4.4.3 Chemistry Paper 3 (233/3)

1. You are provided with:

   - solution **A** containing an oxidising agent **A**;
   - solution **B**, 0.05 M aqueous sodium thiosulphate;
   - solution **C** containing a reducing agent **C**;
   - aqueous potassium iodide;
   - solution **D**, starch solution.

   You are required to determine the:

   - concentration of solution **A**;
   - rate of reaction between the oxidising agent **A** and the reducing agent **C**.

Procedure 1

1. Using a pipette and **pipette filler**, place 25.0 cm^3 of solution **A** into a 250 ml conical flask.

2. Measure 10 cm^3 of aqueous potassium iodide and add it to solution **A** in the conical flask. Shake the mixture. Add 10 cm^3 of 2 M sulphuric (VI) acid to the mixture and shake.

3. Fill a burette with solution **B** and use it to titrate the mixture in the conical flask until it just turns **orange-yellow**. Add 2 cm^3 of solution **D** to the mixture in the conical flask. Shake thoroughly. Continue titrating until the mixture **just turns colourless**. Record your results in **table 1** below.

4. Repeat the procedure and complete table 1. **Retain the remainder of** solution **A** and solution **D** for use in procedure II.

Table 1	**I**	**II**	**III**
Final burette reading			
Initial burette reading			
Volume of solution **B** used (cm^3)			

(4 marks)

(a) Calculate the:

(i) average volume of solution **B** used; (1 mark)

(ii) number of moles of sodium thiosulphate. (1 mark)

(b) Given that one mole of **A** reacts with six moles of sodium thiosulphate, calculate the:

(i) number of moles of **A** that were used; (1 mark)

(ii) concentration of solution **A** in moles per litre. (2 marks)

Procedure II

1. Label six test - tubes as 1, 2, 3, 4, 5 and 6 and place them in a test - tube rack.

2. Using a clean burette, measure the volumes of distilled water shown in **table 2** into the labelled test - tubes.

3. Using a burette, measure the volumes of solution **A** shown in **table 2** into each of the test - tubes.

4. Clean the burette and rinse it with about 5 cm^3 of solution **C**.

5. Using the burette, measure 5 cm^3 of solution **C** and place it into a 100 ml beaker.

6. Using a 10 ml measuring cylinder, measure 5 cm^3 of solution **D** and add it to the beaker containing solution **C**. Shake the mixture.

7. Pour the contents of test - tube number 1 to the mixture in the beaker and immediately start a stop watch. Swirl the contents of the beaker. Record the time taken for a **blue** colour to appear in **table 2**.

8. Repeat steps 5 to 7 using the contents of test - tube numbers 2, 3, 4, 5 and 6.

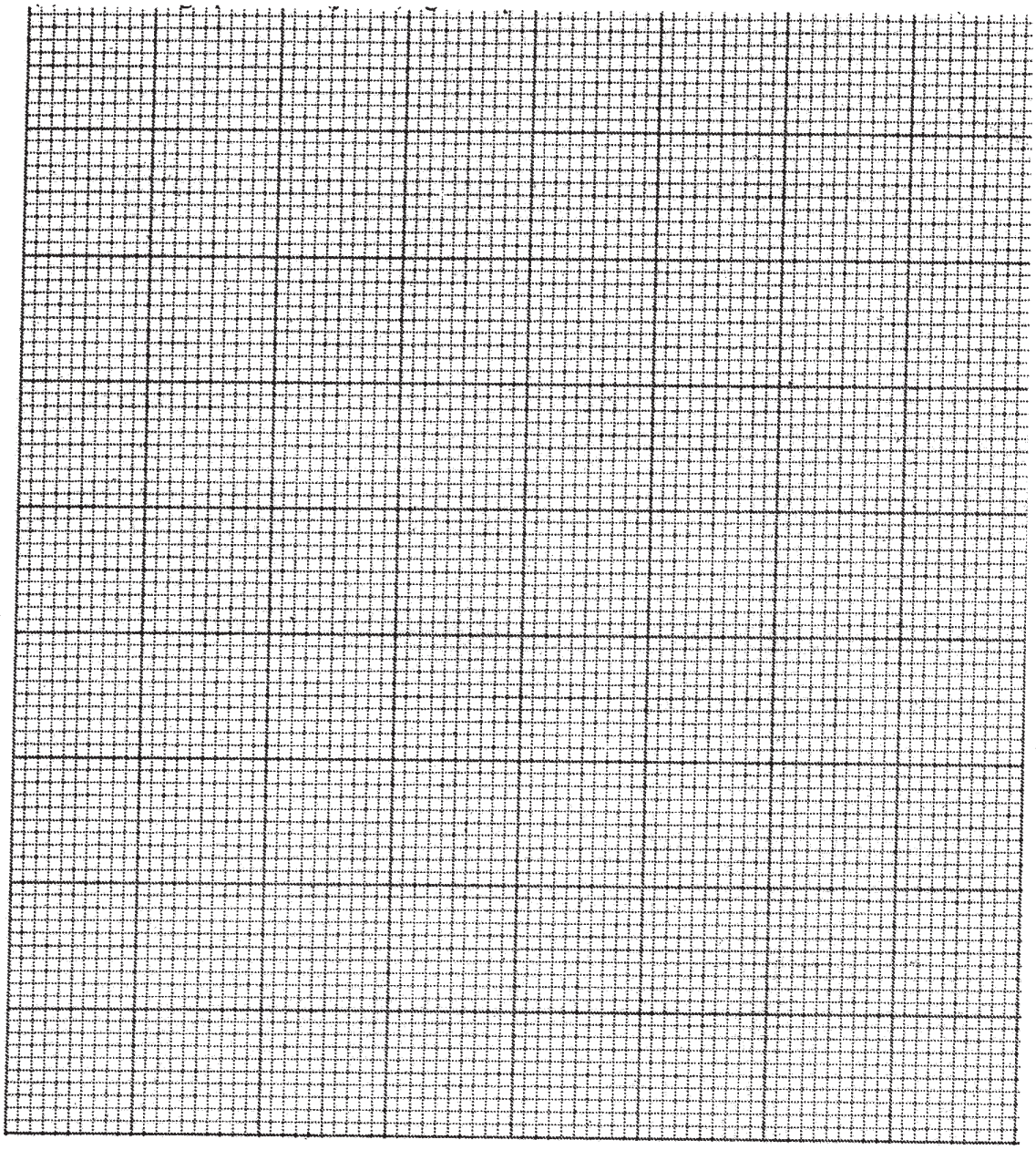
9. Complete **table 2** by computing Rate $= \frac{1}{\text{time}} (S^{-1})$.

Table 2

Test - tube number	1	2	3	4	5	6
Volume of distilled water (cm^3)	0	2	3	5	6	7
Volume of solution **A** (cm^3)	10	8	7	5	4	3
Time (seconds)						
Rate $= \frac{1}{\text{time}} (S^{-1})$						

(6 marks)

(a) Plot a graph of rate (y-axis) against volume of solution **A**. (3 marks)



(b) What time would be taken for the blue colour to appear if the experiment was repeated using 4 cm^3 of distilled water and 6 cm^3 of solution **A**? (2 marks)

2. You are provided with solid **E**. Carry out the experiments below. Write your observations and inferences in the spaces provided.

(a) Place all of solid **E** in a boiling tube. Add about 20 cm^3 of distilled water and shake until all the solid dissolves, label the solution as solution **E**. Use solution **E** for experiments (i) and (ii).

(i) To 2 cm^3 of solution **E**, in a test - tube in each of experiments I, II, III and IV, add:

I. two drops of aqueous sodium sulphate;

Observations	Inferences
(1 mark)	(1 mark)

II. five drops of aqueous sodium chloride;

Observations	Inferences
(1 mark)	(1 mark)

III. two drops of barium nitrate;

Observations	Inferences
(1 mark)	(1 mark)

IV. two drops of lead (II) nitrate;

Observations	Inferences
(1 mark)	(1 mark)

(ii) To 2 cm^3 of solution **E**, in a test - tube, add 5 drops of aqueous sodium hydroxide. Add the piece of aluminium foil provided to the mixture and shake. Warm the mixture and test any gas produced with both blue and red litmus papers.

Observations	Inferences
(2 marks)	(1 mark)

3. You are provided with solid **F**. Carry out the following tests. Write your observations and inferences in the spaces provided.

(a) Place all of solid **F** in a boiling tube. Add about 20 cm^3 of distilled water and shake until all the solid dissolves. Label the solution as solution **F**.

Add about half of the solid sodium hydrogen carbonate provided to 2 cm^3 of solution **F**.

Observations	Inferences
(1 mark)	(1 mark)

(b) (i) Add about 10 cm^3 of dilute hydrochloric acid to the rest of solution **F** in the boiling tube. Filter the mixture. Wash the residue with about 2 cm^3 of distilled water. Dry the residue between filter papers. Place about one third of the dry residue on a **metallic** spatula and burn it in a Bunsen burner flame.

Observations	Inferences
(1 mark)	(1 mark)

(ii) Place all the remaining residue into a boiling tube. Add about 10 cm^3 of distilled water and shake thoroughly. **Retain the mixture for the tests in** (C).

Observations	Inferences
(1 mark)	(1 mark)

(c) Divide the mixture into two portions:

(i) to the first portion, add the rest of the solid sodium hydrogen carbonate.

Observations	Inferences
(1 mark)	(1 mark)

(ii) to the second portion, add two drops of bromine water.

Observations	Inferences
(1 mark)	(1 mark)