On the Move:

Understanding Newton's Laws of Motion

Grades 6–8

Using AIT Products

- *Minds on Science*, Program 9, "Motion: Why Does the Remote Control Car Run Off the Track?"
- *Inventing Flight*, Unit 1: Science Tutorial, "Newton's Laws"

Overview

If you have ever been in a vehicle when the brakes have suddenly been applied, tried to push a heavy shopping cart, or observed a fish swimming in water, then you have witnessed Sir Isaac Newton's Laws of Motion. Newton's three laws of motion govern 99 percent or more of our everyday experiences—from how the planets orbit the Sun to how a person rides a bicycle. This lesson is designed to help students understand the relationship between force and motion. Students will observe objects in motion and speculate why they move the way they do. They will then discuss the meaning of Newton's three laws of motion and apply these laws to everyday situations.

Objectives

Students will:

- Conduct experiments and investigate how different forces affect objects in motion.
- Define Newton's first, second, and third laws of motion.
- Describe everyday events and identify the associated law of motion

Every object will remain at rest or in uniform motion in a straight line unless compelled to change its state by the action of an external force.

—Newton's First Law of Motion

Vocabulary

acceleration
direction
force
inertia
mass
motion
speed

Preparation

Materials needed

- AIT video: *Minds on Science,* Program 9, "Motion: Why Does a Remote Control Car Run Off the Track?"
- AIT video: *Inventing Flight,* Unit 1: Science Tutorial, "Newton's Laws"
- Large piece of cut cloth, approximately 16 square feet. (The cloth should not have hems.)
- Cups and plates with smooth bottoms
- Utensils (forks, spoons, knives)
- Large sheets of smooth paper
- Books with a hard, glossy cover
- Books with a rough or non-glossy cover
- Small objects, such as coins, blocks, or washers
- Tennis ball
- Tennis racket
- Basketball
- Meter sticks
- Toy trucks
- $\frac{3}{8}$-inch washers
- 4-inch binders
- balloons

Planning Notes

Each day begins with a demonstration. They are fairly easy to do, but you may want to practice each demonstration before class.

Arrange students in work groups to complete this lesson. Groups of three to five are best.

Time

This project will take three class periods, in addition to homework time.

Procedure—Day 1

Advance Preparation

Prior to class, cut a large piece of cloth that is approximately four-feet square. Place the cloth on a flat tabletop. Then put cups, plates, and utensils on top of the cloth, close to the edge of the table. (Make sure the surfaces of the bottoms of the cups and plates are smooth.)

Introduce Topic

Ask students if they have ever seen a magician pull a tablecloth out from underneath a place setting without breaking the dishes. Demonstrate this trick by quickly pulling the table cloth down and away from your table. (Note: The key to performing this trick successfully is using a quick, downward motion.) Ask students to explain why they think the dishes on the table did not fall off the table and break.

Explain to students that this magic trick is best explained with Sir Isaac Newton's Laws of Motion. Quickly assess students' knowledge of Newton. Have students explain who he was and describe some of his major accomplishments.

Video

Cue Program 9 from the series *Minds on Science* to approximate time code 06:48, after Rollo and the kids walk into the science lab. Explain to students that they will watch a video that describes Newton's first law of motion. Tell them to pay close attention during the video and write down the meaning of Newton's first law of motion. PLAY through time code 09:31, after Rollo stops talking about the car crash video.

Ask the following questions after the video.

- What is Newton's first law of motion?
- How do the dummies wearing seat belts exemplify Newton's first law of motion?
- How does Newton's first law of motion apply to the tablecloth trick?

Group Work

Explain to students that they will now perform an experiment demonstrating Newton's first law of motion. This experiment is similar to the tablecloth trick.

Give each group one large, smooth piece of paper; a book with a hard, glossy cover; a book with a rough or non-glossy cover (such as an old, worn book); and four small objects such as coins, blocks, or washers.

Have students place the piece of paper on the flat, smooth desk and put the book with the glossy cover on the piece of paper. Then ask students to quickly yank the paper out from under the book and record what happens.

Ask students to conduct the experiment again, but this time they should also put the small objects on the paper. Make sure they record their observations.

Have students repeat the two steps above using the book with a rough cover. Remind them to record their observations.

Discuss the experiment with students. Ask:

- Does the mass (weight) have any effect? Why?
- Does the type of object you added to the paper have an effect? In what way? Why?
- How does this experiment relate to Newton's first law of motion?

Homework

Ask students to write a paragraph that describes an everyday event and explains how Newton's first law of motion applies to that event.

Procedure—Day 2

Reflection

Have several students share their paragraphs with the class.

Introduce New Topic

Tell students that Newton's first law of motion explains that a force is needed to overcome inertia (the tendency to resist any change in motion). Newton's second law explains what happens to an object when an unbalanced force acts on it.

Take the class outside. Select four student volunteers. Have each of them hit a tennis ball with a racket and ask the rest of the class to observe what happens.

Ask the class what would happen if the students tried to hit a basketball with the racket. Then have each of the four volunteers try to hit a basketball with the racket. Ask the volunteers to describe what happened.

Video

Cue *Inventing Flight,* Unit 1: Science Tutorial, "Newton's Laws," to approximate time code 03:24, where they begin to discuss Newton's second law of motion. Explain to students that they will watch a video that describes Newton's

second law of motion. Tell them to pay close attention during the video and write down the meaning of Newton's second law of motion. PLAY through time code 06:53, when the video starts to fade out.

After the video, use the following as prompts for discussion.

- What is Newton's second law of motion?
- How does pushing a shopping cart exemplify Newton's second law?
- How does Newton's second law apply to hitting a tennis ball and basketball?

Group Work

Note: The following experiment is best performed on wooden, linoleum, or tile floor.

Give each group one 4-inch binder, a meter stick, one toy truck, and six $\frac{3}{8}$-inch washers.

Have students place the three-ring binder on the floor and form a ramp. They should then roll the toy truck down the ramp and record how far it travels.

Ask students to add three washers to the truck, roll it down the ramp, and record how far it travels.

Tell students to add three more washers to the truck (for a total of six), roll it down the ramp, and record how far it travels.

Discuss the experiment with the class, using the following questions as prompts.

- How does increasing mass (adding washers) affect the force of the objects in motion (the distance the truck rolls)?
- What would happen if you added more washers to the truck?
- How does this experiment apply to Newton's second law?

Homework

Ask students to write a paragraph that describes an everyday event and explains how Newton's second law of motion applies to that event.

Advance Preparation for Day 3

Ask two students to bring roller blades or a skate board to class the next day.

The amount of acceleration (**a**)(change in speed) that a force (**F**) can produce depends on the mass of the object being accelerated. (**F=ma**).

—Newton's Second Law of Motion

Procedure—Day 3

Reflection

Have several students share their paragraphs with the class. Review the meaning of Newton's second law of motion.

Introduce New Topic

Tell students that Newton's third law describes the forces in action and reaction pairs. Then take the class outside. Have the two students with the roller blades or skate board throw a baseball. Ask

the class to observe what happens. Ask: What direction did the students move when they threw the ball?

Video

Cue *Inventing Flight,* Unit 1: Science Tutorial, "Newton's Laws," to approximate time code 06:55, where they begin to discuss Newton's third law of motion. Explain to students that they will watch a video that describes Newton's third law of motion. Tell them to pay close attention during the video and write down the meaning of Newton's third law of motion. PLAY through the end of the video.

After the video, use the following questions as prompts for discussion.

- What is Newton's third law of motion?
- How do airplanes apply to Newton's third law of motion?
- How does throwing a ball while on roller blades or a skateboard exemplify Newton's third law?

Group Work

Take the class outside or to the gym. Give each group enough balloons for each student.

Have every student blow up a balloon and tie the end of it. Tell students to hold the ends of their balloons. On the count of three, have students let go of the balloons. (They should not throw the balloon; just let go). Ask students to describe what happened.

Tell students to blow up the second balloon and hold the opening of the balloon closed with their fingers. On the count of three, have students release their balloons.

Ask students to describe what happened and explain how it demonstrates Newton's third law of motion.

Homework

Ask students to write a paragraph that describes an everyday event and explains how Newton's third law of motion applies to that event.

Assessment

Individual Assessment

Have students write answers to the following questions.

- What is inertia?
- What is Newton's first law of motion?
- What is Newton's second law of motion? What is the formula that expresses this law?
- What does Newton's third law of motion state about action-reaction forces?
- Would you be surprised if a ball flew up into the air by itself? Why? According to Newton's first law, what is needed to make the ball move?
- If a given force is applied to two objects of different mass, which object will accelerate more?
- How do rockets exemplify Newton's third law of motion?

Group Assessment

Give each group several balls that are different sizes and weights, and materials to build a track. Have groups of students build a track and use the balls to demonstrate Newton's three laws of motion.

Extension Activity

Have students bring in materials from home, such as toys, sporting goods, or tools. Ask groups of students to use the materials to develop a

For every action there is an equal and opposite reaction.

—Newton's Third Law of Motion

demonstration of one of Newton's laws of motion. Allow students to share their demonstrations with the class and discuss the law of motion that is being exemplified.

Resources

The Physics Classroom: Newton's Laws of Motion
www.glenbrook.k12.il.us/gbssci/phys/Class/newtlaws/newtltoc.html
This Web site was created by a science teacher at Glenbrook South High School in Glenview, Illinois. It covers basic physics topics using informative graphics and easy-to-understand language. Each unit is broken up into lessons and sub-lessons. The sub-lessons are accompanied by Check Your Understanding sections, which give you the opportunity to assess students' understanding of the lesson material.

Newton's Laws of Motion
www.grc.nasa.gov/WWW/K-12/airplane/newton.html
This Web site was created by NASA's Glenn Research Center. It explains Newton's Laws of Motion and describes how these laws can be applied to aeronautics. This Web site also includes activities for students in grades 6–12.

May the Force Be with You
www.usoe.k12.ut.us/curr/science/sciber00/8th/forces/sciber/intro.htm
This Web site, hosted and funded by the Utah State Office of Education, explains Newton's Laws of Motion and illustrates how these laws apply to everyday situations. This Web site also includes directions for quick activities that encourage students to investigation Newton's laws further.

Tips for Teachers: How to Access AIT Materials without Spending Your Own Nickel(s)
www.ait.net/technos/e-zine/tech_notes/grants.php