PHYSICS

Measurements Outline:

I. Basic Quantities
II. Derived Quantities
III. Units of Measurement
IV. Conversion of Units
  a. Dimensional Analysis
V. Significant Digits
VI. Test Yourself

Basic Quantities

What is Measurement?

- the action of measuring something.
- the size, length, or amount of something, as established by measuring.
- a unit or system of measuring.

Basic Quantities

- They are physical quantities that cannot be defined in terms of other quantities

Basic Quantity	Example of Units
Length (l)	m, cm, in, ft, mi
Mass (s)	g, kg, lb, ton, amu
Time (t)	s, min, h, day, year

(**Table 1.1 Basic Quantities**)

Physical Quantities

- any number that is used to describe a physical phenomenon.

Derived Quantities

What are derived quantities?

- They are obtained by combining basic quantities.
- Basic examples are volume and density.

Volume

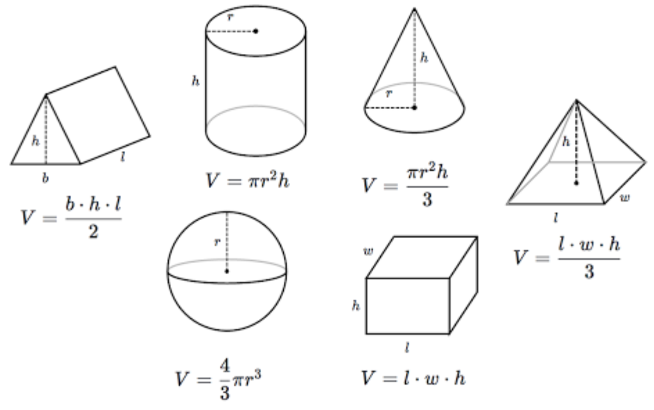
- Amount of space an object takes up
- Expressed in cubic units (m^3 , cm^3, in^3, etc.)
- Depends on the shape of the object.
- Example below is the volume of a cube where a is equal to the sides.

$$\boxed{V = a^3}$$

Density

- A substance's mass (m) per unit volume (V)
- SI Unit: kilogram per cubic meter (kg/m^3)

$$\boxed{\rho = \frac{m}{V}}$$



(**Figure 1.1 Volume of other solids**)

Try this!

If the radius of a cylinder is doubled. What will happen to its volume?

a. Doubled
b. Quadrupled
c. Halved
d. Stay the same

Units of Measurement

SI Unit

- The International System of Units (SI), commonly known as the metric system, is the international standard for measurement.
- The SI is made up of 7 base units that define the 22 derived units with special names and symbols.
- The SI plays an essential role in international commerce and is commonly used in scientific and technological research and development.

Physical quantity measured	Base unit	SI abbreviation
Amount of substance	mole	mol
Length	meter	m
Mass	kilogram	kg
Time	second	s
Thermodynamic temperature	kelvin	K
Electric current	ampere	A
Luminous intensity	candela	cd

(**Table 1.2 SI Units**)

SI Prefixes

- The SI prefixes are a series of prefixes to units in the International System of Units, or SI.
- These can denote very small or very large amounts.

Factor	Name	Symbol	Factor	Name	Symbol
10^{24}	yotta	Y	10^{-1}	deci	d
10^{21}	zetta	Z	10^{-2}	centi	c
10^{18}	exa	E	10^{-3}	milli	m
10^{15}	peta	P	10^{-6}	micro	µ
10^{12}	tera	T	10^{-9}	nano	n
10^{9}	giga	G	10^{-12}	pico	p
10^{6}	mega	M	10^{-15}	femto	f
10^{3}	kilo	k	10^{-18}	atto	a
10^{2}	hecto	h	10^{-21}	zepto	z
10^{1}	deka	da	10^{-24}	yocto	y

(**Table 1.3 SI Prefixes**)

Conversion of Units

Conversion Factors

- an arithmetical multiplier for converting a quantity expressed in one set of units into an equivalent expressed in another.

Length	Mass	Time	Volume
1 ft = 12 in 1 in = 2.54 cm 1 mi = 5280 ft 1 cm = 10 mm 1 m = 100 cm = 1000mm 1 km = 1000 m = 100000 cm 1 km^2 = 1000000m^2 1 km^3 = 1000000000m^2	1 kg = 1000g 1 g = 1000 mg 1 kg = 2.2lbs	1 year = 365 days 1 day = 24 h 1 h = 60 mins 1 min = 60 s 1 h = 3600 s	1 L = 1000 mL 1000 mL = 1000cm^3 1 mL = 1 cm^3

(**Table 1.4 Commonly Used Conversion Factors**)

Dimensional Analysis

- In conversion of units, we use equations.
- Equations express relationship among physical quantities.
- Equations must be dimensionally consistent.
- Dimensional Analysis can be used to:
  - Derive an equation
  - Check if the equation is dimensionally correct
  - Know the units or the dimension of the physical quantity

Try this!

1) Check whether **s = vt** is dimensionally correct using:

s = Length t = time

v = Speed

2) According to the song Live Like We're Dying, how many seconds are there in a day?

Significant Digits

Significant Figures

- This is defined like this: each of the digits of a number that are used to express it to the required degree of accuracy, starting from the first nonzero digit.

Rules on Significant Figures

1.) Nonzero digits are always significant.

Example:

2.) All final zeros after the decimal points are significant.

Example:

3.) Zeros between two other significant digits are always significant.

Example:

4.) Zeros used solely for spacing the decimal point are not significant.

Example:

5.) In addition and subtraction, round up your answer to the less precise measurement.

Example:

6.) In multiplication and division, round it up to least number of significant digits.

Example:

Try this!

How many significant digits do 1020.001 have?

Test Yourself

iPadCutie. Kylie is on hunt to buy a new gadget. He is looking for a low-density gadget for convenience. Assuming that all masses are equal, which of the following will have the lowest density?

a. An iPad Air (V=18 in^3)
b. An iPad Mini (V=12 in^3)
c. An iPhone (V = 3 in^3)
d. An iPod Touch (V = 2 in^3)

Solution:

Dapat Consistent! If ρ has a unit of $[\mathrm{kg/m^3}]$, v has a unit of $[\mathrm{m/s}]$, D has a unit of $[\mathrm{m}]$ and R is unitless, what is the unit of μ in the equation $R = v\rho D/\mu$?

A. unitless B. $\dfrac{\mathrm{kg}}{\mathrm{m\cdot s}}$ C. $\dfrac{\mathrm{kg\cdot m}}{\mathrm{s}}$ D. $\dfrac{\mathrm{kg\cdot s}}{\mathrm{m^2}}$

Solution:

Edi Wow. In a foreign land, $1\,\mathrm{edi} = 13.67\,\mathrm{m}$ and $1\,\mathrm{wow} = 28.41\,\mathrm{s}$. What is $5.00\,\mathrm{m/s^2}$ in units of $\mathrm{edi/wow^2}$?

A. $10.4\,\mathrm{edi/wow^2}$
B. $295\,\mathrm{edi/wow^2}$
C. $8.47\times10^{-2}\,\mathrm{edi/wow^2}$
D. $2.41\,\mathrm{edi/wow^2}$

Solution:

Tinimbang ka ngunit kulang. The weight of a computer on earth is 20.0 N. What is the weight of the same computer if it is placed at the surface of Jupiter's moon Io? The acceleration due to gravity in Io is $1.81\ \mathrm{m/s^2}$.

A. 3.69 N B. 11.0 N C. 36.2 N D. 4.90 N

Solution:

Dimensyon. In simple harmonic motion, the frequency is given by

$$f = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$$

where π is a dimensionless constant. If the unit for m is in kg and the unit for f is in $\mathrm{s^{-1}}$, what should be the unit of k for the equation to be dimensionally consistent?

A. $\mathrm{N/m^2}$
B. $\mathrm{N/m}$
C. $\mathrm{N\cdot m}$
D. $\mathrm{N/(m\cdot s)}$

Solution: