Chemistry 172

ΙΣΠ

Winter 2016

1 General Equations

1.1 Entropy Equations

Table 1: Equations for Entropy

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

$$S = k \ln W$$

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

1.2 Enthalpy Equations

$$\begin{aligned}
\Delta H &= \Delta U + P\Delta V \\
\Delta H &= \Delta U + \Delta nRT \\
\Delta H &= \frac{C_p}{\Delta T} \\
\Delta U &= \frac{C_V}{\Delta T} \\
C_p &= C_v + nR \\
w_{\mathrm{sys}} &= -\int_{V_f}^{V_i} P dV
\end{aligned}$$

Table 2: Equations for Work

Constant Pressure	Constant Temperature	Constant Volume
$w_{\mathrm{sys}} = -P_{\mathrm{ext}}\Delta V$	$w_{\mathrm{sys}} = -nRT \ln \frac{V_{\mathrm{f}}}{V_{\mathrm{i}}}$	0

2 Carnot/Heat Engines

No engine working between two given heat reserviors can be more efficient than a reversible engine working between these two reserviors. 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

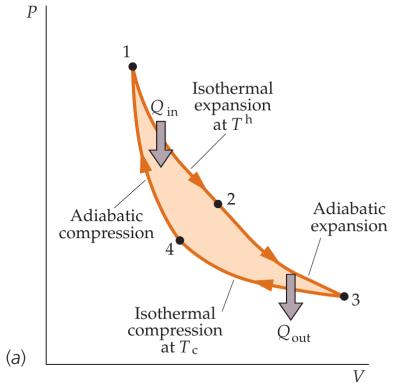
Molecule	Translation	Rotation	C_v	C_p	Internal Energy
Atom	3	0	$\frac{3}{2}R$	$\frac{5}{2}R$	$\frac{3}{2}\ nRT$
Linear	3	2	$\frac{5}{2}R$	$\frac{7}{2}R$	$\frac{5}{2}\ nRT$
Non-Linear	3	3	3R	4R	3 nRT

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

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

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

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



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 $\lvert T\Delta S\rvert < \Delta$ H
>0	>0	?	yes if $\Delta H < T\Delta$ S

4 Clausius Inequality

$$\Delta U = q + w$$

ΔU is same for paths that start and end point. $w_{rev} > w_{irr}$

$$\Delta U = \text{constant}, q_{irr} > q_{rev}$$

5 Credits

1. Carnot Cycle, Physics for Science and Engineers