

1 You are provided with:

- solid **A**
- 2.0M hydrochloric acid, solution **B**.
- 0.1M sodium hydroxide.

You are required to determine the enthalpy change ΔH , for the reaction between solid **A** and one mole of hydrochloric acid.

Procedure A

Using a burette, place 20.0cm^3 of 2.0M hydrochloric acid, solution **B** in a 100ml. beaker. Measure the temperature of the solution after every half-minute and record the values in table 1. At exactly $2\frac{1}{2}$ minutes, add **all** of solid **A** to the acid. Stir the mixture gently with the thermometer. Measure the temperature of the mixture after every half-minute and record the values in table 1. (**Retain the mixture for use in procedure B**).

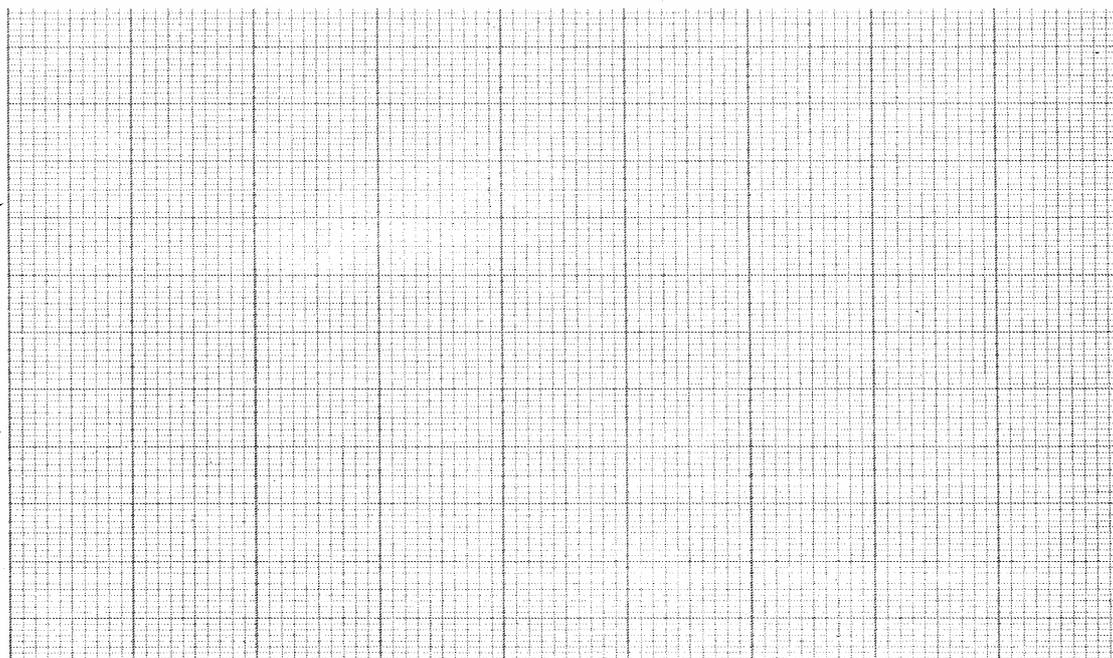
Table 1

Time (min)	0	$\frac{1}{2}$	1	$1\frac{1}{2}$	2	$2\frac{1}{2}$	3	$3\frac{1}{2}$	4	$4\frac{1}{2}$	5
Temperature ($^{\circ}\text{C}$)						X					

(5 marks)

(i) Plot a graph of temperature (Y-axis) against time.

(3 marks)



- (ii) Using the graph, determine the change in temperature, ΔT . (1 mark)
- (iii) Calculate the heat change for the reaction (Assume that the specific heat capacity of the mixture is $4.2\text{Jg}^{-1}\text{K}^{-1}$ and the density of the mixture is 1g/cm^3). (2 marks)

Procedure B

Rinse the burette thoroughly and fill it with sodium hydroxide. Transfer **all** the contents of the 100ml. beaker used in procedure **A** into a 250ml. volumetric flask. Add distilled water to make up to the mark. Label this solution **C**. Using a pipette and a **pipette filler**, place 25.0 cm^3 of solution **C** into a 250ml. conical flask. Add two or three drops of phenolphthalein indicator and titrate against sodium hydroxide. Record your results in table 2. Repeat titration two more times and complete table 2.

Table 2

	I	II	III
Final burette reading			
Initial burette reading			
Titre (cm^3)			

(3 marks)

Calculate the:

- (i) average volume of sodium hydroxide used. (1 mark)
- (ii) the number of moles of:
- I sodium hydroxide used (1 mark)
 - II hydrochloric acid in 25cm^3 of solution **C** (1 mark)
 - III hydrochloric acid in 250cm^3 of solution **C** (1 mark)
 - IV hydrochloric acid in 20.0cm^3 of solution **B** (1 mark)
 - V hydrochloric acid that reacted with solid **A**. (1 mark)
- (c) Calculate the enthalpy of reaction between solid **A** and one mole of hydrochloric acid (show the sign of ΔH). (2 marks)

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

- (a) Place **all** of solid **D** in a clean dry test-tube and heat it strongly until no further change occurs. Test any gases produced with both blue and red litmus papers. Allow the residue to cool and use it for test (b).

Observations	Inferences
(2 marks)	(1 mark)

- (b) Add about 10cm³ of 2M hydrochloric acid to the residue and shake for about three minutes. **Keep the mixture for test (c).**

Observations	Inferences
(1 mark)	(1 mark)

- (c) (i) Place about 1cm³ of the mixture in a test-tube and add aqueous ammonia dropwise until in excess.

Observations	Inferences
(1 mark)	(1 mark)

- (ii) To the rest of the mixture, add **all** of solid **E** provided and shake the mixture well.

Observations

Inferences

(1 mark)

(1 mark)

3

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

- (a) Place about one third of solid **F** on a **metallic** spatula and burn it using a Bunsen burner.

Observations

Inferences

($\frac{1}{2}$ mark)

($\frac{1}{2}$ mark)

- (b) Place the remaining of solid **F** in a test-tube. Add about 6cm^3 of distilled water and shake the mixture well. (**Retain the mixture for use in test (c).**)

Observations

Inferences

(1 mark)

(1 mark)

- (c) (i) To about 2cm³ of the mixture, add a small amount of solid sodium hydrogen carbonate.

Observations	Inferences
(1 mark)	(1 mark)

- (ii) To about 1cm³ of the mixture, add 1cm³ of acidified potassium dichromate (VI) and warm.

Observations	Inferences
(1 mark)	(1 mark)

- (iii) To about 2cm³ of the mixture, add two drops of acidified potassium manganate (VII).

Observations	Inferences
(1 mark)	(1 mark)