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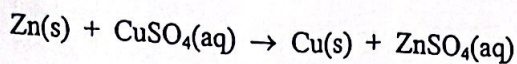
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3. You are provided with

- A stoppered tube containing powdered zinc.
- Aqueous copper(II) sulphate,  $\text{CuSO}_4$ , concentration  $0.50 \text{ mol dm}^{-3}$ , labelled H.

10.88  
10.89  
13.39

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



(a) Procedure

1. Use a measuring cylinder to transfer  $50 \text{ cm}^3$  of solution H to a dry polystyrene cup firmly held in a  $250 \text{ cm}^3$  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.  $19^\circ$
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

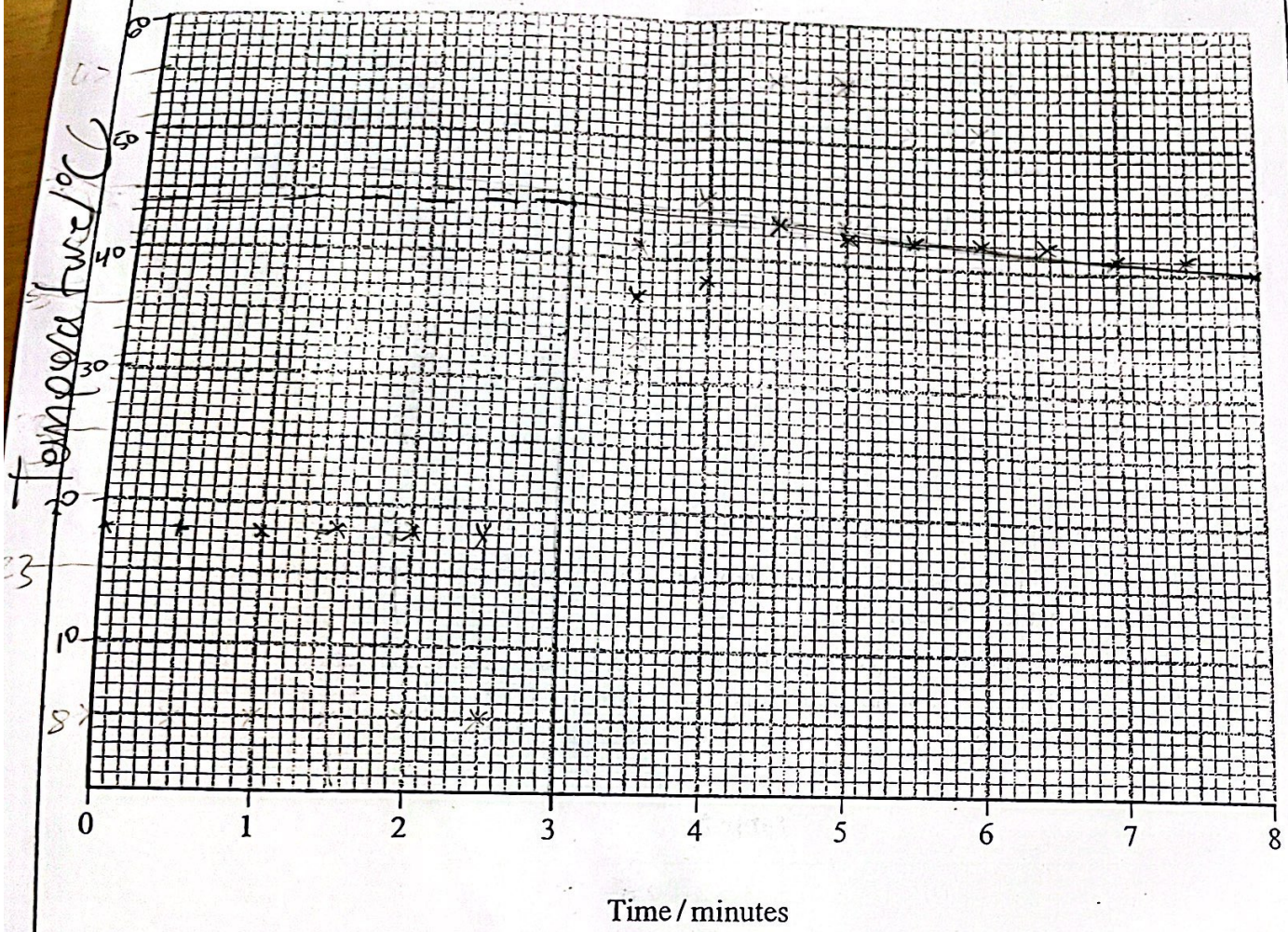
Time / min	0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
Temperature / °C	18	<del>18</del> 18	18	18	18	18		37	38

Time / min	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0
Temperature / °C	43	42	42	42	42	41	41	40

(2)



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



(2)

(c) Calculations

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

$$\Delta T = 26 \text{ } ^\circ\text{C}$$

$$48 - 18 = 26$$

(5)



(ii) Calculate the amount (moles) of copper(II) sulphate,  $\text{CuSO}_4$ , in  $50 \text{ cm}^3$  of  $0.50 \text{ mol dm}^{-3}$  solution.

$$\frac{\text{Mol}}{\text{Conc/Vol}} \quad 0.5 \times 0.05 = 0.025 \quad 0.050 \div 1000$$

(1)

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

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

$$\text{heat} = m c \Delta T$$

$$50 \times 4.18 \times 26 = 5434 \text{ J}$$

(1)

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

$$5434 \div 1000$$

$$\frac{-5.434}{0.025} = \frac{-5.434}{0.025} = -217.36$$

$$\Delta H = -220 \text{ kJ mol}^{-1}$$

(3)

(d) A student suggests repeating the experiment using  $100 \text{ cm}^3$  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.

It has no effect, since both masses double.

(1)

Q3

(Total 15 marks)

