TLC Elementary School Lesson Plan
Forces

Subject
Physical Science

Grade Level
3-5

Duration
One to two class periods

Objectives
Students will

- 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; and
- make conclusions about the affects of forces on the sport of luging.

Materials

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

Procedures

1. Begin the lesson by reviewing the definition of a force. 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 their answers with examples from the video.

3. Introduce the lab by asking students if they know about the Olympic sport called luge.

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 the 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 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. 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 ___

    b. Which object would go faster down any of the tracks listed above: a quarter or a Popsicle stick?

    c. 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?

d. Would an object with wind blowing up the ramp go faster or slower than an object with no wind resistance?

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 prop theirs 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 sue 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?

10. 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? What conclusions can they make about wind resistance?

11. 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?

12. Have students combine all their information to make conclusions about the effect of forces on the sport of luging.

Evaluation
Use this 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.

One 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

This lesson plan addresses the following standards from the National Science Education Standards:

Grades K-4
Unifying Concepts and Processes: Evidence, models, and explanation
Unifying Concepts and Processes: Change, constancy, and measurement
Science as Inquiry: Abilities necessary to do scientific inquiry
Science as Inquiry: Understandings about scientific inquiry
Physical Science: Properties of objects and materials
Physical Science: Position and motion of object

Grades 5-8
Unifying Concepts and Processes: Evidence, models, and explanation
Unifying Concepts and Processes: Change, constancy, and measurement
Science as Inquiry: Abilities necessary to do scientific inquiry
Science as Inquiry: Understandings about scientific inquiry
Physical Science: Properties and changes of properties in matter
Physical Science: Motions and Forces

Credit

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