



Numbers, units and data presentation.

Marks are lost in numerical papers for reasons that have nothing to do with the subject: a unit written wrongly, a result quoted to nine figures, a table captioned underneath. This document sets out the conventions examiners apply, and names the sources they come from.

1 One authority for units, and three habits

Every figure you write down is a measurement, and in the physical sciences measurements are expressed in the International System of Units. The authority is the BIPM's *SI Brochure*, ninth edition (2019): it defines the seven base units, the prefixes, and how symbols are written.

Three habits follow. **Leave a space** between number and symbol — 25.4 mm, not 25.4mm. **Keep symbols as defined** — lower case unless the unit is named after a person, so m, s, kg but N, Pa, J — and never pluralise them: 5 km, never 5 kms. **Do not mix names with symbols**: write 20 m/s or 20 metres per second, never "20 m per s".

FOUR THINGS TO FIX BEFORE THE EXAM

■ 25.4mm → 25.4 mm

■ 5 kgs → 5 kg

■ 20 m per s → 20 m/s

■ 10 Amps → 10 A

AUTHORITY BIPM, *The International System of Units (SI)*, 9th ed. (2019).

2 The prefixes you will actually use

Multiples	Symbol	Factor	Sub-multiples	Symbol	Factor
tera	T	10^{12}	centi	c	10^{-2}
giga	G	10^9	milli	m	10^{-3}
mega	M	10^6	micro	μ	10^{-6}
kilo	k	10^3	nano	n	10^{-9}
hecto	h	10^2	pico	p	10^{-12}

SOURCE Set in the *SI Brochure*. Note that micro is μ, not u, and kilo is a lower-case k: write km, never Km or KM.

3 Quantity calculus — carry the units through

Treat a unit as an algebraic symbol attached to its number. A conversion factor is a fraction equal to one, because top and bottom describe the same quantity. Carry units through the working and they cancel exactly as the numbers do, so the unit of the answer arrives with the answer — and a unit that refuses to cancel warns you while there is still time to fix the arithmetic.

WORKED EXAMPLE — 72 KM/H IN SI BASE UNITS

$$72 \text{ km/h} \times (1000 \text{ m} \div 1 \text{ km}) \times (1 \text{ h} \div 3600 \text{ s})$$

$$= (72 \times 1000 \div 3600) \text{ m/s} = 20 \text{ m/s}$$

km appears once above and once below, so it cancels; the same happens to h. Only m/s survives.

4 The seven base quantities

Base quantity	Symbol	Unit	Symbol
length	l	metre	m
mass	m	kilogram	kg
time	t	second	s
electric current	I	ampere	A
temperature	T	kelvin	K
amount of substance	n	mole	mol
luminous intensity	I _v	candela	cd

Every other unit is a derived unit built from these seven by multiplication and division. The joule is $\text{kg m}^2 \text{s}^{-2}$, the newton kg m s^{-2} , the pascal $\text{kg m}^{-1} \text{s}^{-2}$. You never have to memorise those: they fall out of the quantity calculus.

The kilogram already carries its prefix. Write masses as mg, g or kg, never as "kkg" or "μkg".

SOURCE The seven base quantities and their units as defined in the *SI Brochure*, 9th ed. (2019).



5 Significant figures — which authority you follow

The conventions for significant figures and rounding are set out in the IUPAC *Green Book, Quantities, Units and Symbols in Physical Chemistry*. That book is the authority to cite when you are asked where a rounding rule comes from.

There is deliberately no separate standalone IUPAC document devoted to significant figures. The rules below are the ones applied in marking keys and journals, and they agree with the Green Book.

THE THREE RULES, IN WORDS

- Non-zero digits count. Zeros between them count too: 1.005 has four figures.
- Leading zeros never count. 0.0045 has two.
- Trailing zeros count only with a decimal point. 1500 has two; 1.500×10^3 has four.

AUTHORITY IUPAC, *Quantities, Units and Symbols in Physical Chemistry* (Green Book), 4th ed. (abridged), RSC Publishing, 2023.

6 Eight numbers, rounded to three significant figures

Number	To 3 s.f.	Rule applied
2.5447	2.54	Fourth digit is 4: round down.
0.004 839 2	0.004 84	Leading zeros never count; next digit 9 rounds up.
47.651	47.7	Third figure 6, next digit 5: round up.
1.005 03	1.01	Zeros between digits count; 5 with digits behind rounds up.
999.6	1.00×10^3	Carries into a new digit, so use standard form.
83 495	83 500	Fourth digit 9 rounds the 4 up to 5.
0.085 047	0.085 0	Third figure is 0, next digit 4: keep it.
12.35	12.4	Bare 5 at the cut: most keys round up.

METHOD Count from the first non-zero digit. Keep that many figures, then decide once, from the first digit you are dropping. Never round twice.

7 Two rules for two different operations

MULTIPLYING AND DIVIDING — COUNT FIGURES

The answer carries as many **significant figures** as the least precise input.

$2.50 \times 3.1 = 7.75$ on the calculator, but 3.1 has two figures, so **7.8**. And $12.0 \div 4.000 = 3.0$, not 3.000.

ADDING AND SUBTRACTING — COUNT PLACES

The answer carries as many **decimal places** as the least precise input.

$1.25 + 0.3 = 1.55$ on the calculator, but one term is known to one decimal place, so **1.6**. $100.0 - 0.5 = 99.5$; a term known to no decimals gives **100**.

STANDARD FORM AND EXPONENTS, INCLUDING NEGATIVE ONES

Standard form writes a number as $a \times 10^n$ with a at least 1 and less than 10. A negative exponent means a small number, not a negative quantity: 4.5×10^{-3} is 0.0045 and has two significant figures. Use the exponent form to remove doubt about trailing zeros: 1.500×10^3 states four figures where 1500 leaves the reader guessing.

8 Common errors in rounding

- Rounding twice.** Round once, from the original number.
- Counting leading zeros.** 0.0025 has two figures, not five.
- Dropping significant trailing zeros.** 2.50 differs from 2.5.
- Quoting the calculator.** Eight digits claim precision the apparatus never had.
- Rounding every intermediate step.** Carry one extra figure and round the final answer only.
- Applying the wrong rule.** Decimal places for a multiplication, figures for an addition.
- Adding the unit to the number alone.** The unit belongs to the whole quantity.
- Writing 1e3 or 10^3 .** Use a real superscript in written work.



9 Reporting a measurement with its uncertainty

A measured value is incomplete without an uncertainty. The JCGM *Guide to the expression of uncertainty in measurement*, the GUM, defines the three quantities below.

STANDARD UNCERTAINTY, U

One standard deviation — from repeated readings, or from the instrument: a stated tolerance divided by a sensible factor.

COMBINED UNCERTAINTY, U_c

Inputs are combined, not added, each in proportion to its effect on the result.

EXPANDED UNCERTAINTY, U

Combined uncertainty $\times$ a coverage factor. With $k = 2$ it corresponds to about 95% confidence.

SOURCE JCGM, *Evaluation of measurement data — Guide to the expression of uncertainty in measurement* (GUM), 2008. A companion, JCGM GUM-1:2023, also exists.

10 How to write the result, and the percentage form

WRITING THE ANSWER

A local value of gravitational field strength might be written:

$$g = 9.81 \pm 0.02 \text{ m/s}^2$$

The unit goes once, after the whole expression. The uncertainty carries the same decimal places as the value; for the expanded form, state it as " $U = 0.02 \text{ m/s}^2$ ($k = 2$)".

WORKED PERCENTAGE UNCERTAINTY

Divide the uncertainty by the value and multiply by 100:

$$(0.02 \div 9.81) \times 100 = 0.20\%$$

For $2.00 \pm 0.01 \text{ s}$ the same step gives 0.5%. Compare percentage uncertainties to see which measurement limits the experiment.

11 Presentation rules for tables

Rule	What it means
Caption above	A table caption goes above the table, numbered "Table 1."; a figure caption goes below.
Units in the header	Quantity, symbol and unit in the heading: "Time t / s". Never in every cell.
No vertical rules	Horizontal rules only — one under the headings, one at the foot.
Decimal alignment	Equal decimal places, column aligned right; the points line up.

THE TWO MOST COMMON FAULTS

- **"Length (m)" with "0.85 m" in the cell.** The unit appears twice, in the wrong place.
- **A ragged column of decimals.** 0.9 beside 0.85 beside 0.850 reads as three levels of precision.

12 Two tables set out correctly

Length l / m	T / s	T^2 / s ²	g / m s ⁻²
0.400	1.27	1.61	9.79
0.600	1.55	2.40	9.85
0.800	1.79	3.20	9.84
1.000	2.01	4.04	9.77

TABLE 1 Caption above the table. Every heading carries quantity, symbol and unit; every cell carries a number only.

Quantity	Measured	Accepted	Diff.
Gravitational field strength g / m s ⁻²	9.81 ± 0.02	9.81	0.0%
Acceleration a / m s ⁻²	2.34 ± 0.05	2.50	6.4%

TABLE 2 The uncertainty carries the same decimal places as the value; the comparison column is defined in the heading.

13 Presentation rules for figures

- **Label both axes.** Each axis carries quantity, symbol and unit — "Time t / s" — never a bare number.
- **Show error bars where you have uncertainty;** without them a graph claims more than the data supports.
- **Number and title every figure** below it: "Figure 1." then the title.
- **The caption must be readable alone** — what was measured, on what, and in what units.
- **Plot points; join them only** if the theory predicts a continuous line.
- **Label the gradient if it is your result** — the slope triangle and its unit.