

i) Isothermal Reversible

$$\begin{aligned} ① W &= -nRT \ln\left(\frac{V_2}{V_1}\right) & ② \Delta U &= 0 \\ &= -nRT \ln\left(\frac{P_1}{P_2}\right) & ③ q &= -W \\ & & ④ \Delta H &= 0 \end{aligned}$$

$$W = -2.303 nRT \log_{10}\left(\frac{V_2}{V_1} / \frac{P_1}{P_2}\right)$$

ii) Isothermal irreversible ($P_{ext} \neq P_2$)

$$\begin{aligned} ① W &= -P_{ext} \Delta V = -P_{ext} \left(\frac{nRT_2}{P_2} - \frac{nRT_1}{P_1} \right) \\ &= -nRT \left(1 - \frac{P_2}{P_1} \right) \\ ② \Delta U &= 0 \\ ③ q &= -W \\ ④ \Delta H &= 0 \end{aligned}$$

$$W = -P_{ext} \Delta V$$

iii) Adiabatic Reversible

$$\begin{aligned} ① W &= \Delta U = nC_v \Delta T \\ W &= \frac{nR \Delta T}{\gamma - 1} \\ ② \Delta U &= nC_v \Delta T & PV^\gamma &= K \\ ③ q &= 0 & TV^{\gamma-1} &= K \\ ④ \Delta H &= nC_p \Delta T & TP^{\frac{\gamma}{1-\gamma}} &= K \end{aligned}$$

iv) Adiabatic irreversible

$$\begin{aligned} ① W &= \Delta U = nC_v \Delta T \\ W &= \frac{nR \Delta T}{\gamma - 1} \\ ② \Delta U &= nC_v \Delta T \\ ③ q &= 0 \\ ④ \Delta H &= nC_p \Delta T \end{aligned}$$

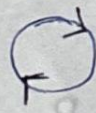
iv) Isochoric

$$\begin{aligned} ① W &= 0 \\ ② \Delta U &= q = nC_v \Delta T \\ ③ q &= \Delta U = nC_v \Delta T \\ ④ \Delta H &= nC_p \Delta T \end{aligned}$$

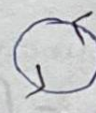
v) Isobaric

$$\begin{aligned} ① W &= -P_{ext} \Delta V = -nR \Delta T \\ ② \Delta U &= nC_v \Delta T \\ ③ q &= \Delta H = nC_p \Delta T \\ ④ \Delta H &= nC_p \Delta T \end{aligned}$$

vii) Cyclic Process



C.W. = $\Delta V = +ve$
 $W = -ve$



A.C.W. = $\Delta V = -ve$
 $W = +ve$

• Entropy (S)

- Measure of randomness
- State function, Extensive property

$$\Delta S = \frac{q_{\text{reversible}}}{T} = \sum S_p - \sum S_R$$

$$\Delta S_{\text{fusion}} = \frac{\Delta H_{\text{fusion}}}{T_{m.p}}$$

$$\Delta S_{\text{vapour}} = \frac{\Delta H_{\text{vapour}}}{T_{b.p}}$$

$$\Delta S_{\text{sublime}} = \frac{\Delta H_{\text{sublime}}}{T_{s.p}}$$

Exception: Boiling of an egg = $\downarrow$ Entropy due to denaturation of protein

stretching of rubber = $\downarrow$ Entropy

① Entropy change due to phase transformation

• Criteria for spontaneity

- $\Delta S_{\text{universe}} = 0$
- To minimise energy
- To maximise disorderness

• Entropy: Solid < Liquid < gas

• Bigger the molecule = $\uparrow$ Entropy

• $\Delta n_g > 0 = \uparrow$ Entropy

• $\Delta n_g < 0 = \downarrow$ Entropy

• $T \uparrow = \uparrow$ Entropy

• Entropy: subs < Mixture