

A-Level Maths – Pure Year 1

A-Level Mathematics (Edexcel/AQA/OCR, Year 1 / AS Pure) · Total marks: 55 · Answers on the last page

Practice questions covering AS Pure content: algebra, coordinate geometry, the binomial expansion, trigonometry, differentiation, integration and vectors. Section A is non-calculator; a calculator may be used for Sections B and C.

Section A – Algebra and Coordinate Geometry (Non-calculator)

1. Solve the quadratic equation $2x^2 - 7x - 4 = 0$, giving your answers as exact fractions or integers. [3]
2. The points $A(-2, 5)$ and $B(4, -7)$ lie on a line l .
 - (a) Find the equation of l in the form $y = mx + c$.
 - (b) Find the equation of the perpendicular bisector of AB , giving your answer in the form $y = mx + c$. [6]
3. Find the first four terms, in ascending powers of x , of the binomial expansion of $(1 + 2x)^5$. [4]
4. Solve $2\sin x - 1 = 0$ for $0 \leq x \leq 360$, giving your answers in degrees. [3]

Section B – Differentiation and Integration (Calculator allowed)

5. A curve has equation $y = x^3 - 4x^2 + 2$.
 - (a) Find $\frac{dy}{dx}$.
 - (b) Find the equation of the tangent to the curve at the point where $x = 1$. [5]
6. Find the value of $\int_1^3 (3x^2 - 2x + 1) dx$. [4]
7. A curve has equation $y = x^3 - 3x^2 - 9x + 5$.
 - (a) Find the coordinates of the stationary points.
 - (b) Determine the nature of each stationary point. [6]
8. Solve $2\sin^2 x - \sin x - 1 = 0$ for $0 \leq x \leq 360$, giving all solutions in degrees. [5]

Section C – Vectors and Extended Problems (Calculator allowed)

9. The vector $\mathbf{a} = 3\mathbf{i} - 4\mathbf{j}$.
 - (a) Find $|\mathbf{a}|$.
 - (b) Find the unit vector in the direction of $\mathbf{a}$. [3]
10. Two lines have vector equations $l_1 : \mathbf{r} = (1, 2, 3) + t(1, -1, 2)$ and $l_2 : \mathbf{r} = (1, -3, 6) + s(2, 3, 1)$. Show that l_1 and l_2 intersect, and find the coordinates of the point of intersection. [5]
11. An open box is made from a square sheet of card of side 20 cm by cutting a square of side x cm from each corner and folding up the sides.
 - (a) Show that the volume of the box is $V = x(20 - 2x)^2$.

(b) Find the value of x that maximises V , and find this maximum volume, correct to 1 decimal place. [7]

12. Show that $x = 2$ is a root of $f(x) = x^3 - 3x^2 - 4x + 12$, and hence factorise $f(x)$ completely. [4]

Answers

Check your working against these. If an answer does not match, try the question again before looking for the method.

- $(2x + 1)(x - 4) = 0$, so $x = -\frac{1}{2}$ or $x = 4$.
- (a) Gradient $m = \frac{-7 - 5}{4 - (-2)} = -2$, so $y = -2x + 1$.
(b) Midpoint $(1, -1)$; perpendicular gradient $= \frac{1}{2}$, so $y = \frac{1}{2}x - \frac{3}{2}$.
- $(1 + 2x)^5 = 1 + 10x + 40x^2 + 80x^3 + \dots$
- $\sin x = \frac{1}{2}$, so $x = 30$ or $x = 150$.
- (a) $\frac{dy}{dx} = 3x^2 - 8x$.
(b) At $x = 1$: gradient $= -5$, $y = -1$, so tangent is $y = -5x + 4$.
- $[x^3 - x^2 + x]_1^3 = (27 - 9 + 3) - (1 - 1 + 1) = 21 - 1 = 20$.
- (a) $\frac{dy}{dx} = 3x^2 - 6x - 9 = 0 \Rightarrow x = -1, x = 3$; points $(-1, 10)$ and $(3, -22)$.
(b) $\frac{d^2y}{dx^2} = 6x - 6$: at $x = -1$, $\frac{d^2y}{dx^2} = -12 < 0$ (maximum); at $x = 3$, $\frac{d^2y}{dx^2} = 12 > 0$ (minimum).
- Factorising: $(2 \sin x + 1)(\sin x - 1) = 0$, so $\sin x = 1$ or $\sin x = -\frac{1}{2}$. This gives $x = 90, 210, 330$.
- (a) $|\mathbf{a}| = \sqrt{3^2 + (-4)^2} = 5$.
(b) $\hat{\mathbf{a}} = \frac{3}{5}\mathbf{i} - \frac{4}{5}\mathbf{j}$.
- Setting components equal: $1 + t = 1 + 2s$, $2 - t = -3 + 3s$, $3 + 2t = 6 + s$. The first two equations give $t = 2$, $s = 1$, which also satisfies the third ($3 + 4 = 6 + 1 = 7$), so the lines intersect. Substituting $t = 2$ into l_1 gives the point $(3, 0, 7)$.
- (a) The base has side $(20 - 2x)$ and height x , so $V = x(20 - 2x)^2$.
(b) $\frac{dV}{dx} = (20 - 2x)^2 - 4x(20 - 2x) = (20 - 2x)(20 - 6x) = 0$, giving $x = 10$ (rejected, gives $V = 0$) or $x = \frac{10}{3}$. Since $\frac{d^2V}{dx^2} < 0$ there, this is a maximum: $x = \frac{10}{3} \approx 3.3$ cm, with $V_{\max} = \frac{16000}{27} \approx 592.6$ cm³.
- $f(2) = 8 - 12 - 8 + 12 = 0$, so $(x - 2)$ is a factor. Dividing: $f(x) = (x - 2)(x^2 - x - 6) = (x - 2)(x - 3)(x + 2)$.

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