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Centre Number | Candidate Number

# Pearson Edexcel Level 3 GCE

**Time** 2 hours

**Paper reference** **8MA0/01**

# Mathematics

## Advanced Subsidiary
## PAPER 1: Pure Mathematics

**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 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*


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**1.** Find

$$\int \left( 8x^3 - \frac{3}{2\sqrt{x}} + 5 \right) \mathrm{d}x$$

giving your answer in simplest form.

**(4)**

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**Question 1 continued**

**(Total for Question 1 is 4 marks)**

**2.** $$f(x) = 2x^3 + 5x^2 + 2x + 15$$

(a) Use the factor theorem to show that $(x + 3)$ is a factor of $f(x)$.

**(2)**

(b) Find the constants $a$, $b$ and $c$ such that

$$f(x) = (x + 3)(ax^2 + bx + c)$$

**(2)**

(c) Hence show that $f(x) = 0$ has only one real root.

**(2)**

(d) Write down the real root of the equation $f(x - 5) = 0$

**(1)**

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**Question 2 continued**

**Question 2 continued**

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**Question 2 continued**

**(Total for Question 2 is 7 marks)**

**3.** The triangle $PQR$ is such that $\overrightarrow{PQ} = 3\mathbf{i} + 5\mathbf{j}$ and $\overrightarrow{PR} = 13\mathbf{i} - 15\mathbf{j}$

(a) Find $\overrightarrow{QR}$

**(2)**

(b) Hence find $|\overrightarrow{QR}|$ giving your answer as a simplified surd.

**(2)**

The point $S$ lies on the line segment $QR$ so that $QS : SR = 3 : 2$

(c) Find $\overrightarrow{PS}$

**(2)**

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**Question 3 continued**

**(Total for Question 3 is 6 marks)**

**4.**

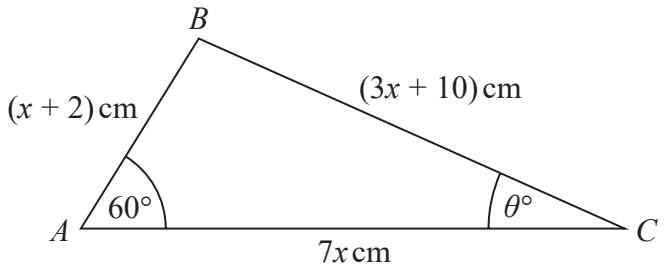


**Figure 1**

Figure 1 shows a sketch of triangle $ABC$ with $AB = (x + 2)$ cm, $BC = (3x + 10)$ cm, $AC = 7x$ cm, angle $BAC = 60°$ and angle $ACB = \theta°$

(a) (i) Show that $17x^2 - 35x - 48 = 0$

**(3)**

(ii) Hence find the value of $x$.

**(1)**

(b) Hence find the value of $\theta$ giving your answer to one decimal place.

**(2)**

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**Question 4 continued**

**Question 4 continued**

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**Question 4 continued**

**(Total for Question 4 is 6 marks)**

**5.** The mass, $A$ kg, of algae in a small pond, is modelled by the equation

$$A = pq^t$$

where $p$ and $q$ are constants and $t$ is the number of weeks after the mass of algae was first recorded.

Data recorded indicates that there is a linear relationship between $t$ and $\log_{10} A$ given by the equation

$$\log_{10} A = 0.03t + 0.5$$

(a) Use this relationship to find a complete equation for the model in the form

$$A = pq^t$$

giving the value of $p$ and the value of $q$ each to 4 significant figures.

**(4)**

(b) With reference to the model, interpret

(i) the value of the constant $p$,

(ii) the value of the constant $q$.

**(2)**

(c) Find, according to the model,

(i) the mass of algae in the pond when $t = 8$, giving your answer to the nearest 0.5 kg,

(ii) the number of weeks it takes for the mass of algae in the pond to reach 4 kg.

**(3)**

(d) State one reason why this may not be a realistic model in the long term.

**(1)**

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**Question 5 continued**

**Question 5 continued**

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**Question 5 continued**

**(Total for Question 5 is 10 marks)**

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

$$\left(3 - \frac{2x}{9}\right)^8$$

giving each term in simplest form.

**(4)**

$$\mathrm{f}(x) = \left(\frac{x-1}{2x}\right)\left(3 - \frac{2x}{9}\right)^8$$

(b) Find the coefficient of $x^2$ in the series expansion of $\mathrm{f}(x)$, giving your answer as a simplified fraction.

**(2)**

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**Question 6 continued**

**Question 6 continued**

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**Question 6 continued**

**(Total for Question 6 is 6 marks)**

**7.** (a) Factorise completely $9x - x^3$

**(2)**

The curve $C$ has equation

$$y = 9x - x^3$$

(b) Sketch $C$ showing the coordinates of the points at which the curve cuts the $x$-axis.

**(2)**

The line $l$ has equation $y = k$ where $k$ is a constant.

Given that $C$ and $l$ intersect at 3 distinct points,

(c) find the range of values for $k$, writing your answer in set notation.

**Solutions relying on calculator technology are not acceptable.**

**(3)**

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**Question 7 continued**

**Question 7 continued**

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**Question 7 continued**

**(Total for Question 7 is 7 marks)**

**8.** **In this question you must show all stages of your working.**

**Solutions relying entirely on calculator technology are not acceptable.**

The air pressure, $P$ kg/cm$^2$, inside a car tyre, $t$ minutes from the instant when the tyre developed a puncture is given by the equation

$$P = k + 1.4e^{-0.5t} \qquad t \in \mathbb{R} \qquad t \geqslant 0$$

where $k$ is a constant.

Given that the initial air pressure inside the tyre was 2.2 kg/cm$^2$

(a) state the value of $k$.

**(1)**

From the instant when the tyre developed the puncture,

(b) find the time taken for the air pressure to fall to 1 kg/cm$^2$
Give your answer in minutes to one decimal place.

**(3)**

(c) Find the rate at which the air pressure in the tyre is decreasing exactly 2 minutes from the instant when the tyre developed the puncture.
Give your answer in kg/cm$^2$ per minute to 3 significant figures.

**(2)**

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**Question 8 continued**

**(Total for Question 8 is 6 marks)**

**9.** (a) Given that $p = \log_3 x$, where $x > 0$, find in simplest form in terms of $p$,

(i) $\log_3\left(\frac{x}{9}\right)$

(ii) $\log_3\left(\sqrt{x}\right)$

**(2)**

(b) Hence, or otherwise, solve

$$2\log_3\left(\frac{x}{9}\right) + 3\log_3\left(\sqrt{x}\right) = -11$$

giving your answer as a simplified fraction.

**Solutions relying on calculator technology are not acceptable.**

**(4)**

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**Question 9 continued**

**(Total for Question 9 is 6 marks)**

**10.**

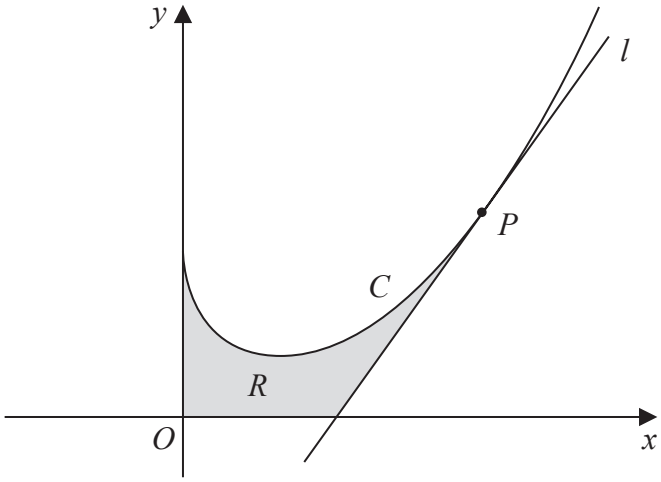


**Figure 2**

**In this question you must show all stages of your working.**

**Solutions relying on calculator technology are not acceptable.**

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

$$y = \frac{1}{3}x^2 - 2\sqrt{x} + 3 \qquad x \geqslant 0$$

The point $P$ lies on $C$ and has $x$ coordinate 4

The line $l$ is the tangent to $C$ at $P$.

(a) Show that $l$ has equation

$$13x - 6y - 26 = 0$$

**(5)**

The region $R$, shown shaded in Figure 2, is bounded by the $y$-axis, the curve $C$, the line $l$ and the $x$-axis.

(b) Find the exact area of $R$.

**(5)**

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**Question 10 continued**

**Question 10 continued**

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**Question 10 continued**

**(Total for Question 10 is 10 marks)**

**11.**

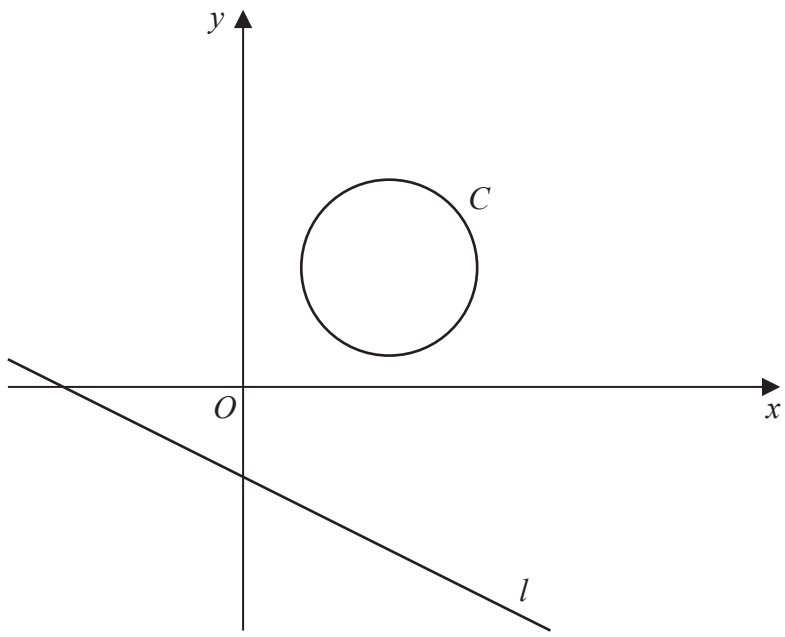


**Figure 3**

Figure 3 shows the circle $C$ with equation

$$x^2 + y^2 - 10x - 8y + 32 = 0$$

and the line $l$ with equation

$$2y + x + 6 = 0$$

(a) Find

(i) the coordinates of the centre of $C$,

(ii) the radius of $C$.

**(3)**

(b) Find the shortest distance between $C$ and $l$.

**(5)**

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**Question 11 continued**

**Question 11 continued**

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**Question 11 continued**

**(Total for Question 11 is 8 marks)**

**12.** A company makes drinks containers out of metal.

The containers are modelled as closed cylinders with base radius $r$ cm and height $h$ cm and the capacity of each container is 355 $\text{cm}^3$

The metal used

- for the circular base and the curved side costs 0.04 pence/$\text{cm}^2$
- for the circular top costs 0.09 pence/$\text{cm}^2$

Both metals used are of negligible thickness.

(a) Show that the total cost, $C$ pence, of the metal for one container is given by

$$C = 0.13\pi r^2 + \frac{28.4}{r}$$

**(4)**

(b) Use calculus to find the value of $r$ for which $C$ is a minimum, giving your answer to 3 significant figures.

**(4)**

(c) Using $\frac{\mathrm{d}^2C}{\mathrm{d}r^2}$ prove that the cost is minimised for the value of $r$ found in part (b).

**(2)**

(d) Hence find the minimum value of $C$, giving your answer to the nearest integer.

**(2)**

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**Question 12 continued**

**Question 12 continued**

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**Question 12 continued**

**(Total for Question 12 is 12 marks)**

**13.** **In this question you must show all stages of your working.**

**Solutions relying entirely on calculator technology are not acceptable.**

(a) Show that

$$\frac{1}{\cos\theta} + \tan\theta \equiv \frac{\cos\theta}{1 - \sin\theta} \qquad \theta \neq (2n+1)90° \quad n \in \mathbb{Z}$$

**(3)**

Given that $\cos 2x \neq 0$

(b) solve for $0 < x < 90°$

$$\frac{1}{\cos 2x} + \tan 2x = 3\cos 2x$$

giving your answers to one decimal place.

**(5)**

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**Question 13 continued**

**Question 13 continued**

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**Question 13 continued**

**(Total for Question 13 is 8 marks)**

**14.** (i) A student states

"if $x^2$ is greater than 9 then $x$ must be greater than 3"

Determine whether or not this statement is true, giving a reason for your answer.

**(1)**

(ii) Prove that for all positive integers $n$,

$$n^3 + 3n^2 + 2n$$

is divisible by 6

**(3)**

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**Question 14 continued**

**Question 14 continued**

**(Total for Question 14 is 4 marks)**

**TOTAL FOR PAPER IS 100 MARKS**

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