

1 You are provided with:

- solution **A**, aqueous copper (II) sulphate;
- solid **B**, iron powder;
- 0.02 M acidified potassium manganate (VII), solution **C**.

You are required to determine the molar heat of displacement of copper by iron.

Procedure I

Using a burette, place 50.0 cm³ of solution **A** in a 100 ml beaker. Measure the temperature of the solution and record it in table **1** below. Add **all** of solid **B** provided at once and start a stop watch. Stir the mixture **thoroughly** with the thermometer and record the temperature of the mixture after every one minute in the table. **Retain** the mixture for use in procedure **II** below.

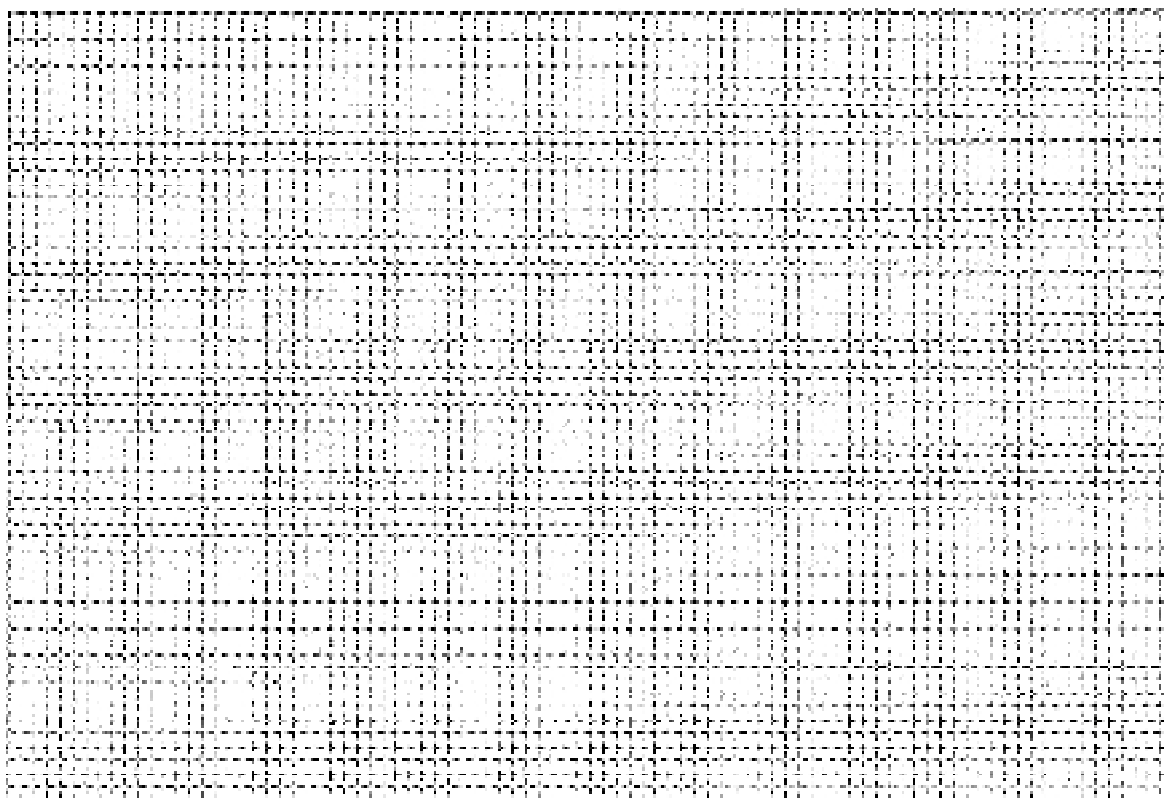
Table 1

Time (Min.)	0	1	2	3	4	5	6	7
Temperature (°C)								

(3 marks)

- (a) (i) Plot a graph of temperature (vertical axis) against time in the grid provided.

(3 marks)



- (ii) From the graph, determine the;

(I) highest change in temperature, ΔT ;

(1 mark)

(II) time taken for reaction to be completed. ($\frac{1}{2}$ mark)

(iii) Calculate the heat change for the reaction. (Specific heat capacity of solution is $4.2 \text{ J g}^{-1} \text{ K}^{-1}$; Density of the solution is 1 g cm^{-3}). (2 marks)

Procedure II

Carefully decant the mixture obtained in procedure I into a 250 ml volumetric flask. Add about 10 cm^3 of distilled water to the residue in the 100 ml beaker. Shake well, allow the mixture to settle and carefully decant into the volumetric flask. **Immediately**, add about 50 cm^3 of 2 M sulphuric (VI) acid to the mixture in the volumetric flask. Add more distilled water to make 250.0 cm^3 of solution. Label this as solution **D**.

Fill a burette with solution **C**. Using a pipette and a **pipette filler**, place 25.0 cm^3 of solution **D** into a 250 ml conical flask. Titrate solution **D** against solution **C** until the **first permanent pink** colour is obtained. Record your results in table 2 below. Repeat the titration two more times and complete the table. Retain the remaining solution **C** for use in question 3.

Table 2

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

(4 marks)

(a) Determine the average volume of solution **C** used. ($\frac{1}{2}$ mark)

(b) Calculate the number of moles of:

(i) aqueous potassium manganate (VII) used; (1 mark)

(ii) iron (II) ions in 25.0 cm^3 of solution **D**. (1 mole of MnO_4^- reacts with 5 moles of Fe^{2+}). (1 mark)

(iii) iron(II) ions in 250 cm^3 of solution **D**. (1 mark)

(c) Calculate the molar heat of displacement of copper by iron. (2 marks)

2 You are provided with solid **E**. Carry out the following tests and write your observations and inferences in the spaces provided.

(a) Place **all** of solid **E** in a boiling tube. Add about 10 cm^3 of distilled water and shake thoroughly. Filter the mixture into another boiling tube. **Retain** the filtrate for use in test 2(b) below. Dry the residue using pieces of filter papers.

- (i) Transfer about half of the dry residue into a dry test-tube. Heat the residue strongly and test any gas produced using a burning splint.

Observations	Inferences
(1 mark)	(1 mark)

- (ii) Place the rest of the residue in a dry test-tube. Add 4 cm³ of 2M hydrochloric acid. **Retain** the mixture for test (iii) below.

Observations	Inferences
(1 mark)	(1 mark)

- (iii) To 2 cm³ of the solution obtained in (ii) above, add 6 cm³ of aqueous ammonia dropwise.

Observations	Inferences
(1 mark)	(1 mark)

- (b) (i) To 2 cm³ of the filtrate obtained in (a) above, add about 3 cm³ of aqueous ammonia (Excess).

Observations	Inferences
(1 mark)	(1 mark)

- (ii) To 2 cm³ of the filtrate, add about 2 cm³ of 2M hydrochloric acid.

Observations	Inferences
(1 mark)	(1 mark)

- (iii) To 2 cm³ of the filtrate, add one or two drops of barium nitrate solution.

Observations	Inferences
(1 mark)	(1 mark)

3 You are provided with solid **G**. Carry out the tests in (a) and (b) and write your observations and inferences in the spaces provided. Describe the method used in part (c).

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

Observations	Inferences
(1 mark)	(1 mark)

- (b) Dissolve all of the remaining solid **G** in about 10 cm³ of distilled water in a boiling tube. Use the solution for tests (b)(i), (ii) and (c).

- (i) Place 2 cm³ of the solution in a test-tube and add 2 drops of acidified potassium manganate (VII); solution **C**.

Observations	Inferences
(1 mark)	(1 mark)

- (ii) To 2 cm³ of the solution, add all of solid sodium hydrogen carbonate provided.

Observations	Inferences
(1 mark)	(1 mark)

- (c) Determine the pH of the solution obtained in (b) above.

Method used	Inferences
(2 marks)	(1 mark)