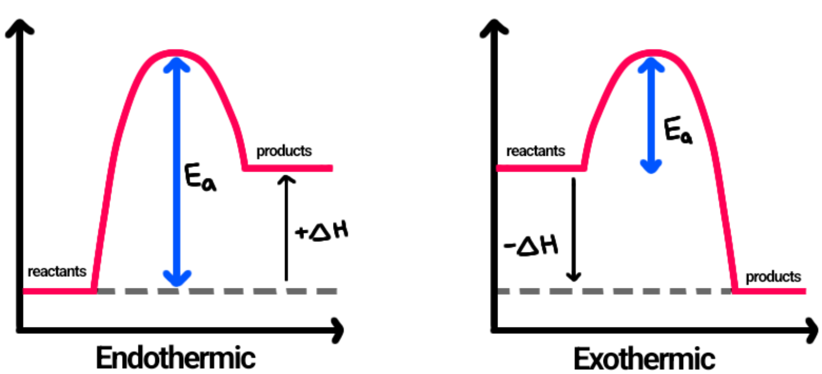
Chemical Energetics

Enthalpy Changes
- Total chemical energy inside a substance is called enthalpy
- the change in chemical energy during a chemical reaction is the enthalpy change
- Enthalpy change is represented by ΔH
- An enthalpy change can be positive or negative
- The activation energy is the minimum amount of energy needed for a reaction to take place
- The activation energy is represented by E_a

Exothermic Reactions
- A reaction is exothermic when the products have lesser energy than the reactants
- Heat energy is given off to the surroundings
- The enthalpy decreases so ΔH is negative
- They have a lower E_a than endothermic reactions
- Bond making is exothermic
- If more energy is released when new bonds are formed than energy is required to break bonds, the reaction is exothermic

Endothermic Reactions
- A reaction is endothermic when the products have greater energy than the reactants
- Heat energy is absorbed from the surroundings
- The enthalpy increases so ΔH is positive
- Have a higher E_a than exothermic reactions
- Bond breaking is endothermic
- If more energy is required to break bonds than energy is released when new bonds are formed, the reaction is endothermic

Energy Level Diagrams
- It is a graph of the energies of reactants and products against time



Enthalpy Changes at Standard Conditions

- Enthalpy changes are measured at standard conditions for fair comparison between reactions
- Pressure 101kPa
- Temperature of 298 K (25 degrees)
- Aqueous solutions should be at concentration of 1.0mol dm-1
- Enthalpy change under standard conditions is represented by ΔH°

Enthalpy Change of Formation ($\Delta H°_f$)

The enthalpy change when one mole of a compound is formed from its constituent elements under standard conditions.

Enthalpy Change of Combustion ($\Delta H°_c$)

The enthalpy released when one mole of a substance is burnt in air completely under standard conditions

Enthalpy Change of Neutralisation ($\Delta H°_{neut}$)

The enthalpy released when one mole of water is formed by the reaction between an acid and an alkali under standard conditions

Bond Energy

- Exact bond energy is the amount of energy required to break one mole of a specific covalent bond
- Average bond energy is the average of bond energies in different environments
- Average bond energy is calculated through enthalpy changes
- Average bond energy = total bond energy/number of bonds

Calculating Enthalpy Change with Bond Energies

ΔH = Total bond energy of reactants - total bond energy of products

Measuring Enthalpy Change

$$Q=mc\Delta T$$

Q = energy transferred (J)
m = mass (g)
c = specific heat capacity ($Jg^{-1}K^{-1}$)
ΔT = change in temperature

Hess's Law

- The law states that the total enthalpy change in a reaction is independent of the route by which the chemical reaction takes place as long as the initial and final conditions are the same
- whatever route the reaction takes, the enthalpy change will be the same
- this is used to calculate enthalpy changes that cant be measured
- it can be calculated through the enthalpy change of formation, combustion

Calculating ΔH from standard enthalpy change of formation

ΔH = total standard enthalpy change of formation of products - total enthalpy change of formation of reactants

Steps

1. Write down balanced equation
2. Write down all the elements that the compounds involved in the reaction form from
3. Draw arrows correctly from elements to compounds
4. Apply Hess Law, energy change of direct route should equal indirect route, subtract the enthalpy going the opposite direction of an arrow and add when going in the same direction

Calculating ΔH from standard enthalpy change of combustion

ΔH = total standard enthalpy change of combustion of reactants - total standard enthalpy change of combustion of products

Steps

1. Write down balanced equation
2. Write down all the products of combustion of reactants and products
3. Draw arrows correctly from reactants and products to combustion compounds
4. Apply Hess Law, energy change of direct route should equal indirect route, subtract the enthalpy going the opposite direction of an arrow and add when going in the same direction

Calculating standard enthalpy change of formation from standard enthalpy change of combustion

ΔH_f = total standard enthalpy change of combustion of reactants - total standard enthalpy change of combustion of products

Steps

1. Write down balanced equation
2. Write down all the products of combustion of reactants and products
3. Draw arrows correctly from reactants and products to combustion compounds
4. Apply Hess Law, energy change of direct route should equal indirect route, subtract the enthalpy going the opposite direction of an arrow and add when going in the same direction