CONCEPTS TO REMEMBER

Solution components. The component of a solution that is present in the greatest amount is the *solvent*. A *solute* is a solution component that is present in a small amount relative to the solvent (Section 8.1).

Solution characteristics. A solution is a homogeneous (uniform) mixture. Its composition and properties are dependent on the ratio of solute(s) to solvent. Dissolved solutes are present as individual particles (molecules, atoms, or ions) (Section 8.1).

Solubility. The solubility of a solute is the maximum amount of solute that will dissolve in a given amount of solvent. The extent to which a solute dissolves in a solvent depends on the structure of solute and solvent, the temperature, and the pressure. Molecular polarity is a particularly important factor in determining solubility. A *saturated* solution contains the maximum amount of solute that can be dissolved under the conditions at which the solution exists (Section 8.2).

Solution concentration. Solution concentration is the amount of solute present in a specified amount of solution. Percent solute and molarity are commonly encountered concentration units. Percent concentration units include percent by mass, percent by volume, and mass–volume percent. Molarity gives the moles of solute per liter of solution (Section 8.5).

Dilution. Dilution involves adding solvent to an existing solution. Although the amount of solvent increases, the amount of solute remains the same. The net effect of dilution is a decrease in the concentration of the solution (Section 8.6).

Colloidal dispersions and suspensions. Colloidal dispersions are homogeneous mixtures in which the particles in the dispersed phase are small enough that they do not settle out under the influence of gravity but yet large enough to scatter light (Tyndall effect), even though they cannot be seen with the naked eye. Colloidal dispersions are often encountered within the human body. A suspension is a heterogeneous mixture in which the particles in the dispersed phase are large enough to settle out under the influence of gravity (Section 8.7).

Colligative properties of solutions. Properties of a solution that depend on the number of solute particles in solution, not on their identity, are called colligative properties. Vapor-pressure lowering, boiling-point elevation, freezing-point depression, and osmotic pressure are all colligative properties (Section 8.8).

Osmosis and osmotic pressure. Osmosis involves the passage of a solvent from a dilute solution (or pure solvent) through a semipermeable membrane into a more concentrated solution. Osmotic pressure is the amount of pressure needed to prevent the net flow of solvent across the membrane in the direction of the more concentrated solution (Section 8.9).

Dialysis. Dialysis is the process in which a semipermeable membrane permits the passage of solvent, dissolved ions, and small molecules but blocks the passage of large molecules. Many plant and animal membranes function as dialyzing membranes (Section 8.10).

KEY REACTIONS AND EQUATIONS

1. Percent by mass (Section 8.5)

$$\%(\text{m/m}) = \frac{\text{mass of solute}}{\text{mass of solution}} \times 100$$

2. Percent by volume (Section 8.5)

$$\%(\text{v/v}) = \frac{\text{volume of solute}}{\text{volume of solution}} \times 100$$

3. Mass–volume percent (Section 8.5)

$$\%(\text{m/v}) = \frac{\text{mass of solute (g)}}{\text{volume of solution (mL)}} \times 100$$

4. Molarity (Section 8.5)

$$\text{M} = \frac{\text{moles of solute}}{\text{liters of solution}}$$

5. Dilution of stock solution to make less-concentrated solution (Section 8.6)

$$C_s \times V_s = C_d \times V_d$$

6. Osmolarity (Section 8.9)

$$\text{osmol} = \text{M} \times i$$

EXERCISES *and* PROBLEMS

The members of each pair of problems in this section test similar material.

Solution Characteristics (Section 8.1)

8.1 Indicate whether each of the following statements about the general properties of solutions is true or false.
a. A solution may contain more than one solute.
b. All solutions are homogeneous mixtures.
c. Every part of a solution has exactly the same properties as every other part.
d. The solutes present in a solution will "settle out" with time if the solution is left undisturbed.

8.2 Indicate whether each of the following statements about the general properties of solutions is true or false.
a. All solutions have a variable composition.
b. For solution formation to occur, the solute and solvent must chemically react with each other.
c. Solutes are present as individual particles (molecules, atoms, or ions) in a solution.
d. A general characteristic of all solutions is the liquid state.

8.3 Identify the *solute* and the *solvent* in solutions composed of the following:
a. 5.00 g of sodium chloride (table salt) and 50.0 g of water
b. 4.00 g of sucrose (table sugar) and 1000 g of water
c. 2.00 mL of water and 20.0 mL of ethyl alcohol
d. 60.0 mL of methyl alcohol and 20.0 mL of ethyl alcohol

8.4 Identify the *solute* and the *solvent* in solutions composed of the following:
a. 5.00 g of NaBr and 200.0 g of water
b. 50.0 g of $AgNO_3$ and 1000 g of water
c. 50.0 mL of water and 100.0 mL of methyl alcohol
d. 50.0 mL of isopropyl alcohol and 20.0 mL of ethyl alcohol

Solubility (Section 8.2)

8.5 For each of the following pairs of solutions, select the solution for which solute solubility is greatest.
a. Ammonia gas in water with P = 1 atm and T = 50°C
Ammonia gas in water with P = 1 atm and T = 90°C
b. Carbon dioxide gas in water with P = 2 atm and T = 50°C
Carbon dioxide gas in water with P = 1 atm and T = 50°C
c. Table salt in water with P = 1 atm and T = 60°C
Table salt in water with P = 1 atm and T = 50°C
d. Table sugar in water with P = 2 atm and T = 40°C
Table sugar in water with P = 1 atm and T = 70°C

8.6 For each of the following pairs of solutions, select the solution for which solute solubility is greatest.
a. Oxygen gas in water with P = 1 atm and T = 10°C
Oxygen gas in water with P = 1 atm and T = 20°C
b. Nitrogen gas in water with P = 2 atm and T = 50°C
Nitrogen gas in water with P = 1 atm and T = 70°C
c. Table salt in water with P = 1 atm and T = 40°C
Table salt in water with P = 1 atm and T = 70°C
d. Table sugar in water with P = 3 atm and T = 30°C
Table sugar in water with P = 1 atm and T = 80°C

8.7 Classify each of the following solutions as *saturated, unsaturated,* or *supersaturated* based on the following observations.
a. Agitation of the solution produces a large amount of solid crystals.
b. Heating the solution causes excess undissolved solute present to dissolve.
c. Excess undissolved solute is present at the bottom of the solution container.
d. The amount of solute dissolved is less than the maximum amount that could dissolve under the conditions at which the solution exists.

8.8 Classify each of the following solutions as *saturated, unsaturated,* or *supersaturated* based on the following observations about adding a small piece of solid solute to the solution.
a. The added solute rapidly dissolves.
b. The added solute falls to the bottom of the container where it remains without any decrease in size.
c. The added solute falls to the bottom of the container where it decreases in size for several hours and thereafter its size remains constant.
d. The added solute causes the production of a large amount of solid white crystals.

8.9 Use Table 8.1 to determine whether each of the following solutions is *saturated* or *unsaturated.*
a. 1.94 g of $PbBr_2$ in 100 g of H_2O at 50°C
b. 34.0 g of NaCl in 100 g of H_2O at 0°C
c. 75.4 g of $CuSO_4$ in 200 g of H_2O at 100°C
d. 0.540 g of Ag_2SO_4 in 50 g of H_2O at 50°C

8.10 Use Table 8.1 to determine whether each of the following solutions is *saturated* or *unsaturated.*
a. 175 g of CsCl in 100 g of H_2O at 100°C
b. 455 g of $AgNO_3$ in 100 g of H_2O at 50°C
c. 2.16 g of Ag_2SO_4 in 200 g of H_2O at 50°C
d. 0.97 g of $PbBr_2$ in 50 g of H_2O at 50°C

8.11 Use Table 8.1 to determine whether each of the following solutions is *dilute* or *concentrated.*
a. 0.20 g of $CuSO_4$ in 100 g of H_2O at 100°C
b. 1.50 g of $PbBr_2$ in 100 g of H_2O at 50°C
c. 61 g of $AgNO_3$ in 100 g of H_2O at 50°C
d. 0.50 g of Ag_2SO_4 in 100 g of H_2O at 0°C

8.12 Use Table 8.1 to determine whether each of the following solutions is *dilute* or *concentrated.*
a. 255 g of $AgNO_3$ in 100 g of H_2O at 100°C
b. 35.0 g of NaCl in 100 g of H_2O at 0°C
c. 1.87 g of $PbBr_2$ in 100 g of H_2O at 50°C
d. 1.87 g of $CuSO_4$ in 100 g of H_2O at 50°C

Solution Formation (Section 8.3)

8.13 Match each of the following statements about the dissolving of the ionic solid NaCl in water with the term *hydrated ion, hydrogen atom,* or *oxygen atom.*
a. A Na^+ ion surrounded with water molecules
b. A Cl^- ion surrounded with water molecules
c. The portion of a water molecule that is attracted to a Na^+ ion
d. The portion of a water molecule that is attracted to a Cl^- ion

8.14 Match each of the following statements about the dissolving of the ionic solid KBr in water with the term *hydrated ion, hydrogen atom,* or *oxygen atom.*
a. A K^+ ion surrounded with water molecules
b. A Br^- ion surrounded with water molecules
c. The portion of a water molecule that is attracted to a K^+ ion
d. The portion of a water molecule that is attracted to a Br^- ion

8.15 Indicate whether each of the following actions will *increase* or *decrease* the rate of the dissolving of a sugar cube in water.
a. Cooling the sugar cube–water mixture
b. Stirring the sugar cube–water mixture
c. Breaking the sugar cube up into smaller "chunks"
d. Crushing the sugar cube to give a granulated form of sugar

8.16 Indicate whether each of the following actions will *increase* or *decrease* the rate of the dissolving of table salt in water.
a. Heating the table salt–water mixture
b. Shaking the table salt–water mixture
c. Heating the table salt prior to adding it to the water
d. Heating the water prior to its receiving the table salt

Solubility Rules (Section 8.4)

8.17 Predict whether the following solutes are *very soluble* or *slightly soluble* in water.
a. O_2 (a nonpolar gas)
b. CH_3OH (a polar liquid)
c. CBr_4 (a nonpolar liquid)
d. AgCl (an ionic solid)

8.18 Predict whether the following solutes are *very soluble* or *slightly soluble* in water.
a. NH_3 (a polar gas)
b. N_2 (a nonpolar gas)
c. C_6H_6 (a nonpolar liquid)
d. Na_3PO_4 (an ionic solid)

8.19 Ethanol is a polar solvent and carbon tetrachloride is a nonpolar solvent. In which of these two solvents are each of the following solutes more likely to be soluble?
a. NaCl, ionic
b. Cooking oil, nonpolar
c. Sugar, polar
d. $LiNO_3$, ionic

8.20 Methanol is a polar solvent and heptane is a nonpolar solvent. In which of these two solvents are each of the following solutes more likely to be soluble?
a. KCl, ionic
b. Rubbing alcohol, polar
c. Gasoline, nonpolar
d. $NaNO_3$, ionic

8.21 Classify each of the following types of ionic compounds in the solubility categories *soluble, soluble with exceptions, insoluble,* or *insoluble with exceptions.*
a. Chlorides and sulfates
b. Nitrates and ammonium–ion containing
c. Carbonates and phosphates
d. Sodium–ion containing and potassium–ion containing

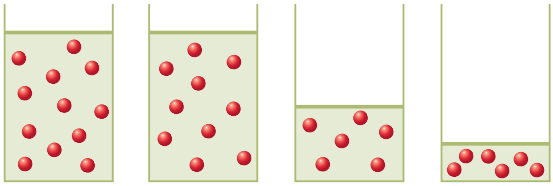
8.22 Classify each of the following types of ionic compounds in the solubility categories *soluble, soluble with exceptions, insoluble,* or *insoluble with exceptions.*
a. Nitrates and sodium–ion containing
b. Chlorides and bromides
c. Hydroxides and phosphates
d. Sulfates and iodides

8.23 In each of the following sets of ionic compounds, identify the members of the set that are soluble in water.
a. NaCl, Na_2SO_4, $NaNO_3$, Na_2CO_3
b. $AgNO_3$, KNO_3, $Ca(NO_3)_2$, $Cu(NO_3)_2$
c. $CaBr_2$, $Ca(OH)_2$, $CaCl_2$, $CaSO_4$
d. $NiSO_4$, $Ni_3(PO_4)_2$, $Ni(OH)_2$, $NiCO_3$

8.24 In each of the following sets of ionic compounds, identify the members of the set that are soluble in water.
a. K_2SO_4, KOH, KI, K_3PO_4
b. NaCl, AgCl, $BeCl_2$, $CuCl_2$
c. $Ba(OH)_2$, $BaSO_4$, $BaCO_3$, $Ba(NO_3)_2$
d. $CoBr_2$, $CoCl_2$, $Co(OH)_2$, $CoSO_4$

Percent Concentration Units (Section 8.5)

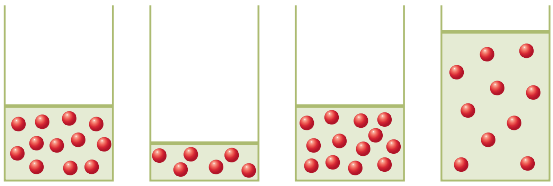
8.25 The following diagrams show varying amounts of the same solute (the red spheres) in varying amounts of solution.



I II III IV

a. In which of the diagrams is the solution concentration the largest?
b. In which two of the diagrams are the solution concentrations the same?

8.26 The following diagrams show varying amounts of the same solute (the red spheres) in varying amounts of solution.



I II III IV

a. In which of the diagrams is the solution concentration the largest?
b. In which two of the diagrams are the solution concentrations the same?

8.27 Calculate the mass percent of solute in the following solutions.
a. 6.50 g of NaCl dissolved in 85.0 g of H_2O
b. 2.31 g of LiBr dissolved in 35.0 g of H_2O
c. 12.5 g of KNO_3 dissolved in 125 g of H_2O
d. 0.0032 g of NaOH dissolved in 1.2 g of H_2O

8.28 Calculate the mass percent of solute in the following solutions.
a. 2.13 g of $AgNO_3$ dissolved in 30.0 g of H_2O
b. 135 g of CsCl dissolved in 455 g of H_2O
c. 10.3 g of K_2SO_4 dissolved in 93.7 g of H_2O
d. 10.3 g of KBr dissolved in 125 g of H_2O

8.29 How many grams of glucose must be added to 275 g of water in order to prepare each of the following percent-by-mass concentrations of aqueous glucose solution?
a. 1.30% b. 5.00% c. 20.0% d. 31.0%

8.30 How many grams of lactose must be added to 655 g of water in order to prepare each of the following percent-by-mass concentrations of aqueous lactose solution?
a. 0.50% b. 2.00% c. 10.0% d. 25.0%

8.31 Calculate the mass, in grams, of K_2SO_4 needed to prepare 32.00 g of 2.000%(m/m) K_2SO_4 solution.

8.32 Calculate the mass, in grams, of KCl needed to prepare 200.0 g of 5.000%(m/m) KCl solution.

8.33 How many grams of water must be added to 20.0 g of NaOH in order to prepare a 6.75%(m/m) solution?

8.34 How many grams of water must be added to 10.0 g of $Ca(NO_3)_2$ in order to prepare a 12.0%(m/m) solution?

8.35 Calculate the volume percent of solute in each of the following solutions.
a. 20.0 mL of methyl alcohol in enough water to give 475 mL of solution
b. 4.00 mL of bromine in enough carbon tetrachloride to give 87.0 mL of solution

8.36 Calculate the volume percent of solute in each of the following solutions.
a. 60.0 mL of water in enough ethylene glycol to give 970.0 mL of solution
b. 455 mL of ethyl alcohol in enough water to give 1375 mL of solution

8.37 What is the percent by volume of isopropyl alcohol in an aqueous solution made by diluting 22 mL of pure isopropyl alcohol with water to give a volume of 125 mL of solution?

8.38 What is the percent by volume of acetone in an aqueous solution made by diluting 75 mL of pure acetone with water to give a volume of 785 mL of solution?

8.39 Calculate the mass–volume percent of $MgCl_2$ in each of the following solutions.
a. 5.0 g of $MgCl_2$ in enough water to give 250 mL of solution
b. 85 g of $MgCl_2$ in enough water to give 580 mL of solution

8.40 Calculate the mass–volume percent of $NaNO_3$ in each of the following solutions.
a. 1.00 g of $NaNO_3$ in enough water to give 75.0 mL of solution
b. 100.0 g of $NaNO_3$ in enough water to give 1250 mL of solution

8.41 How many grams of Na_2CO_3 are needed to prepare 25.0 mL of a 2.00%(m/v) Na_2CO_3 solution?

8.42 How many grams of $Na_2S_2O_3$ are needed to prepare 50.0 mL of a 5.00%(m/v) $Na_2S_2O_3$ solution?

8.43 How many grams of NaCl are present in 50.0 mL of a 7.50%(m/v) NaCl solution?

8.44 How many grams of glucose are present in 250.0 mL of a 10.0%(m/v) glucose solution?

Molarity (Section 8.5)

8.45 Calculate the molarity of the following solutions.
a. 3.0 moles of potassium nitrate (KNO_3) in 0.50 L of solution
b. 12.5 g of sucrose ($C_{12}H_{22}O_{11}$) in 80.0 mL of solution
c. 25.0 g of sodium chloride (NaCl) in 1250 mL of solution
d. 0.00125 mole of baking soda ($NaHCO_3$) in 2.50 mL of solution

8.46 Calculate the molarity of the following solutions.
a. 2.0 moles of ammonium chloride (NH_4Cl) in 2.50 L of solution
b. 14.0 g of silver nitrate ($AgNO_3$) in 1.00 L of solution
c. 0.025 mole of potassium chloride (KCl) in 50.0 mL of solution
d. 25.0 g of glucose ($C_6H_{12}O_6$) in 1.25 L of solution

8.47 Calculate the number of grams of solute in each of the following solutions.
a. 2.50 L of a 3.00 M HCl solution
b. 10.0 mL of a 0.500 M KCl solution
c. 875 mL of a 1.83 M $NaNO_3$ solution
d. 75 mL of a 12.0 M H_2SO_4 solution

8.48 Calculate the number of grams of solute in each of the following solutions.
a. 3.00 L of a 2.50 M HCl solution
b. 50.0 mL of a 12.0 M HNO_3 solution
c. 50.0 mL of a 12.0 M $AgNO_3$ solution
d. 1.20 L of a 0.032 M Na_2SO_4 solution

8.49 Calculate the volume, in milliliters, of solution required to supply each of the following.
a. 1.00 g of sodium chloride (NaCl) from a 0.200 M sodium chloride solution
b. 2.00 g of glucose ($C_6H_{12}O_6$) from a 4.20 M glucose solution
c. 3.67 moles of silver nitrate ($AgNO_3$) from a 0.400 M silver nitrate solution
d. 0.0021 mole of sucrose ($C_{12}H_{22}O_{11}$) from an 8.7 M sucrose solution

8.50 Calculate the volume, in milliliters, of solution required to supply each of the following.
a. 4.30 g of lithium chloride (LiCl) from a 0.089 M lithium chloride solution
b. 429 g of lithium nitrate ($LiNO_3$) from an 11.2 M lithium nitrate solution
c. 2.25 moles of potassium sulfate (K_2SO_4) from a 0.300 M potassium sulfate solution
d. 0.103 mole of potassium hydroxide (KOH) from an 8.00 M potassium hydroxide solution

Dilution (Section 8.6)

8.51 What is the molarity of the solution prepared by diluting 25.0 mL of 0.220 M NaCl to each of the following final volumes?
a. 30.0 mL b. 75.0 mL c. 457 mL d. 2.00 L

8.52 What is the molarity of the solution prepared by diluting 35.0 mL of 1.25 M $AgNO_3$ to each of the following final volumes?
a. 50.0 mL b. 95.0 mL c. 975 mL d. 3.60 L

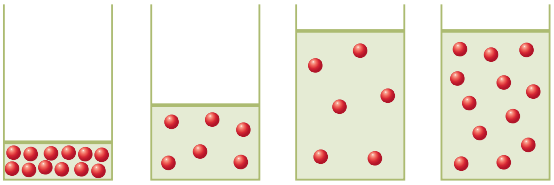
8.53 For each of the following solutions, how many milliliters of water should be added to yield a solution that has a concentration of 0.100 M?
a. 50.0 mL of 3.00 M NaCl b. 2.00 mL of 1.00 M NaCl
c. 1.45 L of 6.00 M NaCl d. 75.0 mL of 0.110 M NaCl

8.54 For each of the following solutions, how many milliliters of water should be added to yield a solution that has a concentration of 0.125 M?
a. 25.0 mL of 1.00 M $AgNO_3$
b. 5.00 mL of 10.0 M $AgNO_3$
c. 2.50 L of 2.50 M $AgNO_3$
d. 75.0 mL of 0.130 M $AgNO_3$

8.55 Determine the final concentration of each of the following solutions after 20.0 mL of water has been added.
a. 30.0 mL of 5.0 M NaCl solution
b. 30.0 mL of 5.0 M $AgNO_3$ solution
c. 30.0 mL of 7.5 M NaCl solution
d. 60.0 mL of 2.0 M NaCl solution

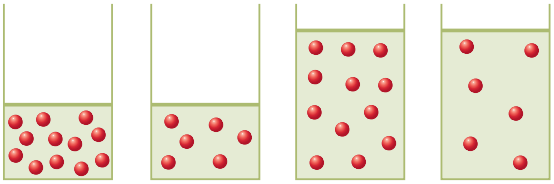
8.56 Determine the final concentration of each of the following solutions after 30.0 mL of water has been added.
a. 20.0 mL of 5.0 M NaCl solution
b. 20.0 mL of 5.0 M $AgNO_3$ solution
c. 20.0 mL of 0.50 M NaCl solution
d. 60.0 mL of 3.0 M NaCl solution

8.57 The following diagrams show various amounts of the same solute (the red spheres) in varying amounts of solution. If one-half of the solution in diagram I is withdrawn and then diluted by a factor of 4, which of the other diagrams (II–IV) represent the newly formed solution?



I II III IV

8.58 The following diagrams show various amounts of the same solute (the red spheres) in varying amounts of solution. If one-half of the solution in diagram I is withdrawn and then diluted by a factor of 2, which of the other diagrams (II–IV) represent the newly formed solution?



I II III IV

Colloidal Dispersions and Suspensions (Section 8.7)

8.59 Indicate whether each of the following characterizations applies to a *true solution,* a *colloidal dispersion,* or a *suspension.* There may be more than one correct answer for a given characterization.
a. Dispersed phase can be trapped by filter paper
b. Dispersed phase can often be seen with the naked eye
c. Appearance is that of a homogeneous mixture
d. Dispersed phase is transparent to light

8.60 Indicate whether each of the following characterizations applies to a *true solution,* a *colloidal dispersion,* or a *suspension.* There may be more than one correct answer for a given characterization.
a. Dispersed phase cannot be trapped by filter paper

b. Dispersed phase rapidly settles out under the influence of gravity
c. Dispersed phase scatters light
d. Dispersed phase contains very large particles

8.61 Indicate whether each of the following statements about colloidal dispersions and suspensions are *true* or *false.*
a. The dispersed particles in a colloidal dispersion can be seen with the naked eye.
b. With time, the particles in a colloidal dispersion settle out under the influence of gravity.
c. Milk is an example of a suspension.
d. The dispersed phase in a suspension can be trapped by filter paper.

8.62 Indicate whether each of the following statements about colloidal dispersions and suspensions are *true* or *false.*
a. Blood is an example of a colloidal dispersion.
b. The dispersed particles in a colloidal dispersion are several times larger than those in a suspension.
c. A beam of light is scattered by the dispersed phase in a colloidal dispersion.
d. With time, the particles in a suspension settle out under the influence of gravity.

Colligative Properties of Solutions (Section 8.8)

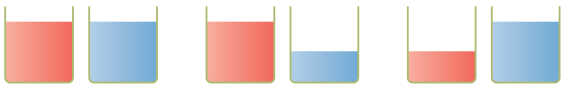
8.63 Why is the vapor pressure of a solution that contains a nonvolatile solute always less than that of pure solvent?

8.64 How are the boiling point and freezing point of water affected by the addition of solute?

8.65 Why does seawater evaporate more slowly than fresh water at the same temperature?

8.66 How does the freezing point of seawater compare with that of fresh water?

8.67 Assume that you have identical volumes of two liquids; the first is pure water and the second is 0.1 M sucrose (table sugar) solution. Consider the following diagrams, where red is the pure water and blue is the sucrose solution.



I II III

Which one of these diagrams best represents the two liquids after they have stood uncovered for a few days and some evaporation of liquid has occurred?

8.68 Assume that you have identical volumes of two liquids; the first is 0.3 M glucose solution and the second is 0.1 M glucose solution. Based on the diagrams in Problem 8.67, where red is the 0.3 M glucose and blue is the 0.1 M glucose, which one of the diagrams best represents the two liquids after they have stood uncovered for a few days and some evaporation of liquid has occurred?

Osmosis and Osmotic Pressure (Section 8.9)

8.69 Indicate whether the osmotic pressure of a 0.1 M NaCl solution will be *less than, the same as,* or *greater than* that of each of the following solutions.
a. 0.1 M NaBr b. 0.050 M $MgCl_2$
c. 0.1 M $MgCl_2$ d. 0.1 M glucose

8.70 Indicate whether the osmotic pressure of a 0.1 M $NaNO_3$ solution will be *less than, the same as,* or *greater than* that of each of the following solutions.
a. 0.1 M NaCl b. 0.1 M KNO_3
c. 0.1 M Na_2SO_4 d. 0.1 M glucose

8.71 What is the ratio of the osmotic pressures of 0.30 M NaCl and 0.10 M $CaCl_2$?

8.72 What is the ratio of the osmotic pressures of 0.20 M NaCl and 0.30 M $CaCl_2$?

8.73 Would red blood cells *swell, remain the same size,* or *shrink* when placed in each of the following solutions?
a. 0.9%(m/v) glucose solution
b. 0.9%(m/v) NaCl solution
c. 2.3%(m/v) glucose solution
d. 5.0%(m/v) NaCl solution

8.74 Would red blood cells *swell, remain the same size,* or *shrink* when placed in each of the following solutions?
a. Distilled water
b. 0.5%(m/v) NaCl solution
c. 3.3%(m/v) glucose solution
d. 5.0%(m/v) glucose solution

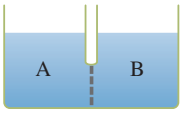
8.75 Will red blood cells *crenate, hemolyze,* or *remain unaffected* when placed in each of the solutions in Problem 8.73?

8.76 Will red blood cells *crenate, hemolyze,* or *remain unaffected* when placed in each of the solutions in Problem 8.74?

8.77 Classify each of the solutions in Problem 8.73 as hypotonic, hypertonic, or isotonic.

8.78 Classify each of the solutions in Problem 8.74 as hypotonic, hypertonic, or isotonic.

8.79 Consider two solutions, A and B, separated by an osmotic semipermeable membrane that allows only water to pass through, as shown in the following diagram.



Osmotic membrane

Based on each of the following identities for solutions A and B, indicate whether the liquid level in compartment A, with time, will *increase, decrease,* or *not change.*
a. A = 1.0 M NaCl solution and B = 2.0 M NaCl solution
b. A = 5.0%(m/v) glucose solution and B = 4.0%(m/v) glucose solution
c. A = 2.0 M KCl solution and B = 2.0 M KNO_3 solution
d. A = 1.0 M glucose solution and B = 1.0 M NaCl solution

8.80 Consider two solution, A and B, separated by an osmotic semipermeable membrane that allows only water to pass through, as shown in the diagram in Problem 8.79. Based on each of the following identities for solutions A and B, indicate whether the liquid level in compartment A, with time, will *increase, decrease,* or *not change.*
a. A = 1.0 M glucose solution and B = 2.0 M glucose solution
b. A = 5.0%(m/v) NaCl solution and B = 4.0%(m/v) NaCl solution
c. A = 2.0 M Na_2SO_4 solution and B = 3.0 M KNO_3 solution
d. A = 2.0 M glucose solution and B = 1.0 M NaCl solution

Dialysis (Section 8.10)

8.81 What happens in each of the following situations?
a. A dialyzing bag containing a 1 M solution of potassium chloride is immersed in pure water.
b. A dialyzing bag containing colloidal-sized protein, 1 M potassium chloride, and 1 M glucose is immersed in pure water.

8.82 What happens in each of the following situations?
a. A dialyzing bag containing a 1 M solution of potassium chloride is immersed in a 1 M sodium chloride solution.
b. A dialyzing bag containing colloidal-sized protein is immersed in a 1 M glucose solution.

ADDITIONAL PROBLEMS

8.83 With the help of Table 8.2, determine in which of the following pairs of compounds both members of the pair have like solubility in water (both soluble or both insoluble).
a. $(NH_4)_2CO_3$ and $AgNO_3$
b. $ZnCl_2$ and $Mg(OH)_2$
c. BaS and $NiCO_3$
d. AgCl and $Al(OH)_3$

8.84 How many grams of solute are dissolved in the following amounts of solution?
a. 134 g of 3.00%(m/m) KNO_3 solution
b. 75.02 g of 9.735%(m/m) NaOH solution
c. 1576 g of 0.800%(m/m) HI solution
d. 1.23 g of 12.0%(m/m) NH_4Cl solution

8.85 What volume of water, in quarts, is contained in 3.50 qt of a 2.00%(v/v) solution of water in acetone?

8.86 How many liters of 0.10 M solution can be prepared from 60.0 g of each of the following solutes?
a. $NaNO_3$ b. HNO_3 c. KOH d. LiCl

8.87 What is the molarity of the solution prepared by concentrating, by evaporation of solvent, 2212 mL of 0.400 M potassium sulfate (K_2SO_4) solution to each of the following final volumes?
a. 1875 mL b. 1.25 L c. 853 mL d. 553 mL

8.88 After all the water is evaporated from 10.0 mL of a CsCl solution, 3.75 g of CsCl remains. Express the original concentration of the CsCl solution in each of the following units.
a. mass–volume percent b. molarity

8.89 Find the molarity of a solution obtained when 352 mL of 4.00 M sodium bromide (NaBr) solution is mixed with
a. 225 mL of 4.00 M NaBr solution
b. 225 mL of 2.00 M NaBr solution

8.90 Which of the following aqueous solutions would give rise to a greater osmotic pressure?
a. 8.00 g of NaCl in 375 mL of solution or 4.00 g of NaBr in 155 mL of solution
b. 6.00 g of NaCl in 375 mL of solution or 6.00 g of $MgCl_2$ in 225 mL of solution

Multiple-Choice Practice Test

8.91 Which of the following statements about solutions is *incorrect*?
a. A solution is a homogeneous mixture.
b. Solutions in which both solute and solvent are solids are possible.
c. Solutions readily separate into solute and solvent if left undisturbed for 24 hours.
d. The substance present in the greatest amount is considered to be the solvent.

8.92 Which of the following statements is true for an *unsaturated* solution?
a. Undissolved solute must be present.
b. No undissolved solute may be present.
c. The solubility limit for the solute has been reached.
d. Solid crystallizes out if the solution is stirred.

8.93 Which of the following statements is most closely related to Henry's law?
a. Most solid solutes become more soluble in water with increasing temperature.
b. Most solid solutes become less soluble in water with increasing pressure.
c. Gaseous solutes become less soluble in water with increasing temperature.
d. Gaseous solutes become more soluble in water with increasing pressure.

8.94 Solubility in water is a general characteristic of which of the following types of ionic compounds?
a. Phosphates b. Nitrates
c. Carbonates d. Hydroxides

8.95 What is the concentration, in mass percent, of a solution that contains 20.0 g of NaCl dissolved in 250.0 g of water?
a. 6.76% by mass b. 7.41% by mass
c. 8.00% by mass d. 8.25% by mass

8.96 For which of the following solutions is the concentration 1.0 molar?
a. 0.050 mole of solute in 25.0 mL of solution
b. 2.0 moles of solute in 500.0 mL of solution
c. 3.0 moles of solute in 1.5 L of solution
d. 0.50 mole of solute in 500.0 mL of solution

8.97 Which of the following is a correct characterization for the particles present in the dispersed phase of a colloidal dispersion?
a. Large enough that they can be seen by the naked eye
b. Small enough that they do not settle out under the influence of gravity
c. Large enough that they can be filtered out using filter paper
d. Small enough that they do not scatter a beam of light

8.98 Which of the following is not a colligative property?
a. Osmotic pressure b. Boiling-point elevation
c. Freezing-point depression d. Density

8.99 Which of the following solutions has an osmolarity of 3.0?
a. 1.5 M glucose b. 2.0 M sucrose
c. 1.0 M $CaCl_2$ d. 3.0 M NaCl

8.100 The osmotic pressure of a *hypotonic solution* is which of the following?
a. The same as that in cells
b. Lower than that in cells
c. Double that in cells
d. Higher than that in cells