R = 0.08206 liter atm K^{-1} $mole^{-1}$
R = 8.314 J K^{-1} $mole^{-1}$ J = kg m^2 s^{-2}

k = 1.3807 x 10^{-23} J K^{-1}

No = 6.02 x 10^{23} $mole^{-1}$

F = 96485 C mol^{-1} = 96485 J eV^{-1}

h = 6.621 x 10^{-34} J s

g = 9.807 m s^{-2}

1 mole of electrons moving 1 cm in a field of 1 V cm^{-1} acquires an energy of 96485 J

"You simply associate each number with a word, such as 'Table' and 3,476,029."

General

$$E_2 - E_1 = q + w$$

$$H = E + PV$$

$$dE = -PdV + TdS$$

$$dH = VdP + TdS$$

$$dG = VdP - SdT$$

$$dA = -PdV - SdT$$

$$C = \frac{\partial q}{\partial T}$$

$$dS = \frac{dq_{rev}}{T} \qquad S = k \ln N$$

$$G = H - TS \qquad A = E - TS$$

Work

$$w = -\int_{V_1}^{V_2} P_{ex} dV \text{ (gases)}$$

$$w = -EIt \text{ (Electrical)}$$

$$w = F\, d \text{ (linear)}$$

$$w = m\, g\, \Delta h \text{ (against gravity)}$$

PV Work only

$$E_2 - E_1 = q_v = n\int_{T_1}^{T_2} \overline{C_v} dT$$

$$H_2 - H_1 = q_P = n\int_{T_1}^{T_2} \overline{C_P} dT$$

Solutions

Vapor pressures (solvent): $P_A = X_A P_A^o$

Vapor pressures (solute): $P_B = k_B X_B$

Gibbs Free Energy

$$G_1 - G_2 = \int_{P_1}^{P_2} VdP - \int_{T_1}^{T_2} SdT$$

$$\frac{\Delta G(T_2)}{T_2} - \frac{\Delta G(T_1)}{T_1} = -\int_{T_1}^{T_2} \frac{\Delta H(T)}{T^2} dT$$

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

$$\overline{G}_A = \overline{G}_A^o + RT \ln a_A = \mu_A = \left(\frac{dG}{dn_A}\right)_{T,P,n_j \neq n_A}$$

$$a_A = \gamma_A c_A \qquad a_A = \gamma_A X_A$$

$$\ln \frac{K_2}{K_1} = -\frac{\Delta H^\circ}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

$$\Delta G = -n\mathcal{E} \text{ (in eV)} = -96.485 nE \text{ (in kJ)}$$

$$E = E^\circ - \frac{RT}{nF} \ln Q$$

Phase Equilibria

At equilib: $\mu_{A,total}(\text{phase 1}) = \mu_{A,total}(\text{phase 2})$

Free energy of transport of n moles of a molecule from phase 1 to phase 2:

$$\Delta G = nRT \ln \frac{a_A \text{ (phase 2)}}{a_A \text{ (phase 1)}} + nFZV$$

$R = 8.314 \text{ J K}^{-1} \text{ mole}^{-1} = 0.08206 \text{ liter atm K}^{-1} \text{ mole}^{-1}$ $\quad$ $J = \text{kg m}^2 \text{ s}^{-2}$

$N_o = 6.02 \times 10^{23} \text{ mole}^{-1}$ $\quad$ $k = 1.3807 \times 10^{-23} \text{ J K}^{-1}$ $\quad$ $h = 6.621 \times 10^{-34} \text{ J s}$

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$$\ln\frac{K_2}{K_1} = -\frac{\Delta H^\circ}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

Kinetic Theory

$$\langle U_{translational} \rangle = \frac{3}{2} kT$$

$$\sqrt{\langle u^2 \rangle} = \sqrt{\frac{3RT}{M}}$$

$$P_i = \frac{N_i}{N} = \frac{g_i e^{-E_i/kT}}{\sum_i g_i e^{-E_i/kT}}$$

$$z = 4\sqrt{\pi}\, \frac{N}{V} \sigma^2 \sqrt{\frac{RT}{M}} = \frac{collisions}{molecule \quad sec}$$

$$l = \frac{1}{\sqrt{2}\pi \frac{N}{V} \sigma^2} = mean\ free\ path$$

$$\sqrt{\langle d^2 \rangle} = \sqrt{N}\ l \quad (N\ steps\ of\ length\ l)$$

Diffusion

$$J_x = -D\left(\frac{dc}{dx}\right)_t$$

$$\left(\frac{dc}{dx}\right)_t = D\left(\frac{d^2 c}{dx^2}\right)_t$$

$$D = \frac{kT}{f}$$

Sedimentation

$$s = \frac{u_t}{\omega^2 t} = \frac{m(1 - \bar{\nu}_2 \rho)}{f}$$

$$M = \frac{RTs}{D(1 - \bar{\nu}_2 \rho)}$$

Friction

$$f = 6\pi\eta r \quad (sphere)$$

$$r = \left(\frac{3m\bar{\nu}_2}{4\pi}\right)^{1/3} \quad (sphere)$$

$$r = \left(\frac{3m(\bar{\nu}_2 + \delta_1 \nu_1^0)}{4\pi}\right)^{1/3} \quad (solvated\ sphere)$$

$$[\eta] = \nu(\bar{\nu}_2 + \delta_1 \nu_1^0) \quad (general)$$

Electrophoresis

$$\mu = \frac{u}{E} = \frac{ZeE}{f} = mobility$$

Kinetics

First order - *you should know*

2nd order (I) - $\frac{1}{c_A} - \frac{1}{c_A^o} = kt$

2nd order (II) - $\ln\left(\frac{c_A c_B^o}{c_A^o c_B}\right) = (c_A^o - c_B^o)kt$

$$k = Ae^{-E_a/kT} \quad \text{Arrhenius}$$

$$k = \frac{k_B T}{h} e^{\Delta S^\ddagger/R} e^{-\Delta H^\ddagger/RT} \quad \text{Eyring}$$