



Cambridge O Level

CANDIDATE
NAME



CENTRE
NUMBER

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ADDITIONAL MATHEMATICS

4037/22

Paper 2

October/November 2024

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 Solve the following simultaneous equations.

$$\frac{y}{x} = \frac{3}{2}$$

$$\frac{y^4}{x^5} = \frac{27}{16}$$

[3]





2 Variables x and y are related by the equation $y = x\sqrt{1+2x}$.

(a) Find $\frac{dy}{dx}$. [3]

(b) It is given that when $y = 12$, $x = 4$. Find the approximate change in x when y increases from 12 by the small amount 0.06. [3]

(c) Find the x -coordinate of the stationary point on the curve $y = x\sqrt{1+2x}$. [2]



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

The polynomial p is defined by $p(x) = ax^3 - 3x^2 - 3x + b$, where a and b are constants.

(a) Given that $x = 2$ and $x = -1$ are roots of the equation $p(x) = 0$, find a and b . [3]

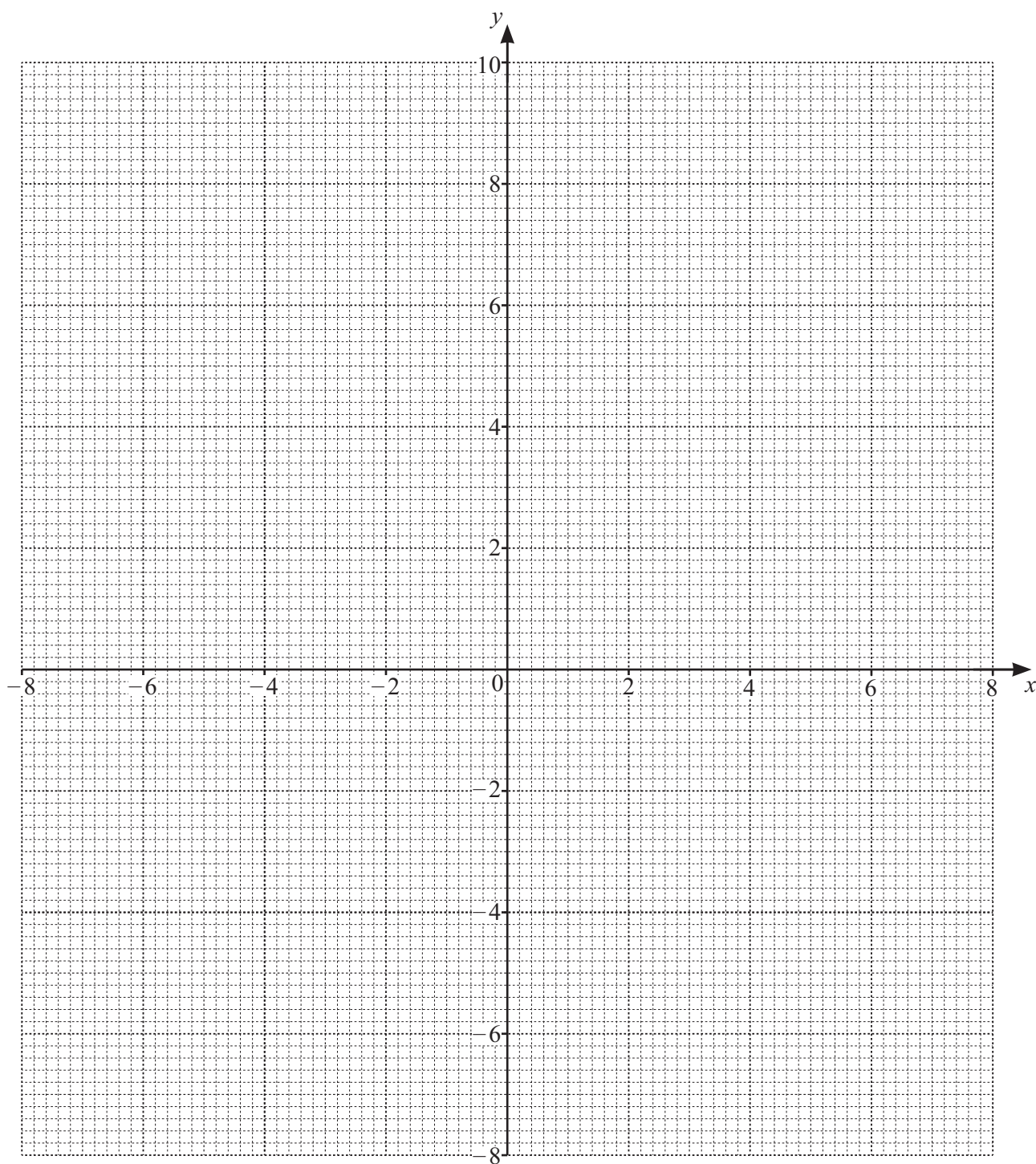
(b) Solve the equation $p(x) = 0$. [2]





4 Use a graphical method to solve the inequality $|2x - 8| > 4$.

[5]



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5 Solve the following equations.

(a) $\log_2 x^2 + \log_{16} x = 18$

[4]

(b) $e^{2x+1} - 10e^{-2x-1} = 3$

[4]



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

Write $(5 - \sqrt{3})(\sqrt{6} + \sqrt{2})^{-2}$ in the form $a + b\sqrt{3}$, where a and b are constants.

[5]

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7 A class of 10 students includes Abby and Ben.

(a) A group of 5 students is to be selected from the class. Find the number of possible groups in the following cases.

(i) There are no restrictions. [1]

(ii) The group includes both Abby and Ben. [2]

(iii) The group includes either Abby or Ben, but not both. [2]

(b) All 10 students are arranged in a line. How many arrangements are possible if there are exactly three students between Abby and Ben? [3]





8 Solve the equation $\cot^2 2\theta + 3 \operatorname{cosec} 2\theta = 9$ for $-90^\circ \leq \theta \leq 90^\circ$.

[6]

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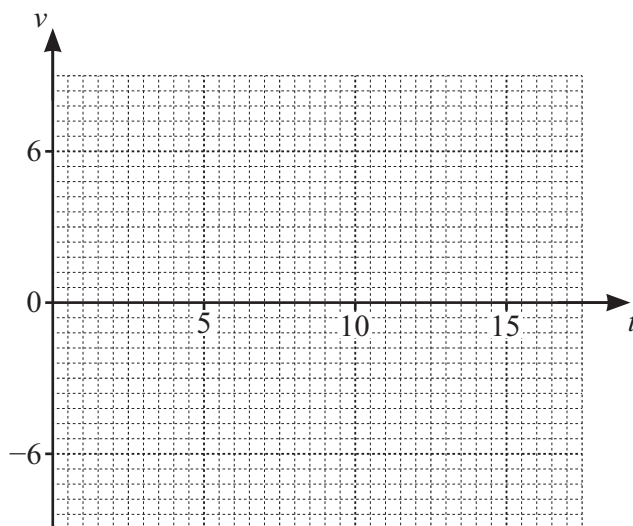
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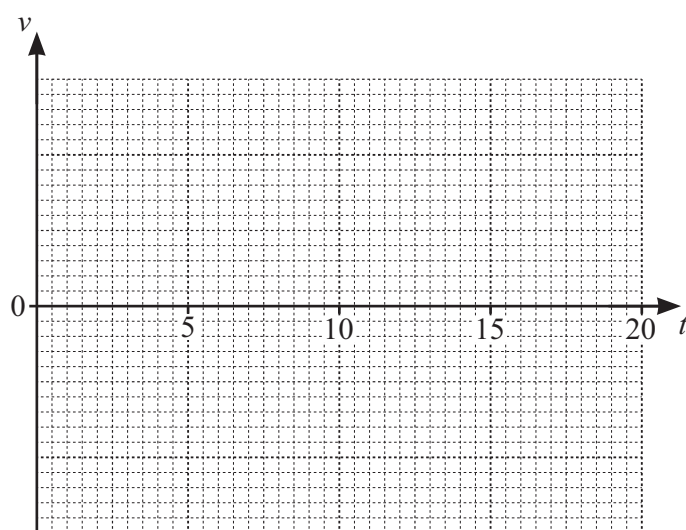


9 In this question time is measured in seconds.

- (a) A particle is moving in a straight line with constant velocity of 6 ms^{-1} . At time $t = 0$, it passes a fixed point A . At time $t = 5$ it suddenly changes direction and moves with a different constant velocity along the same straight line. It passes the point A again at time $t = 15$. Sketch the velocity–time graph for the motion. [3]

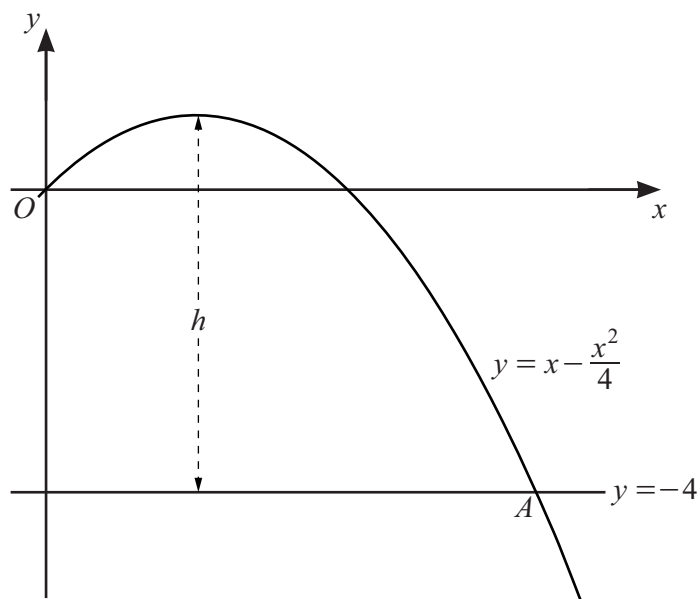


- (b) Another particle is moving in a straight line with constant acceleration. At time $t = 0$ it passes a fixed point B with velocity -8 ms^{-1} . It passes the point B again at time $t = 20$. Sketch the velocity–time graph for the motion. [3]





- 10 The diagram shows part of the curve $y = x - \frac{x^2}{4}$ and the line $y = -4$. The curve and the line intersect at the point A .



- (a) The maximum point on the curve is at a perpendicular distance h from the line $y = -4$. Find the value of h .

[4]





(b) Find the exact x -coordinate of A .

[3]

(c) Find the acute angle between the tangent to the curve at A and the line $y = -4$.

[4]

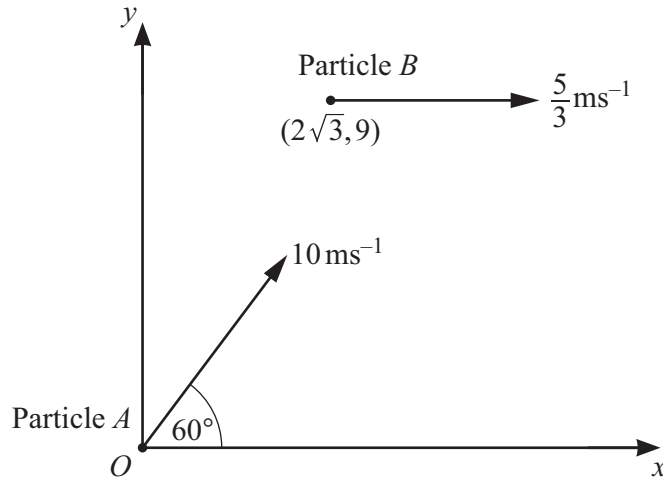


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- 11 In this question $\mathbf{i}$ is a unit vector in the positive x -direction and $\mathbf{j}$ is a unit vector in the positive y -direction. Time is in seconds and distances are in metres.

The diagram shows the initial positions and velocities of two particles, A and B , that move in the x - y plane.



Particle A starts from the origin O at time $t = 0$. It moves with constant speed 10 ms^{-1} in the direction 60° above the x -axis.

- (a) Find the exact values of the components of the velocity of particle A in the x -direction and the y -direction. [2]

- (b) Find, in terms of t , the position vector of particle A at time t . [1]





Particle B starts from the point $(2\sqrt{3}, 9)$ at time $t = 0$. It moves with constant speed $\frac{5}{3} \text{ ms}^{-1}$ parallel to the positive x -axis.

- (c) Find, in terms of t , the position vector of particle B at time t . [2]

- (d) Hence show that the particles collide. [4]

Question 12 is printed on the next page.





- 12 A metal tank is in the shape of a cuboid with a square base of side x m and an open top. The tank has a volume of 5 m^3 . Given that x can vary, and that the area of the metal used to make the tank is a minimum, find the dimensions of the tank. [6]

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