Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel Level 3 GCE

Thursday 14 May 2026

Afternoon (Time: 1 hour 30 minutes)

Paper reference **9FM0/01**

Further Mathematics

Advanced

PAPER 1: Core Pure Mathematics 1

You must have:
Mathematical Formulae and Statistical Tables (Green), calculator

Total Marks

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.

I nstruc tions

- 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 9 questions in this question paper. The total mark for this paper is 75.
  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 answerevery question.
  Check your answers ifyouhave time at the end.

Turn over ▶

1.

*With respect to the **right-hand rule**, a rotation through $\theta°$ anticlockwise about the y-axis is represented by the matrix*

$$\mathbf{M} = \begin{matrix} \cos & 0 & \sin \\ 0 & 1 & 0 \\ \sin & 0 & \cos \end{matrix}$$

The point P has coordinates $(k, 2, k)$, where k is a constant.

(a) Determine the coordinates of the image of P under the transformation represented by **M**, giving the answer in terms of k and θ

(2)

Given that the image of P lies on the plane with equation

$$x + z = 4$$

(b) show that $k = 2 \sec \theta$

(2)

Given also that $k = 4$ and $0 < \theta < \dfrac{\pi}{2}$

(c) describe the single geometric transformation represented by **M**

(1)

Question 1 continued

(TotalforQuestion 1 is 5 marks)

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

A complex number z is given by $z = \lambda - 2i$, where λ is a real constant and $\lambda > 0$

(a) Show that

$$3z^* + z^2 = (\lambda^2 + 3\lambda - 4) + i(6 - 4\lambda)$$

(3)

Given that $3z^* + z^2$ is imaginary,

(b) determine the value of λ.

(2)

(c) Hence determine,

(i) the exact value of $\frac{1}{2} z \frac{1}{2}$

(1)

(ii) arg z, giving your answer in radians, to 3 significant figures.

(2)

(d) Show z, z^* and $3z^* + z^2$ on a single Argand diagram.

(2)

(TotalforQuestion 2 is 10 marks)

3. (a) Use the standard results for summations to show that, for all positive integers n,

$$\sum_{r=1}^{n} (2r-1)^3 \equiv n^2(an^2+b)$$

where a and b are integers to be determined.

(5)

(b) Hence, making your method clear, determine

$$11^3 + 13^3 + 15^3 + \ldots + 97^3 + 99^3$$

(2)

(TotalforQuestion 3 is 7 marks)

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

f()^{x} $^{x\ 5}$ ~~$x2\ \ 25$~~

Show that the mean value of f (x) over the interval [0, 5] is

$$a \ln 2 + b\pi$$

where a and b are rational numbers to be determined.

(5)

(TotalforQuestion 4 is 5 marks)

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

The cubic equation

$$16x^3 - 156x^2 + 260x + 75 = 0$$

has roots α, β and γ

Without solving the equation,

(a) write down the value of

(i) $\alpha + \beta + \gamma$

(ii) $\alpha\beta + \alpha\gamma + \beta\gamma$

(iii) $\alpha\beta\gamma$

(2)

Given that $\beta = 3\alpha$

(b) use the results from part (a) to determine the exact roots of the equation.
You must make your method clear.

(3)

Question 5 continued

(TotalforQuestion 5 is 5 marks)

6. A game is downloaded from the internet.

During the download, the download speed, x megabits per second (Mb s^{-1}), is modelled by the differential equation

$$\frac{d^2x}{t2d} \quad 4\frac{dx}{dt} \quad 148x\ 4440$$

where t minutes is the time after the download was started.

(a) Determine the general solution of the differential equation.

(6)

Given that initially

- the download speed is 28 Mb s^{-1}
- the download speed is increasing at a rate of 47 Mb s^{-1} every minute

(b) determine the particular solution of the differential equation.

(3)

Question 6 continued

(TotalforQuestion 6 is 9 marks)

7. (i) The series S is defined as

$$S = e^{i\theta} + e^{3i\theta} + e^{5i\theta} + e^{7i\theta} + \ldots + e^{19i\theta}$$

Show that

$$S = \frac{e^{10i\theta} \sin 10\theta}{\sin\theta}$$

(3)

(ii) The convergent infinite series P and Q are defined as

$$P \quad \frac{1}{2}\cos\theta \quad \frac{1}{4}\cos 3\theta \quad \frac{1}{8}\cos 5\theta \quad \ldots$$

$$Q \quad \frac{1}{2}\sin\theta \quad \frac{1}{4}\sin 3\theta \quad \frac{1}{8}\sin 5\theta \quad \ldots$$

Making your method clear, show that

$$P \quad iQ \quad \frac{1}{2e^{i\theta} \quad e^{i\theta}}$$

(4)

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Question 7 **continued**

(TotalforQuestion 7 is 7 marks)

8. (a) Given that

$$z^n + \frac{1}{z^n} \equiv 2\cos n\theta \qquad n \in \mathbb{N}$$

show that

$$64\cos^7\theta \equiv a\cos 7\theta + b\cos 5\theta + c\cos 3\theta + d\cos\theta$$

where a, b, c and d are integers to be found.

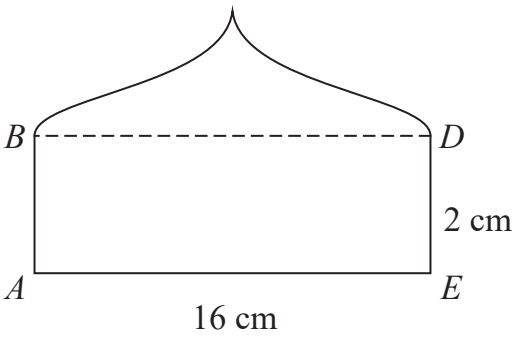

Figure 1

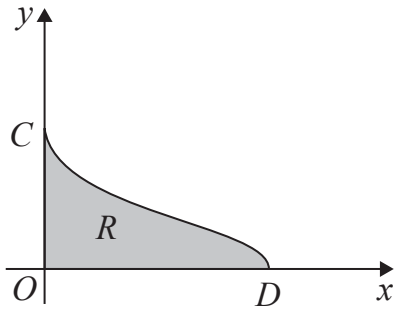

Figure 2

(5)

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

Figure 1 shows the central vertical cross-section *ABCDEA* of a solid paperweight.

Figure 2 shows the region *R*, bounded by the curve *CD*, the *x*-axis and the *y*-axis.

The paperweight is made up of a dome on top of a cylinder such that

- the cylinder has diameter 16 cm and height 2 cm
- the dome is obtained by rotating *R* through 2π radians about the *y*-axis

The curve *CD* is modelled by the equation

$$x = k\sqrt{\cos^7 y} \qquad 0 \quad y \quad \frac{\pi}{2}$$

where k is a constant.

(b) Determine the value of k

(1)

(c) Using algebraic integration and showing all your working, determine, according to the model, the volume of the paperweight, giving your answer to the nearest cm^3

(5)

(d) State a limitation of the model.

(1)

Question 8 **continued**

(TotalforQuestion 8 is 12 marks)

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

A scientist studies the reaction of two chemicals X and Y during an experiment.

The masses of each chemical, t hours after the experiment begins, are modelled by the differential equations

$$\frac{dx}{dt} = 5x - y \qquad \frac{dy}{dt} = 2x - 2y$$

where x and y are the masses, in mg, of chemical X and chemical Y respectively.

(a) Show that

$$\frac{d^2x}{dt^2} - 7\frac{dx}{dt} + 12x = 0 \qquad \text{(I)}$$

(3)

Initially, the mass of chemical X is 3 mg and the mass of chemical Y is 1 mg.

(b) Solve equation (I) to determine the particular solution for the mass of chemical X at time t.

(6)

(c) Hence, or otherwise, determine the particular solution for the mass of chemical Y at time t.

(2)

(d) Use the equations found in part (b) and part (c) to determine

(i) the mass, in mg, of chemical X after 15 minutes, giving the answer to 3 significant figures,

(ii) the exact time when the mass of chemical Y is four times the mass of chemical X

(3)

Given that it takes 2 hours for the mass of chemical Y to be four times the mass of chemical X

(e) evaluate the model, giving a reason for your answer.

(1)

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(Total for Question 9 is 15 marks)

TOTAL FOR PAPER IS 75 MARKS