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TOPIC 5: ENERGY CHANGES

THE ABOUT

CHAPTER ANALYSIS

TIME

- Relatively straight forward chapter
- Understand big idea: ‘system’ & ‘surroundings’

EXAM

- Learn how to calculate bond energy
- Learn how to sketch energy profile diagram

WEIGHTAGE

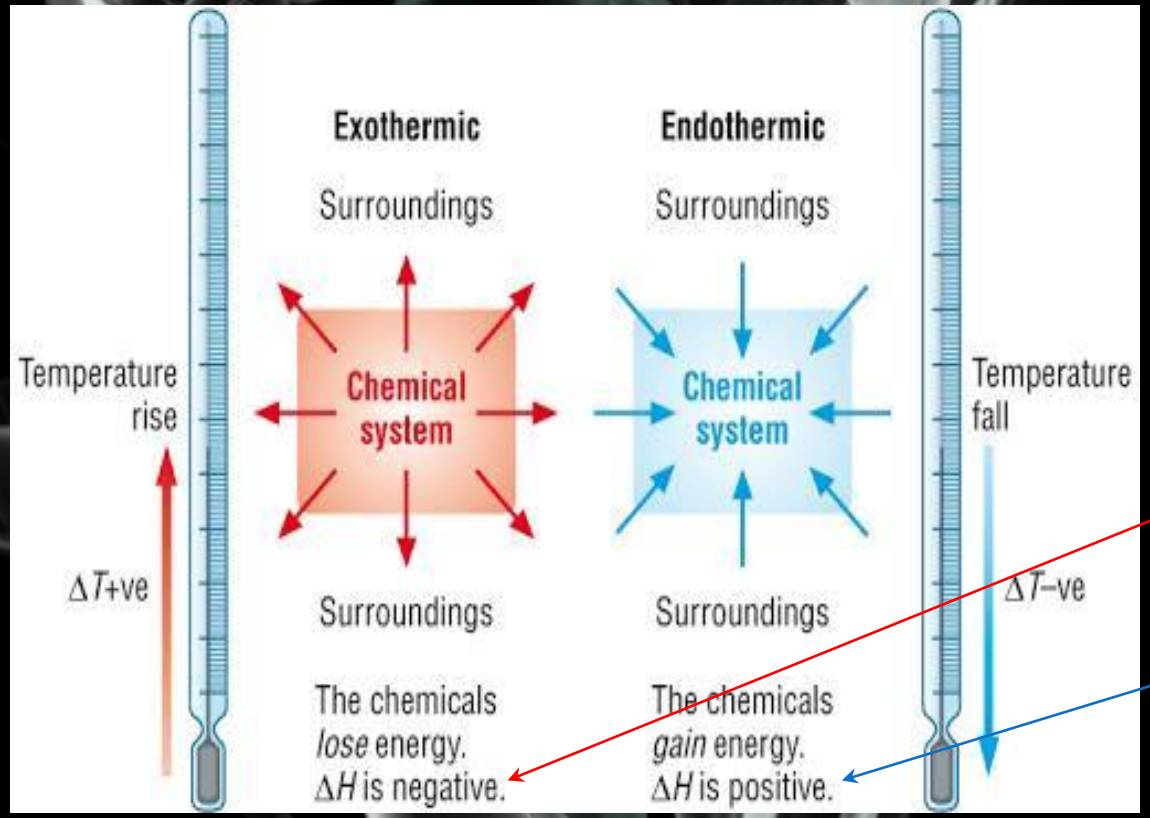
- Light-medium overall weightage
- Constitute to **3%** of marks for past 5 year papers

Pay special attention to your understanding of 'system' & surrounding.
It is the foundation of this chapter.

KEY CONCEPT

ENERGY FROM CHEMICALS
EXOTHERMIC
ENDOTHERMIC
ENERGY PROFILE DIAGRAM

ENERGY FROM CHEMICAL REACTIONS



ENERGY FROM CHEMICAL REACTION

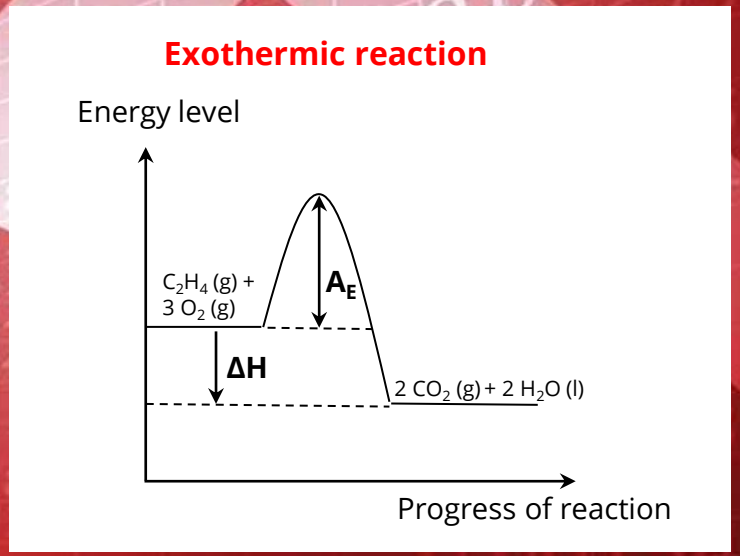
During chemical reactions, chemical bonds within the reactants are broken and new bonds are formed, creating new products.

The **reactants and products** make up the **system** and when it releases or absorbs heat energy, the **surrounding** would experience **a change in temperature**.

For an **exothermic reaction**, the chemical reactions causes the **system to release heat energy** to the surroundings. The overall **energy level of the system** would hence **decrease**.

For an **endothermic reaction**, the chemical reactions causes the **system to gain heat energy** from the surroundings. The overall **energy level of the system** would hence **increase**.

EXOTHERMIC REACTION



EXOTHERMIC REACTION

An exothermic reaction occurs where energy is expelled out to the surroundings.

Examples of exothermic processes would include **condensation and freezing** as heat is expelled out to the surroundings to lower the units' temperature.

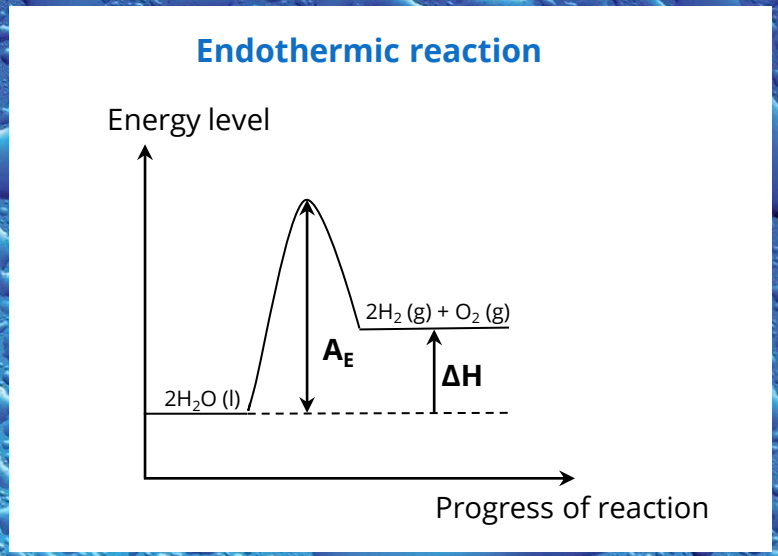
- Combustion reactions are also exothermic. Burning a hydrocarbon in the presence of oxygen will produce heat and raise the temperature of the surroundings.

$$C_2H_4\,(g) + 3\,O_2\,(g) \rightarrow 2\,CO_2\,(g) + 2\,H_2O\,(l) + \text{heat}$$

- Neutralisation reactions are also exothermic. Heat is produced when H^+ ions undergo bond forming with OH^- ions to form water.

$$H^+\,(aq) + OH^-\,(aq) \rightarrow H_2O\,(l) + \text{heat}$$

ENDOTHERMIC REACTION



ENDOTHERMIC REACTION

An endothermic reaction occurs when energy is absorbed from the surroundings.

Examples of endothermic process are **melting and boiling** where heat energy is absorbed to change states.

- Dissolving ionic salts in water is endothermic. For example, dissolving sodium chloride in water causes the temperature of the solution to decrease.

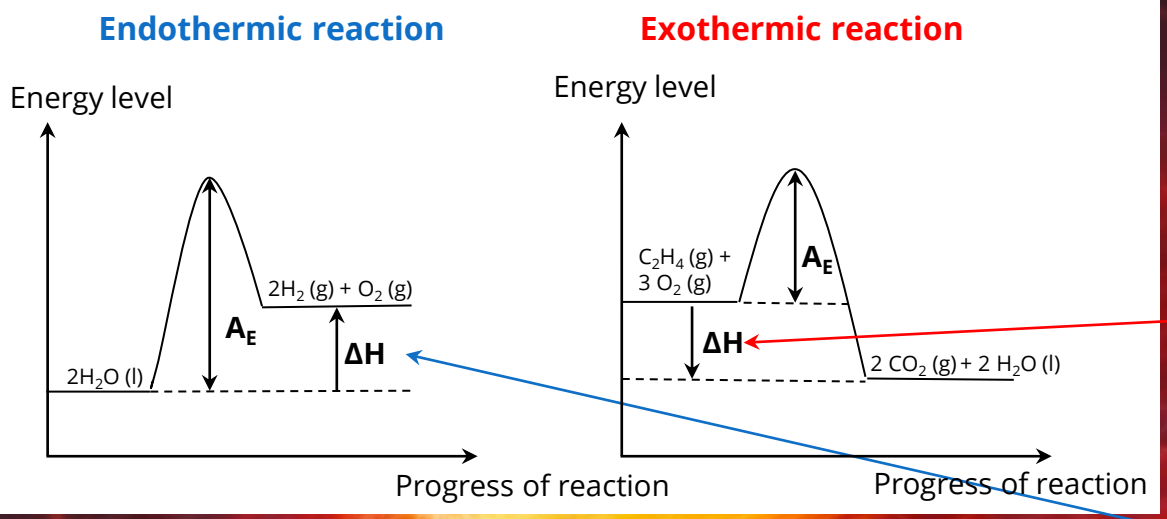
$$NaCl\ (s) + heat \rightarrow NaCl\ (aq)$$

- Thermal decomposition is an endothermic process as heat is required for most compounds to be decomposed.

$$PbCO_3\ (s) + heat \rightarrow PbO\ (s) + CO_2\ (g)$$

- Electrolysis is an endothermic reaction which occurs without absorbing heat energy. Instead, electrolysis occurs by **absorbing in electrical energy** for a reaction.

ENERGY PROFILE DIAGRAM



Energy level diagrams

In exothermic reactions, reactants lose energy to the surroundings to form resultant products. Hence, the energy level of the products is lower than the energy level of the initial reactants.

In endothermic reactions, reactants gain energy from the surroundings to form resultant products. Thus, the energy level of the products is higher than the energy level of the initial reactants.

ENTHALPY CHANGE

Enthalpy change is the total **amount of energy given out or absorbed during a chemical reaction** in the form of heat energy.

Enthalpy change (**ΔH**) would be positive for endothermic reactions and be negative for exothermic reactions.

$$C_2H_4\,(g) + 3\,O_2\,(g) \rightarrow 2CO_2\,(g) + 2\,H_2O\,(l)$$

ΔH = −1411 kJ (Exothermic)

This is an **exothermic** reaction.

$$2H_2O\,(l) \rightarrow 2H_2\,(g) + O_2\,(g)$$

ΔH = + 262 kJ (Endothermic)

This is an **endothermic** reaction.

KEY CONCEPT

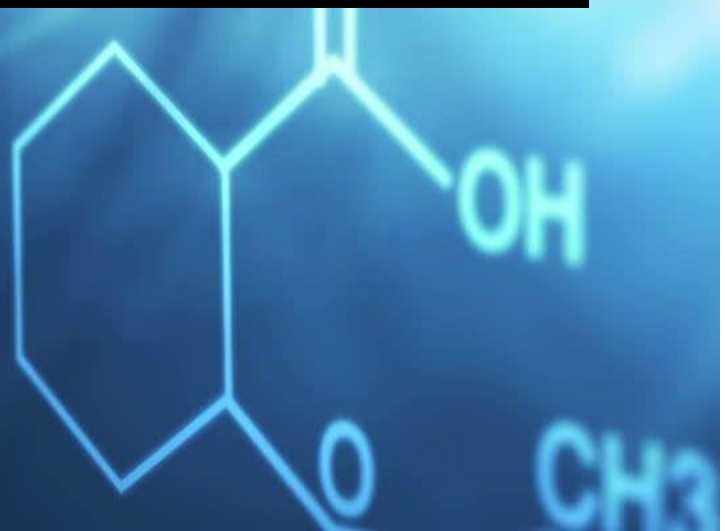
BOND BREAKING & BOND FORMING
ACTIVATION ENERGY
COMMON FUELS & HYDROGEN FUEL CELL

BOND BREAKING & BOND FORMING

Remember:

"Your bb (bae) is more important than your bf (best friend)"

BB – BF
(Bond breaking – Bond forming)



BOND BREAKING AND BOND FORMATION

Bond energy is defined as the amount of energy that is released when the bond is formed or the amount of energy that is required to be absorbed to break the bond.

ΔH,

= **Energy absorbed to break bonds + Energy released to form bonds**

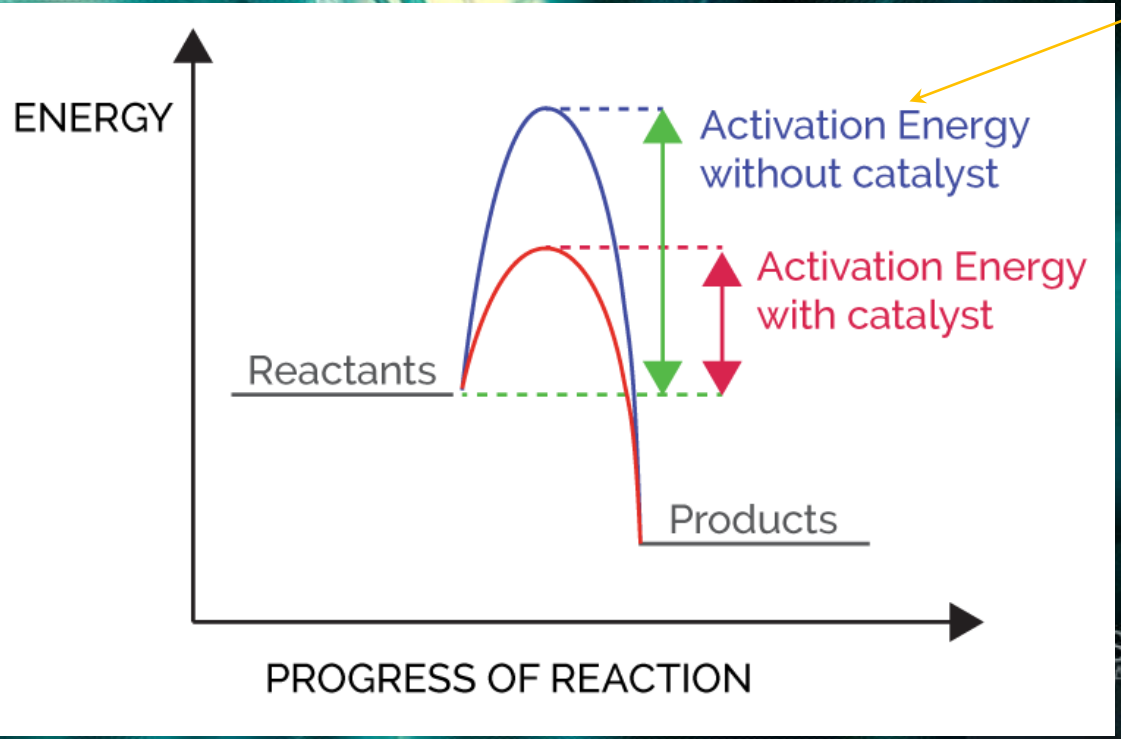
For an **exothermic reaction**,

Energy absorbed for bond breaking < Energy released from bond forming

For an **endothermic reaction**,

Energy absorbed for bond breaking > Energy released from bond forming

ACTIVATION ENERGY



ACTIVATION ENERGY

Activation energy is defined as the **minimum energy required to start a reaction**.

The symbol, E_a, is used to represent activation energy.

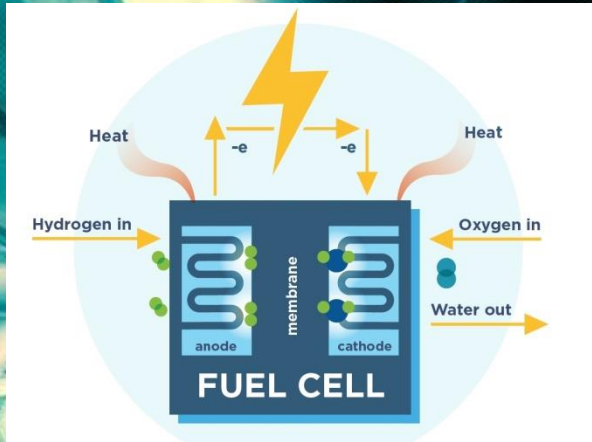
For a reaction to occur, it has to **possess at least the amount of energy that is equivalent to its activation energy**.

This is the same level of energy required to be absorbed in order to break the bonds in the reactants.

**Recall 2 conditions for reactions from "Rate of Reaction"*

1) Sufficient energy (activation energy)
2) Collide in correct orientation

HYDROGEN FUEL CELL



There is always a readily available supply of hydrogen that can be derived either from water or hydrocarbons, making it a **renewable** resource.

The product formed from its reaction is only water, which is a non-pollutant, making it **environmentally-friendly**.

The overall equation for the reaction is:

$$\mathbf{2H_2(g) + O_2(g) \rightarrow 2H_2O(l)}$$

COMMON FUELS

Fuels are sources of energy. When they undergo combustion, it releases energy as it is an exothermic reaction.

Fuels + oxygen → Energy released

During **complete combustion,** methane undergoes combustion in presence of sufficient oxygen to produce carbon dioxide and water.

$$CH_4\,(g) + 2O_2\,(g) \rightarrow CO_2\,(g) + 2H_2O\,(g) + \text{heat energy}$$

During in**complete combustion,** methane undergoes combustion in presence of insufficient oxygen to produce carbon monoxide and water.

$$4CH_4\,(g) + 6O_2\,(g) \rightarrow 4CO\,(g) + 8H_2O\,(g) + \text{heat energy}$$

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