

Ib Math Studies Formula Sheet

Mathematics: Analysis & Approaches SL & HL

1 Page Formula Sheet – First Examinations 2021 – Updated Version 1.3

Prior Learning SL & HL

Area: Parallelogram	$A = bh$, b = base, h = height
Area: Triangle	$A = \frac{1}{2}bh$, b = base, h = height
Area: Trapezoid	$A = \frac{1}{2}(a + b)h$, a, b = parallel sides, h = height
Area: Circle	$A = \pi r^2$, r = radius
Circumference: Circle	$C = 2\pi r$, r = radius
Volume: Cuboid	$V = lwh$, l = length, w = width, h = height
Volume: Cylinder	$V = \pi r^2 h$, r = radius, h = height
Volume: Prism	$V = Ah$, A = cross section area, h = height
Area: Cylinder curve	$A = 2\pi rh$, r = radius, h = height
Distance between two points $(x_1, y_1), (x_2, y_2)$	$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$
Coordinates of midpoint $(x_1, y_1), (x_2, y_2)$	$\left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2}\right)$ for endpoints $(x_1, y_1), (x_2, y_2)$

Topic 1: Number and algebra – SL & HL

The n th term of an arithmetic sequence	$u_n = a + (n - 1)d$
Sum of n terms of an arithmetic sequence	$S_n = \frac{n}{2}(2a + (n - 1)d) = \frac{n}{2}(u_1 + u_n)$
The n th term of a geometric sequence	$u_n = ar^{n-1}$
Sum of n terms of a finite geometric seq.	$S_n = \frac{a(1 - r^n)}{1 - r}$, $r \neq 1$
Compound interest	$FV = PV \left(1 + \frac{r}{n}\right)^{nt}$ PV is future value, PV is present value, n is the number of years, t is the number of compounding periods per year, r is the nominal annual rate of interest
Exponents & logarithms	$a^x \cdot a^y = a^{x+y}$, $a > 0, x, y \in \mathbb{R}$ $\log_a a^x = x$, $a > 0, x \in \mathbb{R}$ $\log_a a = 1$, $a > 0$
Exponents & logarithms	$\log_a a^x = x$, $a > 0, x \in \mathbb{R}$ $\log_a a = 1$, $a > 0$
The sum of an infinite geometric sequence	$S_\infty = \frac{a}{1 - r}$, $ r < 1$
Binomial Theorem	For $n \in \mathbb{N}$, $(x + y)^n = \sum_{k=0}^n \binom{n}{k} x^{n-k} y^k$
Binomial coefficient	$\binom{n}{k} = \frac{n!}{k!(n-k)!}$

Topic 1: Number and algebra – HL only

Combinatorics	$nCr = \frac{n!}{r!(n-r)!}$, $nPr = \frac{n!}{(n-r)!}$
Permutations	$nPr = \frac{n!}{(n-r)!}$
Extension of Binomial Theorem, $ x < 1$	$(1 + x)^n = 1 + nx + \frac{n(n-1)}{2!}x^2 + \dots$
Complex numbers	$z = a + bi$
Modulus argument (polar) & Exponential (Euler) form	$z = r(\cos \theta + i \sin \theta) = re^{i\theta}$
De Moivre's Theorem	$[r(\cos \theta + i \sin \theta)]^n = r^n(\cos n\theta + i \sin n\theta) = r^n e^{in\theta}$

Topic 2: Functions – SL & HL

Equations of a straight line	$y = mx + c$, $mx + c = 0$
Gradient formula	$m = \frac{y_2 - y_1}{x_2 - x_1}$
Axis of symmetry of a quadratic function	$f(x) = ax^2 + bx + c$, $x = -\frac{b}{2a}$
Solutions of a quadratic equation in the form $ax^2 + bx + c = 0$	$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$, $a \neq 0$
Discriminant	$\Delta = b^2 - 4ac$
Exponential and logarithmic functions	$a^x = e^{x \ln a}$; $\log_a a^x = x = a^{\ln a^x}$ where $a, x > 0, a \neq 1$

Topic 2: Functions – HL only

Sum & product of the roots of polynomial equations of the form $ax^2 + bx + c = 0$	$\sum_{i=1}^n x_i = -\frac{b}{a}$; $\prod_{i=1}^n x_i = \frac{c}{a}$
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Topic 3: Geometry and trigonometry – SL & HL

Distance between 2 points $(x_1, y_1, z_1), (x_2, y_2, z_2)$	$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2 + (z_2 - z_1)^2}$
Coordinates of midpoint of a line with endpoints $(x_1, y_1, z_1), (x_2, y_2, z_2)$	$\left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2}, \frac{z_1 + z_2}{2}\right)$
Volume: Right pyramid	$V = \frac{1}{3}Ah$, A = base area, h = height
Volume: Right cone	$V = \frac{1}{3}\pi r^2 h$, r = radius, h = height
Area: Cone curve	$A = \pi r l$, r = radius, l = slant height
Volume: Sphere	$V = \frac{4}{3}\pi r^3$, r = radius
Surface area: Sphere	$A = 4\pi r^2$, r = radius
Sine rule	$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$
Cosine rule	$c^2 = a^2 + b^2 - 2ab \cos C$
Area: Triangle	$A = \frac{1}{2}ab \sin C$
Length of an arc	$l = r\theta$, r = radius, θ = angle in radians
Area of a sector	$A = \frac{1}{2}r^2\theta$, r = radius, θ = angle in radians
Identify for $\tan \theta$	$\tan \theta = \frac{\sin \theta}{\cos \theta}$
Pythagorean identity	$\cos^2 \theta + \sin^2 \theta = 1$
Double angle identities	$\sin 2\theta = 2 \sin \theta \cos \theta$ $\cos 2\theta = \cos^2 \theta - \sin^2 \theta$ $\tan 2\theta = \frac{2 \tan \theta}{1 - \tan^2 \theta}$

Topic 3: Geometry and trigonometry – HL only

Residual trigonometric identities	$\sin \theta = \frac{1}{\csc \theta}$; $\cos \theta = \frac{1}{\sec \theta}$ $\tan \theta = \frac{\sin \theta}{\cos \theta}$; $\cot \theta = \frac{\cos \theta}{\sin \theta}$ $\sec \theta = \frac{1}{\cos \theta}$; $\csc \theta = \frac{1}{\sin \theta}$
Pythagorean identities	$\sin^2 \theta + \cos^2 \theta = 1$; $\tan^2 \theta + 1 = \sec^2 \theta$
Compound angle identities	$\sin(A \pm B) = \sin A \cos B \pm \cos A \sin B$ $\cos(A \pm B) = \cos A \cos B \mp \sin A \sin B$ $\tan(A \pm B) = \frac{\tan A \pm \tan B}{1 \mp \tan A \tan B}$
Double angle identity for \tan	$\tan 2\theta = \frac{2 \tan \theta}{1 - \tan^2 \theta}$
Magnitude of a vector	$ u = \sqrt{u_1^2 + u_2^2 + u_3^2}$
Scalar product	$u \cdot v = u v \cos \theta$ where θ is the angle between u and v
Angle between two vectors	$\cos \theta = \frac{u \cdot v}{ u v }$
Vector eqn. of a line	$r = a + \lambda b$
Parametric form of the equation of a line	$x = x_0 + \lambda a$, $y = y_0 + \lambda b$, $z = z_0 + \lambda c$
Cartesian equations of a line	$\frac{x - x_0}{a} = \frac{y - y_0}{b} = \frac{z - z_0}{c}$
Vector product	$u \times v = (u_2v_3 - u_3v_2, u_3v_1 - u_1v_3, u_1v_2 - u_2v_1)$
Area of a parallelogram	$A = u \times v $, where u and v form two adjacent sides of a parallelogram
Vector eqn. of a plane	$r = a + \lambda b + \mu c$
Equation of a plane	$r = a + \lambda b + \mu c$ (using the normal vector)
Cartesian eqn. of a plane	$ax + by + cz = d$

Topic 4: Statistics and probability – SL & HL

Interquartile range	$IQR = Q_3 - Q_1$
Mean, \bar{x} , of a set of data	$\bar{x} = \frac{1}{n} \sum_{i=1}^n f_i x_i$, where $f_i = \sum_{j=1}^k f_{ij}$
Probability of an event A	$P(A) = \frac{n(A)}{n(S)}$
Complementary events	$P(A) + P(A^c) = 1$
Combined events	$P(A \cup B) = P(A) + P(B) - P(A \cap B)$
Mutually exclusive events	$P(A \cup B) = P(A) + P(B)$
Conditional probability	$P(A B) = \frac{P(A \cap B)}{P(B)}$
Independent events	$P(A \cap B) = P(A)P(B)$
Expected value: Discrete random variable X	$E(X) = \sum x_i P(X = x_i)$
Binomial distribution	$X \sim B(n, p)$
Variance	$Var(X) = npq$, $Var(X) = np(1 - p)$
Standard normal variable	$z = \frac{x - \mu}{\sigma}$

Topic 4: Statistics and probability – HL only

Bayes' theorem	$P(A B) = \frac{P(A)P(B A)}{P(B)}$
Variance s^2	$s^2 = \frac{1}{n} \sum (x_i - \bar{x})^2 = \frac{1}{n} \sum x_i^2 - \bar{x}^2$
Standard Deviation s	$s = \sqrt{s^2}$
Linear transformation of a single random variable	$Y = aX + b$ $E(Y) = aE(X) + b$ $Var(Y) = a^2 Var(X)$
Expected value: Continuous random variable X	$E(X) = \int_{-\infty}^{\infty} xf(x)dx$
Variance	$Var(X) = E[(X - \mu)^2] = E(X^2) - [E(X)]^2$
Variance of a discrete random variable X	$Var(X) = \sum (x_i - \mu)^2 P(X = x_i) = \sum x_i^2 P(X = x_i) - \mu^2$
Variance of a continuous random variable X	$Var(X) = \int_{-\infty}^{\infty} (x - \mu)^2 f(x)dx = \int_{-\infty}^{\infty} x^2 f(x)dx - \mu^2$

Topic 5: Calculus – SL & HL

Derivative of x^n	$f(x) = x^n \Rightarrow f'(x) = nx^{n-1}$
Integral of x^n	$\int x^n dx = \frac{x^{n+1}}{n+1} + C$, $n \neq -1$
Area between curve $y = f(x)$ & x -axis	$A = \int_a^b f(x) dx$, where $f(x) \geq 0$
Derivative of $\sin x$	$f(x) = \sin x \Rightarrow f'(x) = \cos x$
Derivative of $\cos x$	$f(x) = \cos x \Rightarrow f'(x) = -\sin x$
Derivative of e^x	$f(x) = e^x \Rightarrow f'(x) = e^x$
Derivative of $\ln x$	$f(x) = \ln x \Rightarrow f'(x) = \frac{1}{x}$
Chain rule	$y = g(u)$, $u = f(x) \Rightarrow \frac{dy}{dx} = \frac{dy}{du} \cdot \frac{du}{dx}$
Product rule	$y = uv \Rightarrow \frac{dy}{dx} = u \frac{dv}{dx} + v \frac{du}{dx}$
Quotient rule	$y = \frac{u}{v} \Rightarrow \frac{dy}{dx} = \frac{v \frac{du}{dx} - u \frac{dv}{dx}}{v^2}$
Acceleration	$a = \frac{dv}{dt} = \frac{d^2x}{dt^2}$
Distance: Displacement travelled from t_1 to t_2	$dis = \int_{t_1}^{t_2} v(t) dt$; $dis = \int_{t_1}^{t_2} v(t) dt$
Standard integrals	$\int \frac{1}{x} dx = \ln x + C$ $\int \sin x dx = -\cos x + C$ $\int \cos x dx = \sin x + C$ $\int e^x dx = e^x + C$
Area enclosed by a curve and x -axis	$A = \int_a^b f(x) dx$

Topic 5: Calculus – HL only

Derivative of $f(x)$	$\frac{dy}{dx} = f'(x) = \lim_{h \rightarrow 0} \frac{f(x+h) - f(x)}{h}$
from first principles	$f(x) = \tan x \Rightarrow f'(x) = \sec^2 x$ $f(x) = \sec x \Rightarrow f'(x) = \sec x \tan x$ $f(x) = \csc x \Rightarrow f'(x) = -\csc x \cot x$ $f(x) = \cot x \Rightarrow f'(x) = -\csc^2 x$ $f(x) = a^x \Rightarrow f'(x) = a^x (\ln a)$
Standard derivatives	$f(x) = \log_a x \Rightarrow f'(x) = \frac{1}{x \ln a}$ $f(x) = \arcsin x \Rightarrow f'(x) = \frac{1}{\sqrt{1-x^2}}$ $f(x) = \arccos x \Rightarrow f'(x) = -\frac{1}{\sqrt{1-x^2}}$ $f(x) = \arctan x \Rightarrow f'(x) = \frac{1}{1+x^2}$
Standard integrals	$\int \frac{1}{x^2} dx = -\frac{1}{x} + C$ $\int \frac{1}{x^2+1} dx = \arctan\left(\frac{x}{1}\right) + C$ $\int \frac{1}{x^2+a^2} dx = \frac{1}{a} \arctan\left(\frac{x}{a}\right) + C$
Integration by parts	$\int u \frac{dv}{dx} dx = uv - \int v \frac{du}{dx} dx$
Area enclosed by a curve and y -axis	$A = \int_c^d x dy$
Volume of revolution about x or y -axis	$V = \int_a^b \pi y^2 dx$ or $V = \int_c^d \pi x^2 dy$
Euler's method	$y' = f(x, y)$, $y(x_0) = y_0$ where h is a constant (step length)
Integrating factor for $y' + P(x)y = Q(x)$	$\mu(x) = e^{\int P(x) dx}$
Maclaurin series	$f(x) = f(0) + x f'(0) + \frac{x^2}{2!} f''(0) + \dots$
Maclaurin series for special functions	$e^x = 1 + x + \frac{x^2}{2!} + \dots$ $\ln(1+x) = x - \frac{x^2}{2} + \frac{x^3}{3} - \dots$ $\sin x = x - \frac{x^3}{6} + \frac{x^5}{120} - \dots$ $\cos x = 1 - \frac{x^2}{2} + \frac{x^4}{24} - \dots$

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Understanding the IB Math Studies Course

The IB Math Studies course is aimed at students who enjoy mathematics but may not have an extensive background in the subject. It emphasizes practical applications of mathematical concepts rather than theoretical understanding. This course covers various topics, including algebra, statistics, geometry, and introductory calculus, making it crucial for students to grasp each concept thoroughly.

Importance of the Formula Sheet

The formula sheet is an invaluable tool for IB Math Studies students for several reasons:

- **Quick Reference:** The formula sheet provides a quick reference to essential formulas, which can save time during exams and assignments.
- **Study Aid:** It serves as an excellent study aid, helping students review key concepts and formulas efficiently.
- **Exam Preparation:** Familiarity with the formula sheet can boost students' confidence and performance during exams.
- **Concept Reinforcement:** Regularly using the formula sheet can help reinforce understanding of mathematical concepts.

Contents of the IB Math Studies Formula Sheet

The IB Math Studies formula sheet is organized into several sections, each focusing on different mathematical concepts. Below are the primary categories and some of the key formulas included in each.

1. Algebra

Algebra forms the foundation of many mathematical concepts. The formula sheet includes:

- Quadratic Formula:

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

- Factoring Techniques:

$$a^2 - b^2 = (a - b)(a + b)$$

- Exponential Growth and Decay:

$$y = a(1 + r)^t \text{ (growth)}, \quad y = a(1 - r)^t \text{ (decay)}$$

2. Geometry

Geometry is another essential component. Key formulas include:

- **Area of Shapes:**

- Triangle:

$$\begin{aligned} & \backslash[\\ A &= \frac{1}{2} \times \text{base} \times \text{height} \\ & \backslash] \end{aligned}$$

- Rectangle:

$$\begin{aligned} & \backslash[\\ A &= \text{length} \times \text{width} \\ & \backslash] \end{aligned}$$

- **Volume of Solids:**

- Cylinder:

$$\begin{aligned} & \backslash[\\ V &= \pi r^2 h \\ & \backslash] \end{aligned}$$

- Sphere:

$$\begin{aligned} & \backslash[\\ V &= \frac{4}{3} \pi r^3 \\ & \backslash] \end{aligned}$$

3. Trigonometry

Trigonometry is vital for understanding relationships in triangles. Important formulas include:

- **Sine, Cosine, and Tangent Ratios:**

$$\begin{aligned} \sin(\theta) &= \frac{\text{opposite}}{\text{hypotenuse}}, \quad \cos(\theta) = \frac{\text{adjacent}}{\text{hypotenuse}}, \quad \tan(\theta) = \frac{\text{opposite}}{\text{adjacent}} \end{aligned}$$

- **Trigonometric Identities:**

- Pythagorean Identity:

$$\sin^2(\theta) + \cos^2(\theta) = 1$$

- Angle Sum Identity:

$$\sin(a + b) = \sin(a)\cos(b) + \cos(a)\sin(b)$$

4. Statistics and Probability

Statistics is crucial for data interpretation. Key formulas include:

- **Mean, Median, Mode:**

- Mean:

$$\text{Mean} = \frac{\sum x}{n}$$

- Median: Middle value of a data set

- Mode: Most frequently occurring value

- **Standard Deviation:**

$$s = \sqrt{\frac{\sum (x - \bar{x})^2}{n - 1}}$$

- **Probability:**

$$P(A) = \frac{\text{Number of favorable outcomes}}{\text{Total number of outcomes}}$$

5. Functions

Understanding functions is critical for higher-level mathematics. Important concepts include:

- **Linear Function:**

$$y = mx + b$$

- **Quadratic Function:**

$$y = ax^2 + bx + c$$

- **Exponential Function:**

$$y = a \cdot b^x$$

How to Use the IB Math Studies Formula Sheet Effectively

Using the IB Math Studies formula sheet effectively can significantly enhance your learning experience.

Here are some tips:

1. **Familiarize Yourself:** Spend time getting to know the formulas and concepts on the sheet. Regularly revisiting the sheet can help solidify your understanding.
2. **Practice Problems:** Apply the formulas to various problems. Practicing with real-world applications can help you understand when and how to use each formula.
3. **Highlight Key Formulas:** If certain formulas are particularly challenging for you, highlight or underline them for easier reference.
4. **Use During Study Sessions:** Keep the formula sheet handy during study sessions to reinforce the material you are learning.
5. **Mock Exams:** Use the formula sheet during practice exams to simulate the real exam environment.

Conclusion

The **IB Math Studies formula sheet** is an essential component of a student's toolkit in the IB Mathematics Studies course. By understanding its contents and how to utilize it effectively, students can enhance their mathematical skills and boost their confidence. Whether preparing for exams or tackling assignments, the formula sheet is a valuable resource for mastering the fundamental concepts of mathematics. Make the most of this tool, and you will set yourself up for success in your mathematical journey.

Frequently Asked Questions

What is the purpose of the IB Math Studies formula sheet?

The IB Math Studies formula sheet provides students with essential mathematical formulas and concepts that are necessary for solving problems in the course, ensuring they have quick access to important information during exams.

Which topics are typically included in the IB Math Studies formula sheet?

The IB Math Studies formula sheet usually includes topics such as statistics, probability, geometry, trigonometry, and algebraic formulas, along with information about functions and their properties.

Can students bring their own notes or additional formulas to the IB Math Studies exam?

No, students are only allowed to use the official IB Math Studies formula sheet provided during the exam, and they cannot bring any additional notes or materials.

How can students effectively use the formula sheet during the exam?

Students should familiarize themselves with the layout of the formula sheet before the exam, practice using the formulas in sample problems, and prioritize understanding how to apply each formula to different types of questions.

Is the formula sheet the same for all IB Math courses?

No, the formula sheet for Math Studies is specifically designed for that course and may differ from the formula sheets used in other IB Math courses such as Math SL or Math HL.

Where can students find the IB Math Studies formula sheet for practice?

Students can access the IB Math Studies formula sheet through the official IB website, their school's resources, or study guides specifically designed for the IB curriculum.

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