Chapter Project
Worksheet 1

1. Answers will vary. Sample: cherries, blueberries, and grass

2. Answers will vary. Sample: Cut 5 g of cherries into small pieces and place in blender. Blend for two minutes, adding water 2 mL at a time if the cherry mixture is too dry. Pour mixture through cheesecloth, squeezing out as much liquid as possible. Store the liquid in a labeled container in the refrigerator.

3. Answers will vary. Sample: Brand X cleaning solution, Brand Y bleach, apple juice, Brand Z baby shampoo.

Worksheet 2

1. A good indicator should show distinct colors for different pH values (e.g., bright red for a pH of 1, pink for a pH of 2, etc.). Students may notice that some of their indicators worked better for acids than bases and vice versa. Good acid and base indicators could be used together when making a test kit.

2. A bad indicator is one that either does not change for various pH values or shows only slight variations in color, for example making it difficult to distinguish a pH of 1 from a pH of 4.

3. Check that answers reflect actual experiences doing the research, including both successes and problems.

4. Answers will vary, depending on the particular indicators chosen. Check that answers reflect actual observations from the data table. Some substances may work fairly well as indicators, others may work poorly. Some indicators will only test acids, while others will test only bases. It is probable that some will only work well for strong acids or for strong bases, or a limited range of pH.

5. Answers will vary. Samples: Class presentation, poster display, demonstration of testing and results of the best indicator. The list of materials will include the substances to test, the indicators to do the testing, and test tubes and bottles to hold the substances.

Understanding Solutions
Guided Reading and Study

Use Target Reading Skills

Sample answers:

a. Detail A solvent is the part of a solution that is present in the largest amount and that dissolves other substances.

b. Detail A solute is present in a smaller amount and is dissolved by th solvent.

c. Detail Water is often called the "universal solvent" because so many substances can form solutions in water.

d. Detail Solutions can also be made with solvents other than water using any combination of gasses, liquids, or solids.

Understanding Solutions
Guided Reading and Study

1. solution

2. **a.** Solvent
b. Solute
c. Water
d. Sugar

3. solute; solvent

4. Water dissolves so many substances.

5. false

6. A colloid is a mixture containing small, undissolved particles that do not settle out.

7. larger

8. a, c

9. A suspension is a mixture in which particles can be seen and easily separated by settling or filtration.

10. Unlike a solution, a suspension does not have the same properties throughout. It contains visible particles that are larger than the particles in solutions or colloids.

11. The particles of the solute leave each other and become surrounded by particles of the solvent.

12. c, d

13. salt solution

14. a, b

Understanding Solutions
Review and Reinforce

1. Suspension; The particles are visible and they have separated.
2. Solution; The particles are too small to see.
3. Colloid; The particles are too small to be seen, but scatter light.
4. In an ionic solid, the positive and negative ions are surrounded by water molecules. In a molecular solid, the particles break into individual neutral molecules, which are surrounded by water molecules.
5. Solutes lower the freezing point and raise the boiling point of a solvent.
6. solute
7. solvent
8. colloid
9. suspension
10. solution

Understanding Solutions
Enrich

1. The water would freeze at a higher temperature than the other ingredients do. All of the water in ice cream would exist as ice. Large crystals of ice would form, which would prevent the ice cream from having a smooth texture.
2. As the particles of the colloid clump together, the air would escape from the mixture.
3. There would be no point in adding air to the mixture until the particles became sufficiently mixed and their temperature is cool enough to trap the air.
4. Milk is more stable because it remains a colloid at a much wider range of temperatures than does ice cream.

Design Your Own Lab
Speedy Solutions

For answers, see the Teacher's Edition.

Concentration and Solubility
Guided Reading and Study

Use Target Reading Skills
Sample answers:
dilute solution: I put just a dash of salt in the boiling water while I made dinner, making a dilute solution.
concentrated solution: I left the tea bag in my cup a long time, making a concentrated solution.
solubility: My aunt's iced tea was so sweet, I wondered if sugar's solubility in water is actually higher than what I'd learned in my textbook.
saturated solution: My aunt's super sweet tea must have been a saturated solution.
unsaturated solution: On the other hand, my uncle makes a weak sweetened tea that surely must be an unsaturaed solution.
supersaturated solution: If you heated my aunt's sweet tea, I supose you might get a bit more sugar to dissolve in it, making it a supersaturated solution.

1. b
2. a
3. You can add more solute or you can add or remove solvent.
4. To measure concentration, you compare the amount of solute to the amount of solvent or to the total amount of solution.
5. Solubility is a measure of how well a solute can dissolve in a solvent at a given temperature.
6. saturated solution
7. unsaturated solution
8. sugar
9. true
10. pressure; type of solvent; temperature
11. more
12. false
13. a, b, d

Concentration and Solubility
Review and Reinforce

1. To measure concentration, you compare the amount of solute to the amount of solvent or to the total amount of solvent.
2. You could measure the solubility of the white powder in water at 0°C and compare it to a table of solubilities.
3. A solution under high pressure will have more gas dissolved in it.
4. Ionic and polar compounds usually dissolve in polar solvents. Nonpolar compounds do not usually dissolve in polar solvents.
5. For most solids, solubility increases as the temperature increases.
6. d
7. f
8. a
9. c
10. e
11. b

Concentration and Solubility
Enrich

1. For both graphs, solubility is the responding variable and temperature is the manipulated variable.
2. In general, the solubilities of solids increase with increasing temperature. The solubilities of gases decrease with increasing temperature.
3. No. $Yb_2(SO_4)_3$ is less soluble at higher temperatures. The solubility of NaCl is relatively constant.
4. The solubility of KNO_3 increases significantly between 30°C and 80°C.
5. The particles of a gas have much more energy at higher temperatures and escape from the liquid solvent more easily.

Describing Acids and Bases
Guided Reading and Study

Use Target Reading Skills
Sample answers:
Q. What is an acid?
A. An acid is a substance that tastes sour, reacts with metals and carbonates, and turns blue litmus paper red.
Q. What is a base?
A. A base is a substance that tastes bitter, feels slippery, and turns red litmus paper blue.
Q. What are uses of acids and bases?
A. Uses of acids include cleaning products, fertilizers, and car batteries; uses of bases include cleaning products, baking ingredients, and cement manufacturing.
1. It tastes sour. It reacts with metals and carbonates. It turns blue litmus paper red.
2. Scientists never taste chemicals in order to identify them. Many acids are not safe to eat.
3. Acids eat away at other materials.
4. Carbon dioxide gas forms.
5. indicator
6. It turns blue litmus paper red because lemon juice is acidic.
7. It tastes bitter. It feels slippery. It turns red litmus paper blue.
8. false
9. true
10. home; industry
11. acids

Describing Acids and Bases Review and Reinforce

1. Sour
2. Bitter
3. Corrosive to magnesium, zinc, and iron; eats them away and produces bubbles of hydrogen gas
4. Doesn't react with metals
5. Produces carbon dioxide
6. Doesn't react with carbonates
7. Red
8. Blue
9. Corrosive describes a substance that can eat away certain materials.
10. The substance is an acid.
11. An indicator is a substance that turns different colors in an acid or a base.
12. Bases are bitter rather than sour, turn litmus paper blue rather than red, and don't react with metals or carbonates as acids do.

Describing Acids and Bases Enrich

1. Answers may vary. Sample: Placing a book in a liquid solution would be much like soaking the book in water. The pages would become rippled, the ink might run, and the binding could be ruined.
2. Linen paper is less acidic than wood-based papers. Linen paper lasts much longer.
3. Basic paper would not become brittle and fall apart as acidic paper does. In addition, the base in the paper would react with any acid the paper might come into contact with.
4. Answers may vary. Samples: A base might be added after the stage in which alum is added, or a process for making paper without the chemical alum could be developed.

Acids and Bases in Solution Guided Reading and Study

Use Target Reading Skills
Sample questions and answers:
Q. What is a neutral solution?
A. A neutral solution is one that has a pH close to 7.
Q. What is neutralization?
A. Neutralization is a reaction between an acid and a base.
1. A hydrogen ion is an atom of hydrogen that has lost its electron.
2. hydrogen ions and negative ions
3. acid
4. A hydroxide ion is a negative ion made of oxygen and hydrogen.
5. base
6. a, c
7. The pH scale is a range of values from 0 to 14. It express the concentration of hydrogen ions in a solution.
8. Milk: about 6.5; soap: 10; water: 7; vinegar: about 2.8; lemon: about 2.2; ammonia: about 11.5
9. false
10. high
11. a, b
12. neutralization
13. false
14. A salt is any ionic compound made from the neutralization of an acid with a base.
15. water; a salt

Acids and Bases in Solution
Review and Reinforce

1. acids
2. bases
3. hydrogen
4. hydroxide
5. In a strong acid, most of the molecules break up into ions in solution. In a weak acid, fewer molecules break up into ions.
6. In a strong base, most of the molecules break up into ions in solution. In a weak base, fewer molecules break up into ions.
7. The solution with a pH of 3 has a greater concentration of hydrogen ions. As pH values decrease, the concentration of hydrogen ions increases.
8. Water and a salt
9. 7
10. e
11. c
12. d
13. b
14. a

Acids and Bases in Solution
Enrich

1. As pH increases, the amount of hypochlorous acid decreases and the amount of hypochlorite ion increases.
2. An acid added to the water will decrease the pH. The acid will separate into hydrogen ions and negative ions. As the concentration of hydrogen ions increases, pH decreases.
3. A base added to the water will increase pH. The base will neutralize some of the acid in the water to produce water and a salt. This reaction will remove hydrogen ions from the water. As the concentration of hydrogen ions decreases, pH increases.

Consumer Lab
The Antacid Test

For answers, see the Teacher's Edition.

Digestion and pH
Guided Reading and Study

Use Target Reading Skills
Sample answers:
a. mouth
b. 2
c. proteins
d. At a pH near 8, enzymes in the small intestine complete the breakdown of carbohydrates, fats, and proteins.

1. digestion
2. Foods must be broken down into simpler substances that the body can use for raw materials and energy.
3. **a.** A physical process in which large pieces of food are torn and ground into smaller pieces
   b. Chemical reactions break large molecules into smaller ones.
4. a, c, d
5. true
6. Amylase is an enzyme in saliva that breaks down starch into smaller sugar molecules.
7. 7
8. proteins
9. Cells in the lining of the stomach release hydrochloric acid.
10. Pepsin breaks down proteins into amino acids.
11. Digestive fluid in the small intestine contains bicarbonate ions, which create a slightly basic solution.
12. true
13. small intestine

Digestion and pH
Review and Reinforce

1-2. a. mouth, 7
b. stomach, 2
c. small intestine, 8

3. Digestion supplies raw materials and energy from foods to the body.

4. The various digestive enzymes work best at different pH levels.

5. The process of breaking down complex molecules of foods into smaller molecules the body can use

6. Physical process in which large food particles are torn and ground into smaller pieces

7. Chemical process where large molecules are broken down into smaller molecules with the help of enzymes

Digestion and pH
Enrich

1. The reactions on the left side of the table are the reverse of those on the right side.

2. The reaction $H^+ + HCO_3^- \rightarrow H_2CO_3$ removes hydrogen ions. The reaction $H_2CO_3 \rightarrow H^+ + HCO_3^-$ adds hydrogen ions.

3. The carbon dioxide could react with water to produce carbonic acid. The carbonic acid could decompose to produce bicarbonate ions and hydrogen ions. The increase of hydrogen ions causes a decrease in pH.

4. Without the enzyme, less carbonic acid would be produced and fewer hydrogen ions would be produced. That means that blood pH would be high.

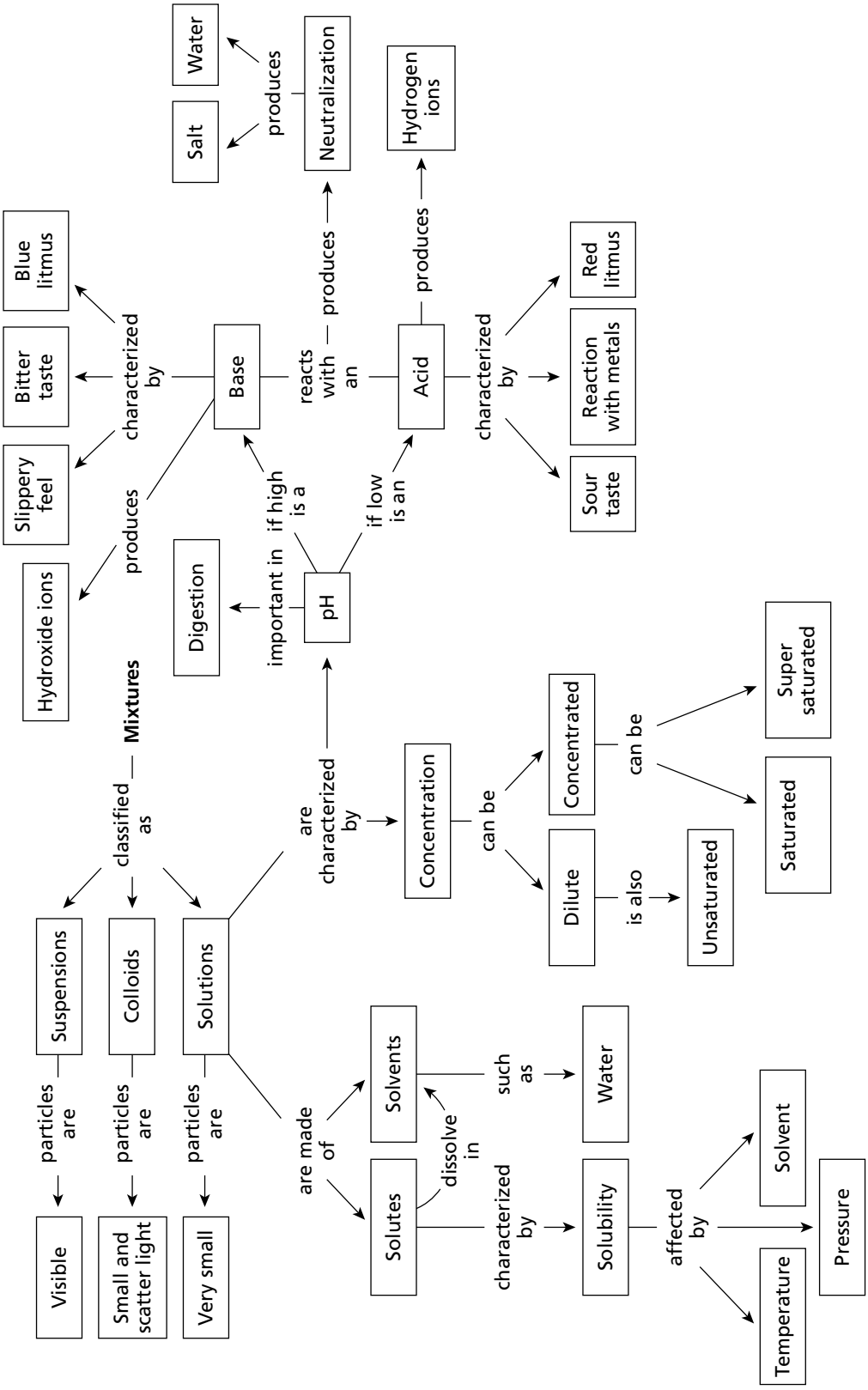
Key Terms

A. 6
B. 1
C. 8
D. 7
E. 5
F. 3
G. 2
H. 9
I. 4

Sums: 15

Connecting Concepts

This concept map is only one way to represent the main ideas and relationships in this chapter. Accept other logical answers from students.



Laboratory Investigation
Determining Solubility

Pre-Lab Discussion

1. A solution is a well-mixed mixture that contains a solvent and at least one solute.
2. In a saturated solution, no more solute can be dissolved in the solvent.
3. More solute added to the solvent will not dissolve and will remain visible in the solvent.

Observations

The data in each student's table will vary depending on the temperatures you assigned. Each student should begin with 25 g of potassium nitrate. Make sure they add the mass of the paper.
The data plotted in the graph should be the same for each student as each student graphs the class data. The mass of potassium nitrate dissolved in water will increase with increasing temperature. Sample data: At 0°C, about 1.3 g of potassium nitrate will dissolve. At 60°C, about 15.3 g of potassium nitrate will dissolve. At 100°C, about 24.7 g of potassium nitrate will dissolve.

Analyze and Conclude

1. More potassium nitrate can dissolve in warmer water.
2. Answers will vary. Sample answer: About 15.3 g of potassium nitrate would dissolve.
3. The volume of water increases by a factor of 10, so the amount of solute will increase by about the same factor. For the sample data, this will be 153 g of potassium nitrate, or ten times the amount in 10 mL of water at 60°C.
4. Answers will vary. Sample answer: 54°C

Critical Thinking and Applications

1. The solubility of potassium nitrate would decrease, and some would precipitate on the bottom of the test tube.
2. Answers will vary. For the sample data, 24.7 g of potassium nitrate will dissolve in 10 mL of water at 100°C. Therefore, $19 \times 24.7\ g \cong 469\ g$ of potassium nitrate will dissolve in 190 mL of water at 100°C.
3. A graph of two points is a straight line. If the mathematical relationship is not linear and some curvature is actually present, the two data points won't show this relationship, and the graph would be inaccurate. In addition, the fewer data points you have, the more likely it is that measurement errors will result in an incorrect graph.
4. 15.3 g at 60°C minus 3.6 g at 10°C = 11.7 g

More to Explore

1. Compared to potassium nitrate, more sodium chloride dissolves in water at 0°C, and less dissolves in water at 100°C. So the line has a much flatter slope.
2. Sample answer: At about 10°C. Sodium chloride is much more soluble in water at lower temperatures than potassium nitrate is. But it is much less soluble than potassium nitrate at higher temperatures. Sodium chloride's solubility in water differs very little between 0°C and 100°C.

Performance Assessment

1. Answers may vary. Most students will find that lemon juice is the best cleaner and baking soda the worst.

2. Answers may vary. Most students will find that solutions with lower pH clean the pennies better. pH is a measure of the concentration of hydrogen ions (H^+) in a solution.

3. Lemon juice and vinegar are acids because their pH levels are less than 7. The soapy water and baking soda solutions are bases because their pH levels are greater than 7. In addition to having pH levels below 7, acids react with metals and carbonates, and turn blue litmus paper red. In addition to having pH levels above 7, bases feel slippery, and turn red litmus blue.

Chapter Test

1. a
2. b
3. c
4. c
5. b
6. c
7. c
8. d
9. a
10. c
11. concentrated
12. corrosive
13. indicator
14. colloid
15. digestion
16. true
17. true
18. acid
19. solvent
20. increase

21. You can infer that the solution is a saturated solution of sugar in water because sugar crystals remain on the bottom. This means that as much sugar as possible has dissolved in the water.

22. Cooling the jar lowers the solubility of sugar in water. Since the solution is already saturated, more of the sugar will come out of the solution as it is cooled. The amount of solid sugar on the bottom of the jar would increase. If the jar was heated (lid off, of course) instead of cooled, the solubility of sugar would increase. More sugar would dissolve, and there would be fewer or no sugar crystals on the bottom.

23. The solute particles break away from each other and become surrounded by particles of the solvent. The solute and solvent become evenly mixed.

24. The mouth, stomach, and small intestine produce enzymes that function best at specific and different pH levels. If the pH is not at the correct level for each organ, the enzymes won't be able to work and food will not be digested properly.

25. Adding antifreeze to the water lowers the freezing point and raises the boiling point. The antifreeze and water solution does not freeze in very cold weather as water alone would. It also protects the engine from overheating because it boils at a higher temperature than pure water would.

26. Ammonia is a base because it forms hydroxide ions in water.

27. If the solution is composed of ions in water, it will conduct electricity. Solutions of dissolved molecular solids do not conduct electricity.

28. A neutralization reaction takes place as the acidic rain and basic lake water react. A salt is formed, and the pH of the lake decreases.

29. A weak acid is one that doesn't easily form H^+ ions in water. A dilute acid is one in which a small amount of acid has been dissolved in water.

30. The dissolved particles of a molecular solid are completely surrounded by the solvent particles, but they remain as neutral molecules. An ionic solid in a solvent separates into positive and negative ions.