GCSE Mathematics Foundation Tier

Number · Algebra · Ratio, proportion and rate of change · Geometry & measures · Probability · Statistics

Here is pretty much all the Foundation Tier content you need to know on 10 sheet of paper, including all the formulas you are required to know for GCSE. Its ✚ packed in as illustrative example. The notes refer to the DfE subject content. The idea is a well, keep it in your desk, carry it in your bag, write notes on it (sorry, don't take it into the examination)...

BIDMAS

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

- Brackets
- Indices (or Orders)
- 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, and indices for repeated factors.
✚ $120 = 5 \times 3^1 \times 2^3$

Powers and roots

Special indices: for any value a

$$a^0 = 1$$

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

✚ $$3^{-2} = \frac{1}{3^2} = \frac{1}{9}$$

Calculating with fractions

Adding or subtracting fractions: use a common denominator...

✚ $$\frac{1}{4} + \frac{1}{3} = \frac{3}{12} + \frac{4}{12} = \frac{7}{12}$$

Multiplying fractions: multiply numerators and denominators...

✚ $$\frac{1}{4} \times \frac{1}{3} = \frac{1}{12}$$

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

✚ $$\frac{1}{4} \div \frac{1}{3} = \frac{1}{4} \times \frac{3}{1} = \frac{3}{4}$$

Fractions, decimals

Fraction to numerator ÷ denominator

✚ $$\frac{1}{4} = 1 \div 4 = 0.25$$

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:

1/2	1/3	2/3	1/4	3/4	1/5	2/5	3/5
4/5	1/6	5/6	1/8	3/8	5/8	7/8	1/10

Circle

Look for the biggest square number factor of the number:
✚ $\sqrt{80} = \sqrt{16 \times 5} = 4\sqrt{5}$

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 "smaller digit" to round up or down.
Decimal places: use the decimal point
✚ 162.5483 to 1dp.
162.5 (1 dp) < 162.57 to 2dp
Significant figures: use the first non-zero digit.
✚ 162.5483 to 2sf.
16 | 2.5483 = 160 to 2sf
✚ 0.007 | 11, 0 = 0.0077 to 2sf
0.007 < 11, 0 = 0.0077 to 2sf

Error intervals

Find the range of numbers that will round to a given value:
✚ $x = 5.03$ (2 decimal places)
$5.025 \le x < 5.035$
✚ $y = 60$ (2 significant figures)
$55 \le y < 65$

Note: one of $\le$ and $<$, and that the last significant figure of each is 5.

Algebraic notation

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

Expansion and simplification

An equation is true for some particular value of x
✚ $2x + 3 = 7$ is true at $x = 2$
...but an identity is true for every value of x
✚ $(x + a)^2 = x^2 + 2ax + a^2$
(note the use of the symbol $\equiv$)

Laws of indices

For any value a

$$a^m \times a^n = a^{m+n}$$
$$a^m \div a^n = a^{m-n}$$
$$(a^m)^n = a^{mn}$$

✚ $$\left(\frac{3x^2}{2y^3}\right)^4 = \frac{3^4x^8}{2^4y^{12}} = \frac{81x^8}{16y^{12}}$$

Number grids

$y = mx + c$

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 the gradient:

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

...and the y intercept...
Point 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

$$p(q + r) = pq + pr$$

✚ $5(x - 2y) = 5x - 10y$
$(x + a)(x + b) = x^2 + ax + bx + ab$
✚ $(2x - 3)(x + 5)$
$= 2x^2 - 3(x + 5)$
$= 2x^2 - 6x - 15$
$= 2x^2 + 7x - 15$

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 $\begin{cases} 2x + 3y = 13 \\ 5x - 3y = 7 \end{cases}$

Multiply to match a term in x or y

$$\begin{cases} 10x + 15y = 65 \\ 9x - 15y = 21 \end{cases}$$

Add or subtract to cancel...
$19x = 76$, so $x = 4$
Finally, substitute and solve...
$2 \times 4 + 3y = 13$, so $y = 1$

Rearrange a formula

The subject of a formula is the term on its own. The rules that "balance" the formula to change its subject.
✚ Make x the subject of
$2x + 3y = z$
Move 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.
By 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

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

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

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

θ°	$\sin\theta^\circ$	$\cos\theta^\circ$	$\tan\theta^\circ$
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 volume

Area of triangle = $\frac{1}{2} \times$ base $\times$ height Volume of cuboid = length $\times$ width $\times$ 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 = $\frac{\theta}{360} \times \pi \times D$

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 $\times$ length

Transformations

Reflection
- Line of reflection

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

Enlargement
- Centre of enlargement
- Scale factor (SF)
- SF > 1 the shape will get smaller).

Translation
- Vector

Angle facts

Equal angles in parallel lines always are correct homologs...

Alternate angles Corresponding angles

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...

...or 180° × (n − 2)

Interior angles always total 360°

Sequences

Triangular numbers:

1	3	6	10	15

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

1	4	9	16	25

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

1	8	27	64	125

Nth term of an arithmetic (linear) sequence is $an + d$
✚ sub terms of 5, 8, 11, 14, ... is
Result (always increases 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, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, ...

Probability

p = (number ways to succeed) ÷ (number ways to succeed + number ways to fail)

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

Expected Value

Multiply for independent events
✚ P(H on fair coin) & P(H on coin)

$$\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$$

Add for mutually exclusive events
✚ P(T on a fair die)

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

Apply these rules to tree diagrams.

Pie charts of a circle

Ratio

Use a ratio for unequal sharing
✚ Divide £400 in the ratio 1 : 3
1 + 3 = 4; then £400 ÷ 4 = £100
1 × £100 = £100, 3 × £100 = £300
(check: £100 + £300 = £400 ✓)

Ratio and fractions

Link between ratios and fractions
✚ Ratio for girls to ratio 2 : 3

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

Percentages

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

✚ Increase £150 by 20%

$$\frac{20}{100} = 150 \times 1.15 = 172.50$$

$$£150 + £15.00 = £172.50$$

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

✚ The population of a town increases from 75000 to 84750. Find the percentage increase.

$$\frac{84750}{75000} = 100\% + 13\%$$

$$\text{Percentage change} = \frac{\text{increase}}{\text{original}} \times 100\%$$

Learn the most frequently used ones:

1	1/2	1/3	1/4	1/5
100%	50%	33%	25%	20%

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

Pixl Maths Jan 2ppe Paper Mark Scheme

Raffaela Di Napoli

Pixl Maths Jan 2ppe Paper Mark Scheme:

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Table of Contents Pixl Maths Jan 2ppe Paper Mark Scheme

1. Understanding the eBook Pixl Maths Jan 2ppe Paper Mark Scheme
    - The Rise of Digital Reading Pixl Maths Jan 2ppe Paper Mark Scheme
    - Advantages of eBooks Over Traditional Books
2. Identifying Pixl Maths Jan 2ppe Paper Mark Scheme
    - Exploring Different Genres
    - Considering Fiction vs. Non-Fiction
    - Determining Your Reading Goals
3. Choosing the Right eBook Platform
    - Popular eBook Platforms
    - Features to Look for in an Pixl Maths Jan 2ppe Paper Mark Scheme
    - User-Friendly Interface
4. Exploring eBook Recommendations from Pixl Maths Jan 2ppe Paper Mark Scheme
    - Personalized Recommendations
    - Pixl Maths Jan 2ppe Paper Mark Scheme User Reviews and Ratings
    - Pixl Maths Jan 2ppe Paper Mark Scheme and Bestseller Lists
5. Accessing Pixl Maths Jan 2ppe Paper Mark Scheme Free and Paid eBooks
    - Pixl Maths Jan 2ppe Paper Mark Scheme Public Domain eBooks
    - Pixl Maths Jan 2ppe Paper Mark Scheme eBook Subscription Services
    - Pixl Maths Jan 2ppe Paper Mark Scheme Budget-Friendly Options
6. Navigating Pixl Maths Jan 2ppe Paper Mark Scheme eBook Formats
    - ePub, PDF, MOBI, and More
    - Pixl Maths Jan 2ppe Paper Mark Scheme Compatibility with Devices
    - Pixl Maths Jan 2ppe Paper Mark Scheme Enhanced eBook Features
7. Enhancing Your Reading Experience
    - Adjustable Fonts and Text Sizes of Pixl Maths Jan 2ppe Paper Mark Scheme
    - Highlighting and Note-Taking Pixl Maths Jan 2ppe Paper Mark Scheme
    - Interactive Elements Pixl Maths Jan 2ppe Paper Mark Scheme

8. Staying Engaged with Pixl Maths Jan 2ppe Paper Mark Scheme
    - Joining Online Reading Communities
    - Participating in Virtual Book Clubs
    - Following Authors and Publishers Pixl Maths Jan 2ppe Paper Mark Scheme
9. Balancing eBooks and Physical Books Pixl Maths Jan 2ppe Paper Mark Scheme
    - Benefits of a Digital Library
    - Creating a Diverse Reading Collection Pixl Maths Jan 2ppe Paper Mark Scheme
10. Overcoming Reading Challenges
    - Dealing with Digital Eye Strain
    - Minimizing Distractions
    - Managing Screen Time
11. Cultivating a Reading Routine Pixl Maths Jan 2ppe Paper Mark Scheme
    - Setting Reading Goals Pixl Maths Jan 2ppe Paper Mark Scheme
    - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Pixl Maths Jan 2ppe Paper Mark Scheme
    - Fact-Checking eBook Content of Pixl Maths Jan 2ppe Paper Mark Scheme
    - Distinguishing Credible Sources
13. Promoting Lifelong Learning
    - Utilizing eBooks for Skill Development
    - Exploring Educational eBooks
14. Embracing eBook Trends
    - Integration of Multimedia Elements
    - Interactive and Gamified eBooks

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