FRONT PAGE FORMULA SHEET - TEAR OFF

1A												3A	4A	5A	6A	7A	8A
1 H 1.01	2A																2 He 4.00
3 Li 6.94	4 Be 9.01											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.87	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.41	31 Ga 69.72	32 Ge 72.64	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc [98]	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	71 Lu 175.0	72 Hf 178.5	73 Ta 181.0	74 W 183.8	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po [209]	85 At [210]	86 Rn [222]
87 Fr [223]	88 Ra [226]	103 Lr [262]	104 Rf [261]	105 Db [262]	106 Sg [266]												

57 La 138.9	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm [145]	62 Sm 150.4	63 Eu 152.0	64 Gd 157.2	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0
89 Ac [227]	90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np [237]	94 Pu [244]	95 Am [243]	96 Cm [247]	97 Bk [247]	98 Cf [251]	99 Es [252]	100 Fm [257]	101 Md [258]	102 No [259]

$N_A = 6.022 \times 10^{23}$

1 amu = 1.661×10^{-27} kg

1 atm = 760 torr = 760 mm Hg

1 atm = 1.013 bar

$R = 0.08206$ L·atm/mol·K

$R = 8.314$ J/mol·K

$h = 6.626 \times 10^{-34}$ J·s

$c = 2.998 \times 10^{8}$ m/s

$R_H = 1.097 \times 10^{-2}$ nm^{-1}

$\ln(p) = -(\Delta H°/R) + C$

$°C = (5/9)(°F - 32)$

$°C = K - 273.15$

$\Delta U = q + w$

$H = U + pV$

$1\ J = 1\ kg \cdot m^2/s^2$

1 L·atm = 101.3 J

$E_{photon} = h\nu = hc/\lambda$

$\lambda_{deBroglie} = h/mv$

$\ln(p_2/p_1) = -(\Delta H°_{vap}/R)[(1/T_2) - (1/T_1)]$

$°F = (9/5)(°C) + 32$

$K = °C + 273.15$

$pV = nRT$

$p = nRT/(V - nb) - an^2/V^2$

$p_i = X_i\ p_{total}$

$v_{ave} = (3RT/M)^{1/2}$

$\Delta H_{rxn} = \Delta U_{rxn} + \Delta n_g RT$

$\Delta H°_{rxn} = [\Sigma\ \Delta H°_f(\text{products})] - [\Sigma\ \Delta H°_f(\text{reactants})]$

$c = \nu\lambda \quad (\Delta x)(m\Delta v) \geq (h/4\pi)$

$(1/\lambda) = R_H[(1/m^2) - (1/n^2)]$

GENERAL CHEMISTRY 1
FINAL EXAM
DECEMBER 10, 2008

Name _____

Panthersoft ID _____

Signature _____

Part 1 _____ **(60 points)**

Part 2 _____ **(66 points)**

Part 3 _____ **(74 points)**

TOTAL_____ **(200 points)**

Do all of the following problems. <u>Show your work</u>.

Part 1. Multiple choice. Circle the letter corresponding to the correct answer. There is one and only one correct answer per problem. [5 points each]

1) Which of the following is a transition metal?

a) Au (gold)
b) Bi (bismuth)
A c) Ca (calcium)
d) both b and c
e) both a and b and c

2) 1.00 milliwebers = _____ webers

a) 1.00 x 10^{-9} webers
b) 1.00 x 10^{-6} webers
C c) 1.00 x 10^{-3} webers
d) 1.00 x 10^{3} webers
e) 1.00 x 10^{6} webers

3) Which element is most similar to O (oxygen) in its physical and chemical properties?

a) Se (selenium)
b) Ne (neon)
A c) F (fluorine)
d) Cl (chlorine)
e) C (carbon)

4) Which of the following is an ionic compound?

a) AgCl
b) HCl
D c) KCl
d) Both a and c
e) Both a and b and c

5) Which of the following is a strong acid?

a) HCl
b) HF
A c) HIO_2
d) Both a and b
e) Both a and c

6) Consider the following gases: He, Ne, Ar, N_2. At T = 500.0 K, which gas has the largest average speed per atom or molecule?

a) He
b) Ne
A c) Ar
d) N_2
e) The average speed for all four gases is the same

7) Which of the following is a state function?

a) U (internal energy)
b) H (enthalpy)
D c) w (work)
d) Both a and b
e) Both a and c

8) Which of the following experiments demonstrates the wave properties of electrons?

a) electron diffraction
b) photoelectric effect
A c) X-ray diffraction
d) Both a and b
e) Both a and c

9) Consider the following atoms: Be, Mg, O. Of these three atoms

a) Mg has the largest 1st ionization energy and O has the smallest 1st ionization energy.
b) O has the largest 1st ionization energy and Be has the smallest 1st ionization energy.
C c) O has the largest 1st ionization energy and Mg has the smallest 1st ionization energy.
d) Be has the largest 1st ionization energy and Mg has the smallest 1st ionization energy.
e) Be has the largest 1st ionization energy and O has the smallest 1st ionization energy.

10) A particular central atom is surrounded by five electron containing regions. Two of the regions are covalent bonds, and three of the regions are lone pairs of electrons. The molecular geometry around the central atom is

a) trigonal bipyramid
b) trigonal pyramid
D c) trigonal planar
d) linear
e) nonlinear

11) Which of the following molecules is polar? (Note that a C - H bond is nonpolar, while a C - F bond is polar.)

a) CH_2F_2
b) CF_4
A c) CH_4
d) Both a and b
e) None of these three molecules is polar

12) Sublimation is the phase transition

a) solid to gas
b) solid to liquid
A c) liquid to gas
d) liquid to solid
e) gas to liquid

Part 2. Short answer.

1) How many oxygen atoms are there in 50.00 g of strontium nitrate ($Sr(NO_3)_2$, M = 211.6 g/mol)? [8 points]

$$\text{\# atoms} = 50.00 \text{ g } Sr(NO_3)_2 \times \frac{1 \text{ mol } Sr(NO_3)_2}{211.6 \text{ g } Sr(NO_3)_2} \times \frac{6 \text{ mol O}}{1 \text{ mol } Sr(NO_3)_2} \times \frac{6.022 \times 10^{23} \text{ atom O}}{1 \text{ mol O}} = 8.53 \times 10^{23} \text{ atoms}$$

2) A solution is prepared by dissolving 1.018 g of potassium chloride (M = 74.55 g/mol) in water. The final volume of the solution that is formed is V = 250.0 mL. What is the molarity of the solution? [8 points]

$$\text{molarity} = \frac{1.018\ \text{g KCl}}{0.2500\ \text{L}} \quad \frac{1\ \text{mol KCl}}{74.55\ \text{g KCl}} = 0.0546\ \text{mol/L}$$

3) Complete the table below by filling in the blanks. [2 points each]

Atom	Number of protons	Number of neutrons	Number of electrons
__^{104}**Ru**_	44	60	__**44**____
^{94}Zr	__**40**____	__**54**____	__**40**____

4) Consider a process on a system kept at a constant pressure p = 2.50 atm. During the process 540. J of heat is added to the system. The volume of the system decreases by 0.500 L. Find the following: q, w, ΔE, and ΔH. [12 points]

q = 540. J

process is constant pressure, so ΔH = q = 540. J

$$w = - p\,\Delta V = - (2.50\ \text{atm})\,(- 0.500\ \text{L}) = + 1.25\ \text{L·atm} \quad \frac{101.3\ \text{J}}{1\ \text{L·atm}} = 127.\ \text{J}$$

ΔE = q + w = 540. J + 127. J = 667. J

5) A particular electron is found in a d orbital. List the following [4 points each]

a) The possible values for m_λ for the electron. _____-2, -1, 0, 1, 2_____

b) The possible values for m_s for the electron. _____- 1/2, 1/2_____

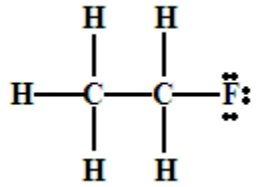
6) Give the number of core electrons, the number of valence electrons, and the effective nuclear charge for the valence electrons for one atom of sulfur (S). [8 points]

number of core electrons __10_____ number of valence electrons __6_____

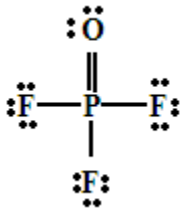
effective nuclear charge __6_____

7) Give Lewis structures for the following molecules. Give resonance structures when appropriate. [6 points each]

a) C_2H_5F



b) POF_3



Part 3. Problems.

1) Manganese metal (Mn) can be produced by the reaction of manganese IV oxide (MnO_2) with aluminum metal (Al). The balanced chemical equation for the reaction is

$$3\ MnO_2(s) + 4\ Al(s) \rightarrow 3\ Mn(s) + 2\ Al_2O_3(s)$$

a) What is the oxidation number of Al in Al_2O_3? [4 points] __+ 3_____

b) How many grams of aluminum metal are required to completely react with 374.4 g of manganese IV oxide? [10 points]

$M(MnO_2) = 86.94$ g/mol

$M(Al) = 26.98$ g/mol

$$g\ Al = 374.4\ g\ MnO_2 \frac{1\ mol\ MnO_2}{86.94\ g\ MnO_2} \frac{4\ mol\ Al}{3\ mol\ MnO_2} \frac{26.98\ g\ Al}{1\ mol\ Al} = 154.9\ g\ Al$$

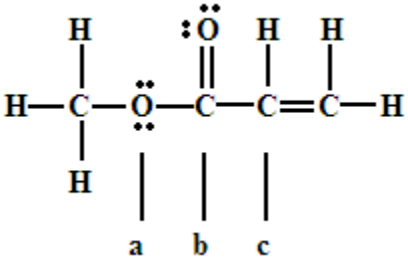
2) The density of an unknown ideal gas at p = 0.880 atm and T = 70.0 °C is D = 3.36 g/L. What is the molecular mass of the unknown gas? Give your answer in units of g/mol. [16 points]

Assume 1.00 L T = (70.0 + 273.2) = 343.2 K

$pV = nRT$, so $n = \frac{pV}{RT} = \frac{(0.880\ \text{atm})(1.00\ \text{L})}{(0.08206\ \text{L·atm/mol·K})(343.2\ \text{K})} = 0.03125\ \text{mol}$

And so $M = \frac{m}{n} = \frac{3.36\ \text{g}}{0.03125\ \text{mol}} = 108.\ \text{g/mol}$

3) Answer the questions about the Lewis structure given below by filling in the blanks. [4 points each]



a) Electron geometry around the oxygen atom labeled a ____tetrahedral_____

b) Molecular geometry around the carbon atom labeled b ____trigonal planar_____

c) Hybridization of the carbon atom labeled c _____sp^2_____

d) Value for the O - C - O bond angle _____120°_____

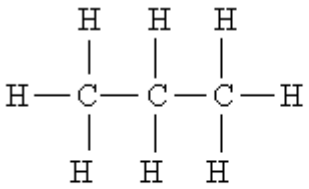
e) The total number of pi bonds present in the molecule _____2_____

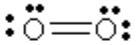
4) Propane is a low molecular mass hydrocarbon whose reaction with oxygen is often used to produce heat. The equation for the reaction of propane with oxygen is

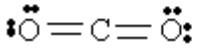
$CH_3CH_2CH_3(g) + 5\ O_2(g) \rightarrow 3\ CO_2(g) + 4\ H_2O(g)$

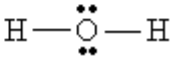
Based on the table of average bond energies given below estimate the value for $\Delta H°_{rxn}$ for the above reaction. [20 points]

Bond	Energy (kJ/mol)	Bond	Energy (kJ/mol)	Bond	Energy (kJ/mol)	Bond	Energy (kJ/mol)
C - C	347.	O - O	142.	C - H	414.	C - O	360.
C = C	611.	O = O	498.	O - H	464.	C = O	799.









$\Delta H°_{rxn} \cong$ [Σ bond energies of reactants] - [Σ bond energies of products]

= [8 (C-H) + 2 (C-C) + 5 (O=O)] - [6 (C=O) + 8 (O-H)]

= 8 (414) + 2 (347) + 5 (498)] - [6 (799) + 8 (464)] = - 2010. kJ/mol