★ not in the Pearson Edexcel IAL formulae booklet — learn it. Everything else is printed in the booklet.

## P1 · Pure 1

★ Quadratic formula: $x = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$

★ Discriminant $b^2 - 4ac$: $> 0$ two real roots, $= 0$ equal roots, $< 0$ no real roots

★ Completing the square:
$x^2 + bx + c = \left(x + \frac{b}{2}\right)^2 + c - \frac{b^2}{4}$

★ Indices; surds: $a^{-n} = \frac{1}{a^n}$, $a^{\frac{m}{n}} = \sqrt[n]{a^m}$; $\frac{1}{\sqrt{a}} = \frac{\sqrt{a}}{a}$

★ Lines: $y - y_1 = m(x - x_1)$, $m = \frac{y_2 - y_1}{x_2 - x_1}$, $m_1 m_2 = -1$

★ Transformations: $f(x) + a$ up $a$; $f(x + a)$ left $a$; $af(x)$ vertical $\times a$; $f(ax)$ horizontal $\times \frac{1}{a}$

Mensuration: sphere $A = 4\pi r^2$, cone curved $A = \pi r l$

★ Sine rule; cosine rule: $\frac{a}{\sin A} = \frac{b}{\sin B}$, $a^2 = b^2 + c^2 - 2bc\cos A$

★ Area; arc; sector (radians): $\frac{1}{2}ab\sin C$; $s = r\theta$; $\frac{1}{2}r^2\theta$

★ Differentiate / integrate $x^n$: $\frac{d}{dx}x^n = nx^{n-1}$, $\int x^n\,dx = \frac{x^{n+1}}{n+1} + c\ (n \neq -1)$

★ Tangent; normal: $y - y_1 = m(x - x_1)$, $m_n = -\frac{1}{m}$

## P2 · Pure 2

★ Factor & remainder theorems: $f(a) = 0 \iff (x - a)$ a factor; remainder $f(a)$

★ Circle: $(x-a)^2 + (y-b)^2 = r^2$; tangent $\perp$ radius

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

★ $n$th terms: $u_n = a + (n-1)d$, $u_n = ar^{n-1}$

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

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: $\log_a xy = \log_a x + \log_a y$, $\log_a \frac{x}{y} = \log_a x - \log_a y$, $\log_a x^k = k\log_a x$

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

★ Trig: $\tan\theta = \frac{\sin\theta}{\cos\theta}$, $\sin^2\theta + \cos^2\theta = 1$

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

★ Area under a curve: $\int_a^b y\,dx$

## P3 · Pure 3

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

★ Reciprocal identities: $\sec^2\theta = 1 + \tan^2\theta$, $\operatorname{cosec}^2\theta = 1 + \cot^2\theta$

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

★ Double angle: $\sin 2A = 2\sin A\cos A$, $\cos 2A = 2\cos^2 A - 1 = 1 - 2\sin^2 A$, $\tan 2A = \frac{2\tan A}{1-\tan^2 A}$

★ $R$ form: $a\sin\theta \pm b\cos\theta = R\sin(\theta \pm \alpha)$, $R = \sqrt{a^2+b^2}$, $\tan\alpha = \frac{b}{a}$

★ Standard derivatives: $(e^{kx})' = ke^{kx}$, $(\ln x)' = \frac{1}{x}$, $(\sin kx)' = k\cos kx$, $(\cos kx)' = -k\sin kx$

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: $(uv)' = uv' + vu'$; $\frac{dy}{dx} = \frac{dy}{du}\cdot\frac{du}{dx}$

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

★ Inverse: $\frac{dx}{dy} = \frac{1}{dy/dx}$

★ Integrals: $\int e^{kx}dx = \frac{1}{k}e^{kx} + c$, $\int \frac{1}{x}\,dx = \ln|x| + c$, $\int \cos kx\,dx = \frac{1}{k}\sin kx + c$

★ Iteration; sign change: $x_{n+1} = g(x_n)$; $f(a)f(b) < 0 \Rightarrow$ root in $(a, b)$

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

## 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: $\frac{\cdots}{(x-a)(x-b)} = \frac{A}{x-a} + \frac{B}{x-b}$, $\frac{\cdots}{(x-a)^2(x-b)} = \frac{A}{x-a} + \frac{B}{(x-a)^2} + \frac{C}{x-b}$

★ Parametric; implicit: $\frac{dy}{dx} = \frac{dy/dt}{dx/dt}$; $\frac{d}{dx}y^2 = 2y\frac{dy}{dx}$

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

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

★ Reverse chain: $\int \frac{f'(x)}{f(x)}\,dx = \ln|f(x)| + c$

★ Volume of revolution: $V = \pi\int_a^b y^2\,dx$

★ Separable DE: $\int \frac{dy}{g(y)} = \int f(x)\,dx$

★ Vectors: $\mathbf{a}\cdot\mathbf{b} = a_1b_1 + a_2b_2 + a_3b_3 = |\mathbf{a}||\mathbf{b}|\cos\theta$

★ Line; perpendicular: $\mathbf{r} = \mathbf{a} + \lambda\mathbf{b}$; $\mathbf{a}\cdot\mathbf{b} = 0$

★ Magnitude: $|\mathbf{a}| = \sqrt{a_1^2 + a_2^2 + a_3^2}$

## S1 · Statistics 1

★ Mean; variance: $\bar{x} = \frac{\sum fx}{\sum f}$, $\sigma^2 = \frac{\sum fx^2}{\sum f} - \bar{x}^2$

★ Coding $y = \frac{x-a}{b}$: $\bar{x} = a + b\bar{y}$, $\sigma_x = |b|\sigma_y$

★ Median by interpolation: $Q_2 = L + \frac{\frac{n}{2} - F}{f} \times w$

★ Outliers (if asked): $< Q_1 - k(Q_3 - Q_1)$ or $> Q_3 + k(Q_3 - Q_1)$

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: $P(A \mid B) = \frac{P(A\cap B)}{P(B)}$; $P(A \cap B) = P(A)P(B)$

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

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

★ Linear: $E(aX + b) = aE(X) + b$, $\mathrm{Var}(aX + b) = a^2\mathrm{Var}(X)$

★ Discrete uniform on $1, \ldots, n$: $E(X) = \frac{n+1}{2}$, $\mathrm{Var}(X) = \frac{n^2-1}{12}$

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

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: $Z = \frac{X-\mu}{\sigma} \sim N(0, 1)$

## M1 · Mechanics 1 (nothing printed)

★ suvat: $v = u + at$, $s = ut + \frac{1}{2}at^2$, $s = vt - \frac{1}{2}at^2$, $s = \frac{1}{2}(u+v)t$, $v^2 = u^2 + 2as$

★ Vectors: $\mathbf{v} = \mathbf{u} + \mathbf{a}t$, $\mathbf{r} = \mathbf{r}_0 + \mathbf{v}t$, speed $= |\mathbf{v}|$

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

★ Friction: $F \leq \mu R$; limiting $F = \mu R$

★ Momentum; impulse: $p = mv$; $I = Ft = mv - mu$

★ Conservation of momentum: $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

★ Moments: moment $= F \times d_\perp$; equilibrium: $\sum F = 0$, $\sum M = 0$

★ Slope at $\theta$: weight component $mg\sin\theta$ down the slope; $R = mg\cos\theta$ if nothing else acts perpendicular to it

★ Velocity–time graph: gradient = acceleration, area = displacement



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