

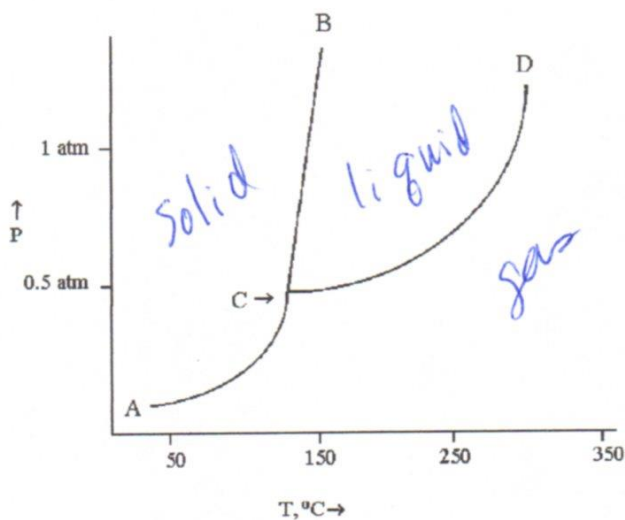
Name key (print) Name _____ (sign)

Please show work for partial credit & full credit on the Short Answer Questions. Multiple choice questions have no partial credit. Please write anything you want graded legibly. If you run out of space, continue on the empty back pages but clearly label where the remaining answers can be found. (Please count your exam pages and make sure there are ## pages) For the multiple choice, put the Test Form number (CA or CB) on the scantron and be sure to fully erase any wrong answer pencil marks. and fully mark your correct answers.

$(M = \text{moles solute} / \text{L solution})$ $(m = \text{moles solute} / \text{kg solvent})$
 $[\text{mass \%} = (\text{mass of solute} / \text{mass solution}) * 100]$ $[X (\text{mole fraction}) = \text{moles solute or solvent} / \text{moles solution}]$
 $(K = ^\circ\text{C} + 273.15)$ $[\text{mass \%} = (\text{mass of solute} / \text{mass solution}) * 100]$ $\Delta T_b = i K_b m$ $\Delta T_f = i K_f m$
 $P_{\text{solution}} = i P_{\text{solvent}} X_{\text{solvent}}$ $\Pi = i M R T$ $[R = 0.08206 \text{ L atm} / (\text{mol K})]$

MULTIPLE CHOICE. Choose the one best alternative.

Use the diagram below to answer the following questions.



1) The temperature and pressure at which all three phases can coexist in equilibrium is

- A) 1.0 atm and 140°C.
 B) 0.45 atm and 130°C.
 C) 0.25 atm and 110°C.
 D) 1.25 atm and 300°C.

1) B

2) Boiling occurs along the

- A) CD line.
 B) AC line.
 C) CB line.
 D) All of these

2) A

3) Which of the following solutions will have the lowest freezing point?

- A) 0.0150 m MgCl₂
 B) 0.0100 m NaCl
 C) 0.0400 m CH₃CH₂CH₂OH
 D) 0.0120 m Li₂SO₄

3) A

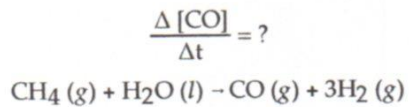
Handwritten calculations:
 For A: $0.015 \times 3 = 0.045$
 For B: $0.0100 \times 2 = 0.02$
 For D: $0.012 \times 3 = 0.036$

- 4) When ethylene glycol, HOCH₂CH₂OH, is added to the water in an automobile radiator, the effect is to 4) B
- A) raise the boiling point and raise the freezing point.
 - B) raise the boiling point and lower the freezing point.**
 - C) lower the boiling point and lower the freezing point.
 - D) lower the boiling point and raise the freezing point.

- 5) Which type of bonding does solid diamond form? 5) A
- A) covalent network**
 - B) ionic
 - C) molecular
 - D) metallic

- 6) In general, as the temperature increases, the solubility of solids in water in and the solubility of most gases in water de. 6) A
- A) increases, decreases**
 - B) decreases, increases
 - C) increases, increases
 - D) decreases, decreases

- 7) Molecular hydrogen can be made from methane gas by the reaction below. How is the rate of appearance of CO related to the rate of appearance of H₂? 7) B



- A) $+\frac{\Delta [\text{H}_2]}{\Delta t}$
- B) $+\frac{1\Delta [\text{H}_2]}{3\Delta t}$**
- C) $+3\frac{\Delta [\text{H}_2]}{\Delta t}$
- D) none of these

- 8) The decomposition of dinitrogen pentoxide is described by the chemical equation 8) B
- $$2\text{N}_2\text{O}_5(\text{g}) \rightarrow 4\text{NO}_2(\text{g}) + \text{O}_2(\text{g})$$
- $\frac{1}{4} \frac{\Delta \text{NO}_2}{\Delta t} = \frac{1}{2} \frac{\Delta \text{N}_2\text{O}_5}{\Delta t}$
 $\Delta \text{N}_2\text{O}_5 / \Delta t = (2/4) \frac{\Delta \text{NO}_2}{\Delta t}$
 $\frac{\Delta \text{NO}_2}{\Delta t} = 1.40$
 $(\frac{2}{4})(1.40)$

If the rate of appearance of NO₂ is equal to 1.40 mol/min at a particular moment, what is the rate of disappearance of N₂O₅ at that moment?

- A) 5.60 mol/min
- B) 0.700 mol/min**
- C) 1.40 mol/min
- D) 2.80 mol/min

- 9) What is the weight percent of vitamin C in a solution made by dissolving 1.30 g of vitamin C, C₆H₈O₆, in 55.0 g of water? 9) D
- A) 2.36%
 - B) 0.195%
 - C) 0.242%
 - D) 2.31%**

- 10) To make a 0.125 M solution, one could take 0.125 moles of solute and add 10) D
- A) enough solvent to make 1.00 kg of solution.
 - B) 1.00 kg of solvent.
 - C) 1.00 L of solvent.
 - D) enough solvent to make 1.00 L of solution.**

11) For the process of dissolving a solid in a liquid, which of the following statements is true?

- A) ΔH_{soln} is either positive or negative and ΔS_{soln} is usually positive.
B) ΔH_{soln} is always positive and ΔS_{soln} is usually negative.
C) ΔH_{soln} is either positive or negative and ΔS_{soln} is usually negative.
D) ΔH_{soln} is always negative and ΔS_{soln} is usually positive.

11) A

12) Arrange the following compounds in order of their expected ~~decreasing~~ ^{increasing - typo} solubility in water:

NaCl, CH₃CH₂-O-CH₂CH₃, CH₃CH₂CH₂CH₂-OH, CH₃CH₂CH₂CH₃.

- A) CH₃CH₂CH₂CH₃ < CH₃CH₂-O-CH₂CH₃ < NaCl < CH₃CH₂CH₂CH₂-OH
B) CH₃CH₂CH₂CH₃ < NaCl < CH₃CH₂-O-CH₂CH₃ < CH₃CH₂CH₂CH₂-OH
 C) CH₃CH₂CH₂CH₃ < CH₃CH₂-O-CH₂CH₃ < CH₃CH₂CH₂CH₂-OH < NaCl
D) NaCl < CH₃CH₂-O-CH₂CH₃ < CH₃CH₂CH₂CH₂-OH < CH₃CH₂CH₂CH₃

12) C

13) Molality is defined as moles of solute per

- A) total moles present. B) liter of solvent.
 C) kilogram of solvent. D) mole of solvent.

13) C

14) Which of the following forms a molecular solid?

- A) C₉H₈O₄ B) C, graphite C) palladium D) CaCl₂

14) A

15) Solids having no ordered long-range structure are classified as

- A) nonmetallic solids. B) covalent network solids.
 C) amorphous solids. D) crystalline solids.

15) C

16) A solution is made by dissolving 19.5 g of sucrose, C₁₂H₂₂O₁₁, (FM = 342.34 g/mol) water producing a solution with a volume of 125 mL at 293.15 K. What is the expected osmotic pressure?

- A) 50.0 atm B) 11.0 atm C) 58 atm D) 23.2 atm

16) B

$$\left[\frac{19.5 \text{ g}}{342.34} \right] (0.08206) (293.15) = 10.96$$

$i = 1$

Part II: Short Answers Please show work on all questions for partial credit even on questions which do not specify. (40 total pts)

Hint: Please watch the units on all work to ensure that your answer is correct.

(M = moles solute / L solution) (m = moles solute / kg solvent)
 [mass % = (mass of solute / mass solution) * 100] [X (mole fraction) = moles solute or solvent / moles solution]
 (K = °C + 273.15) [mass % = (mass of solute / mass solution) * 100] $\Delta T_b = i K_b m$ $\Delta T_f = i K_f m$
 $P_{\text{solution}} = i P_{\text{solvent}} X_{\text{solvent}}$ $\Pi = i M R T$ [R = 0.08206 L atm / (mol K)]

1. You have a solution made by dissolving 1.27 grams of Li_3PO_4 (FM = 115.79 g/mol) in 245.3 grams of water (FM water = 18.02 g/mol). The entire solution fits into a volumetric flask with a solution volume of 250.1 mL

(a) What is the molarity of the solution? (8 pts)

(BA-4)

$$\text{mole} = \frac{1.27 \text{ g}}{115.79} = 0.01097 \text{ mole} = 0.0439 \text{ M}$$

$\frac{250.1 \text{ mL}}{1000 \text{ mL/L}} = 0.2501 \text{ L}$

$\frac{0.01097 \text{ mole}}{0.2501 \text{ L}} = 0.0439 \text{ M}$

~~$\frac{0.01097 \text{ mole}}{0.2453 \text{ L}} = 0.0447 \text{ M}$~~

(b) What is the molality of the solution? (8 pts)

(BA-4)

$$\frac{0.01097 \text{ mol } \text{Li}_3\text{PO}_4}{245.3 \text{ g} / (1000 \text{ g/kg})} = 0.0447 \text{ m}$$

(2 pt) \rightarrow (4 pt) \leftarrow (4 pt)

(4 pt) \leftarrow (4 pt)

(2 pt left off) (used mL not g -)

(c) What is the mole fraction of the solution? (8 pts)

(BA-4) math - 1/2 pt

$$\frac{0.01097 \text{ mol}}{\left(\frac{245.3 \text{ g H}_2\text{O}}{18.02 \text{ g/mol}} \right) + 0.01097} = 8.05 \times 10^{-4}$$

(4 pts) \rightarrow (4 pts) \rightarrow (2 pt) \rightarrow (2 pt)

(4 pts) \rightarrow (2 pt) \rightarrow (2 pt)

2. What is the Freezing Point for the following solution. You dissolve 17.9 grams of Na_3PO_4 (FM = 163.97 g/mol) in 0.289 kilograms of water. [FP water = 0.0°C , $K_f = 1.86^\circ\text{C kg/mol}$] (8 pts)

$$\frac{17.9 \text{ g Na}_3\text{PO}_4}{163.97 \text{ g/mol}} = 0.109 \text{ mol} \quad (2 \text{ pt}) \quad \Delta T_f = i K_f m$$

$$i = 4 \quad (1 \text{ pt}) \quad m = \frac{\text{mol}}{\text{kg solve}}$$

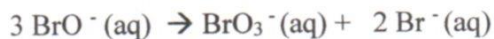
$$\frac{0.109 \text{ mol Na}_3\text{PO}_4}{0.289 \text{ kg H}_2\text{O}} = 0.377 \text{ m} \quad (2 \text{ pt})$$

$$\Delta T_f = (4)(1.86^\circ\text{C kg/mol})(0.377) = 2.80^\circ\text{C}$$

$$\text{FP} = 0.0^\circ\text{C} - 2.80^\circ\text{C} = -2.80^\circ\text{C} \quad (2 \text{ pt})$$

(1 pt)

3. Given the reaction, write the rate expression ($\Delta [\text{reactant} / \text{product}] / \Delta t$) for the relationship between the rate of the BrO_3^- and the rate of BrO^- (8 pts)



$$\frac{\Delta \text{BrO}_3^-}{\Delta t} = -\frac{1}{3} \frac{\Delta \text{BrO}^-}{\Delta t}$$

Sign - 1/2 pt

wrong #
1 pt

extra
incorrect
stuff -2 pt

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Make green pen

(M = moles solute / L solution) (m = moles solute / kg solvent)

[mass % = (mass of solute / mass solution) * 100] [X (mole fraction) = moles solute or solvent / moles solution]

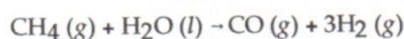
(K = °C + 273.15) [mass % = (mass of solute / mass solution) * 100] $\Delta T_b = i K_b m$ $\Delta T_f = i K_f m$

$P_{\text{solution}} = i P_{\text{solvent}} X_{\text{solvent}}$ $\Pi = i M R T$ [R = 0.08206 L atm / (mol K)]

MULTIPLE CHOICE. Choose the one best alternative.

- 1) When ethylene glycol, HOCH₂CH₂OH, is added to the water in an automobile radiator, the effect is to 1) C
- A) lower the boiling point and lower the freezing point.
 B) lower the boiling point and raise the freezing point.
 C) raise the boiling point and lower the freezing point.
 D) raise the boiling point and raise the freezing point.
- 2) For the process of dissolving a solid in a liquid, which of the following statements is true? 2) D
- A) ΔH_{soln} is always positive and ΔS_{soln} is usually negative.
 B) ΔH_{soln} is either positive or negative and ΔS_{soln} is usually negative.
 C) ΔH_{soln} is always negative and ΔS_{soln} is usually positive.
 D) ΔH_{soln} is either positive or negative and ΔS_{soln} is usually positive.
- 3) Molarity is defined as moles of solute per 3) D
- A) kilogram of solvent.
 B) mole of solute.
 C) total moles present.
 D) liter of solution.
- 4) Molecular hydrogen can be made from methane gas by the reaction below. How is the rate of appearance of CO related to the rate of appearance of H₂? 4) B

$$\frac{\Delta [\text{CO}]}{\Delta t} = ?$$



A) $+\frac{\Delta [\text{H}_2]}{\Delta t}$

B) $+\frac{1\Delta [\text{H}_2]}{3\Delta t}$

C) $+3\frac{\Delta [\text{H}_2]}{\Delta t}$

D) none of these

5) The decomposition of dinitrogen pentoxide is described by the chemical equation



If the rate of appearance of NO_2 is equal to 1.40 mol/min at a particular moment, what is the rate of disappearance of N_2O_5 at that moment?

- A) 2.80 mol/min **B) 0.700 mol/min** C) 1.40 mol/min D) 5.60 mol/min

5) B

6) A 0.50 m solution of which solute has the smallest van't Hoff factor?

- A) CaF_2 **B) NaNO_3** C) Li_3PO_4 D) K_2CO_3

3

2

4

3

6) B

7) In general, as the temperature increases, the solubility of solids in water in and the solubility of most gases in water de.

- A) increases, increases **B) decreases, decreases**
C) decreases, increases **D) increases, decreases**

7) D

8) To make a 0.125 m solution, one could take 0.125 moles of solute and add

- A) enough solvent to make 1.00 L of solution.
B) enough solvent to make 1.00 kg of solution.
C) 1.00 kg of solvent.
D) 1.00 L of solvent.

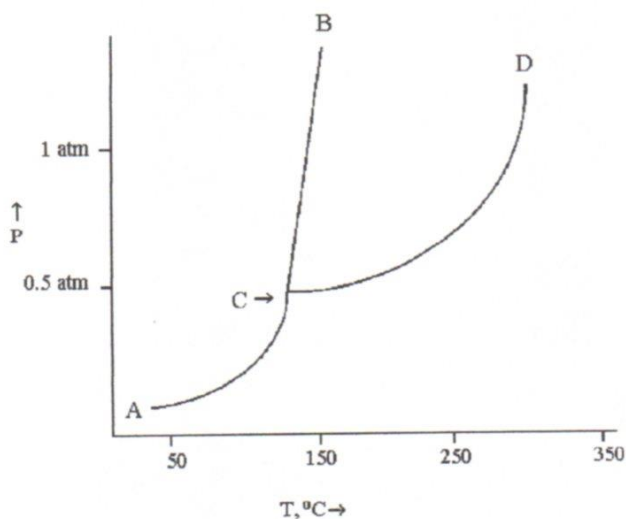
8) C

9) Which of the following forms an ionic solid?

- A) NH_3 **B) NH_4Cl** C) CH_3NH_2 D) Au

9) B

Use the diagram below to answer the following questions.



10) Boiling occurs along the

- A) AC line. **B) CD line.** C) CB line. D) All of these

10) B

- 11) The temperature and pressure at which all three phases can coexist in equilibrium is 11) C
 A) 1.25 atm and 300°C. B) 0.25 atm and 110°C.
 C) 0.45 atm and 130°C. D) 1.0 atm and 140°C.
- 12) Solids having no ordered long-range structure are classified as 12) D
 A) covalent network solids. B) nonmetallic solids.
 C) crystalline solids. D) amorphous solids.
- 13) What is the weight percent of a caffeine solution made by dissolving 4.35 g of caffeine, $C_8H_{10}N_4O_2$, in 75 g of benzene, C_6H_6 ? 13) A
 A) 5.5% B) 0.058% C) 5.8% D) 0.055%
 (Handwritten: $\frac{4.35}{75 + 4.35}$)
- 14) A solution is made by dissolving 19.5 g of sucrose, $C_{12}H_{22}O_{11}$, (FM = 342.34 g/mol) water producing a solution with a volume of 125 mL at 293.15 K. What is the expected osmotic pressure? 14) D
 A) 23.2 atm B) 58 atm C) 50.0 atm D) 11.0 atm
 (Handwritten: $[(19.5g/342.34)/0.125L](293.15)(0.08206)$)
- 15) Arrange the following compounds in order of their expected decreasing solubility in water: 15) B
 $NaCl, CH_3CH_2-O-CH_2CH_3, CH_3CH_2CH_2CH_2-OH, CH_3CH_2CH_2CH_3$.
 A) $CH_3CH_2CH_2CH_3 < CH_3CH_2-O-CH_2CH_3 < NaCl < CH_3CH_2CH_2CH_2-OH$
 B) $CH_3CH_2CH_2CH_3 < CH_3CH_2-O-CH_2CH_3 < CH_3CH_2CH_2CH_2-OH < NaCl$
 C) $CH_3CH_2CH_2CH_3 < NaCl < CH_3CH_2-O-CH_2CH_3 < CH_3CH_2CH_2CH_2-OH$
 D) $NaCl < CH_3CH_2-O-CH_2CH_3 < CH_3CH_2CH_2CH_2-OH < CH_3CH_2CH_2CH_3$
 (Handwritten: increasing)
- 16) Which of the following solutions will have the **lowest** freezing point? 16) C
 A) 0.0120 m Li_2SO_4 B) 0.0400 m $CH_3CH_2CH_2OH$
 C) 0.0150 m $MgCl_2$ D) 0.0100 m $NaCl$
 (Handwritten: $3 \times 0.012 = 0.036$, $3 \times 0.015 = 0.045$, $0.01 \times 2 = 0.02$)

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Hint: Please watch the units on all work to ensure that your answer is correct.

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 [mass % = (mass of solute / mass solution) * 100] [X (mole fraction) = moles solute or solvent / moles solution]
 $(K = \Delta C + 273.15)$ [mass % = (mass of solute / mass solution) * 100] $\Delta T_b = i K_b m$ $\Delta T_f = i K_f m$
 $P_{\text{solution}} = i P_{\text{solvent}} X_{\text{solvent}}$ $\Pi = i M R T$ [R = 0.08206 L atm / (mol K)]

1. You have a solution made by dissolving 9.77 grams of Na_3PO_4 (FM = 163.97 g/mol) in 501.2 grams of water (FM water = 18.02 g/mol). The entire solution fits into a volumetric flask with a solution volume of 502.7 mL

(a) What is the molarity of the solution ? (8 pts)

$$\frac{9.77 \text{ g}}{163.97} = 0.0596 \text{ mol} \quad \text{(BA-4)}$$

$$\frac{0.0596 \text{ mol}}{502.7 \text{ mL} / 1000 \text{ mL/L}} = 0.119 \text{ M} \quad \begin{matrix} \text{(4 pt)} \\ \text{(4 pt)} \end{matrix}$$

(b) What is the molality of the solution ? (8 pts)

$$\frac{0.0596 \text{ mol}}{501.2 \text{ g} / 1000 \text{ g/kg}} = 0.119 \text{ m} \quad \begin{matrix} \text{(BA-4)} \\ \text{(4 pt)} \\ \text{(4 pt)} \end{matrix}$$

used ml not g - 1

(c) What is the mole fraction of the solution ? (8 pts)

$$\frac{501.2 \text{ g}}{18.02 \text{ g}} = 27.8 \text{ mol} \quad \begin{matrix} \text{solute in} \\ \text{(BA-4)} \end{matrix}$$

$$\frac{0.0596 \text{ mol}}{27.8 \text{ mol} + 0.0596 \text{ mol}} = 2.14 \times 10^{-3} \quad \begin{matrix} \text{(4 pt)} \\ \text{(4 pt)} \end{matrix}$$

left - 2 pt off

2 What is the Boiling Point for the following solution. Assume complete dissociation of the solute in the water. You dissolve 59.4 grams of Li_3PO_4 (FM= 115.79 g/mol) in 259.8 grams of water. [BP water = 100.0°C , $K_b = 0.51^\circ\text{C kg/mol}$] (8 pts)

$$\left(\frac{59.4 \text{ g}}{115.79 \text{ g/mol}} \right) \cdot 0.513 = 1.97 \text{ m}$$

$\Delta T_b = i k_b m$
 $i = 4$ 1 pt

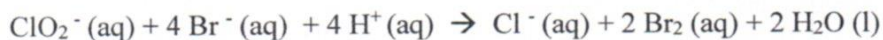
$$\Delta T_b = (4)(0.51)(1.97 \text{ m}) = 4.0^\circ\text{C}$$

eqn. -2

$$\text{BP} = 100.0^\circ\text{C} + 4.0^\circ\text{C} = 104.0^\circ\text{C}$$

1 pt

3. Given the reaction, write the rate expression ($\Delta [\text{product/reactant}] / \Delta t$) for the relationship between the rate of the Br^- and the rate of ClO_2^- (8 pts)



$$\frac{1}{4} \frac{\Delta [\text{Br}^-]}{\Delta t} = \frac{\Delta [\text{ClO}_2^-]}{\Delta t}$$

either OK.
 both + or
 both -

wrong #
 -1 pt

sign
 -1/2 pt

extra
 incorrect
 stuff
 -2 pt

Name Key (print) Name _____ (sign)

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$$[\text{mass \%} = (\text{mass of solute} / \text{mass solution}) * 100] \quad [X (\text{mole fraction}) = \text{moles solute or solvent} / \text{moles solution}]$$

$$(K = 0.01) \quad [\text{mass \%} = (\text{mass of solute} / \text{mass solution}) * 100] \quad \Delta T_b = i K_b m \quad \Delta T_f = i K_f m$$

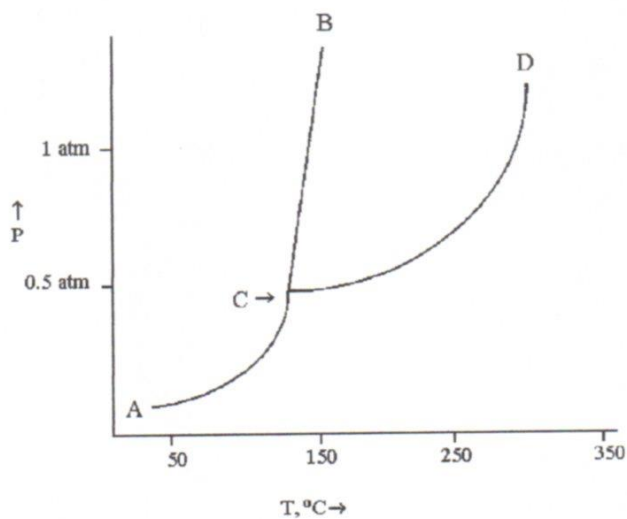
$$P_{\text{solution}} = i P_{\text{solvent}} X_{\text{solvent}} \quad \Pi = i M R T \quad [R = 0.08206 \text{ L atm} / (\text{mol K})]$$

MULTIPLE CHOICE. Choose the one best alternative.

- 1) To make a 0.125 m solution, one could take 0.125 moles of solute and add
- A) enough solvent to make 1.00 kg of solution.
 - B) enough solvent to make 1.00 L of solution.
 - C) 1.00 L of solvent.
 - D) 1.00 kg of solvent.**

1) D

Use the diagram below to answer the following questions.



- 2) The temperature and pressure at which all three phases can coexist in equilibrium is
- A) 1.0 atm and 140°C.
 - B) 0.25 atm and 110°C.
 - C) 0.45 atm and 130°C.**
 - D) 1.25 atm and 300°C.

2) C

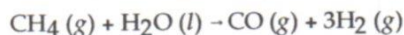
- 3) Boiling occurs along the
- A) CB line.
 - B) AC line.
 - C) CD line.**
 - D) All of these

3) C

- 4) When ethylene glycol, HOCH₂CH₂OH, is added to the water in an automobile radiator, the effect is to 4) B
- A) raise the boiling point and raise the freezing point.
 B) raise the boiling point and lower the freezing point.
 C) lower the boiling point and lower the freezing point.
 D) lower the boiling point and raise the freezing point.

- 5) Molecular hydrogen can be made from methane gas by the reaction below. How is the rate of appearance of CO related to the rate of appearance of H₂? 5) A

$$\frac{\Delta [\text{CO}]}{\Delta t} = ?$$



- A) $+\frac{1\Delta [\text{H}_2]}{3\Delta t}$ B) $+3\frac{\Delta [\text{H}_2]}{\Delta t}$ C) $+\frac{\Delta [\text{H}_2]}{\Delta t}$ D) none of these

- 6) For the process of dissolving a solid in a liquid, which of the following statements is true? 6) B
- A) ΔH_{soln} is always negative and ΔS_{soln} is usually positive.
 B) ΔH_{soln} is either positive or negative and ΔS_{soln} is usually positive.
 C) ΔH_{soln} is always positive and ΔS_{soln} is usually negative.
 D) ΔH_{soln} is either positive or negative and ΔS_{soln} is usually negative.

- 7) Which of the following solutions will have the **lowest** freezing point? 7) B
- A) 0.0120 m Li₂SO₄ $0.0120 \times 3 = 0.036$ B) 0.0150 m MgCl₂ $3 \times 0.015 = 0.045$
 C) 0.0400 m CH₃CH₂CH₂OH D) 0.0100 m NaCl $2 \times 0.01 = 0.02$

- 8) Which of the following forms an ionic solid? 8) B
- A) Au B) NH₄Cl C) CH₃NH₂ D) NH₃

- 9) Molarity is defined as moles of solute per 9) D
- A) mole of solute. B) total moles present.
 C) kilogram of solvent. D) liter of solution.

- 10) A solution is made by dissolving 19.5 g of sucrose, C₁₂H₂₂O₁₁, (FM = 342.34 g/mol) water producing a solution with a volume of 125 mL at 293.15 K. What is the expected osmotic pressure? 10) A
- A) 11.0 atm B) 58 atm C) 50.0 atm D) 23.2 atm

$$\pi = iMRT$$

$$(1) \left[\frac{\left(\frac{19.5 \text{ g}}{342.34} \right)}{\left(125 \text{ mL} / 1000 \right)} \right] (0.08206) (293.15 \text{ K}) = 10.96$$

11) The decomposition of dinitrogen pentoxide is described by the chemical equation



$$\frac{1}{4} \frac{\Delta \text{NO}_2}{\Delta t} = \frac{1}{2} \frac{\Delta \text{N}_2\text{O}_5}{\Delta t}$$

If the rate of appearance of NO_2 is equal to 1.40 mol/min at a particular moment, what is the rate of disappearance of N_2O_5 at that moment?

A) 2.80 mol/min

B) 5.60 mol/min

C) 1.40 mol/min

D) 0.700 mol/min

$$\frac{1}{4}(1.40) = \frac{1}{2}$$

12) Arrange the following compounds in order of their expected ~~decreasing~~ ^{increasing} solubility in water:

NaCl , $\text{CH}_3\text{CH}_2\text{-O-CH}_2\text{CH}_3$, $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{-OH}$, $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$.

A) $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3 < \text{NaCl} < \text{CH}_3\text{CH}_2\text{-O-CH}_2\text{CH}_3 < \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{-OH}$

B) $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3 < \text{CH}_3\text{CH}_2\text{-O-CH}_2\text{CH}_3 < \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{-OH} < \text{NaCl}$

C) $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3 < \text{CH}_3\text{CH}_2\text{-O-CH}_2\text{CH}_3 < \text{NaCl} < \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{-OH}$

D) $\text{NaCl} < \text{CH}_3\text{CH}_2\text{-O-CH}_2\text{CH}_3 < \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{-OH} < \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$

13) In general, as the temperature increases, the solubility of solids in water in and the solubility of most gases in water de.

A) decreases, increases

B) decreases, decreases

C) increases, increases

D) increases, decreases

14) A 0.50 m solution of which solute has the smallest van't Hoff factor?

A) CaF_2

B) Li_3PO_4

C) K_2CO_3

D) NaNO_3

$$i = 3$$

$$i = 4$$

$$i = 3$$

$$i = 2$$

15) What is the weight percent of a caffeine solution made by dissolving 4.35 g of caffeine, $\text{C}_8\text{H}_{10}\text{N}_4\text{O}_2$, in 75 g of benzene, C_6H_6 ?

A) 0.055%

B) 5.8%

C) 0.058%

D) 5.5%

16) Solids having no ordered long-range structure are classified as

A) crystalline solids.

B) covalent network solids.

C) amorphous solids.

D) nonmetallic solids.

$$\left(\frac{4.35 \text{ g}}{4.35 + 75} \right) \times 100 = 5.5\%$$

Part II: Short Answers Please show work on all questions for partial credit even on questions which do not specify. (40 total pts)

Hint: Please watch the units on all work to ensure that your answer is correct.

(M = moles solute / L solution) (m = moles solute / kg solvent)

[mass % = (mass of solute / mass solution) * 100] [X (mole fraction) = moles solute or solvent / moles solution]

(K = °C + 273.15) [mass % = (mass of solute / mass solution) * 100] $\Delta T_b = i K_b m$ $\Delta T_f = i K_f m$

$P_{\text{solution}} = i P_{\text{solvent}} X_{\text{solvent}}$ $\Pi = i M R T$ [R = 0.08206 L atm / (mol K)]

1. You have a solution made by dissolving 3.52 grams of $\text{Al}_2(\text{SO}_4)_3$ (FM = 342.18 g/mol) in 245.3 grams of water (FM water = 18.02 g/mol). The entire solution fits into a volumetric flask with a solution volume of 250.1 mL

(a) What is the molarity of the solution? (8 pts)

(4pt) $\frac{3.52 \text{ g } \text{Al}_2(\text{SO}_4)_3}{342.18 \text{ g/mol}} = 0.010 \text{ mol } \text{Al}_2(\text{SO}_4)_3$ (BA-4)

(4pt) $\frac{0.010 \text{ mol}}{250.1 \text{ mL} / 1000 \text{ mL/L}} = 0.03998 \text{ M}$

(b) What is the molality of the solution? (8 pts)

(4pt) $\frac{0.010 \text{ mol } \text{Al}_2(\text{SO}_4)_3}{245.3 \text{ g} \times \frac{\text{kg}}{1000 \text{ g}}} = 0.0407 \text{ m}$ (BA-4)

(0.2453) (4pt)

(c) What is the mole fraction of the solution? (8 pts)

solute in (BA-4)

(4pt) $\frac{245.3 \text{ g } \text{H}_2\text{O}}{18.02 \text{ g } \text{H}_2\text{O}} = 13.61 \text{ mol } \text{H}_2\text{O}$

$= 7.34 \times 10^{-4}$

(4pt) $\frac{0.010 \text{ mol } \text{Al}_2(\text{SO}_4)_3}{(13.61 \text{ mol } \text{H}_2\text{O} + 0.010 \text{ mol } \text{Al}_2(\text{SO}_4)_3)}$

(2pt) (2pt)

2 What is the Boiling Point for the following solution. Assume complete dissociation of the solute in the water. You dissolve 32.5 grams of $\text{Al}_2(\text{SO}_4)_3$ (FM = 342.18 g/mol) in 359.2 grams of water. [BP water = 100.0 °C, $K_b = 0.51$ (°C kg) / mol] (8 pts)

$$m = \frac{32.5 \text{ g} / 342.18 \text{ g/mol } \text{Al}_2(\text{SO}_4)_3}{359.2 \text{ g} / 1000 \text{ g/kg}} = 0.2644 \text{ m } \text{Al}_2(\text{SO}_4)_3$$

(2pt) $i = 5$ (1pt)

$$\Delta T_b = (5) \left(0.51 \frac{^\circ\text{C}}{\text{m}} \right) (0.2644 \text{ m}) \quad \Delta T_b = i K_b m$$

(2pt)

$$\Delta T_b = 0.6742 ^\circ\text{C}$$

(2pt eqn.)

$$100.0 + 0.6742 = 100.7 ^\circ\text{C}$$

(1pt)

3. Given the reaction, write the rate expression (Δ [product] / Δt) for the relationship between the rate of the Cl^- and the rate of $\text{C}_2\text{O}_4^{2-}$ (8 pts)



$$\frac{1}{2} \frac{\Delta[\text{Cl}^-]}{\Delta t} = - \frac{\Delta[\text{C}_2\text{O}_4^{2-}]}{\Delta t}$$

(1pt)

(2pt) sign.

did not set equal -

BA-4

extra incorrect stuff - 2pt