1 You are provided with:

- aqueous sulphuric acid labelled solution **A**
- solution **B** containing 8.0 g per litre of sodium carbonate
- an aqueous solution of substance **C** labelled solution **C**.

You are required to determine the:

- concentration of solution **A**
- enthalpy of reaction between sulphuric acid and substance **C**.

A Procedure

Using a pipette and a ***pipette filler***, place 25.0 cm^3 of solution **A** into a 250 ml. volumetric flask. Add distilled water to make 250 cm^3 of solution. Label this solution **D**.

Place solution **D** in a burette. Clean the pipette and use it to place 25.0 cm^3 of solution **B** into a conical flask. Add 2 drops of methyl orange indicator provided and titrate with solution **D**. Record your results in table 1. Repeat the titration two more times and complete the table.

Table 1

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

(3 marks)

Calculate the:

(i) average volume of solution **D** used (1 mark)

(ii) concentration of sodium carbonate in solution **B** (Na = 23.0; O = 16.0; C = 12.0) (1 mark)

(iii) concentration of sulphuric acid in solution **D** (2 marks)

(iv) concentration of sulphuric acid in solution **A**. (1 mark)

B Label six test-tubes as 1, 2, 3, 4, 5 and 6. Empty the burette and fill it with solution A. From the burette, place 2 cm^3 of solution A into test-tube number 1. From the same burette, place 4 cm^3 of solution A in test-tube number 2. Repeat the process for test-tube numbers 3, 4, 5 and 6 as shown in table 2.

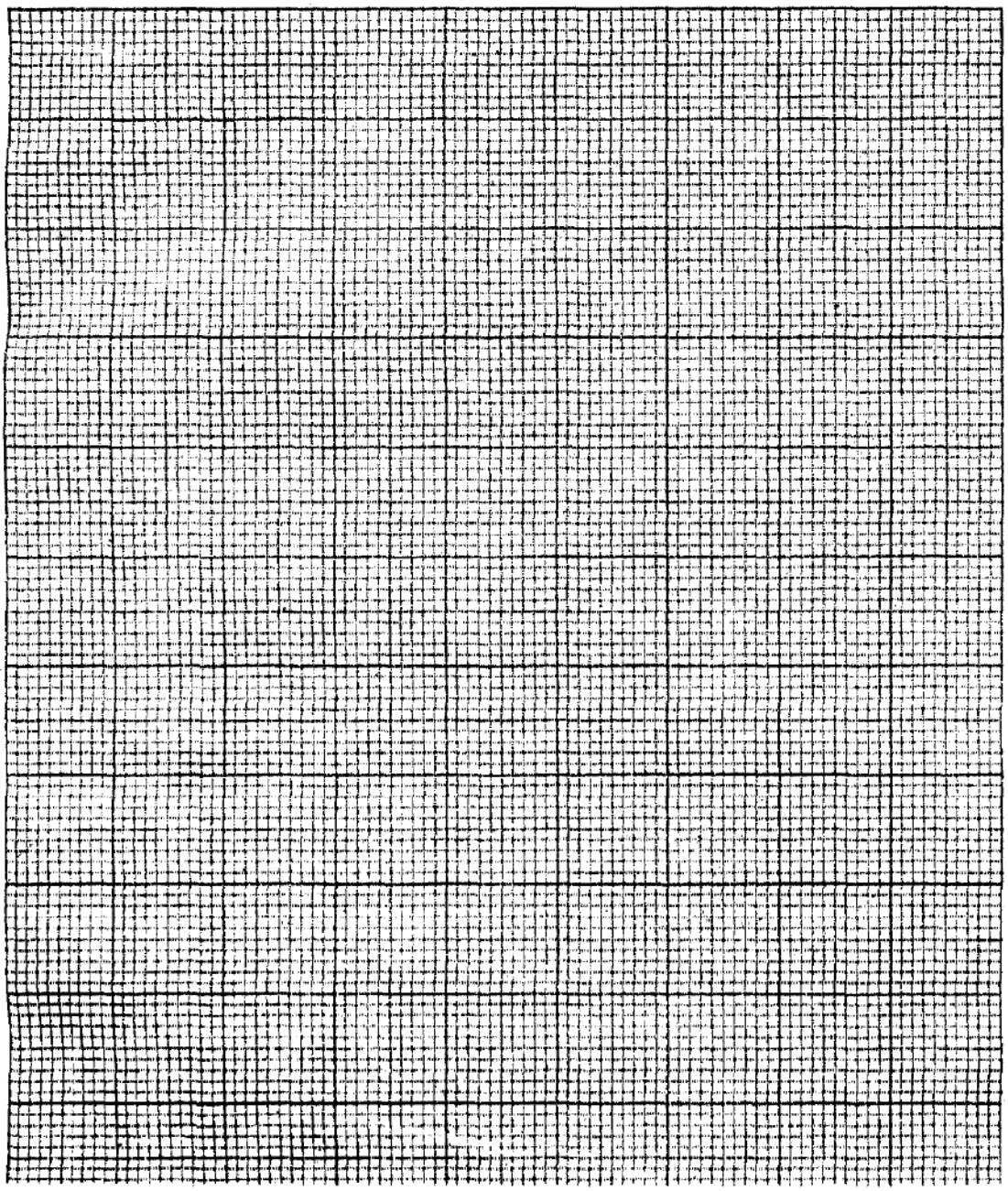
Clean the burette and fill it with solution C. From the burette, place 14 cm^3 of solution C into a boiling tube. Measure the initial temperature of solution C to the nearest 0.5°C and record it in table 2. Add the contents of test-tube number 1 to the boiling tube containing solution C. Stir the mixture with the thermometer. Note and record the highest temperature reached in table 2. Repeat the process with the other volumes of solution C given in table 2 and complete the table.

Table 2

Test-tube number	1	2	3	4	5	6
Volume of solution A (cm^3)	2	4	6	8	10	12
Volume of solution C (cm^3)	14	12	10	8	6	4
Initial temperature of solution C (°C)						
Highest temperature of mixture (°C)						
Change in temperature, ΔT (°C)						

(6 marks)

(i) On the grid provided, draw a graph of ΔT (vertical axis) against volume of solution A used. (3 marks)



(ii) From the graph, determine:

I the maximum change in temperature (1 mark)

.....

II the volume of solution A required to give the maximum change in temperature. (1 mark)

(iii) Calculate the:

I number of moles of sulphuric acid required to give the maximum change in temperature (1 mark)

II molar enthalpy of reaction between sulphuric acid and substance C (in kilojoules per mole of sulphuric acid).
Assume the specific heat capacity of the solution is $4.2 Jg^{-1}K^{-1}$ and density of solution is 1.0 g cm^{-3} (2 marks)

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

(a) Place one half of solid E in a clean dry test-tube and heat it strongly. Test any gases produced with blue and red litmus papers.

Observations (2 marks)	Inferences (1 mark)

(b) Place the other half of solid E in a boiling tube. Add about 10 cm^3 of distilled water and shake until **all** the solid dissolves. (Use the solution for tests (i), (ii), (iii) and (iv).)

(i) Place two or three drops of the solution in a test-tube. Add 3 cm^3 of distilled water. Add two drops of universal indicator to the mixture obtained and then determine the P^H of the mixture.

Observations (1 mark)	Inferences (1 mark)

(ii) To about 1 cm^3 of the solution in a test-tube, add aqueous ammonia drop-wise until in excess.

Observations (1 mark)	Inferences (1 mark)

(iii) To 2 cm^3 of the solution in a test-tube, add three or four drops of solution G (aqueous potassium iodide.)

Observations (1 mark)	Inferences (1 mark)

(iv) To about 1 cm^3 of the solution in a test-tube, add four or five drops of barium nitrate solution. Shake the mixture then add about 1 cm^3 of dilute nitric acid and allow the mixture to stand for about 2 minutes.

Observations (1 mark)	Inferences (1 mark)

3 You are provided with liquid **F**. Carry out the tests below. Record your observations and inferences in the spaces provided.

(a) Place three or four drops of liquid **F** on a watch glass. Ignite the liquid using a Bunsen burner.

Observations	**Inferences**
(1 mark)	(1 mark)

(b) To about 1 cm^3 of liquid **F** in a test-tube, add about 1 cm^3 of distilled water and shake thoroughly.

Observations	**Inferences**
($\frac{1}{2}$ mark)	($\frac{1}{2}$ mark)

(c) To about 1 cm^3 of liquid **F** in a test-tube, add a small amount of solid sodium carbonate.

Observations	**Inferences**
(1 mark)	(1 mark)

(d) To about 2 cm^3 of liquid **F** in a test-tube, add about 1cm^3 of solution **H** [acidified potassium dichromate(VI)]. Warm the mixture gently and allow it to stand for about one minute.

Observations	**Inferences**
(1 mark)	(1 mark)