

Write your name here

Surname

Other names

**Pearson Edexcel**  
**Level 3 GCE**

Centre Number

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Candidate Number

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# Mathematics

**Advanced**

**Paper 2: Pure Mathematics 2**

Sample Assessment Material for first teaching September 2017

**Time: 2 hours**

Paper Reference

**9MA0/02**

**You must have:**

Mathematical Formulae and Statistical Tables, 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.**

## 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.
- 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.
- If you change your mind about an answer cross it out and put your new answer and any working out underneath.

Turn over ►

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Answer ALL questions. Write your answers in the spaces provided.

1.

$$f(x) = 2x^3 - 5x^2 + ax + a$$

Given that  $(x + 2)$  is a factor of  $f(x)$ , find the value of the constant  $a$ .

(3)

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(Total for Question 1 is 3 marks)

2. Some A level students were given the following question.

Solve, for  $-90^\circ < \theta < 90^\circ$ , the equation

$$\cos \theta = 2 \sin \theta$$

The attempts of two of the students are shown below.

Student A

$$\cos \theta = 2 \sin \theta$$

$$\tan \theta = 2$$

$$\theta = 63.4^\circ$$

Student B

$$\cos \theta = 2 \sin \theta$$

$$\cos^2 \theta = 4 \sin^2 \theta$$

$$1 - \sin^2 \theta = 4 \sin^2 \theta$$

$$\sin^2 \theta = \frac{1}{5}$$

$$\sin \theta = \pm \frac{1}{\sqrt{5}}$$

$$\theta = \pm 26.6^\circ$$

- (a) Identify an error made by student A.

(1)

Student B gives  $\theta = -26.6^\circ$  as one of the answers to  $\cos \theta = 2 \sin \theta$ .

- (b) (i) Explain why this answer is incorrect.

- (ii) Explain how this incorrect answer arose.

(2)

(Total for Question 2 is 3 marks)

3. Given  $y = x(2x + 1)^4$ , show that

$$\frac{dy}{dx} = (2x + 1)^n (Ax + B)$$

where  $n$ ,  $A$  and  $B$  are constants to be found.

(4)

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



5. The mass,  $m$  grams, of a radioactive substance,  $t$  years after first being observed, is modelled by the equation

$$m = 25e^{-0.05t}$$

According to the model,

- (a) find the mass of the radioactive substance six months after it was first observed, (2)

- (b) show that  $\frac{dm}{dt} = km$ , where  $k$  is a constant to be found. (2)

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(Total for Question 5 is 4 marks)

6. Complete the table below. The first one has been done for you.

For each statement you must state if it is always true, sometimes true or never true, giving a reason in each case.

Statement	Always True	Sometimes True	Never True	Reason
The quadratic equation $ax^2 + bx + c = 0$ , ( $a \neq 0$ ) has 2 real roots.		✓		It only has 2 real roots when $b^2 - 4ac > 0$ . When $b^2 - 4ac = 0$ it has 1 real root and when $b^2 - 4ac < 0$ it has 0 real roots.
(i)  When a real value of $x$ is substituted into $x^2 - 6x + 10$ the result is positive.  (2)				
(ii)  If $ax > b$ then $x > \frac{b}{a}$  (2)				
(iii)  The difference between consecutive square numbers is odd.  (2)				

(Total for Question 6 is 6 marks)

7. (a) Use the binomial expansion, in ascending powers of  $x$ , to show that

$$\sqrt{4-x} = 2 - \frac{1}{4}x + kx^2 + \dots$$

where  $k$  is a rational constant to be found.

(4)

A student attempts to substitute  $x = 1$  into both sides of this equation to find an approximate value for  $\sqrt{3}$ .

- (b) State, giving a reason, if the expansion is valid for this value of  $x$ .

(1)

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8.

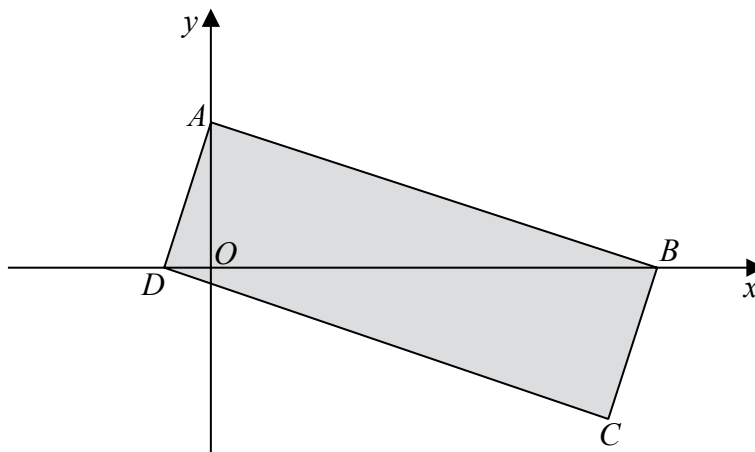


Figure 1

Figure 1 shows a rectangle  $ABCD$ .

The point  $A$  lies on the  $y$ -axis and the points  $B$  and  $D$  lie on the  $x$ -axis as shown in Figure 1.

Given that the straight line through the points  $A$  and  $B$  has equation  $5y + 2x = 10$

(a) show that the straight line through the points  $A$  and  $D$  has equation  $2y - 5x = 4$  (4)

(b) find the area of the rectangle  $ABCD$ . (3)

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9. Given that  $A$  is constant and

$$\int_1^4 (3\sqrt{x} + A) dx = 2A^2$$

show that there are exactly two possible values for  $A$ .

(5)

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**(Total for Question 9 is 5 marks)**

10. In a geometric series the common ratio is  $r$  and sum to  $n$  terms is  $S_n$

Given

$$S_{\infty} = \frac{8}{7} \times S_6$$

show that  $r = \pm \frac{1}{\sqrt{k}}$ , where  $k$  is an integer to be found.

(4)

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(Total for Question 10 is 4 marks)





12. (a) Solve, for  $-180^\circ \leq x < 180^\circ$ , the equation

$$3 \sin^2 x + \sin x + 8 = 9 \cos^2 x$$

giving your answers to 2 decimal places.

(6)

(b) Hence find the smallest positive solution of the equation

$$3 \sin^2(2\theta - 30^\circ) + \sin(2\theta - 30^\circ) + 8 = 9 \cos^2(2\theta - 30^\circ)$$

giving your answer to 2 decimal places.

(2)

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14. A company decides to manufacture a soft drinks can with a capacity of 500 ml.

The company models the can in the shape of a right circular cylinder with radius  $r$  cm and height  $h$  cm.

In the model they assume that the can is made from a metal of negligible thickness.

- (a) Prove that the total surface area,  $S$  cm<sup>2</sup>, of the can is given by

$$S = 2\pi r^2 + \frac{1000}{r} \quad (3)$$

Given that  $r$  can vary,

- (b) find the dimensions of a can that has minimum surface area. (5)
- (c) With reference to the shape of the can, suggest a reason why the company may choose not to manufacture a can with minimum surface area. (1)

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15.

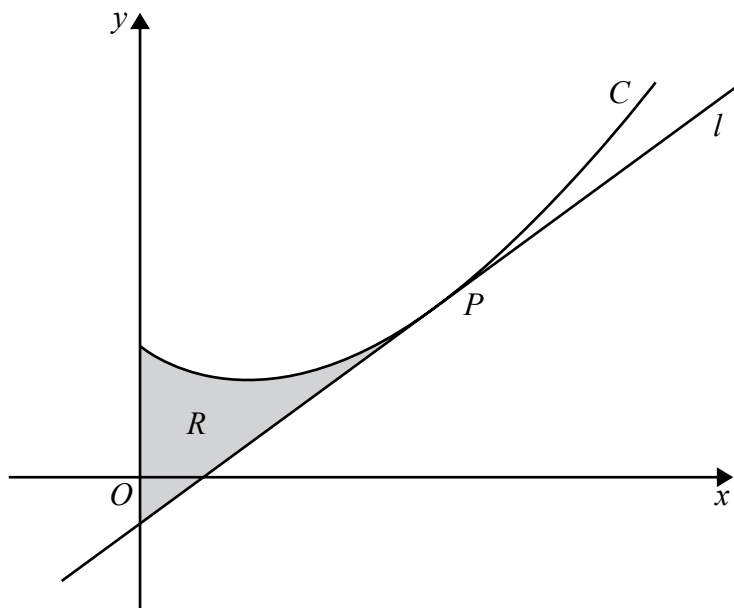


Figure 4

Figure 4 shows a sketch of the curve  $C$  with equation

$$y = 5x^{\frac{3}{2}} - 9x + 11, x \geq 0$$

The point  $P$  with coordinates  $(4, 15)$  lies on  $C$ .

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

The region  $R$ , shown shaded in Figure 4, is bounded by the curve  $C$ , the line  $l$  and the  $y$ -axis.

Show that the area of  $R$  is 24, making your method clear.

*(Solutions based entirely on graphical or numerical methods are not acceptable.)*

(10)

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16. (a) Express  $\frac{1}{P(11 - 2P)}$  in partial fractions. (3)

A population of meerkats is being studied.

The population is modelled by the differential equation

$$\frac{dP}{dt} = \frac{1}{22}P(11 - 2P), \quad t \geq 0, \quad 0 < P < 5.5$$

where  $P$ , in thousands, is the population of meerkats and  $t$  is the time measured in years since the study began.

Given that there were 1000 meerkats in the population when the study began,

- (b) determine the time taken, in years, for this population of meerkats to double, (6)

- (c) show that

$$P = \frac{A}{B + Ce^{-\frac{1}{2}t}}$$

where  $A$ ,  $B$  and  $C$  are integers to be found. (3)

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