

The seven basic units of measurement: the SI base units, derived units and prefixes

The seven base units

Quantity	Unit	Symbol	Measures	Defined by (since 2019)
Length	metre	m	Distance	The speed of light, 299,792,458 m/s
Mass	kilogram	kg	Amount of matter (not weight)	The Planck constant
Time	second	s	Duration	9,192,631,770 periods of a caesium-133 transition
Electric current	ampere	A	Flow of charge	The elementary charge
Temperature	kelvin	K	Thermodynamic temperature from absolute zero	The Boltzmann constant; $0\text{ }^{\circ}\text{C} = 273.15\text{ K}$
Amount of substance	mole	mol	A counted number of particles	$6.022\ 140\ 76 \times 10^{23}$ particles exactly
Luminous intensity	candela	cd	Brightness of a source	A fixed luminous efficacy, 683 lm/W

Derived units, in base units

Quantity	Unit	Symbol	In other units	In base units
Speed	metre per second	m/s		m s^{-1}
Acceleration	metre per second squared	m/s^2		m s^{-2}
Force	newton	N		kg m s^{-2}
Pressure	pascal	Pa	N/m^2	$\text{kg m}^{-1} \text{s}^{-2}$
Energy, work	joule	J	N m	$\text{kg m}^2 \text{s}^{-2}$
Power	watt	W	J/s	$\text{kg m}^2 \text{s}^{-3}$
Frequency	hertz	Hz	$1/\text{s}$	s^{-1}
Charge	coulomb	C	A s	A s
Voltage	volt	V	W/A , J/C	$\text{kg m}^2 \text{s}^{-3} \text{A}^{-1}$
Resistance	ohm	Ω	V/A	$\text{kg m}^2 \text{s}^{-3} \text{A}^{-2}$
Density	kilogram per cubic metre	kg/m^3		kg m^{-3}

Prefixes

giga G 10^9	mega M 10^6	kilo k 10^3	hecto h 10^2	deca da 10
deci d 10^{-1}	centi c 10^{-2}	milli m 10^{-3}	micro μ 10^{-6}	nano n 10^{-9}

Symbol rules, mistakes, and ten questions

The symbol rules examiners mark

- [] No full stop, no plural: 5 kg, not 5 kgs.
- [] Lower case unless named after a person: m, s, kg, mol; N, J, W, Pa, Hz, K, A (litre: L or l)
- [] A space between number and symbol: 10 m, 25 °C; but 90° and 50%
- [] Quotients with one slash or a negative power: m/s or m s^{-1} , never m/s/s
- [] The unit name is lower case even when the symbol is capital: five newtons, 5 N
- [] Prefix and unit are one word: kilometre, km

The six mistakes

- [] The gram given as the base unit (it is the kilogram)
- [] 'Degrees kelvin' or °K
- [] Mass (kg) confused with weight (N)
- [] A derived unit wrong in base units: the joule is $\text{kg m}^2 \text{s}^{-2}$
- [] Squared and cubed units converted once: $1 \text{ m}^2 = 10,000 \text{ cm}^2$, $1 \text{ m}^3 = 1,000,000 \text{ cm}^3$
- [] The mole treated as a mass

Ten questions

1. Name the seven base units and their symbols.
2. 3.5 km in metres; 250 mL in litres; 0.004 s in milliseconds.
3. Express the newton in base units.
4. Express the joule in base units, from energy = force × distance.
5. Convert 2 m^2 to cm^2 .
6. 27 °C in kelvin.
7. What quantity does the ampere measure?
8. Which is the base unit: gram or kilogram? Why?
9. Write 'five newtons' as a number with a symbol.
10. 1 litre is how many cubic centimetres, and what fraction of a cubic metre?

Answers

- 1) m, kg, s, A, K, mol, cd 2) 3,500 m; 0.25 L; 4 ms 3) kg m s^{-2} 4) $\text{kg m s}^{-2} \times \text{m} = \text{kg m}^2 \text{s}^{-2}$ 5) 20,000 cm^2 6) 300.15 K
7) Electric current 8) Kilogram: the SI chose it in 1960 because the gram is too small for a standard 9) 5 N 10) 1,000 cm^3 ;
one thousandth

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