CHEMISTRY CHEM 1101 C
SAMPLE FINAL EXAMINATION
It was real in *Winter* term 2016

DURATION: 3 HOURS No. of Students:

Department Name & Course Number: CHEM 1101 C
Course Instructor(s) Pamela Wolff

AUTHORIZED MEMORANDA CALCULATORS

Students MUST count the number of pages in this examination question paper before beginning to write, and report any discrepancy to a proctor. This question paper has pages.

This examination question paper MAY be taken from the examination room.

In addition to this question paper, students require: an examination booklet **yes**
a Scantron sheet no

ANSWER ALL 10 QUESTIONS. EACH IS WORTH 10 MARKS. (THIS DOESN'T NECESSARILY MEAN YOU SHOULD SPEND THE SAME AMOUNT OF TIME ON EACH!)

- You may do the questions in any order
- You may detach the question pages (you don't need to hand in the exam paper)

PLEASE: **Space out your answers – if I can't read it, I can't give you marks for it**

Don't write in the margins – except the question number

- If you need an extra exam booklet, ***HOLD UP the one you have in the air*** – we'll bring you another.
- If you don't have a calculator, or have trouble with yours, ask for one; we have spares

DATA/EQUATIONS

$E = h\nu$

$E = hc/\lambda$

$E = R_H \left(\frac{1}{n_i^2} - \frac{1}{n_f^2} \right)$

$PV = nRT$

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

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

$\Delta T_b = K_b \, m \, \iota$

$\Delta T_f = K_f \, m \, \iota$

$\Delta G° = \Delta H° - T\Delta S°$

$\Delta G = \Delta G° + RT \ln Q$

$h = 6.626 \times 10^{-34}$ J·s

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

$R_H = 2.18 \times 10^{-18}$ J

$R = 0.08206$ L·atm/K·mol

$= 8.314$ J/K·mol

$T(K) = T(°C) + 273$

K_b (H_2O) = 0.52 °C/m

K_f (H_2O) = 1.86 °C/m

Avogadro's number: 6.02×10^{23}

	$\Delta H_f°$ (kJ/mol) 25 °C	S° (J/K mol) 25 °C	$\Delta G_f°$ (kJ/mol) 25 °C
$NO_{2(g)}$	33.2	240.1	51.3
$H_2O_{(l)}$	–285.8	69.9	–237.1
$H_2O_{(g)}$	–241.8	188.7	–228.7
$HNO_{3(g)}$	–133.9	266.9	–73.5
$NO_{(g)}$	91.3	210.8	87.6

PHASE DIAGRAM: H_2O

Use one from your notes

PERIODIC TABLE

Use one from your notes

1. Gold has a work function of 492 kJ/mol.

   a) Calculate the wavelength of the electromagnetic radiation just energetic enough cause electrons to be emitted from a gold surface, in **nanometres**.

   b) Calculate the wavelength in **nanometres** of the electromagnetic radiation just energetic enough cause electrons to be emitted from a gold surface with a kinetic energy of 1.3×10^{-18} J.

2. For the following elements – predict their most likely ion or ions, and give the electron configurations of each of those ions:

   a) Al

   b) Tl

   c) Se

   d) Give the electron configuration of the cobalt (III) ion.

3. Give the systematic (IUPAC) name for the following:

   a) $BiCl_3$ b) $AlCl_3$ c) $CrCl_3$

   Give the chemical formula for the following:

   d) lead sulfate e) lead sulfide f) iron (III) sulfide

4. For the iodine tetrachloride anion, ICl_4^-:

   a) Draw the Lewis Diagram.

   b) **Draw** and **name** the VSEPR (molecular) geometry.

   c) Indicate the bond orders

   d) Indicate the **bond dipoles** and **net dipole** (redraw the structure for this, please, so that I can see it better.)

5. a) Draw and label a molecular orbital diagram for phosphorous monofluoride, PF. ***Use at least half a page.***

   b) Give the bond order

   c) Give the magnetism, and explain your choice briefly (a few words are enough)

   d) If you ionized PF to give PF^+, would the bond length be shorter or longer? Explain your reasoning briefly (again, a few words are plenty.)

6. Mercury (Hg) has a normal boiling point of 356.7 °C, and a standard heat of vaporization of 59.11 kJ/mol.

   a) Determine its vapour pressure at 22 °C.

   b) Determine what mass of mercury will vaporize in a closed container at 22°C if it has a volume of 1.7 L of space above the liquid.

7. Using the phase diagram of water given with the data sheets:

   a) Label regions A, B, and C, lines 1, 2, and 3, and points a and b. (*Use the letters and numbers given on the diagram and answer in your exam booklet* ***or*** *give a sketch of the diagram.* ***Don't write it on the question paper; I don't want that handed in!****)*

   b) Describe **in POINT FORM** what happens when the pressure of the H_2O is raised from 0.001 atm to 217 atm at a temperature of 0°C. Make reasonable pressure and temperature estimates as needed.

   c) Describe **in POINT FORM** what happens when H_2O is heated from −100°C to 370°C at a pressure of 30 atm. Make reasonable pressure and temperature estimates as needed.

8. A 6.0 M NaCl (table salt) solution has a density of 1.20 g/ml. If you want to use this solution to boil your pasta:

   a) Given the data on the data page, determine its normal boiling point.

   b) If you had a solution of magnesium chloride with exactly the same molality, would you expect its normal boiling point to be higher or lower than that of the sodium chloride solution? Explain briefly (a few words is plenty)

9. Phosphoric acid, H_3PO_4 , can be produced in the reaction:

$$Mg_3(PO_4)_2 + H_2SO_4 \rightarrow H_3PO_4 + MgSO_4$$

   If 6.50 x 10^3 kg of magnesium phosphate is allowed to react with 7.25 x 10^3 kg of sulfuric acid, determine the mass of phosphoric acid that is produced, <u>in kilograms</u>. ***Show enough work to justify your answer.***

10. The following reaction is important in the synthesis of agricultural fertilizers:

$$3\ NO_{2(g)} + H_2O_{(g)} \rightarrow 2\ HNO_{3(g)} + NO_{(g)}$$

   a) Determine the standard enthalpy of reaction at 25°C

   b) Determine the standard entropy of reaction at 25°C

   c) Determine the standard free energy of reaction at 25°C

   d) Determine the temperature range over which the reaction is spontaneous

   e) Determine the free energy of reaction at 250.°C , when the pressures are:

$NO_{2(g)}$: 50.0 atm $H_2O_{(g)}$: 30.0 atm

$HNO_{3(g)}$: 0.60 atm $NO_{(g)}$: 0.10 atm.

   NOTE: there is data on the data page for this question