# AQA AS Chemistry-Taster lesson - PRACTICAL

Beaumont Chemistry

## Determining the enthalpy change of a reaction

**Aim**

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

$$Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$$

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<br>Heat-proof mat<br>25cm$^3$ pipette<br>Pipette filler<br>Polystyrene cup with lid<br>Weighing bottle/boat<br>250ml Beaker | Balance<br>Thermometer<br>Stop clock<br>Spatula<br>Zinc powder<br>1.0M copper(II) sulphate solution<br>Graph paper (for analysis) |  |

**Method**

1. Pipette 25.0cm$^3$ of the copper (II) sulphate solution into the polystyrene cup. (You may need to be shown how to use a pipette filler!). Place the cup into a 250 ml beaker for stability.
2. Weigh about 6g of zinc powder in the weighing boat – as this is an excess, there is no need to be very precise.
3. Put the thermometer through the hole in the lid, stir, and record the temperature every half minute for 1½ minutes in the table below.
4. At precisely 2 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 (s) | 0 | 30 | 60 | 90 | 120 | 150 | 180 | 210 | 240 | 270 |
|---|---|---|---|---|---|---|---|---|---|---|
| Temp (ºC) | | | | | X | | | | | |
| | | | | | | | | | | |
| Time (s) | 300 | 330 | 360 | 390 | 420 | 450 | 480 | | | |
| Temp (ºC) | | | | | | | | | | |

**Analysis**

1. Plot your results onto graph paper using an appropriate scale.

2. Calculate the overall temperature change, $\Delta T$, by calculating the temperature rise, to do this you will need to extrapolate from your graph.

3. Calculate the enthalpy change, $\Delta H$, 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 $g^{-1}$ $K^{-1}$

$\Delta T$ = rise in temperature (K)

4. Calculate the enthalpy change for one mole of Zn and $CuSO_4$(aq). Hints:

   i. You need to work out first how many moles of $CuSO_4$ you initially had!

   ii. No. moles = concentration x volume

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

5. 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. List some possible reasons for any difference between your value and the accepted value.

2. Explain why the accepted value is negative.

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).

4. Instead of drawing a graph and *extrapolating*, you could just calculate temperature rise by max temp – initial temp. Can you explain why this leads to a less accurate value of ΔH and also whether carrying out the experiment this way leads to a higher or lower value of ΔH?

**Teacher Notes:**

1. Pupils may be aware of how to use a pipette + filler (suggest practice with water first?)
2. Ensure students stir the mixture regularly/continuously so that heat spreads evenly
3. When drawing graph help students choose appropriate scales on y-axis (temp); too large and they cannot fit extrapolation in; too small and not easy to see change.

**TECHNICAL SUPPORT-Apparatus list**

**Per Class**

0.1g precision balance

**Per Group (Students work in pairs)**

| | |
|---|---|
| $25cm^3$ pipette<br>Pipette filler<br>Polystyrene cup with card lid<br>Weighing bottle/boat<br>Thermometer (0-100ºC, mercury)<br>Stop clock<br>Approx. 10g Zinc powder<br>$50.0cm^3$ of 1.0M copper(II) sulphate solution |  <br>  |

**Also:**

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|---|
| Access to :<br><br>Goggles<br>Heat-proof mats<br>Spatulas<br>Tripods<br>Graph papers (for analysis)]<br>Rulers |