Chapter 10 States of Matter Study Guide

Please answer all questions on a separate piece of paper.

Section 1

SHORT ANSWER

1. Identify whether the descriptions below describe an ideal gas or a real gas.

a. The gas will not condense because the molecules do not attract each other.

b. Collisions between molecules are perfectly elastic.

c. Gas particles passing close to one another exert an attraction on each other.

2. The formula for kinetic energy is $KE = 1/2\ mv^2$.

a. As long as temperature is constant, what happens to the kinetic energy of the colliding particles during an elastic collision?

b. If two gases have the same temperature and share the same energy but have different molecular masses, which molecules will have the greater speed?

3. Use the kinetic-molecular theory to explain each of the following phenomena:

a. A strong-smelling gas released from a container in the middle of a room is soon detected in all areas of that room.

b. As a gas is heated, its rate of effusion through a small hole increases if all other factors remain constant.

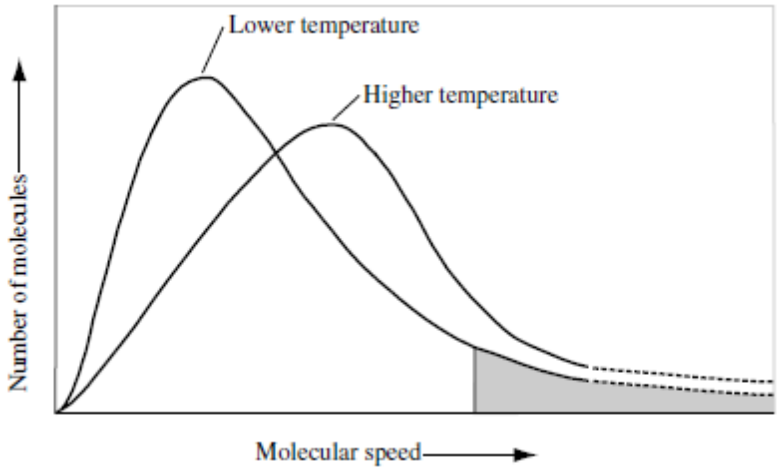
4. a. List the following gases in order of rate of effusion, from lowest to highest. (Assume all gases are at the same temperature and pressure.) **(a)** He **(b)** Xe **(c)** HCl **(d)** Cl_2

b. Explain why you put the gases in the order above. Refer to the kinetic-molecular theory to support your explanation.

5. Explain why polar gas molecules experience larger deviations from ideal behavior than nonpolar molecules when all other factors (mass, temperature, etc.) are held constant.

6. The two gases in the figure below are simultaneously injected into opposite ends of the tube. The ends are then sealed. They should just begin to mix closest to which labeled point?

7. Explain the difference in the speed-distribution curves of a gas at the two temperatures shown in the figure below.



Section 2

SHORT ANSWER

1. Liquids possess all the following properties *except* **(a)** relatively low density. **(b)** the ability to diffuse. **(c)** relative incompressibility. **(d)** the ability to change to a gas.

2. a. Chemists distinguish between intermolecular and intramolecular forces. Explain the difference between these two types of forces.

Classify each of the following as intramolecular or intermolecular:

b. hydrogen bonding in liquid water

c. the O—H covalent bond in methanol, CH_3OH

d. the bonds that cause gaseous Cl_2 to become a liquid when cooled

3. Explain the following properties of liquids by describing what is occurring at the molecular level.

a. A liquid takes the shape of its container but does not expand to fill its volume.

b. Polar liquids are slower to evaporate than nonpolar liquids.

4. Explain briefly why liquids tend to form spherical droplets, decreasing surface area to the smallest size possible.

5. Is freezing a chemical change or a physical change? Briefly explain your answer.

6. Is evaporation a chemical or physical change? Briefly explain your answer.

7. What is the relationship between vaporization and evaporation?

Section 3

SHORT ANSWER

1. Match description on the right to the correct crystal type on the left.

ionic crystal	**(a)** has mobile electrons in the crystal
covalent molecular crystal	**(b)** is hard, brittle, and nonconducting
metallic crystal	**(c)** typically has the lowest melting point of the four crystal types
covalent network crystal	**(d)** has strong covalent bonds between neighboring atoms

2. For each of the four types of solids, give a specific example ***other than one listed*** in Table 1 on page 340 of the text.

3. A chunk of solid lead is dropped into a pool of molten lead. The chunk sinks to the bottom of the pool. What does this tell you about the density of the solid lead compared with the density of the molten lead?

4. Answer *amorphous solid* or *crystalline solid* to the following questions:

a. Which is less compressible?

b. Which has a more clearly defined shape?

c. Which is sometimes described as a supercooled liquid?

d. Which has a less clearly defined melting point?

5. Explain the following properties of solids by describing what is occurring at the atomic level.

a. Metallic solids conduct electricity well, but covalent network solids do not.

b. The volume of a solid changes only slightly with a change in temperature or pressure.

c. Amorphous solids do not have a definite melting point.

d. Ionic crystals are much more brittle than covalent molecular crystals.

6. Experiments show that it takes 6.0 kJ of energy to melt 1 mol of water ice at its melting point but only about 1.1 kJ to melt 1 mol of methane, CH_4, at its melting point. Explain in terms of intermolecular forces why it takes so much less energy to melt the methane.

Section 4

SHORT ANSWER

1. When a substance in a closed system undergoes a phase change and the system reaches equilibrium,

(a) the two opposing changes occur at equal rates.

(b) there are no more phase changes.

(c) one phase change predominates.

(d) the amount of substance in the two phases changes.

2. Match the following definitions on the right with the words on the left.

equilibrium	**(a)** melting
volatile	**(b)** opposing changes occurring at equal rates in a closed system
fusion	**(c)** readily evaporated
deposition	**(d)** a change directly from a gas to a solid

3. Match the process on the right with the change of state on the left.

solid to gas	**(a)** melting
liquid to gas	**(b)** condensation
gas to liquid	**(c)** sublimation
solid to liquid	**(d)** vaporization

4. Refer to the phase diagram for water in Figure 16 on page 347 of the text to answer the following questions:

a. What point represents the conditions under which all three phases can coexist?

b. What point represents a temperature above which only the vapor phase exists?

c. Based on the diagram, as the pressure on the water system increases, what happens to the melting point of ice?

d. What happens when water is at point A on the curve and the temperature increases while the pressure is held constant?

5. Use this general equilibrium equation to answer the following questions:

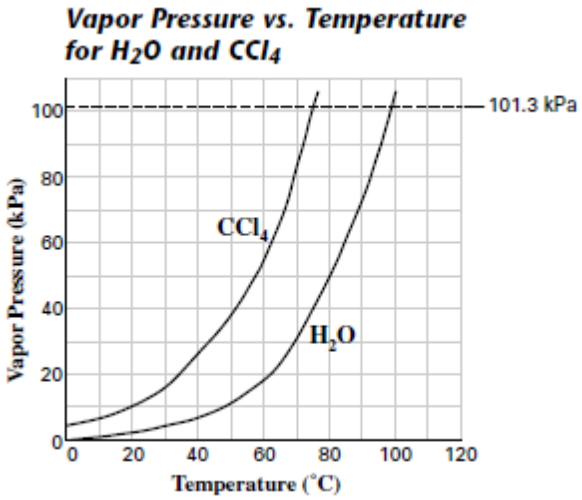
reactants ⇔ products + energy

a. If the forward reaction is favored, will the concentration of reactants increase, decrease, or stay the same?

b. If extra product is introduced, which reaction will be favored?

c. If the temperature of the system decreases, which reaction will be favored?

6. Refer to the graph below to answer the following questions:



a. What is the normal boiling point of CCl_4?
b. What would be the boiling point of water if the air pressure over the liquid were reduced to 60 kPa?
c. What must the air pressure over CCl_4 be for it to boil at 50°C?
d. Although water has a lower molar mass than CCl_4, it has a lower vapor pressure when measured at the same temperature. What makes water vapor less volatile than CCl_4?

Section 5

SHORT ANSWER

1. Indicate whether each of the following is a *physical* or *chemical* property of water.

a. The density of ice is less than the density of liquid water.
b. A water molecule contains one atom of oxygen and two atoms of hydrogen.
c. There are strong hydrogen bonds between water molecules.
d. Ice consists of water molecules in a hexagonal arrangement.

2. Compare a polar water molecule with a less-polar molecule, such as formaldehyde, CH_2O. Both are liquids at room temperature and 1 atm pressure.

a. Which liquid should have the higher boiling point?
b. Which liquid is more volatile?
c. Which liquid has a higher surface tension?
d. In which liquid is NaCl, an ionic crystal, likely to be more soluble?

3. Describe hydrogen bonding as it occurs in water in terms of the location of the bond, the particles involved, the strength of the bond, and the effects this type of bonding has on physical properties.

PROBLEMS ***Work out your answers on a separate piece of paper*.**

4. The molar enthalpy of vaporization of water is 40.79 kJ/mol, and the molar enthalpy of fusion of ice is 6.009 kJ/mol. The molar mass of water is 18.02 g/mol.

a. How much energy is absorbed when 30.3 g of liquid water boils?
b. An energy unit often encountered is the calorie (4.18 J = 1 calorie). Determine the molar enthalpy of fusion of ice in calories per gram.

5. A typical ice cube has a volume of about 16.0 cm^3. Calculate the amount of energy needed to melt the ice cube. (Density of ice at 0.°C = 0.917 g/mL; molar enthalpy of fusion of ice = 6.009 kJ/mol; molar mass of H_2O = 18.02 g/mol.)

a. Determine the mass of the ice cube.

b. Determine the number of moles of H_2O present in the sample.

c. Determine the number of kilojoules of energy needed to melt the ice cube.

Mixed Review

SHORT ANSWER

1. The average speed of a gas molecule is most directly related to the

(a) polarity of the molecule.

(b) pressure of the gas.

(c) temperature of the gas.

(d) number of moles in the sample.

2. Use the kinetic-molecular theory to explain the following phenomena:

a. When 1 mol of a real gas is condensed to a liquid, the volume shrinks by a factor of about 1000.

b. When a gas in a rigid container is warmed, the pressure on the walls of the container increases.

3. Which of the following statements about liquids and gases is *not* true?

(a) Molecules in a liquid are much more closely packed than molecules in a gas.

(b) Molecules in a liquid can vibrate and rotate, but they are bound in fixed positions.

(c) Liquids are much more difficult to compress into a smaller volume than are gases.

(d) Liquids diffuse more slowly than gases.

4. Answer *solid* or *liquid* to the following questions:

a. Which is less compressible?

b. Which is quicker to diffuse into neighboring media?

c. Which has a definite volume and shape?

d. Which has molecules that are rotating or vibrating primarily in place?

5. Explain why almost all solids are denser than their liquid states by describing what is occurring at the molecular level.

6. A general equilibrium equation for boiling is liquid + energy ⇔ vapor

Indicate whether the forward or reverse reaction is favored in each of the following cases:

a. The temperature of the system is increased.

b. More molecules of the vapor are added to the system.

c. The pressure on the system is increased.

7. Freon-11, CCl_3F has been commonly used in air conditioners. It has a molar mass of 137.35 g/mol and its enthalpy of vaporization is 24.8 kJ/mol at its normal boiling point of 24°C. Ideally how much energy in the form of heat is removed from a room by an air conditioner that evaporates 1.00 kg of freon-11?

8. Use the data table below to answer the following:

Substance	Molar mass (g/mol)	Enthalpy vaporization (kJ/mol)	Normal boiling point (°C)	Critical temperature (°C)
He	4	0.08	-269	-268
Ne	20	1.8	-246	-229
Ar	40	6.5	-186	-122
Xe	131	12.6	-107	+17
H_2O	18	40.8	+100	+374
HF	20	25.2	+20	+188
CH_4	16	8.9	-161	-82
C_2H_6	30	15.7	-89	+32

a. Among *nonpolar* liquids, those with higher molar masses tend to have normal boiling points that are (higher, lower, or about the same).

b. Among compounds of approximately the same molar mass, those with greater polarities tend to have enthalpies of vaporization that are (higher, lower, or about the same).

c. Which is the only noble gas listed that is stable as a liquid at 0°C? Explain your answer using the concept of critical temperature.