

Heat Change in Reactions

3.1

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Classification of Chemical Reaction	
Exothermic Reaction	Endothermic Reaction
Chemical reactions that release heat to the surroundings.	Chemical reactions that absorb heat from the surroundings.

Chemical Reaction

Exothermic Reaction

- Definition: Chemical reaction that releases heat to the surrounding.
- Heat released to the surroundings causes the surrounding temperature to rise.
- The container becomes hot.
- Examples;
 - Respiration
 - Combustion of fuel
 - Decomposition of organic compound
 - Iron rusting
 - The reaction of reactive metal (potassium and sodium) with water
 - Neutralisation reaction
 - The reaction of an acid with metal
 - The reaction of an acid with metal carbonate
 - Dissolving sodium hydroxide in water
 - Addition of concentrated acid into water
 - Metal oxidation
 - Formation of ammonia in the Haber process
- The energy of the reactant is higher than the energy of the product.

Endothermic Reaction

- Definition: Chemical reaction that absorbs heat from the surrounding.
- Heat absorbed from the surroundings causes the temperature to drop.
- The container becomes cold.
- .The example of endothermic reaction is as stated below:

Example of Endothermic Reaction

- Photosynthesis.
- Dissolving ammonium salt in water.
- The process of cooking food.
- Decomposition of metal carbonate
- Decomposition of metal nitrate.



- The energy of the reactant is lower than the energy of the product.

Energy Level Diagram

- During a chemical reaction, heat is absorbed or released.
- This heat is called heat of reaction, and is given the symbol ΔH .
- The unit for heat of reaction is kJ mol^{-1} .
- In a chemical reaction, when heat is released to the surroundings, ΔH is given a negative sign.
- When heat is absorbed from the surroundings, ΔH is given a positive sign.
- The energy change in a chemical reaction can be represented using an energy level diagram.
- The energy level diagram shows the difference in the heat energy content between the reactants and the products.
- The definition of heat of reaction is as stated below:

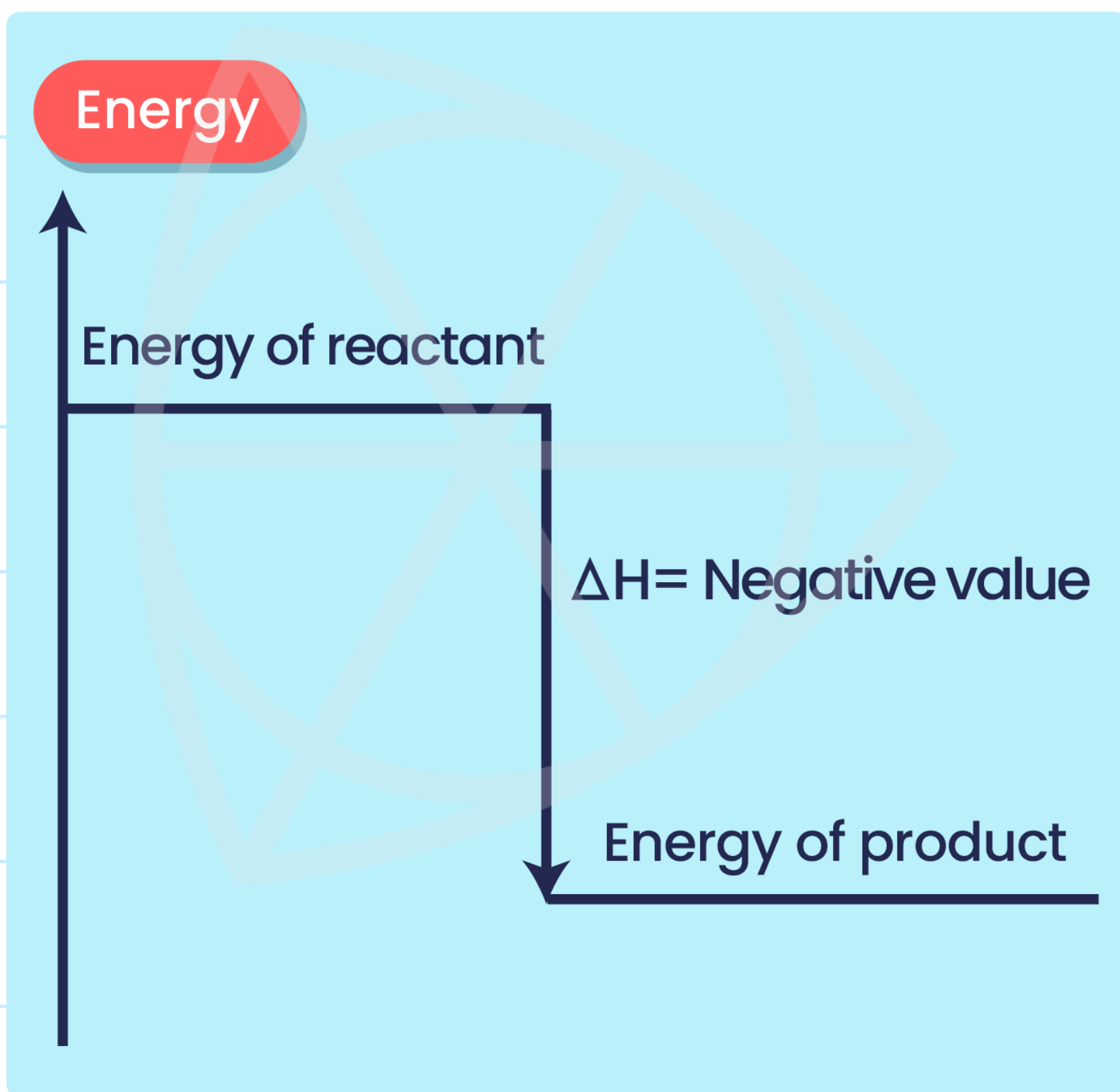
Definition of Heat of Reaction, ΔH

The heat change of one mole of reactant that reacts or one mole of product that is formed

$$\Delta H = H_{\text{product}} - H_{\text{reactant}}$$

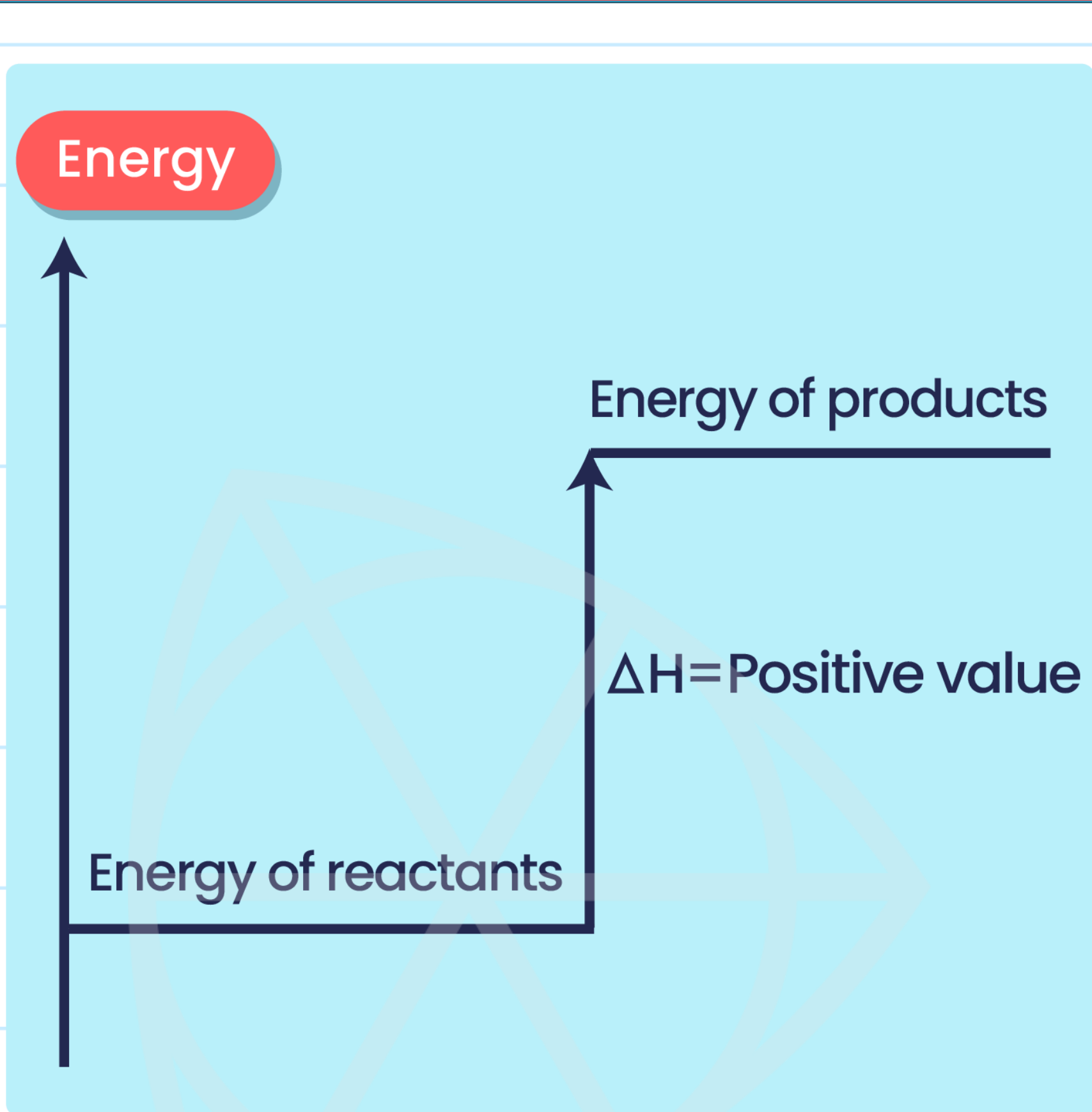
- Example of energy level diagram of the exothermic reaction:

Energy Level Diagram of the Exothermic Reaction



- Example of energy level diagram of the endothermic reaction:

Energy Level Diagram of the Endothermic Reaction



Energy Change During Breaking and Formation of Bonds

- During a chemical reaction, the chemical bonds in the reactants are broken, and new bonds are formed in the products.
- In an exothermic reaction, the heat energy released during the formation of the bonds in the products is greater than the heat energy absorbed to break the bonds in the reactants.
- In an endothermic reaction, the heat energy absorbed to break the bonds in the reactants is greater than the heat energy released during the formation of the bonds in the products.

Change of Energy	Value of ΔH	Type of Reaction
Energy absorbed to break bond < Energy released to form a bond	Negative	Exothermic
Energy absorbed to break bond > Energy released to form a bond	Positive	Endothermic

