Item 2

$NaOH + HCl \longrightarrow NaCl_{(aq)} + H_2O_{(l)}$

Step 1 (Concentration) of NaOH

molar of HCl in $20cm^3$

$1000cm^3$ Contain 1 mole of HCl.

$20cm^3$ of solution Contain $\frac{1}{1000} \times 20 = 0.02$ moles. Ha

moles of NaOH in $20cm^3$.

1 mole of HCl react with 1 mole of NaOH.

moles of NaOH = 0.02 moles. Ha

Molarity of NaOH solution.

$20cm^3$ of solution Contain 0.02 moles of NaOH.

$1000cm^3$ of solution Contain $\frac{0.02}{20} \times 1000 = 1M$ Ha

Therefore the molarity (concentration) of NaOH is $1 mol\,dm^{-3}$ Ha

Step 2

Moles of HCl in $23Cm^3$

$1000cm^3$ of solution Contain 1 mole of HCl

$23Cm^3$ of solution " $\frac{1}{1000} \times 23 = 0.023$ moles Ha

Moles of NaOH reacted with HCl (excess)

1 mole of HCl react with 1 mole of NaOH.

Moles of NaOH = 0.023 moles Ha

∴

Moles of NaOH in $100cm^3$.

$1000cm^3$ of solution Contain 1 mole of NaOH

$100cm^3$ of " Contain $\frac{1}{1000} \times 100 = 0.1$ moles. Ha

moles of NaOH reacted with citric acid: $= 0.1 - 0.023$ Ha

$= 0.077$ moles

$C_6H_8O_{7(aq)} + 3NaOH_{(aq)} \longrightarrow Na_3C_6H_5O_{7(aq)} + 3H_2O_{(l)}$

Moles of $C_6H_8O_7$ reacted with NaOH.

3 moles of NaOH react with 1 mole of $C_6H_8O_7$

0.077 moles of react with $\frac{1}{3} \times 0.077$ ✓ Ha.

$= 0.02567$ moles

mass of pure Citric acid

RMM of $C_6H_8O_7 = 12\times6 + 1\times8 + 16\times7 = 192$

mass $= 0.02567 \times 192$

$= 4.929\,g$ ✓ Ha

percentage purity $= \frac{4.929}{5.3} \times 100$ ✓ Ha.

$= 93\%$

Therefore the percentage purity of Citric acid is 93% ✓ Hi

⇒ The percentage purity of Citric acid is 93% which is between 85% and 100%. ✓ Hc

⇒ The available Citric acid can be used as an ingredient for food preservation since it's purity is between 85 and 100% ✓ R.

Other applications of this technique

⇒ Can be used to determine the relative atomic mass of elements in a compound mostly insoluble ones

⇒ Analysing composition of salts to determine the quality of a given atom or group of atoms like Ammonium fertilisers

⇒ Can also be used to determine percentage impurity of given chemical samples.

Suitability of the technique.

⇒ Some solids to be analysed like citric acid in this case are insoluble in water and can easily dissolve in other substances.

Step 1

3 Ha + Hi = 5 scores.

3 Ha = 3 scores.

1 - 2 Ha = 1 Score.

Step 2.

7 Ha + Hi + Hc = 10 scores

7 Ha + Hi = 7 scores

7 Ha = 5 scores.

1 - 6 Ha = 3 Scores.

2A + R = 7 scores

2A = 5 scores.

Fe = 3 scores.

Total = 25 scores.