

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

Grades 2 and 3

Materials:

Period 1:

- PowerPoint presentation
- Exploring forces hand out

Period 2:

- Piece of paper, 8 ½" X 11"
- Dixie cups (3 or 4 for each group)
- Weights such as pennies or scientific weights
- Rulers
- Beam bridge construction info sheet
- Beam bridge question sheet

LESSON GOALS

Students will:

- Learn what the High Line is
- Learn why the High Line was built
- Learn that the High Line was unused for many years
- Learn that the High Line is now open as a public park
- Learn that the High Line is a type of bridge called a beam bridge
- Learn about different forces
 - Compression
 - Balanced force
 - Unbalanced force
- Build a model of a beam bridge
- 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, 'What is a bridge?' Encourage them to share their experiences of bridges. With which bridges are they familiar? Where do these bridges go? Why do people build bridges? 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. Tell the students that they are going to learn about a very unusual bridge today.

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) Tell students that when most people think of a bridge, they think of something like the Brooklyn Bridge. But bridges come in all shapes and sizes.

Slide 2: Washington Bridge.

Tell the students that this bridge is called the Washington Bridge (not the George Washington Bridge—that is entirely different.) Ask how it looks different from the Brooklyn Bridge. They may notice that it does not have towers, or that it has a large arch.

Slide 3: The High Line.

Ask students if all bridges must go over water? (Not necessarily.) Tell them that this is a bridge, but not what most people think of when they think of a bridge. Ask students to describe what they see. They might not be sure what it is. Explain that it is a train track called the High Line. It was built long ago to carry goods (not people) into and out of Manhattan. Why might it be considered a bridge? (It is going over the land.) Ask students what is holding the track up? (The piers, they might say or point to the poles.) Explain to students that this High Line is a special place in New York because it doesn't have trains anymore, but is being turned into a park. Students might share examples of elevated subway lines that they travel on. *(More background for teacher: 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.)*

Is the High Line similar to the Brooklyn Bridge or the Washington Bridge? (Not really.) Explain that the High Line 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. In the case of the High Line, the span is called a *continuous span*.

Ask what is making the beam bridge stand up? Explain that something called a *force* makes it stand up. Let's learn about forces! (NOTE: This is a kind of active activity that the children will enjoy, but you can keep them on task by asking questions as you go along.)

Have the students find a partner and stand up. They can work on the rug area. Have them stand back-to-back and lean into one another so that nobody is moving. Ask if they are pushing or pulling against one another. (Pushing.) Ask why they think they are able to push against one another without anybody falling or losing their balance. Elicit that they are pushing against one another with the same force. The force is *balanced*. Introduce the term 'balanced force.' What will happen if one person pushes *ever so slightly more* than the other person? (That person will lose their balance.) Ask what they think this kind of force might be called? Elicit an *imbalanced force*. Tell students that when they are pushing, this is called 'compression.' You may play a little game if you like, something like Simon Says where you ask the students to demonstrate compression! Balanced force! Imbalanced force!

Return to the images of the High Line from the PowerPoint. Ask students if parts of the High Line are pushing down, or in compression. Elicit that the span and the piers are in compression, and that is what is keeping the High Line in place.

Building a Beam Bridge**Period 2:**

Tell the students that today they will build a beam bridge to find out what makes it strong.

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 8 ½" X 11" piece of paper as the span. Fold it lengthwise three times, so it is actually a quadruple thickness.
2. Use the Dixie cups as the span. Begin by using two Dixie cups, positioned at either end of the span.
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.

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 2 and 3

Group Member Names _____

Date _____

Instructions: Construct a beam bridge. First, watch your teacher demonstrate. Then, build your own with your group. Fold the piece of 8 1/2" X 11" paper by folding it three times the long way. Use the Dixie cups as the piers (supports). Place the paper (the span) on top of the Dixie cups.

1. Use two piers (Dixie cups) to begin. Add pennies. When the bridge begins to fail, or sag, stop. How many pennies could you put on before the bridge failed?

3. Add a pier (Dixie cup) to the middle of the bridge, so that it now has three piers. Add pennies. When the bridge begins to fail, or sag, stop. How many pennies could you put on before the bridge failed?

5. Now try again with four piers (Dixie cups). Add pennies. When the bridge begins to fail, or sag, stop. How many pennies could you put on before the bridge failed?

6. What made the beam bridge the strongest? _____

7. What made it the weakest? _____

8. Is this beam bridge in compression? _____

9. What parts are pushing down? _____

ANSWER KEY

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Grades 2 and 3

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Date _____

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5. Now try again with four piers (Dixie cups). Add pennies. When the bridge begins to fail, or sag, stop. How many pennies could your put on before the bridge failed? _____
6. What made the beam bridge the strongest? **More piers means a shorter span.**
7. What made it the weakest? **Fewer piers and a longer span**
8. Is this beam bridge in compression? **Yes**
9. What parts are pushing down? **The span is pushing down onto the piers, and the piers are pushing down onto the desk.**