**Thermo chemical Principles: Heat Transfer Reactions**

During a chemical reaction, atoms in reactants are rearranged into products with different heat energies (enthalpy).

2 situations can arise depending upon the relative heat energy of the reactants and products

1. **Exothermic Reactions:**
   Total heat energy of products is less than energy of reactants.

   - Energy has been released as **heat**
   - Temperature of surroundings increases
   - Bond **making** process
   - Examples
     - physical changes of state
       - gas →liquid,
       - liquid → solid
       - gas → solid
     - chemical reactions:
       - neutralization
       - combustion
       - respiration
       - precipitation

2. **Endothermic Reactions**
   Total heat energy of products is greater than energy of the reactants
   - Heat energy has been **absorbed**
   - Temperature of surroundings decreases
   - Bond **breaking** process
   - Examples
     - physical changes of state
       - liquid → gas,
       - solid → liquid
       - solid → gas (sublimation)
     - Chemical reactions:
       - photosynthesis

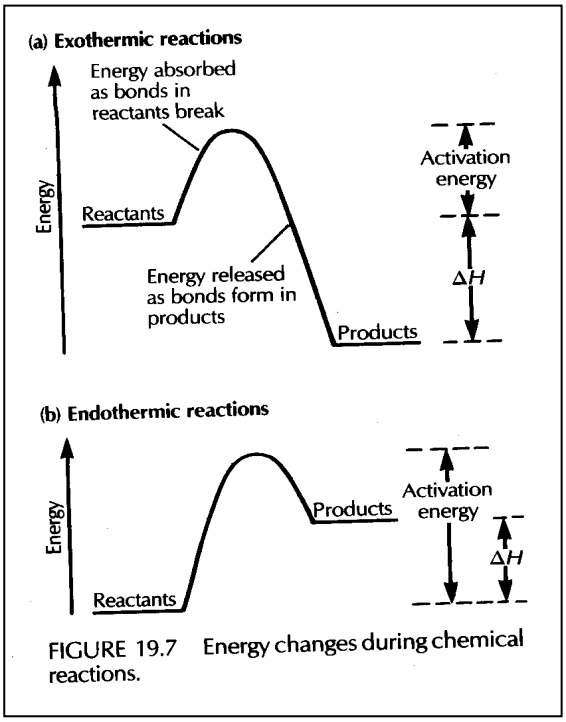


FIGURE 19.7 Energy changes during chemical reactions.

## Enthalpy (H)

- heat content of a substance)
- When heat is released/absorbed in a reaction, the enthalpy (heat content) of reactants and products must be different

## Enthalpy change (ΔH)

- loss or gain of heat energy in a reaction.
- The amount of energy released / absorbed depends on the **amount** of reagents involved.
- Unit = kJ (kilojoules) or kJ $mol^{-1}$(kilojoules per mol)

| $\Delta_r H$ | = | $\Sigma H_p$ | - | $\Sigma H_r$ |
|---|---|---|---|---|
| Enthalpy Change for a reaction | | Sum of Enthalpy of Products | | Sum of Enthalpy of Reactants |

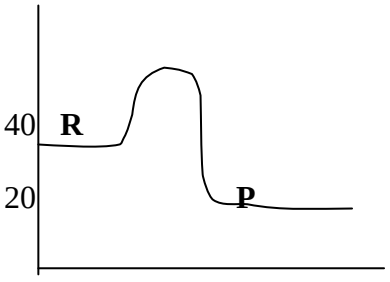
**Exothermic Reactions**: ΔH = negative

- products have less energy than reactants

**Endothermic Reactions:** ΔH = positive

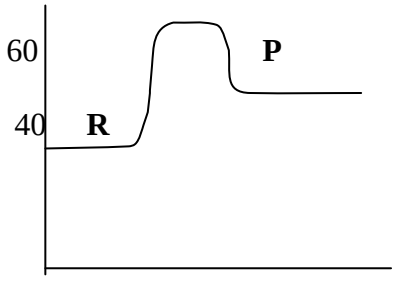
- products have more energy than reactants

ΔH = negative (exo)




$\Delta H = H_p - H_r$
$= 20 - 40$
$= -20$

ΔH = positive (endo)




$\Delta H = H_p - H_r$
$= 60 - 40$
$= +20$

## Activation Energy

Minimum amount of energy required to initiate a chemical reaction.

The minimum energy required to break the bonds of reactants so that a reaction can proceed. For this to occur, energy must be **absorbed**

Then new bonds form as products are created. Energy is **released** as this happens.

The ΔH for the reaction is thus the net result of energy absorbed and released.