

the mole, and every calculation that hangs off it

Matter, in the words the paper marks *

- a **pure substance** has a fixed composition throughout: an **element** cannot be broken into simpler substances chemically, a **compound** can, and its parts are present in a fixed mass ratio
- a **mixture** has no fixed composition; **homogeneous** means one visible phase (air, brine) and **heterogeneous** means more than one (sand in water)
- a **physical property** can be measured without changing what the substance is (density, melting point, colour); a **chemical property** only shows up when it becomes something else
- the SI base quantities used here are **mass in kg**, **amount of substance in mol**, **temperature in K**, and the derived ones that matter are volume, density and concentration

Significant figures, which are marks not decoration

- every non zero digit counts; zeros **between** digits count; leading zeros never count; trailing zeros count only when a decimal point is written
- adding or subtracting**, the answer keeps the **FEWEST** decimal places; **multiplying or dividing**, it keeps the **FEWEST** significant figures
- round the final answer once, at the end, never at each step, and round 5 to the nearest even digit
- accuracy** is closeness to the true value, **precision** is closeness of repeated readings to each other, and a set can be precise and badly wrong



*precise but inaccurate:
the shots agree with each
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*accurate but imprecise:
the shots scatter, yet
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The factor label method, which turns a conversion into cancelling

- write the quantity you have, multiply by a fraction equal to 1 whose top carries the unit you want and whose bottom carries the unit you are killing
- keep multiplying until only the wanted unit survives, and the arithmetic is then just numbers
- the same trick converts a density into a volume, a molarity into a mass, and grams into moles, so it is worth writing out in full in a long question
- if the units do not cancel to the answer's unit, the setup is wrong and no amount of arithmetic will rescue it

The laws of chemical combination

- conservation of mass**: matter is neither created nor destroyed in a chemical change, so a balanced equation is a mass statement before it is anything else
- definite proportions**: a given compound always holds the same elements in the same fixed mass ratio, however it was made
- multiple proportions**: when two elements form more than one compound, the masses of one combining with a fixed mass of the other are in a small whole number ratio, as in CO and CO₂ where the oxygen masses go 1 to 2
- Gay Lussac, gaseous volumes**: gases react in volumes that bear a simple whole number ratio, at the same temperature and pressure
- Avogadro**: equal volumes of all gases under the same conditions hold equal numbers of molecules, which is what separated an atom from a molecule at last

