Maxwell thermodynamic Relations

The various expressions connecting internal energy (U) enthalpy (H), Helmholtz free energy (A) and Gibbs free energy (G) with relevant parameters such as P, T, and V may put as.

$$dU = Tds - Pdv \quad \text{——— (i)}$$
$$dH = Tds + Vdp \quad \text{——— (ii)}$$
$$dA = -SdT - Pdv \quad \text{——— (iii)}$$
$$dG = -SdT + VdP \quad \text{——— (iv)}$$

1st Taking eqn $du = T.ds - Pdv$

If V is constant so, $dv = 0$

then $du = Tds$.

$$\text{or} \left(\frac{\partial u}{\partial s}\right)_v = T \quad \text{——— (1)}$$

Again eqn $du = Tds - Pdv$

If s is constant, $ds = 0$

$$du = -Pdv$$

$$\text{or} \left(\frac{\partial u}{\partial v}\right)_s = -P \quad \text{——— (2)}$$

Differentiating eqn ① with respect to V, where S is constant.

$$\frac{\partial^2 U}{(\partial s)_v (\partial v)_s} = \left(\frac{\partial T}{\partial v}\right)_s \quad \text{——— (3)}$$

Again Differentiating eqn ② w.r.to S, where V is constant.

$$\frac{\partial^2 U}{(\partial v)_s (\partial s)_v} = -\left(\frac{\partial P}{\partial s}\right)_v \quad \text{——— (4)}$$

from equation ③ and equation ④

$$\left(\frac{\partial T}{\partial v}\right)_s = -\left(\frac{\partial P}{\partial s}\right)_v \quad \text{——— (5)}$$

This eqn ⑤ is Maxwell Relation.

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