**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.

\[ \text{H}_3\text{C}--\text{CH}_3, \quad \text{H}_3\text{C}--\text{C}--\text{H}, \quad \text{H}_3\text{C}--\text{CH}_2--\text{OH}, \quad \text{H}--\text{C}--\text{H} \]

Lowest \(1\) < \(2\) < \(3\) < \(4\) Highest

1. 
2. 
3. 
4. 

**Question #: 3**

Which sketch shows the strongest hydrogen bond?

A.
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 **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.

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. _______
2. _______

Question #: 8

What is the enthalpy change ($\Delta H$) 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.
$\Delta H = \Box$ kJ

1. _______

Question #: 9
How much energy is required to convert 156.2 g of solid benzene, \( \text{C}_6\text{H}_6(s) \), at 5.53 °C to gaseous benzene, \( \text{C}_6\text{H}_6(g) \), at 80.1 °C?

- Molar mass \( \text{C}_6\text{H}_6 = 78.11 \text{ g/mol} \)
- Melting point = 5.53 °C
- Boiling point = 80.1 °C
- \( \Delta H_{\text{fus}} = 9.90 \text{ kJ/mol} \)
- \( \Delta H_{\text{vap}} = 30.77 \text{ kJ/mol} \)
- \( C_s \) of \( \text{C}_6\text{H}_6(s) = 1.52 \text{ J/g °C} \)
- \( C_s \) of \( \text{C}_6\text{H}_6(l) = 1.73 \text{ J/g °C} \)
- \( C_s \) of \( \text{C}_6\text{H}_6(g) = 1.06 \text{ J/g °C} \)

A. \( 6.44 \times 10^3 \text{ kJ} \)
B. \( 20.5 \text{ kJ} \)
C. \( 45.0 \text{ kJ} \)
D. \( 101 \text{ kJ} \)

**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.

![Diagram of unit cell with Zr, Pb, and O atoms](image)
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. $5.62 \times 10^{-25}$ cm³  
B. $3.02 \times 10^{-22}$ cm³  
C. $6.94 \times 10^{-24}$ cm³  
D. $4.73 \times 10^{-23}$ cm³

**Question #: 14**

Identify each solid as molecular, ionic, or atomic:

AgCl(s)  
CBr₄(s)
Question #: 15

Silicon doped with arsenic forms a(n) \( \text{1}\) -type semiconductor.
Silicon doped with gallium forms a(n) \( \text{2}\) -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. 

Kr(s) \( \text{3}\)
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. _______
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 maximize 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 arsenic atoms (79.9 g/mol) are found in a 8.00 g water sample that is 17.0 ppb by mass arsenic?

A. $1.02 \times 10^{15}$ atoms  
B. $3.05 \times 10^{23}$ atoms  
C. $4.08 \times 10^{12}$ atoms  
D. $5.56 \times 10^{24}$ 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
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. Na₂SO₄, \( i = 3 \)  
B. H₃PO₄, \( i = 7 \)  
C. naphthalene (non-electrolyte), \( i = 1.5 \)  
D. BaCO₃, \( i = 5 \)

Question #: 27

The vapor pressure of pure methanol (CH₃OH, 32.0 g/mol) is 75.4 torr at 12.0 ºC. 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?

\[
P_{\text{solution}} = \frac{1}{1. \quad \text{torr}}
\]

Question #: 28

Calculate the freezing point of a solution prepared by dissolving 7.76 g of nonvolatile naphthalene (C₁₀H₈) in 215.0 g CCl₄.
molar mass \( (\text{C}_{10}\text{H}_8) \) = 128.1 g/mol
molar mass \( (\text{CCl}_4) \) = 153.8 g/mol
normal freezing point \( \text{CCl}_4 = -22.90 \; ^\circ\text{C} \)
\( K_f (\text{CCl}_4) = 29.90 \; ^\circ\text{C}/m \)
frozen point of solution (report with one decimal place) = 1 °C

1. ______

Question #: 29

What is the molarity of a \( \text{K}_3\text{PO}_4 \) 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 \( \text{AlBr}_3 \)  
B. 1.0 m \( \text{CaCl}_2 \)  
C. 1.0 m \( \text{C}_{12}\text{H}_{22}\text{O}_{11} \) (sucrose)  
D. 1.0 m \( \text{KClO}_3 \)
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.

Lowest 1 < 2 < 3 < 4 Highest

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

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

A.

✓ B.

C.

D.
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 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.

Question #: 7
The direct conversion from solid to gas is ___________.
The direct conversion from solid to liquid is ___________, more commonly known as "melting."

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

Question #: 8
What is the enthalpy change ($\Delta H$) when 73.8 g of water at 0 °C freezes?
molar mass of water = 18.02 g/mol
$\Delta H^\circ_{\text{fus}}$ of water = 6.02 kJ/mol
Report your answer with three significant figures and the correct sign.
$\Delta H = \underline{\phantom{-}1\phantom{.}}$ 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, C₆H₆(s), at 5.53 ºC to gaseous benzene, C₆H₆(g), at 80.1 ºC?
molar mass C₆H₆ = 78.11 g/mol  
melting point = 5.53 ºC  
boiling point = 80.1 ºC  
ΔHₘₚ = 9.90 kJ/mol  
ΔHᵥₐₚ = 30.77 kJ/mol  
Cₛ of C₆H₆(s) = 1.52 J/g ºC  
Cₛ of C₆H₆(l) = 1.73 J/g ºC  
Cₛ of C₆H₆(g) = 1.06 J/g ºC

A. 6.44 ×10³ 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 ___[critical, triple] point.
Point G is located in the ___[solid, liquid, gas] region.
Point E is located on the ___[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.

A. PbZrO$_6$
✓ B. PbZrO$_3$
C. Pb$_8$ZrO$_3$
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 × 10$^{-25}$ cm$^3$
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C. 6.94 × 10$^{-24}$ cm$^3$
✓ D. 4.73 × 10$^{-23}$ cm$^3$

Question #: 14
Identify each solid as molecular, ionic, or atomic:

AgCl(s)  1
CBr$_4$(s)  2
Kr(s)  3

1. ionic
2. molecular
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Question #: 15
Silicon doped with arsenic forms a(n) \( \text{1} \)-type semiconductor.
Silicon doped with gallium forms a(n) \( \text{2} \)-type semiconductor.

1. \( \text{n-type}\) negative \( \text{n type} \)
2. \( \text{p-type}\) positive \( \text{p type} \)

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

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D. Liquid solutions can have gases, liquids, or solids as the dissolved solute.

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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 ✓
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D. large lattice energy of an ionic solute

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

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C. supersaturated
D. polyunsaturated
Question #: 21
Which set of conditions will maximize 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.

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What is the molality of a solution prepared by dissolving 25.0 g H$_2$SO$_4$ (98.08 g/mol) in 400. g of water?

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✓ B. 0.637 m
C. 0.106 m
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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 $\times$ 10$^{15}$ atoms
B. 3.05 $\times$ 10$^{23}$ atoms
C. 4.08 $\times$ 10$^{12}$ atoms
D. 5.56 $\times$ 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. Na₂SO₄, \( i = 3 \)
B. H₃PO₄, \( i = 7 \)
C. naphthalene (non-electrolyte), \( i = 1.5 \)
D. BaCO₃, \( i = 5 \)

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**Question #**: 27
The vapor pressure of pure methanol (CH₃OH, 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?

\[ P_{\text{solution}} = \text{1 torr} \]

1. 72.5

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**Question #**: 28
Calculate the freezing point of a solution prepared by dissolving 7.76 g of nonvolatile naphthalene (C₁₀H₈) in 215.0 g CCl₄.

molar mass (C₁₀H₈) = 128.1 g/mol
molar mass (CCl₄) = 153.8 g/mol
normal freezing point CCl₄ = –22.90 °C

\( K_f(CCl_4) = 29.90 \text{ °C/mol} \)

freezing point of solution (report with one decimal place) = \( \text{1 °C} \)

1. -31.3

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**Question #**: 29
What is the molarity of a K₃PO₄ 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

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

A. 1.0 \( m \) AlBr₃
B. 1.0 \( m \) CaCl₂
✓ C. 1.0 \( m \) C₁₂H₂₂O₁₁ (sucrose)
D. 1.0 \( m \) KClO₃