

Chemistry 172

IΣII

Winter 2016

1 General Equations

1.1 Entropy Equations

Table 1: Equations for Entropy

Vary Temperature	Vary Pressure	Vary Volume
$\Delta S = C_{v/p} \ln \frac{T_f}{T_i}$	$\Delta S = nR \ln \frac{P_i}{P_f}$	$\Delta S = nR \ln \frac{V_f}{V_i}$

$$S = k \ln W$$

$$S_{\text{surr}} = -q_{\text{reaction}}/T$$

1.2 Enthalpy Equations

$$\Delta H = \Delta U + P\Delta V$$

$$\Delta H = \Delta U + \Delta nRT$$

$$\Delta H = \frac{C_p}{\Delta T}$$

$$\Delta U = \frac{C_v}{\Delta T}$$

$$C_p = C_v + nR$$

$$w_{\text{sys}} = - \int_{V_f}^{V_i} PdV$$

Table 2: Equations for Work

Constant Pressure	Constant Temperature	Constant Volume
$w_{\text{sys}} = -P_{\text{ext}}\Delta V$	$w_{\text{sys}} = -nRT \ln \frac{V_f}{V_i}$	0

2 Carnot/Heat Engines

No engine working between two given heat reservoirs can be more efficient than a reversible engine working between these two reservoirs. The cycle is known as the Carnot cycle. No engine can have the a greater efficiency than a Carnot engine because all steps are reversible.

Table 3: Ideal Molecules

Molecule	Translation	Rotation	C_v	C_p	Internal Energy
Atom	3	0	$\frac{3}{2}R$	$\frac{5}{2}R$	$\frac{3}{2} nRT$
Linear	3	2	$\frac{5}{2}R$	$\frac{7}{2}R$	$\frac{5}{2} nRT$
Non-Linear	3	3	3R	4R	3 nRT

$$\epsilon = 1 - \frac{Q_c}{Q_h}$$

$$Q_h = W_{\text{by gas}}, \quad Q_c = W_{\text{on gas}}$$

$$Q_{h/c} = nRT_{h/c} \frac{V_2}{V_1}$$

$$\epsilon_C = 1 - \frac{T_c}{T_h} \text{ (Carnot Efficiency)}$$

3 Equilibrium

$$\Delta S_{\text{total}} = 0$$

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

Table 4: Gibbs Free Energy

ΔH	ΔS	ΔG	Spontaneous?
<0	>0	<0	yes
>0	<0	>0	no
<0	<0	?	yes if $ T\Delta S < \Delta H$
>0	>0	?	yes if $\Delta H < T\Delta S$