Noteset 6A (Part 2) - Avogadro's Number and the Mol

The atom

Atomic Structure contains protons(p^+), electrons(e^-) and neutrons (n°).

Protons (p^+)	+1 charge	1.67262×10^{-24} g
Neutrons (n°)	0 charge (neutral)	1.67493×10^{-24} g
Electron (e^-)	-1 charge	9.10939×10^{-28} g

Mass Number ($p^+ + n^\circ$) - the number of atoms that contribute to the mass of the atom

Atomic Mass Unit (amu) - Avg. mass of the proton (p^+) and neutron (n°)

$1 \text{ amu} = 1.67377 \times 10^{-24}$ g

Atomic Mass (g or amu) - Mass of an isotope of an atom

$^{12}_{6}C$ ← Mass # (12), ← Atomic # (6)

Mass $^{12}_{6}C$

$$12.00 \text{ amu} \;\Big|\; 12\,(1.67377 \times 10^{-24}\text{ g}) = 2.008524 \times 10^{-23}\text{ g}$$

Average Atomic Mass

All atomic isotopes have a particular fractional OR percent (%) abundance (amount) of all isotopes.

Isotopes C

Carbon-12	$^{12}_{6}C$	0.989	98.9%
Carbon-13	$^{13}_{6}C$	0.0109	1.09%
Carbon-14	$^{14}_{6}C$	0.0001	0.01%

The average atomic mass is based on the following equation:

$$\boxed{\text{Avg. Atomic Mass} = \frac{\sum(\text{isotope mass} \times \%\ \text{abund})}{n}}$$

$(n = \#\ \text{isotopes})$

Average Atomic Mass for C $= \frac{12.011\ \text{amu}}{\text{atom}}$

(1 atom = 12.011 amu)

Microchemistry vs. Macrochemistry

Micro: Small scale, individual atoms, compounds, molecules, ions, reactions

Macro: large scale, can directly measured (grams, etc)

Micro explains Macro Chemistry!

6 C carbon 12.011

Avg. Atomic Mass

The periodic table always gives the avg. atomic mass

Converting the micro to macro - The molar unit (mol)

Measuring Mass of representative particles (r.p.)

Atomic Mass	micro $\longrightarrow$ macro	Molar Mass
Mass / r.p.		Mass / mol r.p.

Defining the mol

Mol - unit of matter representative of a large group of particles

Carbon Atomic Mass $= 12 \frac{amu}{atom}$ Molar Mass $= 12 \frac{g}{mol}$

$1 \text{ atom} = 12 \text{ amu } (2.008524 \times 10^{-23} g)$
$1 \text{ mol} = 12.0 g$ (______ atoms ?)

How many atoms $^{12}_{6}C$ in 1 mol $^{12}_{6}C$?

$$\text{\_\_\_\_\_ atoms } ^{12}_{6}C = \frac{\text{Molar Mass } ^{12}_{6}C}{\text{Atomic Mass } ^{12}_{6}C} = \frac{12.0 \cancel{g}/mol}{2.008524 \times 10^{-23} \cancel{g}/atom}$$

$$= 5.97 \times 10^{23} \text{ atoms/mol}$$

A lot of Atoms !!!

Avagadro's # is the number of atoms in 1 mol of the atom.

$$\boxed{N_A = 6.02214076 \times 10^{23} \text{ atoms/mol}}$$

Avagadro's #

Avagadro's # and the Mol

1 mol of any particle contains N_A of particles

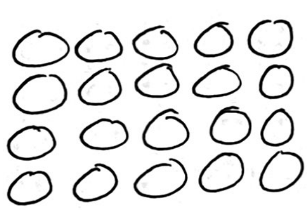
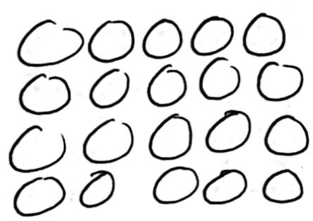
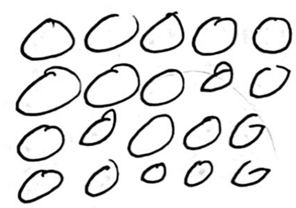
$$\boxed{1 \text{ mol}_{\text{r.p.}} = 6.022 \times 10^{23} \text{ r.p.}}$$

The <u>molar mass</u> of any particle is the mass of an avagadro's # of r.p.

${}^{12}_{6}C$ 1 mol C = 12.00g C || ${}^{16}_{8}O$ 1 mol O = 16.00g O

Visualizing the mol

1 serving candy = 20 pieces of candy = 1 $\text{mol}_{\text{candy}}$

Candy A	Candy B	Candy C
light (low mass)	medium (medium mass)	heavy (high mass)
		
20.0g total (1.0 g/candy)	40.0 g total (2.0g/candy)	60.0g total (3.0 g/candy)

If 1 serving = 20 candies (mol), the <u>molar mass</u> is the mass of 20 candies (g/mol)