EXPERIMENT NO. 18

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(II) sulfate crystals, $FeSO_4 \cdot xH_2O$, contain water of crystallisation. You will carry out a titration to determine the value of x in the formula, where x is an integer. A solution containing a known mass of the crystals will be titrated with acidified aqueous potassium manganate(VII) of known concentration.

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

FA 1 contains 26.52 g dm^{-3} of hydrated iron(II) sulfate, $FeSO_4 \cdot xH_2O$.
FA 2 is 0.0200 mol dm^{-3} potassium manganate(VII), $KMnO_4$.
FA 3 is dilute sulfuric acid, H_2SO_4.

(a) Method

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

final burette reading / cm^3	25.90
initial burette reading / cm^3	0.60
titre / cm^3	25.30

The rough titre is ......25.30...... cm^3.

- Carry out as many accurate titrations as you think necessary to obtain consistent results.
- Make sure any recorded results show the accuracy of your practical work.
- Record in a suitable form below all your burette readings and the volume of **FA 2** added in each accurate titration.

final burette reading / cm^3	27.20	30.90	
initial burette reading / cm^3	2.60	6.30	
titre / cm^3	24.60	24.60	
best titres	✓	✓	

I	
II	
III	
IV	
V	
VI	
VII	

[7]

(b) From your accurate titration results, obtain a suitable value to be used in your calculations. Show clearly how you obtained this value.

$\frac{24.60 + 24.60}{2}$

25.0 cm^3 of **FA 1** required ....24.60.... cm^3 of **FA 2**. [1]

(c) Calculations

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

(ii) Calculate the number of moles of potassium manganate(VII) present in the volume of **FA 2** calculated in **(b)**.

$n = cV$

$= 0.0200 \times \frac{24.60}{1000}$

moles of $KMnO_4$ = ...4.92×10^{-4}.... mol [1]

(iii) Calculate the number of moles of iron(II) sulfate present in 1.00 dm^3 of **FA 1**.

$Fe^{2+} : KMnO_4$

$5 : 1$

$x : 4.92 \times 10^{-4}$

2.46×10^{-3} mol/25cm3

$c = \frac{n}{V} = \frac{2.46 \times 10^{-3}}{25.0/1000}$

moles of $FeSO_4$ = ...0.0984.... mol [1]

(iv) Calculate the mass of iron(II) sulfate present in 1.00 dm^3 of **FA 1**.

M_r of $FeSO_4$: 151.9

$m = n \times M_r$

$= 0.0984 \times 151.9$

mass of $FeSO_4$ = ...14.95.... g [1]

(v) Calculate the value of x in $FeSO_4 \cdot xH_2O$.

mass of H_2O = $FeSO_4 \cdot xH_2O - FeSO_4$

$= 26.52 - 14.95$

11.57 g

moles of $H_2O = \frac{11.57}{18}$

0.643 mol

$FeSO_4 : H_2O$

0.0984 mol : 0.643 mol

1 mol : x

$1 : 6.53 \approx 7$

x = ...7.... [2]

(d) Iron(II) sulfate in solution is readily oxidised by air to form iron(III) sulfate.

State the effect, on the value of *x* calculated in **(c)(v)**, if some of your sample of **FA 1** had oxidised before you carried out the titration.
Explain your answer.

Value of x will be greater because of less volume of $KMnO_4$ so less number of moles of $KMnO_4$ and $FeSO_4$ and more mass of water. [2]

[Total: 16]