3. You are provided with

- A stoppered tube containing powdered zinc.
- Aqueous copper(II) sulphate, $CuSO_4$, concentration 0.50 mol dm^{-3}, labelled **H**.

You are required to measure the temperature change when **excess** zinc reacts with copper(II) sulphate solution.

$$Zn(s) + CuSO_4(aq) \rightarrow Cu(s) + ZnSO_4(aq)$$

(a) **Procedure**

1. Use a measuring cylinder to transfer 50 cm^3 of solution **H** to a dry polystyrene cup firmly held in a 250 cm^3 beaker. Place the thermometer in the solution in the polystyrene cup.
2. Read the temperature of the solution and record it, to the nearest degree, in **Table 2**.
3. Continue to record the temperature of the solution at half-minute intervals.
4. At exactly 3.0 minutes, add the zinc powder to the polystyrene cup, stirring with the thermometer as you do so.
5. While continuing to stir with the thermometer, record the temperature of the solution in the polystyrene cup every half minute from 3.5 to 8.0 minutes. Record all the temperatures, to the nearest degree, in **Table 2**.

Table 2

Time / min	0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
Temperature /°C	22	22	22	22	22	22		37	37

Time / min	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0
Temperature /°C	40	40	41	42	44	44	44	44

(2)

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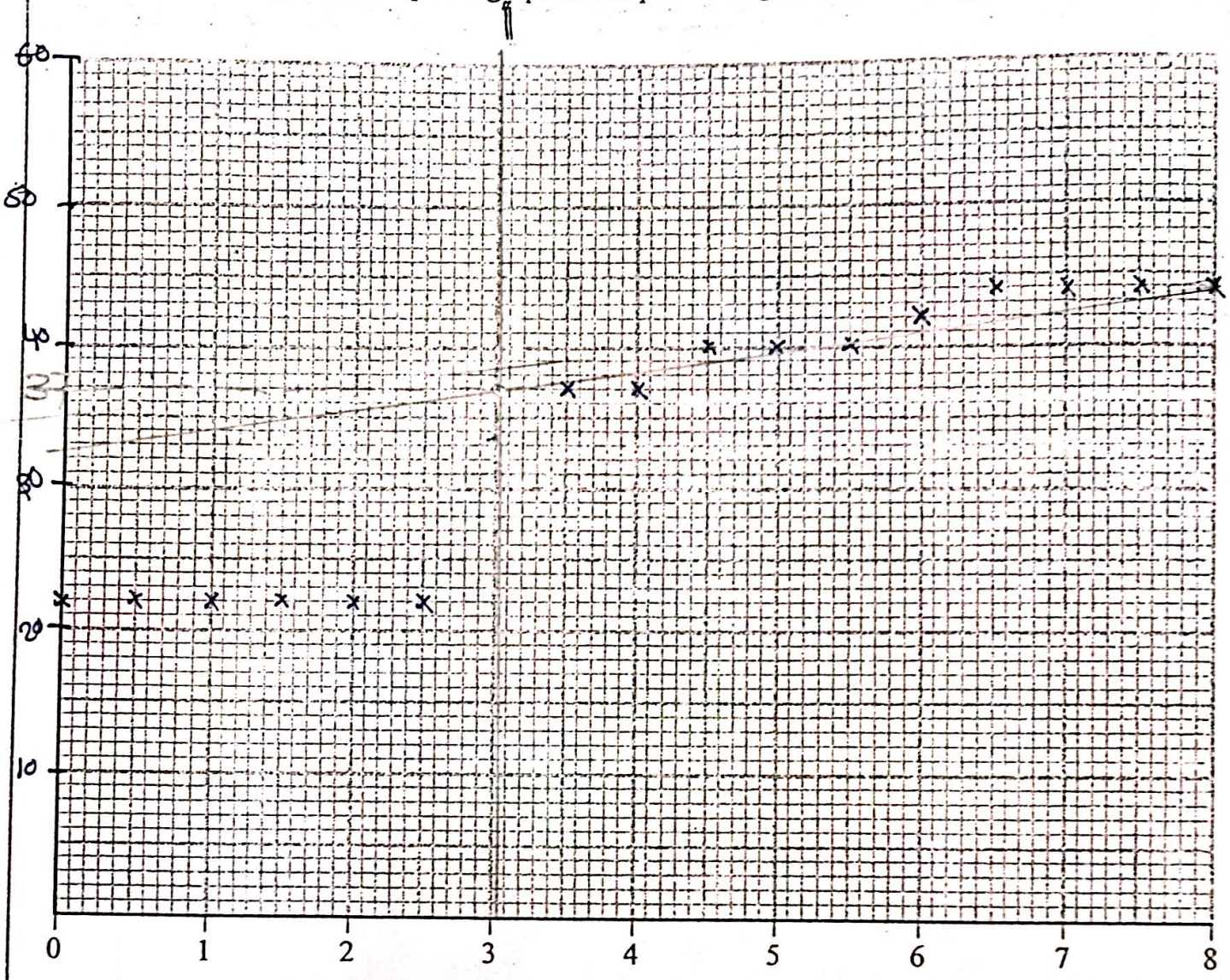
(b) On the grid below plot a graph of temperature against time.



(2)

(c) **Calculations**

(i) From your graph find the maximum temperature change, ΔT, for the reaction. On your graph show how this was calculated. Give your value of ΔT to the nearest degree.

$\Delta T =$ 22 °C

Max at 44°C
Min at 22°C

44 − 22 = 22.

(5)

(ii) Calculate the amount (moles) of copper(II) sulphate, $CuSO_4$, in 50 cm^3 of 0.50 mol dm^{-3} solution.

$0.05 dm^3$

0.05×0.5

$= 0.025 mol$

(1)

(iii) Calculate the heat evolved in the reaction. Include units with your answer.

Assume that the total mass of the solution is 50 g and that the specific heat capacity of the solution is 4.18 J g^{-1} °C^{-1}.

$50 \times 4.18 \times 22 = 4598 J$

$4.598 kJ$

(1)

(iv) Use your answers from (c)(ii) and (iii) to calculate the **molar** enthalpy change for the reaction. Give your answer in kJ mol^{-1} and to **two** significant figures. **Include a sign** with your answer.

$$\frac{-4.598}{0.025} = -183.92 kJ.mol^{-1}$$

$\Delta H = -183.92$ ..... kJ mol^{-1}

(3)

(d) A student suggests repeating the experiment using 100 cm^3 of the same copper(II) sulphate solution and twice the mass of zinc. What effect, if any, will this have on the temperature change? Explain your answer.

$Q_1 = 2Q$
$mc\Delta T = 2mc\Delta T$
$100(22) = 2\ 50\ 22$
$2200 = 2200$

No effect, both limiting factor moles increased and the surrounding mass increased, so ΔT will not change.

(1)

Q3

(Total 15 marks)