



**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*

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

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

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

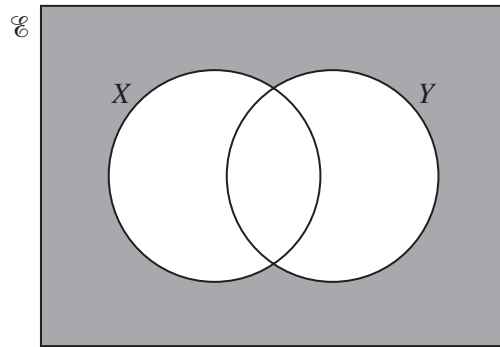
*Formulae for  $\Delta ABC$* 

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

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

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

1 (a)



Express, in set notation, the set represented by the shaded region. [1]

(b) In a class of 30 students, 17 are studying politics, 14 are studying economics and 10 are studying both of these subjects.

(i) Illustrate this information using a Venn diagram. [1]

Find the number of students studying

(ii) neither of these subjects, [1]

(iii) exactly one of these subjects. [1]

2 Given that  $\mathbf{A} = \begin{pmatrix} 7 & 6 \\ 3 & 4 \end{pmatrix}$ , find  $\mathbf{A}^{-1}$  and hence solve the simultaneous equations

$$7x + 6y = 17,$$

$$3x + 4y = 3.$$

[4]

3 Sketch the graph of  $y = |x^2 - 8x + 12|$ . [4]

4 Find the coefficient of  $x^4$  in the expansion of

(i)  $(1 + 2x)^6$ , [2]

(ii)  $\left(1 - \frac{x}{4}\right)(1 + 2x)^6$ . [3]

5 Two variables,  $x$  and  $y$ , are related by the equation

$$y = 6x^2 + \frac{32}{x^3}.$$

(i) Obtain an expression for  $\frac{dy}{dx}$ . [2]

(ii) Use your expression to find the approximate change in the value of  $y$  when  $x$  increases from 2 to 2.04. [3]

6 The function  $f$  is defined by  $f(x) = 2 + \sqrt{x-3}$  for  $x \geq 3$ . Find

(i) the range of  $f$ , [1]

(ii) an expression for  $f^{-1}(x)$ . [2]

The function  $g$  is defined by  $g(x) = \frac{12}{x} + 2$  for  $x > 0$ . Find

(iii)  $gf(12)$ . [2]

7 Given that  $\log_p X = 9$  and  $\log_p Y = 6$ , find

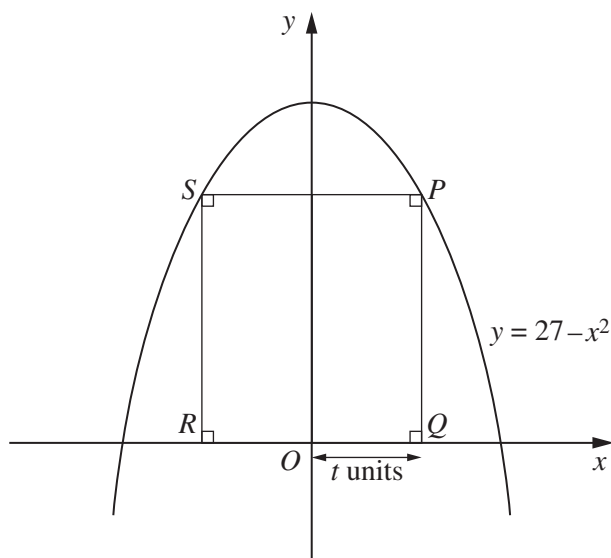
(i)  $\log_p \sqrt{X}$ , [1]

(ii)  $\log_p \left(\frac{1}{X}\right)$ , [1]

(iii)  $\log_p (XY)$ , [2]

(iv)  $\log_Y X$ . [2]

8



The diagram shows part of the curve  $y = 27 - x^2$ . The points  $P$  and  $S$  lie on this curve. The points  $Q$  and  $R$  lie on the  $x$ -axis and  $PQRS$  is a rectangle. The length of  $OQ$  is  $t$  units.

- (i) Find the length of  $PQ$  in terms of  $t$  and hence show that the area,  $A$  square units, of  $PQRS$  is given by

$$A = 54t - 2t^3. \quad [2]$$

- (ii) Given that  $t$  can vary, find the value of  $t$  for which  $A$  has a stationary value. [3]

- (iii) Find this stationary value of  $A$  and determine its nature. [3]

- 9 A musician has to play 4 pieces from a list of 9. Of these 9 pieces 4 were written by Beethoven, 3 by Handel and 2 by Sibelius. Calculate the number of ways the 4 pieces can be chosen if

- (i) there are no restrictions, [2]

- (ii) there must be 2 pieces by Beethoven, 1 by Handel and 1 by Sibelius, [3]

- (iii) there must be at least one piece by each composer. [4]

- 10 The line  $2x + y = 12$  intersects the curve  $x^2 + 3xy + y^2 = 176$  at the points  $A$  and  $B$ . Find the equation of the perpendicular bisector of  $AB$ . [9]

- 11 (a) Find all the angles between  $0^\circ$  and  $360^\circ$  which satisfy

(i)  $2\sin x - 3\cos x = 0$ , [3]

(ii)  $2\sin^2 y - 3\cos y = 0$ . [5]

- (b) Given that  $0 \leq z \leq 3$  radians, find, correct to 2 decimal places, all the values of  $z$  for which  $\sin(2z + 1) = 0.9$ . [3]

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

**EITHER**

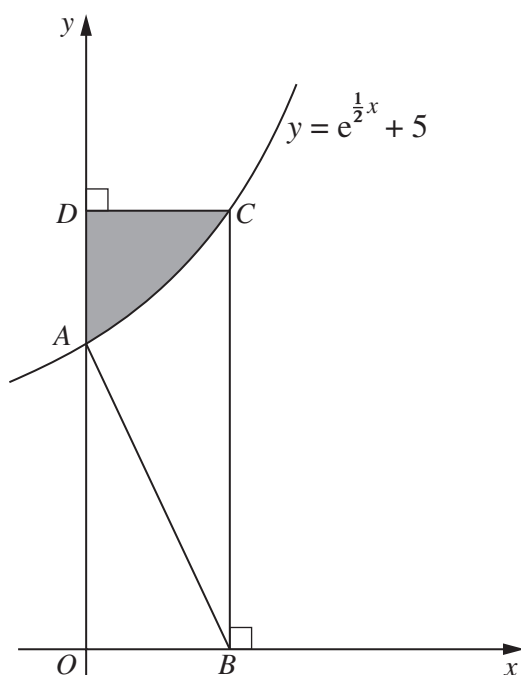
The point  $P(0, 5)$  lies on the curve for which  $\frac{dy}{dx} = e^{\frac{1}{2}x}$ . The point  $Q$ , with  $x$ -coordinate 2, also lies on the curve.

(i) Find, in terms of  $e$ , the  $y$ -coordinate of  $Q$ . [5]

The tangents to the curve at the points  $P$  and  $Q$  intersect at the point  $R$ .

(ii) Find, in terms of  $e$ , the  $x$ -coordinate of  $R$ . [5]

**OR**



The diagram shows part of the curve  $y = e^{\frac{1}{2}x} + 5$  crossing the  $y$ -axis at  $A$ . The normal to the curve at  $A$  meets the  $x$ -axis at  $B$ .

(i) Find the coordinates of  $B$ . [4]

The line through  $B$ , parallel to the  $y$ -axis, meets the curve at  $C$ . The line through  $C$ , parallel to the  $x$ -axis, meets the  $y$ -axis at  $D$ .

(ii) Find the area of the shaded region. [6]

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