

## Thermodynamics

When heating a system,  $S$  increases where

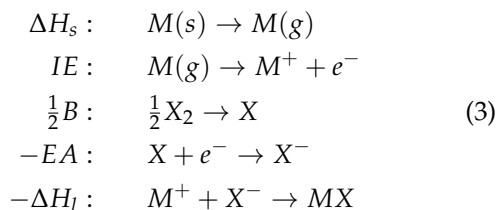
$$\Delta S_u = \Delta S + \Delta S_s > 0 \quad (1)$$

and  $\Delta \sum v > 0 \iff \Delta S > 0$ . As well,  $S \propto T \propto r \propto V \propto n \propto P^{-1}$  where  $n$  is the moles the side to which equilibrium moves to has.

The Born Haber cycle is used to find  $H_f$  of an ionic compound  $MX$ ,

$$\Delta H_f = \sum H \quad H_B = \frac{1}{2}B \quad (2)$$

where the sub-reactions are given by



The change in  $X : \{S, G, \Delta H_f\}$  is

$$\Delta X^\ominus = \Delta \sum v X^\ominus \quad (4)$$

If  $G < 0$  the reaction is spontaneous.

## Equilibrium

The equilibrium constant is given by

$$K_c \sim K_p = K_c RT^{\Delta v_h} \quad (5)$$

where  $K_p$  is for gaseous reactions. Reactions are homogeneous iff it is the same phase.

To calculate the eq. concentrations, construct an ICE table where

$$[A_i]_{eq} = [A_i] \mp ax \quad (6)$$

More reactants are formed in a reaction where

$$[A] \uparrow \iff [B] \downarrow \iff Q > K \quad (7)$$

Exothermic reactions produce heat such that if temperature increases as well, more reactants are formed.

For a reaction  $A(s) \rightleftharpoons bB(aq)$ , the constant

$$K_{sp} = [B]^b \iff x = (K_{sp}/\Pi b^b)^{1/\Sigma b} \quad (8)$$

## Materials Science

The density of a unit cell is given by

$$\rho = \frac{nM}{a^3 N_a} \quad a = \{2r, 4r/\sqrt{3}, 2\sqrt{2}r\} \quad (9)$$

for sc, bcc, and fcc respectively. The packing efficiency is given by  $nV_{sph}/a^3$ .

In semiconductors, temperature and impurities are proportional to conductivity, and opposite for conductors.

Thermoplastic polymers melt and deform upon heating. The DP is  $\bar{M}/M_m$  and the average molecular weight is

$$\bar{M}_n = \frac{\Sigma MN}{\Sigma N} \quad \bar{M}_w = \frac{\Sigma M^2 N}{\Sigma MN} \quad (10)$$

where  $n_{chains} = mN_a/\bar{M}$ . Polymers are linear, branched, and crosslinked.

The former two are connected by non-bonded interactions and can be easily recycled, and the latter by covalent bonds.

Linear polymers form crystals more easily and thus become liquid when heated.

## Miscellaneous

A ketone is  $-C(=O)-$ ; amides, carboxylics, aldehydes, and esters are  $KN-$ ,  $KOH$ ,  $KH$ , and  $KO-$ .

For stoichiometric problems, use

$$n_1/v_1 = n_2/v_2 \quad (11)$$

where  $n = m/M = CV$ . For an equilibrium reaction, the constant is  $K_c$  and only includes gaseous or aqueous compounds.

The partial pressure of a gas is

$$P_i = X_i P \quad X_i = n_i / \Sigma n \quad P = \Sigma P_i \quad (12)$$

For a reactant  $A$  dissociated  $\delta\%$ , then

$$P_A = (1 - \delta)x \quad P_B = (v_b \delta / v) ax \quad (13)$$

where the mole fraction is

$$x_i = m_i M / m M_i = n_i / n \quad (14)$$

The force in liquids is proportional to BP, viscosity, number of  $OH^-$  ions,  $H$ , and inversely proportional to  $P$  and  $T$ .

