

Enthalpy and Energy Changes

Hess's Law:

States that the total enthalpy change associated with a reaction is independent of the route taken and is therefore always the same.

Standard Conditions:

- Temperature: 298K
- Pressure: 100kPa or 1atm
- All solutions have a concentration of 1 mol dm⁻³.

Standard Enthalpy of Formation: Energy change when 1 mol of a substance is formed from its elements in their standard states under the standard conditions.

Standard Enthalpy of Combustion: Energy change when 1 mol of a substance is completely burnt in excess oxygen under the standard conditions.

Standard Enthalpy of Reaction: Energy change when 1 mol of matter is changed by a chemical reaction under the standard conditions.

Standard Enthalpy of Neutralisation: Energy change when solutions of acid and alkali react under standard conditions to form 1 mol of water.

Standard Enthalpy of Atomisation: Energy change when 1 mol of gaseous atom is formed from the element in its standard physical state under standard conditions.

Calculations:

1) $Q = mc\Delta T$

Where m = mass of water in g (total of the volumes of acid and alkali in cm³ in solution). This is because water has a density of 1g cm⁻³.

ΔT = Change in Temp in °C or Kelvin.

Q = Energy change in Joules

c = specific heat capacity of water = 4.18 J/g °C.

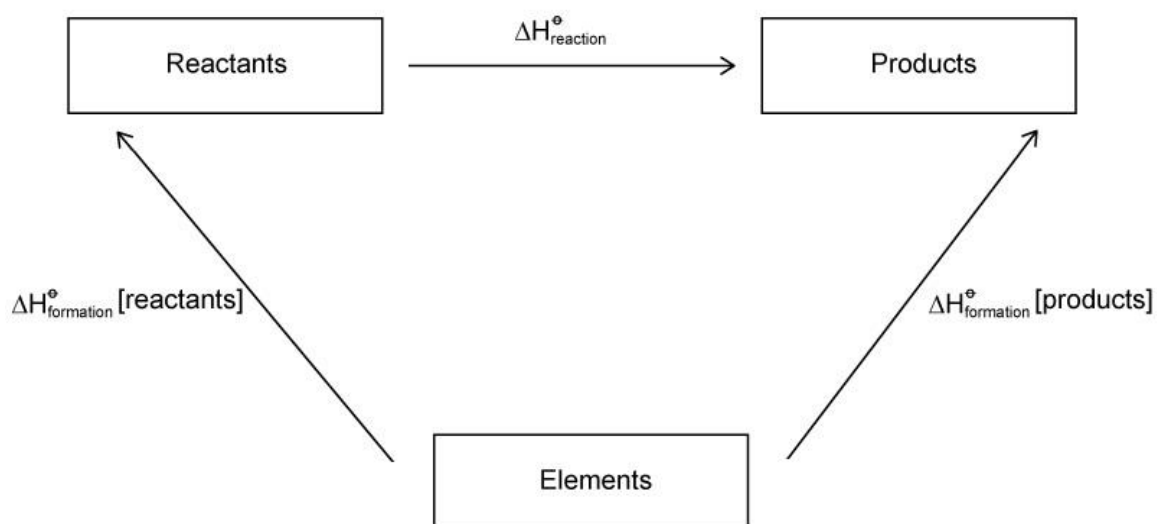
NB: For an endothermic reaction, Q will be negative because temperature decreases. For an exothermic reaction, Q will be positive because temperature increases.

2) $\Delta H = - Q/n$

Where n = number of moles.

ΔH is in KJ mol⁻¹ so it is necessary to divide Q/1000.

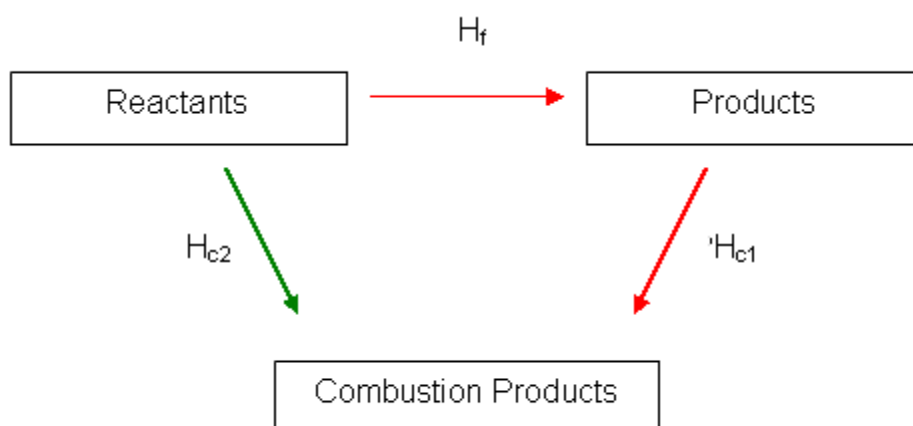
3) Hess's law: Standard Enthalpy of formation



NB: The arrows will both be going up from the 'Elements' box.

$$\Delta H_r = \Delta H_f (\text{products}) - \Delta H_f (\text{reactants})$$

4) Hess's law: Standard Enthalpy of combustion

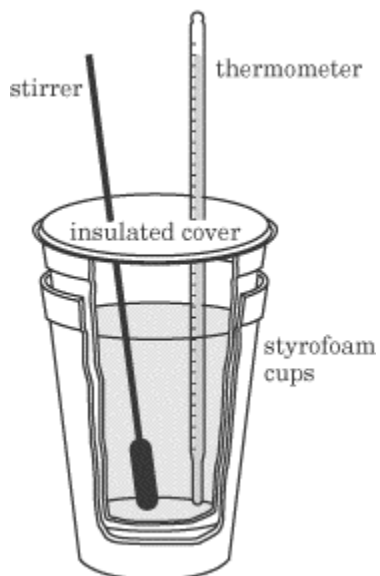


NB: The combustion products are always carbon dioxide and water. Both arrows go down towards the combustion products. To calculate the enthalpy of the reaction from the above;

$$\Delta H_f = \Delta H_{c2} - \Delta H_{c1}$$

Enthalpy of combustion is always exothermic.

Calorimeter



Why experimental and theoretical enthalpy values differ?

- Experiment may not have been done in standard conditions.
- Not all reactants may have fully reacted.
- Loss of heat to the surroundings.
- Measurement and recording errors.
- Non-uniform stirring.