

RAMPS AND SLIDERS

BENCHMARKS and TASKS

SC.B.1.2.4 The student knows the many ways in which energy can be transformed from one type to another.

SC.C.1.2.1 The student understands that the motion of an object can be described and measured.

SC.C.2.2.2 The student knows that an object may move in a straight line at a constant speed, speed up, slow down, or change direction dependent on net force acting on the object.

SC.C.2.2.3 The student knows that the more massive an object is, the less effect a given force has.

SC.C.2.2.4 The student knows that the motion of an object is determined by the overall effect of all of the forces acting on the object.

- The student identifies force as any push or pull (e.g., gravity, electricity, and magnetism) that causes objects to change their state of motion. The greater the force is, the greater the change in motion.
- The student describes the motion of an object by its position, direction, and speed.
- The student uses scientific tools (e.g., stopwatch, meter stick) to measure the speed and distance traveled by an object and displays the data in a graphic representation.
- The student traces the flow of energy as it is converted from one form to another (e.g., potential to kinetic) through a system.
- The student discovers through activities that the more mass an object has, the more force it takes to change its state of motion.
- The student demonstrates how inertia (an object's tendency to resist a change in motion), gravity, friction, and mass affect motion.

KEY QUESTION

What forces affect the amount of energy transferred to a moving object?

BACKGROUND INFORMATION

This lesson is a great opportunity for students to observe and apply some of Isaac Newton's Laws of Motion. Newton was an excellent observer of everyday occurrences. Newton's First Law of Motion states that objects at rest tend to stay at rest until a **force** acts on them. An object's tendency to resist a change in motion is called **inertia**.

A sphere is an object that has **mass**. When the sphere is held at the top of the ramp in this lesson, it is not moving, but it does have stored **energy**, called **gravitational potential energy**, due to its position. It will stay there with its potential energy until some force acts upon it. When the sphere is released, the force of gravity (a pulling force) takes over and the sphere rolls downward, releasing its stored energy. The energy is changed into **kinetic energy**, energy of motion. This kinetic energy is then transferred to the slider, which causes it to move. The heavier and larger the sphere is, the more potential energy it would have, the faster it would travel, and the farther the slider would move. This lesson provides an opportunity for students to experience physics that is fun, not intimidating!

MATERIALS

Teacher

overhead projector
graph transparency

Per group

1 large steel sphere (or marble)
1 small steel sphere (or marble)
1 commercial ramp and slider **or**
slider: ½ paper cup - cut lengthwise or
a small milk carton with an open end
ramp: ruler with a groove
1 measuring tape
masking tape
Ramps and Sliders data sheet
1 calculator
1 sheet of graph paper
1 stopwatch

TEACHING TIPS

1. Have students tape their ramp to the table for stability.
2. This lesson will likely require more than one class period.

ENGAGE

1. Have the ramp and slider set up in place on a smooth surface where everybody can see it.
2. Ask: *How far do you think the small sphere will go when it is released at level 2 on the ramp?*
Record student responses.
3. Ask: *How far do you think the small sphere will go when I release it at level 5 on the ramp?*
Record student responses.
4. Discuss reasons for the wide range of responses given by students. Discuss the difference between a *guess* and a *prediction*. Since one needs reliable data to make a prediction, guide students to the conclusion that their responses must be guesses.

EXPLORE

1. Distribute the materials. Before starting the experiment, establish these guidelines:
 - All experiments should take place in the area that you designate for each group.
 - Make sure the sliders are placed even with the end of the ramp for each trial.
 - The spheres should be released down the ramp – not pushed.
 - Re-check the set up before starting each trial.(Note: If you are using rulers, marbles, and cups instead of commercial ramps and sliders, have students set the 4 cm mark of the ruler on a textbook to form a ramp. Designate markings on the ruler at which students should release the marbles.)
2. Students should take turns releasing the small sphere three times from levels 1, 3, 4, and 6 on the ramp. **STUDENTS ARE NOT TO TEST AT LEVELS 2 AND 5 AT THIS TIME.**
3. Each time students should record the distance the slider travels by measuring in centimeters from the end of the ramp to the leading edge of the slider.
4. Each test should be repeated for a minimum of three trials with results averaged.
5. Have students create a bar graph of their data.
6. Collect one group's data and create a bar graph on a transparency. Display the graph on the overhead. Discuss the results with the class and ask if they can see any pattern in the data.

7. Using this information, ask students if they can now predict how far a slider would travel when the same small sphere is released at levels 2 and 5 on the ramp.
8. Discuss the small range of responses. Ask: *How did the data collected help you predict?* Explain that now students have data on which to base their predictions, so they are not just making wild guesses.
9. Have all groups perform tests at levels 2 and 5 to verify the accuracy of their predictions.
10. Have students repeat the investigation using the large sphere. Compare this data with that of the small sphere.

EXPLAIN

Why was the range of responses for the guesses so large? (No data was available to give the students a reasonable range of results.)

Why was the range of responses for the predictions so small? (The data revealed a pattern that made it easier to determine what the actual result would be.)

What information do you need in order to make accurate predictions? (reliable data)

What sphere position made the slider travel farther? Why? (An object's acceleration depends on the size and direction of the force acting on it and on the mass of the object.)

From where did the energy come to move the sphere and the slider?

(The sphere is sitting at rest at a level on the ramp; it is not moving, but it has stored energy, called gravitational potential energy due to its position. When the sphere was released, potential energy was converted to kinetic energy. When the sphere hit the slider, energy was transferred from the sphere to the slider and the slider moved.)

As the sphere rolled down the ramp, according to Newton's law, the sphere had inertia and should keep rolling along unless acted on by an outside force. What force caused the sphere to suddenly stop? (the force of friction from the table and the slider)

How does the size of the sphere affect the slider? (The greater the force is, the greater the change in motion.)

How did you predict the slider's travel distance for levels 2 and 5?

Were your predictions correct? Explain why or why not.

EXTEND/APPLY

Have students repeat the investigation using stopwatches to time the spheres as they move. Students can then determine the speed of the spheres by dividing the distance traveled by the time it took.

EXTENSIONS

1. Suggest students add mass to the space on the sliders. Does mass make a difference in the distance traveled?
2. Encourage students to experiment using the sliders on various surfaces (e.g., sandpaper, carpet, wax paper) to determine the effect of friction on sliding distance.
3. Ask: *At what ramp levels would you have to place the large sphere and the small sphere so that they would cause the slider to travel the same distance?* (Let students try this!)

| RAMP POSITION | TRIAL 1 | TRIAL 2 | TRIAL 3 | AVERAGE DISTANCE |
|----------------------|----------------|----------------|----------------|-------------------------|
| LEVEL 1 | | | | |
| LEVEL 3 | | | | |
| LEVEL 4 | | | | |
| LEVEL 6 | | | | |

After studying the bar graph of the data collected at Levels 1, 3, 4, and 6, predict how far the slider will travel when the sphere is released from Levels 2 and 5. Record your predictions.

| RAMP POSITION | PREDICTION | TRIAL 1 | TRIAL 2 | TRIAL 3 | AVERAGE DISTANCE |
|----------------------|-------------------|----------------|----------------|----------------|-------------------------|
| LEVEL 2 | | | | | |
| LEVEL 5 | | | | | |