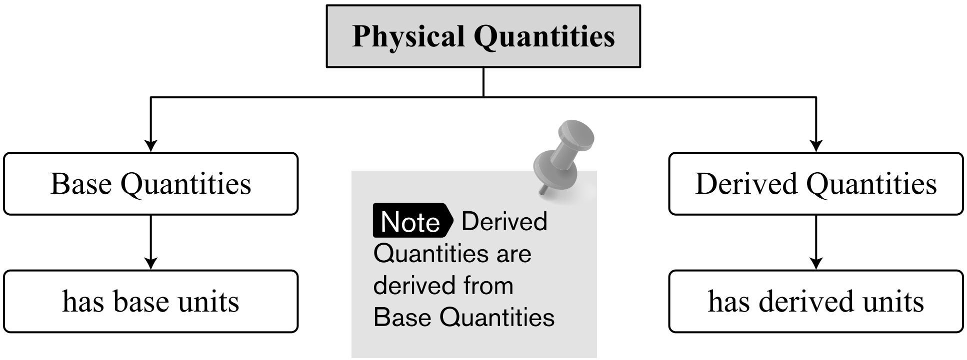
# Contents

**Data**

| | |
|---|---|
| speed of light in free space | $c = 3.00 \times 10^{8}\ \mathrm{m\,s^{-1}}$ |
| permeability of free space | $\mu_0 = 4\pi \times 10^{-7}\ \mathrm{H\,m^{-1}}$ |
| permittivity of free space | $\varepsilon_0 = 8.85 \times 10^{-12}\ \mathrm{F\,m^{-1}}$ |
| elementary charge | $e = 1.60 \times 10^{-19}\ \mathrm{C}$ |
| the Planck constant | $h = 6.63 \times 10^{-34}\ \mathrm{J\,s}$ |
| unified atomic mass constant | $u = 1.66 \times 10^{-27}\ \mathrm{kg}$ |
| rest mass of electron | $m_e = 9.11 \times 10^{-31}\ \mathrm{kg}$ |
| rest mass of proton | $m_p = 1.67 \times 10^{-27}\ \mathrm{kg}$ |
| molar gas constant | $R = 8.31\ \mathrm{J\,K^{-1}\,mol^{-1}}$ |
| the Avogadro constant | $N_A = 6.02 \times 10^{23}\ \mathrm{mol^{-1}}$ |
| the Boltzmann constant | $k = 1.38 \times 10^{-23}\ \mathrm{J\,K^{-1}}$ |
| gravitational constant | $G = 6.67 \times 10^{-11}\ \mathrm{N\,m^{2}\,kg^{-2}}$ |
| acceleration of free fall | $g = 9.81\ \mathrm{m\,s^{-2}}$ |

## 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 | $\ell$ | 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.

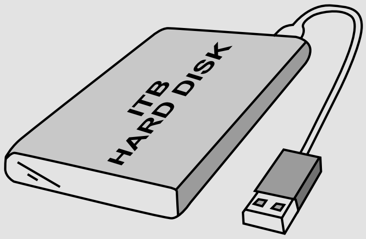
**Practical Applications**

**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 |

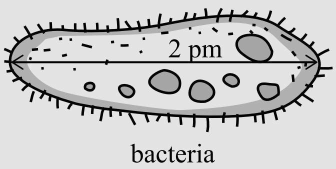
**Practical Applications**

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




**Practical Applications**

We usually say the bacteria has a diameter of 2 picometre, i.e. 2 pm, instead of $2 \times 10^{-12}$ 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.

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

***Step 2***: Calculate the uncertainty $\Delta V$ using the equations above.

$V = l \times b \times h$

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

$$\text{So } \Delta V = \left(\frac{0.01}{5.00} + \frac{0.01}{2.10} + \frac{0.01}{1.90}\right) \times V$$

$= (0.012025)(19.95)$

$= 0.2399$

$= 0.2$ (1 sf)

***Step 3***: Present it correctly

$(19.95 \pm 0.2)\ m^3$

$= (20.0 \pm 0.2)\ m^3$

**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.*

*If d = 2r,* $\frac{\Delta d}{d} = \frac{\Delta r}{r}$ ........................................ *(1)*

*If d = r + r, Δd = Δr + Δr. Hence Δd = 2Δr* ........................................ *(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: Δd = 2Δr*