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Chapter 11

#### Question 1

List the three states of matter in order of increasing molecular disorder.

- gas < liquid < solid
- gas < solid < liquid
- solid < liquid < gas
- liquid < gas < solid
- liquid < solid < gas

#### Question 2

Identify the phase transition that occurs when  $\text{CO}_2$  solid turns to  $\text{CO}_2$  gas as it is heated.

- deposition
- vaporization
- sublimation
- freezing
- condensation

#### Question 3

What is the significance of a line in a phase diagram?

- The distinction between two phases disappears.
- Three phases are in equilibrium.
- Two phases are in equilibrium.
- Only one phase is present.

#### Question 4

Rationalize the difference in boiling points between  $\text{CH}_2\text{BrCl}$  ( $68^\circ\text{C}$ ) and  $\text{CH}_3\text{Br}$  ( $3.5^\circ\text{C}$ ).

$\text{CH}_2\text{BrCl}$  is more polarizable than  $\text{CH}_3\text{Br}$ .

$\text{CH}_2\text{BrCl}$  can hydrogen bond.

$\text{CH}_2\text{BrCl}$  has a dipole moment, and  $\text{CH}_3\text{Br}$  does not have a dipole moment.

$\text{CH}_2\text{BrCl}$  does not have a dipole moment, and  $\text{CH}_3\text{Br}$  has a dipole moment.

$\text{CH}_2\text{BrCl}$  is less polarizable than  $\text{CH}_3\text{Br}$ .

#### Question 5

When the pressure over a liquid is *decreased*, the boiling point of the liquid will

remain the same.

always decrease.

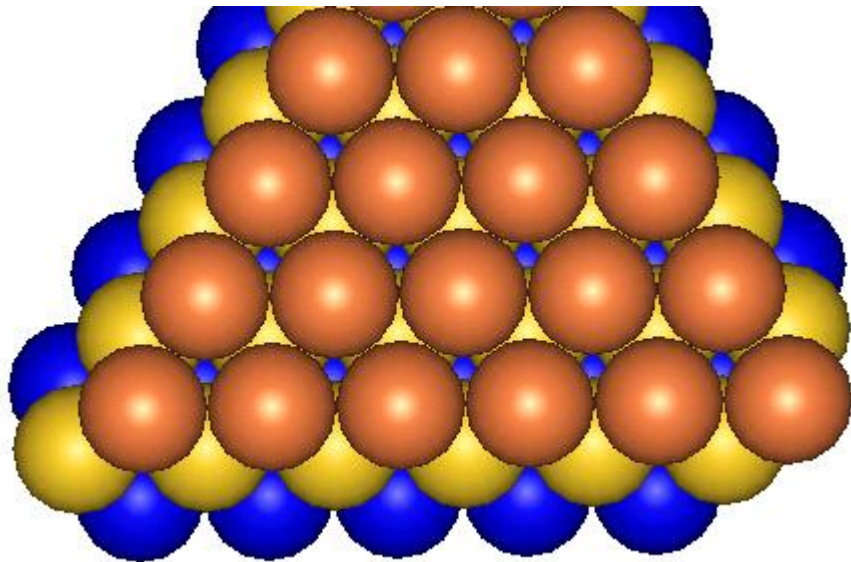
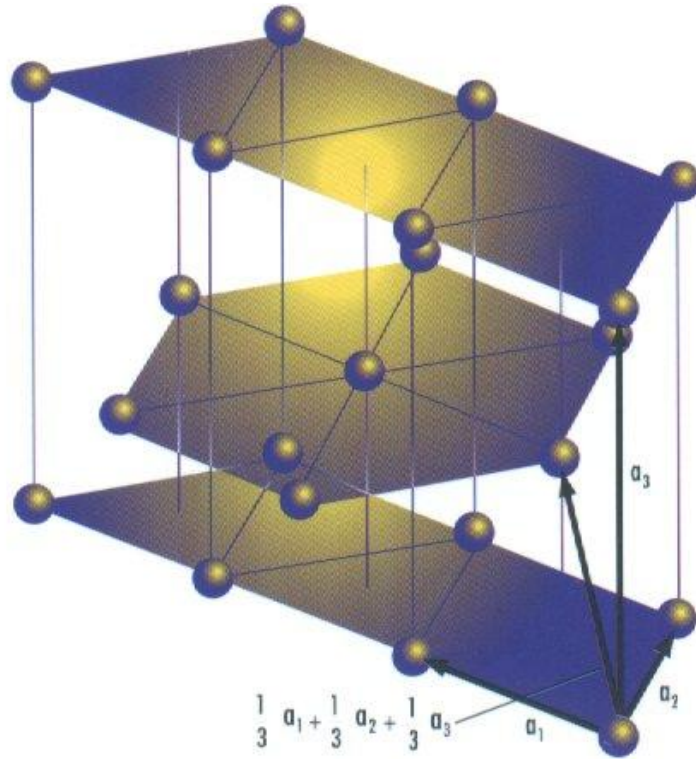
always increase.

increase or decrease.

#### Question 6

What is the coordination number in close-packed structures?

6  
12  
2  
4  
8



#### Question 7

Predict the boiling point of  $\text{H}_2\text{Se}$  if the following is true for the boiling points:

$\text{H}_2\text{O}$  –  $100^\circ\text{C}$

$\text{H}_2\text{Te}$  –  $-2^\circ\text{C}$

$\text{H}_2\text{S}$  –  $-61^\circ\text{C}$

It will have a boiling point of about  $-100^\circ\text{C}$ .

It is impossible to estimate.

It will have a boiling point about  $-32^\circ\text{C}$  (if linear interpolation with molar mass is done).

It will have a boiling point about  $10^\circ\text{C}$ .

It will have a boiling point about  $110^\circ\text{C}$ .

#### Question 8

What is  $H$  in kJ for the condensation of 25.0 g of  $\text{CH}_3\text{OH}$  at  $25^\circ\text{C}$ ? ( $H_{\text{vap}} = 38.0 \text{ kJ/mol}$ )

950 kJ

-950 kJ

-29.7 kJ

$1.22 \times 10^3 \text{ kJ}$

29.7 kJ

#### Question 9

What types of intermolecular forces can exist between neutral molecules?

dipole-dipole attraction, London dispersion, and hydrogen bonding

dipole-dipole attraction

London dispersion

ionic interaction

hydrogen bonding

#### Question 10

Arrange the following in terms of *decreasing* boiling points:

$\text{N}_2$ ,  $\text{O}_2$ ,  $\text{NO}$

O<sub>2</sub> > N<sub>2</sub> > NO  
N<sub>2</sub> > O<sub>2</sub> > NO  
NO > N<sub>2</sub> > O<sub>2</sub>  
N<sub>2</sub> > NO > O<sub>2</sub>  
NO > O<sub>2</sub> > N<sub>2</sub>

#### Question 11

Indicate the type of crystal (molecular, metallic, covalent-network, or ionic) each of the following would form upon solidification: O<sub>2</sub>, Mo, SiC

O<sub>2</sub> -- molecular; Mo -- ionic; SiC -- ionic  
O<sub>2</sub> -- covalent-network; Mo -- metallic; SiC -- covalent-network  
O<sub>2</sub> -- covalent-network; Mo -- metallic; SiC -- ionic  
O<sub>2</sub> -- molecular; Mo -- metallic; SiC -- covalent-network  
O<sub>2</sub> -- molecular; Mo -- metallic; SiC -- ionic

#### Question 12

Which of the following would have the highest vapor pressure at 0°C?

CH<sub>2</sub>Cl<sub>2</sub>  
NH<sub>3</sub>  
CH<sub>4</sub>  
CH<sub>3</sub>OH  
H<sub>2</sub>O

#### Question 13

Which one of the following will have the highest vapor pressure at a given temperature?

CH<sub>3</sub>COOH  
C<sub>14</sub>H<sub>30</sub>  
C<sub>5</sub>H<sub>10</sub>  
NaCl  
H<sub>2</sub>O

#### Question 14

Crystalline solids differ from amorphous solids in that crystalline solids have

a long-range repeating pattern of atoms, molecules, or ions.  
much larger atoms, molecules, or ions.  
atoms, molecules, or ions that are close together.  
appreciable intermolecular attractive forces.  
atoms, molecules, or ions that have no orderly structure.

#### Question 15

Which of these molecules can form hydrogen bonds?

HOCH<sub>3</sub>  
BH<sub>3</sub>  
PH<sub>3</sub>  
N(CH<sub>3</sub>)<sub>3</sub>  
CH<sub>3</sub>F

#### Question 16

Which one of the following is likely to be a liquid at room temperature?

**(i)** CH<sub>4</sub> **(ii)** Br<sub>2</sub> **(iii)** NaCl **(iv)** H<sub>2</sub>O **(v)** H<sub>2</sub>S **(vi)** CH<sub>3</sub>OH

iv and vi only  
ii, iii, iv, and vi only  
i and v only  
iv, v, and vi only  
ii, iv, and vi only

#### Question 17

Increasing the amount of liquid in a closed container will cause the vapor pressure of the liquid to

increase.  
decrease.  
remain the same.  
It depends on the liquid.

#### Question 18

The reason that some insects can walk on water is due to

capillary action.  
surface tension.  
adhesive forces.  
dishwashing detergent.  
vaporization.

#### Question 19

Molecular nitrogen,  $N_2$ , and carbon monoxide, CO, are isoelectronic and nearly equal in molecular mass. Explain why the boiling point of CO is slightly higher than that of  $N_2$ .

$N_2$  has a larger dipole moment.  
CO is less massive.  
CO is more massive.  
 $N_2$  can hydrogen bond.  
CO has a dipole moment.

#### Question 20

Which one of the following is an exothermic process?

melting  
subliming  
freezing  
boiling  
none of the above

#### Question 21

A substance above its critical temperature and pressure is known as a

liquid.  
gas.  
supercritical fluid.  
super-cooled liquid.  
none of the above

#### Question 22

Which one of the following statements is *incorrect*?

The higher the temperature, the more likely it is that a molecule has enough energy to escape into the gas phase.

Volatile liquids have relatively weak intermolecular forces.

The stronger the intermolecular forces, the higher the vapor pressure.

Vapor pressure is determined by a dynamic equilibrium of the liquid and the vapor.

Vapor pressure increases with temperature.

#### Question 23

How many of the following processes are exothermic?

1. freezing (liquid to solid)
2. vaporization
3. sublimation
4. melting
5. condensation (gas to liquid)

1

2

3

4

5

#### Question 24

Which of the following statements is *incorrect*?

Three-dimensional covalent-network solids are easy to deform.

The layers in graphite are held together by dispersion forces.

Metals are easily deformed because the electrons can easily adapt to new configurations.

The melting point of an ionic solid should depend on the charge of the ions.

Buckyballs are molecular solids.

#### Question 25

Which types of intermolecular attractive forces operate between polar molecules?



London dispersion  
London dispersion and dipole-dipole attraction  
London-dispersion and hydrogen bonding  
dipole-dipole attraction  
hydrogen bonding

#### Question 26

The enthalpy of fusion of water is 6.0 kJ/mol and the heat capacity is 75 J/mol·°C. How many kJ of heat would it take to convert 50. g of ice at 0°C to liquid water at 22°C? ( $\Delta H_{\text{vap}} = 38.0$  kJ/mol)

4600 kJ  
17 kJ  
 $3.8 \times 10^2$  kJ  
21 kJ  
120 kJ

#### Question 27

In which case are adhesive forces involved?

hydrogen bonding in water  
capillary action  
surface tension  
viscosity

#### Question 28

What kind of attractive forces must be overcome to sublime CO<sub>2</sub>?

dipole-dipole attraction  
hydrogen bonding  
London dispersion  
van der Waals forces  
all of these

#### Question 29

Which of these molecules do *not* form hydrogen bonds?

diethyl ether,  $\text{CH}_3\text{CH}_2\text{OCH}_2\text{CH}_3$

water,  $\text{H}_2\text{O}$

ammonia,  $\text{NH}_3$

ethylene glycol,  $\text{HOCH}_2\text{CH}_2\text{OH}$

ethyl alcohol,  $\text{CH}_3\text{CH}_2\text{OH}$

#### Question 30

Freon-11, which has the chemical formula  $\text{CCl}_3\text{F}$ , has a normal boiling point of  $23.8^\circ\text{C}$ . The specific heats of  $\text{CCl}_3\text{F}(l)$  and  $\text{CCl}_3\text{F}(g)$  are  $0.87 \text{ J/g}\cdot\text{K}$  and  $0.59 \text{ J/g}\cdot\text{K}$ , respectively. The heat of vaporization is  $24.75 \text{ kJ/mol}$ . Calculate the heat required to convert  $10.0 \text{ g}$  of Freon-11 from a liquid at  $-50.0^\circ\text{C}$  to a gas at  $50.0^\circ\text{C}$ .

0.15 kJ

2.6 kJ

2.5 kJ

1.8 kJ

0.64 kJ

#### Question 31

Name two points on a phase diagram characterized by a unique value of temperature and pressure.

critical point and melting point

boiling point and triple point

boiling point and critical point

triple point and melting point

critical point and triple point

#### Question 32

Predict the order of the melting points (from highest to lowest) of  $\text{NH}_3$ ,  $\text{CH}_4$ ,  $\text{SiH}_4$ , and  $\text{GeH}_4$ .

$\text{CH}_4 > \text{SiH}_4 > \text{GeH}_4 > \text{NH}_3$

$\text{NH}_3 > \text{GeH}_4 > \text{SiH}_4 > \text{CH}_4$

$\text{GeH}_4 > \text{SiH}_4 > \text{CH}_4 > \text{NH}_3$

$\text{NH}_3 > \text{SiH}_4 > \text{CH}_4 > \text{GeH}_4$

$\text{NH}_3 > \text{CH}_4 > \text{SiH}_4 > \text{GeH}_4$