

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 $\binom{n}{r} = \frac{n!}{(n-r)!r!}$.

2. TRIGONOMETRY*Identities*

$$\sin^2 A + \cos^2 A = 1.$$

$$\sec^2 A = 1 + \tan^2 A.$$

$$\operatorname{cosec}^2 A = 1 + \cot^2 A.$$

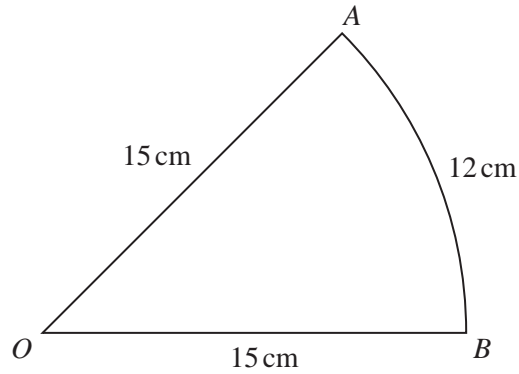
Formulae for ΔABC

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

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

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

1



The diagram shows a sector AOB of a circle, centre O , radius 15 cm. The length of the arc AB is 12 cm.

- (i) Find, in radians, angle AOB . [2]
- (ii) Find the area of the sector AOB . [2]
- 2 The equation of a curve is $y = x^3 - 8$. Find the equation of the normal to the curve at the point where the curve crosses the x -axis. [4]
- 3 Show that $\frac{1 - \cos^2\theta}{\sec^2\theta - 1} = 1 - \sin^2\theta$. [4]
- 4 The line $y = 5x - 3$ is a tangent to the curve $y = kx^2 - 3x + 5$ at the point A . Find
- (i) the value of k , [3]
- (ii) the coordinates of A . [2]
- 5 (a) Solve the equation $9^{2x-1} = 27^x$. [3]
- (b) Given that $\frac{a^{-\frac{1}{2}}b^{\frac{2}{3}}}{\sqrt{a^3b^{-\frac{2}{3}}}} = a^pb^q$, find the value of p and of q . [2]
- 6 Solve the equation $2x^3 + 3x^2 - 32x + 15 = 0$. [6]
- 7 (i) Find $\frac{d}{dx}\left(xe^{3x} - \frac{e^{3x}}{3}\right)$. [3]
- (ii) Hence find $\int xe^{3x}dx$. [3]

8 A curve has equation $y = \frac{2x}{x^2 + 9}$.

(i) Find the x -coordinate of each of the stationary points of the curve. [4]

(ii) Given that x is increasing at the rate of 2 units per second, find the rate of increase of y when $x = 1$. [3]

9 At 10 00 hours, a ship P leaves a point A with position vector $(-4\mathbf{i} + 8\mathbf{j})$ km relative to an origin O , where \mathbf{i} is a unit vector due East and \mathbf{j} is a unit vector due North. The ship sails north-east with a speed of $10\sqrt{2}$ km h⁻¹. Find

(i) the velocity vector of P , [2]

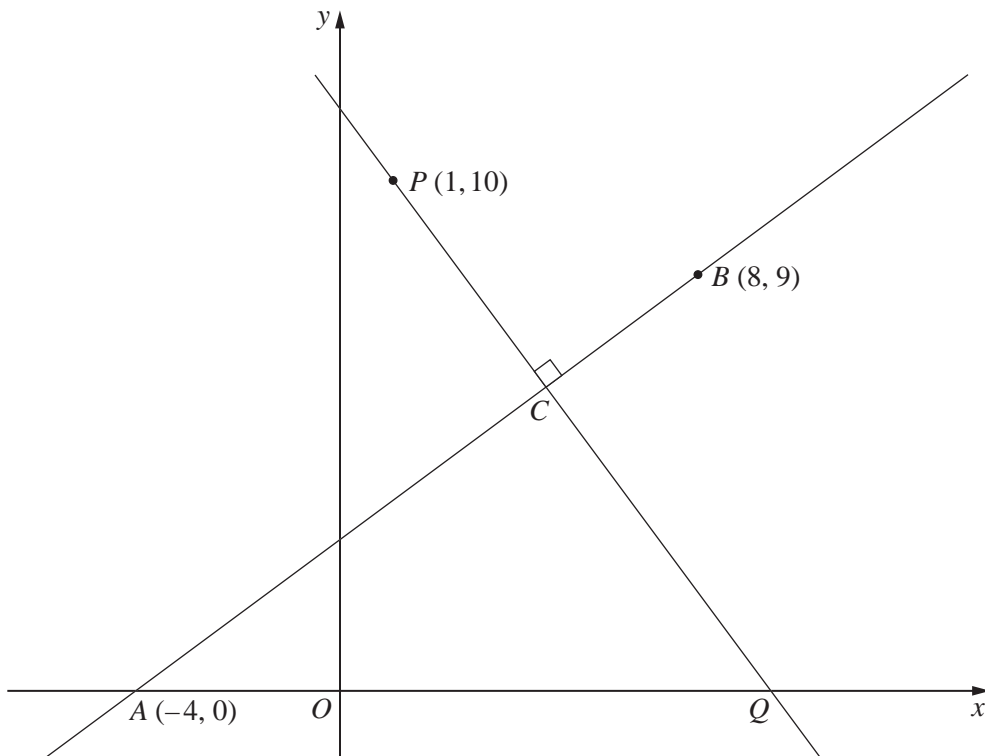
(ii) the position vector of P at 12 00 hours. [2]

At 12 00 hours, a second ship Q leaves a point B with position vector $(19\mathbf{i} + 34\mathbf{j})$ km travelling with velocity vector $(8\mathbf{i} + 6\mathbf{j})$ km h⁻¹.

(iii) Find the velocity of P relative to Q . [2]

(iv) Hence, or otherwise, find the time at which P and Q meet and the position vector of the point where this happens. [3]

10 Solutions to this question by accurate drawing will not be accepted.



The diagram shows the line AB passing through the points $A(-4, 0)$ and $B(8, 9)$. The line through the point $P(1, 10)$, perpendicular to AB , meets AB at C and the x -axis at Q . Find

- (i) the coordinates of C and of Q , [7]
- (ii) the area of triangle ACQ . [2]

11 The table shows experimental values of variables s and t .

t	5	15	30	70	100
s	1305	349	152	55	36

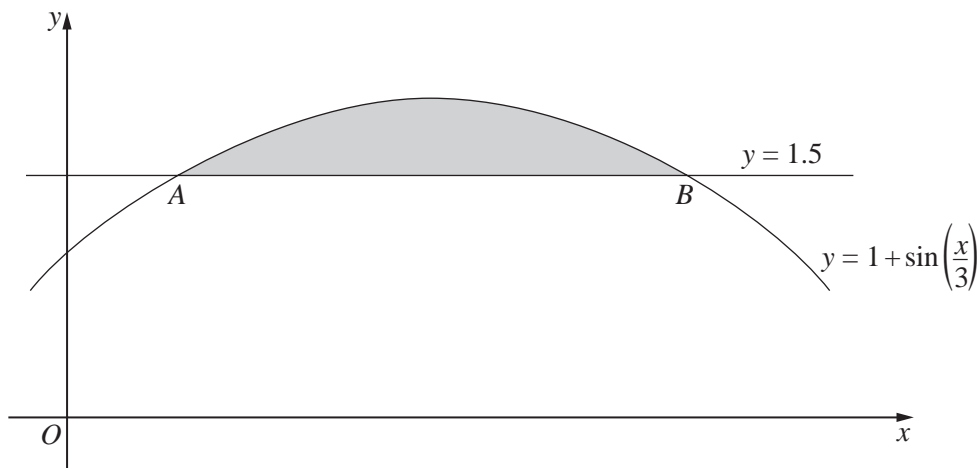
- (i) By plotting a suitable straight line graph, show that s and t are related by the equation $s = kt^n$, where k and n are constants. [4]
- (ii) Use your graph to find the value of k and of n . [4]
- (iii) Estimate the value of s when $t = 50$. [2]

12 Answer only **one** of the following two alternatives.

EITHER

(i) State the amplitude of $1 + \sin\left(\frac{x}{3}\right)$. [1]

(ii) State, in radians, the period of $1 + \sin\left(\frac{x}{3}\right)$. [1]



The diagram shows the curve $y = 1 + \sin\left(\frac{x}{3}\right)$ meeting the line $y = 1.5$ at points A and B. Find

(iii) the x -coordinate of A and of B, [3]

(iv) the area of the shaded region. [6]

OR

A particle moves in a straight line such that t s after passing through a fixed point O , its velocity, v ms^{-1} , is given by $v = k \cos 4t$, where k is a positive constant. Find

(i) the value of t when the particle is first instantaneously at rest, [1]

(ii) an expression for the acceleration of the particle t s after passing through O . [2]

Given that the acceleration of the particle is 12 m s^{-2} when $t = \frac{3\pi}{8}$,

(iii) find the value of k . [2]

Using your value for k ,

(iv) sketch the velocity-time curve for the particle for $0 \leq t \leq \pi$, [2]

(v) find the displacement of the particle from O when $t = \frac{\pi}{24}$. [4]

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