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 you could fit onto an A3 sheet of paper, including all the formulae you are required to know for GCSE. An ✚ points to an illustrative example. The codes refer to the DfE subject content. [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

$$a^0 = 1$$

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

✚ $3^{-4} = \frac{1}{3^4} = \frac{1}{81}$

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:

✚ $\sqrt{50} = \sqrt{25 \times 2} = 5\sqrt{2}$

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

✚ 542.3681 to 2dp
542.36|81 = 542.37 to 2dp

Significant figures: use the first non-zero digit

✚ 542.3681 to 2sf
54|2.3681 = 540 to 2sf

✚ 0.007 070 to 2sf
0.0070|70 = 0.0071 to 2sf

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 = 44 (2 significant figures)
$43.5 \le y < 44.5$

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 value 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:

$$a^x \times a^y = a^{x+y}$$
$$\frac{a^x}{a^y} = a^{x-y}$$
$$(a^x)^y = a^{xy}$$

✚ [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 $y = 2x - 1$ both have gradient 2 so are parallel

Expanding brackets

$$a(b + c) = ab + ac$$

✚ [illegible]

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

✚ [illegible]

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 [illegible]

Multiply to match a term in x or y

[illegible]

Add or subtract to cancel...

[illegible]

Finally, substitute and solve...

[illegible]

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 $2x + 3y = z$

First, 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.

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

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

Trigonometry.
Links two sides and one angle.
SOH CAH TOA

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

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

Special values of sin, cos, tan. Learn (or be able to find without a calculator)...

θ°	sin θ°	cos θ°	tan θ°
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 = $\frac{1}{2}$ × base × height

Volume of cuboid = length × width × height

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

Circumference of circle = π × D
Area of circle = π × r^2

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

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

Volume of cylinder = πr^2 × 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...

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 × 1 + 2 = 5)

Geometric sequence: multiply each term by a constant ratio

✚ [illegible]

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

✚ [illegible]

Probability

$p = \frac{\text{number of ways the outcome can happen}}{\text{number of possible outcomes}}$

$p = 0$ 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

✚ [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

p percent of $x = \frac{p}{100} \times x$

✚ [illegible]

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

✚ The population of a town increases from [illegible] to [illegible]. Find the percentage increase.

[illegible]

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

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

Correlation

Positive correlation

Negative correlation

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Seller: Better World Books: West A Queer Thing Happened to America by Michael L. Brown A Queer Thing Happened to America chronicles the amazing transformation of America over the last forty years, and addresses the question head-on: Is there ... A Queer Thing Happened to America: And What a Long ... Renée Richards (née Richard Raskind), who had sex change surgery and who came to have lots of regrets (pp. 574-78). Brown shows real examples of how the ...