Forces: Teacher's Guide

Grade Level: 3-5 | **Curriculum Focus:** Physical Science | **Lesson Duration:** Two class periods

Program Description

Gripping friction! The powerful attraction of gravity and magnetism! And why buoyancy is all wet! Learn about these exciting forces of nature. Caution: Understanding forces may lead to an acute case of the "smarts." Symptoms include knowledge of why things fall, float, skid, stop, push, and pull.

Onscreen Activities

Segment 1, Magnetism

- Activity: Make your own "magna-face"! You'll need a sheet of paper, markers, a clear plastic bag, iron filings, and a magnet. Draw a face on the paper and place it in the plastic bag. Then add iron filings to the bag and seal it. Drag a magnet over the filings and drop them onto the drawing to decorate the picture.

Segment 2, Gravity and Buoyancy

- Activity: Which will fall faster, a book or a pencil? Compare the weights of each and make your prediction. Then hold both objects at equal heights and drop them at the same time. What do you discover? Did the weight of the objects make a difference in how fast they fell? Now try the experiment with a book and a piece of paper. What happens?

Segment 3, Friction

- Activity: Design a new playground for your school that includes different areas for kids to play sports and games such as basketball, soccer, baseball and jump rope. Choose the ground material — grass, dirt, sand, clay, or concrete — that will work best for each play area and explain why. How does friction affect your choices?

Lesson Plan

Student Objectives

- Build a simulated luge track and make predictions about the impact of surface type, wind resistance, size of slope and shape of luge on their track.
- Test their predictions by conducting several simulated luge runs.

- Make conclusions about the affects of forces on the sport of luging.

Materials

- *Forces* video and VCR, or DVD and DVD player
- Long cardboard strips
- Tape
- Aluminum foil
- Wax paper
- Oil
- Butter
- Crushed ice
- Stopwatches
- Quarters
- Popsicle sticks
- Protractors
- Rulers

Procedures

1. Begin the lesson by reviewing the definition of a *force* and two types of forces: gravity and friction. Explain that gravity is a force that pulls two objects toward each other. Ask if students can recall examples of gravity from the video. (*Possible answers include the roller coaster, the skydiver, and the toboggan*.) Explain that friction is a force that pulls when two objects touch each other. Ask if students can recall examples from the video of friction from the video. (*Possible answers include wind resistance in skydiving, the shoes against the ladder for climbing, the tires against the road, and the chalk on a pole-vaulter's hands against the pole*.)
2. Ask students if they think friction increases or decreases acceleration. Challenge them to support their answers with examples from the video.
3. Introduce the lab by asking students if they know about the Olympic sport called luge. Share the following background information:

   > The word *luge* (pronounced LOOZH) is French for "racing sled." Luge has its roots in the 16th century, but it didn't become an Olympic sport until 1964. The luge sled usually has two wooden runners connected by two steel bridges with a seat slung between. The surface of each runner is plastic or steel.
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   > At the start gate, competitors grasp handles that help them launch the sled down the ice. Racers "paddle" along the ice to increase their momentum for about ten feet. They use gloves with small spikes in the fingertips for better grip. Once underway, racers travel

down the course lying on their backs, feet first. In this position, they have limited vision. They go through 17 curves on 4,318 feet of track in less than one minute, sometimes traveling 90 miles an hour. A luge has no brakes. Athletes steer by applying pressure against the sides of the luge with their feet, shoulders, and legs. They stop the sled by sitting up and putting their feet on the ice.

The Olympic luge events include singles (one racer) and doubles (two racers). In singles luge, a racer takes four runs down the track. The four times are added together for a total time. The winner achieves the fastest total time. In doubles luge, pairs take two runs; the winners have the fastest time.

4. If possible, have students watch a demonstration of luge skills and a run at this Web site: http://www.olympic.org/uk/sports/programme/disciplines_uk.asp?DiscCode=LG. After viewing the video and learning about the sport from the site above, have students brainstorm the forces that affect a luge run. What forces can cause a luge to gain speed? What forces can cause its speed to decrease?
5. Tell students that they will learn more about the effect of forces by building their own luge track. They will make predictions and conduct a lab to test their predictions. During the lab, two different objects will careen down a cardboard slope covered by a selected type of surface.
6. Before the lab, have students make predictions about the following questions:
    - A real luge track surface is made of hard ice. Review the kinds of surfaces below. Predict the order of these track surfaces in order of fastest (1) to slowest (10). (You may substitute other types of surface materials.)

        _____ Aluminum foil

        _____ Aluminum foil with butter

        _____ Aluminum foil with water

        _____ Aluminum foil with crushed ice

        _____ Aluminum foil with oil

        _____ Wax paper

        _____ Wax paper with butter

        _____ Wax paper with water

        _____ Wax paper with crushed ice

        _____ Wax paper with oil

    - Which object would go faster down any of the tracks listed above: a quarter or a Popsicle stick?
    - Would the object go faster, slower, or at the same rate of speed on a slope with a 30-degree angle or a 60-degree angle?
7. Divide the class into groups. Give each group a strip of cardboard to use as their simulated track. Have each group choose a surface from the list above to cover their cardboard. As a class,

come up with ways to keep all of the other variables the same on the track. Once the tracks are covered, have each group use a protractor to make sure their tracks are propped up at a 60-degree angle.

8. Give each group two objects to simulate the luge: a Popsicle stick and a quarter.
9. Have each group select a person to use a stopwatch to time each run. Have each group place the quarter flat at the top of their ramp. Have one or two students use a ruler to hold the quarter in place at the starting line. At your command, have them lift the ruler quickly (like raising a gate). As in the Olympics singles event, have each group make four runs: two with the quarter and two with the Popsicle stick. Add the times together for all four runs. Which track surface demonstrated the fastest luge? Which object had the fastest time? How do these results compare to student predictions? Have students explain their results in terms of friction.
10. Finally, have students make another set of runs on a slope with a 30-degee angle. Does the speed of the run increase, decrease, or stay the same? How does this compare to student predictions? Have students explain the results in terms of gravity.
11. Have students combine all their information to make conclusions about the effect of forces on the sport of luging.

Assessment

Use the following three-point rubric to evaluate students' work during this lesson.

- 3 points: Students made predictions based on sound reasoning; performed experiments carefully; recorded their results accurately and completely; made clear and logical explanations; and worked cooperatively in groups.
- 2 points: Students made predictions based on sound reasoning; performed experiments with sufficient care; recorded their results incompletely; made acceptable explanations; and worked somewhat cooperatively in groups.
- 1 point: Students made predictions based on guesswork; performed experiments with sufficient care; recorded their results incompletely or inaccurately; made confusing explanations; and had trouble working in groups.

Vocabulary

acceleration

Definition: The rate of change of velocity with respect to time

Context: The acceleration of the luge increased as the ice melted.

aerodynamic

Definition: Designed to reduce wind drag and improve efficiency or acceleration

Context: Luge racers often wear skintight, aerodynamic suits.

deceleration

Definition: To decrease the velocity of

Context: Racers can cause deceleration when they sit up in their luge.

friction

Definition: The force that pulls or resists the motion of two objects or materials that are in contact with each other

Context: As the ice surface melts, the friction between the luge and the ice is reduced.

gravity

Definition: The force that pulls two objects toward each other.

Context: Gravity is the force that causes the luge to ride downward.

velocity

Definition: The rate at which an object changes its position

Context: The velocity of the luge changes dramatically as it goes through the "s" curve of the track.

Academic Standards

Mid-continent Research for Education and Learning (McREL)
McREL's Content Knowledge: A Compendium of Standards and Benchmarks for K-12 Education addresses 14 content areas. To view the standards and benchmarks, visit http://www.mcrel.org/compendium/browse.asp.

This lesson plan addresses the following national standards:

- Science—Physical Science: Understands forces and motion.
- Science—Nature of Science: Understands the nature of scientific inquiry.

National Academy of Sciences

The National Academy of Sciences provides guidelines for teaching science in grades K-12 to promote scientific literacy. To view the standards, visit this Web site:
http://books.nap.edu/html/nses/html/overview.html#content.

This lesson plan addresses the following national standards:

- Unifying Concepts and Processes: Evidence, models, and explanation; Change, constancy, and measurement
- Science as Inquiry: Abilities necessary to do scientific inquiry; Understandings about scientific inquiry
- Physical Science: Properties of objects and materials; Position and motion of object; Properties and changes of properties in matter; Motions and Forces

Support Materials

Develop custom worksheets, educational puzzles, online quizzes, and more with the free teaching tools offered on the Discoveryschool.com Web site. Create and print support materials, or save them to a Custom Classroom account for future use. To learn more, visit

- http://school.discovery.com/teachingtools/teachingtools.html

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