CH 221 Chapter Six Concept Guide

1. Molarity

Problem

A student prepared a solution by dissolving 1.455 g of potassium nitrate in enough water to make 20.00 mL of solution. Calculate the molarity of the solution.

Approach

Molarity is calculated by dividing the number of moles of solute by the volume of solution (in liters).

Solution

Step 1. Calculate the number of moles of solute, KNO_3.

Number of moles of KNO_3 = (1.455 g KNO_3)(1 mol / 101.11 g KNO_3) = 0.01439 moles KNO_3

Step 2. Calculate the molarity of the solution.

Molarity = 0.01439 moles KNO_3 / 0.02000 L solution = 0.7195 M KNO_3

2. Molarity

Question

How many moles of NaCl are present in 15.00 mL of a 1.60 M NaCl?

Approach

To calculate the number of moles, multiply the molarity of the solution with the volume of solution (in liters).

Solution

Number of moles NaCl = 1.60 mol/L NaCl * 0.01500 L solution = 0.0240 mol NaCl

3. Molarity

Question

What volume of a 1.35×10^{-3} M $C_6H_{12}O_6$ solution should you transfer to obtain a solution that contains 2.44×10^{-6} moles of glucose?

Approach

Use the molarity of the glucose solution to convert from units of moles to units of liters.

Solution

Volume of solution to transfer = 2.44×10^{-6} moles glucose / 1.35×10^{-3} M $C_6H_{12}O_6$

= 0.00181 L

= 1.81 mL of 1.35×10^{-3} M $C_6H_{12}O_6$

4. Dilution

Problem

Calculate the volume of 0.0111 M HCl that we should use to prepare 100 mL of a 4.23×10^{-4} M HCl solution.

Approach

Use the following equation to calculate the final volume of the solution. The other variables, $M_{initial}$, $V_{initial}$, and M_{final} are all known values.

$$M_{initial} \times V_{initial} = M_{final} \times V_{final}$$

Solution

$M_{initial} \times V_{initial} = M_{final} \times V_{final}$

$(0.0111 \text{ M HCl})(V_{initial}) = (4.23 \times 10^{-4} \text{ M HCl})(100 \text{ mL})$

$V_{initial} = 3.81 \text{ mL}$

3.81 mL of a 0.0111 M HCl(aq) solution are needed to prepare 100 mL of a 4.23×10^{-4} M HCl(aq) solution.

5. Titrations

Question

If 20.00 mL of a solution of oxalic acid, $H_2C_2O_4$, was titrated with 0.500 M NaOH(aq) and the endpoint was reached when 30.0 mL of the solution of base had been added, what is the molarity of the oxalic acid solution?

Approach

First, we need to write the balanced chemical equation. Calculate the number of moles of NaOH that were added. Then calculate the number of moles of $H_2C_2O_4$ consumed using the mole ratios indicated in the balanced equation.

Solution

Step 1. Write the balanced chemical equation.

$H_2C_2O_4(aq) + 2\ NaOH(aq) \rightarrow Na_2C_2O_4(aq) + 2\ H_2O(l)$

Step 2. Calculate the number of moles of NaOH added.

0.03000 L NaOH x 0.500 mo/L NaOH = 0.0150 mol NaOH

Step 3. Calculate the number of moles of $H_2C_2O_4$.

The stoichiometric relation we need is 2 mol NaOH: 1 mol $H_2C_2O_4$.

Number of moles of $H_2C_2O_4$

= 0.0150 mol NaOH x (1 mol $H_2C_2O_4$ / 2 mol NaOH)

= 0.00750 mol $H_2C_2O_4$

Step 4. The molarity of the oxalic acid solution can be calculated by dividing the moles of $H_2C_2O_4$ by the volume of base added in liters.

0.00750 mol $H_2C_2O_4$ / 0.0200 L solution = 0.375 M $H_2C_2O_4$

6. Titrations

Question

A student prepared a sample of aqueous HCl that contained 0.45 g of HCl in 250 mL of solution. This solution was used to titrate 20.0 mL of a solution of $Ca(OH)_2$ and the equivalence point was reached when 14.4 mL of acid solution had been added. What was the molarity of the $Ca(OH)_2$ solution?

Approach

First, we need to write the balanced chemical equation. Then the molarity of the HCl solution must be calculated. From this value, the number of moles of HCl can be determined, and the number of moles of $Ca(OH)_2$ can be calculated using a mole ratio. Then, the molarity of the $Ca(OH)_2$ solution can be calculated.

Solution

Step 1. Write the balanced chemical equation.

$2\ HCl(aq) + Ca(OH)_2(aq) \rightarrow CaCl_2(aq) + 2\ H_2O(l)$

Step 2. Calculate the molarity of HCl.

(0.45 g HCl)(1 mol HCl / 36.46 g HCl) / 0.250 L solution = 0.049 mol/L HCl

Step 3. Calculate the number of moles of HCl.

0.049 mol/L HCl x 0.0144 L HCl = 7.1×10^{-4} mol HCl

Step 4. Calculate the number of moles of $Ca(OH)_2$.
The stoichiometric relation we need is 2 mol HCl : 1 mol $Ca(OH)_2$.
Number of moles of $Ca(OH)_2$
= 7.1×10^{-4} mol HCl * (1 mol $Ca(OH)_2$ / 2 mol HCl)
= 3.6×10^{-4} mol $Ca(OH)_2$.

Step 5. The molarity of the $Ca(OH)_2$ solution can be calculated by dividing the moles of $Ca(OH)_2$ by the volume of $Ca(OH)_2$ solution, in liters.

3.6×10^{-4} mol $Ca(OH)_2$ / 0.020 L $Ca(OH)_2$ = 0.018 mol/L $Ca(OH)_2$