



Formula Booklet

Mathematics: Applications & Interpretation
Standard Level (SL)

For use during the course and in examinations
Based on IB Diploma Programme · First examinations 2021

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Contents

- Topic 1** Number and Algebra
- Topic 2** Functions
- Topic 3** Geometry and Trigonometry
- Topic 4** Statistics and Probability
- Topic 5** Calculus



Topic 1: Number and Algebra

1.2 — Arithmetic Sequences & Series

Formula

$$u_n = u_1 + (n - 1)d$$

$$S_n = \frac{n}{2}(2u_1 + (n - 1)d)$$

$$S_n = \frac{n}{2}(u_1 + u_n)$$

Explanation / Variables

n -th term of an arithmetic sequence. u_1 = first term, d = common difference, n = term number.

Sum of n terms. Use when the last term is unknown.

Sum of n terms. Use when both the first and last term are known.

1.3 — Geometric Sequences & Series

Formula

$$u_n = u_1 \cdot r^{n-1}$$

$$S_n = \frac{u_1(r^n - 1)}{r - 1} = \frac{u_1(1 - r^n)}{1 - r} \quad (r \neq 1)$$

Explanation / Variables

n -th term of a geometric sequence. u_1 = first term, r = common ratio.

Sum of n terms of a finite geometric sequence. Both forms are equivalent.

1.4 — Compound Interest

Formula

$$FV = PV \times \left(1 + \frac{r}{100k}\right)^{kn}$$

Explanation / Variables

FV = future value, PV = present value, $r\%$ = nominal annual interest rate, k = compounding periods per year, n = number of years.

1.5 — Exponents and Logarithms

Formula

$$\log_a x = b \Leftrightarrow a^b = x$$

Explanation / Variables

Definition of a logarithm. $a > 0$, $a \neq 1$, $b > 0$. The logarithm is the exponent to which the base a must be raised to get x .

1.6 — Percentage Error

Formula

$$\varepsilon = \left| \frac{v_E - v_A}{v_E} \right| \times 100\%$$

Explanation / Variables

v_E = exact value, v_A = approximate value.
Measures how far an approximation is from the true value.

Topic 2: Functions**2.1 — Straight Lines****Formula**

$$y = mx + c$$

$$ax + by + d = 0$$

$$y - y_1 = m(x - x_1)$$

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$

Explanation / Variables

Slope-intercept form. m = gradient, c = y -intercept.

General form of a straight line.

Point-slope form. (x_1, y_1) is a known point on the line.

Gradient formula between two points (x_1, y_1) and (x_2, y_2) .

2.5 — Quadratic Functions**Formula**

$$f(x) = ax^2 + bx + c \Rightarrow x = -\frac{b}{2a}$$

Explanation / Variables

Axis of symmetry of a parabola. Also gives the x -coordinate of the vertex.

Topic 3: Geometry and Trigonometry

Prior Learning — Areas & Volumes

Formula

$$A = bh$$

$$A = \frac{1}{2}bh$$

$$A = \frac{1}{2}(a + b)h$$

$$A = \pi r^2$$

$$C = 2\pi r$$

$$V = lwh$$

$$V = \pi r^2 h$$

$$V = Ah$$

$$A = 2\pi rh$$

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

$$M = \left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2} \right)$$

Explanation / Variables

Area of a parallelogram. b = base, h = perpendicular height.

Area of a triangle. b = base, h = perpendicular height.

Area of a trapezoid. a , b = parallel sides, h = height.

Area of a circle. r = radius.

Circumference of a circle. r = radius.

Volume of a cuboid. l = length, w = width, h = height.

Volume of a cylinder. r = radius, h = height.

Volume of a prism. A = area of cross-section, h = height.

Curved surface area of a cylinder.

Distance between two points in 2D.

Midpoint of a line segment in 2D.

3.1 — 3D Geometry

Formula

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2 + (z_2 - z_1)^2}$$

$$M = \left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2}, \frac{z_1 + z_2}{2} \right)$$

Explanation / Variables

Distance between two points (x_1, y_1, z_1) and (x_2, y_2, z_2) in 3D.

Midpoint of a line segment in 3D.

3D Solids

Formula

$$V = \frac{1}{3}Ah$$

$$V = \frac{1}{3}\pi r^2 h$$

$$A = \pi r l$$

$$V = \frac{4}{3}\pi r^3$$

$$A = 4\pi r^2$$

Explanation / Variables

Volume of a right pyramid. A = base area, h = perpendicular height.

Volume of a right cone. r = base radius, h = height.

Curved surface area of a cone. l = slant height.

Volume of a sphere. r = radius.

Surface area of a sphere.

3.2 — Trigonometry**Formula**

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$c^2 = a^2 + b^2 - 2ab \cos C$$

$$\cos C = \frac{a^2 + b^2 - c^2}{2ab}$$

$$A = \frac{1}{2}ab \sin C$$

Explanation / Variables

Sine rule. Use when a side and its opposite angle are known (non-right triangles).

Cosine rule (finding a side). C = angle opposite side c .

Cosine rule (finding an angle). Rearrangement of the above.

Area of a triangle using two sides and the included angle C .

3.4 — Arc Length & Sector Area**Formula**

$$l = \frac{\theta}{360} \times 2\pi r$$

$$A = \frac{\theta}{360} \times \pi r^2$$

Explanation / Variables

Length of an arc. θ in degrees, r = radius.

Area of a sector. θ in degrees, r = radius.

Topic 4: Statistics and Probability

4.2 — Spread

Formula

$$\text{IQR} = Q_3 - Q_1$$

Explanation / Variables

Interquartile range. Measures the spread of the middle 50% of data. Q_1 = lower quartile, Q_3 = upper quartile.

4.3 — Mean

Formula

$$\bar{x} = \frac{\sum_{i=1}^k f_i x_i}{n} \quad \text{where } n = \sum_{i=1}^k f_i$$

Explanation / Variables

Mean of a frequency distribution. x_i = data value, f_i = frequency of that value.

4.5 — Probability

Formula

$$P(A) = \frac{n(A)}{n(U)}$$

Explanation / Variables

Probability of event A . $n(A)$ = number of favourable outcomes, $n(U)$ = total outcomes (equally likely).

$$P(A) + P(A') = 1$$

Complementary events. A' = complement of A (event A does not occur).

4.6 — Combined Events

Formula

$$P(A \cup B) = P(A) + P(B) - P(A \cap B)$$

Explanation / Variables

Addition rule (combined events). Subtracts the overlap to avoid double-counting.

$$P(A \cup B) = P(A) + P(B)$$

Mutually exclusive events: A and B cannot both occur, so $P(A \cap B) = 0$.

$$P(A | B) = \frac{P(A \cap B)}{P(B)}$$

Conditional probability. Probability of A given that B has already occurred.

$$P(A \cap B) = P(A) \cdot P(B)$$

Independent events. Occurrence of one does not affect the other.

4.7 — Expected Value

Formula

$$E(X) = \sum_{i=1}^k x_i \cdot P(X = x_i)$$

Explanation / Variables

Expected value (mean) of a discrete random variable X . Weighted average of all possible values by their probabilities.

4.8 — Binomial Distribution**Formula**

$$X \sim B(n, p)$$

Explanation / Variables

Notation: n = number of trials, p = probability of success per trial. Requires fixed n , independent trials, constant p .

$$E(X) = np$$

Mean (expected number of successes) of a binomial distribution.

$$\text{Var}(X) = np(1 - p)$$

Variance of a binomial distribution. $1 - p$ = probability of failure.

Topic 5: Calculus

5.3 — Differentiation

Formula

$$f(x) = x^n \Rightarrow f'(x) = nx^{n-1}$$

Explanation / Variables

Power rule for differentiation. Multiply by the exponent and reduce the power by 1. Valid for all real n .

Key differentiation rules: Sum: $(f \pm g)' = f' \pm g'$ Constant multiple: $(cf)' = cf'$ $f'(x) > 0$: increasing $f'(x) < 0$: decreasing $f'(x) = 0$: stationary point

5.5 — Integration

Formula

$$\int x^n dx = \frac{x^{n+1}}{n+1} + C \quad (n \neq -1)$$

$$A = \int_a^b y dx \quad \text{where } f(x) > 0$$

Explanation / Variables

Power rule for integration (anti-differentiation). C is the constant of integration. Increase the power by 1 and divide.

Area enclosed between the curve $y = f(x)$ and the x -axis, from $x = a$ to $x = b$.

Note: For areas below the x -axis, $f(x) < 0$, use $A = \left| \int_a^b f(x) dx \right|$. For areas between two curves:

$$A = \int_a^b [f(x) - g(x)] dx \quad \text{where } f(x) \geq g(x).$$

5.8 — The Trapezoidal Rule

Formula

$$\int_a^b y dx \approx \frac{h}{2}(y_0 + 2y_1 + 2y_2 + \dots + 2y_{n-1} + y_n)$$

where $h = \frac{b-a}{n}$

Explanation / Variables

Numerical approximation of a definite integral using n trapezoids. y_0, y_1, \dots, y_n are the function values at equally spaced x -values. The first and last values are counted once; all interior values are doubled.

How to apply: (1) Find $h = \frac{b-a}{n}$ (2) List all x -values: $x_0 = a, x_1 = a+h, \dots, x_n = b$ (3) Calculate $y_i = f(x_i)$ for each (4) Apply the formula above.

Note on Calculator Use

In IB AI SL exams, a GDC (Graphic Display Calculator) is permitted in Papers 2 and 3. Always show working clearly — answers alone without method may not receive full marks.