

Energy and Spontaneous Processes

$$\Delta S_{\text{univ}} = \Delta S_{\text{sys}} + \Delta S_{\text{surr}}$$

$$= \Delta S_{\text{sys}} - \frac{\Delta H_{\text{sys}}}{T}$$

$$-T \Delta S_{\text{univ}} = \Delta H_{\text{sys}} - T \Delta S_{\text{sys}}$$

$$\Delta G = \Delta H - T \Delta S$$

$\Delta G > 0$ spontaneous reverse (minimum energy that must be supplied to go forward)

$\Delta G < 0$ spontaneous forward (maximum energy available to do work)

$\Delta G = 0$ equilibrium

$$\Delta G^{\circ} = \Delta H^{\circ} - T \Delta S^{\circ}$$

$$\Delta H^{\circ} = \sum \Delta H^{\circ}_{f,\text{prod}} - \sum \Delta H^{\circ}_{f,\text{react}}$$

$$\Delta S^{\circ} = \sum S^{\circ}_{\text{prod}} - \sum S^{\circ}_{\text{react}}$$

$$\Delta G^{\circ} = \sum \Delta G^{\circ}_{f,\text{prod}} - \sum \Delta G^{\circ}_{f,\text{react}}$$

$$\Delta G = \Delta G^{\circ} + RT \ln Q$$

$$\Delta G^{\circ} = -RT \ln K$$