Practice Exercises

Multiple-Choice

For the first four problems below, one or more of the following responses will apply; each response may be used more than once or not at all in these questions.

I. osmotic pressure
II. freezing-point depression
III. vapor pressure
IV. Raoult's law
V. Henry's law

1. Which of these best explains why a soda bottle fizzes when opened?

(A) I
(B) II
(C) III
(D) IV
(E) V

2. Which of these is the method of choice to determine the molecular mass of large biomolecules?

(A) I
(B) II
(C) III
(D) IV
(E) V

3. Which two items are most closely related to each other?

(A) I and III
(B) II and V
(C) III and IV
(D) IV and V
(E) V and I

4. The extent of ion pairing in a solution of an electrolyte can be best estimated by using which of these?

(A) I and III
(B) II
(C) III and V
(D) IV
(E) V

5. The solubility of cadmium chloride, $CdCl_2$, is 140 g per 100 mL of solution. What is the molar solubility (molarity) of a saturated solution of $CdCl_2$?

(A) 0.765 *M*
(B) 1.31 *M*
(C) 7.65 *M*
(D) 12.61 *M*
(E) 0.131 *M*

6. The vapor pressure of an ideal solution is 456 mm Hg. If the vapor pressure of the pure solvent is 832 mm Hg, what is the mole fraction of the nonvolatile solute?

(A) 0.548
(B) 0.354
(C) 0.645
(D) 1.82
(E) 0.452

7. All of the following physical properties change as solute is added to the solution. Which is NOT a colligative property?

(A) boiling point
(B) surface tension
(C) vapor pressure
(D) melting point
(E) osmotic pressure

8. Which of the following is expected to be the most soluble in hexane, C_6H_{14}?

(A) KCl
(B) C_2H_5OH
(C) C_6H_6
(D) H_2O
(E) $HC_2H_3O_2$

9. Molarity units are most appropriate in calculating which of the following?

   (A) freezing-point depression
   (B) vapor pressure
   (C) boiling-point elevation
   (D) surface tension
   (E) osmotic pressure

10. All of the following may be used to determine molar masses. Which one requires an ideal solution for accurate results?

   (A) freezing-point depression
   (B) boiling-point elevation
   (C) osmotic pressure
   (D) vapor pressure
   (E) gas density

11. To make a solution, 3.45 mol of $C_6H_{13}Cl$ and 1.26 mol of C_5H_{12} are mixed. Which of the following is needed, but not readily available, to calculate the molarity of this solution?

   (A) the density of the solution
   (B) the densities of $C_6H_{13}Cl$ and C_5H_{12}
   (C) the temperature
   (D) the molar masses of $C_6H_{13}Cl$ and C_5H_{12}
   (E) the volumes of $C_6H_{13}Cl$ and C_5H_{12}

12. Which of the following, when added to 1.00 kg H_2O, is expected to give the greatest increase in the boiling point of water? (k_b = 0.052°C m^{-1})

   (A) 1.25 mol sucrose
   (B) 0.25 mol iron(III) nitrate
   (C) 0.50 mol ammonium chloride
   (D) 0.60 mol calcium sulfate
   (E) 1.00 mol acetic acid

13. Ethyl alcohol, C_2H_5OH, and water become noticeably warmer when mixed. This is due to

   (A) the decrease in volume when they are mixed
   (B) smaller attractive forces in the mixture than in the pure liquids
   (C) the hydrogen bonding of the two liquids
   (D) the change in vapor pressure observed
   (E) stronger attractive forces in the mixture than in the pure liquids

14. Which is the most appropriate method for determining the molar mass of a newly discovered enzyme?

   (A) freezing-point depression
   (B) osmotic pressure
   (C) boiling-point depression
   (D) gas density
   (E) vapor pressure

15. A polluted pond contains 25 ppb of lead ions. What is the concentration of lead ions in molarity units?

   (A) $1.2 \times 10^{8}\ M$
   (B) $1.2 \times 10^{-7}\ M$
   (C) $2.5 \times 10^{-8}\ M$
   (D) $0.121\ M$
   (E) $1.2 \times 10^{-10}\ M$

16. When algae decay in a pond, the process uses up the available oxygen. Which of the following factors will also contribute to a decrease in oxygen in a pond?

    (A) decreasing salinity (salt concentration)
    (B) increasing acidity due to acid rain
    (C) increasing temperature
    (D) increasing surface tension of the water
    (E) increasing atmospheric pressure

17. Liquid A has a vapor pressure of 437 mm Hg, and liquid B has a vapor pressure of 0.880 atm at 85°C. Which of the following represents a possible solution of the two liquids?

    (A) a mixture with a vapor pressure of 345 mm Hg
    (B) a mixture with a vapor pressure of 0.750 atm
    (C) a mixture with a boiling point of 165°C
    (D) a mixture with a vapor pressure of 1106 mm Hg
    (E) a mixture with a boiling point of 85°C

18. The freezing-point-depression constant for water is 1.86°C m^{-1}. When 100 g of a compound is dissolved in 500 g H_2O, the freezing point is −10.0°C. Of the five possibilities below, which is the identity of the compound?

    (A) $Mg(NO_3)_2$
    (B) KCl
    (C) Na_2SO_4
    (D) HCOOH
    (E) HF

19. Which of the following compounds is incorrectly classified?

    (A) NaF
    electrolyte
    (B) CH_3OH
    weak electrolyte
    (C) $Mg(C_2H_3O_2)_2$
    electrolyte
    (D) CH_3CH_2COOH
    weak electrolyte
    (E) glucose
    nonelectrolyte

20. The k_f and k_b values for water are 1.86 and 0.52°C m^{-1}, respectively. A solution boils at 107.5°C. At what temperature does this solution freeze?

    (A) 7.5°C
    (B) −7.5°C
    (C) 0.0°C
    (D) −26.8°C
    (E) −284.5°C

21. If equal numbers of moles of each of the following are dissolved in 1 kg of distilled water, the one with the lowest boiling point will be

    (A) NaF
    (B) $AlCl_3$
    (C) $Mg(C_2H_3O_2)_2$
    (D) CH_3CH_2COOH
    (E) glucose

22. The solubility of acetylene, CHCH in water at 30°C is 0.975 g L^{-1} when the pressure of acetylene is 1.00 atm. What is the solubility, at the same temperature, when the pressure of acetylene above the water is reduced to 0.212 atm?

    (A) 4.60 g L^{-1}
    (B) 0.207 g L^{-1}
    (C) 0.975 g L^{-1}
    (D) 0.212 g L^{-1}
    (E) The answer cannot be determined from the data given.

23. When KCl dissolves in water, the solution cools noticeably to the touch. It may be concluded that

(A) the solvation energy is greater than the lattice energy
(B) KCl is relatively insoluble in water
(C) the entropy decreases when KCl dissolves
(D) the boiling point of the solution will be less than 100°C
(E) the entropy increase overcomes the unfavorable heat of dissolution

24. If 20.0 g of ethanol (molar mass = 46) and 30.0 g of water (molar mass = 18) are mixed together, the mole fraction of ethanol in this mixture is

(A) 0.207
(B) 0.261
(C) 0.739
(D) 0.793
(E) 4.83

Free-Response

Use the fundamental concepts of this chapter to consider solutions and their behaviors.

(a) Use the concepts in this chapter to explain the rule "like dissolves like."

(b) Explain how a nonvolatile, nondissociating solute affects the boiling point of a solvent.

(c) The freezing-point depression constant of cyclohexane is 20.2°C per molal. The melting point of cyclohexane is 6.50°C. What is the freezing point of a hexane solution prepared by dissolving 20.0 g of $C_{18}H_{38}$ in 100 g of cyclohexane?

(d) Solutes in aqueous systems are usually classified based on how electricity is conducted. Name these classifications and give examples of each.

(e) A solution is prepared by dissolving 15.2 milligrams of $CrCl_3$ in 2.50 liters of water. What is the concentration of cesium in parts per million?