**Formulae, that you need to know:**

Area of a circle $Area = \pi r^2$

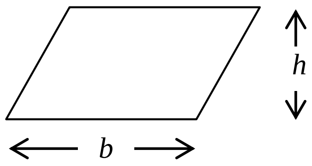
Circumference of a circle $C = 2\pi r$ or $\pi d$

Volume of a prism Cross section area $\times$ height (or length) = $A \times l$

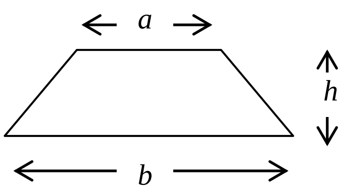
Volume of a cylinder $V = \pi r^2 h$

Curved surface area of a cylinder $A = 2\pi rh$

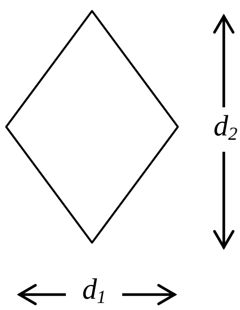
Area of parallelogram




Area Trapezium

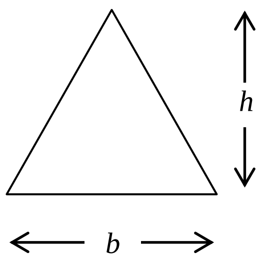



Area of rhombus or kite



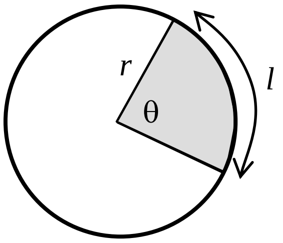

½ × diag $_1$ × diag $_2$

Area of a triangle




$A = \frac{1}{2}bh$ ( = ½ base x height )

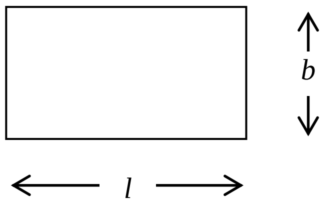
Sectors and arc lengths




Area of sector: $A = \dfrac{\theta}{360} \times \pi r^2$ *or* $\dfrac{\theta}{2\pi} \times \pi r^2$ (in radians)

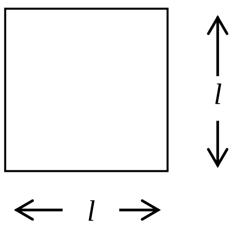
Arc length: $l = \dfrac{\theta}{360} \times \pi d$ *or* $\dfrac{\theta}{2\pi} \times \pi d$ (in radians)

Area of rectangle



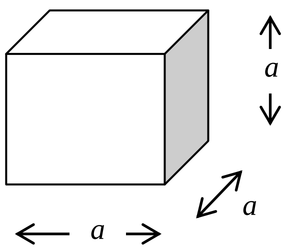

$A = l \times b$ (length × breadth)

Area of square



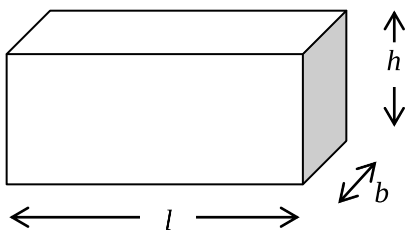

$A = l^2$

Volume of cube



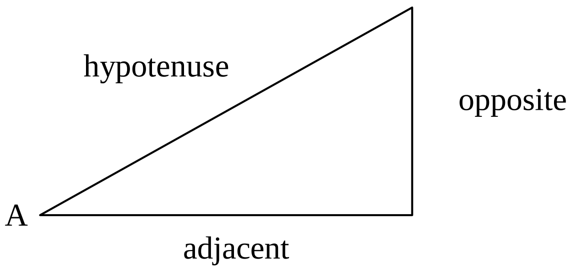

$V = a^3$

Volume of cuboid




$V = l \times b \times h$

## Trigonometry




**SOH – CAH - TOA**

$$\sin A = \frac{opposite}{hypotenuse}$$

$$\cos A = \frac{adjacent}{hypotenuse}$$

$$\tan A = \frac{opposite}{adjacent}$$

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

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

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

Area of a triangle $$A = \tfrac{1}{2} ab \sin C$$

Related Angles

$$\begin{aligned} \sin(-A) &= -\sin(A) & \cos(-A) &= \cos A \\ \sin(90 - A) &= \cos A & \cos(90 - A) &= \sin A \\ \sin(180 - A) &= \sin A & \cos(180 - A) &= -\cos A \end{aligned}$$

Sin-cos-tan formulae $$\sin^2 A + \cos^2 A = 1$$

$$\frac{\sin A}{\cos A} = \tan A$$

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

# Algebra

The Quadratic formula $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

Recurrence relation: $u_{n+1} = mu_n + c$

Limit formula: if $|m| < 1 \quad (-1 < m < 1) \qquad L = \dfrac{c}{1-m}$

Rules of indices

$a^m \times a^n = a^{m+n} \qquad a^m \div a^n = a^{m-n} \qquad (a^m)^n = a^{mn}$

$a^{-n} = \dfrac{1}{a^n} \qquad a^{\frac{p}{q}} = \sqrt[q]{a^p} = \left(\sqrt[q]{a}\right)^p \qquad a^{-\frac{p}{q}} = \dfrac{1}{\sqrt[q]{a^p}} = \dfrac{1}{\left(\sqrt[q]{a}\right)^p}$

$a^0 = 1 \qquad a^1 = a$

Rules of Surds

$\sqrt{a} \times \sqrt{b} = \sqrt{ab} \qquad \sqrt{\dfrac{a}{b}} = \dfrac{\sqrt{a}}{\sqrt{b}}$

Rules of Logarithms

$y = \log_a x \quad \Leftrightarrow \quad x = a^y$

Special Logarithms

$\log_a a = 1 \qquad \log_a 1 = 0$

Percentage increase, decrease, change etc,

$\%\ change = \dfrac{actual\ change}{original\ value} \times 100$

# Straight Line formulae

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

Mid-point formula $= \left( \frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2} \right)$ (simple average)

Gradient formula $m = \frac{y_2 - y_1}{x_2 - x_1}$ (rise over run)

Equation of a line with gradient $m$
passing through point $(a, b)$ $y - b = m(x - a)$

Equation of a line in normal form: $y = mx + c$

in which case, $m$ is gradient
and $c$ is the $y$-intercept

Equation of a line with integer coefficients. $ax + by + c = 0$

Product of gradients of perpendicular lines: $m_1 \times m_2 = -1$

Gradient of a line perpendicular
to a line of gradient $m$ $gradient = -\frac{1}{m}$

Angle $\theta$ between a line of gradient $m$
and the **positive** direction of the $x$-axis
is related:

$m = \tan\theta$
$\theta = \tan^{-1}(m)$

Equation of line parallel to $x$-axis
passing through $(0, k)$ $y = k$

Equation of line parallel to $y$-axis
passing through $(k, 0)$ $x = k$

**Calculus**

| | | |
|---|---|---|
| Differentiation | $f(x) = x^n$ | $f'(x) = nx^{n-1}$ |
| | $f(x) = kx$ | $f'(x) = k$ |
| | $f(x) = k$ | $f'(x) = 0$ |
| Integration | $f'(x) = x^n$ | $f(x) = \dfrac{x^{n+1}}{n+1}$ |
| | $f'(x) = kx$ | $f(x) = \dfrac{kx^2}{2}$ |
| | $f'(x) = k$ | $f(x) = kx$ |

Area between a curve $y = f(x)$,
the lines $x = a,\ x = b$ and the $x$-axis

$$A = \int_a^b f(x)\,dx \quad = \quad \left[F(x)\right]_a^b \quad = \quad F(b) - F(a) \qquad where \quad F'(x) = f(x)$$

Area between the curves $y = f(x)$ *and* $y = g(x)$, where $y = g(x)$ is the top curve on the graph.

$$A = \int_a^b g(x) - f(x)\,dx$$

where $a$ and $b$ are the $x$-coordinates of the points of intersection of $y = f(x)$ *and* $y = g(x)$

**Extra formulae you should know**

$\sin^2\theta + \cos^2\theta = 1$
$\tan^2\theta + 1 = \sec^2\theta$ (divide by $\cos^2\theta \rightarrow \tan^2\theta + 1 = \sec^2\theta$)
$1 + \cot^2\theta = \operatorname{cosec}^2\theta$ (divide by $\sin^2\theta \rightarrow 1 + \cot^2\theta = \operatorname{cosec}^2\theta$)

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

$\sin 2A = 2\sin A\cos A$
$\cos 2A = \cos^2 A - \sin^2 A$
$\cos 2A = 2\cos^2 A - 1$

$\cos 2A = 1 - 2\sin^2 A$

**Wave Equation**

$R\cos(x - \alpha) = R\cos x\cos\alpha + R\sin x\sin\alpha$

Compare coefficients to obtain:

$R\cos\alpha = .....$

$R\sin\alpha = .....$

Square and add to get: $R^2(\cos^2\alpha + \sin^2\alpha) = (....)^2 + (....)^2$

$$R = \sqrt{(....)^2 + (....)^2}$$

Divide to get:

$$\frac{R\sin\alpha}{R\cos\alpha} = \frac{.....}{.....} \Rightarrow \tan\alpha = \frac{.....}{.....}$$

All formulae from Higher.