

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**

Afternoon (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

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(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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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  $\vec{AB}$

(2)

(b) Show that quadrilateral  $OABC$  is a trapezium, giving reasons for your answer.

(2)

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**Question 3 continued**

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**(Total for Question 3 is 4 marks)**











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Question 5 continued

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(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  $\alpha$  are constants,  $R > 0$  and  $0 < \alpha < \frac{\pi}{2}$

Give the exact value of  $R$  and give the value of  $\alpha$  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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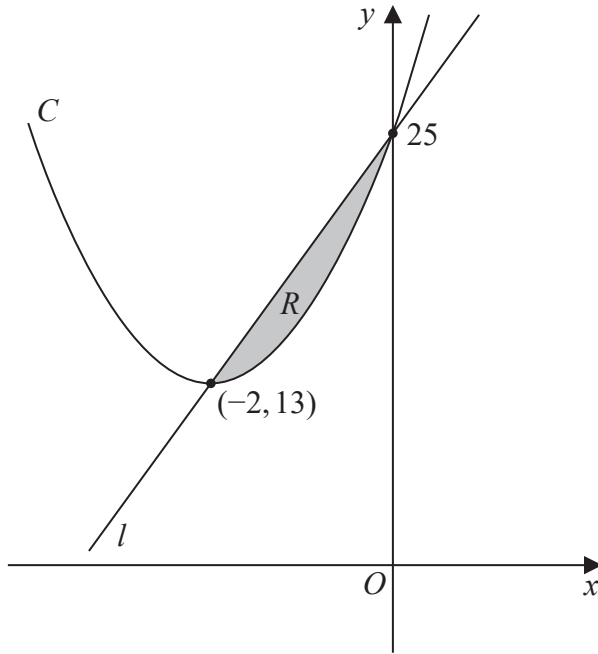
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**Figure 1**

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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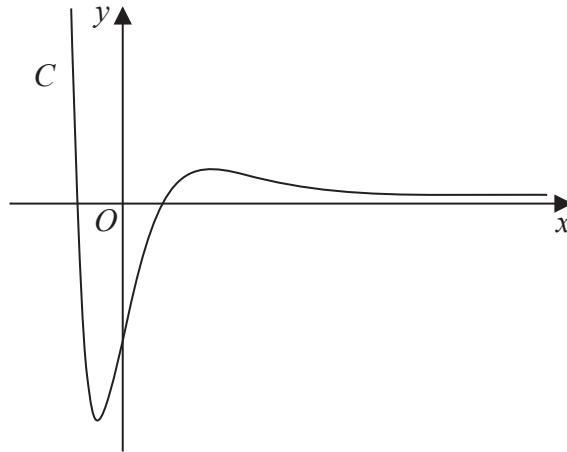








9.



**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**

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**(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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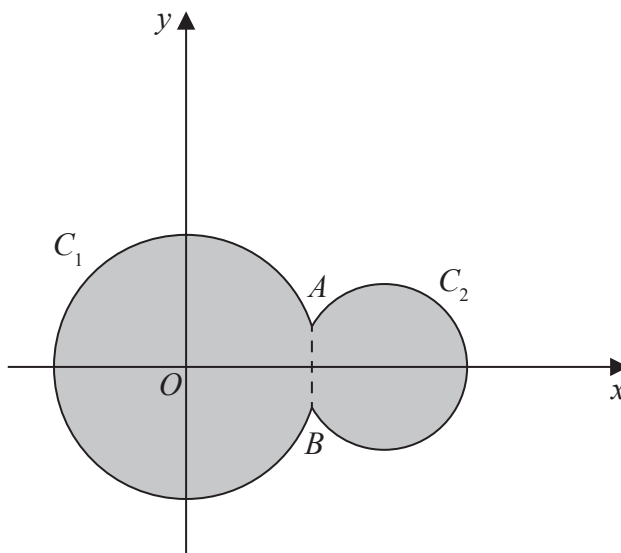


Figure 3

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**

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### Question 12 continued

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(Total for Question 12 is 8 marks)



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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

$$k^2 + k - 2 = 0 \tag{3}$$

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

(c) Find the value of (3)

$$\sum_{r=1}^{80} a_r$$

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**Question 13 continued**

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Question 13 continued

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(Total for Question 13 is 7 marks)



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**14.** A large spherical balloon is deflating.

At time  $t$  seconds the balloon has radius  $r$  cm and volume  $V$  cm<sup>3</sup>

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**

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15. The curve  $C$  has equation

$$x^2 \tan y = 9 \quad 0 < y < \frac{\pi}{2}$$

(a) Show that

$$\frac{dy}{dx} = \frac{-18x}{x^4 + 81} \quad (4)$$

(b) Prove that  $C$  has a point of inflection at  $x = \sqrt[4]{27}$  (3)

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**Question 15 continued**

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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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