Thermodynamic Identity

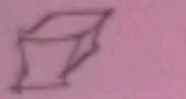
$dE = TdS + dR$; dR differential work

$dR = -PdV$ generally $dR = \vec{B} \cdot d\vec{H}$ magnetic

Combined 1st & 2nd laws Reversible changes

1st law $dE = dQ + dR$ increment heat

dQ? quantity ?



$1\ cm^3$ water; Calorie amount needed raise $1^\circ C$ 0° freezes 100° boiles

Heat capacity $C = \frac{\Delta Q}{\Delta T}$ (specific heat)

depends on how do it

$C_V = \left(\frac{dQ}{dT}\right)_V = T\left(\frac{dS}{dT}\right)_V$ system does no work

hard to measure

dQ thermal exp.

$C_p = T\left(\frac{dS}{dT}\right)_p$ exp. easier

Calorimetry

Alternate Thermodynamic Potentials (16)

"Potentials"

$E = E(S, V)$

New Potentials

Enthalpy & W

$W = E + PV$

$dW = dE + PdV + VdP$

but $\boxed{dE = TdS - PdV}$

$\boxed{dW = TdS + VdP}$ easy

More pot: Free Energy (Helmholtz)

$F = E - TS$

$dF = dE - TdS - SdT$

$\boxed{dF = -SdT - PdV}$

Thermodynamic Pot. Gibbs Free energy

$\Phi = F + PV$

$d\Phi = dF + PdV + VdP$

$\boxed{d\Phi = -SdT + VdP}$

friendly variables

Legendre trans. $L(q, V)$

reminder $H = pq - L$

$H(q, p)$