# QuickView

Students investigate the strength of various truss joints.

# Standards Addressed

NSTA 5-8
Students develop abilities necessary to do scientific inquiry.

- Students identify questions that can be measured through scientific inquiry.
- Students use appropriate tools and techniques to gather, analyze, and interpret data.
- Students think critically and logically to make the relationships between evidence and explanations.
- Students communicate scientific procedures and explanations.

Students develop abilities for technological design.

- Students evaluate completed technological designs or products.

NCTM 6-8
Students develop and evaluate inferences and predictions that are based on data.

ITEEA 6-9

- Students learn that modeling, testing, evaluating, and modifying are used to transform ideas into practical solutions.
- Students learn to make a product or system and document the solution.
- Students develop abilities to assess the impact of products and systems.

# Time Required

90-135 minutes (will vary with class size)

# Content Areas

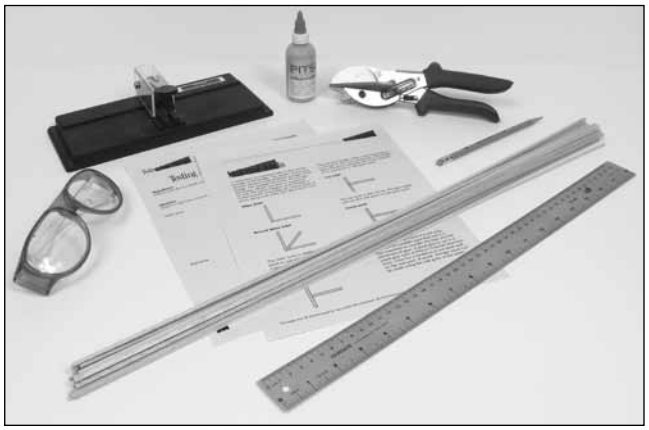
Primary: Science
Secondary: Math; technology; language arts

# Vocabulary

- angle
- compression
- conclusion
- end grain
- hypothesis
- joint
- side grain
- side view

# Materials

- 1/8" x 1/8" balsa wood strips
- Pitsco Structures Glue
- Timber Cutter or hobby knife
- Easy Cutter (optional)
- Safety glasses
- Ruler
- Protractor (optional – not shown)
- Pencil
- "Testing Joint Strength Data Sheet"
- "Different Joints" resource page



# Procedure

1 Locate the "Different Joints" resource page and the "Testing Joint Strength Data Sheet." After reviewing the resource page, write a hypothesis stating which joint you believe will be the strongest.

*Middle school students should understand hypotheses. However, you may wish to explain that a hypothesis is a prediction based on prior knowledge or experience.*

2 Construct a miter joint similar to that shown in the "Different Joints" resource page. Using one piece of balsa wood, cut two pieces each with a length of five centimeters.

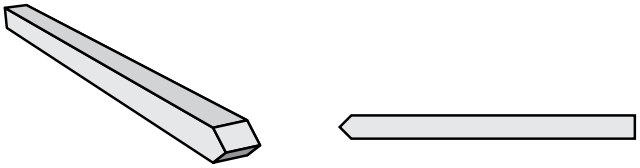
*Students can share the remaining wood with each other in order to minimize the amount of wood used.*

3 Using the Timber Cutter or hobby knife, cut one end of each beam at a 45-degree angle.

*The students may want to practice cutting wood strips at different angles before cutting this piece.*

4 Glue the two beams together at the angled ends. Let the glue dry.

5 Meanwhile, construct another miter joint, but add a five-centimeter brace that extends from the joint at a 45-degree angle. One end of the brace needs to be angled to fit tightly into the joint. Use the Easy Cutter or hobby knife along with a protractor to cut two 45-degree angles on the brace. The angles should be cut opposite of each other so there is a point in the center of the brace end.



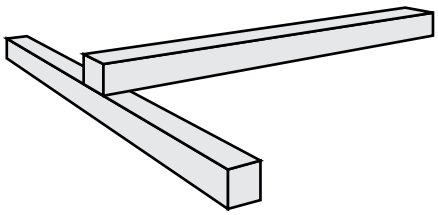
6 Glue the three pieces together; place the pointed brace so it fits tightly between the two beams. Refer to the "Different Joints" resource page for an example. Let the glue dry.

7 Construct a butt joint similar to the one shown in the "Different Joints" resource page. Use one piece of balsa wood to cut two five-centimeter pieces.

8 Glue the two beams together so a side-grain-to-end-grain joint is created. Refer to the "Different Joints" resource page for an example. Let the glue dry.

9 Construct a lap joint of five-centimeter beams.

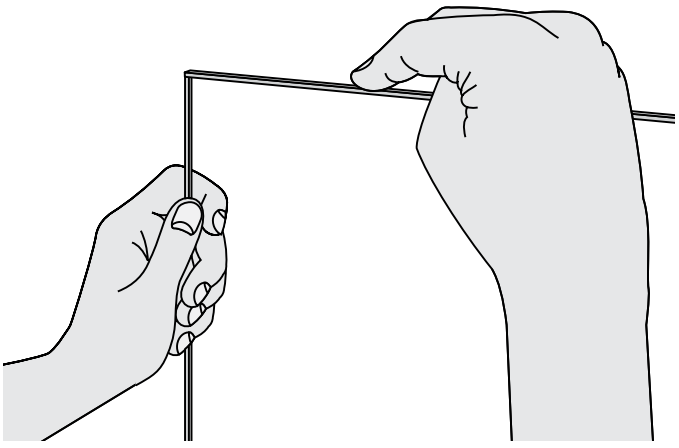
10 Glue the two beams together so a side-grain-to-side-grain joint is created. This will require one beam to be glued to the top side of the other beam. See the illustration below. Let the glue dry.



11 After the glue has dried, collect all four joints. Locate and put on the safety glasses.

12 To test the general strength of the joints, perform a compression test in which the results will be observed. Pay careful attention to the joints as the test is being performed.

13 Take the first miter joint and hold the vertical member as shown in the illustration. With your other hand, press down on the horizontal member of the joint. Observe whether the joint breaks, how long it takes for the joint to break, and how difficult it was to break.



14 Record your observations on the data sheet.

15 Repeat the previous two steps for the braced miter joint, the butt joint, and the lap joint.

16 Remember to perform the same test for all four joints.

17 Rate the strength of the joints from 1 to 5 with 1 being the strongest joint and 5 being the weakest joint.

18 Complete the data sheet.

# QuickView

Investigate the strength of various truss joints.

# Materials

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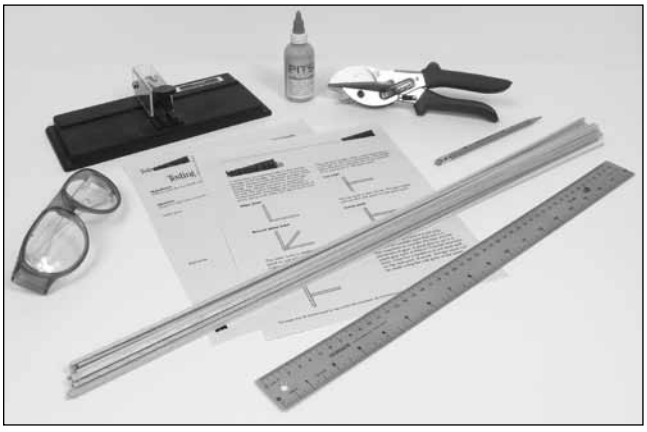

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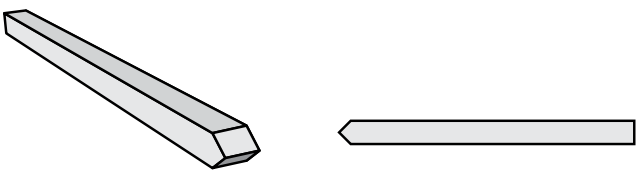

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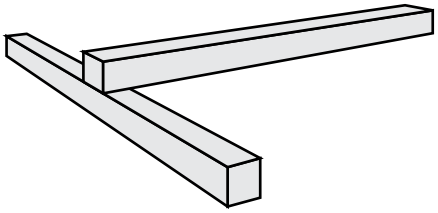

11 After the glue has dried, collect all four joints. Locate and put on the safety glasses.

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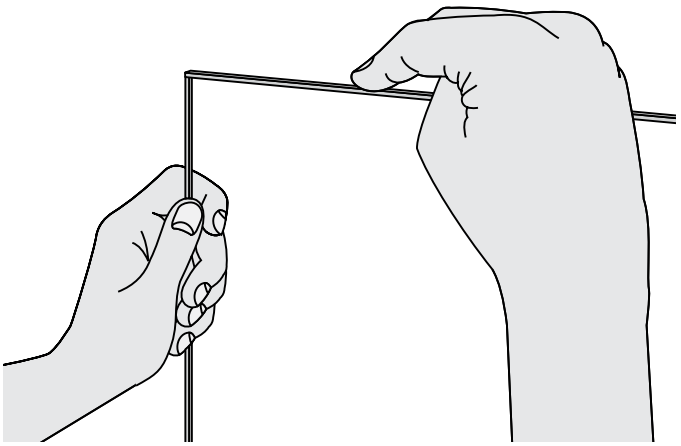
13 Take the first miter joint and hold the vertical member as shown in the illustration. With your other hand, press down on the horizontal member of the joint. Observe whether the joint breaks, how long it takes for the joint to break, and how difficult it was to break.



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16 Remember to perform the same test for all four joints.

17 Rate the strength of the joints from 1 to 5 with 1 being the strongest joint and 5 being the weakest joint.

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# Testing Joint Strength Data Sheet

**Hypothesis**
Which joint do you think will be the strongest? Record your hypothesis.

**Sketches**
Sketch a side view of your completed joints.

Miter Joint

Braced Miter Joint

Butt Joint

Lap Joint

# Testing Joint Strength Data Sheet continued

**Data**
Record your observations from the four tests.

Miter Joint Strength Rating _____

Braced Miter Joint Strength Rating _____

Butt Joint Strength Rating _____

Lap Joint Strength Rating _____

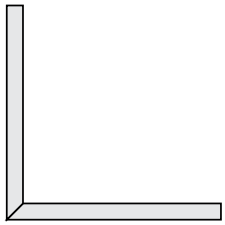
What conclusion can you make about the strength of the joints? Which joint was the strongest?

**Comparison**
How does your conclusion compare to your original hypothesis?

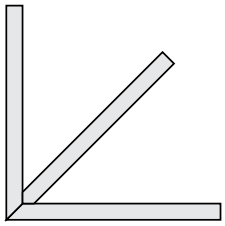
# Different Joints

A joint plays an important role in the overall strength of the bridge. The quality of the joint directly influences the potential strength of the bridge. The stronger the joints, the stronger the bridge. When one joint is weakened or fails, the entire integrity of the bridge is compromised. Following are several types of joints along with a few tips about each joint.

**Miter Joint**

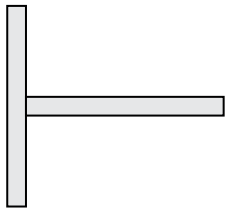


**Braced Miter Joint**



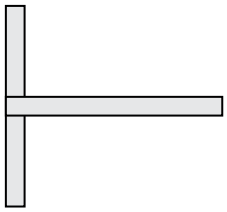
The miter joint is moderately strong and is good to use where several other members connect. However, the end grains are glued together. The miter joint can be braced. This joint can be difficult to make, but it provides more strength.

**Butt Joint**



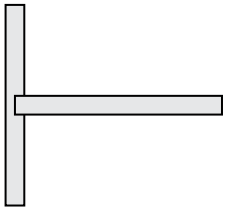
The butt joint breaks when a downward force is exerted on the horizontal beam. It also breaks when the joint is twisted. This is an example of an end-grain-to-side-grain joint.

**Lap Joint**



The lap joint is very strong. The glue holds well on this side-grain-to-side-grain joint.

**Notch Joint**



A notch joint can be very strong. The two beams are cut into or notched to ensure a tight fit.

When constructing a joint, it is not only important to consider joint type but it is also important to consider the type and the placement of glue. A good glue to use is a wood glue such as Pitsco Structures Glue. Glue has a tendency to not work well on the end grain of wood. Stronger joints can be made using the side grain of the wood.