



## Cambridge O Level

CANDIDATE  
NAME

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**ADDITIONAL MATHEMATICS**

**4037/22**

Paper 2

**May/June 2022**

**2 hours**

You must answer on the question paper.

No additional materials are needed.

### 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.
- 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 80.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **16** pages.

**Mathematical Formulae****1. ALGEBRA***Quadratic Equation*

For the equation  $ax^2 + bx + c = 0$ ,

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

*Binomial Theorem*

$$(a + b)^n = a^n + \binom{n}{1}a^{n-1}b + \binom{n}{2}a^{n-2}b^2 + \dots + \binom{n}{r}a^{n-r}b^r + \dots + b^n$$

where  $n$  is a positive integer and  $\binom{n}{r} = \frac{n!}{(n-r)!r!}$

*Arithmetic series*      $u_n = a + (n-1)d$

$$S_n = \frac{1}{2}n(a+l) = \frac{1}{2}n\{2a + (n-1)d\}$$

*Geometric series*      $u_n = ar^{n-1}$

$$S_n = \frac{a(1-r^n)}{1-r} \quad (r \neq 1)$$

$$S_\infty = \frac{a}{1-r} \quad (|r| < 1)$$

**2. TRIGONOMETRY***Identities*

$$\begin{aligned} \sin^2 A + \cos^2 A &= 1 \\ \sec^2 A &= 1 + \tan^2 A \\ \operatorname{cosec}^2 A &= 1 + \cot^2 A \end{aligned}$$

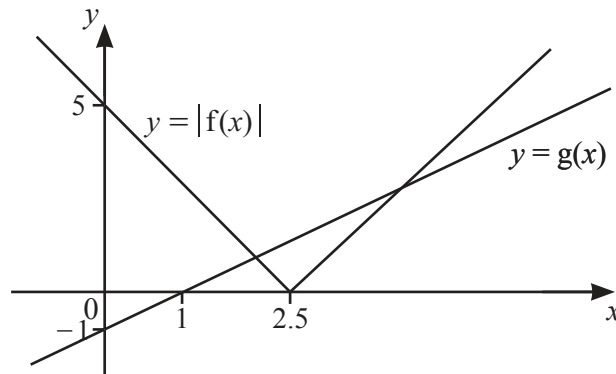
*Formulae for  $\triangle ABC$* 

$$\begin{aligned} \frac{a}{\sin A} &= \frac{b}{\sin B} = \frac{c}{\sin C} \\ a^2 &= b^2 + c^2 - 2bc \cos A \\ \Delta &= \frac{1}{2}bc \sin A \end{aligned}$$

**1 DO NOT USE A CALCULATOR IN THIS QUESTION.**

A curve has equation  $y = \frac{6 + \sqrt{x}}{3 + \sqrt{x}}$  where  $x \geq 0$ . Find the exact value of  $y$  when  $x = 6$ . Give your answer in the form  $a + b\sqrt{c}$ , where  $a$ ,  $b$  and  $c$  are integers. [3]

**2**



The diagram shows the graphs of  $y = |f(x)|$  and  $y = g(x)$ , where  $y = f(x)$  and  $y = g(x)$  are straight lines. Solve the inequality  $|f(x)| \leq g(x)$ . [5]

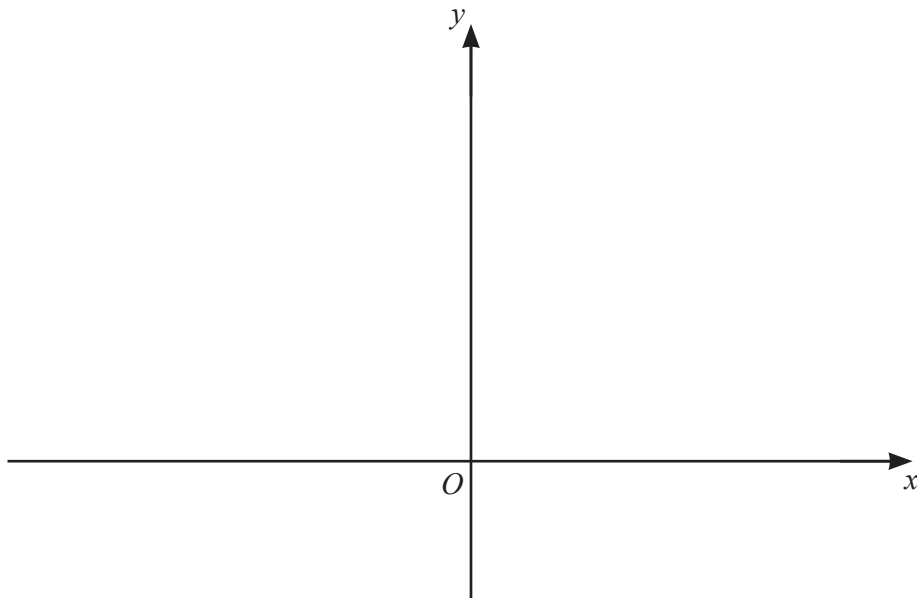
3 Find the possible values of  $k$  for which the equation  $kx^2 + (k+5)x - 4 = 0$  has real roots. [5]

4 Variables  $x$  and  $y$  are related by the equation  $y = 1 + \frac{2}{x} + \frac{1}{x^2}$  where  $x > 0$ . Use differentiation to find the approximate change in  $x$  when  $y$  increases from 4 by the small amount 0.01. [5]

5 (a) Solve the equation  $\frac{625^{\frac{x^3-1}{2}}}{125^{x^3}} = 5$ .

[3]

(b) On the axes, sketch the graph of  $y = 4e^x + 3$  showing the values of any intercepts with the coordinate axes. [2]



- 6 (a) In this question,  $\mathbf{i}$  is a unit vector due east and  $\mathbf{j}$  is a unit vector due north.

A cyclist rides at a speed of  $4 \text{ ms}^{-1}$  on a bearing of  $015^\circ$ . Write the velocity vector of the cyclist in the form  $x\mathbf{i} + y\mathbf{j}$ , where  $x$  and  $y$  are constants. [2]

- (b) A vector of magnitude 6 on a bearing of  $300^\circ$  is added to a vector of magnitude 2 on a bearing of  $230^\circ$  to give a vector  $\mathbf{v}$ . Find the magnitude and bearing of  $\mathbf{v}$ . [5]

7 Differentiate  $y = \frac{e^{4x} \tan x}{\ln x}$  with respect to  $x$ .

[4]

8 The function  $f$  is defined by  $f(x) = 3 \sin^2 x - 2 \cos x$  for  $2 \leq x \leq 4$ , where  $x$  is in radians.

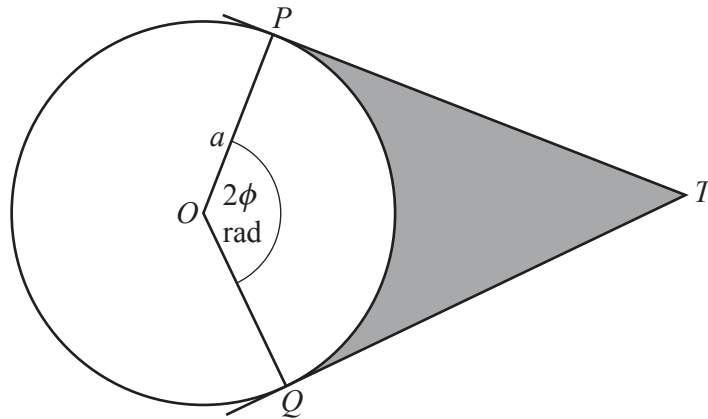
(a) Find the  $x$ -coordinate of the stationary point on the curve  $y = f(x)$ . [5]



(b) Solve the equation  $f(x) = 1 - 3 \cos x$ .

[5]

9 In this question all lengths are in centimetres.



The diagram shows a circle, centre  $O$ , radius  $a$ . The lines  $PT$  and  $QT$  are tangents to the circle at  $P$  and  $Q$  respectively. Angle  $POQ$  is  $2\phi$  radians.

- (a) In the case when the area of the sector  $OPQ$  is equal to the area of the shaded region, show that  $\tan \phi = 2\phi$ . [4]

- (b) In the case when the perimeter of the sector  $OPQ$  is equal to half the perimeter of the shaded region, find an expression for  $\tan \phi$  in terms of  $\phi$ . [3]

10 (a) A geometric progression has first term  $a$  and common ratio  $r$ , where  $r > 0$ . The second term of this progression is 8. The sum of the third and fourth terms is 160.

(i) Show that  $r$  satisfies the equation  $r^2 + r - 20 = 0$ . [4]

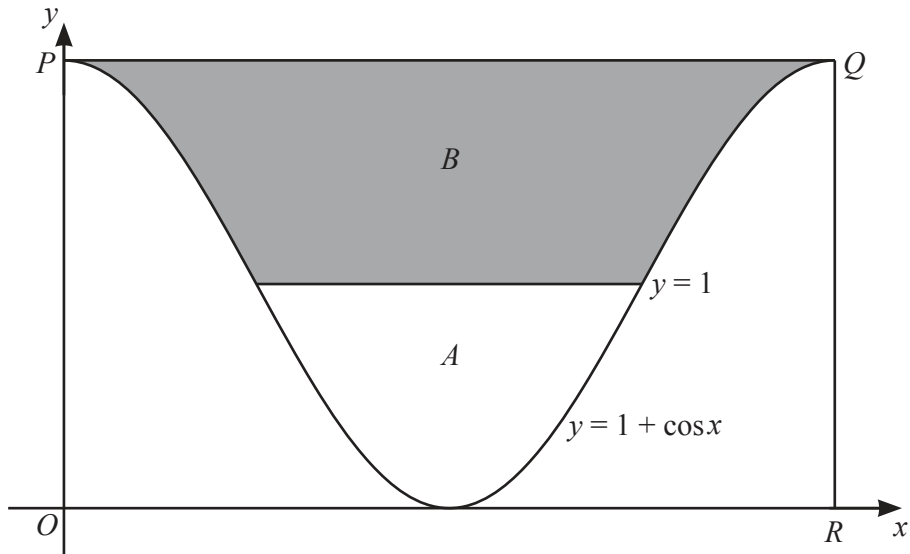
(ii) Find the value of  $a$ . [3]

- (b) An arithmetic progression has first term  $p$  and common difference 2. The  $q$ th term of this progression is 14.  
A different arithmetic progression has first term  $p$  and common difference 4. The sum of the first  $q$  terms of this progression is 168.

Find the values of  $p$  and  $q$ .

[6]

11



The diagram shows part of the line  $y = 1$  and one complete period of the curve  $y = 1 + \cos x$ , where  $x$  is in radians. The line  $PQ$  is a tangent to the curve at  $P$  and at  $Q$ . The line  $QR$  is parallel to the  $y$ -axis. Area  $A$  is enclosed by the line  $y = 1$  and the curve. Area  $B$  is enclosed by the line  $y = 1$ , the line  $PQ$  and the curve.

Given that area  $A$  : area  $B$  is  $1 : k$  find the exact value of  $k$ .

[9]

Continuation of working space for Question 11.

**Question 12 is printed on the next page.**

- 12 A curve is such that  $\frac{d^2y}{dx^2} = \left(\frac{\sqrt{x}+1}{\sqrt[4]{x}}\right)^2$ . Given that the gradient of the curve is  $\frac{4}{3}$  at the point  $(1, -1)$ , find the equation of the curve. [7]

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