Thermodynamics Unit 1 - Quick Revision Sheet

1. Characteristic Functions & Natural Variables

U(S,V) Internal Energy
H(S,P) = U + PV Enthalpy
F(T,V) = U - TS Helmholtz Free Energy
G(T,P) = U + PV - TS = H - TS Gibbs Free Energy

2. Enthalpy

dH = T dS + V dP
At constant P: H = Qp

3. Helmholtz & Gibbs

dF = -S dT - P dV
dG = -S dT + V dP

4. Two Mathematical Theorems

1. Equality of mixed partial derivatives: z/xy = z/yx
2. Exact differential condition: M/y = N/x

5. Maxwells Relations

From U: (T/V)S = -(P/S)V
From H: (T/P)S = (V/S)P
From F: (S/V)T = (P/T)V
From G: (S/P)T = -(V/T)P

6. TdS Equations

1. T dS = dU + P dV
2. T dS = dH - V dP

7. Internal Energy Equation

dU = Cv dT + [T(P/T)V - P] dV

8. Heat Capacity Equation

Cp - Cv = (T V) / T
= (1/V)(V/T)P
T = -(1/V)(V/P)T

9. JouleKelvin Effect

Coefficient JT = (T/P)H
Positive cooling, Negative heating
Inversion temperature JT = 0
Porous Plug Experiment shows constant enthalpy expansion.

10. Liquefaction by JouleKelvin Effect

LindeHampson Process: Compress Pre-cool Throttle Heat exchange Repeat

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Works below inversion temperature
Used for N2, O2, Ar; Pre-cooling needed for H2, He