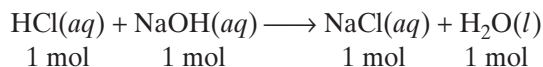


The known solution can be used to determine the molarity of another solution by titration. Suppose 20.0 mL of 5.0×10^{-3} M NaOH is required to reach the end point in the titration of 10.0 mL of HCl of unknown concentration. How can these titration data be used to determine the molarity of the acidic solution?

Begin with the balanced neutralization reaction equation. From the equation, determine the chemically equivalent amounts of HCl and NaOH.



Calculate the number of moles of NaOH used in the titration.

$$\frac{5.0 \times 10^{-3} \text{ mol NaOH}}{1 \text{ L}} \times \frac{1 \text{ L}}{1000 \text{ mL}} \times 20.0 \text{ mL} = 1.0 \times 10^{-4} \text{ mol NaOH used}$$

Because 1 mol of NaOH is needed to neutralize 1 mol of HCl, the amount of HCl in the titration must be 1.0×10^{-4} mol. This is confirmed by the following equation.

$$1.0 \times 10^{-4} \text{ mol NaOH} \times \frac{1 \text{ mol HCl}}{1 \text{ mol NaOH}} = 1.0 \times 10^{-4} \text{ mol HCl}$$

This amount of acid must be in the 10.0 mL of the HCl solution used for the titration. The molarity of the HCl solution can now be calculated.

$$\begin{aligned} \frac{1.0 \times 10^{-4} \text{ mol HCl}}{10.0 \text{ mL}} \times \frac{1000 \text{ mL}}{1 \text{ L}} &= \frac{1.0 \times 10^{-2} \text{ mol HCl}}{1 \text{ L}} \\ &= 1.0 \times 10^{-2} \text{ M HCl} \end{aligned}$$

Sample Problem F illustrates the following four steps.

1. Start with the balanced equation for the neutralization reaction, and determine the chemically equivalent amounts of the acid and base.
2. Determine the moles of acid (or base) from the known solution used during the titration.
3. Determine the moles of solute of the unknown solution used during the titration.
4. Determine the molarity of the unknown solution.

SAMPLE PROBLEM F

In a titration, 27.4 mL of 0.0154 M $\text{Ba}(\text{OH})_2$ is added to a 20.0 mL sample of HCl solution of unknown concentration until the equivalence point is reached. What is the molarity of the acid solution?

SOLUTION

1 ANALYZE

Given: volume and concentration of known solution = 27.4 mL of 0.0154 M $\text{Ba}(\text{OH})_2$
volume of unknown HCl solution = 20.0 mL

Unknown: molarity of acid solution