

A SCIENCE CURRICULUM GUIDE: WHAT CAN THE HIGH LINE TEACH US ABOUT FORCES?

Grades 6 and 7

Materials:

Period 1:

- PowerPoint presentation
- Exploring forces hand out

Period 2:

- Block of balsa wood for the bridge's span—1/4" X 4" X 12" (one for each group)
- Blocks of balsa wood for the bridge's piers-- 2" X 2" X 6" (four for each group)
- NOTE: If you cannot find balsa wood, you may use oak tag and math manipulatives, such as the plastic cubes. Just cut the oak tag into 4" X 12" rectangles.
- Weights such as pennies or scientific weights
- Scissors
- Scale
- Rulers
- Beam bridge construction info sheet
- Beam bridge question sheet

LESSON GOALS

Students will:

- Learn that the High Line was built in the 1930s to carry freight along Manhattan's west side
- Learn that the High Line is now open as a public park
- Learn to identify different types of bridges
 - Suspension bridge
 - Beam bridge
 - Arch bridge
- Learn about different forces
 - Tension
 - Compression
 - Balanced force
 - Unbalanced force
- Build a model of a beam bridge
- Learn the names of different parts of a beam bridge
 - Span
 - Continuous span
 - Pier

- Learn why some beam bridges are stronger than others

Duration: 2 periods

Period 1—PowerPoint presentation with exploration of different forces

Period 2—students build a beam bridge and test its strength

PERIOD 1:

Ask students to share their experiences of bridges. With which bridges are they familiar? Where do these bridges go? What type of traffic do these bridges hold? (e.g., vehicular, bicycle, pedestrian, train, etc.?) Are all bridges the same length as one another? Ask students to share their experiences of short and long bridges and the distances they span.

Set up the PowerPoint presentation.

Slide 1: The Brooklyn Bridge.

Ask students to name the bridge. Where is it? What body of water does it cross? (The East River.) What two bodies of land does it connect? (Manhattan and Brooklyn) Explain that the Brooklyn Bridge was built between 1869 and 1883 and was the longest bridge of its type at that time. Ask if any students know what type of bridge it is. Explain that it is called a suspension bridge. What does suspension mean? Help students identify the part of the bridge that is being held up. (The roadway is being suspended by the suspenders, i.e., the vertical cables.)

Slide 2: Washington Bridge.

Ask the same types of questions about this bridge, i.e., where it is, etc. Students might be less familiar with this bridge. It crosses the Harlem River and connects Manhattan and the Bronx. It was built in 1889 and is an arch bridge. Ask students to describe how it looks different from the suspension bridge.

Slide 3: The High Line.

Ask students to describe what they see. They might not think of it as a bridge. They might not be sure what it is. Explain. Students might share examples of elevated subway lines that they travel on. Ask if any students are familiar with what they are seeing. Briefly explain the history of the High Line and what is happening with it now. (It was built in 1934 as part of a program called the West Side Improvement to ameliorate heavy shipping traffic on Manhattan's west side. At that time, the west side of Manhattan was NY's center of freight traffic—ship, train, and truck—and the streets were clogged with all manner of conveyance. Freight trains actually ran at grade along portions of 10th, 11th, and 12th avenues, and were a public nuisance as well as safety hazard. The High Line was built to get the freight trains off of the streets. It begins at 34th Street and runs to Gansevoort Street (a southern portion was previously demolished) between 10th and 11th Avenues. By 1980, the High Line had become defunct, and it sat idle for more than 20

years. In the late 1990s, threatened with demolition, a grass-roots organization, Friends of the High Line [FHL], formed to preserve this important piece of New York's industrial history. FHL was successful in saving the structure and it is now open as a public park. FHL now serves as a conservancy, raising funds and operating the park in a partnership with the New York City Department of Parks & Recreation.)

Do the students think the High Line is an arch bridge? A suspension bridge? (No.) Explain that it is a kind of bridge called a beam bridge. What makes the beam bridge stand up? (The piers.) What supports the track bed? (The piers.) Ask if students can look around the room and find any examples of anything that is built on the same basic principle as a beam bridge? (A desk or chair could arguably be described as a type of beam bridge.)

Slide 4:

The High Line under construction. This image clearly shows the piers and the span. Introduce students to these terms and have them identify them on the image.

Tell students that these bridges look different and function differently from one another because there are different forces that act upon them. They will work in pairs to learn about the different forces.

Students work through the questions in the acting out forces hand out. They share their results. Go back to the images from the PowerPoint. Explain how the forces of compression and tension are at work in each of the three types of bridge.

Building a Beam Bridge

PERIOD 2:

Have the students work in groups of 3 or 4. Each group will construct a rudimentary beam bridge and test its strength. Begin by demonstrating at the front of the room how to construct a beam bridge. Then, give each group the materials they need, as well as the question sheet to experiment with the bridge's strength. Then, students will conduct the experiment.

How to construct the beam bridge:

1. Use the 2" X 2" X 6" pieces of Balsa wood as the piers. Begin with two. Place them 11 inches apart. (Or use the plastic math manipulative cubes.)
2. Place the 1/4" X 4" X 12" piece of Balsa wood atop the pier as the span. If using oak tag, cut the oak tag to 4" X 12".
3. As students work through the experiment, they will add additional piers.

Afterward, each group will share their results. Reinforce that the High Line is an example of a beam bridge.

EXPLORING FORCES

Grades 6 and 7

Group Member Names _____

Date _____

Directions: Work through the activities and instructions on this sheet to learn about forces with your group.

A **force** can be a push or a pull. A force can be **balanced** or **imbalanced**. A force that is a push is called **compression** and a force that is a pull is called **tension**.

1. Look at a chair sitting in the classroom. Is it moving? _____ It is not moving because the forces acting upon it are **balanced**. The chair is pushing _____, while the floor (which is suspended) is pushing _____. That's why the chair does not move.

○ Is the chair in compression or tension? _____

2. Have two students face each other and raise their arms over their heads, as in London Bridges. Lean against one another so that nobody moves. The two of you are exerting a _____ force. Are you in compression or tension? _____

3. Now, have one person push a *little* harder, so that the other person loses his balance. Now, the forces are _____.

4. Still face each other, but hold your hands low, at your hip level. Hold the other person's hands, and lean back. Lean back with the same rate, so that nobody moves. Your bodies are exerting a _____ force upon one another.

○ When you are leaning (or pulling) against one another this way, are the students in compression or tension? _____

5. Still lean back, but have one person pull a *little* bit harder to make the other person lose their balance. Now, the forces are _____.

6. What forces do you think are at work in a suspension bridge? _____

7. What forces do you think are at work in an arch bridge? _____

8. What forces do you think are at work in a beam bridge? _____

ANSWER KEY

EXPLORING FORCES

Grades 6 and 7

Group Member Names _____

Date _____

Directions: Work through the activities and instructions on this sheet to learn about forces with your group.

A **force** can be a push or a pull. A force can be **balanced** or **imbalanced**. A force that is a push is called **compression** and a force that is a pull is called **tension**.

1. Look at a chair sitting in the classroom. Is it moving? **No**. It is not moving because the forces acting upon it are **balanced**. The chair is pushing **down** while the floor (which is suspended) is pushing **up**. That's why the chair does not move.

- Is the chair in compression or tension? **compression**

2. Have two students face each other and raise their arms over their heads, as in London Bridges. Lean against one another so that nobody moves. The two of you are exerting a **balanced** force. Are you in compression or tension? **Compression**.

3. Now, have one person push a *little* harder, so that the other person loses his balance. Now, the forces are **imbalanced**.

4. Still face each other, but hold your hands low, at your hip level. Hold the other person's hands, and lean back. Lean back with the same rate, so that nobody moves. Your bodies are exerting a **balanced** force upon one another.

- When you are leaning (or pulling) against one another this way, are the students in compression or tension? **tension**

5. Still lean back, but have one person pull a *little* bit harder to make the other person lose their balance. Now, the forces are **imbalanced**.

6. What forces do you think are at work in a suspension bridge? **Compression and tension**

7. What forces do you think are at work in an arch bridge? **Compression and tension**

8. What forces do you think are at work in a beam bridge? **compression**

CONSTRUCTING A BEAM BRIDGE

—information for the teacher to demonstrate to the class. It is suggested that you demonstrate the construction of the beam bridge to the class, and then let them do it in their groups.

Materials:

Each group will need:

- Block of balsa wood for the bridge's span—1/4" X 4" X 12"
- Four blocks of balsa wood for the bridge's piers-- 2" X 2" X 6"

OR

- Oak tag, cut into a 4" X 12" rectangle
- 16 math manipulatives such as plastic cubes

- Weights such as pennies or scientific weights
- Scissors (if you are using oak tag)
- Scale
- Rulers
- Beam bridge question sheet
- pencils

Instructions:

1. Cut the oak tag (if necessary)
2. Weigh the oak tag or the balsa wood (whichever you are using)
3. Place two piers 11" apart. Place the span on top, so that 1/2" hangs off of either edge. The piers should be placed in the middle of the width of the span.
4. Start adding weights to the bridge. If you are using oak tag, you should add one penny at a time. If you are using balsa wood, you will probably want to use rolls of pennies.
5. Once the beam bridge is constructed, answer the questions.

BEAM BRIDGE QUESTION SHEET

Grades 6 and 7

Group Member Names _____

Date _____

Instructions: Construct your group's beam bridge, following your teacher's instructions. Then, working as a group, answer the following questions.

1. How much does the span weigh? _____

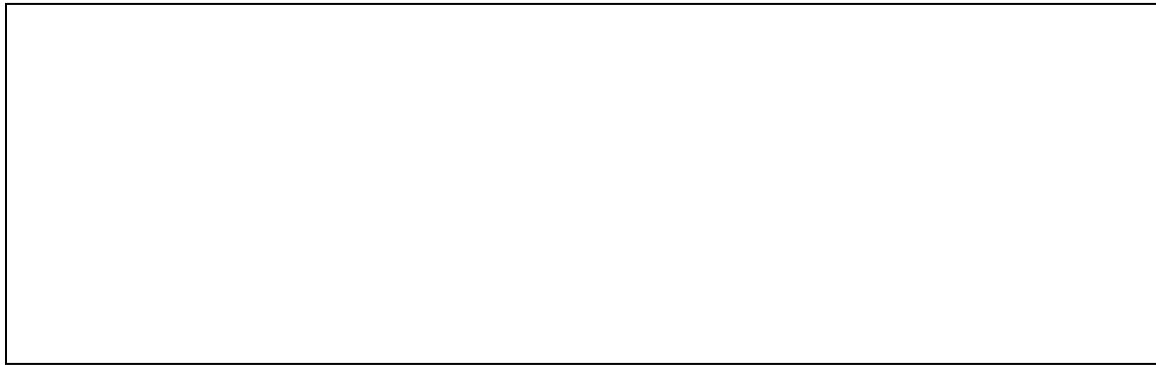
This is called the "dead" load, because it will not change.

2. Add pennies or scientific weights. When the bridge begins to fail, or sag, stop. This is called the "live" load. How much did the live load weigh? _____

3. Add two piers to your bridge, so that it now has four piers. How much live load can your bridge handle now? _____

4. Move your piers closer to the center of the bridge. (In other words, create a shorter span.) How much live load can your bridge handle now? _____

5. Arrange your piers in a different position, either with one pier, or three, or moving them so that they are located under different parts of the span. Draw a sketch of your arrangement here.



6. How much live load can the bridge handle with this arrangement? _____

7. What conclusions can you and your group draw about the relationship between the piers, the span, and the load? _____

8. What forces (compression, tension, or a combination) do you think are at work on a beam bridge? Why? _____