

Newton's Laws of Motion

Experiment with these exhibits to learn about the three **laws** that explain how all objects move.

Think About It

- What are the different **variables** that affect how the balls start, stop, speed-up, or slow down?
- How are things like **friction, gravity, momentum and inertia** related to one another, and how do they affect the ball's **motion**?

How to use this guide

To help guide your visit, we have developed this learning pathway to explore a specific topic using some of the exhibit components.

- Look up the words in bold in the vocabulary list on the back.
- Continue your investigations into other areas of the museum by checking out "Where To Learn More" on the back of this page.

Path

LOOP-THE-LOOP

- How close to each loop can you start the ball and still have it travel all the way around?
- What are the different **forces** that keep the ball on the track? In what directions is the ball being pushed or pulled by these forces?



ROLLERCOASTER MODEL

- Why do you think the first hill is the highest?
- Do you think the coaster could keep going forever? What are the different things that make it slow down?



SKI JUMP

- Can you get a ball into each of the buckets using each ramp? How is the ball's motion at each ramp different?
- How does the speed change as the ball moves down each ramp?



MOTION DISH

- Why do you think the ball **accelerates** as it rolls?
- What do you have to change to make the ball circle around longer before it falls in the hole?



HIT THE BUCKET

- Start the ball at the top of the ramp and try to get it in the bucket. At what point in the circle is the bucket when you let go of the ball?
- Try again with the ball only half-way up the ramp. What changes about when you need to let go?



THE SPIRAL

- Try to walk around and follow the ball as it rolls. How can you explain what happens?
- Does the ball ever stop before it reaches the bottom? Why? What do you need to do to start it rolling again?



What's Going On?

The study of how forces affect movement is called dynamics. In 1687, English scientist Isaac Newton described **three laws of motion** that explain the principals behind the movement of all objects. Scientists use terms like inertia and momentum to describe how easily objects both start and stop moving. As a ball rolls around "The Spiral", sometimes it may stop because an outside force called friction slows it down; this is Newton's first law. Newton's 2nd law says that in order for a ball to go upside-down at "Loop-the-Loop" it needs to travel fast enough to **exert** a force greater than gravity. If it moves fast enough, the ball doesn't fall down in the loop. If two balls **collide** in the "Motion Dish", they sometimes fly off in opposite directions. This is Newton's 3rd law.

NEWTON'S LAWS OF MOTION

...continued

Learn More About It!

H. Gold-Dworkin

Learn About The Way Things Move

McGraw-Hill, 2000.

M. P. Goodstein

Science Fair Success Using Newton's Laws of Motion

Enslow Publishers, 2003

B. K. Hixson

Bernoulli's book

Wild Goose Publications, 1991

B. Parker

The Isaac Newton School of Driving

Johns Hopkins Univ. Press, 2003

B. Zubrowski

Raceways - Having fun with balls and tracks.

William Morrow and Company, 1985

Standard Deviants School - Physics, Program 5 (DVD, 26 min.)

Cerebellum Corp., 2004

Amusement Park Physics

<http://www.learner.org/exhibits/parkphysics/>

Physics Learning Resource

<http://web.archive.org/web/20050208005712/http://www.exploratorium.edu/ti/resources/physics.html>



Vocabulary

Acceleration - The rate of change in speed or direction.

Collide - When two or more objects smash into each other.

Exert - To have and use.

Force - A push or a pull.

Friction - The force that tends to slow down moving objects that are touching.

Gravity - A force that acts at a distance and attracts objects toward each other. The force that attracts objects toward the center of the Earth.

Inertia - The tendency of an object to resist a change in motion.

Law - A statement that summarizes the identical results observed in an experiment that is repeated many times by many different scientists. A scientific law is widely accepted as true or as a fact.

Mass - The amount of material an object contains.

Momentum - The mass of an object multiplied by its **velocity**.

Motion - Movement: a natural event that involves a change in the position or location of something.

Newton's Laws of Motion - The three laws of motion: **#1)** An object at rest remains at rest. An object in motion remains in motion. **#2)** A force is directly related to an object's **mass** and acceleration. **#3)** With every force there is an equal, but opposite, force.

Variables - Properties of an object or experiment that can change.

Velocity - How far something moves in a specific amount of time.

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