Fun with Forces

Overview

A video introduction shows how objects at rest interact with a force using the famous magician's trick of pulling a tablecloth out from underneath some dishes. Students then investigate the effect of different mass and distribution of mass as they recreate this demonstration.

Guiding Question

How much force is needed to move objects at rest?

Objectives

Students will be able to explain that objects with greater mass and objects located closer together require more force to move them.

Background

This "magic trick" demonstrates Newton's First Law of Motion—an object at rest will stay at rest unless acted on by an unbalanced force. Inertia is a measure of how hard it is to change an object's motion. The more mass an object has, the more inertia it has—it's harder to make a more massive object move! This means that if something is sitting still, its inertia keeps it in place. By adding mass to the structure on the table, the tablecloth can move underneath the structure without significantly changing its motion (and knocking it over).

Time: 15–20 minutes

Grade Level: 6–8

Vocabulary

- Force
- Mass
- Gravity
- Friction
- At rest

Standards

NGSS MS-PS2-2. Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.

Preparation

For this activity, the educator will need the following:

- Video: Fun with Forces (1:51) (English | Spanish)
- A way to show the video to students
- For this activity, each group of 2–3 students will need the following:
- 1 copy of Force Investigation (English | Spanish | Answer Key)
- surface, smooth and flat, such as a table or desk
- 3 cups, smooth-bottomed (more cups optional)
- 3 weights, non-breakable, such as beanbags (more weights optional)
- 1 piece of fabric, such as a rayon or polyester handkerchief, ideally without seams, 12" x 12" (30.5 cm x 30.5 cm)

EiE® Connections

Continue your classroom activities with this unit:

Engineering Everywhere®

- *Engineering Safety Helmets*

Museum of Science Connections

Visit the Museum's *Science in the Park* exhibit to have more fun with forces and motion.

Watch another Sparks of Science video, "It's a Wrap!", to see more forces in action.

Family Connections

Continue the learning at home with EiE Families and STEM Events or Family STEM Activities from MOS at Home.

Credits

MOS at School programs are offered at no cost, thanks to the generosity of the Akamai Foundation, Bloomberg Philanthropies, BNY Mellon, Gordon Foundation, Hood, Lincoln and Therese Filene Foundation, Lowell Institute, Mabel Louise Riley Foundation, MathWorks, Richard K. Lubin Family Foundation, Sanofi, and TJX.

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Activity Instructions

These steps offer support for implementing the Fun with Forces video introduction and follow-up activity with students.

1. Before showing the video introduction, discuss these questions:

Q: What happens when you push or pull on something?

A: Accept all responses.

Q: What is a force?

A: Accept all responses. As necessary, explain to students that a force is a push or pull on one object caused by another.

Q: What forces are acting on you right now?

A: Accept all responses. Possible responses include gravity pulling down, the floor pushing up, or moving air pushing sideways.

Q: Why might someone want to learn more about forces?

A: Accept all responses. Possible responses include so they can build strong bridges or roads, so they can succeed in a sport, or so they can perform magic tricks.

2. Play the video Fun with Forces (1:51). This video shows what happens to a tower of treats at rest when a force is applied to it.

watch video

3. After showing the video, discuss these questions:

Q: Why doesn't the tower fall when the educator pulls the tablecloth?

A: The educator pulls the tablecloth so quickly that the force does not have time to act on the tower very much.

Q: What do you notice about the speed and direction in which the educator pulls the fabric?

A: The educator pulls straight down very quickly.

Q: What might happen if the educator pulled the fabric differently?

A: Accept all responses.

Q: What might happen if the glasses didn't have milk in them?

A: Accept all responses.

4. Distribute the Force Investigation (English | Spanish) handouts to students and have them form groups of 2–3 to complete a scientific investigation of what they saw in the video.
5. Give each group cups, weights, and fabric. Within each group, students can find the roles that work best for them. Suggested roles are setting up structures, pulling the fabric, and recording the results.
6. Have students recreate the demonstration from the video, then experiment with stacking the cups in a tower, pyramid, and their own arrangement. They can also try adding weights to these structures. If students struggle to remove the fabric without toppling the objects, use this as an opportunity to investigate the forces that are moving the cups.
7. Have students experiment with pulling on the piece of cloth at different speeds and in different directions.

8. After completing the activity, discuss these questions:

Q: Some magicians do a trick where they set an entire table with cups, plates, cutlery, etc., then pull the tablecloth out from under them. What do you think a magician needs to do to make the trick work?

A: Responses may include pulling the tablecloth fast, pulling the tablecloth straight down, or using heavy cups.

Q: What happened when you added more mass to your tower?

A: A tower with more mass requires more force to move it, so it is less likely to fall over.

Q: What forces were acting on your tower?

A: Gravity pushing down and the table or desk pushing up. There is also friction between all surfaces in motion. If necessary, explain to students that gravity is the force that pulls objects toward the center of the Earth and toward all other objects with mass, while friction is the resistance to motion of one object relative to another.

Q: How much force is needed to move objects at rest?

A: The amount of force needed depends on the mass and the distribution of the mass of the objects. More force is needed to move objects with more mass. More force is also needed to move objects located close together.

Glossary

At rest
not changing position with respect to its surroundings

Force
a push or pull on one object caused by interaction with another object

Friction
the resistance to motion of one object moving relative to another

Gravity
the force that pulls objects toward the center of the Earth and toward all other objects with mass

Mass
a measure of the amount of matter in an object, usually given in grams (g) or kilograms (kg)