Activity Preparation for Chapter 16

Activity/Investigation	Advance Preparation	Time Required	Other Considerations
What's Going On? Slip, Grip, or Slide (page 284) (TR page 351)	• 3 or 4 days before – Locate spring scales and coffee cups. – Photocopy **BLM 16–1 Slip, Grip, or Slide**, **BLM 16–2 Spring Scale Certification**, and any assessment masters you decide to use.	• 15 min	• Before starting the activity, teach students how to use a spring scale. Remind them that over-stretching the spring will damage this instrument.
Test It! Shoes and Surfaces (page 286) (TR page 355)	• 3 or 4 days before – Have students bring or wear running shoes to class. • 1 day before – Photocopy any needed assessment masters.	• 25 min to plan • 25 min to complete	• **BLM 16–3 Anatomy of a Running Shoe** provides basic information on the parts of a running shoe. If students did not complete this activity earlier, you may wish to have them do so now.
Try This! (page 287) (TR page 357)	• 3 or 4 days before – Obtain a piece of wood 30 cm wide by 1 m long.	• 20 min	• You may wish to do this activity as a teacher-led demonstration.
Try This! (page 288) (TR page 361)	• 3 or 4 days before – Obtain several tennis balls, golf balls, racquetballs, basketballs, and volleyballs. – Purchase or gather chalk dust; washable, dry poster paint; or baby powder.	• 15 min	• Students with respiratory allergies or problems should make sure to stay out of the "dust" used in this activity. • This activity lends itself to a small group activity or teacher demonstration. You could do this activity ahead of time and bring in the "prints" for students to examine.
Test It! Rebound Ranking (page 290) (TR page 363)	• 3 or 4 days before – Gather materials. • 1 day before – Photocopy any blackline masters you decide to use.	• 25 min to plan • 25 min to complete	• You may wish to decide in advance whether students can choose to test 1. a), b), or c) on page 290, or whether they will manipulate the same variable.
Try This! (page 292) (TR page 366)	• 2 or 3 days before – Place a sleeve of tennis balls in the freezer. – Place a sleeve of tennis balls in a sunny window. • Day of – Photocopy **Master 1 Centimetre Grid**.	• 25 min	• Do this activity as a demonstration.
Find Out: Two Sports, Two Helmets (page 293) (TR page 369)	• 3 or 4 days before – Obtain a bicycle helmet and a hockey helmet. – Obtain some Styrofoam™ and high-density foam such as the material used in a camping mattress (optional). • 1 day before – Photocopy **BLM 16–5 Two Sports, Two Helmets**.	• 20 min	• This activity is best suited for a class discussion.
Test It! Humpty's Helmet (page 294) TR (page 370)	• 2 or 3 days before – Gather the materials. • 1 day before – Photocopy **BLM 16–6 Humpty's Helmet Rubric** if you wish to use this tool to evaluate your students.	• 25 min to build • 25 min to test	• You can turn this into a math activity if you include play money. Give each group a certain amount of money and have them "buy" their materials including their eggs. This will reduce the amount of material wasted and will give your students practice with money.

Materials Needed for Chapter 16

Activity/Investigation	Apparatus	Materials	Blackline Masters
What's Going On? Slip, Grip, or Slide (page 284) (TR page 351)	For each group: • coffee mug or similar object with rough, unglazed bottom • smooth table top • spring scale • spoon	For each group: • piece of string • sandpaper • water	**Recommended** BLM 16–1 Slip, Grip, or Slide **Optional** BLM 16–2 Spring Scale Certification Assessment Master 1 Co-operative Group Work Checklist Assessment Master 2 Co-operative Group Work Rubric Assessment Master 11 Using Tools and Equipment Checklist Assessment Master 12 Using Tools and Equipment Rubric
Test It! Shoes and Surfaces (page 286) (TR page 355)	For each group: • variety of sports shoes • variety of surfaces • measuring tape or metre stick (optional) • spring scale (optional)	For each group: • masking tape • string • sandpaper	**Optional** BLM 16–3 Anatomy of a Running Shoe Assessment Master 3 Lab Report Checklist Assessment Master 4 Lab Report Rubric Assessment Master 13 Fair Test Checklist Assessment Master 14 Fair Test Rubric
Try This! (page 287) (TR page 357)	For each group: • variety of sports shoes • piece of wood 0.5 m wide by 1 metre long • aluminum tray at least 0.5 m long • protractor	For each group: • water • sandpaper • oil • paper towel • masking tape or a marker • garbage bag or plastic to protect the floor	
Try This! (page 288) (TR page 361)	• digital movie camera (optional) • power drill For each group: • several different types of balls • sidewalk	For each group: • chalk dust; washable, dry poster paint; or baby powder • art paper (dark if using chalk, white if using poster paint)	
Test It! Rebound Ranking (page 290) (TR page 363)	For each group: • metre stick or measuring tape • 1 or more balls • 1 or more surfaces	For each group: • masking tape	**Optional** Assessment Master 13 Fair Test Checklist Assessment Master 13 Fair Test Rubric
Try This! (page 292) (TR page 366)	• tennis balls • refrigerator • metre sticks		**Recommended** Master 1 Centimetre Grid
Find Out: Two Sports, Two Helmets (page 293) (TR page 369)	For each group: • bike helmet • hockey helmet • magnifying glass or dissecting microscope	For each group: • pieces of Styrofoam™ (optional) • pieces of high-density foam (optional)	**Recommended** BLM 16–5 Two Sports, Two Helmets OHT D–5 Compare Helmets
Test It! Humpty's Helmet (page 294) TR (page 370)	For each group: • large plastic sheet • metre stick • play money (optional)	For each group: • raw egg • materials to make the shell of the helmet • materials to make the liner • materials to make the chin strap	**Optional** BLM 16–6 Humpty's Helmet Rubric

CHAPTER 16 Science in Sports

(page 284)

SUGGESTED TIMING	MATERIALS	BLACKLINE MASTERS
15 min for introduction 15 min for What's Going On?	• plywood or kitchen cutting board • coffee mug or similar object with rough, unglazed bottom • coffee mug with smooth, glazed bottom	BLM 16–1 Slip, Grip, or Slide BLM 16–2 Spring Scale Certification Assessment Master 1 Co-operative Group Work Checklist Assessment Master 2 Co-operative Group Work Rubric Assessment Master 11 Using Tools and Equipment Checklist Assessment Master 12 Using Tools and Equipment Rubric

Overall Expectations

SILV.01 – illustrate how science is a part of daily life
SILV.02 – use appropriate scientific skills, tools, and safety procedures to investigate problems
SILV.03 – examine the connections between science and activities in daily life
CPMV.01 – explain the characteristics and classification of common materials, using appropriate scientific terminology
CPMV.02 – investigate the physical and chemical properties of common materials through laboratory activities
CPMV.03 – analyze how the use of various materials is based on their physical and chemical properties
BSAV.03 – analyze how personal health and safety in everyday life and in the workplace are protected through the proper use of equipment and safety practices

Activity Planning Notes

You could introduce the text portion of page 284 by listing on the chalkboard student responses to the questions posed in the opening paragraph.

You could also rent a sports blooper video or the Top Plays of the Week and show it to your class. Pause the video every few minutes or when they switch to a different sport, and have your students focus on the equipment being used and how it helps or protects athletes.

Consider doing the following demonstration of friction before starting What's Going On? on page 284. Make an inclined plane at a shallow angle using a flat piece of plywood, a kitchen cutting board, or even a large coffee table book. Place two coffee cups on the board. Use the POE method to get your students involved with the demonstration:

- **P**redict: Ask the students to predict what will happen when you slowly raise the plane to a steeper angle.
- **O**bserve: Have the students record their observations.
- **E**valuate: Ask students to infer why one cup slides down the inclined plane before the other one. Continue the discussion until students have developed an operational definition of friction.

You can point out that the force of gravity must be great enough to overcome the force of friction in order for the cups to move. Friction is a force that occurs between two surfaces, and it acts to prevent or slow down motion.

During this section, you may wish to use the following blackline masters:
- **BLM 16–1 Slip, Grip, or Slide**
- **BLM 16–2 Spring Scale Certification**

What's Going On? Activity (page 284)

Slip, Grip, or Slide

Purpose

- Students compare the friction of several different surfaces.

Science Background

Friction is a force that occurs between two surfaces, and acts to impede motion.

Friction works in a direction opposite to the direction of motion. The friction between two surfaces before they move is called static friction. Once the two surfaces are on the move, it is easier to keep them moving and the value of the frictional force becomes less. This force is known as sliding friction.

Spring scales are simply springs with a pointer and calibrated scale. When a force is acting on a spring, it changes its length. The change in length is proportional to the force acting on the spring.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
3 or 4 days before	• Locate spring scales and coffee cups. • Photocopy **BLM 16–1 Slip, Grip, or Slide**, **BLM 16–2 Spring Scale Certification**, and any assessment masters you decide to use.

APPARATUS	MATERIALS
For each group: • coffee mug or similar object with rough, unglazed bottom • smooth table top • spring scale • spoon	For each group: • piece of string • sandpaper • water

Suggested Timing

15 min

Safety Precautions

- There are no special safety considerations for this activity.
- Make sure that students clean up their work area and wash their hands when they have completed the activity.

Activity Planning Notes

Teach students how to use a spring scale. Remind them that over-stretching the spring will damage this instrument. Include the following points.
- The scale should be slightly above the table top, not resting on it.
- Keep the scale flat (parallel to the table). Pull on the top end of the scale until the string tightens and you begin to pull gently on the cup.
- Keep both the string and the scale parallel to the table as you pull.
- At the point where you just begin to move the cup, you should notice that the marker on the scale has moved away from the zero point and down onto the

gauge of the scale. Watch carefully to see what the marker does.
- Pull the cup so that it slides at a steady speed across the table, and does not "stutter."
- Record the force in newtons (N) when the cup is sliding along the surface.
- Take turns in your group so that everyone can practise both pulling and reading the scale.

BLM 16–1 Slip, Grip, or Slide is designed to help students record their observations. Note that this worksheet is slightly different than the activity on page 284. Students perform three trials on each surface and then calculate the average force. You may have to teach them how to calculate the average force (the sum of the forces of three trials divided by three).

You may wish to do this activity as a demonstration. Use the POE (predict-observe-evaluate) method to keep students engaged during the demonstration.

Depending on the sensitivity of your spring scales, you might have students fill the cup with water.

You may wish to have students complete **Assessment Master 11 Using Tools and Equipment Checklist** while they work.

Accommodations

- Group students into teams of three. One student might do the activity, the second might be the observer and read the spring scale while the cup is in motion, and the third might record the force on page 284 or in the data chart provided in **BLM 16–1 Slip, Grip, or Slide**. Have them switch roles for the three surfaces being tested.

What Did You Learn? Answers (page 284)

5. Yes. Look for the following ideas.
- Water on the table reduced the friction. It took less force to move the cup.
- Sandpaper increased the friction between the cup and the table. It took more force to move the cup.

6. If there is very little friction between the sole of a shoe and a playing surface, the shoe will slide very easily. The more friction there is, the more grip a shoe will have on the surface.

Activity Wrap-up

- Based on their observations, have students develop an operational definition of friction. An operational definition is a clear and precise definition of what is to be measured and observed.
- Photocopy and distribute **BLM 16–2 Spring Scale Certification** to students who demonstrate that they can use a spring scale to measure the force of an object.
- You may wish to distribute **Assessment Master 1 Co-operative Group Work Checklist** for students to complete.

Ongoing Assessment

- Consider using **Assessment Master 2 Co-operative Group Work Rubric** and/or **Assessment Master 12 Using Tools and Equipment Rubric** to assess students during What's Going On?

16.1 Getting a Grip on Friction (page 285)

SUGGESTED TIMING

15 min to discuss page 285
50 min to design and complete Test It!
20 min to design and complete Try This!

BLACKLINE MASTERS

BLM 16–3 Anatomy of a Running Shoe
Assessment Master 3 Lab Report Checklist
Assessment Master 4 Lab Report Rubric
Assessment Master 13 Fair Test Checklist
Assessment Master 14 Fair Test Rubric

Specific Expectations

SIL1.01 –describe how the procedures, skills, and tools employed in different areas of science are also evident in daily life
SIL2.01 – formulate questions about problems or issues that can be scientifically tested
SIL2.02 – plan, conduct, and refine simple investigations to answer student-generated questions
SIL2.03 – conduct investigations safely, using appropriate lab equipment
SIL2.04 – observe and record data, using a variety of formats, including the use of SI units, where appropriate
SIL2.05 – assess data to make inferences and conclusions and to answer questions and refine procedures
SIL2.06 – communicate plans, observations, and results using a variety of oral, written, and graphic representations, and including the use of SI units, where appropriate
SIL3.01 – develop and investigate research questions about an everyday science-related topic of personal interest
BSA3.01 – analyze how specific equipment and safe practices are used to protect personal health and safety at home and in the workplace

Key Terms Teaching Strategies

Friction is a force that prevents or slows down movement whenever two things rub against each other. Students can experience friction by rubbing the palm of their hands over their desks. You could discuss other real-world examples such as the friction between the moving parts in a car's engine and how lubricants (oil) reduce the friction.

Reading Icon Answer (page 285)

1. Students should circle the following statement.

When you try to move an object, the force that prevents or slows down the movement is called friction.

Activity Planning Notes

Students were introduced to the notion of friction in the What's Going On? activity. Refer students to this activity as you work through the information on page 285.

BLM 16–3 Anatomy of a Running Shoe provides basic information on the parts of a running shoe. This worksheet could be used as an introduction to Test It! Shoes and Surfaces on page 286.

The following are some suggestions that you can use to help bring friction into the real world for students. Any or all of these activities tie the What's Going On? activity to the Test It! Shoes and Surfaces investigation on page 286.

- If you have access to a video on curling or, better yet, if you can take your students to a curling rink as part of the physical education program, you can demonstrate how the shape of the curling rock and the pebble applied to the ice reduces friction between the granite and the ice surface. You can also compare the bottom of the curling shoe that the curlers use to "slide" on the ice with the "gripper" shoe that the curler uses to push along the ice surface. Questions should focus on how the surface of the sliding shoe reduces friction while the surface of the gripping shoe increases the friction between the shoe and the ice surface.
- A video of a drag-car race or a funny-car race can be used to show how the drivers warm up their tires before the start of the race. This increases the friction between the tires and the surface of the race track ensuring a speedy start.
- Bring in a pair of cross-country skies or a video of cross-country skiing and discuss friction in terms of the wax applied to the bottom of the skis.

Students may be interested to discover that wax is a critical piece of equipment in competitions like the Winter Olympics, and that the choice of wax can determine whether a cross-country skier wins or loses a race. International teams have wax technicians who use computers to analyze data to help them select the proper wax to prepare skis for competition.

There are two types of wax: glide wax and kick wax. Glide wax is used to decrease the friction between the skis and the snow. Kick wax, also known as grip wax, is used to increase friction between the skis and the snow in order to prevent slipping. Ask students to suggest why glide wax is applied to the entire underside of the skis for freestyle events. Have students consider when it would be helpful to have glide wax applied to the front and back tips of the skis and kick wax applied in the middle. (This combination is good for classical events that include both uphill and downhill.)

Accommodations

- Friction may be a difficult concept for many students to comprehend. Bringing in some or all of the real-world examples provided in the Activity Planning Notes could help the students internalize this concept.

Consider using the following blackline master:

- **BLM16–3 Anatomy of a Shoe**

Making Connections Answers (page 285)

2. a) Answers will vary but might include skating, snowboarding, curling, and skiing.

b) Answers will vary but might include soccer, football, track events, rock climbing, and basketball.

Test It! Activity (page 286)

Shoes and Surfaces

Purpose

- Students design an investigation to test sports shoes on different surfaces.

Science Background

The main function of the outsole (bottom of a shoe) is to provide traction as well as to reduce wear on the midsole, thereby increasing the overall durability of the shoe.

How well a shoe needs to grip depends on the sporting event. A cross-country runner might need a different shoe on a rainy day than she would need on a hard, compacted surface. A basketball player needs an outsole that will grip well when running, but not when he is pivoting. A basketball player also needs a shoe that will not "grab" when he is trying to stop, since this can cause him to sprain his ankle or tear up his knee.

The traction properties of a shoe, really a measure of the friction between the outsole and the playing surface, are directly related to the materials used in the outsole's construction as well as the pattern on the outsole.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
3 or 4 days before	• Have students bring or wear running shoes to class.
1 day before	• Photocopy any blackline masters you decide to use.

APPARATUS	MATERIALS
For each group: • variety of sports shoes • variety of surfaces • measuring tape or metre stick (optional) • spring scale (optional)	For each group: • masking tape • string • sandpaper

Suggested Timing

25 min to plan
25 min to complete

Safety Precautions

- Students' plans to test the shoes should not include wearing them during the test — there is too much chance of slipping and falling.
- Ensure that students clean up their test areas.

Activity Planning Notes

BLM 16–3 Anatomy of a Running Shoe provides basic information on the parts of a running shoe. If students did not complete this activity earlier, you may wish to have them do so now.

There are four choices for how you might organize this activity.

- Group students into teams of four and have each team come up with their own experimental design. Grouping will distribute the responsibility for the activity as well as provide support for those students with learning disabilities.
- Group students into teams of four as above. Provide students with more direction in terms of what they will be doing. For example, you might want the students to use the spring scales and follow the procedure that they used in the What's Going On? activity on page 284.
- This activity can be completed as a demonstration. Use the POE method to engage your students. The procedure that you use for the demonstration could evolve out of a class discussion in which they outline how to do the activity.
- You could set this activity up in centres each with a different type of shoe. For example, Centre 1 (basketball shoe); Centre 2 (running shoe); Centre 3 (football or soccer shoe). Students could go from centre to centre testing the different types of shoes on the surfaces that you provide.

Accommodations

- The different strategies listed in Activity Planning Notes should accommodate the diverse learning styles of your students.

Test It! Answers (pages 286–287)

1. Questions will vary. Sample questions include:
- Which shoes have the best grip?
- Which shoes slide the farthest?

2. Accept all reasonable answers. For example: The force required to slide will vary depending on the type of sports shoe.

3. Accept all reasonable answers. Students' plans to test the shoes should not include wearing them during the test — there is too much chance of slipping and falling. Ensure that students clean up their test areas.

4. Answers will vary, but might include a spring scale, string, sandpaper, measuring tape or metre stick, and masking tape to mark start and stop lines.

5. Answers will vary according to the question being investigated. Some students may choose to use the spring scale to measure the force required to move three different types of sport shoes over the same surface. Other students might measure the force required to move one shoe over three different surfaces. Other students may have different ideas. Whatever form the investigation takes, students should include several trials or repetitions to obtain more accurate data.

6. Answers will vary. Here is a sample answer.

Manipulated Variable	Responding Variable	Controlled Variables
type of shoe	force required to slide	• texture of surface • slope of surface

8. Accept all reasonable observations. Encourage students to repeat their trials for more accurate data.

9. Answers will vary according to investigation results, but should reflect the observations.

10. Answers will vary according to investigation results, but should reflect the observations.

11. Answers will vary, but should reflect the observations. Students may have tried to duplicate the floor of a gym, outdoor tracking, or playing field.

Activity Wrap-up

- You may wish to have students complete **Assessment Master 3 Lab Report Checklist** and/or **Assessment Master 13 Fair Test Checklist**.

Try This! Activity (page 287)

Purpose

- Students design an investigation to determine the effects of changing the playing surface.

Science Background

The force of friction applies when you move any two surfaces against each other. Friction works in a direction opposite to the direction of motion. The size of the frictional force depends on the force pushing the two surfaces together and their roughness.

Playing surfaces and the soles of running shoes must provide sufficient friction to ensure that runners do not slip. However, too much friction between surfaces and shoes can lead to ankle and knee injuries.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
3 or 4 days before	• Obtain a piece of wood 30 cm wide by 1 m long.

APPARATUS	MATERIALS
For each group: • variety of sports shoes • piece of wood 0.5 m wide by 1 metre long • aluminum tray at least 0.5 m long • protractor	For each group: • water • sandpaper • oil • paper towel • masking tape or a marker • garbage bag or plastic to protect the floor

Suggested Timing

20 min

Safety Precautions

- Ensure that students clean up their test areas, including any oil or water spills. Oil and water will make surfaces slippery.

Activity Planning Notes

You may wish to provide students with the following instructions:

1. Lay the board down on the plastic. Use masking tape or a marker to indicate the starting line.
2. Position a running shoe at the starting line.
3. Place the other end of the board into the aluminum pan.
4. Slowly lift the end with the shoe up. Raise this end until the shoe starts to slide.
5. Use the protractor to measure the angle that the board makes with the table top.
6. Record this angle or have a student trace the angle on a piece of paper and label it.
7. Tape sandpaper to the bottom of the shoe and repeat steps 1 to 6. (You would have to glue sand onto the surface of the board to keep it in place).
8. Repeat steps 1 to 6 when the board and the bottom of the shoe have been covered with water.
9. Repeat steps 1 to 6 when the board and the bottom of the shoe have been covered with oil.
10. Compare the slope of the board in all four cases.

Do this activity as a teacher-led demonstration to save time and to minimize any mess that may be created. Use the POE method to engage students.

- **P**redict: Have students predict the angle that the board will make before the shoes slide. They can use words such as steep or low rather than using a numerical value for the angle.
- **O**bserve: Have students record the angle using the protractor or have them draw the angle that the board makes with the table top. They could even cut out the angle to make it easier to compare the slope of the board in each case.
- **E**valuate: Use questions 9, 10, and 11 on page 287 to evaluate the results of this investigation.

Accommodations

- If you do this as a teacher-led demonstration, you will be able to adjust your questions to meet the needs of your students.

Try This! Sample Answers (page 287)

1. What happens when you add water to the playing surface?
   Most playing surfaces get slippery when wet.
2. What about sand?
   Sandpaper taped to the bottom of the running shoe increases friction on the playing surface.
3. What about oil?
   Most oiled surfaces get very slippery.

Activity Wrap-up

- Discuss the following statement with your students: "Playing surfaces and the soles of running shoes must provide sufficient friction to ensure that runners do not slip. However, too much friction between surfaces and shoes can lead to ankle and knee injuries."
- Have students discuss accidents that resulted from a shoe or cleat not grabbing a playing surface.

Ongoing Assessment

- Consider using **Assessment Master 4 Lab Report Rubric** and/or **Assessment Master 14 Fair Test Rubric** to assess student work during Test It! Shoes and Surfaces.
- Have students complete an Exit Card for this section. Possible questions that you could have students complete include
  1. What is friction?
  2. Why do you think workers at a basketball arena rush out to dry the court every time a player falls down on the playing surface?
  3. What would happen if you tried to play hockey while wearing shoes instead of skates?

Technology Links

- For more information on using probeware, go to **www.mcgrawhill.ca/books/Se9** and follow the links to Technology in the Lab.
- For more information on friction and footwear, go to **www.mcgrawhill.ca/books/Se9** and follow the links to Friction and Footwear.

Alternative Activity

- If your school has access to probeware and the appropriate software, you could have students determine the kinetic and static friction force and associated coefficients of friction for different shoes or sneakers sliding against a surface such as wood.

16.2 That's the Way the Ball Bounces (page 288)

SUGGESTED TIMING

25 min to discuss pages 288 and 289
15 min for Try This! on page 288
15 min to remind students how to calculate the average of three rebounds
15 min to complete the Making Connections activity on page 289
50 min for Test It!
25 min for Try This! on page 292

MATERIALS

- racquetball
- SuperBall™
- no-bounce road hockey ball
- metre stick

BLACKLINE MASTERS

Master 1 Centimetre Grid
BLM 16–4 Why a Ball Bounces
OHT 26 Centimetre Grid
Assessment Master 13 Fair Test Checklist
Assessment Master 14 Fair Test Rubric

Specific Expectations

SIL1.01 – describe how the procedures, skills, and tools employed in different areas of science are also evident in daily life
SIL1.02 – explain the importance of a "fair test" for troubleshooting and testing everyday science problems
SIL2.01 – formulate questions about problems or issues that can be scientifically tested
SIL2.02 – plan, conduct, and refine simple investigations to answer student-generated questions
SIL2.03 – conduct investigations safely, using appropriate lab equipment
SIL2.04 – observe and record data, using a variety of formats, including the use of SI units, where appropriate
SIL2.05 – assess data to make inferences and conclusions and to answer questions and refine procedures
SIL2.06 – communicate plans, observations, and results using a variety of oral, written, and graphic representations, and including the use of SI units, where appropriate
SIL3.01 – develop and investigate research questions about an everyday science-related topic of personal interest
SIL3.02 – evaluate the investigation of the topic they selected and suggest possible refinements
SIL3.03 – demonstrate an understanding of how problem-solving and decision-making activities in the workplace use scientific process skills

Key Terms Teaching Strategies

To help students remember the key terms, try the following activities:

- Use **BLM 16–4 Why a Ball Bounces** in conjunction with the Try This! activity on page 288.
- Basketball players in your class will be familiar with the word "rebound" in terms of retrieving a basketball after a missed shot at the basket. Have these students describe or demonstrate rebounding.

Reading Icon Answer (page 288)

1. Students may have some difficulty in deciding which is the definition of rebound. The middle paragraph as a whole defines rebound, particularly these sentences: When the ball pushes against the ground, the ground pushes back. The ball lifts back into the air.

Activity Planning Notes

Introduce students to the term "rebound" and to how a ball bounces by using the visual and text on page 288. Then, you may wish to do the Try This! activity.

When starting to discuss rebound ratio, ask students what they know about balls in different sports and how they behave. Some of your students may have played racquet ball, squash, or tennis in physical education classes. Have these students describe how the ball reacts in different situations. Some of your students may have played baseball, softball, or slow-pitch. Have these students describe what happens to the ball when it strikes the bat.

Use a racquetball, SuperBall™, and no-bounce road hockey ball to demonstrate how a ball bounces. These three balls are roughly the same size. Drop the three balls simultaneously and have students describe what happens. Repeat this demonstration to see if the results can be duplicated. Pass the three balls around and have your students relate the structure of each to how well it bounces.

If you have lots of room, try to drop the no-bounce ball and the SuperBall™ so that the no-bounce ball lands on top of the SuperBall™ as it strikes the floor. Be careful, however, because the SuperBall™ will launch the no-bounce high into the air.

Use the racquet ball and a metre stick to demonstrate how to measure rebound height and rebound ratio. Start by drawing a data chart on the chalkboard for your students.

Ball Drop Height (cm)	Trial 1 Rebound Height (cm)	Trial 2 Rebound Height (cm)	Trial 3 Rebound Height (cm)	Average Rebound Height (cm)	Rebound Ratio
100					

1. Have two students assist you with this demonstration (see top of page 289).
2. Have one student drop the racquetball from a predetermined height (100 cm) while the second student measures the rebound height at the bottom of the ball.
3. Record this rebound height on the data chart.
4. Repeat this procedure at least two more times.
5. Use the data to show how to calculate the average rebound and the rebound ratio.
6. Students could use this information to complete the Making Connections questions on page 289.

Once these have been completed, you may wish to have students do the Test It! activity on page 290.

Consider using the following blackline master during this section:

- **BLM 16–4 Why a Ball Bounces**

Accommodations

- It might make it easier for students to see how you calculate the average of the three trials if you line the numbers up in columns instead of rows.

Check Your Understanding Answer (page 288)

2. Some of its energy of motion has been converted into other forms of energy (sound and heat), and some is used to overcome friction.

Making Connections Answers (page 289)

3. Answers will vary. Sample answer for a ball dropped from 240 cm:

a) 180 cm, 183 cm, 177 cm
average rebound = 540 cm ÷ 3 = 180 cm

b) 180 ÷ 240 = .75

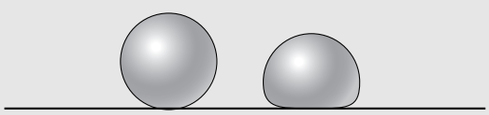
Try This! Activity (page 288)

Purpose

- Students observe the "ball print" left behind as different balls bounce on the sidewalk.

Science Background

When you drop a ball, gravity pulls it toward the floor. The ball gains energy of motion, known as kinetic energy. When the ball hits the floor and stops, that energy has to go somewhere, resulting in both the ball and floor deforming inward as shown in the following figure.



This deforming extracts energy from the ball's motion and stores much of it in the elastic surfaces of the floor and ball. Because the ball is softer than the floor, it does most of the deforming and stores most of the energy. By the time the ball comes briefly to a stop, most of its missing energy has been stored in its deformed surface. The ball then rebounds. It returns to its normal shape and tosses itself up into the air to a fraction of its original height (rebound height). This fraction of returned energy is nearly independent of how much energy the ball had to begin with. It depends only on the elasticity of the ball itself.

When you drop a ball from a greater height, it has more kinetic energy just before it hits the floor and stores more energy during the bounce — it deforms more as it comes to a stop. When the ball rebounds, its stored energy reappears and it leaps higher into the air than it would have had you dropped it a shorter distance.

The ball is most stable in a round shape, so the gas inside expands to push the ball back to form the round shape. This forces the outside of the ball to push out, causing the ball to bounce back up. For this reason, boring holes in the ball (as suggested in the Activity Planning Notes below) will decrease the bouncing ability because the gas will escape when hitting the ground and will not be able to reform the shape of the ball as easily. Also, the holes decrease the stability of the shape of the ball, so it will not bounce as high.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
3 or 4 days before	• Obtain several tennis balls, golf balls, racquetballs, basketballs, and volleyballs. • Purchase or gather chalk dust; washable, dry poster paint; or baby powder.

APPARATUS	MATERIALS
• digital movie camera (optional) • power drill For each group: • several different types of balls • sidewalk	For each group: • chalk dust; washable, dry poster paint; or baby powder • art paper (dark if using chalk, white if using poster paint)

Suggested Timing

15 min

Safety Precautions

- Students with respiratory allergies or problems should make sure to stay out of the "dust" used in this activity.
- Remind students to clean up the work area and wash their hands after completing this activity.

Activity Planning Notes

This activity lends itself to a small group activity or teacher demonstration. You could do this activity ahead of time and bring in the "prints" for students to examine. Spread the powder or poster paint on an individual sheet of art paper. Drop the ball at a 90° angle. Carefully bring the individual prints into the class. You can make this a bit of mystery and have students match the ball to the print made in the dust or powder.

If you have access to a digital movie camera, set it up so that the lens of the camera can capture the deformation of a ball as it strikes the surface. Do not use the camera if you are going to drop the ball into dust or powder. Use a relatively soft ball such as a racquetball. Replay the movie and use the freeze frame feature to show students what happens to the ball as it strikes the ground.

Take two tennis balls. Use the power drill to drill small holes into one of the balls (do not tell the students) and leave the other one intact. Use a marker to label one of the tennis balls A and the other tennis ball B. Have students predict what will happen when you drop both balls from the same height. Drop both tennis balls simultaneously. The one with the holes in it will not bounce nearly as high as the one without the holes. Repeat this demonstration several times to see if the students can explain why one ball does not bounce as high as the other.

Accommodations

- If students are having trouble with this concept, have them try to squeeze a regular tennis ball, and then try to squeeze the ball with holes bored into it.

Activity Wrap-up

- Have students use scrap paper to make a "flip book" showing the ball dropping, hitting the ground, flattening on impact, springing back into shape, and rebounding back into the air. To make a flip book, cut paper into four rectangles or squares. Staple eight to ten squares together along one side.

Test It! Activity (page 290)

Rebound Ranking

Purpose

- Students design an investigation to measure rebounds and calculate rebound ratios.

Science Background

See background information for the Try This! activity on page 288.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
3 or 4 days before	• Gather materials.
1 day before	• Photocopy any needed assessment masters.

APPARATUS	MATERIALS
For each group: • metre stick or measuring tape • 1 or more balls • 1 or more surfaces	For each group: • masking tape

Suggested Timing

25 min to plan
25 min to complete

Safety Precautions

- Ensure that students have a clear area such as the gymnasium in which to work.
- Remind students to use the balls appropriately and to take care that the balls do not smash into anything or anyone.
- Remind students to clean up their work area and wash their hands at the end of the investigation.

Activity Planning Notes

Group students into teams of three for this investigation. One member of the team can conduct the investigation, the second can be the observer, and the third can record the data.

You may wish to decide in advance whether students will choose 1. a), b), or c) on page 290, or whether they will manipulate the same variable. If students are going to use 1. a) different balls or 1. c) different surfaces, they should draw a bar graph of their results. The data that they will gather are discontinuous in these situations. However, if they are doing 1. b) different heights, then they should draw a line graph. The data are continuous in this case.

You may decide to give students more direction. For example, you may decide that everyone in the class is going to drop the same ball from different heights. In this case, purchasing a class set of table tennis balls is relatively cheap and they provide consistent results.

Review the rules for drawing either line or bar graphs.

You may need to help students design their data chart. Here is an example of 1. b) dropping the same type of ball from a different height.

Ball used: _____

Ball Drop Height (cm)	Trial 1 Rebound Height (cm)	Trial 2 Rebound Height (cm)	Trial 3 Rebound Height (cm)	Average Rebound Height (cm)	Rebound Ratio
10					
20					
30					
40					
50					
60					

In this case, students would draw a line graph of Average Rebound Height and Ball Drop Height.

To speed things up, assign each group to drop the ball from one height only. Put the data chart on the chalkboard and have them fill in the data for their group. Look for any discrepancies in the data.

The following is an example of 1. a) dropping different types of balls from the same height.

Ball Drop Height (cm)	Trial 1 Rebound Height (cm)	Trial 2 Rebound Height (cm)	Trial 3 Rebound Height (cm)	Average Rebound Height (cm)	Rebound Ratio
table tennis					
ball					
racquetball					
squash ball					
SuperBall™					
baseball					
golf ball					

In this case, students would draw a bar graph of Average Rebound Height and Type of Ball Used.

To speed this up, assign each student one type of ball to test. Draw the data chart on the chalkboard and have students fill in the data.

Accommodations

- Use **OHT 26 Centimetre Grid** and marker pens to show students how to set up their graph.
- Students who need more room to make a graph could use **Master 1 Centimetre Grid**.

Test It! Answers (pages 290–292)

1. a) If I use different balls, then the *height* and the *surface* must be kept the same.

b) If I use different heights, then the *ball* and the *surface* must be kept the same.

c) If I use different surfaces, then the *height* and the *ball* must be kept the same.

2. Questions will vary. Sample: Which ball will rebound the highest when dropped on the classroom floor from a height of 200 cm?

3. Accept all reasonable answers. Sample answer: I think the tennis ball will bounce higher than the volleyball or the baseball.

4. Accept all reasonable answers. Sample answer:
- Make sure the working area is clear.
- Make sure that any bouncing balls do not smash anyone or anything.
- Use the balls appropriately.

5. Answers will vary according to the question being investigated. Sample answer:
- Each time I will drop the ball from 200 cm and my partner will record the rebound.
- First I will drop the tennis ball three times. Then I will drop the volleyball three times. Last, I will drop the baseball three times.
- My partner and I will calculate the rebound ratio for each trial.

7. Answers will vary according to results.

8.
- For variables 1. a) and c), look for a bar graph.
- For variable 1. b), look for a line graph.

9. a) Answers will vary based on the question and the results. Accept all reasonable answers.

b) Answers will vary, but should refer directly to the evidence.

10. Answers will vary. The rebound ratio will depend on any number of variables such as the type of ball, the amount of air in the ball (basketball), the height that the ball was dropped from, if the ball has been used (an old tennis ball will not bounce as high as a new tennis ball), the temperature of the ball.

11. Answers will vary. If students answer "yes," then they would have to make sure that all of the variables were the same (type of ball, air pressure, air temperature, surface, the way the ball was released, the technique used to record the rebound height).

If students answer "no," they should state that it would be difficult to replicate the exact conditions as stated above.

12. Student answers will vary. Encourage students to discuss controlling more variables.

Activity Wrap-up

- Use the Try This! activity on page 292 as a wrap-up of this investigation. Asking students to make predictions about the rebound height of a cold and a hot tennis ball will give you a good idea if students understand the physics of a bouncing ball.
- You may wish to have students complete **Assessment Master 13 Fair Test Checklist**.

Try This! Activity (page 292)

Purpose

- Students design an investigation to determine how temperature affects the rebound height of a tennis ball.

Science Background

A tennis ball has a fabric covering and a hollow inner core of a rubber-like substance. Inside the core is a gas such as air or nitrogen.

Gases take the shape of their containers, and also expand or contract within the container. The gas in a tennis ball fills the entire inner core of the ball. A gas can be expanded or compressed. As the tennis ball strikes the court the bottom of the ball is pushed in. The tennis ball material is pliable and deforms (bends). The compressed (pressed in) ball has less volume than the original uncompressed ball. As the ball comes off the court the gas and tennis ball material act like a spring and the ball returns to its original shape.

As the temperature increases, the molecules of the gas expand and move around more rapidly inside the ball. As the molecules move, they strike the inner surface of the ball and apply more pressure to it.

However, when the temperature decreases, the molecules of gas slow down and the pressure inside the tennis ball decreases. This will result in less spring when the ball strikes the sidewalk or floor.

When you freeze a ball, the outer shell turns very hard, which in most cases will result in a lower bounce since the ball is not as elastic as it was before freezing. The ball therefore does not deform as much and will not bounce as high.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
2 or 3 days before	• Place a sleeve of tennis balls in the freezer. • Place a sleeve of tennis balls in a sunny window.
Day of	• Photocopy **Master 1 Centimetre Grid**.

APPARATUS	MATERIALS
• tennis balls • refrigerator • metre sticks	

Suggested Timing

25 min

Safety Precautions

- Ensure there is a clear area to work in where the balls will not smash into anything or anyone.
- Remind students to clean up the work area and wash their hands at the end of the activity.

Activity Planning Notes

Do this activity as a demonstration.

Drop the frozen tennis balls first before they have a chance to warm up. Use a procedure similar to the one shown at the top of page 289. Repeat this step at least three times. Have students record the rebound height of the frozen tennis ball and then the average rebound height for the three trials.

Repeat this procedure (make sure that all other variables remain the same) using the warm tennis balls. Have students record the rebound height of the warm tennis ball and calculate the average rebound height for the three trials.

If you have time, have your students draw a bar graph of the average rebound heights for the frozen and the warm tennis ball. Use **Master 1 Centimetre Grid** for students to make the graph.

Accommodations

- Since this activity is being conducted as a class demonstration, it is unlikely that you will need to implement any unusual strategies to meet the diverse needs of your students.

Activity Wrap-up

- Have student describe how temperature affects the rebound height of a tennis ball.

Alternative Activity

- You could do this activity with cold and warm basketballs or volleyballs.

Ongoing Assessment

- Go back to the Check Your Understanding question on page 288. Have students explain why a ball does not bounce all the way back to its starting height. Then ask students to list three factors that affect how high a ball bounces.
- Consider using **Assessment Master 14 Fair Test Rubric** to assess students during Test It! Rebound Ranking.

Technology Links

- For more information on bouncing balls, go to **www.mcgrawhill.ca/books/Se9** and follow the links to Bouncing Balls.

16.3 Head Strong, Helmet Stronger

(page 293)

SUGGESTED TIMING

15 min to discuss information at the top of page 293
20 min for Find Out
50 min for Test It!

MATERIALS

- video clips of sporting events such as cycling, BMX riding, in-line skating, snowboarding

BLACKLINE MASTERS

BLM 16–5 Two Sports, Two Helmets
BLM 16–6 Humpty's Helmet Rubric
OHT D–5 Compare Helmets

Specific Expectations

SIL1.01 – describe how the procedures, skills, and tools employed in different areas of science are also evident in daily life
SIL2.02 – plan, conduct, and refine simple investigations to answer student-generated questions
SIL2.03 – conduct investigations safely, using appropriate lab equipment
SIL2.04 – observe and record data, using a variety of formats, including the use of SI units, where appropriate
SIL2.05 – assess data to make inferences and conclusions and to answer questions and refine procedures
SIL2.06 – communicate plans, observations, and results using a variety of oral, written, and graphic representations, and including the use of SI units, where appropriate
SIL3.01 – develop and investigate research questions about an everyday science-related topic of personal interest
SIL3.02 – evaluate the investigation of the topic they selected and suggest possible refinements
SIL3.03 – demonstrate an understanding of how problem-solving and decision-making activities in the workplace use scientific process skills
BSA3.01 – analyze how specific equipment and safe practices are used to protect personal health and safety at home and in the workplace

Key Terms Teaching Strategies

Discuss the meanings of "crash," "multiple," and "impact." Ask students to describe their experiences of crashing, especially while riding a bike. Ask any hockey players to describe the number of times their helmets might be hit during a hockey game. Help students understand the difference between a crash helmet and a multiple-impact helmet.

Activity Planning Notes

Show video clips of several different sporting events. Discuss the role that helmets play in these sports. Discuss different types of helmets and what sports use each type. For example, motorcycle racers and horseback riders use crash helmets. Many manufacturers of these types of helmets offer a reduced cost on a replacement helmet if the helmet is damaged during a fall. Figure skaters use multiple-impact helmets.

Find Out Activity (page 293)

Two Sports, Two Helmets

Purpose

- Students compare a bike helmet and a hockey helmet.

Science Background

Hockey players and bicycle riders wear helmets to protect their heads. Each sport is different. It is not surprising that the helmets worn by the participants are also different.

- Bike helmets are crash helmets. A bike helmet must be able to withstand a single blow from large objects such as a light post or curb. This blow is likely to occur at relatively high speeds.
- Hockey helmets are multiple-impact helmets. Multiple-impact helmets are designed to withstand falls to the ice and collisions with the boards. Hockey helmets also cover more of the back of the head.

The main difference between these two helmets is the type of foam used in the core of the helmet.

The parts of a bike helmet include the following:

- Shell: A full-cover hard shell spreads the impact energy in a collision.
- Liner: A good helmet must have a stiff foam liner. This material is non-springy foam. It absorbs shock and doesn't bounce back at your head. The density and thickness of the liner are critical factors in the amount of energy the liner will be able to absorb. Once involved in a collision, a bike helmet should be discarded. This is because the foam liner is compacted and no longer offers any protection.
- Chin Strap: The helmet must stay on your head even if you hit hard surfaces more than once. The helmet needs a strong strap and fastener.

The parts of a hockey helmet include the following:

- Shell: The shell of a hockey helmet is made of impact plastic. It is designed to absorb and deflect the energy of a body check or a collision with the boards. It also protects the head from puck and stick impact.
- Foam Padded Liner: Liner materials are usually made from urethane foams with a thickness of about 16 mm. This foam squishes when the player's head hits the ice. This squishing absorbs some of the energy. This foam returns to its normal size after a blow and is good for more hits. Lighter and more effective energy-absorbing materials have been introduced in some helmet models.
- Chin Strap: The chin strap holds the helmet in place. It prevents the helmet from flying off on impact. The chin strap also prevents the helmet from turning. If a helmet turns, it might expose the head to injury.

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
3 or 4 days before	• Obtain a bicycle helmet and a hockey helmet. • Obtain some Styrofoam™ and high-density foam such as the material used in a camping mattress (optional).
1 day before	• Photocopy **BLM 16–5 Two Sports, Two Helmets**.

APPARATUS	MATERIALS
For each group: • bike helmet • hockey helmet • magnifying glass or dissecting microscope	For each group: • pieces of Styrofoam™ (optional) • pieces of high-density foam (optional)

Suggested Timing

20 min

Activity Planning Notes

This activity is best suited for a class discussion.

Hand out pieces of Styrofoam™ and high density foam and a magnifying glass. Ask students to compare the two pieces of foam paying particular attention to the density of the materials. Have your students squeeze or compress both pieces of foam and describe what happens to each.

Hand out **BLM 16–5 Two Sports, Two Helmets** and pass around the two types of helmets. Have students pay particular attention to the foam liners and the thickness of the plastic shells. Students should be able to answer the two questions at the bottom of the handout.

If you have a dissecting microscope give your students an opportunity to look at the foam under higher magnification.

Use **OHT D–5 Compare Helmets** to help your students fill in the Venn diagram at the bottom of page 293.

Accommodations

- Looking at the pieces of foam and trying to compress them should help students learn the difference between these types of helmets.

What Did You Observe? Answer (page 293)

2. Look for the following information in the Venn diagram.

Bike Helmet	Similarities	Hockey Helmet
• thin shell • non-springy foam	• shell liner • chin strap	• thick shell • springy foam

Activity Wrap-up

- Ask why it is important to wear a helmet when participating in and competing in sports. Ask why it is important to have the chin strap of a helmet done up properly.

Test It! Activity (page 294)

Humpty's Helmet

Purpose

- Students make a model of a helmet designed to protect a raw egg.

Science Background

In recent years, the use of helmets for bicycle riding, in-line skating, and other sports has become more prominent. English riders have worn hunt caps for many years and are now using a variety of well-designed helmets. In some areas, Western horseback riders are wearing riding helmets instead of cowboy hats as riders realize the importance of protecting their brain. Safety is obviously more important than a fashion statement!

Advance Preparation

WHEN TO BEGIN	WHAT TO DO
2 or 3 days before	• Gather the materials.
1 day before	• Photocopy **BLM 16–6 Humpty's Helmet Rubric** if you wish to use this tool to evaluate your students.

APPARATUS	MATERIALS
For each group: • large plastic sheet • metre stick • play money (optional)	For each group: • raw eggs • materials to make the shell of the helmet • materials to make the liner • materials to make the chin strap

Suggested Timing

25 min to design the helmet
25 min to build and test the helmet

Safety Precautions 

- Remind students to be sure to drop the egg on the plastic sheet.
- Remind students not to eat anything in the science lab.
- Remind students to wash their hands and clean up the work area at the end of the activity.

Activity Planning Notes

Group students into teams of three or four. Hand out **BLM 16–6 Humpty's Helmet Rubric** if you are going to use this tool to evaluate your students. You may have to modify the rubric to meet the needs of your students.

Focus students' attention on the importance of designing their helmet before they start to build it. You may wish to put some constraints on their design (e.g., size of the helmet, types of materials they can use, how much "tape" they can use).

You can turn this into a math activity if you include play money. Give each group a certain amount of money and have them buy their materials including the eggs. This will reduce the amount of material wasted and will give students practice with money.

You can increase the excitement by turning it into a bit of group competition. Award prizes for different categories to make sure that all students are rewarded for their effort.

Provide your students with a few key guidelines rather than highly specified step-by-step instructions. For example:

1. Construct the helmet according to your plan.
2. Make adjustments to the design if necessary.
3. Test your design.
4. Revise your helmet based on the results of your test.

Accommodations

- You may have to demonstrate the use of some materials, design constraints, or construction ideas.

Test It! Answers (pages 294–295)

2. **a)** Materials will likely include tape, foam, balloons, pieces of plastic, string.

b) You may wish to put constraints on the size of the helmet that students build.

3. Answers will vary slightly, but should include dropping the egg in the helmet from a height of 2 m to pavement that is protected by a plastic sheet.

5. Answers will vary according to the results, but should indicate that either the egg was protected or the egg was broken.

6. **a)** The shell spreads the impact over a wider area.

b) The liner compacts when it absorbs shock.

c) The chin strap holds the helmet firmly in place.

7. Accept all reasonable answers. Students may find that they need more padding, or that the strap needs to fit much tighter.

8. A properly fitting helmet protects the head and absorbs the impact of a collision. If the helmet does not stay on during a collision, then your head will not be protected.

Activity Wrap-up

- Ask student questions such as
  – Does your helmet work every time?
  – How strong is the helmet?
  – Would making a very large, heavy helmet be practical?

Ongoing Assessment

- Use **BLM 16–6 Humpty's Helmet Rubric** to evaluate the project. You may wish to go over the expectations in this rubric with students before they start work on their investigation.
- You could use a speak-write strategy. Ask students to think about the concepts covered in this section, and quickly write a response to a set of tasks, such as draw and describe a helmet, or explain the differences between a hockey helmet and a bicycle helmet.

Technology Links

- For more information on helmets and sports safety, go to **www.mcgrawhill.ca/books/Se9** and follow the links to Safety and Helmets.

Alternative Activities

- If you can obtain old helmets, students might enjoy taking them apart to observe the structure.
- Invite a doctor to discuss head injuries and the importance of wearing protective equipment.

Chapter 16 Review (page 296)

SUGGESTED TIMING

25 min to complete and take up the review, and then assign Practice Test

BLACKLINE MASTERS

Master 3 Certificate
Master 4 List of Skills
BLM 16–7 Chapter 16 Word Puzzle
BLM 16–8 Chapter 16 Practice Test
BLM 16–9 Chapter 16 Test

Using the Chapter Review

Depending on your class, students should be able to work through the review at their own pace. In order to have success with the Chapter Review, some students may need to do it in chunks, by completing several questions and then taking them up before continuing. This process will prevent students from completing many questions incorrectly.

To provide additional reinforcement of key terms, have students complete **BLM 16–7 Chapter 16 Word Puzzle**. Once the review is completed and taken up, assign **BLM 16–8 Chapter 16 Practice Test** for students to answer individually. They may wish to use their completed review to help them answer the practice test questions.

Accommodations

- Allow students to make a chapter summary page of the key ideas/skills from the chapter. The back of the student resource provides space to do this. Alternatively, you might develop a chapter summary as an entire class.
- If students have difficulty with a particular review question, use the Review Guide to identify the section they need to review.
- **BLM 16–8 Chapter 16 Practice Test** can be customized to produce extra reinforcement questions.
- **BLM 16–7 Chapter 16 Word Puzzle** can be used to help students review all of the key terms from Unit D.

Review Guide

Question	Section(s)	Refer to
1	9.3	Head Strong, Helmet Stronger (page 293)
2	9.2	That's the Way the Ball bounces (page 288)
3	9.2	Rebound Ratio (page 289)
4	9.3	Head Strong, Helmet Stronger (page 293)
5	9.1	Slip, Grip, or Slide (page 284)
6	9.1	Try This! (page 287)
7	9.1	Get a Grip on Friction (page 285), Shoes and Surfaces (pages 286–287)
8 a)	9.2	Rebound Ratio (page 289), Rebound Ranking (pages 290–292)
8 b)	9.2	Rebound Ratio (page 289), Rebound Ranking (pages 290–292)
9 a)	9.2	Rebound Ranking (page 292)
9 b)	9.2	Rebound Ranking (page 292)
10 a)	9.3	Head Strong, Helmet Stronger (page 293)
10 b)	9.3	Head Strong, Helmet Stronger (page 293)

Chapter 16 Review Answers (pages 296–297)

1. **e)** multiple-impact helmet

2. **a)** friction; **b)** rebound

3. **c)** rebound ratio

4. **d)** crash helmet

5. Answers will vary slightly. Sample answer:
You could tie an object by a string to a spring scale and then gently pull it along different surfaces. The greater the force needed to pull the object, the greater the friction of the surface.

6. Answers will vary. Sample answer:
Enrico could scientifically test different shoes to see which has the most friction on an oily surface.

7. Answers will vary. In some sports, such as rock climbing, the best shoes might be those with the best grip. In other sports, such as running, the best shoes might be those with a moderate grip but with extra cushioning.

8. **a)** Answers will vary, but will probably include a measuring tape or metre stick and one or more tennis balls.

b) Answers will vary. Sample answer:
Determine the rebound ratio for a tennis ball. Then play tennis with it for two hours. Stop to measure the rebound ratio every 15 minutes. Graph the results.

9. **a)** Look for two advantages. For example:
- It would be easy to hit the ball high or far.
- It would not hurt to catch the ball.

b) Look for two disadvantages.
- The ball would bounce so high, it would be hard to catch.
- It would be harder to control where the ball would go when you throw or hit it.

10. **a)** Answers will vary. Sample answer:
A crash helmet is used in biking. It protects the biker's head in a collision.

b) Answers will vary. Sample answer:
A multiple-impact helmet is worn in hockey. It protects the player's head on contact with the boards, ice, puck, or other players.

Summative Assessment

- Have students complete **BLM 16–9 Chapter 16 Test** to assess individual skills.
- You may wish to develop **Master 3 Certificate** to show students what they have learned during this chapter. Cut and paste the related skills from **Master 4 List of Skills**.

Unit D Task: Safety Check (page 298)

SUGGESTED TIMING

25 min

BLACKLINE MASTERS

BLM D–2 The Science Behind Sports Drinks
BLM D–3 Develop a Skit Rubric
OHT 25 Safety Equipment

Specific Expectations

SIL1.01 – describe how the procedures, skills, and tools employed in different areas of science are also evident in daily life
SIL1.02 – explain the importance of a "fair test" for troubleshooting and testing everyday science problems
SIL2.06 – communicate plans, observations, and results using a variety of oral, written, and graphic representations, and including the use of SI units, where appropriate
SIL3.01 – develop and investigate research questions about an everyday science-related topic of personal interest
SIL3.03 – demonstrate an understanding of how problem-solving and decision-making activities in the workplace use scientific process skills
BSA3.01 – analyze how specific equipment and safe practices are used to protect personal health and safety at home and in the workplace
BSA3.02 – examine case studies of common workplace environments to develop a checklist of safety practices necessary to sustain systems and processes critical to life

Activity Planning Notes

Accommodations

- Use **OHT 25 Safety Equipment** as an overhead transparency. Complete this chart as a group activity.

Use the task on pages 298 and 299 as a culminating activity. Have students complete the chart on page 299 and discuss it in small groups. Discuss how safety is important both in the science classroom and in other aspects of life.

Use **BLM D–2 The Science Behind Sports Drinks** to provide students with additional information on the importance of proper hydration before, during, and after sporting events.

Consider using the following activity to help students demonstrate what they have learned during the unit. Group students into teams of four or five. Challenge the students to develop a skit that depicts a situation similar to the ones illustrated on page 257 or any of the activities from the unit. Remind them that the purpose is to focus attention on scientific concepts that they have learned in this unit.

Consider providing props such as the following:
– chef's hat, apron, cooking utensils, measuring cups
– Hawaiian shirt, shorts, sandals, sunscreen
– basketball, running shoes
– science lab coat, pocket protector, pens, clipboard

You may find the following blackline master and overhead transparency useful:
- **BLM D–2 The Science Behind Sports Drinks**
- **OHT 25 Safety Equipment**

Making Connections Answers (pages 298–299)

1. Most students have probably used at least the bicycle helmet. You might want to have students add illustrations of other safety equipment they have used such as hockey gloves, shoulder pads, personal flotation devices, or training wheels on a bicycle when they were younger.
2. Answers will vary. Students might mention examples of safety equipment. Other examples will likely depend on the types of sports students do. They might mention considering the weather and being careful to avoid overexertion during extremely cold or extremely hot temperatures. If they do not mention it, you might introduce the term "hypothermia" and discuss how this can occur at extremes of temperature, what the symptoms are, and how to avoid it. Students with experience in backcountry skiing may also talk about avalanche dangers and how to keep as safe as possible during avalanche conditions.
3. Answers will vary. The following is a sample answer:
   - baseball: batting helmet; Never throw your bat.
   - swimming: goggles; Never dive into unknown waters. Never swim alone.
   - skiing: helmet, warm clothes and gloves, goggles, sunblock; Always give the person on the slope below you the right of way. Don't go so fast that you are out of control.
   - mountain biking: full face helmet, body armour, gloves; Always check your brakes and tire pressure before riding. Keep your bike tuned up.

Summative Assessment

- Use **BLM D–3 Develop a Skit Rubric** to help you evaluate the skits.
- Alternatively, if you have any musicians in your class, ask them to write a jingle that discusses the scientific concepts that they have learned in this unit.