DISCOVERING SCIENCE 7 TEACHER'S RESOURCE

UNIT 3: MIXTURES AND SOLUTIONS

Table of Contents

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UNIT 3: OVERVIEW

In Unit 3, Mixtures and Solutions, students will learn that all the matter in the world around them and that they have encountered in their lives can be classified into two broad groups: mixtures and pure substances. Students use the particle theory of matter to help them understand the differences between mixtures and pure substances as well as the differences between heterogeneous and homogeneous mixtures. Following an examination of homogeneous mixtures—solutions—students then investigate methods for separating and recovering the components of mixtures of all kinds.

Chapter 7: Matter can be classified as mixtures or pure substances.

The seemingly endless variety of types of matter can be organized into a more manageable conceptual framework by using the idea of particles and properties as a basis for grouping them as either mixtures or pure substances. Mixtures, as students will learn in this chapter, may be either homogeneous, with the same properties throughout, or heterogeneous, with visibly different components that have different properties. While mixtures, both homogeneous and heterogeneous, are comprised of two or more components whose particles retain their own characteristic properties, each pure substance is comprised of its own type of particle, which is different from the kinds of particles that make up all other pure substances. Further examination and classification of pure substances awaits students in subsequent grades. In the remainder of this chapter, students refine their thinking about the nature of the heterogeneous and homogeneous mixtures.

Chapter 8: Some substances dissolve to form solutions faster and more easily than others.

Unlike their experiences with heterogeneous mixtures, students' exploration of and communication about homogeneous mixtures—solutions—requires a more specialized and extensive conceptual vocabulary. The first section of Chapter 8 introduces the parts of this vocabulary that are associated with the making of solutions, while the second section focuses on vocabulary that enables students to describe and compare solutions qualitatively and quantitatively in terms of their concentration and their solubility. Throughout their explorations, students consider the great variety of solutions that is made possible through the combination of solutes and solvents of various states. Students also investigate ways to modify the rate at which solutes dissolve in given solvents.

Chapter 9: Many useful products depend on technology for separating mixtures and solutions.

Technology enables us to make and "un-make" (separate) mixtures through various methods and for various purposes. Students begin this chapter by appreciating that, on a daily basis, they separate or observe the separation of numerous mixtures for many practical purposes. Students then proceed to draw upon their understanding of properties to explore ways to separate the components of heterogeneous and homogeneous mixtures. With this conceptual foundation developed through the first section of the chapter, students investigate, in the second section, how many of the separation techniques they use themselves may be applied on a much larger scale to obtain and process materials such as petroleum and gold—mineral resources on which society depends.

MULTIPLE INTELLIGENCES CORRELATION FOR UNIT 3 ACTIVITIES AND INVESTIGATIONS

The table below identifies possible multiple intelligences that could be incorporated into activities and investigations in this unit. For more information about differentiated instruction and multiple intelligences, see the Introduction and Implementation section in this Teacher's Resource.

Multiple Intelligences:	VL	VS	BK	MR	LM	N	E	IA	IE
UNIT 3: Mixtures and Solutions									
Find Out Activity: Mixed or Pure?	■	■	■		■				■
Chapter 7: Matter can be classified as mixtures or pure substances.									
Find Out Activity 7-1A: Now You See It…	■	■	■		■				
Find Out Activity 7-1B: Mixture Match-Up	■	■	■		■				■
Conduct an Investigation 7-1C: Examining Three Common Beverages	■	■	■		■				
Conduct an Investigation 7-2A: Shine On	■	■	■		■				
Conduct an Investigation 7-2B: What Kind of Mixture?	■	■	■		■				
Chapter 8: Some substances dissolve to form solutions faster and more easily than others.									
Think About It 8-1A: Name That Solute and Solvent	■				■				
Find Out Activity 8-1B: Eggshell Shocked	■	■	■		■				
Find Out Activity 8-1C: Does It Dissolve?	■	■	■		■				
Conduct an Investigation 8-2A: How Does Temperature Affect Solubility?	■	■	■		■				
Find Out Activity 8-2B: How Much is Too Much?	■	■	■		■				■
Find Out Activity 8-2C: Concentrations of Consumer Products	■				■				
Find Out Activity 8-2D: Dissolved Carbon Dioxide	■				■				
Chapter 9: Many useful products depend on technology for separating mixtures and solutions.									
Think About It 9-1A: Strategies for Separation	■				■				■
Conduct an Investigation 9-1B: Make Dirty Water Clear	■	■	■		■	■			■
Find Out Activity 9-1C: Separating Salt from Salt Water	■	■	■		■				
Find Out Activity 9-2A: Panning for "Gold"	■	■	■		■				■
Think About It 9-2B: Mining for Gold	■	■			■				
Unit 3 Project: Purifying Mixtures	■	■	■		■				■
Unit 3 Integrated Research Investigation: Safe, Clean Water for Everyone	■	■						■	■

Multiple Intelligence codes:
VL = Verbal-Linguistic Intelligence; VS = Visual-Spatial Intelligence; BK = Body-Kinesthetic Intelligence; MR = Musical Rhythmic Intelligence; LM = Logical-Mathematical Intelligence; N = Naturalist Intelligence; E = Existential Intelligence; IA = Intrapersonal Intelligence; IE = Interpersonal Intelligence

Planning Chart for Activities and Investigations for Unit 3: Mixtures and Solutions

ACTIVITY/ INVESTIGATION	ADVANCE PREPARATION	APPARATUS/MATERIALS	TIME REQUIRED
Unit 3: Mixtures and Solutions			
Find Out Activity: Mixed or Pure?	• 2 or 3 days before: – Collect the items listed. (Note that the aluminum foil-plastic wrap pair should be a single sheet of each. Similarly, the stainless steel-glass pair should be a single piece of each, perhaps about the size of a hand or post card.) • 1 day before: – Photocopy BLM 3-3, Reviewing Physical Properties	For the class: One pair of the following: – vinegar and water – aluminum foil and plastic wrap – stainless steel and glass – molasses and cooking oil – metal paper clips and sawdust	• 15–20 min
Chapter 7: Matter can be classified as mixtures or pure substances.			
Find Out Activity 7-1A: Now You See It	• 1 day before: – Review the definition of the term mixture on page 232. – Photocopy BLM 3-4, Now You See It Observation Chart	For each group: – beaker or plastic cup – tap water – white sugar – measuring spoon – magnifying lens	• 35–40 min
Find Out Activity 7-1B: Mixture Match-Up	• 1 day before or day of – Students could prepare a full-page copy of the table of observations in their notebooks, or they could use BLM 3-5, Mixture Match-Up Observation Chart.	Students are to use only those items listed in the introductory paragraph of this activity on page 235.	• 30 min
Conduct an Investigation 7-1C: Examining Three Common Beverages	• 1 day before – Gather apparatus and materials. – Ensure that test tubes are clean. – Purchase fresh milk, orange juice, and soda water. – Photocopy BLM 3-8, Examining Three Common Beverages Table of Observations • Before class: – Set up at least one (if possible, three) compound light microscopes and set up samples on slides.	For each group: – 3 clean test tubes – marking pen and masking tape for labels – test tube rack – magnifying glass – eye dropper – watch glass or Petri dish – homogenized milk – orange juice (either fresh or from concentrate) – soda water	• 40–60 min
Conduct an Investigation 7-2A: Shine On	• 1 day before – Collect materials and equipment. – Determine if additional mixtures will be available for testing and either prepare them or collect materials for students to do so.	For each group: – 3 250 mL beakers or jars – 5 mL fine-grained starch – 5 mL table salt – water – 2 stirring rods – masking tape and marker (for labels) – flashlight – additional mixtures (optional)	• 40–50 min
Conduct an Investigation 7-2B: What Kind of Mixture?	• 1 or 2 days before – Prepare the four mixtures. – Photocopy BLM 3-11, What Kind of Mixture? Table of Observations	For each group: – 4 mixtures – 4 small beakers or jars – 4 pieces of filter paper – ring stand and clamp – funnel	• 20–25 min

ACTIVITY/ INVESTIGATION	ADVANCE PREPARATION	APPARATUS/MATERIALS	TIME REQUIRED
Chapter 8: Some substances dissolve to form solutions faster and more easily than others.			
Think About It 8-1A: Name That Solute and Solvent	No advance preparation necessary.	For each group: – student book	• 15–20 min
Find Out Activity 8-1B: Eggshell Shocked	• 2 or 3 days before – Decide whether this activity will be a take-home or in-class task. If done at school, ensure that sufficient quantities of eggs are available.	For each group: – 2 large beakers (400 mL or 500 mL) or large jam jars – 2 raw eggs – water – vinegar	• 15 min (plus several days of observation time)
Find Out Activity 8-1C: Does It Dissolve?	• 3 days before – Gather materials (unless the activity is assigned as a take-home task)	For each group: – 4 small transparent containers (e.g., small beakers or plastic cups) – 4 labels – 4 stir sticks – water – vegetable oil – salt – flour – measuring spoons	• 30 min
Conduct an Investigation 8-2A: How Does Temperature Affect Solubility?	• 7 days before – Book time in the computer lab so students can use spreadsheet or other graphing software to prepare a graph • 2 or 3 days before – Gather necessary equipment and materials	For each group: – balance – graduated cylinder – thermometer – small beakers or test tubes with stoppers – (if using test tubes) test tube rack – stirring rod – measuring spoon – choice of solutes (e.g., table salt, Epsom salts, flavoured drink powder, baking soda) – clock or stopwatch	• 20–25 min (plus computer time) for Part 1; 90–120 min for Part 2
Find Out Activity 8-2B: How Much is Too Much?	• 2 or 3 days before – Gather the apparatus and materials	For each group: – graduated cylinder – 250 mL beaker – measuring spoon – 40 g of salt – Petri dish (or piece of paper) – water – stirring rod – balance – additional substances for testing (e.g., sugar, bluestone (copper(II) sulfate), calcium hydroxide)	• 35–40 min
Find Out Activity 8-2C: Concentrations of Consumer Products	No advance preparation necessary.	For each group: – student book	• 20 min
Find Out Activity 8-2D: Dissolved Carbon Dioxide	• 3 days before – Obtain plastic bottles of pop (if the activity is to be completed at school). • 1 day before – Organize the equipment and materials. • 1 to 2 hours before – Warm and cool bottles of pop.	For each group (for example): – large basin or sink – sealed, plastic bottles of pop – hot water – ice cubes – refrigerator (if possible)	• 50–60 min

ACTIVITY/ INVESTIGATION	ADVANCE PREPARATION	APPARATUS/MATERIALS	TIME REQUIRED
Chapter 9: Many useful products depend on technology for separating mixtures and solutions.			
Think About It 9-1A: Strategies for Separation	• 1 day before – Determine group sizes for this activity and how students will be paired.	For each group: – student book	• 15–20 min
Conduct an Investigation 9-1B: Make Dirty Water Clear	• 3 or 4 days before – Make a pail of dirty water.	For each group: – 2 L pop bottle with bottom cut off – ring clamp – ring stands – stopwatch – sand – gravel – cotton cloth – dirty water – bucket or larger beaker	• 40 min
Conduct an Investigation 9-1C: Separating Homogeneous Mixtures	**Part 1: Evaporate** • 1–2 days before – Gather equipment and materials. **Part 2: Distillation** • 2–3 days before – Gather materials and equipment. – Insert glass tubing in stoppers. – Do a trial run of the activity. **Part 3: Paper Chromatography** • 1–2 days before – Gather materials and equipment	**Part 1: Evaporate** For each group: – evaporating dish – 50 mL graduated cylinder – hot pad – hot plate – stirring rod – tongs – watch glass – salt water **Part 2: Distillation** For each group: – distilled water – salt – microscope slide – marker – 2 beakers (250 mL) – graduated cylinder – medicine dropper – hot plate – 500 mL Erlenmeyer flask – stopper with glass tubing inserted – 50 cm rubber or plastic tubing – tongs (for beaker or flask) – measuring spoon **Part 3: Paper Chromatography** For each group: – 2 beakers (250 mL) – filter paper – black marker pen (water-soluble) – black marker pen (permanent) – water – 2 plastic straws – scissors – ruler – tape – waxed paper	**Part 1: Evaporate** • 25–30 min **Part 2: Distillation:** • 40–60 min initially • overnight to complete step 5 **Part 3: Paper Chromato-graphy** • 40–50 min
Find Out Activity 9-2A: Panning for "Gold"	• 2 or 3 days before – Gather materials and equipment.	For each group: – 1 L Styrofoam packing chips – 1 L marbles – large paper bag – large basin – hair dryer	• 15 min
Think About It 9-2B: Mining for Gold	No advance preparation necessary.	For each group: – student book	• 20–30 min

ACTIVITY/ INVESTIGATION	ADVANCE PREPARATION	APPARATUS/MATERIALS	TIME REQUIRED
Unit 3 Project: Purifying Mixtures	• 2 or 3 days before – Prepare enough dry mixture and "kits" of separation equipment for each group.	For each group: – several beakers (250 mL to 600 mL), bottles, or cups – magnet – variety of filters (fine to coarser mesh) – small funnels – hot plate (optional) – evaporating dishes – labels or grease pencil – variety of substances for dry mixtures (e.g., sand, coarse gravel, marbles, metal paper clips (magnetic), wood chips or cut-up toothpicks, salt, instant, coffee, small plastic beads, various-sized stones) – water – paper	• 75–120 min
Unit 3 Integrated Research Investigation: Safe, Clean Water for Everyone	1 week before: – Book library and computer time.	For each group: – print and electronic resources to be determined by students – presentation materials to be determined by students	• 120 min

TALKS AND TOURS

Possible sources of speakers on topics related to the material in Unit 3 include local colleges and universities or businesses (such as the oil industry or mining) that use or develop related technology. Many of these organizations may have a speakers bureau or, if applicable, be able to provide an opportunity to see science in action. In addition, consider contacting:

- a local cook or chef to talk about (and, if possible, demonstrate) the important role of mixtures in food preparation

UNIT 3 BLACKLINE MASTERS

CONTENT-RELATED BLACKLINE MASTERS	ASSESSMENT-RELATED BLACKLINE MASTERS
Unit BLM 3-1, Unit 3 Summary BLM 3-2, Unit 3 Key Terms BLM 3-34, Unit 3 Review BLM 3-35, Unit 3 BLM Answers	Assessment Rubric 1, Concept Rubric Assessment Rubric 9, Communication Rubric Assessment Rubric 7, Scientific Research Planner Rubric Assessment Rubric 8, Research Project Rubric Assessment Rubric 3, Co-operative Group Work Rubric Assessment Rubric 5, Conduct an Investigation Rubric Assessment Rubric 6, Design an Investigation Rubric Assessment Checklist 13, Concept Map Assessment Checklist 21, Project Self-Assessment Assessment Checklist 22, Project Group Assessment Assessment Checklist 25, Safety Checklist Process Skills Rubric 8, Interpreting Data Process Skills Rubric 5, Fair Testing Process Skills Rubric 2, Hypothesizing Process Skills Rubric 3, Controlling Variables
Chapter 7 BLM 3-3, Reviewing Physical Properties BLM 3-4, Now You See It Observation Chart BLM 3-5, Mixture Match-Up Observation Chart BLM 3-6, Comparing Particles in a Pure Substance and a Mixture BLM 3-7, A Particle View of the States of Matter BLM 3-8, Examining Three Common Beverages Table of Observations BLM 3-9, A Classification of Matter BLM 3-10, Shine On Observation Chart BLM 3-11, What Kind of Mixture? Table of Observations BLM 3-12, From Heterogeneous to Homogeneous BLM 3-13, Chapter 7 Review	Assessment Checklist 1, Making Observations and Inferences Assessment Checklist 2, Asking Questions Assessment Checklist 4, Laboratory Report Assessment Checklist 9, Oral Presentation Assessment Checklist 18, Data Table Assessment Checklist 21, Project Self-Assessment Assessment Checklist 22, Project Group Assessment Assessment Checklist 23, Learning Skills Assessment Checklist 24, KWL Assessment Checklist Assessment Checklist 25, Safety Checklist Assessment Rubric 1, Concept Rubric Assessment Rubric 2, Science Notebook Rubric Assessment Rubric 3, Co-operative Group Work Rubric Assessment Rubric 5, Conduct an Investigation Rubric Assessment Rubric 9, Communication Rubric Assessment Rubric 10, Presentation Rubric Assessment Rubric 11, Using Tools, Equipment, and Materials Rubric Process Skills Rubric 2, Hypothesizing Process Skills Rubric 3, Controlling Variables Process Skills Rubric 5, Fair Testing Process Skills Rubric 6, Designing Experiments Process Skills Rubric 7, Predicting Process Skills Rubric 8, Interpreting Data Process Skills Rubric 9, Questioning Process Skills Rubric 10, Measuring and Reporting

CONTENT-RELATED BLACKLINE MASTERS	ASSESSMENT-RELATED BLACKLINE MASTERS
Chapter 8 BLM 3-14, Does It Dissolve? Observation Chart BLM 3-15, Attraction among Particles/Particles Acting Out BLM 3-16, How Stains Are Removed BLM 3-17, Alternative Cleaners BLM 3-18, Make Your Own Snow Globe BLM 3-19, Solubility Sequencing BLM 3-20, How Does Temperature Affect Solubility? BLM 3-21, Solubility and Temperature BLM 3-22, Concentrations of Consumer Products Recording Chart BLM 3-23, Working with Concentration Units Recording Chart BLM 3-24, Chapter 8 Review	Assessment Checklist 1, Making Observations and Inferences Assessment Checklist 2, Asking Questions Assessment Checklist 3, Designing an Experiment Assessment Checklist 4, Laboratory Report Assessment Checklist 6, Developing Models Assessment Checklist 9, Oral Presentation Assessment Checklist 13, Concept Map Assessment Checklist 14, Events Chain or Flowchart Assessment Checklist 17, Science Math Connect Assessment Checklist 18, Data Table Assessment Checklist 19, Graph from Data Assessment Checklist 23, Learning Skills Assessment Checklist 24, KWL Assessment Checklist Assessment Checklist 25, Safety Checklist Assessment Rubric 1, Concept Rubric Assessment Rubric 2, Science Notebook Rubric Assessment Rubric 3, Co-operative Group Work Rubric Assessment Rubric 5, Conduct an Investigation Rubric Assessment Rubric 6, Design an Investigation Rubric Assessment Rubric 9, Communication Rubric Assessment Rubric 10, Presentation Rubric Assessment Rubric 11, Using Tools, Equipment, and Materials Rubric Process Skills Rubric 1, Developing Models Process Skills Rubric 2, Hypothesizing Process Skills Rubric 3, Controlling Variables Process Skills Rubric 5, Fair Testing Process Skills Rubric 6, Designing Experiments Process Skills Rubric 7, Predicting Process Skills Rubric 8, Interpreting Data Process Skills Rubric 9, Questioning Process Skills Rubric 10, Measuring and Reporting
Chapter 9 BLM 3-25, Settling Undissolved Solids BLM 3-26, Growing Salt Crystals BLM 3-27, Methods of Separation BLM 3-28, Strategies for Separation Observation Chart BLM 3-29, Simple Distillation Setup BLM 3-30, Separating Homogeneous Mixtures Recording Sheet BLM 3-31, Fractional Distillation Tower BLM 3-32, Visualizing Key Ideas Recording Sheet BLM 3-33, Chapter 9 Review	Assessment Checklist 1, Making Observations and Inferences Assessment Checklist 2, Asking Questions Assessment Checklist 3, Designing an Experiment Assessment Checklist 4, Laboratory Report Assessment Checklist 6, Developing Models Assessment Checklist 9, Oral Presentation Assessment Checklist 18, Data Table Assessment Checklist 19, Graph from Data Assessment Checklist 23, Learning Skills Assessment Checklist 24, KWL Assessment Checklist Assessment Checklist 25, Safety Checklist Assessment Rubric 1, Concept Rubric Assessment Rubric 2, Science Notebook Rubric Assessment Rubric 3, Co-operative Group Work Rubric Assessment Rubric 5, Conduct an Investigation Rubric Assessment Rubric 6, Design an Investigation Rubric Assessment Rubric 9, Communication Rubric Assessment Rubric 10, Presentation Rubric Assessment Rubric 11, Using Tools, Equipment, and Materials Rubric Process Skills Rubric 1, Developing Models Process Skills Rubric 2, Hypothesizing Process Skills Rubric 3, Controlling Variables Process Skills Rubric 4, Problem Solving Process Skills Rubric 5, Fair Testing Process Skills Rubric 6, Designing Experiments Process Skills Rubric 7, Predicting Process Skills Rubric 8, Interpreting Data Process Skills Rubric 9, Questioning Process Skills Rubric 10, Measuring and Reporting

Teaching Notes
for
Pages 226 to 309 of the Student Book

UNIT 3 OPENER, pp. 226–227

The opening photo shows a mixture of rocks found on the beach at Green Point in Gros Morne National Park, but such a mixture might be visible on any beach anywhere in the world. What makes this particular image so compelling is that, in their individual play of multiple, mottled colours, we can see easily that the rocks themselves are mixtures—materials made up of more than a single component.

USING THE UNIT OPENER

Situating this opening image in the province helps to deliver the message, if only subtly, that Newfoundland and Labrador is a source of mixtures of great diversity and variety. In fact, looking beyond students' immediate environment to a more global context, one can appreciate that Earth itself abounds with mixtures and is, itself, a mixture of mixtures—from the rocks that make up the crust to the ocean of air that surrounds us to the ocean and other bodies of water that bridge the landmasses. By appreciating that nature is a source of mixtures, it should come as no surprise that human invention—technology—has followed suit to create a similarly impressive array of mixtures. As students will discover, however, we are as interested in being able to separate the components of mixtures as we are to make use of them in their own right.

You may want to hand out BLM 3-1, Unit 3 Summary, and BLM 3-2, Unit 3 Key Terms, to help students record their understanding of the unit and useful terms.

GETTING STARTED, pp. 228–229

USING THE TEXT

The story of King Hiero II is often used to demonstrate the concept of the property of density. The story also benefits students, tangentially, by providing with an actual context in which to appreciate the use and origins of a word they likely have heard: "eureka." (Language, it could be said, is also a mixture—a mixture of words, phrases, and sounds from numerous peoples and points in history.) While density figures into this unit introduction, the focus is on the practical use of properties to solve a problem: Is the king's crown pure gold or a mixture? This linking of properties to mixtures is an essential component of students' study of mixtures, their use, and their processing.

USING THE ACTIVITY

Find Out Activity

Mixed or Pure?, p. 229

Purpose

- Students relate the concept of properties to the identification of components that make up mixtures.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO	APPARATUS/MATERIALS
2–3 days before	Collect the items listed. (Note that the foil-plastic wrap pair should be a single sheet of each. Similarly, the steel-glass pair should be a single piece of each, perhaps about the size of a hand or digest book.)	For each group or the class: One pair of the following: – vinegar and water – aluminum foil and plastic wrap – stainless steel and glass – metal paper clips and sawdust
1 day before	Photocopy BLM 3-3, Reviewing Physical Properties	

Time Required

- 15–20 min

Safety Precautions

- Remind students that the science classroom is a place where safety is of primary concern. Students must never taste or eat any item in the science classroom unless they are specifically requested to do so by you. They must also behave with respect toward their classmates' safety as well as their own.

Expected Results

Students will begin to appreciate that paying close and careful attention to the properties of matter is a key factor in being able to describe and separate mixtures of matter.

Activity Notes

- To troubleshoot for safety issues, a single set of each pair of items can be on display at the front of the class. Each group of students can come to the front to observe the pair of items.
- The activity could be set up with pairs of items at stations. Each group of students can work at each station, clean up, and then rotate to a different station.
- It might be prudent to substitute transparent plastic (Plexiglas™) for glass. Otherwise, students should be cautioned to handle the glass carefully.

- The emphasis in this activity is not on the number of differences between items that the class comes up with, but on the variety of differences. The ability to perceive such variety in the properties of matter will help students in their study of mixtures.

Supporting Diverse Student Needs

- You might wish to partner students with reading difficulties or students who need additional academic support with students who have strong oral and written language skills.
- This is an excellent activity for students with strong body-kinesthetic skills and/or visual-spatial skills.

What Did You Find Out? Answers

1. Students will note differences in, for example, size, shape, colour, transparency, and texture.
2. (a) Students might suggest using a filter of some kind (such as a sieve), using a magnet, and/or picking out paper clips or aluminum foil by hand.
   (b) Adding water might help the aluminum bits float more readily, making them easier to remove.

CHAPTER 7 OPENER, pp. 230–231

USING THE PHOTO AND TEXT

Chapter 7 introduces students to the mixtures and their great variety in the students' lives. To complement the introductory text, you could pull a nickel out of a pocket or hand bag and display it to the class. Ask students to identify the coin and to describe it to you. As necessary, prompt students with questions such as these:

- How big is it?
- What colour is it?
- What is its shape?
- What is its texture like?
- What is it used for?
- What is it made of?

Some of students' answers will cite properties of the coin. Some will describe its use or function. Of particular importance to this chapter and unit are students' answers to the question, "What is it made of?" If students have not yet read the introductory paragraph, they might wonder why a nickel is made of substances other than nickel. That would be a good time to read and discuss the introduction with the class.

While this intro is focussed mainly on introducing the idea of mixtures, you could also probe further to invite students' ideas about the nature of the material of which a nickel is made. For instance, students could offer their ideas about what nickel is and how something that is purely nickel might differ from something that is a mixture of steel, copper, and nickel. If students have completed Unit 2, remind them of the particle theory of matter and encourage them to imagine what a piece of pure nickel and a "nickel" coin might look like at the particle level. At this point, you are planting conceptual seeds that will bear fruit as students near the end of section 7.1.

USING THE WHAT YOU WILL LEARN/WHY IT IS IMPORTANT/SKILLS YOU WILL USE

Use the boldface verbs to illustrate the variety of opportunities that students will have to engage the topic of mixtures. Have students demonstrate, to you and to one another, their understanding of these verbs. In addition to ensuring students truly do know what the words mean, this task is also essential to the assessment of their work. As necessary, remind students that the marks and remarks that you provide to them through formative and summative assessment are linked directly to verbs such as those in boldface type.

USING THE FOLDABLES™ FEATURE

See the Foldables™ section of this resource.

7.1 HOW MIXTURES ARE DIFFERENT FROM PURE SUBSTANCES

SCIENCE BACKGROUND

A mixture is a physical combination of two or more kinds of matter. Soil is a mixture, for example, of sand, silt, clay, air, water, and decomposed organic material. Some of these components are visible to the unaided eye, while others might require a microscope to see them.

The components in a mixture occur in different proportions, with each individual component retaining its chemical identity. A heterogeneous mixture is a mixture in which the different components are visible, either to the unaided eye or through magnification. A homogeneous mixture is a mixture in which the components are combined so thoroughly that the mixture appears to be one substance. Homogeneous mixtures are called solutions.

A pure substance is matter that has a definite composition that stays the same in response to physical changes. Elements (e.g., gold, iron, nickel, oxygen, hydrogen) and compounds (e.g., pure water, carbon dioxide, sodium chloride) are pure substances. An element cannot be separated into any simpler substances, while a compound is a substance that results when two or more elements combine chemically to form a different substance with properties that are different from those of the original elements.

COMMON MISCONCEPTIONS

- The particle theory of matter is a common source of misconceptions for students at this level—both the nature of the particles themselves and the spaces between them. At this level, it is sufficient for students to understand that the particles that make up one kind of matter are different from the particles that make up another kind of matter. For instance, the particles that make up copper are different from the particles that make up water. This is why copper and its properties are different from water and its properties. The notion of space between particles is a more difficult concept for students to grasp. Most students think that this space is air. This is not the case. The space between particles is precisely that: space, empty space. This space is not matter. It is simply what separates the particles of a particular type of matter from one another. While many students have difficulty with this concept (because of its inherent abstraction), they can, at least, be encouraged to appreciate it. It will be several more years before this concept becomes more readily accessible and acceptable to the majority of students.
- Students might believe that all mixtures are easily and/or rigidly categorized as either heterogeneous or homogeneous. They will learn in section 7.2 that classifying mixtures is more involved than this simple dichotomy would otherwise imply. Students could, in this introductory section, be encouraged to think "outside of the box" imposed by rigid dichotomies; however, this is not necessary, and should only be done if students can demonstrate a fair level of mastery of the concepts supporting the dichotomy in the first place.

ADVANCE PREPARATION

- Order or arrange access to chemicals and equipment needed for Find Out Activity 7-1A, Now You See It, and Conduct an Investigation 7-1C, Examining Three Common Beverages, in advance.
- Consult the Unit front matter for a list of BLMs that can be used when teaching this section.

INTRODUCING THE SECTION, pp. 232–233

Using the Text

Have students read the three paragraphs on page 232. The first three questions in the last paragraph are rhetorical, meant to spark students' thinking. The last question could be used for brief class discussion to collect students' ideas before they do the activity on the next page and before they consider the text material that follows it.

Using the Key Terms and Section Summary

At the beginning of each section in the student book are the Key Terms and section summary. Both can be used as a pre-reading strategy and a review tool. Before reading the text in the section, students should be able to define the terms listed in the Key Terms by scanning the text and using the glossary. The Key Terms include terms from the curriculum outcomes and additional terms that are useful for students to know and understand.

The section summary provides an overview of the key concepts being covered in the section. Students may not know all the concepts and terms described in the summary, but they can use this information to help guide them through their reading.

After reading the section, students can go back to the Key Terms and section summary to consolidate their understanding and identify areas that require clarification. At the end of the chapter or unit, students can use the Key Terms and section summary for review. BLM 3-2, Unit 3 Key Terms listing all the terms listed in the unit can be used to assist students.

USING THE ACTIVITY

Find Out Activity 7-1A

Now You See It, p. 233

Purpose

- Students use their prior experience with and knowledge of the properties of sugar and water to develop an operational understanding of homogeneous mixtures.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO	APPARATUS/MATERIALS
1 day before	Review the definition of the term mixture on page 232. Photocopy BLM 3-4, Now You See It Observation Chart	For each group: – beaker or plastic cup – tap water – white sugar – measuring spoon – magnifying lens

Time Required

- 35–40 min

Safety Precautions

- Safety eyewear, lab coats, and gloves must be worn in accordance with provincial safety standards.
- Do not taste, eat, or drink the sugar and water.

Expected Results

Students will see that a mixture of sugar and water looks just like water alone. There is no visual evidence of the sugar's presence until the mixture is left to evaporate. Only then can the sugar be observed once again.

Activity Notes

- Have students prepare the data table in their notebooks or photocopy BLM 3-4.
- Discuss the idea that students will be using their senses to observe the properties of sugar, water, and a mixture of the two. Then they will use their observations to select a summary statement that they think best applies to their experiences and ideas.
- Some students might feel frustrated with their inability to use taste to extend their observations. Advise students that many scientists in the past became seriously ill, and sometimes died, because they used taste as a means to investigate matter. Even though sugar and water are common, usually safe materials, advise students that they should *always* assume that the materials they work with are potentially harmful and should be treated with caution and sensible respect.
- All the chemicals used in this activity can safely go into solid waste or be rinsed down the sink with water.

Supporting Diverse Student Needs

- This is a good activity for tactile or visual learners. Such learners might benefit from being paired with students who are strong readers, who can read aloud various steps or questions of the activity.

What Did You Find Out? Answers

1. The third statement is the most accurate. Students must rely either on their experiences at home with sugar and water and/or their observations in step 6 to arrive at this conclusion.
2. This question is intended to get students thinking about the particle nature of mixtures—a topic they will address specifically on pages 236 and 237. At this point in the chapter, students' creative imagination and critical thinking are to be encouraged; "correct" answers are neither required nor desired. Students can discuss their models and ideas with one another to help them assess their thinking.

TEACHING THE SECTION, pp. 232–241

Using Reading

Pre-reading—K-W-L (Know, Want to Know, Learned)

Have students record their answers to the question, "What do I know about mixtures?" Then ask them to review their answers and record questions that they have about mixtures. Later, students can share their questions as a class and together discuss the answers.

During Reading—GIST

As students read the paragraphs of this section, have them write short summaries after each of the following sub-sections: heterogeneous and homogeneous mixtures (page 234), pure substances (page 236), and the difference between mixtures and pure substances (pages 236 and 237). Students should keep their summaries brief—to 20 words or fewer—to help them more easily understand facts and recognize relationships.

Some students might benefit from a review or reinforcement of concepts related to the particle theory.

After Reading—Semantic Mapping

Have students construct a concept map such as a flowchart or a Venn diagram to help them summarize and synthesize their understanding of mixtures, pure substances, and the relationships between them. (A flowchart with this purpose appears on page 242 of the student text. Students who notice this should be challenged to develop an alternative map to demonstrate their understanding.)

Reading Check Answers, p. 235

1. A mixture is a combination of two or more different types of matter.
2. A heterogeneous mixture, such as soil or salad dressing, is made up of two or more parts that are usually visible to the eye.
3. A homogeneous mixture, such as salt water or clean air, is made up of parts that appear to be the same throughout the mixture.

Reading Check Answers, p. 237

1. Two examples of pure substances are copper (i.e., an element) and calcium carbonate (i.e., a compound).
2. According to the particle theory of matter, a pure substance is a substance that has only one type of particle throughout.
3. A pure substance is different from a mixture because a pure substance has only one type of particle throughout, and a mixture has two or more types of particles throughout.

USING THE ACTIVITIES

- Activity 7-1A, Now You See It, on page 233 of the student book is best used after students have read and discussed the introductory text material about mixtures on page 232.
- Activity 7-1B, Mixture Match-Up, on page 235 of the student book is best used to help students self-assess their understanding of the concepts of heterogeneous and homogeneous mixtures introduced on page 234.
- Activity 7-1C on pages 238–239 of the student book is best used to help students apply their understanding of heterogeneous and homogeneous mixtures introduced on page 234.

Detailed notes on doing the activities follow.

Find Out Activity 7-1B

Mixture Match-Up, p. 235

Purpose

- Students classify some common materials as heterogeneous or homogeneous.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO	APPARATUS/MATERIALS
1 day before or day of	Students could prepare a full-page copy of the table of observations in their notebooks , or photocopy BLM 3-5, Mixture Match-Up Observation Chart.	Students are to use only those items listed in the introductory paragraph of this activity on page 235.

Time Required

- 30 min

Safety Precautions

- The suggested products have been chosen as safe for you to examine. Do not use any products other than those listed here. Wash your hands after handling each product.

Expected Results

Students will discover that many of the products in their homes are mixtures, and most of these are heterogeneous mixtures.

Activity Notes

- You might want to send home a note to tell students' parents or guardians about the activity and to suggest ways they might help.
- Discuss the activity in class so that students fully understand it.
- Students are required to use whatever clues they can to determine whether an item is homogeneous or heterogeneous. Some students might take this literally and list the ingredients/components on product labels. What students must decide is whether or not the combination of the ingredients/components has resulted in a homogeneous or a heterogeneous mixture.
- As necessary, stress to students that their focus should be reasoning, rather than right answers. Their investigations of mixtures have only begun, and much of the unit still lies ahead.

Supporting Diverse Student Needs

- This is an excellent activity for visual learners.
- Some students might need some assistance in filling in their tables. Their responses could be done orally if desired.

What Did You Find Out? Answers

1. Students' answers could include properties such as texture, colour, and transparency. Accept all reasonable answers.
2. Disagreements could be related to an over-dependence on physical appearance as a defining trait, as well as impatience to get the activity "over with." Thus, for example, prepared mustard might be considered homogeneous at a quick glance; however, given time, the water component of most brands of prepared mustard will separate from the other components to some extent. Encourage students to explain their reasoning for all agreements and disagreements.

Conduct an Investigation 7-1C

Examining Three Common Beverages, pp. 238–239

Purpose

- Students investigate three common beverages to determine experimentally whether they are heterogeneous or homogeneous.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO	APPARATUS/MATERIALS
1 day before	Gather apparatus and materials Ensure that test tubes are clean. Purchase fresh milk, orange juice, and soda water. Copy Assessment Checklist 25, Safety Checklist. Copy BLM 3-8, Examining Three Common Beverages Table of Observations.	For each group: – 3 clean test tubes – marking pen and masking tape for labels – test tube rack – magnifying glass – eye dropper – watch glass or Petri dish – homogenized milk – orange juice (either fresh or from concentrate) – soda water
Before class	Set up at least one (if possible, three) compound light microscopes. Prepare slide samples.	

Time Required

- 40–60 min

Safety Precautions

- Safety eyewear, lab coats, and gloves must be worn in accordance with provincial safety standards.
- Do not taste or drink the three beverages.

Expected Results

Students likely will identify soda water as homogeneous and orange juice as heterogeneous. Milk will almost certainly be identified as homogeneous, even though it is, technically, heterogeneous.

Activity Notes

- Hand out Assessment Checklist 25, Safety Checklist.
- Hand out BLM 3-8, Examining Three Common Beverages Table of Observations.
- Do a trial run of the investigation to identify time-consuming snags or methods.
- Provide one set of equipment for each group of students, but (if possible) supply each student with a magnifying glass.
- Discuss the introductory paragraph as a class. What are students' favourite beverages? Why do they like them? What kind of mixtures are they?
- Provide each group with a small amount (about 15 to 20 mL) of each beverage in small disposable or recyclable containers (e.g., medicine cups).
- All students should record their own observations on their own table of observations.

Supporting Diverse Student Needs

- Ensure that students who need additional academic support are included in a group with students who can help them with terminology and the instructions.
- Visual learners may benefit from observing you quickly demonstrate pertinent steps of the procedure.
- Additional beverages could be supplied (e.g., apple juice, sports drinks, iced tea, coffee) for students to classify.

Analyze Answers

1. (a) The milk looked the same throughout; bits were not visible. The orange juice likely had bits of pulp of different sizes. The soda water had bubbles of various sizes.
   (b) The types of matter varied in shape.
   (c) Visible bits in the orange juice were solid. The types of matter in the soda water were gas.
2. (a) The milk remained homogeneous.
   (b) The bits could be seen more clearly in the orange juice.
   (c) The bits could be seen more clearly in the soda water.
3. (a) Milk appeared homogeneous until viewed with the microscope.
   (b) Bits of some kind became visible.
   (c) Students might say that there were different kinds of bits or the bits tended to clump together or break apart. (Students have no way of knowing if either of these ideas is correct.)
4. Sample answers: Soda water and orange juice looked mainly the same when viewed with the eye, the hand lens, and the microscope, except the view was much larger with the microscope. Milk looked the same with the eye and the hand lens. With the microscope, some floating blobs were visible. These couldn't be seen just with eyes or lens.

Conclude and Apply Answers

1. Students should realize that they would require some means of determining that the material had the same composition throughout. It is not necessary for them to suggest what such means might be.

USING THE FEATURE

www science: What's the Metal in the Ice Man's Axe?, p. 240

This feature provides a practical application of the need to determine whether a material is a mixture or a pure substance. Some students might be fascinated with the means by which investigators determined the Ice Man's cause of death—a mystery fit for an episode of CSI. For years after the discovery, researchers debated possible causes. By the middle of 2007, the case was considered essentially closed. Investigators concluded that the Ice Man was killed as a result of massive arterial bleeding resulting from an arrow wound. However, whether death resulted from battle or ritual killing remains an open question.

SECTION 7.1 ASSESSMENT, p. 241

Check Your Understanding Answers

Checking Concepts

1. (a) pure substance; (b) mixture; (c) mixture*; (d) mixture; (e) mixture; (f) pure substance; (g) mixture; (h) mixture; (i) mixture; (j) mixture
   Students' reasons for their choices should make reference to whether the item appears to be the same throughout and/or is made of only one type of particle (pure substance) or is made of two or more components (mixture). The answer marked with an asterisk (whipped cream) is perhaps the strongest candidate for an "unsure" answer; have students think about what whipped cream is made from (that is, it's a milk product) to help them make a more final choice.
2. Air, (b), is the only homogeneous mixture; all the others are heterogeneous. (Some students might argue that air could be heterogeneous, since air can contain visible pollutants; this is a fair and thoughtful argument and should be accepted.)
3. Students likely will copy any of the diagrams in Figure 7.5 or either of the first two diagrams in Figure 7.7. Challenging students to explain the labels they used is one way to determine whether they are simply copying from their book or understanding their answers.
4. Students either will copy the last diagram in Figure 7.7 or will make a sketch with two or more visibly different types of particles. Challenging students to explain their labelling should help to indicate the level of their understanding.

Understanding Key Ideas

5. (a) The pop is heterogeneous, because it is a mixture of a gas and a liquid (the gas is coming out of the solution, although students likely will not know this).
   (b) To answer this question, students must associate the pop "going flat" with its somehow losing its gassy (fizzy) properties. The pop, once all the dissolved gas has evaporated (is totally "flat"), is homogeneous.
6. Smog is heterogeneous because it contains visible solid and gaseous components in addition to the gaseous components that are invisible.

Pause and Reflect Answer

Students likely will say that most materials on Earth are heterogeneous, if only because there are more readily observable examples of things with two or more visible components than there are things that appear to be the same throughout. Some students, however, might say the opposite based on their own perception that more things appear homogeneous than heterogeneous. Accept all reasonable and reasoned answers.

Other Assessment Opportunities

- Consult the Unit front matter for a list of applicable Assessment BLMs.

7.2 CLASSIFYING MIXTURES

BACKGROUND INFORMATION

Mixtures may be classified as heterogeneous or homogeneous. Heterogeneous mixtures have components that are easy to see, and the composition varies both within the sample and from one sample to another. Heterogeneous mixtures in which the individual components are easily visible are called mechanical mixtures. In nature, most matter is a complex mechanical mixture in which there are at least two, and quite often more, easily identifiable components.

Homogeneous mixtures have components that are difficult or impossible to see, and the composition is the same throughout the sample and from one sample to another. Thus, a homogeneous solution appears to have only one visible component. Solutions are homogeneous mixtures. The particles that make up solutions are smaller in size than those of other mixtures and are much too small to be seen without optical microscopes.

The classification of mixtures as heterogeneous and homogeneous is an artificial dichotomy that is not easily applied to many common mixtures. For instance, is freshly squeezed orange juice heterogeneous or homogeneous? Taken as a whole, the mixture is heterogeneous, with easily identifiable bits (pulp) mixed within the liquid. The liquid itself, however, is a homogeneous solution of sugars and various other chemicals in water. Thus, many common mixtures that students are likely to encounter are more properly considered to be mixtures of mixtures. Note: To aid in classification, it is common to find heterogeneous mixtures further classified as suspensions and colloids. A suspension (e.g., silty water) is a heterogeneous mixture in which the components settle slowly after mixing. A colloid is a mixture in which the tiny particles of one substance (the dispersed substance) remain suspended in the medium (dispersing medium) of another. The following chart is provided for quick reference. The topic of colloids is not part of the required outcomes of the curriculum. However, it is worth noting that many common household mixtures that might be referred to as solutions are actually colloids. (The word "colloid" was originally coined to describe mixtures that were called pseudosolutions.) Common household colloids include hand creams and lotions, paints, milk, jellies, gelatin, and many types of cheese, notably "cheddar" and "mozzarella" processed cheese slices.

COLLOID TYPE	DISPERSED SUBSTANCE	DISPERSING MEDIUM	EXAMPLES
aerosol	liquid	gas	fog
aerosol	solid	gas	smoke
foam	gas	liquid	whipped cream
solid foam	gas	solid	marshmallow
emulsion	liquid	liquid	milk; mayonnaise
solid emulsion	liquid	solid	butter
sol	solid	liquid	paint; cellular fluid
solid sol	solid	solid	opal

COMMON MISCONCEPTIONS

- Some students might believe that the distinction between heterogeneous and homogeneous mixtures is firm and absolute. Consequently, students can become frustrated if a given mixture eludes classification or if an answer is labelled incorrect by a peer or teacher. The information on pages 244 and 245 of the student text can help students with this confusion.
- The distinction between solutions (homogeneous mixtures) and pure substances can be a source of confusion, which arises largely because students lack a conceptual vocabulary to describe the particulate nature (atoms, ions, molecules) of matter. The flowchart on page 242 of the student text is intended to help students recall the essential differences between pure substances and homogeneous mixtures. A more elaborated model for matter in later studies of chemistry will help to resolve this confusion for students.

ADVANCE PREPARATION

- Determine if sufficient numbers of flashlights will be available for all students to be involved, hands-on, in Activity 7-2A, Shine On. If not, larger group sizes or a class demonstration with volunteers might be necessary.
- Obtain the substances needed to prepare the mixtures for Activity 7-2B, What Kind of Mixture, well in advance.
- Consult the Unit front matter for a list of BLMs that can be used when teaching this section.

INTRODUCING THE SECTION, p. 242

Using the Key Terms and Section Summary

At the beginning of each section in the student book are the Key Terms and section summary. Both can be used as a pre-reading strategy and a review tool. Before reading the text in the section, students should be able to define the terms listed in the Key Terms by scanning the text and using the glossary. The Key Terms include terms from the curriculum outcomes and additional terms that are useful for students to know and understand.

The section summary provides an overview of the key concepts being covered in the section. Students may not know all the concepts and terms described in the summary, but they can use this information to help guide them through their reading.

After reading the section, students can go back to the Key Terms and section summary to consolidate their understanding and identify areas that require clarification. At the end of the chapter or unit, students can use the Key Terms and section summary for review. BLM 3-2, Unit 3 Key Terms listing all the terms listed in the unit can be used to assist students.

TEACHING THE SECTION, pp. 242–249

Using Reading

Pre-reading—Predict-Read-Verify

Before they start the section, ask students how they think the following mixtures should be classified:

– pizza	– clean air
– vinegar	– dirty air
– squeezed orange juice	– milk

Students could make a chart in their notebooks like the following to record each question, their idea(s) for an answer, and then the actual location in their textbooks where they could find/verify the answer.

QUESTION	MY ANSWER	WHERE I FOUND IT
What kind of mixture is pizza?		

During Reading—Where Do I Find the Answer? (QAR—Question-Answer Relationship Strategy)

The chart suggested in the Pre-reading strategy is set up to assist students in verifying their answers. The answers are "scattered" throughout the text of the section, almost in the sequence in which they are presented. The only exception involves the latter two; in the student text, milk is discussed before orange juice. For stronger readers in the class, you could jumble the mixtures in the suggested list above so their answers do not follow the sequence of presentation in the text.

After Reading—Reflect and Evaluate

Students could use a Venn diagram to demonstrate their understanding of key concepts and examples for heterogeneous mixtures, homogeneous mixtures, and mixtures of mixtures.

Reading Check Answers, p. 245

1. Common examples of solutions include pop, clean air, fruit drinks, steel, and antifreeze.
2. A mechanical mixture has clearly visible parts, while the parts of a solution are mixed together so thoroughly that it appears to be the same throughout.
3. You will see nothing. That is, the solution does not scatter light.
4. Students likely will cite the two examples given in their book: freshly squeezed orange juice and milk.

USING THE ACTIVITIES

- Activity 7-2A, Shine On, on page 246 of the student book is best used once students have learned that a beam of light can be used to distinguish homogeneous from heterogeneous mixtures.
- Conduct an Investigation 7-2B, What Kind of Mixture?, on page 247 of the student book is best used following Activity 7-2A as a further example of a technique that students could use to distinguish a homogeneous from a heterogeneous mixture. (Note: Students will learn more about filtration, in the context of separating mixtures, in Chapter 9.)

Detailed notes on doing the activities follow.

Conduct an Investigation 7-2A

Shine On, p. 246

Purpose

- Students use a light beam to tell if a mixture is homogeneous or heterogeneous.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO	APPARATUS/MATERIALS
1 day before	Collect materials and equipment. Determine if additional mixtures will be available for testing and either prepare them or collect materials for students to do so. Photocopy BLM 3-10	For each group: – 3 250 mL beakers or jars – 5 mL fine-grained starch – 5 mL table salt – water – 2 stirring rods – masking tape and marker (for labels) – flashlight – additional mixtures (optional)

Time Required

- 40–50 min

Safety Precautions

- Safety eyewear, lab coats, and gloves must be worn in accordance with provincial safety standards.

Expected Results

A beam of light will be visible in a heterogeneous mixture and not in a homogeneous mixture, enabling students to distinguish one from the other.

Activity Notes

- The scattering effect is called the Tyndall effect, after British scientist John Tyndall who described it during the mid-1800s.
- If time is an issue, this investigation could be done as a demonstration with assistance from student volunteers. A projector could be substituted for the flashlight if desired.
- Additional mixtures, if supplied, could include solutions such as tea, apple juice (from concentrate), apple juice (organic or freshly prepared, which will include sediment that will scatter light), lemon drink, and Gatorade, and heterogeneous mixtures such as silty water and baking soda in water.

Supporting Diverse Student Needs

- Students who have difficulty expressing themselves in writing could supply their answers orally.
- This is a good learning opportunity for body-kinesthetic learners.

What Did You Find Out? Answers

1. The starch-water mixture is heterogeneous because it scattered the beam of light.
2. The salt-water mixture is homogeneous because no light was scattered.
3. Assuming that students predict the light-scattering of heterogeneous mixtures and the absence of such scattering from homogeneous mixtures, their observations should support their predictions.

Conduct an Investigation 7-2B

What Kind of Mixture?, p. 247

Purpose

- Students use a filter to help them distinguish heterogeneous mixtures from homogeneous mixtures.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO	APPARATUS/MATERIALS
1–2 days before 1 day before	Prepare the four mixtures. Photocopy BLM 3-11, What Kind of Mixture Table of Observations	For each group: – 4 mixtures – 4 small beakers or jars – 4 pieces of filter paper – ring stand and clamp – funnel

Time Required

- 20–25 min

Safety Precautions

- Safety eyewear, lab coats, and gloves must be worn in accordance with provincial safety standards.
- Remind students not to eat or taste anything in the science classroom.

Expected Results

Students will observe that filtration can help identify a solution as heterogeneous, but it cannot be used with certainty to identify a solution as homogeneous.

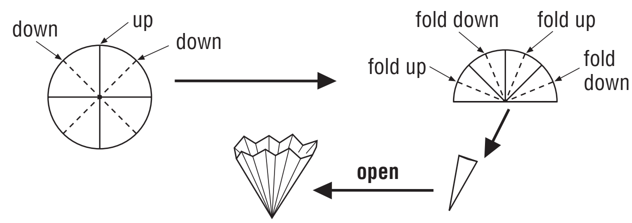
Activity Notes

- Provide at least one heterogeneous mixture (e.g., orange juice with pulp, Italian salad dressing, percolator coffee with some residual grounds, prepared chicken noodle soup, muddy water) and one solution (e.g., vinegar, instant coffee, apple juice from concentrate).
- This investigation could be done as a cooperative learning activity, with an expert group assigned to investigate each mixture.
- Demonstrate to students the technique for fluting filter paper. One version of this technique is presented below. Filter paper is typically fluted so that the liquid part of the mixture passes through the filter paper very quickly. As well, the multiple folds in the filter paper provide a large amount of surface area to trap the solid parts of the mixture.

  Fluting Filter Paper

  (a) Fold the circle of filter paper in half to form a half-circle.
  (b) Fold the half-circle in half to form a quarter-circle.
  (c) Fold the quarter-circle in half to form an eighth-circle.
  (d) Unfold the filter paper to arrive back at the half-circle. Three creases will be visible.
  (e) Use these creases as guidelines to fold the filter paper first upward and then back on itself, and then upward again and back on itself again—like an accordion.
  (f) Fully unfold the filter paper. There are now 16 creases (folds) in it.
  (g) Insert the filter paper into the funnel.
  (h) If desired, the outside of the filter paper (the part in contact with the inside of the funnel) can be moistened with some of the solvent to help it stay in place in the funnel.

  Note: Various methods for folding (fluting) filter paper may be viewed in the form of sequential slides and movie formats on the *Chemistry Comes Alive!* web site, administered by the American Chemical Society. The URL at this time is http://jchemed.chem.wisc.edu/jcesoft/CCA/CCA6/MAIN/1ChemLabMenu/Separating/Filtration/gravfilt_menu/FiltrationGravity2/MENU.HTM. Should this web site become unavailable in the future, it is possible the web pages will still be accessible via Google's cached page service.



- Students could work in groups of 2 to 4.

Supporting Diverse Student Needs

- Students who are tactile learners can feel the mixtures to predict if they are a solution or heterogeneous mixture. Once the mixture is filtered, have them feel the residue and the filtrate (the liquid in the beaker) to confirm their predictions. (Students will not be able to wear protective gloves to do this, so advise students that, in this case and under your supervision, it is safe to handle the materials in this manner.) Note: Be sure to check for any allergies students might have.

Analyze Answers

1. Look for evidence that students have compared their results to their predictions.

Conclude and Apply Answers

1. Observing matter on the filter enables students to state confidently that the mixture is heterogeneous because heterogeneous mixtures have visible components.
2. No. If there is nothing left on the filter paper, the mixture could be a solution, but it could

also be a "mixture of mixtures." To state with confidence that the mixture is a solution, a light could be shone through it; absence of a beam in the mixture would confirm it is a solution. Another way to tell is to view the mixture under a microscope; if components are visible, the mixture is heterogeneous.

USING THE FEATURE

Science Watch: A Mix for Lips, p. 248

If possible, display a tube of lipstick and ask students if they think it is a mixture and, if so, to classify it. Despite reading about alloys (solid solutions) earlier in the chapter, some students might find it surprising to think of lipstick as a mixture, since it appears so smooth and regular to the eye. Interested students could do further research to find out more about the lipstick-making process.

Science Watch Answers

1. According to step A, two mixtures are prepared and mixed together.
2. It is unlikely that the mixture created in step C is a solution because it is strained (which suggests there are visible components present to strain out).
3. The two mixtures are heated separately because components in one mixture likely will melt at a temperature that is different from the other.

SECTION 7.2 ASSESSMENT, p. 249

Check Your Understanding Answers

Checking Concepts

1. (a) heterogeneous; (b) heterogeneous; (c) heterogeneous; (d) solution; (e) solution; (f) solution
2. (a) For example: cereal in milk, pulp in orange juice, noodles in broth, algae in water.
   (b) For example: sand, raisin flakes cereal, a closet full of clothes, a rock such as granite, books on a bookshelf.
   (c) For example: soot in air, hot air balloons in the air, birds in flight, insects in the air.
3. Mixture A is a solution. Mixture B is heterogeneous.
4. Students should suggest that enough evidence is needed to have reasonable confidence that the mixture is made up of particles that are the same throughout. (Thus, for example, any mixture in which filtering results in residue could not possibly be a solution. Similarly, any liquid mixture that scatters light could not possibly be a solution.)

Understanding Key Ideas

5. (a) The mixture is probably a solution, since nothing is filtered out.
   (b) You could look at it through a microscope or shine a light through it.
6. The air in the room is not a solution because light is being scattered.

Pause and Reflect Answer

(a) Students' diagrams should look in some way like the third picture in Figure 7.7. That is, there should be two types of particles represented, and these two types of particles should be arranged in a way that suggests they are uniformly arranged.

(b) Having rendered two types of particles uniformly arranged, students can point to the fact that the mixture has properties of the two components. (Some students might use the word "blended" to help them explain themselves. While this is not scientifically accurate, the metaphor is useful at this level and could be accepted as long as students appreciate the fact that it is not literally true.)

(c) The following answers are provided as examples of student thinking. None of these answers is correct, but all display some attempt to apply particle theory to the formation of solutions. Sample 1. The iodine particles combine with the alcohol particles so that the alcohol particles become purple. Sample 2: The iodine particles blend with the alcohol particles so that they are all mixed up together equally. Sample 3: The iodine particles dissolve in the alcohol particles so they become combination particles like iodihol or alcodine.

Other Assessment Opportunities

- Consult the Unit front matter for a list of applicable Assessment BLMs.

CHAPTER 7 ASSESSMENT, pp. 250–251

PREPARE YOUR OWN SUMMARY

Student summaries should incorporate the following main ideas:

1. How Mixtures Are Different from Pure Substances
   - Pure substances contain only one component, which is made up of just one type of particle with its own properties.
   - Mixtures contain two or more components, and each keeps its own properties.

2. Heterogeneous and Homogeneous Mixtures
   - Heterogeneous mixtures have two or more components that are easy to observe.
   - The composition of a heterogeneous mixture varies within the sample and from one sample to another.
   - The components of homogeneous solutions are difficult or impossible to observe.
   - The composition of a homogeneous mixture is the same throughout the sample and from one sample to another.
3. Classifying Mixtures
   - Mixtures may be classified as heterogeneous or homogeneous.
   - Heterogeneous mixtures in which the different components are clearly visible are called mechanical mixtures. The parts of such mixtures are easy to separate manually.
   - Homogeneous mixtures are solutions.
4. Combinations of Mixtures
   - Many mixtures are neither just heterogeneous or just homogeneous. Instead they are mixtures of both types of mixtures. In other words, they are mixtures of mixtures.

CHAPTER REVIEW ANSWERS

Checking Concepts

1. (a) heterogeneous; (b) homogeneous; (c) heterogeneous; (d) heterogeneous; (e) homogeneous; (f) heterogeneous; (g) heterogeneous; (h) pure substance
2. (a) A solution is a type of mixture.
   (b) A solution is a mixture that is homogeneous.
   (c) A pure substance is made up of only one type of particle, while a mixture is made up of two or more types of particles.
   (d) Some types of mixtures are heterogeneous.
   (e) A pure substance is a type of matter, and all matter is made up of particles. (Alternative: Pure substances are made up of only one type of particle.)
3. (a) Salt water and filtered tea are two examples of mixtures that are definitely homogeneous.
   (b) Granite and a chocolate chip cookie are two examples of mixtures that are definitely heterogeneous.
   (c) Milk looks homogeneous, but it is actually heterogeneous.
4. (a) Diagram C
   (b) Diagram A
   (c) Diagram B or D
   (d) Diagram D or B
5. For example:
   (a) Diagram C has two types of particles that are uniformly arranged.
   (b) Diagram A has two types of particles that are arranged randomly.
   (c) Diagram B (or D) has only one type of particle that is uniformly arranged.
   (d) Diagram D (or B) has only one type of particle that is uniformly arranged.

Understanding Key Ideas

6. Mike is right, because mixing sugar and water results in a solution. A solution is a homogeneous mixture, not a heterogeneous mixture.
7. (a) Tap water is a homogeneous mixture (a solution).
   (b) If tap water were a pure substance, any sample of water from any source would taste exactly the same. Since tap water is a solution, with variable composition, the taste of tap water samples will vary from one city or town to another.
8. Students likely will say it's a homogeneous mixture in which the particles appear to be the same throughout and are evenly arranged. (But see the answer to the next question.)
9. When the drink is opened and poured, there is evidence of at least two different kinds of matter. Bubbles can be seen separately from the liquid, and they are unevenly distributed in the mixture. So the opened drink is heterogeneous. (Some students might use the latter reasoning to argue that the unopened drink is also heterogeneous, since no change in the nature of the mixture occurs when it is opened. Based on such reasoning, this answer could be accepted.)
10. The mixture in the first beaker will be heterogeneous because the sand will remain distinct and distinctly visible from the water. The mixture in the second beaker will be homogeneous because the salt will dissolve in the water and become invisible to the eye.

Pause and Reflect Answer

Students might suggest:

- alloys are less expensive
- alloys have properties that are more desirable
- alloys are easier to make
- alloys look more attractive (or equally attractive)

Accept any three of these or similar answers that appear reasonable.

CHAPTER 8 OPENER, pp. 252–253

USING THE PHOTO AND TEXT

Ask students if they have ever gone swimming in a natural setting like the one shown in the photo. Did they think about the quality of the water? Did they think about its purity? What does "pure water" mean to them? Have students read the introductory text to develop a context for their studies in this chapter and the next.

USING THE WHAT YOU WILL LEARN/WHY IT IS IMPORTANT/SKILLS YOU WILL USE

Encourage students to read, especially, the Why It Is Important. Have them generate a list of solutions (or mixtures that they believe to be solutions). They can reexamine their lists over the course of this chapter.

USING THE FOLDABLES™ FEATURE

See the Foldables™ section of this resource.

8.1 MAKING SOLUTIONS: SOLUTES AND SOLVENTS

BACKGROUND INFORMATION

A solvent is any substance that can dissolve other substances. In a solution, the substance present in the largest amount is usually considered the solvent; the other substance(s) present in the solution are called the solutes.

Solutions are uniform throughout, so the solute and the solvent are not distinguishable to the unaided eye. For example, in a solution of salt water, the salt particles (solute) are indistinguishable from the water particles (solvent).

Although the appearance of solutions is uniform, the amount of solute dissolved in the solvent is variable; that is, you can mix solutes and solvents together in varying ratios. For example, a salt water solution might be made by dissolving 5 g of salt in 500 mL of water, or 10 g of salt in 1 L of water, or 1 g of salt in 50 mL of water, and so on.

Any solute that dissolves in a solvent is termed soluble, while any solute that does not dissolve in a solvent is termed insoluble. For example, salt, sugar, and alcohol are soluble in water; glass, plastic, and oil, are insoluble in water. Note, however, that a substance that is insoluble in one solvent might be soluble in another. For example, oil is soluble in gasoline, even though it is insoluble in water.

There are many types of solutions involving all three states of matter. The following table provides an overview.

When a solid solute (such as salt or sugar) dissolves in a liquid solvent (such as water), the solute looks like it disappears. What happens is that the particles of solid solute are held together by forces of attraction. When a solute dissolves, these bonds are broken and the unbonded particles are attracted to the particles of the solvent. The solute particles then disperse randomly, but uniformly, throughout the solvent. Because the dispersal is uniform, the unaided eye cannot distinguish solute from solvent. Note: The chemistry of the dissolving process—that is, what happens at the particle level—is deliberately over-simplified in the student book because the concepts necessary for appreciating and describing this process are introduced and developed in later grades.

ORIGINAL STATE OF SOLUTE	STATE OF SOLVENT	EXAMPLES
gas	gas	• air (oxygen, argon, carbon dioxide, and water vapour dissolved in nitrogen) • natural gas (ethane, propane, and trace amounts of other gases dissolved in methane) • welding fuel (oxygen dissolved in acetylene)
gas	liquid	• filtered ocean water (contains dissolved oxygen)
gas	solid	• hydrogen dissolved in platinum
liquid	liquid	• alcohol dissolved in water • propylene glycol (antifreeze) dissolved in water • vinegar dissolved in water
liquid	solid	• dental amalgam (e.g., mercury dissolved in silver)
solid	liquid	• sugar dissolved in water • salt dissolved in water
solid	solid	• brass (copper dissolved in zinc)

COMMON MISCONCEPTIONS

- Some students may describe the dissolving process as melting (e.g., the dissolving of solid sugar in liquid water is viewed as a type of melting). This misconception can be approached by encouraging students to use the particle theory of matter to describe melting and the dissolving of sugar in water. Melting is a change of state that involves the particles of a single substance as they move farther from each other and move about more freely in response to an input of energy such as heat. Dissolving, on the other hand, always involves at least two substances; during dissolving, the particles of the solvent pull away particles of

the solute so that the solute particles become dispersed evenly throughout the solvent particles.
- Confusion between the terms solute and solvent, while not based on a misconception, is common. Students might find it helpful to use the following idea to help them keep the distinction straight: Since there is usually *more* of a solvent than a solute in a solution, use the number of letters in these words as the way to recall which is which—that is, "solvent" (7 letters) has *more* letters than "solute" (6 letters).

ADVANCE PREPARATION

- If Activity 8-1B, Eggshell Shocked, is being done in class, ensure that sufficient numbers of eggs are available for students. As a partial precaution against *Salmonella*, due to contamination of the shells, rinse all eggs in a dilute solution of bleach and then rinse several times afterward with water to remove as much of the bleach smell as possible. Note: This does not guarantee protection from food poisoning and is not a substitute for the safety precautions noted in the student book.
- Consult the Unit front matter for a list of BLMs that can be used when teaching this section.

INTRODUCING THE SECTION, pp. 254–255

Using the Text

Read through and discuss the text and captions on page 254. Use the example of sugar dissolved in water to help students differentiate between solute and solvent. Having physical examples of sugar and water available to demonstrate the solution-forming process would be beneficial, especially for Pathway 3, visual-spatial, and kinesthetic learners.

Table 8.1 on page 255 and the information supporting it provide further opportunities for students to become accustomed to the concepts of solute and solvent and to enhance their earlier study of the states of matter.

Using the Key Terms and Section Summary

At the beginning of each section in the student book are the Key Terms and section summary. Both can be used as a pre-reading strategy and a review tool. Before reading the text in the section, students should be able to define the terms listed in the Key Terms by scanning the text and using the glossary. The Key Terms include terms from the curriculum outcomes and additional terms that are useful for students to know and understand.

The section summary provides an overview of the key concepts being covered in the section. Students may not know all the concepts and terms described in the summary, but they can use this information to help guide them through their reading.

After reading the section, students can go back to the Key Terms and section summary to consolidate their understanding and identify areas that require clarification. At the end of the chapter or unit, students can use the Key Terms and section summary for review. BLM 3-2, Unit 3 Key Terms listing all the terms listed in the unit can be used to assist students.

USING THE ACTIVITY

Think About It Activity 8-1A
Name That Solute and Solvent, p. 255

Purpose
- Students identify the solute and solvent, and their states, in several solutions.

Advance Preparation

none

Time Required
- 15–20 min

Safety Precautions
- none

Activity Notes
- This activity could be assigned as homework for students to do individually, or it could be done in pairs in class.
- Answers to step 2 are as follows:
  Statement 1:
  (a) solid dissolved in solid solution
  (b) zinc
  (c) copper
  Statement 2:
  (a) liquid dissolved in liquid solution
  (b) hydrogen peroxide
  (c) water
  Statement 3:
  (a) liquid dissolved in solid solution
  (b) mercury
  (c) tin
  Statement 4:
  (a) liquid dissolved in liquid solution
  (b) propylene glycol
  (c) water

Supporting Diverse Student Needs
- Body-kinesthetic learners who are having difficulties could use their hands or small objects to mime or act out the central "point" of each description. For example, for "Brass is a solution of zinc metal

in copper metal," students could form a cup shape with one hand and place a finger of the other hand into the cup as a representation of placing one object *in* another. The assumption here is that one puts (mixes) the substance that is of a smaller quantity (i.e., the solute) *in* a substance of a greater quantity (i.e., the solvent).

What Did You Find Out? Answers

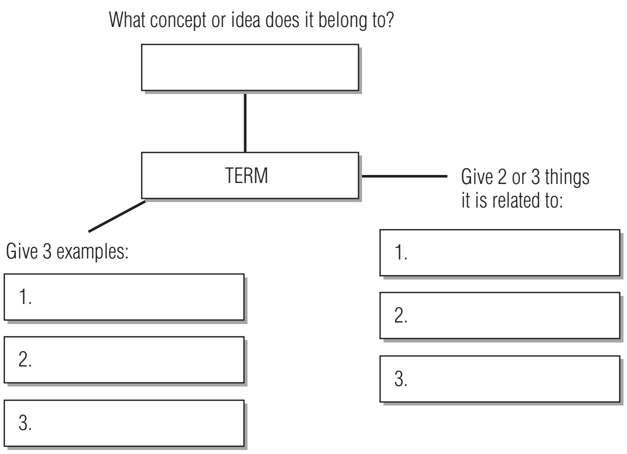
1. Students' explanations should in some way suggest that the smaller-quantity substance, being the solute, was dissolved in the larger-quantity substance, being the solvent.

TEACHING THE SECTION, pp. 256–261

Using Reading

Pre-reading—Key Word Concept Maps

This section introduces four essential and related terms: insoluble substance, soluble substance, solute, and solvent. For each term, have students create a key word concept map similar to the following:



During Reading—Think, Pair, Share

Have students pair up with a classmate (or assign pairings based on ability or multiple-intelligences criteria) to compare their key word concept maps and to share and assess their maps as they work through this section.

After Reading—Reflect and Evaluate

When they have completed this section, student pairs can collaborate to refine their word maps for the four key terms and develop a single shared response.

Reading Check Answers, p. 257

1. Soluble means able to dissolve in a solvent.
2. Insoluble means unable to dissolve in a solvent.
3. Vinegar is not a totally insoluble substance because vinegar is soluble in other substances, such as water.

Reading Check Answers, p. 258

1. Some substances are insoluble in a certain solvent because there are no forces of attraction between the solute particles and the solvent particles.
2. The attraction of water particles for sugar particles is stronger. (That is why the sugar dissolves in the water.)

USING THE ACTIVITIES

- Activity 8-1B, Eggshell Shocked, on page 256 of the student book is best used as an informal reinforcement for the concept that some substances are soluble in a given solvent and others are not.
- Activity 8-1C, Does It Dissolve?, on page 259 of the student book is best used as a more formal investigation of the concept that solutes may be soluble or insoluble in a given solvent.

Detailed notes on doing the activities follow.

Find Out Activity 8-1B

Eggshell Shocked, p. 256

Purpose

- Students will place a raw egg in vinegar to observe that the hard shell is soluble in vinegar and the thin membrane underneath the shell is not.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO	APPARATUS/MATERIALS
2–3 days before	Decide whether this activity will be done as a take-home or in-class task. If done at school, ensure that sufficient quantities of eggs are available.	For each group: – 2 large beakers (400 mL or 500 mL) or large jam jars – 2 raw eggs – water – vinegar

Time Required

- 15 min (plus several days of observation time)

Safety Precautions

- Students must wash their hands after handling raw eggshells. As a precaution, the eggs could be washed in hydrogen peroxide or a weak bleach solution ahead of students' handling them.

Expected Results

Over a period of days, the calcium carbonate eggshells will dissolve in the vinegar, leaving only the underlying membrane to keep the contents of the egg from being dispersed in the vinegar. The eggs in water will not dissolve.

Activity Notes

- To save time, the whole activity could be done as a demonstration with a single pair of eggs, and students making and recording observations each day. Alternatively, half the class could be asked to work with just water and the other half with just vinegar.
- Some students might confuse air bubbles in the water with “dissolving bubbles” (carbon dioxide gas) in the vinegar. Close inspection of the bubbles over a period of days should help students realize that those in the vinegar are functionally different from those in the water.

What Did You Find Out? Answers

1. No changes were observed.
2. The shell dissolved in the vinegar.
3. Eggshell is insoluble in water and soluble in vinegar because the shell slowly “disappeared” in the vinegar over time.

Find Out Activity 8-1C

Does It Dissolve? p. 259

Purpose

- Students investigate whether a solute that is soluble in one solvent is soluble in a different solvent.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO	APPARATUS/MATERIALS
3 days before	Gather materials (unless the activity is assigned as a take-home task) Photocopy BLM 3-14.	For each group: – 4 small transparent containers (e.g., small beakers of plastic cups) – 4 labels – 4 stir sticks – water – vegetable oil – flour – measuring spoons

Time Required

- 30 min

Safety Precautions

- Do not taste, eat, or drink any of the substances in this activity.

Expected Results

Salt is soluble in water but not in vegetable oil. Flour is insoluble in water and in vegetable oil.

Activity Notes

- If time is a factor, students could be asked to do this activity at home.
- Students might think they need more liquid than the small amount they are using. Advise them to keep the amounts of salt and flour they add very small. A few bits of each—enough to cover just the tip of a stir stick—are sufficient to determine whether they will dissolve in a given solvent.
- Students could summarize, either orally or in writing, the results of the activity.

Supporting Diverse Student Needs

- Students who have reading-skill difficulties might become confused by the use of numerals in steps 2, 3, and 6 (e.g., in step 2, numerals are used to differentiate the four cups; in step 3, numerals are used for this purpose as well as to specify quantities of substances). Especially in step 3, students might find it helpful to “slow down” each sentence. For instance, “Use a measuring spoon to pour about 2 mL of water into cup 1. Use a measuring spoon to pour about 2 mL of water into cup 2. Pour about 2 mL of vegetable oil into cup 3. Pour about 2 mL of vegetable oil into cup 4.”

What Did You Find Out? Answers

1. Students should be able to use their table of observations to write their summaries. For example, “The solute dissolved in cup 1. The solute did not dissolve in cups 2, 3, and 4.”
2. Students’ predictions for salt and water likely were accurate. The other combinations were probably guesses, perhaps based on cooking experiences. Accurate predictions or guesses should include a reasonable suggestion for the successful choice.
3. Students likely will predict that the ethanol will be soluble in water; their prediction for ethanol mixed with vegetable oil likely will be a guess unless students have observed the use of alcohol as a solvent in cleaning up oily stains. Perhaps have some ethanol on hand to test students’ predictions quickly.

USING THE FEATURE

www science: The Strange Case of the Water That Wasn’t, p. 260

The polywater incident is a good example of the sometimes-observed human tendency to see exactly what one wants to see. Students could also use this feature to remind themselves that—contrary to depictions of science and scientists common in the media—scientists are human and fallible; in other words, scientists can be wrong. The development of scientific knowledge is governed at least as much by "wrong" answers as it is by "right" answers. One of the most important thinking traits (sometimes called "habits of mind") of scientists is skepticism. Good scientists always maintain a healthy dose of skepticism about their findings and ideas as well as those of their peers. This approach to the development of knowledge makes sense, given that science is largely an evidence-based enterprise.

SECTION 8.1 ASSESSMENT, p. 261

Check Your Understanding

Checking Concepts

1. Students might say, for example, salt, sugar, vinegar, apple juice concentrate.
2. Students might say, for example, glass, wood, aluminum, CD.
3. Students might say oil (which is insoluble in water but soluble in gasoline) , olive oil (which is insoluble in water but soluble in canola oil), gasoline (which is insoluble in water but soluble in motor oil).
4. (a) solute: drink crystals; solvent: water
   (b) solute: acetic acid; solvent water
   (c) solute: water vapour; solvent: air
   (d) solute: vinegar; solvent: water
   (e) solute: concentrated apple juice; solvent: water
   (f) solute: motor oil; solvent: gasoline
   (g) solute: lemon juice; solvent: tea (or, solute: lemon juice and tea; solvent: water)
   (h) solute: medicinal plant oil; solvent: almond oil
5. (a) The solvent is iron.
   (b) One solute is carbon. (Another could be silicon.)

Understanding Key Ideas

6. To answer this question, students must draw upon their understanding of Figure 8.6 and the text material on page 258. This may be challenging to some students, since they do not have a visual model on which to base their answer. The key is for students to recognize that there would be no forces of attraction between glass particles and water particles. Thus, students' depictions of glass particles (however student choose to depict these) would be shown present among water particles (again, however students choose to depict these) with no indication of interactions between them.
7. Sample answer: Although many substances are soluble in the solvent water, ink stains are insoluble in water. Ink stains will dissolve in the chemicals in hair spray, however. Hair spray is a solvent in which ink stains are soluble.
8. (a) Sample answer: Salt and sugar, alcohol and vinegar, and oxygen and carbon dioxide dissolve in water.
   (b) Any six solids that are insoluble in water are acceptable (e.g., plastic, paper, wool, batteries, fish, fingernails). (Note that students are not required specifically to name insoluble liquids and gases. However, students could cite oil and gasoline as examples of insoluble liquids.)
   (c) A universal solvent would be one that dissolves all substances. However, there are substances that do not dissolve in water.
   (d) The statement is useful and accurate because water is the most common liquid solvent on Earth, and there are so many substances that do, in fact, dissolve in it.

Pause and Reflect Answer

Sample answer: Imagine putting a lump of sugar in your mouth and just letting it sit on your tongue. What happens? Slowly but surely, the lump of sugar breaks apart and disappears. Substances that break apart and disappear when they are put into a liquid such as water or saliva are called soluble substances. Sugar is a soluble substance. Now imagine putting a piece of carrot in your mouth and letting it sit on your tongue. What happens? Nothing. The piece of carrot does not break apart and disappear the way the sugar does. Substances that do not break apart and disappear when they are put into a liquid such as water or saliva are called insoluble substances. Carrot is an insoluble substance.

Other Assessment Opportunities

- Consult the Unit front matter for a list of applicable Assessment BLMs.

8.2 CONCENTRATION AND SOLUBILITY

BACKGROUND INFORMATION

Solubility refers to the amount of solute that dissolves in a given quantity of solvent at a given temperature. For example, the solubility of sodium chloride in water at 20°C is 36 g per 100 mL of water.

A solution is saturated when no more solute will dissolve in a solution, and excess solute is present. For example, 100 mL of saturated solution of sodium chloride in water at 20°C contains 36 g of sodium chloride. If more sodium chloride is added to the solution, the sodium chloride will not dissolve.

An unsaturated solution is one that is not yet saturated, so it can dissolve more solute. For example, a solution that contains 25 g of sodium chloride dissolved in 100 mL of water at 20°C is unsaturated. The solution, at this temperature, can dissolve another 11 g of sodium chloride before it is saturated.

The rate of any process or event is a measure of how quickly it occurs in a given period of time. The addition of energy (heat) and the introduction of motion, such as shaking or stirring, helps to spread the particles of a solute through the solvent, increasing the interaction between solute and solvent particles, and thus might contribute to increasing the rate at which it dissolves. (Note: the addition of energy and/or agitation affects the rate of dissolving for some solutes more than others. There are no hard-and-fast rules or simple correlations here.) Decreasing the size of the solute increases the rate of dissolving because there is more surface area that is in contact with the solvent.

COMMON MISCONCEPTIONS

- Some students become confused over whether the terms "concentrated" and "dilute" refer to solutes or solvents of a solution. The confusion can be eased by having students slow down their thinking so they can consider the situation more clearly. These terms are words that describe a solution. "Concentrated" means there is more of something. "Dilute" means there is less of something. For example, if you have two glasses with 250 mL of water in them, and if you add 10 g of salt to one and 5 g of salt to the other, the solution with 10 g of salt is more concentrated than then the solution with 5 g of salt. Conversely, the solution with 5 g of salt is more dilute than the solution with 10 g of salt. Students can physically make these solutions if it helps them to "internalize" the distinction.
- Some students may be confused over whether the term solubility is qualitative or quantitative. Technically, the term solubility is quantitative—it refers to the specific quantity of a substance that can dissolve in a given quantity of a solvent at a specific temperature. However, the term solubility is also used when discussing whether a subject is soluble or insoluble; in such a context, the term solubility is qualitative.
- The concept of concentration is easy to confuse with the concept of solubility, since both concepts may be used qualitatively and quantitatively, and both seem to describe the same thing. Qualitatively, concentration means that something is either concentrated or dilute, whereas (qualitatively) solubility means that something is either soluble or insoluble. Quantitatively, concentration expresses an amount (any amount) of solute that is dissolved in an amount (any amount) of solvent; the amount of solute is often given in grams, and the amount of solvent is often given in millilitres or litres. Quantitatively, solubility refers to a specific amount of solute that may be dissolved in a specific amount of solvent at a specific temperature. Note: Further confusion can enter the picture with the introduction of the concept of saturation, since a saturated solution is one in which the solute has reached the limit of its solubility and is, for instance, more concentrated than a solution that is unsaturated. One way that students can avoid this confusion is by making accurate concept maps. The Foldables™ task at the start of this chapter is another method that many students could find useful.

ADVANCE PREPARATION

- Gather and bring in a variety of products from home that have concentration information on their packaging or labels. Such products can include, but are not limited to, personal care products such as toothpaste, shampoos, and skin cleansers; vinegar (any variety); and various food products.
- Note that Activity 8-2A, How Does Temperature Affect Solubility?, is identified as a Core Lab
- Consult the Unit front matter for a list of BLMs that can be used when teaching this section.

INTRODUCING THE SECTION, pp. 262–263

Using the Text

Have students compare the two mugs of tea in Figure 8.7 and make inferences about the nature of each. (For instance, which is a stronger mug of tea? On what evidence are you basing your answer? Which mug likely has had a tea bag in longer? What's your evidence? Is there a way to make tea stronger or weaker that doesn't involve the tea bag?) Use the terms dilute and concentrated to describe the two mugs of tea after students have discussed the photo.

Using the Key Terms and Section Summary

At the beginning of each section in the student book are the Key Terms and section summary. Both can be used as a pre-reading strategy and a review tool. Before reading the text in the section, students should be able to define the terms listed in the Key Terms by scanning the text and using the glossary. The Key Terms include terms from the curriculum outcomes and additional terms that are useful for students to know and understand.

The section summary provides an overview of the key concepts being covered in the section. Students may not know all the concepts and terms described in the summary, but they can use this information to help guide them through their reading.

After reading the section, students can go back to the Key Terms and section summary to consolidate their understanding and identify areas that require clarification. At the end of the chapter or unit, students can use the Key Terms and section summary for review. BLM 3-2, Unit 3 Key Terms listing all the terms listed in the unit can be used to assist students.

TEACHING THE SECTION, pp. 263–273

Using Reading

Pre-reading—Predict-Read-Verify

Break the section into smaller conceptual chunks—for example, concentrated/diluted (pp. 262–263); concentration (p. 263); solubility (including saturation) (p. 264); rate of dissolving (p. 265); factors affecting rate of dissolving (p. 266); solutions involving gases (p. 267). Use the chunks as topic titles for discussion.

During Reading—Note-taking

Students can record notes (key ideas) under the topic titles developed from the pre-reading strategy.

After Reading—Semantic Mapping

Have students develop concept maps around the Key Terms from the start of the section to synthesize their understanding of the central concepts of the section.

Reading Check Answers, p. 263

1. The first jug is more concentrated.
2. The qualitative definition uses words, while the quantitative definition uses numbers (specific amounts).
3. g/L means grams per litre—the units used to express concentration quantitatively.

Reading Check Answers, p. 267

1. A saturated solution contains as much solute as it can in a given amount of solvent at a specific temperature. An unsaturated solution can hold more solute in that same amount of solvent at that same temperature.
2. This means that at a temperature of 0°C, a total of 357 g of salt can dissolve in 1 L of water. No more salt than this can dissolve in that amount of water at that temperature.
3. The larger the size of the solute, the slower the rate of dissolving (and, conversely, the smaller the size of the solute, the faster the rate of dissolving).
4. The gas comes out of solution.

USING THE ACTIVITIES

- Activity 8-2A on page 268 of the student book is best used after students have considered factors that affect the rate of dissolving, but it also could be used to introduce these factors.
- Activity 8-2B, How Much Is Too Much?, on page 270 of the student book can be used either to introduce or support the concept of solubility.
- Activity 8-2C, Concentrations of Consumer Products, on page 271 could be used to introduce the section as well as to support the material on concentration on page 263.
- Activity 8-2D, Dissolved Carbon Dioxide, on page 271 is best done after students have discussed the solubility of gases in liquids.

Detailed notes on doing the activities follow.

Conduct an Investigation 8-2A

How Does Temperature Affect Solubility? (Core Lab), pp. 268–269

Purpose

- Students compare the solubilities of three solutes at different temperatures.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO	APPARATUS/MATERIALS
7 days before	Book time in the computer lab so students can use spreadsheet or other graphing software to prepare a graph	For each group: – balance – graduated cylinder – thermometer – small beakers or test tubes with stoppers – (if using test tubes) test tube rack
3 days before	Gather necessary equipment and materials Photocopy BLM 3-20 and 3-21.	– measuring spoon – stirring rod – choice of solute (e.g, table salt, Epsom salts, flavoured drink powder, baking soda) – clock or stopwatch

Time Required
- 20–25 min (plus computer time) for Part 1; 90–120 min for Part 2

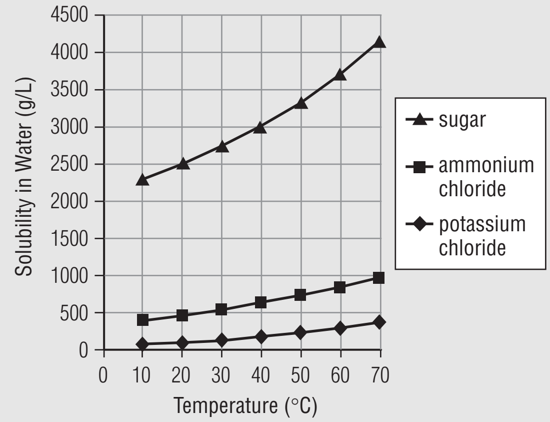
Safety Precautions
- Remind students that it is not safe to taste any substances in the science classroom, even if they think they are safe. Containers or substances that look clean may still contain invisible traces of harmful chemicals left over from a previous activity

Expected Results
In Part 1, students will see that an increase in temperature is directly proportional to an increase in solubility, although the solubilities of different substances differ in relation to one another. In Part 2, students will design an investigation that leads to experimental data such as those displayed in Part 1.

Activity Notes
- Students could produce hand-drawn graphs instead of or in concert with computer-generated graphs.
- Refer students to Science Skill 1 at the back of their textbooks to review line graphs and the concept of extrapolation.
- Refer students to Science Skill 2 at the back of their textbooks to review the features of a scientific investigation. Science Skill 6 may be used for students to review the essential features of a lab report.
- Have the class agree on suitable amounts of water and solutes for everyone to use (e.g., 10 mL of solute and 100 mL of water). Note that small amounts of both solute and solvent (e.g., 1 mL and 10 mL, respectively) may be used to obtain satisfactory results (and conserve materials).
- A suitably controlled experiment would hold the following variables constant: amount and type of solute; amount and type of solvent; speed of stirring; length of stirring time; unit of time measurement. The independent (manipulated) variable is temperature. The dependent (responding) variable is solubility.

Supporting Diverse Student Needs
- Pair students with weaker reading skills with students who are stronger readers.
- Demonstrate the use of graphing software for visual-spatial students.
- Students could be asked to investigate other variables—notably the effect of changing the rate of stirring and the effects of changing the size of the solute crystals/granules.

Analyze Answers
1. The line for ammonium chloride will be straight, rising to the right. The lines for sucrose and potassium chlorate will be gently curved, rising to the right.



2. As temperature increases, the lines rise (angle upward).
3. For sucrose, students likely will predict values in the 4000 g/L range. For ammonium chloride, likely values would be in the 700 g/L range. For potassium chlorate, likely values would be in 400 g/L range.
4. The solubility in warmer water was likely greater than the solubility in colder water.

Conclude and Apply Answers
1. The solubility increased.
2. Students' results should support their hypotheses (assuming that students hypothesize an increase in solubility with an increase in temperature—a likely assumption, given the data and results from Part 1).

Find Out Activity 8-2B
How Much Is Too Much?, p. 270

Purpose
- Students investigate the amount of salt that can dissolve in a specific volume of water at room temperature.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO	APPARATUS/MATERIALS
3 days before	Gather the apparatus and materials	For each group: – graduated cylinder – 250 mL beaker – measuring spoon – 40 g of salt – Petri dish (or piece of paper) – water – stirring rod – balance – additional substances for testing (e.g., sugar, bluestone (copper(II) sulfate), calcium hydroxide)

Time Required

- 35–40 min

Safety Precautions

- Safety eyewear, lab coats, and gloves must be worn in accordance with provincial safety standards.

Expected Results

Students will find that there is a limit to the amount of salt that can dissolve in specific volume of water at room temperature.

Activity Notes

- Students should stir the mixture thoroughly each time salt is added.
- Discuss what students should look for to decide that no more salt will dissolve. (The crystals that will not dissolve will settle to the bottom.)
- If necessary, explain to students how the measurement method for determining the amount of salt that dissolves in 100 mL of water works.
- If time is an issue, this activity could be done as a demonstration with student volunteers.

Supporting Diverse Student Needs

- Encourage students to use the terms “solution,” “solute,” “solvent,” “soluble,” “saturated,” and “unsaturated” to describe the appearance and condition of the solution throughout this activity. (Consider including the term “insoluble” as long as students are not confused by its use in the context of a substance that is normally soluble in water. In this context, when a salt water solution is saturated, any salt that is added to the solution will not be soluble—that is, is insoluble.)
- Additional substances could be investigated if time and interest permits. If this activity is done after Investigation 8-2A, students should make predictions about limits (i.e., solubility). If this activity is done before Investigation 8-2A, the use of additional solutes permits a more inquiry/discovery approach to students’ investigation of solubility.

What Did You Find Out? Answers

1. (a) The volume of water was 100 mL.
   (b) Answers will depend on the temperature of the water. It is unlikely that students will obtain identical results, but their results should fall within a fairly narrow range of similar values—from about 34 g to 36 g per 100 mL. For reference: at 10°C, the solubility of sodium chloride in water is 35.8 g/100 mL; at 20°C, solubility is 36.0 g/100 mL; at 30°C, solubility is 36.3 g/100 mL.
2. (a) Students likely used 100 mL, but the value could be different.
   (b) This will depend on the substance chosen. As with salt, students’ results will not be identical but should fall within a fairly narrow range of similar values.
3. Possible reasons for different results include inaccurate decisions about when the solution is saturated; imprecise measurements; differences in water temperatures from sample to sample.

Find Out Activity 8-2C

Concentrations of Consumer Products, p. 271

Purpose

- Students recognize that concentration information is common on a variety of consumer items and is expressed in various ways.

Advance Preparation

none

Time Required

- 20 min

Safety Precautions

- Have students handle each product carefully as they observe its label. As a precaution, supervise them while they do this activity.

Activity Notes

- Many students might become confused over the fact that concentration is expressed in different ways in different contexts. Similarly, most students will not be in a position to understand the meaning of “percentage by mass” and “percentage by volume” until their more indepth study of solutions in high school chemistry. Students’ minds can be put at ease if they understand, therefore, that they are expected only to *identify* different measures of concentration, not necessarily explain them. An alternative to treating this activity as an

at-home task is to bring in selected items (see the notes below) to have for display in the classroom and to have volunteers identify various concentration measurements for the benefit of the class.
- At home, students likely will encounter products with concentrations expressed as g/L (or, more commonly, g/mL or mg/mL). Such concentrations are readily available on the nutrient labels affixed to all fluid and fluid-containing products (e.g., salad dressings, drinks, soups).
- Concentrations expressed as percentage by mass are fairly common on personal care products such as medicated shampoos, antiperspirants, and toothpaste. The labels will refer to concentration with the percentage symbol, %, as well as the unit abbreviations w/v or w/w. It is important to note that the nutrient labels for solid foods (e.g., breads, pastas) state masses of nutrients per masses of serving portions; however, the percentages provided on the labels refer to "% daily value"—that is, the percentage of the recommended daily allowance of a given nutrient—so they are not concentration values. This is likely to be a source of confusion for many students. It might be necessary to state that the use of the percentage symbol on all food product nutrient labels does not mean concentration.
- The only common product on which students are likely to see a percentage by volume (% v/v) concentration is vinegar. Vinegar is a 5% (v/v) solution of acetic acid; there are 5 mL of acetic acid in 100 mL of solution. The volume is given in mL and not L because percentage is expressed out of 100. (Hydrogen peroxide is a 3% solution, but it is a m/v solution, with 3 g of hydrogen peroxide per 100 mL of solution.)
- Concentrations expressed in ppm (and ppb, parts per billion) are commonly used in association with substances in biological systems (such as the human body) and environmental systems (such as oceans, aquifers, ore bodies). Units of ppm are commonly used on bottled water products; otherwise, students are unlikely to encounter these units in and around the home unless they live on a farm or have a parent involved in a medical or environmental profession. They might, however, hear of or read these units in news reports related to water quality or pollution.

Supporting Diverse Student Needs
- Having a selection of common products (see Activity Notes) available for student inspection would be of benefit to all students, not only students who might have difficulty reading product labels.

What Did You Find Out? Answers
1. Students likely will answer water.
2. Students should be able to appreciate that concentration information would be provided for reasons of health and safety.

Find Out Activity 8-2D
Dissolve Carbon Dioxide, p. 271

Purpose
- Students design an experiment to compare the solubility of carbon dioxide gas in cold and warm water.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO	APPARATUS/MATERIALS
3 days before	Obtain plastic bottles of pop (if the activity is to be completed at school).	For each group (for example): – large basin or sink – sealed, plastic bottles of pop – hot water – ice cubes – refrigerator (if possible)
1 day before	Organize the equipment and materials.	
1–2 hours before	Warm and cool bottles of pop.	

Time Required
- 50–60 min

Safety Precautions
- Use sealed, plastic bottles of pop.
- Compare cold and warm (not hot) bottles.

Expected Results
Students should find that carbon dioxide is more soluble in cold pop than in warm pop.

Activity Notes
- The simplest way to create the necessary temperature difference is to refrigerate one bottle and place the other in a basin or sink of warm water.
- The Hint in the activity asks students to think about the sound they hear when they open a can or bottle of pop. The noise is caused by carbon dioxide gas coming out of solution. Students can use this sound as a means to assess, qualitatively, the solubility of the pop; a louder sound means more gas coming out of solution (that is, lower solubility).
- Refer students to Science Skill 2 for a review of variables and other concepts related to experimental design.

Supporting Diverse Student Needs

- Logical-mathematical students could be called upon to assist other students who are having difficulty with the idea that more noise = lower solubility.

What Did You Find Out? Answers

1. You would store it in a cupboard because the activity provided evidence that gases are less soluble at higher temperatures, so there will be more bubbles when the pop was opened.
2. Since gases are more soluble in colder water, the cold polar waters hold more dissolved oxygen, which would support more sea life.

USING THE FEATURE

Science Math Connect: Working with Concentration Units, p. 272

The central purpose of this feature is to help students convert millitres to litres so that they can express concentration units expressed in g/mL as g/L. Practice Problem 2 requires students to recognize that, since they must multiply the denominator values by a factor of 10, they must do the same with the numerator values.

Practice Problem Answers

Note: BLM 8-23 is a handout on which students can fill in their answers to the Practice Problems.

1. (a) 1 L; (b) 0.5 L; (c) 0.1 L; (d) 0.01 L; (e) 0.005 L; (f) 0.001 L
2. (a) 100 g/L; (b) 520 g/L; (c) 650 g/L; (d) 1000 g/L; (e) 1370 g/L; (f) 1.5 g/L
3. baking soda: 6.9 g/L; bluestone: 31.6 g/L; calcium hydroxide: 0.19 g/L; carbon dioxide: 0.34 g/L; Epsom salts: 70 g/L; ethanol: n/a; limestone: 0.0007 g/L; nitrogen; 0.003 g/L; oxygen: 0.007 g/L; salt: 35.7 g/L; sugar: 179.2 g/L

SECTION 8.2 ASSESSMENT, p. 273

Check Your Understanding Answers

Checking Concepts

1. The most soluble substance is ethanol since its solubility is unlimited; sugar is the next-most soluble substance.
2. (a) The least soluble substance is limestone.
   (b) Its low solubility (in water) means that buildings and other structures made with limestone are less likely to dissolve when exposed to water.
3. The solution is more concentrated because there is more solute for the same amount of solvent.
4. (a) The solution is unsaturated. You could add another 1492 g of sugar (per 1 L of water; or 149.2 g per 100 mL) before it becomes saturated.
   (b) To answer this question, students must refer to their extrapolated graph from Conduct an Investigation 8-2A, Part 1. Accept any answer that is close to the true value: 4760 g/L.
5. (a) sucrose; (b) sucrose; (c) sucrose

Understanding Key Ideas

6. Solution A: The solution was unsaturated and could now be saturated, or it could remain unsaturated.
   Solution B: The solution is saturated.
   Solution C: The solution was unsaturated and could now be saturated, or it could remain unsaturated.
7. Rock salt would stay longer because the crystals have less surface area and, thus, will dissolve more slowly.
8. The solubility is $\frac{495\text{ g}}{500\text{ mL}} \times 2 = \frac{990\text{ g}}{1000\text{ mL}} = \frac{990\text{ g}}{1\text{ L}}$ = 990 g/L

Pause and Reflect Answer

To determine the data they need, students must divide the numerator value by the appropriate factor needed to reduce 1 L (1000 mL) to the denominator value. The values for 1000 mL are the same as those already given in the table. For the rest:

Substance	10 mL	50 mL	100 mL	500 mL
bluestone	3.16 g	15.8 g	31.6 g	158 g
Epsom salts	7 g	35 g	70 g	350 g
salt	3.57 g	17.85 g	35.7 g	178.5 g
sugar	17.92 g	89.6 g	179.2 g	896 g

Other Assessment Opportunities

- Consult the Unit front matter for a list of applicable Assessment BLMs.

CHAPTER 8 ASSESSMENT, pp. 274–275

PREPARE YOUR OWN SUMMARY

Student summaries should incorporate the following main ideas:

1. Solutes and Solvents
   - In a solution, the solute is the substance that dissolves.
   - The solvent is the substance in which the solute dissolves.
2. Concentration
   - A concentrated solution has a large mass of dissolved solute for a given quantity of solvent.
   - A dilute solution has a small mass of dissolved solute for a given quantity of solvent.
   - The quantity of solute that is dissolved in a certain quantity of solvent is the concentration of the solution.
   - Concentration is commonly expressed in units of grams per litres (g/L).
3. Solubility
   - A soluble substance is able to dissolve in a given solvent.
   - An insoluble substance is not able to dissolve in a given solvent.
   - A substance that is soluble in one solvent might be insoluble in another solvent.
   - The solubility of a substance is the quantity (mass) of solute that dissolves in a quantity (volume) of solvent at a certain temperature.
   - Solubility may be expressed quantitatively in grams/litre (g/L) for a certain temperature.
   - A saturated solution is one in which no more solute will dissolve in a specific amount of solvent at a certain temperature.
   - An unsaturated solution is one in which more solute will dissolve in a specific amount of solvent at a certain temperature.
   - Gases are more soluble in liquids at a lower temperature than they are at a higher temperature.
4. Rate of Dissolving
   - Rate of dissolving refers to how quickly a solute dissolves in a solvent.
   - Three variables that affect the rate of dissolving are temperature, stirring, and solute size.

CHAPTER REVIEW ANSWERS

Checking Concepts

1. The phrasing of the statement provides the clue to determine which substance is the solute and which is the solvent.
   (a) solute: sodium fluoride; solvent: water
   (b) solute: copper; solvent: tin
   (c) solute: sugars; solvent: water
   (d) solute: carbon dioxide; solvent: water
   (e) solute: carbon; solvent: iron
   (f) solute: sodium; solvent: water (or apple juice)
2. (a) A saturated solution has reached the limit of solubility for its solute. (Or, a saturated solution holds the maximum amount of solute for a given solvent at a certain temperature.) For a given solvent at a certain temperature, more solute can dissolve in a solution that is unsaturated.
   (b) A dilute solution has less solute for a given volume of solvent than a concentrated solution with the same volume of solvent.
   (c) A substance that is soluble in water dissolves in the water, while an insoluble substance does not.
   (d) More (a greater mass) of a substance with a high solubility in water can dissolve than a substance with a low solubility in water.
3. Temperature must be included because temperature affects the amount of solute that can dissolve in a solvent.
4. Students' graphs must show that concentration increases (that is, the amount of solute increases); the amount (volume) of solvent must remain the same.
5. Sodium chloride: 8.6 g/L; calcium chloride: 0.33 g/L; potassium chloride: 0.3 g/L.
6. (a) The solution is unsaturated because the solubility of Epsom salts in water at 0°C is 70 g/100 mL.
   (b) The solution could hold 5 g more of solute.
7. Shaking increases the rate of dissolving because there is greater interaction of solute and solvent particles.
8. Students' graphs should show an increase in the amount of solvent that dissolves as temperature increases. The line can be straight or curved, as long as it rises to the right.
9. As the pressure on a solution increases, solubility increases. As pressure decreases, solubility decreases.

Understanding Key Ideas

10. (a) Students likely will say less solute will dissolve because solubility tends to increase or decrease with temperature.
    (b) The temperature of the solution must be raised so that more solute can dissolve in that same amount of solvent.
    (c) The solution is now unsaturated because more solute is able to dissolve in it.
11. The concentrations of the solutions are identical. Neither is more dilute than the other.

12. She could be telling the truth, because she has not stated the temperature at which she dissolved the salt. If the temperature is greater than 0°C, she would be telling the truth.
13. Both terms deal with the dissolving of solutes, but solubility is the amount of solute that dissolves at a certain temperature, while rate of dissolving is the speed at which a solute dissolves in a given amount of time.

Pause and Reflect Answer

Much of the water that flows over the limestone never actually comes in contact with it, so that non-contact water cannot dissolve the limestone. As well, the water is moving so quickly that any given water particle is in contact with any given limestone particle for a mere fraction of a second.

CHAPTER 9 OPENER, pp. 276–277

USING THE PHOTO AND TEXT

Some, perhaps many, students will be surprised to learn that the four products shown in the inset photo come from a type of grass. Students could discuss briefly their ideas about how these products are derived from cane sugar or sugar beets. Clues they could draw upon for their ideas are found in the third-last and second-last sentences (the references to filtering and evaporation). Students might require one additional hint—that sugars in plants are dissolved in the sap (watery liquid) that is transported throughout the plant.

USING THE WHAT YOU WILL LEARN/WHY IT IS IMPORTANT/SKILLS YOU WILL USE

Invite students to share any previous knowledge they have about separation techniques. If necessary, suggest students think about the kitchen; this suggestion should yield, at least, the making of tea, coffee, and pasta.

USING THE FOLDABLES™ FEATURE

See the Foldables™ section of this resource.

9.1 SEPARATING MIXTURES AND SOLUTIONS

BACKGROUND INFORMATION

Techniques for the mechanical separation (sorting) of heterogeneous mixtures are based on differences in properties such as the following:

- density of the components (e.g., skimming the fat off soup)
- size and shape of the components or particles (e.g., picking out bolts from nuts; sifting/filtering)
- charge of the particles (e.g., industrial electrostatic precipitators for removing particulates from smokestack emissions)
- magnetic propensity of the particles (e.g., using a magnet to remove scrap metal from non-metallic wastes)

Techniques for separation of homogeneous mixtures are based on properties such as boiling point (evaporation, distillation) and solubility (chromatography).

Distillation is a separation process that involves two changes of state: vaporization (boiling a liquid to change it to its gaseous state) followed by condensation (cooling the gas below its boiling point so that it changes to its liquid state). Distillation is used to produce drinkable water from ocean water in some places around the world (e.g., California) where there is plentiful energy supplied by the Sun. Otherwise, the process is too expensive to be practical for producing sufficient water for large populations.

Simple distillation is a method of separating one liquid from another liquid with a much lower boiling point (e.g., a water and alcohol mixture) or separating a liquid from a dissolved solid (e.g., a salt water mixture). A typical apparatus for simple distillation has three main components: a container (usually a Florence flask) for boiling the mixture, a container for collected the distillate (the purified liquid), and a condenser (in which cold water is passed to condense the gaseous distillate) to connect the two containers.

Chromatography is a separation process that involves differences in solubility. For example, ink is a solution of two or more pigments (coloured substances). The pigments can be separated using a type of chromatography that uses filter paper. The ink is dissolved in a solvent, and then the solvent is allowed to move through the filter paper. Dissolved pigments that are more soluble in the solvent travel faster and farther along the filter paper than pigments that are less soluble. So the less soluble substances are absorbed by the filter paper first and they become visible on the filter paper sooner than the more soluble pigments. In this way, the various pigments are separated from each other at different places along the filter paper. Figure 9.11 on page 284 of the student book shows this clearly.

COMMON MISCONCEPTIONS

- Students might believe that a liquid must boil in order for it to evaporate. This is not the case, and students can confirm this from experience; for instance, a drop of water at room temperature (that is, below the boiling point of water) in still air will slowly "disappear" over several hours. This occurs because *surface* particles of the water slowly escape into the gaseous (vapour) state. Boiling, on the other hand, is the rapid change from the liquid to the gaseous state at the boiling point of a given substance. Unlike evaporation, which takes place at the surface of a liquid, boiling takes place at and below the surface of a liquid.
- Some students might wonder why filtration is set off (through the use of headings) from mechanical sorting, since it seems to fall into that category. Encourage students to justify their point of view and acknowledge that the concepts could be modified to be presented that way. Point out to students that there is no right or wrong way to organize or present information. Some ways, however, are

more logical or "flow better" than others. Sometimes, two or more different ways are equally effective in presenting the same information.

ADVANCE PREPARATION

- Conduct an Investigation 9-1C is a three-part core lab. Be sure to photocopy BLM 3-30 for students to more easily record their answers to all the questions. If necessary due to time constraints, Part 1, which focuses on evaporation, could be omitted, since it is variation of distillation, which is the focus of Part 2. As well, Conduct an Investigation 9-1B could be discussed in class as a type of "thought experiment", or it could be used, orally, as a basis for formative assessment (also treated as a "thought experiment").
- Common mixture-separation tools (real objects or pictures or both) could be gathered and brought to the classroom for display. In addition to those examples in the student book, a centrifuge (for separating blood components), a garlic press, an electric juicer, and an "old-fashioned" juice squeezer could be used.
- Consult the Unit front matter for a list of BLMs that can be used when teaching this section.

INTRODUCING THE SECTION, pp. 278–279

Using the Text

To help students relate the subject matter to their daily lives and experiences, use Figures 9.1 and 9.2 as the focal point for discussing ways in which students separate mixtures. Display and/or discuss other mixture-separating tools and techniques as a lead-in to Think About It Activity 9-1A, Strategies for Separation.

Using the Key Terms and Section Summary

At the beginning of each section in the student book are the Key Terms and section summary. Both can be used as a pre-reading strategy and a review tool. Before reading the text in the section, students should be able to define the terms listed in the Key Terms by scanning the text and using the glossary. The Key Terms include terms from the curriculum outcomes and additional terms that are useful for students to know and understand.

The section summary provides an overview of the key concepts being covered in the section. Students may not know all the concepts and terms described in the summary, but they can use this information to help guide them through their reading.

After reading the section, students can go back to the Key Terms and section summary to consolidate their understanding and identify areas that require clarification. At the end of the chapter or unit, students can use the Key Terms and section summary for review. BLM 3-2, Unit 3 Key Terms listing all the terms listed in the unit can be used to assist students.

USING THE ACTIVITY

Think About It Activity 9-1A

Strategies for Separation, p. 279

Purpose

- Students relate the properties of the components of mixtures to separation techniques.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO	APPARATUS/MATERIALS
1 day before	Determine group sizes for this activity and how students will be paired. Prepare containers of mixtures. Photocopy BLM 3-28.	For each group: – student book –container of the mixture

Time Required

- 15–20 min

Safety Precautions

- Remind students not open the containers unless you ask them to do so.

Expected Results

Students will realize that separating the components of mixtures depends on observing the properties of the components and of the mixtures themselves.

Activity Notes

- This is not intended to be a hands-on activity. Its aim is to help students focus their thinking on the properties of matter, since the separation of mixtures—homogeneous as well as heterogeneous—depends on differences in the properties of the components.
- Encourage students to go beyond the obvious. For instance, some mixtures might require more than one step (that is, one technique) to separate the components. (What Did You Find Out question 4 is designed to address this idea directly.)
- If time is an issue, this activity could be done as a whole-class discussion.

Supporting Diverse Student Needs

- Some students might benefit from having separated samples of the various materials to examine more closely.
- Students could be asked to test their ideas for separating one or several mixtures.

What Did You Find Out? Answers

1. Students likely will refer most often to size, “heaviness” (density), and shape. Accept all reasonable answers.
2. Filtering and settling are the likeliest choices. Accept all reasonable answers.
3. (a) Likely responses are the nuts and bolts mixture (because the individual components can be seen easily and separated easily by hand) and the iron filings and sand mixtures (because a magnet makes the separation fairly simple). Accept all reasonable answers.
   (b) Vegetable oil and sand is likely to be a popular choice for most difficult because there does not seem to be a readily recognizable property that would allow fast or simple separation. Accept all reasonable answers.
4. To answer this question, students must consider more than a single method and single step to separate the mixture. Thus, for example, a magnet could be used to remove the iron filings from the other two components. Then simple hand-sorting could be used to remove the marbles from the sand.

TEACHING THE SECTION, pp. 280–291

Using Reading

Pre-reading—Key Word Concept Maps

Most students will know the terms “evaporation” and “filtration” from either previous studies or experience. Have students discuss and define, either formally or operationally, these terms. Then ask students what they think the term “mechanical sorting” is or refers to. Encourage students to consider this term could be related to evaporation and filtration. If necessary, direct students to the titles for this section and for this chapter.

The remaining terms in the Key Terms list, “paper chromatography” and “simple distillation,” are probably foreign to most of the students. Have them flip through the section to find where these terms are used and explained. Then have students think of ways these two terms are linked to the others and to concept-map their ideas.

As students read the text in this section, remind them to refer to their concept maps to clarify or modify their understanding of these terms in context and to refine their notes (see the During-Reading Strategy).

During Reading—Note Taking

Have students use their concept maps as well as the headings and subheadings in Section 9.1 to record essential information about the concepts under discussion. Students could rewrite headings in the form of questions, or they could develop tables to help them differentiate methods for separating heterogeneous and homogeneous mixtures.

After Reading—Reflect and Evaluate

Ask students to compare their current understanding of the key concepts in this section with the concept map they developed before their study of the section. Based on their comparison, have them write a brief paragraph (or describe orally) to demonstrate in what ways, if any, their understanding of the individual key terms has developed.

Reading Check Answers, p. 281

1. Mechanical sorting is a way to separate the parts of a mixture based on properties such as magnetism. For example, in a mixture that contains magnetic substances as well as other substances, the property of magnetism would enable someone to remove the magnetic substances, leaving the non-magnetic substances behind.
2. It is easier to separate the parts of a heterogeneous mixture because the parts (components) are usually easier to see and they retain their own properties.
3. The size of the holes in a filter permit some substances in the mixture (those with parts smaller than the holes) to pass through, while trapping other substances (those with parts larger than the holes).

Reading Check Answers, p. 284

1. Evaporation recovers the solute.
2. Distillation recovers both the solute and the solvent.
3. Chromatography is a method for separating the solvents in mixtures that contain two or more solvents.
4. Paper chromatography works by comparing how fast dissolved substances are carried by a solvent through an absorbent material. Different substances move through an

absorbent material at different rates, enabling them to be distinguished from each other and identified.

USING THE ACTIVITIES

- Activity 9-1A, Strategies for Separation, on page 279 of the student book is best used near the start of the section as a discovery-oriented task.
- Activity 9-1B, Make Dirty Water Clear, on page 285 of the student book can be used at any time in the section, but it is best suited for use after students have discussed mechanical sorting.
- Activity 9-1C, Separating Homogeneous Mixtures, on page 286 could be done at the end of the section, or it could be broken into two segments with the first (Parts 1 and 2) being done after the discussion of evaporation and distillation and the second (Part 3) being done after the discussion of paper chromatography.

Detailed notes on doing the activities follow.

Conduct an Investigation 9-1B

Make Dirty Water Clear, p. 285

Purpose

- Students design a filter to make muddy water clear.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO	APPARATUS/MATERIALS
3–4 days before	Make a pail of dirty water.	For each group: – 2 L pop bottle with bottom cut off – ring clamp – ring stands – stopwatch – sand – gravel – cotton cloth – dirty water – bucket or larger beaker

Time Required

- 40 min

Safety Precautions

- Remind students not to taste, smell, or drink the water in this activity. It is not safe for these purposes.
- Remind students to handle the pop bottle carefully so that they do not accidentally cut themselves on the cut-off end.
- Remind students to wash their hands thoroughly after working with dirty water.

Expected Results

Students will use filtering techniques to make muddy water clear (or clearer).

Activity Notes

- To create the muddy water, mix soil, leaves, and sawdust with tap water.
- Any scraps of cloth will work for filtering material—old jeans, T-shirts, or cheesecloth. Plastics, rayon, and nylons do not work as well.
- Any gravel or pebbles will work. This could be omitted if too costly.
- Inexpensive sand can be purchased at many hardware and garden supply stores.
- Materials from this investigation can be re-used.
- To make filters more creative, have students bring materials from home. To increase motivation, emphasize the purpose of this challenge. If students do not camp, consider other times when they might need this knowledge.

Supporting Diverse Student Needs

- This activity is easily done in the classroom by all levels and types of learners. For added effect, a sense of adventure and practicality can be established if the students are taken to a nearby creek or pond and asked to create and test the filter right on site. You may even consider not telling students the purpose of the trip and then have them build filters from materials they can find in the area. (Troubleshoot for safety-related issues.)
- Have different groups work with different types of cloth. (Their results will vary.)

Evaluate Answers

1. Student should be able to see whether or not the water that came out of their filter was clear.
2. Students likely will link surface area and/or size of filtering holes to efficiency of their filters. Accept all reasonable answers.
3. Filters might work faster if there was more surface area. They might produce clearer water if the material had smaller holes.
4. Some of the ways to prevent the filter from clogging include letting the water settle and skimming off the clearer water for filtering and adding a pre-filter to remove larger parts.

Conduct an Investigation 9-1C

Separating Homogeneous Mixtures (Core Lab)—Part 1: Evaporation, p. 286

Purpose

- Students separate a salt water solution using the technique of evaporation.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO	APPARATUS/MATERIALS
1–2 days before	Gather equipment and materials.	For each group: – evaporating dish – 50 mL graduated cylinder – hot pad – hot plate – stirring rod – tongs – watch glass – salt water

Time Required
- 25–30 min

Safety Precautions
- Have students use oven mitts or tongs to handle hot glassware.
- Students should wear safety goggles when near the evaporating dish while it is heating.
- Remind students to unplug the hot plate after it is turned off. Let it cool before putting it away.

Expected Results
The solvent will evaporate, leaving the solute behind.

Activity Notes
- A stock solution made with 50 g of salt dissolved in 1 L of water will provide excellent results.
- A smaller sample of water for each group of students will speed up the process.
- The separation technique used in this activity is also called crystallization. Students could be invited to explain why this name is used and whether it is a better name than evaporation. (Since crystallization refers to the solute, which is what remains as a result of the process, some students might argue that it is a better name.)

Supporting Diverse Student Needs
- It might be necessary or helpful to demonstrate the procedure for students who are body-kinesthetic learners. Encourage students to illustrate their observations.

What Did You Find Out? Answers
1. The solution is clear and colourless.
2. The material is white and crusty.
3. The water evaporated.
4. (a) Salt likely remained.
   (b) Many substances look like salt because they are white crystals, and many solutions are clear and colourless. Taste is always an unsafe method for identifying a substance.
5. Students likely will refer to a setup similar to Figure 9.10—a setup in which a plastic tent is arranged over salt water in a dish that is sitting on a shallow tray so that the water will condense on the plastic and run down the sides and into the tray.

Conduct an Investigation 9-1C

Separating Homogeneous Mixtures (Core Lab)—Part 2: Distillation, pp. 287–288

Purpose
- Students use simple distillation to separate and recover the components of a solution of salt water.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO	APPARATUS/MATERIALS
2–3 days before	Gather materials and equipment. Insert glass tubing in stoppers. Do a trial run of the activity. Photocopy BLM 3-29.	For each group: – distilled water – salt – microscope slide – marker – 2 beakers (250 mL) – graduated cylinder – medicine dropper – hot plate – 500 mL Erlenmeyer flask – stopper with glass tubing inserted – 50 cm rubber or plastic tubing – tongs (for beaker or flask) – measuring spoon

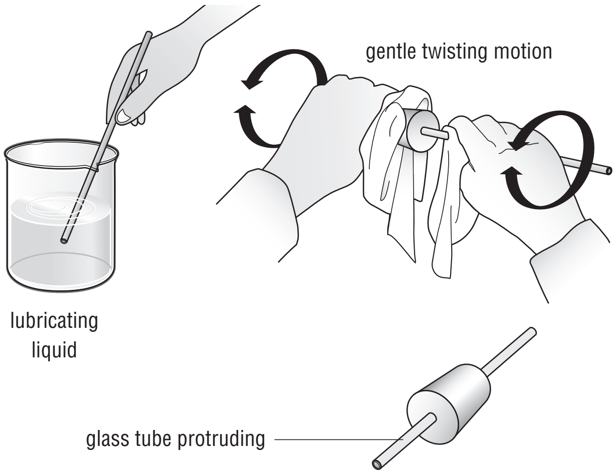
Time Required
- 40–60 min initially
- overnight to complete step 5

Safety Precautions
- Remind students they will be working with a hot plate, boiling water, and hot steam, all of which can cause painful burns. They need to work carefully around hot objects, especially steam.

Expected Results
The solvent (water) will vaporize and then condense to return to the liquid state. The solute will remain after the solvent evaporates.

Activity Notes
- To insert glass tubing into a rubber stopper, begin by lubricating the top of the glass tubing and the rubber stopper with soapy water, glycerol, or some other suitable substance. Protect your hands with a cloth towel. Never force the tubing into the

stopper. Ease it in with a gentle twisting motion. The end of the glass tubing should protrude from the stopper.



- Due to the involved nature of this activity, as well as the use of hot plates and glass tubing, hold a class discussion to review safety and safe practices.
- Group sizes of four or five students work well as long as students in each group have clearly defined roles. Assessing students (individually and as a group) on the performance of their roles, as well as on the "content" of the activity, can help to ensure individual and group accountability.

Supporting Diverse Student Needs

- It might be necessary or helpful to demonstrate the procedure for ESL students or for students who are body-kinesthetic learners. Encourage ESL students to illustrate their observations.
- Some students might require you to review how to measure accurately with a graduated cylinder or measuring spoon. They might also require assistance setting up the equipment.

Analyze Answers

1. (a) Steam began to form in the top half of the flask.
   (b) Evaporation was taking place because heat was being applied to a water-containing solution, and steam was visible.
2. (a) Water droplets began to form at the end of the tubing and dripped into the beaker.
   (b) Condensation was taking place because the water vapour was cooling and, therefore, condensing.
3. (a) White crystals remained.
   (b) Ideally, no material remained. However, it is possible that a tiny amount of solute (white crystals) remained to due incomplete distillation.
   (c) Ideally, no material should remain, since distilled water is pure water.
4. The rinsing process referred to in step 5 helps to prevent contamination of the liquid to be observed. In both steps (c) and (d), the only liquid from the dropper that could come in contact with the liquid being collected from each beaker is the liquid being collected.

Conclude and Apply Answers

1. The solvent collected in the beaker. The test performed in step 5 helps to confirm that.
2. The substance not collected in the beaker remained in the flask.
3. The distilled water was pure water because no material of any kind remained after the water evaporated.
4. Students likely will say no, perhaps because the method seems like it would be very energy-intensive, time-consuming, and costly. However, accept all reasonable answers.

Conduct an Investigation 9-1C

Separating Homogeneous Mixtures (Core Lab)—Part 3: Paper Chromatography, p. 289

Purpose

- Students use paper chromatography to separate the solvents that are mixed together in the ink of a black marker pen.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO	APPARATUS/MATERIALS
1–2 days before	Gather materials and equipment. Photocopy BLM 3-30.	For each group: – 2 beakers (250 mL) – filter paper – black marker pen (water-soluble) – black marker pen (permanent) – water – 2 plastic straws – scissors – ruler – tape – waxed paper

Time Required

- 40–50 min

Safety Precautions

- Remind students not to sniff the markers. Their fumes can irritate and damage the lining of the nose, throat, and lungs.
- Remind students to handle the scissors carefully.

- Dispose of all waste materials in accordance with school or board policy.
- Note: While the use of ethanol and other volatile solvents is common in many paper chromatography activities, the use of these substances at this level is not recommended. Students can experience paper chromatography sufficiently with water-soluble substances.

Expected Results

Students will observe solvents separating from the ink in the water-soluble marker but not the permanent marker.

Activity Notes

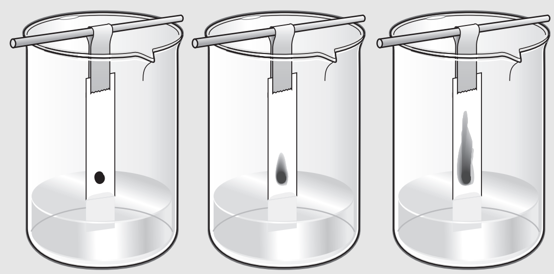
- If time is an issue, the filter paper strips could be cut ahead of time for student use.
- If laboratory filter paper is not available, good-quality white paper towelling could be substituted. Since paper towelling is quite porous, however, students may obtain poor results. Note that filter paper used to make coffee filters is not a suitable substitute because solvent is absorbed too quickly and, consequently, runs.
- Students can re-apply their ink dots several times to ensure that a sufficient quantity of ink has been absorbed.
- Make sure that the ink dots sit at least a few millimetres *above* the water in the beakers.
- If necessary, advise students that black is a colour.
- Students could experiment with a variety of coloured markers.
- If time permits, students could conduct Part 3 again using alcohol as the solvent in step 2 of the Procedure, instead of water. Students could be asked to predict the results of this investigation and to provide reasons for their prediction. (Their study of the nature of solvents in section 8.1 and their experiences with the textbook version of Part 3 should enable them to make accurate predictions.) Note: When using alcohol in the classroom, ensure that the room is well-ventillated. Students should treat the alcohol as they would any hazardous chemical, and gloves, safety glasses, and safety coats must be worn. If necessary, advise students that the alcohol used in science class has a chemical added to it to make it poisonous to all living things, including them.
- As an extension to the previous suggestion, or as an alternative to it, students could separate the pigments in plant leaves. The juice from ground-up spinach leaves (use a food processor, or boil spinach leaves for awhile in a small amount of water) can be substituted for the marker ink, and alcohol would once again be used for the solvent. After students observe the separation of the green spinach liquid into different colours (red, yellow, and green), students could be encouraged to relate this to the colour change of leaves in the fall.

Supporting Diverse Student Needs

- It might be necessary or helpful to demonstrate the procedure for tudents who are body-kinesthetic learners. Encourage ESL students to illustrate their observations.

Analyze Answers

1. The water-soluble ink will spread out and become more diffuse in colour, looking like ink or water-colour paint that has "run" when exposed to dampness. Depending on the type of marker used, at least two shades of colour (representing two different inks) will be visible. (These might be difficult to differentiate, however.) There will be no change to the permanent ink.



2. Only the ink dot made with the water-soluble marker runs.

Conclude and Apply Answers

1. Ink is a mixture of different substances because more than one colour was separated from the ink.
2. The separated colours can be put together again by dissolving them back into water. This would work because the colours are water-soluble.

USING THE FEATURE

www science: Cleaning Up for Peat's Sake, p. 290

Students could visit Hi-Point's web site to find out current information about the company and its products. Students could also do research to find out more about peat and its relationship to an important fossil fuel: coal.

SECTION 9.1 ASSESSMENT, p. 291

Check Your Understanding

Checking Concepts

1. A colander is designed to separate heterogeneous mixtures such as noodles in water. Three other examples of separating mixtures include wearing a surgical mask, washing dirty clothes, and using a salad spinner.
2. One filter would have holes the size of the smallest marble. The second filter would have holes the size of the next-smallest marble.
3. Sample answers:
   (a) Add water to the mixture; the wood might float.
   (b) Use a magnet to attract the iron filings.
   (c) Add water to the mixture. Salt will dissolve in the water; pepper won't. Then filter out the pepper. Then evaporate the water from the salt water to get the salt back.
4. Both evaporation and distillation can be used to separate the parts of a solution. Evaporation only recovers the solute. Distillation recovers both the solute and the solvent.

Understanding Key Ideas

5. (a) They have different densities.
   (b) Water (gravy) is more dense than fat, so it will sink to the bottom where the spout is. Two other methods might be (i) chilling the gravy and then skimming off the hardened fat; (ii) soaking up the liquid fat with paper towelling.
6. (a) The Sun's heat causes the water to evaporate. The resulting water vapour cools as it rises and condenses on the underside of the plastic sheet. The condensed liquid water then runs down the plastic sheet into collecting containers.
   (b) This method works because as water particles in the solution reach their boiling point, they leave the solution, leaving the solute (which has a different boiling point) behind. Since the water vapour condenses in a separate container, it contains only water particles.

Pause and Reflect Answer

Some, perhaps many, students will conclude that the method involves distillation because they will focus on individual words (notably "droplets") and not on the meaning of the sentences. The method is really a form of filtration because the fine-meshed net filters extremely fine droplets of water from air.

Other Assessment Opportunities

- Consult the Unit front matter for a list of applicable Assessment BLMs.

9.2 SEPARATING MIXTURES FROM UNDERGROUND

BACKGROUND INFORMATION

Fractional distillation is a method of separating more complex mixtures of substances (often all volatile, such as crude oil). The essential difference between simple and fractional distillation is the addition of a fourth component—a fractionating column—between the first container and the condenser. The fractionating column provides a series of surfaces, in vertical succession, to improve the precision of the distillation, allowing a high proportion of individual volatile components to be separated one at a time.

As petroleum forms, it moves upward under pressure through layers of porous sedimentary rock until it reaches a layer of impermeable rock. Impermeable rock has no spaces for liquids to flow through. Oil that has collected in large amounts may be removed by drilling a well. If the oil is under pressure, it will rise up the well without pumping. Otherwise, it might have to be pumped or forced up with water, gas, or air.

Gold may be separated from gold ore either physically (the panning method, due to density differences) or chemically. Gold has the greatest density of any mineral, which is why it accumulates at the bottom of streams. Gold is about 19 times heavier than water, so it tends to get caught in the slower-moving sections of streams.

COMMON MISCONCEPTIONS

- Some students might become confused over how a fractional distillation tower works. Such confusion can arise by equating higher in the tower with higher temperature and lower in the tower with lower temperature. Encourage students to think through the process logically with Figure 9.13 in front of them. The hot vapours from the first tower enter the second (fractionating) tower at the bottom—that is, "lower" in the tower. So lower in the tower means hotter. As the hot vapours rise, they get cooler, so "higher" in the tower means cooler. Students could make a sketch of Figure 9.13 and use colours (red and blue) to help them visualize the parts of the second tower that are hotter and the parts that are cooler.

ADVANCE PREPARATION

- Activity 9-2B, Mining for Gold, on page 296 requires about 1 L of Styrofoam chips ("peanuts"), so these should be acquired in advance. In a pinch, puffed wheat cereal could be substituted.
- Consult the Unit front matter for a list of BLMs that can be used when teaching this section.

INTRODUCING THE SECTION, p. 292

Using the Text

Ask students for examples of natural resources in the province, and advise or remind them of mineral (notably nickel) and petroleum resources that help contribute to Newfoundland and Labrador's economic prosperity.

Using the Key Terms and Section Summary

At the beginning of each section in the student book are the Key Terms and section summary. Both can be used as a pre-reading strategy and a review tool. Before reading the text in the section, students should be able to define the terms listed in the Key Terms by scanning the text and using the glossary. The Key Terms include terms from the curriculum outcomes and additional terms that are useful for students to know and understand.

The section summary provides an overview of the key concepts being covered in the section. Students may not know all the concepts and terms described in the summary, but they can use this information to help guide them through their reading.

After reading the section, students can go back to the Key Terms and section summary to consolidate their understanding and identify areas that require clarification. At the end of the chapter or unit, students can use the Key Terms and section summary for review. BLM 3-2, Unit 3 Key Terms listing all the terms listed in the unit can be used to assist students.

TEACHING THE SECTION, pp. 292–297

Using Reading

Pre-reading—Predict-Read-Verify

Ask students to find and look at the diagram in Figure 9.13. Have students work in pairs or small groups to discuss their interpretations of the diagram—what it means to them now, based on the current knowledge of distillation and the information provided in the caption, labels, and actual depiction of the fractional distillation tower. Students could also do the same for the diagram on page 296, which provides a simple outline of the processes involved in one method for separating gold from ore.

During Reading—GIST

Have students record the subheadings in this section and then read the text for each subheading. In each case, they are to write down a summary of the information, reduced to just 20 words that capture the essence—the gist—of what they have read. Encourage students to draw upon their experiences in interpreting the diagrams from the Pre-reading exercise.

After Reading—Reflect and Evaluate

Ask the students to think about how the processes for separating a liquid and a solid mixture from underground are related to the nature of the mixtures and the properties of the components. As they synthesize this information, they can refer to their Pre-reading exercise and compare their current understanding with the ideas they developed before studying the section.

Reading Check Answers, p. 294

1. Petroleum is a mixture because it contains more than one component/substance.
2. Fractional distillation is a method for separating the parts of complex mixtures.
3. Fractional distillation is used to process petroleum because petroleum is a complex mixture.
4. Gold ore is a mixture because it contains rock material as well as gold.

USING THE ACTIVITIES

- Activity 9-2A, Panning for "Gold", on page 295 of the student book can be used to model the panning technique described in the student book on page 294.
- Activity 9-2B, Mining for Gold, on page 296 of the student book is best used to augment students' understanding of ways in which gold may separated from its ore.

Detailed notes on doing the activities follow.

Find Out Activity 9-2A

Panning for "Gold," p. 295

Purpose

- Students use a model to show the role of density in gold panning.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO	APPARATUS/MATERIALS
2–3 days before	Gather materials and equipment.	For each group: – 1 L Styrofoam packing chips – 1 L marbles – large paper bag – large basin – hair dryer

Time Required
- 15 min

Safety Precautions
- Remind students to turn off the hair dryer when it is not in use.

Expected Results
The foam ships are easily separated from the marbles due to density differences.

Activity Notes
- This activity is easily done as a class demonstration, thus saving time and materials. Volunteers can try their hand at the technique.
- The mixture could be made ahead of time to save a step.
- If the school is located near a small stream or creek, consider conducting a variation of the activity at the site. Survey the area ahead of time to see how or if the activity could be modified to use the natural materials in the stream or creek. (To prevent accidental pollution, do not bring marbles or Styrofoam chips to a natural area.) Ensure that students are adequately dressed (e.g., boots) and that safe and respectful practices have been discussed before students enter the site area.

Supporting Diverse Student Needs
- Students who demonstrate difficulty in understanding the concept of density or the role of density in gold panning would benefit from observing and experiencing, hands-on, step 1 of the procedure.

What Did You Find Out? Answers
1. (a) The marbles represent gold nuggets.
   (b) The chips represent gravel.
   (c) The blowing air representing running water.
2. Students likely will say that the use of the chips and marbles is a reasonable simulation of the gold bits and nuggets that would be mixed with sediment. The blowing air is like the flowing motion of running water. Accept all reasonable answers.

Think About It Activity 9-2B

Mining for Gold, p. 296

Purpose
- Students use a flowchart that shows how gold is mined and processed to learn more about this process.

Advance Preparation
none

Time Required
- 20–30 min

Activity Notes
- This activity can be assigned for individual enrichment, homework, class discussion, or small group work.
- The process by which gold comes out of solution in step G might require some explanation. This step involves a chemical change, not a physical one. Ground gold ore is mixed with a solution that contains cyanide. The addition of zinc to this solution causes a chemical reaction in which the gold separates from the solution by precipitation.

Supporting Diverse Student Needs
- Although the flowchart is lettered to indicate reading sequence, some students might become confused by the zig-zag orientation of the information. Have students redesign (in their notebooks) the flowchart either vertically or horizontally to ease the reading process.

What Did You Find Out? Answers
1. The gold is still part of a mixture because blasting has only broken the ore into smaller pieces; it does not separate the components.
2. The ore is crushed into a fine powder to speed up the process of dissolving (because of increased surface area).
3. It is easier to pump the ore through the system when it is part of a liquid.
4. Adding lime thickens the mixture so that the components do not settle.
5. The rock materials with which the gold was mixed are not soluble in the chemicals that are able to dissolve gold.
6. The solid waste material is made up of the limestone powder and the chemicals used to dissolve the gold. It must be treated before disposal to make them less dangerous.
7. Gold is the main solute when the liquid is added. When powdered zinc is added, the gold separates from the solution. The leftover liquid must be treated to make it less dangerous.

USING THE FEATURE

Career Connect: Oil Spill Advisor, p. 298

Students could discuss why cleaning up oil spills is so difficult and so costly, in terms of life and property, to the environment. Students could also do research to investigate some of the more disastrous oil spills in recent decades (for example, the Amoco Cadiz spill in 1978, the Exxon Valdez spill in 1989, and the Sea Empress spill in 1996).

National Geographic: Visualizing Salt, p. 299

Table salt, sodium chloride, is one of the most important pure substances for living things. The cells of all living things depend on sodium (along with potassium) to move vital substances across their membranes. Without salt, we would die.

The model (unit cell) of sodium chloride is made up of two types of particles: sodium (the smaller white spheres) and chlorine (the larger yellow spheres). Students should understand that the particles that make up matter do not actually have colours like this; the colours are used to help distinguish the two types of particles in this model.

SECTION 9.2 ASSESSMENT, p. 297

Check Your Understanding Answers

Checking Concepts

1. Petroleum is a complex mixture that is made up of hundreds of pure substances, each with its own boiling point.
2. Petroleum may be found in, for example, Alberta and off the shore of the island of Newfoundland.
3. Petroleum that has been pumped to the surface is processed to separate and refine its components.
4. Fractional distillation of petroleum is similar to the distillation of salt water in that separating the individual components depends on the fact that the components have different boiling points. It is different in that petroleum contains many, many more substances than salt water does. (Some students might also refer to the volatility of the petroleum components compared to salt and water, which would be a fair comment.)
5. A petrochemical is any chemical or product that is made by processing the components of petroleum.

Understanding Key Ideas

6. Students' flowcharts should in some way demonstrate that petroleum is heated to produce vapours (gases) that condense at different heights of a distillation tower, yielding a different substance at each indicated height.
7. An ore is a mixture because it contains rock material that is mixed with one or more pure substances.
8. Panning was a useful method because gold is heavier (more dense) than the rock material of stream beds, so even the smallest bits of gold will always settle to the bottom of the pan.

Pause and Reflect Answer

The pump on the right is lifting oil to the surface. The other pump is injecting water into the oil-bearing area. Because oil is lighter (less dense) than water, the oil will collect on top of the water. As a result, it is possible, and easier, to pump out a greater proportion of oil.

Other Assessment Opportunities

- Consult the Unit front matter for a list of applicable Assessment BLMs.

CHAPTER 9 ASSESSMENT, pp. 300–301

PREPARE YOUR OWN SUMMARY

Student summaries should incorporate the following main ideas:

1. Separating Heterogeneous Mixtures
   - Mechanical sorting separates the parts of a heterogeneous mixture based on properties.
   - Filtration is a type of mechanical sorting based on particle size.
   - Flotation is a type of mechanical sorting based on density.
   - Magnetism is a type of mechanical sorting based on whether parts of a mixture are magnetic.
2. Separating Homogeneous Mixtures
   - Homogeneous mixtures can be separated using evaporation, distillation, and chromatography.
   - Evaporation recovers the solid solute from a solution by evaporating the liquid solvent.
   - Distillation is similar to evaporation, except the solvent is also recovered by condensing and collecting the gaseous solvent.
   - Paper chromatography separates two or more substances in a solution based on seeing how fast each is carried by a solvent through an absorbent material.

3. Separating a Liquid Mixture from Underground
   - Petroleum is a complex mixture of liquid, solid, and gaseous substances.
   - Fractional distillation can be used to separate complex mixtures.
   - In fractional distillation, a complex mixture is vaporized and the different parts of the mixture condense at their individual boiling points.
4. Separating a Solid Mixture from Underground
   - All rocks are mixtures. An ore is a rock mixture that contains one or more valuable substances such as gold or iron.
   - Gold can be separated from rock material based on density, since gold is more dense than most rock material.
   - Gold also can be separated from rock material by crushing and grinding it and mixing it with water and other chemicals to help recover the gold.

CHAPTER REVIEW ANSWERS

Checking Concepts

1. (a) prevents germs, vapours, and odours from entering the nurse's nose
   (b) collects tiny, solid particles from the air
   (c) collects tiny, solid particles (impurities) from the gasoline
   (d) separates rock material from pottery fragments
   (e) lets excess water out of the basket so roots don't become water-logged
   (f) prevents mosquitoes from gaining access to the face
2. Mechanical sorting can't be used to recover any part of a homogeneous mixture because the parts of such mixtures are too small to be filtered or otherwise mechanically separated.
3. Evaporation could be used to recover some parts of a heterogeneous mixture because any parts of the mixture that were dissolved or suspended in the liquid component would remain behind.
4. The cell membrane is a type of filter because (like other filters) it permits some substances to pass through and not others.
5. Based on the description of mechanical sorting on page 280 in the student text, magnetism and sorting by hand are examples of mechanical sorting by definition. Some students might say that they are examples of mechanical sorting because the parts of the mixture can be separated by physical manipulation fairly easily. Accept all reasonable answers.
6. (a) The type of mechanical sorting is flotation.
   (b) Flotation depends on the property of density. The density of rice in water is greater than the density of the dust and dirt specks in water, so the rice sinks to the bottom of the pot and the other materials float. (Note that in their explanations, students must contextualize (compare) the density of the rice, dirt, and dust—that is, the density of these materials *in water;* this is necessary because the density of any of these materials in a different fluid might be different.
7. Tap water is a solution that is made up of water particles and the particles of various other solutes. Distillation causes the water particles to move faster and farther apart with the addition of heat, leading to a change of state from liquid to gas. As the particles of gaseous water are cooled, the particles move more slowly and their spacing decreases—that is, the water condenses. The resulting liquid is pure water, separated from the solutes that once were dissolved in it.

Understanding Key Ideas

8. Like all filters, a spam filter works by trapping some things (e-mails) and allowing others to pass through. Two essential differences between a spam filter and an actual filter are (a) e-mails are not real (that is, they are virtual objects, rather than real objects) and (b) spam filters use criteria other than holes and particle size to perform their function.
9. Students likely will suggest that they could add water to dissolve the sugar, filter the mixture to remove the sand, and then use either distillation or evaporation to recover the sugar. Equipment needed for these processes would include water, filter paper, a source of heat, and containers to hold the substances/mixtures at different steps of the process.
10. From lowest to highest volatility: asphalt and tar, greases, lubricating oils, diesel oil, kerosene, jet fuel, gasoline, propane. (Note: To place propane in this continuum, students would have to know or guess that propane is a gas at low temperatures.)
11. (a) The one that appears homogeneous is likely the solution.
    (b) The other mixture could be filtered to obtain a solution of apple juice.

12. The marbles and gravel can be removed by filtration. (The marbles also could be picked out by hand.) The iron filings can be removed from the whole mixture or a filtered mixture by magnetism. The puffed wheat will float and can be removed by hand. The water can be removed by distillation (or evaporation, if recovery is not desired). The vegetable oil will remain. (Some students might suggest freezing the mixture at some point to remove the vegetable oil from the water by skimming. This could work as well since most vegetable oils have freezing points within a range obtainable by a typical home freezer—e.g., corn oil freezes at about –20°C; olive oil freezes at about –10°C.)
13. Students likely will suggest evaporation or distillation.
14. (a) Filtration allows the liquid coffee-water mixture to be separated from the grounds of coffee once the water has dissolved/extracted the various desired substances from the grounds.
    (b) The filter does its job by having holes that are small enough to trap the size of the coffee grounds.

Pause and Reflect Answer

The pepper can be recovered by mixing the mixture with water to dissolve the sugar and then filtering it. (The pepper will float on the water, so some students might suggest skimming off the floating bits.) If no water or other solvent were available, at least two other options are available. Some students will suggest hand-sorting using tweezers to remove the grains of sugar—an extremely time-consuming process, but one that is possible for one possessing great patience. Another option some students might suggest is charging an object such as a plastic comb and bringing it slowly and carefully near the sugar and pepper mixture. The lower-density pepper bits should be attracted to the comb, leaving the sugar grains behind. This answer should receive top marks for problem-solving and concept-synthesis.

UNIT 3 ASSESSMENT

PROJECT

Purifying Mixtures, p. 304

Purpose

- Students are challenged to separate a dry mixture into the pure substances of which it is comprised.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO	APPARATUS/MATERIALS
2–3 days before	Prepare enough dry mixture and "kits" of separation equipment for each group.	For each group: – several beakers (250 mL to 600 mL), bottles, or cups – magnet – variety of filters (fine to coarser mesh) – small funnels – hot plate (optional) – evaporating dishes – labels or grease pencil – variety of substances for dry mixtures (e.g., sand, coarse, gravel, marbles, metal paper clips (magnetic), wood chips or cut-up toothpicks, salt, instant, coffee, small plastic beads, various-sized stones) – water – paper

Time Required

- 75–120 min

Safety Precautions

- Remind students to be careful if a hot plate is used. It should be unplugged it when it is not in use.
- Remind students to wipe up any spills as soon as they occur.

Activity Notes

- When preparing each dry mixture, try not to combine two items that would be separated together. For example, the flotation method would separate wood chips and toothpicks from all the sinking and soluble items but not from each other.
- The table below outlines different dry mixtures that can be prepared, with the items that can be separated using each separation method. You can substitute other materials with similar properties for any of the items in the table. Most plastics float, so they can be substituted for other floating items. Before using them, though, check them to ensure they float.
- If using staples, "fire" them out of a stapler first so that their ends will be folded under for greater safety.
- If using iron filings, ensure that magnets are wrapped in plastic or sealed in plastic bags first; otherwise, magnet-cleaning will be a nightmare.
- Suggest that students draw a flowchart for step 3 to show the sequence of separation. The flowchart will help students organize their ideas and is easily modified.

- Remind students to divide the work among the group. For example, while two students prepare for the next separation, a third student could label the newly separated fraction and examine it for contamination, while a fourth can be cleaning and replacing dirty equipment.

SEPARATION METHOD	MIXTURE						
	1	2	3	4	5	6	7
sifting	two different sizes of stones or lentils	stones and beads	stones	beads	stones and marbles	two different sizes of marbles	red lentils
magnetism	paper clips or staples	staples	staples	paper clips	staples	staples	staples
flotation	wood chips	tooth-picks	plastic beads	tooth-picks	wood chips	plastic beads	wood chips
filtration	sand	coarse gravel	sand	coarse gravel	sand	coarse gravel	sand
evaporation	salt	salt	instant coffee	instant coffee	salt	salt	instant coffee

Supporting Diverse Student Needs

- Ensure that students with different needs are placed in appropriate groups and that all students have significant roles in their group.
- Some students might benefit from having a checklist of steps to be completed so that each step can be checked off as it is completed.

Report Answers

1. Students' answers will range from excellent to poor. The order of steps affects purity if water is added to the sample too early. Water-logged sand and gravel do not separate well from beads and marbles, and magnets might not be strong enough to separate watery metals from wood chips or sand and gravel.
2. Methods used to separate substances that are not clearly visible include magnetism, a fine filter, flotation, and evaporation. A method works if it can separate one fraction from another.
3. Possible answers include increasing the quality of the apparatus (e.g., finer filters, stronger magnets), using other methods such as distillation, and repeating some methods. For instance, after using a magnet once, use it again in other separated fractions just in case some magnetic substances were left behind the first time.

INTEGRATED RESEARCH INVESTIGATION

Safe, Clean Water for Everyone, p. 305

Purpose

- Students develop their research skills and communication skills by exploring and reporting on ways that water is made safe to drink and use in their community.

Activity Notes

- Refer to page TR-vii for advance planning suggestions.
- Students who live on a farm or in a location serviced by a private well should still investigate ways that their water is treated. Depending on the source of the water, common well-water problems include water an overabundance of silt, water being too hard (too high a concentration of dissolved substances), the presence of iron or tannins (or both), bacteria or other pathogens, and unpleasant odours. Flow-reducers, water-softening mechanisms, filters, UV lamps, and iron-removing chemicals are common methods for making well water safe to drink and use.
- Discuss different presentation formats with the class. Encourage students to try something new for the activity.
- If computer class time or library time is not available, it might be suitable to spread the activity out over a week.

Supporting Diverse Student Needs

- Students with reading difficulties could be partnered with students who have strong communication skills.
- The method of presentation can be tailored to suit students with particular needs.
- For enrichment or for gifted students, the depth of presentation expected could be modified.

UNIT 3 REVIEW ANSWERS, pp. 306–309

Visualizing Key Ideas

1. Examples of words that could be included along each quarter of the spider map include:
   - for solutions: homogeneous, distillation, evaporation, paper chromatography, solute, solvent, soluble, insoluble
   - for solubility: soluble, insoluble, saturated, unsaturated, solute, solvent
   - for types of mixtures: heterogeneous, homogeneous, mechanical, solutions
   - for separating techniques: distillation, evaporation, paper chromatography, filtration, mechanical sorting, magnetism

Using Key Terms

2. (a) False. A solution is a homogeneous mixture.
   (b) False. Each pure substance is made up of its own distinct type of particle.
   (c) True
   (d) False. The concentration of a solution may be expressed as the mass of solvent that can dissolve in a certain volume of solute (g/L).
   (e) True
   (f) False. An unsaturated solution can allow more solute to dissolve at a certain temperature.
   (g) True
   (h) False. Filtration cannot work on solutions.
   (i) False. Units of ppm tell you the concentration of a solution in parts per million.
   (j) False. There are many, many examples of mixtures in the world.
   (k) False. In a solution, the solvent is the substance that does the dissolving and the solute is the substance that dissolves.
   (l) False. A solution of salt and water is a homogeneous mixture because its properties are the same throughout.

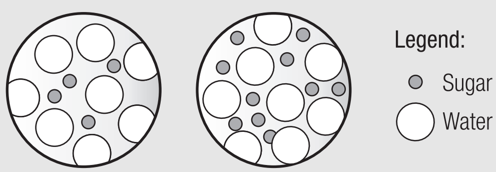
Checking Concepts

3. A mixture is made up of two or more components, while a pure substance is made up of only one component.
4. A heterogeneous is a mixture that is made up of two or more components that are usually visible to the eye, while a homogeneous mixture is a solution—a mixture that is made up of two or more components that appear to be the same throughout.
5. A homogeneous mixture is made up of two or more types of particles that retain their own properties.
6. An alloy is a metallic, solid solution of a solid solute dissolved in a solid solvent.
7. A solution is a homogeneous mixture because homogeneous mixtures are made up of two or more components that appear to be the same throughout
8. A solute and a solvent are the parts that mix together to form a solution. The solute is the part that dissolves and the solvent is the part in which the solute dissolves. Students might also define according to the quantities; in this context, the solute is the substance present in the least amount and the solvent is the substance present in the greatest amount.
9. A saturated solution contains all the dissolved solute it can hold at a certain temperature, while an unsaturated solution can hold more solute at a certain temperature.
10. Solubility is the mass of a certain solute that can dissolve in a certain volume of solvent at a certain temperature. For example, at a temperature of 0°C, 35.7 g of salt can dissolve in 1 L of water. In other words, the solubility of salt at 0°C is 35.7 g/L.
11. The concentration of solute in a solvent is greater in a concentrated solution than in a dilute solution.
12. As temperature increases, the solubility of a gas in a liquid decreases.
13. Magnetism and flotation are examples of mechanical sorting because they depend on physical properties such as magnetism and density, which can be used to separate heterogeneous mixtures.
14. A fishing net is a type of filter because it has holes that permit some substances (such as water) to pass through it but trap larger things such as fish.
15. Fractional distillation is the method used to separate petroleum.
16. Separating gold from gravel is a type of mechanical sorting because it depends on the property of density of the gold.

Understanding Key Ideas

17. Gold (b) and carbon dioxide gas (d) are the pure substances because they are made up of only one type of particle. The other items are mixtures because they contain two or more types of particle.
18. Oatmeal-and-raisin cookie (a) and tomato juice (f) are heterogeneous. Petroleum (c) and ink (e) are homogeneous. Note: Petroleum (c) and ink (e) are homogeneous mixtures because they appear the same throughout. (Some student might also say that petroleum can be separated with fractional distillation and ink with paper chromatography, both of which are methods for separating homogeneous mixtures.) The cookie (a) and tomato juice (f) are heterogeneous because they have different visible components.
19. According to the particle theory, a pure substance is made up of only one type of particle, while a mixture would contain two or more different types of particles.

20. Most students will agree, citing examples such as milk and freshly squeezed orange juice to support their answers.
21. Pizza is a heterogeneous mixture because it contains several clearly visible components. Clean air, on the other hand, is a homogeneous mixture because it is made up of various gases, all of which are dissolved together.
22. (a) soda water—solute: carbon dioxide; solvent: water
    (b) vinegar—solute: acetic acid; solvent: water (Note: Student might just say acid instead of acetic acid, which would be acceptable.)
    (c) brass—solute: zinc; solvent: copper
    (d) ice tea—solute: tea, sugar, lemon juice; solvent: water
    (e) instant coffee—solute: instant coffee granules; solvent: water
    (f) lemonade—solute: lemon juice, sugar; solvent: water
23. Students' sketches should have two main features. First, the particles for sugar in each solution should be identical to each other in size and shape, and the particles for water in each solution should be identical to each other in size in shape. Second, the proportion of sugar particles to water particles in the dilute solution should be less than the proportion of sugar particles to water particles in the concentrated solution.



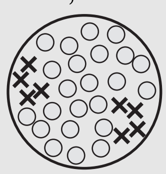
24. Yes, there is a limit. At a certain temperature, there is a limit to the amount of solute that can dissolve in a given solvent.
25. Powdered sugar grains are smaller than granulated sugar grains and have more surface area so they dissolve more quickly.
26. Gases are more soluble in water at higher pressures than at lower pressures.
27. Examples include using a magnet, using a filter, and flotation.
28. Evaporation alone is not designed to collect or retain the solvent from a solution, whereas distillation is.
29. (a) A filter works by having holes that are large enough to trap desirable parts from a heterogeneous mixture and small enough to let other parts through.
    (b) Examples could include a fishing net, a colander, a washing machine, a surgical mask, and a strainer.
30. Students' answers should identify the sap as a dilute solution of sugars that, through boiling (that is, evaporation), becomes more concentrated.

Thinking Critically

31. (a) Examples include salt, sugar, and carbon dioxide.
    (b) Examples include sand, calcium carbonate, and gold.
    (c) Yes. For example, motor oil is insoluble in water but is soluble in gasoline.
32. You could tell if a salt water solution is saturated or not by adding salt to it, a small amount at a time. As long as the added salt dissolves (assuming a constant temperature), the solution remains unsaturated.
33. (a) Students might suggest that the rock material could be crushed into smaller pieces and then a magnet used to remove the magnetic portions, which would be magnetite.
    (b) Magnetite is a pure substance that is made up of iron particles and oxygen particles, while iron is a pure substance that is made up only of iron particles. (Note: This might confuse students, since it sounds like magnetite—with two types of particles—is a mixture, not a pure substance. In fact, the two particles are chemically bonded together as a single particle—a compound that is an iron oxide with the chemical formula Fe_3O_4. Explain to students that the two types of particles in magnetite belong to a single larger particle called iron oxide, and that magnetite is made up only of iron oxide particles; that is why it is a pure substance.
    (c) Students will have to think about the fact that iron rusts, so it could not—for example—be found in streams the way that gold is. Accept all reasonable answers.
34. The key difference is that lake water is fresh water, while ocean water is salt water. While lake water contains dissolved substances, ocean water contains a greater concentration of such substances. Therefore, evaporation or distillation would separate the solutes from the solvent; assuming equal volumes of samples, students could reasonably infer that the sample yielding the greater concentration of solutes is ocean water.

Developing Skills

35. (a) Students' drawings should be similar to those made for question 23, although a solvent other than water could be included.
 (b) Students' drawings likely will show that the saturated solution is "full" of solute, compared with the unsaturated one. That is, saturated drawings will depict solute and solvent particles packed together to the extent that no additional solute particles could fit into any empty space—there would, in effect, be no empty spaces left. The unsaturated drawings, on the other hand, would have spaces left for additional solute to fit.
 (c) Students' drawings of a soluble substance in water will be like their drawings for part (a) or (b). Of special note is the fact that the solute particles should be shown uniformly spread out among the solvent particles. Drawings of an insoluble substance in water will lack the uniform arrangement of the insoluble particles. For example, they might appear all clustered together in one or several areas, as shown below.



36. Based on the few experiences that students have had with this concept, they could conceivably select (a), (c), or (d) as their answer, since all three show a trend in which increasing temperature results in increasing solubility. Accept all reasonable answers.
37. (a) 0.015 g/L
 (b) 200 g/L
 (c) 0.159 g/L
 (d) 1.4 g/L
38. The cup of tea on the left is the most concentrated because it has the strongest colour; the cup of tea on the right is the most dilute because it has the weakest/faintest colour.

Pause and Reflect Answer

(a) The particles of one substance differ from the particles of other substances.
(b) There are attractive forces between the particles of each substance. Water particles do not attract nail polish particles.
(c) Particles are always moving; there are spaces among particles; adding energy causes particles to move faster and farther apart and might, if enough energy is added, cause a change of state.
(d) The same points used in (c) apply here. Some students might include a reference to boiling point, which would be acceptable as long as this idea is linked to each pure substance having its own distinct boiling point.