



**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*

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

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

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

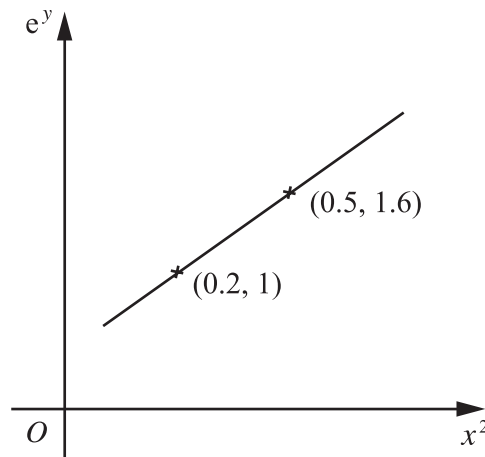
*Formulae for  $\Delta ABC$* 

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

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

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

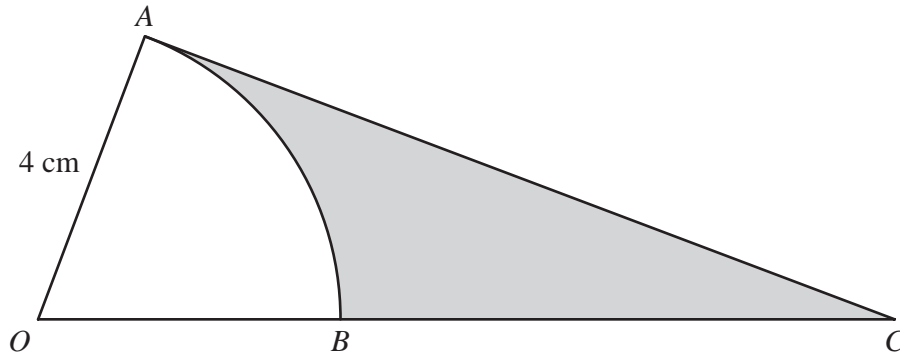
- 1 Express  $\frac{8-3\sqrt{2}}{4+3\sqrt{2}}$  in the form  $a+b\sqrt{2}$ , where  $a$  and  $b$  are integers.
- 2 A committee of 5 people is to be selected from 6 men and 4 women. Find
- (i) the number of different ways in which the committee can be selected, [1]
- (ii) the number of these selections with more women than men. [4]
- 3 The line  $y = 3x + k$  is a tangent to the curve  $x^2 + xy + 16 = 0$ .
- (i) Find the possible values of  $k$ . [3]
- (ii) For each of these values of  $k$ , find the coordinates of the point of contact of the tangent with the curve. [2]
- 4 Variables  $x$  and  $y$  are such that, when  $e^y$  is plotted against  $x^2$ , a straight line graph passing through the points  $(0.2, 1)$  and  $(0.5, 1.6)$  is obtained.



- (i) Find the value of  $e^y$  when  $x = 0$ . [2]
- (ii) Express  $y$  in terms of  $x$ . [3]
- 5 Variables  $x$  and  $y$  are connected by the equation  $y = \frac{x}{\tan x}$ . Given that  $x$  is increasing at the rate of 2 units per second, find the rate of increase of  $y$  when  $x = \frac{\pi}{4}$ . [5]
- 6 Solve the equation  $x^2(2x + 3) = 17x - 12$ . [6]

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The diagram shows a sector  $OAB$  of a circle, centre  $O$ , radius 4 cm. The tangent to the circle at  $A$  meets the line  $OB$  extended at  $C$ . Given that the area of the sector  $OAB$  is  $10\text{ cm}^2$ , calculate

- (i) the angle  $AOB$  in radians, [2]  
 (ii) the perimeter of the shaded region. [4]

- 8 (i) Given that  $\log_9 x = a \log_3 x$ , find  $a$ . [1]  
 (ii) Given that  $\log_{27} y = b \log_3 y$ , find  $b$ . [1]  
 (iii) Hence solve, for  $x$  and  $y$ , the simultaneous equations

$$\begin{aligned} 6\log_9 x + 3\log_{27} y &= 8, \\ \log_3 x + 2\log_9 y &= 2. \end{aligned}$$

[4]

- 9 A curve is such that  $\frac{dy}{dx} = 2\cos\left(2x - \frac{\pi}{2}\right)$ . The curve passes through the point  $\left(\frac{\pi}{2}, 3\right)$ .

(i) Find the equation of the curve. [4]

(ii) Find the equation of the normal to the curve at the point where  $x = \frac{3\pi}{4}$ . [4]

**10** In this question,  $\mathbf{i}$  is a unit vector due east and  $\mathbf{j}$  is a unit vector due north.

At 0900 hours a ship sails from the point  $P$  with position vector  $(2\mathbf{i} + 3\mathbf{j})$  km relative to an origin  $O$ . The ship sails north-east with a speed of  $15\sqrt{2}$  km h<sup>-1</sup>.

- (i) Find, in terms of  $\mathbf{i}$  and  $\mathbf{j}$ , the velocity of the ship. [2]
- (ii) Show that the ship will be at the point with position vector  $(24.5\mathbf{i} + 25.5\mathbf{j})$  km at 1030 hours. [1]
- (iii) Find, in terms of  $\mathbf{i}$ ,  $\mathbf{j}$  and  $t$ , the position of the ship  $t$  hours after leaving  $P$ . [2]

At the same time as the ship leaves  $P$ , a submarine leaves the point  $Q$  with position vector  $(47\mathbf{i} - 27\mathbf{j})$  km. The submarine proceeds with a speed of 25 km h<sup>-1</sup> due north to meet the ship.

- (iv) Find, in terms of  $\mathbf{i}$  and  $\mathbf{j}$ , the velocity of the ship relative to the submarine. [2]
- (v) Find the position vector of the point where the submarine meets the ship. [2]

**11** Solve the equation

- (i)  $3 \sin x + 5 \cos x = 0$  for  $0^\circ < x < 360^\circ$ , [3]
- (ii)  $3 \tan^2 y - \sec y - 1 = 0$  for  $0^\circ < y < 360^\circ$ , [5]
- (iii)  $\sin(2z - 0.6) = 0.8$  for  $0 < z < 3$  radians. [4]

[Question 12 is printed on the next page.]

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

**EITHER**

A curve has equation  $y = (x^2 - 3)e^{-x}$ .

- (i) Find the coordinates of the points of intersection of the curve with the  $x$ -axis. [2]
- (ii) Find the coordinates of the stationary points of the curve. [5]
- (iii) Determine the nature of these stationary points. [3]

**OR**

A particle moves in a straight line such that its displacement,  $s$  m, from a fixed point  $O$  at a time  $t$  s, is given by

$$s = \ln(t + 1) \quad \text{for } 0 \leq t \leq 3,$$

$$s = \frac{1}{2}\ln(t - 2) - \ln(t + 1) + \ln 16 \quad \text{for } t > 3.$$

Find

- (i) the initial velocity of the particle, [2]
- (ii) the velocity of the particle when  $t = 4$ , [2]
- (iii) the acceleration of the particle when  $t = 4$ , [2]
- (iv) the value of  $t$  when the particle is instantaneously at rest, [2]
- (v) the distance travelled by the particle in the 4th second. [2]



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