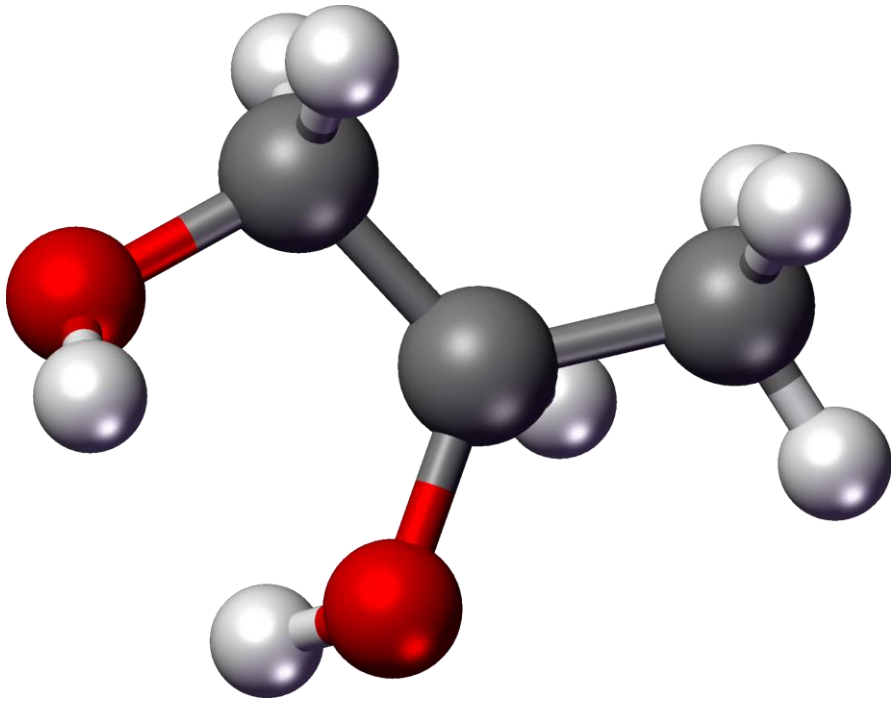
[6.1]
The Mole and Molar Mass



How do we measure matter?

- We can count the number of pencils in your pen case
- We can the number of coins in your pocket
- How do you buy fruit?
  - By counting how much you are buying, Usually by **weight.**

How do we measure an atom?

- In chemistry we **don't** work with **individual** atoms or molecules because they are **too small** to be weighed or measured

Recall:

Atom (原子) – The smallest part of a substance that can take part in a chemical reaction.

How small are atoms?

- There are more atoms in one gram (1g) of salt (NaCl) than grains of sand on all the beaches of all the oceans in all the world.

How do we measure an atom?

- So how do we measure something so small like an atom?

The Mole

The mole is just a number like:

1. Pair = 2
2. Pi (π) = 3.14159…
3. Dozen = 12

MOLE is 602,000,000,000,000,000,000,000

Example: A **mole** of apples is 6.02×10^{23} apples

The Mole

- The mole (**mol**) is a **unit of measure for an amount of a chemical substance**
- A mole is **Avogadro's number of particles**, that Is 6.02×10^{23} particles.

1 *mol* = Avogadro's Number = 6.02×10^{23} units

- We can use the mole relationship to convert between the number of particles and the mass of a substance

Practice Problem #1

Find the number of molecules in each:

1. **56.5 mol of NaCl**

2. **24.0 mol of H_2O**

Practice Problem #1

Find the number of molecules in each:

1. **15.0 mol of CO_2**

1. **0.65 mol of H_2**

Practice Problem #1

Find the number of molecules in each:

1. **56.5 mol of NaCl = (56.5 mols) × (6.02×10^{23}) = 3.40×10^{25} molecules**
2. **24.0 mol of H_2O = (24.0 mols) × (6.02×10^{23}) = 1.44×10^{25} molecules**
3. **15.0 mol of CO_2 = (15.0 mols) × (6.02×10^{23}) = 9.03×10^{24} molecules**
4. **0.65 mol of H_2 = (0.65 mols) × (6.02×10^{23}) = 3.91×10^{23} molecules**

Time to think!

- In the last example we found the number of molecules in a given amount of moles

- **But, how can we find the number of atoms of a certain element within that molecule?**

Example: Find the number of hydrogen atoms in a given number of H_2O molecules

Practice Problem #2

Find the number of hydrogen atoms in 24.0 moles of H_2O:

In a H_2O molecule we have 2 × H atoms and 1 × O atom

In 1 mole of H_2O we have:

Practice Problem #3

Find the number of Sodium atoms in 56.5 moles of NaCl

In a NaCl molecule we have 1 × Na atom and 1 × Cl atom

In 1 mole of NaCl we have:

The Molar Mass

- The atomic mass of any substance expressed in grams is the **molar mass (MM)** of that substance.

- The atomic mass of iron is **55.85 amu**.

- Therefore, the molar mass of iron is **55.85 g/mol**.

Calculating Molar Mass

- The molar mass of a compound is the **sum** of the molar masses of each element.

Practice: What is the molar mass of magnesium nitrate, Water (H_2O)?

Problem Problem #4

Calculate the molar mass of the following compounds

1. **Water (H_2O)**

Type of atom	Mass of 1 mole x number of atoms	Total Mass per mole
H		
O		

Molar Mass of H_2O =

Problem Problem #4

Calculate the molar mass of the following compounds

1. **Water (H_2O)**

Type of atom	Mass of 1 mole x number of atoms	Total Mass per mole
H	1.00 x 2 atoms	2.00 g
O	16.0 x 1 atom	16.00 g

Molar Mass of H_2O = 2.00 g + 16.0 g = **18.0 g/mol**

Problem Problem #4

Molar Mass of $Mg_3(PO_4)_2$

Type of atom	Mass of 1 mole x number of atoms	Total Mass per mole
Mg		
P		
O		

MM of $Mg_3(PO_4)_2$ =

Problem Problem #4

Molar Mass of $Mg_3(PO_4)_2$

Type of atom	Mass of 1 mole x number of atoms	Total Mass per mole
Mg	24.3g x 3 atoms	72.9 g
P	31.0g x 2 atoms	62.0 g
O	16.0g x 8 atoms	128.0 g

MM of $\mathbf{Mg_3(PO_4)_2}$ = 72.9g + 62.0g +128.0g = **262.9 g/mol**

Problem Problem #4

Molar Mass of $Cu(NO_3)_2$

Type of atom	Mass of 1 mole x number of atoms	Total Mass per mole
Cu		
N		
O		

MM of **$Cu(NO_3)_2$** = :

Problem Problem #4

Molar Mass of $Cu(NO_3)_2$

Type of atom	Mass of 1 mole x number of atoms	Total Mass per mole
Cu	63.5g x 1 atom	63.5 g
N	14.0g x 2 atoms	28.0 g
O	16.0g x 6 atoms	96.0 g

MM of **$Cu(NO_3)_2$** = 63.5g + 28.0g + 96.0g = **187.5 g/mol**

Practice 5:

What is the molar mass of magnesium nitrate, $Mg(NO_3)_2$?

(Try it without the table!)

Practice 5:

What is the molar mass of magnesium nitrate, $Mg(NO_3)_2$?

The sum of the atomic masses is:

=

- The molar mass for $Mg(NO_3)_2$ is

Practice 5:

What is the molar mass of magnesium nitrate, $Mg(NO_3)_2$?

The sum of the atomic masses is:

$$= 24.31g + 2(14.01g + 16.00g + 16.00g + 16.00g)$$

$$= 24.31g + 2(62.01g)$$

$$= 148.33\ g/mol$$

- The molar mass for $Mg(NO_3)_2$ is **148.33 g/mol.**

HOMEWORK

Textbook:

- p.78 #2 - 5,
- p.80 #6a-h, 7a-d

Show all your work!