EXPERIMENT NO. 6

1 In this experiment you will determine the value of **x** in the formula for hydrated copper(II) sulfate, $CuSO_4.\mathbf{x}H_2O$. You will first react a solution of Cu^{2+} ions with excess iodide ions, I^-. This reaction produces iodine.

$$2Cu^{2+}(aq) + 4I^-(aq) \rightarrow 2CuI(s) + I_2(aq)$$

The amount of iodine produced can be determined by titrating with thiosulfate ions, $S_2O_3^{2-}$.

$$I_2(aq) + 2S_2O_3^{2-}(aq) \rightarrow 2I^-(aq) + S_4O_6^{2-}(aq)$$

FA 1 is 0.150 mol dm^{-3} sodium thiosulfate, $Na_2S_2O_3$.
FA 2 is dilute sulfuric acid.
FA 3 is 1.00 mol dm^{-3} potassium iodide, KI.
FA 4 is a solution made by dissolving 32.5 g of $CuSO_4.\mathbf{x}H_2O$ in 1.00 dm^3 of solution.
starch indicator

(a) Method

- Fill the burette with **FA 1**.
- Pipette 25.0 cm^3 of **FA 4** into a conical flask.
- Use the measuring cylinder to add 10 cm^3 of **FA 2** to the same conical flask.
- Use the measuring cylinder to add 10 cm^3 of **FA 3** to the same conical flask. The mixture will become brown because of the formation of I_2, and will become cloudy because of the formation of the white precipitate of CuI.
- Add **FA 1** from the burette until the mixture becomes a light brown colour.
- Add 10 to 20 drops of starch indicator until the mixture becomes blue-black.
- Continue to titrate with **FA 1** until the blue-black colour disappears leaving a mixture with an off-white solid. This is the end-point.
- You should test that the end-point has been reached by adding 2 more drops of starch indicator. If the titration has reached the end-point the added starch indicator will cause no change in colour.
- Perform a rough titration and record your burette readings in the space below.

final burette reading / cm^3	28.00
initial burette reading / cm^3	1.40
titre / cm^3	26.60

The rough titre is ....26.60..... cm^3.

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

final burette reading / cm^3	33.20	38.60	28.30	
initial burette reading / cm^3	6.90	12.50	2.20	
titre / cm^3	26.30	26.10	26.10	
best titre		✓	✓	

I	
II	
III	
IV	
V	
VI	
VII	

[7]

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

$\frac{26.10 + 26.10}{2}$

25.0 cm^3 of **FA 4** required ....26.10.... cm^3 of **FA 1**. [1]

(c) Calculations

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

(i) Calculate the number of moles of thiosulfate ions in the volume of **FA 1** calculated in **(b)**.

$n = cV$
$= 0.150 \times \frac{26.10}{1000}$

moles of $S_2O_3^{2-}$ = ...3.92×10^{-3}.... mol

(ii) Using the equations on page 1, calculate the number of moles of copper(II) ions in 25.0 cm^3 of **FA 4**.

$Cu^{2+} : S_2O_3^{2-}$
$1 : 1$

moles of Cu^{2+} = ...3.92×10^{-3}.... mol

(iii) Calculate the concentration, in mol dm^{-3}, of copper(II) ions in **FA 4**.

$c = \frac{n}{V} = \frac{3.92 \times 10^{-3}}{25/1000}$

concentration of Cu^{2+} in **FA 4** = ...0.157.... mol dm^{-3}

(iv) Calculate the value of **x** in $CuSO_4.xH_2O$.

$M_r = \frac{m}{n} = \frac{32.5}{0.157}$

$M_r = 207$

$xH_2O = CuSO_4.xH_2O - CuSO_4$
$= 207 - 159.6$
$= 47.4$

$x = \frac{47.4}{18} = 2.63 \approx 3$

x = ...3....
[5]

(d) (i) Calculate the maximum percentage error in one of your accurate titres.

error = Least Count / 2

% error = error / value x 100

error = 0.10 / 2 = ±0.05 cm³

% error = 2(0.05) / 26.10 x 100

maximum percentage error = 0.383 %

(ii) A student suggests that the experiment could be made more accurate if the volume of **FA 3** was measured using a burette.

Give a reason why the student might make this suggestion.

The volume from the burette has a smaller error.

OR

Burette is more precise.

Explain why this change would **not** improve the accuracy of the experiment.

As FA3 is in excess.

[3]

[Total: 16]