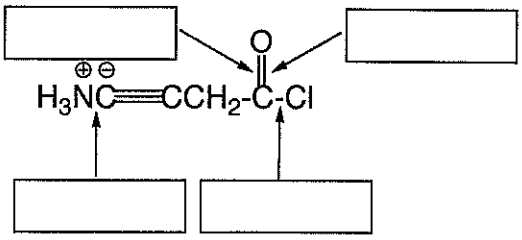
CHEMISTRY 121 MIDTERM 3

Nov. 21, 2007

Unless otherwise stated, show all your reasoning/work/sig figs for full marks.

(4) **1)** If possible, describe the AO (atomic orbital) overlap for each arrow.



2) Consider the BS molecule (ahem, that's boron and sulfur).

(4) **a)** Could it exist? You may add another logical level to your MO Aufbau diagram...

(1) **b)** Use a term to predict the BS molecule's behaviour towards a magnet. No explanation required.

(3) **3)** An arctic sea drilling ship hits a methane pocket deep under the sea at 74 °C and 7.49 atm. All the methane is collected in the ship and found to occupy 20,000 L at -40 °C. Find the original volume of the methane under the sea.

4) In a 2 L flask, ethane gas (C_2H_6, 5 moles) is burned with O_2 gas (4 moles) to form CO_2 and H_2O gases. It leaves one of the reactant gases partially unreacted. After the reaction, the 3 gases combine for a pressure in the flask of 2.1 atm.

(3) **a)** Calculate the number of moles of reactant gas which remains. Show your calculations/reasoning. Equation...

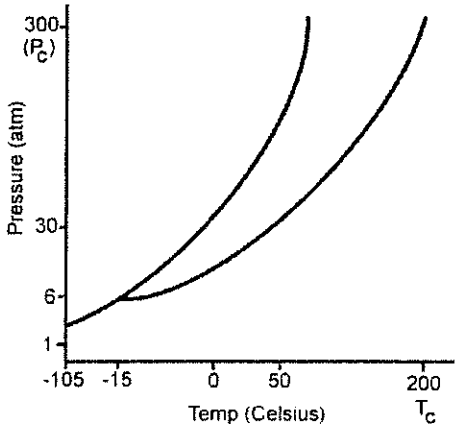
(3) **b)** Find the partial pressure of water which contributes to the total pressure of 2.1 atm.

(2) **c)** Calculate Graham's effusion velocity <u>ratio</u> of $C_2H_6 : O_2$.

(2) **d)** Would you expect the root mean square velocity <u>ratio</u> of C_2H_6: O_2 to have the identical value as c) above. Explain without a calculation.

(3) **5)** Mixing 3 moles of H_2O (l) with 3 moles of CH_3OH (l) makes 6 moles in total. True! So it follows that at constant temperature and pressure that mixing 3 L of water and 3 L of methanol must make 6 L in total. Comment.

6) Answer the questions below based upon this phase diagram.

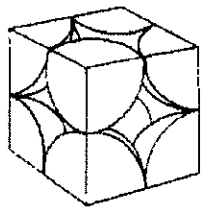


(1) **a)** Identify the phase present at STP.

(1) **b)** Define T_c. (don't say critical temperature)

(1) **c)** Moving isopiestically from 30 atm and -15 °C will encounter what new phase?

(3) **7)** Diagram look familiar? Atomic radius is still 1.2×10^{-8} cm. Calculate the **% volume** in the simple cubic unit cell which is **free space**. Volume of a sphere = $^4/_3\pi r^3$, mL = cm^3



(1) **Bonus**. Circle the meaning of "postulate".

a) a late letter b) experiment c) theoretical proposal d) fact-based statement e) incorrect statement