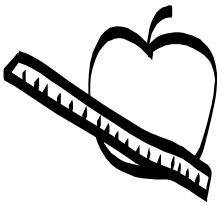


5: Bridging the Gap

Based on the West Virginia quarter reverse

OBJECTIVE

Students will explore the role that bridges play in our society. They will conduct an investigation to examine the various shapes and functions of bridges. They will determine which type of bridge would best suit a given scenario, and will give evidence to support this decision.

MATERIALS

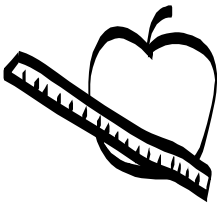
- 1 overhead projector (optional)
- "What's the Problem?" page
- "`Missing Bridge' Quarter" page
- 1 class map of the United States
- Chart paper
- Markers
- Images of bridges such as those found at:
  - www.nmt.edu/~armiller/bridgefu.htm
  - www.peterlanger.com/Specialty/Details/Bridges/
  - www.bridgesite.com/bridgephoto.htm
- 1 copy of an age-appropriate text that relates to bridges, such as:
  - *Bridges* by Etta Kaner
  - *Bridges are to Cross* by Philemon Sturges
  - *Bridges* by Susan Canizares
  - *Bridges* by Lynn M. Stone
  - *Bridges: Amazing Structures to Design, Build and Test* by Carol Johmann
- "Building Bridges" lab sheet
- Several books of identical thickness
- 4" x 6" index cards
- U.S. quarters
- Rulers
- Scissors
- Additional hardcover books
- String
- 2 chairs with backs
- 2 nine-foot pieces of rope
- Strong tape

Bridging the Gap

- Heavy string
- 3' x 1.5' piece of cardboard
- "Bridge Basics" note-taking sheet
- 1 VCR and TV
- 1 copy of an age-appropriate video that provides basic information about bridges, such as:
  - *How Do They Build Bridges?* Anchor Bay Entertainment, 1996. Approximately 30 minutes.
  - *Building Big—Bridges.* WGBH Boston Video, 2000. Approximately 60 minutes.
  - *Awesome Bridges.* Simitar Video, 1994. Approximately 12 minutes
  - *Structures (Bill Nye the Science Guy).* Disney Educational Productions, 1995. Approximately 52 minutes.
- A reserved computer lab with Internet access
- Writing paper
- "West Virginia Quarter Reverse" page

PREPARATIONS

- Make copies of the following:
  - "Building Bridges" lab sheet (1 per student)
  - "Bridge Basics" note-taking sheet (1 per student)
  - "`Missing Bridge' Quarter" page (1 per student)
- Make an overhead transparency (or photocopy) of each of the following:
  - "What's the Problem?" page
  - "Missing Bridge" West Virginia quarter page
  - "West Virginia Quarter Reverse" page
- Locate 1 copy of an age-appropriate text that relates to bridges (see examples under "Materials").
- Locate images of bridges (see example sources under "Materials").
- Assemble material trays for Session 2.
- Assemble quarters into groups (16 quarters per group).
- Assemble materials needed for Investigation #3
- Arrange to use a VCR and TV.
- Locate 1 copy of an age-appropriate video that provides basic information about bridges (see examples under "Materials").
- Arrange to use the school computer lab for one class period.
- Bookmark appropriate Internet sites.



Bridging the Gap

GROUPINGS

- Whole group
- Pairs
- Individual work

CLASS TIME

Five 45- to 60-minute sessions

CONNECTIONS

- Science
- Social Studies
- Language Arts
- Mathematics

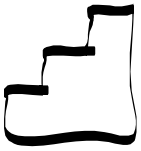
TERMS AND CONCEPTS

- Quarter
- Reverse (back)

BACKGROUND KNOWLEDGE

Students should have a basic knowledge of:

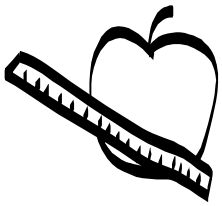
- Conducting science investigations in which inferences are made based on observations
- Cooperative learning
- Note taking



STEPS

Session 1

1. Display the "What's the Problem?" overhead transparency and ask the students to discuss what they notice about this image. The students should point out the division of the communities by the ravine between them. Ask the students what might help bring these communities together. The students should respond that a bridge would make it easier to travel between the homes and the store.
2. Ask the students to pretend that they are responsible for constructing a bridge to connect the communities. Invite them to consider the following questions: How would a bridge help this community? Who would use the bridge? Would the bridge be crossed by foot



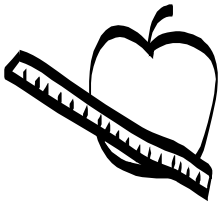
Bridging the Gap

or by motor vehicle? What kind of material would be the best to use in building this bridge?

3. Explain that, over the next few days, the students will be looking at different types of bridges and their functions and will decide which type of bridge would be most suitable for this type of crossing.
4. Ask the students why we build bridges. Create a K-W-L chart and record student responses in the **K** column of this chart to mark what the students **K**now about bridges.
5. Explain that the purpose of any structure is either to create a shape or create support. Based on that information, which one is the primary purpose of a bridge? The students should realize that a bridge is built as a means of supporting the individuals or machines that need to cross it. Add this information to the **K** column as well.
6. Ask the students to contribute any other information that they may know about bridges. Add this information to the **K** column also.
7. Remind the students that they will be looking at what type of bridge would be best for this situation. Ask the students to generate questions they need to ask to find out which type of bridge would be best. Guide the students' questions so that they focus on how a bridge is built and why certain bridge structures are better than others. Show the students images of different types of bridges and famous bridges to help them generate their questions. Add student responses to the **W** column of the K-W-L chart.
8. Introduce students to the related text about bridges.
9. Read the selected text to the class and attend to any unfamiliar vocabulary.
10. Explain to the students that they will be looking at three types of bridges. They will be testing two types of bridges in investigations, and watching a demonstration of a third kind.

Session 2

1. Describe the 50 State Quarters® Program for background information, if necessary, using the example of your own state, if available. Then display the transparency or photocopy of the West Virginia quarter reverse without the image of the bridge included. Locate West Virginia on a classroom map. Note its position in relation to your school's location.
2. With the students, examine the coin design. Have the students point out the elements of this design, including the river, the vegetation around the river, and the words "New River Gorge."
3. Ask the students to define the word "gorge" based on this coin's design. The students should realize that a gorge is a deep passage (in this case the passage holds a river) with steep, rocky sides.
4. Ask the students what they can tell you about West Virginia based on the design of this coin. Answers should include that the state has very dense green vegetation, rolling rivers, and steep mountains.

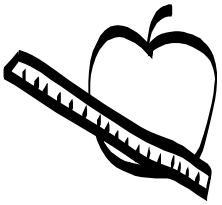


Bridging the Gap

5. Explain that the quarter design is actually missing an image of a bridge. The bridge that actually crosses the New River Gorge is very important in improving travel within the state of West Virginia.
6. Explain that, today, the students will break into small groups in which they will construct two types of bridges. The students will explore what happens to the structure when pressure is applied on the top of it.
7. Distribute a "Building Bridges" lab sheet to each student and then divide the students into small groups of two or three. Direct the students to meet in their groups.
8. Read through the lab sheet as a class and answer any questions about the students' responsibilities during this investigation.
9. Model the students' first investigation problem to show how they will construct a beam bridge.
10. Direct each group to gather a materials tray, follow the directions on the lab sheet, and answer the first set of questions listed under "Investigation #1."
11. Once the students have all completed the first investigation, model the students' second investigation problem to show how they will construct an arch bridge. Direct them to read and complete the remainder of the investigation activities.
12. Direct each group to follow the directions on the lab sheet and answer the first set of questions listed under "Investigation #2."
13. As the students complete the investigations, direct them to compare the two bridges (beam and arch) with their lab partners.
14. Have the students file their "Building Bridges" lab sheets for use at a later time.

Sessions 3 and 4

1. Revisit the bridge-building activity from the previous session. As a class, discuss what the students learned about the bridges. Ask the students which of their models held the greatest amount of weight over the longest distance. Have the students discuss which of their questions from the K-W-L chart were answered by these activities. Add student responses to the **L** column of the chart.
2. Tell the students that, today, they will see a demonstration of Investigation #3, the third type of bridge, a suspension bridge. Explain that the experiment will be demonstrated to the class and that four student helpers will be needed.
3. The students should take out their "Building Bridges" lab sheets to record the findings of the demonstration under "Investigation #3."
4. Explain to the students that the third bridge investigation is more complicated than the other two. It requires more steps, time, and materials. Solicit four student volunteers. Have the other students follow along in their lab sheets as you set up, explain, and conduct the investigation for a suspension bridge. Tell them that a suspension bridge operates

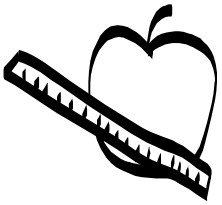


much like this example. Two towers (the chairs) support cables (the rope) that are anchored at each end. The roadway (the cardboard) is suspended from these cables.

5. Conduct the investigation and, from the class discussion, have the students fill out their lab sheets. Provide enough time for them to create their drawings of the investigation.
6. Review the discussion from Session 2 about the beam and arch bridges with the students. Discuss the strengths and weaknesses of the suspension bridge as well.
7. Direct the students to complete the "Investigation" question on their lab sheets.
8. Introduce the students to the selected video about bridges.
9. Distribute a "Bridge Basics" note-taking sheet to each of the students. Explain that, as the students watch the video, they will need to take notes about the different types of bridges that exist and how engineers choose a specific type of bridge.
10. As a class, view the selected video. After the viewing, attend to any student questions or concerns.
11. Direct the students to use the information from this video to amend their responses to the "Investigation" question on their lab sheets if necessary.
12. Review all the material presented in the investigation and video. Have the students discuss which of their questions from the K-W-L chart were answered by this video. Add student responses to the **L** column of the chart.
13. Tell the students to file their "Bridge Basics" note-taking sheets for use at a later time.

Session 5

1. Lead a discussion about the three investigations. Have the students reflect on the various parts of each investigation. They should review and discuss items such as the amount of time, materials, and people needed to complete the task.
2. Have the students discuss the strengths and weaknesses of the three bridge types. Responses should reflect that both the arch and suspension bridges can span longer distances. The suspension bridge takes the longest to build, costs the most, and requires the most materials. The beam bridge is the most basic type of bridge, requiring very little time and materials.
3. Direct the students to get with a partner and think about all of the new information that they have learned about bridges and the area surrounding the New River Gorge. Based on the information the students have collected on their "Building Bridges" and "Bridge Basics" sheets as well as the information listed on the K-W-L chart, the students should make a final decision about what kind of bridge they feel would work best for crossing the New River Gorge.
4. Distribute a photocopy of the 'Missing Bridge' page and the "'Missing Bridge' Quarter" page to each student.

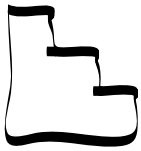


Bridging the Gap

5. Direct each student to complete the West Virginia quarter design by drawing his or her selected bridge type on this image. On a piece of writing paper, have each student write an explanation for why he or she believes his or her selected type of bridge would work best in this scenario. The students should use information from their investigations and research to support this choice.
6. After all papers are written and collected, display the actual West Virginia quarter design for the students.
7. Have the students identify the type of bridge displayed on this coin. Ask the students how many of them thought that an arch would be the best choice for this bridge.
8. As a class, discuss why this is an appropriate bridge type for this situation and have the students justify their conclusions. Direct the students to include in their final response reasons that the other types of bridges would not be appropriate bridge options for this site.

ENRICHMENT/EXTENSIONS

- Introduce students to the terms "compression" and "tension" in relation to bridges. Use these terms when discussing the way the bridge reacts to the weight being placed upon it.
- Invite students to explore the bridge that is shown on the Rhode Island quarter. They should investigate what type of bridge this is, where this bridge is located, and express why this type of bridge was selected rather than a different type.



DIFFERENTIATED LEARNING OPTION

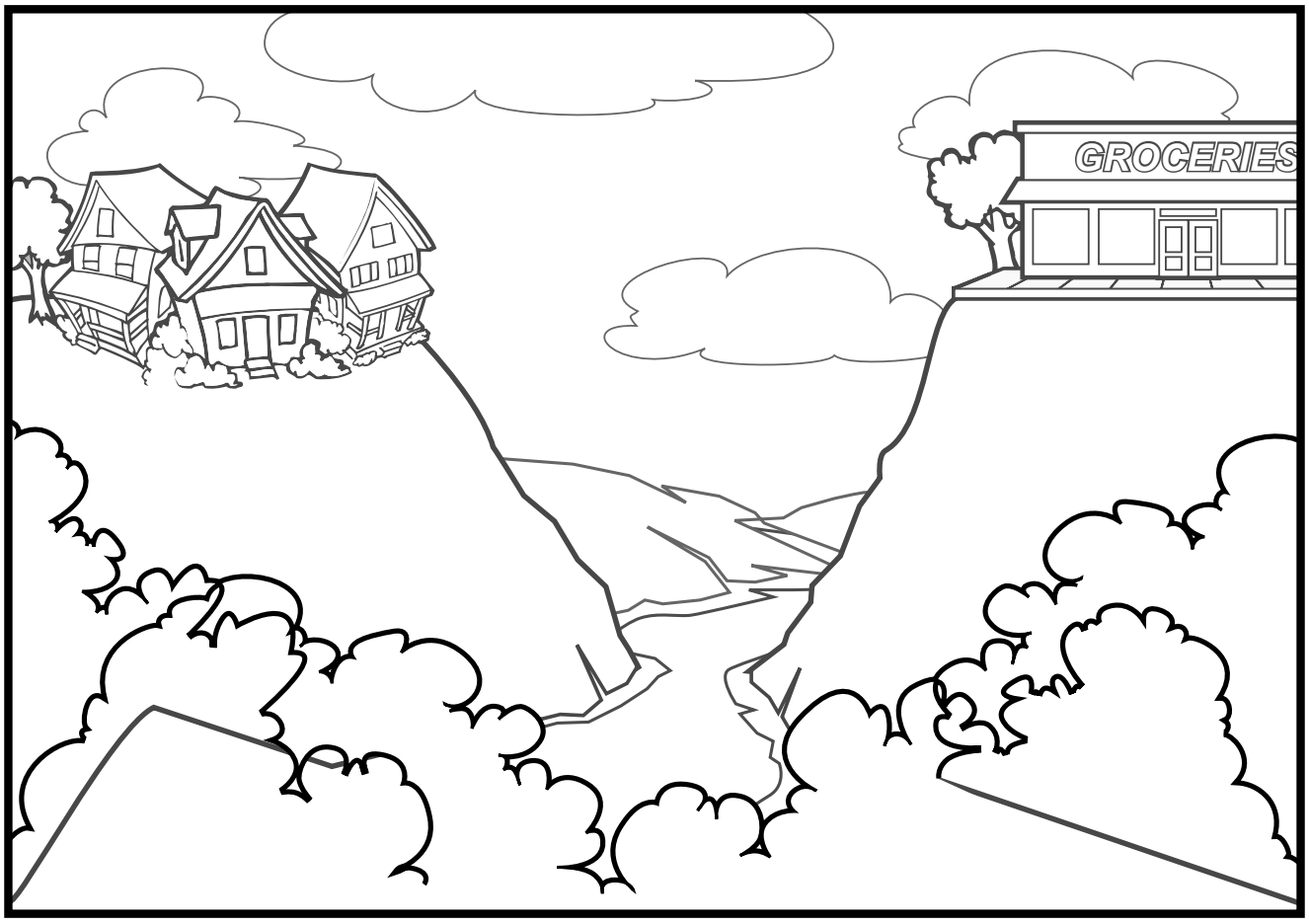
Provide students with a vocabulary list of key bridge terms to assist with their investigation.

CONNECTION TO WWW.USMINT.GOV/KIDS

What's another great arch that has been featured on a coin? Take a look at the Missouri quarter under "The Coins Are Coming" on the United States Mint H.I.P. Pocket Change™ Web site. (www.usmint.gov/kids/index.cfm?fileContents=coinNews/50sq.cfm)

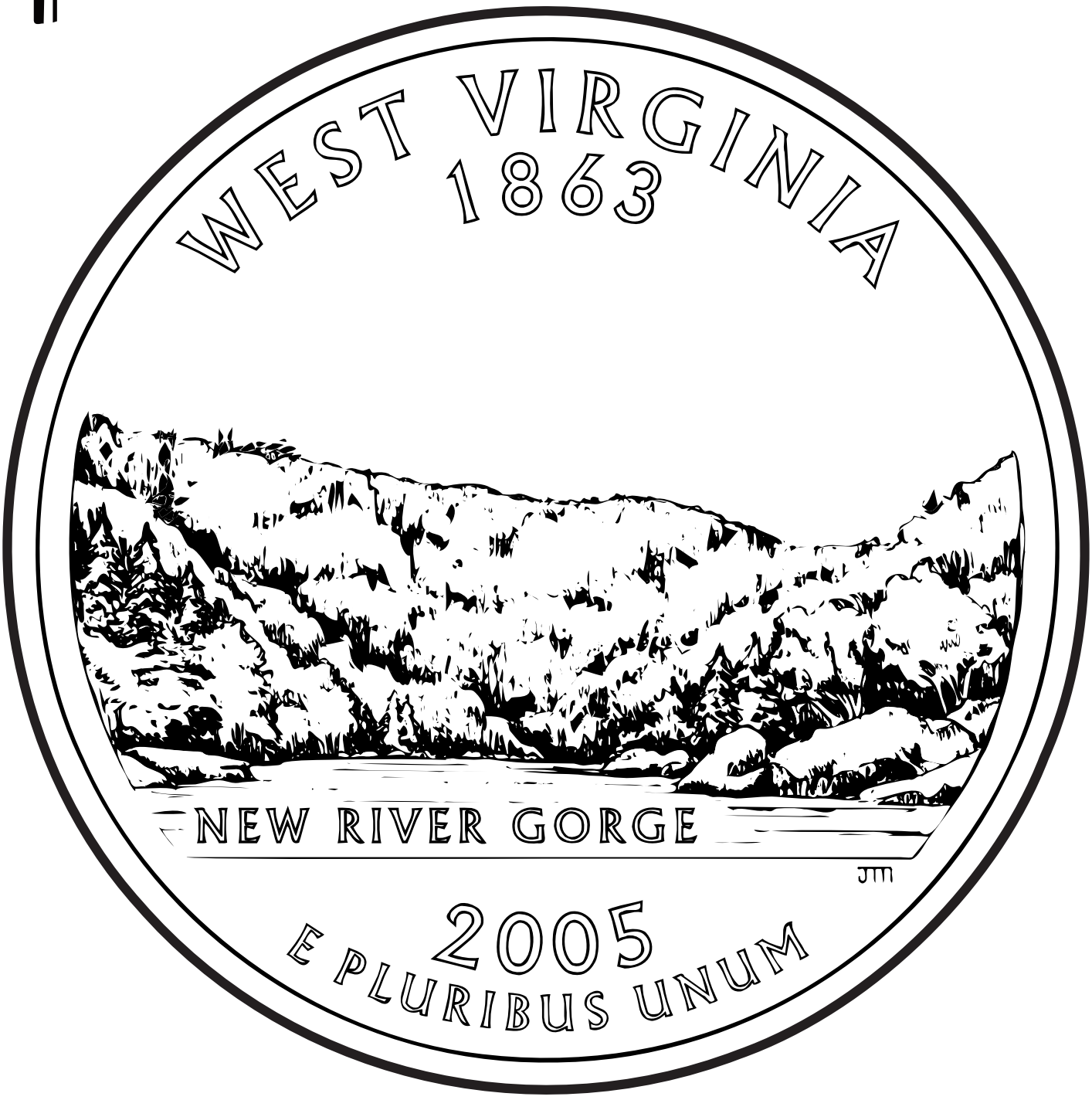
NAME_____

What's the Problem?



NAME_____

"Missing Bridge" Quarter



NAME_____

Building Bridges (1)

INVESTIGATION #1: BUILDING A BEAM BRIDGE

Materials:

- Two books of identical thickness
- One 4" x 6" index card
- Sixteen U.S. quarters
- One ruler

Directions:

1. Use your ruler to help you place the two books one inch away from each other.
2. Place the index card across the two books so that same amount of index card is covering both books.
3. One at a time, stack your quarters on the bridge that you've made between the two books.
4. How many quarters was your bridge able to hold when the books were only one inch apart? _____
5. Remove all of your quarters and the index card from their current location.
6. Now move your books so that the gap between them is two inches apart.
7. Again, place the index card across the two books so that same amount of index card is covering both books.
8. One at a time, add your quarters to the bridge that you've made between the two books.
9. How many quarters was your bridge able to hold when the books were two inches apart? _____
10. Draw a picture and describe what your bridge looked like with that number of quarters on it.

    _____

    _____

    _____

11. Repeat steps 5 through 8, but make the gap between the books three inches apart.
12. How many quarters was your bridge able to hold when the books were three inches apart? _____
13. Draw a picture and describe what your bridge looked like with that number of quarters on it.

    _____

    _____

    _____

14. Does the weight of the quarters seem to settle in the middle or at the end of the bridge? _____
15. What can you tell about a beam bridge based on this model? Do you think it is a poor or ideal structure to place across a long distance? Why?

    _____

    _____

    _____

NAME_____

Building Bridges (2)

INVESTIGATION #2: BUILDING AN ARCH BRIDGE

Materials:

- Two books of identical thickness
- One 4"x 6" index card
- Sixteen U.S. quarters
- Scissors
- One ruler

Directions:

1. Hold the index card so that the lines are facing you and vertical (up and down).
2. Cut a one-inch notch along the pink line at the top of the card.
3. Cut a second one-inch notch along the third blue line from the bottom of the card. Your card should look like Figure 1.
4. Turn the card so that you now have the opposite end facing you.
5. Repeat steps 2 and 3 for this side of the card. Your card should look like Figure 2.

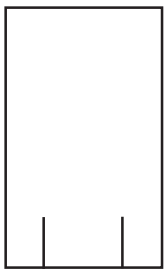


Figure 1

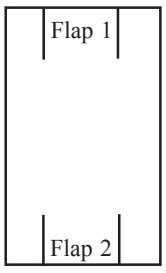


Figure 2

6. Place the two books two inches apart with their openings facing each other.
7. Bend flaps 1 and 2 and place them under the book covers.
8. In piles of four, stack your quarters on the bridge that you've made between the two books.
9. How many quarters was your bridge able to hold when the books were two inches apart? _____
10. When these coins were added, were the flaps against the books, or did they stick up in the air? Draw a picture and describe the bridge at this point.

    _____

    _____

11. Remove all of your quarters from the bridge. Carefully spread your books to four inches apart.
12. Replace the quarters. How many quarters did your bridge hold when the books were four inches apart? _____
13. When these coins were added, were the flaps against the books, or did they stick up in the air? Draw a picture and describe the bridge at this point.

    _____

    _____

14. Based on what you've seen, which type of bridge do you think would hold more weight? Explain your reasons.

    _____

    _____

15. Which type of bridge (beam or arch) would work best across a long distance? Why do you think so?

    _____

    _____

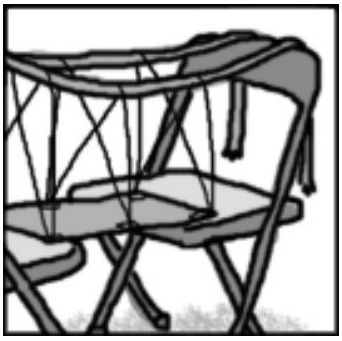
NAME_____

Building Bridges (3)

INVESTIGATION #3: BUILDING A SUSPENSION BRIDGE

Materials:

- Two chairs with backs
- Heavy string
- 1 piece of cardboard 3 feet by 1-1/2 feet
- Stack of books
- Two 9-foot pieces of rope
- Strong tape
- Scissors



Directions:

1. Your teacher will ask for four volunteers to help with this more complex experiment.
2. Two chairs will be placed to face each other and the cardboard will rest on them, each end on a seat.
3. The two pieces of rope will be suspended between the chair backs, above the cardboard.
4. The students pull the ropes until they are tight, with extra rope hanging down the chair backs.
5. Three pieces of string will be tied onto each one of the ropes. The ends of the string will be taped to the outer edges of the cardboard at both ends and the middle of the cardboard.
6. Predict how many books the bridge will hold: _____ books.
7. Now to test the bridge. Students will place one stack of books on the cardboard.
8. How many books did it hold? _____ books.
9. More books will be placed on the bridge. How many were added? _____ books.
10. Describe what happened: _____.
11. Why was the bridge able or not able to support the weight of the books?

_____

13. Try the same experiment not pulling on the ropes as hard. What happens?

_____

_____

14. Draw what the bridge looks like at this point.
15. Of the three types of bridges you have investigated, which would be the strongest for crossing an extremely long distance? Explain.

_____

_____

_____

Investigation Question: The distance across the New River Gorge is 3,030 feet. Now, make a prediction! Based on what you've seen from these investigations, which type of bridge do you think would work best at the New River Gorge? Why?

_____

_____

_____

NAME_____

Bridge Basics

Directions: Record what you learn about each of the following types of bridges. Be sure to listen for reasons that an engineer would choose one type of design over another.

TYPE OF BRIDGE	BEAM	ARCH	SUSPENSION
What are the strengths of this type of bridge?			
What are the weaknesses of this type of bridge?			
Normally, how long is this type of bridge (between what lengths)?			
List any other important information you have learned about this type of bridge (such as amount of materials needed, time required for construction, cost of building materials, etc.).			

West Virginia Quarter Reverse