Please note:

- Enclosed is a draft manuscript excerpt from the grade 7 Investigating Science and Technology Teacher’s Resource Package. The grade 8 Teacher’s Resource Package has exactly the same structure.
- The final versions of the Teacher’s Resource Package lesson note pages will have the teaching notes wrapped around reduced student book pages. **LESSON PLANNING MADE EASIER!**
- The Teacher’s Resource includes comprehensive materials and equipment lists.
- The entire Teacher’s Resource Package will be available on disk. This provides:
  - The option for all line masters to be customized.
  - The ability for every page of the student book to be projectable (either on white board, or for shared reading).
- The final Teacher’s Resource Package for both grades 7 and 8 will be available in early Fall 2008.

Other Teacher Support Components include:

- Image Bank
- 1500 Item Practice and Test Generator.
- Student Success Companion and Teacher’s Resource
- Comprehensive Web Site support at [www.pearsonscience.ca](http://www.pearsonscience.ca)
This sample of teacher’s resource material contains the following:

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Unit B Outline 5
Student Preconceptions 6
Using Community Resources 7
Suggested Unit Plan 8
Unit B Opener Teaching Notes 9
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   Differentiated Instruction 20
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Sample Line Masters for Section 4.2 25
Investigating Science and Technology 7 — Teacher’s Resource

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  - Using the Photo and Text
  - Using What You Will Learn, Skills You Will Use, and Why This Is Important
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- Background Information
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**DURING**
- Using the Section Summary
- Starting Point Activity
  - Activity Notes
  - Answers to Questions
- Using a Demonstration (if applicable)
- Teaching Suggestions for the Section
- During Reading/During Writing/Learning Checkpoint
- Differentiated Instruction
- Take It Further
- Teaching Notes for Each Activity
AFTER
Check and Reflect Answers
  Key Concept Review
  Connect Your Understanding
  Practise Your Skills
STSE Focus — Thinking about …
  Activity Notes
  Answers to Questions
Extend Your Understanding
Reteaching Strategy
ESL/ELL Strategy
Assessment of Learning
Science World [or] Making Connections Feature
  Purpose
  Teaching Suggestions

Chapter Review — Assess Your Learning
After Reading
Chapter Review Answers
  Key Concept Review
  Connect Your Understanding
  Practise Your Skills
Unit Task Link
STSE Focus — Thinking about …
  Activity Notes
  Answers to Questions

Unit Summary
Unit Assessment
Unit Task
Answers to Unit Review Questions
  Key Terms Review
  Key Concept Review
  Connect Your Understanding
  Practise Your Skills
  Revisit the Big Ideas
STSE Focus — Thinking about Science, Technology, Society, and the Environment
  Activity Notes
  Answers to Questions

Unit Line Masters

VI. Toolkits
  Answers to Instant Practice questions in the Toolkits
Structures are all around us. Almost everything we see or touch is a structure. Every structure has a form (a basic shape) and a function (a specific job). There are natural structures, such as a bird’s nest, a tree, and a beaver dam, and manufactured structures, such as a pen, a desk, and a building. Humans construct structures for a specific purpose. Structures are designed with a function in mind. When humans design structures they have to carefully choose the materials they are going to use, use strategies to improve the strength of the structures, consider the forces on the structures, and think about the structures’ lifespan. This unit gives students opportunities to investigate how to improve the strength of a structure, how to assess different forces that act on structures, how to design a good structure, and how to become more aware of the structure’s entire lifespan.

Chapter 4.0
In the first chapter of this unit, students see that the structures around them are more than just bridges and buildings. They learn that most of the objects they see and use every day are structures. Students classify the forms of these structures as solid, frame, and shell. They then take this knowledge and classify structures that they find around the classroom. This classification of structures gives students the knowledge they need to understand when different types of structures are best used.

Students continue on to look at how different forces affect different structures. They learn the difference between internal and external forces that act on structures. They learn to use scientific vocabulary such as tension, shear, compression, and torsion to describe the types of forces that act on structures. This understanding of the forces acting on structures is reinforced through the B12 Quick Lab: What It Feels Like to Be a Structure on page 113 of the student book. In this activity, students experience the forces of compression, tension, shear, and torsion with their own bodies. Lastly, students look at how to design structures that will stand up to the forces that act on them and ensure a safe design.

Chapter 5.0
In the second chapter of the unit, students read about the factors that make a structure more stable. The centre of gravity — the point at which all the weight of the structure comes down equally around it — plays an important role in the stability of the structure. Students learn to describe this point and what symmetry in structures looks like. They then take this knowledge of the centre of gravity and use it to predict the stability of structures. B24 Learning Checkpoint: Triangular Strength on page 131 of the student book is a quick activity in which students compare the strength of a straw bent into a rectangle against the strength of a straw bent into a triangle. This activity gives students the kinesthetic understanding that a triangular shape is actually stronger than a rectangular shape. Students see by doing a quick lab on stability that, in some shapes, it is easy to find the centre of gravity, but in others, it is more difficult (B26 Quick Lab: Stability on page 137 of the student book).
Students also read about the elements of a good design. They have the opportunity to see if the way they carry their own school backpack is an effective way to carry a load. This knowledge is then used to design a bookcase from paper in the B33 Problem-Solving Activity: Newspaper Bookcase on page 135 of the student book. In this activity, students apply all that they have learned about structures to this point.

Chapter 6.0
In the last chapter, students look at what makes a good design for a structure. In the B39 Design a Lab: Surveying the Market on page 159 of the student book, students take on the role of a manufacturer and create a survey to find out what elements consumers want in a certain product. They are also asked to think of the impact they have as consumers. Students are asked if they themselves are wise consumers or if their buying practices have a negative impact on the environment. Students learn about and research the lifespan of a product. They take this knowledge and create a plan that finds ways to lessen their impact on the natural environment.

Unit Task
The unit task offers students an opportunity to consolidate all their knowledge about structures to design or modify a structure so it will conserve more energy. This project gives students the opportunity to apply what they are learning in their science class to the world they live in.

STUDENT PRECONCEPTIONS

- Students often come to the science classroom believing that structures are only bridges and buildings. This belief may make it difficult for them to see how this unit relates to the world immediately around them. It is important that students overcome this preconception so they can apply what they learn to their own life.
- Students often think that if they cannot see the structure react to a force that there is no force.
- Students often do not understand that the forces acting on a structure have an equal balance. They can visualize the force of a truck pushing down on a bridge, but find it difficult to understand that a force is pushing up on the truck.
- Students may have difficulty understanding stress and fatigue and may assume that signs of stress and fatigue automatically lead to failure of the structure.
- Students are able to buy different structures with ease, so they come to the classroom often unaware of the fact that everything they buy must be disposed of, and therefore they are affecting the natural environment around them.
- Students rarely come to the classroom thinking about the fact that every object has a lifespan and that this needs to be considered when buying structures.
- Students often have little to no understanding of ergonomics. They assume that a computer chair, for example, was designed for comfort, not that it was designed to decrease the stress on the human body.
USING COMMUNITY RESOURCES

- Invite someone who designs buildings, roads, bridges, or other structures to talk to students about the different aspects she or he must consider when designing a structure.
- Ask a local bicycle repair shop owner to the class to discuss where most of the repairs are done on the bike. Relate this to where most of the stress is on different bicycles and why.
- Take a community walk and have students look for shell, frame, and solid structures. Also have students look for the different factors that affect the strength of a structure.
- Take a community walk through both the natural and constructed environment and have students look for both natural and human constructed structures.
- Take a community walk and look for signs of stress, fatigue, and perhaps structural failure of structures in the neighbourhood.
- Invite a house inspector to the classroom to explain some of the main problems he or she sees when inspecting houses.
- Go on a field trip to the local recycling plant and landfill site to give the students an opportunity to see how structures are disposed.
Suggested Unit Plan for Unit B: Structures: Form and Function

This suggested plan shows how the unit could be covered in 20 hours. It is based on 40 minutes per class.

<table>
<thead>
<tr>
<th>Part of Unit</th>
<th>Total Time for the Section</th>
<th>Introducing the Section</th>
<th>Teaching the Section</th>
<th>Assessing the Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit Opener</td>
<td>60 min</td>
<td>10 min</td>
<td>40 min</td>
<td>10 min</td>
</tr>
<tr>
<td>4.0 Getting Started</td>
<td>20 min</td>
<td>5 min</td>
<td>10 min</td>
<td>5 min</td>
</tr>
<tr>
<td>4.1 Classification of Structures</td>
<td>100 min</td>
<td>5 min</td>
<td>85 min</td>
<td>10 min</td>
</tr>
<tr>
<td>4.2 Forces That Can Act on Structures</td>
<td>120 min</td>
<td>10 min</td>
<td>90 min</td>
<td>20 min</td>
</tr>
<tr>
<td>4.3 Designing for Safety</td>
<td>100 min</td>
<td>5 min</td>
<td>85 min</td>
<td>10 min</td>
</tr>
<tr>
<td>5.0 Getting Started</td>
<td>20 min</td>
<td>5 min</td>
<td>10 min</td>
<td>5 min</td>
</tr>
<tr>
<td>5.1 Stabilizing Structures</td>
<td>120 min</td>
<td>10 min</td>
<td>90 min</td>
<td>20 min</td>
</tr>
<tr>
<td>5.2 Elements of Design</td>
<td>120 min</td>
<td>15 min</td>
<td>100 min</td>
<td>5 min</td>
</tr>
<tr>
<td>6.0 Getting Started</td>
<td>40 min</td>
<td>10 min</td>
<td>25 min</td>
<td>5 min</td>
</tr>
<tr>
<td>6.1 Determining Consumer Need</td>
<td>120 min</td>
<td>15 min</td>
<td>100 min</td>
<td>5 min</td>
</tr>
<tr>
<td>6.2 Lifespans of Common Structures</td>
<td>120 min</td>
<td>10 min</td>
<td>90 min</td>
<td>20 min</td>
</tr>
<tr>
<td>6.3 Exploring Greener Options</td>
<td>140 min</td>
<td>15 min</td>
<td>110 min</td>
<td>15 min</td>
</tr>
<tr>
<td>Unit Task</td>
<td>120 min</td>
<td>20 min</td>
<td>70 min</td>
<td>30 min</td>
</tr>
</tbody>
</table>
TEACHING NOTES
UNIT B

Student Book pages 90–91

UNIT B OPENER
Time: 1 class

The unit opener is vivid picture of a building that demonstrates many aspects of structures. The building in the foreground allows students the opportunity to see many factors of stability and form of structures. The white concrete beam shows how the load of the building above is spread equally across the beam. The bridge walkway to the building shows the frame structure of a bridge spanning the distance from the building to an unknown landing. The buildings in the background hint at the triangular shaped trusses under the roof, another example of a structural component. The electrical towers far in the distance give students a clear example of a frame structure.

Using the Unit B Opener

Have students read the Unit Overview and examine the unit opener picture. Ask them to make a list of different structures they know and describe how the form of each structure (its shape) is related to its function (its job). Use this information as a diagnostic tool to see what the students come to the unit knowing and what preconceptions they already have. Once this diagnostic is complete, you may want to hand out BLM B-1 Unit Summary and BLM B-2 Key Terms to help students record their understanding of the unit and key terms.

Student Book pages 92–93

EXPLORING

Teaching Suggestions

Read the first paragraph of the Exploring together. Ask students what they think is most important about this paragraph. Elicit that the main idea is that everything around them, including themselves, is a structure. Have students, in groups of two or three, read the whole Exploring piece, discussing the main ideas of each paragraph. After reading, assign each group a paragraph and ask them to share their main ideas with the class. Together, write an outline of the Exploring text. Explain that this outline will help guide their learning throughout the unit.

P1 - We can see and touch structures.
P2 - Structures have form and function.
P3 - Structures are both manufactured and natural.
P4 - Forces act on structures.
P5 - Good decisions about buying structures can help protect the environment.
Unit B Structures: Form and Function

P6 - Ergonomic structures help to protect people from injury.
P7 - Humans interact with the structures.
P8 - Manufacturers design structures with the purpose in mind.
P9 - Manufacturers research the use of structures they make.

**Student Book page 94**

B1 Quick Lab: Design a Better Desk

*Grouping:* individuals
*Time:* 10 minutes
*Skills:* observing, communicating

**Purpose**
To have students suggest improvements to the form of a school desk so it can perform its function better

**Activity Notes**
- Read the activity together as a class. Brainstorm a few functions to get students started.
- Give students five minutes to complete the first three steps of the Procedure, and a few more minutes to share in pairs. Then ask them to answer the questions. Have a few volunteers share their answers.

**Answers to Questions**
5. More often than not, students will feel that the most important function of their desk is as a surface to work upon. The desk will be used as a workspace most of the time.
6. Students will come up with a variety of answers. These might include making the desk more comfortable by increasing the size, putting the surface on more of an angle, and providing more room to store things in the desk.

**STSE Focus**
B2 Thinking about Science, Technology, Society, and the Environment: Considering Form and Function

This activity gives students the opportunity to think about the form and function of different structures found in their class. The activity provides students with their first opportunity to see how science is part of the things they use everyday.

**Activity Notes**
- Have students work either individually or in a group to create a chart to list six structures they see in the class.
- Remind students that all objects are a structure.
Unit B Structures: Form and Function

- Model on the board how to complete the chart for one structure. Prompt students by asking what materials the structure is made from and what shape the object takes. Have students explain what the structure does. For example:

<table>
<thead>
<tr>
<th>Structure</th>
<th>Description of Form</th>
<th>Description of Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desk</td>
<td>Hollow inside. Four legs attached to an open rectangular prism.</td>
<td>To write on, to hold books and papers</td>
</tr>
</tbody>
</table>

- Suggested modifications: Have very new English language learners fill out the chart in their own language. For students that need prompting or have difficulty writing, provide them with BLM-3: Charting Form and Function, which is a partially filled out chart.

Answers to Questions

1. Students’ charts may be similar to the following:

<table>
<thead>
<tr>
<th>Structure</th>
<th>Description of Form</th>
<th>Description of Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desk</td>
<td>Hollow inside. Four legs attached to an open rectangular prism.</td>
<td>To write on, to hold books and papers</td>
</tr>
<tr>
<td>Chair</td>
<td>Four legs, sometimes attached to the desk. Made from plastic and metal.</td>
<td>To hold students while they sit and work, listen, and write</td>
</tr>
<tr>
<td>Coat Rack</td>
<td>Attached to wall on a piece of wood. Made from metal and plastic.</td>
<td>To hang coats and other clothing. To hang bags</td>
</tr>
<tr>
<td>Pen</td>
<td>Made from plastic. Hollow container in a stick-like shape.</td>
<td>To hold ink that will be used to write with</td>
</tr>
<tr>
<td>Bulletin Board</td>
<td>Piece of corkboard attached to the wall with a metal frame.</td>
<td>To display student work</td>
</tr>
<tr>
<td>Shelves</td>
<td>Flat pieces of wood. Attached to wall horizontally.</td>
<td>To hold books, baskets, supplies</td>
</tr>
<tr>
<td>Binder</td>
<td>Made from plastic, cardboard, and metal. Plastic covers the outside of rectangular cardboard.</td>
<td>To store and organize papers.</td>
</tr>
</tbody>
</table>

4. Students’ answers will vary. Possible answers include: the PA system, the teacher’s desk.

5. Students’ answers will vary. Possible answers include: desks (for writing on, storing supplies, tables for eating during snack time or lunch, easels during art classes); coat racks (hold coats, backpacks, and lunch bags).
6. Students’ answers will vary but may include the following ideas: If a structure is designed with only form in mind, it might not serve the purpose or do its job. If a structure is designed only with the function in mind, the structure might fail. A structure must have a form that matches its function.

Student Book page 95

Unit B Table of Contents

As a class, read through the Unit Table of Contents. Explain that a Table of Contents lists all the topics/titles of the chapters and sections in each chapter. These titles give the reader an overview or summary of the unit. Ask students what they think they will be learning about in this unit. Have them consider why these topics are important. Ask students, “Would you consider the titles of the chapters and the sections the main ideas of the unit?” At the end of the unit, consider having the students discuss what their Table of Contents would look like if they were writing a unit on structures.

Note that sections 4.2, 5.2, and 6.3 are supported by additional ways to differentiate the instruction in the teaching notes for each lesson.

Planning the Unit Task

In the unit task, students will design and build a prototype or a model of a structure that could lessen the environmental impact of their house, apartment building, or school. The focus throughout the textbook is finding something that will conserve energy. Students will either modify an existing structure to make it work more efficiently, invent the next “green” invention, or do research on an innovation that is not yet used widely. Through this task, students will show their understanding of the form and function of structures. Students will have to consider the forces that act on structures and the factors that affect the stability of a structure in their design and model.

Getting Ready to Read

• Have students work with a partner to write out each of the key terms from Chapters 4, 5, and 6 on a cue cards or strips of paper. Prompt students to use the glossary at the back of the book to find the meaning of the words. Students can write the meanings of the words on the back of the cards. Encourage English language learners to use a translation dictionary to write the words in their first language on the back of the card.
• Suggest to students that they may choose to use some of the words as category headings, create their own headings, or use a combination of both.
TEACHING NOTES FOR CHAPTER 4.0

Student Book pages 96–97

CHAPTER 4.0

Background Information

This chapter reinforces the idea for students that structures are all around them—they are not just bridges and buildings. It is designed to help students classify structures as a shell, a frame, or a solid structure. This classification then makes it easier for students to see which structures are best suited for certain purposes. For example, a shell structure, which is hollow on the inside, acts best as a container.

As they look at structures around them, students need to remember that structures have a form and a function. The function of the structure dictates how strong it must be. However, there are always forces acting on structures, and designers must keep this in mind when they design structures.

For additional information on this topic, go to PearsonScience.

Prior Knowledge

Students come to the classroom with different levels of scientific knowledge. Students may have already been exposed to the idea that structures are all around us, but many will still focus on bridges and buildings as structures. In grade 5, students were first exposed to the classification of structures as shell, frame, and solid structures when they were asked to build a frame structure to withhold a load. However, they have not been formally introduced to this classification until now. In grade 5 students were also introduced to the concept of internal and external loads.

CHAPTER 4.0 OPENER

Using the Photo and Text

Chapter 4.0 opens with a photo of a group of people packing up after camping. The picture gives students the opportunity to see different structures in use. The poles of the tent make up a frame structure that ensures the nylon tent will have the strength and stability needed to keep the tent up and keep its shape. The nylon tent is a shell structure providing a place for people to sleep in. Tents have to withstand the forces of rain, wind, and sometimes snow.

Ask students to identify the different structures and their functions in the picture. Ask them to consider the form and function of the structures that they identified. Students can think about what forces the designer considered when making the structures.
Using What You Will Learn, Skills You Will Use, and Why This Is Important
Read “What You Will Learn,” “Skills You Will Use,” and “Why This Is Important” with students. Encourage students to use the three points under what they will learn as a chapter organizer. Ask students to think of why it is important for them to learn what makes a good structure.

Using the Before Reading Literacy Activity and Key Terms List
The Before Reading literacy activity will provide students with a graphic organizer of Chapter 4.0 when they are finished. Students should start their graphic organizer with the word “structures” in the middle. Encourage students to use a pencil initially to make this graphic organizer; that way they can make changes as they learn more information. Students will add to their graphic organizer with pictures and words as they read through the chapter.

Have students work in pairs to define one word from the key terms list in their own words. Students can also draw a picture to show the meaning. Have ELL students write the word in their own language. As a class, share the different meanings and the pictures. Come to a consensus on the meanings for each word and use the meanings to start a Word Wall. Remind students that they may find other meanings in the text, or they may need to revise ones they have written, so changes/additions may need to be made to the definitions. Invite students to add their pictures to the wall.

Student Book pages 98–99

GETTING STARTED

Using the Text
Bring in or use a number of objects around the classroom. Lay them out before the class starts. Have students read the Getting Started text. After the students have finished reading, ask:
• Are the objects at the front of the class a structure?
• What is their function?
• What forces do you think might act on them?
Have students take five minutes to discuss these questions with a partner.

Using the Activity

B3 Quick Lab: Wind Effects
Grouping: pairs or groups, depending on how many plants are available
Time: 10 minutes
Skills: observing, predicting

Purpose
To have students observe the effects of wind on various structures
Unit B  Structures: Form and Function

Activity Notes
• Arrange students in groups and give each group three or four plants. Make sure that at least one plant is quite different from the others in structure; for example, a fern and a cactus. If possible, the plants should be in different types of pots; for example, the thin plastic pots plants usually come in and more substantial pots used for repotting.
• Each student in a group should have the chance to wave the cardboard, even if the simulation is repeated for the same plant.
• If there aren’t enough plants available for groups, do the activity as a demonstration with volunteers waving the cardboard.

Answers to Questions
4. Students will find that the wind affected each plant a bit differently. A plant with a thick stem might bend and sway very little. A plant with a thin stem may bend and sway a lot. A plant that is quite tall in a small pot might fall over.
5. Students’ answers will vary depending on the plants. Possible answers include: plants with thin stems bent a lot; plants that were short and close to the soil didn’t move much; plants that were in thin plastic pots fell over.
6. Students’ answers will vary. Possible answers include: the plant with the thin stem might fall over; some of the leaves of the bushy plant might blow off.

Skill Worksheets

The following Skill Worksheets could be used in Chapter 4.0:

<table>
<thead>
<tr>
<th>Skills Worksheet</th>
<th>4.1</th>
<th>4.2</th>
<th>4.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Observing</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>2. Measuring</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>3. Classifying</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Inferring</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>5. Predicting</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>6. Asking questions related to scientific inquiry</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Developing hypotheses</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Controlling variables</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>9. Forming operational definitions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Graphing data</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Interpreting data</td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
TEACHING NOTES FOR SECTION 4.2

Student Book page 108

[Note to readers: For this sampler, section 4.2 was chosen rather than section 4.1 in order to show a greater range of the resource material available.]

4.2 FORCES THAT CAN ACT ON STRUCTURES

Time: 2 classes

BEFORE

Expectation Assessment Chart

<table>
<thead>
<tr>
<th>STSE and Basic Concepts Expectations</th>
<th>Assessment Opportunities</th>
</tr>
</thead>
</table>
| 1.1 evaluate the importance for individuals, society, the economy, and the environment of factors that should be considered in designing and building structures and devices to meet specific needs (e.g., function; efficiency; ease of use; user preferences; aesthetics; cost; intended lifespan; effect on the environment; safety, health, legal requirements) | • Discussions with students in class  
• B14 Thinking about Science and Technology: Damaged Structures |
| 3.3 identify the magnitude, direction, point of application, and plane of application of the forces applied to a structure | • Discussions with students in class  
• Check and Reflect Questions 1, 4, 5 |
| 3.4 distinguish between external forces (e.g., wind, gravity, earthquakes) and internal forces (tension, compression, shear, and torsion) acting on a structure | • Discussions with students in class  
• B12 Quick Lab: What It Feels Like to Be a Structure  
• Check and Reflect Questions 2, 3, 6–8 |

Background Information

Whether visible or not, all structures have forces acting on them. A force is a push or pull. Since all structures both big and small have forces acting on them, they must be designed to withstand these forces. Forces can act on a structure internally, from the inside, or externally, from the outside. The magnitude, or size of the force, influences how it affects the structure. For example, a small breeze is not likely to snap a branch off a tree. The location and the direction that the force comes from can also influence how much the force affects the structure.
Unit B  Structures: Form and Function

Prior Knowledge

Students now know to classify structures. Students will have also looked at forces in earlier grades. Some students may remember what forces are and that there are internal and external forces.

Preparing for Differentiated Instruction

In this chapter, students need to understand the different forces that affect structures and how these forces are a big part of the design process of structures. Forces are not always visible to students, and often structures are designed to withstand the forces acting on them, so students won’t be aware of the forces. In section 4.2, students read and learn about forces through both visual and kinesthetic learning. Teachers can augment this learning by using some of the different strategies listed in the teaching notes. Different ways to teach forces can be used both before and during the lesson depending on the needs of the students.

DURING

Using the Section Summary

As a class, read the summary of what students will learn in this section. Ask students to give examples of forces they have seen acting on a structure. Most of these examples will be ones the students can see, that is, external forces. Ask students to identify words in the summary that they do not know or are unsure of. If any of these are not key words, add them to the Word Wall. After reading the section, students can come back to the section summary to consolidate their understanding and identify areas that require clarification. At the end of the chapter or unit, students can use the section summary for review.

B9 Starting Point: Gravity Is a Force

This Starting Point activity gives students the opportunity to think about what makes a structure stable, what forces act on a structure, and how to build a structure that might withstand these forces. The activity reinforces gravity as a force — gravity can cause structures to fail, or gravity acting with other forces can cause a structure to fail.

Activity Notes

• Read this section together as a class. Allow students five minutes to build a structure from things in their pencil cases and their desks until it fails.

• As the students’ structures begin to fail, ask them why they think their structure failed. Prompt them to think about the materials they chose (Were they strong enough?), the type of structure they built (Was it a frame, shell, or solid structure?), and the balance of the structure they built (Was the weight equally distributed?).
Unit B Structures: Form and Function

- As a class share the findings. Reinforce with students that it is the force of gravity that is causing the structures to fail. Their structures could not resist the pull of gravity.
- Then have students continue on and apply the external forces of wind and an earthquake on a structure. Again prompt them with similar questions listed above. Ask students if it mattered how far away the wind was applied and how strong the wind was.
- A student’s structure might topple when someone in close proximity creates the earthquake at another desk. If this does happen, use the incident to show how structures some distance from the epicentre of an earthquake can be affected. Bring attention to the fact that forces not directly applied to structures can also affect them.
- Have students share with a partner why they think their structures failed and what they could have done to delay the time it took for the failure of their structure.

Answers to Questions
- Students’ answers to what caused their structures to fail will vary, but may include ideas similar to: the last thing they added to their structure wasn’t balanced properly; some materials were too heavy for the materials underneath to support; the materials weren’t joined together securely.
- Students’ answers about how they could have delayed the failure of their structures will vary, but may include ideas similar to: building the structure out of heavier materials such as books; attaching the parts of the structure together with glue or pins.

Student Book page 109

Teaching Suggestions
- Read the first paragraph with students. Ask students if they have had any personal experiences with any failed structures. Students that have lived in other countries might have personal experiences with tornadoes and earthquakes or other forces that act on structures.
- As the students continue to read, have them take the palms of their hands and push them against each other for 20 seconds. Explain that what they feel is a force.
- After students discuss B11 During Reading, they will use note taking as a guide as they read the rest of the section.
- After reading “Describing Forces,” have students turn to a partner and using the Questions to Consider and the example, ask them to brainstorm other examples of the factors. Have a few students share their examples.
- Have students continue reading and filling out their chart for the During Reading activity.
- After reading “External Forces and Loads,” challenge students to find a way to remember that dynamic is a force that moves and changes, while a static force does not; for example, create a rhyme or acronym.
• As the students read “Internal Forces,” encourage them to act out the different types of forces with their hands.

**B11 During Reading: Note Taking**

Note taking is an important technique that students need to learn. A chart is a way for students to identify the main ideas of what they have read. Turning the topic headings into questions gives the students a set purpose to read for: to find the answers to the questions they created. Ask students to make a table like Figure 4.2. with two columns. The first column will have the title Topic Heading in the Form of a Question and the second column will have the title, Point Form Notes.

Accommodations for students who require them could include:
• providing a chart with the questions already inserted but the point form notes blank
• providing point form notes (such as those in the chart below) with important words deleted. Students can fill in the words as they read the section.

<table>
<thead>
<tr>
<th>Topic Heading in the Form of a Question</th>
<th>Point Form Notes</th>
</tr>
</thead>
</table>
| What are internal forces?              | • caused by one part of a structure acting on another part  
|                                        | • tension in a stretched elastic  
|                                        | • compression from weight pressing down |
| What are external forces?              | • force that acts from outside a structure  
|                                        | • gravity pulls on structures towards Earth’s centre  
|                                        | • wind blowing  
|                                        | • weight of a person on a ladder  
|                                        | • people pulling on things |
| How do you describe forces?            | • magnitude — how big the force is  
|                                        | • direction — where the force is coming from  
|                                        | • point and plane of application — the place where the force meets the structure |
| What is load? How does it act as an external force? | • structures support a load  
|                                              | • the sum of both the static and dynamic loads  
|                                              | • static load is the effect of gravity on a structure  
|                                              | • dynamic load is the forces that move or change |
| How do internal forces affect a structure? | • tension stretches apart  
|                                              | • compression squeezes together  
|                                              | • shear pushes in opposite directions  
|                                              | • torsion twists |
| How can we design for forces?           | • consider all the forces over a structures lifespan |
Student Book pages 110–112

Differentiated Instruction

Before continuing, students should understand the following key concept:
Forces are either internal or external, and there are different kinds of internal and external forces that can affect structures.

<table>
<thead>
<tr>
<th>What to Look for</th>
<th>What to Do</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student does not understand how external forces affect structures.</td>
<td>Brainstorm with students the different kinds of weather they have been exposed to. Discuss each kind and talk about how it affects them. For example, rain can make them cold and wet. Then discuss how being cold and wet can affect other structures, such a house.</td>
</tr>
<tr>
<td>Student does not understand the difference among the internal forces tension, compression, shear, and torsion.</td>
<td>Have students use clay to act out the four internal forces. Have them use the diagrams on page 112 to guide them.</td>
</tr>
</tbody>
</table>

Take It Further
This feature provides the students with an alternative method to demonstrate their understanding of the forces that act on structures.

Student Book page 113

B12 Quick Lab: What It Feels like to Be a Structure
Grouping: pairs
Time: 15 minutes
Skills: observing

Purpose
To have students experience compression, tension, shear, and torsion by using their bodies

Safety Precautions
Ensure that students have enough space to carry out the experiment. Watch that the students do not apply too much force on their peers or do any activity that could cause too much strain on their bodies.

Activity Notes
• Remind students to consider actions that involve both partners, as well as those that involve only one student. Encourage them to think of more than one action for each force if they can.
• Check over the students’ ideas for how to experience the forces, looking for any activities that might be harmful.
Answers to Questions

3. Students’ answers will vary depending on how they acted out the forces. Many will use similar words to those in the student book to describe the forces. Some examples are compression (felt pressure pushing down), tension (body stretched), torsion (twisting), and shear (being pulled in two different directions). Students might say that a structure would experience compression if another load is placed on top of it. A structure that is hanging might experience tension or torsion.

4. Students’ answers will vary. Possible answers include: When I reach for something my body feels tension. When I twist to look at something behind me, my body feels torsion. My body feels these forces. If I reach too high or twist too fast, my body can get injuries from these forces.

5. Students’ answers will vary. Possible answers include: Filled cardboard boxes stacked on top of each cause compression to the boxes underneath. To minimize compression, the top of the boxes could be reinforced with a stronger material. If you reinforced all the surfaces of a box, you would also minimize tension, torsion, and shear because the surfaces wouldn’t bend easily so it would be hard to twist them or pull them in different directions.

Student Book page 114

B13 Quick Lab: Raise the Flag

Grouping: pairs
Time: 15 minutes
Skills: observing, inferring

Purpose
To have students investigate the effects of wind on a model flag

Activity Notes
• Discuss with students how to make their flags by matching materials to the photo (tissue paper actual flag; pencil the flagpole, and so on). Explain that the Canadian flag is twice as long as it is wide, and they should consider these proportions when making their model.

• Read through the Procedure and Questions with students. With them, create a table that they can use to record their observations. For example:

<table>
<thead>
<tr>
<th>Force</th>
<th>Observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fan waved at flag</td>
<td></td>
</tr>
<tr>
<td>Fan waved at top of pencil</td>
<td></td>
</tr>
<tr>
<td>Fan waved at middle of pencil</td>
<td></td>
</tr>
<tr>
<td>Fan waved at bottom of pencil</td>
<td></td>
</tr>
<tr>
<td>Straw used to blow at different parts of flag</td>
<td></td>
</tr>
<tr>
<td>Straw used to blow at top of pencil</td>
<td></td>
</tr>
</tbody>
</table>
Straw used to blow at middle of pencil
Straw used to blow at bottom of pencil

**Answers to Questions**

4. The entire flag moves when using a fan. However, when the fan is waved on only parts of the flag, the movement is less throughout the flag and more concentrated at the section at which the fan is aimed.

5. When you blow through a straw at the flag, the flag ripples in the area at which the straw is aimed.

6. Even though the fan is aimed at only one section, the wind created still has enough force to create some movement throughout the whole structure, just like the “plane of application” of a force.

7. “The point of application” for a force is clearly demonstrated with the straw because only the part of the structure where the wind is directed reacted to the force.

**Student Book page 115**

**AFTER**

**4.2 CHECK AND REFLECT ANSWERS**

**Key Concept Review**

1. A force is any push or pull on a structure.

2. Both external and internal forces act on structures. Examples of external forces are gravity, wind, the weight of something, and pulling at it. Examples of internal forces are tension, torsion, shear, and compression.

3. (a) external force  
   (b) internal force  
   (c) external force  
   (d) internal force

4. Students’ answers may vary but could include the following: Two forces acting on a beaver dam would be gravity and the water coming down the stream towards the dam. The magnitude of the gravity would be the mass of the dam; the direction would be down, and the point and plane of application would be the same for the whole dam. The magnitude of the force of the water might change because the water may be travelling faster and slower at different times. The direction would be towards the side of the dam that is facing the flow of water. The point and plane of application should be the same across the side of the dam unless there are fast currents. The currents would have a different point of application.

**Connect Your Understanding**

5. The weight of the trucks and their load might cause a large downward force that could cause cracks or potholes in the road.
6. Students’ answers may vary but could include the following: Internal forces might be easier to anticipate because the designers know the materials they are using and what internal pressures might happen because of the design of the structure. Designers cannot always anticipate exactly the strength of the wind that might strike the structure or other external forces.

7. Answers may vary but could include the following: In soccer, players often suffer from injuries to the knees and ankles. This shows that the players have internal forces acting such as compression (from the weight of the player’s own body and maybe from another player that falls on him or her), tension (when a player stretches to get the ball), and torsion (when a player twists to reach the ball).

Practise Your Skills
8. Answers may vary, but could be similar to the following: Most playground equipment is a combination structure. Wood or metal posts would be a frame structure. A hollow cylinder shaped slide would be a shell structure. The wood beams would be solid. The equipment would face external forces of gravity, the weight of the people using it, the wind, the rain, and snow. The equipment might be exposed to a variety of different internal forces. For example, the weight of the wood or metal on the top of a piece of equipment will cause compression on the parts below it. If there is a swing that can be twisted, the internal force of torsion will be at work.

STSE Focus
B13 Thinking about Science and Technology: Damaged Structures
This activity allows students to examine the information they have learned about internal and external forces and look for signs of structures that have been subjected to a large external force.

Activity Notes
Before students complete the activity, take them on a community walk where they might see some structures that have been affected by external forces or assign this to be done over a weekend. If students have access to a camera, they can take pictures of these structures. Or show students photos of structures damaged by a hurricane or tornado. Talk about the damage caused to the structures and what caused the damage.

Answers to Questions
1. Students’ answers will vary depending on the structure they choose. For example, a small tree has been exposed to very strong external forces because the tree is cracked at the base and has fallen over. A basketball net has been exposed to large external forces because the netting is ripped and the wood post is cracking.

2. Students’ answers will vary depending on the structure they choose. For example, the trunk of the tree could be reinforced with stakes and wiring. The basketball net could be made from a stronger fiber, such as nylon or chain, and the post could be put into a cement foundation and be made from metal.
3. Students’ answers will vary depending on the structure they choose. For example, technology can be used to make stronger material for the net, and to make a device to support the tree.

Extend Your Understanding

Students could extend their understanding of this section by researching famous structural damages. Suggest students research the Tacoma Bridge, the effects of the ice storm or recent tornados in Ontario, or Hurricane Katrina.

Reteaching Strategy

Have students choose a structure and draw a diagram of it. Guide students to articulate their understanding of external and internal forces that may act on the structure with prompts/questions. For example: What would happen to your structure in a strong wind? Where might this force affect the structure? Could the structure twist? Why might this happen? What do we call the internal force that twists?

ESL/ELL Strategy

- Teach the following words in context: buckling, load, dynamic load, static load, internal and external forces, compression, shear, tension, torsion, plane of application, and point of application. Have students use a translation dictionary to look up the words in their own language.
- Partner English language learners with an English-speaking student to read the text. Have students take turns reading the paragraphs and summarizing what they read.

Assessment of Learning

<table>
<thead>
<tr>
<th>What to Look for</th>
<th>What to Do</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students use scientific words to describe forces, for example: forces, internal and external forces, dynamic and static loads, compression, tension, shear, and torsion.</td>
<td>• Circulate around the class as students do the Quick Labs. Ask questions about what they are doing to check if they use scientific terms to explain.</td>
</tr>
<tr>
<td>Students distinguish between internal and external forces.</td>
<td>• Check students’ answers to questions 1–3 and 6–8 in the Check and Reflect. • Have students label the forces on a picture that includes both external and internal forces.</td>
</tr>
</tbody>
</table>
Unit B Structures: Form and Function

Line Master B-1

Unit B Summary

Chapter 4.0

☐ Structures can be classified by their function. (4.1)
☐ Structures can be classified by their form as solid, frame, and shell structures. (4.1)
☐ Internal and external forces act on structures. (4.2)
☐ Designing a structure requires an understanding of the forces and loads that act on it. (4.3)

Chapter 5.0

☐ Structural shapes, structural components, and structural materials are the main things to consider for structural strength. (5.1)
☐ The centre of gravity of a structure affects its stability. (5.1)
☐ Structural stress, fatigue, and failure affect structures. (5.1)
☐ Designers must ask themselves questions about the elements of design throughout the design process. (5.2)
☐ Some of the questions have definite answers. Others are a matter of personal taste. (5.2)

Chapter 6.0

☐ Manufacturers determine consumer need by using market research, and try to influence consumer thinking with advertising. (6.1)
☐ Being a wise consumer involves identifying personal needs and wants. (6.1)
☐ The lifespan of a product might include planned obsolescence. (6.2)
☐ Product disposal should be a factor in buying decisions. (6.2)
☐ Conserving energy in each phase of the lifespan of a product, from idea to disposal, affects Earth positively. (6.3)
☐ Modifying their personal behaviour to reduce their impact on Earth is the responsibility of every citizen. (6.3)
Unit B Structures: Form and Function

Unformatted Sample Line Masters

Line Master B-2

Unit B Key Terms

Chapter 4.0

☐ compression
☐ form
☐ frame
☐ function
☐ load
☐ shear
☐ shell
☐ solid
☐ structure
☐ tension
☐ torsion

Chapter 5.0

☐ centre of gravity
☐ failure
☐ fatigue
☐ product recall
☐ prototype
☐ stability
☐ stress
☐ structural components
☐ symmetry

Chapter 6.0

☐ consumer
☐ lifespan
☐ manufacturer
☐ market research
B2 Thinking about Science, Technology, Society, and the Environment: Considering Form and Function
(Student Book page 94)

Charting Form and Function

<table>
<thead>
<tr>
<th>Structure</th>
<th>Description of Form</th>
<th>Description of Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desk</td>
<td>Made from</td>
<td>Used to</td>
</tr>
<tr>
<td></td>
<td>Its shape is</td>
<td></td>
</tr>
<tr>
<td>Chair</td>
<td>Four legs, sometimes attached to the desk. Made from plastic and metal.</td>
<td>Used to</td>
</tr>
<tr>
<td>Coat Rack</td>
<td>Made from</td>
<td>Used to hang coats and other clothing, to hang bags</td>
</tr>
<tr>
<td></td>
<td>Its shape is</td>
<td></td>
</tr>
<tr>
<td>Pen</td>
<td>Made from plastic. Hollow container holds the ink in a stick-like shape.</td>
<td>Used to</td>
</tr>
<tr>
<td>Bulletin Board</td>
<td>Piece of corkboard attached to the wall with a metal frame.</td>
<td>Used to</td>
</tr>
<tr>
<td>Shelves</td>
<td>Made from</td>
<td>Used to</td>
</tr>
<tr>
<td></td>
<td>The shape is</td>
<td></td>
</tr>
<tr>
<td>Binder</td>
<td>Made from plastic, cardboard, and metal. Plastic covers the outside of rectangular cardboard.</td>
<td>Used to</td>
</tr>
</tbody>
</table>
Unit B  Structures: Form and Function

*Investigating Science and Technology 7 — Unit-Specific Line Masters*

Each unit will have about 10 unit-specific line masters.

All the units will have the following line masters:

- Unit summary
- Key Terms
- Chapter Quiz for each chapter
- Unit Test

Additional line masters for each unit will include activity line masters and others as appropriate.
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