Midterm II Equations

Gases

Pressure = Force/Area

Ideal gas law: PV=nRT

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

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

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

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

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

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:

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

$$\lambda = \frac{\mathrm{k}_B\mathrm{T}}{4\pi\sqrt{2}\mathrm{r}^2\mathrm{P}}$$

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:

$w = -P\Delta V$

$H = E + PV$

$\Delta E = q_p + w$ *(constant pressure)*

$q_p = \Delta E + P\Delta V$ *(constant pressure)*

$\Delta E = nC_v\Delta T$ (constant volume)

$\Delta E = nC_v\Delta T + nR\Delta T = nC_p\Delta T$

$\Delta H = \Delta E + \Delta(PV) = nC_p\Delta T$

$C_v = (3/2)R$

$C_p = (5/2)R$

$q = nC\Delta T$

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

Quantum Mechanics

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

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

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

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

p=mv

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

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

Bonding

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

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