Carleton UNIVERSITY

FINAL
EXAMINATION
APRIL 2012

DURATION: 3 HOURS No. of Students: 355

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 7 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 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 pages (you don't need to hand in the exam paper)

PLEASE: **Space out your answers**

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

$E = h\nu$

$E = hc/\lambda$

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

$h = 6.626 \times 10^{-34}$ J·s

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

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

1 mol = 6.02×10^{23}

$PV = nRT$

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

R = 0.08206 L·atm/K·mol

= 8.314 J/K·mol

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

$\Delta T_b = K_b \cdot m \cdot$ i

$\Delta T_f = K_f \cdot m \cdot$ i

K_b (H20) = 0.52 °C/m

K_f (H20) = 1.86 °C/m

$\Delta G° = \Delta H° - T \Delta S°$

T(K) = T(°C) + 273

	$\Delta H°_f$ (kJ/mol)
$CO_{2(g)}$	−393.5
$H_2O_{(g)}$	−241.8
$H_2O_{(l)}$	−285.8
$C_6H_{12}O_{6(s)}$	−1275

PHASE DIAGRAM: CO_2

PERIODIC TABLE

1. Hydrogen emits electromagnetic radiation with energy 984 kJ/mol when electrons make a transition to the ground state. Determine what level the electrons started in.

2. a) Give the electron configuration for iridium, $_{77}$Ir.
   b) Give the valence shell for iridium, and give the orbital diagram and quantum numbers for electrons in it.
   c) Give the highest energy subshell for iridium, and give the orbital diagram and quantum numbers for electrons in it, if different from b.
   d) Give the electron configuration for the Ir(II) ion.

3. For the following compounds:
   i) Draw a Lewis Diagram
   ii) Indicate all bond orders
   iii) Draw and name the VSEPR geometry
   iv) Draw the bond dipoles and the net dipole

   a) $XeOF_2$ b) H_3PO_4 – phosphoric acid

4. a) Draw and label a molecular orbital diagram for the ion NO^-
   b) Give the bond order by bond type (σ and π) and the overall bond order
   c) Give the magnetism
   d) If you had the neutral molecule, NO, would the bond between the elements be longer or shorter? Explain your answer briefly (you do not need to draw a new M.O. diagram unless you want to)

5. a) Draw and label a band diagram for magnesium (Mg) metal

   b) Draw and label a band diagram for silicon doped with a small amount of indium (In). Indicate whether it is an intrinsic or extrinsic semiconductor, and whether it is n-type or p-type.

6. a) Liquid mercury ($Hg_{(l)}$) is used in several kinds of scientific instrument. Mercury has a standard heat of vaporization of 59.2 kJ/mol and a normal boiling point of 357°C. Determine its vapour pressure at 23°C.

   b) If a container of mercury is left open in a lab whose room volume is 3.50×10^5 L, calculate the mass that can evaporate at 23°C (you may assume ideal behaviour at this pressure.)

7. Using the phase diagram of carbon dioxide 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.* ***Don't write it on the question paper; I don't want that handed in!****)*

   b) Describe in POINT FORM what happens when CO_2 is heated from –100ºC to 25ºC at a pressure of 1 atm. Make reasonable pressure and temperature estimates as needed.

   c) Describe in POINT FORM what happens when the pressure of the CO_2 is raised from 1 atm to 70 atm at a temperature of –50ºC. Make reasonable pressure and temperature estimates as needed.

8. Potassium acetate (KCH_3COO) is used as an alternative road salt in some municipalities and on many airport runways. Given that the density of a 5.0M solution is 1.27 g/ml, calculate the normal freezing point of this solution.

9. The reaction of dimethyl hydrazine (DMH: $C_2H_8N_2$) and dinitrogen tetroxide is used to propel rockets:

$$C_2H_8N_{2(l)} + N_2O_{4\ (l)} \rightarrow H_2O_{(g)} + N_{2(g)} + CO_{2(g)}$$

If 2.00×10^5 kg of DMH is combined with 6.00×10^5 kg dinitrogen tetroxide, determine the mass of nitrogen gas that is produced, in kilograms. ***Show enough work to justify your answer.***

10. Green plants produce simple sugars according to the reaction:

$$6\ CO_{2(g)} + 6\ H_2O_{(l)} \rightarrow C_6H_{12}O_{6(s)} + 6\ O_{2(g)}$$

Given the data on the data page, determine $\Delta H°_{rxn}$ at 25 °C