GCSE SCIENCE

The equations

Grouped by topic, with what each symbol is measured in. Twenty-six, and most questions use one of eight.

Motion and forces

Distance travelled
$s = v\,t$
m · m/s · s

Acceleration
$a = \Delta v \div t$
m/s^2 · m/s · s

Resultant force
$F = m\,a$
N · kg · m/s^2

Weight
$W = m\,g$
N · kg · N/kg

Momentum
$p = m\,v$
kg m/s · kg · m/s

Work done
$W = F\,s$
J · N · m

Moment of a force
$M = F\,d$
N m · N · m

Force on a spring
$F = k\,e$
N · N/m · m

Energy and power

Kinetic energy
$E_k = \frac{1}{2}\,m\,v^2$
J · kg · m/s

Gravitational potential energy
$E_p = m\,g\,h$
J · kg · N/kg · m

Elastic potential energy
$E_e = \frac{1}{2}\,k\,e^2$
J · N/m · m

Power
$P = E \div t$
W · J · s

Efficiency
useful output ÷ total input
no unit — a ratio

Thermal energy
$\Delta E = m\,c\,\Delta\theta$
J · kg · J/kg°C · °C

Latent heat
$E = m\,L$
J · kg · J/kg

Waves

Wave speed
$v = f\,\lambda$
m/s · Hz · m

Period
$T = 1 \div f$
s · Hz

Electricity

Charge flow
$Q = I\,t$
C · A · s

Potential difference
$V = I\,R$
V · A · Ω

Power
$P = V\,I$
W · V · A

Power
$P = I^2\,R$
W · A · Ω

Energy transferred
$E = P\,t$
J · W · s

Energy transferred
$E = Q\,V$
J · C · V

Density and pressure

Density
$\rho = m \div V$
kg/m^3 · kg · m^3

Pressure
$p = F \div A$
Pa · N · m^2

Pressure in a liquid
$p = h\,\rho\,g$
Pa · m · kg/m^3 · N/kg

Write the equation, then the substitution, then the answer with its unit. Three lines. A right answer on its own is worth less than a wrong one with those three lines under it.

Settled subject content. The selection, the wording and every drawing on this sheet are ours. Units are listed in the order the symbols appear, so a reading can be checked before it is substituted.

GCSE SCIENCE

Chemistry and biology calculations

The other two subjects. Eighteen relationships, and the unit conversion that costs more marks than any of them.

Chemistry — amount of substance

Relative formula mass
M_r = sum of the A_r values
one A_r for every atom in the formula

Number of moles
$n = m \div M_r$
mol · g · no unit

Mass from moles
$m = n \times M_r$
g · mol · no unit

Chemistry — solutions and gases

Concentration by mass
$c = m \div V$
g/dm^3 · g · dm^3

Concentration in moles
$c = n \div V$
mol/dm^3 · mol · dm^3

Volume of a gas at room conditions
$V = n \times 24$
dm^3 · mol · dm^3/mol

Chemistry — yield and efficiency

Percentage yield
= (actual ÷ theoretical) × 100
% · g · g

Atom economy
= (M_r wanted ÷ M_r all reactants) × 100
%

Percentage by mass of an element
= (A_r × number of atoms ÷ M_r) × 100
%

Rates and gradients

Mean rate of reaction
= quantity used or made ÷ time
g/s or cm^3/s

Rate at one moment
= gradient of the tangent there
steeper means faster

Percentage change
= ((final − start) ÷ start) × 100
% · a minus sign means it lost mass

Biology — microscopy and exchange

Magnification
= image size ÷ actual size
no unit — it is a ratio

Actual size
= image size ÷ magnification
keep both lengths in the same unit

Surface area : volume
= surface area ÷ volume
falls as the object gets bigger

Biology — rates and intensity

Rate from a time
= 1 ÷ time taken
the shorter the time, the faster the rate

Light intensity
$\propto 1 \div \text{distance}^2$
double the distance, a quarter of the light

Cardiac output
= stroke volume × heart rate
cm^3/min · cm^3 · beats/min

One volume unit causes more lost marks here than all the rearranging put together: 1 dm^3 = 1000 cm^3 = 1 litre. A concentration in g/dm^3 needs the volume in dm^3, so divide cm^3 by 1000 before you substitute.

Settled subject content. The selection and the wording on this sheet are ours. Rearrange before you substitute, and check the unit of the answer against the unit of the question.

GCSE SCIENCE

Units, prefixes and standard form

The arithmetic every topic depends on. Get the prefix wrong and the physics was wasted.

The units you measure in

m	**metre** length	**kg**	**kilogram** mass
s	**second** time	**A**	**ampere** current
K	**kelvin** temperature	**mol**	**mole** amount

The units you calculate

N	**newton** force	**J**	**joule** energy
W	**watt** power	**Pa**	**pascal** pressure
V	**volt** potential difference	**Ω**	**ohm** resistance
C	**coulomb** charge	**Hz**	**hertz** frequency

PREFIXES — WHAT THE LETTER IN FRONT OF THE UNIT DOES

n	μ	m	c	k	M	G
nano	**micro**	**milli**	**centi**	**kilo**	**mega**	**giga**
$\times 10^{-9}$	$\times 10^{-6}$	$\times 10^{-3}$	$\times 10^{-2}$	$\times 10^{3}$	$\times 10^{6}$	$\times 10^{9}$
0.000000001	0.000001	0.001	0.01	1 000	1 000 000	1 000 000 000

STANDARD FORM

What it is

A number that is at least 1 and less than 10, multiplied by a power of ten. 9.9×10^3 is standard form; 10×10^3 is not.

Large numbers

6 400 000 m becomes 6.4×10^6 m. The power counts how far the point moved left.

Small numbers

0.000 002 5 m becomes 2.5×10^{-6} m. A negative power means the point moved right.

On a calculator

Use the EXP or $\times 10^x$ key. Typing “× 10 ^” as well gives you the answer times ten.

GCSE SCIENCE

Working scientifically

The words a method has to use. Most marks lost here are lost on vocabulary, not on the science.

Independent variable
The one thing you change on purpose.

Dependent variable
The thing you measure each time.

Control variables
Everything else you keep the same. Name them — "fair test" on its own is not an answer.

Accurate
Close to the true value.

Precise
Repeat readings close to each other. Precise and wrong is possible.

Resolution
The smallest change an instrument can show. A ruler in mm has a resolution of 1 mm.

Repeatable
The same person, same method, gets the same result again.

Reproducible
Someone else, or a different method, gets the same result.

Valid
The experiment actually measures what it set out to measure.

Anomaly
A result that does not fit the pattern. Identify it, and leave it out of the mean.

Hypothesis
A testable idea about why something happens.

Prediction
What you expect to see, and why — stated before you start.

Random error
Scatter that differs each time. Repeat and mean it out — this is what precision measures.

Systematic error
The same offset every time. Repeating will not remove it; only finding the cause will.

Zero error
The instrument does not read zero when it should. The commonest systematic error on a school bench.

Range
The lowest to the highest value in a set of readings.

Uncertainty
The interval a true value is likely to sit in. Half the range is the usual estimate.

Settled subject content. The selection, the wording and every drawing on this sheet are ours. Accurate and precise are not the same word, and a set of readings can be one without the other.

GCSE SCIENCE

Hazard symbols

Nine symbols. You will meet five of them on a school bench and should know all nine.

Flammable

Catches fire easily. Keep away from naked flames — no Bunsen nearby.

Oxidising

Provides oxygen, so it makes other things burn harder.

Corrosive

Attacks skin, eyes and metal. Goggles on, and wash any splash off at once.

Toxic

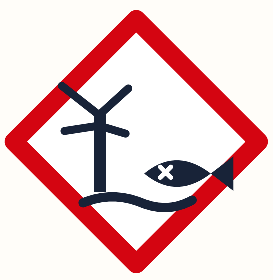
Poisonous in small amounts. Never taste, never inhale, wash hands after.

Harmful or irritant

Stings skin and eyes. The commonest symbol on a school bench.

Serious health hazard

Long-term harm — the lungs or the organs. Use in a fume cupboard.



Hazardous to the environment

Do not pour it down the sink. Use the waste container.

Explosive

May detonate. You will not meet this often in a school lab.

Gas under pressure

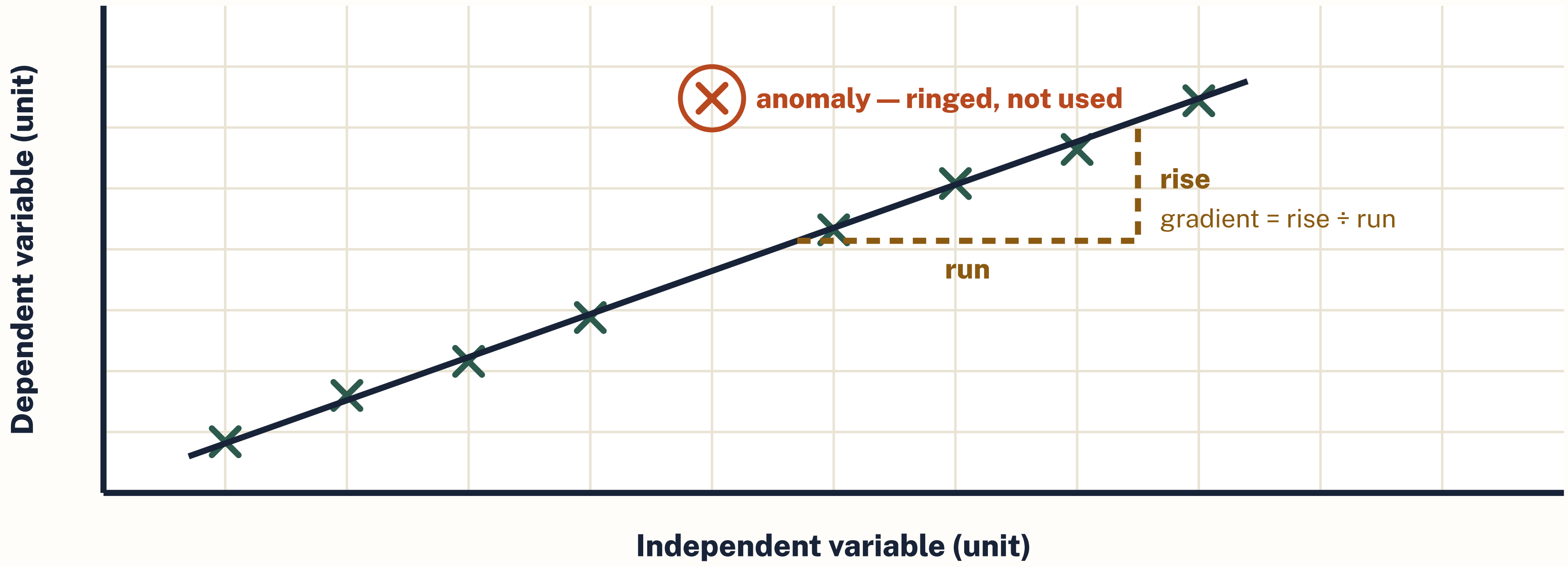
The cylinder itself is the hazard. Never knock one over.

The symbols are the standard international pictograms found on any chemical bottle. These are drawn by us rather than copied, and are for learning to recognise — the label on the bottle in front of you is the one that counts.

GCSE SCIENCE

Drawing a graph

Six rules, and one worked set of axes with every one of them on it.



1 **Independent across, dependent up**
What you changed goes on the x axis. What you measured goes on the y.

2 **Label with the quantity and the unit**
"Length (cm)", not "length". A missing unit is a lost mark on any graph.

3 **Choose a scale that fills the grid**
Use more than half the paper. Go up in 1s, 2s, 5s or 10s — never in 3s or 7s.

4 **Plot with small crosses**
A cross marks a point exactly. A blob covers four squares and hides where the reading actually was.

5 **Draw a line of best fit, not dot-to-dot**
One smooth line or curve with roughly as many points above as below.

6 **Circle an anomaly and ignore it**
It stays on the graph so the examiner sees you spotted it. The line goes past it, not through it.

Settled subject content. The selection, the wording and every drawing on this sheet are ours. The line of best fit passes through the trend, not through every point — and never through the anomaly.