

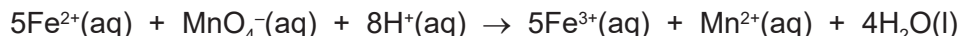
# EXPERIMENT NO. 18

## 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,  $\text{FeSO}_4 \cdot x\text{H}_2\text{O}$ , 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.



**FA 1** contains  $26.52 \text{ g dm}^{-3}$  of hydrated iron(II) sulfate,  $\text{FeSO}_4 \cdot x\text{H}_2\text{O}$ .

**FA 2** is  $0.0200 \text{ mol dm}^{-3}$  potassium manganate(VII),  $\text{KMnO}_4$ .

**FA 3** is dilute sulfuric acid,  $\text{H}_2\text{SO}_4$ .

### (a) Method

- Fill the burette with **FA 2**.
- Pipette  $25.0 \text{ cm}^3$  of **FA 1** into a conical flask.
- Use the  $25 \text{ cm}^3$  measuring cylinder to transfer  $25 \text{ cm}^3$  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 / $\text{cm}^3$	25.90
initial burette reading / $\text{cm}^3$	0.60
titre / $\text{cm}^3$	25.30

The rough titre is ..... *25.30* .....  $\text{cm}^3$ .

- 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 / $\text{cm}^3$	27.20	30.90	
initial burette reading / $\text{cm}^3$	2.60	6.30	
titre / $\text{cm}^3$	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<sup>3</sup> of FA 1 required 24.60 cm<sup>3</sup> 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]

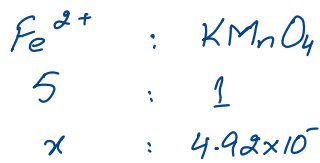
- (ii) Calculate the number of moles of potassium manganate(VII) present in the volume of FA 2 calculated in (b).

$$n = cV$$

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

moles of KMnO<sub>4</sub> = 4.92 × 10<sup>-4</sup> mol [1]

- (iii) Calculate the number of moles of iron(II) sulfate present in 1.00 dm<sup>3</sup> of FA 1.



$$c = \frac{n}{V} = \frac{4.92 \times 10^{-4}}{25.0/1000}$$

$$2.46 \times 10^{-3} \text{ mol} / 25 \text{ cm}^3$$

moles of FeSO<sub>4</sub> = 0.0984 mol [1]

- (iv) Calculate the mass of iron(II) sulfate present in 1.00 dm<sup>3</sup> of FA 1.

$$M_r \text{ of FeSO}_4 = 151.9 \quad m = n \times M_r$$

$$= 0.0984 \times 151.9$$

mass of FeSO<sub>4</sub> = 14.95 g [1]

- (v) Calculate the value of x in FeSO<sub>4</sub>·xH<sub>2</sub>O.

$$\text{mass of H}_2\text{O} = \text{FeSO}_4 \cdot x\text{H}_2\text{O} - \text{FeSO}_4$$

$$= 26.52 - 14.95$$

$$\boxed{11.57 \text{ g}}$$

$$\text{moles of H}_2\text{O} = \frac{11.57}{18}$$

$$\boxed{0.643 \text{ mol}}$$



$$0.0984 \text{ mol} : 0.643 \text{ mol}$$

$$1 \text{ mol} : x$$

$$1 = 6.53 \approx 7$$

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  $\text{KMnO}_4$  so less number of moles of  
 $\text{KMnO}_4$  and  $\text{FeSO}_4$  and more mass of  
water. [2]

[Total: 16]