0.1 Outline

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0.2 Terminology

In solution, we need to define the following terms:

- solvent – The medium (e.g., water, ethanol, benzene, etc.) in which a solute is dissolved to form a solution.
- solute – The substance (e.g. NaCl, glucose, etc.) dissolved in a solvent to form a solution.

0.3 Concentration of Solute

The amount of solute in a solution is given by its concentration.

$$\text{Molarity(M)} = \frac{\text{moles of solute}}{\text{liters of solution}} \tag{1}$$

$$\begin{aligned}[\text{NaCl}] &= 0.1M \\ &= \frac{0.1 \text{ moles of NaCl}}{1 \text{ L of solution}}\end{aligned}$$

0.4 Preparing Solutions

- Weigh out a solid solute and dissolve in a given quanitity of solvent.
- Dilute a concentrated solution to give one that is less concentrated.

0.5 Using Molarity,

What mass of oxalic acid, $H_2C_2O_4$, is required to make 250.00 mL of a 0.0500 M solution?

$$\begin{aligned}\text{molar mass} &= (2 * 1.008) + (2 * 12.011) + (4 * 15.999) \\ &= 2.016 + 24.022 + 63.996 \\ &= 90.034 \text{ g mol}^{-1}\end{aligned}$$

$$250.00 \text{ mL} \times \frac{1 \text{ L}}{1,000 \text{ mL}} \times \frac{0.05 \text{ mol}}{1\text{L}} \times \frac{90.034 \text{ g } H_2C_2O_4}{1 \text{ mol } H_2C_2O_4} = 1.125425 \text{ g } H_2C_2O_4$$

0.6 Preparing a Solution by Dilution

You have 50.0 mL of 3.0 M NaOH and you want 0.50 M NaOH. What does one do?

$$\begin{aligned} M_1V_1 &= M_2V_2 \\ (3.0)(50.0) &= (0.5)V_2 \\ V_2 &= \frac{(3.0)(50.0)}{0.5} \\ V_2 &= (6.0)(50.0) \\ V_2 &= 300.0 \text{ mL} \\ &= 3.0 \times 10^2 \text{ mL} \end{aligned}$$

In an acid-base titration, it takes 38.55 mL of 0.650 M perchloric acid ($HClO_4$) to completely neutralize 25.00 mol calcium hydroxide ($Ca(OH_2)$) solution.

$$Ca(OH_2)(aq.) + 2HClO_4(aq.) \rightarrow Ca(ClO_4)_2(aq.) + 2H_2O(l)$$

A) How many moles of $HClO_4$ are needed for the complete neutralization?

$$38.55\text{mL perchloric acid} \times \frac{1 \text{ L perchloric acid}}{1,000 \text{ mL perchloric acid}} \times \frac{0.650 \text{ mol}}{1 \text{ L}} = 0.0251 \text{ mol perchloric acid}$$

B) How many moles of $Ca(OH_2)_2$ got consumed during the neutralization?

$$0.0251 \text{ mol perchloric acid} \times \frac{1 \text{ mol } Ca(OH_2)_2}{2 \text{ mol perchloric acid}} = 0.01255 \ Ca(OH_2)_2$$

C) What is the concentration of $Ca(OH_2)_2$ in the original solution before titration?

$$\frac{25.00 \text{ mol } Ca(OH_2)_2}{38.55\text{mL}} \times \frac{1,000 \text{ mL}}{1 \text{ mL}} =$$

0.7 Dissociation

- When an ionic compound dissolves in water, the solvent pulls the individual ions from the crystal and solvates them.
- This process is called dissociation.

$$NaCl(s) \rightarrow Na^+(aq) + Cl^-(aq)$$

- An electrolyte is a substance that dissociates into ions when dissolved in water.
- Ionic compounds dissociate in water ().
- Only a few molecular compounds are capable of dissociating in water.
- For example,

$$HCl \rightarrow H^+ + Cl^-$$

0.8 Electrolytes

- An electrolyte is a substance that dissociates into ions when dissolved in water.
- A nonelectrolyte may dissolve in water, but it does not dissociate into ions when it does so.
- There are many examples of molecular compounds (e.g.,) that serve as nonelectrolytes in water.