ENERGY - capacity to do work

WORK - Motion aganist an
opposing force

System - Part of the world
where we have interest

Surroundings - where we make
observation

Open System - Energy & matter
exchanges

closed System - Energy exchange

Isolated System - No exchange of
Energy & matter

DIATHERMIC - walls that Permit heating

ADIABATIC - walls that do not Permit heating

Exothermic - release heat to Surroundings

Endothermic - absorb heat from Surroundings

work - transfer of energy uniform motion

heat - transfer of energy disorderly motion work done $w = -P_{ex} \Delta V$

$\Delta V = V_f - V_i$ f - final
i - initial

A = Area of Piston

h = height it moved

$\Delta V = Ah$.

External force P_{ex} opposes the expansion with

force $= P_{ex} \times A$

work done = distance moved × opposing force

$= h \times (P_{ex} A) = P_{ex}(Ah)$

$= P_{ex} \Delta V \left[\because \Delta V = Ah \right]$

when $p_{ex} = 0 \Rightarrow w = 0$

It is free expansion.

$\left.\begin{array}{c}\text{maximum}\\ \text{work}\end{array}\right\} \Rightarrow$ maximum pressure.

But $P_{ex} \ngtr P_{internal}$

when $P_{ex} > P_{internal} \Rightarrow$ compression.

$\therefore$ maximum work = P_{ex} little le
than $P_{(int)}$)

when actually

$P_{ex} > P_{(int)}$.

The Situation is rerersible

2.4

1. A Sustem does maximum Expansion work when the $P_{ex} = P_{(int)}$ at every stage of expansion.

2. A system does maximum Expansion work when it is in mechanical equilibrium with its surroundings.

3. maximum expansion work is achieved in a reversible change.

Heat capacity

$$C = \frac{q \ (\text{Energy supplied } \underline{\text{heat}}]}{\Delta T \ (\text{change in temp.})}$$

Specific heat capacity) $c_s = \dfrac{C}{m \ (\text{mass}}$ $\mathrm{J\,K^{-1}\,g^{-}}$

Molar heat capacity) $C_m = \dfrac{C}{n \ (\text{mole})}$ $\mathrm{J\,K^{-1}\,mol}$
amount

Calorimeter.

$q = IVt$

I - current 'Ampere'

V - Potential 'volt'

t - time 'sec'

Endothermic reaction

Ex. CO_2 liberated. volume change in System. It pushes the Surrounding [does work

∴ Increase in internal Energy $\neq$ heat supplie

Exothermic reaction

Ex. volume decrease. So surroun does work. Energy is given to the System.

∴ Decrease in internal Energy $\neq$ Energy releas as heat [work done ~~by~~ to system

For Isothermal expansion

Initial temp = Final temp.

mean speed of molecule before expansion = after expansi

∵ for Perfect gas

Energy = KE

∴ Total Energy before expansion = after expansio

∴ $q = -w$

Energy entered (heat) — work left the system

For isothermal reversible Expansion of a perfect gas

$$q = nRT \ln \frac{V_f}{V_i}$$

greater V_f to V_i higher work

$\Rightarrow$ higher influx of Energy

According to Isothermal Expansion of a Perfect gas

$$q = -w$$

$$\therefore \boxed{\Delta U = 0}$$

The internal Energy of a sample of Perfect gas at a given temp. is independent of the volume it occupies.

1st Law of Thermodynamics

The internal energy of an isolated system is constant

$\therefore$ heat = work

heat (or) work is used to increase temp.

Internal Energy $U = KE + PE$

$$U \propto T \text{ and } P$$

"U" difficult to measure.

ΔU = change in internal Energ

$$\Delta U = w + q$$

w - Energy transfered by doing work

q - energy transfered by heating

for Iso ~~the~~ thermal Expansion

$$\Delta U = 0$$

$\therefore$ $w = -q$ (or) $q = -w$

2-11

$$\Delta U = q + w$$

if 'w' = 0 [non-expansion work]

↳ constant vol.

$$\Delta U = q_v$$

Bomb calorimeter

constant volume calorimeter.

Enthalpy. [Heat content at constant Pre]

$$H = U + pV$$

$$\Delta H = \Delta U + \Delta(PV)$$

at constant Pre

$$\Delta H = \Delta U + P(\Delta V)$$

$$H_m = U_m + PV_m = U_m + RT$$

[∵ $PV_m = RT$]

molar Enthalpy H_m = molar internal Energy $U_m + 2.5$ KJ

$$\boxed{\Delta H = q_p}$$

constant Pre

no non-Expansion work

"At constant Pressure"

Endothermic reaction $[q > 0]$

$\Rightarrow \Delta H > 0$ [Energy enters System

Exothermic Process $[q < 0]$

$\Rightarrow \Delta H < 0$ [Energy leaves system]

Increase in temp $\Rightarrow$ Increase in Enthalpy.

At constant pressure

$$\Delta H = q$$

$$C_p = q/\Delta T \Rightarrow \frac{\Delta H}{\Delta T}$$

$$H_m = U_m + RT \Rightarrow H_m - U_m = RT$$

$$\Delta H_m - \Delta U_m = R\,\Delta T$$

$$\frac{\Delta H_m}{\Delta T} - \frac{\Delta U_m}{\Delta T} = R.$$

$$C_{P_m} - C_{V_m} = R.$$