Hands On!

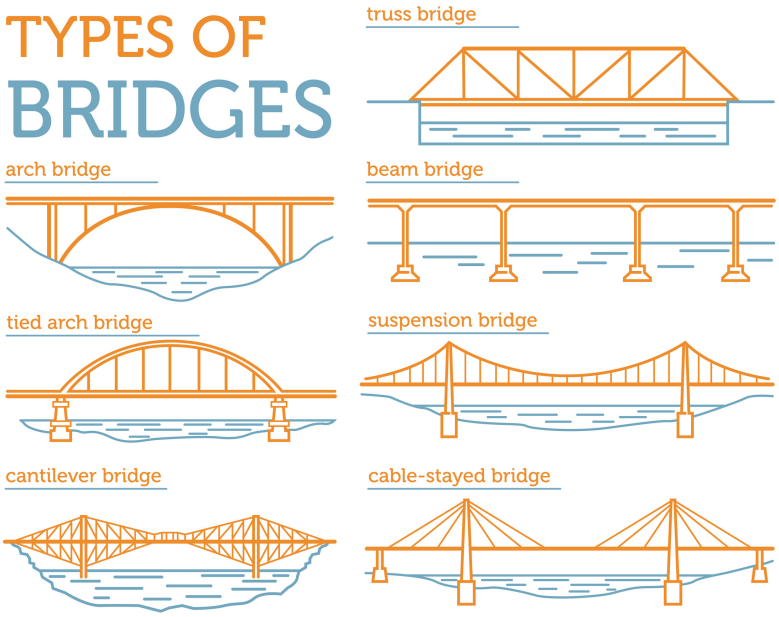
Bridge Challenge

NGSS Standards	**MS-PS2-2: Motion & Stability: Forces and Interactions** **MS-ETS1-1, 2, 3: Engineering Design**
Cross Cutting Concepts	• Systems and System Models • Structure and Function • Stability and Change
Science & Engineering Practices	• Asking Questions and Defining Problems • Planning and Carrying Out Investigations • Analyzing and Interpreting Data • Constructing Explanations and Designing Solutions
Objective	With the materials provided, students will build a bridge that spans a gap of at least 30 cm. The bridge should be sturdy enough to hold a maximum load in its center, without collapsing, for at least 30 seconds.

Materials

(Use any combination of materials.)

- Craft Sticks, toothpicks, wooden dowels, straws and/or pasta
- Glue or tape
- String or dental floss
- Binder clips, Paper clips
- Scissors
- Various weights (small cans of vegetables also make great weights)
- Ruler or measuring tape
- Books or blocks for support
- Balance scale
- Stopwatch or timer



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This STEM programming was made possible by the Virginia General Assembly for COVA STEM Hub for regional activities and programming.

Terms:

Arch, Beam, Cantilever, Force, Gravity. Load, Load-Bearing Capacity, Span, Stability, Strain, Stress, Support (Abutment), Suspension Bridge, Tension, Truss

Lesson Overview

1. Introduction (15 minutes)

- Start by discussing the importance of bridges and their various types, such as arch, beam, suspension, truss bridges, etc.
- TIP: The Virtual Science Teacher Bridges Interactive is a great is a great introductory activity!
- Introduce the challenge: **Students are tasked with designing and constructing a bridge that should span 30 cm and have the capability to support a predetermined load for at least 30 seconds. Students will then be challenged to have their bridge support the greatest load possible for at least 30 seconds.**

2. Brainstorming and Planning (15 minutes)

- Encourage students to brainstorm different bridge designs and materials they can use.
- Inform the students of the minimum weight load with which they will initially test their designs.
- Have them sketch their initial design ideas and label the materials they plan to use.
- Emphasize the need to consider stability, load-bearing capacity, and the bridge's overall structure during planning.

3. Bridge Construction (20 minutes)

- Provide students with the materials and allow them to start building their bridges.
- Remind them to refer back to their design sketches and make any necessary adjustments as they work.
- Encourage collaboration and problem-solving within each group.

4. Initial Testing (10 minutes)

- Set up one or more testing areas where each group can place the bridge between two supports (e.g., books or blocks) with a 30 cm gap.
- One partner gently places the predetermined weight on the center of the bridge, while another partner should start timing for 30 seconds.
- If the bridge sustains the load for 30 seconds, students can progressively add more weight every subsequent 30 seconds (timer may pause while more weight is added).
- Students should continue to add weight and time 30 seconds until the bridge collapses.
- The students should measure and record the maximum weight sustained and reflect on what aspects of their design were successful or what could be improved.
- The goal is to construct a bridge that holds the maximum load possible before collapsing, noting the highest weight sustained for a minimum of 30 seconds.

5. Redesign & Retest (15 minutes+)

- Based on the analysis and reflection, instruct students to redesign their bridges with the goal of improving their load-bearing capacity and/or stability.
- They can modify their existing designs or create entirely new ones.
- Students will repeat the testing and recording process for the redesigned bridges.

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Lesson Continued

6. Final Reflection (15 minutes)
Encourage students to articulate what they've learned about engineering and problem-solving. If time allows, have each group present their redesign process, discuss their thought process, and share their final testing results with the class.

Final Analysis Questions For Students:

- Did your initial bridge design meet your expectations? Why or why not?
- Did your redesigned bridge(s) perform better than the initial version in terms of load-bearing capacity and stability? Explain.
- How did the forces acting on your bridge, such as gravity and tension, influence its stability and ability to support weight during testing?
- Sketch a picture of the load positioned on your bridge and label all the forces acting on the load
- If you had more time or resources, what additional changes might you consider for further improvement?
- How did teamwork and collaboration play a role in your project?

7. Assessment
Students will be assessed on teamwork, participation in discussions, clarity of reflections, comprehension of the bridge engineering and design process, and the ability to adhere to the design criteria.

Extra Challenge!!
If time allows, students can redesign and retest with a 45 cm span!

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Student Worksheet

Your Mission:

Using the materials given to you, your task is to construct a bridge that spans a minimum gap of 30 cm. Your bridge will need to pass a strength test: after meeting your teacher's minimum weight requirement, you are challenged to build a bridge that can hold the most weight possible for at least 30 seconds before collapsing.

Terms:

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Method:

1. Brainstorming and Planning

- Your teacher will inform you of the minimum weight your bridge must carry for the test.
- With your group and the materials provided, brainstorm different bridge designs.
- Sketch your initial design idea and make a list of materials you plan to use.
- Consider stability, load-bearing capacity, and the bridge's overall structure during planning.

3. Bridge Construction

- Working as a group, construct your initial design.

4. Initial Testing

- Place your bridge between two supports (e.g., books or blocks), ensuring a 30 cm gap.
- As one partner gently places the minimum weight (predetermined by your teacher) on the center of the bridge, another partner should start timing for 30 seconds.
- If the bridge holds this load, add more weight and time for 30 more seconds.
- Continue to add weight at 30 second intervals until the bridge collapses.
- Record the maximum weight your bridge sustained for a minimum of 30 seconds.
- Evaluate the successful elements of your design and pinpoint areas for refinement.

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Student Worksheet

Bridge Challenge

Method, Continued...

5. Redesign & Retest

- Analyze your test results and compare them to your expectations. Discuss what worked well in your design and what could be improved.
- Based on your analysis and reflection, redesign your bridge with the goal of improving its load-bearing capacity and/or stability.
- You can modify your existing design or create an entirely new one.
- Repeat the testing process for the redesigned bridges, recording time and making reflections.

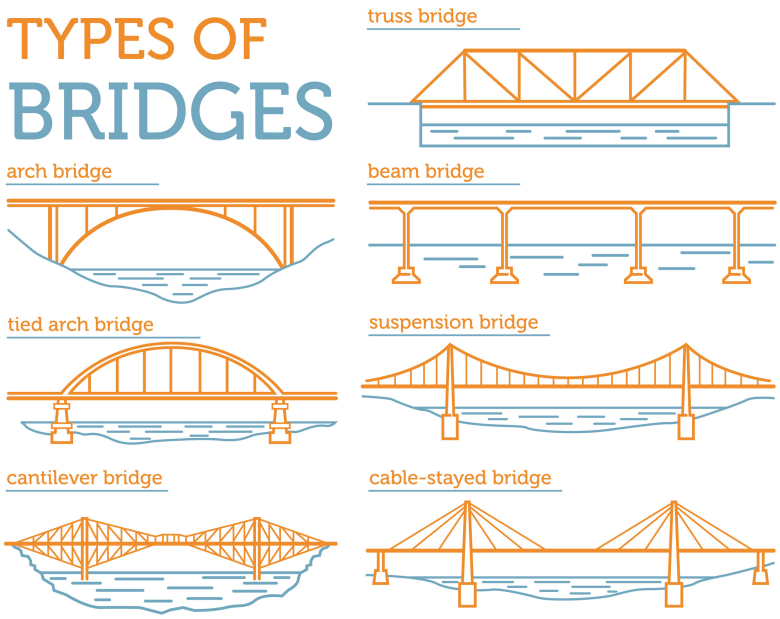
Extra Challenge!! If time allows, redesign and retest with a 45 cm span!

6. Final Reflection

Discuss and answer the Final Analysis Questions provided.

7. Assessment

You will be assessed on teamwork, participation in discussions, clarity of reflections, comprehension of the bridge engineering and design process, and the ability to adhere to the design criteria, and follow-up question analysis.



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Bridge Challenge

Data Tables

Design	Sketch Design and Label Materials Needed	Maximum Load Held for 30 sec	Reflection *Comments* *What worked* *What didn't work* *What can be improved*
Design 1			
Design 2			
Design 3			

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Bridge Challenge

Final Analysis Questions

Did your initial bridge design meet your expectations? Why or why not?

Did your redesigned bridge(s) perform better than the initial version in terms of load-bearing capacity and stability? Explain.

How did the forces acting on your bridge, such as gravity and tension, influence its stability and ability to support weight during testing?

Sketch a picture of the load positioned on your bridge and label all the forces acting on the load:

If you had more time or resources, what additional changes might you consider for further improvement?

How did teamwork and collaboration play a role in your project?

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Suggested Grading Rubric

Criteria	3 points	2 points	1 point
Comprehension of Bridge Engineering and Design Process	Demonstrates thorough understanding of bridge engineering and design concepts	Demonstrates partial understanding of bridge engineering and design concepts	Demonstrates limited understanding of bridge engineering and design concepts
Adherence to Design Criteria	Fully meets the design criteria; bridge is sturdy, spans the gap, holds maximum weight for at least 30 seconds	Partially meets the design criteria; bridge is somewhat sturdy but may not hold maximum weight or meet time requirement	Fails to meet the minimum design criteria; bridge collapses or does not span the gap
Clarity of Reflections	Reflections are clear, detailed, and provide thoughtful explanations of ideas and experiences	Reflections are somewhat clear and provide some explanation of ideas and experiences	Reflections lack clarity and depth; does not explain ideas or experiences
Teamwork	Active collaboration; consistently contributes to the team	Some collaboration; occasionally contributes to the team	Little to no collaboration; does not contribute to the team

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