B.Sc. II (II), P-III A-I

Work function

The work function is defined mathematically as

$$A = E - TS \quad \text{---} \quad (1)$$

Where A = Work function, E = Internal energy and T = temperature and S = Entropy of the system.

As E, T and S is function of state of the system, hence A is also function of state of system.

To understand the physical significance of the work function, consider a isothermal change of a system from state 1 to state 2.

$$A_1 = E_1 - TS, \text{ initial state} - 1 \quad \text{---} \quad (ii)$$

$$A_2 = E_2 - TS_2 \text{ Final state} - 2. \quad \text{---} \quad (iii)$$

Here A_1, E_1 and S_1 are the work function, internal energy and entropy of initial state and A_2, E_2 and S_2 are the work function, internal energy and entropy of final state.

Change in work function.

$$A_2 - A_1 = (E_2 - TS_2) - (E_1 - TS_1).$$

or $\Delta A = (E_2 - E_1) - T(S_2 - S_1)$.

or, $\Delta A = \Delta E - T\Delta S$ ——— (iv)

From definition of entropy.

$$S = \frac{q_{rev}}{T} \quad \text{——— (v)}$$

Further according to First law of thermodynamics

$$\Delta E = q_{rev} - W_{max} \quad \text{——— (vi)}$$

Putting the values of ΔS and ΔE from eq (v) and (vi), we get

$$\Delta A = \left(q_{rev} - W_{max}\right) - T\frac{q_{rev}}{T}$$

or, $\boxed{-\Delta A = W_{max}}$.

Thus for a process occuring at constant temperature, the decrease in the work function A is equal to maximum work done by the system. In fact it is for This reason that this thermodynamic has been termed as work function.