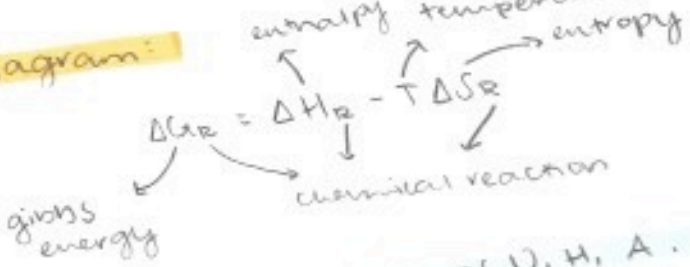
6.1 the gibbs free energy and the helmholtz energy

- ΔG_R depends on the concentrations of reactants and products in the reaction vessel, and a reaction mixture will evolve until $\Delta G_R = 0$ when equilibrium is achieved unless the reaction rate is zero.
- for macroscopic changes at constant V and T in which no expansion work is possible, the conditions for spontaneity is $\Delta A_R < 0$

$$\Delta A_R = \Delta U_R - T\Delta S_R \quad (15)$$

- two contributions determine if an isothermal chemical transformation is spontaneous: ΔU_R is an energetic contribution, and $T\Delta S_R$ is an entropic contribution to ΔA_R
- the same conclusions can be drawn from this equation as for those listed for ΔG_R, w/ U substituted for H

idea diagram:



6.2 the differential forms of U, H, A, and G

- state functions: U, H, A, and G
- U and H are used to calculate changes in energy for processes.
- A and G are used to calculate the direction in which processes evolve and the maximum work the reactions can produce.

$$H = U + PV$$
$$A = U - TS$$
$$G = H - TS = U + PV - TS \quad (1)$$

- the following differentials can be formed:

$$dU = TdS - PdV \quad (2)$$
$$dH = TdS - PdV + PdV + VdP = TdS + VdP \quad (3)$$
$$dA = TdS - PdV - TdS - SdT = -SdT - PdV \quad (4)$$
$$dG = TdS + VdP - TdS - SdT = -SdT + VdP \quad (5)$$

→ these differentials express the internal energy as U(S,V), the enthalpy as H(S,P), the helmholtz energy as A(T,V) and the Gibbs energy as G(T,P)