



SPECIMEN MATERIAL

Please write clearly, in block capitals.

Centre number

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Candidate number

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Surname

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Forename(s)

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Candidate signature

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# A-level MATHEMATICS

## Paper 1

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Exam Date

Morning

Time allowed: 2 hours

### Materials

For this paper you must have:

- The AQA booklet of formulae and statistical tables.
- You may use a graphics calculator.

### Instructions

- Use black ink or black ball-point pen. Pencil should be used for drawing.
- Answer **all** questions.
- You must answer each question in the space provided for that question. If you require extra space, use an AQA supplementary answer book; do **not** use the space provided for a different question.
- Do not write outside the box around each page.
- Show all necessary working; otherwise marks for method may be lost.
- Do all rough work in this book. Cross through any work that you do not want to be marked.

### Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 100.

### Advice

Unless stated otherwise, you may quote formulae, without proof, from the booklet. You do not necessarily need to use all the space provided.

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Answer **all** questions in the spaces provided.

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- 1 Find the gradient of the line with equation  $2x + 5y = 7$

Circle your answer.

[1 mark]

$$\frac{2}{5}$$

$$\frac{5}{2}$$

$$-\frac{2}{5}$$

$$-\frac{5}{2}$$

- 2 A curve has equation  $y = \frac{2}{\sqrt{x}}$

Find  $\frac{dy}{dx}$

Circle your answer.

[1 mark]

$$\frac{\sqrt{x}}{3}$$

$$\frac{1}{x\sqrt{x}}$$

$$-\frac{1}{x\sqrt{x}}$$

$$-\frac{1}{2x\sqrt{x}}$$

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- 3** When  $\theta$  is small, find an approximation for  $\cos 3\theta + \theta \sin 2\theta$ , giving your answer in the form  $a + b\theta^2$

**[3 marks]**

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**Turn over for the next question**

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**Turn over ▶**

**4**       $p(x) = 2x^3 + 7x^2 + 2x - 3$

**4 (a)**      Use the factor theorem to prove that  $x + 3$  is a factor of  $p(x)$

**[2 marks]**

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**5 (b)** Find the value of  $\theta$ . Explain why it is the only possible value.

**[4 marks]**

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**Turn over for the next question**

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**Turn over ▶**

**6** Sam goes on a diet. He assumes that his mass,  $m$  kg after  $t$  days, decreases at a rate that is inversely proportional to the cube root of his mass.

**6 (a)** Construct a differential equation involving  $m$ ,  $t$  and a positive constant  $k$  to model this situation.

**[3 marks]**

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**6 (b)** Explain why Sam's assumption may not be appropriate.

**[1 mark]**

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**9 (b)** Find the values of  $x$  for which  $y$  is increasing.

**[2 marks]**

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**Turn over for the next question**

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**Turn over ▶**

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**10** The function  $f$  is defined by

$$f(x) = 4 + 3^{-x}, \quad x \in \mathbb{R}$$

**10 (a)** Using set notation, state the range of  $f$

**[2 marks]**

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**10 (b)** The inverse of  $f$  is  $f^{-1}$

**10 (b) (i)** Using set notation, state the domain of  $f^{-1}$

**[1 mark]**

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**10 (b) (ii)** Find an expression for  $f^{-1}(x)$

**[3 marks]**

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**10 (c)** The function  $g$  is defined by

$$g(x) = 5 - \sqrt{x}, \quad (x \in \mathbb{R} : x > 0)$$

**10 (c) (i)** Find an expression for  $gf(x)$

[1 mark]

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**10 (c) (ii)** Solve the equation  $gf(x) = 2$ , giving your answer in an exact form.

[3 marks]

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**11** A circle with centre  $C$  has equation  $x^2 + y^2 + 8x - 12y = 12$

**11 (a)** Find the coordinates of  $C$  and the radius of the circle.

**[3 marks]**

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- 11 (b)** The points  $P$  and  $Q$  lie on the circle.  
The origin is the midpoint of the chord  $PQ$ .  
Show that  $PQ$  has length  $n\sqrt{3}$ , where  $n$  is an integer.

[5 marks]

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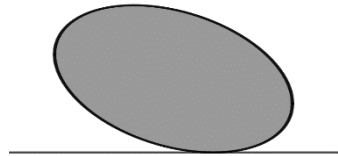
12

A sculpture formed from a prism is fixed on a horizontal platform, as shown in the diagram.

The shape of the cross-section of the sculpture can be modelled by the equation

$$x^2 + 2xy + 2y^2 = 10, \text{ where } x \text{ and } y \text{ are measured in metres.}$$

The  $x$  and  $y$  axes are horizontal and vertical respectively.



Find the maximum vertical height above the platform of the sculpture.

**[8 marks]**

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**13** Prove the identity  $\cot^2 \theta - \cos^2 \theta \equiv \cot^2 \theta \cos^2 \theta$

**[3 marks]**



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**14 (b) (i) In reality, the thickness of the base and sides of the tank is 2.5 cm**

Briefly explain how you would refine your modelling to take account of the thickness of the sides and base of the tank of the tank.

**[1 mark]**

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**14 (b) (ii) How would your refinement affect your answer to part (a)?**

**[1 mark]**



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**15 (b)** Find the maximum height of the column of water, giving your answer to the nearest cm.

**[1 mark]**

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**16** A student argues that when a rational number is multiplied by an irrational number the result will always be an irrational number.

**16 (a)** Identify the rational number for which the student's argument is not true. **[1 mark]**

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**16 (b)** Prove that the student is right for all rational numbers other than the one you have identified in part (a). **[4 marks]**

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**17**  $f(x) = \sin x$

Using differentiation from first principles find the exact value of  $f'\left(\frac{\pi}{6}\right)$

Fully justify your answer.

**[6 marks]**

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**END OF QUESTIONS**

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**There are no questions printed on this page**

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