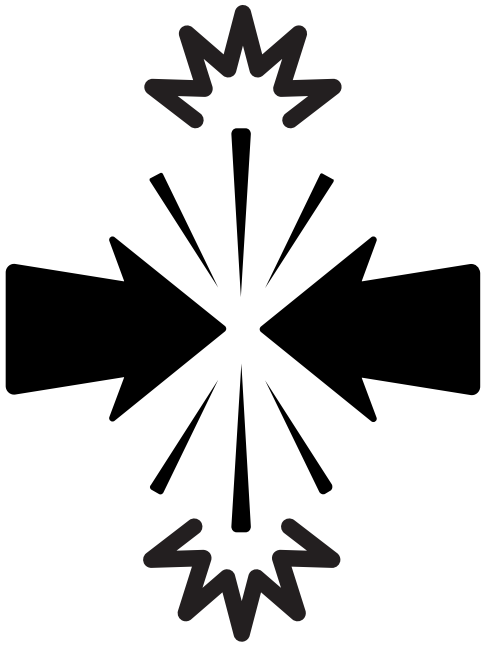
LESSON 4 | Forces and Motion



Objective

Students will plan an investigation to demonstrate that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.

Time

45–60 minutes

Materials

- 4–6 skateboards (ask several students to bring to class; or substitute large toy trucks)
- Heavy textbooks
- Masking tape
- Timers
- String to attach the books to the skateboard
- Conduct a Collision Test activity sheet

Extension Material

- This lesson is part of the "Science in Action" program. You can implement the lessons as standalone experiments or use them sequentially. Elevate experiments by using Google's free Science Journal app on classroom tablets or Chromebooks to measure and record observations; experiment data will be stored on Google Drive so you can access it across devices. To get more info and to download the app, go to **sciencejournal.withgoogle.com**.

Instructions

1 Place a large book on your desk and ask students what would happen if you were to push hard on its side (it would slide across the desk). This is an example of Newton's Third Law of Motion: For every action, there is an equal and opposite reaction. Prompt students to describe other action-reaction examples, such as a collision between two cars, ball hit by bat, etc.

2 Explain that the motion of colliding objects depends on momentum. Every moving body has momentum: p = mass (m) * velocity (v). The momentum is conserved in a collision if it is a closed system (without other forces acting on it). Before and after the collision, the combined momentum of the objects is the same. When a moving object collides with another object, the hit object will gain momentum by moving, while the colliding object loses momentum by slowing or stopping.

3 Divide students into groups. Explain that they'll perform a collision test with two skateboards to compare how adding weight affects the results. Direct them to:

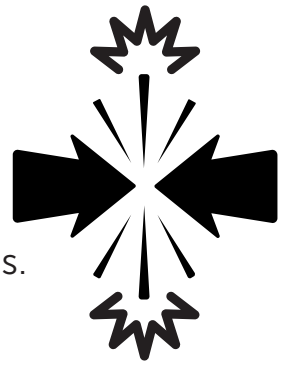
- Place skateboard 1 on the floor and mark the position of its front and back ends with tape. This skateboard will be hit in the collision. Place a piece of tape 0.5 meters from the back end of skateboard, and then place the second skateboard (the colliding skateboard) so its front end is at the tape mark.
- One student will push the colliding skateboard, another will use a stop-watch to measure the time it takes before the collision occurs, and a third will use a stopwatch to measure the travel time of skateboard 2 after it is hit.
- Conduct initial test by colliding skateboards with nothing on top. Then add mass to the colliding skateboard by placing two heavy textbooks on top, attached with string. Repeat test. Remove textbooks from colliding skateboard, and secure to hit skateboard. Repeat test.

4 Choose one group's setup. As a class, calculate the momentum of the colliding skateboard before the collision and the momentum of the hit skateboard after the collision. (The values likely won't be equal; other forces such as friction act on the system, and the colliding skateboard retains some momentum.)

Science Journal Extension

Take two classroom tablets or phones and wrap each in a layer of bubble wrap. Have groups use tape to attach one device to each of the skateboards. Use the Accelerometer X or Y tool on the app to measure the acceleration of the colliding and hit skateboards. Students can use the acceleration of the colliding skateboard to determine the force with which it hits the other skateboard in each setup. Force (F) = mass (m) * acceleration (a).

Name _____



Conduct a Collision Test

Investigate how mass affects the collision between two skateboards.

Step 1 Record your test results below.

			Colliding Skateboard (Before Collision)			Hit Skateboard (After Collision)		
		MASS OF EACH SKATEBOARD	**TIME**	**DISTANCE**	**AVERAGE VELOCITY**	**TIME**	**DISTANCE**	**AVERAGE VELOCITY**
No Weight	**Trial 1**							
	Trial 2							
	Trial 3							
Weight on Colliding Skateboard	**Trial 1**							
	Trial 2							
	Trial 3							
Weight on Hit Skateboard	**Trial 1**							
	Trial 2							
	Trial 3							

Step 2 Make a prediction: Based on your results above, what do you think would happen if a heavier ice hockey player were to collide with a lighter player? What other factors would determine what happened to the player who was hit? Use data to support your answer.

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