

Helmholtz Free Energy

It is a part of internal energy of system that is isothermally available

$$A = E - TS$$

It is the energy available in system for doing useful work at constant temperature (in reversible system)

$$\Delta A = \Delta E - T\Delta S \quad [\because \Delta T = 0]$$

$$\text{But, } \boxed{\Delta S = \frac{q_{\text{rev}}}{T}} \leftrightarrow \boxed{T\Delta S = q_{\text{rev}}}$$

$$\therefore \Delta A = \Delta E - q_{\text{rev}}$$

$$\text{But, } \boxed{\Delta E = q_{\text{rev}} - W} \leftrightarrow \boxed{\Delta E = q_{\text{rev}} = -W}$$

$$\therefore \Delta A = -W_{\text{max}}$$

$$\Rightarrow -\Delta A = W_{\text{max}}$$

\therefore When ΔA is -ve, Maximum work is done
When ΔA is +ve, Minimum work is done

Here, • By 1st law $\rightarrow \Delta E = q_{\text{rev}} - W_{\text{max}}$

• By 2nd law $\rightarrow \Delta S = \frac{q_{\text{rev}}}{T}$

In Gibbs Energy :- $\Delta G = \Delta A + p\Delta V$
(or)

$$-\Delta G = W_{\text{max}} - p\Delta V$$

\therefore When ΔG is -ve, Maximum work is done
When ΔG is +ve, Minimum work is done