Practical 2 – Chapter 5

Displacement reactions: data-logging to find an enthalpy change

The aim of this experiment is to determine the enthalpy change for the displacement reaction:

$$Zn(s) + Cu^{2+}(aq) \rightarrow Cu(s) + Zn^{2+}(aq)$$

What to do

1 Pipette 25.0 cm^3 of a 0.500 mol dm^{-3} copper(II) sulfate solution into a polystyrene cup. The polystyrene cup will be your calorimeter. Make a lid for the calorimeter, remembering to put a hole in the lid for the temperature probe.

2 Weigh about 3 g of zinc powder in a weighing bottle. Since this is in excess there is no need to be accurate.

3 Set the data-logger to record temperature every second for 10 minutes.

4 Put the temperature probe through the hole in the lid and stir.

5 Start collecting data and keep stirring.

6 After 20 s add the zinc powder to the calorimeter.

7 Stir vigorously.

8 Continue stirring and collecting data until the 10 minutes is up.

9 Your data should allow you to plot a graph of temperature against time which can be extrapolated to give you the maximum temperature rise, i.e. the graph must be extrapolated to the point at which the zinc is added.

10 From the maximum temperature rise and the specific heat capacity, which you can take as 4.18 J K^{-1} cm^{-3}, you should be able to calculate the enthalpy change per mole of copper sulfate.

Evaluation

Complete this table to work out the total percentage uncertainty.

Maximum temperature		Uncertainty			
Temperature change		Uncertainty		Percentage uncertainty	
Volume of solution		Uncertainty		Percentage uncertainty	

Total percentage uncertainty = _____

Random error = _____

In the evaluation you should compare your value with the accepted value of –217 kJ mol^{-1}.

$$\text{final \% error} = \frac{\text{your calculated value} - \text{literature value}}{\text{literature value}} \times 100$$

If your final % error is greater than that due to random errors then there are systematic errors in the experiment. You should list as many of these as possible and suggest improvements.