Worksheet – Molar Concentrations and Preparing Aqueous Solutions

Review the following sample problem.

Sample Problem

Using Molar Concentration to Find Mass

Problem

At 20°C, a saturated solution of calcium sulfate, $CaSO_4$, has a concentration of 0.0153 mol/L. A student takes 65 mL of this solution and evaporates it. What mass (in g) is left in the evaporating dish?

What Is Required?

You need to find the mass (in g) of the solute, calcium sulfate.

What Is Given?

The molar concentration is 0.0153 mol/L. The volume of the solution is 65 mL.

Plan Your Strategy

Step 1 Convert the volume from mL to L using the formula

$$\text{Volume (in L)} = \text{Volume (in mL)} \times \frac{1.000\ \text{L}}{1000\ \text{mL}}$$

Step 2 Rearrange the following formula to solve for the amount of solute (in mol).

$$\text{Molar concentration (in mol/L)} = \frac{\text{Amount of solute (in mol)}}{\text{Volume of solution (in L)}}$$

Step 3 Determine the molar mass of calcium sulfate. Use the molar mass to find the mass in grams, using the formula below:

$$\text{Mass (in g) of } CaSO_4 = \text{Amount (in mol)} \times \text{Molar mass of } CaSO_4 \text{ (in g/mol)}$$

Act on Your Strategy

Step 1 Convert the volume from mL to L.

$$\text{Volume} = 65\ \cancel{\text{mL}} \times \frac{1.000\ \text{L}}{1000\ \cancel{\text{mL}}}$$
$$= 0.065\ \text{L}$$

Step 2 Rearrange the formula to solve for the amount of solute.

$$\text{Molar concentration} = \frac{\text{Amount of solute}}{\text{Volume of solution}}$$

$$\therefore \text{Amount of solute} = \text{Molar concentration} \times \text{Volume of solution}$$
$$= 0.0153\ \text{mol/L} \times 0.065\ \text{L}$$
$$= 9.94 \times 10^{-4}\ \text{mol}$$

Step 3 Determine the molar mass. Then find the mass in grams.

$$\text{Molar mass of } CaSO_4 = 40.08 + 32.07 + (4 \times 16.00)$$
$$= 136.15\ \text{g/mol}$$

$$\text{Mass (in g) of } CaSO_4 = 9.94 \times 10^{-4}\ \text{mol} \times 136\ \text{g/mol}$$
$$= 0.135\ \text{g}$$

1. What is the molar concentration of each solution?

(a) 0.50 mol of NaCl dissolved in 0.30 L of solution

(b) 0.289 mol of iron(III) chloride dissolved in 120.0 mL of solution

(c) 0.0877 mol of copper(II) sulfate dissolved in 70.0 mL of solution

(d) 4.63 g of sugar, $C_{12}H_{22}O_{11}$, dissolved in 16.8 mL of solution

(e) 1.2 g of $NaNO_3$ dissolved in 80.0 mL of solution

2. What mass of solute is present in each aqueous solution?

(a) 1.00 L of 0.045 mol/L calcium hydroxide, $Ca(OH)_2$, solution

(b) 500.0 mL of 0.100 mol/L silver nitrate, $AgNO_3$, solution

(c) 2.5 L of 1.00 mol/L potassium chromate, K_2CrO_4, solution

(d) 40.0 mL of 6.0 mol/L sulfuric acid solution

(e) 4.24 L of 0.775 mol/L ammonium nitrate solution

3. A student dissolves 30.46 g of $AgNO_3$ in water to make 500.0 mL of solution. What is the molar concentration of the solution?
4. What volume of 0.25 mol/L solution can be made using 14 g of sodium hydroxide?
5. A 100.0 mL bottle of skin lotion contains a number of solutes. One of these solutes is zinc oxide. The concentration of zinc oxide in the skin lotion is 0.915 mol/L. What mass of zinc oxide is present in the bottle?

6. Formalin is an aqueous solution of formaldehyde, HCHO, used to preserve biological specimens. What mass of formaldehyde is needed to prepare 1.50 L of formalin with a concentration of10.0 mol/L?
7. Suppose that you are given a solution of 1.25 mol/L sodium chloride in water, NaCl(aq). What volume of this solution do you need to prepare the following solutions?
   a) 50 mL of 1.00 mol/L NaCl(aq)
   b) 200 mL of 0.800 mol/L NaCl(aq)
   c) 250 mL of 0.300 mol/L NaCl(aq)
8. What concentration of solution is obtained by diluting 50.0 mL of 0.720 mol/L aqueous $NaNO_3(aq)$, to a final volume of:
   (a) 120.0 mL **(b)** 400.0 mL **(c)** 5.00 L
9. A solution is prepared by adding 600.0 mL of distilled water to 100.0 mL of 0.15 mol/L ammonium nitrate. Calculate the molar concentration of the solution.
10. What mass of potassium chloride is used to make 25.0 mL of a solution with a concentration of 2.00 mol/L?
11. A solution is prepared by dissolving 42.5 g of $AgNO_3$ in a 1 L volumetric flask. What is the molar concentration of the solution?
12. The solution of aqueous ammonia that is supplied to schools has a concentration of 14 mol/L. Your class needs 3.0 L of a solution with a concentration of 0.10 mol/L. Write a procedure that explains how you would prepare this solution in the laboratory. Clearly state what equipment you will be using.
13. 47.9 g of potassium chlorate is used to make a solution with a concentration of 0.650 mol/L. What is the volume of the solution?
14. Water and 8.00 mol/L potassium nitrate solution are mixed to produce 700.0 mL of a solution with a concentration of 6.00 mol/L. What volumes of water and potassium nitrate solution are used?