STUDY FORMULA BOOKLET

IB Maths applications and interpretation (SL and HL) formula booklet

The AI booklet prints formulae for all five topics, with HL only parts, but not the chi-squared statistic, log laws at SL or standardising. Learn those.

IN THE BOOKLET printed in the official booklet LEARN IT not printed: students must recall it

Based on the official **Mathematics: applications and interpretation formula booklet, IB Diploma Programme, version 1.0, first examinations 2021**, with what to learn and exam tips added by CuratedPrep.

Prior learning: SL and HL

Printed in the booklet as prior learning for both levels.

Area of a parallelogram b is the base, h the perpendicular height.	$A = bh$	IN THE BOOKLET
Area of a triangle b is the base, h the perpendicular height.	$A = \frac{1}{2}bh$	IN THE BOOKLET
Area of a trapezoid a and b are the parallel sides, h is the height.	$A = \frac{1}{2}(a+b)h$	IN THE BOOKLET
Area of a circle r is the radius.	$A = \pi r^2$	IN THE BOOKLET
Circumference of a circle r is the radius.	$C = 2\pi r$	IN THE BOOKLET
Volume of a cuboid l is the length, w the width, h the height.	$V = lwh$	IN THE BOOKLET
Volume of a cylinder r is the radius, h the height.	$V = \pi r^2 h$	IN THE BOOKLET
Volume of a prism A is the area of cross-section, h the height.	$V = Ah$	IN THE BOOKLET
Curved surface area of a cylinder r is the radius, h the height.	$A = 2\pi rh$	IN THE BOOKLET
Distance between two points Points (x1, y1) and (x2, y2) in two dimensions.	$d = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$	IN THE BOOKLET
Midpoint of a line segment Endpoints (x1, y1) and (x2, y2) in two dimensions.	$M = \left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2}\right)$	IN THE BOOKLET

Prior learning: HL only

Solutions of a quadratic equation HL only. AI SL students do not get this printed.	$ax^2 + bx + c = 0 \Rightarrow x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}, \quad a \neq 0$	IN THE BOOKLET

Topic 1: Number and algebra, SL and HL

nth term of an arithmetic sequence u1 is the first term, d the common difference.	$u_n = u_1 + (n-1)d$	IN THE BOOKLET
Sum of n terms of an arithmetic sequence Use the second form when you know the last term.	$S_n = \frac{n}{2}\big(2u_1 + (n-1)d\big); \quad S_n = \frac{n}{2}(u_1 + u_n)$	IN THE BOOKLET
nth term of a geometric sequence r is the common ratio.	$u_n = u_1 r^{\,n-1}$	IN THE BOOKLET
Sum of n terms of a finite geometric sequence Choose the form with a positive denominator.	$S_n = \frac{u_1(r^n - 1)}{r - 1} = \frac{u_1(1 - r^n)}{1 - r}, \quad r \neq 1$	IN THE BOOKLET
Compound interest FV future value, PV present value, n years, k compounding periods per year, r% nominal annual rate.	$FV = PV \times \left(1 + \frac{r}{100k}\right)^{kn}$	IN THE BOOKLET
Exponents and logarithms	$a^x = b \iff x = \log_a b, \quad a > 0,\ b > 0,\ a \neq 1$	IN THE BOOKLET
Percentage error v_E is the exact value, v_A the approximate value.	$\varepsilon = \left\lvert \frac{v_A - v_E}{v_E} \right\rvert \times 100\%$	IN THE BOOKLET

Topic 1: Number and algebra, HL only

Laws of logarithms HL only. Needs a, x, y > 0.	$\log_a xy = \log_a x + \log_a y; \quad \log_a \frac{x}{y} = \log_a x - \log_a y;$ $\log_a x^m = m \log_a x$	IN THE BOOKLET
Sum of an infinite geometric sequence HL only. Converges only when |r| < 1.	$S_\infty = \frac{u_1}{1 - r}, \quad \lvert r \rvert < 1$	IN THE BOOKLET
Complex number HL only. a is the real part, b the imaginary part.	$z = a + bi$	IN THE BOOKLET
Discriminant HL only. Positive: two real roots. Zero: one repeated root. Negative: no real roots.	$\Delta = b^2 - 4ac$	IN THE BOOKLET
Modulus-argument (polar) and exponential (Euler) form HL only. r is the modulus, θ the argument.	$z = r(\cos\theta + i\sin\theta) = re^{i\theta} = r\,\mathrm{cis}\,\theta$	IN THE BOOKLET
Determinant of a 2 by 2 matrix HL only.	$A = \begin{pmatrix} a & b \\ c & d \end{pmatrix} \Rightarrow \det A = \lvert A \rvert = ad - bc$	IN THE BOOKLET
Inverse of a 2 by 2 matrix HL only. No inverse when the determinant is zero.	$A^{-1} = \frac{1}{\det A}\begin{pmatrix} d & -b \\ -c & a \end{pmatrix}, \quad ad \neq bc$	IN THE BOOKLET
Power formula for a matrix HL only. P is the matrix of eigenvectors, D the diagonal matrix of eigenvalues.	$M^n = PD^nP^{-1}$	IN THE BOOKLET

Topic 2: Functions, SL and HL

Equations of a straight line Gradient-intercept, general and point-gradient forms.	$y = mx + c; \quad ax + by + d = 0; \quad y - y_1 = m(x - x_1)$	IN THE BOOKLET
Gradient formula Gradient through (x1, y1) and (x2, y2).	$m = \dfrac{y_2 - y_1}{x_2 - x_1}$	IN THE BOOKLET
Axis of symmetry of a quadratic The vertex lies on this line.	$f(x) = ax^2 + bx + c \Rightarrow x = -\dfrac{b}{2a}$	IN THE BOOKLET

Topic 2: Functions, HL only

Logistic function HL only. L is the limiting value.	$f(x) = \dfrac{L}{1 + Ce^{-kx}}, \quad L, k, C > 0$	IN THE BOOKLET

Topic 3: Geometry and trigonometry, SL and HL

Distance between two points in three dimensions Points (x1, y1, z1) and (x2, y2, z2).	$d = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2 + (z_1 - z_2)^2}$	IN THE BOOKLET
Midpoint of a line segment in three dimensions Endpoints (x1, y1, z1) and (x2, y2, z2).	$M = \left(\dfrac{x_1 + x_2}{2}, \dfrac{y_1 + y_2}{2}, \dfrac{z_1 + z_2}{2}\right)$	IN THE BOOKLET
Volume of a right pyramid A is the area of the base, h the height.	$V = \frac{1}{3}Ah$	IN THE BOOKLET
Volume of a right cone r is the radius, h the height.	$V = \frac{1}{3}\pi r^2 h$	IN THE BOOKLET
Curved surface area of a cone r is the radius, l the slant height.	$A = \pi r l$	IN THE BOOKLET
Volume of a sphere r is the radius.	$V = \frac{4}{3}\pi r^3$	IN THE BOOKLET
Surface area of a sphere r is the radius.	$A = 4\pi r^2$	IN THE BOOKLET
Sine rule Each side is opposite the angle with the same letter. Watch the ambiguous case (two sides and a non-included angle).	$\dfrac{a}{\sin A} = \dfrac{b}{\sin B} = \dfrac{c}{\sin C}$	IN THE BOOKLET
Cosine rule Use the second form to find an angle from three sides.	$c^2 = a^2 + b^2 - 2ab\cos C; \quad \cos C = \dfrac{a^2 + b^2 - c^2}{2ab}$	IN THE BOOKLET
Area of a triangle using sine C is the angle between sides a and b.	$A = \frac{1}{2}ab\sin C$	IN THE BOOKLET
Length of an arc (degrees) θ is the angle in degrees, r the radius.	$l = \dfrac{\theta}{360} \times 2\pi r$	IN THE BOOKLET
Area of a sector (degrees) θ is the angle in degrees, r the radius.	$A = \dfrac{\theta}{360} \times \pi r^2$	IN THE BOOKLET

Topic 3: Geometry and trigonometry, HL only

Length of an arc (radians) HL only. r is the radius, θ the angle in radians.	$l = r\theta$	IN THE BOOKLET

Area of a sector (radians) HL only. r is the radius, θ the angle in radians.	$A = \frac{1}{2}r^2\theta$	IN THE BOOKLET
Pythagorean identity HL only.	$\cos^2\theta + \sin^2\theta = 1$	IN THE BOOKLET
Identity for tan θ HL only.	$\tan\theta = \frac{\sin\theta}{\cos\theta}$	IN THE BOOKLET
Reflection in the line y = (tan θ)x HL only. Transformation matrix.	$\begin{pmatrix} \cos 2\theta & \sin 2\theta \\ \sin 2\theta & -\cos 2\theta \end{pmatrix}$	IN THE BOOKLET
Horizontal stretch HL only. Stretch parallel to the x-axis with scale factor k.	$\begin{pmatrix} k & 0 \\ 0 & 1 \end{pmatrix}$	IN THE BOOKLET
Vertical stretch HL only. Stretch parallel to the y-axis with scale factor k.	$\begin{pmatrix} 1 & 0 \\ 0 & k \end{pmatrix}$	IN THE BOOKLET
Enlargement HL only. Scale factor k, centre (0, 0).	$\begin{pmatrix} k & 0 \\ 0 & k \end{pmatrix}$	IN THE BOOKLET
Anticlockwise rotation HL only. Anticlockwise (counter-clockwise) rotation of angle θ about the origin, θ > 0.	$\begin{pmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{pmatrix}$	IN THE BOOKLET
Clockwise rotation HL only. Clockwise rotation of angle θ about the origin, θ > 0.	$\begin{pmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{pmatrix}$	IN THE BOOKLET
Magnitude of a vector HL only.	$\lvert\mathbf{v}\rvert = \sqrt{v_1^2 + v_2^2 + v_3^2}, \quad \mathbf{v} = \begin{pmatrix} v_1 \\ v_2 \\ v_3 \end{pmatrix}$	IN THE BOOKLET
Vector equation of a line HL only. a is a point on the line, b the direction vector.	$\mathbf{r} = \mathbf{a} + \lambda\mathbf{b}$	IN THE BOOKLET
Parametric form of the equation of a line HL only.	$x = x_0 + \lambda l, \quad y = y_0 + \lambda m, \quad z = z_0 + \lambda n$	IN THE BOOKLET
Scalar product (components) HL only.	$\mathbf{v}\cdot\mathbf{w} = v_1w_1 + v_2w_2 + v_3w_3, \quad \mathbf{v} = \begin{pmatrix} v_1 \\ v_2 \\ v_3 \end{pmatrix}, \ \mathbf{w} = \begin{pmatrix} w_1 \\ w_2 \\ w_3 \end{pmatrix}$	IN THE BOOKLET
Scalar product (angle form) HL only. θ is the angle between v and w.	$\mathbf{v}\cdot\mathbf{w} = \lvert\mathbf{v}\rvert\lvert\mathbf{w}\rvert\cos\theta$	IN THE BOOKLET
Angle between two vectors HL only.	$\cos\theta = \frac{v_1w_1 + v_2w_2 + v_3w_3}{\lvert\mathbf{v}\rvert\lvert\mathbf{w}\rvert}$	IN THE BOOKLET
Vector product (components) HL only.	$\mathbf{v}\times\mathbf{w} = \begin{pmatrix} v_2w_3 - v_3w_2 \\ v_3w_1 - v_1w_3 \\ v_1w_2 - v_2w_1 \end{pmatrix}$	IN THE BOOKLET
Vector product (magnitude) HL only. θ is the angle between v and w.	$\lvert\mathbf{v}\times\mathbf{w}\rvert = \lvert\mathbf{v}\rvert\lvert\mathbf{w}\rvert\sin\theta$	IN THE BOOKLET
Area of a parallelogram from vectors HL only. v and w form two adjacent sides.	$A = \lvert\mathbf{v}\times\mathbf{w}\rvert$	IN THE BOOKLET

Topic 4: Statistics and probability, SL and HL

Interquartile range	$\mathrm{IQR} = Q_3 - Q_1$	IN THE BOOKLET
Mean of a set of data For grouped data use the midpoint of each class as x.	$\bar{x} = \frac{\sum_{i=1}^{k} f_i x_i}{n}, \quad n = \sum_{i=1}^{k} f_i$	IN THE BOOKLET
Probability of an event A Equally likely outcomes: n(A) favourable out of n(U) in the sample space.	$P(A) = \frac{n(A)}{n(U)}$	IN THE BOOKLET
Complementary events	$P(A) + P(A') = 1$	IN THE BOOKLET
Combined events Subtract the overlap so it is not counted twice.	$P(A \cup B) = P(A) + P(B) - P(A \cap B)$	IN THE BOOKLET
Mutually exclusive events Only when A and B cannot happen together.	$P(A \cup B) = P(A) + P(B)$	IN THE BOOKLET
Conditional probability The probability of A given that B has happened.	$P(A \mid B) = \frac{P(A \cap B)}{P(B)}$	IN THE BOOKLET
Independent events Only when A and B do not affect each other.	$P(A \cap B) = P(A)\,P(B)$	IN THE BOOKLET
Expected value of a discrete random variable	$E(X) = \sum x\,P(X = x)$	IN THE BOOKLET
Binomial distribution n trials, probability of success p on each.	$X \sim B(n, p)$	IN THE BOOKLET
Mean of a binomial distribution	$E(X) = np$	IN THE BOOKLET
Variance of a binomial distribution	$\mathrm{Var}(X) = np(1-p)$	IN THE BOOKLET

Topic 4: Statistics and probability, HL only

Linear transformation of a single random variable HL only. Adding b does not change the variance.	$E(aX + b) = aE(X) + b; \quad \mathrm{Var}(aX + b) = a^2\,\mathrm{Var}(X)$	IN THE BOOKLET
Linear combinations of n independent random variables HL only. X1, X2, ..., Xn are independent random variables.	$E(a_1X_1 \pm \cdots \pm a_nX_n) = a_1E(X_1) \pm \cdots \pm a_nE(X_n)$	IN THE BOOKLET
Variance of a linear combination HL only. Variances add, even when the combination subtracts.	$\mathrm{Var}(a_1X_1 \pm \cdots \pm a_nX_n) = a_1^2\mathrm{Var}(X_1) + \cdots + a_n^2\mathrm{Var}(X_n)$	IN THE BOOKLET
Unbiased estimate of the population variance HL only. Sample statistics: s_n is the sample standard deviation with divisor n.	$s_{n-1}^2 = \frac{n}{n-1}\,s_n^2$	IN THE BOOKLET
Mean of a Poisson distribution HL only.	$X \sim \mathrm{Po}(m): \quad E(X) = m$	IN THE BOOKLET
Variance of a Poisson distribution HL only. Mean and variance are both m.	$\mathrm{Var}(X) = m$	IN THE BOOKLET

Transition matrices HL only. s0 is the initial state.	$T^n\mathbf{s}_0 = \mathbf{s}_n$	IN THE BOOKLET

Topic 5: Calculus, SL and HL

Derivative of x^n	$f(x) = x^n \;\Rightarrow\; f'(x) = nx^{n-1}$	IN THE BOOKLET
Integral of x^n	$\int x^n\,dx = \frac{x^{n+1}}{n+1} + C, \quad n \neq -1$	IN THE BOOKLET
Area between a curve and the x-axis Where f(x) > 0 between a and b.	$A = \int_a^b y\,dx$	IN THE BOOKLET
The trapezoidal rule n is the number of strips.	$\int_a^b y\,dx \approx \frac{1}{2}h\big((y_0 + y_n) + 2(y_1 + y_2 + \cdots + y_{n-1})\big), \quad h = \frac{b-a}{n}$	IN THE BOOKLET

Topic 5: Calculus, HL only

Derivative of sin x HL only. x in radians.	$f(x) = \sin x \;\Rightarrow\; f'(x) = \cos x$	IN THE BOOKLET
Derivative of cos x HL only. x in radians.	$f(x) = \cos x \;\Rightarrow\; f'(x) = -\sin x$	IN THE BOOKLET
Derivative of tan x HL only.	$f(x) = \tan x \;\Rightarrow\; f'(x) = \frac{1}{\cos^2 x}$	IN THE BOOKLET
Derivative of e^x HL only.	$f(x) = e^x \;\Rightarrow\; f'(x) = e^x$	IN THE BOOKLET
Derivative of ln x HL only.	$f(x) = \ln x \;\Rightarrow\; f'(x) = \frac{1}{x}$	IN THE BOOKLET
Chain rule HL only.	$y = g(u),\ u = f(x) \;\Rightarrow\; \frac{dy}{dx} = \frac{dy}{du} \times \frac{du}{dx}$	IN THE BOOKLET
Product rule HL only.	$y = uv \;\Rightarrow\; \frac{dy}{dx} = u\frac{dv}{dx} + v\frac{du}{dx}$	IN THE BOOKLET
Quotient rule HL only.	$y = \frac{u}{v} \;\Rightarrow\; \frac{dy}{dx} = \frac{v\frac{du}{dx} - u\frac{dv}{dx}}{v^2}$	IN THE BOOKLET
Standard integral of 1/x HL only.	$\int \frac{1}{x}\,dx = \ln\lvert x\rvert + C$	IN THE BOOKLET
Standard integral of sin x HL only.	$\int \sin x\,dx = -\cos x + C$	IN THE BOOKLET
Standard integral of cos x HL only.	$\int \cos x\,dx = \sin x + C$	IN THE BOOKLET
Standard integral of 1/cos squared x HL only.	$\int \frac{1}{\cos^2 x}\,dx = \tan x + C$	IN THE BOOKLET
Standard integral of e^x HL only.	$\int e^x\,dx = e^x + C$	IN THE BOOKLET
Area of the region enclosed by a curve and the x or y axis HL only.	$A = \int_a^b \lvert y\rvert\,dx \quad \text{or} \quad A = \int_a^b \lvert x\rvert\,dy$	IN THE BOOKLET

Volume of revolution about the x or y axis HL only. Use the first for rotation about the x-axis, the second for the y-axis.	$V = \int_a^b \pi y^2 \, dx \quad \text{or} \quad V = \int_a^b \pi x^2 \, dy$	IN THE BOOKLET
Acceleration HL only. v is velocity, s displacement, t time.	$a = \frac{dv}{dt} = \frac{d^2s}{dt^2} = v\frac{dv}{ds}$	IN THE BOOKLET
Distance travelled from t1 to t2 HL only. The modulus counts movement in both directions.	$\text{distance} = \int_{t_1}^{t_2} \lvert v(t) \rvert \, dt$	IN THE BOOKLET
Displacement from t1 to t2 HL only. Signed: backwards movement is negative.	$\text{displacement} = \int_{t_1}^{t_2} v(t) \, dt$	IN THE BOOKLET
Euler's method HL only. h is a constant step length.	$y_{n+1} = y_n + h \times f(x_n, y_n); \quad x_{n+1} = x_n + h$	IN THE BOOKLET
Euler's method for coupled systems HL only. h is a constant step length.	$x_{n+1} = x_n + h \times f_1(x_n, y_n, t_n); \quad y_{n+1} = y_n + h \times f_2(x_n, y_n, t_n); \quad t_{n+1} = t_n + h$	IN THE BOOKLET
Exact solution for coupled linear differential equations HL only. λ 1 and λ 2 are eigenvalues, p1 and p2 the matching eigenvectors.	$\mathbf{x} = Ae^{\lambda_1 t}\mathbf{p}_1 + Be^{\lambda_2 t}\mathbf{p}_2$	IN THE BOOKLET

Learn these: not in the booklet

Laws of exponents

$a^m \times a^n = a^{m+n}$; $\frac{a^m}{a^n} = a^{m-n}$; $(a^m)^n = a^{mn}$; $a^{-n} = \frac{1}{a^n}$; $a^{1/n} = \sqrt[n]{a}$

Laws of logarithms for AI SL (printed for HL only)

$\log_a xy = \log_a x + \log_a y$; $\log_a \frac{x}{y} = \log_a x - \log_a y$; $\log_a x^m = m \log_a x$

Special logarithm values

$\log_a 1 = 0$; $\log_a a = 1$

Quadratic formula and discriminant for AI SL (printed for HL only)

$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$; $\Delta = b^2 - 4ac$

Parallel and perpendicular lines

$m_1 = m_2$ (parallel); $m_1 m_2 = -1$ (perpendicular)

Other forms of a quadratic

$f(x) = a(x-p)(x-q)$ gives roots p, q; $f(x) = a(x-h)^2 + k$ gives vertex (h, k)

Percentage change

$\frac{\text{new} - \text{old}}{\text{old}} \times 100\%$

Exponential models

$f(x) = ka^x + c$; growth $N = N_0 e^{rt}$; decay $N = N_0 e^{-rt}$

Sinusoidal model

$f(x) = a\sin\big(b(x-c)\big) + d$; amplitude $|a|$; period $\frac{360^\circ}{b}$ or $\frac{2\pi}{b}$; midline $y = d$

Right-angled trigonometry

$\sin\theta = \frac{\text{opp}}{\text{hyp}}$; $\cos\theta = \frac{\text{adj}}{\text{hyp}}$; $\tan\theta = \frac{\text{opp}}{\text{adj}}$; $a^2 + b^2 = c^2$

Radians and degrees (HL)

π rad $= 180^\circ$

Modulus and conjugate of a complex number (HL)

$|z| = \sqrt{a^2 + b^2}$; $z^* = a - bi$; $zz^* = |z|^2$

Outliers

$x < Q_1 - 1.5 \times \text{IQR}$ or $x > Q_3 + 1.5 \times \text{IQR}$

Binomial probability

$P(X = r) = \binom{n}{r} p^r (1-p)^{n-r}$

Standardising a normal variable (not printed for AI)

$z = \frac{x - \mu}{\sigma}$

Spearman's rank correlation

$r_s = 1 - \frac{6\sum d^2}{n(n^2-1)}$

Chi-squared statistic

$$\chi^2 = \sum \frac{(f_o - f_e)^2}{f_e};\ f_e = \frac{\text{row total} \times \text{column total}}{\text{grand total}};\ \text{degrees of freedom} = (r-1)(c-1)$$

Chi-squared goodness of fit

$$\text{degrees of freedom} = \text{number of categories} - 1$$

Poisson probability (HL)

$$P(X = r) = \frac{e^{-m} m^r}{r!}$$

Distribution of the sample mean (HL)

$$E(\bar{X}) = \mu;\ \text{Var}(\bar{X}) = \frac{\sigma^2}{n}$$

Tangent and normal at x = a

$$\text{tangent } y - f(a) = f'(a)(x-a);\ \text{normal gradient} = -\frac{1}{f'(a)}$$

Stationary points and curvature

$$f'(x) = 0 \text{ at a stationary point};\ f''(x) > 0 \text{ minimum};\ f''(x) < 0 \text{ maximum}$$

Velocity (HL)

$$v = \frac{ds}{dt}$$

Reverse chain rule (HL)

$$\int f(ax+b)\,dx = \frac{1}{a}F(ax+b) + C$$

Eigenvalues and eigenvectors (HL)

$$M\mathbf{v} = \lambda\mathbf{v};\ \det(M - \lambda I) = 0$$

Steady state of a transition matrix (HL)

$$T\mathbf{s} = \mathbf{s}$$

Separable differential equations (HL)

$$\frac{dy}{dx} = f(x)g(y) \Rightarrow \int \frac{1}{g(y)}\,dy = \int f(x)\,dx$$

Using the booklet in the exam

- Practise with the booklet open all year, so you know where each topic sits and can find a row in seconds.
- Check the HL only rows before relying on them: AI SL students get no quadratic formula, log laws, trig identities or Poisson formulae printed.
- Match the angle formulae to the unit: arc length and sector area use degrees at SL and radians in the HL only rows.
- Compound interest needs the rate as r%, so r = 5 means 5 per cent, not 0.05. Keep k as compounding periods per year.
- The chi-squared statistic, Spearman's coefficient and normal standardising are not printed, so write the rule before substituting.

Based on: IB Mathematics: applications and interpretation (SL and HL), Mathematics: applications and interpretation formula booklet, version 1.0. Statistical tables are calculated by CuratedPrep to the same layout. Updated 31 October 2026. Always practise with the version of the official booklet your exam uses. More free sheets and topic worksheets at curatedprep.com.