



# Cambridge O Level

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NAME

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**ADDITIONAL MATHEMATICS**

**4037/24**

Paper 2

**May/June 2021**

**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  $\triangle ABC$* 

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

3

1 Find the exact solution of the equation  $\frac{p^{\frac{3}{2}} + p^{\frac{1}{2}}}{p^{-\frac{1}{2}}} = 4$ . [3]

2 Find  $\int \left( \frac{1}{2x-3} + \sqrt{x} \right) dx$ . [3]

- 3 Variables  $x$  and  $y$  are such that when  $\lg y$  is plotted against  $\lg x$  a straight line passing through the points  $(-1, -4)$  and  $(2, 11)$  is obtained. Show that  $y = ax^n$ , where  $a$  and  $n$  are integers. [6]

- 4 The normal to the curve  $y = x^5 - 2x^3 + x^2 + 3$  at the point on the curve where  $x = -1$ , cuts the  $x$ -axis at the point  $P$ . Find the equation of the normal and the coordinates of  $P$ . [7]

- 5 Solve the simultaneous equations  $3y = x - 20$  and  $x^2 + y^2 - 2x + 6y = 0$ . [4]

6 The variables  $x$  and  $y$  are such that  $y = \sqrt[3]{x^3 - 91}$ .

(a) Find an expression for  $\frac{dy}{dx}$ . [2]

(b) Hence, find the approximate change in  $y$  as  $x$  increases from 6 to  $6 + h$ , where  $h$  is small. [2]

7 (a) Write the expression  $4x^2 - 4x + 7$  in the form  $p(x+q)^2 + r$ , where  $p$ ,  $q$  and  $r$  are constants. [3]

(b) Hence find the greatest value of  $\frac{1}{4x^2 - 4x + 7}$  and state the value of  $x$  at which this occurs. [2]



8 (a) (i) Show that  $\frac{\cos^2 2x}{1 + \sin 2x} = 1 - \sin 2x$ . [2]

(ii) Hence solve  $\frac{3 \cos^2 2x}{1 + \sin 2x} = 1$  for  $0^\circ \leq x \leq 90^\circ$ . [4]

(b) Solve  $\cot\left(y - \frac{\pi}{2}\right) = \sqrt{3}$  for  $0 \leq y \leq \pi$  radians. [3]

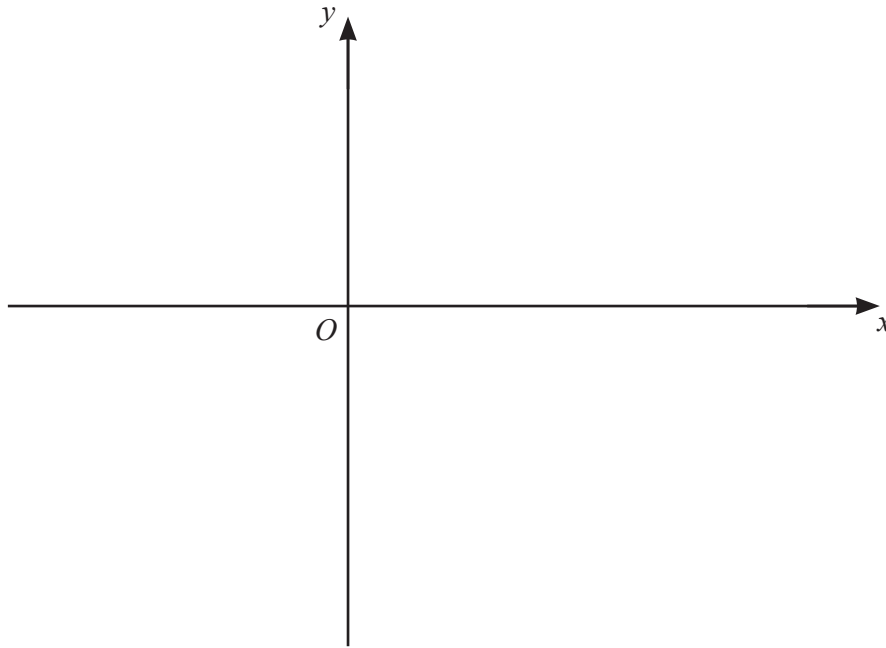
9 A function  $f$  is defined, for all real values of  $x$ , by  $f(x) = 3 + e^{5x}$ .

(a) Find the range of  $f$ . [1]

(b) Find an expression for  $f^{-1}(x)$  and state its domain. [3]

(c) Solve  $f^{-1}(x) = 0$ . [2]

- (d) Sketch the graph of  $y = f(x)$ . Hence, on the same axes, sketch the graph of  $y = f^{-1}(x)$ . Give the coordinates of any points where the graphs cross the axes. [4]



- 10 (a) A particle  $P$  travels in a straight line so that,  $t$  seconds after passing through a fixed point  $O$ , its displacement,  $s$  metres from  $O$ , is given by

$$s = \frac{31}{3} - \frac{e^t}{3} - 10e^{-t}.$$

- (i) Find the value of  $t$  when  $P$  is at instantaneous rest, giving your answer correct to 2 significant figures. [4]

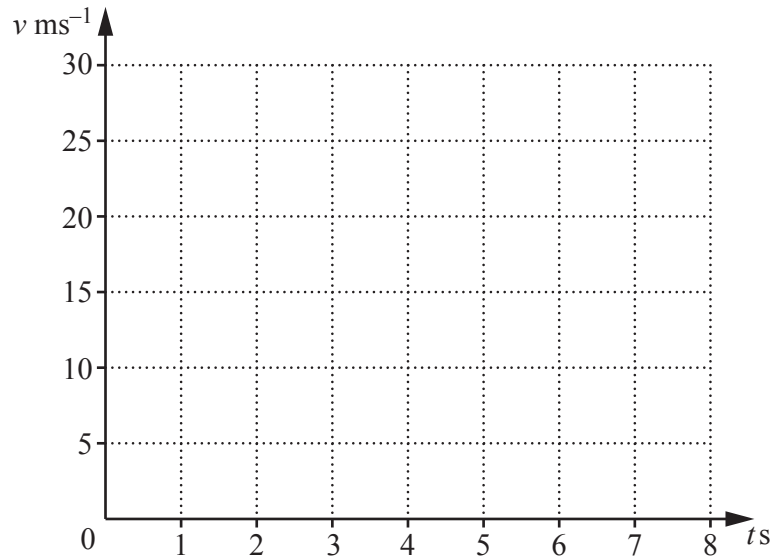
- (ii) Find the distance travelled in the first two seconds. [3]

- (b) A particle  $Q$  travels in a straight line so that  $t$  seconds after leaving a fixed point  $O$ , its velocity,  $v \text{ ms}^{-1}$ , is given by

$$v = 2t \quad \text{for } 0 \leq t \leq 5,$$

$$v = t^2 - 8t + 25 \quad \text{for } t > 5.$$

- (i) On the axes below, sketch the velocity-time graph for the first 8 seconds of the motion of particle  $Q$ . [2]



- (ii) Showing all your working, find the distance travelled by  $Q$  in the first 8 seconds of its motion. [5]

11  $OAB$  is a triangle. The position vectors of points  $A$  and  $B$  relative to the origin  $O$  are  $\mathbf{a}$  and  $\mathbf{b}$  respectively.

The side  $AB$  is extended to point  $C$  such that  $AB = \frac{1}{4}AC$ .

(a) Show that  $\overrightarrow{OC} = 4\mathbf{b} - 3\mathbf{a}$ .

[2]

- (b) The point  $D$  lies on  $OA$  such that  $OD : DA$  is  $3 : 2$ . The line  $CD$  meets  $OB$  at the point  $E$ . Find the position vector of the point  $E$ . [5]

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

- 12 (a) The first term of an arithmetic progression is  $-5$  and the fifth term is  $7$ . Find the sum of the first 40 terms of this progression. [4]

- (b) A geometric progression has third term of  $8$  and sixth term of  $0.064$ . Find the sum to infinity of this progression. [4]

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