CHEMISTRY CHEM 1101
Sample FINAL EXAMINATION

DATA/EQUATIONS

$E = h\nu$

$E = hc/\lambda$

$E = R_H (\ -\ )$

$PV = nRT$

$[P + \ ] [V - nb] = nRT$

$\ln(\ ) = (\ \ )$

$T(K) = T(^oC) + 273$

$h = 6.626 \times 10^{-34}$ 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

Avogadro's number $= 6.02 \times 10^{23}$

Van der Waals Constants, hydrogen gas:

$a = 0.244$ L^2·atm/mol^2

$b = 0.0266$ L/mol

	$\Delta H_f°$ (kJ/mol)	S° (J/K mol)
$Cu_{(s)}$	0	33.2
$CuO_{(s)}$	–157.3	42.6
$H_2O_{(l)}$	–285.83	69.95
$H_2O_{(g)}$	–241.83	188.84
$N_{2(g)}$	0	191.61

$NH_{3\,(g)}$	−45.9	192.8

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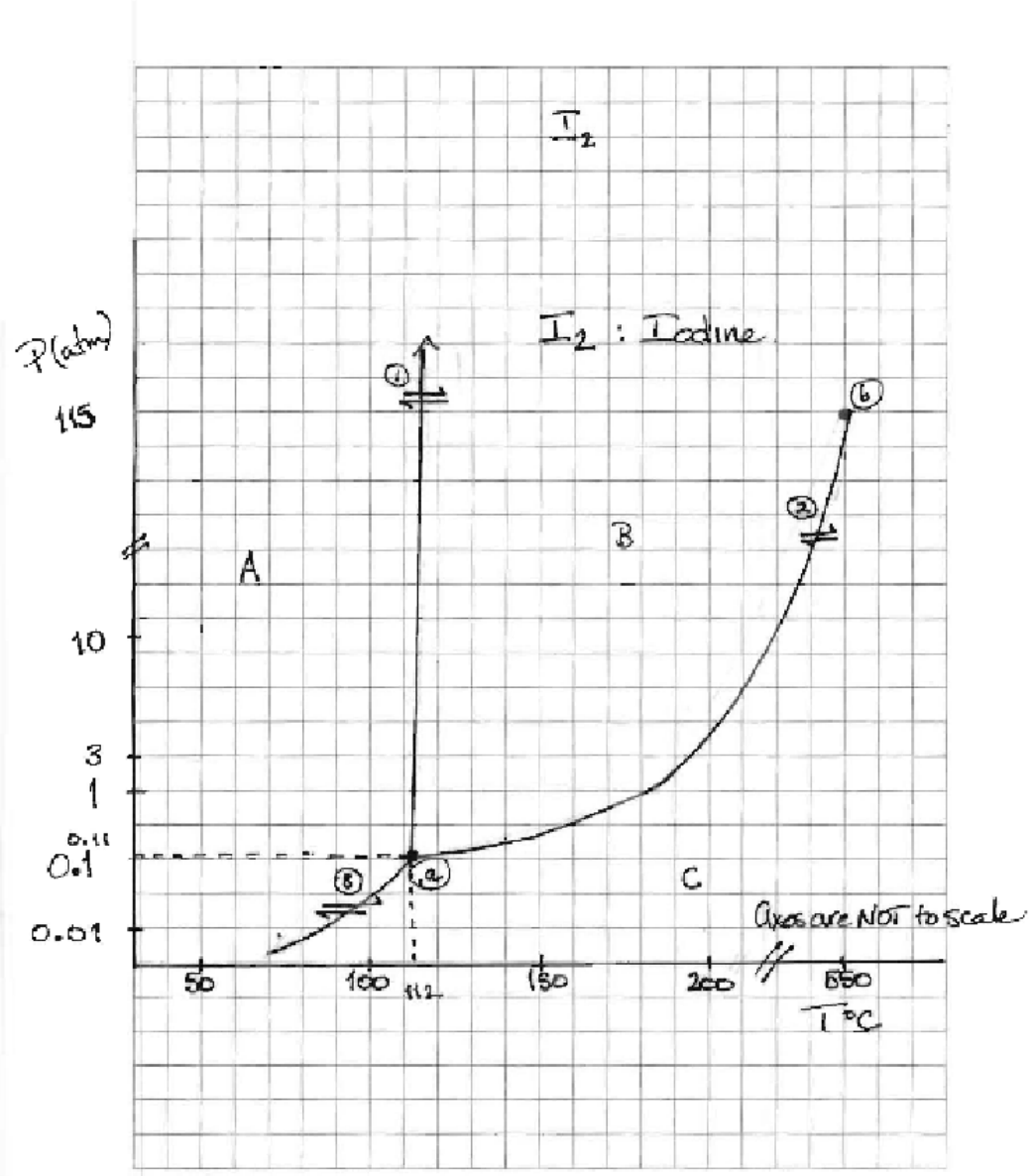
PHASE DIAGRAM: I_2



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PERIOD IC TABLE

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1. The ionization energy of carbon is 1086 kJ/mol. Determine the wavelength of the electromagnetic radiation just energetic enough to ionize carbon.

2. For the copper(II) ion, Cu^{2+}
   a) Give the electron configuration.
   b) Identify the valence shell for Cu^{2+}, and give the orbital diagram and quantum numbers for the electrons in it
   c) Identify the highest energy subshell for Cu^{2+}, (and give the orbital diagram and quantum numbers for the electrons in it, if different from b)

3. Predict the likely ion or ions for
   a) Al b) In c) As d) Bi

4. For the molecule $XeOF_4$ ***(use at least half a page of space for this.)***
   a) Show the Lewis diagram
   b) Give the bond order for each bond
   c) draw and name the molecular geometry
   d) indicate the bond dipoles
   e) indicate the net dipole

5. a) Draw and label a band diagram for sodium (Na) metal
   b) Draw and label a band diagram for silicon doped with an element which will make it a p-type extrinsic semiconductor. Indicate which element you will add to the silicon. ***(use at least half a page of space for this.)***

6. a) Given $\Delta H°_{vap(H_2O)}$=40.7 kJ/mol, determine the vapour pressure of water at 31°C.

   b) If the water is in a bottle with a head space (the space above the liquid) of 0.65L, what mass of water will evaporate at this temperature?

7. Using the phase diagram of iodine (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 I_2 is heated from 75°C to 300°C at a pressure of 3 atm. Make reasonable pressure and temperature estimates as needed.

   c) Describe in **POINT FORM** what happens when the pressure of the I_2 is raised from 0.01 atm to 12 atm at a temperature of 100°C. Make reasonable pressure and temperature estimates as needed.

   d) Determine the normal boiling point of iodine.

8. Given the reaction (one step in the production of steel):

   $$CO_{(g)} + Fe_2O_{3(s)} \rightarrow CO_{2(g)} + Fe_3O_{4(s)}$$

   If 37.3 kg of carbon monoxide is allowed to react with 636.1 kg of Fe_2O_3, determine the mass of Fe_3O_4 produced, in kilograms. ***Show enough work to justify your answer.***

9. Copper metal can be produced from copper(II) oxide according to the reaction:

$$3\ CuO_{(s)} + 2\ NH_{3\,(g)} \rightarrow 3\ Cu_{(s)} + 3\ H_2O_{(l)} + N_{2(g)}$$

Using the table of thermodynamic data on page 2:

a) Calculate the standard state heat of the reaction

b) Calculate the standard state entropy of the reaction

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

d) Determine the temperature range over which the reaction is spontaneous at standard state

e) Determine the free energy when you have present in a 2.00 L flask: 8.0 atm pressure of $NH_{3\,(g)}$ and 4.0 atm pressure of $N_{2(g)}$.

10. Given the equilibrium reaction:

$$2\ NO_{(g)} \leftrightarrow N_{2(g)} + O_{2(g)}\ \ K_{eq}\ (\text{at } 0^0C) = 25$$

If 9.0 moles of $NO_{(g)}$ is placed in a 2.00L container at 0^0C, determine the amount in moles of each gas once equilibrium is reached.