Discussions that ensue from thought-provoking questions provide a good way to assess the overall depth of student understanding. The following are some suggested discussion questions.

1. Discuss the idea that the push and pull of forces is the foundation of the shape of everything in the universe.
2. Discuss how the formula — pressure = force / area — explains why a knife blade or a woman's high heel can have a great deal of force.

## Follow-up Activities

- Discuss Sir Isaac Newton's reputation as one of the greatest thinkers of all time and ask students to research his life and work. Have them discuss their findings in small groups. Make sure they know that while advances in physical science are due to the foundation of his theories, some of his concepts were incorrect.
- Have students generate a list of sports activities and explain how the forces of our world combine to affect each activity.
- Ask students to think about how different their lives might be if a Law of Motion was missing. Have them write a descriptive essay. You may wish to assign one law to each small group of students, who would be responsible for sharing ideas.

## Internet Resources

Periodically, Internet Resources are updated on our Web site at www.libraryvideo.com

- **lyra.colorado.edu/sbo/mary/play/**
  This "Playground Physics" site is geared to students in grades 4 through 7 and is designed to give an introduction to classical physics that is fun. Experiments, teacher's guides and standards are included.
- **www.glenbrook.k12.il.us/gbssci/phys/Class/newtlaws/newtltoc.html**
  This high school physics tutorial site may be useful for older middle-school students. Newton's Laws and Forces are topics that are covered.
- **www.lerc.nasa.gov/www/k-12/TRC/Rockets/RocketActivitiesHome.html**
  This NASA Web site has some excellent ideas for demonstrating Newton's Laws and includes biographical information about Sir Isaac Newton as well as how people have learned how to put the Laws of Motion together for useful purposes.



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## Suggested Print Resources


- Doherty, Paul. *The Spinning Blackboard and Other Dynamic Experiments on Force and Motion.* Wiley Pub., New York, NY; 1996.
- Taylor, Beverly. *Teaching Physics With Toys: Activities for Grades K–9.* Blue Ridge, Summit, PA; 1995.
- Tocci, Salvatore. *Experiments With Motion.* Children's Book Press, Berkeley, CA; 2003.
- Ward, Alan. *Forces and Energy.* Watts Publishing, Danbury, CT; 1992.



**TEACHER'S GUIDE CONSULTANT**

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**TITLES**

- ATOMS & MOLECULES
- CHANGES IN PROPERTIES OF MATTER
- CHARACTERISTICS OF WAVES
- ELECTRICITY
- ELEMENTS, COMPOUNDS & MIXTURES
- FLIGHT
- FORCES
- FRICTION
- GRAVITY
- LIGHT
- MAGNETISM
- MOTION & BALANCE
- THE PERIODIC TABLE
- PROPERTIES OF MATTER
- SIMPLE MACHINES
- SOUND




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TEACHER'S GUIDE

# PHYSICAL SCIENCE IN ACTION™

# Forces

## Grades 5–8

Students in grade 5-8 classrooms possess a wide range of background knowledge. Student response to this video program is sure to be varied, so the teachers at these grades need all the help they can get! This guide has been designed to help the 5-8 science teacher by providing a brief synopsis of the program, previewing and follow-up questions, activities, vocabulary and additional resources.

**Before Viewing:** Extensive research tells how important it is for the teacher to discover what the students know — or think they know — about a topic, before actually starting a new unit. Therefore, after prompting discussion with the pre-viewing questions, lead your class to create a "Everything We Think We Know About…" list. You may also wish to preview key vocabulary words, and have students raise additional questions they hope will be answered.

**After Viewing:** Have your students share video excerpts that fascinated or surprised them, then challenge your students to prove or disprove the accuracy of the facts they put on their "Everything We Think We Know About…" list. Discuss what else they learned and use the follow-up questions and activities to inspire further discussion. Encourage students to research the topic further with the Internet and reading resources provided.

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## Program Summary

There are many forces at work shaping the world as we know it. A force is defined as a push or a pull on an object, causing a change in its motion. Forces can be balanced, resulting in no movement at all. If one force is stronger than another, there is a change in motion. This constant push and pull of forces shapes the universe.

There are a number of forces affecting us at all times. Friction is a force that opposes motion between two surfaces that come in contact. There is friction any time two things are touching. Another force that we couldn't live without is the fundamental force of attraction between all objects, better known as gravity. The more mass an object has, the greater the force of its gravity. Humans make use of electromagnetic forces by harnessing the push and pull that we associate with electricity and magnetic fields. The most powerful known force is nuclear force, the truly awesome forces of attraction and repulsion within the particles of every atom.

Sir Isaac Newton, a 17th century English physicist and mathematician, spent his life studying forces. He is known for the development of the Theory of Gravity and the Laws of Motion. Newton's First Law of Motion explains that an object at rest will stay at rest, and an object in motion will stay in motion, unless acted upon by an outside force. The forces of friction and gravity oppose forward motion, causing the object — like a golf ball in flight — to return to a balanced state. Inertia is the basis of this law: the greater the mass of an object, the greater the tendency to stay at rest or in motion. Newton's Second Law of Motion deals with acceleration, which is a change in an object's direction or rate of motion. The amount of force applied to an object — like hitting a baseball with a bat — as well as the mass of the object, determines how far and in which direction it will go. The Third Law of Motion explains that for every action, there is an equal and opposite reaction. This means that in order to launch a rocket upward, the force of the engine thrust is downward. Finally, the force of air pressure is examined in two exciting demonstrations that illustrate the power of imbalanced forces.

## Vocabulary

The following words are included for teacher reference or for use with students. They are listed in the order in which they appear in the video.

**force —** A push or a pull on an object, causing a change in motion.

**balanced forces —** When opposing forces push and pull equally on an object, resulting in no change in motion.

**friction —** The force that opposes movement between two objects in contact with each other.

*(Continued)*



**gravity —** The fundamental force of attraction between all objects. The more mass an object has, the greater the force of its gravity.

**electromagnetic force —** The attraction or repulsion between charged particles. Electromagnetic force is harnessed to produce electricity.

**nuclear force —** The strongest force known, responsible for the joining of subatomic particles within an atom.

**attraction —** The action of pulling two objects together and resisting their separation.

**repulsion —** The action of pushing two objects apart.

**Sir Isaac Newton —** (1642-1727 C.E.) English physicist and mathematician who studied gravitational forces and motion, and is considered the founder of physical science. Newton formulated the Theory of Gravity and developed the Laws of Motion.

**inertia —** The property of matter that causes an object to resist a change of motion, direction or speed. The amount of inertia depends upon the object's mass.

**mass —** The quantity of matter that is contained in an object. The more mass an object has, the greater weight it has in a gravitational field.

**Newton's Cradle —** A device with suspended, swinging steel balls that demonstrates Newton's Third Law of Motion — for every action there is an equal and opposite reaction.

**acceleration —** Any change in an object's direction or rate of speed.

**pressure —** The force of molecules pushing on every surface area with which they come in contact. The pressure of a knife blade results from the application of force over a small area. Air pressure decreases with height because there are less molecules pressing down from above. Water pressure increases with depth because there are more water molecules pushing on objects near the bottom of a body of water than objects close to the surface.

## Pre-viewing Discussion

Before students generate their list of "Everything We Think We Know About…" for this topic, stimulate and focus their thinking by raising these questions so that their list will better reflect the key ideas in this show:

1. What are forces?
2. How do forces influence our world?
3. Are forces always in balance?
4. What happens when forces are not in balance?

After the class has completed their "Everything We Think We Know About…" list, ask them what other questions they have that they hope will be answered during this program. Have students listen closely to learn if everything on their class list is accurate and to hear if any of their own questions are answered.



## Focus Questions

1. How is force defined?
2. What are some examples of forces that are a push? What are some that are a pull?
3. What happens when forces are balanced?
4. How is friction defined? How is that force either a push or a pull?
5. How is the potter throwing clay an example of the force of friction at work?
6. What is the force of gravity? How is gravity vital to our existence?
7. What is electromagnetic force?
8. How is a magnetic field considered to be a push or a pull?
9. Which force is considered to be the "…most powerful force known?"
10. What is nuclear force?
11. How has Sir Isaac Newton contributed to our understanding of forces?
12. What is Newton's First Law of Motion? Explain.
13. What must happen to a golf ball in order for it to fly through the air and come to rest?
14. What is inertia?
15. What is the factor involved in increasing an object's inertia?
16. What is Newton's Second Law of Motion?
17. What is acceleration? Explain the following formula: force = mass x acceleration
18. How does the "Newton's Cradle" toy demonstrate Newton's Third Law of Motion?
19. What are some examples of the Third Law of Motion?
20. What is air pressure? How is this a push/pull force?
21. In the investigation, how did the hard-boiled egg get into the bottle?

## Follow-up Discussion

Research indicates that students will retain their previous misconceptions about a topic, in preference to new information, until they actively recognize and correct their own errors. Therefore, it is important to have your students re-examine the facts/beliefs they put on their "Everything We Think We Know About…" list. It might also be helpful to review the list by marking each entry with a "+" or "-" to show which facts were correct and which were incorrect.

*(Continued)*