



## Cambridge International AS & A Level

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**MATHEMATICS**

**9709/12**

Paper 1 Pure Mathematics 1

**February/March 2021**

**1 hour 50 minutes**

You must answer on the question paper.

You will need: List of formulae (MF19)

### INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- If additional space is needed, you should use the lined page at the end of this booklet; the question number or numbers must be clearly shown.
- You should use a calculator where appropriate.
- You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.

### INFORMATION

- The total mark for this paper is 75.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **20** pages. Any blank pages are indicated.

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1 (a) Find the first three terms in the expansion, in ascending powers of  $x$ , of  $(1 + x)^5$ . [1]

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(b) Find the first three terms in the expansion, in ascending powers of  $x$ , of  $(1 - 2x)^6$ . [2]

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(c) Hence find the coefficient of  $x^2$  in the expansion of  $(1 + x)^5(1 - 2x)^6$ . [2]

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2 By using a suitable substitution, solve the equation

$$(2x - 3)^2 - \frac{4}{(2x - 3)^2} - 3 = 0. \quad [4]$$

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3 Solve the equation  $\frac{\tan \theta + 2 \sin \theta}{\tan \theta - 2 \sin \theta} = 3$  for  $0^\circ < \theta < 180^\circ$ .

[4]

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4 A line has equation  $y = 3x + k$  and a curve has equation  $y = x^2 + kx + 6$ , where  $k$  is a constant.

Find the set of values of  $k$  for which the line and curve have two distinct points of intersection. [5]

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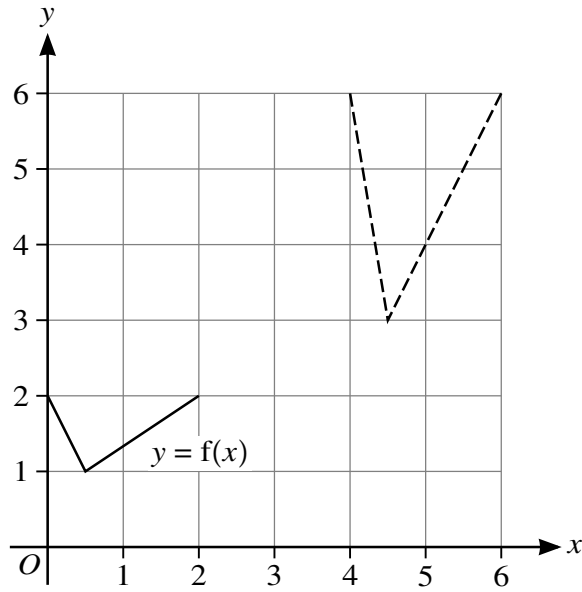
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In the diagram, the graph of  $y = f(x)$  is shown with solid lines. The graph shown with broken lines is a transformation of  $y = f(x)$ .

- (a) Describe fully the two single transformations of  $y = f(x)$  that have been combined to give the resulting transformation. [4]

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- (b) State in terms of  $y$ ,  $f$  and  $x$ , the equation of the graph shown with broken lines. [2]

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- 6 A curve is such that  $\frac{dy}{dx} = \frac{6}{(3x-2)^3}$  and  $A(1, -3)$  lies on the curve. A point is moving along the curve and at  $A$  the  $y$ -coordinate of the point is increasing at 3 units per second.

(a) Find the rate of increase at  $A$  of the  $x$ -coordinate of the point. [3]

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7 Functions  $f$  and  $g$  are defined as follows:

$$f : x \mapsto x^2 + 2x + 3 \text{ for } x \leq -1,$$

$$g : x \mapsto 2x + 1 \text{ for } x \geq -1.$$

(a) Express  $f(x)$  in the form  $(x + a)^2 + b$  and state the range of  $f$ . [3]

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(b) Find an expression for  $f^{-1}(x)$ . [2]

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(c) Solve the equation  $gf(x) = 13$ . [3]

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8 The points  $A(7, 1)$ ,  $B(7, 9)$  and  $C(1, 9)$  are on the circumference of a circle.

(a) Find an equation of the circle. [5]

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(b) Find an equation of the tangent to the circle at  $B$ . [2]

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9 The first term of a progression is  $\cos \theta$ , where  $0 < \theta < \frac{1}{2}\pi$ .

(a) For the case where the progression is geometric, the sum to infinity is  $\frac{1}{\cos \theta}$ .

(i) Show that the second term is  $\cos \theta \sin^2 \theta$ . [3]

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(ii) Find the sum of the first 12 terms when  $\theta = \frac{1}{3}\pi$ , giving your answer correct to 4 significant figures. [2]

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- (b) For the case where the progression is arithmetic, the first two terms are again  $\cos \theta$  and  $\cos \theta \sin^2 \theta$  respectively.

Find the 85th term when  $\theta = \frac{1}{3}\pi$ . [4]

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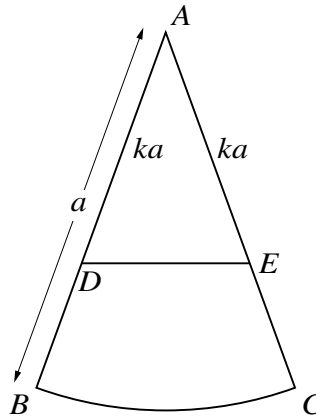
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The diagram shows a sector  $ABC$  which is part of a circle of radius  $a$ . The points  $D$  and  $E$  lie on  $AB$  and  $AC$  respectively and are such that  $AD = AE = ka$ , where  $k < 1$ . The line  $DE$  divides the sector into two regions which are equal in area.

- (a) For the case where angle  $BAC = \frac{1}{6}\pi$  radians, find  $k$  correct to 4 significant figures. [5]

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- (b) For the general case in which angle  $BAC = \theta$  radians, where  $0 < \theta < \frac{1}{2}\pi$ , it is given that  $\frac{\theta}{\sin \theta} > 1$ .

Find the set of possible values of  $k$ .

[3]

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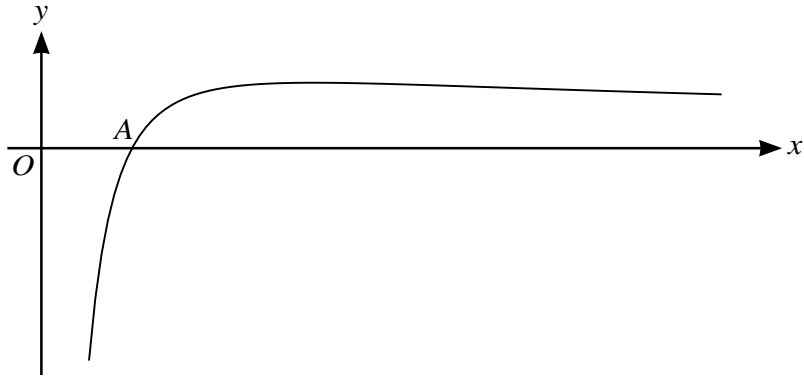
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The diagram shows the curve with equation  $y = 9(x^{-\frac{1}{2}} - 4x^{-\frac{3}{2}})$ . The curve crosses the  $x$ -axis at the point  $A$ .

(a) Find the  $x$ -coordinate of  $A$ . [2]

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(b) Find the equation of the tangent to the curve at  $A$ . [4]

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(c) Find the  $x$ -coordinate of the maximum point of the curve. [2]

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(d) Find the area of the region bounded by the curve, the  $x$ -axis and the line  $x = 9$ . [4]

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**Additional Page**

If you use the following lined page to complete the answer(s) to any question(s), the question number(s) must be clearly shown.

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