Lecture 19.1 Gibbs Free Energy

Note Title 3/16/2012

Review: 2nd Law $\Delta S_{univ} > 0$ ... for spontaneous change

$$\left(\Delta S_{univ} = -\frac{\Delta H_{rxn}}{T} + \Delta S_{rxn}\right) \cdot (-)T$$

$$-T\Delta S_{univ} = \Delta H_{rxn} - T\Delta S_{rxn}$$

$$\Delta G_{rxn} = -T\Delta S_{univ}$$

$$\Delta G_{rxn} = \Delta H_{rxn} - T\Delta S_{rxn}$$

goldfish are horrible w/o tartar sauce

$\Delta G_{rxn} < 0$ spontaneous ... ΔG_{rxn} = max avail work

$\Delta G_{rxn} = 0$ equilibrium

$\Delta G_{rxn} > 0$ non-spont. ΔG_{rxn} work required to make rxn happen

Example: $C_{(graphite)} + 2H_{2(g)} \longrightarrow CH_{4(g)}$ T=25°C

	$C_{(graphite)}$	$2H_{2(g)}$	$CH_{4(g)}$	
ΔH_f°	0	0	-74.6 kJ/mol	$\Delta H_{rxn}^\circ = -74.6$ kJ/mol (exothermic) ☺
S°	5.7 J/molK	130.7 J/molK	186.3 J/molK	$\Delta S_{rxn}^\circ = -80.8$ J/molK (decr.) ☹
ΔG°	0 kJ/mol	0 kJ/mol	-50.5 kJ/mol	$\Delta G_{rxn} = -50.5$ kJ/mol

$$\Delta G_{rxn} = \Delta H_{rxn}^\circ - T\Delta S_{rxn}^\circ$$

$$\Delta G_{rxn} = -74.6 \text{ kJ/mol} - (298.15\text{K})(-0.0808 \text{ kJ/molK}) = \underbrace{-50.5 \text{ kJ/mol}}_{\text{max work}}$$

neg ⇒ spontaneous

Two ways to calc. ΔG i) Tabulated ΔH & S°, $\Delta G = \Delta H - T\Delta S$

ii) Tabulated ΔG°, prod − react.

Last Note.

$\Delta H_{rxn}^\circ = -74.6$ kJ/mol exothermic rxn... heat released

$-\Delta G_{rxn}^\circ = -50.5$ kJ/mol max. avail. work!

heat loss -24.1 kJ/mol heat released but unavailable for work

required for spontaneous. required to increase entropy surroundings