# *May the Force Be with You!*

**Organizing Topic** Investigating Motion

**Overview** Students conduct mini-experiments to experience five different types of forces: magnetic, electrical, gravitational, frictional, and elastic.

**Related Standards of Learning** 4.1; 4.2b

## Objectives

The students should be able to

- identify the forces that cause an object's motion.

## Materials needed

- Metric ruler
- Rubber bands
- Plastic bucket
- Clear plastic cup
- Paperclips
- Magnet
- Plastic bread bag
- Scissors
- Wool fabric (scarves or socks work well)
- Newspaper
- Bath towel
- Board
- Books
- Plastic 2-liter bottle
- Plastic boat
- Ring magnets and pencil
- Metal spring
- Balloon
- Ball
- Paper ball
- Goggles
- Attached data sheet
- Attached "Station Directions" sheets
- Pictures demonstrating the five common forces

## Instructional activity

### *Content/Teacher Notes*

A **force** is a push or pull exerted by one object on another. A force can alter the shape or the motion of an object. The most common forces acting on objects on Earth are **magnetic, electrical, gravitational, elastic,** and **frictional forces.** In order for an object to change direction, a force such as gravity must exert its force to redirect the motion. An example of this would be a ball rolling along a tabletop until it reaches the edge. Once it reaches the edge, the

force of gravity takes over to change the ball's direction of motion from horizontal to vertical (down).

***Introduction***

1. Ask students to rub their hands together slowly and then faster and faster. What happens? Why do your hands gets warmer? *(Because of friction)*
2. Tell students that **friction** is a **force** that can stop or change an object's direction. Explain that there are many forces on Earth which can stop or change motion. We deal with these forces everyday. Five of the most common of these forces are **frictional, gravitational, magnetic, elastic,** and **electrical forces.** A simple explanation of each is given below; however, at this grade level it is probably best only to explain each force and give an example of each, but to focus on the most common forces.
   - **Friction** – Friction changes the movement of an object by slowing the object down. Examples: brakes on a car or bike. Without friction, an object would follow the same path at a constant speed. Demonstration: Have students rub their hands together.
   - **Gravity** – Gravity affects all objects of mass. The more the mass, the stronger the gravitational pull. Gravity is a force that pulls objects toward the Earth. Demonstration: Tell students you can throw a ball, make it pause briefly, and return back to you. As you explain this, make a throwing motion with the ball in your hand. Ask students if they believe that you can perform this feat. Ask students why they think this would never work. Show them your "magic" by throwing the ball straight *up* and catching it. You threw the ball; it paused briefly in midair, and returned to you. Gravity changes an object's motion by pulling it toward Earth.
   - **Magnetism** – Demonstration: Alternate ring magnets on a pencil so that the opposing poles make the magnets "float" in the air. Ask the students what force is keeping the magnets apart. *(The force of magnetism changes some objects' motion by attracting or repelling them.)* Ask if all objects are affected by magnetism. *(No, only those with iron and certain other metals are affected by magnets.)*
   - **Elasticity** – Demonstration: Pull a metal spring out and release it so that it returns to its original position. A substance is elastic if it quickly returns to it original shape or position when it is disturbed. Elastic forces change an object's motion by returning the object to its original position.
   - **Electricity** – Demonstration: Rub a balloon across a piece of wool fabric or on your hair. Ask students how your hair's motion was changed. *(It was changed from hanging straight down due to the force of gravity to floating up due to the force of static electricity.)*

***Procedure***

1. Divide class into groups of two or three, and give each student a data sheet and goggles.
2. Post the five station directions (see Station Directions sheets) around the room.
2. Move from station to station, briefly going over the directions with the students, discussing how to reset the station for the next group, and pointing out where to respond on the data sheet. Answer any questions.
4. Give student groups about 5 minutes at each station. Students do not need to move in the order of 1–5 but may move with their group to any open station.
5. After all are finished, allow a few minutes for groups to discuss and refine their answers.

6. Go from station to station, reviewing each force and having students share their ideas and answers. Allow students to change their answers on their data sheets as needed.

***Observations and Conclusions***

1. Ask the students the following questions to stimulate conclusions:
   - Can there be force without some object giving the force and some object receiving the force? *(No)*
   - Is it possible for one object to exert a force on another without ever touching it? *(Yes, the noncontact force of a magnet can move metal through paper without actually touching the metal; the Earth can exert a gravitational pull on an object and pull it downward without touching it.)*
   - Can forces change the shape of an object? *(Yes, such as the force of wind changing the shape of sails on a sailboat)*

## Sample assessment

- Have students give additional examples of each type of force as found in everyday life.
- Divide class into five groups. Give each group a magazine picture demonstrating one of these five forces. Have the group discuss their picture, decide which force it shows, and share it with the class.

## Follow-up/extension

- In physics, terms such as *agent of force, receiver of force,* and *effect of force* are used to describe the action and reaction of each force. The agent is the origin of the force and the receiver is the object that receives the force. The effect is the action that takes place. For example, in this lesson, the magnet is the agent and the paperclips are the receivers of the force. The effect of the force is the magnet attracting the paperclips and causing them to move toward it. Students may use the same magazine pictures used in the assessment above to find the agent, receiver, and effect for each picture.
- Lead the class in naming and discussing other common forces, such as that exerted by wind or water.

## Resources

- *Connections: Connecting Books to the Virginia SOLs.* Fairfax County Public Schools and The College of William and Mary. http://www.fcps.edu/cpsapps/connections. Presents a database of more than 1,000 works of children's literature and their connection to the Virginia Standards of Learning.
- *Outstanding Science Trade Books for Students K–12.* National Science Teachers Association (NSTA). http://www.nsta.org/ostbc.
- *Science Museum of Virginia*. http://www.smv.org/.
- *Search for Literature: Literature for Science and Mathematics*. California Department of Education. http://www.cde.ca.gov/ci/sc/ll/ap/searchlist.asp. Offers a searchable database.

# May the Force Be with You!
## Station Directions

# Station One

Place a rubber band beside a metric ruler, and see whether you can stretch the rubber band 10 cm, 20 cm, 30 cm, and 50 cm. How many centimeters do you think you could stretch the rubber band before it breaks?

# Station Two

Stack two or three books on the floor, and place a board or piece of cardboard slanted from the top of the books down to the floor to form a ramp (inclined plane). Place a 2-liter bottle on its side at the top of the ramp and let it go. See how far the bottle will roll before it stops. Measure the distance it rolled from the end of the ramp to the spot where it stopped. Place several sheets of newspaper on the floor at the base of the ramp and repeat the experiment. Record the distance rolled. Replace the newspaper with a towel and repeat the experiment. Record the distance rolled.

# Station Three

Place 15 or 20 paper clips on the table, and cover them with a clear plastic cup. Hold a strong magnet near the cup. Try to move paper clips to the top of the cup. Feel the amount of force the magnet is placing on the steel paper clips.

# Station Four

Hold up two long strips of plastic cut from a bread bag, and observe how they hang. Rub both pieces of plastic, back and front, with woolen material. Hold them up again and observe how the strips hang now.

# Station Five

Hold the paper ball about shoulder high and release it. Repeat five more times and observe where the ball goes.

# May the Force Be with You!
# Data Sheet

**Name: _____ Date: _____**

Five different mini-experiments have been set up in stations around the room. You and your partner/group may go to any open station in any order until you have done all five experiments. Be sure to answer the questions for each station on this data sheet while you're at that station. As you move from station to station, decide and record which type of force each station demonstrates:

1. Elastic force
2. Magnetic force
3. Gravity
4. Electrical force
5. Friction

## Station One

- How many centimeters of stretch do you predict it would take to break the rubber band? _____
- We think the force demonstrated here is _____.

## Station Two

- Record the distances the bottle rolled. Roll 1:_____ Roll 2:_____ Roll 3:_____
- Compare your three rolls. Why do you think the distance was shorter on the second and third roll? _____
- We think the force demonstrated here is _____.

## Station Three

- How many paper clips were you able to move to the top of the cup? _____

- Were you able to lift the cup with the magnet? _____
- We think the force demonstrated here is _____.

## Station Four

- What did you observe when you first held up the plastic strips?

  _____

- What happened after you rubbed the strips with wool?

  _____

- We think the force demonstrated here is _____.

## Station Five

- What happened every time you dropped the paper ball? _____
- Would it have been unusual for the ball *not* to fall? _____
- We think the force demonstrated here is _____.