# Lesson Plan for Bridge Building

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### Introduction/Background Info

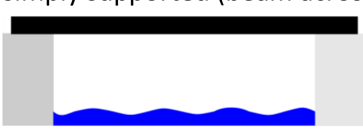
Bridges are structures built to get from point A to point B when the land in between is inaccessible. The earliest bridges were simply logs laid across a stream or stones creating a path across a river, and grew to be more advanced by weaving together combinations of sticks, logs, branches, weeds and other fibers to form ropes capable of holding together bridge materials. These simple ideas were the foundations of the beam designs used in modern culture. Bridges today are made of wood, concrete, and/or steel and have many different structures. Some examples include beam, truss, cantilever, arch, suspension, and cable.

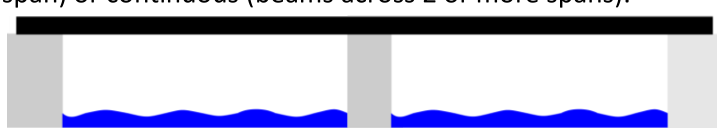
### Student Objectives

Through this activity, students will learn the basic design of bridges and which structures are the most stable and efficient in terms of the amount of material used.

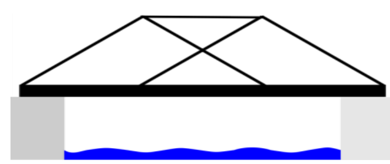
### Topics/Vocabulary

- ***Beam Bridge.*** The simplest design, a horizontal beam spanning between two regions; it can either be simply supported (beam across a single span) or continuous (beams across 2 or more spans).

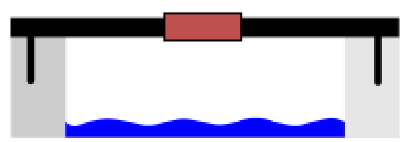




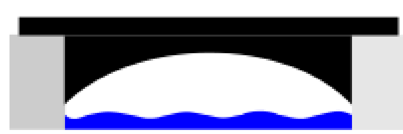
- ***Truss.*** Structure of connected elements forming a triangle. Truss bridges are structurally stable because the forces are distributed throughout the triangle.



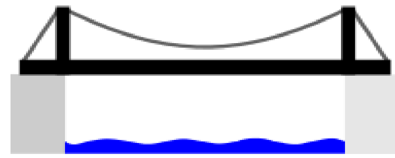
- ***Cantilever.*** Horizontal beam supported only on one end. Most cantilever bridges have 2 cantilever beams coming from opposite directions and connected by a suspended span in the middle.



- ***Arch***. Horizontal beam with structures on both end where the load is distributed



- ***Suspension Bridge*.** Bridge suspended from cables that are attached to large towers that are implanted deep into the floor of a lake or river.



## Overview of Lesson Process

- Intro (5 mins): Talk about the different types of bridges, see if they can match the famous bridges to what structure/type they are. Ask which design they think will be the most structurally stable. Then, introduce the activity. *Answers: (top left) – Arch; (top right) – Cantilever. Notice the small suspended span in the middle; (middle) – Suspension; (bottom left) – Truss; (bottom right) – Beam.*
- Activity (30-40mins): Split into groups of 3 or 4 and build 2 different bridges – truss and beam. These are the simplest kinds of bridges and will aid in understanding why some structures and shapes work better than others.
- Testing (10-15 mins): Test the bridges. You can do this either with the individual groups or everyone together. If there is a time crunch, then do it within the individual groups.
- Wrap-up (10 mins): Ask which bridge worked best and why. Clean up.

## Materials

- Marshmallows: 48 per group ($3 for 16 oz. bag)
  - *Keep the marshmallows in an airtight bag so they don't get stale*
- Round Toothpicks: 83 per group ($1.50 for 250)

## Procedures

*Phase 1. Making the bridges*

- Give students the materials and plan sheets for both bridges. Tell them that the best method to make the bridges is to assemble the 2 sides, then add the top and bottom. Work from left to right across the plan, making sure to not miss any toothpicks.

*Phase 2. Testing*

- Have the kids place 2 chairs next to each other with some gap in between. Lay the bridge across the chairs. Then, slowly push down on the bridge. The marshmallow bridges are pretty weak and will cave almost immediately without any pressure. When the bridge breaks, notice whether it has just come apart at a joint or a toothpick has snapped. Also notice how the squares have turned into rhombuses, but the triangles have remained the same shape.
- For the second bridge, pile the books on in the same order so the "weight added" remains the same.

*Phase 3. Conclusion*

- Go over concepts in conclusion section

**Conclusion: "What Makes a Bridge Good?"**

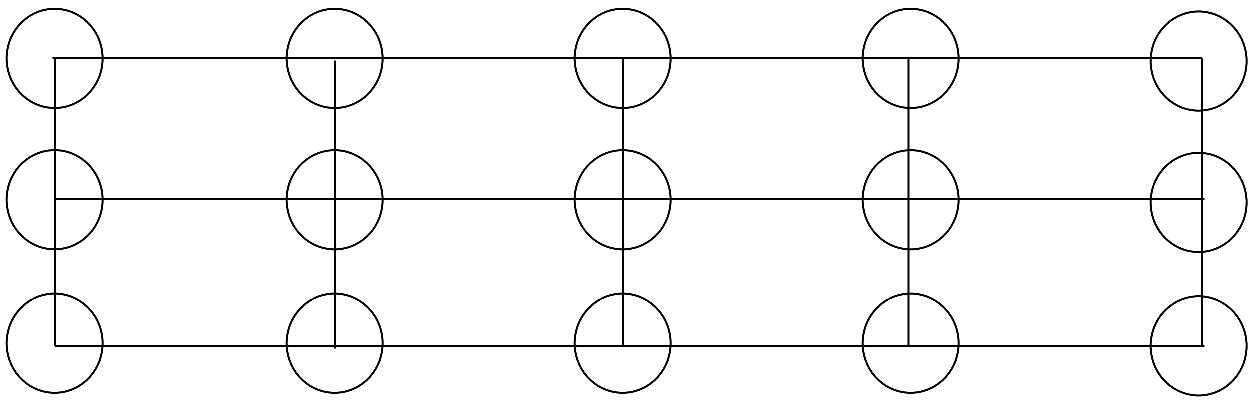
- Even Weight Distribution
  - Want weight to be borne by the entire structure, no stress concentrated at a single point.
  - Stress = Force/Area. By increasing the load bearing area, the stress at each point is reduced.
  - Want weight to be transmitted from the center of the bridge outward towards the base (contact points with the chair).
- Trusses (Triangular Units)
  - Direct weight (stress) toward the corners of the triangle.
  - Triangles are strong bases because their geometry is fixed/locked in place: triangles cannot be squished/deformed without changing the length of the sides.
  - Squares elongate/stretch to become diamonds, triangles don't have this flexibility
- Small Repeating Units
  - Build the bridge from smaller repeating units, adds stability and allows for symmetry
- Symmetry
  - Allows for even load distribution
  - Bridges must maintain good strength at every point. If there is a single weak spot, the bridge will buckle.

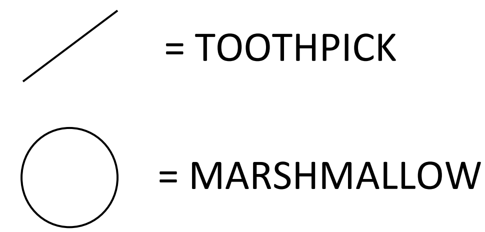
**Resources**

UC Berkeley BEAM Lesson: **http://beam.berkeley.edu/node/793**

Gumdrop Bridges: **http://kansasenginerd.hubpages.com/hub/Gumdrop-Bridges**

# BRIDGE PLAN #1



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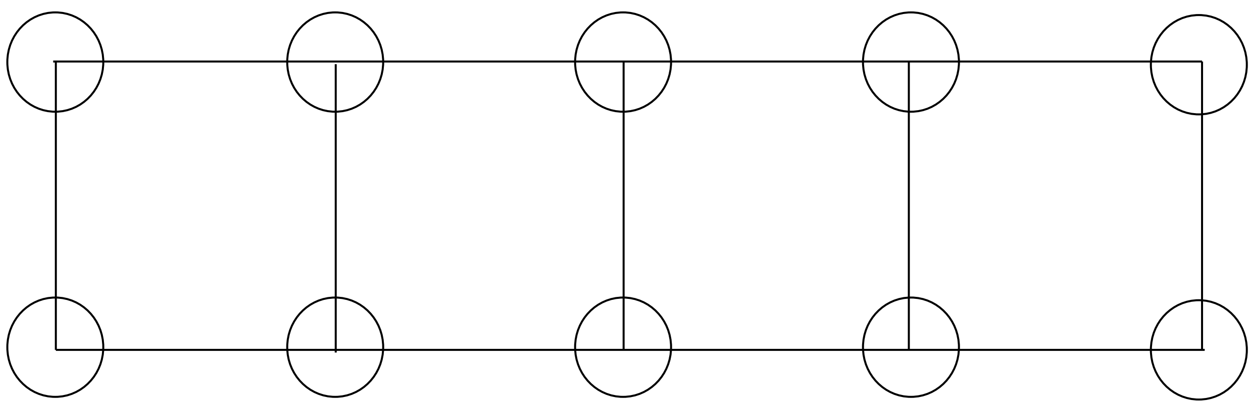
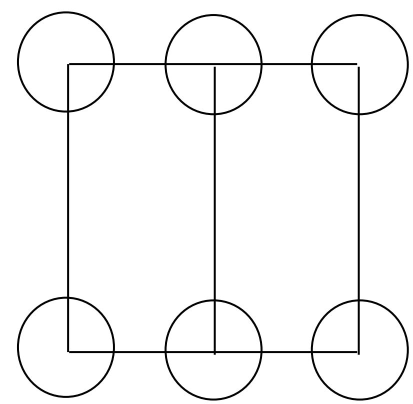


**SIDE**



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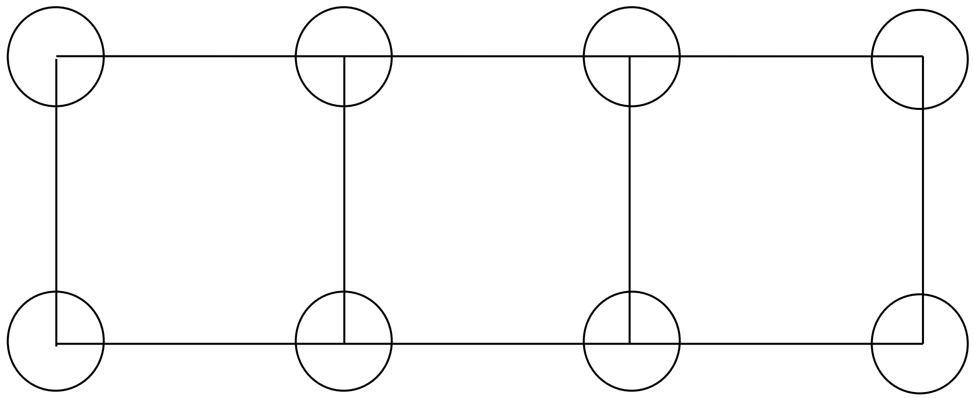
# BRIDGE PLAN #2



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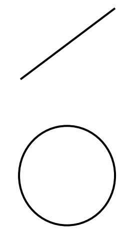
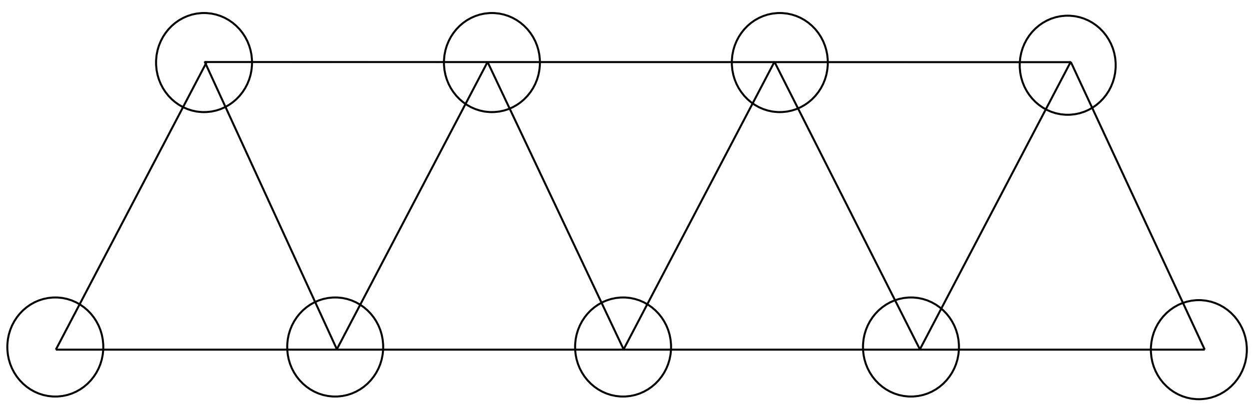
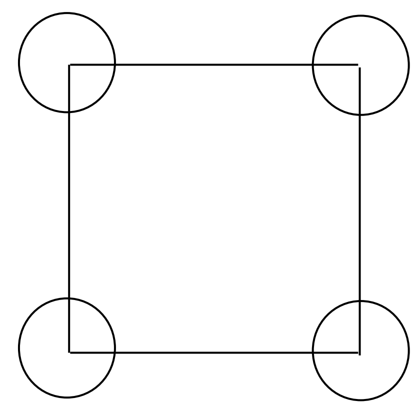


= TOOTHPICK

= MARSHMALLOW



**SIDE**



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