3M Young Scientist Lab

WHELMERS Student Activity | Grades 3–5

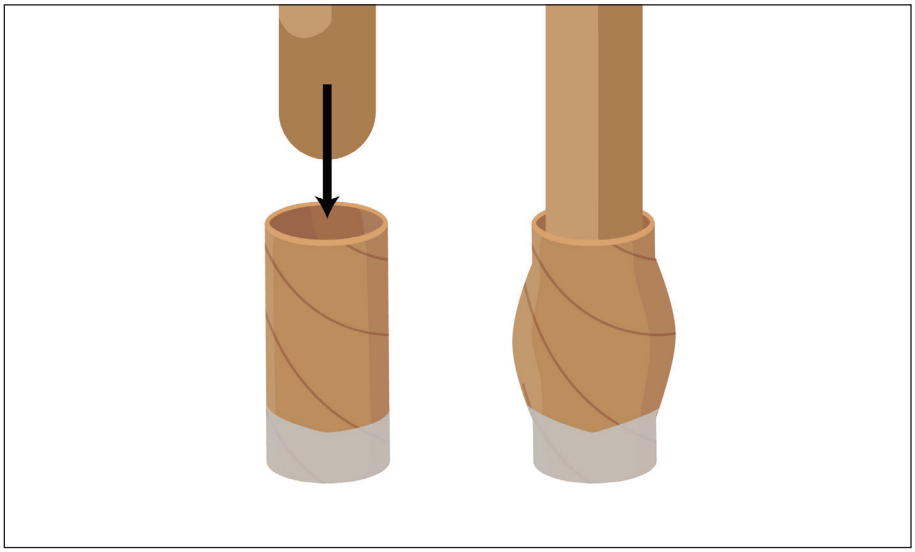
Salt Engineering

WHAT YOU NEED:

- Ruler
- Cardboard tube, such as an aluminum foil tube or a paper towel roll tube
- Tissue paper or wax paper
- Rubber bands or masking tape
- Table salt- enough to fill the tube half full
- Broomstick

DESCRIPTION

Salt crystals demonstrate how forces can be directed in mechanical systems.



NEXT GENERATION SCIENCE STANDARDS

- **PS2.A: Forces and Motion**
  - Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion. (Boundary: Qualitative and conceptual, but not quantitative addition of forces are used at this level.) (3-PS2-1)
  - The patterns of an object's motion in various situations can be observed and measured; when that past motion exhibits a regular pattern, future motion can be predicted from it. (Boundary: Technical terms, such as magnitude, velocity, momentum, and vector quantity, are not introduced at this level, but the concept that some quantities need both size and direction to be described is developed.) (3-PS2-2)

- **PS2.B: Types of Interactions**
  - Objects in contact exert forces on each other. (3-PS2-1)
  - The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center. (5-PS2-1)
- **PS3.A: Definitions of Energy**
  - The faster a given object is moving, the more energy it possesses. (4-PS3-1)
- **PS3.C: Relationship Between Energy and Forces**
  - When objects collide, the contact forces transfer energy so as to change the objects' motions. (4-PS3-3)

WHAT YOU DO

1. Using a ruler, cut the tissue paper or wax paper into 6" x 6" squares.
2. Use the rubber bands or tape to attach the paper over one end of the cardboard tube, creating what looks like a drumhead.
3. Push the broomstick through the tube so it bursts through the paper cover. Pretty easy, right?
4. Now, remove the damaged paper and replace it with a fresh piece.
5. Before you try again, pour salt into the tube to a depth of about 3 inches. The salt should fill about half of the tube. The wax paper should hold the salt in the tube.
6. Hold the open end of the tube straight up. Try again to burst the paper by pushing the broomstick through the surface of the salt. Not so easy anymore, is it? But why?

WHAT HAPPENS

The numerous tiny salt crystals transfer most of the force you apply toward the walls of the cardboard cylinder instead of straight down. This leaves almost no force being applied against the thin paper. Trusses and beams made for large structures such as bridges and tall buildings use similar designs to spread or change the direction of forces and loads.

WHERE IN THE WORLD

Did you cross a bridge on your way to school today? If so, you may have walked, cycled, or drove over a bridge. Think about this activity and then think about how the engineers and construction workers got the beams of the bridge into the water and sand below the bridge. How did they use trusses to evenly distribute the force and tension of the bridge so it would stand and support a lot of weight? They experienced the same forces you did when pushed the broomstick through the salt.

Here are a few other examples of this in the world around you:

- Houses and roofs
- The Eiffel Tower
- Bicycles

Can you think of anything else that uses trusses and beams to spread or change the direction of forces and loads?