FORMULA POSTER

Edexcel International A Level Mathematics

2018 spec · v2 Oct 2026

A Level Math Revision
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Interactive version

★ Learn it: not in the Pearson Edexcel IAL formulae booklet 📖 In the booklet

P1 · Pure 1

★ **Quadratic formula:** $x = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$ → 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** → Find unknown constants from a condition on the roots
Watch for: Rearrange to $ax^2+bx+c=0$, then choose >0, $=0$ or <0

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

★ **Indices; surds:** $a^{-n} = \frac{1}{a^n}$, $a^{\frac{m}{n}} = \sqrt[n]{a^m}$; $\frac{1}{\sqrt{a}} = \frac{\sqrt{a}}{a}$ → Negative and fractional indices without a calculator; surds
Watch for: Convert every term to one base, then substitute $y = a^x$

Scan to practise

★ **Lines:** $y-y_1 = m(x-x_1)$, $m = \frac{y_2-y_1}{x_2-x_1}$, $m_1m_2 = -1$ → 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 $\times \frac{1}{a}$** → Stretches and reflections of a given graph
Watch for: "Stretch parallel to the y-axis, scale factor k": use the full words

📖 **Mensuration:** sphere $A = 4\pi r^2$, cone curved $A = \pi rl$

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

📖 **Cosine rule:** $a^2 = b^2+c^2-2bc\cos A$

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

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

★ **Tangent; normal:** $y-y_1 = m(x-x_1)$, $m_{\text{n}} = -\frac{1}{m}$ → Equations of the tangent and normal at a point
Watch for: Normal gradient $= -1 \div$ tangent gradient

Watch for When you see the calculator warning, write every algebraic step

P2 · Pure 2

★ **Factor & remainder theorems:** $f(a)=0 \iff (x-a)$ **a factor; remainder** $f(a)$ → Finding unknown coefficients and factorising cubics
Watch for: Write "$f(-3)=0$" first

★ **Circle:** $(x-a)^2+(y-b)^2 = r^2$; **tangent** $\perp$ **radius** → Circle geometry: centres, radii, tangents and intersections
Watch for: Complete the square in x and y to find the centre

📖 **Arithmetic series:** $S_n = \frac{1}{2}n(a+l) = \frac{1}{2}n[2a+(n-1)d]$

📖 **nth terms:** $u_n = a+(n-1)d$, $u_n = ar^{n-1}$

📖 **Geometric series:** $S_n = \frac{a(1-r^n)}{1-r}$, $S_\infty = \frac{a}{1-r}\ (|r|<1)$

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📖 **Binomial, $n \in \mathbb{N}$:** $(a+b)^n = a^n + \binom{n}{1}a^{n-1}b + \cdots + b^n$, $\binom{n}{r} = \frac{n!}{r!(n-r)!}$

★ **Log laws:** $\log_a xy = \log_a x + \log_a y$, $\log_a \frac{x}{y} = \log_a x - \log_a y$, $\log_a x^k = k\log_a x$ → Solving log equations and linearising data
Watch for: One log law per line; reject roots with an argument ≤ 0

📖 **Change of base:** $\log_a x = \frac{\log_b x}{\log_b a}$

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

📖 **Trapezium rule, $h = \frac{b-a}{n}$:** $\int_a^b y\,dx \approx \frac{1}{2}h\{(y_0+y_n) + 2(y_1+\cdots+y_{n-1})\}$

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

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

Watch for One log law per line, then remove the log

Calculator find sums of sequences; make a table of values: keystrokes at alevelmathrevision.com/alevel-frontend/calculator-skills

P3 · Pure 3

📖 **Exponential form:** $e^{x\ln a} = a^x$

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

📖 **Compound sin:** $\sin(A\pm B) = \sin A\cos B \pm \cos A\sin B$

📖 **Compound cos:** $\cos(A\pm B) = \cos A\cos B \mp \sin A\sin B$

📖 **Compound tan:** $\tan(A\pm B) = \frac{\tan A \pm \tan B}{1 \mp \tan A\tan B}$

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

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

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

📖 **Trig derivatives:** $(\tan kx)' = k\sec^2 kx$, $(\sec x)' = \sec x\tan x$, $(\cot x)' = -\operatorname{cosec}^2 x$, $(\operatorname{cosec} x)' = -\operatorname{cosec} x\cot x$

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

📖 **Quotient:** $\frac{d}{dx}\left(\frac{f}{g}\right) = \frac{f'g-fg'}{g^2}$

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

★ **Integrals:** $\int e^{kx}dx = \frac{1}{k}e^{kx}+c$, $\int \frac{1}{x}\,dx = \ln|x|+c$, $\int \cos kx\,dx = \frac{1}{k}\sin kx + c$ → 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) → 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** → Inverse functions and modulus graphs
Watch for: Domain of f^{-1} = range of f; for fg, apply g first

Watch for $P3$ calculus and root-finding are in radians

Calculator solve equations; find derivatives and integrals: keystrokes at alevelmathrevision.com/alevel-frontend/calculator-skills

P4 · Pure 4

📖 **Binomial, $|x|<1$, $n \in \mathbb{Q}$:** $(1+x)^n = 1 + nx + \frac{n(n-1)}{1\times 2}x^2 + \cdots$

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

★ **Parametric; implicit:** $\frac{dy}{dx} = \frac{dy/dt}{dx/dt}$; $\frac{d}{dx}y^2 = 2y\frac{dy}{dx}$ → Tangents and normals for parametric or implicit curves
Watch for: $\frac{dy}{dx} = \left(\frac{dy}{dt}\right) \div \left(\frac{dx}{dt}\right)$, not the other way up

📖 **Integrals:** $\int \sec^2 kx\,dx = \frac{1}{k}\tan kx$, $\int \tan x\,dx = \ln|\sec x|$, $\int \cot x\,dx = \ln|\sin x|$

📖 **More integrals:** $\int \operatorname{cosec} x\,dx = -\ln|\operatorname{cosec} x + \cot x|$, $\int \sec x\,dx = \ln|\sec x + \tan x|$

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📖 **By parts:** $\int u\frac{dv}{dx}\,dx = uv - \int v\frac{du}{dx}\,dx$

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

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

★ **Separable DE:** $\int \frac{dy}{g(y)} = \int f(x)\,dx$ → Separate the variables; general and particular solutions
Watch for: Add $+c$ at the integration step, then find c

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

★ **Line; perpendicular:** $\mathbf{r} = \mathbf{a} + \lambda\mathbf{b}$; $\mathbf{a}\cdot\mathbf{b} = 0$ → Vector equation of a line; intersecting, parallel or skew
Watch for: Write $\boldsymbol{r} = \boldsymbol{a} + \lambda\boldsymbol{b}$; substitute λ back to get the point

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

Watch for Add $+c$ at the integration step

Calculator find derivatives and integrals; do vectors: keystrokes at alevelmathrevision.com/alevel-frontend/calculator-skills

S1 · Statistics 1

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

Scan to practise

★ **Coding $y = \frac{x-a}{b}$:** $\bar{x} = a + b\bar{y}$, $\sigma_x = |b|\sigma_y$ → Getting back to the original data from coded summaries
Watch for: Mean: undo every step; SD: undo only the multiplying

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

★ **Outliers (if asked):** $< Q_1 - k(Q_3-Q_1)$ **or** $> Q_3 + k(Q_3-Q_1)$ → Identify outliers using a rule based on the quartiles
Watch for: Calculate both fences and name the outlier

📖 **Union:** $P(A\cup B) = P(A) + P(B) - P(A\cap B)$

📖 **Intersection:** $P(A\cap B) = P(A)P(B \mid A)$

★ **Conditional; independent:** $P(A \mid B) = \frac{P(A\cap B)}{P(B)}$; $P(A\cap B) = P(A)P(B)$ → Testing independence and reading two-way tables and Venn diagrams
Watch for: Independent: $P(A\cap B) = P(A)P(B)$; exclusive: $P(A\cap B) = 0$

📖 **Discrete r.v.:** $E(X) = \sum xP(X=x)$, $\operatorname{Var}(X) = \sum x^2P(X=x) - \mu^2$

📖 **Function of X:** $E(g(X)) = \sum g(x)P(X=x)$

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

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

📖 **S_{xx}, S_{xy}:** $S_{xx} = \sum x^2 - \frac{(\sum x)^2}{n}$, $S_{xy} = \sum xy - \frac{\sum x\sum y}{n}$

📖 **PMCC:** $r = \frac{S_{xy}}{\sqrt{S_{xx}S_{yy}}}$

📖 **Regression line $y = a+bx$:** $b = \frac{S_{xy}}{S_{xx}}$, $a = \bar{y} - b\bar{x}$

★ **Normal:** $Z = \frac{X-\mu}{\sigma} \sim N(0,1)$ → Using the normal tables, and finding an unknown mean or standard deviation
Watch for: Write $P(X<a) = P\left(Z < \frac{a-\mu}{\sigma}\right)$ first

Watch for Write the standardisation before the probability

Calculator find mean, SD and quartiles; do a normal distribution; do regression: keystrokes at alevelmathrevision.com/alevel-frontend/calculator-skills

M1 · Mechanics 1 (nothing printed)

★ **suvat:** $v = u+at$, $s = ut + \frac{1}{2}at^2$, $s = vt - \frac{1}{2}at^2$, $s = \frac{1}{2}(u+v)t$, $v^2 = u^2+2as$ → Straight-line motion with constant acceleration
Watch for: Choose up as positive and say so

★ **Vectors:** $\mathbf{v} = \mathbf{u} + \mathbf{a}t$, $\mathbf{r} = \mathbf{r}_0 + \mathbf{v}t$, **speed** $= |\mathbf{v}|$ → Position vector of a particle with constant velocity
Watch for: Speed is the magnitude; bearings clockwise from north

Scan to practise

★ **Newton's 2nd law; weight:** $F = ma$, $W = mg$ $(g = 9.8\ \text{m s}^{-2})$ → Every dynamics question
Watch for: After using $g = 9.8$, round to 2 or 3 s.f.

★ **Friction:** $F \leq \mu R$; **limiting** $F = \mu R$ → Rough horizontal surfaces and inclined planes
Watch for: Resolve perpendicular to the plane for R, then $F = \mu R$

★ **Momentum; impulse:** $p = mv$; $I = Ft = mv - mu$ → Collisions and impulses
Watch for: Choose a positive direction and sign every velocity

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

★ **Moments:** **moment** $= F \times d_\perp$; **equilibrium:** $\sum F = 0$, $\sum M = 0$ → Rods on supports, ladders and tipping questions
Watch for: Take moments about the point where an unknown acts

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

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

Watch for After using $g = 9.8$, round final answers to 2 or 3 s.f.

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