

CHAPTER 13 REVIEW*Ions in Aqueous Solutions and Colligative Properties***SECTION 1****SHORT ANSWER** Answer the following questions in the space provided.

1. Use the guidelines in Table 1 on page 437 of the text to predict the solubility of the following compounds in water:

- _____ a. magnesium nitrate
_____ b. barium sulfate
_____ c. calcium carbonate
_____ d. ammonium phosphate

2. 1.0 mol of magnesium acetate is dissolved in water.

- _____ a. Write the formula for magnesium acetate.
_____ b. How many moles of ions are released into solution?
_____ c. How many moles of ions are released into a solution made from 0.20 mol magnesium acetate dissolved in water?

3. Write the formula for the precipitate formed

- _____ a. when solutions of magnesium chloride and potassium phosphate are combined.
_____ b. when solutions of sodium sulfide and silver nitrate are combined.

4. Write ionic equations for the dissolution of the following compounds:

a. $\text{Na}_3\text{PO}_4(s)$

b. iron(III) sulfate(s)

5. a. Write the net ionic equation for the reaction that occurs when solutions of lead(II) nitrate and ammonium sulfate are combined.

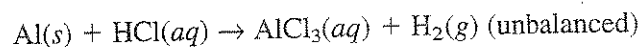
b. What are the spectator ions in this system?

SECTION 1 continued

6. The following solutions are combined in a beaker: NaCl, Na₃PO₄, and Ba(NO₃)₂.
- a. Will a precipitate form when the above solutions are combined? If so, write the name and formula of the precipitate.

- b. List all spectator ions present in this system.

7. It is possible to have spectator ions present in many chemical systems, not just in precipitation reactions. Consider this example:



- _____ a. In an aqueous solution of HCl, virtually every HCl molecule is ionized. True or False?

- _____ b. There is only one spectator ion in this system. Is it Al³⁺(aq), H⁺(aq), or Cl⁻(aq)?

- c. Balance the above equation.

- _____ d. If 9.0 g of Al metal react with excess HCl according to the balanced equation in part c, what volume of hydrogen gas at STP will be produced? Show all your work.

8. Acetic acid, CH₃CO₂H, is a weak electrolyte. Write an equation to represent its ionization in water. Include the hydronium ion, H₃O⁺.

CHAPTER 13 REVIEW*Ions in Aqueous Solutions and Colligative Properties***SECTION 2**

PROBLEMS Write the answer on the line to the left. Show all your work in the space provided.

1. _____ a. Predict the boiling point of a 0.200 *m* solution of glucose in water.
- _____ b. Predict the boiling point of a 0.200 *m* solution of potassium iodide in water.
2. A chief ingredient of antifreeze is liquid ethylene glycol, $C_2H_4(OH)_2$. Assume $C_2H_4(OH)_2$ is added to a car radiator that is holding 5.0 kg of water.
- _____ a. How many moles of ethylene glycol should be added to the radiator to lower the freezing point of the water from $0^\circ C$ to $-18^\circ C$?
- _____ b. How many grams of ethylene glycol does the quantity in part a represent?
- _____ c. Ethylene glycol has a density of 1.1 kg/L. How many liters of $C_2H_4(OH)_2$ should be added to the water in the radiator to prevent freezing down to $-18^\circ C$?

SECTION 2 continued

d. In World War II, soldiers in the Sahara Desert needed a supply of antifreeze to protect the radiators of their vehicles. The temperature in the Sahara almost never drops to 0°C , so why was the antifreeze necessary?

3. An important use of colligative properties is to determine the molar mass of unknown substances. The following situation is an example: 12.0 g of unknown compound X, a nonpolar nonelectrolyte, is dissolved in 100.0 g of melted camphor. The resulting solution freezes at 99.4°C . Consult **Table 2** on page 448 of the text for any other data needed to answer the following questions:

_____ a. By how many $^{\circ}\text{C}$ did the freezing point of camphor change from its normal freezing point?

_____ b. What is the molality of the solution of camphor and compound X, based on freezing-point data?

_____ c. If there are 12.0 g of compound X per 100.0 g of camphor, how many grams of compound X are there per kilogram of camphor?

_____ d. What is the molar mass of compound X?

4. Explain why the ability of a solution to conduct an electric current is not a colligative property.

CHAPTER 13 REVIEW

Ions in Aqueous Solutions and Colligative Properties

MIXED REVIEW

SHORT ANSWER Answer the following questions in the space provided.

1. Match the four compounds on the right to their descriptions on the left.

- | | |
|---|--------------------------------------|
| _____ an ionic compound that is quite soluble in water | (a) HCl |
| _____ an ionic compound that is not very soluble in water | (b) NaNO ₃ |
| _____ a molecular compound that ionizes in water | (c) AgCl |
| _____ a molecular compound that does not ionize in water | (d) C ₂ H ₅ OH |

2. Consider nonvolatile nonelectrolytes dissolved in various liquid solvents to complete the following statements:

- _____ a. The change in the boiling point does *not* vary with the identity of the _____ (solute, solvent), assuming all other factors remain constant.
- _____ b. The change in the boiling point varies with the identity of the _____ (solute, solvent), assuming all other factors remain constant.
- _____ c. The change in the boiling point becomes greater as the concentration of the solute in solution _____ (increases, decreases).

3. a. Name two compounds in solution that could be combined to cause the formation of a calcium carbonate precipitate.

b. Identify any spectator ions in the system you described in part a.

c. Write the net ionic equation for the formation of calcium carbonate.

4. Explain why applying rock salt (impure NaCl) to an icy sidewalk hastens the melting process.

MIXED REVIEW continued

PROBLEMS Write the answer on the line to the left. Show all your work in the space provided.

5. _____ Some insects survive cold winters by generating an antifreeze inside their cells. The antifreeze produced is glycerol, $C_3H_5(OH)_3$, a nonvolatile nonelectrolyte that is quite soluble in water. What must the molality of a glycerol solution be to lower the freezing point of water to $-25.0^\circ C$?
6. _____ How many grams of methanol, CH_3OH , should be added to 200. g of acetic acid to lower its freezing point by $1.30^\circ C$? Refer to **Table 2** on page 448 of the text for any necessary data.
7. _____ The boiling point of a solution of glucose, $C_6H_{12}O_6$, and water was recorded to be $100.34^\circ C$. Calculate the molality of this solution.
8. $HF(aq)$ is a weak acid. A 0.05 mol sample of HF is added to 1.0 kg of water.
- a. Write the equation for the ionization of HF to form hydronium ions.
- _____
- _____ b. If HF became 100% ionized, how many moles of its ions would be released?
9. _____ Which solution has the highest osmotic pressure?
- a. 0.1 *m* glucose
b. 0.1 *m* sucrose
c. 0.5 *m* glucose
d. 0.2 *m* sucrose