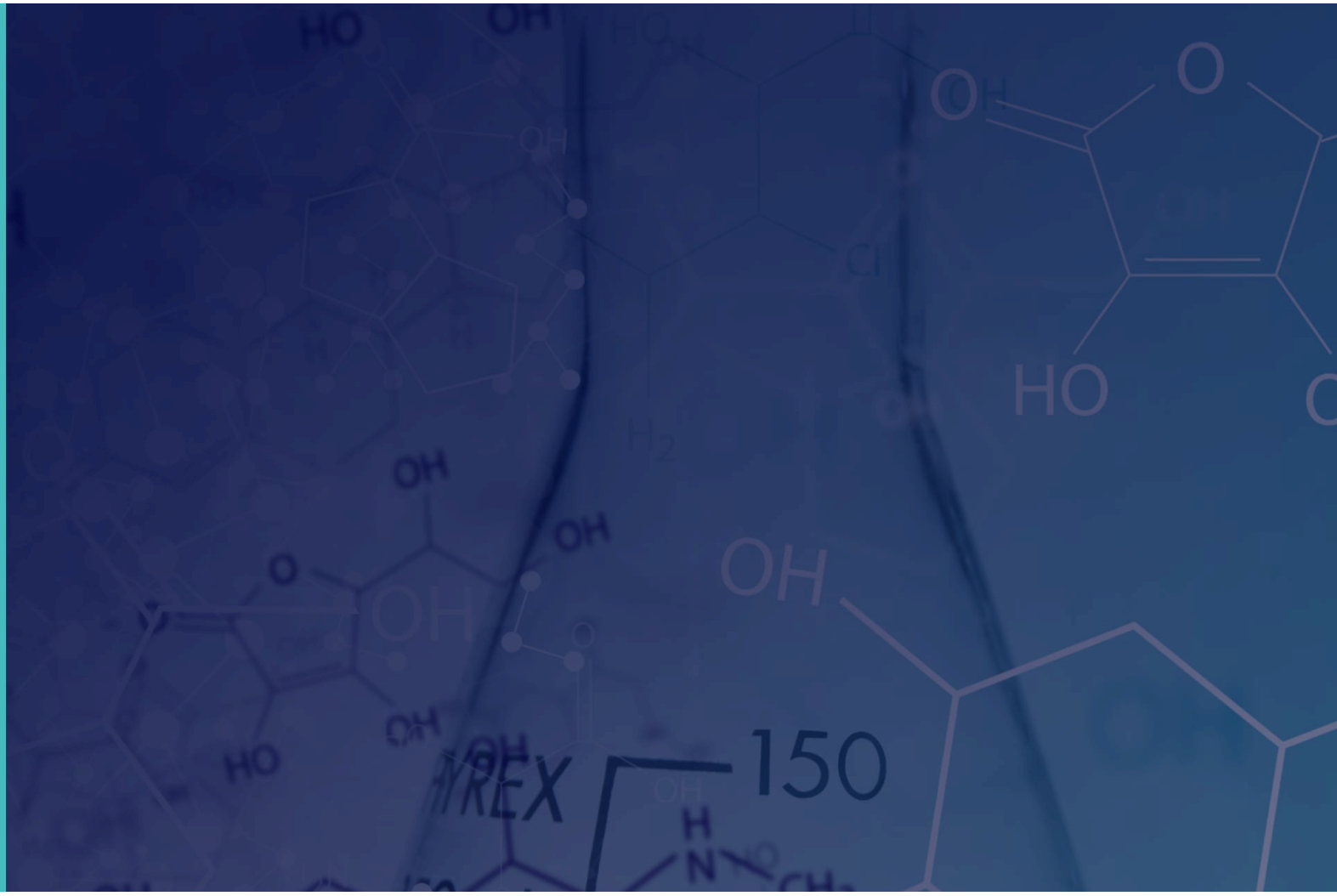



## Ontario High School

# Grade 11 Chemistry

## Summer 2024, Chapter 5 Notes

# Table of Contents

# 5. Quantities in Chemistry

## 5.1 The Mole and Molar Mass

5.1.1

### Moles and Molar Mass

- A **mole** is the exact number of atoms in 12g of carbon
- If we know that: $\boxed{1 \text{ dozen} = 12}$, then $\boxed{1 \text{ mole} = 6.022 \times 10^{23}}$
- The above value, 6.02x10$^{23}$ is referred to as **Avogadro's number ($N_A$)**

$$\boxed{N_A = 6.022 \times 10^{23} \text{ mol}^{-1}}$$

## Molar Mass

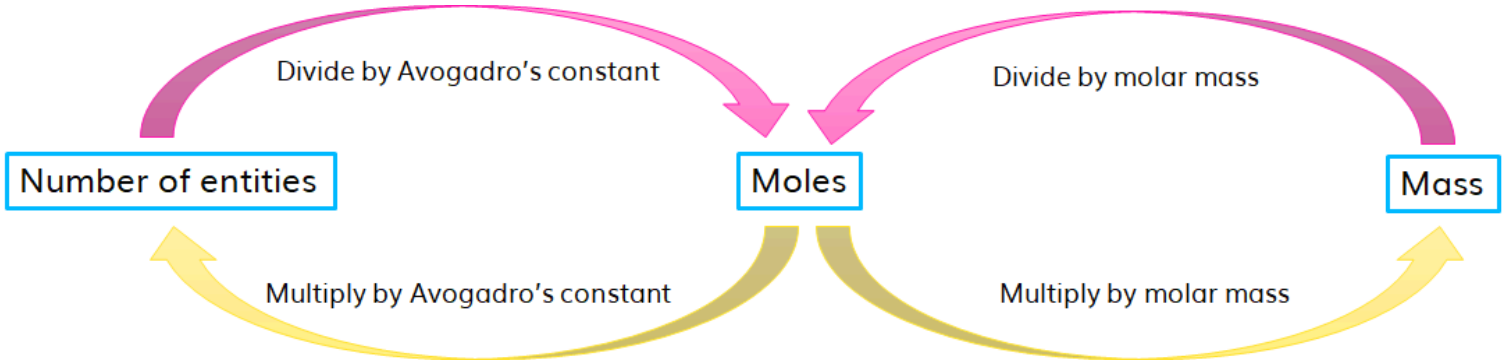
- **Molar mass** is the mass of one mole of particles of that substance
- Units for molar mass are **g/mol.**
- Molar mass is abbreviated using the symbol **M**
  *Example:* Molar mass of elemental oxygen can be represented as $M_{O_2}$

## Molar Mass of Elements

- Found in periodic table.
  *Example:* Molar mass of sodium
- When looking at molar mass of molecular elements, you have to multiply the molar mass of the element by the number of atoms per molecule
  *Example:*Molar mass of elemental chlorine

## Molar Mass of Ionic and Molecular Compounds

- The molar mass of a compound is equal to the sum of the molar mass of each entity in the compound.
  *Example:* Molar mass of sulfuric acid, $H_2SO_4$


Divide by Avogadro's constant
Divide by molar mass
Number of entities
Moles
Mass
Multiply by Avogadro's constant
Multiply by molar mass

5.1.2

# Example: Using Avogadro's Number

Calculate the number of Cu atoms if you have 0.635g of Cu.

5.1.3

# Practice: Calculating Molar Mass

Calculate the molar mass of $H_2O$. Give your answer rounded to the nearest whole integer; do not include units.

Answer

5.1.4

# Practice: Using Avogadro's Number and Molar Mass

**Part 1**

If we are told that a sample of $CO_2(s)$ weighs 11g, how many moles of $CO_2$ are present in the sample?

Answer

---

# Practice: Using Avogadro's Number and Molar Mass

**Part 2**

How many molecules are present in the sample?

Answer

# Practice: Using Avogadro's Number and Molar Mass

**Part 3**

How many oxygen atoms there in this sample of $CO_2$?

Answer

5.1.5

# Practice: Converting Mass to Number of Atoms

Calculate the number of nitrogen atoms in 2.25 g of $Bi(NO_3)_3$.

- $1.03x10^{22}$ atoms
- $1.03x10^{21}$ atoms
- $3.43x10^{21}$ atoms
- $3.43x10^{22}$ atoms

# 5.2 Empirical Formulas

5.2.1

## Percent Composition

- The **percent composition** shows the amount that each element in a compound contributes to the overall mass of that compound.
- The **law of definite proportions** states that the elements in a chemical compound are always present in the same proportions by mass.
  *Example:* A pinch of salt will have the same percent composition as a cup of salt.
- To determine the percent composition of a compound, divide the mass of a particular element by the total mass of the compound and multiply by 100 to get a percentage

$$\%\text{ composition by mass} = \frac{\text{mass contribution of element}}{\text{total mass of compound}} \times 100\%$$

*Example: Percent Composition using Chemical Formula*

What is the percent composition by mass of oxygen in sodium hydroxide, NaOH? _____

5.2.2

# Empirical Vs Molecular Formulas

- **Molecular formulas** tell us exactly how many atoms make up a molecule.
  *Example:* $C_6H_6$ tells us that for each molecule of $C_6H_6$, there are _____ C atoms and _____ H atoms.
- **Empirical formulas** are the smallest possible "unit" of the molecular formula.
  *Example:* The empirical formula of $C_6H_6$ would be: _____

- When a molecular formula cannot be reduced , the molecular formula and empirical formula of the compound are the same
  ***Example:*** $NO_2$

- Many molecules can have the same empirical formula
  ***Example:*** $C_2H_2$ and $C_6H_6$ have the same empirical formula of CH

5.2.3

# Example: Percent Composition using Experimental Mass

A 27.0 g sample of a compound contains 7.20 g of carbon, 2.20 g of hydrogen and 17.6 g of oxygen. Calculate the percent composition of the compound.

5.2.4

# Practice: Percent Composition

What percent of iron (III) hydroxide, $Fe(OH)_3$, is oxygen? Round your answer to the nearest whole integer; do not include any symbols.

Answer

5.2.5

# Practice: Finding Empirical Formula

A compound has the following mass composition: C = 86.59%, H = 8.36% and N = 5.05%. What is the empirical formula of this compound?

- $C_7H_8N_3$
- $C_{20}H_{23}N$
- $C_{87}H_8N_5$
- $C_3H_3N$
- $C_{14}H_{14}N$

5.2.6

# Practice: Finding Molecular Formula

A sample of a compound contains 1.52g of N atoms and 3.47g of O atoms. The molar mass of the compound is 92.02g/mol.  Determine the molecular formula.

- $N_2O_4$
- NO
- $N_2O$
- $N_2O_2$
- $NO_2$