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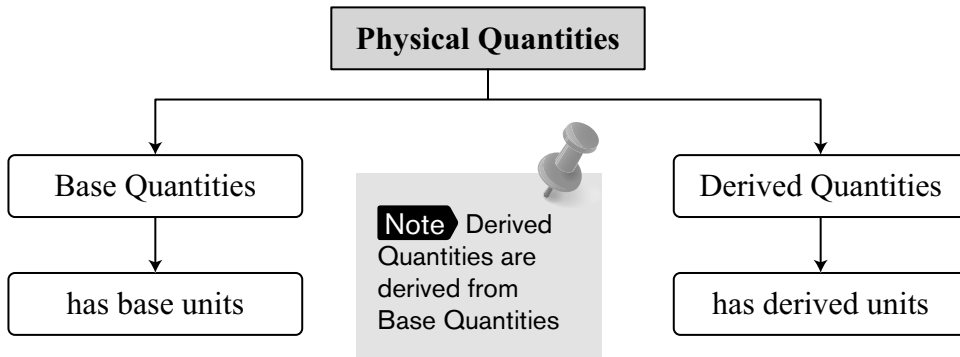
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Data

speed of light in free space	$c = 3.00 \times 10^8 \text{ m s}^{-1}$
permeability of free space	$\mu_0 = 4\pi \times 10^{-7} \text{ H m}^{-1}$
permittivity of free space	$\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$
elementary charge	$e = 1.60 \times 10^{-19} \text{ C}$
the Planck constant	$h = 6.63 \times 10^{-34} \text{ Js}$
unified atomic mass constant	$u = 1.66 \times 10^{-27} \text{ kg}$
rest mass of electron	$m_e = 9.11 \times 10^{-31} \text{ kg}$
rest mass of proton	$m_p = 1.67 \times 10^{-27} \text{ kg}$
molar gas constant	$R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$
the Avogadro constant	$N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$
the Boltzmann constant	$k = 1.38 \times 10^{-23} \text{ J K}^{-1}$
gravitational constant	$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$
acceleration of free fall	$g = 9.81 \text{ m s}^{-2}$

Physical Quantities

- › Properties that can be measured / calculated.
- › Can be expressed in numbers / values.
- › Derived from the word “physics”. So basically, they are quantities in physics.



Base Quantities (Fundamental Quantities) and Base Units

- › Base quantities are physical quantities that are most fundamental
- › Independent of other quantities.
- › Do not vary with time
- › Accessible
- › Accurately reproducible
- › There are 7 base quantities
- › Base Units are units of base quantities

Base Quantity	Symbol	SI Units	Base Unit / Symbol for Units
Mass	m	metre	kg
Length	l	kilogram	m
Time	t	second	s
Current	I	ampere	A
Temperature	T	Kelvin	K
Amount of Substance	η	mole	mol
Luminous Intensity	L	candela	cd

Think Activity!

- Q:** Do we use meter or metre to denote length?
A: We use metre. Meter is an equipment.

Prefix

- › Prefixes are attached to a unit when dealing with very large or very small numbers.
- › They usually accompany standard forms learnt in lower secondary.

Practical Applications

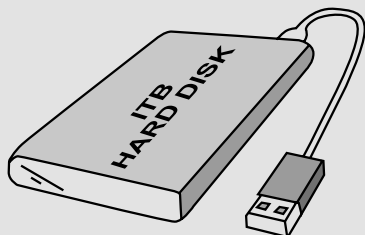
Q: Why do we use prefixes?

A: It is easier to use prefixes rather than standard forms.

Power	Prefix	Symbol
10^{-12}	pico	p
10^{-9}	nano	n
10^{-6}	micro	μ
10^{-3}	milli	m
10^{-2}	centi	c
10^{-1}	deci	d
10^3	kilo	k
10^6	Mega	M
10^9	Giga	G
10^{12}	Tera	T

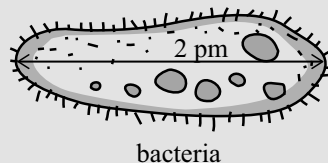
Practical Applications

It is easier to say that a hard disk has a capacity of 1T bytes than 1×10^{12} bytes



Practical Applications

We usually say the bacteria has a diameter of 2 picometre, i.e. 2 μm , instead of 2×10^{-12} m.



Example

Q: An object has length (5.00 ± 0.01) m, breadth (2.10 ± 0.01) m, depth (1.90 ± 0.01) m. Calculate the volume of the object.

A: Step 1: Calculate the volume of the object using the actual values.

$$V = 5.00 \times 2.10 \times 1.90 = 19.95 \text{ m}^3$$

Step 2: Calculate the uncertainty ΔV using the equations above.

$$V = l \times b \times h$$

$$\frac{\Delta V}{V} = \frac{\Delta l}{l} + \frac{\Delta b}{b} + \frac{\Delta h}{h} = \left(\frac{0.01}{5} + \frac{0.01}{2.10} + \frac{0.01}{1.90} \right)$$

$$\begin{aligned} \text{So } \Delta V &= \left(\frac{0.01}{5.00} + \frac{0.01}{2.10} + \frac{0.01}{1.90} \right) \times V \\ &= (0.012025)(19.95) \\ &= 0.2399 \\ &= 0.2 \text{ (1 sf)} \end{aligned}$$

Step 3: Present it correctly

$$\begin{aligned} &(19.95 \pm 0.2) \text{ m}^3 \\ &= (20.0 \pm 0.2) \text{ m}^3 \end{aligned}$$

Note

- If a question asks to find fractional uncertainty, then calculate $\frac{\Delta V}{V}$.
- If a question asks to find percentage uncertainty, then multiply the fractional uncertainty by 100%, i.e. $\frac{\Delta V}{V} \times 100\%$.

EXAM TIPS

Q: Let diameter of circle = d and radius of circle = r .

$$\text{If } d = 2r, \frac{\Delta d}{d} = \frac{\Delta r}{r} \dots\dots\dots (1)$$

$$\text{If } d = r + r, \Delta d = \Delta r + \Delta r. \text{ Hence } \Delta d = 2\Delta r \dots\dots\dots (2)$$

Which is correct?

A: Both

Equation (1) shows that the relationship between the ratios.

Equation (2) shows the direct relationship between Δd and Δr .

Always remember: $\Delta d = 2\Delta r$