

Please check the examination details below before entering your candidate information

Candidate surname

Other names

**Pearson Edexcel
Level 3 GCE**

Centre Number

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Candidate Number

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Wednesday 7 October 2020

Morning (Time: 2 hours)

Paper Reference **9MA0/01**

Mathematics

Advanced

Paper 1: Pure Mathematics 1

You must have:

Mathematical Formulae and Statistical Tables (Green), 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 16 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 ►

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

$$(1 + 8x)^{\frac{1}{2}}$$

giving each term in simplest form.

(3)

- (b) Explain how you could use $x = \frac{1}{32}$ in the expansion to find an approximation for $\sqrt{5}$

There is no need to carry out the calculation.

(2)



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Question 1 continued

Lined area for writing answers.

(Total for Question 1 is 5 marks)



2. By taking logarithms of both sides, solve the equation

$$4^{3p-1} = 5^{210}$$

giving the value of p to one decimal place.

(3)



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Question 2 continued

Lined area for writing answers.

(Total for Question 2 is 3 marks)



3. Relative to a fixed origin O

- point A has position vector $2\mathbf{i} + 5\mathbf{j} - 6\mathbf{k}$
- point B has position vector $3\mathbf{i} - 3\mathbf{j} - 4\mathbf{k}$
- point C has position vector $2\mathbf{i} - 16\mathbf{j} + 4\mathbf{k}$

- (a) Find $\overrightarrow{AB}$ (2)
- (b) Show that quadrilateral $OABC$ is a trapezium, giving reasons for your answer. (2)



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Question 3 continued

Lined area for writing answers.

(Total for Question 3 is 4 marks)



4. The function f is defined by

$$f(x) = \frac{3x - 7}{x - 2} \quad x \in \mathbb{R}, x \neq 2$$

(a) Find $f^{-1}(7)$

(2)

(b) Show that $ff(x) = \frac{ax + b}{x - 3}$ where a and b are integers to be found.

(3)



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Question 4 continued

Lined area for writing the answer to Question 4.

(Total for Question 4 is 5 marks)



5. A car has six forward gears.

The fastest speed of the car

- in 1st gear is 28 km h^{-1}
- in 6th gear is 115 km h^{-1}

Given that the fastest speed of the car in successive gears is modelled by an **arithmetic sequence**,

(a) find the fastest speed of the car in 3rd gear.

(3)

Given that the fastest speed of the car in successive gears is modelled by a **geometric sequence**,

(b) find the fastest speed of the car in 5th gear.

(3)



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Question 5 continued

Lined area for writing the answer to Question 5.

(Total for Question 5 is 6 marks)



6. (a) Express $\sin x + 2 \cos x$ in the form $R \sin(x + \alpha)$ where R and α are constants, $R > 0$ and $0 < \alpha < \frac{\pi}{2}$

Give the exact value of R and give the value of α in radians to 3 decimal places.

(3)

The temperature, $\theta^{\circ}\text{C}$, inside a room on a given day is modelled by the equation

$$\theta = 5 + \sin\left(\frac{\pi t}{12} - 3\right) + 2\cos\left(\frac{\pi t}{12} - 3\right) \quad 0 \leq t < 24$$

where t is the number of hours after midnight.

Using the equation of the model and your answer to part (a),

- (b) deduce the maximum temperature of the room during this day, (1)

- (c) find the time of day when the maximum temperature occurs, giving your answer to the nearest minute.

(3)

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Question 6 continued

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Question 6 continued

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Question 6 continued

Lined area for writing answers.

(Total for Question 6 is 7 marks)



7.

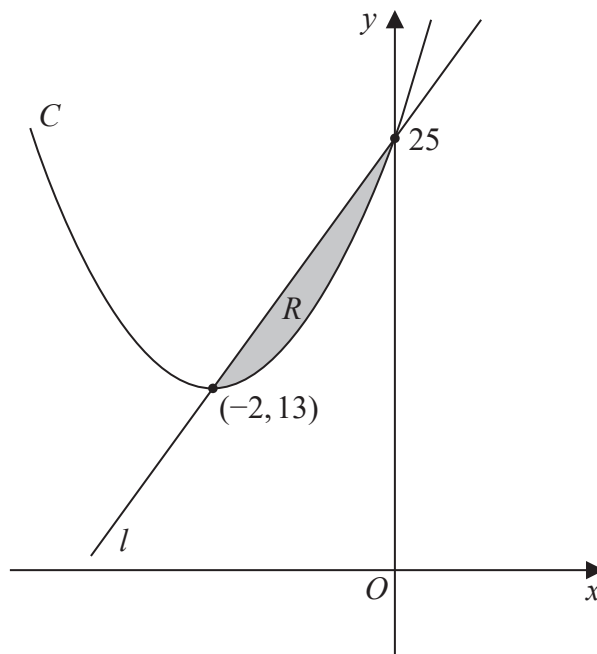


Figure 1

Figure 1 shows a sketch of a curve C with equation $y = f(x)$ and a straight line l .

The curve C meets l at the points $(-2, 13)$ and $(0, 25)$ as shown.

The shaded region R is bounded by C and l as shown in Figure 1.

Given that

- $f(x)$ is a quadratic function in x
- $(-2, 13)$ is the minimum turning point of $y = f(x)$

use inequalities to define R .

(5)

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Question 7 continued

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Question 7 continued

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Question 7 continued

Lined area for writing the answer to Question 7.

(Total for Question 7 is 5 marks)



8. A new smartphone was released by a company.

The company monitored the total number of phones sold, n , at time t days after the phone was released.

The company observed that, during this time,

the rate of increase of n was proportional to n

Use this information to write down a suitable equation for n in terms of t .

(You do not need to evaluate any unknown constants in your equation.)

(2)



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Question 8 continued

Lined area for writing the answer to Question 8.

(Total for Question 8 is 2 marks)



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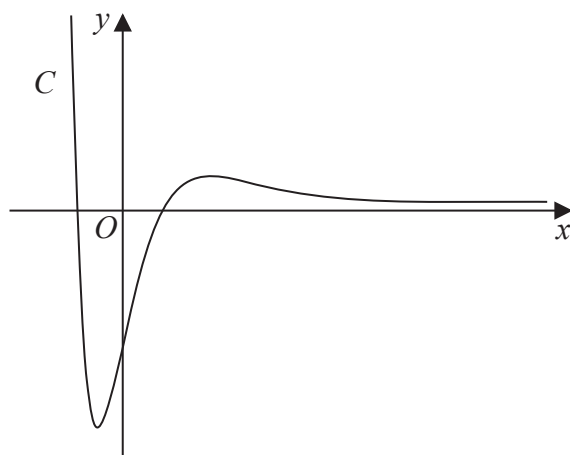


Figure 2

Figure 2 shows a sketch of the curve C with equation $y = f(x)$ where

$$f(x) = 4(x^2 - 2)e^{-2x} \quad x \in \mathbb{R}$$

(a) Show that $f'(x) = 8(2 + x - x^2)e^{-2x}$ (3)

(b) Hence find, in simplest form, the exact coordinates of the stationary points of C . (3)

The function g and the function h are defined by

$$g(x) = 2f(x) \quad x \in \mathbb{R}$$

$$h(x) = 2f(x) - 3 \quad x \geq 0$$

(c) Find
 (i) the range of g
 (ii) the range of h (3)



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Question 9 continued

Lined area for writing the answer to Question 9.



Question 9 continued

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Question 9 continued

Lined area for writing the answer to Question 9.

(Total for Question 9 is 9 marks)



10. (a) Use the substitution $x = u^2 + 1$ to show that

$$\int_5^{10} \frac{3 \, dx}{(x-1)(3+2\sqrt{x-1})} = \int_p^q \frac{6 \, du}{u(3+2u)}$$

where p and q are positive constants to be found.

(4)

(b) Hence, using algebraic integration, show that

$$\int_5^{10} \frac{3 \, dx}{(x-1)(3+2\sqrt{x-1})} = \ln a$$

where a is a rational constant to be found.

(6)



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Question 10 continued

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Question 10 continued

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Question 10 continued

Lined area for writing the answer to Question 10.

(Total for Question 10 is 10 marks)



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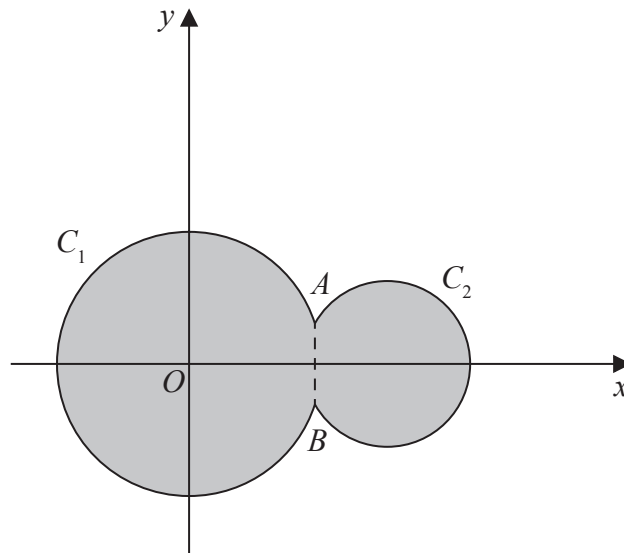


Figure 3

Circle C_1 has equation $x^2 + y^2 = 100$

Circle C_2 has equation $(x - 15)^2 + y^2 = 40$

The circles meet at points A and B as shown in Figure 3.

- (a) Show that angle $AOB = 0.635$ radians to 3 significant figures, where O is the origin.

(4)

The region shown shaded in Figure 3 is bounded by C_1 and C_2

- (b) Find the perimeter of the shaded region, giving your answer to one decimal place.

(4)



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Question 11 continued

Lined area for writing the answer to Question 11.



Question 11 continued

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Question 11 continued

Lined area for writing answers.

(Total for Question 11 is 8 marks)



12.

In this question you must show all stages of your working.**Solutions relying entirely on calculator technology are not acceptable.**

(a) Show that

$$\operatorname{cosec} \theta - \sin \theta \equiv \cos \theta \cot \theta \quad \theta \neq (180n)^\circ \quad n \in \mathbb{Z} \quad (3)$$

(b) Hence, or otherwise, solve for $0 < x < 180^\circ$

$$\operatorname{cosec} x - \sin x = \cos x \cot(3x - 50^\circ) \quad (5)$$



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Question 12 continued

Lined area for writing the answer to Question 12.



Question 12 continued

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13. A sequence of numbers $a_1, a_2, a_3, \dots$ is defined by

$$a_{n+1} = \frac{k(a_n + 2)}{a_n} \quad n \in \mathbb{N}$$

where k is a constant.

Given that

- the sequence is a periodic sequence of order 3
- $a_1 = 2$

(a) show that

$$k^2 + k - 2 = 0 \quad (3)$$

(b) For this sequence explain why $k \neq 1$ (1)

(c) Find the value of

$$\sum_{r=1}^{80} a_r \quad (3)$$



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Question 13 continued

Lined area for writing the answer to Question 13.



Question 13 continued

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Question 13 continued

Lined area for writing the answer to Question 13.

(Total for Question 13 is 7 marks)



14. A large spherical balloon is deflating.

At time t seconds the balloon has radius r cm and volume V cm³

The volume of the balloon is modelled as decreasing at a constant rate.

(a) Using this model, show that

$$\frac{dr}{dt} = -\frac{k}{r^2}$$

where k is a positive constant.

(3)

Given that

- the initial radius of the balloon is 40 cm
- after 5 seconds the radius of the balloon is 20 cm
- the volume of the balloon continues to decrease at a constant rate until the balloon is empty

(b) solve the differential equation to find a complete equation linking r and t .

(5)

(c) Find the limitation on the values of t for which the equation in part (b) is valid.

(2)



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Question 14 continued

Lined area for writing the answer to Question 14.



Question 14 continued

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Question 14 continued

Lined area for writing the answer to Question 14.

(Total for Question 14 is 10 marks)



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Question 15 continued

Lined area for writing the answer to Question 15.



Question 15 continued

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Question 15 continued

Lined area for writing the answer to Question 15.

(Total for Question 15 is 7 marks)



16. Prove by contradiction that there are no positive integers p and q such that

$$4p^2 - q^2 = 25$$

(4)

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Question 16 continued

Lined area for writing the answer to Question 16.



Question 16 continued

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(Total for Question 16 is 4 marks)

TOTAL FOR PAPER IS 100 MARKS

