EXPERIMENT NO. 20

Quantitative Analysis

Read through the whole method before starting any practical work. Where appropriate, prepare a table for your results in the space provided.

Show your working and appropriate significant figures in the final answer to **each** step of your calculations.

1 Iron wire contains impurities. You will investigate the percentage by mass of iron in a sample of iron wire.

A sample of iron wire is reacted with an excess of sulfuric acid to produce a solution of iron(II) sulfate.

$$Fe(s) + H_2SO_4(aq) \rightarrow FeSO_4(aq) + H_2(g)$$

You will titrate the solution of iron(II) sulfate with potassium manganate(VII) of known concentration to determine the amount of iron(II) ions present and hence the percentage by mass of iron in the wire. You may assume the impurities do not form any products that react with potassium manganate(VII).

$$5Fe^{2+}(aq) + MnO_4^-(aq) + 8H^+(aq) \rightarrow 5Fe^{3+}(aq) + Mn^{2+}(aq) + 4H_2O(l)$$

FB 1 is 0.0200 mol dm^{-3} potassium manganate(VII), $KMnO_4$.
FB 2 is a solution of $FeSO_4$ prepared by reacting 6.02 g of iron wire with sulfuric acid to make 1 dm^3 of solution.
FB 3 is dilute sulfuric acid, H_2SO_4.

(a) Method

- Fill a burette with **FB 1**.
- Pipette 25.0 cm^3 of **FB 2** into a conical flask.
- Use the measuring cylinder to transfer 25 cm^3 of **FB 3** into the conical flask.
- Perform a rough titration and record your burette readings in the space below.

final burette reading/cm^3	24.80
initial burette reading/cm^3	0.30
titre /cm^3	24.50

The rough titre is ...24.50... cm^3.

- Carry out as many accurate titrations as you think necessary to obtain consistent results.
- Make certain that any recorded results show the precision of your practical work.
- Record all of your burette readings and the volume of **FB 1** added in each accurate titration.

Results

final burette reading/cm^3	48.90	26.50	
initial burette reading/cm^3	24.80	2.40	
titre /cm^3	24.10	24.10	
best titres	✓	✓	

I	
II	
III	
IV	
V	
VI	
VII	

[7]

(b) From your accurate titration results, obtain a suitable value for the volume of **FB 1** to be used in your calculations. Show clearly how you obtained this value.

$\frac{24.10 + 24.10}{2}$

25.0 cm^3 of **FB 2** required ..24.10.. cm^3 of **FB 1**. [1]

(c) **(i)** Give your answers to **(ii)**, **(iii)**, **(iv)** and **(v)** to the appropriate number of significant figures. [1]

(ii) Use your answer to **(b)** to calculate the number of moles of potassium manganate(VII), **FB 1**, which reacted with 25.0 cm^3 of **FB 2**.

$n = cV$

$= 0.0200 \times \frac{24.10}{1000}$

moles of MnO_4^- = ..4.82×10^{-4}.. mol [1]

(iii) Use the information on page 2 to calculate the number of moles of iron(II) ions present in 25.0 cm^3 of **FB 2**.

$Fe^{2+} : MnO_4^-$

$5 : 1$

$x : 4.82 \times 10^{-4}$

moles of Fe^{2+} = ..2.41×10^{-3}.. mol [1]

(iv) Calculate the mass of iron present in 25.0 cm^3 of **FB 2**.

$m = n \times Ar$

$= 2.41 \times 10^{-3} \times 55.8$

mass of Fe = ..0.1345.. g [1]

(v) Calculate the percentage by mass of iron in the sample of iron wire.

25 cm^3 — 0.1345 g

1000 cm^3 — x

x = 5.38 g

$= \frac{5.38}{6.02} \times 100 = 89.4\ \%$

percentage by mass of iron in iron wire = ..89.4.. % [1]

(d) A student suggested that when a piece of iron wire was dissolved in a known volume and concentration of sulfuric acid, the number of moles of iron that reacted with the acid could be determined by working out how much acid was left after the reaction. The amount of excess acid could be determined by titrating the mixture with a known concentration of sodium hydroxide.

Explain whether the student was correct.

The student is wrong because sodium hydroxide will also react with Fe^{2+} to form ppt of $Fe(OH)_2$. [1]

[Total: 14]