MORE BOUNCING BALLS

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.2.2.4 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.

KEY QUESTION

What is the relationship between the height from which a ball is dropped and the height to which it bounces?

BACKGROUND INFORMATION

Sir Isaac Newton discovered basic laws about how things move. His first law of motion states that objects at rest remain at rest and objects in motion remain in motion unless acted upon by an external **force** - a push or pull - that sets them in motion. **Gravity** is a force that's always pulling things down toward the center of the planet. A tablecloth can be pulled out from underneath a set of dishes, if it is pulled quickly. This is because the dishes have **inertia**, a tendency to remain at rest. A bowling ball, once in motion, will continue in a straight line forever, unless it hits the pins, or **friction** eventually supplies the force to slow it down.

In this activity, a force, gravity, acts upon the ball to pull it down when it is dropped. The force of the surface acts upon the ball to push it back up. The ball changes direction (acceleration). However, the ball does not bounce back to its original height because some **energy** is absorbed by the surface on which it was dropped. Some of the energy is changed into **heat** energy in the collision. The focus in this activity is on the pattern formed from the data. There is a relationship between the height of the drop and the height of the bounce for a particular ball striking a particular surface.

As you hold each ball, it has stored, or **gravitational potential energy**. The higher the ball is held, the greater the amount of potential energy. When you drop the ball, the potential **energy is transformed** to **kinetic** energy, energy of motion.

MATERIALS

Per group

1 tennis ball
1 meter stick
More Bouncing Balls data sheet
paper and crayons for a bar graph

TEACHING TIPS

1. If students compare the differences in bounce heights on a bar graph, they should find they form fairly consistent increments. They can then use this incremental distance to predict the bounce height for a drop from 120 cm.
2. Measurement is never exact. A measurement can always be taken to another, more precise decimal place. Measuring a ball in motion is even more difficult. Students should realize that their measurements are approximations.

ENGAGE

1. Ask: *If I stood on my desk and dropped a tennis ball from above my head, how high would it bounce compared to a ball dropped from above my head while standing on the floor?*
2. Hold the ball at both heights and have students help you measure each of those distances. Record the measurements but don't drop the ball.
3. Record students' predictions and complete the activity after students have had the opportunity to Explore.

EXPLORE

Student Directions:

1. Tape a meter stick to the wall. The bottom of the stick should be even with the top of the table. (One student in each group can hold the meter stick even with the top of the table.)
2. On the data sheet, predict how far the ball will bounce when dropped onto the table from a height of 100 centimeters.
3. One person will drop the ball, and it is very important for the other group members to closely observe the height to which the bottom of the ball bounces.
4. Drop the tennis ball onto the table from a height of 100 centimeters.
5. Based on the observations, determine the height of the bounce and record how high the bottom of the ball bounced.
6. Repeat the procedure of predicting, dropping the ball, and recording the distance the bottom of the ball bounced from heights of 80 cm, 60 cm, 40 cm, and 20 cm.
7. Use the data to create a bar graph.
8. Discuss the bar graph. *Do you see any patterns?*

EXPLAIN

Discuss the groups' data:
Did all groups get the same data? Why? (How well variables are controlled can cause differences.)
What are some variables that might have affected the outcome? (inaccuracies in measurement, different dropping styles, etc.)
What does the graph tell us?
Did you see a pattern in the data you collected?

How can we make a height-of-bounce prediction for a 120-cm drop? (Have students look at patterns in the graph.)
When was potential energy converted to kinetic energy? (The ball held at the designated height had gravitational potential energy. When the ball was dropped, the potential energy was converted to kinetic, or moving energy.)
What is the relationship between the height from which the ball is dropped and the distance it bounces? (As the height from which the ball is dropped increases, the distance the ball bounces increases.)

EXTEND and APPLY

1. Have students drop the ball from 120 cm to test their predictions.
2. Return to the Engage activity and complete it.

EXTENSIONS

1. Repeat the investigation on different types of surfaces and with different types of balls (e.g., Ping-Pong balls, rubber balls).
2. Have students drop a basketball and a tennis ball separately and at the same time. Both balls will bounce up to a position that is below where they were dropped.
   Next, have students drop the basketball and the tennis ball together. **The tennis ball should be placed on top of the basketball as they are dropped.** The tennis ball will bounce much higher than the position from which it was dropped, but the basketball will bounce much lower than before. Some of the original energy of the basketball was transferred to the tennis ball.

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HEIGHT OF THE DROP	PREDICTION	ACTUAL