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

BIDMAS
N3

…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
N4

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
N4

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
N4

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
N6, N7

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
N8

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
N10

Fraction is numerator ÷ denominator
✚ $\frac{5}{8} = 5 \div 8 = 0.625$
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
N8

Look for the biggest square number factor of the number.
✚ $\sqrt{20} = \sqrt{4}\sqrt{5} = 2\sqrt{5}$

Standard form
N9

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

Standard units
N13

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
N15

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
✚ 0.007 659 to 2sf
0.0076|59 = 0.0077 to 2sf

Error intervals
N15

Find the range of numbers that will round to a given value.
✚ $x = 5.83$ (2 decimal places)
$5.825 \leq x < 5.835$
✚ $y = 64$ (2 significant figures)
$63.5 \leq y < 64.5$
Note use of ≤ and <, and that the last significant figure of each is 5.

Algebraic notation
A1

$ab = a \times b$
$3y = y + y + y$
$a^2 = a \times a$
$a^3 = a \times a \times a$
$a^2b = a \times a \times b$
$\frac{a}{b} = a \div b$

Equations and identities
A3

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
A4

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
A12

y = mx + c
A9

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, 2) to (2, 11)
Find its gradient…
$\frac{11 - 2}{2 - 0} = \frac{9}{2} = [illegible]$
…and its y intercept…
Passes through (0, 2), so $c = 2$
Equation is $y = [illegible]x + 2$

Parallel lines: gradients are equal.
✚ $y = 2x + 3$ and $y = 2x - 5$ both have gradient 2 so are parallel.

Expanding brackets
A4

$a(x + c) = ax + ac$
✚ $3(2x - 2y) = 6x - 6y$
$(x + a)(x + b) = x^2 + ax + bx + ab$
✚ $(2x - 3)(x + 5)$
$= 2x^2 - 3x + 10x - 15$
$= 2x^2 + 7x - 15$
Reverse of expanding is factorising: putting an expression into brackets.

Quadratics
A18

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
A4

$a^2 - b^2 = (a + b)(a - b)$
✚ $x^2 - 25 = (x + 5)(x - 5)$

Simultaneous equations
A19

✚ Solve $\begin{cases} 2x + 3y = 13 \\ 3x - 5y = 1 \end{cases}$
Multiply to match a term in x or y
$\begin{cases} 10x + 15y = 65 \\ 9x - 15y = 3 \end{cases}$
Add or subtract to cancel…
$19x = 76$, so $x = 4$
Finally, substitute and solve…
$2 \times 4 + 3y = 13$, so $y = [illegible]$

Rearrange a formula
A5

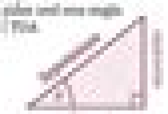
The subject of a formula is the term on its own. Use rules that "balance" the formula to change its subject.
✚ Make x the subject of $3x - 7y = z$
Here, subtract $7y$ from both sides…
$3x = z - 7y$
…then divide both sides by 3
$x = \frac{z - 7y}{3}$

Right-angled triangles
G20, G21

Pythagoras Theorem.
Look at these 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.
Look at two sides and one angle.
SOH | CAH | TOA



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

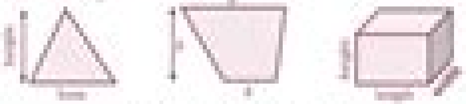
Use "2ndF" or "SHIFT" key to find a missing angle.

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	$\frac{\sqrt{2}}{2}$	$\frac{\sqrt{2}}{2}$	1
60	$\frac{\sqrt{3}}{2}$	$\frac{1}{2}$	$\sqrt{3}$
90	1	0	

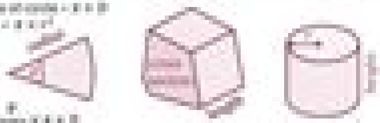
Area and volumes
G16, G17, G18, G22

Area of triangle $= \frac{1}{2} \times$ base $\times$ height
Volume of cuboid = length × width × height



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

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



Arc length $= \frac{\theta}{360} \times \pi \times D$
Area of sector $= \frac{\theta}{360} \times \pi \times r^2$
Volume of cylinder $= \pi r^2 \times$ height
Volume of prism = area of cross section × length

Transformations
G7, G8

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
G3

Know 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
A24, A25

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 increasing by 3; first term is $3 \times 1 + 2 = 5$)
Geometric sequence: multiply each term by a common ratio
✚ 3, 6, 12, 24… (ratio is 2)
Fibonacci sequence: make the next term by adding the previous two…
✚ 1, 2, 3, 5, 8, 13, 21, 34…

Probability
P3, P4

$p = \frac{\text{number of favourable outcomes}}{\text{total number of possible outcomes}}$

$p = 0$ impossible
$0 < p < 0.5$ unlikely
$p = 0.5$ evens
$0.5 < p < 1$ likely
$p = 1$ certain

Probability rules
P8, P9

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
G9

Division using ratio
R5

Use a ratio for unequal sharing
✚ Divide £600 in the ratio 7 : 3
$7 + 3 = 10$, then £600 ÷ 10 = £60
$7 \times £60 = £420$, $3 \times £60 = £180$
(check: £420 + £180 = £600 ✓)

Ratio and fractions
R8

Link between ratios and fractions
✚ Boys to girls in ratio 2 : 3
$\frac{2}{5}$ are boys, $\frac{3}{5}$ are girls

Percentages
R9

y percent of $x = \frac{y}{100} \times x$
✚ Increase £50 by 30%
$\frac{30}{100} \times £50 = £15.00$
£50 + £15.00 = £65.00
y as a percentage of $x = \frac{y}{x} \times 100\%$
✚ The population of a town increases from 3300 to 3630. Find the percentage increase.
$\frac{330}{3300} \times 100\% = 10\%$
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
R11

Speed $= \frac{\text{distance}}{\text{time}}$
✚ A car travels 50 miles in 1 hour 30 minutes. Find its average speed.
50 miles ÷ 1.5 hours = 33 mph

Averages
S4

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
S6

Positive correlation
Negative correlation

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