Ch 14.1 - 14.3 Worksheet

- 1) What is a dipole-dipole interaction?
- 2) What is meant by hydrogen bonding? Is a hydrogen bond a real bond as we learned before?
- 3) The normal boiling point of water is unusually high compared to H₂S, H₂Se, and H₂Te. Why?
- 4) What type of intermolecular forces is each of the following compounds going to experience?
 - a. Kr
 - b. S₈
 - c. NF_3
 - $d. \hspace{0.1in} H_2 O$
- 5) The boiling points of the Noble gases are listed below. Comment on the trend in the boiling points. Using the concept of intermolecular forces, why do the boiling points vary in this manner?
 - He -272°C Ne -245.9°C Ar -185.7°C Kr -152.3°C Xe -107.1°C Rn -61.8°C
- 6) When 50 mL of liquid water at 25°C is added to 50 mL of ethanol (CH₃CH₂OH), also at 25°C, the combined volume is considerably less than 100 mL. Give a possible explanation.
- 7) We all have observed that ice floats on liquid water. Why? What is unusual about this?
- 8) The figure below represents the cooling curve for water. Explain the meaning of the different portions of this curve. (What does each flat section and each sloping section represent? Why is one flat section much longer than the other?)
- 9) What is vaporization? What is melting? Please give the definition and explain each process on a microscopic level?
- 10) List the intermolecular forces in increasing order for the three states of matter. Give a brief description why you chose this order by using what is happening on a microscopic level

Answers

- 1) Dipole-Dipole interactions occur when molecules possessing dipole moments orient themselves so that the positive and negative ends of the adjacent molecules attract each other.
- 2) Hydrogen bonding is a special case of dipole-dipole forces that come into play in molecules in which hydrogen atoms are directly bonded to highly electronegative atoms (such as nitrogen, oxygen, or fluorine.)
- 3) Hydrogen bonding can exist when H is bonded to O, N, or F. This additional intermolecular force requires more energy to separate the molecules for boiling.
- 4) a) London dispersion forces b) London dispersion forces c) dipole-dipole forces and London dispersion forces d) hydrogen bonding and London dispersion forces
- 5) The boiling points increase with an increase in the molar mass of the noble gas. The valence electrons of a larger atom will be farther from the nucleus. At a greater distance from the nucleus, the electron clouds are easier to distort so as to give a momentary dipole moment. Thus, as the size of the noble gas atoms increases, so does the magnitude of the London dispersion forces.
- 6) Strong Hydrogen bonding occurs in both ethanol and water. Thus the molecules have great attraction for one another and are able to approach each other very closely; in fact, they approach each other more closely in the mixture that either can approach a like molecule in separate liquids.
- 7) Ice floats on water because it is less dense than liquid water. Generally a solid is more dense than a liquid, but water is an exception to this rule.
- 8) The sloped portions represent changes in temperature. The flat portion represents phase changes. The heat of fusion is the small flat portion and the heat of vaporization is the large flat portion. The heat of vaporization is larger than the heat of fusion because water requires more heat to go from liquid to gas than it does to go from solid to liquid.
- 9) Vaporization is the process by which a liquid changes to a gas. The energy added to the liquid overcomes attractive forces holding the particles in the liquid state Melting is the process by which a solid changes to a liquid. As energy is added to a solid the vibrations of the particles increase. Eventually the particles are vibrating so strongly that they come apart and begin to move randomly as in a liquid.
- 10) The intermolecular forces in increasing order are gas < liquid < solid. Gases have very little IMF because each of the particles are so far spread out from one another. Liquids have more IMF because the particles are holding each other close together but not tight enough to stop movement. Solids have the most IMF because the particles are holding together so tightly that they don't move, just vibrate.