

## QUEST Lab: Newton's Laws of Motion Educator Guide

A resource for using QUEST video in the classroom



Watch it online <http://www.kqed.org/quest/television/quest-lab-newtons-laws-of-motion> | 2:03 minutes

### QUEST SUBJECTS

**Life Science**      **Biology**  
Health  
Environment

**Earth Science**      **Geology**  
Climate  
Weather  
Astronomy

**Physical Science**      **Physics**  
Chemistry  
Engineering

### PROGRAM NOTES

What causes an object in motion to change course or stop moving? What happens to an object at rest if you leave it alone? A scientist at the Exploratorium in San Francisco shows **QUEST** how Newton's three laws of motion affect all movement in the universe.



In this segment you'll find...

- ⦿ an explanation of Newton's three laws of motion.
- ⦿ demonstrations of Newton's three laws of motion.
- ⦿ examples of how Newton's laws of motion govern activities in our everyday lives.

### CA SCIENCE STANDARDS

**Grade 8**  
*Forces (Focus on Physical Sciences)*

1. (d) The velocity of an object must be described by specifying both the direction and the speed of the object.

*Forces (Focus on Physical Sciences)*

2. (c, e) When the forces on an object are balanced, the motion of the object does not change; when the forces on an object are unbalanced, the object will change its velocity (that is, it will speed up, slow down or change direction).

**Grades 9-12**  
*Motion and Forces (Physics)*

1. (b, d) When forces are balanced, no acceleration occurs; thus an object continues to move at a constant speed or stays at rest (Newton's first law); when one object exerts a force on a second object, the second object always exerts a force of equal magnitude and in the opposite direction (Newton's third law).

### TOPIC BACKGROUND

By describing how forces acting on a body relate to the way a physical body in our universe moves, Sir Isaac Newton formed the basis for the scientific field of study concerned with the motion of objects, known as classical mechanics. His three laws of motion were first introduced to the public in 1687 in his three-book series **Mathematical Principles of Natural Philosophy** (published as **Philosophiæ Naturalis Principia Mathematica**). They have been an important part of scientific study ever since.

Newton's first law of motion is often referred to as the law of inertia, which describes the resistance of a physical object to a change in its state of motion. This law says that an object at rest tends to stay at rest unless acted on by an outside force. Likewise, an object in motion tends to stay in motion with the same speed and in the same direction unless acted on by an unbalanced force. The basic principle at work in this law is that an object—any object—will tend to do what it is doing, exactly how it is doing it, unless something else comes along and creates a change. This tendency to resist change in motion is called inertia.

Newton's second law of motion explains how a physical object speeds up or slows down as it moves. According to this law, the acceleration of an object depends on two different factors: the sum of all forces acting on the object and the object's mass. If the forces acting upon an object increase, the object will move at a faster rate. Conversely, if the mass of the object is increased, the object will move at a slower rate. This law is formally stated, "The acceleration of an object as produced by a net force is directly proportional to the magnitude of the net force, in the same direction as the net force, and inversely proportional to the mass of the object." If something weighs more, it is harder for an outside force to move it. If an outside force increases, the object will move more quickly.

Newton's third law of motion says that for every action there is an equal and opposite reaction. This means that every time two objects interact with one another, they each exert forces upon the other. For example, if a bird flaps its wings in mid-flight, the wings push down on the air. The air reacts and pushes back, allowing the bird to stay aloft.

## VOCABULARY

### Accelerate

to gain speed or move more quickly

### Action

a state or condition of acting or being in motion

### Friction

the force that resists relative motion between two bodies in contact

### Force

any of the natural influences, including electromagnetism or gravity, existing between particles and determining the structure of the universe

### Motion

the act, process or instance of changing place

### Reaction

the force that an object subjected to the action of a force from another object exerts in the opposite direction

### Scientific Law

a formal statement that generalizes a body of observations showing that a phenomenon of nature invariably occurs whenever certain conditions exist or are met

## PRE-VIEWING

- What do you know about Sir Isaac Newton and his contributions to science?
- How do invisible forces in nature affect us in our daily lives? What are some examples?

## VIEWING FOCUS

NOTE: You may choose to watch the television segment twice with your students: once to elicit emotional responses and get an overview of the topic and again to focus on facts and draw out opinions.

- What are Newton's three laws of motion?
- What is friction? How does it affect motion?
- Give an example of a time when Newton's first law of motion affected you in your daily life.
- Give an example Newton's second or third law of motion in your daily life.

*For all media see:*

- Segment Summary Student Sheet  
[http://www.kqed.org/quest/downloads/QUEST\\_SegSum\\_StudentSheet.pdf](http://www.kqed.org/quest/downloads/QUEST_SegSum_StudentSheet.pdf)
- Personal Response Student Sheet  
[http://www.kqed.org/quest/downloads/QUEST\\_PersResp\\_StudentSheet.pdf](http://www.kqed.org/quest/downloads/QUEST_PersResp_StudentSheet.pdf)

## LESSON PLANS and RESOURCES from QUEST, PBS and NPR

### Newton's Dark Secrets: His Legacy PBS

<http://www.pbs.org/wgbh/nova/newton/legacy.html>

Examine the scientific legacy left by Sir Isaac Newton and learn about his greatest accomplishments in this section of the **NOVA** companion Web site.

### Invisible Forces Teachers' Domain

<http://www.teachersdomain.org/resource/kqed07.sci.phys.invisfo/>

This video segment from **SPARK** introduces students to Ned Kahn, a scientist and artist who creates artwork that makes gravity and other invisible forces visible.

### The Art of Forces and Motion Teachers' Domain

<http://www.teachersdomain.org/resource/kqed07.sci.phys.lpforces/>

In this lesson, students create works of art influenced by the laws of nature that exhibit their understanding and knowledge of forces and motion.

### Segway Technology: What's Newton Got to Do with It? Teachers' Domain

<http://www.teachersdomain.org/resource/phy03.sci.phys.mfw.segway/>

This video shows students how Newton's laws of motion pertain to the design and operation of two self-propelled, self-balancing machines, the Segway Human Transporter and the IBOT.

### Newton's Third Law of Motion: Astronauts in Outer Space Teachers' Domain

<http://www.teachersdomain.org/resource/phy03.sci.phys.mfw.asrnt/>

Students will see how Newton's third law of motion affects astronauts as they try to complete tasks in the "weightlessness" of space in this video segment adapted from **NOVA**.

### Kinematics Teachers' Domain

<http://www.teachersdomain.org/resource/psu10phy.sci.kinematics/>

This QuickTime video of an animated car gives students a better understanding of acceleration and velocity.

## VISIT OUR PARTNERS

The Bay Institute  
[www.bay.org](http://www.bay.org)

California Academy of Sciences  
[www.calacademy.org](http://www.calacademy.org)

Chabot Space and Science Center  
[www.chabotspace.org](http://www.chabotspace.org)

East Bay Regional Park District  
[www.ebparks.org](http://www.ebparks.org)

Exploratorium  
[www.exploratorium.edu](http://www.exploratorium.edu)

Girl Scouts of Northern California  
[www.girlscoutsnorcal.org](http://www.girlscoutsnorcal.org)

Golden Gate National Parks Conservancy  
[www.parksconservancy.org](http://www.parksconservancy.org)

The J. David Gladstone Institutes  
[www.gladstone.ucsf.edu](http://www.gladstone.ucsf.edu)

Lawrence Berkeley National Laboratory  
[www.lbl.gov](http://www.lbl.gov)

Lawrence Hall of Science  
[www.lawrencehallofscience.org](http://www.lawrencehallofscience.org)

Monterey Bay Aquarium  
[www.mbayaq.org](http://www.mbayaq.org)

Monterey Bay Aquarium Research Institute  
[www.mbari.org](http://www.mbari.org)

Oakland Zoo  
[www.oaklandzoo.org](http://www.oaklandzoo.org)

The Tech Museum of Innovation  
[www.thetech.org](http://www.thetech.org)

UC Berkeley Natural History Museums  
<http://bnhm.berkeley.edu/>

U.S. Geological Survey  
[www.usgs.gov](http://www.usgs.gov)

## MORE EDUCATIONAL RESOURCES FOR USING QUEST MULTIMEDIA TO ENHANCE 21<sup>st</sup> CENTURY SKILLS IN TEACHING AND LEARNING

### Why Use Multimedia in Science Education?

<http://www.kqed.org/quest/downloads/QUESTWhyMedia.pdf>

- Read about the importance of using multimedia in the 21st century science classroom.

### How to Use Science Media for Teaching and Learning

<http://www.kqed.org/quest/downloads/QUESTMediaTips.pdf>

- A collection of tips, activities and handouts to actively engage students with multimedia.

### Science Multimedia Analysis

<http://www.kqed.org/quest/downloads/QUESTMediaAnalysis.pdf>

- Give your students the tools to recognize the purposes and messages of science multimedia.

### Create Online Science Hikes with Google Maps

[http://www.kqed.org/quest/files/download/52/QUEST\\_ExplorationCreation.pdf](http://www.kqed.org/quest/files/download/52/QUEST_ExplorationCreation.pdf)

- Do you like the science hike Explorations on the QUEST site? Use this place-based educational guide to create similar science-based maps with youth.

## OTHER WAYS TO PARTICIPATE IN QUEST



LOG ON

[www.kqed.org/quest](http://www.kqed.org/quest)



LISTEN

**KQED 88.5 FM San Francisco &  
89.3 FM Sacramento**



WATCH

**KQED Channel 9**

Major funding is provided by the National Science Foundation. Additional support is provided by the Amgen Foundation, S. D. Bechtel, Jr. Foundation, the William K. Bowes, Jr. Foundation, the Dirk and Charlene Kabcenell Foundation, the Vadasz Family Foundation, The David B. Gold Foundation, and the George and Jeanette Stuart Charitable Trust.