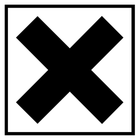
Determining the enthalpy change of a reaction

Aims



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

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

By adding an excess of zinc powder to a known amount of copper(II) sulphate solution, and measuring the temperature change over a period of time, you can calculate the enthalpy change for the reaction.

Apparatus

Goggles
Bench mat
$25cm^3$ pipette
Pipette filler
Polystyrene cup with lid
Weighing bottle
Spatula
Balance
Thermometer
Stop clock
Zinc powder
1.0M copper(II) sulphate solution

Methods

1. Pipette $25.0cm^3$ of the copper(II) sulphate solution into the polystyrene cup.
2. Weigh about 6g of zinc powder in the weighing bottle – as this is an excess, there is no need to be accurate.
3. Put the thermometer through the hole in the lid, stir, and record the temperature every half minute for 2½ minutes in the table below.
4. At precisely 3 minutes, add the zinc powder to the cup.
5. Continue stirring, and record the temperature for an additional 6 minutes in the table below.

Results table

Time (minutes)	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5
Temperature (°C)							**not done**			
Time (minutes)	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5
Temperature (°C)										

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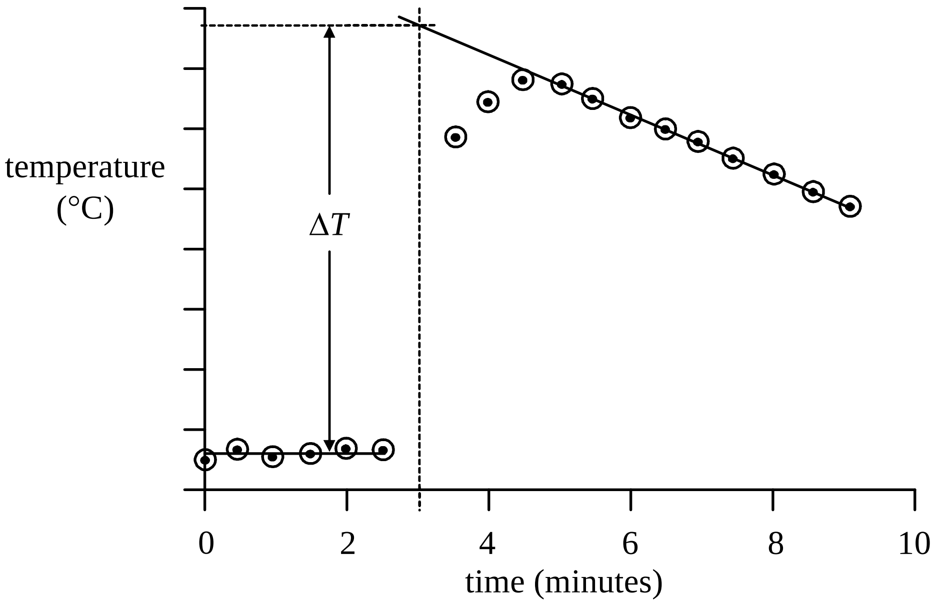
Analysis

1. Plot the temperature (vertical axis) against time (horizontal axis).

2. Extrapolate the curve back to 3.0 minutes to establish the maximum temperature rise as shown in the example below:



3. Calculate the enthalpy change, ΔH, for the quantities used, using the formula:

$\Delta H = m\, c\, \Delta T$ where m = mass of solution (g)

c = specific heat capacity of water = 4.18 J g^{-1} K^{-1}

ΔT = rise in temperature (K)

4. Calculate the enthalpy change for one mole of Zn and $CuSO_{4(aq)}$.

5. Calculate the maximum error for each piece of apparatus, and then the total overall apparatus error.

6. The accepted value for this reaction is –217 kJ mol^{-1}.

   Compare your result with this value by calculating the percentage error in your answer:

$$\text{error} = \frac{\text{experimental value - accepted value}}{\text{accepted value}} \times 100\%$$

Evaluation

1. Compare your total apparatus error with your answer to part 6 above – is the apparatus error enough to account for any difference between the accepted value and your experimental value?

2. List some possible reasons for any difference between your value and the accepted value (these should not be the apparatus errors mentioned above).

3. Why do you think the temperature increases for a few readings after adding the zinc?
   (Hint: the temperature does not go even higher if more zinc is used, or if the powder is finely divided).

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