

NAME \_\_\_\_\_

Exam 1/CHEM1451/Dr. Dooley/S2014

Feb 6, 2014

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*Multiple Choice (30 Points Total): Write the letter corresponding to the correct answer in the blank beside each number.*

- \_\_\_\_\_ 1. Identify the compound that does not have dipole-dipole forces as its strongest force.
- a)  $\text{CH}_2\text{Cl}_2$
  - b)  $\text{CH}_3\text{OCH}_3$
  - c)  $\text{CH}_3\text{Br}$
  - d)  $\text{HCl}$
  - e)  $\text{CO}_2$
- \_\_\_\_\_ 2. Which of the following statements is TRUE?
- a) Vapor pressure increases with temperature.
  - b) Hydrogen bonds are stronger than covalent bonds.
  - c) Intermolecular forces hold the atoms in molecules together.
  - d) Dispersion forces (LDF) are generally stronger than dipole-dipole forces.
  - e) None of the above are true.
- \_\_\_\_\_ 3. Using the heats of vaporization for some unknown molecules, determine which substance below must have the strongest intermolecular forces?
- a)  $\text{A}_2\text{X}$ ,  $\Delta H_{\text{vap}} = 39.6 \text{ kJ/mol}$
  - b)  $\text{BY}_2$ ,  $\Delta H_{\text{vap}} = 26.7 \text{ kJ/mol}$
  - c)  $\text{C}_3\text{X}_2$ ,  $\Delta H_{\text{vap}} = 36.4 \text{ kJ/mol}$
  - d)  $\text{DX}_2$ ,  $\Delta H_{\text{vap}} = 23.3 \text{ kJ/mol}$
  - e)  $\text{EY}_3$ ,  $\Delta H_{\text{vap}} = 21.5 \text{ kJ/mol}$
- \_\_\_\_\_ 4. When comparing a set of molecules at a given temperature, it is seen that one has a distinctly higher vapor pressure than the others. You predict that compared to the molecules in the group, it also:
- a) is the most viscous
  - b) has the lowest surface tension
  - c) has the highest boiling point.
  - d) has the strongest intermolecular forces
  - e) None of these is true

\_\_\_\_\_5. Place the following substances in order of **increasing** boiling point.

Ne    Cl<sub>2</sub>    O<sub>2</sub>

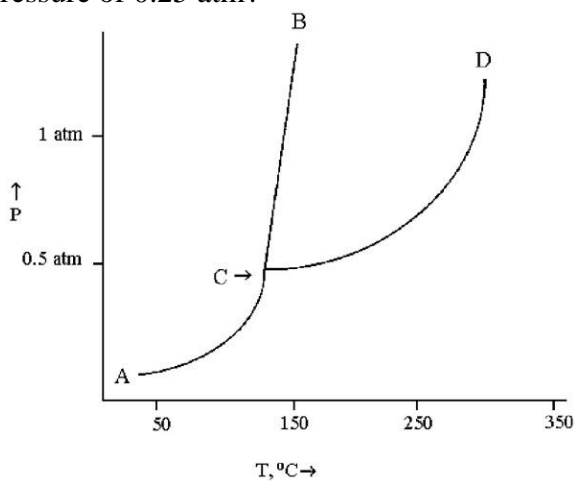
- a) Ne < Cl<sub>2</sub> < O<sub>2</sub>
- b) Cl<sub>2</sub> < O<sub>2</sub> < Ne
- c) O<sub>2</sub> < Cl<sub>2</sub> < Ne
- d) Cl<sub>2</sub> < Ne < O<sub>2</sub>
- e) Ne < O<sub>2</sub> < Cl<sub>2</sub>

\_\_\_\_\_6. Place the following substances in order of **increasing** vapor pressure at a given temperature.

SF<sub>6</sub>    SiH<sub>4</sub>    SF<sub>4</sub>

- a) SF<sub>6</sub> < SiH<sub>4</sub> < SF<sub>4</sub>
- b) SiH<sub>4</sub> < SF<sub>4</sub> < SF<sub>6</sub>
- c) SF<sub>6</sub> < SF<sub>4</sub> < SiH<sub>4</sub>
- d) SF<sub>4</sub> < SF<sub>6</sub> < SiH<sub>4</sub>
- e) SiH<sub>4</sub> < SF<sub>6</sub> < SF<sub>4</sub>

\_\_\_\_\_7. Which phase change occurs as the substance whose phase diagram is shown below is heated at a constant pressure of 0.25 atm?



- a) vaporization
- b) fusion
- c) condensation
- d) sublimation
- e) melting

- \_\_\_\_\_ 8. Which of the following compounds will be most soluble in carbon tetrachloride (CCl<sub>4</sub>)?
- acetone (CH<sub>3</sub>COCH<sub>3</sub>)
  - benzene (C<sub>6</sub>H<sub>6</sub>)
  - sodium chloride
  - methanol (CH<sub>3</sub>OH)
  - None of these compounds should be soluble in pentane
- \_\_\_\_\_ 9. Which of the following statements is TRUE?
- In general, the solubility of a solid in water decreases with increasing temperature.
  - In general, the solubility of a gas in water decreases with increasing temperature.
  - The solubility of a gas in water usually increases with decreasing pressure.
  - The solubility of an ionic solid in water decreases with increasing temperature.
  - None of the above statements are true.
- \_\_\_\_\_ 10. Which of the following statements describes the liquid phase?
- Molecules are only able to vibrate; there are no rotational or translational motions.
  - The intermolecular forces between the molecules have been completely overcome, and the molecules move freely.
  - Molecules have translational, rotational, and vibrational motions, but do not move independently of each other.
  - The molecules are not compressible due to a repeating structure throughout the bulk.
  - The molecules have rotational and vibrational motion, but do not have translational movement.

*Problems and Short Answer: For calculated answers you must also include work that can be followed! No points will be awarded for answers without work as they will be deemed found by magic. Short answers and explanations should be short and to the point. This is not an essay test!*

- (4 Points) Write the reaction/process that is associated with the **heat of vaporization** for CH<sub>3</sub>OH.
  
  
  
  
  
  
  
  
  
  
- (3 Points) Explain why the  $\Delta H_{\text{vap}}$  is higher than  $\Delta H_{\text{fus}}$  for any given compound?

3. (10 Points) Calculate the total quantity of heat required to heat 25.0 g of liquid  $\text{CCl}_4(l)$  from  $-10.0^\circ\text{C}$  to  $100.0^\circ\text{C}$ .

The specific heat of  $\text{CCl}_4(s)$  is  $1.294 \text{ J}/(\text{g} \cdot ^\circ\text{C})$ , for  $\text{CCl}_4(l)$  is  $0.857 \text{ J}/(\text{g} \cdot ^\circ\text{C})$ , for  $\text{CCl}_4(g)$  is  $0.423 \text{ J}/(\text{g} \cdot ^\circ\text{C})$ . Its  $\Delta H_{\text{fus}}$  is  $3.27 \text{ kJ/mol}$ , and its  $\Delta H_{\text{vap}}$  is  $29.82 \text{ kJ/mol}$ . It has a melting point of  $-22.92^\circ\text{C}$  and a boiling point of  $76.8^\circ\text{C}$ .

4. (6 Points) In a closed soda can there was about 2.2 g  $\text{CO}_2$  dissolved in the 355 mL of coke. The Henry's Law constant for  $\text{CO}_2$  is  $3.4 \times 10^{-2} \text{ M/atm}$ . What pressure of  $\text{CO}_2$  must be in the gas at the top of the bottle to maintain that concentration?



5. (7 Points) An aqueous solution has a normal boiling point of  $102.0^\circ\text{C}$ . What is the freezing point of this solution? For water,  $K_b$  is  $0.51^\circ\text{C/m}$  and  $K_f$  is  $1.86^\circ\text{C/m}$ . (Hint: This is a two step problem, and I know you don't have "m"!)

6. (6 Points) A Pb-contaminated water sample contains 0.0011% Pb by mass. How much of the water in mL contains 150 mg of Pb? (Assume the water sample has a density of 1.0 g/mL)
7. (7 Points) Calculate the mole fraction of  $\text{H}_2\text{O}_2$  in a solution made by dissolving 32.56 g of  $\text{H}_2\text{O}_2$  in 275.0 mL of water. (Assume that the density of water is .998 g/mL)
8. (8 Points) Commercial grade HCl solutions are typically 39.0% (by mass) HCl in water. Determine the molarity of the HCl, if the solution has a density of 1.20 g/mL.

9. (7 Points) At a given temperature the vapor pressures of benzene and toluene are 183 mm Hg and 59.2 mm Hg, respectively. Calculate the total vapor pressure over a solution of benzene and toluene with  $X_{\text{benzene}} = 0.600$  and  $X_{\text{toluene}} = 0.400$ . (10 Pts)

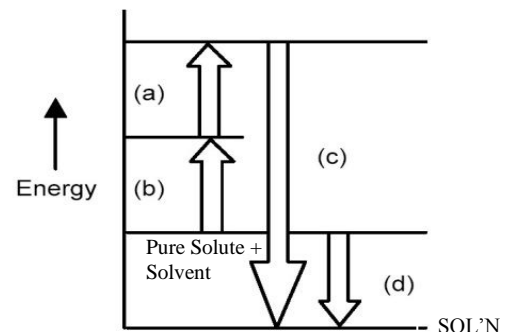
10. (8 Points) Arrows in the energy diagram below represent enthalpy changes occurring in the formation of a solution. Write the label of the appropriate arrow (a-d) in the blanks beside the corresponding enthalpy change (Note: Arrows (a) and (b) are interchangeable.)

\_\_\_\_\_  $\Delta H_{\text{soln}}$  = enthalpy of solution

\_\_\_\_\_  $\Delta H_{\text{solute-solute}}$  = enthalpy change involving solute-solute interactions

\_\_\_\_\_  $\Delta H_{\text{solute-solvent}}$  = enthalpy change involving solute-solvent interactions

\_\_\_\_\_  $\Delta H_{\text{solvent-solvent}}$  = enthalpy change involving solvent-solvent interactions



- a) (2 Points) Would you expect the solute to dissolve at this temperature? Base your answer on the enthalpy from above and on your knowledge of the entropy of this process.

- b) (2 Points) “Blue Heat” is a brand of snow and ice melter that claims to raise the temperature of the road or sidewalk when the salt is spread on the ice. The pellets are made of calcium chloride. Assume that there is no chemical process other than dissolving at play here. Is the dissolution of calcium chloride exothermic or endothermic?

