FORMULAS YOU MUST MEMORISE

Edexcel International A Level Mathematics

Not in the Pearson Edexcel IAL formulae booklet: learn these by heart.

★ Not given in the exam: learn every formula on this page. The full sheet and the booklet have the rest.

P1 · Pure 1

★ **Quadratic formula:** $x = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$
When: Solving quadratics that do not factorise; "for what k" root questions

★ **Discriminant $b^2 - 4ac$: > 0 two real roots, $= 0$ equal roots, < 0 no real roots**
When: Find unknown constants from a condition on the roots

★ **Completing the square:**
$x^2 + bx + c = \left(x + \frac{b}{2}\right)^2 + c - \frac{b^2}{4}$
When: Completed-square form: solve exactly; line of symmetry

★ **Indices; surds:** $a^{-n} = \frac{1}{a^n}$, $a^{\frac{m}{n}} = \sqrt[n]{a^m}$; $\frac{1}{\sqrt{a}} = \frac{\sqrt{a}}{a}$
When: Negative and fractional indices without a calculator; surds

★ **Lines:** $y - y_1 = m(x - x_1)$, $m = \frac{y_2 - y_1}{x_2 - x_1}$, $m_1 m_2 = -1$
When: Equation of a line through a point with a given gradient

★ **Transformations: $f(x) + a$ up a; $f(x + a)$ left a; $af(x)$ vertical $\times a$; $f(ax)$ horizontal $\times \frac{1}{a}$**
When: Stretches and reflections of a given graph

★ **Sine rule:** $\frac{a}{\sin A} = \frac{b}{\sin B}$
When: A side and its opposite angle are known

★ **Area; arc; sector (radians):** $\frac{1}{2}ab\sin C$; $s = r\theta$; $\frac{1}{2}r^2\theta$
When: Any circle-sector question with the angle in radians

★ **Differentiate / integrate x^n:** $\frac{d}{dx}x^n = nx^{n-1}$, $\int x^n\,dx = \frac{x^{n+1}}{n+1} + c\ (n \neq -1)$
When: Every $P1$ calculus question: write roots and fractions as powers first

★ **Tangent; normal:** $y - y_1 = m(x - x_1)$, $m_n = -\frac{1}{m}$
When: Equations of the tangent and normal at a point

P2 · Pure 2

★ **Factor & remainder theorems:**
$f(a) = 0 \iff (x - a)$ **a factor; remainder** $f(a)$
When: Finding unknown coefficients and factorising cubics

★ **Circle:** $(x - a)^2 + (y - b)^2 = r^2$; **tangent** $\perp$ **radius**
When: Circle geometry: centres, radii, tangents and intersections

★ **Log laws:** $\log_a xy = \log_a x + \log_a y$, $\log_a \frac{x}{y} = \log_a x - \log_a y$, $\log_a x^k = k\log_a x$
When: Solving log equations and linearising data

★ **Trig:** $\tan\theta = \frac{\sin\theta}{\cos\theta}$, $\sin^2\theta + \cos^2\theta = 1$
When: Simplify expressions and prove simple identities

★ **Stationary points:** $f'(x) = 0$; $f'' < 0$ **max,** $f'' > 0$ **min**
When: Optimisation and curve sketching

★ **Area under a curve:** $\int_a^b y\,dx$
When: Regions below the x-axis or bounded by a curve and a line

P3 · Pure 3

★ **Reciprocal identities:** $\sec^2\theta = 1 + \tan^2\theta$, $\operatorname{cosec}^2\theta = 1 + \cot^2\theta$
When: Equations mixing $\tan^2$ and sec, or $\cot^2$ and cosec

★ **Double angle:** $\sin 2A = 2\sin A\cos A$, $\cos 2A = 2\cos^2 A - 1 = 1 - 2\sin^2 A$, $\tan 2A = \frac{2\tan A}{1 - \tan^2 A}$
When: Equations with $2x$ and x together, and integrating $\sin^2 x$

★ **R form:** $a\sin\theta \pm b\cos\theta = R\sin(\theta \pm \alpha)$, $R = \sqrt{a^2 + b^2}$, $\tan\alpha = \frac{b}{a}$
When: Maximum and minimum values; solving $a\sin\theta + b\cos\theta = c$

★ **Standard derivatives:** $(e^{kx})' = ke^{kx}$, $(\ln x)' = \frac{1}{x}$, $(\sin kx)' = k\cos kx$, $(\cos kx)' = -k\sin kx$
When: Every calculus question with exponentials, logs or trig

★ **Product; chain:** $(uv)' = uv' + vu'$; $\frac{dy}{dx} = \frac{dy}{du} \cdot \frac{du}{dx}$
When: Differentiating products and functions of functions

★ **Inverse:** $\frac{dx}{dy} = \frac{1}{dy/dx}$
When: Use $\frac{dy}{dx} = 1 \div \left(\frac{dx}{dy}\right)$ where helpful

★ **Integrals:** $\int e^{kx}dx = \frac{1}{k}e^{kx} + c$, $\int \frac{1}{x}\,dx = \ln|x| + c$, $\int \cos kx\,dx = \frac{1}{k}\sin kx + c$
When: Integrate e^x, e^{kx} and $\frac{1}{x}$; evaluate exactly

★ **Iteration; sign change:** $x_{n+1} = g(x_n)$; $f(a)f(b) < 0 \Rightarrow$ **root in** (a, b)
When: Rearrange to $x = g(x)$ and iterate to find a root

★ **Functions:** $fg(x) = f(g(x))$; f^{-1} **reflects** f **in** $y = x$; **modulus graphs**
When: Inverse functions and modulus graphs

P4 · Pure 4

★ **Partial fractions:** $\frac{\ldots}{(x-a)(x-b)} = \frac{A}{x-a} + \frac{B}{x-b}$, $\frac{\ldots}{(x-a)^2(x-b)} = \frac{A}{x-a} + \frac{B}{(x-a)^2} + \frac{C}{x-b}$
When: Integration and series expansions of rational functions

★ **Parametric; implicit:** $\frac{dy}{dx} = \frac{dy/dt}{dx/dt}$; $\frac{d}{dx}y^2 = 2y\frac{dy}{dx}$
When: Tangents and normals for parametric or implicit curves

★ **Reverse chain:** $\int \frac{f'(x)}{f(x)}\,dx = \ln|f(x)| + c$
When: Any fraction whose top is (a multiple of) the derivative of the bottom

★ **Volume of revolution:** $V = \pi\int_a^b y^2\,dx$
When: Rotating a region through $360°$ about the x-axis

★ **Separable DE:** $\int \frac{dy}{g(y)} = \int f(x)\,dx$
When: Separate the variables; general and particular solutions

★ **Vectors:** $\mathbf{a}\cdot\mathbf{b} = a_1b_1 + a_2b_2 + a_3b_3 = |\mathbf{a}||\mathbf{b}|\cos\theta$
When: Angles between lines, and testing for perpendicular vectors

★ **Line; perpendicular:** $\mathbf{r} = \mathbf{a} + \lambda\mathbf{b}$; $\mathbf{a}\cdot\mathbf{b} = 0$
When: Vector equation of a line; intersecting, parallel or skew

★ **Magnitude:** $|\mathbf{a}| = \sqrt{a_1^2 + a_2^2 + a_3^2}$
When: Magnitudes and unit vectors in three dimensions

S1 · Statistics 1

★ **Mean; variance:** $\bar{x} = \frac{\sum fx}{\sum f}$, $\sigma^2 = \frac{\sum fx^2}{\sum f} - \bar{x}^2$
When: Mean and spread of raw and grouped data

★ **Coding** $y = \frac{x-a}{b}$: $\bar{x} = a + b\bar{y}$, $\sigma_x = |b|\sigma_y$
When: Getting back to the original data from coded summaries

★ **Median by interpolation:**
$Q_2 = L + \frac{\frac{n}{2} - F}{f} \times w$
When: Quartiles and percentiles of grouped data

★ **Outliers (if asked):** $< Q_1 - k(Q_3 - Q_1)$ **or** $> Q_3 + k(Q_3 - Q_1)$
When: Identify outliers using a rule based on the quartiles

★ **Conditional; independent:**
$P(A \mid B) = \frac{P(A \cap B)}{P(B)}$; $P(A \cap B) = P(A)P(B)$
When: Testing independence and reading two-way tables and Venn diagrams

★ **Linear:** $E(aX + b) = aE(X) + b$, $\operatorname{Var}(aX + b) = a^2\operatorname{Var}(X)$
When: Coding and linear functions of a random variable

★ **Discrete uniform on $1, \ldots, n$:** $E(X) = \frac{n+1}{2}$, $\operatorname{Var}(X) = \frac{n^2-1}{12}$
When: Discrete uniform distribution: mean and variance

★ **Normal:** $Z = \frac{X - \mu}{\sigma} \sim N(0, 1)$
When: Using the normal tables, and finding an unknown mean or standard deviation

M1 · Mechanics 1 (nothing printed)

★ **suvat:** $v = u + at$, $s = ut + \frac{1}{2}at^2$, $s = vt - \frac{1}{2}at^2$, $s = \frac{1}{2}(u + v)t$, $v^2 = u^2 + 2as$
When: Straight-line motion with constant acceleration

★ **Vectors:** $\mathbf{v} = \mathbf{u} + \mathbf{a}t$, $\mathbf{r} = \mathbf{r}_0 + \mathbf{v}t$, **speed** $= |\mathbf{v}|$
When: Position vector of a particle with constant velocity

★ **Newton's 2nd law; weight:** $F = ma$, $W = mg$ $(g = 9.8\ \mathrm{m\,s^{-2}})$
When: Every dynamics question

★ **Friction:** $F \leq \mu R$; **limiting** $F = \mu R$
When: Rough horizontal surfaces and inclined planes

★ **Momentum; impulse:** $p = mv$; $I = Ft = mv - mu$
When: Collisions and impulses

★ **Conservation of momentum:**
$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$
When: Velocities after collisions or explosions

★ **Moments:** **moment** $= F \times d_\perp$; **equilibrium:** $\sum F = 0$, $\sum M = 0$
When: Rods on supports, ladders and tipping questions

★ **Slope at θ: weight component $mg\sin\theta$ down the slope; $R = mg\cos\theta$ if nothing else acts perpendicular to it**
When: Particles on rough and smooth inclined planes

★ **Velocity–time graph: gradient = acceleration, area = displacement**
When: Displacement–time and velocity–time graphs

Independent revision resource, not endorsed by Pearson Edexcel. ★ = our reading of the current IAL booklet; if unsure, learn it.