SCH3U1

**Acid/Base Reactions and Titrations**

ACID   +   BASE  SALT   +   WATER

BCE:

NIE:

TIE:

ACID  +  CARBONATE  SALT  +  CARBON DIOXIDE  +  WATER

BCE:

**TITRATION** is the process of determining the concentration of an acidic or basic solution by reacting it with a solution of a known concentration.   To determine the unknown concentration, we must measure the volume of acid or base carefully using a burette (see figure). By recording the initial volume and final volume, the volume of solution added can be easily measured.  usually: analyte is in the Erlenmeyer flask

 titrant (standard) is in the burette

The **end point** of the reaction is detected with an indicator such as phenolphthalein. The compound turns pink close to neutral pH, when all the acid or base present has been neutralized; the **equivalence point.**



**Example 1: Titration of a Strong Acid with a Strong Base**

A 10.00 mL solution of hydrochloric acid

was  titrated with 0.225 mol/L sodium hydroxide.

The following data was collected:

 Vinitial = 12.45 mL

 Vfinal =  \_\_\_\_\_

 Vadded = Vfinal – Vinitial = \_\_\_\_\_\_\_\_

What is the concentration of the hydrochloric acid solution?

**Solution:**

Acid-base titration questions can be solved using stoichiometry.

To solve this acid-base titration question:

1. Write a balanced chemical equation for the neutralization reaction.
2. Calculate the number of moles of base used in the titration (n = c⋅V)
3. Using mole rations, determine the number of moles of acid that reacted.
4. Calculate the concentration of the unknown acid solution (c = n / V)

**e.g.1**

**Titration of a Strong Acid with a Strong Base**

A 10.00 mL solution of hydrochloric acid was titrated with 0.225 mol/L sodium hydroxide.   The following data was collected:

 Vinitial = 12.45 mL

 Vfinal =   15.75 mL

 Vadded = Vfinal – Vinitial = 3.30 mL

BCE: HCl (aq) + NaOH (aq) NaCl (aq) + H2O

Cacid = ? cbase = 0.225 mol/L

Vacid = 10.00 mL = 0.01000 L Vbase = 3.30 mL = 0.00330 L

Moles Base: n = cV = (0.00330mol/L)(0.225L) = 7.425 x 10-4 mol

Mole Ratio: nacid = nbase = 7.425 x 10-4 mol

Concentration of Acid: c = n/V = (7.425 x 10-4 mol)/(0.01000L) = 0.0742 mol/L

Therefore the concentration of acid was 0.0742 mol/L.

**e.g.2**

**Titration of a Strong Base with a Diprotic Acid (H2X)**

What volume of 0.159 mol/L KOH solution would be required to neutralize 27.48 mL of 0.104 mol/L H2SO4?

BCE: H2SO4 (aq)  +  2 KOH (aq)      K2SO4 (aq)    +   2H2O

Cacid = 0.104 mol/L cbase = 0.159 mol/L

Vacid = 27.48 mL = 0.02748 L Vbase = ?

Moles Acid: nacid = cV = (0.104)(0.02748) = 0.002858 mol

Mole Ratio nacid = 1

 nbase 2

 nbase = 2 x nacid = (2) (0.002858) = 0.005716 mol

Volume of Base Needed: V = n/c = 0.005716 / 0.159 = 0.035948 L

 V = 35.9 mL (to 3 significant digits)

Therefore 35.9 mL of the KOH base is needed to neutralize the acid.

**e.g. 3**

**Cleaning up Acid Spills**

What mass of sodium hydrogen carbonate is needed to clean up a 250 mL spill of concentrated hydrofluoric acid (27.6 mol/L)?

BCE: NaHCO3 (s) + HF (aq) NaF (aq)   +   H2O    +   CO2 (g)

Moles Acid:: nacid = cV = (27.6 mol/L)(0.250 L) = 6.90 mol

Mole ratio: nacid  = nbase = 6.90 mol

Moles to Mass: m = nM = (6.90 mol)(84.01 g/mol) = 580 g

Therefore 580 g of the sodium hydrogen carbonate is required for the clean-up.