

AP CHEMISTRY

Section I

Time – 15 minutes

1. Formation of solutions where the process is endothermic can be spontaneous provided that:
A) They are accompanied by another process that is exothermic
B) They are accompanied by an increase in order
C) They are accompanied by an increase in disorder
D) The solvent is a gas and the solute is a solid
E) The solvent is water and the solute is a gas
2. The phrase “like dissolves Like” refers to the fact that:
A) Gases can only dissolve other gases
B) Polar solvents dissolve polar solutes and nonpolar solvents dissolve nonpolar solutes
C) Solvents can only dissolve solutes of similar molar mass
D) Condensed phases can only dissolve other condensed phases
E) Polar solvents dissolve nonpolar solutes and vice versa
3. A saturated solution _____.
A) Contains as much solvent as it can hold
B) Contains no double bonds
C) Contains dissolved solute in equilibrium with undissolved solid
D) Will rapidly precipitate by the addition of additional solute
E) Is produced through variations in temperature
4. Which of the following substances is more likely to dissolve in H_2O ?
A) CCl_4
B) Kr
C) N_2
D) $\text{CH}_3\text{CH}_2\text{OH}$
E) H_2
5. The solubility of Oxygen gas in water at 25°C and 1.0 atm pressure of Oxygen is 0.041 g/L. The solubility of oxygen in water at 3.0 atm and 25°C is _____ g/L.
A) 0.041
B) 0.014
C) 0.31
D) 0.12
E) 3.0
6. Which of the following choices has the compounds correctly arranged in order of increasing solubility in CCl_4 ? (least soluble to most soluble)
A) $\text{H}_2\text{O} < \text{CHCl}_3 < \text{NaNO}_3$
B) $\text{NaNO}_3 < \text{CH}_3\text{OH} < \text{CH}_4$
C) $\text{CH}_4 < \text{NaNO}_3 < \text{CHCl}_3$
D) $\text{LiF} < \text{NaNO}_3 < \text{CHCl}_3$
E) $\text{CH}_3\text{OH} < \text{Cl}_2 < \text{CHCl}_3$

7. The concentration of urea in a solution prepared by dissolving 16g of Urea in 39g of water is _____ % by mass. The molar mass of Urea is 60.0g/mol
- A) 29
B) 41
C) 0.29
D) 0.41
E) 0.48
8. The concentration of KBr in a solution prepared by dissolving 2.21 g of KBr in 897 g of water is ____ molal.
- A) 2.46
B) 0.0167
C) 0.0207
D) 2.07×10^{-5}
E) 0.0186
9. A 0.100 m solution of which one of the following solutes will have the lowest vapor pressure?
- A) KClO_4
B) $\text{Ca}(\text{ClO}_4)_2$
C) $\text{Al}(\text{ClO}_4)_3$
D) sucrose
E) NaCl
10. Adding solute to a solution decreases the _____ of the solution.
- A) Freezing Point
B) Osmotic Pressure
C) Boiling Point
D) Vapor Pressure
E) Freezing Point and Vapor Pressure.
11. What is the freezing point in Celsius of a solution prepared by dissolving 11.3 g of Calcium Nitrate in 115g of water? The molal freezing point depression constant, K_f , for water is 1.86 °C/m.
- A) -3.34
B) -1.11
C) 3.34
D) 1.11
E) 0.00
12. A solution containing 10.0 g of an unknown liquid and 90.0 g of water has a freezing point of -3.33 degrees Celsius. Given $K_f = 1.86$ °C/m for water, the molecular mass of the unknown liquid is _____.
- A) 69.0
B) 333
C) 619
D) 161
E) 62.1
13. Which of the following can not be a colloid?
- A) an emulsion
B) an aerosol
C) a homogeneous mixture
D) a foam
E) All of the above are colloids
- END OF SECTION IIF YOU FINISH BEFORE TIME IS CALLED, YOU MAY CHECK YOUR WORK ON THIS SECTION ONLY. DO NOT GO ON TO SECTION II UNTIL YOU ARE TOLD TO DO SO.**

FREE RESPONSE SECTION II – PART A

DO NOT TURN THE PAGE UNTIL
YOU ARE TOLD TO DO SO

Part A

Time – 20 minutes

YOU MAY USE A CALCULATOR FOR PART A

CLEARLY SHOW THE METHOD USED AND THE STEPS INVOLVED IN ARRIVING AT YOUR ANSWERS. It is to your advantage to do this since you may obtain partial credit if you do and you will receive little or no credit if you do not. Attention should be paid to significant figures in your final answer.

Be sure to write your answers on the lined pages that follow each question. DO NOT write your work on the insert.

Answer question 1 below. The section II scoring weighting for this question is 20 percent.

1. Answer the following questions about a pure compound that contains only carbon, hydrogen, and oxygen.

- a) A 0.7549 g sample of the compound burns in $\text{O}_2(\text{g})$ to produce 1.9061 g of $\text{CO}_2(\text{g})$ and 0.3370 g of $\text{H}_2\text{O}(\text{g})$
- i) Calculate the individual masses of C, H, and O in the 0.7549 g sample. .5198 g C, .03744 g H, .1977 g O
- ii) Determine the empirical formula for the compound. $\text{C}_7\text{H}_3\text{O}_2$
- b) A 0.5246 g sample of the compound was dissolved in 10.012 g of lauric acid, and it was determined that the freezing point of the lauric acid was lowered by 1.68°C . The value of K_f of lauric acid is $3.90^\circ\text{C m}^{-1}$. Assume that the compound does not dissociate in lauric acid.
- i) Calculate the molality of the compound dissolved in the lauric acid. 0.431 m
- ii) Calculate the molar mass of the compound from the information provided. 120 g/mol
- c) **Without doing any calculations**, explain how to determine the molecular formula of the compound based on the answers to parts (a)(ii) and (b)(ii). Since the molar masses and the empirical formula mass are the same it is evident that the empirical formula and the molecular formula are equal since that have the same molar mass.
- d) Further tests indicate that a 0.10 M aqueous solution of the compound has a pH of 2.6. Identify the organic functional group that accounts for this pH. It would be an acid since it lowers the pH.

STOP

**IF YOU FINISH BEFORE TIME IS CALLED, YOU MAY CHECK YOUR
WORK ON SECTION I AND SECTION II PART A ONLY. DO NOT TURN
TO THE PART B OF THIS TEST UNTIL YOU ARE TOLD TO DO SO.**

FREE RESPONSE SECTION II – PART B

DO NOT TURN THE PAGE UNTIL
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FREE RESPONSE SECTION – Part II

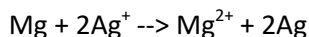
Part B

Time – 25 minutes

NO CALCULATORS MAY BE USED FOR PART B

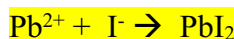
2. Answer all three portions in this part. Give the formulas to show the reactants and the products for the three following chemical reactions. Each reaction occurs in aqueous solution unless otherwise indicated. Represent the substances in solution as ions if the substance is extensively ionized. Omit formulas for any ions or molecules that are unchanged by the reaction. In all cases a reaction occurs. You need to balance the chemical equation. Then answer a question about the reaction.

Example: A strip of magnesium is added to a solution of silver nitrate.



- a. Equal volumes of 0.1M solutions of lead II nitrate and magnesium iodide are combined.

Compare the vapor pressure over each reagent to the vapor pressure of the resulting solution.



The solution will always have a lower vapor pressure than pure solvent (in this case water).

- b. Phosphorus (V) oxide powder is sprinkled over distilled water.

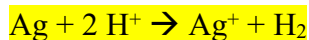
Will the pH of the resulting solution be >7 , <7 , or neutral?



Less than 7.

- c. A strip of silver is immersed in dilute nitric acid.

What evidence do you have to know a reaction took place?



Bubbles

3. Explain the following phenomenon using appropriate chemical principles: When table salt and sugar are dissolved in water, it is observed that:

a. Both Solutions have higher boiling points than pure water. Boiling point is the point where the vapor pressure of the liquid is equal to the vapor pressure of the solvent. Because the vapor pressure of any solution is lowered, the boiling point must be increased in order to equal the same pressure above the liquid.

b. the boiling point of .10 M NaCl is higher than that of 0.10 M Sugar.

Boiling point depends on the number of particles in solution. NaCl produces two particles per mole whereas sugar only produces one. Boiling point increases with an increase in particles so NaCl will have a higher boiling point than sugar which only produces one particle per mole.