Course Name: CHE_107_General_Chemistry_2

Question #: 1

Fill in one of the three common phases of matter for each one of these descriptions.

__1__ = High density, definite shape, definite volume.

__2__ = Low density, indefinite shape, indefinite volume.

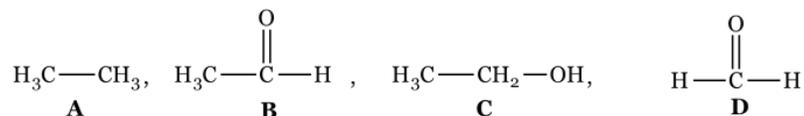__3__ = Medium density, indefinite shape, definite volume.

1. _____
2. _____
3. _____

Question #: 2

Rank the following in order from **lowest** to **highest** boiling point.

H_3C—CH_3, H_3C—$\overset{\overset{O}{\|}}{C}$—$H$, H_3C—CH_2—OH, H—$\overset{\overset{O}{\|}}{C}$—$H$

  A   B   C   D

Lowest __1__ < __2__ < __3__ < __4__ Highest
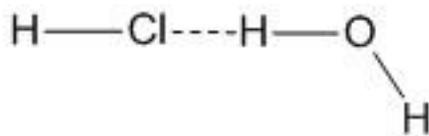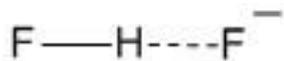
1. _____
2. _____
3. _____
4. _____

Question #: 3

Which sketch shows the strongest hydrogen bond?

A.

H—Cl----H—O
                \
                 H

B.

F—H----F⁻ (F—H----F with negative superscript)

C.

          H
          |
O—H----S
| |
H   H

D.

H
 \
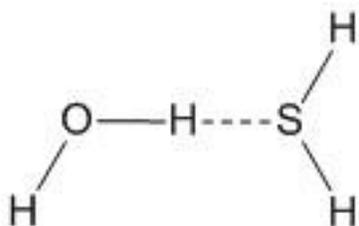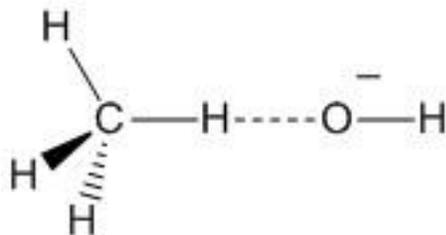 C—H-----O—H
 /   (O has negative superscript)
H
|
H

Question #: 4

The resistance of a liquid to flow is _____, which _____ increasing strength of intermolecular forces.

    A. viscosity; increases with
    B. viscosity; decreases with
    C. surface tension; increases with
    D. surface tension; is independent of

Question #: 5

When the rate of condensation is _____ the rate of evaporation, dynamic equilibrium has been achieved.

    A. less than

B. equal to

C. greater than

Which statement is **false** about the critical point?

    A. The gas phase cannot exist above a substance's critical temperature.

    B. At the critical temperature of a substance, its gas and liquid phases comingle to form a supercritical fluid.

    C. The critical temperature is the highest temperature at which a substance can exist as a liquid.

    D. The gas phase can exist above a substance's critical pressure.

The direct conversion from solid to gas is __1__ .

The direct conversion from solid to liquid is __2__ , more commonly known as "melting."

    1. _____

    2. _____

What is the enthalpy change (ΔH) when 73.8 g of water at 0 °C freezes?

molar mass of water = 18.02 g/mol

ΔH^{o}_{fus} of water = 6.02 kJ/mol

Report your answer with three significant figures and the correct sign.

ΔH = __1__ kJ

    1. _____

How much energy is required to convert 156.2 g of solid benzene, $C_6H_6(s)$, at 5.53 °C to gaseous benzene, $C_6H_6(g)$, at 80.1 °C?

molar mass C_6H_6 = 78.11 g/mol
melting point = 5.53 °C
boiling point = 80.1 °C
ΔH_{fus} = 9.90 kJ/mol
ΔH_{vap} = 30.77 kJ/mol
C_s of $C_6H_6(s)$ = 1.52 J/g °C
C_s of $C_6H_6(l)$ = 1.73 J/g °C
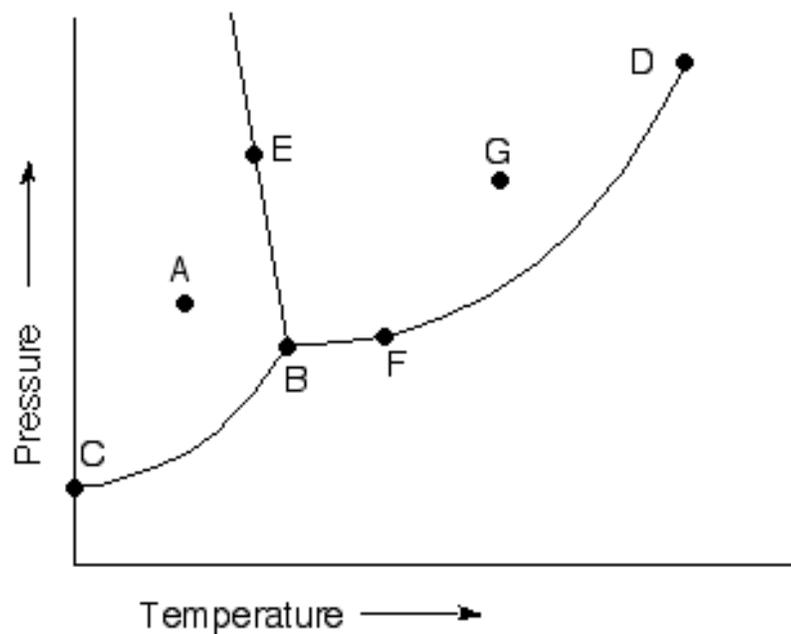C_s of $C_6H_6(g)$ = 1.06 J/g °C

A. 6.44×10^3 kJ
B. 20.5 kJ
C. 45.0 kJ
D. 101 kJ

Question #: 10

Name the indicated points on the phase diagram.

Point B is the __1__ [critical, triple] point.
Point G is located in the __2__ [solid, liquid, gas] region.
Point E is located on the __3__ [fusion, vaporization, sublimation] curve.

1. _____
2. _____
3. _____

Question #: 11

A _____ cubic unit cell is characterized by 4 atoms per unit cell, has a packing efficiency of 68%, and is identical to the cubic closest-packing crystal structure.
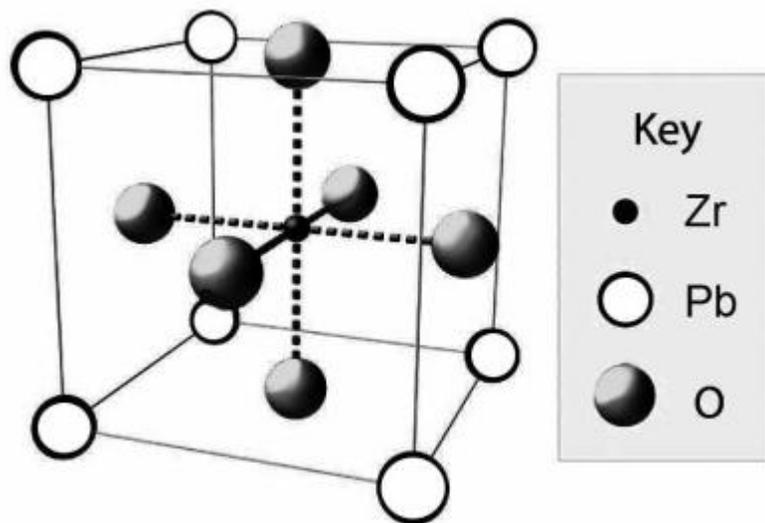
    A. simple
    B. body-centered
   C. face-centered

---

Question #: 12

Determine the formula for the ionic compound shown below. The Zr ion (black circle) is located at the unit cell's body center while Pb ions (open circles) are located on each of the eight corners and oxygen ions (gray circles) are located on six faces of the unit cell.

A. $PbZrO_6$
B. $PbZrO_3$
C. Pb_8ZrO_3
D. $PbZrO$

Question #: 13

Copper (63.55 g/mol) crystallizes in a face-centered cubic structure as shown below. The density of copper is 8.92 g/cm^3. What is the **volume** of the unit cell?
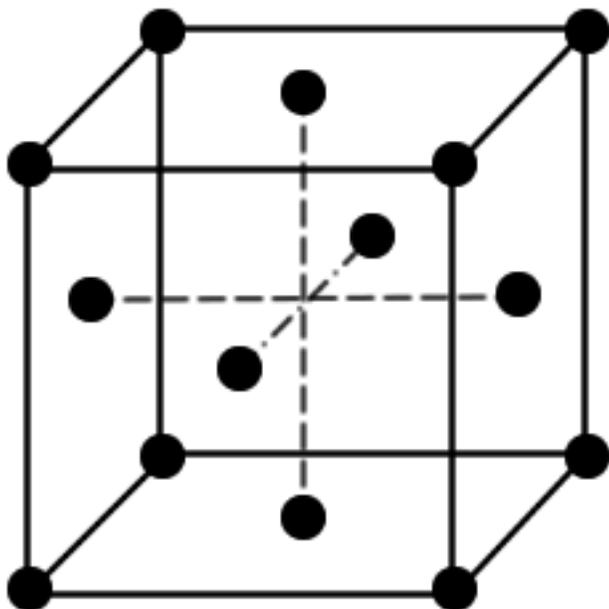
A. $5.62 \times 10^{-25} \text{ cm}^3$

B. $3.02 \times 10^{-22} \text{ cm}^3$

C. $6.94 \times 10^{-24} \text{ cm}^3$

D. $4.73 \times 10^{-23} \text{ cm}^3$

Question #: 14

Identify each solid as molecular, ionic, or atomic:

AgCl(s) ___1___

CBr_4(s) ___2___

Kr(*s*) __3__

    1. _____
    2. _____
    3. _____

Question #: 15

Silicon doped with arsenic forms a(n) __1__ -type semiconductor.
Silicon doped with gallium forms a(n) __2__ -type semiconductor.

    1. _____
    2. _____

Question #: 16
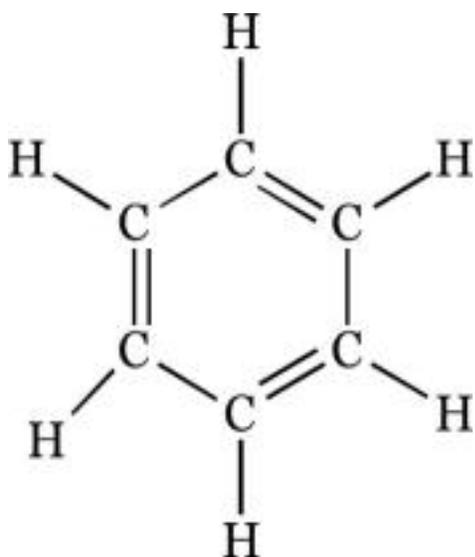
Select the **false** statement.

    A. Solutes and solvents with similar intermolecular forces are more likely to mix.
    B. Solutes and solvents must be miscible (soluble in all proportions) for a solution to form.
    C. Entropy will sometimes drive solution formation even if the solute-solvent interactions are weaker than solvent-solvent and solute-solute interactions.
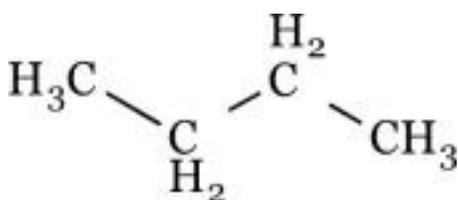   D. Liquid solutions can have gases, liquids, or solids as the dissolved solute.

Question #: 17

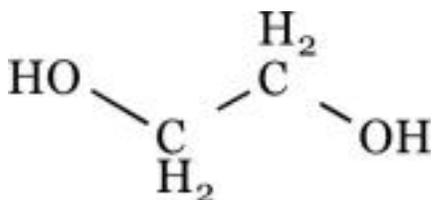Which of the four substances below is/are highly soluble in water? Select **all** that apply.

    A.

H

H.

C

C

H

C

C

H

C

C

H

H

B.

H₃C

H₂
C

C
H₂

CH₃

C.

HO

H₂
C

C
H₂

OH

D.

NaCl

Question #: 18

Match the descriptions to the type of solution they describe: unsaturated, saturated, or supersaturated.

An unstable solution in which more than the equilibrium amount of solute is dissolved. __1__

Any added solute will dissolve in a(n) __2__ solution until equilibrium is reached.

The dissolved solute is in dynamic equilibrium with any undissolved solute; additional solute will not dissolve in a(n) __3__ solution

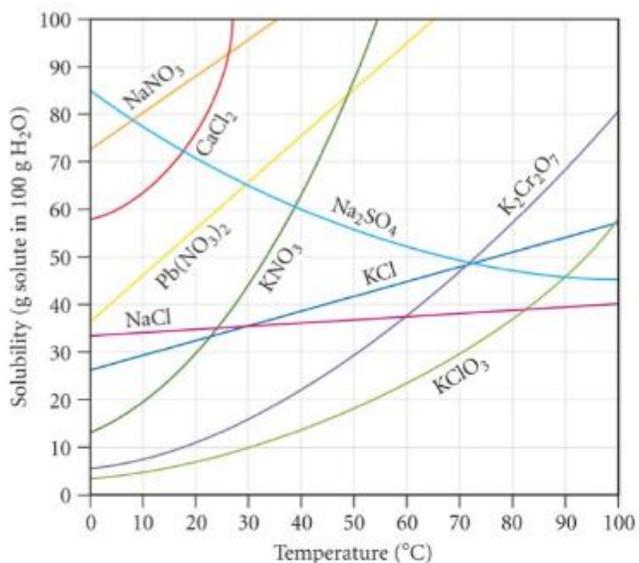1. _____

2. _____
3. _____

Question #: 19

Which factor(s) <u>favor(s) dissolution</u> of a solute in a solvent? Choose all that apply.

    A. solvent-solvent plus solute-solute interactions >solvent-solute interactions
    B. increasing entropy as the solute dissolves
    C. increasing pressure of a gaseous solute above a liquid solvent
    D. large lattice energy of an ionic solute

Question #: 20

Which best describes the KCl solution formed when 59 g of KCl is dissolved in 100 g of water at 40 °C?

    A. unsaturated
    B. saturated
    C. supersaturated
    D. polyunsaturated

Question #: 21

Which set of conditions will **<u>maximize</u>** the amount of dissolved O_2 in water?

    A. Heat the water and decrease P_{O2} above the water.
    B. Cool the water and increase P_{O2} above the water.
    C. Cool the water and decrease P_{O2} above the water.
    D. Heat the water and increase P_{O2} above the water.

Question #: 22

What is the molality of a solution prepared by dissolving 25.0 g H_2SO_4 (98.08 g/mol) in 400. g of water?

    A. 49.0 m
    B. 0.637 m
    C. 0.106 m
    D. 1.93 m

Question #: 23

How many arsenic atoms (79.9 g/mol) are found in a 8.00 g water sample that is 17.0 ppb by mass arsenic?

    A. 1.02×10^{15} atoms
    B. 3.05×10^{23} atoms
    C. 4.08×10^{12} atoms
    D. 5.56×10^{24} atoms

Question #: 24

What is the molality of a 1.55 M copper(II) chloride ($CuCl_2$, 134 g/mol) solution with a density of 1.045 g/mL?

    A. 1.05 m
    B. 1.27 m

C. 1.85 m

D. 2.07 m

Question #: 25

A saline solution is 9.98% NaCl by mass and has a density of 1.011 g/mL. What is the molarity of this NaCl solution?

    A. 1.73 M

    B. 2.69 M

    C. 3.32 M

    D. 9.98 M

Question #: 26

Which substance has the correct van't Hoff factor indicated?

    A. Na_2SO_4, $i = 3$

    B. H_3PO_4, $i = 7$

    C. naphthalene (non-electrolyte), $i = 1.5$

    D. $BaCO_3$, $i = 5$

Question #: 27

The vapor pressure of pure methanol (CH_3OH, 32.0 g/mol) is 75.4 torr at 12.0 °C. If 0.400 mol of a nonvolatile solute is added to 320. g CH3OH, what is the vapor pressure of the solution, reported to three significant figures?

$P_{solution}$ = ___1___ torr

    1. _____

Question #: 28

Calculate the freezing point of a solution prepared by dissolving 7.76 g of nonvolatile naphthalene ($C_{10}H_8$) in 215.0 g CCl_4.

molar mass $(C_{10}H_8)$ = 128.1 g/mol
molar mass (CCl_4) = 153.8 g/mol
normal freezing point CCl_4 = −22.90 °C
$K_f(CCl_4)$ = 29.90 °C/m
freezing point of solution (report with one decimal place) = __1__ °C

1. _____

Question #: 29

What is the molarity of a K_3PO_4 solution with an osmotic pressure of 12.4 atm at 30.0 °C?

A. 1.24 M
B. 0.0805 M
C. 0.400 M
D. 0.125 M

Question #: 30

Which solution has the **highest** vapor pressure?

A. 1.0 m $AlBr_3$
B. 1.0 m $CaCl_2$
C. 1.0 m $C_{12}H_{22}O_{11}$ (sucrose)
D. 1.0 m $KClO_3$

CHE 107 Fall 2015 Exam 1
September 17, 2015

Question #: 1
Fill in one of the three common phases of matter for each one of these descriptions.
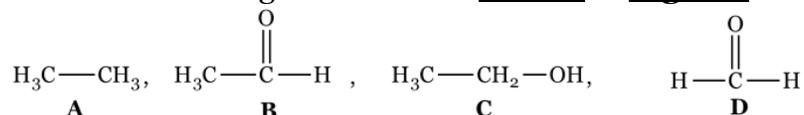__1__ = High density, definite shape, definite volume.
__2__ = Low density, indefinite shape, indefinite volume.
__3__ = Medium density, indefinite shape, definite volume.

    1. solid|Solid|solids|
    2. gas|Gas|gasses|
    3. liquid|Liquid|liquids|

Question #: 2
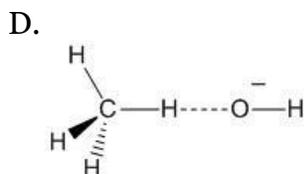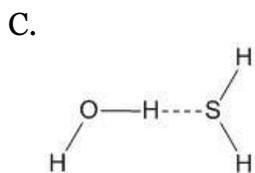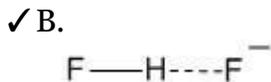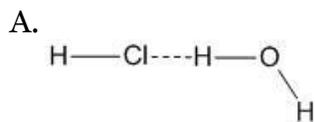Rank the following in order from **lowest** to **highest** boiling point.

$$H_3C—CH_3, \quad H_3C—\overset{\overset{\displaystyle O}{\|}}{C}—H \; , \quad H_3C—CH_2—OH, \quad H—\overset{\overset{\displaystyle O}{\|}}{C}—H$$
$$\text{A} \qquad\qquad \text{B} \qquad\qquad\qquad \text{C} \qquad\qquad\qquad \text{D}$$

Lowest __1__ < __2__ < __3__ < __4__ Highest

    1. A
    2. D
    3. B
    4. C

Question #: 3
Which sketch shows the strongest hydrogen bond?

A.

    H—Cl----H—O
                   \\
                       H

✓ B.

    F—H----F⁻

C.

                H
                /
    O—H----S
   /   \\
  H   H

D.

  H
   \\
    C—H-----O—H
  /
 H
  H

Question #: 4

The resistance of a liquid to flow is _____, which _____ increasing strength of intermolecular forces.

   ✓ A. viscosity; increases with
      B. viscosity; decreases with
      C. surface tension; increases with
      D. surface tension; is independent of

Question #: 5

When the rate of condensation is _____ the rate of evaporation, dynamic equilibrium has been achieved.

      A. less than
   ✓ B. equal to
      C. greater than

Question #: 6

Which statement is **<u>false</u>** about the critical point?

      A. The gas phase cannot exist above a substance's critical temperature.
      B. At the critical temperature of a substance, its gas and liquid phases comingle to form a supercritical fluid.
      C. The critical temperature is the highest temperature at which a substance can exist as a liquid.
   ✓ D. The gas phase can exist above a substance's critical pressure.

Question #: 7

The direct conversion from solid to gas is __1__.
The direct conversion from solid to liquid is __2__, more commonly known as "melting."

      1. sublimation|sublime|subliming|sublamation|
      2. fusion|fuzion|fusing|fuse|

Question #: 8

What is the enthalpy change (ΔH) when 73.8 g of water at 0 °C freezes?
molar mass of water = 18.02 g/mol
$\Delta H°_{fus}$ of water = 6.02 kJ/mol
Report your answer with three significant figures and the correct sign.
ΔH = __1__ kJ

      1. -24.6|-24.7|-24.6 kJ|-24.7 kJ|

Question #: 9

How much energy is required to convert 156.2 g of solid benzene, $C_6H_6(s)$, at 5.53 °C to gaseous benzene, $C_6H_6(g)$, at 80.1 °C?

molar mass C_6H_6 = 78.11 g/mol
melting point = 5.53 °C
boiling point = 80.1 °C
ΔH_{fus} = 9.90 kJ/mol
ΔH_{vap} = 30.77 kJ/mol
C_s of $C_6H_6(s)$ = 1.52 J/g °C
C_s of $C_6H_6(l)$ = 1.73 J/g °C
C_s of $C_6H_6(g)$ = 1.06 J/g °C

    A. 6.44×10^3 kJ
    B. 20.5 kJ
    C. 45.0 kJ
✓D. 101 kJ

Question #: 10

Name the indicated points on the phase diagram.

Point B is the __1__ [critical, triple] point.
Point G is located in the __2__ [solid, liquid, gas] region.
Point E is located on the __3__ [fusion, vaporization, sublimation] curve.

    1. triple
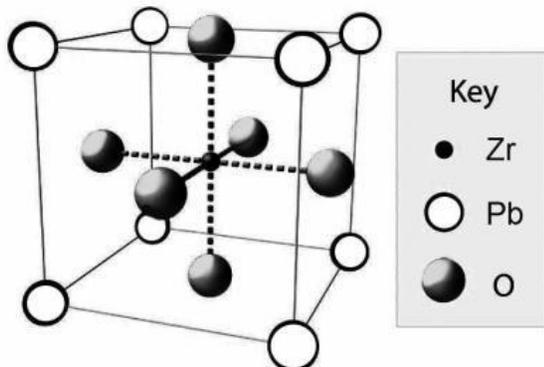   2. liquid
    3. fusion

Question #: 11

A _____ cubic unit cell is characterized by 4 atoms per unit cell, has a packing efficiency of 74%, and is identical to the cubic closest-packing crystal structure.

    A. simple
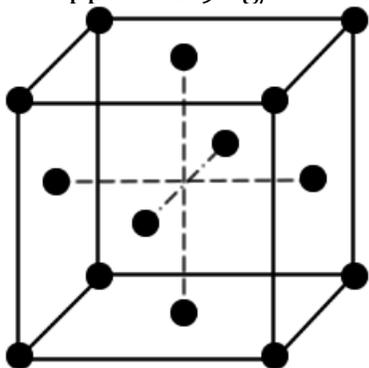   B. body-centered
✓C. face-centered

Question #: 12
Determine the formula for the ionic compound shown below. The Zr ion (black circle) is located at the unit cell's body center while Pb ions (open circles) are located on each of the eight corners and oxygen ions (gray circles) are located on six faces of the unit cell.

Key
• Zr
○ Pb
◐ O

A. $PbZrO_6$
✓ B. $PbZrO_3$
C. Pb_8ZrO_3
D. $PbZrO$

___

Question #: 13
Copper (63.55 g/mol) crystallizes in a face-centered cubic structure as shown below. The density of copper is 8.92 g/cm³. What is the **volume** of the unit cell?

A. 5.62×10^{-25} cm³
B. 3.02×10^{-22} cm³
C. 6.94×10^{-24} cm³
✓ D. 4.73×10^{-23} cm³

___

Question #: 14
Identify each solid as molecular, ionic, or atomic:
$AgCl(s)$ __1__
$CBr_4(s)$ __2__
$Kr(s)$ __3__

1. ionic
2. molecular
3. atomic

Question #: 15
Silicon doped with arsenic forms a(n) __1__ -type semiconductor.
Silicon doped with gallium forms a(n) __2__ -type semiconductor.

     1. n|n-type|negative|n type|
   2. p|p-type|positive|p type|

Question #: 16
Select the **false** statement.

    A. Solutes and solvents with similar intermolecular forces are more likely to mix.
   ✓B. Solutes and solvents must be miscible (soluble in all proportions) for a solution to form.
    C. Entropy will sometimes drive solution formation even if the solute-solvent interactions
       are weaker than solvent-solvent and solute-solute interactions.
    D. Liquid solutions can have gases, liquids, or solids as the dissolved solute.
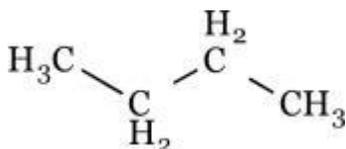
Question #: 17
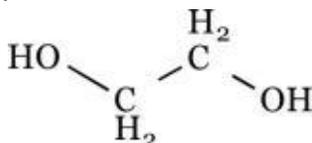Which of the four substances below is/are highly soluble in water? Select **all** that apply.

  A.
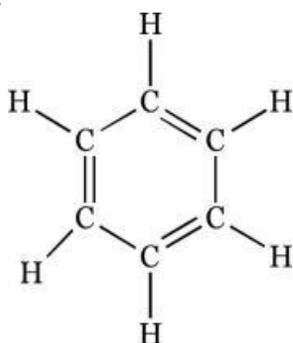
  B.

 ✓C.

 ✓D.
   NaCl

Question #: 18
Match the descriptions to the type of solution they describe: unsaturated, saturated, or supersaturated.

An unstable solution in which more than the equilibrium amount of solute is dissolved. __1__

Any added solute will dissolve in a(n) __2__ solution until equilibrium is reached.

The dissolved solute is in dynamic equilibrium with any undissolved solute; additional solute will not dissolve in a(n) __3__ solution

    1. supersaturated|Supersaturated|super saturated|super|supersaturate|super-saturated|

    2. unsaturated|Unsaturated|un-saturated|
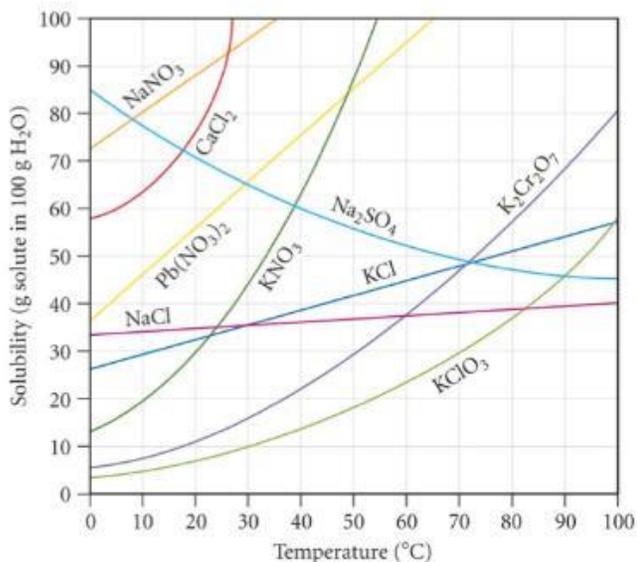
    3. saturated|Saturated|

Question #: 19
Which factor(s) favor(s) dissolution of a solute in a solvent? Choose all that apply.

    A. solvent-solvent plus solute-solute interactions >solvent-solute interactions

    ✓ B. increasing entropy as the solute dissolves

    ✓ C. increasing pressure of a gaseous solute above a liquid solvent

    D. large lattice energy of an ionic solute

Question #: 20
Which best describes the KCl solution formed when 59 g of KCl is dissolved in 100 g of water at 40 °C?

    A. unsaturated

    ✓ B. saturated

    C. supersaturated

    D. polyunsaturated

Question #: 21
Which set of conditions will **<u>maximize</u>** the amount of dissolved O_2 in water?

    A. Heat the water and decrease P_{O_2} above the water.

    ✓ B. Cool the water and increase P_{O_2} above the water.

    C. Cool the water and decrease P_{O_2} above the water.

    D. Heat the water and increase P_{O_2} above the water.

Question #: 22
What is the molality of a solution prepared by dissolving 25.0 g H_2SO_4 (98.08 g/mol) in 400. g of water?

    A. 49.0 m

    ✓ B. 0.637 m

    C. 0.106 m

    D. 1.93 m

Question #: 23
How many bromine atoms (79.9 g/mol) are found in a 8.00 g water sample that is 17.0 ppb by mass bromine?

    ✓ A. 1.02×10^{15} atoms

    B. 3.05×10^{23} atoms

    C. 4.08×10^{12} atoms

    D. 5.56×10^{24} atoms

Question #: 24
What is the molality of a 1.55 M copper(II) chloride ($CuCl_2$, 134 g/mol) solution with a density of 1.045 g/mL?

    A. 1.05 m

    B. 1.27 m

    ✓ C. 1.85 m

    D. 2.07 m

Question #: 25
A saline solution is 9.98% NaCl by mass and has a density of 1.011 g/mL. What is the molarity of this NaCl solution?

    ✓ A. 1.73 M

    B. 2.69 M

    C. 3.32 M

    D. 9.98 M

Question #: 26
Which substance has the correct van't Hoff factor indicated?

  ✓A. Na_2SO_4, $i = 3$
   B. H_3PO_4, $i = 7$
   C. naphthalene (non-electrolyte), $i = 1.5$
   D. $BaCO_3$, $i = 5$

Question #: 27
The vapor pressure of pure methanol (CH_3OH, 32.0 g/mol) is 75.4 torr at 12.0 °C. If 0.400 mol of a nonvolatile solute is added to 320. g CH3OH, what is the vapor pressure of the solution, reported to three significant figures?
$P_{solution}$ = __1__ torr

  1. 72.5

Question #: 28
Calculate the freezing point of a solution prepared by dissolving 7.76 g of nonvolatile naphthalene ($C_{10}H_8$) in
215.0 g CCl_4.
molar mass ($C_{10}H_8$) = 128.1 g/mol
molar mass (CCl_4) = 153.8 g/mol
normal freezing point CCl_4 = −22.90 °C
K_f (CCl_4) = 29.90 °C/m
freezing point of solution (report with one decimal place) = __1__ °C

  1. -31.3

Question #: 29
What is the molarity of a K_3PO_4 solution with an osmotic pressure of 12.4 atm at 30.0 °C?

  A. 1.24 M
  B. 0.0805 M
  C. 0.400 M
  ✓D. 0.125 M

Question #: 30
Which solution has the **highest** vapor pressure?

  A. 1.0 m $AlBr_3$
  B. 1.0 m $CaCl_2$
  ✓C. 1.0 m $C_{12}H_{22}O_{11}$ (sucrose)
  D. 1.0 m $KClO_3$