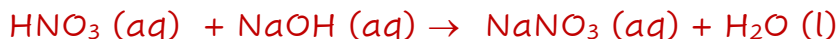


Volumetric (Solution) Stoichiometry and Titration

1. A 45.00 mL sample of HNO_3 was titrated with 0.450 M NaOH. The equivalence point volume was 37.54 mL of NaOH. What is the concentration of the HNO_3 ? (Write a balanced equation)

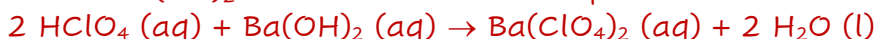


$$\text{Moles of NaOH} = V \times M = 0.03754 \text{ L} \times 0.450 \text{ M} = 0.016893 \text{ mol NaOH}$$

At the equivalence point, all of the NaOH will have reacted with all of the acid. There is a 1:1 ratio of base to acid

$$0.016893 \text{ mol NaOH} \times \frac{1 \text{ mol HNO}_3}{1 \text{ mol NaOH}} = 0.016893 \text{ mol HNO}_3$$
$$\frac{0.016893 \text{ mol HNO}_3}{0.04500 \text{ L}} = \mathbf{0.375 \text{ M}}$$

2. What volume of 0.135 M HClO_4 is required to neutralize 50.00 mL of 0.0926 M $\text{Ba}(\text{OH})_2$? Write a balanced equation.



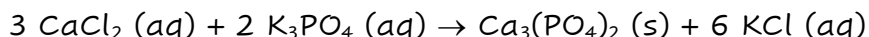
$$\text{mol Ba}(\text{OH})_2 = 0.05000 \text{ L} \times 0.0926 \text{ M} = 0.00463 \text{ mol Ba}(\text{OH})_2$$

$$0.00463 \text{ mol Ba}(\text{OH})_2 \times \frac{2 \text{ mol HClO}_4}{1 \text{ mol Ba}(\text{OH})_2} = 0.00926 \text{ mol HClO}_4$$

We know the molarity and the number of moles of acid. We solve for the volume in L and then convert to mL.

$$\frac{0.00926 \text{ mol}}{0.135 \frac{\text{mol}}{\text{L}}} = \mathbf{0.0686 \text{ L} = 68.6 \text{ mL}}$$

3. Consider the following balanced chemical equation.



If 25.00 mL of 0.455 M CaCl_2 is mixed with 30.00 mL of 0.365 M K_3PO_4 , how many grams of $\text{Ca}_3(\text{PO}_4)_2$ are formed?

$$\text{moles of CaCl}_2 = 0.02500 \text{ L} \times 0.455 \text{ mol/L} = 0.011375 \text{ mol CaCl}_2$$

$$\text{moles of K}_3\text{PO}_4 = 0.03000 \text{ L} \times 0.365 \text{ mol/L} = 0.01095 \text{ mol K}_3\text{PO}_4$$

Find limiting reactant:

$$0.011375 \text{ mol CaCl}_2 \times \frac{1 \text{ mol Ca}_3(\text{PO}_4)_2}{3 \text{ mol CaCl}_2} = 0.003792 \text{ mol Ca}_3(\text{PO}_4)_2$$

$$0.01095 \text{ mol K}_3\text{PO}_4 \times \frac{1 \text{ mol Ca}_3(\text{PO}_4)_2}{2 \text{ mol K}_3\text{PO}_4} = 0.005475 \text{ mol Ca}_3(\text{PO}_4)_2$$

The CaCl_2 is the limiting reactant. The $M_m(\text{Ca}_3(\text{PO}_4)_2) = 310.18 \text{ g/mol}$

$$0.003792 \text{ mol Ca}_3(\text{PO}_4)_2 \times \frac{310.18 \text{ g}}{1 \text{ mol Ca}_3(\text{PO}_4)_2} = \mathbf{1.18 \text{ g Ca}_3(\text{PO}_4)_2}$$