

PHY40-Lesson1
Units and Dimensions

1. Identify Basic and Derived physical quantities.
2. Introduce the units of certain physical quantities.
3. Introduce Prefixes and ways of conversion.
4. Identify Dimensional Analysis.

Physics is the study of Nature, Matter, and Energy.

To start with physics we have to know what we call by Physical Quantities

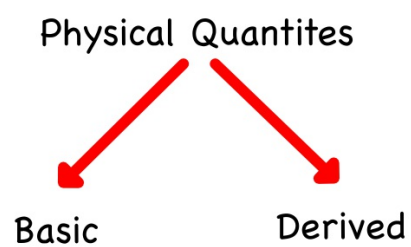


Table 1 SI Base Units		
Base Quantity	Base Unit	Symbol
Length	meter	m
Mass	kilogram	kg
Time	second	s
Temperature	kelvin	K
Amount of a substance	mole	mol
Electric current	ampere	A
Luminous intensity	candela	cd

Examples;

The length of a football field is 120 m.

magnitude or value

The physics book has a mass of 1 kg.

The electric current flowing into the house is around 2 A.

Derived quantities are derived from basic quantities through combining them in different ways such as by multiplying and dividing.

Some examples on derived units are

Derived Quantity	Unit
Velocity $\frac{\text{Length}}{\text{Time}}$	m/s
Area $\text{Length} \times \text{Length}$	m^2 $[\text{m} \times \text{m}]$
Volume	m^3
Density	Kg/m^3
Force	$\text{Kg} \times \text{m/s}^2$ or N (Newton)
Acceleration	m/s^2
Pressure	N/m^2
Energy	J (Joules)
Power	J/s or Watt

$$10^1 = 10$$

$$10^{-1} = 0.1$$

$$10^2 = 100$$

$$10^{-2} = 0.01$$

$$10^3 = 1000$$

$$10^{-3} = 0.001$$

$$10^4 = 10000$$

$$10^{-4} = 0.0001$$

$$10^5 = 100000$$

$$10^{-5} = 0.00001$$

$$1) 0.05 \times 10 = 0.5$$

$$2) 0.05 \times 10^2 = 5$$

$$3) 0.05 \times 10^3 = 50$$

$$0.05000$$

$$4) 500 \times 10^{-1} = 50$$

$$5) 500 \times 10^{-2} = 5$$

$$6) 500 \times 10^{-3} = 0.5$$

Prefixes

small

$\times 10^{-6}$

$\times 10^{-1}$

$\times 10^{-3}$

Large

pico-	p	0.000000000001	10^{-12}	picometer (pm)
nano-	n	0.000000001	10^{-9}	nanometer (nm)
micro-	μ	0.000001	10^{-6}	microgram (μ g)
milli-	m	0.001	10^{-3}	milliamps (mA)
centi-	c	0.01	10^{-2}	centimeter (cm)
deci-	d	0.1	10^{-1}	deciliter (dL)
kilo-	k	1000	10^3	kilometer (km)
mega-	M	1,000,000	10^6	megagram (Mg)
giga-	G	1,000,000,000	10^9	gigameter (Gm)

$\times 10^6$

$\times 10^1$

$\times 10^3$

Convert

$$0.02 \text{ kg to g} = 0.02 \times 10^3 \text{ g} = 20 \text{ g}$$

$$3000 \text{ ms to s} = 3000 \times 10^{-3} \text{ s} = 3 \text{ s}$$

$$1400 \text{ M-bytes to G-bytes} = 1400 \times 10^{-3} \text{ G-bytes} = 1.4 \text{ G-bytes}$$

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The length of a football field is 120 ^m
unit

The height of khalid is 167 ^{cm}
prefix unit

The distance from Abu Dhabi to Al ain is 150 ^{km}
prefix unit

Convert

$$1) \ 0.05 \text{ kg to g} = 0.05 \times 10^3 = 50 \text{ g}$$

$$2) \ 120 \text{ mm to cm} = 120 \times 10^{-1} \text{ cm} = 12 \text{ cm}$$

$$3) \ 300 \text{ mg to g} = 300 \times 10^{-3} = 0.3 \text{ g}$$

$$4) \ 0.05 \text{ s to ms} = 0.05 \times 10^3 \text{ ms} = 50 \text{ ms}$$

Dimensional Analysis

Physics is described by equations such as

$$\text{Force} = \text{mass} \times \text{acceleration}$$

$$\text{momentum} = \text{mass} \times \text{velocity}$$

$$\text{velocity} = \text{displacement} / \text{time}$$

Both sides of the equation should have the same unit. This is what we call by Dimensional Analysis.

Check whether the following formulas are dimensionally consistent?

$d = \text{distance } [m]$ $v = \text{velocity } [\frac{m}{s}]$ $t = \text{time } [s]$

$$d = v \times t$$
$$[m] = [\frac{m}{s}] \times [s]$$

$$[m] = [m]$$

Dimensionally consistent

$$d = \frac{1}{2} a \times t^2$$

$$[m] = [\frac{m}{s^2}] \times [s^2]$$

$$[m] = [m]$$

Dimensionally consistent

$$F = m \times v$$

$$a = \text{acceleration } [\frac{m}{s^2}]$$

$$F = \text{Force } [\frac{kg \cdot m}{s^2}]$$

$$v_f = a \times t + v_i$$