1. You are provided with:-
   - Solution **T**, 2M Hydrochloric acid.
   - Solution **P**, 0.15M Sodium thiosulphate
   - Solution **S,** Sodium carbonate

Procedure 1

Measure $20cm^3$ of 0.15M Sodium thiosulphate (solution **P**) into a $250cm^3$ a conical flask. Place the beaker on a white piece of paper with **ink mark** '**X**' on it. Measure $20cm^3$ of 2M hydrochloric acid solution **T** using a $50cm^3$ measuring cylinder. Put the acid into the conical flask containing Sodium thiosulphate and immediately start off the stop watch. Determine the time taken for the **mark** '**X**' to become invisible /obscured when viewed from above. Repeat the procedure by measuring different volumes of the acid and adding the volumes of the distilled water to complete Table I below.

Table I

Volume of acid (cm^3)	Volume of water (cm^3)	Volume of sodium thiosulphate (cm^3)	Time taken for mark 'X' to be invisible/obscured (seconds)	Reciprocal of time (sec^{-1}) $\frac{1}{t}$
20	0	20	33	0.0303 ✓½
18	2	20	37	0.0270 ✓½
16	4	20	41	0.0244 ✓½
14	6	20	47	0.0213 ✓½
12	8	20	57	0.0175 ✓½
10	10	20	63	0.0159 ✓½

a) Complete the table above (6 marks)

CT1
D ½
A ½

b) Plot a graph of 1/t (rate) against volume of acid used. (3 marks)

1

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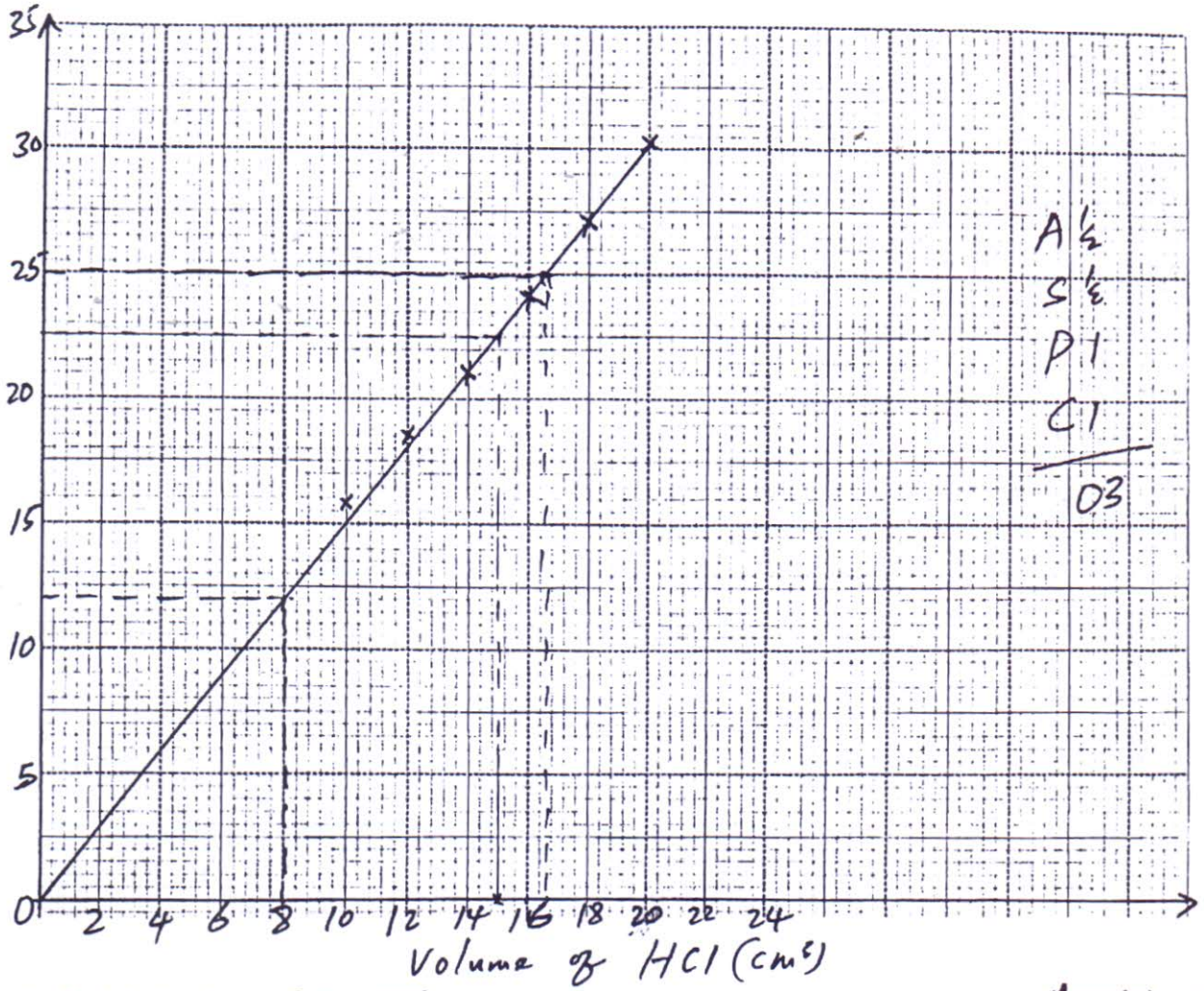

c) Explain the shape of your graph (1 marks)

Increase in volume of HCl increases rate of reaction (1/t) ½
This is due to increase in number of reacting particles ½
hence more successful collisions ... I

d) From the graph determine

(i) Time taken for the cross to be obscured/invisible when the volume of the acid is:

I) 15cm³ (1 mark)

1/t = 0.0225 ½ t = 44.44 ½ sec.
- Must be shown on graph ... I

II) 8cm³ (1 mark)

1/t = 0.0120 ½ t = 83.33 ½ sec.
- Must be shown on graph ... I

06

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(ii) The volume of the acid used if the time taken for the cross to be obscured/invisible is:

I) 40 seconds (1 mark)

$\frac{1}{t} = 0.025$ ✓½ | $V = 16.6\,cm^3$ ✓½

II) 43 seconds (1 mark)

$\frac{1}{t} = 0.0233$ ✓½ | $V = 15.6\,cm^3$ ✓½

Procedure 2

Using a 10 cm^3 measuring cylinder, place 10 cm^3 of solution T into a 250 ml volumetric flask. Add about 200 cm^3 of distilled water. Shake well. Add more distilled water to top up to the mark. Label this solution U. Fill the burette with solution U. Using a pipette and pipette filler, pipette 25 cm^3 of solution S into a conical flask. Add 3 drops of Phenolphthalein indicator and titrate with solution U.

- Record your results in the table.
- Repeat the titration two more times and complete the table.

Table 2

	I	II	III
Final burette reading (cm^3)	15.0	15.0	15.0
Initial burette reading (cm^3)	0.0	0.0	0.0
Volume of solution U (cm^3) added	15.0	15.0	15.0

(4 marks)

CT1 P1 A1 PA1 FA1 05

a) Determine the:-

(I) Average volume of solution U used. ✓½ (1 mark)

$\frac{15.0 + 15.0 + 15.0}{3} = \frac{45.0}{3}$ ✓½

$= 15.0\,cm^3$ Ans.

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(II) Moles of the acid in the average volume of solution U used. (2 marks)

$M_1V_1 = M_2V_2$ ✓1 ½

$M_2 = \frac{10 \times 2}{250}$ ✓½

$= 0.08M$ ✓½

Moles used $= \frac{0.08 \times \text{value in a(i)}}{1000}$ ✓½

$= \text{Ans}$ ✓½

(IV) Concentration of solution S in moles per litre. (2 marks)

$Na_2CO_{3(aq)} + 2HCl_{(aq)} \rightarrow 2NaCl_{(aq)} + CO_{2(g)} + H_2O_{(l)}$ ✓½

moles of $Na_2CO_3 = \frac{\text{Ans II}}{2}$ ✓½

Molarity $= \frac{\text{moles of } Na_2CO_3 \times 1000}{25}$ ✓½

$= \text{Ans IV}$ ✓½

2. (a) Put a spatula end-full of solid Q into a boiling tube and add about $10cm^3$ of distilled water. Shake the mixture well. Divide the resultant solution into 4 equal portions.

Observations	Inferences ✓½ ✓½
Solid A dissolves forming a pale green solution ✓½ (½ mark)	Fe^{2+}, Cu^{2+} suspected (1 mark)

(b) (i) The solution is suspected to contain **ammonium ions**. Using **calcium hydroxide solid** and **red litmus paper** provided, describe how you would confirm presence of the **ammonium ions**.

Description	Expected observations
To the 1st portion, add a little $Ca(OH)_{2(s)}$ and warm ✓½. Test the gas using a moist red litmus paper ✓½ (1 mark)	Colourless gas changes moist red litmus paper to blue. ✓½ (½ mark)

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(ii) Carry out the actual test as described in (b) (i) above.

Observations	Inferences
Colourless gas ½ turns moist red litmus paper to blue ½ (1 mark)	NH_4^+ ½ (½ mark)

1½

(c) To the second portion, add 4 drops of hydrogen peroxide solution. Test the gas produced using a glowing splint.

Observations	Inferences
- Pale green solution turns brown ½ - Colourless gas relights a glowing splint ½ (1 mark)	O_2 gas ½ Fe^{2+} ½ (Must have appeared in (a)) (1 mark)

2

(d) (i) The solution is also suspected to contain **sulphite ions**. Using **Barium nitrate solution** and **dilute hydrochloric acid** solution, describe how you would confirm presence of the **sulphite ions**.

Description	Expected observations
To the third portion, ½ add 3 drops of $Ba(NO_3)_2$ followed by 3 drops of $HCl_{(aq)}$ ½ (1 mark)	White ppt ½ soluble on addition of $HCl_{(aq)}$ ½ (1 mark)

2

05½

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(ii) Carry out the actual test as described in (d) (i) above.

Observations	Inferences
White ppt insoluble on adding of $HCl_{(aq)}$ (1 mark)	SO_4^{2-} present (½ mark)

3. You are provided with solid R. Carry out the tests below and record your observations and inferences in the spaces provided.

(i) Place one third of solid R on a metallic spatula. Burn it in a non-luminous flame of the Bunsen burner.

Observation	Inference
Solid R melts and burns with a yellow sooty/smoky flame. (1 mark)	C=C, C≡C present (1 mark)

(ii) Place the remaining solid in a test-tube. Add about $6cm^3$ of distilled water and shake the mixture well. Retain the solution for the next procedure.

Observation	Inference
solid R dissolves to form a colourless solution (1/2 mark)	polar organic compound (1/2 mark)

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(I)To about $2cm^3$ of the solution, add 2 drops of acidified potassium manganate (VII).

Observation	Inference
Purple $KMnO_4$ changes to colourless/Decolourised	$-\overset{|}{C}=\overset{|}{C}-$ / $-\overset{|}{C}\equiv\overset{|}{C}-$, R-OH
(1 mark)	(1 mark)

(II)To about $1cm^3$ of the solution, add 3 drops of acidified potassium dichromate (VI) and warm.

Observation	Inference
Orange $K_2Cr_2O_7$ turns green	R-OH present
(1/2 mark)	(1/2 mark)

(III) To about $2cm^3$ of the solution, add 1g of sodium hydrogen carbonate.

Observation	Inference
Fizzing / Effervescence / bubbles of colourless gass	H^+, R-COOH, H_3O^+
(½ mark)	(½ mark)

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