

Lesson Topic: Factors Influencing Motion: Newton's First and Second Laws

Objective:

Students will be able to:

1. 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.

Time Required: 60 minutes

Materials Needed:

- Rope for tug-of-war demonstration
- Shoe box filled with cotton balls
- Shoe box filled with sand
- Hair dryer
- Spring scale

Teacher Preparation:

- Assign a Legends of Learning Instructional [Quick Play](#) playlist for the day(s) you will be teaching the lesson.
 - Instructional - Middle School - Factors Influencing Motion: Newton's First and Second Laws
- Assign a Legends of Learning Content Review [Quick Play](#) playlist for the day after the lesson.
 - Content Review - Middle School - Factors Influencing Motion: Newton's First and Second Laws
- Prepare hands-on experience materials

Engage (10 minutes):

1. Ask for students to volunteer to be part of a tug-of-war activity. Make sure there are unequal numbers of students on each side. Students will balk at the unfairness of the game.
2. Tell the students that if they have a good rationale for why the number of students on either side of the rope should be equal, we will change the set up.
 - a. Students will say that extra people on one side is unfair because they will pull harder and pull everyone on the other side forward.
 - b. Some students may argue that it doesn't matter about the number of students because some students may be stronger than others.
3. Explain that today's lesson will explore this concept.

Explore (10 minutes):

1. Set the hair dryer on low and use the moving air as a force. Aim the moving air at the box of sand. Do the same with the box of cotton balls. Ask students to consider what has happened.
 - a. Students should recognize that one of the boxes is heavier than the other (focus students on greater mass, not weight), even though it is the same size

as the other. The box with cotton balls moves more easily than the one filled with sand.

2. Take the lighter shoe box with cotton balls and push it again with the air from the hair dryer on low. Change the speed of the fan to high and observe the difference in the motion of the box. Ask the students to consider this and propose explanations.
 - a. Students will likely say the dryer had more power and therefore, moved the box faster. However, direct students to the concept of acceleration.

Explain (10 minutes):

1. Write this formula on the board for students: $F=ma$
 - a. Explain to students that the amount of force is dependent on the mass of the object and its acceleration.
2. Based on this formula, describe how the first scenario (low fan speed is the force acting on less massive and more massive boxes; the speed at which the box moved is the acceleration).
3. Explain that if no movement occurred during a tug-of-war, the forces would be balanced, which means forces with a net value of zero.

Elaborate (15 minutes):

1. Have your students [sign in to Legends of Learning](#). Instruct students to complete the Instructional playlist.
2. Ask students to work in pairs to come up with other motion scenarios that show the interactions among force, mass, and acceleration.
 - a. Students may borrow examples from the Legends of Learning games or from their everyday lives. For example, it's harder to push a larger student in a chair than it is a smaller student.

Evaluate (15 minutes):

1. Have your students [sign in to Legends of Learning](#). Instruct students to complete the Content Review playlist.
2. [Analyze student results](#) to determine what concepts need to be a focus for reteaching.

Additional Lesson Strategies:

- To use Legends for additional instruction, create a [custom playlist](#) with an [instructional game](#) and pre and post [assessment](#).
- To use Legends for a quick formative assessment, create a 5-question [assessment](#) in a [playlist](#).
- To use Legends for a student-directed experience, create a [targeted freeplay](#) playlist.
- Encourage students to play on their own at home in [Legends of Learning: Awakening](#) for a student-driven experience including avatars, battling, and quests all centered around topics they are covering in class.