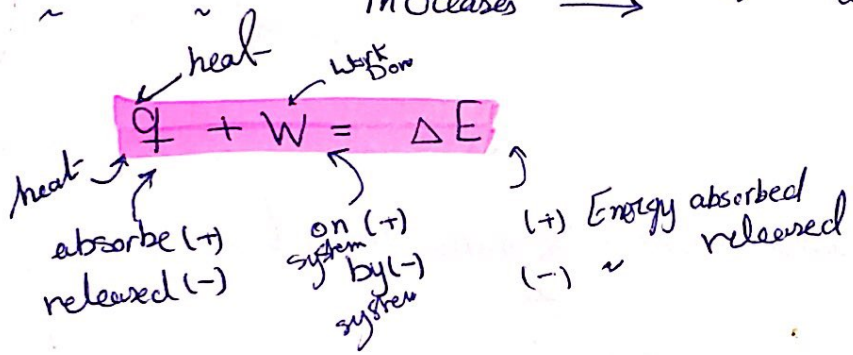
Chapter 6 : Thermochemistry

- **Internal Energy** (E) :- Sum of potential and Kinetic Energies

→ Change of energy in System = opposite Change Energy in Surroindings

$$\Delta E = E_{final} - E_{initial} = E_{products} - E_{reactants}$$

- Energy of System decreases → Energy released to surroundings
- ~ ~ increases → ~ absorbed from ~



$$\Delta E_{universe} = \Delta E_{system} + \Delta E_{surpundings} = 0$$

Units: Joule (SI system)

1 Cal = 4.184 J

1 Btu = 1055 J

Enthalpy: Chemical Change at Constant Pressure

PV Work: Chemical Work

- Work done when the Volume of a system changes in the presence of an external Pressure

$\Delta H = \Delta E + \Delta PV$

- If P is Constant and the Volum Doesn't Change a lot Then

$\boxed{\Delta PV = 0}$

And $\boxed{\Delta H = \Delta E}$

- Reactions That does not involve gases
- " " has a Constant moles of gas

Remember

$-q_{lost} = q_{gained}$

* Exothermic and Endothermic Reactions

Exothermic	Endothermic
• heat is Given Out	• heat is taken in
• $\Delta H < 0$	• $\Delta H > 0$
• heat is a product	• heat is a reactant
• reactant has higher Energy	• products has higher Energy

* Calorimetry

$q = C \times m \times \Delta T$

- C: specific heat Capacity (c) — كمية الحرارة
- m: mass in g
- $\Delta T = T_{final} - T_{initial}$ in Kelvins

(Quantity of heat required to Change Temp of 1 gram of sub by 1K)

Stoichiometry of Thermochemical Equations

* Equation That includes ΔH_{rxn}
  - sign indicates Ex or Endo
  - magnitude of ΔH proportional to the amount of subst-

- How to Solve Problems ?

* **Hess's law**

$$\Delta H_{overall} = \Delta H_1 + \Delta H_2 + \text{----} + \Delta H_n$$

- How to Solve Problems ?
  - find the amount of each reactant and product
  - Change the sign of ΔH when
  - Multiply moles and ΔH by the

Ex

$CO_{(g)} + NO_{(g)} \longrightarrow CO_{2(g)} + \frac{1}{2}N_2$

we have

$CO_{(g)} + \frac{1}{2}O_{2(g)} \longrightarrow CO_{2(g)}$ ΔH

$N_{2(g)} + O_{2(g)} \longrightarrow 2NO_{(g)}$ Δ

$2NO_{(g)} \rightarrow N_{2(g)} + O_{2(g)}$ $\Delta H = 180$

$NO_{(g)} \rightarrow \frac{1}{2}N_{2(g)} + \frac{1}{2}O_{2(g)}$

$\Delta H = -90.3$

$CO + \frac{1}{2}O_2 \rightarrow CO_2$ $\Delta H = -283$

$CO + NO \rightarrow CO_2 + \frac{1}{2}N_2$

$(-283 - 90.3) = -373.3$

Coffee Cup calorimeter :-

→ This device measures the heat transferred at Constant Pressure (q_p)

→ If heat is transferred from a body to another then :-

$$\frac{q_{body(1)}}{q_{body(2)}} = 1 \Rightarrow \frac{C_1 \times m_1 \times \Delta T_1}{C_2 \times m_2 \times \Delta T_2} = 1$$

law :-

$$-q_{sub_1} = q_{sub_2} + q_{calorim}$$

where sub₁ is loosing heat and sub₂ is Getting heat

A bomb calorimeter

→ This device measures the heat released at Constant Volume (q_v)

→ To determine ΔH_{rxn}° from ΔH_f° of reactants and Products

$$\Delta H^{\circ}_{rxn} = \sum m \, \Delta H^{\circ}_{f(products)} - \sum n \, \Delta H^{\circ}_{f(reactants)}$$

Standard Enthalpy of Reaction (Enthalpy for substance in Their standard state)

Notes: * Internal Energy is The same as ΔE

* 28 has a Good idea

* Standard ~~state~~ heat of formation:

ΔH_f° :- formation of one Compound in it's standard state from Elements in Their standard state (1 atm / 1 M of solutes, stable form of liquids and solids)

• $\Delta E = \frac{3}{2} nRT$ for ideal gas

* $\Delta H_f^{\circ} \; O_2 = 0$

* صفر $O + O_2 \rightarrow CO_2 + H_2O$ التفاعل بجوز Combusti يصير C, H, O مركب فيه

(زاد 2)