NAME _____

LESSON 16

PAPER PYRAMID

FOCUS Transfer of Forces

OBJECTIVE To explore how strength is related to structure

OVERVIEW Does strength come only from materials used, or does how they're put together (structure) play a role? In this activity, we'll explore the answer using a sheet of newspaper.

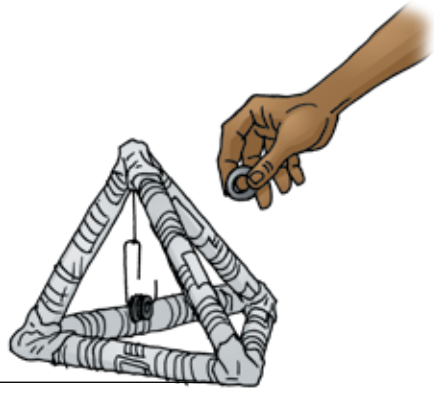
WHAT TO DO

STEP 1

Lay a half sheet of newspaper flat on your work surface. **Place** a straw at the top and **roll** the paper tightly around it. **Remove** the straw once you're done, but keep the roll tight. **Finish** by taping the roll securely.

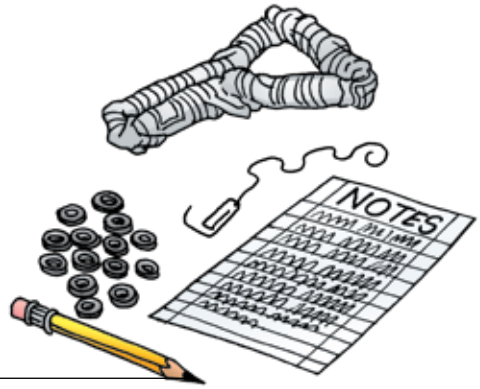
STEP 2

Repeat Step 1 to make six identical rolls. Now **tape** three rolls together to make a triangle. **Place** this flat on your work surface, then **attach** a roll at each corner. **Tape** the ends of these together to make a three-sided pyramid.



STEP 3

Check your corners to make sure they're securely taped. **Attach** a bent paperclip to the top point with string (see illustration). **Test** your **Paper Pyramid** by hanging weights on the paperclip. Slowly **add** more weights until you run out or until your pyramid collapses.



STEP 4

Review each step in this activity. **Compare** the strength of six paper sheets to the six paper rolls you made. **Share** and **compare** observations about your pyramid with the other research teams.

WHAT JUST HAPPENED?

Most paper is made from **wood fibers**. Trees are strong because the wood fibers are all connected together. When wood is ground up and treated with chemicals to make paper, the fibers are separated and smoothed into sheets. This helps make paper easy to write on, read, and fold. (Imagine doing this with a piece of bark!)

One sheet of newspaper is pretty flimsy. But when you roll it up, you're putting **layers** of separated wood fibers back together again. Then when you attach rolls together, you create a **structure** that has a lot of strength!

As you saw, **force** (weight) is easily **transferred** through the rolls by the design of the structure. Transferring force allows all parts of the structure to share the **load**.

MORE ABOUT STRENGTH AND STRUCTURE . . .

As you discovered in this activity, the strength of a structure is not only related to the materials it is made from, but also the way those materials are put together. Engineers are constantly looking for new materials and more efficient ways to put those materials together.

The history of bridges is a good example. The first "bridge" was probably just a log across a stream. This eventually led to bridges made of wooden beams supported on both ends by piers. But because wood is inherently flexible, the longer these bridges were, the weaker they became.

Stone arch bridges followed. Since stone is a very strong material, they are among the strongest and most durable of bridges. But transporting stones is expensive, the labor costs are high, and stone bridges only work for certain applications.

As more modern materials became available, engineers began to design steel arch bridges. Steel arch bridges were capable of covering greater spans and bearing heavier loads. But material and labor costs for construction were still quite high.

Steel truss bridges were pioneered by the U.S. railroads. Although their spans are limited, they can support a lot of weight. The triangles used in truss construction do a great job of transferring loads. A steel truss bridge can be assembled quickly (or even prefabricated), creating huge savings in labor costs.

But engineers continued searching for ways of doing more with less. The result was the suspension bridge. A suspension bridge can cover longer spans than any other type of bridge, and uses materials very efficiently. Some modern suspension bridges are over a mile long, and use far fewer materials than other types of bridges.

DIGGING DEEPER

Research the world's tallest buildings. What are some of the problems engineers faced when constructing these buildings? Choose one building, then find out what is unique about its structure, and how that gives it strength. Create a presentation to share your findings with the class.

WHAT WE LEARNED:

1. When your pyramid finally collapsed, what was its weakest point? How could you have made this stronger?

2. What geometric shape is a pyramid made from? Compare the pyramid's ability to support weight to that of a cube. Which is stronger? Why?

3. Based on what you have learned, why would it be helpful to add diagonal braces at the corner of a fence?

CONCLUSION!

The strength of a structure is not only related to the materials it is made from, but also the way those materials are put together. The way materials are put together can help transfer forces from one part of a structure to another.

FOOD FOR THOUGHT

1 Thessalonians 5:11 The flimsy sheet of newspaper couldn't hold very much on its own. But when you rolled it into a tight cylinder, it gained a lot of strength. Then when you attached it to other cylinders, it became part of a strong, unified structure.

On our own, we can't do much. In our weakness, it's easy to fail. Yet when we wrap ourselves in God's love, we gain needed strength. This Scripture reminds us of another important step. We must learn to encourage and support one another in Christian love. When God's children begin to work together, they become part of a strong, unified "structure" that helps spread God's goodness throughout the world.

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