BACK TITRATION

What is back titration and how does it work ?

- A back-titration is similar to a direct titration - but a bit more difficult. When an end-point is not easily identified due to no colour change, an excess volume of a reactant of known concentration is added to the reactant of unknown concentration. Then the resulting mixture is titrated again (or titrated back) to find the volume of the unreacted reactant, which will tell us the amount that did react with the solution of unknown concentration.

- Back titrations are used when:
  i) one of the reactants is volatile (eg. ammonia)
  ii) an acid / a base is an insoluble salt (eg. $CaCO_3$)
  iii) a particular reaction is too slow.
  iv) the end-point is very difficult to observe / no colour change. (eg. weak acid - weak base direct titration)

Example 1

To determine the concentration of a volatile substance.

25.00 mL of a cloudy ammonia solution was added to 50.00 mL of 0.180 M HCl(aq) in a 250.0 mL conical flask. The excess (unreacted) HCl was then titrated with 21.80 mL 0.050 M Na_2CO_3. Calculate the molarity of the ammonia in the cloudy ammonia solution.

Solution :

$$2HCl(aq) + Na_2CO_3(aq) \longrightarrow 2NaCl(aq) + CO_2(g) + H_2O(l)$$

$n = \frac{MV}{1000}$

$$n_{Na_2CO_3} = \frac{(0.050\ M)(21.80\ mL)}{1000}$$

$$= 1.09 \times 10^{-3}\ mol$$

STOICHIOMETRY : BACK TITRATION

From the balanced equation : $2HCl \equiv Na_2CO_3$

$$\frac{n_{HCl\,(titrated)}}{n_{Na_2CO_3}} = \frac{2}{1} \quad \therefore n_{HCl\,(titrated)} = 2 \times n_{Na_2CO_3}$$

$$= (2 \times 1.09 \times 10^{-3}) \text{ mols}$$

$$= 2.18 \times 10^{-3} \text{ mols}$$

$$n_{HCl\,(total)} = \frac{MV}{1000}$$

$$= \frac{(0.180\,M)(50.00\,mL)}{1000} = 9.0 \times 10^{-3} \text{ mol}$$

$$n(HCl_{total}) = n(HCl_{titrated}) + n(HCl_{reacted\ with\ ammonia})$$

$$9.0 \times 10^{-3} \text{ mols} = 2.18 \times 10^{-3} \text{ mols} + n(HCl_{reacted\ with\ ammonia})$$

$$\therefore n(HCl_{reacted\ with\ ammonia}) = (9.0 \times 10^{-3}) - (2.18 \times 10^{-3})$$

$$= 6.82 \times 10^{-3} \text{ mol}$$

$$NH_3\,(aq) + HCl\,(aq) \longrightarrow NH_4Cl\,(aq)$$

$$n_{NH_3} = n_{HCl}$$

$$\left(\frac{MV}{1000}\right)_{NH_3} = 6.82 \times 10^{-3}$$

$$\frac{M_{NH_3} \times 25.00\,mL}{1000} = 6.82 \times 10^{-3}$$

$$\therefore M_{NH_3} = 0.2728 \text{ mol dm}^{-3} \text{ (Ans)}.$$

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