



# Cambridge O Level

CANDIDATE  
NAME

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**ADDITIONAL MATHEMATICS**

**4037/12**

Paper 1

**October/November 2020**

**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. Blank pages are indicated.

**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  $\triangle ABC$* 

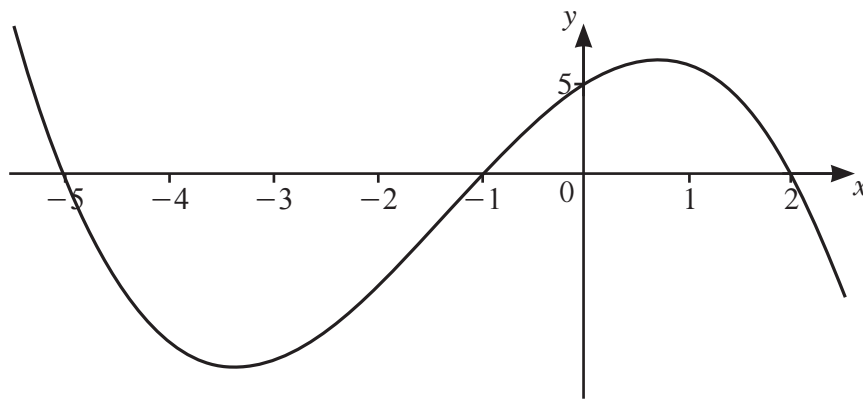
$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$a^2 = b^2 + c^2 - 2bc \cos A$$

$$\Delta = \frac{1}{2}bc \sin A$$

- 1 The curve  $y = 2x^2 + k + 4$  intersects the straight line  $y = (k+4)x$  at two distinct points. Find the possible values of  $k$ . [4]

2



The diagram shows the graph of  $y = f(x)$ , where  $f(x)$  is a cubic polynomial.

- (a) Find  $f(x)$ . [3]

- (b) Write down the values of  $x$  such that  $f(x) < 0$ . [2]

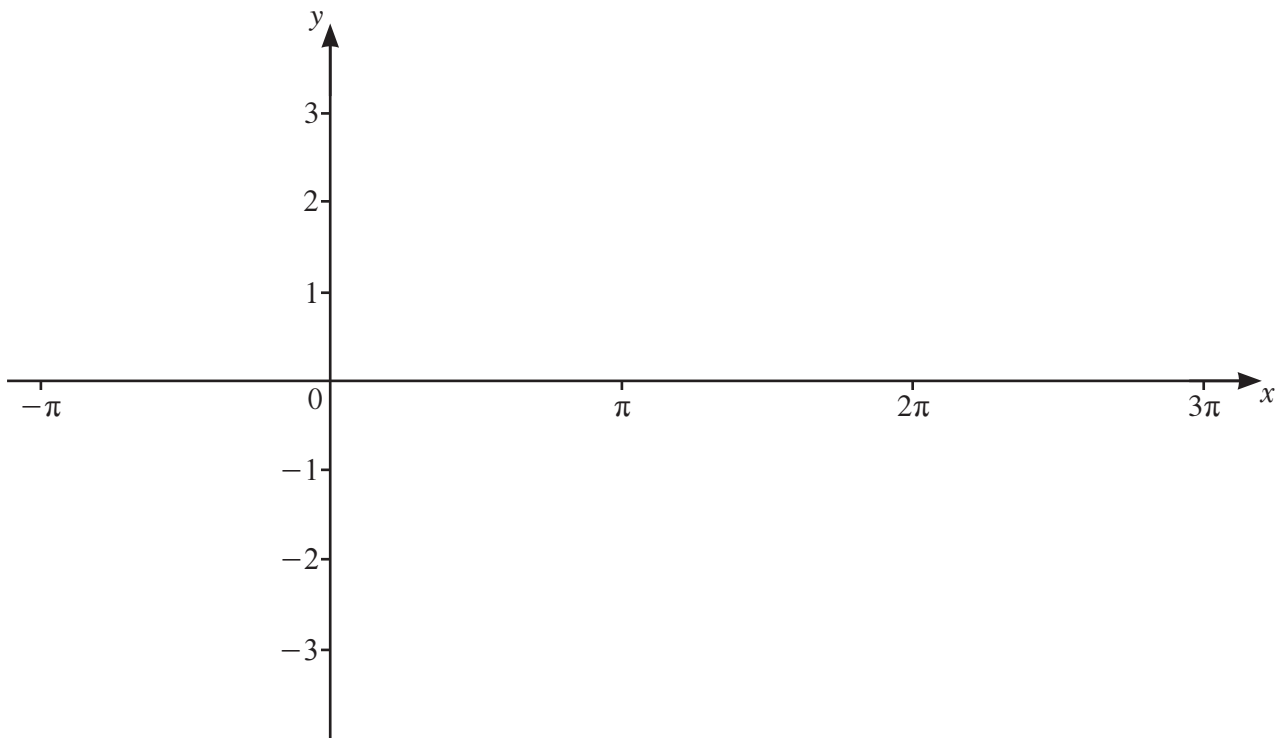
3 (a) Write down the amplitude of  $2 \cos \frac{x}{3} - 1$ .

[1]

(b) Write down the period of  $2 \cos \frac{x}{3} - 1$ .

[1]

(c) On the axes below, sketch the graph of  $y = 2 \cos \frac{x}{3} - 1$  for  $-\pi \leq x \leq 3\pi$  radians.



[3]

4 The 7th and 10th terms of an arithmetic progression are 158 and 149 respectively.

(a) Find the common difference and the first term of the progression.

[3]

(b) Find the least number of terms of the progression for their sum to be negative.

[3]

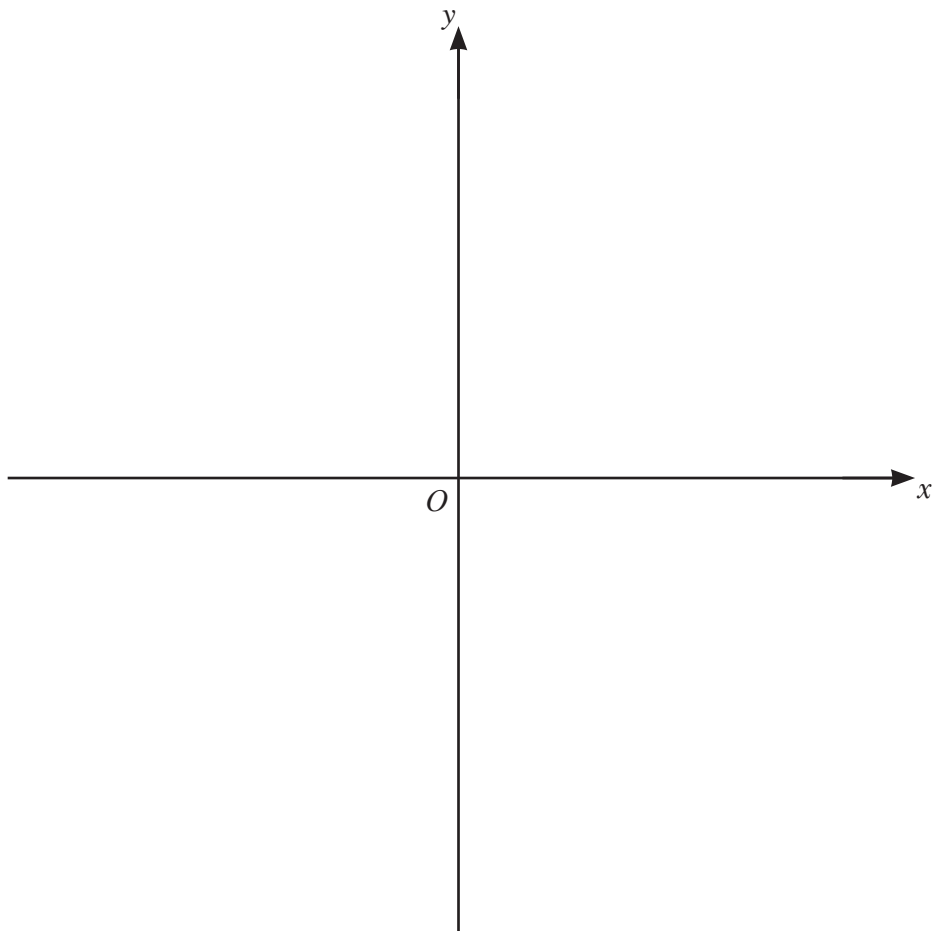
5 Find the coefficient of  $x^2$  in the expansion of  $\left(x - \frac{3}{x}\right)\left(x + \frac{2}{x}\right)^5$ .

[5]

6  $f(x) = x^2 + 2x - 3$  for  $x \geq -1$

- (a) Given that the minimum value of  $x^2 + 2x - 3$  occurs when  $x = -1$ , explain why  $f(x)$  has an inverse. [1]

- (b) On the axes below, sketch the graph of  $y = f(x)$  and the graph of  $y = f^{-1}(x)$ . Label each graph and state the intercepts on the coordinate axes.



[4]

7 A curve has equation  $y = \frac{\ln(3x^2 - 5)}{2x + 1}$  for  $3x^2 > 5$ .

(a) Find the equation of the normal to the curve at the point where  $x = \sqrt{2}$ . [6]

(b) Find the approximate change in  $y$  as  $x$  increases from  $\sqrt{2}$  to  $\sqrt{2} + h$ , where  $h$  is small. [1]



- 8 (a) Find the number of ways in which 12 people can be put into 3 groups containing 3, 4 and 5 people respectively. [3]

- (b) 4-digit numbers are to be formed using four of the digits 2, 3, 7, 8 and 9. Each digit may be used once only in any 4-digit number. Find how many 4-digit numbers can be formed if

(i) there are no restrictions, [1]

(ii) the number is even, [1]

(iii) the number is greater than 7000 and odd. [3]

9 A curve has equation  $y = (2x - 1)\sqrt{4x + 3}$ .

(a) Show that  $\frac{dy}{dx} = \frac{4(Ax + B)}{\sqrt{4x + 3}}$ , where  $A$  and  $B$  are constants.

[5]

(b) Hence write down the  $x$ -coordinate of the stationary point of the curve.

[1]

(c) Determine the nature of this stationary point.

[2]

10 The polynomial  $p(x) = 6x^3 + ax^2 + bx + 2$ , where  $a$  and  $b$  are integers, has a factor of  $x - 2$ .

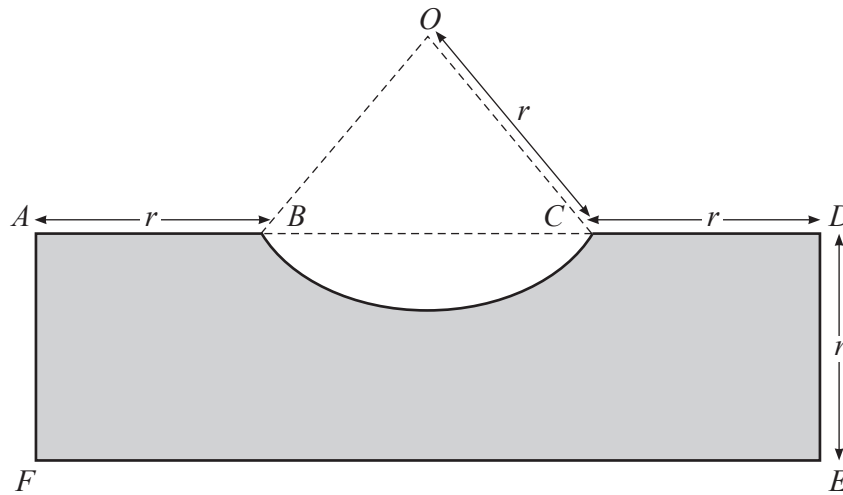
(a) Given that  $p(1) = -2p(0)$ , find the value of  $a$  and of  $b$ . [4]

(b) Using your values of  $a$  and  $b$ ,

(i) find the remainder when  $p(x)$  is divided by  $2x - 1$ , [2]

(ii) factorise  $p(x)$ . [2]

11 In this question all lengths are in centimetres and all angles are in radians.



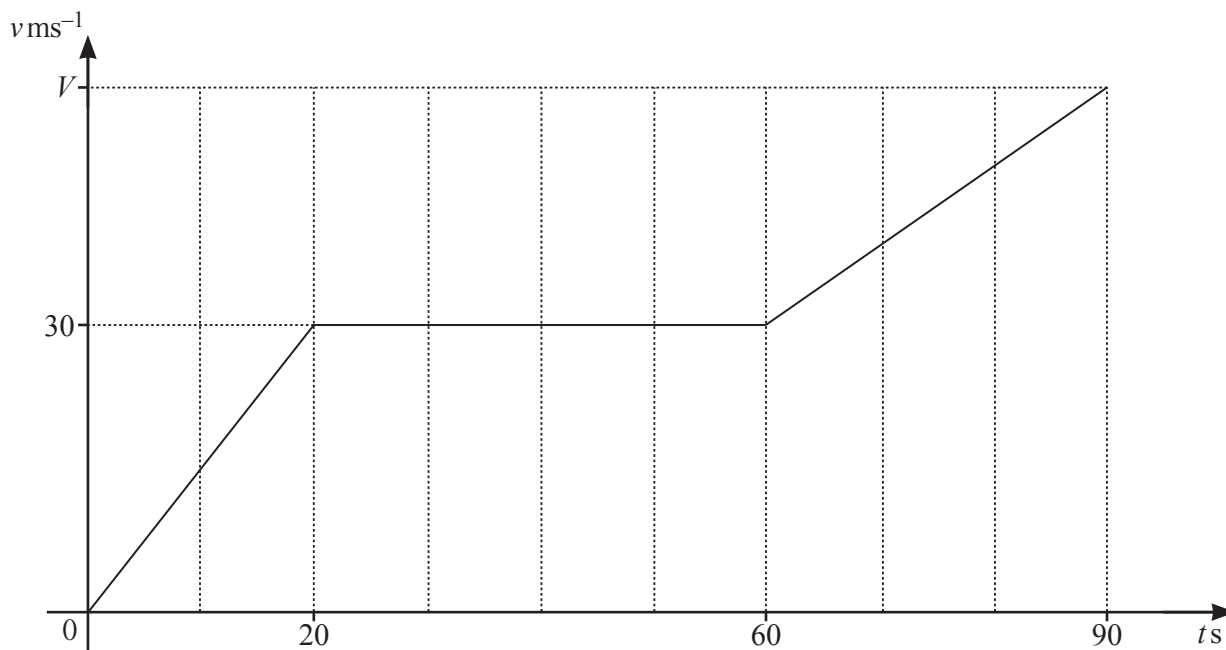
The diagram shows the rectangle  $ADEF$ , where  $AF = DE = r$ . The points  $B$  and  $C$  lie on  $AD$  such that  $AB = CD = r$ . The curve  $BC$  is an arc of the circle, centre  $O$ , radius  $r$  and has a length of  $1.5r$ .

(a) Show that the perimeter of the shaded region is  $(7.5 + 2 \sin 0.75)r$ . [5]

- (b) Find the area of the shaded region, giving your answer in the form  $kr^2$ , where  $k$  is a constant, correct to 2 decimal places. [4]



12 (a)



The diagram shows the velocity–time graph of a particle  $P$  that travels 2775 m in 90 s, reaching a final velocity of  $V \text{ ms}^{-1}$ .

(i) Find the value of  $V$ .

[3]

(ii) Write down the acceleration of  $P$  when  $t = 40$ .

[1]

(b) The acceleration,  $a \text{ ms}^{-2}$ , of a particle  $Q$  travelling in a straight line, is given by  $a = 6 \cos 2t$  at time  $t$  s. When  $t = 0$  the particle is at point  $O$  and is travelling with a velocity of  $10 \text{ ms}^{-1}$ .

(i) Find the velocity of  $Q$  at time  $t$ . [3]

(ii) Find the displacement of  $Q$  from  $O$  at time  $t$ . [3]

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