Chemistry 20

Lesson 18 – Dilution

I. Dilution

Quite often we buy household products in a concentrated form and then dilute it to a usable concentration. For example, dishwashing liquid comes in a concentrated form and we add a few squirts of it to some warm water resulting in a soapy solution that aids in the cleaning of dishes and cutlery. **Dilution** is where we take a known amount of a concentrated solution and add more solvent to form a dilute (less concentrated) solution.

Calculating the concentration of the new solution is quite simple since the quantity of solute being diluted does not change.

$$\mathbf{n_{initial} = n_{final}}$$

Using the relationship n = c v, the **dilution equation** is

$$\mathbf{c_i v_i = c_f v_f}$$

or

$$\mathbf{c_1 v_1 = c_2 v_2}$$

Example 1

What volume of a 0.035 mol/L solution of sodium hydroxide is required to make 200 mL of a 0.0015 mol/L solution?

$$c_1 v_1 = c_2 v_2$$

$$(0.035\,{}^{\text{mol}}\!/_{\text{L}})v_1 = (0.0015\,{}^{\text{mol}}\!/_{\text{L}})(200\text{mL})$$

$$v_1 = \frac{(0.0015\,{}^{\text{mol}}\!/_{\text{L}})(200\text{mL})}{(0.035\,{}^{\text{mol}}\!/_{\text{L}})}$$

$$v_1 = \mathbf{8.6\,mL}$$

Note that there is no need to change the volume from mL to L. The mol/L units cancel out leaving mL as the only remaining unit.

Example 2

What is the concentration of a solution when 15 mL of a 0.035 mol/L solution is diluted to fill a 500 mL container?

$$c_1 v_1 = c_2 v_2$$

$$(0.035\,{}^{\text{mol}}\!/_{\text{L}})(15\text{mL}) = c_2(500\text{mL})$$

$$c_2 = \frac{(0.035\,{}^{\text{mol}}\!/_{\text{L}})(15\text{mL})}{(500\text{mL})}$$

$$c_2 = \mathbf{0.0011\,{}^{mol}\!/_{L}}$$

II. Assignment

1. In pure form methanol has a concentration of 24.7 mol/L. What volume of methanol is necessary to prepare 8.0 L of a 10.0 mol/L solution?

2. What is the molar concentration if 10 L of concentrated caustic soda solution (19.1 mol/L) is diluted to 400 L?

3. Concentrated ammonia ($NH_{3\,(aq)}$) is 14.8 mol/L. What volume is required to prepare 5.0 L of a 0.70 mol/L solution?

4. Pure ethanol is 17.2 mol/L. To what volume must 10.0 mL of ethanol be diluted to prepare a 10.3 mol/L solution?

5. If 2.50 L of water was added to the final solution in question 3, what is the new concentration?

6. If 60.0 L of a 2.50 mol/L toxic substance were dumped into a pond to give a final volume of 5.00×10^3 L, what would be the final concentration?

7. To what volume must the toxic waste in the previous problem be diluted to make a final concentration of 1.00×10^{-6} mol/L?

8. What is the final concentration if 15.6 g of $NaOH_{(s)}$ is added to 3.60 L of a 1.00 mol/L solution of $NaOH_{(aq)}$? (Be careful!)

9. 5.00 g of hydrogen acetate is added to 150 mL of a 3.00 mol/L solution of acetic acid. After another 850 mL of water is added, what is the final concentration?

10. What mass of ammonia gas would have to be added to 75.6 mL of a 0.0350 mol/L solution of ammonia to obtain a 0.100 mol/L solution?