Useful Equations

Density

$$d = \frac{mass}{Volume}\ (\frac{g}{mL})$$

Molarity

$$M = \frac{mol\ solute}{L\ solution}$$

Molality

$$m = \frac{mol\ solute}{kg\ solvent}$$

Solution Dilution

$$M_1V_1 = M_2V_2$$

Ideal Gas Law

$$PV = nRT$$

Dalton's Law

$$P_{total} = P_1 + P_2 + P_3 + \cdots + P_n$$

Mole Fraction

$$\chi_a = \frac{n_a}{n_{total}}$$

Kinetic Energy

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

Root Mean Square Velocity

$$v_{rms} = \sqrt{\frac{3RT}{\mathcal{M}}}$$

Frequency and Wavelength

$$\nu = \frac{c}{\lambda}$$

Energy of a photon

$$E = h\nu = \frac{hc}{\lambda}$$

de Broglie Relation

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

Energy of Hydrogen Atom Levels

$$E_n = -2.18\times10^{-18}J\left(\frac{1}{n^2}\right)\ (n = 1,2,3\ \ldots)$$

Coulomb's Law

$$E = \frac{1}{4p\epsilon_0}\frac{q_1q_2}{r}$$

Van der Waals Equation

$$\left[P + a(\frac{n}{V})^2\right]\times[V - nb] = nRT$$

Osmotic Pressure

$$\Pi = MRT$$

Average Kinetic Energy

$$KE_{avg} = \frac{3}{2}RT$$

Effusion

$$\frac{rate\ A}{rate\ B} = \sqrt{\frac{\mathcal{M}_B}{\mathcal{M}_A}}$$

Standard Enthalpy of Reaction

$$\Delta H^\circ_{rxn} = \sum n_p\Delta H^\circ_f\ (products) - \sum n_r\Delta H^\circ_f(reactants)$$

Internal Energy

$$\Delta U = q + w$$

Pressure-Volume work

$$w = -P\Delta V$$

Heat Capacity

$$q = m\times C_s\times\Delta T$$

Change in Enthalpy

$$\Delta H = \Delta U + P\Delta V$$

Dipole Moment

$$\mu = Q\times r$$

Henry's Law

$$S_{gas} = k_H P_{gas}$$

Raoult's Law

$$P_{solution} = \chi_{solvent}P^\circ_{solvent}$$

Clausius-Clapeyron Equation

$$lnP_{vap} = \frac{-\Delta H_{vap}}{RT} + ln\beta$$

$$ln\frac{p_2}{p_1} = \frac{-\Delta H_{vap}}{R}(\frac{1}{T_2} - \frac{1}{T_1})$$

Freezing Point Depression

$$\Delta T_f = m\times K_f$$

Boiling Point Elevation

$$\Delta T_b = m\times K_b$$

Entropy

$$S = k\ lnW$$

Δ in Entropy of Surroundings

$$\Delta S_{surr} = \frac{-\Delta H_{sys}}{T}$$

ΔGibb's Free Energy

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

Δ in Free Energy Nonstandard Conditions

$$\Delta G_{rxn} = \Delta G^\circ_{rxn} + RTlnQ$$

ΔG°rxn and K

$$\Delta G^\circ_{rxn} = -R\ T\ lnK$$

Nernst Equation

$$E_{cell} = E^\circ_{cell} - \frac{0.0592V}{n}logQ$$

The Rate Law

$Rate = k[A]^n$ (single reactant)

$Rate = k[A]^m[B]^n$ (mult reactants)

Integrated Rate Laws & Half-life

Order	Integrated	½ Life
0	$[A]_t = -kt + [A]_0$	$t_{1/2} = \frac{[A]_0}{2k}$
1	$\ln[A]_t = -kt + \ln[A]_0$	$t_{1/2} = \frac{0.693}{k}$
2	$\frac{1}{[A]_t} = kt + \frac{1}{[A]_0}$	$t_{1/2} = \frac{1}{k[A]_0}$

Arrhenius Equation

$$k = Ae^{\frac{-Ea}{RT}}$$

Two-point Arrhenius Equation

$$ln\frac{k_2}{k_1} = \frac{Ea}{R}(\frac{1}{T_1} - \frac{1}{T_2})$$

Kc and Kp

$$K_p = K_c(RT)^{\Delta n}$$

pH Scale

$$pH = -\log[H_3O^+]$$

Henderson-Hasselbalch Equation

$$pH = pK_a + \log\frac{[conjugate\ base]}{[acid]}$$

Temp Dependence of K

$$lnK = -\frac{\Delta H^\circ_{rxn}}{R}\left(\frac{1}{T}\right) + \frac{\Delta S^\circ_{rxn}}{R}$$

E°cell and K

$$E^\circ_{cell} = \frac{0.0592V}{n}logK$$

ΔG° and E°cell

$$\Delta G^\circ = -n\ F\ E^\circ_{cell}$$

$$E^\circ_{cell} = E^\circ_{cathode} - E^\circ_{anode}$$

$$E_{cell} = E_{cathode} - E_{anode}$$