Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel Level 3 GCE

Centre Number | Candidate Number

Mock Paper – Set 2

(Time: 2 hours) | Paper Reference **9MA0/01**

Mathematics

Advanced
Paper 1: Pure Mathematics 1

You must have:
Mathematical Formulae and Statistical Tables, calculator

Total Marks

Candidates may use any calculator allowed by Pearson regulations. Calculators must not have the facility for symbolic algebra 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.
- Inexact answers should be given to three significant figures unless otherwise stated.

Information

- A booklet 'Mathematical Formulae and Statistical Tables' is provided.
- There are 14 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.

Turn over ▶

Pearson

1. Weed is completely covering the surface of a pond.

Fish are introduced into the pond in an effort to control the weed.

The surface area of the pond, $A\,\text{m}^2$, covered by the weed, t days after the fish are introduced is modelled by the equation

$$A = 105 - 12\mathrm{e}^{0.08t} \qquad t \in \mathbb{R},\ t \geqslant 0$$

According to the model,

(a) state the surface area of the pond covered by the weed at the start of the investigation,

(1)

(b) find the time taken in days, to one decimal place, for the surface area of the pond covered by the weed to fall to $40\,\text{m}^2$

(3)

Stuart wants to predict the surface area of the pond covered by the weed 30 days after the fish are introduced.

(c) Explain why he should not use this model.

(2)

Question 1 continued

(Total for Question 1 is 6 marks)

2. (a) Find the first 4 terms, in ascending powers of x, of the binomial expansion of

$$\sqrt{1 + 4x}$$

giving each coefficient in its simplest form.

(4)

The expansion can be used to find an approximation for $\sqrt{26}$

(b) Explain why $x = \frac{25}{4}$ **should not** be used in the expansion to find an approximation for $\sqrt{26}$

(1)

(c) Explain how you could use $x = \frac{1}{100}$ in the expansion to find an approximation for $\sqrt{26}$

There is no need to carry out the calculation.

(2)

Question 2 continued

(Total for Question 2 is 7 marks)

3. The sequence $u_1, u_2, u_3, \ldots$ is defined by

$$u_{n+1} = \frac{4}{2 - u_n} \qquad u_1 = 1$$

(a) Show that this sequence is periodic, stating the period.

(3)

(b) Hence find $\displaystyle\sum_{n=1}^{50} u_n$

(2)

Question 3 continued

(Total for Question 3 is 5 marks)

Turn over

4.

$$h(x) = \frac{4x^3 - 19x^2 + 28x - 4}{(x-2)^2} \qquad x > 2$$

(a) Write $h(x)$ in the form $Ax + B + \dfrac{C}{(x-2)^2}$ where A, B and C are constants to be found.

(3)

(b) Hence find $\int h(x)\,dx$

(3)

Question 4 continued

(Total for Question 4 is 6 marks)

5. Relative to a fixed origin O,

- the point A has position vector $-2\mathbf{i} + 3\mathbf{j}$
- the point B has position vector $3\mathbf{i} + p\mathbf{j}$, where p is constant
- the point C has position vector $q\mathbf{i} + 7\mathbf{j}$, where q is constant

Given that $\left|\overrightarrow{AB}\right| = 5\sqrt{2}$

(a) find the possible values of p.

(3)

Given that the angle between $\overrightarrow{AC}$ and the unit vector $\mathbf{i}$ is $\frac{\pi}{3}$ radians,

(b) find the exact value of q.

(3)

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Question 5 continued

(Total for Question 5 is 6 marks)

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6. (a) Use the identity for $\tan(A + B)$ to show that

$$\tan 3\theta \equiv \frac{3\tan\theta - \tan^3\theta}{1 - 3\tan^2\theta}$$

(4)

Given $\tan\beta = \sqrt{6}$

(b) use the answer to part (a) to show that

$$\tan 3\beta = k\sqrt{6}$$

where k is a constant to be found.

(2)

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Question 6 continued

(Total for Question 6 is 6 marks)

7.

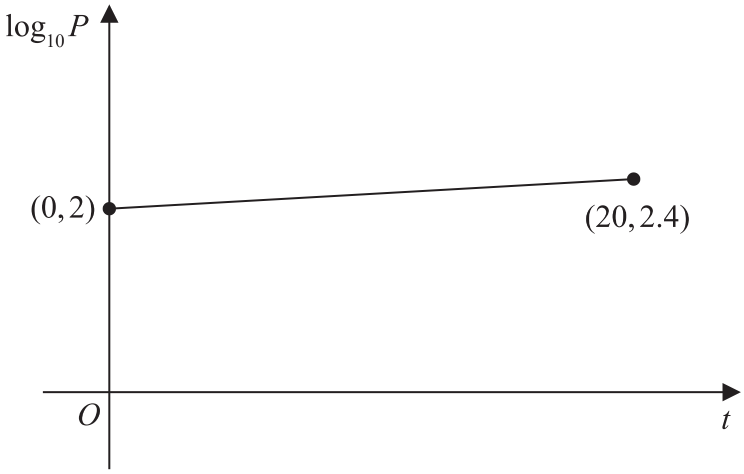

Figure 1

Red squirrels were introduced into a large wood in Northumberland on 1st June 1996.

Scientists counted the number of red squirrels in the wood, P, on 1st June each year for t years after 1996.

The scientists found that over time the number of red squirrels can be modelled by the formula

$$P = ab^t$$

where a and b are constants.

The line l, shown in Figure 1, illustrates the linear relationship between $\log_{10} P$ and t over a period of 20 years.

Using the information given on the graph and using the model,

(a) find an equation for l,

(2)

(b) find the initial number of red squirrels that were introduced into the wood,

(2)

(c) find a complete equation for the model giving the value of b to 4 significant figures.

(2)

On 1st June 2019 there were found to be 198 red squirrels in the wood.

(d) (i) Use this information to show that the model is not valid on 1st June 2019.

(ii) Suggest a reason for the model not being valid at this time.

(3)

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Question 7 continued

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Question 7 continued

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Question 7 continued

(Total for Question 7 is 9 marks)

8.

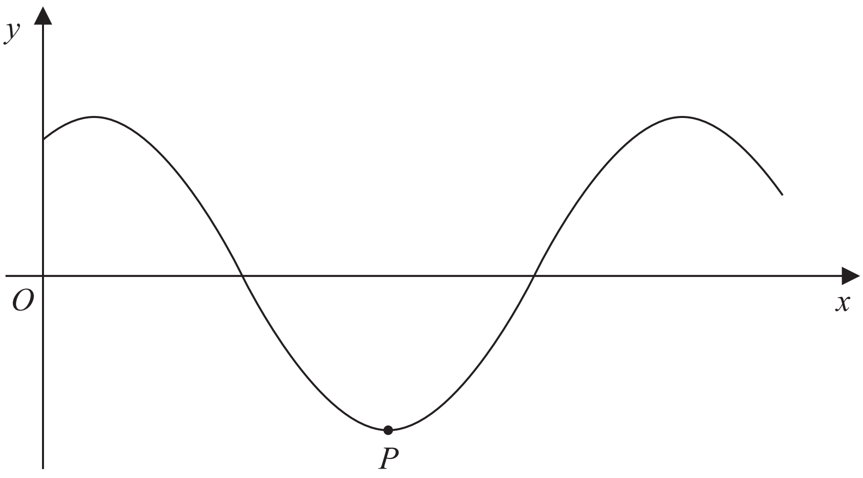

Figure 2

Figure 2 shows a sketch of part of the curve with equation

$$y = 5\cos(x - 30)^\circ \qquad x \geqslant 0$$

The point P on the curve is the minimum point with the smallest positive x coordinate.

(a) State the coordinates of P.

(2)

(b) Solve, for $0 \leqslant x < 360$, the equation

$$5\cos(x - 30)^\circ = 4\sin x^\circ$$

giving your answers to one decimal place.

(4)

(c) Deduce, giving reasons for your answer, the **number of roots** of the equation

$$5\cos(2x - 30)^\circ = 4\sin 2x^\circ \text{ for } 0 \leqslant x < 3600$$

(2)

Question 8 continued

(Total for Question 8 is 8 marks)

9.

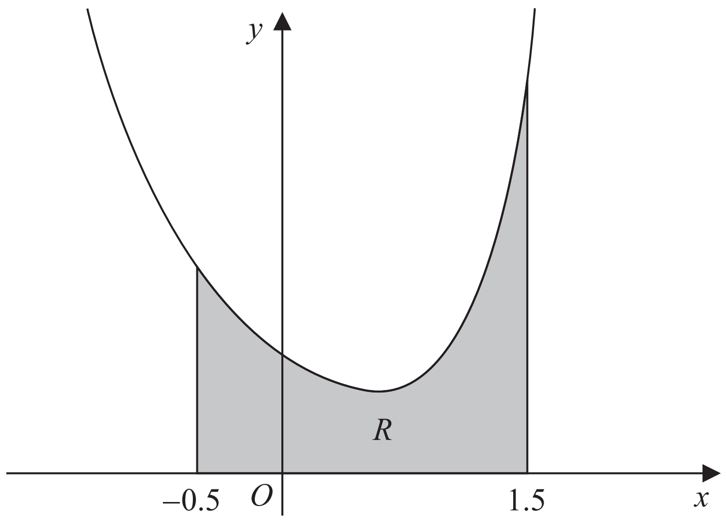

Figure 3

Figure 3 shows a sketch of the curve with equation $y = 2^{x^2} - x$

The finite region R, shown shaded in Figure 3, is bounded by the curve, the line with equation $x = -0.5$, the x-axis and the line with equation $x = 1.5$

(a) Use the trapezium rule with four strips of equal width to find an estimate for the area of R. Show your working and give your answer to two decimal places.

(4)

A copy of Figure 3, called Diagram 1, is drawn below.

(b) Explain, with the aid of Diagram 1, whether your answer in part (a) is an underestimate or overestimate of the true value for the area of R.

(1)

Using your answer to part (a) and showing your working,

(c) estimate the value of $\int_{-0.5}^{1.5} \left(2^{x^2+1} + 2x\right) dx$

(3)

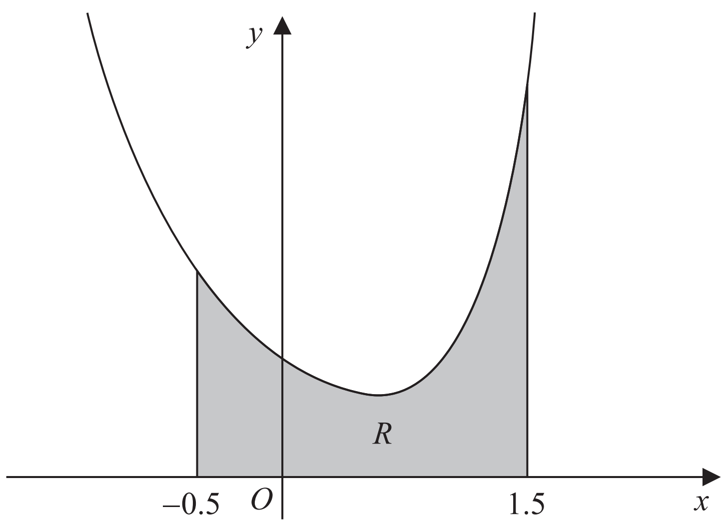

Diagram 1

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Question 9 continued

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Turn over

Question 9 continued

Question 9 continued

(Total for Question 9 is 8 marks)

10. (a) Sketch the graph with equation

$$y = |2x - 9| + 3$$

stating the coordinates of the vertex and any points where the graph crosses the coordinate axes.

(3)

(b) Solve the equation

$$3x + 1 = |2x - 9| + 3$$

(2)

A straight line l has equation $y = kx + 1$, where k is a constant.

Given that l does not meet or intersect the graph with equation $y = |2x - 9| + 3$

(c) find the range of possible values of k.

(3)

Question 10 continued

Question 10 continued

Question 10 continued

(Total for Question 10 is 8 marks)

11. The function f is defined by

$$f(x) = \frac{2 + 3x}{x} \qquad x > 0$$

(a) Find the value of a such that

$$f^{-1}(a) = \frac{5}{3}$$

(2)

(b) Explain why there are no values of x for which

$$f(x) < \frac{3}{2}$$

(2)

(c) Show that f is a decreasing function.

(2)

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Question 11 continued

(Total for Question 11 is 6 marks)

Turn over

12. Using algebraic integration and making your method clear, show that

$$\int_1^5 \frac{4x+9}{x+3}\,\mathrm{d}x = a + \ln b$$

where a and b are constants to be found.

Question 12 continued

(Total for Question 12 is 5 marks)

13.

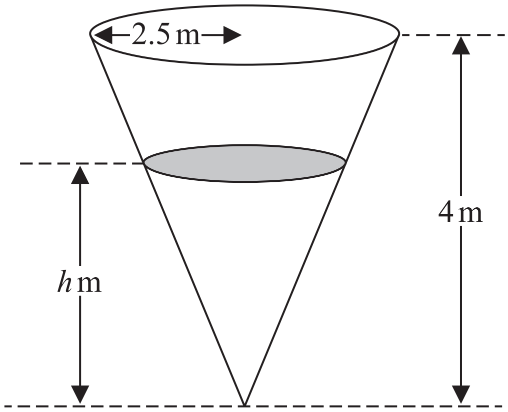

Diagram not drawn to scale

Figure 4

[The volume of a cone of base radius r and height h is $\frac{1}{3}\pi r^2 h$]

Figure 4 shows a container in the shape of an inverted right circular cone which contains some water.

The cone has an internal base radius of 2.5 m and a vertical height of 4 m.

At time t seconds

- the height of the water is h m
- the volume of the water is V m^3
- the water is modelled as leaking from a hole at the bottom of the container at a rate of

$$\left(\frac{\pi}{512}\sqrt{h}\right) m^3 s^{-1}$$

(a) Show that, while the water is leaking

$$h^{\frac{3}{2}}\frac{\mathrm{d}h}{\mathrm{d}t} = -\frac{1}{200}$$

(5)

Given that the container was initially full of water,

(b) find an equation, in terms of h and t, to model this situation.

(3)

It takes approximately 43 minutes for the container to empty.

(c) Use this information to comment on the suitability of this model.

(3)

Question 13 continued

Question 13 continued

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Question 13 continued

(Total for Question 13 is 11 marks)

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14.

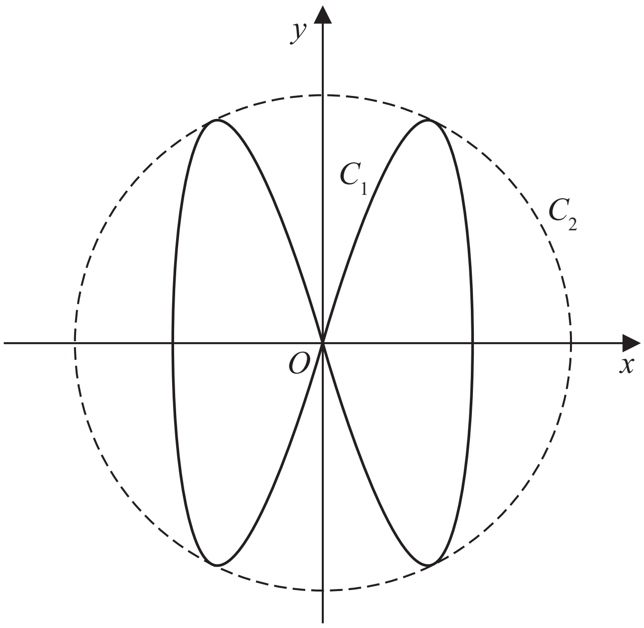

Figure 5

Figure 5 shows a sketch of the curve C_1 with parametric equations

$$x = 2\sin t, \quad y = 3\sin 2t \quad 0 \leqslant t < 2\pi$$

(a) Show that the Cartesian equation of C_1 can be expressed in the form

$$y^2 = kx^2(4 - x^2)$$

where k is a constant to be found.

(4)

The circle C_2 with centre O touches C_1 at four points as shown in Figure 5.

(b) Find the radius of this circle.

(5)

Question 14 continued

Question 14 continued

Question 14 continued

Question 14 continued

(Total for Question 14 is 9 marks)

TOTAL FOR PAPER IS 100 MARKS