4/11/19

Metric system

$10^3 = 1000.$ $\quad 10^{-2} = .01$ $\quad 10^0 = 1$

length	meter	m	prefixes		
volume	liter	L	mega	M	10^6
time	second	s	kilo	k	10^3
mass	kilogram	kg	deci	d	10^{-1}
temperature	Kelvin	K	centi	c	10^{-2}
			milli	m	10^{-3}
			micro	μ	10^{-6}
			nano	n	10^{-9}

unit conversion factor

$$1 \text{ inch (in)} = 2.54 \text{ cm}$$

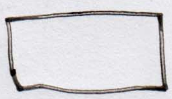
$$9.5 \text{ in} \times \frac{2.54 \text{ cm}}{1 \text{ in}} = 24.13 \text{ cm}$$

$$1 \text{ cm} = 10^{-2} \text{m} \qquad 1 \text{ mm} = 10^{-3} \text{m}$$

$$1 \text{ mm} \times \frac{1 \text{ cm}}{1 \text{ mm}} = \frac{10^{-2} \text{m}}{10^{-3} \text{m}} = 10 \times 1 \text{ mm} \qquad 1 \text{ cm} = 10 \text{ mm}$$

$$4.75 \text{ cm} \times \frac{10 \text{ mm}}{1 \text{ cm}} = 47.5 \text{ mm}$$

area

4 in  6 in

$$\Rightarrow 4 \text{ in} \times 6 \text{ in} = 24 \text{ in}^2$$

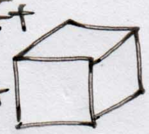
$$24 \text{ in}^2 \times \frac{2.54 \text{ cm}}{1 \text{ in}} \times \frac{2.54 \text{ cm}}{1 \text{ in}}$$

$$= 24 \text{ in}^2 \times \left(\frac{2.54 \text{ cm}}{1 \text{ in}}\right)^2 = 154.8 \text{ cm}^2$$

volume

$$1 \text{ cm}^3 = 1 \text{ mL} = 1 \text{ cc}$$

2ft

1.5ft 

1ft

$$\rightarrow 1 \text{ ft} \times 1.5 \text{ ft} \times 2 \text{ ft} = 3 \text{ ft}^3$$

$$3 \text{ ft}^3 \times \frac{12 \text{ in}}{1 \text{ ft}} \times \frac{12 \text{ in}}{1 \text{ ft}} \times \frac{12 \text{ in}}{1 \text{ ft}} = 5184 \text{ in}^3$$

intensive properties – a physical property that does not depend on the amount of material.

examples – density, temperature

extensive properties – a physical property that does depend on the amount of material.

examples – mass, volume, length, area

$$\text{density} \equiv \frac{\text{mass}}{\text{volume}}$$ ← how much matter there is in a given amount of space

1 mL water has a mass of 1 g ⇒ $\text{density} = \frac{1\,g}{1\,mL} = 1\ g/mL = 1\ g \cdot mL^{-1}$

Ethanol (C_2H_6O) has a density of 0.789 g/mL.

How many grams of ethanol are in 30 mL of ethanol?

$$D = \frac{M}{V}$$

D ← density, M ← mass, V ← volume

$$D \cdot V = m$$

$$30\,mL \cdot 0.789\,\frac{g}{mL} = 23.67\,g$$

heat – energy on the move

units of energy: $1\ \text{Joule} = 1\ kg \cdot m^2 \cdot s^{-2}$

1 calorie (cal) = 4.184 J

1 Calorie (food) = 1 kcal

Temperature

	Celsius (°C)	Fahrenheit (°F)
boiling point of water	100°C	212°
	↕ 100°C	↕ 180°F
freezing point of water	0°C	32°

$$°C = (°F - 32) \times \frac{100}{180} = \frac{5}{9}(°F - 32)$$

$$°F = \frac{9}{5}°C + 32$$

The Kelvin scale is an absolute scale, meaning it has a lowest possible temperature → 0 K

$0°C = 273\,K$ $\quad$ $K = °C + 273$

$°C = K - 273$

law of conservation of mass — in a chemical reaction, matter can change form, but the total amount of matter will not change

law of definite proportions — in a pure substance, there will always be a fixed ratio of elements

law of multiple proportions — elements can combine in different ratios to create different distinct substances.

Dalton's atomic theory

- all matter is composed of indivisible units called atoms
- elements are composed of identical atoms
- compounds are formed from fixed ratios of elements
- in chemical reactions, atoms can rearrange, but the atoms themselves do not change

Modern atomic theory recognizes that atoms can change due to nuclear reactions, but in chemical reactions atoms do not change.

Elements are atoms that all have the same number of protons; but, atoms of an element can have different numbers of neutrons (isotopes).

Mole

1 mole (mol) = 6.022×10^{23}

1 atomic mass unit

$\equiv \frac{1}{12}$ mass of one atom of carbon-12.

1 atom of ^{12}C has a mass of exactly 12 amu

isotope—
isotopes are atoms of the same element (same # of protons) with different numbers of neutrons

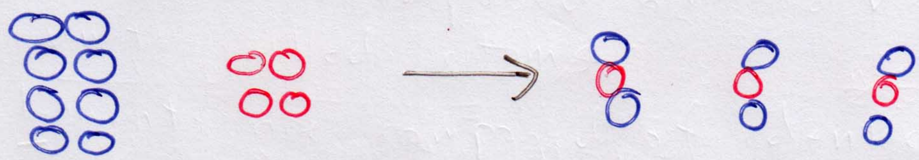
mass number—
= # protons + # neutrons

6.022×10^{23} amu = 1 g

1 mol amu = 1 g

1 amu = 1 g / 1 mol

Chemical reactions occur on the basis of numbers of atoms, not on their mass.



$4\ H_2 + 2\ O_2 \rightarrow 4\ H_2O$

reactants — products

4 moles of H_2 react with 2 moles O_2 to produce 4 moles of water

molar mass — the mass of one mole of a substance

C 6
12.011

The atomic mass listed on the periodic table represents an average of all isotopes of an element.

This mass is in terms of amus for one atom and grams for one mole.

Given 20g of O_2, and 16g of H_2, how many moles of O_2 + H_2 are present?

1 O atom = 16 g/mol   1 H atom = 1.01 g/mol

molar mass of O_2 = 32 g/mol

molar mass of H_2 = 2.02 g/mol

$$O_2 : 20g\ O_2 \times \frac{1\ mol\ O_2}{32\ g\ O_2} = 0.625\ mol\ O_2$$

$$H_2 : 16g\ H_2 \times \frac{1\ mol\ H_2}{2.02\ g\ H_2} = 7.92\ mol\ H_2$$