

JEE Main Physics: Units, Dimensions & Errors

Quick revision notes · Class 11 Physics, Chapter 1 · JEE Main · Physics

1. SI base units

Quantity	SI unit	Symbol
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Amount of substance	mole	mol
Luminous intensity	candela	cd

Common derived units: newton ($N = \text{kg m s}^{-2}$), joule ($J = \text{N m}$), watt ($W = \text{J s}^{-1}$), pascal ($\text{Pa} = \text{N m}^{-2}$), coulomb ($C = \text{A s}$), volt ($V = \text{W A}^{-1}$), ohm ($\Omega = \text{V A}^{-1}$).

2. Dimensional formulas you must know

Quantity	Dimensional formula
Velocity	$[M^0 L T^{-1}]$
Acceleration	$[M^0 L T^{-2}]$
Force	$[M L T^{-2}]$
Momentum, Impulse	$[M L T^{-1}]$
Work, Energy, Torque	$[M L^2 T^{-2}]$
Power	$[M L^2 T^{-3}]$
Pressure, Stress, Young's modulus	$[M L^{-1} T^{-2}]$
Surface tension, Spring constant	$[M T^{-2}]$
Coefficient of viscosity	$[M L^{-1} T^{-1}]$
Gravitational constant G	$[M^{-1} L^3 T^{-2}]$
Planck's constant h, Angular momentum	$[M L^2 T^{-1}]$
Frequency, Angular velocity	$[T^{-1}]$
Strain, Angle, Refractive index	Dimensionless

★ Trick: quantities with the same dimensions (work and torque; impulse and momentum; Planck's constant and angular momentum) are favourite JEE options.

3. Uses and limits of dimensional analysis

- Check whether an equation is dimensionally correct (principle of homogeneity: every term must have the same dimensions).
- Derive a relation when a quantity depends on others as a product of powers, e.g. time period of a pendulum $T \propto \sqrt{l/g}$.
- Convert units: $n_1 u_1 = n_2 u_2$, i.e. $n_2 = n_1 [M_1/M_2]^a [L_1/L_2]^b [T_1/T_2]^c$.
- Limit: cannot find dimensionless constants (like 2π or $1/2$).
- Limit: cannot derive relations that contain sums, differences, trigonometric, logarithmic or exponential terms.

4. Errors in measurement

- Absolute error: $\Delta a_i = |a_{\text{mean}} - a_i|$. Mean absolute error: $\Delta a_{\text{mean}} = (\sum |\Delta a_i|)/n$.
- Relative (fractional) error = $\Delta a_{\text{mean}} / a_{\text{mean}}$. Percentage error = $(\Delta a_{\text{mean}} / a_{\text{mean}}) \times 100$.
- Sum or difference, $Z = A \pm B$: $\Delta Z = \Delta A + \Delta B$ (absolute errors add).
- Product or quotient, $Z = AB$ or A/B : $\Delta Z/Z = \Delta A/A + \Delta B/B$ (relative errors add).
- Power, $Z = A^n$: $\Delta Z/Z = n (\Delta A/A)$. For $Z = A^p B^q / C^r$: $\Delta Z/Z = p \Delta A/A + q \Delta B/B + r \Delta C/C$.

5. Significant figures

- All non-zero digits are significant. Zeros between non-zero digits are significant.
- Leading zeros (0.00ab) are not significant. Trailing zeros after a decimal point are significant (2.500 has 4).
- Addition/subtraction: keep as many decimal places as the number with the fewest decimal places.
- Multiplication/division: keep as many significant figures as the number with the fewest significant figures.

6. Instruments

- Vernier callipers: least count = $1 \text{ MSD} - 1 \text{ VSD}$.
- Screw gauge: least count = pitch / number of circular scale divisions.
- Zero error is subtracted from the reading (corrected reading = observed reading – zero error).

Quick check

Q1. Which pair has the same dimensions: (a) work and power (b) torque and work (c) force and pressure?

Answer: (b) Torque and work, both $[M L^2 T^{-2}]$.

Q2. If the percentage error in the radius of a sphere is 2%, what is the percentage error in its volume?

Answer: $V \propto r^3$, so $3 \times 2\% = 6\%$.

Q3. How many significant figures are in 0.004050?

Answer: Four (4, 0, 5, 0).

Q4. Dimensions of the coefficient of viscosity?

Answer: $[M L^{-1} T^{-1}]$.

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