

**Box 1 - Thermodynamic variables and functions.**

Extensive variables X	Intensive variables Y	Energy $Y_j dx_j$	Variation $X_j dY_j$
Volume V	Pressure P	$-PdV$	$-Vdp$
Entropy S	Temperature T	$TdS$	$SdT$
Quantity n (mol)	Chemical potential $\mu$	$\mu dn$	
Surface A	Surface energy $\gamma$	$\gamma dA$	
Magnetisation M	Magnetic field H	$HdM$	$MdH$
Polarisation P	Electric field F	$FdP$	$PdF$
Electric charge q	Electric potential $\Phi$	$\Phi dq$	$qd\Phi$

**Thermodynamic functions**

Function		Energy variation	
Internal energy	$U = TS + XY + \mu n$	$dU = TdS - pdV + \mu dn$	$(dU)_{V,n} = TdS = dQ_V$
Enthalpy	$H = U - XY = TS + \mu n$	$dH = TdS + VdP + \mu dn$	$(dH)_{P,n} = TdS = dQ_P$
Gibbs potential	$G = U - TS - XY = \mu n$	$dG = -Sdt + VdP + \mu dn$	$(dG)_{P,T} = \mu dn$
Helmholtz potential	$F = U - TS = XY + \mu n$	$dF = -Sdt - PdV + \mu dn$	$(dF)_{T,n} = -PdV$
Chemical potential	$\mu_i = U_i + X_i Y - TS_i$	$dF = -Sdt - PdV + \mu dn$	$d\mu = -Sdt + VdP$