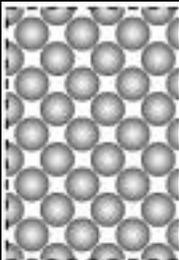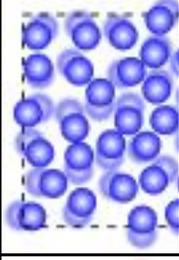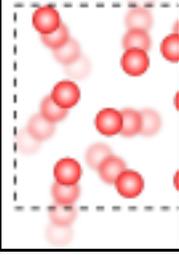# CHE 107 Exam 1 Fall 2016

Your Name: _____   **Your ID:** _____
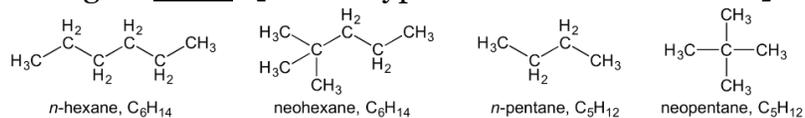
Question #: 1

Molecular View	State	Density	Shape	Volume	Strength of Intermolecular Forces
	solid	high	definite	definite	__1__ [strong, weak]
	liquid	__2__ [high, low]	indefinite	__3__ [definite, indefinite]	moderate
	gas	low	__4__ [definite, indefinite]	indefinite	weak

1. _____
2. _____
3. _____
4. _____

Question #: 2

Of the following compounds, __1__ has the **highest** boiling point because it has the
strongest __2__ [fill in a type of intermolecular force] intermolecular forces in the liquid phase.

H_3C—CH_2—CH_2—CH_2—CH_2—CH_3

n-hexane, C_6H_{14}

neohexane, C_6H_{14}
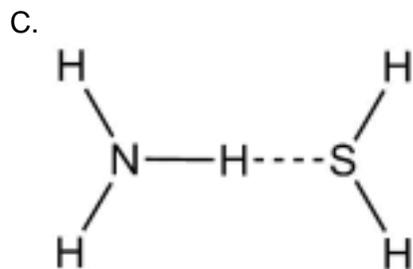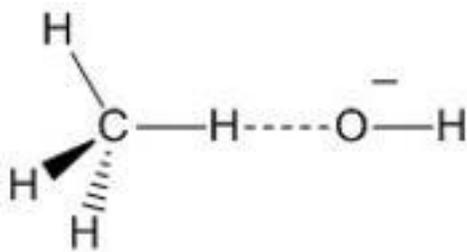
n-pentane, C_5H_{12}

neopentane, C_5H_{12}

1. _____

2. _____

Question #: 3

Which figure shows a very strong hydrogen bond?

A.

H———Br······H

O⁻

B.

H

O——H·····F⁻

C.

H   H

N—H···S

H   H

D.

Question #: 4

Choose the **two** true statements below about surface tension.

    A. Surface tension is the tendency of liquids to maximize their surface area.
    B. Surface tension results from the higher potential energy of surface molecules compared to interior molecules in a liquid.
    C. Generally, liquids with high surface tension also have high viscosity.
    D. Surface tension is the resistance of a liquid to flow.

Question #: 5

A sample of ethanol (C_2H_5OH) is introduced into a sealed container. **Before** dynamic equilibrium is reached, the rate of condensation is _____ the rate of evaporation of ethanol.

    A. less than
    B. equal to
    C. greater than
    D. the opposite of

Question #: 6

The normal boiling point of toluene (C_7H_8) is 384 K. The boiling point of toluene at 1.55 atm is __1__ K.
Enter your answer as a **Kelvin** temperature with **three** significant digits and **without** units.
The heat of vaporization, ΔH_{vap}, of toluene is 38.1 kJ/mol.

1. _____

Question #: 7

Which of the following statements is **<u>true</u>** about the critical point for a substance?

    A. Only a gas exists above the critical temperature.
    B. Only a supercritical fluid exists above the critical point.
    C. The critical pressure is the pressure above which a liquid is stable.
    D. The critical point is the point at which two phases of a substance are in equilibrium.

_____

Question #: 8

Choose the **<u>two true </u>**statements below.

    A. Melting (fusion) is an endothermic process.
    B. Sublimation is an exothermic process.
    C. When a solid is heated to its melting point, the temperature of the solid remains constant while the substance melts.
    D. The heat of fusion of a substance is generally larger than its heat of vaporization.

_____

Question #: 9

Which one of these phase changes is generally the **<u>most</u> <u>exothermic</u>**?

    A. fusion
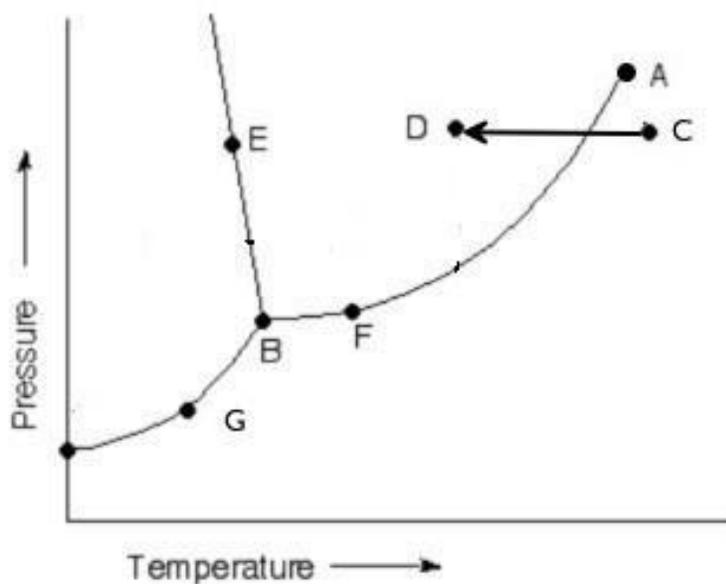   B. deposition
    C. vaporization
    D. sublimation

_____

What is ΔH_{system} when 58.5 g of solid benzene, $C_6H_6(s)$, at 5.53 °C is converted to benzene vapor, $C_6H_6(g)$, 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. +24.2 kJ
B. −7.70 kJ
C. +38.0 kJ
D. −52.1 kJ

Identify the **point** on the phase diagram or the **process** that occurs navigating between the specified points.

Decreasing the temperature at constant pressure from point **C** to point **D**. ___1___

Point B. ___2___

Point G. ___3___

Choose from the following to fill in each blank: **solid-liquid equilibrium, solid-gas equilibrium, vaporization, condensation, triple point, critical point**
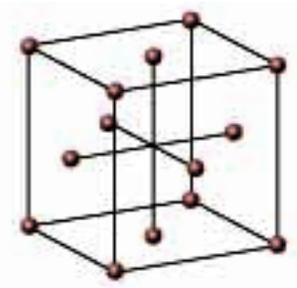
1. _____

2. _____

3. _____

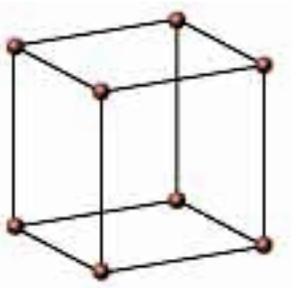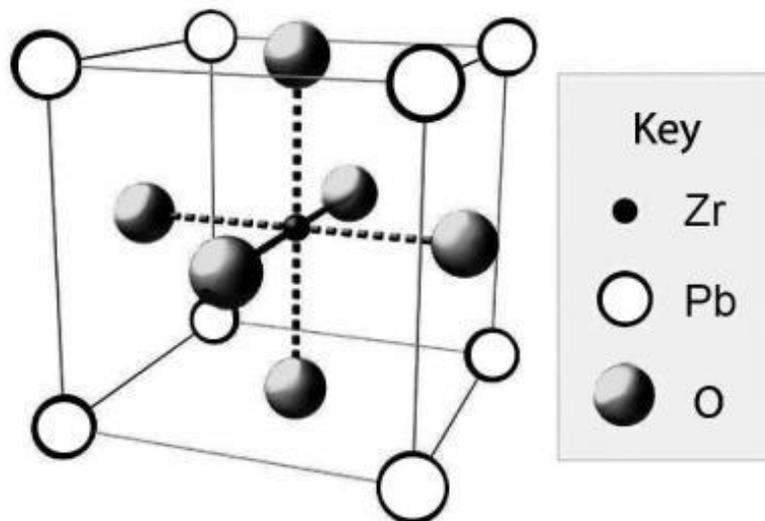Which of these cubic unit cells has the **greatest** packing efficiency?

A.

B.

C.

The formula of the ionic compound with the unit cell below is __1__ .
List the formula in the order Pb# Zr# O#, with the lowest whole-number coefficient for each element (even if it is 1) and a space between each element.
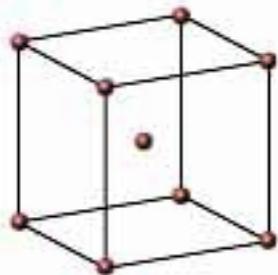

Key

- ● Zr
- ○ Pb
- ◐ O

1. _____

Barium metal crystallizes in a body-centered cubic lattice, as shown below, with an edge length of 507 pm. The density of barium is __1__ g/cm^3.
Report your answer with **two** significant digits. Do **NOT** include units in your answer.

1. _____

Iodine, I_2, has a melting point of 114 °C, whereas methanol (CH_3OH) has a melting point of −98 °C. Why is this true?

    A. Dispersion forces in iodine are stronger than dipole-dipole, hydrogen bonding, and dispersion forces in methanol.

    B. Dispersion forces are always stronger than hydrogen bonding forces.

    C. Iodine is a network covalent solid.

    D. Ionic solids are higher melting than molecular solids.
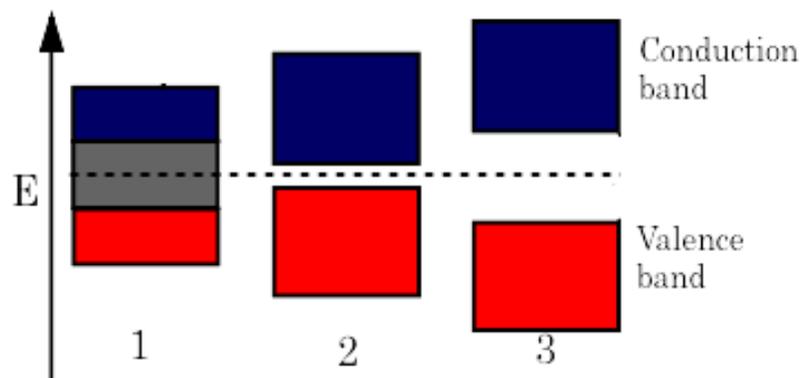

Provide a term to describe the electrical behavior of each of the materials on the band diagram below.

Figure 1 illustrates a(n) __1__.
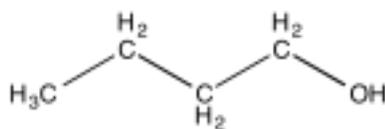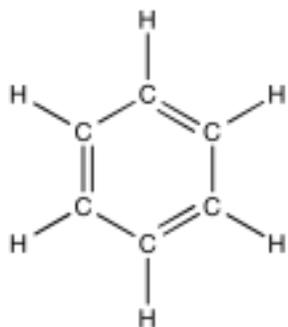Figure 2 illustrates a(n) __2__.
Figure 3 illustrates a(n) __3__.
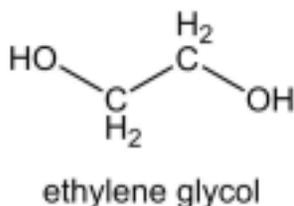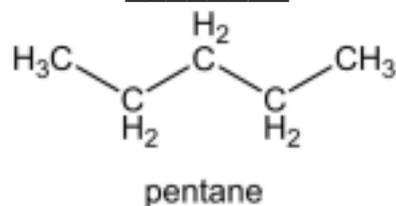

1. _____

2. _____

3. _____

Benzene (C_6H_6) and n-butanol (C_4H_9OH) are miscible with one another in all proportions because

    A. they form strong hydrogen bonds with one another.
    B. there is a large decrease in potential energy for the mixed liquids compared to the two pure liquids.
    C. there is a large increase in entropy for the mixed liquids compared to the two pure liquids.
    D. there are strong dipole-dipole attractions between benzene and *n*-butanol molecules.

The liquids pentane and ethylene glycol are **not** miscible (i.e., they are insoluble in one another) because _____.

pentane   ethylene glycol

    A. intermolecular attractions between pentane molecules are much stronger than intermolecular attractions between ethylene glycol molecules
    B. they are both liquids, and solutes must be solid
    C. intermolecular attractions between pentane and ethylene glycol molecules are weaker than mutual intermolecular attractions between pentane molecules and between ethylene glycol molecules
    D. the entropy of a solution of ethyene glycol in pentane would be less than the entropy of pure pentane and pure ethylene glycol
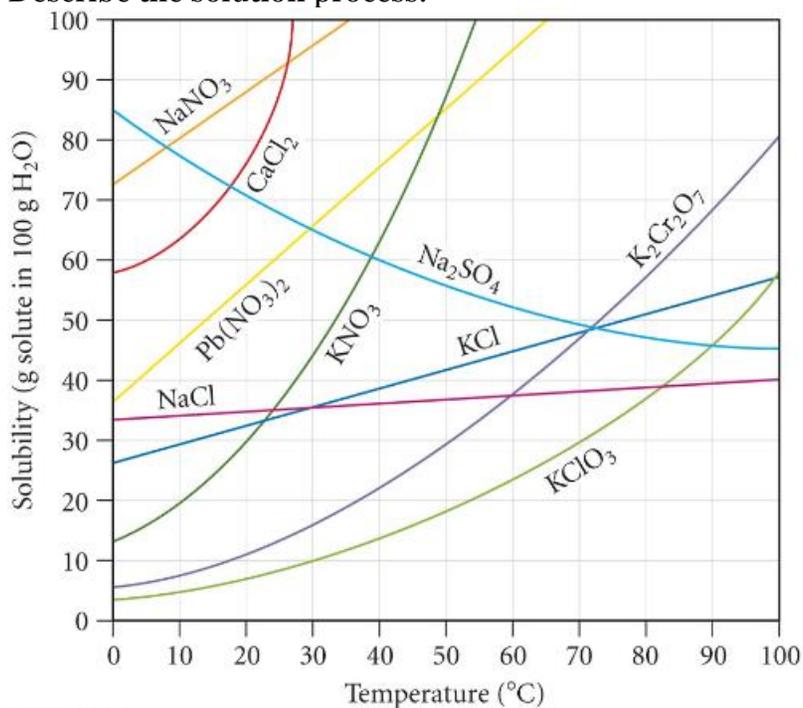

Question #: 19

In a **<u>unsaturated</u>** aqueous solution of $MgCl_2$ with solid $MgCl_2$ present,

    A. $MgCl_2$ is precipitating more rapidly than solid $MgCl_2$ is dissolving.
    B. the processes of dissolution and precipitation have stopped.
    C. $MgCl_2$ is precipitating at the same rate that solid $MgCl_2$ is dissolving.
    D. solid $MgCl_2$ is dissolving more rapidly than $MgCl_2$ is precipitating.

Question #: 20

Water (100.0 g) and solid $K_2Cr_2O_7$ (30.0 g) are warmed from 30 °C to 50 °C with stirring. Describe the solution process.

    A. A saturated solution of $K_2Cr_2O_7$ results at 50 °C.
    B. About half of the $K_2Cr_2O_7$ dissolves, but most of it remains as a solid at 50 °C.
    C. No $K_2Cr_2O_7$ dissolves at 50 °C because ionic solutes are less water soluble at higher temperatures.
    D. An unsaturated solution of $K_2Cr_2O_7$ results at 50 °C.

Question #: 21

An aqueous solution is saturated in both N_2 and KBr at 25 °C.   If the solution is warmed to 80 °C, which of the following processes is most likely to occur?

     A. Some N_2 bubbles out of solution but no KBr precipitates.
     B. No N_2 bubbles out of solution but some KBr precipitates.
     C. Some N_2 bubbles out of solution and some KBr precipitates.
     D. All of the N_2 bubbles out of solution and all of the KBr precipitates.

Question #: 22

The molality of a solution prepared by dissolving 21 grams of sodium bromide (102.9 g/mol) in 85.0 grams of water is ___1___ *m.*
Enter your answer with **two** significant figures.   Do **NOT** include units in your answer.

    1. _____

Question #: 23

A 10.0 L sample of polluted river water with a density of 1.00 g/mL contains 3500 µg (micrograms) of the insecticide DDT ($C_{14}H_9Cl_5$). The concentration of DDT is ___1___ ppm.
Report your answer to **two** significant figures.   Do **NOT** include units in your answer.

    1. _____

Question #: 24

A 35.0% by mass solution of sucrose ($C_{12}H_{22}O_{11}$, 342 g/mol) in water at room temperature has a density of 1.15 g/mL. The concentration of this solution is ___1___ M.
Report your answer to **three** significant figures.   Do **NOT** include units in your answer.

    1. _____

Question #: 25

What is the **molality** of a 1.35 M sucrose (342 g/mol) solution with a density of 1.018 g/mL?

    A. 1.59 M
    B. 1.18 M
    C. 2.43 M
    D. 2.16 M

_____

Question #: 26

For each of the following solutes, enter the expected van't Hoff factor as a whole number (integer).
Na_2SO_4 _1_
$MgSO_4$ _2_
KBr _3_

    1. _____
    2. _____
    3. _____

_____

Question #: 27

A solution at 25 °C contains 0.80 mol H_2O and 0.10 mol of nonvolatile glucose ($C_6H_{12}O_6$).
$P^o(H_2O)$ is 24 torr at 25 °C.
The vapor pressure of the solution is _1_ torr.
Report your answer with **two** significant figures. Do **NOT** include units in your answer.
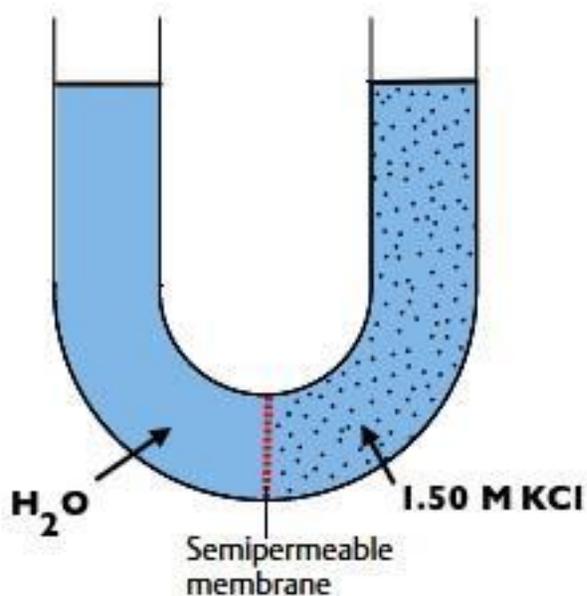
    1. _____

_____

What is the boiling point of a solution of 110. g potassium dichromate ($K_2Cr_2O_7$, 294 g/mol) in 1.50×10^2 g H_2O?
K_b (H_2O) = 0.512 °C/m

   A. 103.8 °C
   B. 100.4 °C
   C. 96.0 °C
   D. 99.3 °C

An osmotic cell with a semipermeable membrane is set up with pure water in the left chamber and 1.50 M KCl in the right chamber. What happens as the cell reaches equilbrium?

H_2O 1.50 M KCl

Semipermeable membrane

   A. The liquid level in the left (H_2O) cell rises.
   B. The liquid level in the right (1.50 M KCl) cell rises.
   C. The levels remain the same.

Of the aqueous solutions below, solution __1__ (**A**, **B**, or **C**) has the **lowest boiling point** and solution __2__ (**A**, **B**, or **C**) has the **lowest freezing point**.

A. 0.02 m $MgBr_2$

B. 0.01 m KI

C. 0.01 m Li_3PO_4

1. _____

2. _____

CHE 107 Exam 1 Fall 2016 - Confidential

Your Name: _____   **Your ID:** _____
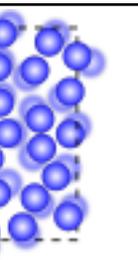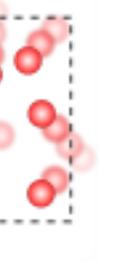
Periodic Table of the Elements

Molar volume of ideal gas at STP = 22.4 L	Ideal gas constant:	Speed of light, $c = 3.00 \times 10^8$ m•s^{-1}
Faraday constant, $F = 9.6485 \times 10^4$ C/mol e	$R = 8.314$ J•K^{-1}•mol^{-1}	Rydberg constant, $R_H = 2.18 \times 10^{-18}$ J
Avogadro's number, $N = 6.022 \times 10^{23}$ mol^{-1}	$R = 1.987$ cal•K^{-1}•mol^{-1}	Electron charge, $e = 1.602 \times 10^{-19}$ C
Planck's constant, $h = 6.626 \times 10^{-34}$ J•s	$R = 8.206 \times 10^{-2}$ L•atm•K^{-1}•mol^{-1}	Atomic mass unit, $u = 1.6605 \times 10^{-24}$ g

attachment_for_pubExamUID_lnxp114744155641568910XX_111.jpg

Question #: 1

ular	State	Density	Shape	Volume	Stre Intern Fo
	solid	high	definite	definite	_1_ [stro
	liquid	_2_ [high, low]	indefinite	_3_ [definite, indefinite]	moderate

gas	low		_4_ [definite, indefinite]	indefinite	weak

1. strong
2. high|hi|
3. definite|definate|
4. indefinite|indefinate|

Question #: 2

Of the following compounds, __1__ has the **highest** boiling point because it has the strongest __2__ [fill in a type of intermolecular force] intermolecular forces in the liquid phase.

n-hexane, C₆H₁₄   neohexane, C₆H₁₄   n-pentane, C₅H₁₂   neopentane, C₅H₁₂
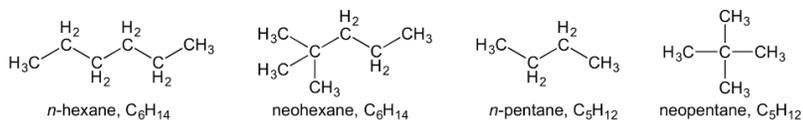
1. n-hexane
2. dispersion|dispercion|dispertion|London|

Question #: 3

Which figure shows a very strong hydrogen bond?

A.

H——Br·······H
　　　　　　　　＼
　　　　　　　　　O⁻

✓B.

H
　＼
　　O——H······F⁻

C.

H　　　　　　H
　＼　　　　　／
　　N——H····S
　／　　　　　＼
H　　　　　　H

D.

H
　＼
　　C——H·····O⁻—H
H／┊
　　H

Question #: 4

Choose the **two** true statements below about surface tension.

    A. Surface tension is the tendency of liquids to maximize their surface area.
  ✓B. Surface tension results from the higher potential energy of surface molecules compared to interior molecules in a liquid.
  ✓C. Generally, liquids with high surface tension also have high viscosity.
    D. Surface tension is the resistance of a liquid to flow.

Question #: 5

A sample of ethanol (C_2H_5OH) is introduced into a sealed container. **Before** dynamic equilibrium is reached, the rate of condensation is _____ the rate of evaporation of ethanol.

   ✓A. less than
   B. equal to
   C. greater than
   D. the opposite of

Question #: 6

The normal boiling point of toluene (C_7H_8) is 384 K. The boiling point of toluene at 1.55 atm is __1__ K.

Enter your answer as a **Kelvin** temperature with **three** significant digits and **without** units.
The heat of vaporization, ΔH_{vap}, of toluene is 38.1 kJ/mol.

   1. 399|400|401|402|403|404|405|406|407|391|392|393|394|395|396|397|398|

Question #: 7

Which of the following statements is **true** about the critical point for a substance?

   A. Only a gas exists above the critical temperature.
   ✓B. Only a supercritical fluid exists above the critical point.
   C. The critical pressure is the pressure above which a liquid is stable.
   D. The critical point is the point at which two phases of a substance are in equilibrium.

Question #: 8

Choose the **two true** statements below.

   ✓A. Melting (fusion) is an endothermic process.
   B. Sublimation is an exothermic process.
   ✓C. When a solid is heated to its melting point, the temperature of the solid remains constant while the substance melts.
   D. The heat of fusion of a substance is generally larger than its heat of vaporization.

Which one of these phase changes is generally the **most exothermic**?

    A. fusion
  ✓B. deposition
    C. vaporization
    D. sublimation

What is ΔH_{system} when 58.5 g of solid benzene, $C_6H_6(s)$, at 5.53 °C is converted to benzene vapor, $C_6H_6(g)$, at 80.1 °C?

molar mass C_6H_6	78.11 g/mol
melting point	5.53 °C
boiling point	80.1 °C
H_{fus}	9.90 kJ/mol
H_{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. +24.2 kJ
    B. −7.70 kJ
  ✓C. +38.0 kJ
    D. −52.1 kJ
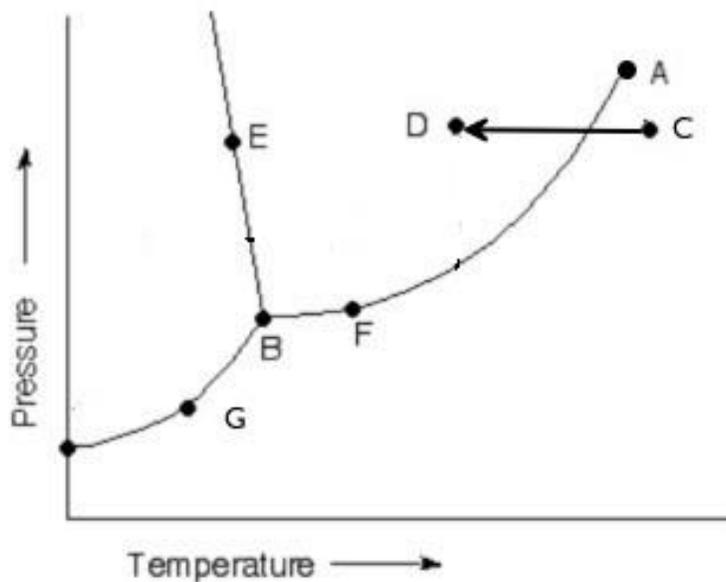
Identify the **point** on the phase diagram or the **process** that occurs navigating between the specified points.

Decreasing the temperature at constant pressure from point **C** to point **D**. __1__

Point B. __2__

Point G. __3__

Choose from the following to fill in each blank: **solid-liquid equilibrium, solid-gas equilibrium, vaporization, condensation, triple point, critical point**

1. condensation|condansation|condonsation|
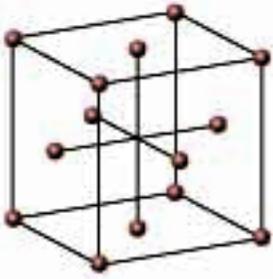2. triple point
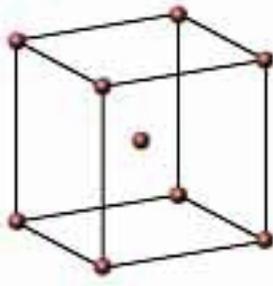3. solid-gas equilibrium

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Question #: 12

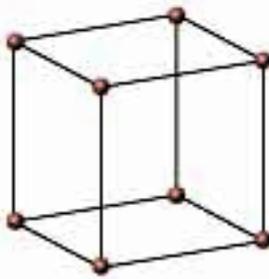Which of these cubic unit cells has the **greatest** packing efficiency?

✓A.

B.

C.

Question #: 13

The formula of the ionic compound with the unit cell below is __1__.

List the formula in the order Pb# Zr# O#, with the lowest whole-number coefficient for each element (even if it is 1) and a space between each element.
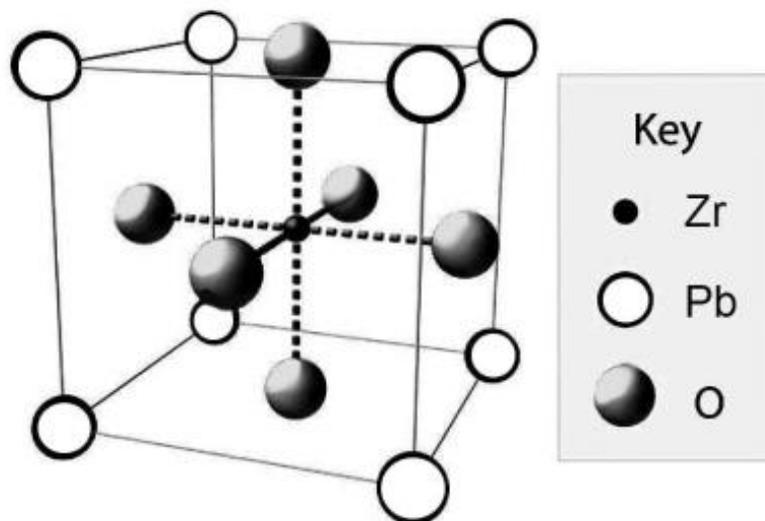
1. Pb1 Zr1 O3|Pb1Zr1O3|PbZrO3|Pb Zr O3|

Question #: 14

Barium metal crystallizes in a body-centered cubic lattice, as shown below, with an edge length of 507 pm. The density of barium is ___1___ g/cm^3.
Report your answer with **two** significant digits. Do **NOT** include units in your answer.
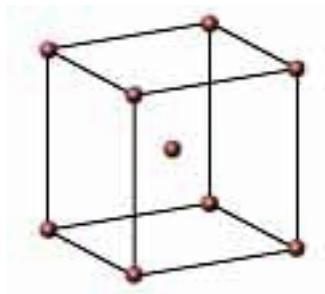
1. 3.5|3.4|3.6|

Question #: 15

Iodine, I$_2$, has a melting point of 114 °C, whereas methanol (CH$_3$OH) has a melting point of −98 °C. Why is this true?

✓A. Dispersion forces in iodine are stronger than dipole-dipole, hydrogen bonding, and dispersion forces in methanol.

   B. Dispersion forces are always stronger than hydrogen bonding forces.

   C. Iodine is a network covalent solid.

   D. Ionic solids are higher melting than molecular solids.

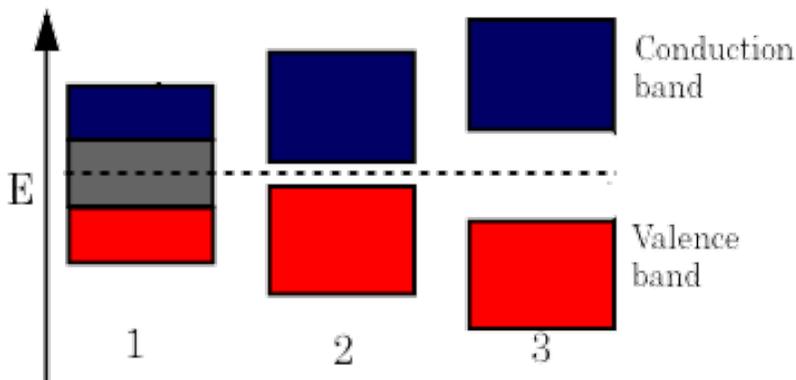**Question #:** 16

Provide a term to describe the electrical behavior of each of the materials on the band diagram below.

Figure 1 illustrates a(n) __1__ .
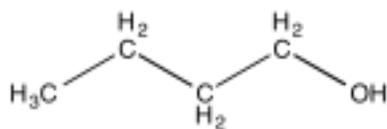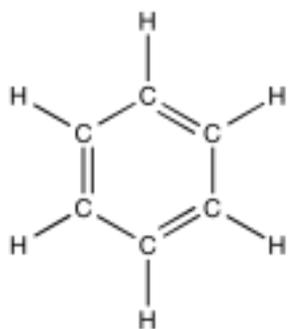
Figure 2 illustrates a(n) __2__ .

Figure 3 illustrates a(n) __3__ .

   1. metal|mettal|medal|

   2. semiconductor|semi conductor|semiconducter|

   3. Insulator|insulater|insulation|
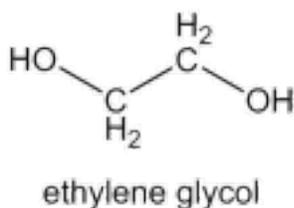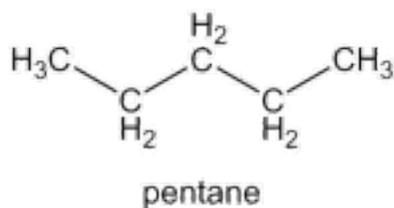

Question #: 17

Benzene (C_6H_6) and n-butanol (C_4H_9OH) are miscible with one another in all proportions because

    A. they form strong hydrogen bonds with one another.
    B. there is a large decrease in potential energy for the mixed liquids compared to the two pure liquids.
  ✓C. there is a large increase in entropy for the mixed liquids compared to the two pure liquids.
    D. there are strong dipole-dipole attractions between benzene and *n*-butanol molecules.

Question #: 18

The liquids pentane and ethylene glycol are **not** miscible (i.e., they are insoluble in one another) because _____.

pentane   ethylene glycol

    A. intermolecular attractions between pentane molecules are much stronger than intermolecular attractions between ethylene glycol molecules
    B. they are both liquids, and solutes must be solid
  ✓C. intermolecular attractions between pentane and ethylene glycol molecules are weaker than mutual intermolecular attractions between pentane molecules and between ethylene glycol molecules
    D. the entropy of a solution of ethyene glycol in pentane would be less than the entropy of pure pentane and pure ethylene glycol
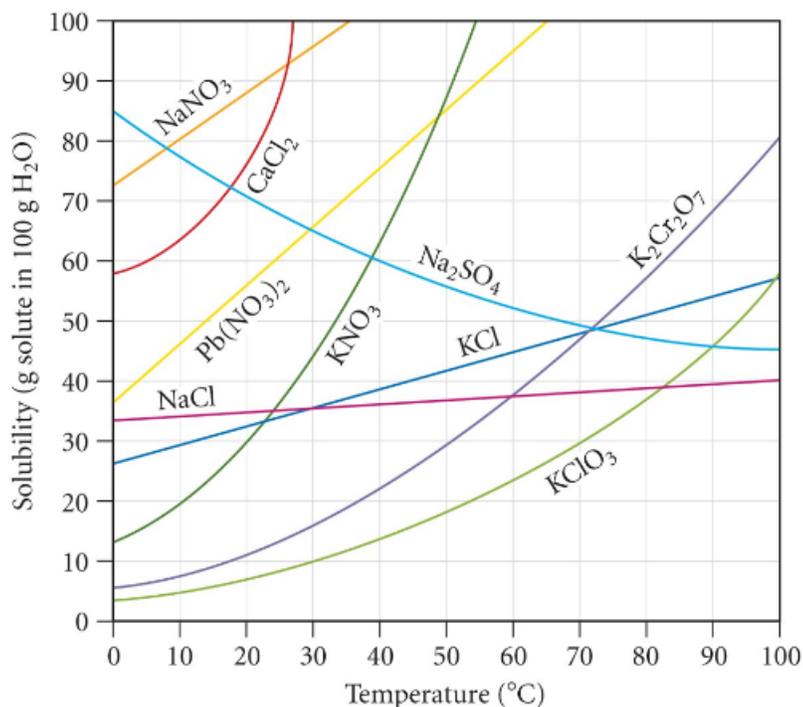
In a **unsaturated** aqueous solution of $MgCl_2$ with solid $MgCl_2$ present,

A. $MgCl_2$ is precipitating more rapidly than solid $MgCl_2$ is dissolving.
B. the processes of dissolution and precipitation have stopped.
C. $MgCl_2$ is precipitating at the same rate that solid $MgCl_2$ is dissolving.
✓D. solid $MgCl_2$ is dissolving more rapidly than $MgCl_2$ is precipitating.

Water (100.0 g) and solid $K_2Cr_2O_7$ (30.0 g) are warmed from 30 °C to 50 °C with stirring. Describe the solution process.

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✓A. A saturated solution of $K_2Cr_2O_7$ results at 50 °C.
B. About half of the $K_2Cr_2O_7$ dissolves, but most of it remains as a solid at 50 °C.
C. No $K_2Cr_2O_7$ dissolves at 50 °C because ionic solutes are less water soluble at higher temperatures.
D. An unsaturated solution of $K_2Cr_2O_7$ results at 50 °C.

Question #: 21

An aqueous solution is saturated in both N_2 and KBr at 25 °C. If the solution is warmed to 80 °C, which of the following processes is most likely to occur?

    ✓A. Some N_2 bubbles out of solution but no KBr precipitates.
    B. No N_2 bubbles out of solution but some KBr precipitates.
    C. Some N_2 bubbles out of solution and some KBr precipitates.
    D. All of the N_2 bubbles out of solution and all of the KBr precipitates.

Question #: 22

The molality of a solution prepared by dissolving 21 grams of sodium bromide (102.9 g/mol) in 85.0 grams of water is __1__ *m*.
Enter your answer with **two** significant figures. Do **NOT** include units in your answer.

    1. 2.4|2.4E0|

Question #: 23

A 10.0 L sample of polluted river water with a density of 1.00 g/mL contains 3500 µg (micrograms) of the insecticide DDT ($C_{14}H_9Cl_5$). The concentration of DDT is __1__ ppm.
Report your answer to **two** significant figures. Do **NOT** include units in your answer.

    1. 0.35|.35|0.36|.36|0.34|.34|

Question #: 24

A 35.0% by mass solution of sucrose ($C_{12}H_{22}O_{11}$, 342 g/mol) in water at room temperature has a density of 1.15 g/mL. The concentration of this solution is __1__ M.
Report your answer to **three** significant figures. Do **NOT** include units in your answer.
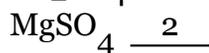
    1. 1.18|1.19|1.20|1.16|1.17|

Question #: 25

What is the **molality** of a 1.35 M sucrose (342 g/mol) solution with a density of 1.018 g/mL?

    A. 1.59 M
    B. 1.18 M
    ✓C. 2.43 M
    D. 2.16 M

Question #: 26

For each of the following solutes, enter the expected van't Hoff factor as a whole number (integer).

Na_2SO_4 ___1___
$MgSO_4$ ___2___
KBr ___3___

    1. $\frac{3}{}$
    2. $\frac{2}{}$
    3. $\frac{2}{}$

Question #: 27

A solution at 25 °C contains 0.80 mol H_2O and 0.10 mol of nonvolatile glucose ($C_6H_{12}O_6$). $P°(H_2O)$ is 24 torr at 25 °C.
The vapor pressure of the solution is ___1___ torr.
Report your answer with **two** significant figures. Do **NOT** include units in your answer.
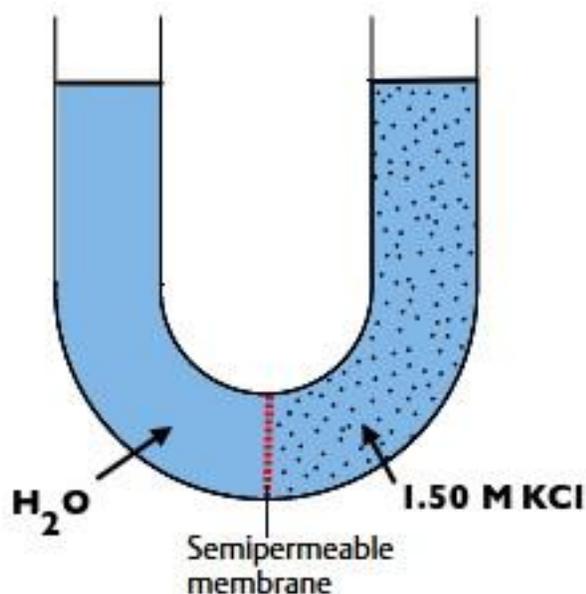
    1. 21|21.3|

Question #: 28

What is the boiling point of a solution of 110. g potassium dichromate ($K_2Cr_2O_7$, 294 g/mol) in 1.50×10^2 g H_2O?
$K_b (H_2O) = 0.512 °C/m$

✓A. 103.8 °C
  B. 100.4 °C
  C. 96.0 °C
  D. 99.3 °C

Question #: 29

An osmotic cell with a semipermeable membrane is set up with pure water in the left chamber and 1.50 M KCl in the right chamber. What happens as the cell reaches equilbrium?

  A. The liquid level in the left (H_2O) cell rises.
✓B. The liquid level in the right (1.50 M KCl) cell rises.
  C. The levels remain the same.

Question #: 30

Of the aqueous solutions below, solution __1__ (**A, B,** or **C**) has the **lowest boiling point** and solution __2__ (**A, B,** or **C**) has the **lowest freezing point**.

A. 0.02 m MgBr$_2$

B. 0.01 m KI

C. 0.01 m Li$_3$PO$_4$

1. B|B.|b|b.|
2. A|A.|a|a.|