PHY40-Lesson1

*Units and Dimensions*

1. Identiy Basic and Derived physical quantities.

2. Introduce the units of certain physical quantites.

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

Physical Quantites

Basic

Derived

**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 |

magnitude or value

Examples;

The length of a football field is 120 m.

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 multipliying and dividing.

Some examples on derived units are

| ***Derived Quantity*** | ***Unit*** |
|---|---|
| Velocity $\frac{Length}{time}$ | [m/s] |
| Area Length x Length | [$m^2$] [m x m] |
| Volume | $m^3$ |
| Density | $Kg/m^3$ |
| Force | $Kg \times m/s^2$ 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

| | | | | |
|---|---|---|---|---|
| pico– | p | 0.000000000001 | $10^{-12}$ | picometer (pm) |
| nano– | n | 0.000000001 | $10^{-9}$ | nanometer (nm) |
| micro– | $\mu$ | 0.000001 | $10^{-6}$ | microgram ($\mu$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) |

pico → micro: $\times 10^{-6}$; micro → pico: $\times 10^{6}$

milli → centi: $\times 10^{-1}$; centi → milli: $\times 10^{1}$

mega → giga: $\times 10^{-3}$; giga → mega: $\times 10^{3}$

Large

Convert

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

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

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

*The length of a football field is 120 m*

unit

*The height of khalid is 167 cm*

prefix unit

*The distance from AbuDhabi to Al ain is 150 km*

prefix unit

## Convert

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

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

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

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

## Dimensional Analysis

Physics is described by equations such as

Force = mass x acceleration

momentum = mass x velocity

velocity = displacement / time

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

*Check whether the folowing formulas are dimensionally consistent?*

d = distance [m]  v = velocity [m/s]  t = time [s]

a = acceleration [m/s²]

F = Force [kg·m/s²]

$$d = v \times t$$

[m] = [m/s] × [s]

[m] = [m]

Dimensionally consistent

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

[m] = [m/s²] × [s²]

[m] = [m]

Dimensionally consistent

$$F = m \times v$$

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