Chemistry 222 Final Exam Study Questions Oregon State University

March 17, 2005 Dr. Alan Richardson

Test Form 4

Student name_____

DO NOT OPEN THIS EXAM UNTIL INSTRUCTED.

CALCULATORS ARE NOT TO BE SHARED.

Instructions: You should have with you several number two pencils, an eraser, your 3" x 5" note card, and your University ID Card. You may use a TI-25X Solar calculator if you wish. If you have notes with you, place them in a sealed backpack and place the backpack OUT OF SIGHT. Or place the notes directly on the table at the front of the room.

Place your name, student identification number, and test form number on the scantron.

There are 20 multiple choice questions and 14 open ended study questions. (If you have any questions before the exam, please ask. If you have any questions during the exam, please raise your hand to attract the attention of a proctor. The proctor will come to you. Open and start this exam when instructed. Present your ID card when submitting the exam.) This part does not apply at this time.

1 H 1.008																	2 He 4.003
3 Li 6.941	4 Be 9.012											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 47.88	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 65.39	31 Ga 69.72	32 Ge 72.61	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 (97.9)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.411	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	57 La* 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.59	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209.0)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89 Ac~ (227)	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110	111	112		114		116		118

$\Delta H° = \sum$ BE (reactants) - $\sum$BE (products) $\quad \Delta H_{sub} = \Delta H_{fus} + \Delta H_{vap} \quad N_A = 6.02 \times 10^{23}$

$\ln ([A]_o / [A]_t) = kt \quad k = A\, e^{(-Ea/RT)} \quad t_{1/2} = \ln(2) / k \quad E = mc^2 \quad \ln (N_o / N_t) = kt$

$\frac{1}{[A]_t} - \frac{1}{[A]_0} = kt \quad \ln\frac{k_1}{k_2} = -\frac{Ea}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right) \quad K_p = K_c\,(0.0821\ T)^{\Delta n} \quad Kc=K'_cK''_c$

$\Pi\, V = n\, R\, T \quad \Pi = M\, R\, T \quad R = 8.314$ J/mole·K $\quad R = 0.0.821$ L·atm/mol·K

$C_g = k_g\, P_g \quad \frac{C_1}{P_1} = \frac{C_2}{P_2} \quad P = X\, P^o \quad P = X_A\, P^o_A + X_B\, P^o_B \quad \Delta T_f = K_f\, m \quad \Delta T_b = K_b\, m$

1 The number of lone pairs of electrons in the ClF_3 molecule is:

a. zero b. one c. two d. three e. four

2 Four of the following statements concerning bond polarity and dipole moments are correct. The one ***incorrect*** statement is:

a. An N_2 molecule has no dipole moment.
b. Although boron-fluorine bonds are quite polar, the boron trifluoride molecule is not .
c. A carbon-chlorine bond is more polar than a carbon-iodine bond.
d. In a series of molecules: CH_4 CH_3Cl CH_2Cl_2 $CHCl_3$ CCl_4, CCl_4 has the largest dipole moment.
e. The water molecule is a distinctly polar molecule.

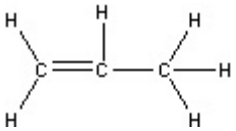
3 Which statement correctly describes the PF_3 molecule? Its molecular geometry is:

a. trigonal planer and it has a dipole moment
b. trigonal planer and it has no dipole moment
c. tetrahedral and it has no dipole moment.
d. trigonal pyramidal and it has no dipole moment.
e. trigonal pyramidal and it has a dipole moment.

4. Among the following, the atom with the largest atomic radius is:

a. C b. Si c. N d. F e. Cl

5. For the structure to the right, what is the hybridization of the **central** (middle) carbon and what are the bond angles around that carbon.



a. sp and 180° b. p and 90° c. sp^2 and 109° d. sp^2 and 120° e. sp^3 and 109°

6. Which of the following molecules have a dipole moment? OCS NH_3 NH_4^+ CH_2F_2

a. all of them
b. only OCS and NH_3
c. only OCS, NH_3, and CH_2F_2
d. only NH_3 and NH_4^+
e. only NH_4^+

7. What is the electron configuration of Sc (Scandium)?

a. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 4p^1$
b. [Ar] $4s^2 3d^1$
c. [Ar] $3s^2 2d^1$
d. [Ar] $4s^2 3p^1$
e. [Ar] $3s^2 3d^1$

8. Suppose the metal Sn crystallizes in a body-centered cubic structure with a unit cell 300 pm on a side. Calculate the density in g/cm^3 of Sn metal. *Note you do not need to know the atomic radius.*

a. 0.79 g/cm^3 b. 6.2 g/cm^3 c. 7.3 g/cm^3
d. 14.6 g/cm^3 e. 29.2 g/cm^3

9. The reaction used in a blast furnace to produce iron metal from iron ore using carbon monoxide is

$$Fe_2O_3\ (s) + 3\ CO\ (g) \rightleftharpoons 2\ Fe\ (l) + 3\ CO_2\ (g)$$

What is the equilibrium (K_c) expression for this reaction?

a. $K_c = \dfrac{[Fe_2O_3][CO]^3}{[Fe]^2[CO_2]^3}$ b. $K_c = \dfrac{[Fe]^2[CO_2]^3}{[Fe_2O_3][CO]^3}$ c. $K_c = \dfrac{[CO_2]^3}{[CO]^3}$ d. $K_c = \dfrac{[CO]^3}{[CO_2]^3}$

10. Which of the following would you expect to be the **least** soluble in water?

a. NH_3 b. HF c. NaCl d. CH_4 e. CsI

11. Which is the **major** intermolecular force between $SrCl_2$ and H_2O when they form a solution?

a. Ion-dipole bonds b. London forces c. Ion-ion bonds
d. Dipole-Dipole bonds e. Hydrogen bonds

12. What is the **molality** of a solution that contains 9.53 g HBr (F.M. = 80.9) added to 400 g of water?

a. 0.294 mol/kg b. 4.02 mol/kg c. 21.0 mol/kg
d. 0.0477 mol/kg e. 23.8 mol/kg

13. What is the **chloride ion** concentration in mol/L for a solution that contains 4.09 g $BaCl_2$ per Liter of solution. The F.M. for $BaCl_2$ is 208.

a. 0.197 mol/L b. 50.85 mol/L c. 25.4 mol/L d. 0.393 mol/L e. 0.0393 mol/L

14. What is the **expected pH** of an NaOH solution that has a concentration of 0.0090 M?

a. 7.0 b. 9.0 c. 1.20 d. 2.05 e. 12.0

15. If $HClO_4$ is a strong acid, then ClO_4^- is best classified as a

a. stronger acid b. weaker acid c. strong base
d. moderately strong base e. weak or ineffective base

16. Which of the following symbols is **INCORRECT**?

a. $^{4}_{2}He$ for an alpha particle b. $^{0}_{-1}e$ for a beta particle c. $^{1}_{1}\gamma$ for a gamma ray
d. $^{0}_{+1}e$ for a positron e. $^{0}_{1}n$ for a neutron

17. Predict the other product from the following radioactive decay.

$$^{214}_{84}Po \rightarrow {}^{4}_{2}He + \_\_\_\_$$

a. $^{214}_{82}Pb$ b. $^{218}_{82}Pb$ c. $^{210}_{82}Pt$ d. $^{210}_{82}Hg$ e. $^{210}_{82}Pb$

18. Strontium-90 has a half-life of 28 years. How many years will it take for all the strontium-90 presently on earth to decay to 1/32 of its present amount.

a. 196 years b. 168 years c. 140 years d. 112 years e. 84 years

19. The cherry farmers in the Willamette Valley wait until the cherries are ripe before picking them. The skins on the cherries are semi-permeable membranes which allow water to pass. If it rains on the day the cherries are to be picked, rainwater sits on the outside of the skins for several hours. The farmers know they have to get the cherries picked very quickly when the cherries are wet. Which of the following is the best explanation for the rush.

a. The rain water cools the cherries too much and makes them stop growing.
b. The rain on the cherries allows the water inside the cherry to pass out, causing a shrunken cherry (similar to a raisin) which is hard to sell.
c. The rain on the cherry will pass into the cherry , causing it to burst.
d. The rain will dissolve the skin.
e. Nothing will happen and the rush is silly.

20. Which of the following is held together primarily by NETWORK COVALENT bonding?

a. ice, H_2O b. RbI c. diamond d. CsI e. BaI_2

YOU MUST SHOW ALL WORK ON NUMERICAL PROBLEMS TO RECEIVE CREDIT.
Be sure to express your answer to the correct number of significant figures, and report it with correct units.

1. A 53.9% solution of H_2SO_4 (F.M. = 98.0) has a density of 1.507 g/mL at room temperature. What is it's molarity?

2. A 262 mL sample of a polymer solution containing 1.22 g of polymer has an osmotic pressure of 30.3 torr at 35 °C. What is the molar mass of the polymer? (R = 0.0821 L·atm/mol·K)

3. At equilibrium, what is the pH of a 0.16 M solution of H_2CO_3? The K_a for H_2CO_3 is 4.2×10^{-7}.

4. What is the expected pH, at equilibrium, of a 0.15 M solution of NH_3 in water? The K_b for NH_3 is 1.85×10^{-5}.

5. A 0.500 M solution of $HAsO_3$ was found to have an equilibrium pH of 3.81 at 25°C. What is the K_a?

6. Pure benzene has a vapor pressure of 75 torr and pure toluene has a vapor pressure of 22 torr at 20 °C. What is the predicted vapor pressure of a mixture containing 3 moles of benzene and 5 moles of toluene at 20 °C?

7. What is the calculated solution vapor pressure if 140 g of an electrolyte, NaOH (F.M. = 40.0), are mixed with 500g of water at 80 °C. The vapor pressure of water at 80 °C is 278 torr.

   This problem is slightly more difficult than I had anticipated. Change it to 140 g of sucrose ($C_{12}H_{22}O_{11}$), this sugar has a formula mass of 342. Leave the water the same.

8. Match the phase transition name to the following phase transition processes.
   Write the number or the name after the process.

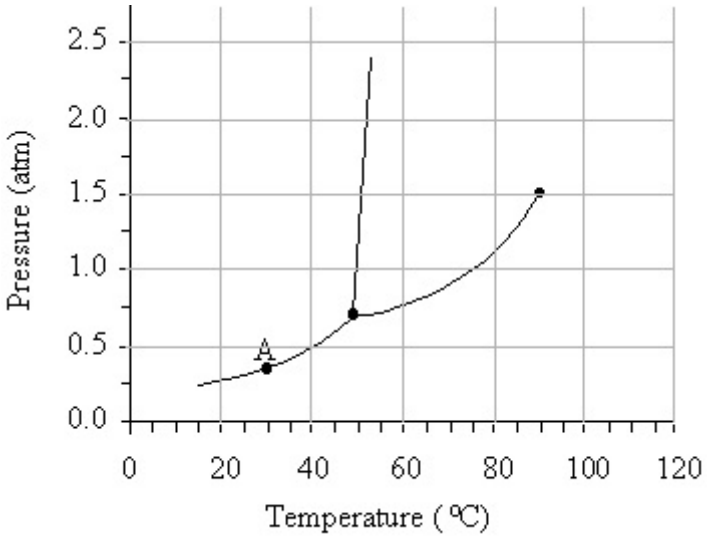
   1) condensation 2) melting 3) deposition 4) vaporization
   5) freezing 6) sublimation

   a) snow converts to water vapor without melting
   b) ice cubes form in the refrigerator
   c) rain drops form from water vapor in the clouds
   d) ice turns liquid
   e) mercury gives of toxic mercury vapor

9. Below are the vapor pressures of some relatively common chemicals measured at 20 °C.
   Arrange the letters of the substances in order of **increasing** intermolecular attractive forces.

a	Benzene, C_6H_6	80 torr
b	Acetic acid, $HC_2H_3O_2$	11.7 torr
c	Acetone, C_3H_6O	184.8 torr
d	Diethyl ether, $C_4H_{10}O$	442.2 torr
e	Water, H_2O	17.5 torr

10. Referring to the phase diagram below, answer the following questions



a) What is the normal boiling point of this substance?

b) What is the critical pressure?

c) If the pressure is decreased from 1.5 atm to 0.5 atm while the temperature increases from 20 °C to 80 °C what phase(s) will be present?

d) What phase(s) are present at the point labeled A?

For questions 11 - 13.

Assume this reaction has reached equilibrium: $3\ H_2 + N_2 \rightleftharpoons 2\ NH_3$ $\Delta H° = -46$ kJ

For the following three separate disturbances, how do the **FINAL** concentrations compare with those of the **ORIGINAL** equilibrium, and in which direction does the reaction shift to reach the new equilibrium, after each of the following three separate disturbances? Mark the box for each change.

11. If the temperature is raised

$[H_2]$	$[N_2]$	$[NH_3]$	[shift]
☐ increase	☐ increase	☐ increase	☐ shifts right
☐ stays the same	☐ stays the same	☐ stays the same	☐ no shift
☐ decrease	☐ decrease	☐ decrease	☐ shifts left

12. If some of the N2 is removed

$[H_2]$	$[N_2]$	$[NH_3]$	[shift]
☐ increase	☐ increase	☐ increase	☐ shifts right
☐ stays the same	☐ stays the same	☐ stays the same	☐ no shift
☐ decrease	☐ decrease	☐ decrease	☐ shifts left

13. If the container's volume is dropped to half the original size

$[H_2]$	$[N_2]$	$[NH_3]$	[shift]
☐ increase	☐ increase	☐ increase	☐ shifts right
☐ stays the same	☐ stays the same	☐ stays the same	☐ no shift
☐ decrease	☐ decrease	☐ decrease	☐ shifts left

14. Write the Lewis structure for XeF_4. Be sure to include ALL the valence electrons

(B) What is the electronic geometry? _____

(C) What is the molecular geometry? _____

(D) Is the molecule polar? _____

(E) What is the hybridization of Xe in this molecule? _____