

## A Sticky Situation: Building a Sweet Bridge

You are part of a civil-engineering team that has been called on by a local engineering company to build the strongest bridge while spending the least amount of money. The problem is you are not the only team that the company asked to take part in this task. The company will pick the best engineering team's model as the official bridge that it will build over the Ohio River. The company will consider two aspects to choose the winner—(1) what is strongest and (2) what is cheapest. You will need to use the given materials to build the sturdiest and strongest bridge.

You are only allowed to use toothpicks and marshmallows plus one other material of your choice (pipe cleaners, Popsicle sticks, or something similar).

### Project Tasks

1. Build a bridge using as many marshmallows and toothpicks as needed plus one other material of your team's choice. Use the table "Bridge Building Price List" to represent parts of the bridge. Be sure that your bridge is four by eight inches long (measured with area squares).
2. Remember to keep track of how many materials you use to build the bridge. Determine how much money you spent building the bridge based on the given price sheet. Complete the "Sticky Situation Project Organizer."
3. Test your bridge. Be sure the desks are separated by five inches when testing weight. Complete the "Testing the Bridge and Analysis Worksheet" (page 204). Critique the overall effectiveness of your bridge design. Could you have made improvements?
4. Examine other designs. Complete the "Comparison Chart" worksheet (page 204) by comparing and contrasting data (price versus weight in grams). Create two bar graphs in Microsoft Excel displaying the data.
5. Think about the impact of gravity on the bridge. Complete the "Gravitational Force Conclusion" worksheet (page 205).
6. Review the section "Criteria for Success" (page 205), and design a persuasive Prezi or Glogster presentation to prove why your design is the best.

**Bridge-Building Price List**

ITEM	PRICE	REPRESENTATION
<b>Toothpick</b>	\$1	Small steel beam
<b>Small marshmallow</b>	\$2	Small joint or bracket
<b>Large marshmallow</b>	\$4	Large joint or bracket
<b>Popsicle stick</b>	\$4	Large steel beam
<b>Glue container</b>	\$2	Cement or concrete
<b>Pipe cleaner</b>	\$3	Cable
<b>String or yarn</b>	\$5 per foot	Steel cable

**Sticky Situation Project Organizer**

Use the following area to sketch your ideas for building a model bridge.

Use the chart to document how many materials you use to create the model. Calculate the total cost. Transfer the data from your recording sheet to Google Sheets or Microsoft Excel. Choose Insert and Chart, and then choose the Double Bar Graph option.

<b>Team number:</b>			
<b>Team name:</b>			
ITEM	AMOUNT NEEDED	PRICE OF ITEM	TOTAL COST
Total cost:			

### Testing the Bridge and Analysis Worksheet

Use this chart to record the number of area tiles your model can hold. Each tile represents 1 gram. Each gram in the model would equal 1,000 pounds.

RESULTS	
<b>Number of Area Tiles (Tallies)</b>	
<b>Pounds the Bridge Can Hold</b>	

After you have tested your bridge, write an analysis of your experiment. Think about ways that you could decrease the pressure of gravity on your bridge. Reflect on the positive aspects of your bridge and areas for improvement. Record your explanation here.

### Comparison Chart

Use this chart to compare and contrast the groups' spending and bridge strength.

GROUP NUMBER	AMOUNT SPENT	AMOUNT OF WEIGHT BEFORE COLLAPSING (IN GRAMS)	OVERALL PLACE: STRENGTH	OVERALL PLACE: COST
1				
2				
3				
4				
5				

Compare and contrast every group's data to your own data. (How much money did each group spend in comparison to how much weight total its bridge was able to hold? Look for connections and such.) Use this information to create a bar graph using Google Sheets or Microsoft Excel.

Use the following directions.

1. Create a bar graph that shows each group's cost compared to the strength of its bridge.
2. Transfer the data from your recording sheet to Google Sheets or Microsoft Excel.
3. In Excel or Sheets, choose Insert and Chart. Choose the Double Bar Graph option.

## Gravitational Force Conclusion

Use your observations to write a paragraph about the effects of gravity on your bridge and ways that you could decrease the pressure of gravity on the suspended bridge.

As you write, be sure to include:

- Scientific information you have learned about the effects of gravity
- How that information relates to your bridge project
- Examples from your project that support the scientific ideas about gravity
- Correct grammar, capitalization, and punctuation

### Criteria for Success

When you complete a task, check it off the list. Use this tool as a guide to make sure you have successfully completed each step of the project.

COMPLETED	TASK
	Take pictures throughout the whole project!
	Use only small marshmallows, large marshmallows, and toothpicks.
	The bridge is four by eight inches long (measured with area squares).
	Desks are separated by five inches when testing weight.
	The amount of material and total cost are tracked on "Sticky Situation Project Organizer."
	The total amount of weight the bridge held is on the tally sheet.
	"Comparison Chart" is completed.
	A bar graph is created using Microsoft Excel or Google Sheets. <ul style="list-style-type: none"> <li>• The bar graph is labeled correctly (title, x-axis, y-axis, numbers).</li> <li>• The bar graph number interval is realistic (if your bridge cost \$400 and held 250 area squares, you don't have an interval of 2).</li> </ul>
	An analysis is typed using Microsoft Word. <ul style="list-style-type: none"> <li>• The analysis is free of grammatical errors.</li> <li>• The analysis uses correct punctuation and capitalization.</li> <li>• The analysis correlates with the bar graph that was created.</li> </ul>
	A Prezi or Glogster presentation is created. <ul style="list-style-type: none"> <li>• It includes progressive photographs from building and testing the bridge.</li> <li>• It has at least three captions on the photographs added to the presentation.</li> <li>• It includes a bar graph.</li> <li>• It includes an analysis.</li> <li>• It includes an explanation of the bridge model construction. The explanation can be created with an app or program like Blabberize (<a href="http://blabberize.com">http://blabberize.com</a>), PowToon (<a href="http://www.powtoon.com">www.powtoon.com</a>), Toontastic (<a href="https://toontastic.withgoogle.com">https://toontastic.withgoogle.com</a>), and such.</li> <li>• It uses correct grammar, capitalization, and punctuation.</li> </ul>
	The gravitational force conclusion is written.

## Scoring Rubric

	<b>1 SIGNIFICANT REVISION NEEDED</b>	<b>2 SOME REVISION NEEDED</b>	<b>3 PROFICIENT</b>	<b>4 EXCEEDS EXPECTATIONS</b>
<b>Objective 1: Students will become engineers by design- ing and building a model of the stron- gest bridge possible.</b>	Plan sketch is miss- ing or irrelevant.	Plan sketch is in- cluded with several mistakes or omis- sions.	Plan sketch is in- cluded, complete, and accurate.	Plan sketch is com- pleted and accurate with creative design elements.
	Model does not meet requirements on criteria for suc- cess.	Model meets some requirements on cri- teria for success.	Model meets all requirements on cri- teria for success.	Model meets all requirements on criteria for success and shows creative thinking.
	Model omits a type of required material, or other items are included.	Model does not omit a type of required material but may include items not listed.	Model utilizes all correct materials.	Materials are cor- rectly and creatively used.
	Bridge is not tested, or bridge is tested with incorrect ma- terials.  Recording chart is missing or incom- plete.	Bridge is tested with the correct materi- als.  Recording chart is complete with errors.	Bridge is correctly tested.  Recording chart is complete with few, minor errors.	Bridge is correctly tested.  Recording chart is complete with no errors.
	Presentation (Prezi, Glogster) is miss- ing, incomplete, or irrelevant.  Presentation does not meet the re- quirements on crite- ria for success.	Presentation (Prezi, Glogster) is com- plete and included.  Presentation meets some of the require- ments on criteria for success.	Presentation (Prezi, Glogster) is com- plete and included.  Presentation meets all the requirements on criteria for suc- cess, with very few errors.	Presentation (Prezi, Glogster) is com- plete and shows creativity.  Presentation meets all the requirements on criteria for suc- cess, with no errors.
	Gravitational force conclusion is miss- ing or incomplete.  No scientific ideas are used to support student's thinking.	Gravitational force conclusion is com- plete.  Few scientific ideas are used to support student's thinking.  Conclusion does not include direct con- nections to bridge project.	Gravitational force conclusion is com- plete.  Scientific ideas are used to accurately support student's thinking.  Conclusion includes some connection to bridge project.	Gravitational force conclusion is com- plete and organized.  Scientific ideas are clearly used to accurately support student's thinking.  Conclusion includes direct ties to and examples of bridge project.

	<b>1 SIGNIFICANT REVISION NEEDED</b>	<b>2 SOME REVISION NEEDED</b>	<b>3 PROFICIENT</b>	<b>4 EXCEEDS EXPECTATIONS</b>
<b>Objective 2: Students will analyze cost effi- ciency by calculating the amount of materials used and finding the final cost of building their bridge.</b>	Calculation chart is missing or included with many errors. Group comparison chart is missing or included with many errors.	Calculation chart is included with several errors. Group comparison chart is included with few errors.	Calculation chart is included with only minor errors. Group comparison chart is included with no errors.	Calculation chart is included with no errors. Group comparison chart is included with no errors.
	Bar graph is missing or completely incorrect. Written analysis is missing or irrelevant.	Bar graph is included with many errors. Written analysis is included with some support from the data in the comparison chart.	Bar graph is included with only minor errors. Written analysis is included with adequate support from the data in the comparison chart.	Bar graph is included with no errors. Written analysis is included with clear support from the data in the comparison chart.