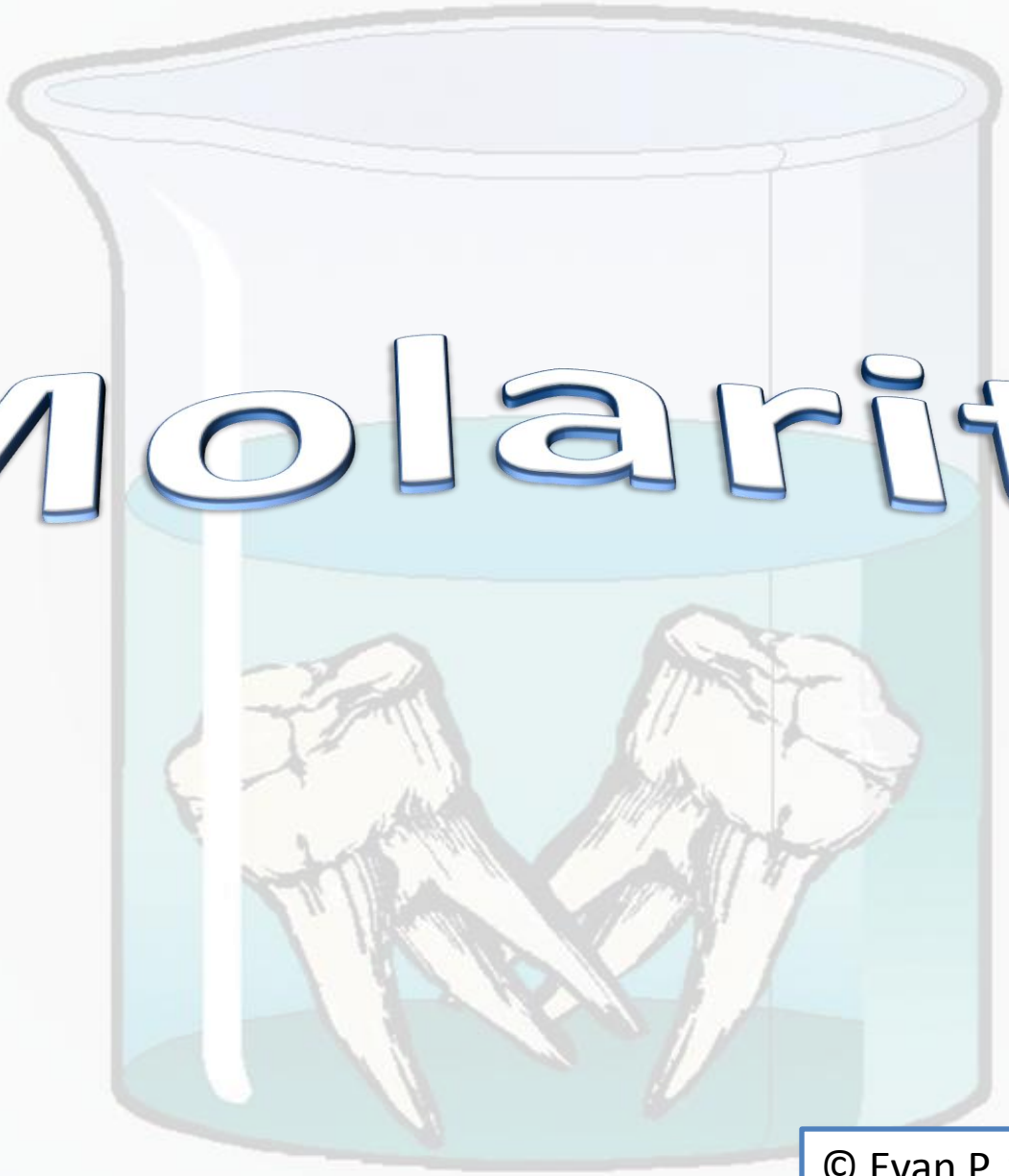
Molarity



Another Type of Concentration

- Recall the quantitative definition of concentration:

$$Concentration = \frac{Mass\ of\ Solute\ (g)}{Volume\ of\ Solvent\ or\ Solution}$$

- Recall also that there is a relationship between mass and moles.
- The amount of solute can be expressed as moles instead of grams.
- The new measure of concentration is called molarity.

Defining Molarity

- To determine molarity:
  - The amount of solute is expressed in moles (*mol*).

and

  - The amount of solution is expressed in liters (*L*).

- Molarity (*M*) is the number of moles of solute per liter of solution.

$$M = \frac{\textbf{mol (solute)}}{\textbf{L (solution)}}$$

Related Relationships

- Considering that $M = \frac{mol}{L}$, find moles.

$$mol = M \times L$$

- Considering that $M = \frac{mol}{L}$ and $mol = \frac{g}{GFM}$, find molarity by substituting for moles.

$$M = \frac{g}{GFM \times L}$$

- Find grams by using algebra .

$$g = M \times GFM \times L$$

Sample Problem 1

Find the molarity of 100. mL of a solution that contains 0.25 moles of dissolved solute.

- **Step 1:** Convert all volumes to liters

$$100.\ mL \times \frac{0.001\ L}{1\ mL} = 0.100\ L$$

- **Step 2:** Substitute values into the definitional equation

$$M = \frac{0.25\ mol}{0.100\ L} = 2.5\ M$$

Sample Problem 2

Find the molarity of 250. mL of a solution that contains 4.0 g of dissolved sodium hydroxide (NaOH).

- **Step 1:** Find the GFM

  Na = 23 × 1 = 23
  O = 16 × 1 = 16
  H = 1 × 1 = 1
  40

- **Step 2:** Convert all volumes to liters

$$250.\ mL \times \frac{0.001\ L}{1\ mL} = 0.250\ L$$

- **Step 3:** Substitute values into the correct equation

$$M = \frac{g}{GFM \times L}$$

$$M = \frac{4.0\ g}{(40.\ {}^{g}/_{mol})(0.250\ L)} = 2.5\ M$$

Sample Problem 3

How many moles of solute are dissolved in 30 mL of a 2 M solution?

- **Step 1:** Convert all volumes to liters

$$30\ mL \times \frac{0.001\ L}{1\ mL} = 0.03\ L$$

- **Step 2:** Substitute values into the correct equation

$$mol = M \times L$$

$$mol = (2\ M)(0.03\ L) = 0.06\ mol$$

NOTE: Since M = $^{mol}/_{L}$, the units cancel properly

Sample Problem 4

How many grams of silver nitrate ($AgNO_3$) are needed to prepare 200. mL of a 0.10 M solution?

- **Step 1:** Find the GFM

  Ag = 108 × 1 = 108
  N = 14 × 1 = 14
  O = 16 × 3 = 48
  170

- **Step 2:** Convert all volumes to liters

$$200.\ mL \times \frac{0.001\ L}{1\ mL} = 0.200\ L$$

- **Step 3:** Substitute values into the correct equation

$$g = M \times GFM \times L$$

$$g = (0.10\ M)(170\ {}^{g}/_{mol})(0.200\ L)$$
$$= 3.4\ g$$

NOTE: Since M = ${}^{mol}/_{L}$, the units cancel properly