Cambridge IGCSE · Mathematics 0580

Mathematics 0580 formulas and definitions

All 336 formulas, facts and definitions to learn, by syllabus topic. Formulas the exam gives you are left out.

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1 Number

1.1–1.2 Types of number and sets

A prime number has exactly two factors, 1 and itself; 1 is not prime; 2 is the only even prime

Squares 1^2 to 15^2 $(1, 4, 9, \ldots, 225)$ and cubes $1, 8, 27, 64, 125$ and 1000

HCF: common primes, **lower** powers. LCM: all primes, **higher** powers

$\mathrm{HCF}(a, b) \times \mathrm{LCM}(a, b) = a \times b$

Square number: every prime power is even. Cube number: every prime power is a multiple of 3

Rational: can be written as $\frac{p}{q}$ with integers p and q, $q \neq 0$

Reciprocal of x is $\frac{1}{x}$; reciprocal of $\frac{a}{b}$ is $\frac{b}{a}$; $x \times \frac{1}{x} = 1$

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

$n(A') = n(\xi) - n(A)$

Probability from a Venn diagram $= \dfrac{\text{number in the region}}{\text{number in the group chosen from}}$

1.3, 1.7, 1.18 Powers, roots, indices and surds

Squares 1^2 to 15^2, cubes 1^3 to 5^3 and 10^3, and their roots

$a^m \times a^n = a^{m+n}$

$a^m \div a^n = a^{m-n}$

$(a^m)^n = a^{mn}$

$a^0 = 1$ (for $a \neq 0$)

$a^{-n} = \dfrac{1}{a^n}$ and $\left(\dfrac{a}{b}\right)^{-n} = \left(\dfrac{b}{a}\right)^n$

Extended: $a^{\frac{1}{n}} = \sqrt[n]{a}$ and $a^{\frac{m}{n}} = (\sqrt[n]{a})^m$

Extended: $\sqrt{a} \times \sqrt{b} = \sqrt{ab}$, $\dfrac{\sqrt{a}}{\sqrt{b}} = \sqrt{\dfrac{a}{b}}$, $\sqrt{a} \times \sqrt{a} = a$

Extended: $\dfrac{k}{\sqrt{a}} = \dfrac{k\sqrt{a}}{a}$

Extended: $(a + \sqrt{b})(a - \sqrt{b}) = a^2 - b$

1.4–1.6 Fractions, decimals, ordering and the four operations

$\dfrac{a}{b} = \dfrac{a \times k}{b \times k}$ (equivalent fractions)

$m\dfrac{a}{b} = \dfrac{mb + a}{b}$ (mixed number to improper fraction)

$\dfrac{a}{b} + \dfrac{c}{d} = \dfrac{ad + bc}{bd}$ (or use the lowest common denominator)

$\dfrac{a}{b} \times \dfrac{c}{d} = \dfrac{ac}{bd}$

$\dfrac{a}{b} \div \dfrac{c}{d} = \dfrac{a}{b} \times \dfrac{d}{c}$

$x\% = \dfrac{x}{100}$; decimal $\times 100$ = percentage

Common equivalents: $\frac{1}{2}$, $\frac{1}{4}$, $\frac{3}{4}$, $\frac{1}{5}$, $\frac{1}{8}$, $\frac{1}{10}$, $\frac{1}{3}$, $\frac{2}{3}$ as decimals and percentages

Extended: recurring decimal to fraction by subtracting two multiples with the same recurring tail

Same signs multiply or divide to a positive; different signs to a negative

Order of operations: brackets, indices, $\div$ and $\times$, $+$ and $-$

1.8 Standard form

Standard form: $A \times 10^n$ with $1 \leqslant A < 10$ and n an integer

$10^n = 1$ followed by n zeros; $10^0 = 1$; $10^{-n} = \dfrac{1}{10^n}$

Number $\geqslant 10$: positive power; number < 1: negative power

$(A \times 10^a) \times (B \times 10^b) = AB \times 10^{a+b}$

$(A \times 10^a) \div (B \times 10^b) = (A \div B) \times 10^{a-b}$

$(A \times 10^a)^2 = A^2 \times 10^{2a}$

Adding or subtracting: make the powers equal first, $A \times 10^n + B \times 10^n = (A + B) \times 10^n$

1 km $= 10^3$ m, 1 kg $= 10^3$ g, 1 litre $= 10^3$ cm³, 1 m³ $= 10^6$ cm³

1.9–1.10 Estimation and limits of accuracy

Round up if the next digit is 5 or more; leave it if it is 4 or less

Significant figures start at the first non-zero digit

Estimate: round every number to 1 significant figure, then calculate

Bounds of a value rounded to the nearest u: value $\pm\frac{1}{2}u$, written lower $\leqslant x <$ upper

(Extended) Upper bound of $a+b$ or $a\times b$: use both upper bounds

(Extended) Upper bound of $a-b$: upper a − lower b; lower bound: lower a − upper b

(Extended) Upper bound of $a\div b$: upper $a\div$ lower b; lower bound: lower $a\div$ upper b

Speed $=$ distance $\div$ time

1.11–1.12 Ratio, proportion and rates

Simplify a ratio: divide every part by the HCF; clear decimals and fractions first

Form $1:n$: divide every part by the first part

Sharing in $a:b$: one part $=\dfrac{\text{total}}{a+b}$, shares $a\times$ part and $b\times$ part

One part $=\dfrac{\text{difference}}{b-a}$ when the difference between the shares is known

Fraction for the first share in $a:b$ is $\dfrac{a}{a+b}$

Unitary method: find the amount for one, then multiply

Rate $=\dfrac{\text{amount}}{\text{time}}$, amount $=$ rate $\times$ time

Speed $=\dfrac{\text{distance}}{\text{time}}$, distance $=$ speed $\times$ time, time $=\dfrac{\text{distance}}{\text{speed}}$

Average speed $=\dfrac{\text{total distance}}{\text{total time}}$

1 m/s $=3.6$ km/h

1.13, 1.17 Percentages, interest and exponential growth and decay

$r\%$ of $Q=\dfrac{r}{100}\times Q$

A as a percentage of $B=\dfrac{A}{B}\times 100$ (same units)

Multiplier for an increase of $r\%$: $1+\dfrac{r}{100}$; for a decrease: $1-\dfrac{r}{100}$

Percentage change $=\dfrac{\text{new}-\text{original}}{\text{original}}\times 100$; percentage profit $=\dfrac{\text{profit}}{\text{cost price}}\times 100$

(Extended only) Reverse percentage: original $=\dfrac{\text{new amount}}{\text{multiplier}}$

(Extended only) Repeated changes: multiply the multipliers

Simple interest $I=\dfrac{Prn}{100}$; value $=P+I$

Compound interest: value $=P\left(1+\dfrac{r}{100}\right)^{n}$; interest $=$ value $-P$

(Extended only) Exponential growth or decay: $V = A \times k^n$, with $k = 1 \pm \dfrac{r}{100}$

Finding the rate: $1 + \dfrac{r}{100} = \left(\dfrac{\text{final}}{\text{start}}\right)^{1/n}$

1.14–1.16 Calculators, time and money

1 min $= 60$ s, 1 h $= 60$ min $= 3600$ s, 1 day $= 24$ h

1 week $= 7$ days, 1 year $= 12$ months $= 365$ days (about 52 weeks)

Decimal hours to minutes: minutes $=$ decimal part $\times 60$

Minutes to decimal hours: hours $= \dfrac{\text{minutes}}{60}$

pm times in the 24-hour clock: add 12 to the hour (except 12 pm)

Ahead: add the time difference; behind: subtract it

Cost $=$ quantity $\times$ price; change $=$ amount paid $-$ total cost

Pay $=$ hours $\times$ rate; "time and a half" $= 1.5\times$ rate

Largest number you can buy $=$ money $\div$ price, rounded **down**

\$$1 = r$ units: dollars $\rightarrow$ units multiply by r; units $\rightarrow$ dollars divide by r

100 cents $=$ \$$1$; money to 2 decimal places

2 Algebra and graphs

2.1–2.3 Algebraic manipulation and algebraic fractions

$a(b + c) = ab + ac$, and $-a(b - c) = -ab + ac$

$(a + b)(c + d) = ac + ad + bc + bd$

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

Extended only: $a^2 - b^2 = (a - b)(a + b)$

Extended only: $x^2 + bx + c = (x + p)(x + q)$ where $pq = c$ and $p + q = b$

Extended only: $x^2 + bx + c = \left(x + \frac{b}{2}\right)^2 - \left(\frac{b}{2}\right)^2 + c$

Extended only: $\dfrac{a}{b} \pm \dfrac{c}{d} = \dfrac{ad \pm bc}{bd}$, $\dfrac{a}{b} \times \dfrac{c}{d} = \dfrac{ac}{bd}$, $\dfrac{a}{b} \div \dfrac{c}{d} = \dfrac{a}{b} \times \dfrac{d}{c}$

Area of a rectangle $=$ length $\times$ width; perimeter $=$ total length of all the sides

2.4 Indices in algebra

$a^m \times a^n = a^{m+n}$

$a^m \div a^n = a^{m-n}$

$(a^m)^n = a^{mn}$

$(ab)^n = a^n b^n$ and $\left(\frac{a}{b}\right)^n = \frac{a^n}{b^n}$

$a^0 = 1$

$a^{-n} = \frac{1}{a^n}$ and $\left(\frac{a}{b}\right)^{-n} = \left(\frac{b}{a}\right)^n$

If $a^x = a^y$ then $x = y$ (same base)

Extended only: $a^{\frac{1}{n}} = \sqrt[n]{a}$ and $a^{\frac{m}{n}} = (\sqrt[n]{a})^m$

2.5 Equations and changing the subject

Do the same to both sides; undo operations in reverse order

Simultaneous equations by elimination: same signs subtract, different signs add

Changing the subject: the same steps as solving an equation

Extended only: $ax + c = bx + d \Rightarrow x(a - b) = d - c \Rightarrow x = \frac{d - c}{a - b}$ (factorise out a subject that appears twice)

Extended only: if $pq = 0$ then $p = 0$ or $q = 0$

Extended only: $(x + p)^2 = k \Rightarrow x = -p \pm \sqrt{k}$

Time $= \frac{\text{distance}}{\text{speed}}$

Perimeter of a rectangle $= 2(l + w)$; area of a rectangle $= lw$

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

Angles on a straight line add to 180°; angles in a triangle add to 180°

2.6 Inequalities

$<$ less than, $>$ greater than, $\leqslant$ less than or equal to, $\geqslant$ greater than or equal to

Number line: open circle for $<$ and $>$; closed circle for $\leqslant$ and $\geqslant$

$a < x \leqslant b$ means $x > a$ and $x \leqslant b$ (smaller number on the left)

Extended only: adding, subtracting, or multiplying or dividing by a positive number keeps the sign

Extended only: multiplying or dividing by a negative number reverses the sign ($-3x < 6 \Rightarrow x > -2$)

Extended only: graph: broken line for $<$ and $>$; solid line for $\leqslant$ and $\geqslant$; shade the unwanted region

Extended only: $x = a$ is vertical, $y = b$ is horizontal; $y = mx + c$ has gradient m and y-intercept c

Extended only: $y > mx + c$ is above the line, $y < mx + c$ is below it

2.7 Sequences

Linear sequence with common difference d: nth term $= dn + (\text{zero term})$, where zero term = first term $-d$

Same thing another way: nth term $= a + (n-1)d$, with first term a

Square numbers n^2: $1, 4, 9, 16, 25, \ldots$; cube numbers n^3: $1, 8, 27, 64, 125, \ldots$

Extended only: quadratic $an^2 + bn + c$: second differences $= 2a$

Extended only: cubic $an^3 + \ldots$: third differences $= 6a$

Extended only: exponential sequence, first term a, multiplier r: nth term $= ar^{n-1}$

Extended only: T_n means the nth term of sequence T

A number N is a term only if solving "nth term $= N$" gives a **positive whole number** n

2.8 Direct and inverse proportion

$y \propto x$ means $y = kx$; "proportional to" means directly proportional

$y \propto \dfrac{1}{x}$ means $y = \dfrac{k}{x}$

Direct to a power or root: $y = kx^2$, $y = kx^3$, $y = k\sqrt{x}$, $y = k\sqrt[3]{x}$

Inverse to a power or root: $y = \dfrac{k}{x^2}$, $y = \dfrac{k}{x^3}$, $y = \dfrac{k}{\sqrt{x}}$, $y = \dfrac{k}{\sqrt[3]{x}}$

A bracket stays whole: $y \propto (x + a)^2$ means $y = k(x + a)^2$

Direct: $\dfrac{y}{\text{thing}}$ is constant; inverse: $y \times \text{thing}$ is constant

Direct, $y = kx^n$: multiplying x by a multiplies y by a^n. Inverse, $y = \dfrac{k}{x^m}$ (m positive): multiplying x by a means y is divided by a^m

2.9 Graphs in practical situations

$\text{speed} = \dfrac{\text{distance}}{\text{time}}$, so $\text{distance} = \text{speed} \times \text{time}$ and $\text{time} = \dfrac{\text{distance}}{\text{speed}}$

$\text{average speed} = \dfrac{\text{total distance}}{\text{total time}}$ (stops included)

Minutes to hours: divide by 60; hours to minutes: multiply by 60

km/h to m/s: divide by 3.6; m/s to km/h: multiply by 3.6

$\text{Gradient} = \dfrac{\text{change up}}{\text{change across}}$

Distance–time graph: gradient = speed; horizontal line = stopped

Extended only: speed–time graph: gradient = acceleration (downward slope: deceleration); horizontal line = constant speed

Extended only: distance travelled = area under a speed–time graph

Area of a rectangle $= \text{base} \times \text{height}$; area of a trapezium $= \frac{1}{2}(a+b)h$

2.10–2.11 Graphs of functions and sketching curves

Straight line: $y = mx + c$, gradient m, y-intercept c

y-intercept: put $x = 0$; roots (x-intercepts): put $y = 0$

Line of symmetry of a quadratic: $x = \dfrac{x_1 + x_2}{2}$, halfway between two points with equal y (such as the roots)

Extended only: $y = (x+p)^2 + q$ has turning point $(-p,\ q)$ and line of symmetry $x = -p$

Extended only: $x^2 + bx = \left(x + \dfrac{b}{2}\right)^2 - \left(\dfrac{b}{2}\right)^2$ (completing the square)

Extended only: $y = \dfrac{m}{x} + n$: asymptotes $x = 0$ and $y = n$

Extended only: $y = m^x + n$: asymptote $y = n$, y-intercept $1 + n$; $y = a \times b^x + c$: asymptote $y = c$, y-intercept $a + c$

$f(x) = k$: solutions are where the line $y = k$ crosses $y = f(x)$

Extended only: to solve $E = 0$ with the graph of $y = f(x)$, first scale E so its curved terms match $f(x)$'s, then draw the line $y = f(x) - E$

2.12 Differentiation

$\dfrac{d}{dx}(ax^n) = anx^{n-1}$

$\dfrac{d}{dx}(ax) = a$, and $\dfrac{d}{dx}(\text{number}) = 0$

Differentiate a sum term by term

Gradient at a point: substitute its x-value into $\dfrac{dy}{dx}$

Turning (stationary) point: $\dfrac{dy}{dx} = 0$

$\dfrac{d^2y}{dx^2} < 0$: maximum; $\dfrac{d^2y}{dx^2} > 0$: minimum

Maximum: gradient $+,\ 0,\ -$; minimum: gradient $-,\ 0,\ +$

Gradient from two points on a tangent: $m = \dfrac{y_2 - y_1}{x_2 - x_1}$

Line: $y = mx + c$; perpendicular gradients multiply to -1

2.13 Functions

$f(a)$: replace every x in $f(x)$ with a, in brackets

$gf(x) = g(f(x))$: do f first, then g

$f^{-1}(x)$: write $y = f(x)$, swap x and y, make y the subject

$f^{-1}f(x) = ff^{-1}(x) = x$

$f^{-1}(x) = k \iff x = f(k)$

Range: the set of outputs from the domain, each listed once

$a^{-n} = \dfrac{1}{a^n}$, $a^0 = 1$ (for exponential functions)

3 Coordinate geometry

Point (x, y): x across, then y up

Straight line $y = mx + c$: gradient m, y-intercept $(0, c)$

Gradient $= \dfrac{\text{change in } y}{\text{change in } x}$; up to the right is positive, down to the right is negative

Extended only: gradient through (x_1, y_1) and (x_2, y_2): $m = \dfrac{y_2 - y_1}{x_2 - x_1}$

$x = k$ is vertical; $y = k$ is horizontal (gradient 0)

Parallel lines have equal gradients

Extended only: perpendicular lines: $m_1 \times m_2 = -1$, so $m_2 = -\dfrac{1}{m_1}$

Extended only: midpoint $= \left(\dfrac{x_1 + x_2}{2}, \dfrac{y_1 + y_2}{2}\right)$

Extended only: length $= \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$

Line through (x_1, y_1) with gradient m: substitute into $y = mx + c$ to find c (or use $y - y_1 = m(x - x_1)$)

Crossing the y-axis: put $x = 0$; crossing the x-axis: put $y = 0$

4 Geometry

4.1, 4.5 Geometrical terms and symmetry

Acute $< 90^\circ$; right $= 90^\circ$; obtuse between 90° and 180°; reflex between 180° and 360°

Interior angle $+$ exterior angle $= 180^\circ$

Exterior angles of a polygon add up to 360°; regular polygon: exterior angle $= \dfrac{360^\circ}{n}$

Regular polygon with n sides: n lines of symmetry, rotational symmetry of order n

Order of rotational symmetry is at least 1 (order 1 means no rotational symmetry)

Diameter $= 2\times$ radius

Prism with n-sided cross-section: $n + 2$ faces, $3n$ edges, $2n$ vertices

Pyramid with n-sided base: $n + 1$ faces, $2n$ edges, $n + 1$ vertices

Similar shapes: every length $\times$ the same scale factor, angles unchanged

4.2–4.3 Constructions, scale drawings and bearings

Bearing: clockwise from north, three figures; N 000°, E 090°, S 180°, W 270°

Back bearing = bearing $+180^\circ$ (if under 180°) or bearing -180° (if over 180°)

Scale "1 cm to k": real length = drawing length $\times k$; drawing length = real length $\div k$

$1 : n$ means 1 cm stands for n cm; 1 m = 100 cm, 1 km = 100 000 cm

Map areas: if 1 cm stands for k, then 1 cm² stands for k^2

Construction: arcs of the two side lengths from the two ends of the base cross at the third vertex

Cuboid: surface area = $2(lw + lh + wh)$, volume $V = lwh$

4.4 Similarity

Scale factor $k = \dfrac{\text{new length}}{\text{matching old length}}$; new length = old length $\times k$

Similar shapes: all matching angles equal and all matching lengths in the same ratio

Triangles with three equal pairs of angles are similar

Extended only: $\dfrac{\text{area}_B}{\text{area}_A} = k^2 = \left(\dfrac{\text{length}_B}{\text{length}_A}\right)^2$

Extended only: $\dfrac{\text{volume}_B}{\text{volume}_A} = k^3 = \left(\dfrac{\text{length}_B}{\text{length}_A}\right)^3$ (also capacity, and mass for the same material)

Extended only: from an area ratio $k = \sqrt{\text{area ratio}}$; from a volume ratio $k = \sqrt[3]{\text{volume ratio}}$

Parallel-line angle facts: corresponding angles equal, alternate angles equal; vertically opposite angles equal

4.6 Angles

Angles at a point add up to 360°

Angles on a straight line add up to 180°

Vertically opposite angles are equal

Angles in a triangle add up to 180°; exterior angle of a triangle = sum of the two opposite interior angles

Base angles of an isosceles triangle are equal; each angle of an equilateral triangle is 60°

Angles in a quadrilateral add up to 360°

Parallel lines: corresponding angles equal, alternate angles equal, co-interior angles add up to 180°

Sum of the interior angles of an n-sided polygon = $(n - 2) \times 180^\circ$

Sum of the exterior angles of any polygon $= 360^\circ$

Interior angle + exterior angle $= 180^\circ$

Regular polygon: exterior angle $= \frac{360^\circ}{n}$, interior angle $= 180^\circ - \frac{360^\circ}{n}$

Number of sides of a regular polygon: $n = \frac{360^\circ}{\text{exterior angle}}$

4.7–4.8 Circle theorems

Angle in a semicircle $= 90^\circ$

Angle between tangent and radius $= 90^\circ$

Two radii make an isosceles triangle: base angles are equal

Extended: angle at the centre $= 2\times$ angle at the circumference (same arc)

Extended: angles in the same segment are equal

Extended: opposite angles of a cyclic quadrilateral add up to 180°

Extended: exterior angle of a cyclic quadrilateral = interior opposite angle

Extended: alternate segment theorem: angle between tangent and chord = angle in the alternate segment

Extended: tangents from an external point are equal in length

Extended: the perpendicular bisector of a chord passes through the centre; equal chords are equidistant from the centre

Angle sum of a triangle $= 180^\circ$; of a quadrilateral $= 360^\circ$; angles on a straight line $= 180^\circ$; at a point $= 360^\circ$

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

5 Mensuration

5.1–5.2 Units, area and perimeter

Rectangle: $A = l \times w$; square: $A = l^2$

Parallelogram: $A = b \times h$ (h perpendicular)

Trapezium: $A = \frac{1}{2}(a + b)h$ (a, b the parallel sides)

Perimeter = total length of all the sides; rectangle $P = 2(l + w)$

1 cm $= 10$ mm, 1 m $= 100$ cm, 1 km $= 1000$ m

1 cm² $= 100$ mm², 1 m² $= 10\,000$ cm², 1 km² $= 1\,000\,000$ m²

1 cm³ $= 1000$ mm³, 1 m³ $= 1\,000\,000$ cm³

1 ml $= 1$ cm³, 1 l $= 1000$ ml $= 1000$ cm³, 1 m³ $= 1000$ l

$1\text{ kg} = 1000\text{ g}$

5.3 Circles, arcs and sectors

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

Arc length $= \dfrac{\theta}{360} \times 2\pi r$

Sector area $= \dfrac{\theta}{360} \times \pi r^2$

Perimeter of a sector = arc $+2r$; semicircle $= \pi r + 2r$

Major sector angle $= 360^\circ -$ minor sector angle

Radius from circumference $r = \dfrac{C}{2\pi}$; from area $r = \sqrt{\dfrac{A}{\pi}}$

Number of turns of a wheel $= \dfrac{\text{distance}}{\text{circumference}}$

Extended: minor segment = sector $-\frac{1}{2}r^2\sin\theta$; major segment = major sector $+\frac{1}{2}r^2\sin\theta$

5.4–5.5 Surface area and volume

Cuboid: $V = lwh$, surface area $= 2lw + 2lh + 2wh$; cube: $V = x^3$, surface area $6x^2$

Total surface area of a cylinder $= 2\pi rh + 2\pi r^2$

Total surface area of a cone $= \pi rl + \pi r^2$, with $l^2 = r^2 + h^2$

Hemisphere: $V = \frac{2}{3}\pi r^3$, curved surface $2\pi r^2$, total surface $3\pi r^2$

Extended: frustum volume = large cone − small cone

Extended: frustum curved surface = large cone's πRl − small cone's πrl; total surface adds $\pi R^2 + \pi r^2$

Density $= \dfrac{\text{mass}}{\text{volume}}$ (printed in the question when needed)

$1\text{ cm}^3 = 1\text{ ml}$, $1000\text{ cm}^3 = 1\text{ litre}$, $1\text{ m}^3 = 1000\text{ litres} = 1\,000\,000\text{ cm}^3$

6 Trigonometry

6.1–6.2 Pythagoras' theorem and right-angled triangles

Pythagoras' theorem: $a^2 + b^2 = c^2$, where c is the hypotenuse

Hypotenuse $c = \sqrt{a^2 + b^2}$; shorter side $b = \sqrt{c^2 - a^2}$

$\sin\theta = \dfrac{\text{opposite}}{\text{hypotenuse}}$

$\cos\theta = \dfrac{\text{adjacent}}{\text{hypotenuse}}$

$\tan\theta = \dfrac{\text{opposite}}{\text{adjacent}}$

Angles in a triangle add up to 180°, so the two acute angles of a right-angled triangle add up to 90°

Extended: angles of elevation and depression are measured from the horizontal

Extended: the shortest distance from a point to a line is the perpendicular distance

6.3–6.4 Exact values and trigonometric functions

$\sin 0^\circ = 0, \sin 30^\circ = \frac{1}{2}, \sin 45^\circ = \frac{\sqrt{2}}{2}, \sin 60^\circ = \frac{\sqrt{3}}{2}, \sin 90^\circ = 1$

$\cos 0^\circ = 1, \cos 30^\circ = \frac{\sqrt{3}}{2}, \cos 45^\circ = \frac{\sqrt{2}}{2}, \cos 60^\circ = \frac{1}{2}, \cos 90^\circ = 0$

$\tan 0^\circ = 0, \tan 30^\circ = \frac{1}{\sqrt{3}} = \frac{\sqrt{3}}{3}, \tan 45^\circ = 1, \tan 60^\circ = \sqrt{3}$

$y = \sin x$: through $(0, 0)$, $(180^\circ, 0)$, $(360^\circ, 0)$; maximum 1 at 90°, minimum -1 at 270°

$y = \cos x$: through $(0, 1)$, $(360^\circ, 1)$; minimum -1 at 180°; zero at 90° and 270°

$y = \tan x$: through $(0, 0)$, $(180^\circ, 0)$, $(360^\circ, 0)$; asymptotes $x = 90^\circ$ and $x = 270^\circ$; repeats every 180°

$\sin x = k$: $x = \alpha$ or $180^\circ - \alpha$

$\cos x = k$: $x = \alpha$ or $360^\circ - \alpha$

$\tan x = k$: $x = \alpha$ or $\alpha + 180^\circ$

$-1 \leqslant \sin x \leqslant 1$ and $-1 \leqslant \cos x \leqslant 1$

6.5 Non-right-angled triangles

Cosine rule for an angle: $\cos A = \dfrac{b^2 + c^2 - a^2}{2bc}$

Sine rule for an angle: $\dfrac{\sin A}{a} = \dfrac{\sin B}{b}$

$\sin(180^\circ - \theta) = \sin\theta$: from $\sin^{-1}$, an angle is θ or $180^\circ - \theta$

Negative cosine $\Leftrightarrow$ obtuse angle

Angles in a triangle add up to 180°; on a straight line to 180°

Largest angle is opposite the longest side

Shortest distance to a line is the perpendicular: $d = \text{side} \times \sin(\text{angle})$ or $d = \dfrac{2 \times \text{area}}{\text{base}}$

Exact values $\sin 30^\circ = \sin 150^\circ = \frac{1}{2}$ (for Paper 2)

6.6 Pythagoras' theorem and trigonometry in 3D

Space diagonal of a cuboid with edges a, b, c: $d = \sqrt{a^2 + b^2 + c^2}$

Pythagoras' theorem: $a^2 + b^2 = c^2$ in a right-angled triangle with hypotenuse c

$\sin\theta = \dfrac{\text{opp}}{\text{hyp}}, \cos\theta = \dfrac{\text{adj}}{\text{hyp}}, \tan\theta = \dfrac{\text{opp}}{\text{adj}}$

Angle between a line and a plane: in the triangle (line, vertical drop, shadow), with the right angle at the foot of the drop

Square of side s: diagonal $s\sqrt{2}$; cube of edge l: space diagonal $l\sqrt{3}$

Pyramid with vertex above the centre of the base: the shadow of a sloping edge is half the base diagonal

7 Transformations and vectors

7.1 Transformations

Translation by $\begin{pmatrix} a \\ b \end{pmatrix}$: $(x, y) \to (x + a,\ y + b)$

Reflection in $x = k$: $(x, y) \to (2k - x,\ y)$; in $y = k$: $(x, y) \to (x,\ 2k - y)$

Extended only: reflection in $y = x$: $(x, y) \to (y, x)$; in $y = -x$: $(x, y) \to (-y, -x)$; in $y = x + c$: $(x, y) \to (y - c,\ x + c)$

Rotation about the origin: 90° clockwise $(x, y) \to (y, -x)$; 90° anticlockwise $(x, y) \to (-y, x)$; 180° $(x, y) \to (-x, -y)$

Enlargement, scale factor k, centre C: image $= C + k \times (\text{point} - C)$

Scale factor $= \dfrac{\text{length on image}}{\text{matching length on object}}$

Area of image $= k^2 \times$ area of object

Centre of a 180° rotation = midpoint of any corner and its image

7.2–7.4 Vectors

$\begin{pmatrix} a \\ b \end{pmatrix} \pm \begin{pmatrix} c \\ d \end{pmatrix} = \begin{pmatrix} a \pm c \\ b \pm d \end{pmatrix}$ and $k \begin{pmatrix} a \\ b \end{pmatrix} = \begin{pmatrix} ka \\ kb \end{pmatrix}$

Magnitude: $\left| \begin{pmatrix} x \\ y \end{pmatrix} \right| = \sqrt{x^2 + y^2}$

$\overrightarrow{BA} = -\overrightarrow{AB}$

$\overrightarrow{AB} = \overrightarrow{AO} + \overrightarrow{OB} = \mathbf{b} - \mathbf{a}$ (end minus start)

Point + vector = point: $A(p, q)$ moved by $\begin{pmatrix} x \\ y \end{pmatrix}$ gives $(p + x,\ q + y)$

P on AB with $AP : PB = m : n$: $\overrightarrow{AP} = \dfrac{m}{m+n}\overrightarrow{AB}$

Midpoint M of AB: $\overrightarrow{OM} = \frac{1}{2}(\mathbf{a} + \mathbf{b})$

Parallel: $\mathbf{u} = k\mathbf{v}$; collinear: $\overrightarrow{PQ} = k\overrightarrow{PR}$ with P a shared point

8 Probability

8.1–8.2 Probability and expected frequency

$0 \leqslant \text{probability} \leqslant 1$; 0 is impossible, 1 is certain

Equally likely outcomes: $\text{probability} = \dfrac{\text{number of ways the event happens}}{\text{total number of outcomes}}$

Probability of not happening $= 1 - \text{probability of happening}$; Extended: $P(A') = 1 - P(A)$

The probabilities of all the possible outcomes add up to 1

One of several outcomes on a single trial ("red or blue"): add their probabilities

$\text{relative frequency} = \dfrac{\text{number of times the event happens}}{\text{number of trials}}$

$\text{expected frequency} = \text{probability} \times \text{number of trials}$

Ratio $a : b$ of two kinds: probability of the first kind $= \dfrac{a}{a+b}$

8.3–8.4 Combined events and conditional probability

Independent events: $P(A \text{ and } B) = P(A) \times P(B)$

Different ways that can't happen together: add their probabilities

Probabilities on each set of branches add up to 1; so do the probabilities at the ends of all the paths

Probability of a path on a tree = the probabilities along it multiplied

Sample space: $\text{probability} = \dfrac{\text{number of cells where the event happens}}{\text{total number of cells}}$

Extended only: without replacement, each later pick has the total reduced by 1 (and the colour taken reduced by 1)

Extended only: $P(A \cap B)$ = both; $P(A \cup B)$ = either or both; $P(A')$ = not A

Extended only: conditional probability $= \dfrac{\text{outcomes in the known group where the event happens}}{\text{outcomes in the known group}}$

Probability of not happening $= 1 -$ probability of happening

At least one $= 1 - P(\text{none})$

First success on attempt n: $P(\text{fail})^{\,n-1} \times P(\text{success})$

9 Statistics

9.1–9.3 Averages and measures of spread

Mean $= \dfrac{\text{total of the values}}{\text{number of values}}$, so total $=$ mean $\times$ number of values

Median: the $\frac{n+1}{2}$th value once the data are in order

Mode: the most common value; range = largest − smallest

Frequency table: mean = $\frac{\Sigma fx}{\Sigma f}$

Extended: lower quartile = $\frac{n+1}{4}$th value, upper quartile = $\frac{3(n+1)}{4}$th value

Extended: interquartile range = UQ − LQ

Extended: grouped data, estimate of mean = $\frac{\Sigma fx}{\Sigma f}$ with x the class midpoint

Extended: midpoint = $\frac{\text{lower boundary} + \text{upper boundary}}{2}$

9.4–9.5 Statistical charts and scatter diagrams

Sector angle = $\frac{\text{frequency}}{\text{total}} \times 360^\circ$

Frequency = $\frac{\text{angle}}{360^\circ} \times \text{total}$

Total = $\text{frequency} \div \frac{\text{angle}}{360^\circ} = \frac{\text{frequency}}{\text{angle}} \times 360^\circ$

Percentage of the whole = $\frac{\text{angle}}{360^\circ} \times 100\%$

The angles in a pie chart add up to 360°; the parts of a composite percentage bar add up to 100%

Missing frequency = total − sum of the other frequencies

Pictogram value = number of symbols × key

Positive correlation: both increase; negative: one increases as the other decreases; zero: no pattern

9.6–9.7 Cumulative frequency and histograms

Class width = upper boundary − lower boundary

Frequency density = frequency ÷ class width

Frequency = frequency density × class width (area of the bar)

Cumulative frequency at an upper boundary = total of all frequencies up to that class

Plot cumulative frequencies at the **upper** class boundaries, starting from 0 at the lowest boundary

Median: read at $\frac{n}{2}$; LQ at $\frac{n}{4}$; UQ at $\frac{3n}{4}$

IQR = UQ − LQ

pth percentile: read at $\frac{p}{100} \times n$

Number **more than** $x = n$− reading at x

Estimated mean $= \frac{\sum fx}{\sum f}$, with x the midpoint of each class