Chem.G11-Q2W4-Qs.Bank-The kinetic theory of matter

Matching

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
l. sublimation
m. temperature
n. volatile

____ 1. The idea that submicroscopic particles of all matter are in constant, random motion is known as the _____.
____ 2. The temperature at which the particles of a substance would have no kinetic energy is called _____.
____ 3. _____ is the force acting on a unit area of surface.
____ 4. The process by which particles spread out and fill a space because of random motion is called _____.
____ 5. During the process of _____, a gas changes to a liquid or a solid.
____ 6. The repeating, orderly, three-dimensional arrangement of particles in a solid is called a(n) _____.
____ 7. The temperature at which a liquid becomes a solid is its _____.
____ 8. is a measure of the average kinetic energy of the particles that make up a substance.
____ 9. The SI unit of energy is the _____.
____ 10. The amount of energy released by one kilogram of a substance at its freezing point is called the _____.
____ 11. A liquid is said to be _____ if it evaporates quickly.
____ 12. Matter in the _____ state consists of ionized gas.

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, 3.34×10^5 J/kg for water
g. state of matter that is easily compressible
h. for water, 0ºC
i. ice directly to water vapor, for example
j. increased kinetic energy of particles
k. striking of particles that involves no loss of energy
l. 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. 2.26×10^6 J/kg for water
t. temperature directly proportional to kinetic energy

____ 13. elastic collisions

____ 14. plasma
____ 15. increased temperature
____ 16. kinetic theory
____ 17. Kelvin scale
____ 18. condensation
____ 19. rate of evaporation
____ 20. gas
____ 21. freezing point
____ 22. liquid
____ 23. heat of fusion
____ 24. diffusion
____ 25. sublimation
____ 26. atmospheric pressure
____ 27. heat of vaporization
____ 28. amorphous material
____ 29. boiling
____ 30. evaporation

Short Answer

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

31. evaporation

32. freezing

33. sublimation

34. boiling

35. condensation

36. How are the observations of the Scottish botanist Robert Brown related to the kinetic theory of matter?

37. Rank the following temperature readings in increasing order: -420ºF, -270ºC, 0ºF, 0ºC, 0 K

38. Rank the following temperature readings in increasing order:
100ºC, 220ºF, 220ºC, 360 K, 450 K

39. Under ordinary conditions of temperature and pressure, most real gases behave as ideal gases. Under what conditions does the behavior of real gases deviate from ideal gas behavior?

40. The melting points of five transition elements are provided in either Celsius or Kelvin temperatures. List the elements in order from the one with the lowest melting point to the one with the highest melting point.
Palladium (Pd) 1552ºC
Platinum (Pt) 2042 K
Cobalt (Co) 1495ºC
Nickel (Ni) 1728 K
Rhodium (Rh) 1960ºC

41. What is the Fahrenheit temperature that corresponds to a temperature of 50ºC?

42. A beaker contains 50 mL of water at a temperature of 70ºF. 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.

43. Explain the relationship between a liquid's vapor pressure and its boiling point. What is the vapor pressure of water at 100ºC?

Element	Freezing Point, ºC	Boiling Point, ºC
Cadmium	321	770
Chlorine	-101	-34
Fluorine	-220	-188
Phosphorus	44	280

44. Which of the elements are gases at 50ºC? At -50ºC?
45. Which of the elements are liquids at 50ºC? At -50ºC?
46. Which of the elements are solids at 50ºC? At -50ºC?
47. Which element has the smallest temperature range as a liquid? The largest temperature range?
48. At -50ºC, does chlorine or fluorine have a higher vapor pressure? Explain.
49. Which element has a higher vapor pressure, cadmium at 700ºC or phosphorus at 300ºC? Explain.
50. The particles of which of the following gases: oxygen at 30ºC, hydrogen at 80ºC, krypton at 30ºC, and oxygen at 80ºC, have the highest average speed? The lowest average speed?
51. Which of the following gas particles: oxygen at 30ºC, hydrogen at 80ºC, krypton at 30ºC, and oxygen at 80ºC, have the highest average kinetic energy? Which have the lowest average kinetic energy?
52. Predict whether the boiling point of water is greater or less than 100ºC in Salt Lake City, Utah, with an approximate elevation of 1300 m above sea level.
53. Methane and ethane are both colorless, odorless gases. Which of these gases has a higher rate of diffusion in air? Explain.
54. In terms of changes in total energy, how does the boiling of 100 g of water at 100ºC differ from the condensation of 100 g of steam at 100ºC?
55. How much energy is absorbed when a 20-g ice cube melts at 0ºC?

Problem

56. Convert each of the following temperature measurements to kelvins: 94ºC, -101ºC, 388ºC.

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.

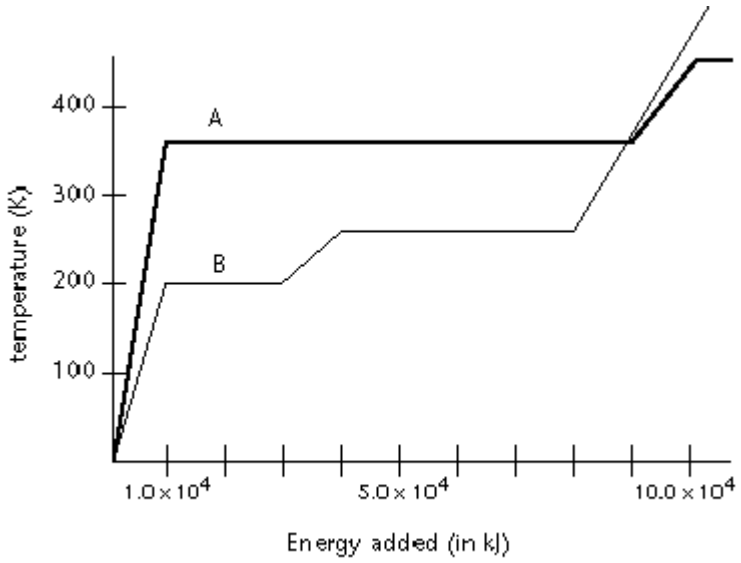

Figure 10-1

57. What is the physical state of substance A at room temperature?
58. What is the physical state of substance B at room temperature?
59. What is the melting point of substance A?
60. What is the melting point of substance B?
61. If you mixed substance A, substance B, and water, and steadily increased the temperature, which would boil last?
62. Estimate the heat of fusion of substance A. (Hint: Consider the length of the appropriate plateau.)
63. Estimate the heat of fusion of substance B.
64. Estimate the heat of vaporization of substance B.

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

Substance	Fusion Melting Point (ºC)	Heat of fusion (joules/mole) (ºC)	Vaporization Boiling Point	Heat of vaporization (joules/mole)
O_2 oxygen	-219	444	-183	6820
N_2 nitrogen	-210	720	-196	5577
NH_3 ammonia	-78	5653	-33	23 351
CO_2 carbon dioxide	-56	8326	-78	25 234*
N_2O nitrous oxide	-91	6540	-89	16 552
I_2 iodine	114	15 648	183	4347*
H_2O water	0	6008	100	40 656

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

65. Which substance has the lowest melting point? Which has the highest melting point?
66. Which substance has the highest boiling point? Which has the lowest boiling point?
67. How much energy, in joules, is required to melt 10.00 moles of ice?
68. Which substance changes from the solid state to the gaseous state with the least total change in temperature?
69. Suppose you have equal volumes of liquid oxygen and liquid nitrogen sitting open in a warm room. Which would boil away first? Explain.
70. Octane, C_8H_{18}, melts at -57ºC and boils at 126ºC. A few grams of octane are heated from -80ºC to +140ºC. Graph the heating curve for octane. Show time on the horizontal axis and temperature on the vertical axis.

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Answer Section

MATCHING

1.	ANS:	I	PTS: 1	DIF:	B	OBJ:	10-2
2.	ANS:	A	PTS: 1	DIF:	B	OBJ:	10-2
3.	ANS:	K	PTS: 1	DIF:	B	OBJ:	10-6
4.	ANS:	D	PTS: 1	DIF:	B	OBJ:	10-2
5.	ANS:	B	PTS: 1	DIF:	B	OBJ:	10-4
6.	ANS:	C	PTS: 1	DIF:	B	OBJ:	10-1
7.	ANS:	E	PTS: 1	DIF:	B	OBJ:	10-2
8.	ANS:	M	PTS: 1	DIF:	B	OBJ:	10-4
9.	ANS:	H	PTS: 1	DIF:	B	OBJ:	10-2
10.	ANS:	G	PTS: 1	DIF:	B	OBJ:	10-4
11.	ANS:	N	PTS: 1	DIF:	B	OBJ:	10-2
12.	ANS:	J	PTS: 1	DIF:	B	OBJ:	10-3
13.	ANS:	K	PTS: 1	DIF:	B	OBJ:	10-2
14.	ANS:	L	PTS: 1	DIF:	B	OBJ:	10-3
15.	ANS:	J	PTS: 1	DIF:	B	OBJ:	10-2
16.	ANS:	D	PTS: 1	DIF:	B	OBJ:	10-2
17.	ANS:	T	PTS: 1	DIF:	B	OBJ:	10-5
18.	ANS:	E	PTS: 1	DIF:	B	OBJ:	10-1
19.	ANS:	P	PTS: 1	DIF:	B	OBJ:	10-4
20.	ANS:	G	PTS: 1	DIF:	B	OBJ:	10-1
21.	ANS:	H	PTS: 1	DIF:	B	OBJ:	10-2
22.	ANS:	B	PTS: 1	DIF:	B	OBJ:	10-1
23.	ANS:	F	PTS: 1	DIF:	B	OBJ:	10-4
24.	ANS:	N	PTS: 1	DIF:	B	OBJ:	10-4
25.	ANS:	I	PTS: 1	DIF:	B	OBJ:	10-1
26.	ANS:	R	PTS: 1	DIF:	B	OBJ:	10-6
27.	ANS:	S	PTS: 1	DIF:	B	OBJ:	10-4
28.	ANS:	O	PTS: 1	DIF:	B	OBJ:	10-3
29.	ANS:	Q	PTS: 1	DIF:	B	OBJ:	10-6
30.	ANS:	M	PTS: 1	DIF:	B	OBJ:	10-4

SHORT ANSWER

31. ANS:
    Particles in the liquid state absorb energy and escape from the surface into the gaseous state, where they move more freely and are farther apart.

    PTS: 1 DIF: B OBJ: 10-4
32. ANS:

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.

PTS: 1 DIF: B OBJ: 10-4

33. ANS:
Particles in the solid state absorb energy and escape from their highly ordered crystal lattice directly into the gaseous state.

PTS: 1 DIF: B OBJ: 10-4

34. ANS:
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.

PTS: 1 DIF: B OBJ: 10-4

35. ANS:
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.

PTS: 1 DIF: B OBJ: 10-4

36. ANS:
While studying water samples with a microscope, Robert Brown observed pollen grains suspended in the water moving continuously in irregular directions. The constant, random motion of tiny chunks of matter is called Brownian motion in honor of Brown. The kinetic theory states that submicroscopic particles of all matter are in constant, random motion.

PTS: 1 DIF: B OBJ: 10-2

37. ANS:
0 K, -270ºC, -420ºF, 0ºF, 0ºC

PTS: 1 DIF: B OBJ: 10-5

38. ANS:
360 K, 100ºC, 220ºF, 450 K, 220ºC

PTS: 1 DIF: B OBJ: 10-5

39. ANS:
Real gases deviate from ideal gas behavior at very low temperatures or very high pressures.

PTS: 1 DIF: B OBJ: 10-1

40. ANS:
Ni, Co, Pd, Pt, Rh

PTS: 1 DIF: B OBJ: 10-5

41. ANS:
A temperature of 50ºC is halfway between the freezing point and the boiling point of water. Since there are 180 Fahrenheit degrees between the freezing and boiling points of water, the halfway point between the two must be 180/2=90 Fahrenheit degrees higher than the freezing point. Therefore, a temperature of 50ºC corresponds to a temperature of 32ºF + 90ºF = 122ºF.

PTS: 1 DIF: B OBJ: 10-5

42. ANS:

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 slower at 80 percent humidity than at 30 percent humidity.

PTS: 1 DIF: B OBJ: 10-4

43. ANS:
The pressure of a substance in equilibrium with its liquid is called its vapor pressure. The boiling point of a substance is its temperature when its vapor pressure equals the pressure exerted on the surface of the liquid. The normal boiling point of water is 100ºC, so the vapor pressure of water at 100ºC is equal to normal atmospheric pressure.

PTS: 1 DIF: B OBJ: 10-4

44. ANS:
chlorine, fluorine; fluorine

PTS: 1 DIF: A OBJ: 10-6

45. ANS:
phosphorus; chlorine

PTS: 1 DIF: A OBJ: 10-6

46. ANS:
cadmium; cadmium, phosphorus

PTS: 1 DIF: A OBJ: 10-6

47. ANS:
fluorine; cadmium

PTS: 1 DIF: A OBJ: 10-6

48. ANS:
Fluorine's boiling point is below -50ºC, while chlorine's boiling point is above -50ºC, so fluorine has a higher vapor pressure at -50ºC.

PTS: 1 DIF: B OBJ: 10-4

49. ANS:
Cadmium is a liquid at 700ºC, while phosphorus is a gas at 300ºC, so phosphorus at 300ºC has the higher vapor pressure.

PTS: 1 DIF: B OBJ: 10-4

50. ANS:
The particles of hydrogen at 80ºC have the highest average speed, since they have the least mass and are at the highest temperature. The particles of krypton at 30ºC have the lowest average speed, since they have the greatest mass and are at the lowest temperature.

PTS: 1 DIF: B OBJ: 10-4

51. ANS:
Temperature is a measure of the average kinetic energy of the gas particles, so the particles of the two gases at 80ºC have the highest average kinetic energy, while the particles of the two gases at 30ºC have the lowest average kinetic energy.

PTS: 1 DIF: B OBJ: 10-4

52. ANS:
Because of the high altitude, the atmospheric pressure in Salt Lake City is less than the pressure at sea level, so water boils at a temperature less than 100ºC.

PTS: 1 DIF: B OBJ: 10-6

53. ANS:
The methane (CH_4) molecules have a lower molecular mass than the ethane (C_2H_6) molecules, so the methane molecules move at a higher average velocity and have a higher rate of diffusion than the ethane molecules.

PTS: 1 DIF: B OBJ: 10-2

54. ANS:
The amount of energy absorbed in boiling 100 g of water at 100ºC equals the amount of energy released in condensing 100 g of steam at 100ºC.

PTS: 1 DIF: B OBJ: 10-4

55. ANS:
The heat of fusion of water is 3.34×10^5 J/kg, or 3.34×10^2 J/g or 334 J/g. The energy absorbed when the ice cube melts is (334 J/g) × (20 g) = 6680 J.

PTS: 1 DIF: B OBJ: 10-4

PROBLEM

56. ANS:
367 K, 172 K, 661 K

PTS: 1 DIF: B OBJ: 10-5

57. ANS:
It is a solid.

PTS: 1 DIF: B OBJ: 10-1

58. ANS:
It is a gas.

PTS: 1 DIF: B OBJ: 10-1

59. ANS:
The melting point is approximately 350 K.

PTS: 1 DIF: B OBJ: 10-4

60. ANS:
It is approximately 200 K.

PTS: 1 DIF: B OBJ: 10-4

61. ANS:
Substance A would boil last.

PTS: 1 DIF: B OBJ: 10-2

62. ANS:
It is approximately 8.0×10^4 kJ.

PTS: 1 DIF: A OBJ: 10-4

63. ANS:
It is approximately 2.0×10^4 kJ.

PTS: 1 DIF: A OBJ: 10-4

64. ANS:
It is approximately 4.5×10^4 kJ.

PTS: 1 DIF: A OBJ: 10-4

65. ANS:
Oxygen has the lowest melting point; iodine has the highest.

PTS: 1 DIF: B OBJ: 10-4

66. ANS:
Iodine has the highest boiling point; nitrogen has the lowest.

PTS: 1 DIF: B OBJ: 10-4

67. ANS:
$6008 \text{ J/mol} \times 10.00 \text{ mol} = 60\,080 \text{ J}$.

PTS: 1 DIF: B OBJ: 10-6

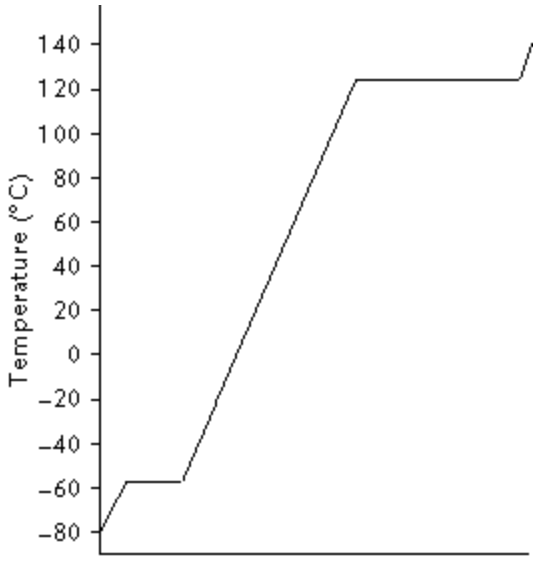
68. ANS:
Nitrous oxide requires the least change in temperature. Its melting and boiling points are the closest together.

PTS: 1 DIF: A OBJ: 10-6

69. ANS:
The nitrogen would boil away first because it has a lower heat of vaporization.

PTS: 1 DIF: A OBJ: 10-6

70. ANS:
See Solution 10-1.



Solution 10-1

PTS: 1 DIF: A OBJ: 10-6