Can you build a bridge?

Using toothpicks and gum drops



Project Goals – your bridge MUST:

* Crosses the river (6 inch gap)
* Allows a truck to pass through
* Be efficient - Carries the most weight using the least amount of materials



What you need:

* About 20 gum drops
* About 40 toothpicks
* Bridge deck (piece of cardboard for truck to drive over)
* Toy truck (to check clearance)
* Cup and pennies (or other weights)



Designing your bridge

Truss bridges use a series of triangles to support themselves and what they are carrying. Take a look at these different types of trusses to help inspire your bridge. Brainstorm with a friend and design the bridge that can carry the most weight with the fewest pieces.



Why use triangles?

Triangles are one of the strongest shapes. When you push on the triangle the load goes through the sides to the ground. In a shape like a square the load goes into a side which may bend and through the joints which may be weak twist. In a shape like a circle the load needs to curve around the shape and it may squash.



Bridge goals

Bridges have two types of goals:

* Must haves or requirements –is strong enough (does not collapse) and can serve its function (carries traffic)?

Your bridge needs to carry a toy truck and allow it to pass through

* Challenges or options – considerations like cost (using the least amount of materials), ease of construction, and how it looks.

Your challenge is to build a bridge that carries the most weight with the least amount of materials

Think about it….

Now it is time to design your bridge. What shapes should you use? How many toothpicks are needed. Brainstorm some ideas with your friends and try to design a bridge the meets the project goals. Use the graph paper (last page) to sketch your design.

Time to test!

Let’s test your bridge. First check that the must have is met…the truck can pass through. Then load up the bridge until it fails!

Redesign?

Your first design may not be the best one. Engineers usually go through many designs before determining which one meets their goals the best. Can you redesign your bridge and make it better?

Was your bridge efficient?

Did you build the strongest bridge with the least amount of materials? Add up the weights and subtract the number of gum drops and toothpicks used. Compare with other groups and see how their designs were different.

Do you want to be an engineer?

Do you like to solve problems, figure out how things work, or make them better? Then engineering might be for you! There is a wide variety of engineers out there and they need lots of different skills. What engineering skills do you have?

* Likes to solve problems
* Good at math and science
* Good at creative thinking (coming up with new ideas)
* Great at communication (writing and talking)
* Ability to organize and make connections
* Can get along well with others
* Determined to get things done and do a good job
* Leadership





6 in gap

Support

Support

Use this graph paper to help design your bridge

6 inches

Teacher Notes:

Prepare ahead of time

* Make sure you have enough supplies (first page) for all students. Students can work in groups.
* Print out copies of instructions including test and graph paper.

Introduce the challenge (20 min video + 10 min discussion)

* Show the video on how bridges work.
* Talk with students about how bridges work. What are the different bridge types? Why are triangles used in trusses? How is a bridge designed?
* Go over activity instructions and goals.

Brainstorm and Design (10 min)

* Give students about 10 min to brainstorm and design their bridges. Have them check:
  + Does the bridge meet the must haves – can it span 6-inch gap and allow a truck to pass through?
  + Is the shape efficient (can you use less materials to carry more weight)?
  + Where might the bridge fail (weak point)? Can this be reinforced?

Build, Test, Evaluate, Redesign (30 min)

* Have students build bridges. Help them think through design and if it will work.
* Test the bridges. Apply weight to the bridge until it fails. Failure is when any one toothpick comes completely out of the gumdrop (bridge may not have completely collapsed). If you have weights (like pennies) of the same size you can count the weights, if not you can simply weigh the total on a scale after testing.
* If there is time let the students redesign and come up with a better bridge.
* Total the weight (or number of weights) and subtract the number of toothpicks and gumdrops used. Who had the most efficient bridge?

Discussion (10 min)

* Ask some of these questions to help students think about their design:
  + Why are triangles used in truss bridges? (see page 2 for answer)
  + Look at which bridges were the most efficient. Did they share any common characteristics?
  + Why is it important that bridges be efficient? (more efficient bridges cost less)
  + What did you learn about bridge design?
  + Did brainstorming and thinking about their design help them come up with a good design?
  + Why is it important to redesign? Did anyone come up with a better design the second time around?

A picture containing person

Description automatically generated

Testing bridge – can pass toy car through



Testing bridge – can carry weight

**How Bridges Work | Educational Standards Alignment**

**Elementary**

* [**Next Generation Science Standards**](https://www.nextgenscience.org/)
  + [K-2 Engineering Design](https://www.nextgenscience.org/topic-arrangement/k-2engineering-design)
    - [K-2-ETS1-1 Engineering Design](https://www.nextgenscience.org/pe/k-2-ets1-1-engineering-design)Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.
    - [K-2-ETS1-2 Engineering Design](https://www.nextgenscience.org/pe/k-2-ets1-2-engineering-design)Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.
    - [K-2-ETS1-3 Engineering Design](https://www.nextgenscience.org/pe/k-2-ets1-3-engineering-design)Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.
  + [3-5 Engineering Design](https://www.nextgenscience.org/dci-arrangement/3-5-ets1-engineering-design)
    - [3-5-ETS1-1 Engineering Design](https://www.nextgenscience.org/pe/3-5-ets1-1-engineering-design)
    - Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
    - [3-5-ETS1-2 Engineering Design](https://www.nextgenscience.org/pe/3-5-ets1-2-engineering-design)Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
    - [3-5-ETS1-3 Engineering Design](https://www.nextgenscience.org/pe/3-5-ets1-3-engineering-design)Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
* **Common Core State Standards Connections:**
  + K-2
    - ELA/Literacy –
      * W.2.8 Recall information from experiences or gather information from provided sources to answer a question. (K-2-ETS1-1),(K-2-ETS1-3)
    - Mathematics –
      * MP.2 Reason abstractly and quantitatively. (K-2-ETS1-1),(K-2-ETS1-3)
      * MP.4 Model with mathematics. (K-2-ETS1-1),(K-2-ETS1-3)
      * MP.5 Use appropriate tools strategically. (K-2-ETS1-1),(K-2-ETS1-3)
  + 3-5
    - ELA/Literacy -
      * RI.5.1 Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. (3-5-ETS1-2)
      * W.5.8 Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources. (3-5-ETS1-1),(3-5-ETS1-3)
    - Mathematics -
      * MP.2 Reason abstractly and quantitatively. (3-5-ETS1-1),(3-5-ETS1-2),(3-5-ETS1-3)
      * MP.4 Model with mathematics. (3-5-ETS1-1),(3-5-ETS1-2),(3-5-ETS1-3)
      * MP.5 Use appropriate tools strategically. (3-5-ETS1-1),(3-5-ETS1-2),(3-5-ETS1-3)