FREE FORMULA SHEET

OCR A Level Maths Formula Sheet

PURE · STATISTICS · MECHANICS

OCR A Level Mathematics A (H240) · Pure, Statistics and Mechanics

1 Given in Your Exam

These formulas are on the formulae pages printed at the start of every OCR A Level Mathematics A paper. You don't need to memorise them, but you do need to know when and how to use each one.

PURE

Arithmetic Series

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

a is the first term, l the last term, d the common difference

Geometric Series

$$S_n = \frac{a(1 - r^n)}{1 - r}$$

$$S_\infty = \frac{a}{1 - r} \text{ for } |r| < 1$$

a is the first term, r the common ratio

Binomial Series

$$(a + b)^n = a^n + \binom{n}{1}a^{n-1}b + \ldots + \binom{n}{r}a^{n-r}b^r + \ldots + b^n$$

$$\binom{n}{r} = \frac{n!}{r!(n - r)!}$$

For positive whole numbers n

General Binomial Expansion

$$(1 + x)^n = 1 + nx + \frac{n(n - 1)}{2!}x^2 + \ldots + \frac{n(n - 1)\ldots(n - r + 1)}{r!}x^r + \ldots$$

Valid for $|x| < 1$ when n is negative or a fraction

Derivatives of Trig Functions

$\tan kx \to k \sec^2 kx$

$\sec x \to \sec x \tan x$

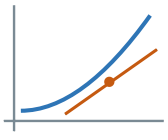
$\cot x \to -\text{cosec}^2 x$

$\text{cosec } x \to -\text{cosec } x \cot x$

f(x) → f′(x)

Quotient Rule

$$y = \frac{u}{v} \Rightarrow \frac{dy}{dx} = \frac{v\frac{du}{dx} - u\frac{dv}{dx}}{v^2}$$



Differentiation From First Principles

$$f'(x) = \lim_{h \to 0} \frac{f(x + h) - f(x)}{h}$$

Integrating f′(x) ÷ f(x)

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

Reverse Chain Rule

$$\int f'(x)[f(x)]^n\,dx = \frac{[f(x)]^{n+1}}{n + 1} + c, n \neq -1$$

Integration by Parts

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

Small Angle Approximations

$$\sin\theta \approx \theta$$

$$\cos\theta \approx 1 - \frac{\theta^2}{2}$$

$$\tan\theta \approx \theta$$

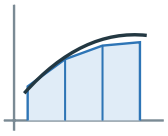
θ in radians

Compound Angle Formulae

$$\sin(A \pm B) = \sin A \cos B \pm \cos A \sin B$$

$$\cos(A \pm B) = \cos A \cos B \mp \sin A \sin B$$

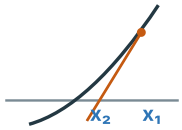
$$\tan(A \pm B) = \frac{\tan A \pm \tan B}{1 \mp \tan A \tan B}$$



The Trapezium Rule

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

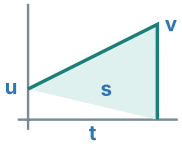
$$h = \frac{b-a}{n}$$



Newton–Raphson Method

$$x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)}$$

MECHANICS



Constant Acceleration (suvat)

$$v = u + at$$

$$s = ut + \frac{1}{2}at^2$$

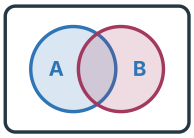
$$s = vt - \frac{1}{2}at^2$$

$$s = \frac{1}{2}(u + v)t$$

$$v^2 = u^2 + 2as$$

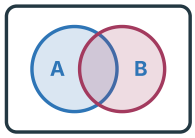
Motion in a straight line with constant acceleration

STATISTICS



Probability: A or B

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



Probability: A and B

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

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

Standard Deviation

$$\sigma = \sqrt{\frac{\Sigma x^2}{n} - \bar{x}^2} \text{ or } \sqrt{\frac{\Sigma f x^2}{\Sigma f} - \bar{x}^2}$$

The Binomial Distribution

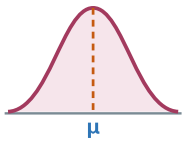
If $X \sim B(n, p)$:

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

$$\text{Mean} = np$$

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

Sample Mean From a Normal Distribution



$$\bar{X} \sim N\left(\mu, \frac{\sigma^2}{n}\right)$$

$$\frac{\bar{X} - \mu}{\sigma/\sqrt{n}} \sim N(0, 1)$$

Used in hypothesis tests for the mean

Percentage Points of the Normal Distribution

$P(Z \leq z) = 0.95 \rightarrow z = 1.645$

$P(Z \leq z) = 0.975 \rightarrow z = 1.960$

$P(Z \leq z) = 0.99 \rightarrow z = 2.326$

$P(Z \leq z) = 0.995 \rightarrow z = 2.576$

A fuller table is printed in the paper

2 Learn These by Heart

These are **not** given in the exam. Students lose marks on them every year, so learn them until you can write them from memory.

ALGEBRA AND FUNCTIONS

The Quadratic Formula

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

Laws of Indices

$a^x \times a^y = a^{x+y}$

$a^x \div a^y = a^{x-y}$

$(a^x)^y = a^{xy}$

Laws of Logarithms

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

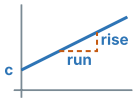
$\log_a x + \log_a y = \log_a(xy)$

$\log_a x - \log_a y = \log_a \frac{x}{y}$

$k \log_a x = \log_a(x^k)$

$a > 0$, $x > 0$

Straight Lines



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

Perpendicular: $m_1 m_2 = -1$

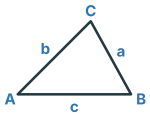
nth Terms of Sequences

Arithmetic: $u_n = a + (n - 1)d$

Geometric: $u_n = ar^{n-1}$

TRIGONOMETRY

Sine Rule, Cosine Rule and Area



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

$a^2 = b^2 + c^2 - 2bc \cos A$

$\text{Area} = \frac{1}{2}ab \sin C$

Pythagorean Identities

$\cos^2 A + \sin^2 A \equiv 1$

$\sec^2 A \equiv 1 + \tan^2 A$

$\text{cosec}^2 A \equiv 1 + \cot^2 A$

Double Angle Formulae

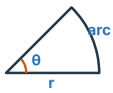
$\sin 2A \equiv 2 \sin A \cos A$

$\cos 2A \equiv \cos^2 A - \sin^2 A$

$\tan 2A \equiv \frac{2 \tan A}{1 - \tan^2 A}$

cos 2A can also be written as $2\cos^2 A - 1$ or $1 - 2\sin^2 A$

Arc Length and Sector Area



$s = r\theta$

$A = \frac{1}{2}r^2\theta$

θ in radians

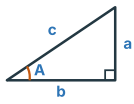
MENSURATION

Circles

$C = 2\pi r = \pi d$

$A = \pi r^2$

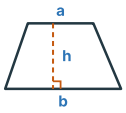
Pythagoras' Theorem



$c^2 = a^2 + b^2$

c is the hypotenuse

Trapezium and Prism



Area of a trapezium = $\frac{1}{2}(a + b)h$

Volume of a prism = area of cross-section × length

CALCULUS AND VECTORS

Standard Derivatives

$x^n \to nx^{n-1}$

$\sin kx \to k \cos kx$

$\cos kx \to -k \sin kx$

$e^{kx} \to ke^{kx}$

$\ln x \to \frac{1}{x}$

f(x) → f′(x)

Product and Chain Rules

$(fg)' = f'g + fg'$

$\frac{d}{dx}f(g(x)) = f'(g(x))g'(x)$

Standard Integrals

$x^n \to \frac{x^{n+1}}{n+1}$ $(n \neq -1)$

$\cos kx \to \frac{1}{k}\sin kx$

$\sin kx \to -\frac{1}{k}\cos kx$

$e^{kx} \to \frac{1}{k}e^{kx}$

$\frac{1}{x} \to \ln|x|$

Add + c to each

Reverse Chain Rule and Area

$\int f'(g(x))g'(x)\,dx = f(g(x)) + c$

Area under a curve = $\int_a^b y\,dx$ $(y \geq 0)$

Magnitude of a Vector

$|xi + yj + zk| = \sqrt{x^2 + y^2 + z^2}$

MECHANICS

Forces and Newton's Second Law

Weight = mg

Friction: $F \leq \mu R$

$F = ma$

Use $g = 9.8\ m\ s^{-2}$ unless told otherwise

Variable Acceleration

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

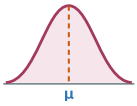
$a = \frac{dv}{dt} = \frac{d^2r}{dt^2}$

$r = \int v\,dt$

$v = \int a\,dt$

Mean

$$\bar{x} = \frac{\Sigma x}{n} = \frac{\Sigma fx}{\Sigma f}$$



Standardising a Normal Variable

$$Z = \frac{X - \mu}{\sigma}, \text{ where } X \sim N(\mu, \sigma^2)$$

Write It First

Write the formula down before you substitute. You can earn a method mark even if the answer goes wrong.

Check the Units

Make sure every length is in the same unit before you use a formula.

Test Yourself

Cover the right-hand side of each card and try to write the formula from memory.

Need Help Using These Formulas?

Book a free 90-minute lesson and I'll show your child exactly when and how to use each one.

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