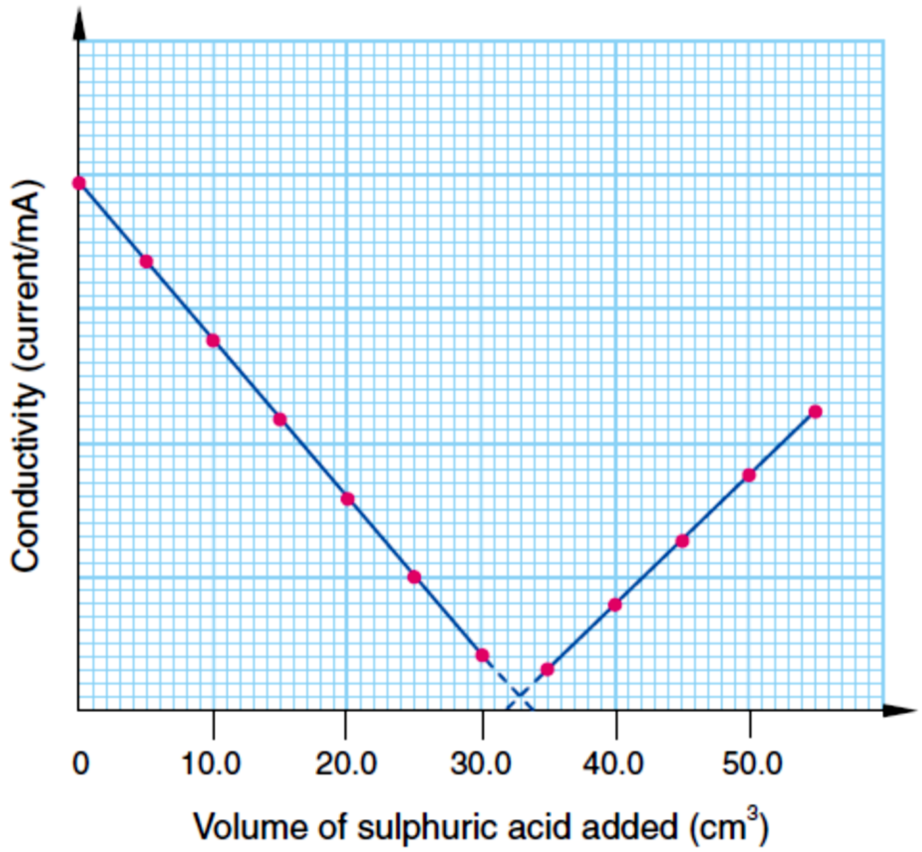
Quiz (Precipitation Titration)

1. The concentration of chloride ions in an unknown sample was determined by Mohr's method. A standard solution of 0.10 M silver nitrate solution was used to titrate with a sample solution using potassium chromate as indicator. 25.0 cm^3 of the sample solution required 22.00 cm^3 of the silver nitrate solution to reach the end point in the titration. Calculate the concentration of chloride ions in the sample solution.

2. A student uses the Mohr's method to determine the concentration of chloride ions in a water sample. 25.0 cm^3 of the water sample is titrated with 0.100 M silver nitrate solution. 26.70 cm^3 of silver nitrate solution is required to reach the end point.
   (a) What is the indicator used in the experiment?
   (b) Calculate the concentration of chloride ions in the water sample.

3. 25.0 cm^3 of a 0.10 M solution of barium hydroxide were placed in a beaker. The electrical conductivity of the solution was measured. Sulphuric acid was then added to the beaker, 5.0 cm^3 at a time. The conductivity was measured after each addition. A precipitate formed during the titration and the reaction was represented by the equation: $Ba(OH)_2(aq) + H_2SO_4(aq) \longrightarrow BaSO_4(s) + 2H_2O(l)$

   The experimental results are shown in the graph below:



   (a) Account for the shape of the graph.
   (b) What is the volume of acid required to reach the equivalence point of the titration?
   (c) Calculate the molarity of the sulphuric acid.

Suggested Answer

1. $Ag^+(aq) + Cl^-(aq) \longrightarrow AgCl(s)$

   Number of moles of Ag^+ in 22.00 cm^3 of 0.10 M $AgNO_3$ solution
   = 0.10 × 0.022
   = 2.2×10^{-3}

   From the equation, mole ratio of $Ag^+ : Cl^- = 1 : 1$.

   Number of moles of Cl^- in 25.0 cm^3 of solution
   = 2.2×10^{-3}

   Concentration of Cl^- in the sample solution
   = 2.2×10^{-3} / 0.025
   = 0.088 M

   The concentration of chloride ions in the sample solution was 0.088 M.

2. (a) Chromate indicator

   (b) Number of moles of $AgNO_3$ required
   = 0.100 × 0.0267
   = 2.67×10^{-3}

   $Ag^+(aq) + Cl^-(aq) \longrightarrow AgCl(s)$

   From the equation, mole ratio of Ag^+ to $Cl^- = 1 : 1$.

   Number of moles of Cl^- present in the water sample = 2.67×10^{-3}

   Concentration of $Cl^-(aq)$ in the water sample
   = 2.67×10^{-3} / 0.025
   = 0.107 mol dm^{-3}

3. (a) Conductivity is high at the beginning due to the large number of mobile Ba^{2+}(aq) and OH^-(aq) ions.
Conductivity decreases due to continuous removal of Ba^{2+}(aq) ions (to form $BaSO_4$(s)) and OH^-(aq) ions (to form H_2O(l)). Conductivity is almost zero at the equivalence point because there are very few mobile ions. It then increases sharply due to the addition of excess H^+(aq) and SO_4^{2-}(aq) ions.

(b) 33.0 cm^3

(c) $Ba(OH)_2(aq) + H_2SO_4(aq) \longrightarrow BaSO_4(s) + 2H_2O(l)$

Number of moles of $Ba(OH)_2$ in 25.0 cm^3 of 0.10 M $Ba(OH)_2$ solution
= 0.10 × 0.025
= 2.5×10^{-3}

From the equation, mole ratio of $Ba(OH)_2$: H_2SO_4 = 1 : 1

Number of moles of H_2SO_4 added = 2.5×10^{-3}

Molarity of H_2SO_4 solution
= 2.5×10^{-3} / 0.033
= 0.076 M