The Canada Science and Technology Museum
presents

The Science of Sports

Section 3
Forces

CANADA SCIENCE AND TECHNOLOGY MUSEUM

Canada

Introduction

We often list bridges, buildings and dams when talking about structures, but the human body can also be considered a structure. It is made up of several parts that are arranged in a particular way to support the force of its own weight. It can also support a load (or additional weight). In this section, students will review the classification of structures, define the centre of gravity, observe different forces acting on structures, and experiment with the force of friction by using the human body, or structures regularly found in sports, as the basis for their study.

This section contains the following components:

3.1. Classification of Structures
3.2. Centre of Gravity and Stability
3.3. Forces Acting on Structures
3.4. Friction

Distinctive icons throughout this exploration guide indicate key features, helping you to navigate your way through the text quickly and efficiently.

 **Classroom Activity**	 **Discussion or Assignment Topic**
 **Deeper Study**	 **Website to Visit**

Activity Resources

Many of the activities below require students to conduct research online. Worksheets for all activities are included at the end of this section. Teachers may request an answer package for the more complex activity sheets by e-mailing **virt_prog@technomuses.ca**. Please allow one to two weeks for a reply.

Activities

Activity 3.1. Classification of Structures

(Suitable for Grades 4 to 7)

The human body is a naturally occurring structure. It comprises a variety of structure types and different materials. Each type of structure has evolved to serve a specific purpose within the body (e.g., to protect, to support, etc.), just as engineers and architects carefully select structure types when building a dam or a tower. The body is also made up of different materials such as bones, muscles, nerves and skin. And, just as in man-made structures, the materials have specific properties tailor-made to suit their function.

By exploring the structures and materials in the human body, students will review the types of structures, as well as where and why they are found in the body.

As an extension of these concepts, students will discover why certain shapes and specific materials are chosen in the manufacture of sport equipment.

Concepts

Structures are objects made up of smaller parts that are arranged together in a specific way, making them capable of supporting a load. Generally, structures are classified into one of the three categories below.

Solid structure: A structure made by staking or piling individual pieces on top of one another, as in a brick wall or a dam. Solid structures are held in place by their own weight, and are thick enough and strong enough to stay in place. They are usually built of strong, heavy materials.

Frame structure: A structure that acts as scaffolding or a skeleton, such as a bicycle frame. Frame structures reduce the amount of material needed, but they must be anchored or braced to stay upright, and may have some weaknesses at the joints. Frame structures are not as strong and resistant to external forces as solid structures, which as constructed with heavy materials.

Shell structure: A structure that has a curved or dome-like shape. It is the outer layer that provides rigidity and strength, without being supported by a frame or solid wall inside. The shape of the shell allows any force acting upon it to be distributed across the structure, so that every part of it supports a very small portion of the total force. Shell structures are very thin and convenient, but they are also vulnerable to small imperfections, which can weaken them.

For more information about structures and shapes, please visit the following website:
http://www.sciencetech.technomuses.ca/english/schoolzone/Info_Structures.cfm

Classroom Discussion: Begin by asking students what kinds of structures they see around them. Write their answers on the board, so that everyone can see and add to the list later on, if necessary. Ask students to classify the structures as either natural or man-made. Ask students if they can name some characteristics of structures (e.g., they are mostly made of solids; they are usually built to be stable; they are usually built to carry a load, etc.). Ask students to group the structures that are written on the board into categories (solid, frame or shell).

Part 1: Classroom Demonstration on Shell Structures

Objective: Demonstrate the strength of shell structures.

For this demonstration, you will need:

- 1 cafeteria tray
- 4 egg cups (you can also cut out 4 individual cells from an egg carton)
- 4 eggs
- An old book covered in plastic (or a large, square piece of wood, strong cardboard or Plexiglas)
- Heavy objects such as additional books, bricks, etc.

Place the 4 egg cups on the cafeteria tray and insert an egg in each cup. The egg cups should be arranged in a square. Place the book on top of all 4 eggs. Each egg should be supporting one corner of the book. Start adding your heavy objects on top of the book, one by one.

After the demonstration, ask your students:

- What type of structure is represented by the egg. (shell)
- Where in the human body can we also find a shell structure? (skull)
- What are the advantages of shell structures? (thin, strong and can enclose something inside)
- What do athletes wear on their heads for further protection? (helmet)
- What type of structure is a helmet? (shell)
- What is the difference between the shell structure of the skull and that of the helmet? (the materials: the skull is made of bone, and the helmet is made of plastic)

Part 2: Frame Structures

Objective: To construct a frame structure in order to observe and understand its advantages and limitations.

Racquets are good examples of frame structures. The outside of the racquet, the frame, supports the tension of the strings on the inside. Students can build their own miniature

tennis racquets. For this activity, each student or group of students will need:

- 10 popsicle sticks (minimum)
- String
- Tape, hot glue or white glue

Students can choose to build a round or square tennis racquet. They will have to think of creative ways to make the outside frame resistant to the tension of the strings. The strings should be tied to the frame (rather than glued to the frame). You can organize a tennis tournament (using a real tennis ball) to determine who has built the strongest racket.

Part 3: Solid Structures

Objective: To construct a solid structure in order to observe and understand its advantages and limitations.

Solid structures are made by piling up small pieces of material to form a larger shape. In this activity, students will construct a baseball bat, using materials of their choosing.

Students can work in teams of two or three. They will have to think about the general shape of their bat, and the materials that they will use for its exterior and interior. For example, for the exterior structure, students could use the inner rolls from paper towels, empty water bottles, or empty potato chip tubes. The interior could be filled with packed newspaper, packing peanuts, rubber balls, etc.

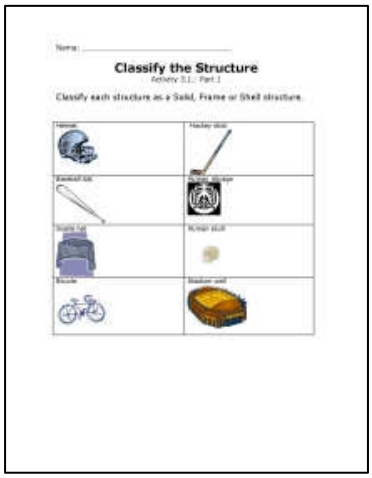
After construction, bring all of your students into the gymnasium to test their bats. This experiment can be done with a softball instead of a baseball, in order to increase the chance of contact between the bat and the ball.

The distance travelled by the ball can be measured and recorded for each team, if a competition-style activity is desired.

Additional Information

Some Major League Baseball (MLB) players have been disciplined for using doctored bats. For example, in 2003 Sammy Sosa was suspended for using a “corked” bat. Doctored bats have been altered or tampered with, and are illegal in the MLB. In the case of a corked bat, a hole is drilled in the centre and filled with cork. This makes the bat lighter than the regulation bat. It is unclear, however, whether having a lighter bat gives the hitter any significant advantage. Although it would allow for a faster swing, it would also decrease the energy available to be transferred to the ball. This means that corked bats might increase the number of hits, but would not enhance the distance travelled by the ball.

http://www.scientificamerican.com/article.cfm?id=do-corked-bats-allow-base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Classify the Structure

Activity 3.1.: Part 1

Classify each structure as a Solid, Frame or Shell structure.

Part 3: Types of Structures

Objective: To classify the different structures found in sports as solid, frame or shell structures.

Ask students to complete the activity sheet. They can complete this in class using the examples on the board as a guide, along with their textbooks.

Activity 3.2. Centre of Gravity and Stability

(Suitable for Grades 4 to 6)

Athletes are constantly looking to keep their bodies stable and balanced in order to give more force to their movement, or to be more efficient in their technique. To do this, athletes must have a good sense of where their centre of gravity is. In the following activities, the centre of gravity will be equal to the centre of mass—the point on an object where its mass is equally distributed. The position of a structure's centre of gravity will affect its stability.

Part 1: Defining the Centre of Gravity

Objective: To define the centre of gravity, and learn how to find it.

An object's centre of gravity is its balance point. If a pivot (or fulcrum) is placed at an object's centre of gravity, it will not topple to one side or the other. Note that an object's centre of gravity is not necessarily in the geometric centre of that object.

Classroom Demonstration

1. Have one student hold a metre stick in front of the class. Ask them to balance the yardstick horizontally on one finger. Mention that the centre of gravity is exactly in the middle, as there is equal weight on either side.
2. Have students find the centre of gravity for objects on their desks. Ensure that they note that the centre of gravity is not always the geometric centre of the object.
3. Have a student stand in front of the class with their feet together and their body as rigid as possible. Ask a classmate to push them slowly towards the right. The student will eventually lose their balance. This happens when the centre of gravity has shifted past the right foot. To avoid losing their balance, the student can take a wider stance. This changes the shape of the body, making it more stable.
4. Ask students to define the term 'centre of gravity' in their own terms.

For a visual demonstration of how the centre of gravity affects a structure's stability, please visit this interactive website:

Department of Physics and Astronomy at the University of Hawaii at Manoa
http://www.phys.hawaii.edu/~teb/java/ntnujava/block/block.html


Name: _____

Target

Activity 3.2 – Part 2

Kneel on the floor with your elbows touching your knees, and your forearms flat on the floor. Place the centre of the target at the tips of your fingers. Now place both arms behind your back, and try to touch the centre of the target with your nose.

Part 2: Finding the Centre of Gravity

Objective: To observe that the centre of gravity will vary from person to person according to their body shape.

As our bodies grow, our centre of gravity will shift. Generally speaking, the centre of gravity for shorter people will be closer to the ground, as compared to that of taller people. Body shape, however, can also affect the position of the centre of gravity.

1. On a crash mat or soft surface, have all students kneel on the ground with their arms extended in front of them.
2. Have them bring their elbows in towards them so that their elbows are touching their knees. Their forearms should be flat on the floor in front of them.
3. Place the centre of the target (on the activity sheet) at the ends of their fingertips.
4. Students will then place both hands behind their backs. (Students can also keep their arms to their sides if they wish to be able to brace themselves in the event that they fall forward.)
5. Students must now try and touch the target with their nose without losing their balance.

Some students may be able to do this, and some may not. Students can observe that, when their centre of gravity is past their knees, they are no longer stable and will fall forward. For those unable to do it, you can suggest the following strategies:

- Spreading the knees apart to widen the base of the body.
- Holding a heavy object (or the hands of a classmate) behind their backs to act as a counterweight.
- Getting closer to the target (in this case, students will not have to lean as far forward).

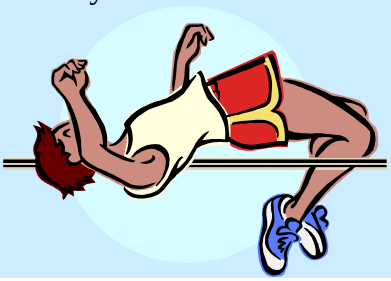
Extension Activities: In the gymnasium, set up the high-jump equipment. Set the bar just below waist height for your smallest students. Tell students that the object of the activity is to jump over the bar. Do not show students any of the standard techniques used in high-jumping. Let them figure out the best way to get over the bar. Once the whole class has jumped once, raise the bar and go through the group again. Repeat 3–4 times. Their technique may change as the bar gets higher. Afterwards, ask students what they found to be the easiest way to jump over the bar. Ask them if their technique changed as the bar got higher, and why.

Background Information

In high jumping, an athlete needs to get their centre of gravity over the bar with the least effort possible. If using a scissor-kick technique, the jumper's centre of gravity is high above the bar. This requires the jumper to use a lot of energy, as they need to jump high enough to get both the centre of gravity (located around the waist) and the lower portion of the body over the bar.

Jumpers can also use the straddle technique, which consists of diving headfirst over the bar. This is more effective, as the centre of gravity is closer to the bar. However, the most effective way known to date is the Fosbery Flop. Jumpers using this technique will rotate their body during the jump, so as to have their backs facing the bar while in the air. The jumper will arch their back in order to have as much body mass below the bar at all times. This means that the jumper's centre of gravity stays either below the bar or very close to it during the jump. This allows athletes to use less energy to jump over the bar, therefore allowing them to jump higher.

This technique was pioneered by American high jumper, Dick Fosbery. Many ridiculed his new technique, until he won gold at the 1968 Olympic Games. This is still the technique used by high jumpers today.



Name: _____

Running with Your Arms Behind Your Back

Activity 3.2.: Part 3

With the data collected by your teacher, please answer the questions below.

1. Determine the average run time of normal runners, and runners not using their arms.
Note: The average is calculated by adding all the run times together, then dividing that number by how many run times there were.

Average run time for normal runners:

Average run time for runners not using their arms:

Which group has the lower average?

2. Please give a few reasons why you think that using your arms while you run is important.

Part 3: Balance During Physical Activity

Objective: To observe that humans use specialized movements to stay balanced.

When doing any kind of physical activity, it is important to stay balanced. To demonstrate this, have students run normally, as well as with their arms behind their backs.

Time each student's run (or have the students time one another), and record their findings in a large chart, such as the one below. Make the time results available to students by posting the sheet on the board. Ask every student to use these results in order to fill out the activity sheet. Alternately, you may wish to have all students participate in running, but select 5 volunteers share their times for the chart. The class can use these times when calculating the averages on their worksheets.

Type of run	Students	Run time
Normal	Student 1	
	Student 2	
	Student 3	
	Student 4	
	Student 5	
With hands behind back	Student 1	
	Student 2	
	Student 3	
	Student 4	
	Student 5	

Generally, students will run faster when they are allowed to use their arms. The movement of the arms helps the students stay balanced. Runners with their arms behind their backs must shift their whole body from side to side to stay balanced. This wastes energy that might otherwise be used for running faster.

Part 4: Using Senses for Balance

Objective: To observe that sight and position-sensing organs in the inner ear allow us to stay balanced.

Classroom Activity: Have students stand on one foot, trying to keep their balance. Then ask them to close their eyes and do the same thing. They will find that it is much harder to stay balanced with their eyes closed. Our brains rely on our sensory organs (such as our eyes and ears) to maintain balance.

The Canada Science and Technology Museum's Crazy Kitchen exhibit is a good example of how we can lose our balance, or even feel dizzy, when our senses tell our brains conflicting messages about the body's position in space. You can find a link to the YouTube video showing and explaining the Crazy Kitchen at:

http://www.youtube.com/user/cstmweb?blend=1&ob=5#p/f/6/aAkw8p5oszI

Ask students if they have ever felt this effect in everyday life. Examples include motion sickness, the feeling you experience when riding some roller coasters or watching an IMAX movie.

Activity 3.3. Forces Acting on Structures
(Suitable for Grades 4 to 7)

The human body is a naturally occurring structure. It is strong enough to support its own weight, and carry an extra load. In our everyday lives, we regularly feel the forces of compression, tension and torsion. In the following activities, students will explore how different forces affect their bodies, and how special equipment can protect the body from these forces.

Concepts

Structures are subject to the forces that act upon them, notably:

- Compression: a squeezing force
- Tension: a stretching force
- Torsion: a twisting force

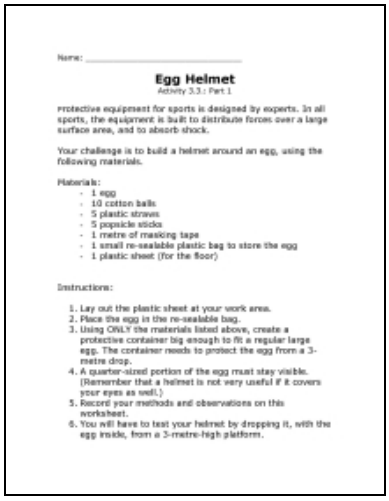
Structures can be subjected to a combination of these forces. For example, a flexed beam exhibits compression on one side, and tension on the other.

Structure can resist these forces by moving and bending. There is always a limit, however, depending on the size, shape and types of materials used. When a structure reaches this limit, it will break.

Classroom Demonstrations

These three demonstrations can be done in the classroom or the gymnasium. If the latter is chosen, there will be enough room for all students to try each activity.

1. Have all students in the class compete in a tug-of-war. Afterwards, ask what kind of force was applied to the rope (tension).
2. Have a couple of students fill their backpacks with books, and have them put these on in front of the class. Ask the class what kind of force is at work in the student's spine (compression).
3. Have two students stand back to back. Give a medicine ball (or other heavy object) to one of the students. Ask them to give the ball to the other person without moving his/her feet. The student will have to rotate their body. Ask the rest of your students what kind of force is at work on the student's spine and muscles (torsion).



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Egg Helmet

Activity 3.3 : Part 1

Protective equipment for sports is designed by experts. In all sports, the equipment is built to distribute forces over a large surface area, and to absorb shock.

Your challenge is to build a helmet around an egg, using the following materials.

Materials:

- 1 egg
- 10 cotton balls
- 5 plastic straws
- 5 popsicle sticks
- 1 metre of masking tape
- 1 small re-sealable plastic bag to store the egg
- 1 plastic sheet (for the floor)

Instructions:

1. Lay out the plastic sheet at your work area.
2. Place the egg in the re-sealable bag.
3. Using ONLY the materials listed above, create a protective container big enough to fit a regular large egg. The container needs to protect the egg from a 3-metre drop.
4. A quarter-sized portion of the egg must stay visible. (Remember that a helmet is not very useful if it covers your eyes as well.)
5. Record your methods and observations on this worksheet.
6. You will have to test your helmet by dropping it, with the egg inside, from a 3-metre-high platform.

Part 1: Distribution of Force

Objective: To discover how distributing a force over a large area can reduce the potential damage of its impact.

Ask students why they think hockey goalies wear more padding and a larger helmet than other players. Explain that protective equipment is built to distribute force over a large surface area. By distributing the force, no single area of the structure reaches the limit of its material's strength and flexibility. This helps prevent injuries such as broken bones and muscle tears.

1. Ask students to create a helmet for an egg that will be dropped from a height of 3 metres. Divide the class into groups, so that students can work collaboratively on this task. Each group will need:

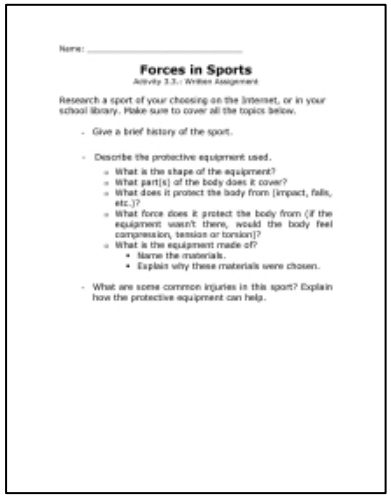
   - 1 egg
   - 10 cotton balls
   - 5 plastic straws
   - 5 popsicle sticks
   - 1 metre of masking tape
   - 1 small re-sealable plastic bag to store the egg
   - 1 plastic sheet

2. Tell students that they must follow the directions and specifications outlined on their activity sheet.

3. Have all students test their helmets on the same day. Remember to test at least one unprotected egg.

Additional Online Resources: For more online activities for students on forces and load-bearing structures, please visit this website:

PBS—Building Big: Forces
http://www.pbs.org/wgbh/buildingbig/lab/forces.html



Name: _____

Forces in Sports

Activity 3.3.: Written Assignment

Research a sport of your choosing on the Internet, or in your school library. Make sure to cover all the topics below.

- Give a brief history of the sport.
- Describe the protective equipment used.
  - What is the shape of the equipment?
  - What part(s) of the body does it cover?
  - What does it protect the body from (impact, falls, etc.)?
  - What force does it protect the body from (if the equipment wasn't there, would the body feel compression, tension or torsion)?
  - What is the equipment made of?
    - Name the materials.
    - Explain why these materials were chosen.
- What are some common injuries in this sport? Explain how the protective equipment can help.

Written Assignment: Ask students to research the protective equipment used in a sport of their choice. Students will follow the instructions on the activity sheet, and will be asked to comment on the types of forces that are felt by an athlete's body while practicing this sport.

Extension Activity (Grade 7): Sports have been around for thousands of years. Ask students to research forgotten or perhaps lesser-known sports, and present these to the class.

Some examples of lesser-known sports can be found in the list below. However, you may also wish to allow students to choose any sport they like for this assignment. A list of national sporting organizations can be found on the following website:
http://www.pch.gc.ca/pgm/sc/fed/index-eng.cfm

Lesser-known sports:

Octopush (underwater hockey)
Koppball
Disc golf
Pitz
Follis
Harpastum
Marn Grook

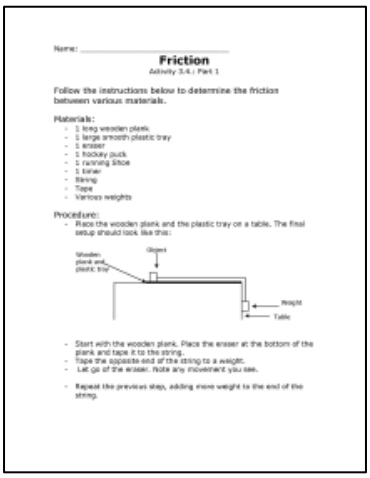
Topics to research:

- Country of origin
- Brief history
- Object of the game (rules)
- Type of equipment used
  - Can include the types of structures these represent (solid, frame or shell)
- Forces acting on the body, and the equipment used to protect it from these forces.

If possible, you can pick one or two new sports to try out in the next gym class.

Activity 3.4. Friction
(Suitable for Grades 4 to 7)

Friction is a force present whenever an object is moving against another solid, or through a liquid or a gas. Friction will always act in the opposite direction of the movement, and can act on matter in all three states: solid, liquid and gas. In this section, students will learn that friction can work to the advantage or disadvantage of an athlete. For example, it is important that a running shoe create enough friction against the track to keep the runner from slipping. It is equally important that the runner not wear excessively loose clothing, which can increase the friction between clothing and the surrounding air (air resistance).



Name: _____

Friction

Activity 3.4.: Part 1

Follow the instructions below to determine the friction between various materials.

Materials:

- 1 long wooden plank
- 1 large smooth plastic tray
- 1 eraser
- 1 hockey puck
- 1 running shoe
- 1 timer
- String
- Tape
- Various weights

Procedure:

- Place the wooden plank and the plastic tray on a table. The final setup should look like this:

- Start with the wooden plank. Place the eraser at the bottom of the plank and tape it to the string.
- Tape the opposite end of the string to a weight.
- Let go of the eraser. Note any movement you see.
- Repeat the previous step, adding more weight to the end of the string.

Part 1: Friction

Objective: To define friction and understand that this force is dependent on the materials that come into contact with one another.

Ask students to test how much friction exists between various materials by following the instructions on the activity sheet. Explain that there is friction between any two objects that rub against one another. The amount of friction between them will depend on their materials.

Each student or group of students will need:

- 1 long wooden plank
- 1 large, smooth plastic tray (e.g., a cafeteria tray)
- 1 eraser
- 1 hockey puck
- 1 running shoe
- 1 timer
- String
- Tape
- Various weights

Classroom Demonstration: This demonstration is a great way to illustrate that friction is a powerful force.

You will need:

- 2 phonebooks (this will also work with books smaller than phone books, as long as the pages of the books are not glossy)
- 1 drill
- Sturdy rope

Preparation:

1. The two phonebooks will need to be interleaved, page by page. This takes some time to do, but the result is a prop that can be used for many years. The end result should look like this:

   a. Place the two phonebooks on a table. The spines should be facing away from one another.
   b. Open both books to the last page.
   c. Place the last page of the book on the right on top of the last page of the book on the left.
   d. Fold back the following page of the book on the left, and then fold back the following page of the book on the right. Repeat with every page.
2. Using the drill, make 3 holes near each spine. The holes should look like binder holes.
3. In order to be able to pull on both books, thread a piece of rope through the holes of each book.

Demonstration:

Ask students to pull on each rope, trying to separate the two phonebooks. The force of friction working between each page is stronger that the pulling force applied by the students. This is what keeps the two phonebooks together.

Name: _____

Friction in Sports

Activity 3.4.: Part 2

Research the types of equipment and materials used by athletes to decrease or increase the amount of friction.

Examples:
- Shape of a competitive bicycle helmet
- New swimsuits for competitive swimming
- Soccer cleats
- Sprinter's clothing
- Shape of a rowing boat

Sport chosen: _____

Name of equipment: _____

What is it made of?

_____

_____

_____

What advantages does it give to the athlete?

_____

_____

_____

_____

Part 2: Friction in Sports

Objective: To understand that athletes sometimes want increased friction and sometimes want decreased friction, depending on the sport.

Have your students research the ways in which athletes either work to increase or decrease friction. Specialized sports equipment can utilize materials that maximize or minimize friction. For example, skis are smooth and thin to minimize friction with the snow, and to increase speed. On the other hand, rock-climbing shoes are made of very soft rubber, increasing friction to minimize the chance of slipping. Students can complete their research by filling in the activity sheet.

Other examples:

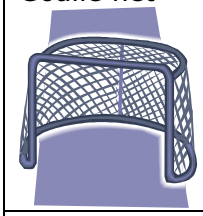
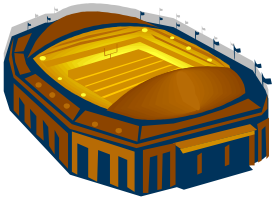
- Ice skates (lower friction with the ice).
- Swimmers can wear specialized swimsuits to minimize friction between their bodies and the water. (Some full-body suits have been banned from the Olympic Games, because they gave the athletes wearing them an unfair advantage.)
- Tires for mountain bikes are thick and rough to increase friction with friable terrains (such as loose rock that can easily break apart), whereas tires for road biking are smooth to maximize friction with a smooth surface and increase speed.

Name: _____

Classify the Structure

Activity 3.1.: Part 1

Classify each structure as a solid, frame or shell structure.

Helmet 	Hockey stick 
Baseball bat 	Human ribcage 
Goalie net 	Human skull 
Bicycle 	Stadium wall 

Name: _____

Target

Activity 3.2.: Part 2

Kneel on the floor with your elbows touching your knees, and your forearms flat on the floor. Place the centre of the target at the tips of your fingers. Now place both arms behind your back, and try to touch the centre of the target with your nose.

CANADA SCIENCE AND TECHNOLOGY MUSEUM

Canada

Name: _____

Running with Your Arms Behind Your Back

Activity 3.2.: Part 3

With the data collected by your teacher, please answer the questions below.

1. Determine the average run time of runners using their arms, and those not using their arms.

Note: The average is calculated by adding all the run times together, then dividing that number by how many run times there were.

Average run time for normal runners:

Average run time for runners not using their arms:

Which group has the lower average?

_____

2. Please give a few reasons why you think it is important to use your arms while you run.

_____

_____

_____

_____

Name: _____

Egg Helmet

Activity 3.3.: Part 1

Protective equipment for sports is designed by experts. All protective sports equipment is built to distribute forces over a large surface area, and to absorb shock.

Your challenge is to build a helmet for an egg using the following materials.

Materials:

- 1 egg
- 10 cotton balls
- 5 plastic straws
- 5 popsicle sticks
- 1 metre of masking tape
- 1 small re-sealable plastic bag to store the egg
- 1 plastic sheet (for the floor)

Instructions:

1. Lay out the plastic sheet at your work area.
2. Place the egg in the re-sealable bag.
3. Using ONLY the materials listed above, create a protective container big enough to fit a regular large egg. The container needs to protect the egg from a 3-metre drop.
4. A quarter-sized portion of the egg must stay visible. (Remember that a helmet is not very useful if it covers your eyes.)
5. Record your methods and observations on this worksheet.
6. You will test your helmet by dropping it, with the egg inside, from a 3-metre-high platform.

Name: _____

Egg Helmet

Activity 3.3.: Part 1

Method:

Note the exact amount of each material used:

_____

_____

Explain the function of each material used:

_____

_____

Results:

Did you egg break after the 3-metre drop?

_____

Analysis:

Explain why your helmet did, or did not, prevent the egg from breaking.

_____

_____

What could you do to improve your helmet?

_____

_____

What materials would you have used if you were not limited to the list included in the instructions?

_____

_____

Name: _____

Forces in Sports

Activity 3.3.: Written Assignment

Research a sport of your choosing on the Internet or in your school library. Write a report, making sure to cover all of the points below.

- Give a brief history of the sport.

- Describe the protective equipment used.
  - What is the shape of the equipment?
  - What part(s) of the body does it cover?
  - What does it protect the body from (impact, falls, etc.)?
  - What force does it protect the body from (if the equipment wasn't there, would the body feel compression, tension or torsion)?
  - What is the equipment made of? Name the materials and explain why these materials were chosen.

- What are some common injuries in this sport? Explain how the protective equipment can help.

Name: _____

Friction

Activity 3.4.: Part 1

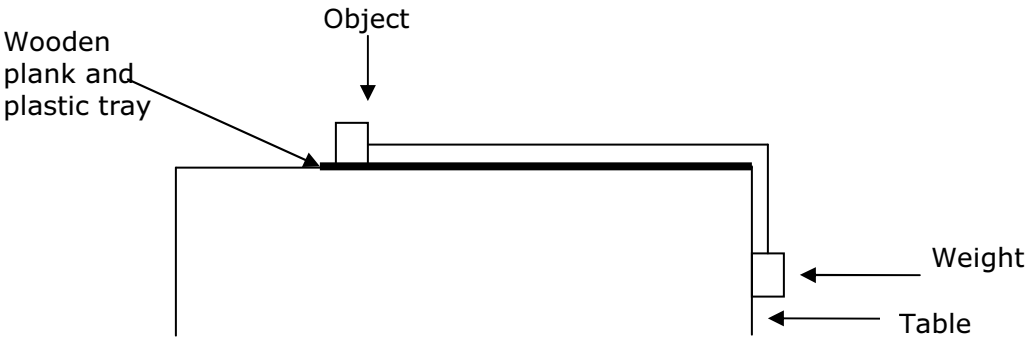
Follow the instructions below to determine the friction between various materials.

Materials:

- 1 long wooden plank
- 1 large smooth plastic tray
- 1 eraser
- 1 hockey puck
- 1 running shoe
- 1 timer
- string
- tape
- various weights

Procedure:

- Place the wooden plank and the plastic tray on a table. The final setup should look like this:



- Start with the wooden plank. Place the eraser at the bottom of the plank and tape it to the string.
- Tape the opposite end of the string to a weight.
- Let go of the eraser. Note any movement you see.
- Repeat the previous step, adding more weight to the end of the string.
- Note how much weight (or force) is necessary to pull the object along the plank.
- Repeat the previous steps, substituting the eraser for the hockey puck and running shoe.
- Repeat all previous steps with the plastic tray.

Observations:

	Weight necessary to move object			
	Eraser	Hockey Puck	Running Shoe	Other:
Wood				
Plastic				

Which surface causes the most friction?

_____

_____

_____

Which object causes the most friction?

_____

_____

_____

Which combination of surface and object produced the most friction?

_____

_____

_____

Which combination of surface and object produced the least friction?

_____

_____

_____

Name: _____

Friction in Sports

Activity 3.4.: Part 2

Research the types of equipment and materials that athletes use to increase or decrease friction.

Examples:

- Shape of a competitive bicycle helmet
- New swimsuits for competitive swimming
- Soccer cleats
- Sprinter's clothing
- Shape of a rowing boat

Sport chosen:_____

Name of equipment:_____

What is it made of?

_____

_____

_____

What advantages does it give to the athlete?

_____

_____

_____

_____