LOSING YOUR MARBLES

BENCHMARKS and TASKS

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 describes the motion of an object by its position, direction, and speed.
- The student demonstrates how inertia (an object's tendency to resist a change in motion), gravity, friction, and mass affect motion.

KEY QUESTION

What are some forces that can affect the motion of an object?

BACKGROUND INFORMATION

Newton's First Law of Motion: An object at rest will stay at rest unless acted on by an unbalanced force. An object in motion will stay in motion at the same speed and in the same direction unless acted on by an unbalanced **force.** Newton's First Law of Motion is also called the law of **inertia.** Inertia is an object's tendency to resist a change in motion. All objects have inertia. The greater an object's **mass**, the greater its inertia, and the larger the force needed to overcome the inertia.

Not all motion is linear (in a straight line). An object may oscillate, move back and forth, about a fixed point. It may also have circular motion caused by centripetal force, which keeps it moving in a circle instead of flying away.

MATERIALS

Per group

1 raw egg and 1 hard-boiled egg (see Teaching Tips)
1 circular bowl
1 Ping-Pong ball and/or other small balls
1 small rubber ball

TEACHING TIPS

1. Prepare one hard-boiled egg for each group ahead of time.
2. Have students wash their hands thoroughly after handling eggs.
3. Part 1 can be done as a teacher demonstration and this would require only two eggs – one raw and one hard-boiled.

ENGAGE

1. *When a car turns a corner, what happens to the passengers?* (They tend to sway or lean away from the curve.)
2. *Why does this happen?* (The passengers are experiencing inertia. The particles in their bodies want to keep going in a straight line. However, the car exerts centripetal force on the passengers; it forces them to turn the corner, changing their direction.)

EXPLORE and EXPLAIN (Part 1)

1. Give students one hard-boiled and one raw egg. Tell them the challenge is, without cracking the eggs, to determine which one is raw and which one is hard-boiled.
2. Have students spin the eggs at the same time and discuss their observations.
3. Have them spin the eggs again and use one finger to touch the top of each egg, causing a brief stop. (The cooked egg will stay still but the raw egg will start spinning again.)
4. Ask students to predict which egg was hard-boiled and which one was raw.
5. *What would cause these results?* (The insides of the egg have more inertia when they are liquid, like the raw egg, than when they are solid, like the hard-boiled egg. This slows the raw egg down so it stops spinning before the hard-boiled egg. However, when you stopped the eggs and then let go, the liquid in the raw egg was still moving. This movement, caused by inertia, started the egg spinning again.)

EXPLORE (Part 2)

1. Hold up a small rubber ball. Ask students if they can think of a way to make it move in a circle. Experiment with some of their ideas.
2. Have students place a ball in the bowl and take turns within their groups, rotating the bowl in a circular motion.
3. Repeat step 2 with the Ping Pong ball and other available balls.
4. *Why is the ball rolling around the bowl?* (Force is being applied to it and it wants to move in a straight line, but it can't because of the rounded walls.)
5. Have students place the rubber ball on a desk and place the bowl over it.
6. Tell them they are going to spin the bowl upside down with the ball beneath it. Have them think about what will happen before they try it.
7. They should move the bowl in fast circular motions, making sure they hear the ball moving around the edge of the bowl.
8. Now have students lift the bowl and observe the ball's path. (It will move across the table in a straight line until it hits another object, which stops it, slows it down, speeds it up, or changes its direction.)

EXPLAIN

Explain how the ball moved when you lifted the bowl and why that happened. (The ball moved in circles under the bowl as it spun, because its inertia was balanced by an inward force—the push of the curved walls of the bowl. This force is known as centripetal force. When the bowl was lifted, the centripetal force was ceased and inertia kept the ball going in its preferred straight line.)

EXTEND/APPLY

1. Play a game to help students visualize motion, including the direction and the changes in direction of moving objects.
   - Draw a horizontal line on the chalkboard. Ask the class to think of some object that moves along a path like this (e.g., a marble rolling across a smooth floor).
   - Draw a vertical line on the chalkboard. Ask what object might move along a path like this (e.g., a ball falling freely).
   - Draw a diagonal line on the chalkboard. Ask what object might move along a path like this (e.g., a plane landing).

2. When you feel the students have the idea, draw other "paths of motion" and see who can name them. Some examples may be:
   - handle of pencil sharpener as a pencil is sharpened
   - pitched baseball
   - rabbit hopping
   - ball bouncing on the floor or down a flight of stairs
   - pendulum
   - pebble skipping across a pond
   - reflector on the pedal of a moving bike
   - skateboarder going down a ramp and then up a ramp
   - pebble stuck on a moving auto tire (test by strapping chalk to the can and then rolling it on the chalkboard)
3. Encourage students to design their own paths of motion and have the class try to guess what made the paths, or give students the paths you want them to draw on the board and see if they can design the path so the class can figure out what path they were assigned (similar to charades).

ASSESSMENT

Read the following scenario to the class and then have them respond:
A boulder on top of a hill begins rolling down the hill when a boy pushes it. Once it starts down the hill, it continues to gain speed because of the force of gravity acting on it. Suddenly a new force acts on the boulder.

- Tell what this new force might have been. (Accept any reasonable answer.)
- Tell how this new force could change the motion of the boulder (e.g., change its direction, slow it down, speed it up, stop it).