EXPERIMENT NO. 13

Quantitative analysis

Read through the whole method before starting any practical work. Where appropriate, prepare a table for your results in the space provided.

Show the precision of the apparatus you used in the data you record.

Show your working and appropriate significant figures in the answer to **each** step of your calculations.

1 You will determine the enthalpy change, ΔH, of the reaction between magnesium and hydrochloric acid. To do this you will measure the change in temperature when a piece of magnesium ribbon reacts with an excess of hydrochloric acid.

$$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$$

FA 1 is hydrochloric acid, HCl.
FA 2 is magnesium ribbon, Mg. You should assume its mass is 0.19 g.

(a) Method

- Support the cup in the 250 cm^3 beaker.
- Coil **FA 2** so that it will fit into the bottom of the cup then remove it.
- Use the measuring cylinder to transfer 25.0 cm^3 of **FA 1** into the cup.
- Place the thermometer in the acid and, if necessary, tilt the cup so that the bulb of the thermometer is fully covered. Measure and record the temperature at time = 0 in the table of results.
- Start timing and do not stop the clock until the whole experiment has been completed at time = 8 minutes.
- Record the temperature of **FA 1** in the cup every half minute for $1\frac{1}{2}$ minutes.
- At time = 2 minutes carefully drop the coil of **FA 2** into the acid and stir the mixture.
- Record the temperature every half minute. Stir the mixture between thermometer readings.

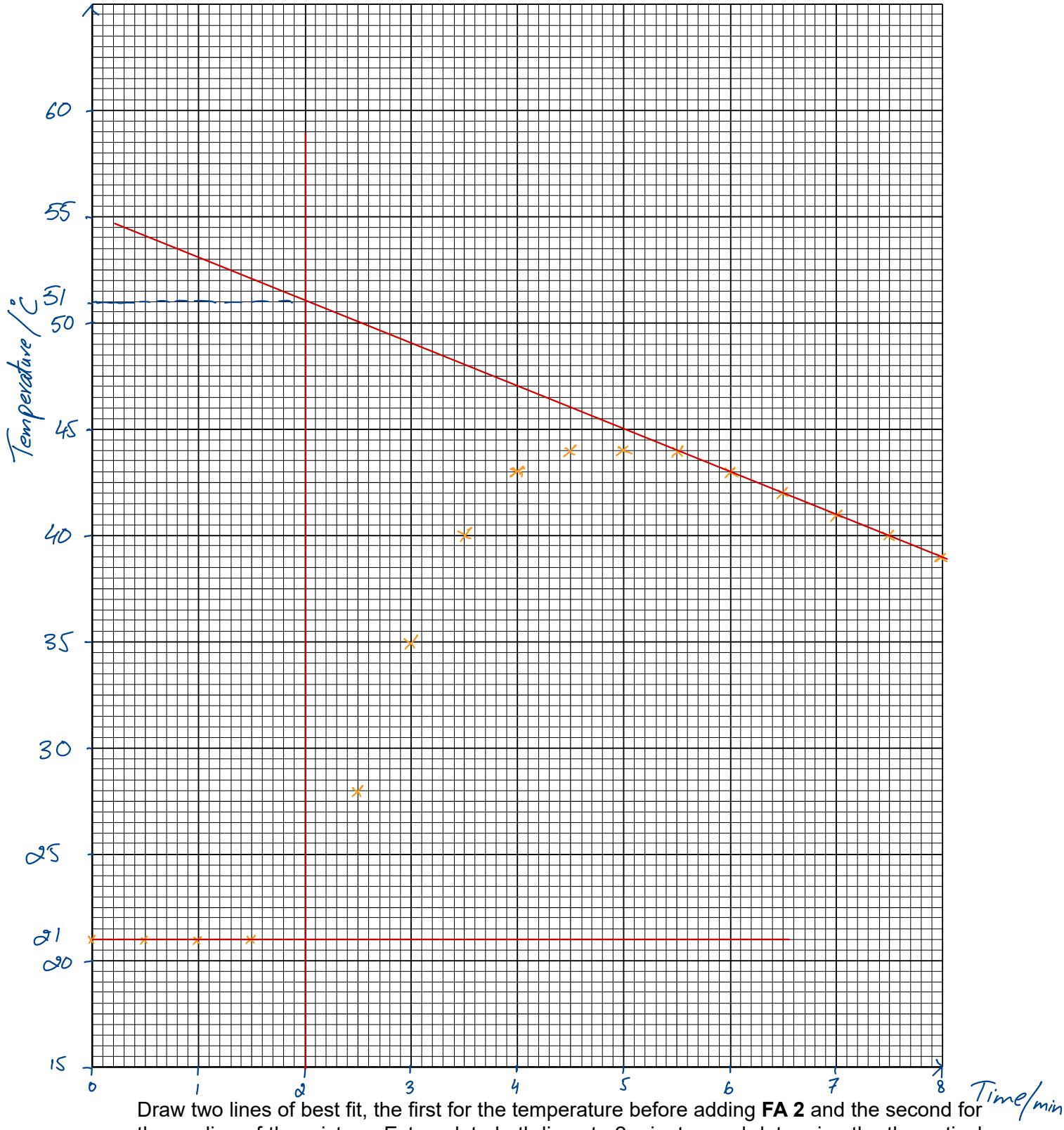
Results

time / minutes	0	$\frac{1}{2}$	1	$1\frac{1}{2}$	2	$2\frac{1}{2}$	3	$3\frac{1}{2}$	4
temperature / °C	21·0	21·0	21·0	21·0		28·0	35·0	40·0	43·0

time / minutes	$4\frac{1}{2}$	5	$5\frac{1}{2}$	6	$6\frac{1}{2}$	7	$7\frac{1}{2}$	8
temperature / °C	44·0	44·0	44·0	43·0	42·0	41·0	40·0	39·0

[4]

(b) Plot a graph of temperature (on the *y*-axis) against time (on the *x*-axis) on the grid.
The scale for the *y*-axis should extend 10 °C above the maximum temperature you recorded.
Circle any points you consider to be anomalous.
You will use the graph to determine the theoretical maximum temperature rise at time = 2 minutes.



Draw two lines of best fit, the first for the temperature before adding **FA 2** and the second for the cooling of the mixture. Extrapolate both lines to 2 minutes and determine the theoretical rise in temperature at this time.

= 51.0 − 21.0

theoretical rise in temperature at 2 minutes = ... 30.0 ..... °C [4]

(c) Calculations

(i) Use your answer to **(b)** to calculate the energy change when **FA 2** is added to **FA 1**. (Assume 4.2 J of energy changes the temperature of 1.0 cm^3 of the mixture by 1.0 °C.)

$= mC\Delta T$

$= 25 \times 4.2 \times 30$

energy change = 3150 J [1]

(ii) Use your answer to **(c)(i)** to calculate the enthalpy change, ΔH, in kJ mol^{-1}, when 1 mol of magnesium, **FA 2**, reacts with hydrochloric acid, **FA 1**.

$n = \frac{m}{Ar} = \frac{0.19}{24.3} = 7.82 \times 10^{-3}$ mol

7.82×10^{-3} mol — 3.150 kJ

1 mol — x

ΔH = − 402.8 kJ mol^{-1}

(sign) (value) [2]

(d) A student repeats the procedure, but instead of hydrochloric acid, uses sulfuric acid, H_2SO_4, of the same concentration. The student predicts that the enthalpy change will be twice the value of the enthalpy change with hydrochloric acid.

Explain whether the student's prediction is correct.

Student is wrong as acid is already in excess and magnesium is limiting reactant [1]

(e) The enthalpy change determined in **(c)(ii)** is **not** accurate.

Suggest and explain one improvement you could make to the method in **(a)** to increase the accuracy of the experiment.

improvement Use a lid

explanation It will prevent heat loss to the surroundings.

[1]

[Total: 13]