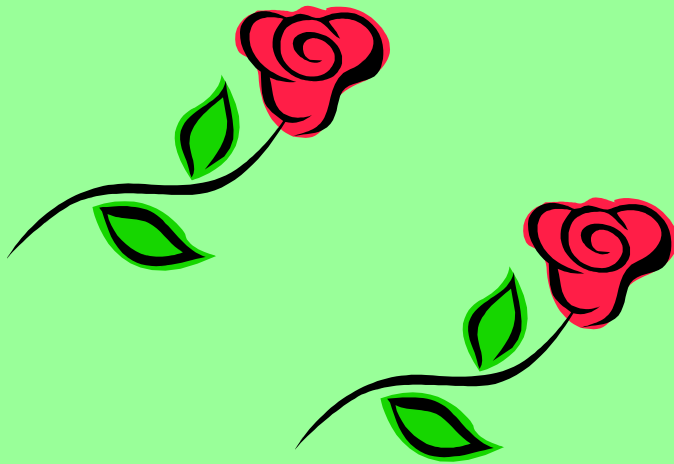


# CHAPTER 7: The Mole



# Measuring Matter

- How many roses are in a **dozen**?
- How many shoes in a **pair**?
- How many pieces of paper are in a **ream**?
- How many pencils are in a **gross**?



# Moles



- **Mole (mol)**-chemist's counting unit; SI base unit used to measure the amount of a substance
- 1 mol =  $6.02 \times 10^{23}$  representative particles (Avogadro's number)

Why is Avogadro's number so big?

# Mass to Number of Atoms

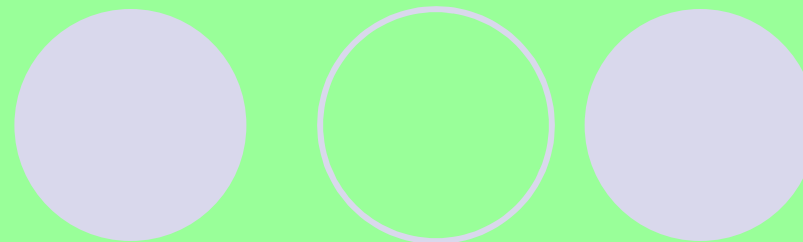
- 1 mole =  $6.02 \times 10^{23}$  particles = Avogadro's number
- Molar Mass = number of grams of one mole of a substance
- Practice: What is the molar mass of each element? He, Li, Hg

# Mass and Moles

1. What is the mass in grams of 3.50 moles of copper?

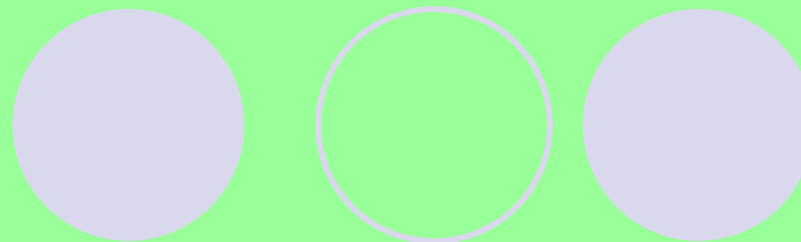
Practice p83

# Moles to Atoms



2. How many atoms of tungsten make up  $1.34 \times 10^{-2}$  moles?

# Atoms to Mass



3. What is the mass in grams of  $7.5 \times 10^{15}$  atoms of nickel?

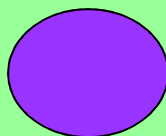
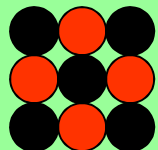
We are going to add...





# Representative Particles

- Representative particles =
- Molecules = molecular compounds
- Atoms = elements
- Formula units = ionic compounds
- Ions = element/compound with a charge



# Example

- Determine the number of representative particles for each:
  1. 1 mol  $\text{H}_2\text{O}$
  2. 1 mol Cu
  3. 1 mol  $\text{CCl}_2\text{F}_2$
  4. 1 mol NaCl
  5. 1 mol  $\text{Na}^{+1}$

# Using Chemical Formulas

- Formula mass – sum of all masses of atoms in formula
- Ex: Determine the formula mass of:
  - a. Fe
  - b. O<sub>2</sub>
  - c. H<sub>2</sub>O
  - d. Fe<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub>

Practice p222

# Molar Mass

- **Molar Mass – mass in grams of one mole of a substance**
- Ex. Determine the molar mass of:
  - a. Fe
  - b. O<sub>2</sub>
  - c. H<sub>2</sub>O
  - d. Fe<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub>

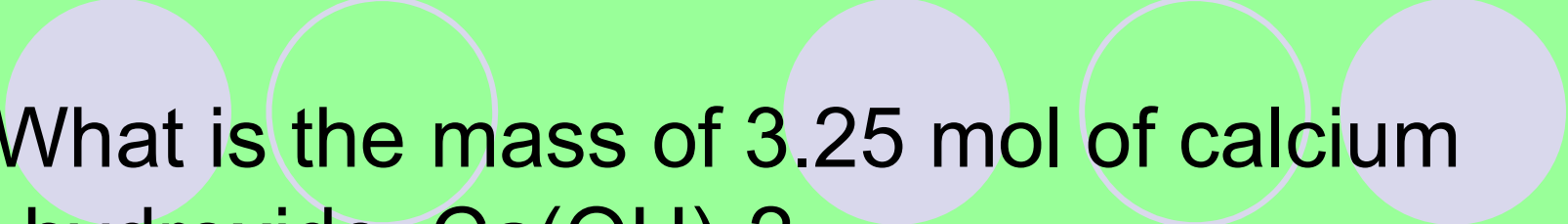
Practice p223

# Formula Mass Vs. Molar Mass

- Note: The only difference between formula mass and molar mass is the unit of amu and grams.

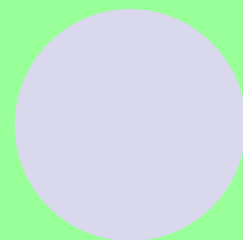
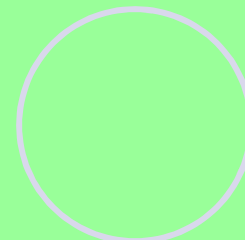
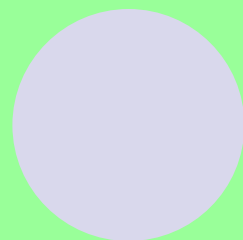
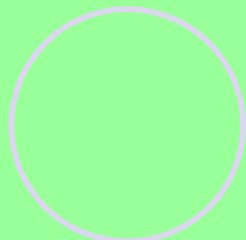
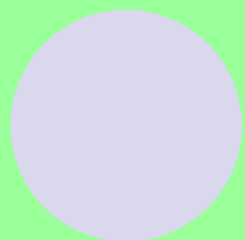
# Practice Problems

1. How many molecules of water are in 3.5 moles?
2. How many moles of salt are in  $4.15 \times 10^{-4}$  formula units of NaCl?
3. Determine the number of moles in 325 g of sulfuric acid,  $\text{H}_2\text{SO}_4$ .

Five decorative circles are arranged horizontally at the top of the slide. The first, third, and fifth circles are solid light purple. The second and fourth circles are hollow with a light purple outline.

4. What is the mass of 3.25 mol of calcium hydroxide,  $\text{Ca}(\text{OH})_2$ ?

5. How many formula units of barium chloride are in 145.26 g of barium chloride?



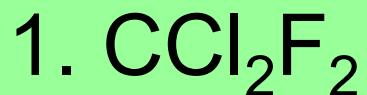
6. How many molecules of  $C_{13}H_{18}O_2$ , ibuprofen, is in the bottle of 206.29g?
7. How much of table salt must be measured out to give  $4.82 \times 10^{25}$  formula units of NaCl?



# Chemical Formula Mole Ratios

- The subscripts of a chemical formula determine the number of moles of the element in **one mole of the compound.**

Example:



2. Aluminum oxide

## Using Mole Ratios

**\*\*Use the mole ratio when you are asked for a specific element in a compound.**

### Examples

1. How many moles of fluorine atoms are in 5.50 moles of freon,  $\text{CCl}_2\text{F}_2$ .



2. Determine the moles of aluminum ions that are in 1.25 mol of  $\text{Al}_2\text{O}_3$ .

3. Determine the number of moles of chloride ions in 2.50 grams zinc chloride.

# Percent Composition

- Percent Composition – percentage by mass of each element in the cmpd

From sample amts:

Mass of element in sample X 100 = % E in cmdp  
mass of sample



Example

A sample contains 9 g Na, 20.6 g Cr, and 22.2 grams oxygen.

Determine the percent of sodium and chromium in the compound.



From formula:

Mass of E in 1 mol of compd X 100 = % E in compd  
molar mass of compd

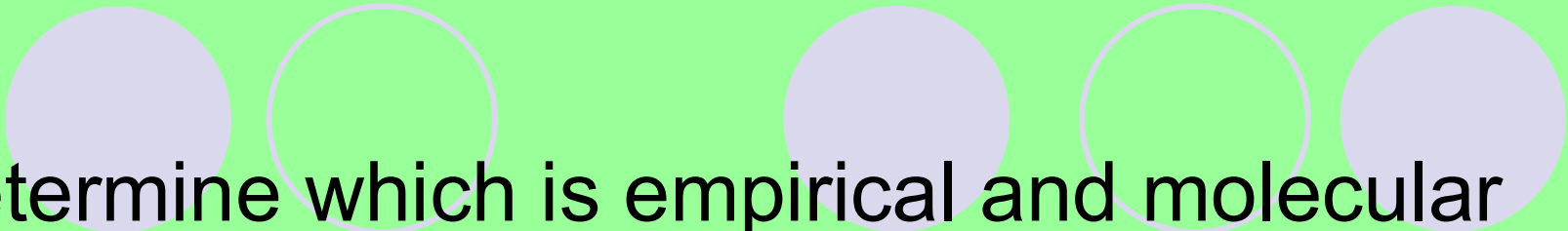
Prac. Find the % composition of  $\text{Cu}_2\text{S}$ .

Prac p228

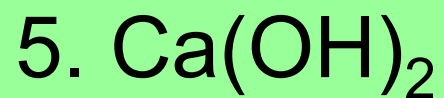
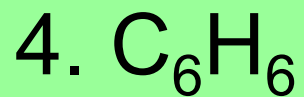
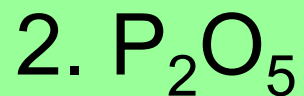
# Formulas



- Empirical Formula – smallest whole number ratio of atoms in a compd. correct formula for an ionic compd.
  - Ex. HCl, H<sub>2</sub>O
- Molecular Formula – actual formula of a molecule – some multiple of the empirical formula
  - Ex. HCl, C<sub>2</sub>H<sub>4</sub>

The top of the slide features five circles arranged horizontally. From left to right, they are: a solid light purple circle, an empty white circle with a light purple outline, a solid light purple circle, an empty white circle with a light purple outline, and a solid light purple circle.

Determine which is empirical and molecular formulas:



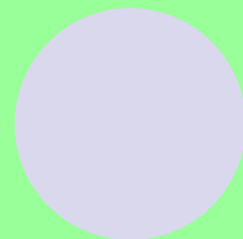
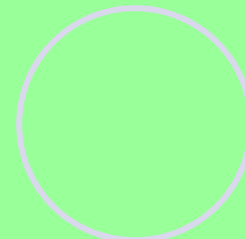
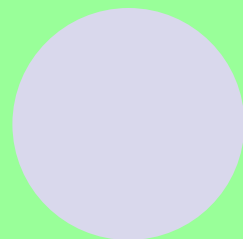
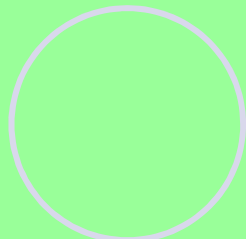
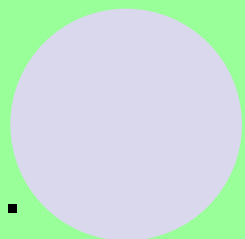




## Determining Empirical Formulas from Quantitative Analysis:

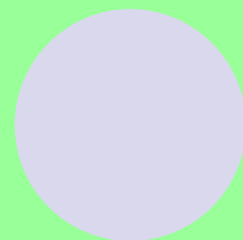
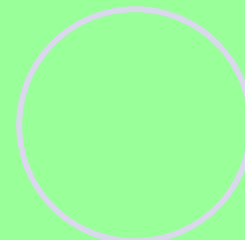
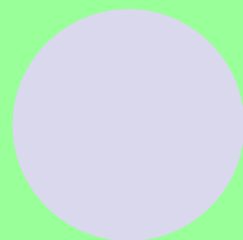
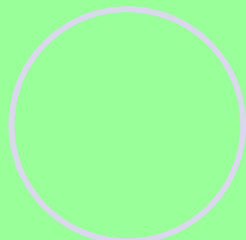
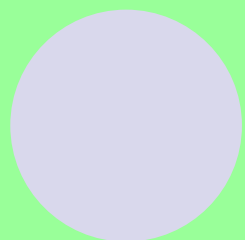
1. Convert % info to grams.
2. Convert grams to moles of each element  
in the cmpd.
3. Get whole number ratios by dividing by  
smallest # of moles.

Ex.



Find the empirical formula of a compd with  
32.38% Na, 22.65% S, and 44.99% O.

Prac p231



3. What is the empirical formula of a compound if a 50.0 gram sample of it contains 18%Na, 40%Cr, 42%O?



2. Find the empirical formula of a compd. that contains 53.70% iron and 46.30% sulfur.

# Molecular Formula

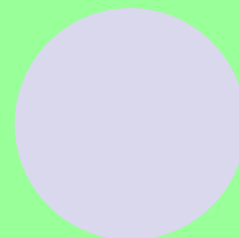
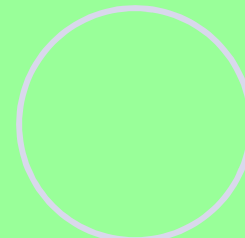
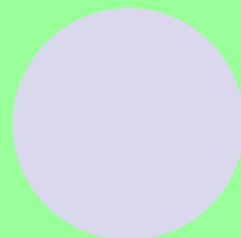
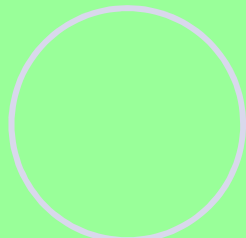
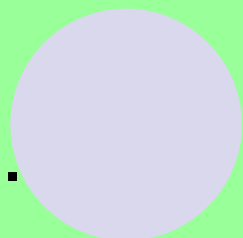
Calculation of Molecular Formula:

$$x(\text{EF}) = \text{MF}$$

$$\frac{\text{MF mass}}{\text{EF mass}} = x$$

Problem must provide the molar mass of the compd from experimental data.

Ex.



A compd of phosphorus and oxygen has an empirical formula of  $P_2O_5$ . The molar mass is determined to be 283.89 g. What is the molecular formula?

Prac p233 and section review p233

## Example



A sample of compound with a molecular mass of 34.00 g/mol is found to consist of 0.44 g of H and 6.92 g O. Find its molecular formula.