GCSE Mathematics Foundation Tier

● Number ● Algebra ● Ratio, proportion and rates of change ● Geometry & measures ● Probability ● Statistics

Here is pretty much all the Foundation Tier content [illegible] on an A3 sheet of paper, including all the formulae you are required to know for GCSE. An ✚ points to an illustrative example. [illegible]

BIDMAS

…or BODMAS. Use the correct order of operations take care when using a calculator.

- Brackets
- Indices (or powers)
- Division and Multiplication
- Addition and Subtraction

Types of number

Integer: a "whole" number

Factors: the divisors of an integer

✚ Factors of 12 are 1, 2, 3, 4, 6, 12

Multiples: a "times table" for an integer (will continue indefinitely)

✚ Multiples of 12 are 12, 24, 36, …

Prime number: an integer which has exactly two factors (1 and the number itself). Note 1 is not a prime number.

HCF, LCM

Highest Common Factor (HCF)

✚ Factors of 6 are 1, 2, 3, 6

Factors of 9 are 1, 3, 9

HCF of 6 and 9 is 3

Lowest Common Multiple (LCM)

✚ Multiples of 6 are 6, 12, 18, 24, …

Multiples of 9 are 9, 18, 27, 36, …

LCM of 6 and 9 is 18

Prime factors

Write a number as a product of its prime factors; use indices for repeated factors.

✚ $720 = 5 \times 3^2 \times 2^4$

Powers and roots

Special indices: for any value a

$$a^0 = 1$$

$$a^{-n} = \frac{1}{a^n}$$

✚ $$2^{-3} = \frac{1}{2^3} = \frac{1}{8}$$

Calculating with fractions

Adding or subtracting fractions: use a common denominator…

✚ [illegible]

Multiplying fractions: multiply numerators and denominators…

✚ [illegible]

Dividing fractions: "flip" the second fraction, then multiply…

✚ [illegible]

Fractions, decimals

Fraction is numerator ÷ denominator

✚ $\frac{3}{8} = 3 \div 8 = 0.375$

Use place values to change decimals to fractions. Simplify where possible.

✚ $0.45 = \frac{45}{100} = \frac{9}{20}$

Learn the most frequently used ones:

$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{10}$	$\frac{1}{5}$	$\frac{3}{4}$
0.5	0.25	0.1	0.2	0.75

Surds

Look for the biggest square number factor of the number.

✚ $\sqrt{20} = \sqrt{4} \times \sqrt{5} = 2\sqrt{5}$

Standard form

Standard form numbers are of the form $a \times 10^n$ where $1 \le a < 10$ and n is an integer.

Standard units

1 tonne = 1000 kilograms

1 kilogram = 1000 grams

1 kilometre = 1000 metres

1 metre = 100 centimetres

= 1000 millimetres

1 centimetre = 10 millimetres

1 day = 24 hours

1 hour = 60 minutes = 3600 seconds

1 minute = 60 seconds

Rounding

Truncate the number, then use a "decider digit" to round up or down. Decimal places: use the decimal point.

✚ 562.3681 to 2dp

562.36|81 = 562.37 to 2dp

Significant figures: use the first non-zero digit.

✚ 562.3681 to 2sf

56|2.3681 = 560 to 2sf

✚ 0.007 070 to 3sf

0.007 07|0 = 0.007 07 to 3sf

Error intervals

Find the range of numbers that will round to a given value.

✚ $x = 5.83$ (2 decimal places)

$5.825 \le x < 5.835$

✚ $y = 66$ (2 significant figures)

$65.5 \le y < 66.5$

Note use of ≤ and <, and that the last significant figure of each is 5.

Algebraic notation

$$ab = a \times b$$

$$3y = y + y + y$$

$$a^2 = a \times a$$

$$a^3 = a \times a \times a$$

$$a^2b = a \times a \times b$$

$$\frac{a}{b} = a \div b$$

Equations and identities

An equation is true for some particular values of x

✚ $2x + 3 = 7$ is true if $x = 2$

…but an identity is true for every value of x

✚ $(x + a)^2 \equiv x^2 + 2ax + a^2$

(note the use of the symbol ≡)

Laws of indices

For any value a

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

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

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

✚ [illegible]

Standard graphs

y = mx + c

Equation of straight line $y = mx + c$

m is the gradient, c is the y intercept

✚ Find the equation of the line that joins (0, 3) to (2, 11)

Find its gradient…

$$\frac{11 - 3}{2 - 0} = \frac{8}{2} = 4$$

…and its y intercept…

Passes through (0, 3), so $c = 3$

Equation is $y = 4x + 3$

Parallel lines: gradients are equal.

✚ $y = 2x + 3$ and $y = 2x - 5$ both have gradient 2 so are parallel.

Expanding brackets

$$a(x + y) = ax + ay$$

✚ $5(x - 2y) = 5x - 10y$

$$(x + a)(x + b) = x^2 + ax + bx + ab$$

✚ $(2x - 3)(x + 5)$

$= 2x^2 - 3x + 10x - 15$

$= 2x^2 + 7x - 15$

Reverse of expanding is factorising: putting an expression into brackets.

Quadratics

Solve a quadratic by factorising

✚ Solve $x^2 - 8x + 15 = 0$

Put into brackets (taking care with any negative numbers)…

$$(x - 3)(x - 5) = 0$$

…then either $x - 3 = 0$ or $x - 5 = 0$

so that $x = 3$ or $x = 5$.

Difference of two squares

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

✚ $x^2 - 25 = (x + 5)(x - 5)$

Simultaneous equations

✚ Solve $\begin{cases} 2x + 3y = 12 \\ 3x - 5y = 7 \end{cases}$

Multiply to match a term in x or y

$\begin{cases} 10x + 15y = 60 \\ 9x - 15y = 21 \end{cases}$

Add or subtract to cancel…

$19x = 76$, so $x = 4$

Finally, substitute and solve…

$2 \times 4 + 3y = 12$, so $y = \frac{4}{3}$

Rearrange a formula

The subject of a formula is the term on its own. Use rules that "balance" the formula to change its subject.

✚ Make x the subject of

$$2x + 3y = z$$

Now, subtract 3y from both sides…

$$2x = z - 3y$$

…then divide both sides by 2

$$x = \frac{z - 3y}{2}$$

Right angled triangles

Pythagoras Theorem

Links all three sides.

No angles.

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

Trigonometry

Links two sides and one angle

SOH | CAH | TOA

$\sin\theta = \frac{opp}{hyp}$ $\cos\theta = \frac{adj}{hyp}$ $\tan\theta = \frac{opp}{adj}$

Use "2ndF" or "SHIFT" key to find a missing angle.

The longest side of any right angled triangle is the hypotenuse; check that your answer is consistent with this.

Special values of sin, cos, tan

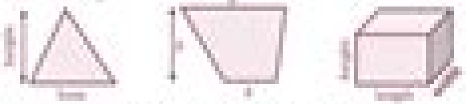
Learn (or be able to find without a calculator)…

θ	$\sin\theta$	$\cos\theta$	$\tan\theta$
0	0	1	0
30	$\frac{1}{2}$	$\frac{\sqrt{3}}{2}$	$\frac{1}{\sqrt{3}}$
45	$\frac{1}{\sqrt{2}}$	$\frac{1}{\sqrt{2}}$	1
60	$\frac{\sqrt{3}}{2}$	$\frac{1}{2}$	$\sqrt{3}$
90	1	0	

Area and volumes

Area of triangle $= \frac{1}{2} \times$ base × height

Volume of cuboid = length × width × height



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

Circumference of circle $= 2 \times \pi \times r$

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

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

Area of sector $= \frac{\theta}{360} \times \pi \times r^2$

Volume of cylinder $= \pi r^2 \times$ height

Volume of prism = area of cross section × length

Transformations

Reflection

- Line of reflection

Translation

- Vector

Rotation

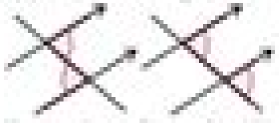
- Centre of rotation
- Angle of rotation
- Clockwise or anticlockwise

Enlargement

- Centre of enlargement
- Scale factor (if SF < 1 the shape will get smaller)

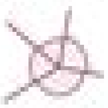
Angle facts

Equal angles in parallel lines: always use correct terminology…

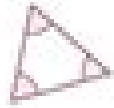


Angles on a straight line total 180°

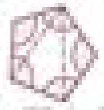
Angles in a full turn total 360°



Interior angles in a triangle total 180°

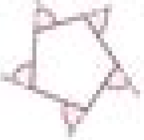


Use this for the interior angles of any polygon…



…so $180° \times (n - 2)$

Exterior angles always total 360°



Sequences

Triangular numbers

1st	2nd	3rd	4th	5th
1	3	6	10	15

Square numbers ($n^2 = n \times n$)

1^2	2^2	3^2	4^2	5^2
1	4	9	16	25

Cube numbers ($n^3 = n \times n \times n$)

1^3	2^3	3^3	4^3	5^3
1	8	27	64	125

nth term of an arithmetic (linear) sequence is $an + d$

✚ nth term of 5, 8, 11, 14, … is $3n + 2$ (always increases by 3, first term is $3 \times 1 + 2 = 5$)

Geometric sequence: multiply each term by a constant ratio

✚ 3, 6, 12, 24, … (ratio is 2)

Fibonacci sequence: make the next term by adding the previous two…

✚ 2, 3, 5, 8, 13, 21, 34, …

Probability

$p = $ [illegible]

$p = 0$ impossible

$0 < p < 0.5$ unlikely

$p = 0.5$ evens

$0.5 < p < 1$ likely

$p = 1$ certain

Probability rules

Multiply for independent events

✚ P(3 on dice and H on coin)

$$\frac{1}{6} \times \frac{1}{2} = \frac{1}{12}$$

Add for mutually exclusive events

✚ P(3 or 4 on dice)

$$\frac{1}{6} + \frac{1}{6} = \frac{2}{6}$$

Apply these rules to tree diagrams.

Parts of a circle

Division using ratio

Use a ratio for unequal sharing

✚ Divide £400 in the ratio 7 : 5

$7 + 5 = 12$, then £400 ÷ 12 = £[illegible]

[illegible]

Ratio and fractions

Link between ratios and fractions

✚ Boys to girls in ratio 2 : 3

$\frac{2}{5}$ are boys, $\frac{3}{5}$ are girls.

Percentages

$$x \text{ percent of } a = \frac{x}{100} \times a$$

✚ Increase £150 by 16%

$$\frac{16}{100} \times 150 = £[illegible]$$

£150 + £[illegible] = £[illegible]

$$x \text{ as a percentage of } a = \frac{x}{a} \times 100\%$$

✚ The population of a town increases from 7500 to 8625. Find the percentage increase.

$$\frac{1125}{7500} \times 100\% = 15\%$$

$$\text{Note: Fraction} = \frac{\text{increase}}{\text{original}}$$

Learn the most frequently used ones:

$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{10}$	$\frac{1}{5}$	$\frac{1}{100}$
50%	25%	10%	20%	1%

Speed, distance, time

$$\text{Speed} = \frac{\text{distance}}{\text{time}}$$

✚ A car travels 90 miles in 1 hour, 30 minutes. Find its average speed.

90 miles ÷ 1.5 hours = 60 mph

Averages

Mode: most frequently occurring

Median: put the data in numerical order, then choose the middle one

$$\text{Mean} = \frac{\text{total of items of data}}{\text{number of items of data}}$$

Correlation

Positive correlation

Negative correlation

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RJ Shavelson

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