## Chem.G11-Q2W4-H.W.-The kinetic theory of matter

#### Short Answer

Explain what is occurring during each of the following processes, in terms of particles and the kinetic theory.

- A. freezing
- B. sublimation
- C. condensation
- D. boiling
- 1. Particles in the liquid state absorb energy and escape into the less highly organized gaseous state, forming bubbles inside the liquid, that rise to the surface.
- 2. Particles in the solid state absorb energy and escape from their highly ordered crystal lattice directly into the gaseous state.
- 3. Particles in the gaseous state release energy and enter the liquid state, in which they tend to be closer together and less free to move.
- 4. Particles in the liquid state release energy and become more highly ordered, forming the crystal lattice that is characteristic of the solid state, and becoming unable to flow around each other.

## 5. Methane and ethane are both colorless, odorless gases. Which of these gases has a higher rate of diffusion in air? Explain.

The methane (CH<sub>4</sub>) molecules have a <u>lower</u> molecular mass than the ethane (C<sub>2</sub>H<sub>6</sub>) molecules, so the methane molecules move at a <u>lower</u> average velocity and have a lower rate of diffusion than the ethane molecules.

- A. The methane (CH<sub>4</sub>) molecules have a <u>lower</u> molecular mass than the ethane (C<sub>2</sub>H<sub>6</sub>) molecules, so the methane molecules move at a <u>higher</u> average velocity and have a higher rate of diffusion than the ethane molecules.
- B. The methane (CH<sub>4</sub>) molecules have a <u>higher</u> molecular mass than the ethane (C<sub>2</sub>H<sub>6</sub>) molecules, so the methane molecules move at a <u>higher</u> average velocity and have a higher rate of diffusion than the ethane molecules.
- C. The methane (CH<sub>4</sub>) molecules have a <u>higher</u> molecular mass than the ethane (C<sub>2</sub>H<sub>6</sub>) molecules, so the methane molecules move at a <u>lower</u> average velocity and have a higher rate of diffusion than the ethane molecules.

# 6. The heat of fusion of water is 334 J/g, How much energy is absorbed when a 20-g ice cube melts at 0°C?

A. 4680 J. B. 5680 J. C. 6680 J. D. 7680 J.

### 7. Rank the following temperature readings in increasing order: -420°F, -270°C, 0°F, 0°C, 0 K.

- A. 0 K, -270°C, -420°F, 0°F, 0°C
- B. 0 K, , -420°F, 0°F, -270°C, 0°C
- C. -270°C, -420°F, 0°F, 0 K, 0°C
- D. 0 K, -270°C, 0°C, -420°F, 0°F

	Element	Freezing Point, °C	Boiling Point, °C
А	Cadmium	321	770
В	Chlorine	-101	-34
С	Fluorine	-220	-188
D	Phosphorus	44	280

- 8. Which element has the smallest temperature range as a liquid?
- 9. The largest temperature range?
- 10. Which of the elements are liquids at 50°C?
- 11. Which of the elements are liquids at -50°C?
- 12. At -50°C, which of chlorine or fluorine has a higher vapor pressure?
- 13. Which element has a higher vapor pressure, cadmium at 700°C or phosphorus at 300°C?
- 14. Which of the elements are solids at 50°C?
- 15. Which of the elements are solids at -110°C?
- 16. What is the Fahrenheit temperature that corresponds to a temperature of 50°C? A. 92°F. B. 102°F. C. 112°F. D. 122°F.
- 17. Predict whether the boiling point of water is greater or less than 100°C in Salt Lake City, Utah, with an approximate elevation of 1300 m above sea level.
  - A. Because of the high altitude, the atmospheric pressure in Salt Lake City is <u>more</u> than the pressure at sea level, so water boils at a temperature <u>more</u> than 100°C.
  - B. Because of the high altitude, the atmospheric pressure in Salt Lake City is <u>less</u> than the pressure at sea level, so water boils at a temperature <u>less</u> than 100°C.

- 18. A beaker contains 50 mL of water at a temperature of 70°F. Will the water level in the beaker fall faster if the relative humidity of the air is 30 percent or if the relative humidity is 80 percent? Explain.
  - A. In both cases, water evaporates from the beaker at about the same rate. When the humidity is 80 percent, however, more water vapor molecules condense and join the liquid phase, so the net rate of evaporation is <u>slower</u> at 80 percent humidity than at 30 percent humidity.
  - B. In both cases, water evaporates from the beaker at about the same rate. When the humidity is 80 percent, however, more water vapor molecules condense and join the liquid phase, so the net rate of evaporation is <u>higher</u> at 80 percent humidity than at 30 percent humidity.
  - C. In both cases, water evaporates from the beaker at about the same rate. When the humidity is 30 percent, however, more water vapor molecules condense and join the liquid phase, so the net rate of evaporation is slower at 30 percent humidity than at 80 percent humidity.

## 19. The particles of which of the following gases: oxygen at 30°C, hydrogen at 80°C, krypton at 30°C, and oxygen at 80°C, have the highest average speed? The lowest average speed?

- A. The particles of <u>hydrogen</u> at 80°C have the highest average speed, since they have the least mass and are at the highest temperature. The particles of <u>krypton</u> at 30°C have the lowest average speed, since they have the greatest mass and are at the lowest temperature.
- B. The particles of <u>krypton</u> at 80°C have the highest average speed, since they have the least mass and are at the highest temperature. The particles of <u>hydrogen</u> at 30°C have the lowest average speed, since they have the greatest mass and are at the lowest temperature.

## 20. Rank the following temperature readings in increasing order: 100°C, 220°F, 220°C, 360 K, 450 K

- A. 100°C, 360 K, 220°F, 450 K, 220°C
- B. 100°C, 220°F, 450 K, 360 K, 220°C
- C. 360 K, 100°C, 220°F, 450 K, 220°C
- D. 100°C, 220°F, 450 K, 220°C,360 K

#### Problem

The table shows the fusion and vaporization data for eight substances. Use the information to answer the following questions.

Substance	Fusion Melting Point (°C)	Heat of fusion (joules/mole) (°C)	Vaporization Boiling Point	Heat of vaporization (joules/mole)
O <sub>2</sub> oxygen	-219	444	-183	6820
N2 nitrogen	-210	720	-196	5577
NH₃ ammonia	-78	5653	-33	23 351
CO2 carbon dioxide	-56	8326	-78	25 234*
N <sub>2</sub> O nitrous oxide	-91	6540	-89	16 552
l2 iodine	114	15 648	183	4347*
H <sub>2</sub> O water	0	6008	100	40 656

\*Goes directly to vapor from solid. These are heats of sublimation.

#### 21. How much energy, in joules, is required to melt 10.00 moles of ice?

- A. 50 080 J.
- B. 60 080 J.
- C. 70 080 J.
- D. 80 080 J.

## 22. Suppose you have equal volumes of liquid oxygen and liquid nitrogen sitting open in a warm room. Which would boil away first? Explain.

- A. The <u>nitrogen</u> would boil away first because it has a <u>higher</u> heat of vaporization.
- B. The <u>nitrogen</u> would boil away first because it has a <u>lower</u> heat of vaporization.
- C. The <u>oxygen</u> would boil away first because it has a <u>higher</u> heat of vaporization.
- D. The <u>oxygen</u> would boil away first because it has a <u>lower</u> heat of vaporization.

## 23. Which substance changes from the solid state to the gaseous state with the least total change in temperature?

- A. The oxygen would boil away first because it has a lower heat of vaporization.
- B. The water would boil away first because it has a lower heat of vaporization.
- C. The iodine would boil away first because it has a lower heat of vaporization.
- D. The nitrogen would boil away first because it has a lower heat of vaporization.

### 24. Which substance has the highest boiling point? Which has the lowest boiling point?

- A. Oxygen has the highest boiling point; nitrogen has the lowest.
- B. Water has the highest boiling point; nitrogen has the lowest.
- C. Iodine has the highest boiling point; nitrogen has the lowest.
- D. Nitrogen has the highest boiling point; iodine has the lowest.

#### 25. Which substance has the lowest melting point? Which has the highest melting point?

- A. Iodine has the lowest melting point; oxygen has the highest.
- B. Oxygen has the lowest melting point; iodine has the highest.
- C. Nitrous oxide has the lowest melting point; carbon dioxide has the highest.
- D. Carbon dioxide has the lowest melting point; Nitrous oxide has the highest.

The graph in Figure 10-1 shows what happens when 1 kg sample of each of two different substances are heated. Use the information in the graph to answer the questions. Assume that room temperature in this case is 300 K.



## 26. What is the physical state of substance B at room temperature?

- A. solid.
- B. liquid.
- C. gas.
- D. plasma.

## 27. Estimate the heat of fusion of substance B.

- A. It is approximately  $1.0 \times 10^4$  kJ.
- B. It is approximately  $2.0 \times 10^4$  kJ.
- C. It is approximately  $3.0 \times 10^4$  kJ.
- D. It is approximately  $4.0 \times 10^4$  kJ.

## 28. What is the physical state of substance A at room temperature?

- A. solid.
- B. liquid.
- C. gas.
- D. plasma.

### 29. What is the melting point of substance A?

- A. The melting point is approximately 050 K.
- B. The melting point is approximately 150 K.
- C. The melting point is approximately 250 K.
- D. The melting point is approximately 350 K.

## 30. If you mixed substance A, substance B, and water, and steadily increased the temperature, which would boil last?

- A. Substance A would boil last.
- B. Substance B would boil last.

## 31. Estimate the heat of vaporization of substance B.

- A. It is approximately  $1.5 \times 10^4 \text{ kJ}$ .
- B. It is approximately 2.5 X 10<sup>4</sup> kJ.
- C. It is approximately  $3.5 \times 10^4 \text{ kJ}$ .
- D. It is approximately 4.5 X 10<sup>4</sup> kJ.

# 32. Estimate the heat of fusion of substance A. (Hint: Consider the length of the appropriate plateau.)

- A. It is approximately 6.0 X 10<sup>4</sup> kJ.
- B. It is approximately 7.0 X 10<sup>4</sup> kJ.
- C. It is approximately 8.0 X 10<sup>4</sup> kJ.
- D. It is approximately 9.0 X 10<sup>4</sup> kJ.

## 33. What is the melting point of substance B?

- A. It is approximately 100 K.
- B. It is approximately 200 K.
- C. It is approximately 300 K.
- D. It is approximately 400 K.

#### Matching

Match each statement with the correct item below.

- a. absolute zero
- b. flows but has definite volume
- c. boiling point of water = 100 degrees
- d. states that submicroscopic particles are in constant, random motion
- e. formation of dew on grass in the morning
- f. for example,  $3.34 \square 10^5$  J/kg for water
- g. state of matter that is easily compressible
- h. for water, 0°C
- i. ice directly to water vapor, for example
- j. increased kinetic energy of particles
- k. striking of particles that involves no loss of energy
- I. exists on the sun and in fluorescent lights
- m. occurs only at the surface of a liquid
- n. spreading process due to random motion
- o. candle wax or glass, for example
- p. determined by temperature, surface area, nature of liquid, humidity
- q. vapor pressure = atmospheric pressure
- r. normally, 14.7 pounds per square inch at sea level
- s. 2.26  $\square$  10<sup>6</sup> J/kg for water
- t. temperature directly proportional to kinetic energy
- \_\_\_\_ 35. kinetic theory
- \_\_\_\_\_ 36. increased temperature
- \_\_\_\_\_ 37. Sublimation
- \_\_\_\_ 38. Kelvin scale
- \_\_\_\_ 39. Condensation
- \_\_\_\_ 40. freezing point
- \_\_\_\_ 41. Liquid
- \_\_\_\_\_ 42. rate of evaporation
- \_\_\_\_ 43. Plasma
- \_\_\_\_ 44. Boiling
- \_\_\_\_\_ 45. elastic collisions
- \_\_\_\_\_ 47. Evaporation
- \_\_\_\_ 48. Gas
- \_\_\_\_ 49. Diffusion
- \_\_\_\_ 50. heat of fusion
- \_\_\_\_\_ 51. atmospheric pressure

Match each item with the correct statement below.

- a. absolute zero
- b. condensation
- c. crystal lattice
- d. Diffusion
- e. freezing point
- f. gas
- g. heat of fusion
- h. joule (J)
- i. kinetic theory
- j. plasma
- k. pressure
- I. sublimation
- m. temperature
- n. volatile
- \_\_\_\_\_ 52. \_\_\_\_\_ is the force acting on a unit area of surface.
- \_\_\_\_\_ 53. is a measure of the average kinetic energy of the particles that make up a substance.
- \_\_\_\_\_ 54. The SI unit of energy is the \_\_\_\_\_.
- \_\_\_\_\_ 55. Matter in the \_\_\_\_\_ state consists of ionized gas.
- \_\_\_\_ 56. The idea that submicroscopic particles of all matter are in constant, random motion is known as the \_\_\_\_\_.
- \_\_\_\_\_ 57. The amount of energy released by one kilogram of a substance at its freezing point is called the \_\_\_\_\_.
- 58. The process by which particles spread out and fill a space because of random motion is called \_\_\_\_\_.
- \_\_\_\_\_ 59. The temperature at which a liquid becomes a solid is its \_\_\_\_\_.
- \_\_\_\_\_ 60. A liquid is said to be \_\_\_\_\_ if it evaporates quickly.