Lesson Summary

In this lesson, students are introduced to Newton's first and second laws of motion. Diagrams and equations help students develop an understanding of how these laws describe relationships between forces and motion. Students also learn how the laws of motion can be used to explain everyday observations.

Lesson Objectives

By the end of the lesson, students will be able to (1) relate forces and motion, (2) apply Newton's first law of motion, (3) apply Newton's second law of motion, and (4) define domain-specific vocabulary related to forces and motion.

National Standards

NGSS Standards

- **MS-PS2-2**: Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.
- **DCI: PS2.A:** Forces and Motion: The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion.
- **DCI: PS2.A:** Forces and Motion: All positions of objects and the directions of forces and motions must be described in an arbitrarily chosen reference frame and arbitrarily chosen units of size. In order to share information with other people, these choices must also be shared.
- **SEP:** Planning and Carrying Out Investigations
- **CCC:** Stability and Change

This ***Expedition: Learn!*** lesson supports the coverage of national content standards and provides a solid foundation for further exploration of this topic and related topics. You can use the activities suggested in this document to extend and enhance students' understanding of the concepts in the lesson.

Background

- Physicist Isaac Newton summarized his study of forces and motion in three scientific laws that describe how forces are related to the motion of objects—whether they are standing still or moving. This lesson covers Newton's first and second laws.

- Newton's first law describes inertia, stating that objects at rest remain at rest, and objects in motion remain in motion with the same velocity, unless acted on by an unbalanced force. To move an object at rest, enough force must be used to overcome the object's inertia.
- Newton's second law states that the acceleration of an object increases with increased force and decreases with increased mass—i.e., the force to move an object is equal to its mass times its acceleration (F = MA).
- This lesson builds on students' background knowledge that a force acts on one particular object and has both strength and a direction and that forces that do not sum to zero can cause changes in the object's speed or direction of motion.

Common Misconceptions

- Students may believe that every object that moves will eventually stop on its own.
    - This misconception is based on students' observations of everyday objects, such as rolling balls, slowing to a stop. However, moving objects don't stop on their own; they stop because of the force of friction or another force acting on them.
- Students may believe that there are no forces acting on unmoving objects.
    - Objects, whether they are moving or unmoving, always have several forces acting on them. For example, gravity is a force that pulls all objects toward the center of Earth.
- Students may believe that if an object is moving, the forces acting on it must be unbalanced.
    - Motion alone does not provide evidence of unbalanced forces acting on an object. A *change* in motion (speed or direction) is evidence that unbalanced forces are acting on an object. A moving object acted on by balanced forces continues moving at the same speed and in the same direction.

Skills Assessed in This Lesson

- Claims-Evidence-Reasoning
- Cause and Effect
- Engineering and Design
- Mathematical Reasoning
- Use Vocabulary

Lesson Vocabulary Words

- acceleration
- force
- motion
- speed

Explore the Lesson

Review and discuss the formative assessment questions below during the lesson to engage students and check their understanding.

- How are forces and motion related?
- How would you restate Newton's first law of motion in your own words?
- What is the mathematical equation for Newton's second law?

Use one or more of the following strategies to support students' understanding as they read the lesson.

Vocabulary: Concept Map Invite students to draw four circles in their notebooks or digital devices, with one of the lesson vocabulary terms in each circle. As students read, they can draw lines between the circles and add labels to the lines explaining how the terms connect. The use of visuals helps students make connections and see how ideas fit together.

Interpret Information As students read the second passage, ask them to write the terms "Force," "Mass," and "Acceleration" on sticky notes. Encourage them to practice stating the relationship between the terms and arranging them to reflect the relationships described in the passage (Force = Mass × Acceleration and Acceleration = Force ÷ Mass). Invite students to determine how they would arrange the sticky notes to show how to solve for an unknown mass using a known net force and acceleration (Mass = Force ÷ Acceleration). Then ask each student to state in their own words how an object's mass and the net force acting on it is related to its change in motion (acceleration). [CCC: Stability and Change]

Learn More In the final section of the lesson, students are invited to explore additional Britannica resources related to the lesson content. In addition, the Expedition: Learn! Hands-On Activity "Investigate Forces and Motion" found in this section can also be used to extend students' understanding of the lesson topic. You'll find the teacher materials for the activity at the end of this document.

Extend the Learning

Provide opportunities for students to extend their learning based on their specific interests. Offer choices whenever possible, with flexible grouping.

Model Newton's Laws Invite students to work individually or in small groups to develop a model that demonstrates Newton's first or second law of motion. The model can be a diagram, a mathematical model such as a graph, or a 3-D model that incorporates available materials. Students should be able to describe their model, explain how it relates to Newton's first or second law, and identify the limitations of their model.

Plan an Investigation Ask students to work in small groups to plan an investigation of the relationship between forces and motion. Using the information in the lesson, each group should develop a testable question. Ask each group to identify the dependent and independent variables, controls, and steps they would use in their investigations. Encourage students to describe the tools and materials they would need, along with the data that would be collected. Select one or more investigations to carry out as a class, if materials are available. [SEP: Planning and Carrying Out Investigations]

Busting the Myths There are many common misconceptions about forces, motion, and how they are related. Invite students to work with a partner to identify one common misconception about forces and motion. Ask them to develop a written scientific explanation of the correct understanding. Encourage them to include diagrams or mathematical relationships as part of their explanation. Invite each pair of students to share their explanation, either with the whole class or with another pair of students.