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Leave blank

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

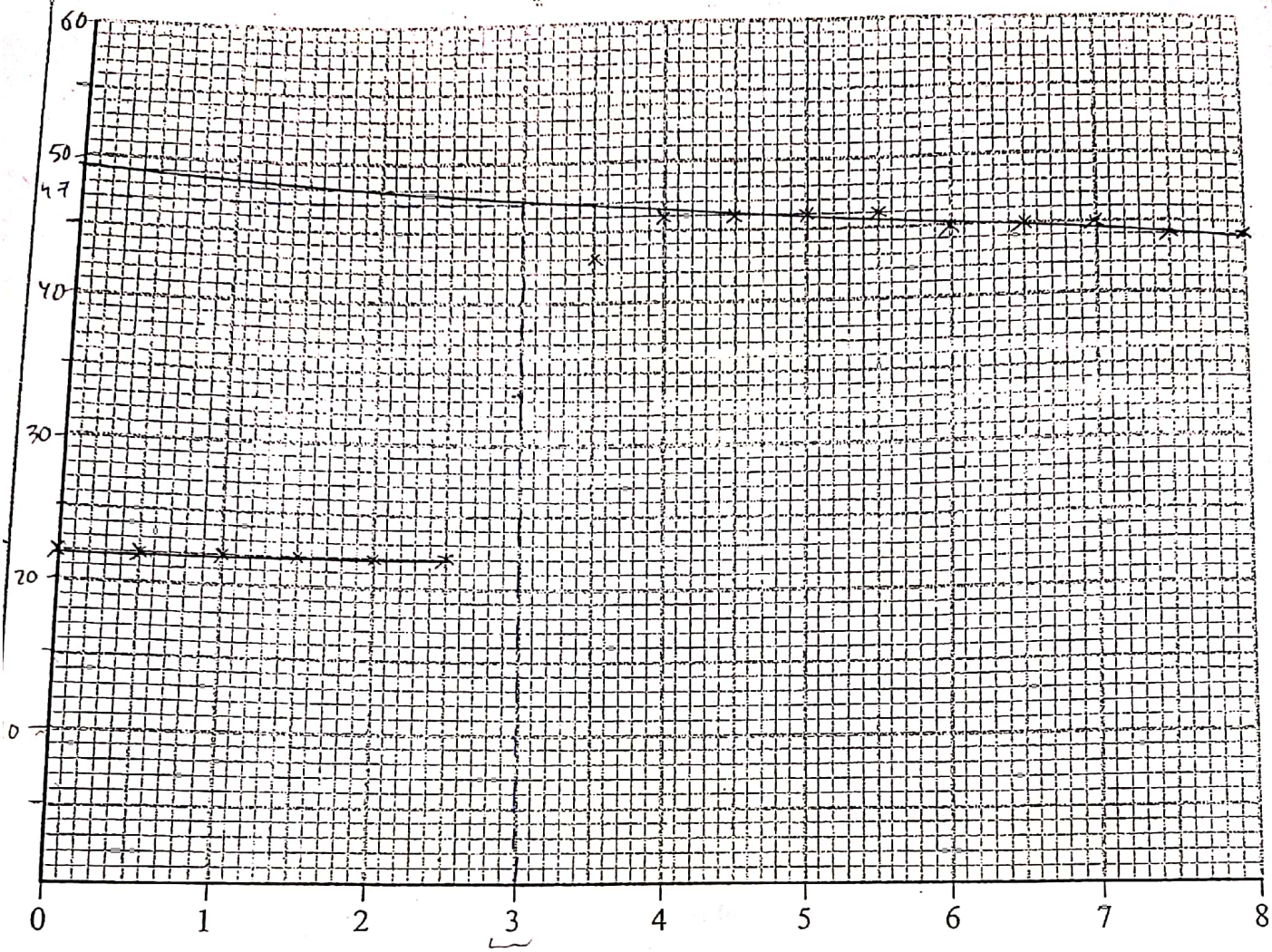
Time / min	0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
Temperature /°C	22	22	22	22	22	22		43	46

Time / min	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0
Temperature /°C	46	46	46	45	45	45	44	44

(2)

Leave blank

(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.

$\Delta T =$ 25 °C

47 - 22 = 25

(5)

Leave blank

(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

$0.05 \times 0.5 = 0.025$ 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} $°C^{-1}$.

$E = mC\Delta T$

$= 50 \times 4.18 \times 25$

$= 5225$ J

$= 5.225$ 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.

$\Delta H = \frac{-Q}{n} = \frac{-5.225}{0.025} = -209$

ΔH = −210 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.

There is ~~effect~~ no effect on the temperature change, it will remain the same, because both the mass of Zinc and the volume of copper II sulphate increased the same, both are doubled **(1)**

Q3

(Total 15 marks)