CHEM 111 Your full name (PLEASE PRINT) KEY

Fourth hour test **page 1 of 5**

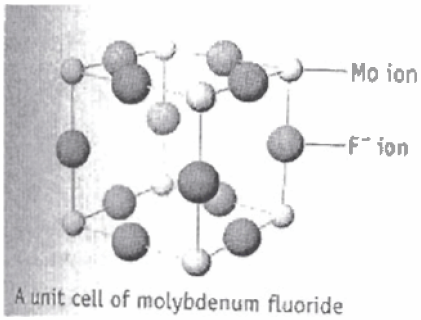
November 30, 2006 Your scheduled **Tuesday** quiz section (please circle) B hr E hr

Your scheduled **Tuesday** quiz instructor:_____

You may use a writing implement, hand-calculator, the pink data page and your Periodic Table (unmarked, honor code) as obtained in this course. **NO scratch paper is permitted!** As requested of the faculty by the Student Executive Committee, students must sit in every other seat during the test. The PROPER METHOD (i.e., Problem Set 0) must be shown clearly on all problems, and final answers must be expressed in appropriate form. Pay attention to dimensions!! **When blanks for answers are provided, write your answer to be graded in the blank—we may not grade answers written in other locations!**

It is your responsibility to make sure the test you turn in has 5 securely fastened pages.

1. (10 pts) A compound involving molybdenum ions (smaller light gray) and fluoride ions (larger dark gray) is shown below. Use the picture to answer the following questions. Circle the best answer for each question:



A unit cell of molybdenum fluoride

a) The molybdenum ions describe which type of lattice?
(simple cubic) body-centered cubic face-centered cubic

b) The equivalent number of molybdenum ions in this unit cell is:
0 1/8 1/2 (1) 2 3 4 6 8

c) The equivalent number of fluoride ions in this unit cell is:
0 1/8 1/2 1 2 (3) 4 6 8

d) The simplest formula of this compound is MoF_3

e) What must be the charge on each molybdenum ion? 3+

2. (9 pts) Balance the following redox reaction that is done in **NEUTRAL** conditions, demonstrating the proper style. ***Clearly box*** each balanced half reaction ***and*** your final balanced overall reaction.

$$NO_2^- \xrightarrow{Neutral} NO(g) + NO_3^-$$

$e^- + 2H^+ + NO_2^- \rightarrow NO + H_2O$
$+2OH^-$ $+2OH^-$
$e^- + H_2O + NO_2^- \rightarrow NO + 2OH^-$

$H_2O + NO_2^- \rightarrow NO_3^- + 2H^+ + 2e^-$

$2e^- + 2H_2O + 2NO_2^- \rightarrow 2NO + 4OH^-$

$H_2O + 3NO_2^- \rightarrow NO_3^- + 2NO + 2OH^-$

3. (10 pts) Calculate the Osmotic pressure at 51 degrees Celsius of a glucose solution $C_6H_{12}O_6$ that has 61 grams of glucose dissolved in enough water to make 1501 ml.

Fundamental Equation(s): $\pi = cRT$

$$\pi = \frac{61\text{ g glu}}{180.19\text{ g glu}} \left| \frac{1\text{ mol glu}}{1501\text{ mL}} \right| \frac{1000\text{ mL}}{1\text{ L}} \left| \frac{(273+51)\text{ K}}{} \right| \frac{0.08206\text{ L atm}}{\text{K mol}} = 6.0\text{ atm}$$

Answer: 6.0 atm

4. (10 pts) You have a sample of helium gas at -25 °C, and you want to increase the average speed of the helium atoms by 15.0%. To what temperature should the gas be heated to accomplish this?

Fundamental Equation(s): $K.E. = \frac{1}{2}m\bar{u}^2 \quad K.E. = \frac{3}{2}RT$

$\frac{1}{2}m\bar{u}^2 = \frac{3}{2}RT$

$\bar{u}^2 = \frac{3RT}{M}$

$\frac{\bar{u}_{T_2}^2}{\bar{u}_{T_1}^2} = \frac{\frac{3RT_2}{M}}{\frac{3RT_1}{M}}$

$\frac{\bar{u}_{T_2}^2}{\bar{u}_{T_1}^2} = \frac{3RT_2M}{3RT_1M}$

$\frac{\bar{u}_{T_2}^2}{\bar{u}_{T_1}^2} = (1.150)^2 = \frac{T_2}{T_1}$

$1.3225 = \frac{T_2}{248K}$

$T_2 = 328K$

answer: 328 K

5. (10 pts) A 4.0 L bulb containing Xe at 0.115 atm is connected by a valve to a 2.5 L bulb containing He at 0.20 atm. What is the total pressure (**in atm**) after the valve connecting the flasks is opened?

$P_{1Xe}V_{1Xe} = P_{2Xe}V_{2Xe}$

$PV = nRT$

$P_{He} + P_{Xe} = P_{TOT}$

$P_{1He}V_{1He} = P_{2He}V_{2He}$

$\frac{P_{1Xe}V_{1Xe}}{V_{2Xe}} = P_{2Xe}$

$\frac{P_{1He}V_{1He}}{V_{2He}} = P_{2He}$

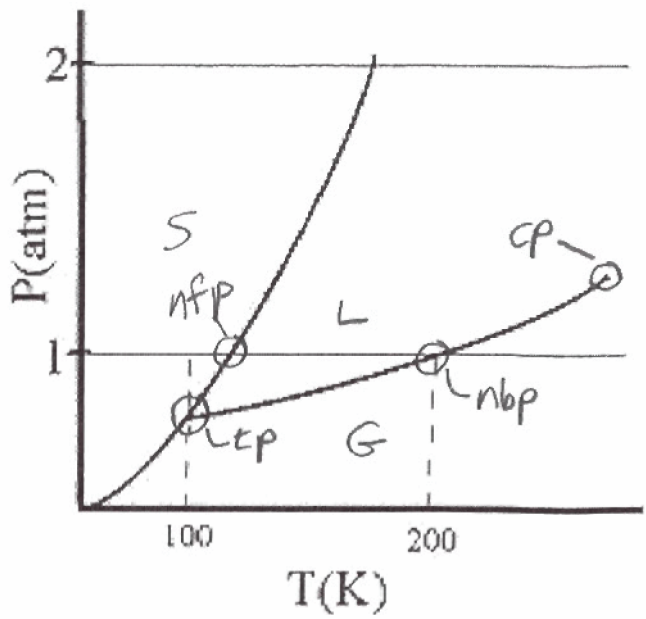
$\frac{0.115\,atm \mid 4.0L}{\mid 6.5L} = P_{2Xe} = 0.0708\,atm$

$\frac{0.20\,atm \mid 2.5L}{\mid 6.5L} = P_{2He} = 0.0769\,atm$

0.0708 atm
0.0769 atm
0.1477 atm
0.148 atm

Answer: 0.148 atm

6. (7 pts) Given at right is a phase diagram for an unknown pure substance. **Clearly label** on the phase diagram: (i) solid (*s*), liquid (*l*) and gas (*g*) regions; (ii) the triple point (tp); (iii) the critical point (cp); (iv) the normal freezing point (nfp); (v) the normal boiling point (nbp).



7. (3 pts) Write the Raoult's Law equation: $P_{VAP(SOL)} = X_{SOLV} P_{VAP(SOLV)}$

8. (3 pts) Write the de Broglie equation: $p = \frac{h}{\lambda}$

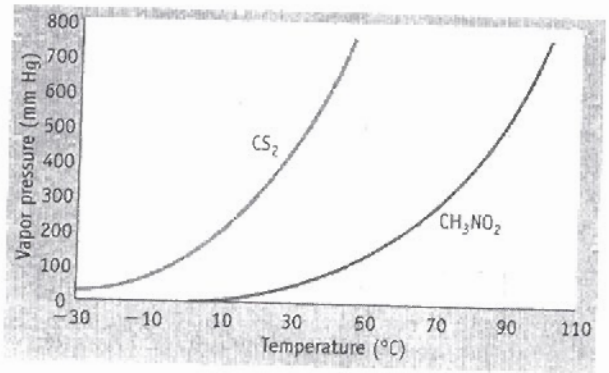
9. (3 pts) Write the Henry's law equation: $S = kP$ (or $P = kC$ in old text)

10. (3 pts) Write the equation for freezing point depression: $\Delta t_{fp} = km$ ← must be little m

11. (3 pts) Write the potential energy form of Coulomb's law: $P.E. = \frac{kQ_1Q_2}{r}$

12. (3 pts) Write the Heisenburg uncertainty equation: $(\Delta p)(\Delta x) \geq \frac{h}{4\pi}$

13. (8 pts) Vapor pressure curves for CS_2 and CH_3NO_2 are shown below:



(a) What is the vapor pressure of CS_2 at 40 °C?

600
~620 mm Hg

(b) What is the normal boiling point of CH_3NO_2?

100
~95 °C

37
(c) At what temperature does CH_3NO_2 have a vapor pressure of 60 mm Hg? ~33°C

(d) What can you say is present in a sample of CS_2 at 200.0 mm Hg and 10.0 °C?

LIQUID CS_2 + VAPOR CS_2

14. (18 pts) Circle T for True or F for False for each of the following statements:

T (F) An ideal gas particle experiences attractive forces with the walls of the container. NO ATTRACTIVE OR REPULSIVE FORCES

T (F) An ideal gas particle experiences inelastic collisions with the walls of the container. ELASTIC

(T) F An ideal gas particle has zero volume of its own.

T (F) Viscosity is explained by adhesive forces. COHESIVE

T (F) Gas particles at a given temperature all have the same velocity. BOLTZMANN DISTRIBUTION

(T) F NO_2 would be a paramagnetic molecule.

(T) F NO is very reactive with O_2.

T (F) NO is a brown gas. NO_2 IS; NO IS COLORLESS

(T) F The universal indicator changed colors on bubbling NO gas through the dilute ammonia solution because the acidity of the solution changed.

T (F) The surface tension of a liquid would be expected to increase with increasing temperature. DECREASE

(T) F Reverse osmosis can be used to purify sea water.

T (F) MRI contrast agents typically have their f electrons paired. UNPAIRED

T (F) Chemiluminescence occurs when the energy derived from breaking chemical bonds is used to absorb photons. EMIT

(T) F A molecule that fluoresces typically does so at a wavelength longer than the absorbance wavelength.

T (F) Boiling point elevation is calculated using molarity. MOLALITY

T (F) Molecules of HI would experience hydrogen bonding as intermolecular forces. MUST BE O, N, OR F

(T) F London Dispersion Forces depend on their strength according to the polarizability of the species present

T (F) Molecules of CF_4 would depend on dipole-dipole interactions as intermolecular forces. POLAR BONDS BUT NON POLAR MOLECULE

T (F) 0.30 m $Ca(OAc)_2$ would have a lower freezing point than 0.25 m Na_3PO_4. 0.90 m IONS 1.00 m IONS

PLEDGE:_____