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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

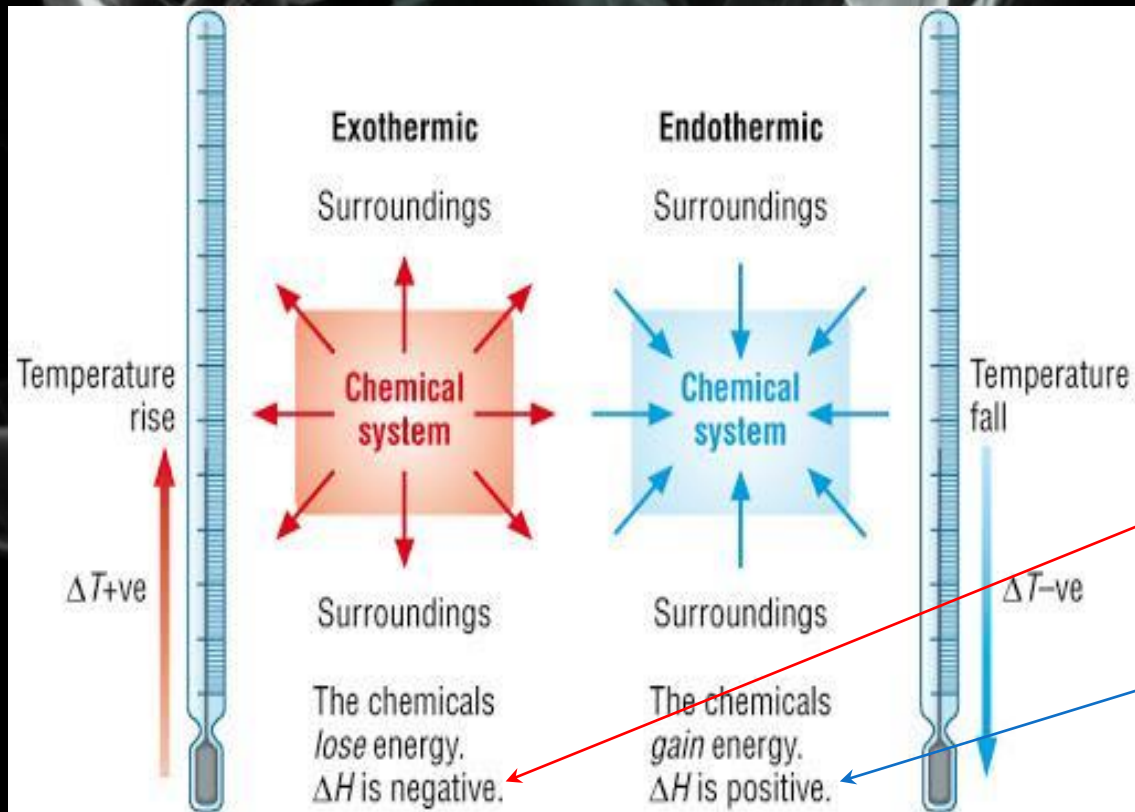
EXOTHERMIC

ENDOTHERMIC

ENERGY PROFILE DIAGRAM



ENERGY FROM CHEMICAL REACTIONS



ENERGY FROM CHEMICAL REACTION

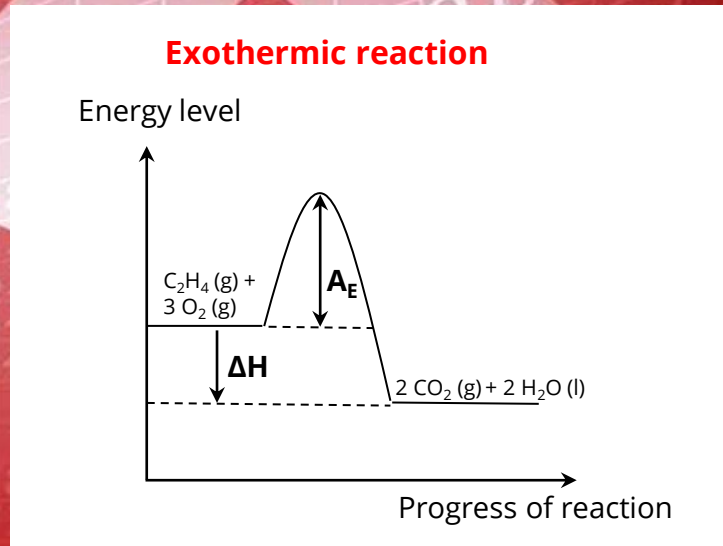
During chemical reactions, chemical bonds within the reactants are broken and new bonds are formed, creating new products.

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

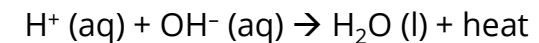
An exothermic reaction occurs where energy is expelled out to the surroundings.

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.

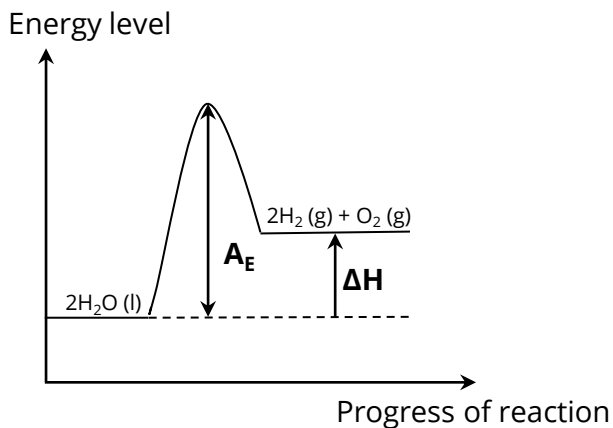


- **Neutralisation reactions** are also exothermic. Heat is produced when H^+ ions undergo bond forming with OH^- ions to form water.



ENDOTHERMIC REACTION

Endothermic reaction



ENDOTHERMIC REACTION

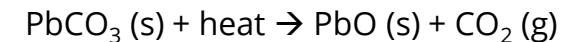
An endothermic reaction occurs when energy is absorbed from the surroundings.

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.



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



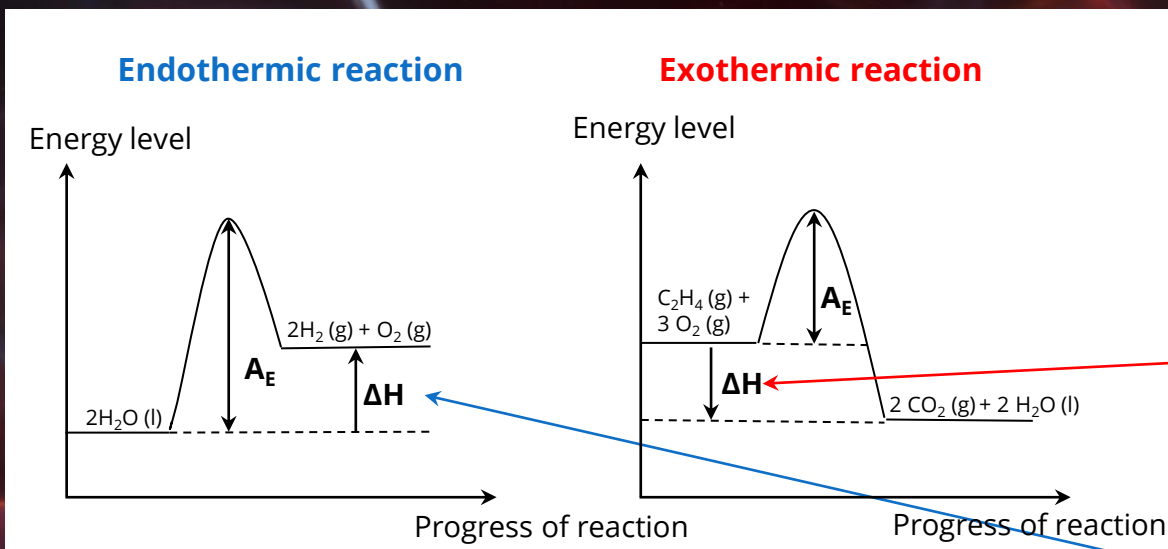
- **Electrolysis** is an endothermic reaction which occurs without absorbing heat energy. Instead, electrolysis occurs by **absorbing in electrical energy** for a reaction.

ENERGY PROFILE DIAGRAM

ENTHALPY CHANGE

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

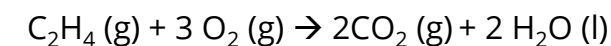
Enthalpy change (ΔH) would be positive for endothermic reactions and be negative for exothermic reactions.



Energy level diagrams

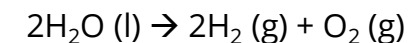
In exothermic reactions, reactants lose energy to the surroundings to form resultant products. Hence, the energy level of the products is lower than the energy level of the initial reactants.

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.



$$\Delta H = -1411 \text{ kJ (Exothermic)}$$

This is an **exothermic** reaction.



$$\Delta H = +262 \text{ kJ (Endothermic)}$$

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**

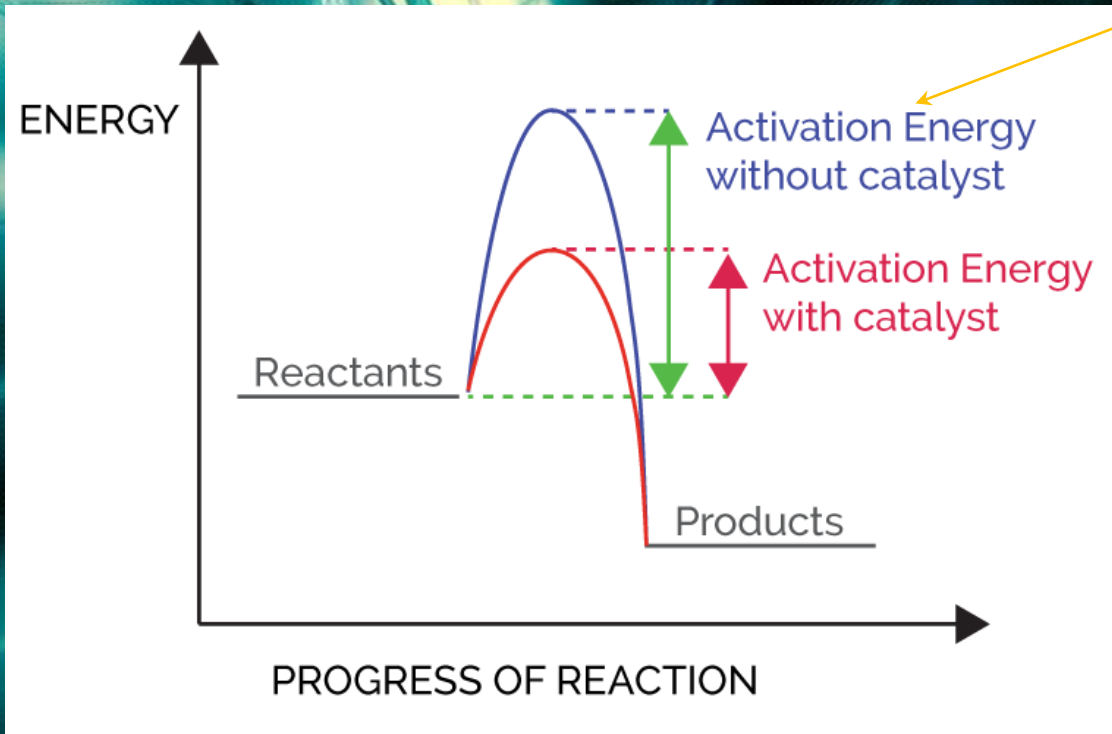
For an **exothermic reaction**,

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.

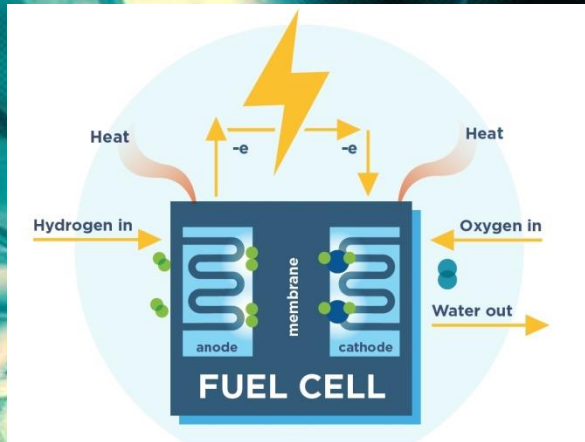
For a reaction to occur, it has to **possess at least the amount of energy that is equivalent to its activation energy.**

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*

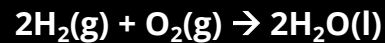
HYDROGEN FUEL CELL



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

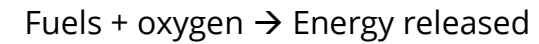
The product formed from its reaction is only water, which is a non-pollutant, making it **environmentally-friendly**.

The overall equation for the reaction is:

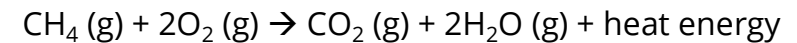


COMMON FUELS

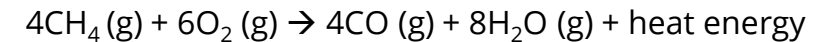
Fuels are sources of energy. When they undergo combustion, it releases energy as it is an exothermic reaction.



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



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



Try it yourself! (TYS Question)

14. A reversible reaction is exothermic in the forward direction and the heat given out is 196 kJ/mol. The activation energy for the forward reaction is 75 kJ/mol. What is the activation energy of the **reverse** reaction? (N2020/P1/Q14)

A 75 kJ/mol
C 196 kJ/mol

B 121 kJ/mol
D 271 kJ/mol

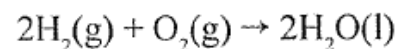
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Answer:

14. **D**
The activation energy of the reverse reaction is the sum of the activation energy of the forward reaction and the enthalpy change.

Try it yourself! (TYS Question)

15. Hydrogen burns in the air to form water as shown.



Which statement concerning the enthalpy change, ΔH , for the reaction is correct?

(N2020/P1/Q15)

	ΔH	explanation
A	negative	energy change in breaking bonds in hydrogen and oxygen is greater than the energy change in making the bonds in water
B	negative	energy change in breaking bonds in hydrogen and oxygen is less than the energy change in making the bonds in water
C	positive	energy change in breaking bonds in hydrogen and oxygen is greater than the energy change in making the bonds in water
D	positive	energy change in breaking bonds in hydrogen and oxygen is less than the energy change in making the bonds in water

Answer:

15. **B**

Hydrogen burning in air is an exothermic reaction. The enthalpy change is negative as the energy taken in during bond breaking in hydrogen and oxygen is less than the energy given out during bond making in water.

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