**Chapter 10 Problem Set**  **Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Liquids & Solids**

***Intermolecular Forces & Physical Properties***

1. Identify all types of interparticle forces present in the solids of each of the following substances. Interparticle forces could include *ionic, dipole, H-bonding,* or *London dispersion forces.*

|  |  |
| --- | --- |
| a) Ar | f) CO |
| b) HCl | g) NaNO3 |
| c) HF | h) NH4Cl |
| d) CaCl2 | i) Polyethylene, CH3(CH2CH2)nCH3 |
| e) CH4 | j) NH3 |

1. Predict which substance in each of the following pairs would have the greater intermolecular forces.

|  |
| --- |
| a) CO2 or OCS |
| b) SeO2 or SO2 |
| c) CH3CH2CH2NH2 or H2NCH2CH2NH2 |
| d) CH3CH3 or H2CO |
| e) CH3OH or H2CO |

1. Consider the compounds Cl2, HCl, F2, NaF, and HF. Which compound has a boiling point closest to that of argon? Explain.
2. Rationalize (explain) the difference in boiling points for each of the following pairs of substances:

a) *n*-pentane CH3CH2CH2CH2CH3  36.2°C

 neopentane 9.5°C

b) HF 20°C

 HCl -85°C

c) HCl -85°C

 LiCl 1360°C

d) *n* - pentane CH3CH2CH2CH2CH3  36.2°C

 *n* - hexane CH3CH2CH2CH2CH2CH3 69°C

1. Consider the following compounds and formulas (*Note:* The formulas are written in such a way as to give you an idea of the structure).

ethanol: CH3CH2OH

 dimethyl ether: CH3OCH3

 propane: CH3CH2CH3

The boiling points of these compound are (in no particular order) -42.1°C, -23°C, and 78.5°C. Match the boiling points to the correct compounds.

1. In each of the following groups of substances, pick the one that has the given property. Justify your answer.

|  |
| --- |
| a) highest boiling point: CCl4, CF4, CBr4 |
| b) lowest freezing point: LiF, F2, HCl |
| c) smallest vapor pressure at 25°C: CH3OCH3, CH3CH2OH, CH3CH2CH3 |
| d) greatest viscosity: H2S, HF, H2O2 (H-O-O-H) |
| e) greatest heat of vaporization: H2CO, CH3CH3, CH4 |
| f) smallest enthalpy of fusion: I2, CsBr, CaO |

***Properties of Liquids***

1. Explain why water forms into beads on a waxed car finish.

1. Hydrogen peroxide (H2O2) is a syrupy liquid with a relatively low vapor pressure and a normal boiling point of 152.2°C. Rationalize the differences of these physical properties from those of water.

***Properties of Solids***

1. What type of solid will each of the following substances form: *ionic, molecular, metallic,* or *network*?

|  |  |
| --- | --- |
| a) CO2 | g) KBr |
| b) SiO2 | h) H2O |
| c) Si | i) NaOH |
| d) CH4 | j) U |
| e) Ru | k) CaCO3 |
| f) I2 | l) PH3 |

***Phase Changes & Phase Diagrams***

1. Plot the following data (yes, I mean create a graph!) to ultimately determine the *heat of vaporization* and *normal boiling point* for liquid nitric acid. You may either use excel to create the graph and linear equation or you may do it by hand.

|  |  |
| --- | --- |
| Temperature (°C) | Vapor Pressure (mm Hg) |
| 0. | 14.4 |
| 10. | 26.6 |
| 20. | 47.9 |
| 30. | 81.3 |
| 40. | 133 |
| 50. | 208 |
| 80. | 670. |

1. What pressure would have to be applied to steam at 350.°C to condense the steam to liquid water
(ΔHvap = 40.7 kJ/mol)?
2. The normal boiling point for acetone is 56.5°C. At an elevation of 5300 ft the atmospheric pressure is 630. Torr.
3. What would be the boiling point of acetone (ΔHvap = 32.0 kJ/mol) at this elevation?
4. What would be the vapor pressure of acetone at 25.0°C at this elevation?
5. How much energy does it take to convert 0.500 kg ice at -20.°C to steam at 250.°C? Specific heat capacities include: ice, 2.03 J/g°C; liquid, 4.2 J/g°C; steam, 2.0 J/g°C. The enthalpy of vaporization for water is 40.7 kJ/mol and the enthalpy of fusion for water is 6.02 kJ/mol.
6. Consider a 75.0 g sample of H2O(g) at 125°C. What phase or phases are present when 215 kJ of energy is removed from this sample? (Use the specific heat capacities and enthalpy values from problem #13).
7. A 0.250 g chunk of sodium metal is cautiously dropped into a mixture of 50.0 g of water and 50.0 g of ice, both at 0°C. The reaction that takes place is

2 Na(s) + 2 H2O(l) 🡪 2 NaOH(aq) + H2 (g) ΔH = -368 kJ

1. *Will all of the ice melt?* Provide support for your answer. The enthalpy of fusion for ice is 6.02 kJ/mol.
2. What is the final temperature of the mixture?
3. Consider the phase diagram given on the right below.



1. What phases are present at points *A* through *H*?

**H•**

1. Label the triple point, normal boiling point,

normal freezing point, and critical point on

the diagram.

1. Which phase is more dense: solid or liquid?
2. Use the accompanying phase diagram for carbon to answer the following questions.



1. How many triple points are in the phase diagram?
2. What phases can coexist at each triple point?
3. What happens if graphite is subjected to very high pressures at room temperature?
4. If we assume that the density increases with an increase in pressure, which is more dense: graphite or diamond?
5. Consider the following data for xenon:

Triple point: -121°C, 280 torr

Normal melting point: -112°C

Normal boiling point: -107°C

1. Which is more dense: Xe (s) or Xe (l)?
2. How do the melting point and boiling point of xenon depend on pressure (how does a change in pressure affect these temperatures for xenon)?

***Answers to Selected Problems***

11. 1.47 x 105 torr

12. a) 51°C b) 221 torr

13. 1.67 x 103 kJ

21. 52.5°C

22. 4650 g H2O