Gravity, Force and Work

Vocabulary:

- force — something that pushes or pulls something else
- gravity — a force that pulls everything toward the center of the earth
- friction — a force that is created when something rubs against something else
- work — using a force to move an object some distance

Comprehension Questions

1. Explain examples of how force pushes and pulls.
2. How does gravity pull something to earth?
3. Explain how a force stops something from moving.
4. Can anything move without a force pushing or pulling it?
5. Identify three kinds of force.
6. Identify two kinds of friction.
7. How does a rocket engine use force?
8. What does distance has to do with the force of gravity?
9. What does weight have to do with the force of gravity?
10. What happens to something when force is put on it?

Activities:

- build a simulated luge track and make predictions about the impact of surface
- test their predictions by conducting several simulated luge runs; and
- make conclusions about the affects of force and friction on the sport of luging.

Materials

- cardboard strips
- tape

- small fans
- aluminum foil
- wax paper
- oil
- butter
- stopwatches
- quarters
- Popsicle sticks

Activities:

A. Luge Run

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1. Begin the lesson by reviewing the definition of **force** as something that pushes or pulls something else and **friction** as a force that occurs when moving two objects that touch each other. Ask if students can recall examples of friction from the video. (Possible answers include the caveman going down the slide or riding in the wagon.

2. Ask students if they think friction increases or decreases acceleration. Challenge them to their answers with examples from the video.

3. Introduce the lab by asking students if they know about the Olympic sport called *luge.* Then share the background information. (Ask volunteers to read)

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.**

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; 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 such as 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 force and friction 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?
- Would an object with wind blowing up the ramp go faster or slower than an object with no wind resistance?

2 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 prop theirs up at a 60-degree angle.

3 Give each group two objects to simulate the luge: a Popsicle stick and a quarter.

4 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 demonstrated the fastest luge? Which object had the fastest time? How do these results compare to student predictions?

5 Next have students test the effect of wind resistance on their tracks. Using the same track surface, have students do another set of four runs with a small fan blowing up the ramp. Does the speed of the run increase, decrease, or stay the same?

6 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?

7 Have students make a chart or graph where they combine all their information to make conclusions about the effect of force and friction on the sport of luging.

B. Bean Bag Toss

This is an activity that will help students understand the concepts that gravity is a force that depends on mass and distance; that mass is not the same as weight but rather the amount of stuff that makes up a thing; and also that weight is a force. It is important you determine whether or not students have a good understanding of forces, motion, etc.

The teacher stands at the front of the classroom and drops a beanbag to the floor. Ask students:

1. Why did the beanbag drop to the floor? Since they just saw a movie on gravity, they should know that it fell to the floor due to the "force of gravity."
2. Students may say "falling" since you've been discussing gravity. If so, push a chair and say that you've just exerted a force on the chair, what happened?)
3. What if I pushed harder (put more force) on the chair? (The chair would move faster or farther.)
4. What does weight have to do with the force of gravity? (Weight is a force, and its strength depends on the strength of gravity. You could give the example of the moon having six times less gravity than earth. Students would weigh only 1/6th of their weight on the moon.)
5. Can you define the word force? (Try to get students to define it in the broadest sense, basically that force causes motion. But do not discount more specific answers, such as force pulls on things or pushes on things.)

This time toss the beanbag up into the air a bit and then let it fall to the ground. Ask students:

6. Did the beanbag fall to the ground the same way as last time? Why or why not? Be sure they understand that force pushed it up into the air, and also pulled it to the ground.

7. Then ask students to predict what would happen if more force were used in tossing the beanbag? What if the angle was just right and it got going fast enough, would it go further?