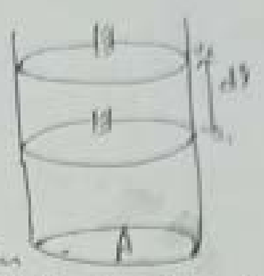
Work done During Expansion :- Let an Ideal gas is filled in a cylinder fitted with a piston having cross. Section Area A and volume V. We know that Pressure is the force per unit Area.



$$P = \frac{\text{Force}}{\text{Area}} = \frac{f}{A}$$

$$f = P \times A \quad \text{——(1)}$$

Suppose piston moves upward, so expansion through a distance dl takes place. So now the surrounding small work done by the gas or system on the surrounding.

Work = force × Distance

$$dw = -f \times dl = -P \times \underline{A \times dl} = -P \times dV$$

When System Expands from volume V_1 to V_2, then by Integration we got,

$$w = -P \int_{V_1}^{V_2} = -P(V_2 - V_1) = -P\Delta V$$

$\boxed{w = -P\Delta V} \Longrightarrow$ During Expansion.

Work done During Contraction :- If External pressure is more than that of the System, then Contraction takes place.

$\boxed{w = P\Delta V} \Longrightarrow$ During Contraction

Workdone In Isothermal and Reversible Expansion

$$dw = -PdV$$

$$\int dw = -P \int_{V_1}^{V_2} dV$$

We know that for an Ideal gas, $P = \frac{nRT}{V}$

$$w = -nRT \int_{V_1}^{V_2} \frac{1}{V} dV = -nRT \ln \frac{V_2}{V_1} = -2.303\, nRT \log \frac{V_2}{V_1}$$

So $\boxed{w = -2.303\, nRT \log \frac{V_2}{V_1}}$

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Internal Energy [E or U] :- Every Substance possess a definite amount of Energy known as Internal Energy. Denoted by $\boxed{E \text{ or } U}$
change in Internal Energy (ΔE) Can be defined as the Difference in the Internal Energies of the product and Reactant.

$$\Delta E = E_P - E_R \quad \text{or} \quad E_2 - E_1$$

According to first law of Thermodynamics, $\Delta E = q + w$
$\Delta E = q + P\Delta V$
But At Constant Volume, $\Delta V = 0$, So

$$\boxed{\Delta E = q_v}$$

So change in Internal Energy Can defined as the heat energy Exchanged b/w System and Surrounding at Constant Temperature and Constant Volume

Enthalpy(H) :- Enthalpy of a System Can be defined as the Sum of Internal Energy and Pressure Volume work.

$$H = E + PV$$

According to first law of Thermodynamics, At Constant Pressure,

$$\Delta E = q - P\Delta V$$

We know that $\Delta E = E_2 - E_1$, $\Delta V = V_2 - V_1$, So

$$E_2 - E_1 = q - P(V_2 - V_1)$$

$$q = E_2 - E_1 + PV_2 - PV_1$$

$$q = (E_2 + PV_2) - (E_1 + PV_1)$$

We know that $H = E + PV$

$$H_1 = E_1 + PV_1$$

$$H_2 = E_2 + PV_2$$

$$q = H_2 - H_1 = \Delta H$$

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

change in Enthalpy (ΔH) Can be defined as the heat energy Exchanged b/w the System and Surrounding at Constant Temperature and Constant Pressure.

Relation Between ΔH and ΔE

$$\Delta H = \Delta E + P\Delta V$$

For and Ideal gas Equation $PV = nRT$