



NEET — JEE MAINS - ADVANCED

Chapter 1 : Units and Measurement (Notes)

by - Tomar Sir

Notes

GSEB and CBSE Board Exam preparation subjective notes • Class 11 Physics • NCERT Chapter 1

Q.1 What is a unit? Define fundamental units, derived units and a system of units. (2 Marks)

Measurement: Measurement of a physical quantity means comparing it with a basic, arbitrarily chosen, internationally accepted reference standard called a **unit**.

Result of measurement: It is expressed as a number (numerical measure) followed by a unit.

$$\text{Physical quantity} = n \times u$$

where n is the numerical value and u is the unit. For example, length = 5 m.

Fundamental (base) units: The units of the fundamental or base quantities (length, mass, time, etc.). They are independent of each other.

Derived units: The units of all other physical quantities, which can be expressed as combinations of the base units. Example: unit of speed = m s^{-1} , unit of force = kg m s^{-2} .

System of units: A complete set of units, both the base units and the derived units.

Key Examination Points for Full Marks:

- Although the number of physical quantities is very large, we need only a **limited number of units**, because the quantities are inter-related.
- A good unit should be well defined, easily reproducible, unchanging with time and place, and internationally accepted.

Q.2 Name the systems of units used for measurement. What is the SI system?(2 Marks)

In earlier times, scientists of different countries used different systems of units. Three such systems were in use till recently:

System	Length	Mass	Time
CGS	centimetre	gram	second
FPS (British)	foot	pound	second
MKS	metre	kilogram	second

SI system: The system of units at present internationally accepted is the *Système International d'Unités* (French for International System of Units), abbreviated as **SI**.

- It was developed by the **BIPM** (International Bureau of Weights and Measures) in **1971**.



- It was recently revised by the General Conference on Weights and Measures in **November 2018**.
- It is used internationally in scientific, technical, industrial and commercial work.

Advantage: SI units use the **decimal system**, so conversions within the system are simple and convenient.

Q.3 Write the seven SI base quantities with their units and symbols. (3 Marks)

In SI, there are **seven base units**:

Base 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

How they are defined now (2018 revision): Each base unit is defined by fixing the numerical value of a fundamental constant.

- **Metre:** defined using the speed of light in vacuum, $c = 299792458 \text{ m s}^{-1}$.
- **Kilogram:** defined using the Planck constant, $h = 6.62607015 \times 10^{-34} \text{ J s}$.
- **Second:** defined using the caesium-133 hyperfine transition frequency, $\Delta\nu_{Cs} = 9192631770 \text{ Hz}$.
- **Ampere:** defined using the elementary charge, $e = 1.602176634 \times 10^{-19} \text{ C}$.
- **Kelvin:** defined using the Boltzmann constant, $k = 1.380649 \times 10^{-23} \text{ J K}^{-1}$.
- **Mole:** contains exactly $6.02214076 \times 10^{23}$ elementary entities (Avogadro number N_A).
- **Candela:** defined using the luminous efficacy of radiation of frequency $540 \times 10^{12} \text{ Hz}$, $K_{cd} = 683 \text{ lm W}^{-1}$.

Note: These exact values need not be memorised. When the mole is used, the elementary entities (atoms, molecules, ions, electrons, etc.) must be specified.

Q.4 Define plane angle and solid angle. Write their SI units. (2 Marks)

Besides the seven base units, two more units are defined in SI (supplementary units).

Plane angle ($d\theta$): The ratio of the length of the arc ds to the radius r :

$$d\theta = \frac{ds}{r}$$

SI unit: radian (rad).

Solid angle ($d\Omega$): The ratio of the intercepted area dA of the spherical surface, described about the apex O as the centre, to the square of its radius r :

$$d\Omega = \frac{dA}{r^2}$$

SI unit: steradian (sr).

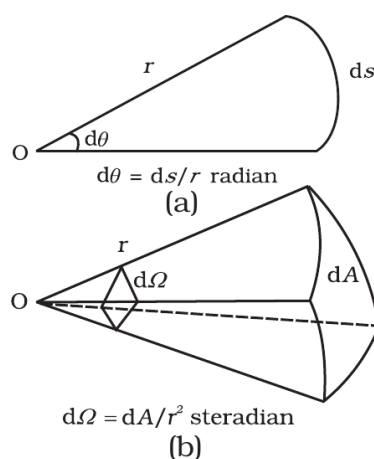


Fig. 1.1: Description of (a) plane angle $d\theta$ and (b) solid angle $d\Omega$

Key Examination Points for Full Marks:

- Both radian and steradian are **dimensionless** quantities (ratio of length/length and area/area).
- Total plane angle around a point = 2π rad; total solid angle around a point = 4π sr.
- $1^\circ = \frac{\pi}{180}$ rad.

Q.5 Name some units outside SI retained for general use.

(2 Marks)

Name	Symbol	Value in SI unit
minute	min	60 s
hour	h	60 min = 3600 s
day	d	24 h = 86400 s
year	y	365.25 d = 3.156×10^7 s
degree	°	$1^\circ = (\pi/180)$ rad
litre	L	$1 \text{ dm}^3 = 10^{-3} \text{ m}^3$
tonne	t	10^3 kg
carat	c	200 mg
bar	bar	$0.1 \text{ MPa} = 10^5 \text{ Pa}$
curie	Ci	$3.7 \times 10^{10} \text{ s}^{-1}$
roentgen	R	$2.58 \times 10^{-4} \text{ C/kg}$
quintal	q	100 kg
barn	b	$100 \text{ fm}^2 = 10^{-28} \text{ m}^2$
are	a	$1 \text{ dam}^2 = 10^2 \text{ m}^2$
hectare	ha	$1 \text{ hm}^2 = 10^4 \text{ m}^2$
standard atmospheric pressure	atm	$101325 \text{ Pa} = 1.013 \times 10^5 \text{ Pa}$

Q.6 What are significant figures? What do they indicate?

(2 Marks)

Definition: Every measurement involves errors. So the result should be reported in a way that indicates its precision. The reported result includes all digits that are known **reliably** plus the **first digit that is uncertain**. These reliable digits plus the first uncertain digit are called **significant digits** or **significant figures**.

Examples:

- Period of a pendulum = 1.62 s: the digits 1 and 6 are reliable, and 2 is uncertain. So it has **three** significant figures.
- Length = 287.5 cm: the digits 2, 8, 7 are certain and 5 is uncertain. So it has **four** significant figures.

Key Examination Points for Full Marks:

- Significant figures indicate the **precision** of a measurement, which depends on the **least count** of the measuring instrument.
- Reporting more digits than the significant digits is superfluous and misleading.
- **A change of units does not change the number of significant figures.** Example: 2.308 cm = 0.02308 m = 23.08 mm = 23080 μm — all have **four** significant figures (2, 3, 0, 8).
- The location of the decimal point does not matter.

Q.7 State the rules for determining the number of significant figures.(3 Marks)

1. **All the non-zero digits are significant.**
2. **All the zeros between two non-zero digits are significant**, no matter where the decimal point is, if at all.
3. **If the number is less than 1, the zero(s) on the right of the decimal point but to the left of the first non-zero digit are not significant.** In 0.002308, the first two zeros after the decimal point are not significant.
4. **The terminal or trailing zero(s) in a number without a decimal point are not significant.** Thus 123 m = 12300 cm = 123000 mm has **three** significant figures.
5. **The trailing zero(s) in a number with a decimal point are significant.** The numbers 3.500 and 0.06900 have **four** significant figures each.
6. **The zero conventionally put on the left of a decimal** for a number less than 1 (like 0.1250) is **never significant**. But the zeros at the end of such a number are significant.
7. **Exact numbers** (factors that are neither rounded nor measured), like 2 in $r = d/2$ or $s = 2\pi r$, and n in $T = t/n$, have an **infinite** number of significant figures.

Number	Significant figures	Reason
0.007 m ²	1	Leading zeros not significant
2.64×10^{24} kg	3	Power of 10 is irrelevant
0.2370 g cm ⁻³	4	Trailing zero after decimal counts
6.320 J	4	Trailing zero after decimal counts
6.032 N m ⁻²	4	Zero between non-zero digits counts
0.0006032 m ²	4	Leading zeros not significant

(These are NCERT Exercise 1.10.)

Q.8 Why is scientific notation used for reporting measurements? Define order of magnitude. (2 Marks)

The confusion with trailing zeros: A length reported as 4.700 m has four significant figures (the zeros show precision). Changing units, $4.700 \text{ m} = 470.0 \text{ cm} = 4700 \text{ mm} = 0.004700 \text{ km}$. In 4700 mm (no decimal), the trailing zeros would wrongly appear non-significant, giving two significant figures. But a mere change of units cannot change the number of significant figures.

Solution — scientific notation: Report every measurement in powers of 10:

$$a \times 10^b, \quad 1 \leq a < 10$$

where b is any positive or negative integer. Then

$$4.700 \text{ m} = 4.700 \times 10^2 \text{ cm} = 4.700 \times 10^3 \text{ mm} = 4.700 \times 10^{-3} \text{ km}$$

All have **four** significant figures. The power of 10 is irrelevant, and all zeros in the base number a are significant.

Order of magnitude: Round a to 1 (for $a \leq 5$) or to 10 (for $5 < a \leq 10$). The number becomes approximately 10^b , and the exponent b is called the **order of magnitude**.

Examples:

- Diameter of the earth = $1.28 \times 10^7 \text{ m}$ — order of magnitude **7**.
- Diameter of a hydrogen atom = $1.06 \times 10^{-10} \text{ m}$ — order of magnitude **-10**.

So the earth's diameter is **17 orders of magnitude** larger than the hydrogen atom.

Q.9 State the rules for arithmetic operations with significant figures.(3 Marks)

The result of a calculation with measured values cannot be more accurate than the original measured values. So the result should not have more significant figures than the original data.

Rule 1 — Multiplication or division: The final result should retain as many **significant figures** as are there in the original number with the **least** significant figures.

- Mass = 4.237 g (4 s.f.), volume = 2.51 cm^3 (3 s.f.):

$$\text{Density} = \frac{4.237 \text{ g}}{2.51 \text{ cm}^3} = 1.6880478... \approx 1.69 \text{ g cm}^{-3}$$

- Speed of light = $3.00 \times 10^8 \text{ m s}^{-1}$ (3 s.f.), 1 year = $3.1557 \times 10^7 \text{ s}$ (5 s.f.). So the light year = $9.47 \times 10^{15} \text{ m}$ (3 s.f.).

Rule 2 — Addition or subtraction: The final result should retain as many **decimal places** as are there in the number with the **least** decimal places.

- $436.32 \text{ g} + 227.2 \text{ g} + 0.301 \text{ g} = 663.821 \text{ g}$. The least precise value (227.2 g) has one decimal place, so the result is **663.8 g**.
- $0.307 \text{ m} - 0.304 \text{ m} = 0.003 \text{ m} = 3 \times 10^{-3} \text{ m}$.

Note: Do not apply rule 1 to addition and subtraction (writing 664 g or $3.00 \times 10^{-3} \text{ m}$ is wrong).

Illustration (NCERT Example 1.1): Each side of a cube = 7.203 m (4 s.f.).

$$\text{Surface area} = 6(7.203)^2 = 311.299254 \text{ m}^2 \approx 311.3 \text{ m}^2$$

$$\text{Volume} = (7.203)^3 = 373.714754 \text{ m}^3 \approx 373.7 \text{ m}^3$$

Illustration (NCERT Example 1.2): 5.74 g of a substance occupies 1.2 cm^3 . The volume has only 2 significant figures, so

$$\text{Density} = \frac{5.74}{1.2} = 4.8 \text{ g cm}^{-3}$$

Q.10 State the rules for rounding off the uncertain digits. (2 Marks)

The result of a computation with approximate numbers, which contains more than one uncertain digit, should be **rounded off**.

Rules:

1. If the insignificant digit to be dropped is **more than 5**, the preceding digit is **raised by 1**. Example: $2.746 \rightarrow 2.75$ (three s.f.).
2. If the insignificant digit to be dropped is **less than 5**, the preceding digit is **left unchanged**. Example: $1.743 \rightarrow 1.74$.
3. If the insignificant digit is **exactly 5**:
 - if the preceding digit is **even**, the 5 is simply dropped: $2.745 \rightarrow 2.74$;
 - if the preceding digit is **odd**, it is raised by 1: $2.735 \rightarrow 2.74$.

Key Examination Points for Full Marks:

- In multi-step calculations, retain **one digit more** than the significant digits in intermediate steps, and round off only at the end.
- Example: $1/9.58 = 0.104$ (3 s.f.), but $1/0.104 = 9.62$, not 9.58. If we keep $1/9.58 = 0.1044$, then $1/0.1044 = 9.58$. Keeping the extra digit avoids rounding errors.
- Exact numbers like 2π in $T = 2\pi\sqrt{L/g}$ have infinite significant figures. π can be taken as 3.142 or 3.14 as required.

Q.11 Explain the rules for determining the uncertainty in the results of arithmetic calculations. (3 Marks)

(1) Error in a product: The length and breadth of a thin rectangular sheet are measured with a metre scale as 16.2 cm and 10.1 cm (three s.f. each).

$$l = 16.2 \pm 0.1 \text{ cm} = 16.2 \text{ cm} \pm 0.6\%$$

$$b = 10.1 \pm 0.1 \text{ cm} = 10.1 \text{ cm} \pm 1\%$$

For a product, the **percentage errors add**:

$$lb = 163.62 \text{ cm}^2 \pm 1.6\% = 163.62 \pm 2.6 \text{ cm}^2$$

The final result is quoted as $lb = 164 \pm 3 \text{ cm}^2$. Here 3 cm^2 is the uncertainty in the area.

(2) Combining data: If a set of experimental data is specified to n significant figures, a result obtained by combining the data will also be valid to n significant figures. But **in subtraction the number of significant figures can be reduced**. Example: $12.9 \text{ g} - 7.06 \text{ g} = 5.84 \text{ g}$ should be reported only as **5.8 g**.

(3) Relative error depends on the number too: The relative error depends not only on n but also on the number itself.

$$\text{For } 1.02 \text{ g} \pm 0.01 \text{ g: } \frac{0.01}{1.02} \times 100\% \approx \pm 1\%$$

$$\text{For } 9.89 \text{ g} \pm 0.01 \text{ g: } \frac{0.01}{9.89} \times 100\% \approx \pm 0.1\%$$

(4) Intermediate results: In a multi-step computation, intermediate results should be calculated to **one more significant figure** than the least precise measurement, otherwise rounding errors build up.

Q.12 What are the dimensions of a physical quantity? Define dimensional formula and dimensional equation. (2 Marks)

Dimensions: All physical quantities can be expressed in terms of seven base quantities, called the seven **dimensions** of the physical world: length [L], mass [M], time [T], electric current [A], thermodynamic temperature [K], luminous intensity [cd] and amount of substance [mol].

The dimensions of a physical quantity are the powers (exponents) to which the base quantities are raised to represent that quantity.

Example: Force = mass $\times$ acceleration = mass $\times$ (length)/(time)²

$$[F] = [M][L]/[T]^2 = [M L T^{-2}]$$

So force has dimension 1 in mass, 1 in length and -2 in time.

Dimensional formula: The expression that shows how and which base quantities represent the dimensions of a physical quantity. Examples: volume $[M^0 L^3 T^0]$, velocity $[M^0 L T^{-1}]$, acceleration $[M^0 L T^{-2}]$, density $[M L^{-3} T^0]$.

Dimensional equation: An equation obtained by equating a physical quantity with its dimensional formula:

$$[V] = [M^0 L^3 T^0], \quad [v] = [M^0 L T^{-1}], \quad [F] = [M L T^{-2}], \quad [\rho] = [M L^{-3} T^0]$$

Key Examination Points for Full Marks:

- Square brackets [] around a quantity mean “the dimensions of” the quantity.
- **Magnitudes are not considered** — only the type of quantity. Change in velocity, initial velocity, final velocity and speed all have dimensions $[L T^{-1}]$.

Q.13 State the principle of homogeneity of dimensions. Check the dimensional consistency of $x = x_0 + v_0 t + \frac{1}{2}at^2$. (3 Marks)

Principle of homogeneity of dimensions: Physical quantities can be added or subtracted only if they have the **same dimensions**. In a correct equation, **every term on both sides must have the same dimensions**.

For example, velocity cannot be added to force, and electric current cannot be subtracted from temperature.

Checking $x = x_0 + v_0 t + \frac{1}{2}at^2$:

$$[x] = [L]$$

$$[x_0] = [L]$$

$$[v_0 t] = [L T^{-1}][T] = [L]$$

$$[1/2 at^2] = [L T^{-2}][T^2] = [L]$$

Every term has the dimension of length. Hence the equation is **dimensionally correct**.

Illustration (NCERT Example 1.3): Check $\frac{1}{2}mv^2 = mgh$.

$$\text{LHS: } [M][L T^{-1}]^2 = [M L^2 T^{-2}], \quad \text{RHS: } [M][L T^{-2}][L] = [M L^2 T^{-2}]$$

LHS and RHS have the same dimensions, so the equation is dimensionally correct.

Key Examination Points for Full Marks:

- **If an equation fails the consistency test, it is proved wrong. If it passes, it is not proved right.** A dimensionally correct equation need not be exact, but a dimensionally wrong equation must be wrong.



- The test of dimensions is the same as a test of units, but it does not depend on any particular choice of units.

Q.14 Write the uses and limitations of dimensional analysis. (2 Marks)

Uses:

- To **check the dimensional consistency** (correctness) of an equation.
- To **deduce relations** among physical quantities.
- To **convert** a physical quantity from one system of units to another.

Illustration (NCERT Example 1.4): Which formula for kinetic energy K can be ruled out? (a) $K = m^2 v^3$, (b) $K = \frac{1}{2} m v^2$, (c) $K = m a$, (d) $K = \frac{3}{16} m v^2$, (e) $K = \frac{1}{2} m v^2 + m a$.

$[K] = [M L^2 T^{-2}]$. The right sides give $[M^2 L^3 T^{-3}]$ for (a), $[M L^2 T^{-2}]$ for (b) and (d), and $[M L T^{-2}]$ for (c). In (e) two quantities of different dimensions are added. So **(a), (c) and (e) are ruled out**. Dimensions cannot decide between (b) and (d); the correct formula (b) comes from the definition of kinetic energy.

Limitations:

- Dimensionless constants** (like $\frac{1}{2}$, 2π) cannot be found.
- It cannot **distinguish** between quantities having the same dimensions (e.g. work and torque).
- It cannot derive relations involving **trigonometric, logarithmic or exponential** functions, or sums of terms.
- It cannot be used if a quantity depends on **more than three** quantities (in mechanics).
- It can only test dimensional validity, not the exact relation.

Note: The arguments of trigonometric, logarithmic and exponential functions must be **dimensionless**. Pure numbers, ratios of similar quantities (angle, refractive index) have no dimensions.

Q.15 Derive the expression for the time period of a simple pendulum using the method of dimensions. (3 Marks)

Assumption: The time period T of a simple pendulum depends on the length l , the mass of the bob m and the acceleration due to gravity g . Write it as a product:

$$T = k l^x g^y m^z$$

where k is a dimensionless constant and x, y, z are exponents.

Dimensions on both sides:

$$[L^0 M^0 T^1] = [L]^x [L T^{-2}]^y [M]^z = [L^{x+y} T^{-2y} M^z]$$

Equating powers:

$$\begin{aligned} x + y &= 0, & -2y &= 1, & z &= 0 \\ \Rightarrow x &= -\frac{1}{2}, & y &= -\frac{1}{2}, & z &= 0 \end{aligned}$$

So $T = k l^{1/2} g^{-1/2}$, i.e.

$$T = k \sqrt{\frac{l}{g}}$$

The value of k cannot be found by dimensions. Actually $k = 2\pi$, so

$$T = 2\pi \sqrt{\frac{l}{g}}$$

Result: The time period is **independent of the mass** of the bob ($z = 0$).

Q.16 Show that a calorie has a magnitude $4.2 \alpha^{-1} \beta^{-2} \gamma^2$ in a system where the units of mass, length and time are α kg, β m and γ s. (3 Marks)

Principle of conversion: The magnitude of a physical quantity stays the same in any system:

$$n_1 u_1 = n_2 u_2$$

If the dimensional formula is $[M^a L^b T^c]$, then

$$n_2 = n_1 \left[\frac{M_1}{M_2} \right]^a \left[\frac{L_1}{L_2} \right]^b \left[\frac{T_1}{T_2} \right]^c$$

Solution (NCERT Exercise 1.3): 1 calorie = 4.2 J = 4.2 kg m²s⁻². Energy has dimensions $[M L^2 T^{-2}]$, so $a = 1, b = 2, c = -2$.

$n_1 = 4.2, M_1 = 1 \text{ kg}, L_1 = 1 \text{ m}, T_1 = 1 \text{ s}$; and $M_2 = \alpha \text{ kg}, L_2 = \beta \text{ m}, T_2 = \gamma \text{ s}$.

$$n_2 = 4.2 \left[\frac{1}{\alpha} \right]^1 \left[\frac{1}{\beta} \right]^2 \left[\frac{1}{\gamma} \right]^{-2}$$

$$n_2 = 4.2 \alpha^{-1} \beta^{-2} \gamma^2$$

Illustration (NCERT Exercise 1.2 (d)): Convert $G = 6.67 \times 10^{-11} \text{ N m}^2 \text{kg}^{-2}$ to CGS. $[G] = [M^{-1} L^3 T^{-2}]$.

$$n_2 = 6.67 \times 10^{-11} \left[\frac{1000 \text{ g}}{1 \text{ kg}} \right]^{-1} \left[\frac{100 \text{ cm}}{1 \text{ m}} \right]^3 = 6.67 \times 10^{-11} \times 10^{-3} \times 10^6 = 6.67 \times 10^{-8}$$

So $G = 6.67 \times 10^{-8} \text{ cm}^3 \text{s}^{-2} \text{g}^{-1}$. Similarly, $1 \text{ J} = 10^7 \text{ erg}$.

Formula Sheet — Dimensional Formulae

Quantity	Dimensional formula	SI Unit
Velocity, speed	$[M^0 L T^{-1}]$	m s ⁻¹
Acceleration	$[M^0 L T^{-2}]$	m s ⁻²
Force, weight	$[M L T^{-2}]$	N
Momentum, impulse	$[M L T^{-1}]$	kg m s ⁻¹
Work, energy, torque	$[M L^2 T^{-2}]$	J
Power	$[M L^2 T^{-3}]$	W
Pressure, stress, Young's modulus	$[M L^{-1} T^{-2}]$	Pa
Density	$[M L^{-3}]$	kg m ⁻³
Frequency, angular velocity	$[T^{-1}]$	Hz, rad s ⁻¹
Gravitational constant G	$[M^{-1} L^3 T^{-2}]$	N m ² kg ⁻²
Planck constant, angular momentum	$[M L^2 T^{-1}]$	J s



Quantity	Dimensional formula	SI Unit
Surface tension, spring constant	$[M T^{-2}]$	$N m^{-1}$
Coefficient of viscosity	$[M L^{-1} T^{-1}]$	Pa s
Electric charge	$[A T]$	C
Plane angle, strain, refractive index	Dimensionless	rad / —

Key relations: Physical quantity = nu ; conversion $n_2 = n_1 [M_1/M_2]^a [L_1/L_2]^b [T_1/T_2]^c$; plane angle $d\theta = ds/r$; solid angle $d\Omega = dA/r^2$; percentage error = $\frac{\Delta a}{a} \times 100\%$.

Conversions: $1 \text{ \AA} = 10^{-10} \text{ m}$; $1 \text{ fermi} = 10^{-15} \text{ m}$; $1 \text{ light year} = 9.46 \times 10^{15} \text{ m}$; $1 \text{ AU} = 1.496 \times 10^{11} \text{ m}$; $1 \text{ parsec} = 3.08 \times 10^{16} \text{ m}$; $1 \text{ J} = 10^7 \text{ erg}$; $1 \text{ N} = 10^5 \text{ dyne}$

Prefixes: pico (10^{-12}), nano (10^{-9}), micro (10^{-6}), milli (10^{-3}), centi (10^{-2}), kilo (10^3), mega (10^6), giga (10^9), tera (10^{12})

NEET / JEE Quick Points and Tricks

- Same dimensions, different quantities:** work, energy and torque; momentum and impulse; Planck constant and angular momentum; pressure, stress and Young's modulus; surface tension and spring constant; frequency and angular velocity. These are favourite "match the pair" questions.
- Bigger unit → smaller number:** Since $n_1 u_1 = n_2 u_2$, $n \propto 1/u$.
- Constants in equations:** In $x = at + bt^2$, each term has dimension $[L]$, so $[a] = [L T^{-1}]$ and $[b] = [L T^{-2}]$.
- Arguments of sin, cos, log, exp are dimensionless:** In $y = A \sin(\omega t - kx)$, $[\omega] = [T^{-1}]$ and $[k] = [L^{-1}]$. In $P = P_0 e^{-\alpha t^2}$, $[\alpha] = [T^{-2}]$.
- Dimensionless but with a unit:** Angle has the unit radian but no dimensions. Strain, refractive index and relative density have neither.
- Dimensional constants:** G, h, c have dimensions. Pure numbers ($2\pi, \frac{1}{2}$) have none.
- Count significant figures fast:** $0.0060 \rightarrow 2$; $6.0 \times 10^3 \rightarrow 2$; $6000 \rightarrow 1$ (no decimal); $6000. \rightarrow 4$ (with decimal).
- Rounding with 5:** Drop the 5 if the preceding digit is even ($2.745 \rightarrow 2.74$); raise it if odd ($2.735 \rightarrow 2.74$).
- Add/subtract → decimal places; multiply/divide → significant figures.** This is the most common trap.
- Errors (for numericals):** For $Z = A \pm B$, $\Delta Z = \Delta A + \Delta B$ (absolute errors add). For $Z = \frac{A^p B^q}{C^r}$, $\frac{\Delta Z}{Z} = p \frac{\Delta A}{A} + q \frac{\Delta B}{B} + r \frac{\Delta C}{C}$ (relative errors always add).
- Pendulum error:** From $g = 4\pi^2 l / T^2$, $\frac{\Delta g}{g} = \frac{\Delta l}{l} + 2 \frac{\Delta T}{T}$. The quantity with the highest power contributes most to the error.
- Dimensional method works only for products:** It fails for sums like $s = ut + \frac{1}{2}at^2$ and for more than three variables.
- Making new units:** If c, h and G are taken as base units, express length, mass and time by equating powers, exactly as in Q.15.
- Order of magnitude (NCERT rule):** Round $a \leq 5$ to 1 and $5 < a \leq 10$ to 10. So $1.28 \times 10^7 \text{ m} \rightarrow 10^7 \text{ m}$, and $7 \times 10^{-3} \rightarrow 10^{-2}$.