

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 $u_n = ar^{n-1}$

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

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

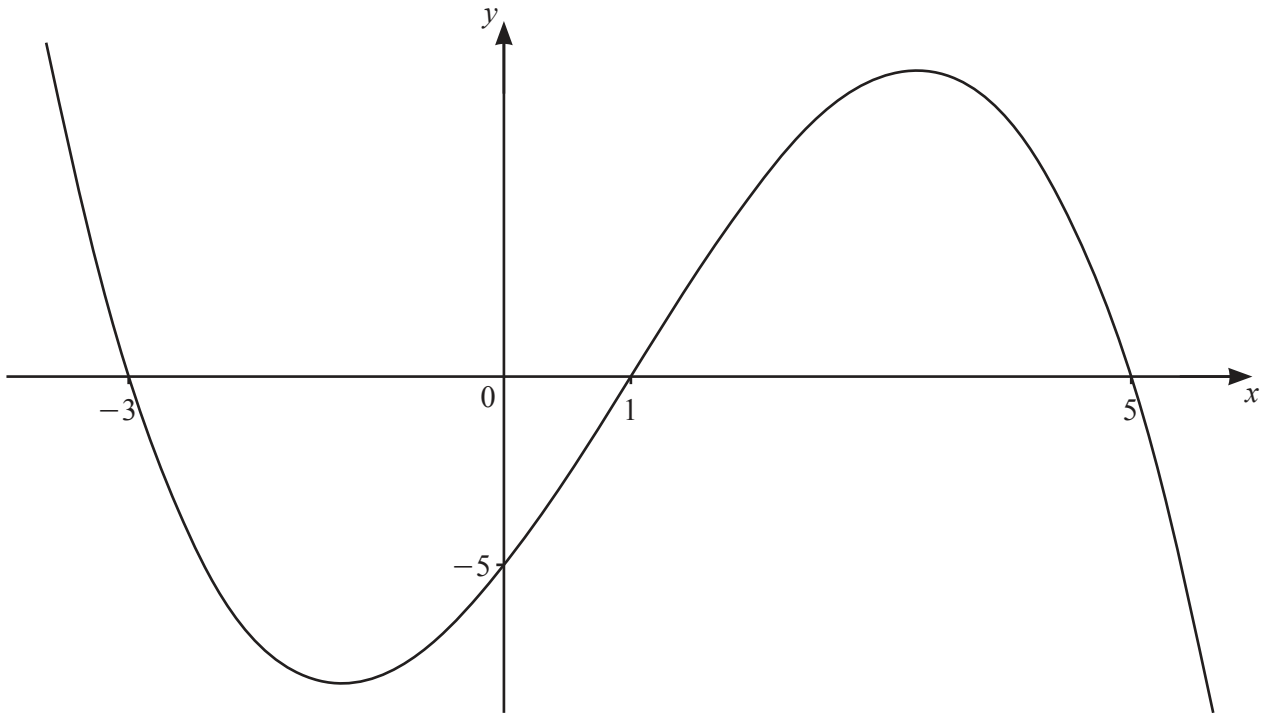
2. TRIGONOMETRY*Identities*

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

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



The diagram shows the graph of the cubic function $y = f(x)$. The intercepts of the curve with the axes are all integers.

(a) Find the set of values of x for which $f(x) < 0$. [1]

(b) Find an expression for $f(x)$. [3]

2 (a) Given that $\frac{\sqrt[3]{xy}(zy)^2}{(xz)^{-3}\sqrt{z}} = x^a y^b z^c$, find the exact values of the constants a , b and c . [3]

(b) Solve the equation $5(2^{2p+1}) - 17(2^p) + 3 = 0$. [4]

3 (a) Write $3 + 2\lg a - 4\lg b$ as a single logarithm to base 10. [4]

(b) Solve the equation $3\log_a 4 + 2\log_4 a = 7$. [5]

- 4 Solve the equation $\cot\left(2x + \frac{\pi}{3}\right) - \sqrt{3} = 0$, where $-\pi < x < \pi$ radians. Give your answers in terms of π . [4]

- 5 Find the possible values of the constant c for which the line $y = c$ is a tangent to the curve $y = 5 \sin \frac{x}{3} + 4$. [3]

6 DO NOT USE A CALCULATOR IN THIS QUESTION.

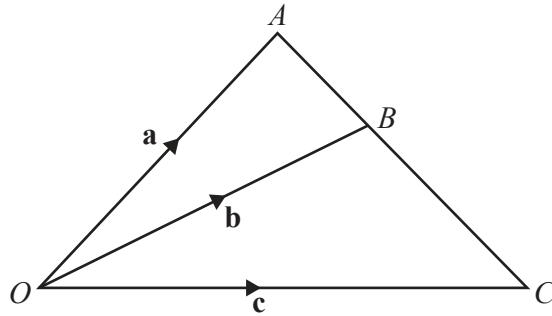
The polynomial $p(x) = 10x^3 + ax^2 - 10x + b$, where a and b are integers, is divisible by $2x + 1$. When $p(x)$ is divided by $x + 1$, the remainder is -24 .

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

(b) Find an expression for $p(x)$ as the product of three linear factors. [4]

(c) Write down the remainder when $p(x)$ is divided by x . [1]

7 (a)



The diagram shows triangle OAC , where $\overrightarrow{OA} = \mathbf{a}$, $\overrightarrow{OB} = \mathbf{b}$ and $\overrightarrow{OC} = \mathbf{c}$. The point B lies on the line AC such that $AB:BC = m:n$, where m and n are constants.

(i) Write down \overrightarrow{AB} in terms of \mathbf{a} and \mathbf{b} . [1]

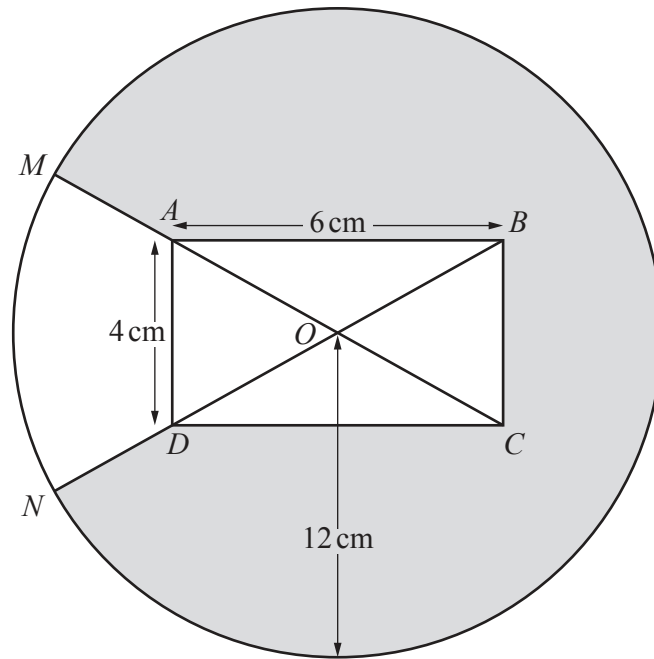
(ii) Write down \overrightarrow{BC} in terms of \mathbf{b} and \mathbf{c} . [1]

(iii) Hence show that $n\mathbf{a} + m\mathbf{c} = (m+n)\mathbf{b}$. [2]

(b) Given that $\lambda \begin{pmatrix} 2 \\ 1 \end{pmatrix} + (\mu - 1) \begin{pmatrix} -4 \\ 7 \end{pmatrix} = (\lambda + 1) \begin{pmatrix} 4 \\ -2 \end{pmatrix}$, find the value of each of the constants λ and μ . [4]

- 8 (a) A 5-digit number is made using the digits 0, 1, 4, 5, 6, 7 and 9. No digit may be used more than once in any 5-digit number. Find how many such 5-digit numbers are even and greater than 50 000. [3]

- (b) The number of combinations of n objects taken 4 at a time is equal to 6 times the number of combinations of n objects taken 2 at a time. Calculate the value of n . [5]



The diagram shows a circle, centre O , radius 12 cm , and a rectangle $ABCD$. The diagonals AC and BD intersect at O . The sides AB and AD of the rectangle have lengths 6 cm and 4 cm respectively. The points M and N lie on the circumference of the circle such that MAC and NDB are straight lines.

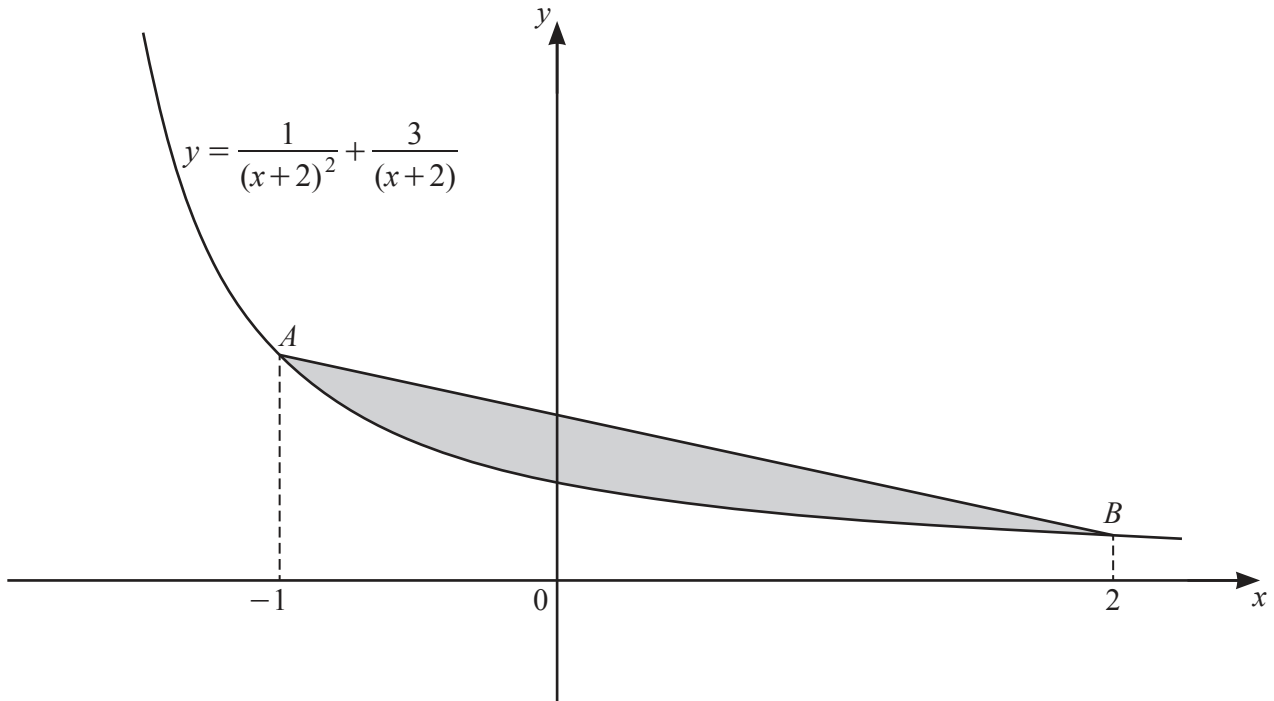
(a) Show that angle AOD is 1.176 radians correct to 3 decimal places. [2]

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

(c) Find the area of the shaded region.

[3]

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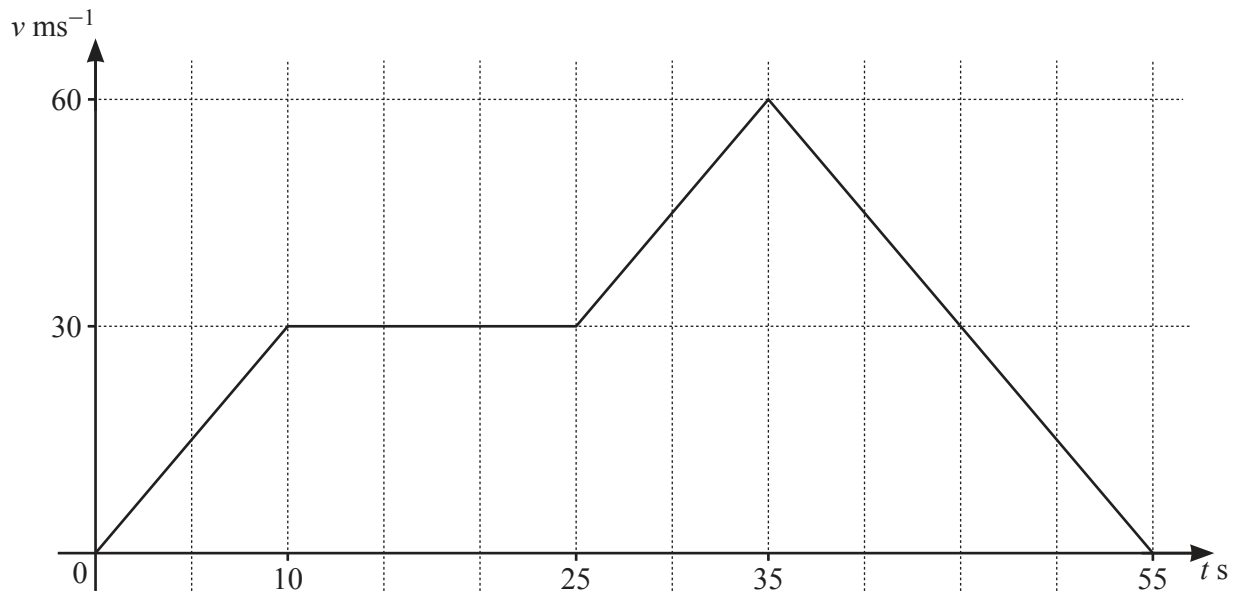
The diagram shows the graph of the curve $y = \frac{1}{(x+2)^2} + \frac{3}{x+2}$ for $x > -2$. The points A and B lie on the curve such that the x -coordinates of A and of B are -1 and 2 respectively.

(a) Find the exact y -coordinates of A and of B . [2]

(b) Find the area of the shaded region enclosed by the line AB and the curve, giving your answer in the form $\frac{p}{q} - \ln r$, where p , q and r are integers. [6]

Additional working space for Question 10(b).

11 (a)



The diagram shows the velocity–time graph for a particle P , travelling in a straight line with velocity $v \text{ ms}^{-1}$ at a time t seconds. P accelerates at a constant rate for the first 10 s of its motion, and then travels at constant velocity, 30 ms^{-1} , for another 15 s. P then accelerates at a constant rate for a further 10 s and reaches a velocity of 60 ms^{-1} . P then decelerates at a constant rate and comes to rest when $t = 55$.

(i) Find the acceleration when $t = 12$. [1]

(ii) Find the acceleration when $t = 50$. [1]

(iii) Find the total distance travelled by the particle P . [2]

(b) A particle Q travels in a straight line such that its velocity, $v \text{ ms}^{-1}$, at time t s after passing through a fixed point O is given by $v = 4 \cos 3t - 4$.

(i) Find the speed of Q when $t = \frac{5\pi}{9}$. [2]

(ii) Find the smallest positive value of t for which the acceleration of Q is zero. [3]

(iii) Find an expression for the displacement of Q from O at time t . [2]

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