

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 $\triangle ABC$

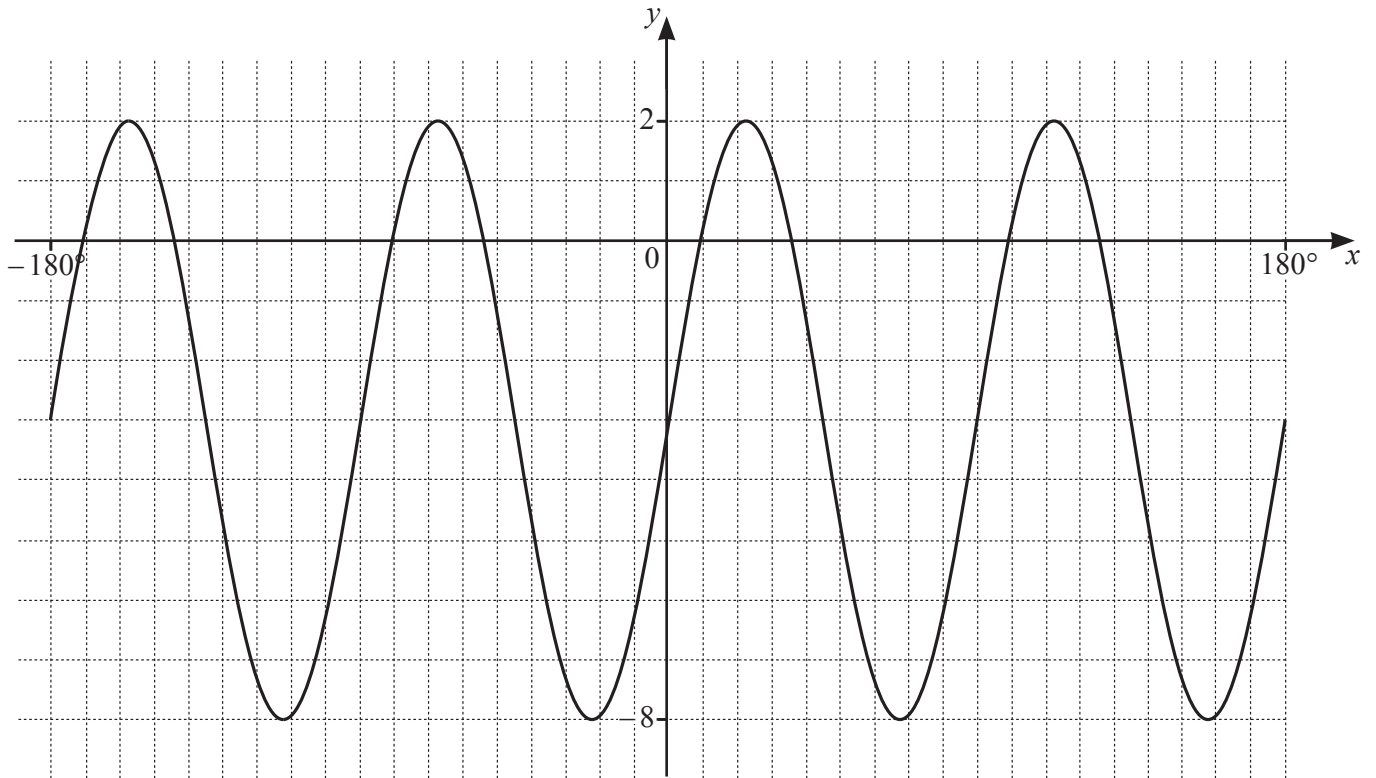
$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

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

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

3

1



The diagram shows the graph of $y = a \sin bx + c$, where a , b and c are integers, for $-180^\circ \leq x \leq 180^\circ$. Find the values of a , b and c .

[3]

2 Given that $x = \sec^2\theta$ and $y+2 = \cot^2\theta$, find y in terms of x .

[4]

3 Variables x and y are such that, when $\lg(2y+1)$ is plotted against x^2 , a straight line graph passing through the points (1, 1) and (2, 5) is obtained.

(a) Find y in terms of x . [4]

(b) Find the value of y when $x = \frac{\sqrt{3}}{2}$. [1]

(c) Find the value of x when $y = 2$. [2]

4 (a) Find the unit vector in the same direction as $\begin{pmatrix} -15 \\ 8 \end{pmatrix}$. [2]

(b) Given that $\begin{pmatrix} 2a \\ -5 \end{pmatrix} + \begin{pmatrix} 4b - 12 \\ 3 \end{pmatrix} = 4 \begin{pmatrix} b - a \\ a + 2b \end{pmatrix}$, find the values of a and b . [3]

- 5 The first three terms, in ascending powers of x , in the expansion of $\left(1 + \frac{x}{6}\right)^{12} (2 - 3x)^3$ can be written in the form $8 + px + qx^2$, where p and q are constants. Find the values of p and q . [8]

6 The polynomial $p(x) = 6x^3 + ax^2 + 6x + b$, where a and b are integers, is divisible by $2x - 1$. When $p(x)$ is divided by $x - 2$, the remainder is 120.

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

(b) Hence write down the remainder when $p(x)$ is divided by x . [1]

(c) Find the value of $p''(0)$. [2]

7 (a) Show that $\frac{2}{2x+3} - \frac{1}{x-1} + \frac{1}{(x-1)^2}$ can be written as $\frac{8-3x}{(x-1)^2(2x+3)}$. [2]

(b) Find $\int_2^a \frac{8-3x}{(x-1)^2(2x+3)} dx$ where $a > 2$. Give your answers in the form $c + \ln d$, where c and d are functions of a . [6]

- 8 (a) A team of 6 people is to be chosen from 10 people. Two of the people are sisters who must not be separated. Find the number of different teams that can be formed. [3]

- (b) A 6-character password is to be chosen from the following characters.

Digits	2	4	8
Letters	x	y	z
Symbols	*	#	!

No character may be used more than once in any password. Find the number of different passwords that may be chosen if

- (i) there are no other restrictions, [1]

- (ii) the password starts with two letters and ends with two digits. [3]

- 9 The normal to the curve $y = \frac{\ln(3x^2 + 2)}{x + 1}$, at the point A on the curve where $x = 0$, meets the x -axis at point B . Point C has coordinates $(0, 3 \ln 2)$. Find the gradient of the line BC in terms of $\ln 2$. [9]

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10 (a) Given the simultaneous equations

$$\lg x + 2 \lg y = 1,$$

$$x - 3y^2 = 13,$$

(i) show that $x^2 - 13x - 30 = 0$.

[4]

(ii) Solve these simultaneous equations, giving your answers in exact form.

[2]

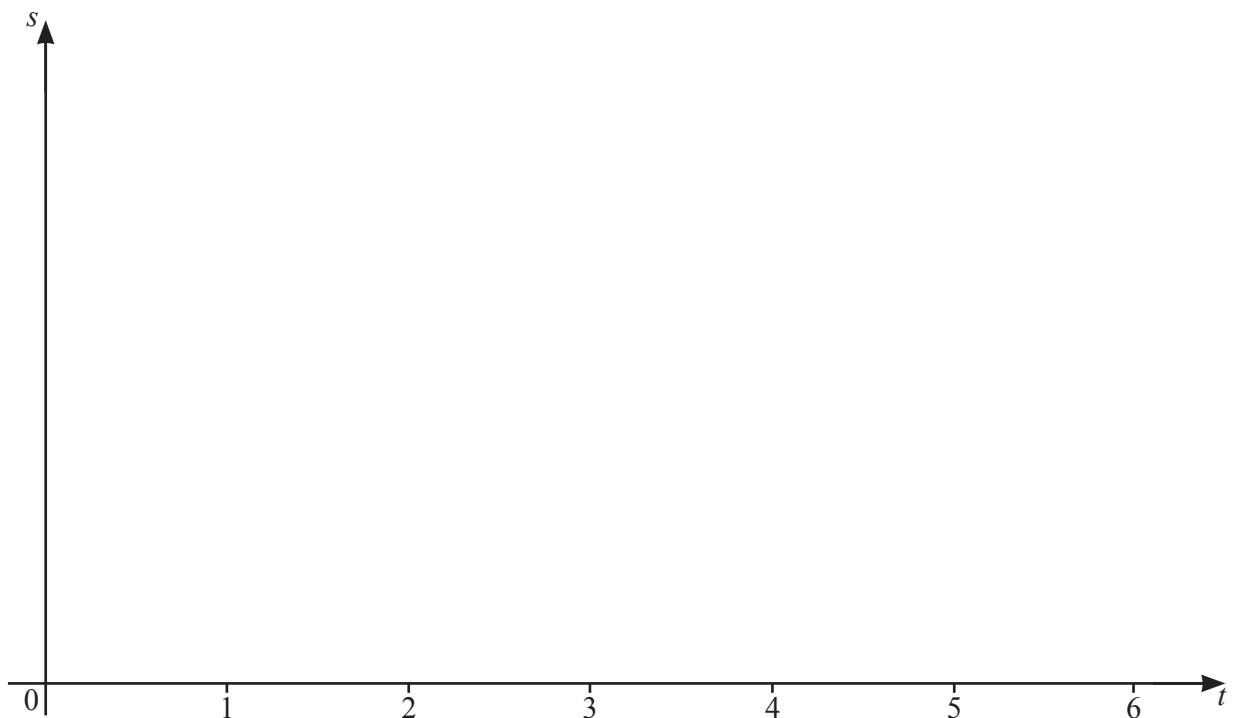
(b) Solve the equation $\log_a x + 3 \log_x a = 4$, where a is a positive constant, giving x in terms of a . [5]

11 In this question all lengths are in kilometres and time is in hours.

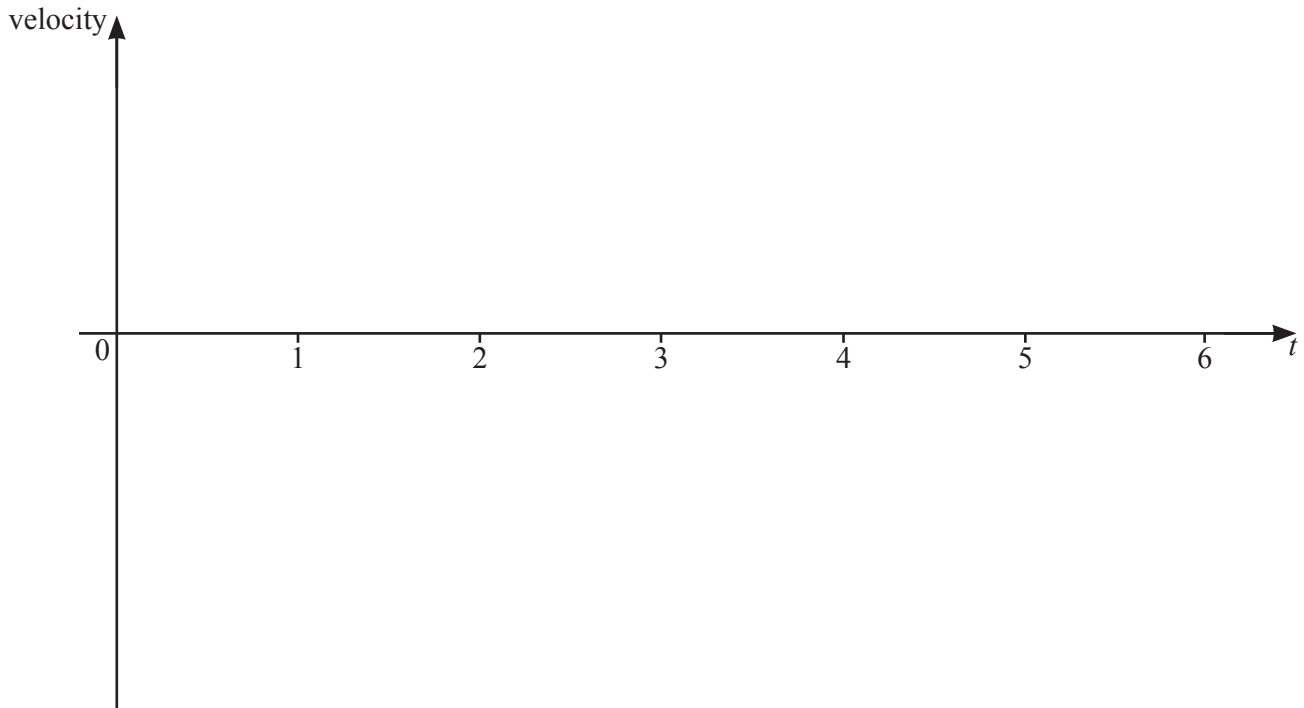
A particle P moves in a straight line such that its displacement, s , from a fixed point at time t is given by $s = (t+2)(t-5)^2$, for $t \geq 0$.

(a) Find the values of t for which the velocity of P is zero. [4]

(b) On the axes, draw the displacement–time graph for P for $0 \leq t \leq 6$, stating the coordinates of the points where the graph meets the coordinate axes. [2]

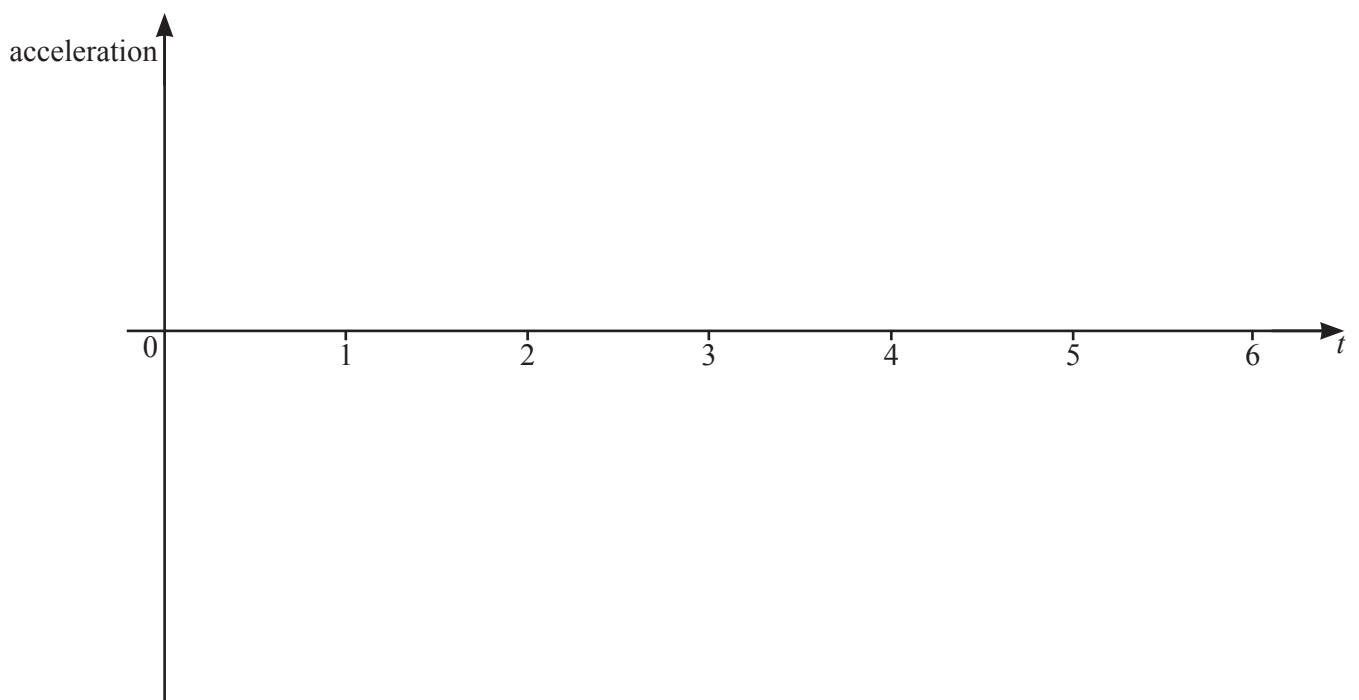


- (c) On the axes below, draw the velocity–time graph for P for $0 \leq t \leq 6$, stating the coordinates of the points where the graph meets the coordinate axes. [2]



- (d) (i) Write down an expression for the acceleration of P at time t . [1]

- (ii) Hence, on the axes below, draw the acceleration–time graph for P for $0 \leq t \leq 6$, stating the coordinates of the points where the graph meets the coordinate axes. [2]



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