Gases

Pressure = Force/Area

Ideal gas law: PV=nRT

Dalton's Law of Partial Pressures: $P_{total} = P_1 + P_2 + P_3$ …..= $n_1RT/V + n_2RT/V + n_3RT/V$

$$X_1 = \frac{n_1}{n_{total}} = \frac{n_1}{n_1 + n_2 + n_3 + ...} \qquad X_1 = \frac{P_1}{P_{Total}}$$

$$\frac{PV}{n} = RT = \frac{2}{3}(KE)_{avg}$$

$$(KE)_{avg} = \frac{3}{2}RT$$

$$u_{rms} = \sqrt{\overline{u^2}} = \sqrt{\frac{3RT}{N_A m}} = \sqrt{\frac{3RT}{M}}$$

Maxwell-Boltzmann Distribution Law:

$$f(u) = 4\pi\left(\frac{m}{2k_BT}\right)^{3/2} u^2 e^{-mu^2/2k_BT}$$

$$u_{mp} = \sqrt{\frac{2RT}{M}}$$

$$u_{avg} = \sqrt{\frac{8RT}{\pi M}}$$

Graham's Law of Effusion:

$$\frac{\text{Rate of effusion for gas 1}}{\text{Rate of effusion for gas 2}} = \frac{\sqrt{M_2}}{\sqrt{M_1}}$$

Collision Frequency of a Gas with a Surface:

$$Z_A = A\frac{N}{V}\sqrt{\frac{RT}{2\pi M}}$$

Collision Frequency of gas particles:

$$Z = 4\frac{N}{V}d^2\sqrt{\frac{\pi RT}{M}}$$

Mean free path:

$$\lambda = \frac{1}{Z} \times u_{avg} = \frac{RT}{4\pi\sqrt{2}r^2 N_A P}$$

$$\lambda = \frac{k_B T}{4\pi\sqrt{2}r^2 P}$$

van der Waals equation:

$$P_{obs} = \frac{nRT}{(V - nb)} - a\left(\frac{n}{V}\right)^2$$

Energy, Enthalpy, and Thermochemistry

Kinetic energy:

$$KE = \frac{1}{2}mv^2$$

Internal energy:

$\Delta E = q + w$

for an expanding gas:

$w = -P\Delta V$

$C_v = (3/2)R$

$C_p = (5/2)R$

$q = nC\Delta T$

$\Delta H_{rxn} = \Delta_f H_{products} - \Delta_f H_{reactants}$

Quantum Mechanics

$E = h\nu = hc/\lambda$

$$KE_{electron} = \frac{1}{2}mv^2 = h\nu - h\nu_0$$

$$\lambda = \frac{h}{mv}$$

$$\Delta x \cdot \Delta p = \frac{\hbar}{2} = \frac{h}{4\pi}$$

$p = mv$

$$E = \frac{n^2 h^2}{8mL^2}$$

$$E_n = -\frac{Z^2}{n^2}\left(\frac{me^4}{8\varepsilon_0{}^2 h^2}\right) = -2.178\times10^{-18}\,\text{J}\left(\frac{Z^2}{n^2}\right)$$

Bonding

$$\text{Lattice Energy} = k\,\frac{Q_1 Q_2}{r}$$

$$\Delta H = \sum \text{D (bonds broken)} - \sum \text{D (bonds formed)}$$

Bond order = [(# of bonding electrons)-(# of antibonding electrons)]/2

Hooke's Law: $F=-k(R-R_e)$

$$\nu = \frac{1}{2\pi}\sqrt{\frac{k}{\mu}}$$

$$\mu = \frac{(m_1)(m_2)}{m_1 + m_2}$$

$$E_{\text{v}} = h\nu_0\left(\text{v} + \frac{1}{2}\right)$$

$$E_J = \frac{h^2}{8\pi^2 I}J(J+1) = hBJ(J+1)$$

$$I = \mu R_e{}^2$$

Bragg Law: $n\lambda = 2d \sin\theta$

Clausius-Clapeyron Equation:

$$\ln\left(\frac{P_{vap}^{T_1}}{P_{vap}^{T_2}}\right) = \frac{\Delta H_{vap}}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

$$\text{Mass percent} = \left(\frac{\text{grams of solute}}{\text{grams of solution}}\right)\times 100$$

$$\text{Mole fraction of component A} = \chi_A = \frac{n_A}{n_A + n_B + \ldots}$$

$$\text{Molality} = \frac{\text{moles of solute}}{\text{kilograms of solvent}}$$

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

Henry's Law: $P = k_H\chi$ or $P = kC$

Raoult's Law:

$P_{solution} = \chi_{solvent}P°_{solvent}$

$P_{Total} = P_a + P_b = \chi_A P°_A + \chi_B P°_B$

$\Delta T = K_b m_{solute}$

$\Delta T = K_f m_{solute}$

$\pi = MRT$

van't Hoff factor,

$$i = \frac{\text{moles of particles in solution}}{\text{moles of solute dissolved}}$$

$\Delta T = iK_b m_{solute}$

$\Delta T = iK_f m_{solute}$

$\pi = iMRT$