

- 6.2 the differential forms of U, H, A , and G
- (11) - (14) refer to partial derivative at constant S
 - because $dS = dq_{rev} / T$, a transformation at constant entropy refers to a reversible adiabatic process
 - the Maxwell relations have been derived using only the property that U, H, A and G are state functions
 - these four relations are extremely useful in transforming seemingly obscure partial derivatives in other partial derivatives in other partial derivatives that can be directly measured

Idea diagram:

from the equation differentials (2) - (4) or (11) - (14)
 (7) - (10)

6.3 the dependence of the Gibbs and Helmholtz energies on P, V , and T

- the state functions A and G are particularly important for chemists because of their roles in determining the direction of spontaneous change in a reaction mixture.
- for the reason we need to know A changes with T and V and how G changes with T and P

- how A changes with T and V

$$\left(\frac{\partial A}{\partial T}\right)_V = -S \text{ and } \left(\frac{\partial A}{\partial V}\right)_T = -P \quad (1)$$

$\rightarrow S$ and P always take positive values
 - therefore the general statement can be made that the Helmholtz energy of a pure substance decreases as either the temperature or the volume increases.

$$\left(\frac{\partial G}{\partial T}\right)_P = -S \text{ and } \left(\frac{\partial G}{\partial P}\right)_T = V \quad (2)$$

- whereas with Gibbs energy decreases with increasing temperature, it increases with increasing temperature
- for a macroscopic change in P at constant T , the second expression in equation (2) from 6.1 is integrated at constant T

$$\int_{P^0}^P dG = G(T, P) - G^0(T, P^0) = \int_{P^0}^P V dP' \quad (3)$$