FORMULAS YOU MUST MEMORISE

Edexcel International GCSE Mathematics A (4MA1)

Not on the 4MA1 Higher formulae sheet: learn these by heart.

★ Not given in the exam: learn every formula on this page. The full sheet and the booklet have the rest.

Number

★ **Indices:** $a^m \times a^n = a^{m+n}$, $a^m \div a^n = a^{m-n}$, $(a^m)^n = a^{mn}$, $a^0 = 1$, $a^{-n} = \frac{1}{a^n}$, $a^{\frac{m}{n}} = (\sqrt[n]{a})^m$
When: Multiply, divide and raise powers; simplify expressions

★ **Standard form:** $A \times 10^n$, $1 \le A < 10$, $n \in \mathbb{Z}$
When: Convert to and from standard form; order numbers

★ **Surds:** $\sqrt{ab} = \sqrt{a}\sqrt{b}$, $\frac{a}{\sqrt{b}} = \frac{a\sqrt{b}}{b}$, $\frac{1}{c+\sqrt{b}} = \frac{c-\sqrt{b}}{c^2-b}$
When: Simplify surds; rationalise denominators

★ **Percentage change:** $\frac{\text{new}-\text{original}}{\text{original}} \times 100\%$
When: Profit or loss as a percentage change

★ **Reverse percentage:** $\text{original} = \frac{\text{new}}{1 \pm \frac{r}{100}}$
When: Finding the price before a rise or a discount

★ **Compound growth / decay:** $A = P\left(1 \pm \frac{r}{100}\right)^n$
When: Savings, depreciation and population questions

★ **Recurring decimal:** $x = 0.\dot{2}\dot{7}$, then $100x - x = 27$, so $x = \frac{27}{99} = \frac{3}{11}$
When: Convert recurring decimals into fractions using algebra

★ **Bounds: a value to the nearest u lies in $[x - \frac{u}{2},\ x + \frac{u}{2})$; for $a - b$ and $a \div b$ use max with min**
When: Rounding and accuracy questions

★ **Compound measures:** $\text{speed} = \frac{\text{distance}}{\text{time}}$, $\text{density} = \frac{\text{mass}}{\text{volume}}$, $\text{pressure} = \frac{\text{force}}{\text{area}}$
When: Speed, density and pressure, with consistent units

★ **Sets:** $n(A \cup B) = n(A) + n(B) - n(A \cap B)$
When: Venn diagrams: find $n(A \cup B)$ and missing numbers

Graphs & calculus

★ **Straight line:** $y = mx + c$, $m = \frac{y_2 - y_1}{x_2 - x_1}$
When: Gradient and y-intercept from $y = mx + c$ or a graph

★ **Parallel; perpendicular:** $m_1 = m_2$; $m_1 \times m_2 = -1$
When: Lines parallel or perpendicular to a given line

★ **Midpoint; length:** $\left(\frac{x_1+x_2}{2}, \frac{y_1+y_2}{2}\right)$, $\sqrt{(x_2-x_1)^2 + (y_2-y_1)^2}$
When: Coordinate geometry

★ **Differentiation:** $y = ax^n \Rightarrow \frac{dy}{dx} = anx^{n-1}$
When: Gradients of curves and finding maximum and minimum points

★ **Turning points:** $\frac{dy}{dx} = 0$; **gradient of the tangent at $x = a$ is** $\frac{dy}{dx}$ **at a**
When: Optimisation and kinematics problems

★ **Kinematics:** $v = \frac{ds}{dt}$, $a = \frac{dv}{dt}$
When: Velocity and acceleration of a particle in a straight line

★ **Distance–time gradient = speed; velocity–time gradient = acceleration, area = distance**
When: Speeds from gradients; distances from areas under graphs

Algebra

★ **Expanding:** $(a+b)^2 = a^2 + 2ab + b^2$, $(a-b)^2 = a^2 - 2ab + b^2$, $a^2 - b^2 = (a+b)(a-b)$
When: Expand double brackets; difference of two squares

★ **Completing the square:** $x^2 + bx + c = \left(x + \frac{b}{2}\right)^2 - \frac{b^2}{4} + c$
When: Solve equations and find turning points

★ **Turning point of $y = (x+p)^2 + q$:** $(-p, q)$
When: Sketch the graph with its roots, intercept and turning point

★ **Arithmetic nth term:** $u_n = a + (n-1)d$
When: Finding a rule and a term of a sequence

★ **Proportion:** $y \propto x^n \Rightarrow y = kx^n$; $y \propto \frac{1}{x^n} \Rightarrow y = \frac{k}{x^n}$
When: Direct and inverse proportion: find k from given values

★ **Functions:** $fg(x) = f(g(x))$; f^{-1}**: swap x, y and rearrange**
When: Composite functions; inverse functions by rearranging

★ **Transformations: $f(x) + a$ up a; $f(x+a)$ left a; $-f(x)$ reflect in x-axis; $f(-x)$ reflect in y-axis**
When: Translations, stretches and reflections of a graph

★ **Inequalities: multiplying or dividing by a negative number reverses the sign**
When: Solve linear inequalities; show them on a number line

Statistics & probability

★ **Mean from a table:** $\bar{x} = \frac{\sum fx}{\sum f}$
When: Mean from a frequency table of discrete data

★ **Median position (n values):** $\frac{n+1}{2}$**th value**
When: Median and quartiles from ordered lists

★ **Interquartile range:** $Q_3 - Q_1$
When: Spread from cumulative frequency curves

★ **Histogram:** $\text{frequency density} = \frac{\text{frequency}}{\text{class width}}$
When: Drawing and reading histograms

★ **Probability:** $P(\text{not } A) = 1 - P(A)$; $\text{expected frequency} = n \times P(A)$
When: Expected frequencies for a number of trials

★ **Mutually exclusive:** $P(A \text{ or } B) = P(A) + P(B)$
When: Combined events from sample space diagrams

★ **Any two events:** $P(A \cup B) = P(A) + P(B) - P(A \cap B)$
When: Unions and intersections from Venn diagrams

★ **Independent:** $P(A \text{ and } B) = P(A) \times P(B)$
When: Tree diagrams for independent events: multiply along branches

★ **Conditional:** $P(B \mid A) = \frac{P(A \cap B)}{P(A)}$
When: Conditional probability from two-way tables and Venn diagrams

★ **Tree diagrams: multiply along branches, add the outcomes you want; without replacement, change the second branch**
When: Selections without replacement where probabilities change

Shape & space

★ **Pythagoras:** $a^2 + b^2 = c^2$
When: Any right-angled triangle, in 2D or 3D

★ **SOHCAHTOA:** $\sin\theta = \frac{\text{opp}}{\text{hyp}}$, $\cos\theta = \frac{\text{adj}}{\text{hyp}}$, $\tan\theta = \frac{\text{opp}}{\text{adj}}$
When: Sides and angles in right-angled triangles, bearings, and elevation

★ **Exact values:** $\sin 30° = \frac{1}{2}$, $\cos 60° = \frac{1}{2}$, $\tan 45° = 1$, $\sin 60° = \frac{\sqrt{3}}{2}$, $\sin 45° = \frac{\sqrt{2}}{2}$
When: Exact lengths in surd form without a calculator

★ **Polygons (n sides):** $\text{interior sum} = (n-2) \times 180°$, $\text{exterior angle (regular)} = \frac{360°}{n}$
When: Number of sides from the exterior angle

★ **Areas: triangle $\frac{1}{2}bh$, parallelogram bh**
When: Perimeter and area of triangles and parallelograms

★ **Circle:** $C = 2\pi r = \pi d$, $A = \pi r^2$
When: Circles, sectors, cylinders and compound shapes

★ **Arc; sector:** $\text{arc} = \frac{\theta}{360} \times 2\pi r$, $\text{sector} = \frac{\theta}{360} \times \pi r^2$
When: Sectors with the angle in degrees

★ **Pyramid:** $V = \frac{1}{3} \times \text{base area} \times h$
When: Pyramids and cones (only the cone is on the 4MA1 Higher sheet)

★ **Similar shapes, scale factor k:** $\text{lengths} \times k$, $\text{areas} \times k^2$, $\text{volumes} \times k^3$
When: Scaling areas and volumes of similar shapes and solids

★ **Circle theorems: angle at centre = 2 × angle at circumference; angle in a semicircle = 90°; angles in the same segment are equal; opposite angles of a cyclic quadrilateral sum to 180°; tangent ⊥ radius; two tangents from a point are equal; alternate segment theorem; perpendicular from the centre bisects a chord**
When: Find angles in circles, giving a reason for each step

★ **Intersecting chords:** $AP \times PB = CP \times PD$
When: Chord properties to find lengths

★ **Vectors:** $\left|\binom{x}{y}\right| = \sqrt{x^2 + y^2}$, $\overrightarrow{AB} = \mathbf{b} - \mathbf{a}$
When: Magnitude; vectors in terms of $\boldsymbol{a}$ and $\boldsymbol{b}$

★ **Bearings: measured clockwise from north, written with 3 figures**
When: Measure and calculate bearings, including a back bearing

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