IB DEMYSTIFIED
EXAMINERS · MODERATORS · AUTHORS

IB MATHEMATICS · FORMULA BOOKLET

Mathematics: Applications & Interpretation

Standard and Higher Level formula booklet, organised by syllabus topic

SL HL

www.ibdemystified.com

JUMP TO Prior learning · Number and algebra · Functions · Geometry and trigonometry · Statistics and probability · Calculus

ASSUMED KNOWLEDGE

Prior learning

Area of a parallelogram	$A = bh$ b = base length, h = perpendicular height
Area of a triangle	$A = \frac{1}{2}bh$ b = base length, h = perpendicular height
Area of a trapezium (trapezoid)	$A = \frac{1}{2}(a+b)\,h$ a, b = lengths of the two parallel sides, h = perpendicular distance between them
Area of a circle	$A = \pi r^2$ r = radius
Circumference of a circle	$C = 2\pi r$ r = radius
Volume of a cuboid	$V = lwh$ l = length, w = width, h = height
Volume of a cylinder	$V = \pi r^2 h$ r = radius, h = height

Volume of a prism	$V = Ah$ A = area of the uniform cross-section, h = length (height)
Curved surface area of a cylinder	$A = 2\pi rh$ r = radius, h = height
Distance between two points in a plane	$d = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$ for the points (x_1, y_1) and (x_2, y_2)
Midpoint of a line segment (2D)	$\left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2}\right)$ for the end points (x_1, y_1) and (x_2, y_2)
Roots of a quadratic equation HL	$ax^2 + bx + c = 0 \Rightarrow x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \qquad a \neq 0$

TOPIC 1

Number and algebra

1.2 **Arithmetic sequence: nth term**	$u_n = u_1 + (n-1)d$ u_1 = first term, d = common difference
1.2 **Arithmetic series: sum of the first n terms**	$S_n = \frac{n}{2}\left(2u_1 + (n-1)d\right) \qquad S_n = \frac{n}{2}\left(u_1 + u_n\right)$
1.3 **Geometric sequence: nth term**	$u_n = u_1 r^{\,n-1}$ r = common ratio
1.3 **Geometric series: sum of the first n terms**	$S_n = \frac{u_1(r^n - 1)}{r - 1} = \frac{u_1(1 - r^n)}{1 - r} \qquad r \neq 1$
1.4 **Compound interest**	$FV = PV \times \left(1 + \frac{r}{100k}\right)^{kn}$ FV = future value, PV = present value, n = number of years, k = number of compounding periods per year, $r\%$ = nominal annual interest rate
1.5 **Link between exponents and logarithms**	$a^x = b \iff x = \log_a b \qquad a, b > 0,\ a \neq 1$
1.6 **Percentage error**	$\varepsilon = \left\lvert \frac{v_A - v_E}{v_E} \right\rvert \times 100\%$ v_E = exact value, v_A = approximate value of v
HL 1.9 **Laws of logarithms**	$\log_a xy = \log_a x + \log_a y \qquad \log_a \frac{x}{y} = \log_a x - \log_a y$ $\log_a x^m = m \log_a x$ for $a, x, y > 0$
1.11 HL **Sum to infinity of a geometric series**	$S_\infty = \frac{u_1}{1 - r} \qquad \lvert r \rvert < 1$
1.12 HL **Complex numbers and the discriminant**	$z = a + b\mathrm{i} \qquad \Delta = b^2 - 4ac$
1.13 HL **Modulus–argument (polar) and Euler forms**	$z = r(\cos\theta + \mathrm{i}\sin\theta) = r\mathrm{e}^{\mathrm{i}\theta} = r\,\mathrm{cis}\,\theta$

1.14 HL

Determinant of a 2×2 matrix

$$\boldsymbol{A} = \begin{pmatrix} a & b \\ c & d \end{pmatrix} \Rightarrow \det \boldsymbol{A} = |\boldsymbol{A}| = ad - bc$$

1.14 HL

Inverse of a 2×2 matrix

$$\boldsymbol{A}^{-1} = \frac{1}{\det \boldsymbol{A}} \begin{pmatrix} d & -b \\ -c & a \end{pmatrix} \qquad ad \neq bc$$

1.15 HL

Power of a diagonalisable matrix

$$\boldsymbol{M}^n = \boldsymbol{P}\boldsymbol{D}^n\boldsymbol{P}^{-1}$$

$\boldsymbol{P}$ = matrix of eigenvectors, $\boldsymbol{D}$ = diagonal matrix of the corresponding eigenvalues

TOPIC 2

Functions

2.1 **Forms of the equation of a straight line**	$y = mx + c \qquad ax + by + d = 0 \qquad y - y_1 = m(x - x_1)$
2.1 **Gradient through two points**	$m = \dfrac{y_2 - y_1}{x_2 - x_1}$
2.5 **Axis of symmetry of a quadratic graph**	$f(x) = ax^2 + bx + c \Rightarrow \text{axis of symmetry: } x = -\dfrac{b}{2a}$
HL 2.9 **Logistic function**	$f(x) = \dfrac{L}{1 + Ce^{-kx}} \qquad L, k, C > 0$ L = upper limit (carrying capacity)

TOPIC 3

Geometry and trigonometry

3.1 **Distance between two points in space**	$d = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2 + (z_1 - z_2)^2}$ for the points (x_1, y_1, z_1) and (x_2, y_2, z_2)
3.1 **Midpoint of a line segment (3D)**	$\left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2}, \frac{z_1 + z_2}{2}\right)$
3.1 **Volume of a right pyramid**	$V = \frac{1}{3}Ah$ A = area of the base, h = vertical height
3.1 **Volume of a right cone**	$V = \frac{1}{3}\pi r^2 h$ r = base radius, h = vertical height
3.1 **Curved surface area of a cone**	$A = \pi r l$ r = base radius, l = slant height
3.1 **Volume of a sphere**	$V = \frac{4}{3}\pi r^3$ r = radius
3.1 **Surface area of a sphere**	$A = 4\pi r^2$ r = radius
3.2 **Sine rule**	$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$ side a is opposite angle A, and so on
3.2 **Cosine rule**	$c^2 = a^2 + b^2 - 2ab\cos C \qquad \cos C = \frac{a^2 + b^2 - c^2}{2ab}$
3.2 **Area of a triangle (two sides and included angle)**	$A = \frac{1}{2}ab\sin C$
3.4 **Arc length (angle in degrees)**	$l = \frac{\theta}{360} \times 2\pi r$ θ = angle at the centre in degrees, r = radius
3.4 **Area of a sector (angle in degrees)**	$A = \frac{\theta}{360} \times \pi r^2$ θ = angle at the centre in degrees, r = radius

3.7 HL **Arc length and sector area (angle in radians)**	$l = r\theta \qquad A = \frac{1}{2}r^2\theta$ r = radius, θ = angle at the centre in radians
3.8 HL **Trigonometric identities**	$\cos^2\theta + \sin^2\theta = 1 \qquad \tan\theta = \dfrac{\sin\theta}{\cos\theta}$
3.9 HL **Transformation matrices**	$\begin{pmatrix}\cos 2\theta & \sin 2\theta \\ \sin 2\theta & -\cos 2\theta\end{pmatrix}$ Reflection in the line $y = (\tan\theta)x$ $\begin{pmatrix}k & 0 \\ 0 & 1\end{pmatrix}$ Horizontal stretch (parallel to the x-axis), scale factor k $\begin{pmatrix}1 & 0 \\ 0 & k\end{pmatrix}$ Vertical stretch (parallel to the y-axis), scale factor k $\begin{pmatrix}k & 0 \\ 0 & k\end{pmatrix}$ Enlargement, scale factor k, centre $(0, 0)$ $\begin{pmatrix}\cos\theta & -\sin\theta \\ \sin\theta & \cos\theta\end{pmatrix}$ Anticlockwise rotation through θ about the origin $(\theta > 0)$ $\begin{pmatrix}\cos\theta & \sin\theta \\ -\sin\theta & \cos\theta\end{pmatrix}$ Clockwise rotation through θ about the origin $(\theta > 0)$
3.10 HL **Magnitude of a vector**	$\lvert\boldsymbol{v}\rvert = \sqrt{v_1^2 + v_2^2 + v_3^2}$ for $\boldsymbol{v} = (v_1, v_2, v_3)$
3.11 HL **Equation of a line in 3D**	$\boldsymbol{r} = \boldsymbol{a} + \lambda\boldsymbol{b} \qquad x = x_0 + \lambda l,\ y = y_0 + \lambda m,\ z = z_0 + \lambda n$ vector and parametric forms; direction vector $\boldsymbol{b} = (l, m, n)$
3.13 HL **Scalar (dot) product**	$\boldsymbol{v}\cdot\boldsymbol{w} = v_1w_1 + v_2w_2 + v_3w_3 \qquad \boldsymbol{v}\cdot\boldsymbol{w} = \lvert\boldsymbol{v}\rvert\lvert\boldsymbol{w}\rvert\cos\theta$ θ = angle between $\boldsymbol{v}$ and $\boldsymbol{w}$
3.13 HL **Angle between two vectors**	$\cos\theta = \dfrac{v_1w_1 + v_2w_2 + v_3w_3}{\lvert\boldsymbol{v}\rvert\lvert\boldsymbol{w}\rvert}$
3.13 HL **Vector (cross) product**	$\boldsymbol{v}\times\boldsymbol{w} = \begin{pmatrix}v_2w_3 - v_3w_2 \\ v_3w_1 - v_1w_3 \\ v_1w_2 - v_2w_1\end{pmatrix} \qquad \lvert\boldsymbol{v}\times\boldsymbol{w}\rvert = \lvert\boldsymbol{v}\rvert\lvert\boldsymbol{w}\rvert\sin\theta$
3.13 HL **Area of a parallelogram from vectors**	$A = \lvert\boldsymbol{v}\times\boldsymbol{w}\rvert$ $\boldsymbol{v}$ and $\boldsymbol{w}$ form two adjacent sides

TOPIC 4

Statistics and probability

4.2 **Interquartile range**	$\mathrm{IQR} = Q_3 - Q_1$
4.3 **Mean of a data set (frequency form)**	$\bar{x} = \dfrac{\sum_{i=1}^{k} f_i x_i}{n} \qquad n = \sum_{i=1}^{k} f_i$ f_i = frequency of the value x_i
4.5 **Probability of an event A**	$\mathrm{P}(A) = \dfrac{n(A)}{n(U)}$ $n(U)$ = number of outcomes in the sample space
4.5 **Complementary events**	$\mathrm{P}(A) + \mathrm{P}(A') = 1$
4.6 **Combined events (addition rule)**	$\mathrm{P}(A \cup B) = \mathrm{P}(A) + \mathrm{P}(B) - \mathrm{P}(A \cap B)$
4.6 **Mutually exclusive events**	$\mathrm{P}(A \cup B) = \mathrm{P}(A) + \mathrm{P}(B)$
4.6 **Conditional probability**	$\mathrm{P}(A \mid B) = \dfrac{\mathrm{P}(A \cap B)}{\mathrm{P}(B)}$
4.6 **Independent events**	$\mathrm{P}(A \cap B) = \mathrm{P}(A)\,\mathrm{P}(B)$
4.7 **Expected value of a discrete random variable X**	$\mathrm{E}(X) = \sum x\,\mathrm{P}(X = x)$
4.8 **Binomial distribution: mean and variance**	$X \sim \mathrm{B}(n, p) \qquad \mathrm{E}(X) = np \qquad \mathrm{Var}(X) = np(1-p)$
4.14 HL **Linear transformation of a random variable**	$\mathrm{E}(aX + b) = a\mathrm{E}(X) + b \qquad \mathrm{Var}(aX + b) = a^2\mathrm{Var}(X)$
4.14 HL **Linear combinations of n independent random variables**	$\mathrm{E}(a_1X_1 \pm a_2X_2 \pm \cdots \pm a_nX_n) = a_1\mathrm{E}(X_1) \pm a_2\mathrm{E}(X_2) \pm \cdots \pm a_n\mathrm{E}(X_n)$ $\mathrm{Var}(a_1X_1 \pm a_2X_2 \pm \cdots \pm a_nX_n) = a_1^2\mathrm{Var}(X_1) + a_2^2\mathrm{Var}(X_2) + \cdots + a_n^2$

4.14 HL **Unbiased estimate of population variance**	$$s_{n-1}^2 = \frac{n}{n-1} s_n^2$$ s_n^2 = variance of the sample
4.17 HL **Poisson distribution: mean and variance**	$$X \sim \mathrm{Po}(m) \qquad \mathrm{E}(X) = m \qquad \mathrm{Var}(X) = m$$
4.19 HL **Transition matrices**	$$\boldsymbol{T}^n \boldsymbol{s}_0 = \boldsymbol{s}_n$$ $\boldsymbol{s}_0$ = initial state vector, $\boldsymbol{T}$ = transition matrix

TOPIC 5

Calculus

5.3 **Derivative of x^n**	$f(x) = x^n \Rightarrow f'(x) = nx^{n-1}$
5.5 **Integral of x^n**	$\int x^n \, \mathrm{d}x = \frac{x^{n+1}}{n+1} + C \qquad n \neq -1$
5.5 **Area between a curve and the x-axis, where $f(x) > 0$**	$A = \int_a^b y \, \mathrm{d}x$
5.8 **Trapezoidal rule**	$\int_a^b y \, \mathrm{d}x \approx \frac{1}{2}h\Big((y_0 + y_n) + 2(y_1 + y_2 + \cdots + y_{n-1})\Big) \qquad h = \frac{b-a}{n}$ n = number of strips of equal width h
HL 5.9 **Standard derivatives**	$f(x) = \sin x \Rightarrow f'(x) = \cos x \qquad f(x) = \cos x \Rightarrow f'(x) = -\sin x$ $f(x) = \tan x \Rightarrow f'(x) = \frac{1}{\cos^2 x} \qquad f(x) = \mathrm{e}^x \Rightarrow f'(x) = \mathrm{e}^x$ $f(x) = \ln x \Rightarrow f'(x) = \frac{1}{x}$
HL 5.9 **Chain rule**	$y = g(u),\ u = f(x) \Rightarrow \frac{\mathrm{d}y}{\mathrm{d}x} = \frac{\mathrm{d}y}{\mathrm{d}u} \times \frac{\mathrm{d}u}{\mathrm{d}x}$
HL 5.9 **Product rule**	$y = uv \Rightarrow \frac{\mathrm{d}y}{\mathrm{d}x} = u\frac{\mathrm{d}v}{\mathrm{d}x} + v\frac{\mathrm{d}u}{\mathrm{d}x}$
HL 5.9 **Quotient rule**	$y = \frac{u}{v} \Rightarrow \frac{\mathrm{d}y}{\mathrm{d}x} = \frac{v\frac{\mathrm{d}u}{\mathrm{d}x} - u\frac{\mathrm{d}v}{\mathrm{d}x}}{v^2}$
HL 5.11 **Standard integrals**	$\int \frac{1}{x} \, \mathrm{d}x = \ln\lvert x\rvert + C \qquad \int \sin x \, \mathrm{d}x = -\cos x + C$ $\int \cos x \, \mathrm{d}x = \sin x + C \qquad \int \frac{1}{\cos^2 x} \, \mathrm{d}x = \tan x + C$ $\int \mathrm{e}^x \, \mathrm{d}x = \mathrm{e}^x + C$
HL 5.12 **Area enclosed by a curve and either axis**	$A = \int_a^b \lvert y\rvert \, \mathrm{d}x \qquad A = \int_a^b \lvert x\rvert \, \mathrm{d}y$

5.12 **Volume of revolution about the x- or y-axis** HL	$V = \int_a^b \pi y^2 \, \mathrm{d}x \qquad V = \int_a^b \pi x^2 \, \mathrm{d}y$
5.13 **Acceleration** HL	$a = \frac{\mathrm{d}v}{\mathrm{d}t} = \frac{\mathrm{d}^2 s}{\mathrm{d}t^2} = v\frac{\mathrm{d}v}{\mathrm{d}s}$
5.13 **Distance travelled from t_1 to t_2** HL	$\text{distance} = \int_{t_1}^{t_2} \lvert v(t) \rvert \, \mathrm{d}t$
5.13 **Displacement from t_1 to t_2** HL	$\text{displacement} = \int_{t_1}^{t_2} v(t) \, \mathrm{d}t$
5.16 **Euler's method** HL	$y_{n+1} = y_n + h \times f(x_n, y_n) \qquad x_{n+1} = x_n + h$ h = constant step length
5.16 **Euler's method for coupled systems** HL	$x_{n+1} = x_n + h \times f_1(x_n, y_n, t_n) \qquad y_{n+1} = y_n + h \times f_2(x_n, y_n, t_n)$ $t_{n+1} = t_n + h$ h = constant step length
5.17 **Exact solution for coupled linear differential equations** HL	$\boldsymbol{x} = A\mathrm{e}^{\lambda_1 t}\boldsymbol{p}_1 + B\mathrm{e}^{\lambda_2 t}\boldsymbol{p}_2$ λ_1, λ_2 = eigenvalues with eigenvectors $\boldsymbol{p}_1, \boldsymbol{p}_2$

© 2026 IB Demystified · Examiners. Moderators. Authors.