Name: _____
(Print) Surname Given Names

Student Number:_____

The Irving K. Barber School of Arts and Sciences

Chemistry 121
FINAL EXAM

Drs. P. Knoess, K. Perry and E. Neeland

FRIDAY, Dec. 9, 2005
9:00 – 12:00 noon

Gym

This exam contains pages numbered 1 through 11 and a detachable periodic table/data sheet.

Instructions:

Answer the questions in the space provided.
You may use the backs of pages for calculations if necessary.

You must clearly show your method to receive full credit for the calculation problems.

Make sensible use of significant figures.
Write out any equations you use and show all your work.
Include units with the final answer whenever appropriate.

DO NOT WRITE IN THESE BOXES

1	2	3	4	5	6	7	8	9	10	Σ
15	9	9	13	8	7	11	9	8	10	99

Exam booklets **are not** required.
Computer Sheets **are not** required.

Chem 121 Final Exam

(2) 1) The product of (0.023023 x 4.531) has 2.3 subtracted from it. Correct answer (sig. figs.) in the box.

(2) 2) Write down the name (not the symbol) of any transition metal element.

(2) 3) The density of aluminum metal is 2.70 g/cm^3. Calculate the volume of one mole of aluminum.

(3) 4) The dianion of an unknown element contains 54 electrons and 75 neutrons. Fill in the blanks below.

a) The atomic number of the compound is _____.
b) Its atomic symbol is _____.
c) The Z of the compound is _____.

(6) 5) Name the following compounds or write the formula.

a) $(NH_4)ClO_4$ _____

b) Magnesium sulfite _____

c) P_2O_5 _____

d) Copper (I) thiosulfate _____

e) NAs _____

f) Hydrogen sulfate _____

6) Consider 5.72 g of propane (C_3H_8 FW = 44.1 g/mol)

(2) a) Calculate the number of molecules of propane in the sample

(2) b) Calculate the number of carbon atoms in the sample.

(5) 7) Combustion analysis of a 10.68 g sample containing only C, H and P produced 20.64 g of CO_2 and 11.61 g of H_2O. Determine the empirical formula of the compound.

8) Carbon disulfide (FW = 76.14 g/mol) and disulfur dichloride (FW = 135.04 g/mol) react to produce an S_8 allotrope of sulfur (FW = 256.56 g/mol) and carbon tetrachloride (FW = 153.81 g/mol) according to the balanced equation:

(3) a) Calculate the theoretical yield of the sulfur allotrope if 5.0 g of S_2Cl_2 are reacted with excess CS_2.

$$4\ CS_2(l) + 8\ S_2Cl_2\ (l) \longrightarrow 3\ S_8\ (s) + 4\ CCl_4(l)$$

(2) b) Which reactant will be the limiting reagent if equal masses of reactants are used?

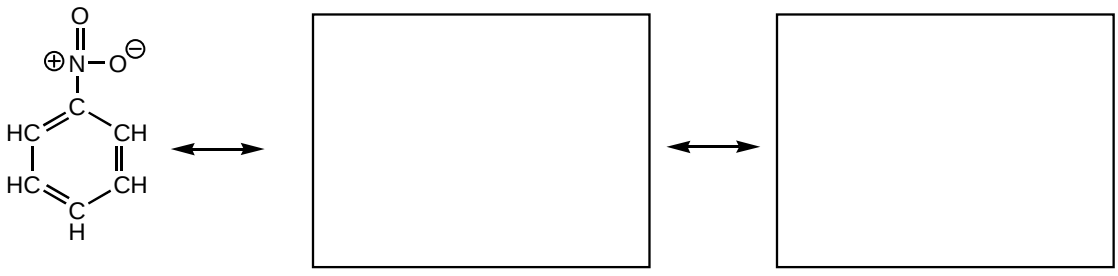
(4) c) Find the mass of CS_2 required to produce 100. g of S_8 if the reaction proceeds in a 77% yield in the presence of excess disulfur dichloride.

$$4\ CS_2(l) + 8\ S_2Cl_2\ (l) \longrightarrow 3\ S_8\ (s) + 4\ CCl_4(l)$$

(9) 9) Complete the table below. Indicate any formal charges directly on the atoms.

Molecular Formula	Lewis Structure with Formal Charge on Atoms	Molecular Geometry Name	Hybridization of Central Atom	Bond Angles	Overall Polarity (Yes/No)
ICl_2^+					
TlH_3					
SeF_4^{2-}					

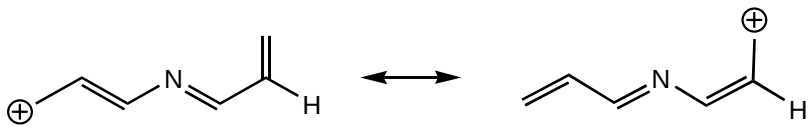
(4) 10) Complete the boxes with two different resonance structures.



11) Complete EITHER part A or part B but not both (do not answer both questions!).

(2) A) What is the average number of bonds between any 2 atoms in the NO_3 anion. Explain.

(2) B) Complete the electron flow arrows on both sides of the equation to account for the structures.



(4) 12) A 200 mL flask containing oxygen gas at 56.2 KPa and a 300 mL flask containing nitrogen gas at 27.8 kPa were connected so each gas filled their combined volume. Assuming no change in the temperature, calculate the partial pressure of each gas in the final mixture. Also calculate the mole fraction of the nitrogen gas in the final mixture.

(7) 13) A 1.210 g mixture of methane (CH_4, FW = 16.0 g/mol) and pentane (C_5H_{12}, FW = 72.1 g/mol) are burned in excess oxygen gas to give CO_2 (FW = 44.0 g/mol) and H_2O (FW = 18.0 g/mol) according to the equations below. The water was isolated and weighed 2.268 g. Find the number of grams of methane in the original sample.

$$CH_4(g) + 2\,O_2(g) \longrightarrow 2\,H_2O(g) + CO_2(g)$$

$$C_5H_{12}(l) + 8\,O_2(g) \longrightarrow 6\,H_2O(g) + 5\,CO_2(g)$$

(3) 14) The empirical formula of fluorocarbonyl hypofluorite is CF_2O_2. If the density of gaseous fluorocarbonyl hypofluorite is 3.36 g/L at 50.0 kPa and 20.0^{o}C, determine the molecular formula.

(3) 15) How would you go about predicting the relative strength of the bond in C_2 vs. that of B_2?

16) A hydrogen electron makes a transition directly from n = 5 to n = 2.

(1) a) Is energy absorbed or transmitted during the transition?

(4) b) Calculate the wavelength of the energy absorbed or transmitted.

(3) 17) Ionization energy (IE) increases from left to right on the periodic table and is a measure of the energy required to abstract an electron. Yet the first IE for phosphorus is larger (10.5 volts) than the first IE of sulfur (10.4 volts). Explain this anomaly.

(3) 18) How many electrons could be accommodated at n = 5, l = 0 and 2, with m_s = -1/2. Describe the orbitals.

(3) 19) Arrange the following in order of increasing attraction to a magnetic field. Show your work.

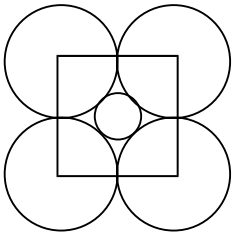
Mg B Ge As Cr

(4) 20) Manganese (Mn) is a transition metal which possesses many oxidation states (charges). A compound made up of manganese and fluoride (F) exists in a simple cubic cell with the Mn atoms in the corners of the cell and the F

anions in the center of each edge of the cell. Assume that F is a monoanion, the unit cell has no net charge and determine the charge of the Mn atom in this unit cell. Explain your reasoning.

(4) 21) Gallium is a metal which has a density of 5.91 g/cm^3. The edge length of its unit cell is 2.70 angstroms. In what type of cubic cell does gallium exist? Explain.

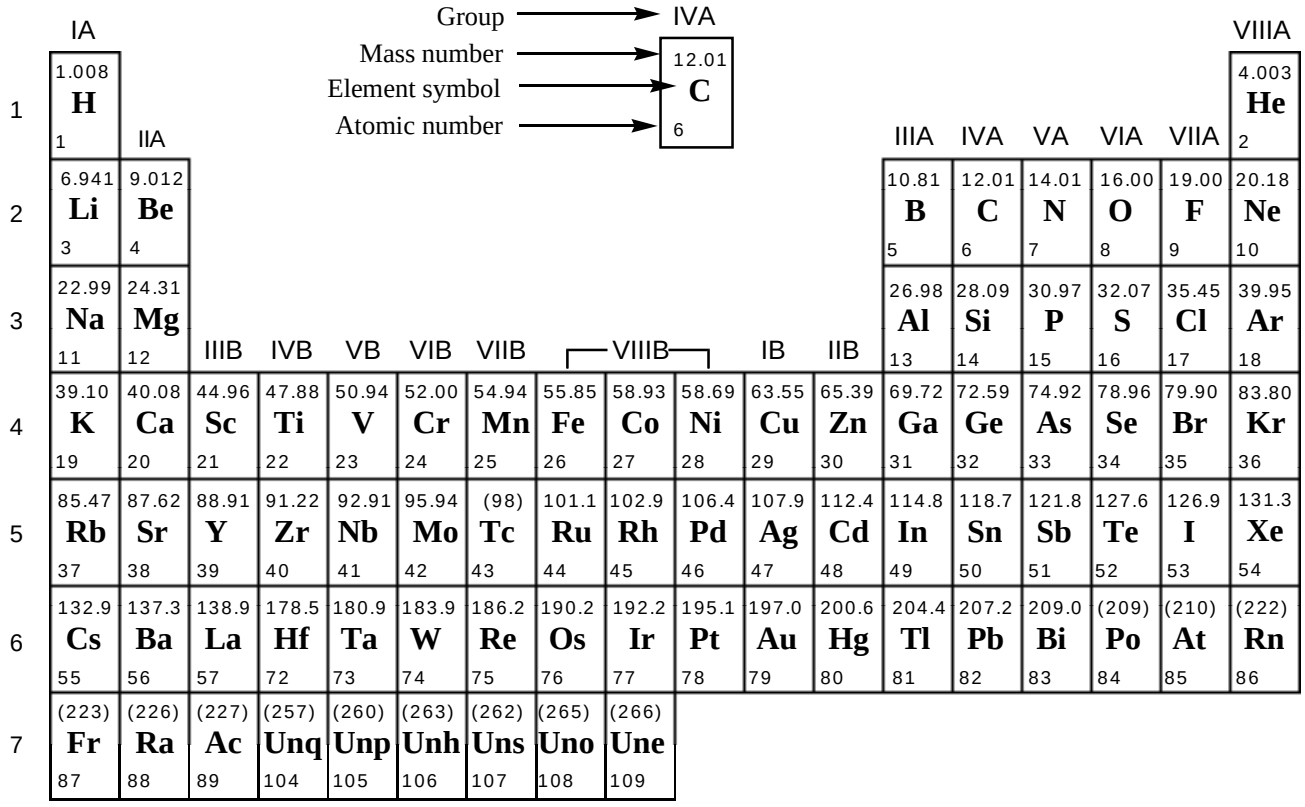
(4) 22) An ionic compound containing iodide atoms crystallizes in a simple cubic unit cell. The anions are positioned at the corners of the cell. Given that an iodide atom has a radius of 1.32 angstoms; calculate the maximum diameter of cationic atom that could fit in the middle of a face in this unit cell.



(6) 23) Sketch a phase diagram for a compound whose solid state is less dense than its liquid state.
Label: a) Solid, liquid and gas states
b) x and y parameters with correct units
b) triple point,
c) critical point.
d) Draw an arrow showing where sublimation will occur at constant pressure.

Useful Values

R = 8.314 J K^{-1} mol^{-1}
R = 0.08206 L atm K^{-1} mol^{-1}
h = 6.6262 x 10^{-34} J s
1 mole = 6.022 x 10^{23} things
1 dozen = 12 things
c = 3.00 x10^{8} m/s
STP = 1 atm and 0 °C
760 torr = 1 atm = 101.3 kPa
1 Å = 1 x 10^{-10} m
J = kg m^2 s^{-2}



	IA	IIA	IIIB	IVB	VB	VIB	VIIB	VIIIB			IB	IIB	IIIA	IVA	VA	VIA	VIIA	VIIIA
1	1.008 **H** 1																	4.003 **He** 2
2	6.941 **Li** 3	9.012 **Be** 4											10.81 **B** 5	12.01 **C** 6	14.01 **N** 7	16.00 **O** 8	19.00 **F** 9	20.18 **Ne** 10
3	22.99 **Na** 11	24.31 **Mg** 12											26.98 **Al** 13	28.09 **Si** 14	30.97 **P** 15	32.07 **S** 16	35.45 **Cl** 17	39.95 **Ar** 18
4	39.10 **K** 19	40.08 **Ca** 20	44.96 **Sc** 21	47.88 **Ti** 22	50.94 **V** 23	52.00 **Cr** 24	54.94 **Mn** 25	55.85 **Fe** 26	58.93 **Co** 27	58.69 **Ni** 28	63.55 **Cu** 29	65.39 **Zn** 30	69.72 **Ga** 31	72.59 **Ge** 32	74.92 **As** 33	78.96 **Se** 34	79.90 **Br** 35	83.80 **Kr** 36
5	85.47 **Rb** 37	87.62 **Sr** 38	88.91 **Y** 39	91.22 **Zr** 40	92.91 **Nb** 41	95.94 **Mo** 42	(98) **Tc** 43	101.1 **Ru** 44	102.9 **Rh** 45	106.4 **Pd** 46	107.9 **Ag** 47	112.4 **Cd** 48	114.8 **In** 49	118.7 **Sn** 50	121.8 **Sb** 51	127.6 **Te** 52	126.9 **I** 53	131.3 **Xe** 54
6	132.9 **Cs** 55	137.3 **Ba** 56	138.9 **La** 57	178.5 **Hf** 72	180.9 **Ta** 73	183.9 **W** 74	186.2 **Re** 75	190.2 **Os** 76	192.2 **Ir** 77	195.1 **Pt** 78	197.0 **Au** 79	200.6 **Hg** 80	204.4 **Tl** 81	207.2 **Pb** 82	209.0 **Bi** 83	(209) **Po** 84	(210) **At** 85	(222) **Rn** 86
7	(223) **Fr** 87	(226) **Ra** 88	(227) **Ac** 89	(257) **Unq** 104	(260) **Unp** 105	(263) **Unh** 106	(262) **Uns** 107	(265) **Uno** 108	(266) **Une** 109									

$PV = nRT$

$\frac{P_1V_1}{n_1T_1} = \frac{P_2V_2}{n_2T_2}$

$\frac{v_1}{v_2} = \left(\frac{m_2}{m_1}\right)^{\frac{1}{2}}$

$E = h\nu$

$\lambda\nu = c$

$E = mc^2$

$E = -2.178 \times 10^{-18}\ J(Z^2/n^2)$

² $E = -2.178 \times 10^{-18} J(1/n_f^2 - 1/n_i^2)$

$\sigma_{1s} < \sigma^*_{1s} < \sigma_{2s} < \sigma^*_{2s} < \pi_{2p_y} = \pi_{2p_z} < \sigma_{2p_x} < \pi^*_{2p_y} = \pi^*_{2p_z} < \sigma^*_{2p_x}$

$\sigma_{1s} < \sigma^*_{1s} < \sigma_{2s} < \sigma^*_{2s} < \sigma_{2p_x} < \pi_{2p_y} = \pi_{2p_z} < \pi^*_{2p_y} = \pi^*_{2p_z} < \sigma^*_{2p_x}$

$F = \frac{2.31 \times 10^{-19} J\ nm\ q_1 q_2}{d}$