

Significant Figures & Measurement

Counting sig figs, rounding, scientific notation, SI units and prefixes, and dimensional analysis.

01 Exact vs measured

CORE RULE

Exact numbers (counts, definitions) have infinite sig figs and never limit precision. Measured values are inexact and do limit sig figs.

02 Counting significant figures

CORE RULE

Rules for counting significant digits: (1) All nonzero digits are significant. (2) Zeros between nonzero digits are always significant. (3) Leading zeros (before the first nonzero digit) are never significant. (4) Trailing zeros after a decimal point are significant. (5) Trailing zeros without a decimal point are NOT significant.

03 Scientific notation

CORE RULE

Write as $a.bcd \times 10^n$ with exactly one nonzero digit before the decimal (1.23×10^4 , not 12.3×10^3). Every digit shown in the coefficient is significant.

04 Rounding

CORE RULE

If the first dropped digit is ≥ 5 , round the last kept digit up; cascade the carry (999.6 to 3 sf $\rightarrow 1.00 \times 10^3$).

05 Arithmetic with sig figs

METHOD

Add/subtract: round to the fewest decimal places among inputs. Multiply/divide: round to the fewest sig figs. Exact numbers never limit sig figs.

Multi-step: carry all digits through every step and round only the final result. Early rounding propagates error.

06 Dimensional analysis

METHOD

Multiply by conversion factors equal to 1 with the old unit in the denominator so units cancel. Track every unit through every step.

Squared/cubic units: raise the factor to that power ($1 \text{ m} = 10^2 \text{ cm} \rightarrow 1 \text{ m}^2 = 10^4 \text{ cm}^2$). Compound units ($\text{g/cm}^3 \rightarrow \text{kg/m}^3$): convert top and bottom separately.

07 Common SI base units

REFERENCE

length $\rightarrow \text{m}$ · mass $\rightarrow \text{kg}$ · time $\rightarrow \text{s}$ · temperature $\rightarrow \text{K}$ · amount $\rightarrow \text{mol}$. Liter, m/s, and kg/m^3 are derived units.

08 Temperature

CORE RULE

$\text{K} = ^\circ\text{C} + 273.15$ (273.15 is exact). $^\circ\text{C} = (^\circ\text{F} - 32) \times 5/9$. $^\circ\text{F} = ^\circ\text{C} \times 9/5 + 32$.

09 Common SI prefixes

REFERENCE

Prefix	Symbol	Value
tera	T	10^{12}
giga	G	10^9
mega	M	10^6
kilo	k	10^3
deci	d	10^{-1}
centi	c	10^{-2}
milli	m	10^{-3}
micro	μ	10^{-6}
nano	n	10^{-9}
pico	p	10^{-12}
femto	f	10^{-15}

10 Common conversions

REFERENCE

Exact (defined): $1 \text{ in} = 2.54 \text{ cm}$ · $1 \text{ lb} = 0.45359237 \text{ kg}$ · $1 \text{ mi} = 1609.344 \text{ m}$ · $1 \text{ gal} = 3.785411784 \text{ L}$ · $1 \text{ mL} = 1 \text{ cm}^3$ · $1 \text{ Å} = 10^{-10} \text{ m}$ · $1 \text{ atm} = 101,325 \text{ Pa} = 760 \text{ torr}$ · $1 \text{ cal} = 4.184 \text{ J}$ (thermochemical). Approximate: $1 \text{ atm} \approx 760 \text{ mmHg}$.

11 Density as a conversion

CORE RULE

Density links mass and volume; write it in the orientation that cancels the known unit and leaves the unknown.

12 Watch out

WATCH OUT

You cannot add sig figs a measurement does not have. To show a whole-number result's trailing zeros are significant, use a trailing decimal (300.) or scientific notation.