

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

$$u_n = ar^{n-1}$$

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

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

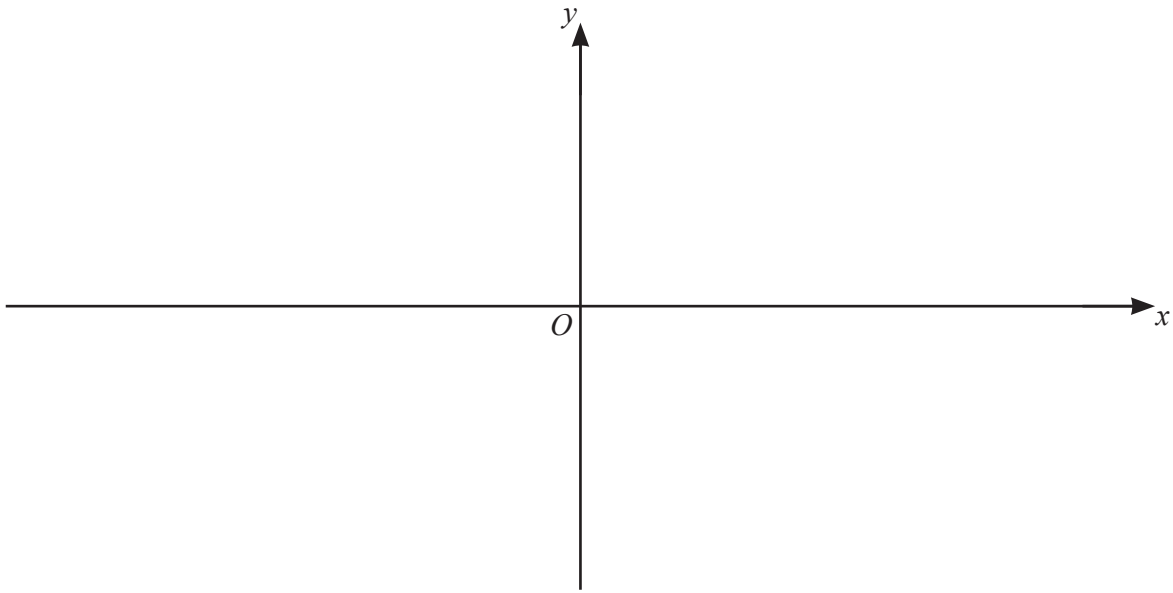
2. TRIGONOMETRY*Identities*

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

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 (a) On the axes, sketch the graph of $y = 5(x+1)(3x-2)(x-2)$, stating the intercepts with the coordinate axes. [3]



- (b) Hence find the values of x for which $5(x+1)(3x-2)(x-2) > 0$. [2]

- 2 Find $\int_3^5 \left(\frac{1}{x-1} - \frac{1}{(x-1)^2} \right) dx$, giving your answer in the form $a + \ln b$, where a and b are rational numbers. [5]

- 3** The polynomial $p(x) = ax^3 - 9x^2 + bx - 6$, where a and b are constants, has a factor of $x - 2$. The polynomial has a remainder of 66 when divided by $x - 3$.

(a) Find the value of a and of b . [4]

(b) Using your values of a and b , show that $p(x) = (x - 2)q(x)$, where $q(x)$ is a quadratic factor to be found. [2]

(c) Hence show that the equation $p(x) = 0$ has only one real solution. [2]

- 4 The first 3 terms in the expansion of $(a+x)^3\left(1-\frac{x}{3}\right)^5$, in ascending powers of x , can be written in the form $27+bx+cx^2$, where a , b and c are integers. Find the values of a , b and c . [8]

5 The functions f and g are defined as follows.

$$f(x) = x^2 + 4x \quad \text{for } x \in \mathbb{R}$$

$$g(x) = 1 + e^{2x} \quad \text{for } x \in \mathbb{R}$$

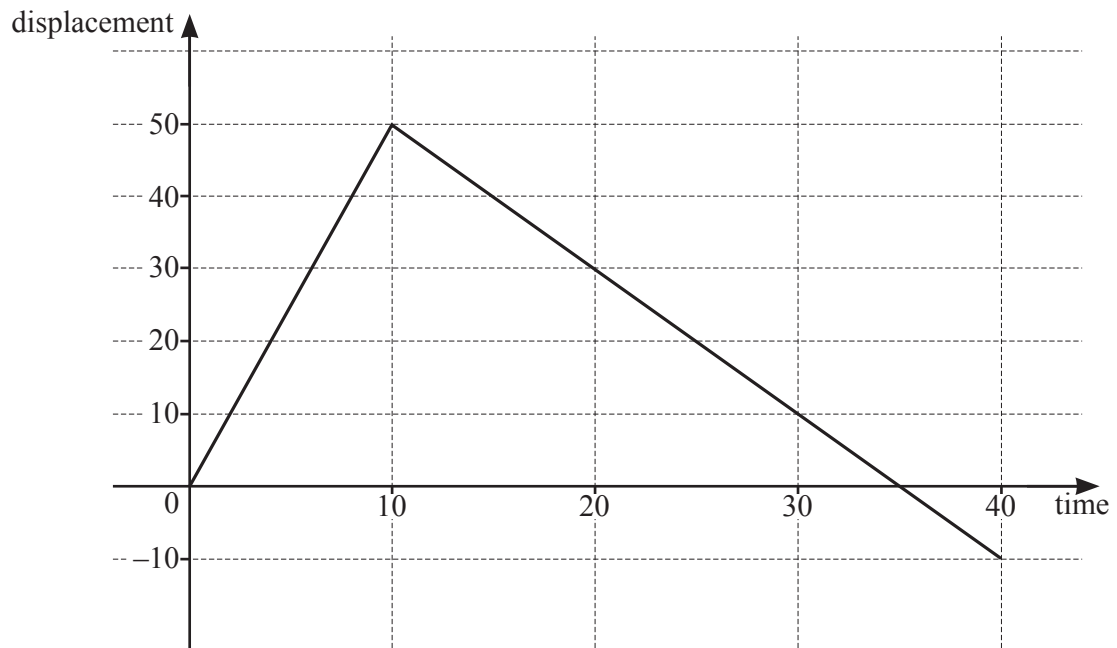
(a) Find the range of f . [2]

(b) Write down the range of g . [1]

(c) Find the exact solution of the equation $fg(x) = 21$, giving your answer as a single logarithm. [4]

- 6 (a) (i) Find how many different 5-digit numbers can be formed using the digits 1, 3, 5, 6, 8 and 9. No digit may be used more than once in any 5-digit number. [1]
- (ii) How many of these 5-digit numbers are odd? [1]
- (iii) How many of these 5-digit numbers are odd and greater than 60 000? [3]
- (b) Given that $45 \times {}^nC_4 = (n+1) \times {}^{n+1}C_5$, find the value of n . [4]

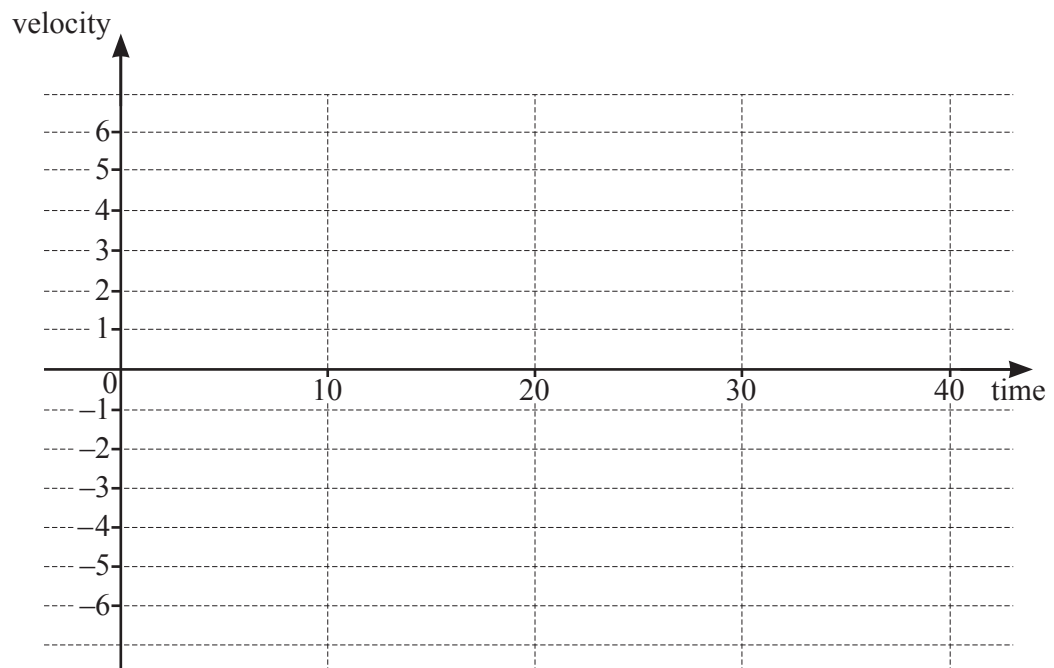
- 7 (a) In this question, all lengths are in metres and time, t , is in seconds.



The diagram shows the displacement–time graph for a runner, for $0 \leq t \leq 40$.

- (i) Find the distance the runner has travelled when $t = 40$. [1]

- (ii) On the axes, draw the corresponding velocity–time graph for the runner, for $0 \leq t \leq 40$. [2]



- (b) A particle, P , moves in a straight line such that its displacement from a fixed point at time t is s .

The acceleration of P is given by $(2t+4)^{-\frac{1}{2}}$, for $t > 0$.

- (i) Given that P has a velocity of 9 when $t = 6$, find the velocity of P at time t . [3]

- (ii) Given that $s = \frac{1}{3}$ when $t = 6$, find the displacement of P at time t . [3]

8 DO NOT USE A CALCULATOR IN THIS QUESTION.

A curve has equation $y = (2 - \sqrt{3})x^2 + x - 1$. The x -coordinate of a point A on the curve is $\frac{\sqrt{3} + 1}{2 - \sqrt{3}}$.

- (a) Show that the coordinates of A can be written in the form $(p + q\sqrt{3}, r + s\sqrt{3})$, where p , q , r and s are integers. [5]

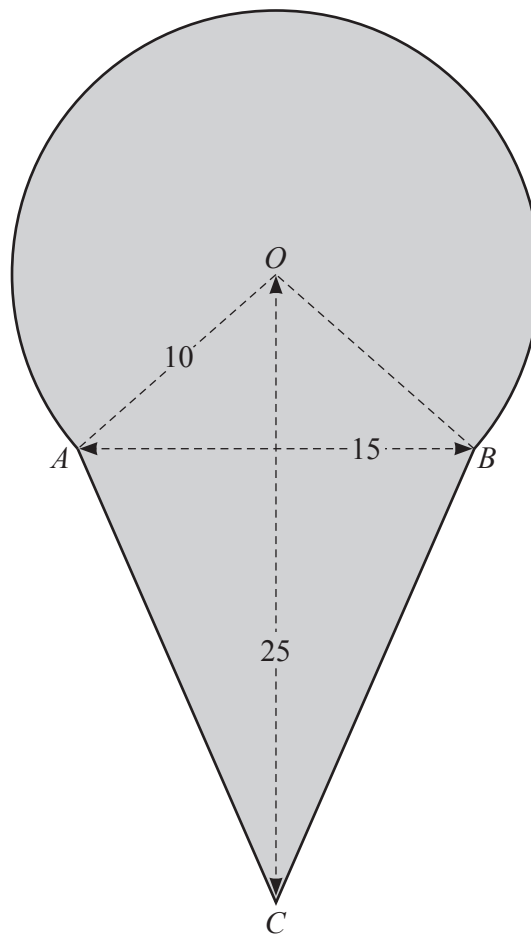
- (b) Find the x -coordinate of the stationary point on the curve, giving your answer in the form $a + b\sqrt{3}$, where a and b are rational numbers. [3]

- 9 (a) (i) Write $6xy + 3y + 4x + 2$ in the form $(ax + b)(cy + d)$, where a , b , c and d are positive integers. [1]

- (ii) Hence solve the equation $6 \sin \theta \cos \theta + 3 \cos \theta + 4 \sin \theta + 2 = 0$ for $0^\circ < \theta < 360^\circ$. [4]

- (b) Solve the equation $\frac{1}{2}\sec\left(2\phi + \frac{\pi}{4}\right) = \frac{1}{\sqrt{3}}$ for $-\pi < \phi < \pi$, where ϕ is in radians. Give your answers in terms of π . [5]

10 In this question all lengths are in centimetres.



The diagram shows a shaded shape. The arc AB is the major arc of a circle, centre O , radius 10. The line AB is of length 15, the line OC is of length 25 and the lengths of AC and BC are equal.

(a) Show that the angle AOB is 1.70 radians correct to 2 decimal places. [2]

(b) Find the perimeter of the shaded shape. [4]

(c) Find the area of the shaded shape.

[5]

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