Chem 101 2017 Discussion #6 Chapter 6

Your name: _____ TF's name:_____ Discussion Day/Time: _____

Things you should know when you leave Discussion today:

1. Vapor pressure
2. Gas phase verses Liquid phase verses solid phase
3. Heat during temperature change: q=m*c*ΔT, Heat capacity
4. Heat during phase change: q = n *ΔH
5. Endothermic and Exothermic process
6. Enthalpy of vaporization $\Delta_{vap}H$ and enthalpy of fusion $\Delta_{fus}H$
7. Molecular geometry
8. Electronegativity, Bond Polarity, Dipole
9. IMF Intermolecular forces and their relative strengths

1. The normal boiling point of ammonia is −33 ˚C, of hydrogen chloride is −85 ˚C, of methane is −162 ˚C and of nitrogen is −196 ˚C. Assume that at −210 ˚C all four of these substances are liquids at 1 bar pressure. Which substance has the **smallest vapor pressure** at −210 ˚C? (Hint: define vapor pressure)

   Define vapor pressure:

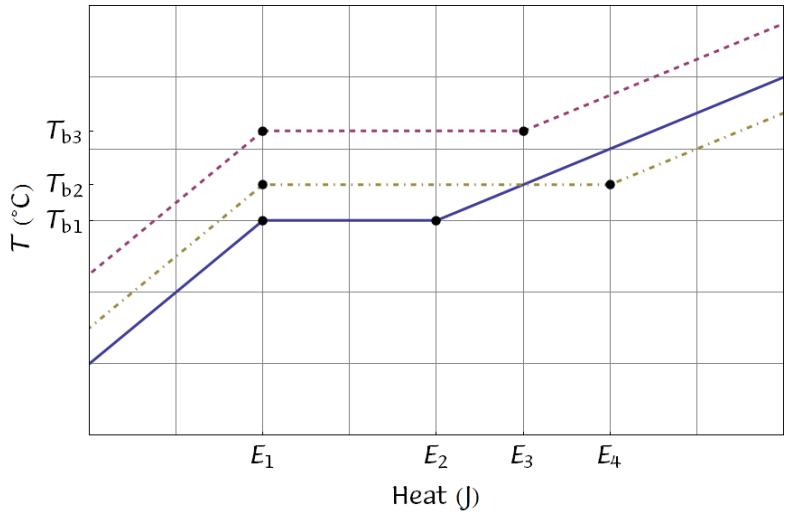
   Why?

2. At room temperature, the vapor pressure of liquid acetone is 31kPa, bromine is28.7 kPa, hexane is 20.2 kPa. Which of these liquids has the highest normal boiling point?

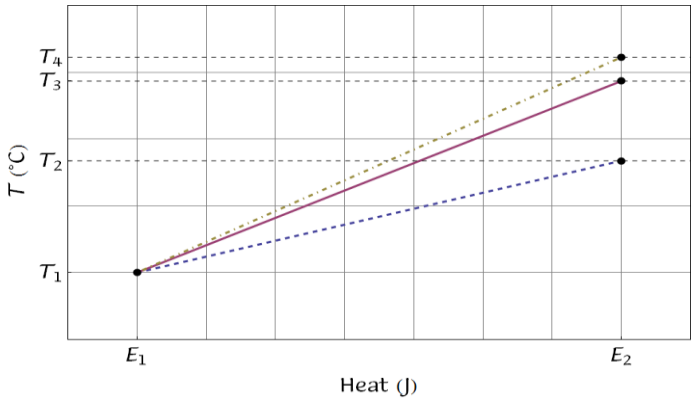
3. The figure shows the heating of three liquids to their corresponding boiling point, then subsequent heating until each liquid has been completely converted to gas, and finally heating of the gas.

   a. Define **enthalpy of vaporization $\Delta_{vap}H$:**

   b. The boiling point of the substance with the **highest enthalpy of vaporization, $\Delta_{vap}H$,** is (circle your answer) … T_{b1} T_{b2} T_{b3}



4. The figure shows the heating equal masses of three substances, each initially at temperature T_1. The same amount of energy, $\Delta E = E_2 - E_1$, is added to each substance. The substance with the **highest heat capacity** is the one whose final temperature is (circle your answer)



T_2 T_3 T_4

5. What bond is a polar bond?

6. What are necessary conditions for a molecule to be a polar molecule?

7. Define what are the Intermolecular forces:

   a. Name all Intermolecular forces:

   b. Which Intermolecular force exist in all the molecules?

      i. What are the factors that will make that force greater?

   c. Which Intermolecular force exist only in polar molecules?

      i. What are the factors that will make that force greater?

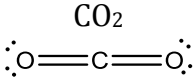
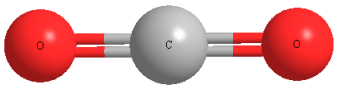
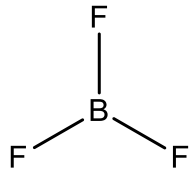
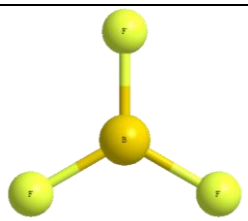
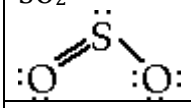
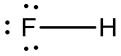
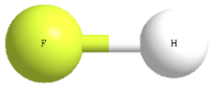
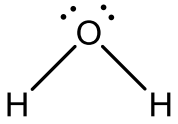
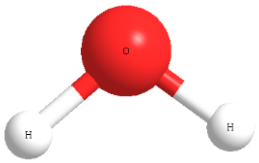
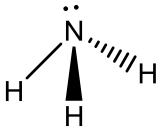
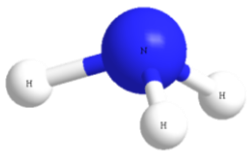
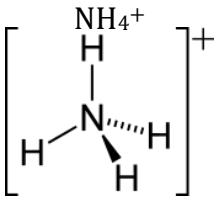
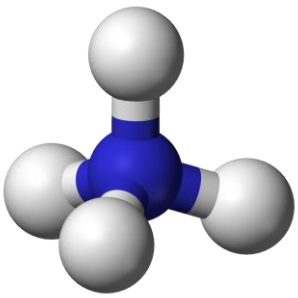
   d. What is ***Hydrogen Bond intermolecular force:***

   e. What are necessary conditions to have ***Hydrogen Bond intermolecular force?***

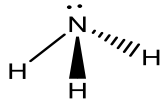
8. IMF Intermolecular forces have relative strengths as follows for the molecules of comparable size: ***Hydrogen Bonds > Dipole-Dipole > Induced Dipole – Induced Dipole (Dispersion Force).***
   Which Intermolecular forces will become much more significant in larger molecules?

9. Which Intermolecular force is least significant around the Boiling point?

10. Add to the pictures the bond dipoles and fill in the table for the **center** atom.

Molecule	*3-D Drawing (draw arrows indicating any polar bonds)*	*# of atoms bonded to the center atom*	*#of lone pairs on the center atom*	*#of atoms + # of lone pairs attached to the center atom*	*What is Geometry* *Net Dipole? (polar/not polar)*	*List All IMF intermolecular forces*
CO_2 						
BF_3 						
SO_2 						
HF 						
OH_2 						
NH_3 						
NH_4^+ 						

11. Calculate the maximum number of moles of hydrogen bonds that can form in a sample of 68 g of pure liquid ammonia, :NH_3. (Answer: 4moles)



b. How many hydrogen bonds will be in 24 Liters of gaseous ammonia? (Answer: 0moles)

12. Hydrogen bonds in water: In one mole of solid ice, there are 2.0 moles of hydrogen bonds.

a. Water at 0 °C only contains 1.8 moles of hydrogen bonds per mole of H_2O. If it takes 5.25 kJ to melt one mole of ice, calculate the energy required to break one mole of hydrogen bonds. (at home: calculate how much energy is required to break an individual hydrogen bond)

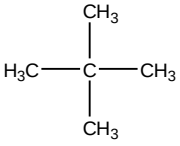
b. Water at 100 °C has 1.6 moles of hydrogen bonds per mole of H_2O. Assuming that all the heat is used only to break hydrogen bonds, predict the value of ΔH_{vap} in kJ/mol of H_2O. (hint: how many hydrogen bonds remain in water vapor?)

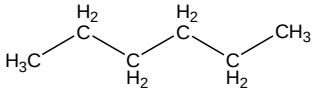
13. For each group, circle the compound that has the highest boiling point. **Justify your answers**.

Group 1:	He	Al	H_2O
Group 2:	CH_4	CH_3OH	N_2
Group 3:	NH_3	NI_3	BH_3

14. Circle the compound that has the higher boiling point in each pair and **explain why.**

a.

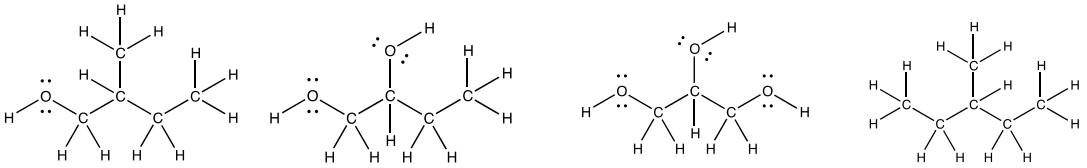




b. CH_2F_2 or CH_3OH

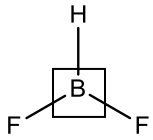
c. NH_3 or NF_3

15. Using number labels 1, 2, 3 and 4, rank the following molecules in order of **lowest** (label 1) to **highest** (label 4) **boiling point**. Give the reason why?

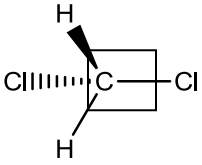


16. For each of the molecules below:
(1) Indicate the molecule's geometry about the boxed atom,
(2) Indicate all the polar bonds molecule has
(3) Indicate if molecule has a dipole moment. (draw arrows indicating direction of the dipole moment)
(3) List all intermolecular forces between two of those molecules.

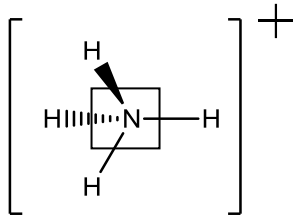
a. BF_2H



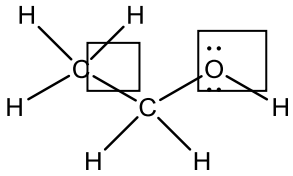
b. CH_2Cl_2



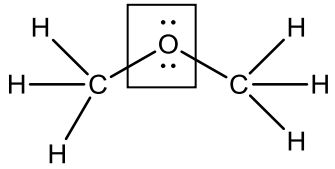
c. NH_4^+



d. CH_3CH_2OH



e. CH_3OCH_3



17. While boiling water to cook pasta, you notice a vapor bubble form that is 1.00 cm in radius. Assuming that 1 mol of gas at 100. °C occupies 30.6 L of space; calculate how many water molecules are contained in the bubble. (Answer: $8.37 \cdot 10^{19} atoms$)

18. One mole of a water vapor at 100 °C occupies 30,000 cm^3. Estimate the distance between the water molecules in the vapor. (Answer: $4*10^{-7}$cm/atom)

19. SCI/109 has the approximate dimensions: 10 m x 5 m x 30 m. Assuming that air is completely N_2, if all of the air in SCI/109 were liquefied, what is a volume of the liquid air would be in gallons?(Additional information $d(N_2(l))=0.8$ g/mL, 1 mol of any ideal gas occupies 24.4L) (Answer: 600 gallons)

20. If it takes 60.0 s for a kettle to heat 1.00 kg of water, (heat capacity of water is 4.18 J/(g K)), from 25.0 °C to 100.0 °C, how long (in "s") would it take for the same kettle to heat 0.500 kg of ethanol, (heat capacity of ethanol is 2.44 J/(g K)), through the same temperature range? (Answer: 17.5s)

21. If 42. kJ of energy is add to 1.0 kg of water (C = 4.184 J/(gK)), initially at 25°C. (Answer:35 °C)
    a. What is the final temperature of the water (in K)?

    b. The same amount of energy was added to 2.0 kg of an unknown substance and its temperature increased by 6.0°C. What is the specific heat of the unknown substance (in J/(gK))?(Answer:3.5 J/(gK))

22. A sample of ethanol (CH_3CH_2OH) is maintained at a temperature of 352. K (the boiling point of ethanol) until the entire sample evaporates. It was found that the evaporation of the sample required 78.0 kJ of energy. Determine the volume of the sample of ethanol that was used. (Useful information: ΔH_{vap}=39.0kJ/mol, density=0.800 g/mL)(Answer:115mL)

23. Student A heats a 0.25 L sample of water (d = 1 g/mL) from 25 °C to the boiling point of water. Student B uses a sample of carbon tetrachloride with twice the mass of the sample of student A and heats it from 50. °C to the boiling point of carbon tetrachloride (75 °C). Assuming that neither solution begins to boil, and the ratio, of the energy required by student A to the energy required by student B , E_A/E_B=7. What is the heat capacity of carbon tetrachloride? (Answer: 0.9 J/(gK))

Valence Electron Pairs ***Steric Number = #of atoms + # of lone pairs attached to the center atom***	**Electron Pair Geometry**	**Number of Bond Pairs** ***(Number of atoms bonded to the center atom)***	**Number of Lone Pairs**	**Molecular Shape Geometry**
2	Linear(<180°)	2	0	Linear
3	Trigonal Planar (<120°)	3	0	Trigonal Planar
3	Trigonal Planar	2	1	Bent
4	Tetrahedral (<109.5°)	4	0	Tetrahedral
4	Tetrahedral	3	1	Trigonal Pyramidal
4	Tetrahedral	2	2	Bent