

How can enthalpy changes be measured?

Try this test

- Put a small amount (thumbnail covering) of anhydrous copper(II) sulfate into a test-tube.
- Add water drop by drop.
- Carefully touch the outside of the test-tube.
- What do you notice?
- What happens to the copper(II) sulfate?

Some enthalpy changes are easy to measure – enthalpy changes of combustion, for example, can be measured by completely burning the substance in oxygen and measuring the amount of energy produced. Others are difficult, because chemists cannot easily control the bond-breaking, bond-making processes.

The experiment below introduces a law, **Hess's Law**, to help.

Hess's Law says that the enthalpy change for a reaction will be the same regardless of the route taken. This means that if you imagine a chemical journey from A → B, the enthalpy change will be the same even if you were to get there going through C, D and / or E!

This means that by breaking a 'non-measurable' enthalpy change into measurable steps that give two different routes, we can measure the change.

Experiment: Measuring an enthalpy change you cannot measure directly

Requirements

- Anhydrous copper(II) sulfate powder (**Toxic** if ingested)
- Hydrated copper(II) sulfate crystals (**Toxic** if ingested)
- Weighing boat (or similar)
- Polystyrene cup
- Thermometer reading 0-110 °C in 0.1 °C increments
- Water
- 50 cm³ pipette or measuring cylinder
- Access to a balance
- Eye protection.

What you do

1. Calculate the mass of 0.025 moles of anhydrous copper(II) sulfate.
2. Measure out this mass into a weighing boat.
3. Measure out 50 cm³ of water into the polystyrene cup.
4. Record the temperature of the water in the cup.
5. Add the copper(II) sulfate to the water and stir with the thermometer.
6. Record the highest temperature reached.
7. Repeat these steps with hydrated copper(II) sulfate.

Working out the enthalpy changes

1. Calculate the energy released.

$$\text{Energy (Joules)} = 50 \times 4.2 \times \text{temperature rise}$$

2. Divide the energy figure by the number of moles.
3. Write equations with state symbols for the enthalpy changes you have measured. Put their enthalpy changes alongside.

Write a summary

Write a summary of the experiment.

Make sure you explain:

- the name of the enthalpy change you are trying to measure
- why this enthalpy change can't be measured directly
- why the two routes have the same enthalpy change
- what the value of the enthalpy change is from your measurements.