2.5	3
y	3	2.3041	1.9242	1.9089	2.2958

- (a) Use the trapezium rule, with all the values of y in the table, to obtain an estimate for the area of S , giving your answer to 3 decimal places. (3)
- (b) Explain how the trapezium rule could be used to obtain a more accurate estimate for the area of S . (1)
- (c) Show that the exact area of S can be written in the form $\frac{a}{b} + \ln c$, where a , b and c are integers to be found. (6)

(In part c, solutions based entirely on graphical or numerical methods are not acceptable.)

Question 14 continued

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(Total for Question 14 is 10 marks)

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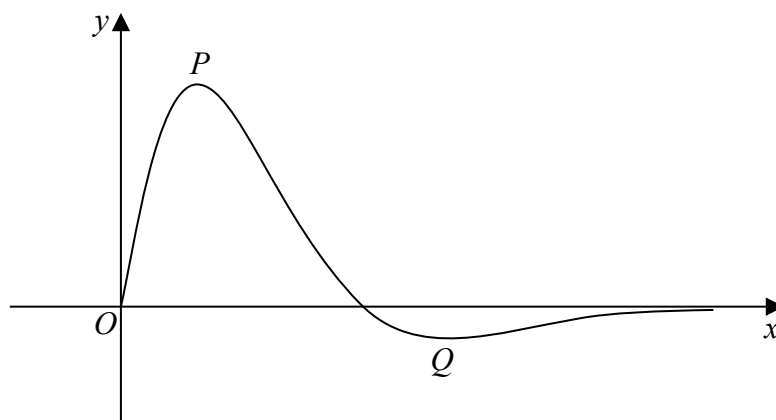


Figure 5

Figure 5 shows a sketch of the curve with equation $y = f(x)$, where

$$f(x) = \frac{4\sin 2x}{e^{\sqrt{2x}-1}}, \quad 0 \leq x \leq \pi$$

The curve has a maximum turning point at P and a minimum turning point at Q as shown in Figure 5.

(a) Show that the x coordinates of point P and point Q are solutions of the equation

$$\tan 2x = \sqrt{2} \quad (4)$$

(b) Using your answer to part (a), find the x -coordinate of the minimum turning point on the curve with equation

(i) $y = f(2x)$.

(ii) $y = 3 - 2f(x)$. (4)

Question 15 continued

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(Total for Question 15 is 8 marks)

TOTAL FOR PAPER IS 100 MARKS