CHE 111– Cheat Sheet
Spring 2015

Chapter 5

Speed of a Wave
$u = \lambda\nu$

Energy of a Wave
$E = h\nu$

Balmer-Rydberg Equation I
$\frac{1}{\lambda} = R(\frac{1}{m^2} - \frac{1}{n^2})$ with n > m

Balmer-Rydberg Equation II
$\nu = R \cdot c(\frac{1}{m^2} - \frac{1}{n^2})$ with n > m

Rydberg Constant
$R = 1.097 \times 10^{-2}\ nm^{-1}$

Speed of Light
$c = 3.00 \times 10^{8}$ m/s

Planck's Constant
$h = 6.626 \times 10^{-34}$ J•s

De Broglie Equation
$$\lambda = \frac{h}{mv}$$

Heisenberg Uncertainty Principle
$$(\Delta x)(\Delta mv) \geq \frac{h}{4\pi}$$

Effective Nuclear Charge
$$Z_{eff} = Z_{actual} - Electron\ Sheilding$$

Chapter 6

Ionization Energy (kJ/mol)								
Ionization Energy (E_{IE})	**Na**	**Mg**	**Al**	**Si**	**P**	**S**	**Cl**	**Ar**
1	496	738	578	787	1,012	1,000	1,251	1,520
2	4,562	1,451	1,817	1,577	1,903	2,251	2,297	2,665
3	6,912	7,733	2,745	3,231	2,912	3,361	3,822	3,931
4	9,543	10,510	11,575	4,356	4,956	4,564	5,158	5,770
5	13,353	13,630	14,380	16,091	6,273	7,013	6,540	7,238
6	16,610	17,995	18,376	19,784	22,233	8,495	9,458	8,781
7	20,114	21,703	23,293	23,783	25,397	27,106	11,020	11,995

Lattice Energies (kJ/mol)					
	Anion				
Cation	F^-	Cl^-	Br^-	O^-	O^{-2}
Li^+	1,036	853	807	757	2,925
Na^+	923	787	747	704	2,695
K^+	821	715	682	649	2,360
Be^{+2}	3,505	3,020	2,914	2,800	4,443
Mg^{+2}	2,957	2,524	2,440	2,327	3,791
Ca^{+2}	2,630	2,258	2,176	2,074	3,401
Al^{+3}	2,515	5,492	5,361	5,218	1,5916

Chapter 7

Average Bond Dissociation Energies (D) (kJ/mol)													
H-H	436		C-H	410		N-H	390		O-H	460		F-F	159
H-C	410		C-C	350		N-C	300		O-C	350		Cl-Cl	243
H-F	570		C-F	450		N-F	270		O-F	180		Br-Br	193
H-Cl	432		C-Cl	330		N-Cl	200		O-Cl	200		I-I	151
H-Br	366		C-Br	270		N-Br	240		O-Br	210		S-F	310
H-I	298		C-I	240		N-I	-		O-I	220		S-Cl	250
H-N	390		C-N	300		N-N	240		O-N	200		S-Br	210
H-O	460		C-O	350		N-O	200		O-O	180		S-S	225
H-S	340		C-S	260		N-S	-		O-S	-			
Multiple Covalent Bonds:													
C=C	611		C≡C	835		C=O	732		O=O	498		N≡N	945

Chapter 8

Kinetic Energy
$$E_K = \frac{1}{2}mv^2$$

Work (PV)
$w = -P\Delta V$

Energy Transfer
$q_v = \Delta E\ (\Delta V = 0)$
$q_p = \Delta E + P\Delta V = \Delta H$(Constant P)

Gibbs Free Energy
$\Delta G = \Delta H - T\Delta S$
$$T = \frac{\Delta H}{\Delta S}$$

Heating Curves
$q = ms\Delta T$
$q = m\Delta H$

Chapter 9

Pressure:

$$P = \frac{F}{A} = \frac{m \times a}{A}$$

Ideal Gas Law:

$$PV = nRT$$

Pascal Units:

$$1\ Pa = \frac{N}{m^2} = \frac{kg}{m \cdot s^2}$$

Gas Constant:

$$R = \frac{8.314\ J}{K \cdot mol} = 0.08205 \frac{L \cdot atm}{mol \cdot K}$$

STP

(Standard Temperature and Pressure)

$0°C\ and\ 1\ atm$

Mole Fraction (X):

$$\frac{moles\ of\ component}{Total\ mols\ in\ mixture}$$

Daltson's Law:

$$P_{total} = \sum P_i = P_1 + P_2 + P_3\ \ldots$$

$$P_1 = X_1 \cdot P_{Total}$$

Kinetic-Molecular Theory:

$$E_K = \frac{3}{2}\frac{RT}{N_A} = \frac{1}{2}mu^2$$

Kinetic-Molecular Theory:

$$u = \sqrt{\frac{3RT}{mN_A}} = \sqrt{\frac{3RT}{M}}$$

Graham's Law:

$$\frac{Rate_1}{Rate_2} = \frac{\sqrt{m_2}}{\sqrt{m_1}} = \sqrt{\frac{m_2}{m_1}}$$

Effusion:

$$\frac{u_1}{u_2} = \frac{\sqrt{m_2}}{\sqrt{m_1}} = \sqrt{\frac{m_2}{m_1}}$$

van der Waals Equation:

$$P = \frac{nRT}{(v-nb)} - \frac{an^2}{V^2}$$

van der Waals Equation:

$$\left(P + \frac{an^2}{V^2}\right)(V - nb) = nRT$$

Chapter 10

Clausius-Clapeyron Equation I

$$\ln P_{vap} = \left(-\frac{\Delta H_{vap}}{R}\right)\frac{1}{T} + C$$

Clausius-Clapeyron Equation II

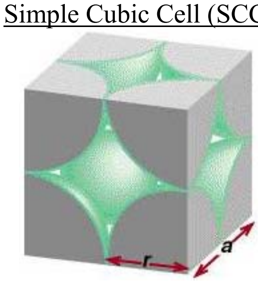
$$\ln P_2 = \ln P_1 + \left(\frac{\Delta H_{vap}}{R}\right)\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

Calorimetry

$$q = ms\Delta T$$

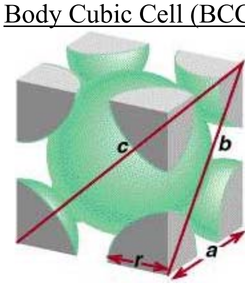
$$q = m\Delta H$$

Simple Cubic Cell (SCC)



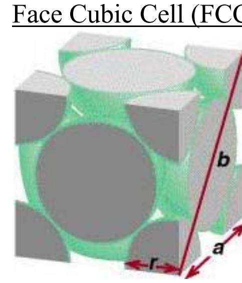
a = 2r

Body Cubic Cell (BCC)



$$a = \frac{4r}{\sqrt{3}}$$

Face Cubic Cell (FCC)



$$a = \sqrt{8}r$$

Bragg Equation

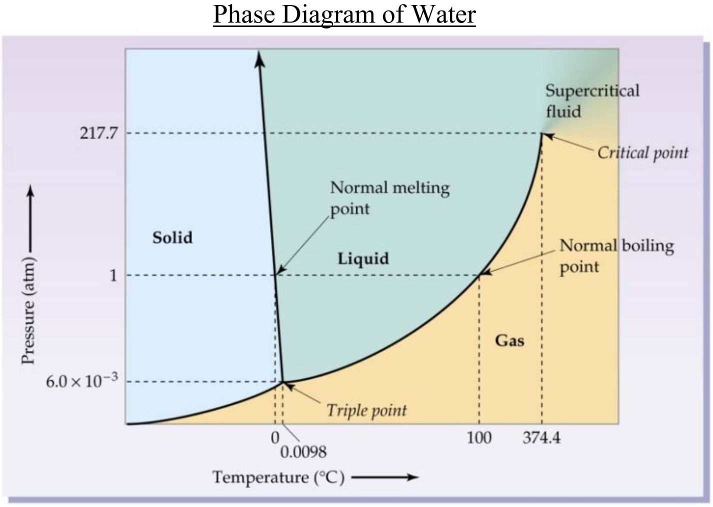
$$d = \frac{n\lambda}{2\ \sin\theta}$$

Dipole Moments

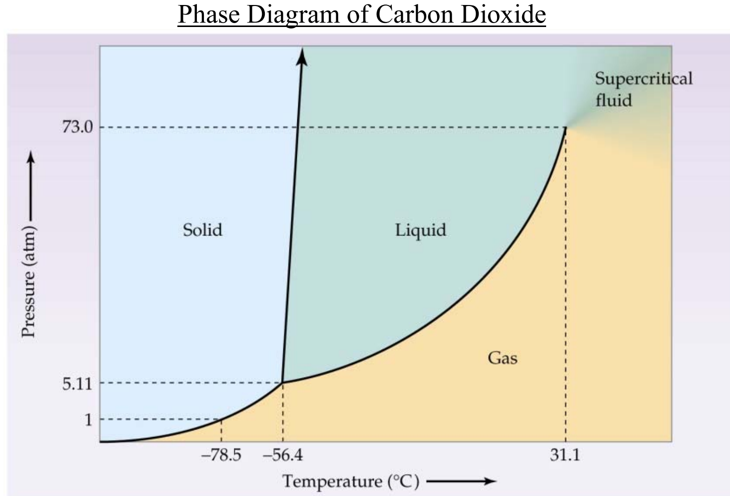
$$\mu = Q \times r$$

$$1\ D = 3.36 \times 10^{30} C \cdot m$$

Phase Diagram of Water



Phase Diagram of Carbon Dioxide



Chapter 11

Molarity (M):
$$\frac{mol\ solute}{L\ solution}$$

Molality (m):
$$\frac{mols\ solute}{kg\ solvent}$$

Mole Fraction(X):
$$\frac{moles\ solute}{mols\ solute+mols\ solvent} = \frac{mols\ solute}{mols\ solution}$$

Mass Percent (m/m):
$$\frac{Mass\ of\ component}{Total\ mass\ of\ solution}$$

Part per million (ppm):
$$\frac{Mass\ of\ component}{Total\ mass\ of\ solution} \times 10^6$$

Part per billion (ppb):
$$\frac{Mass\ of\ component}{Total\ mass\ of\ solution} \times 10^9$$

Henry's Law:
$$Solubility = k \cdot P$$

Raoult's Law:
$$P_{soln} = P_{solv} \times X_{solv}$$
$$\Delta P_{soln} = P_{solv} \times X_{solute}$$

van't Hoff Factor:
$$i = \frac{mols\ of\ particle}{mols\ of\ solute\ disolved}$$

Volatile Solute:
$$P_{Total} = P_A + P_B$$
$$P_{Total} = \left(P_A^\circ \cdot X_A\right) + \left(P_B^\circ \cdot X_B\right)$$

Boiling Point Elevation:
$$\Delta T_B = imK_B$$

Freezing Point Depression:
$$\Delta T_F = imK_F$$

Osmotic Pressure:
$$\Pi = MRT$$

Chapter 12 and 13

0th Order Reaction
$$[A]_t = -kt + [A]_0$$

1st Order Reaction
$$ln\frac{[A]_t}{[A]_0} = -kt$$
$$\ln[A]_t = -kt + ln[A]_0$$
$$t_{1/2} = \frac{0.693}{k}$$

2nd Order Reaction
$$\frac{1}{[A]_t} = kt + \frac{1}{[A]_0}$$
$$t_{1/2} = \frac{1}{k[A]_0}$$

Arrhenius Equation
$$k = Ae^{-E_a/RT}$$
$$\ln k = \left(\frac{-E_a}{R}\right)\left(\frac{1}{T}\right) + \ln A$$
$$\ln\left(\frac{k_2}{k_1}\right) = \left(\frac{-E_a}{R}\right)\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

Relationship k_p and k_c
$$k_p = k_c(RT)^{\Delta n}$$

Quadratic Equation
$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Chapter 14 and 15

Log Relationships
$$\text{pH} = -\log[\text{H}^+]$$
$$[H^+] = 10^{-pH}$$

Dissociation of Water
$$\text{pH} + \text{pOH} = 14$$
$$[\text{H}^+][\text{OH}^-] = 1 \times 10^{-14}$$

Henderson-Hasselbalch Equation
$$\text{pH} = \text{pK}_\text{a} + \log\frac{[\text{Base}]}{[\text{Acid}]}$$

Chapter 16 - Thermodynamics

Boltzmann Equation:
$S = k \ln(W)$
$k = \frac{R}{N_a} = 1.38 \times 10^{-23}$ J/K

Entropy:
$\Delta S^o_{Total} = \Delta S^o_{System} + \Delta S^o_{Surr}$
$\Delta S^o_{Surr} = \frac{-\Delta H^o}{T}$

Standard Change:
$\Delta S^o = S^o_{Prod} - S^o_{React}$
$\Delta H^o = H^o_{Prod} - H^o_{React}$
$\Delta G^o = G^o_{Prod} - G^o_{React}$

Entropy and Expansion I:
$\Delta S = n\, R \ln(\frac{V_f}{V_i})$

Entropy and Expansion II:
$\Delta S = n\, R \ln(\frac{P_i}{P_f})$

Free Energy and Equilibrium
$\Delta G^o = -RTlnK_{eq}$
$K_{eq} = e^{-\frac{\Delta G^o}{RT}}$

Gibbs Free Energy:
$\Delta G = \Delta H - T\Delta S$

Equilibrium Temperature:
$T = \frac{\Delta H}{\Delta S}$

Free Energy and Non-Equilibrium
$\Delta G = \Delta G^o + RTlnQ$

Chapter 17 - Electrochemistry

Electromotive Force (EMF)
$E^o_{cell} = E^o_{red} - E^o_{oxid}$
$E^o_{cell} = E^o_{cathode} - E^o_{anode}$

Gibbs Free Energy and EMF
$\Delta G = -nFE$

Conversion Factors:
$1\ Faraday\ (F) = \frac{96{,}500C}{mol\ e^-}$
$1\ F = \frac{C}{A \cdot sec}$

Nearnst Equation I (General):
$E = E^o_{cell} - \frac{2.303RT}{nF} \log Q$

Units of Energy:
$1\ V = \frac{1\ J}{1\ C}$

Watts:
$1\ Watt\ (W) = \frac{1\ J}{sec}$

Nearnst Equation I (STP):
$E = E^o_{cell} - \frac{0.0592\ V}{n} \log Q$

Coloumbs:
$C = amp \cdot sec$

Chapter 22 – Nuclear Chemistry

Decay
Decay Rate = $k \times N$
$\ln\left(\frac{N_t}{N_0}\right) = -kt$
$t_{1/2} = \frac{0.693}{k}$

Atomic Masses
proton = 1.00728 amu
neutron = 1.00866 amu
electron = 5.486×10^{-4} amu

Conversion Factors
1 eV = 1.60×10^{-19}J
$1\ J = \frac{kg \cdot m^2}{s^2}$
$1\ g = 6.022 \times 10^{23} amu$

Einstein
$E = mc^2$
$c = 3.00 \times 10^8 m/s^2$

Units for Measuring Radiation

Becquerel:	1 Bq = 1 dis/s
Curie:	1 Ci = 3.7×10^{10}dis/s
Gray:	1 Gy = 1J/kg tissue
Rad:	1 Rad 0.01 Gy
Sievert:	1 Sv = 1 J/kg tissue
Rem:	1 rem = 0.01 Sv