Empirical Formulas

Chemical = combination of elements & subscripts
= represents # of elements present in pure compound

Empirical = lowest (simplest) integer ratio of elements
= determined empirically (by experiment)
= maybe generalized (like C_nH_{n+2})
= formulas for ionic compounds
= RATIO of elements present

For $C_4H_8O_2$ = chemical For CH_3OH = chemical

C_2H_4O = empirical CH_4O = empirical

To determine an Empirical Formula:

Find masses (g) of elements in a sample of the compound
Usually given
Convert from grams to moles
Use Molar Mass (determined from Periodic Table)
Express lowest integer ratio of moles
Divide each number of moles by the smallest number of moles
Write simplest formula using integer ratio

Calculate the empirical formula for a compound composed of 19.32 g iron and 8.304 g oxygen

Determine # Moles: ratio gives formula
(Use Periodic Table to get atomic weight of Fe and O)

For Iron (Fe)
$19.32\ g \times \frac{1\ mole}{55.847\ g} = 0.345945 \rightarrow 0.3459\ mol$

For Oxygen (O)
$8.304\ g \times \frac{1\ mole}{16.00\ g} = 0.5190 \rightarrow 0.5190\ mol$

Determine Mole Ratio: ratio gives formula

Ratio Fe / O = 0.3459 / 0.5190 = 0.6666 ➔ 2:3
Formula = Fe_2O_3

(Formulas usually written with metal first)

Alternative Method:
Divide # moles by smallest # of moles
(This forces one value to 1)
Multiply both # moles by same integer
Until small, whole numbers are reached

Fe	**O**
0.3459	0.5190
1	1.5
2	3

Find the empirical formula of a compound containing 20.21 g Fe and 5.79 g O.

Determine # Moles: ratio gives formula
(Use Periodic Table to get atomic weight of Fe and O)

For Iron (Fe)
20.21 g x $\frac{1 \text{ mole}}{55.847 \text{ g}}$ = 0.361882 ➔ 0.3619 mol

For Oxygen (O)
5.79 g x $\frac{1 \text{ mole}}{16.00 \text{ g}}$ = 0. 361875 ➔ 0. 362 mol

Determine Mole Ratio: ratio gives formula
Ratio Fe / O = 0.3619/ 0.362 = 0.999724 ➔ 1.0
Formula = FeO

Alternative Method:
Divide # moles by smallest # of moles
(This forces one value to 1)
Multiply both # moles by same integer
Until small, whole numbers are reached

Fe	O
0.3619	0.3619
1	1

Find the empirical formula of a compound that contains 741 g lead and 76.0 g oxygen

Determine # Moles: ratio gives formula
(Use Periodic Table to get atomic weight of Pb and O)

For Lead (Pb)
741 g x $\frac{1 \text{ mole}}{207.19 \text{ g}}$ = 3.57643 ➔ 3.58 mol

For Oxygen (O)
76.0 g x $\frac{1 \text{ mole}}{16.00 \text{ g}}$ = 4.75

Determine Mole Ratio: ratio gives formula
Ratio Pb / O = 3.58 / 4.75 = 0.753 ➔ 0.75 ➔ 3:4
Formula = Pb_3O_4

Determine the empirical formula of a compound that is 62.8% Cl, 31.9% C, and 5.3% H.

When given elemental %, assume 100 grams total
Get weights from the Periodic Table

For carbon:
31.9 g x $\frac{1 \text{ mole}}{12.011 \text{ g}}$ = 2.6559 ➔ 2.66 mol

For hydrogen:
multiply mole ratios by 2 ➔ $C_3H_6Cl_2$ 5.3 g x $\frac{1 \text{ mole}}{1.008 \text{ g}}$ = 5.25794 ➔ 5.3 mol

For chlorine:
62.8 g x $\frac{1 \text{ mole}}{35.453 \text{ g}}$ = 1.77136 ➔ 1.77 mol

Determine Ratio: C: H: Cl :
Divide by 1.77: 1.5 2.99 1 ➔ $C_{1.5}H_{2.99}Cl$

multiply mole ratios by 2 ➔ $C_3H_6Cl_2$

Calculate the empirical formula of malonic acid whose composition is 34.6% carbon, 3.9% hydrogen, and 61.5% oxygen.

When given elemental %, assume 100 grams total
Get weights from the Periodic Table

For carbon:

$$34.6\ g \times \frac{1\ mole}{12.011\ g} = 2.88069 \rightarrow 2.88\ mol$$

For hydrogen:

$$3.9\ g \times \frac{1\ mole}{1.008\ g} = 3.86905 \rightarrow 3.9\ mol$$

For oxygen:

$$61.5\ g \times \frac{1\ mole}{16.00\ g} = 3.84375 \rightarrow 3.84\ mol$$

Determine Ratio: C: H: O :

Divide by 2.88: 1.00 1.35 1.33 ➔ $CH_{1.35}O_{1.33}$

Need integer; multiply by 3 ➔ $C_3H_4O_4$

Alternative Method:
Divide # moles by smallest # of moles
(This forces one value to 1)
Multiply both # moles by same integer
Until small, whole numbers are reached

C	H	O
2.88	3.9	3.84
1	1.35	1.33
2	2.7	2.66
3	4	4

Think Moles
Not
Grams

Assignment

Start Taking Unit 6 Practice Test
Blackboard only records highest score
Take until multiple 100's have been scored (questions are variable)
(Gives sense of test exam format and content)

The Practice Quiz is very similar to the Unit Exam
Success on Unit exam is directly related to practice exam experiences

At this point:
Elements & polyatomic ions should be memorized