2.3

- Calculation of Ave Atomic Mass

2.4

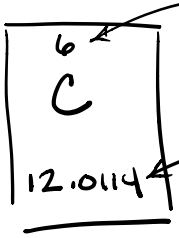
Representations of atoms & Molecules

⇒ Empirical formulas

Isomers

⇒ Mole
- molar Mass
- Calculation Stoichiometry

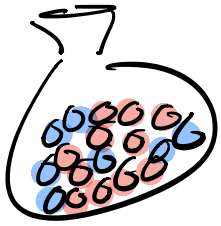
2.3 Ave atomic Mass



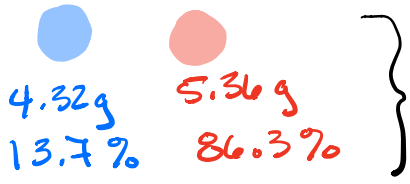
atomic # = # of protons

atomic Mass
= Weighted average of the individual isotopic masses

Marble factory



100 marbles into each bag



Weighted Ave

Ave Marble

5.22 g

$$0.137 \times 4.32\,g = 0.59184\,g$$
$$0.863 \times 5.36\,g = +\ 4.62568\,g$$
$$5.21752\,g$$

(3 sig figs; % × mass)

$$= \boxed{5.22\,g}$$

$100 \text{ marbles} \times \frac{5.22\text{g}}{1 \text{ Ave Marble}} = 522\text{g}$ into each bag

On average if I weigh out 522g of marbles than each bag will have $\approx$ 100 marbles.

Ex Oxygen

	^{16}O	^{17}O	^{18}O	
%	99.762%	0.0380%	0.200%	← Relative natural abundance
mass	15.995	16.999	17.999	← mass of isotope in amu

$p^+ \approx 1 \text{ amu} = 1.0073 \text{ amu}$

$n \approx 1 \text{ amu} = 1.0087 \text{ amu}$

Weighted Ave

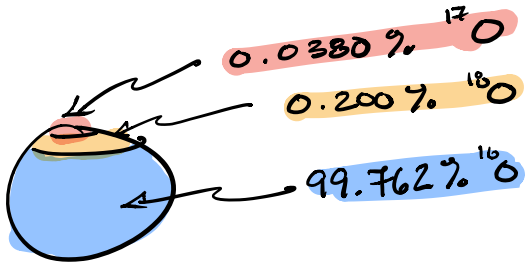
^{16}O $\frac{99.762\ ^{16}O}{100 \text{ oxygen}} \times 15.995 \text{ amu } ^{16}O =$ Contribution from ^{16}O

$0.99762 \times 15.995 \text{ amu} = 15.9569319 \text{ amu}$

% expressed in decimal form

mass

^{16}O $15.995 \text{ amu } ^{16}O \times \frac{99.762\ ^{16}O}{100 \text{ oxygen atoms}} = 15.9569319 \text{ amu}$



Ave oxygen mass

^{16}O $15.995\ \text{amu}\ ^{16}O \times \frac{99.762\ \text{amu}\ ^{16}O}{100\ \text{oxygen atoms}} = 15.9569319\ \text{amu}$

^{17}O $16.999\ \text{amu}\ ^{17}O \times \frac{0.0380\ \text{amu}\ ^{17}O}{100\ \text{oxygen atoms}} = 0.00645562\ \text{amu}$

^{18}O $17.999\ \text{amu}\ ^{18}O \times \frac{0.200\ \text{amu}\ ^{18}O}{100\ \text{oxygen atoms}} = 0.035998\ \text{amu}$

$+$

$15.999|38952\ \text{amu}$

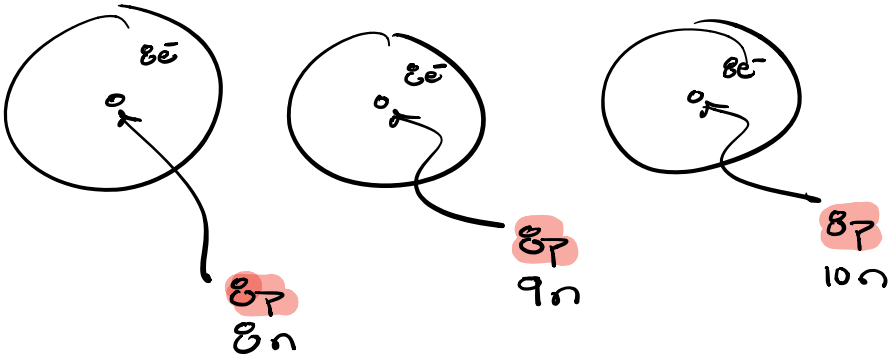
Ave for Oxygen = 15.999 amu

8
O
15.999

← Ave mass for an oxygen atom

^{16}O ^{17}O ^{18}O

Individual Isotopes = Individual Atoms



99.762% = 0.99762 decimal

$\frac{99.762}{100}$

what does % mean? How do we calc %?

$\frac{\text{part}}{\text{whole}} \times 100 = \%$

$\frac{\text{part } ^{16}O}{\text{whole sample}} \times 100 = 99.762\%$

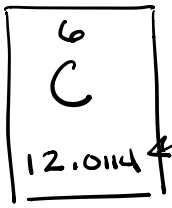
$\frac{\text{How many } ^{16}O \text{ atoms}}{\text{Total \# Oxy atoms measured}} \times 100 = 99.762\%$

% = part per hundred

$$\frac{8.955 \times 10^{26}\ {}^{16}O \text{ atoms}}{8.976 \times 10^{26} \text{ oxygen atoms}} \times 100 = 99.762\ \%\ {}^{16}O$$

~~percent~~ % =	Part per hundred ppH	$\frac{\text{Part}}{\text{whole}} \times 100$
ppt =	part per thousand	$\frac{\text{Part}}{\text{whole}} \times 1000$
ppm =	part per million	$\frac{\text{part}}{\text{whole}} \times 10^6$
ppb =	parts per billion	

Concentration $\frac{\text{part}}{\text{whole}}$



ave atomic mass = 12.0114 amu

$1 \text{ amu} = 1.6605 \times 10^{-24} \text{ g}$

Chapter 2.4 Mole

The mole is a unit similar to a dozen

1 dozen = 12

1 dozen eggs = 12 eggs

1 dozen rocks = 12 rocks

$1 \text{ mole} = 6.022 \times 10^{23}$

$1 \text{ mole eggs} = 6.022 \times 10^{23} \text{ eggs}$

Original definition of mole = # of atoms in exactly 12g of ^{12}C

^{12}C $6p^+$, $6n^\circ$ } 12 amu

6.022×10^{23} atoms = 1 mole

New definition of mole

Exactly $6.022140\,76 \times 10^{23}$ things

use to 4 sig figs 6.022×10^{23}

Mole is called Avagadro's # N_A

1 mole Carbon

6.723 moles oxygen

Ex of use

3.72 dozen eggs

$$3.72 \text{ dozen} \times \frac{12}{1 \text{ dozen}} = 44.64 \text{ eggs}$$

44.6 eggs

3.72 moles of Carbon atoms

$$3.72 \text{ moles C atom} \times \frac{6.022 \times 10^{23} \text{ atoms}}{1 \text{ mole atoms}} = 2.240184 \times 10^{24} \text{ atoms}$$

2.24×10^{24} atoms C

$3.72 \times 6.022 \text{ EE } 23 = 2.240184 \times 10^{24}$

EE

10^x

y^x $\quad$ $\times 10\ y^x\ 23$

How many grams does 1 mole of ^{12}C weigh?

1 mole $\xrightarrow{\text{mole}}$ # atoms $\xrightarrow{\text{use atomic mass}}$ amu $\xrightarrow{g \to amu}$ g

1 mole = 6.022×10^{23}

1 C atom = 12 amu

1 amu = 1.66006×10^{-24} g

exact $\quad$ 4 $\quad$ def $\quad$ 5 sf

$$1 \text{ mole } {}^{12}C \times \frac{6.022 \times 10^{23} \text{ } {}^{12}C \text{ atoms}}{1 \text{ mole } {}^{12}C} \times \frac{12 \text{ amu}}{1 \text{ atom } {}^{12}C} \times \frac{1.66006 \times 10^{-24} \text{ g}}{1 \text{ amu}} =$$

$$12.00\cancel{0}\,15984 \text{ g}$$

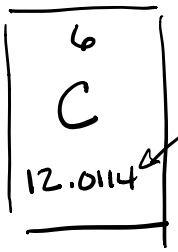
12.00 g ^{12}C in 1 mole

$^{12}_{6}C$ ← p+n

= 12 amu $\quad$ Same

↑ p = 1 mole $^{12}_{6}C$ = 12.00 g

How many g of C are in 1 mole of average Carbon (All isotopes ⇒ Ave mass 12.0114 amu)



Ave atomic mass
12.0114 amu

$$\frac{1}{6.022\times10^{23}} = 1.6606\times10^{-24}$$

mole → atoms → amu → g

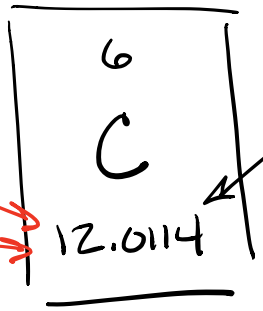
$$1\text{ mole C} \times \frac{6.022\times10^{23}\text{ C atoms}}{1\text{ mole C}} \times \frac{12.0114\text{ amu}}{1\text{ C atom}} \times \frac{1.6606\times10^{-24}\text{ g}}{1\text{ amu}} =$$

$$= 12.01155999\text{ g}$$

6.022 EE 23 × 12.0114 × 1.6606 EE (-) 24 =

(Change Sign)

$$= 12.01\text{ g}$$



amu/atom

g/mol

It is both

The Ave mass for a single atom in amu

also

The mass of 1 mole of C in g

8	1	6	7
O	H	C	N
15.9994	1.00794	12.0114	14.00674

amu/atom

g/mole

1 O atom = 15.9994 amu

1 mole O = 15.9994 g

How we use atomic mass (amu/atom) vs. Molar mass (g/mole)

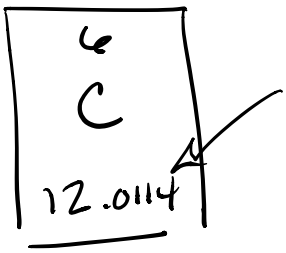
How many amu's do 10 hydrogen atoms weigh?

10 H atoms (Counted Exact) $\times \frac{1.00794 \text{ amu}}{1 \text{ atom H}}$ (6) = **10.0794 amu** (6)

How many grams does 1.52 moles of hydrogen weigh

1.52 (3) mole H $\times \frac{1.00794 \text{ g H}}{1 \text{ mole H}}$ (6) = 1.5320688 g H

= **1.53 g Hydrogen**



molar Mass g/mole

Conversion factor

g ⇌ mole

mass count

How many g does 10 atoms of H weigh

$$10 \text{ atom H} \times \frac{1.00794 \text{ amu}}{1 \text{ atom H}} \times \frac{1.66006 \times 10^{-24} \text{ g}}{1 \text{ amu}} = 1.6738 \times 10^{-23} \text{ g}$$

$$= \boxed{1.6738 \times 10^{-23} \text{ g}}$$

need 6 sig figs

0.320000 ← Add Zeros to get # of required sig figs

New homework set up for tonight
on Canvas ⇒ Chapter 2 Suggested

New Quiz up on Canvas
Dimensional Analysis ⇒ Due Wed night