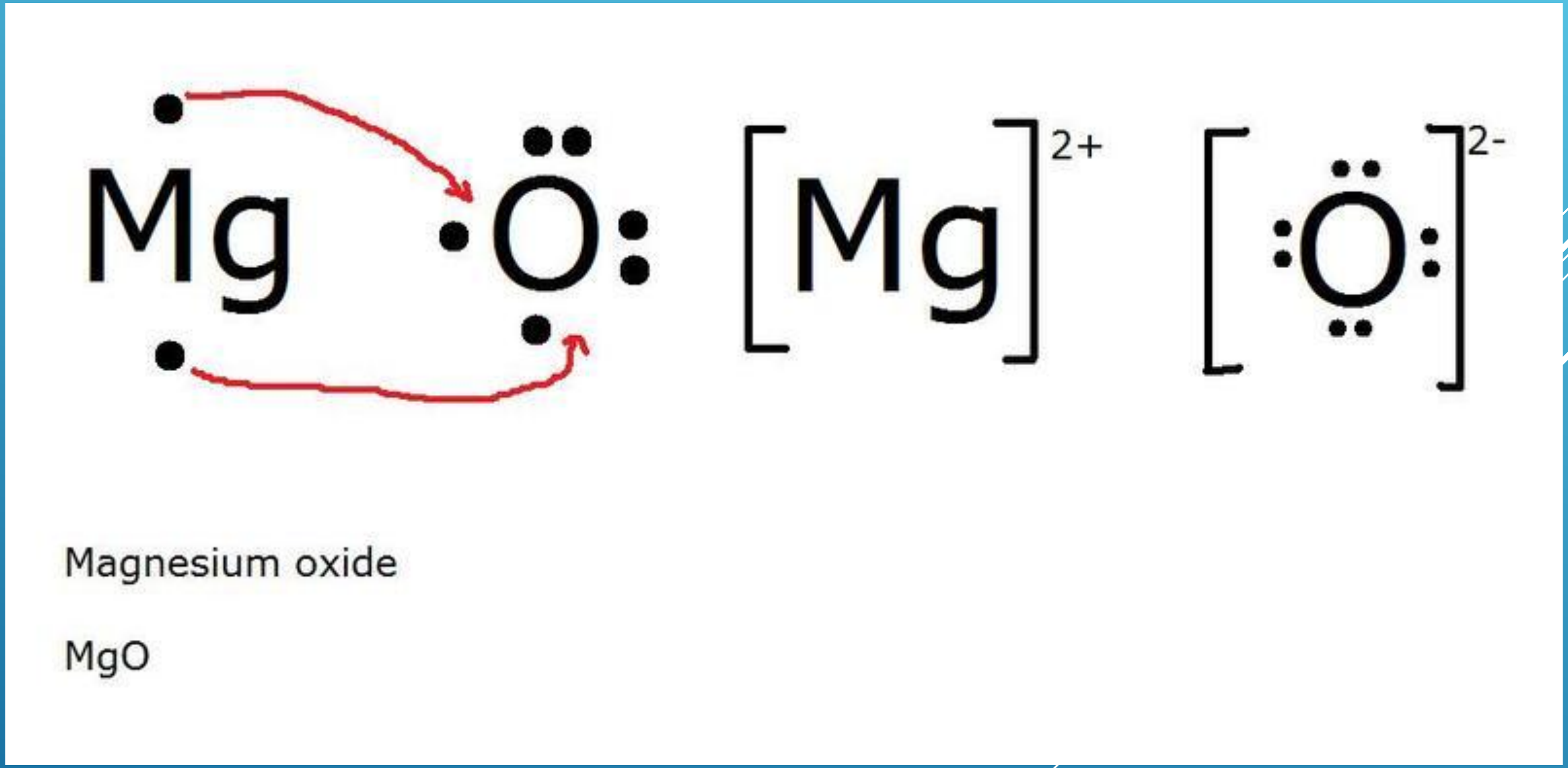
EMPIRICAL AND MOLECULAR FORMULA

- Sketch the Lewis-Dot Diagram for Magnesium Oxide



WARM-UP

DIFFERENCE BETWEEN C_2H_2 VS. C_6H_6?

- Notice that in these structures, the subscripts in the chemical formulas are NOT in their simplest form. For instance, both compounds could be written as: CH (reduced)

EMPIRICAL FORMULAS

- **Empirical or Simplest Formula**
  - The formula of a compound that represents a mole ratio in the *smallest whole number ratio* of the atoms present.
  - Which compounds from the warm-up contain empirical formulas? MgO and CH

- Ionic Compounds are ALWAYS empirical

MOLECULAR FORMULAS

- **Molecular Formula**
  - The **actual formula/ratio** of the number of atoms of each type bonded to form a molecule
  - Molecular Compounds can be represented with empirical OR molecular formulas
  - C_2H_2 = Molecular Formula
  - CH = Empirical Formula
  - Sometimes the molecular formula IS the empirical formula. Such as: H_2O cannot be reduced any further.

DIFFERENCE BETWEEN C_2H_2 VS. C_6H_6?

C_2H_2	C_6H_6
$\% C = \frac{24.0g}{26.0g} \times 100\% = 92.3\%$ $\% H = 100 - 92.3\% = 7.7\%$	$\% C = \frac{72g}{78g} \times 100\% = 92.3\%$ $\% H = 100 - 92.3\% = 7.7\%$

TO OBTAIN AN *EMPIRICAL FORMULA*

- 1. Determine the mass in grams of each element present, if necessary.
- 2. Calculate the number of *moles* of each element.
- 3. Divide each by the smallest number of moles to obtain the *simplest whole number ratio*.

4. If whole numbers are not obtained* in step 3, multiply through by the smallest number that will give all whole numbers
   - If a mole ratio is 1.5, then multiply mole ratio by 2 to get 3.
   - If a mole ratio is 1.25, then multiply mole ratio 4 to get 5.
   - If a mole ratio is 1.33, then multiply mole ratio by 3 to get 4

- * Be careful! Do not round off numbers prematurely

CALCULATING EMPIRICAL FORMULA FROM % COMPOSITION

A compound of carbon, chlorine and fluorine was analyzed and found to contain 16.3% carbon, 32.1% chlorine, 51.6% fluorine by MASS. Determine the simple formula of the compound.

Element	Assume 100 g sample	# of moles (n = m/M)	Ratio (÷ by lowest # of moles)	WHOLE # ratio
C	[redacted]	[redacted]	[redacted]	[redacted]
Cl	[redacted]	[redacted]	[redacted]	[redacted]
F	[redacted]	[redacted]	[redacted]	[redacted]

Therefore, empirical (simple) formula is $C_3Cl_2F_6$

DETERMINING MOLECULAR FORMULA

- To determine molecular formula you must know
  - ✔ Simple formula
  - ✔ Molar mass of compound

- Sample Problem #1: A student has determined that the empirical formula for a compound of sulphur and chlorine is SCl. The molar mass of this compound is 135.0 g/mol. Determine its molecular formula.

1. Find M of empirical formula. $M_{SCl} = 32.1 + 35.5 = 67.6$ g/mol
2. Divide M of compound by M of empirical formula to get the # of units.

$$\text{\# of units} = \frac{135.0\ g/mol}{67.6\ g/mol} = 2$$

- ∴Simple formula = SCl $\xrightarrow{\times 2}$ S_2Cl_2 = molecular formula

- For some questions, you must determine the simple formula first then do the 2 steps in the previous problem.
- Sample Problem #2: Determine the molecular formula of a compound containing 85.7% carbon and 14.3% hydrogen by mass. The molar mass of the compound is 84.0 g/mol

Element	Assume 100 g sample	# of moles (n = m/M)	Ratio (÷ by lowest # of moles)
C	85.7 g	[redacted]	[redacted]
H	14.3 g	[redacted]	[redacted]

Empirical formula is CH_2

- $M(CH_2) = 2(1.0) + 12.0 = 14.0$ g/mol
- $M_{compound} = 84.0$ g/mol
- ∴ molecular formula is $6 \times (CH_2) = C_6H_{12}$

$$\# \text{ of units} = \frac{84.0 \text{ g/mol}}{14.0 \text{ g/mol}} = 6$$