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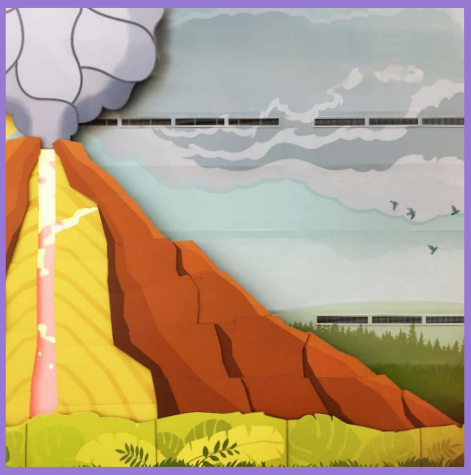
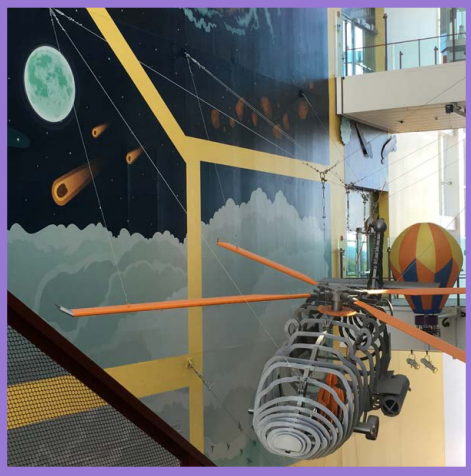
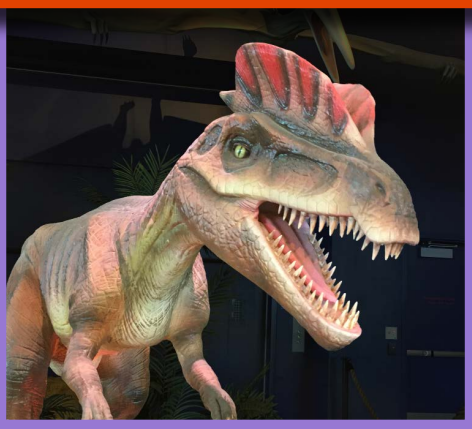


EXPLORATION GUIDE

2017-2018





CTScienceCenter.org
250 Columbus Blvd.
Hartford, CT 06103

Connecticut Science Center®

FORCES: WHEN OBJECTS COLLIDE

Objectives

- Students will observe how moving objects carry energy that can be transferred to other objects through contact.
- Students will explore how the size and speed of objects influence the outcome of a collision.
- Students will design experiments that test what factors affect the impact of a collision.
- Students will examine illustrations of Newton's law that every action has an equal and opposite reaction (a cause and effect).
- Students will look at patterns in collisions across a variety of scenarios, including collisions with water, with air, and with solid objects such as a hammer.

Overview

Getting Started: This discussion could occur in the classroom, or on the bus ride, when preparing students for the field trip.

Introduction: Have you ever tossed a water balloon with a friend? Is the balloon more likely to break with a gentle toss or with a hard throw? Is it more likely to break if it is very full, or only somewhat full? Water balloons are a good example of what happens when objects collide. Every moving object has energy. The bigger the water balloon, and the faster you throw it, the more likely it is to break because it carries more energy when it reaches the point of impact. As we go through the museum today, be on the look out for:

Focus Questions

- What happens when objects collide?
- How does the speed or size of an object affect what happens during a collision?
- How do fluid forms of matter—like water or air—react in collisions with a solid form of matter?
- What happens when forces are in balance during a collision?
- What happens when forces are unbalanced?

HINT: These are great questions to use while exploring the galleries with your group to help them think about forces.

FORCES: WHEN OBJECTS COLLIDE

Visit Debrief

On the bus ride home, or back in your classroom, ask your students to reflect on what they learned.

- What are examples of collisions that they see in the classroom? In their homes? In their neighborhoods?
- How can a collision between objects change the strength and direction of an object's motion?
- What is the evidence that energy is transferred from one object to another during a collision?
- Compare and contrast the collision of forces between the hammer and the helmets (two solid objects) vs. the collision between the air stream and the paper heliflyers (one solid object and a gas).

Concept Summary

- Energy can be moved from place to place by moving objects.
- When objects collide, the contact forces transfer energy so as to change the objects' motions.
- The faster an object moves, the more energy it has.
- Each force acts on an object with a specific strength and direction.
- Objects that are in motion stay in motion until something else affects them.
- The direction and speed of moving objects depends on their size and the force applied to them.
- For every action, there is an equal and opposite reaction (a cause and effect).
- When observation of an object's motion demonstrates a pattern, then future motion can be predicted based on the past.

Next Generation Science Standards

SCIENCE AND ENGINEERING PRACTICES
Planning and Carrying Out Investigations
Analyzing and Interpreting Data
Constructing Explanations and Designing Solutions
Engaging in Argument from Evidence

DISCIPLINARY CORE IDEAS
PS2.A Forces and Motion
PS2.B Types of Interactions
PS3.A Definitions of Energy
PS3.B Conservation of Energy and Energy Transfer
PS3.C Relationship Between Energy and Forces

CROSSCUTTING CONCEPTS
Patterns
Cause and Effect
Energy and Matter
Structure and Function

STUDENT GUIDE:

GETTING STARTED:
Chaperones, these activities can be done in any order as you move through the galleries.

EXPLORATION GUIDE: STUDENTS
GRADE LEVEL 3-5

CONNECTICUT SCIENCE CENTER

NAME: _____

Activity Station: Play Newton's Air Hockey

Level 5, Exploring Space Gallery

PREDICT: *If you give one asteroid a gentle push on a clear path, what will happen?*

TEST your prediction. Notice the speed and direction of movement. DRAW a diagram or use your own words to describe how the asteroid moved.

PREDICT: *If a large and a small asteroid collide, what will happen?*

TEST your prediction. Notice the speed and direction of movement. DRAW a diagram or use your own words to describe how the asteroids moved. (continued)

STUDENT GUIDE:

EXPLORATION GUIDE: STUDENTS
GRADE LEVEL 3-5

CONNECTICUT
SCIENCE CENTER

NAME: _____

Activity Station: Play Newton's Air Hockey

Level 5, Exploring Space Gallery (continued)

PREDICT: *If asteroids of similar size collide, but one is moving faster than the other, what will happen?*

TEST your prediction. Notice the speed and direction of movement. DRAW a diagram or use your own words to describe how the asteroids moved.

Nearby, look for the *Make a Crater* station. DRAW a picture with labels to show what happens when the asteroid slams fast into the loose surface material of the moon.

HINT: Diagrams should show multiple asteroids hitting the moon, and debris flying up. Arrows should indicate directions of motion for the colliding objects. Labels should indicate a cause and an effect.

STUDENT GUIDE:

EXPLORATION GUIDE: STUDENTS
GRADE LEVEL 3-5

CONNECTICUT SCIENCE CENTER

NAME: _____

Activity Station: Test a Helmet Crash

Level 5, Sports Lab Gallery

The faster the brain moves, the more likely a person would be to get a concussion from the hammer's blow. Helmets lessen the forces that shake up your brain by spreading the force of an impact over a hard outer shell. They also have inner linings to absorb a blow's force.

PREDICT: *Examine each of the helmets. Which do you predict will absorb the most force from this hammer? Why?*

TEST: Pick the 3 helmets that you think will protect the head the best. Test them out. For each trial, hold the button to bring the hammer to the top. Release the button. After the hammer hits each helmet, look at the screen to find a number with a "g" after it. The g-force measures the amount of force that reached the brain. RECORD your results in the table on page 5. (continued)

HINT: Units of measurement are often defined based on things we know well. For example, the "foot" unit originally related to the length of a person's foot. All forces can be measured by comparing them to how hard gravity pulls. One "g" is equal to the pull of gravity we experience every day.

HINT: Sudden changes in speed or direction increase the effect of gravity. A body in motion at 2g feels twice as heavy as it normally does. In the helmet crash, sensors measure the acceleration of what would be a brain moving within its skull due to the force of the hammer.

STUDENT GUIDE:

HINT: Students should be recording two separate trials for each of the 3 helmets they choose in the appropriate space on the chart.

EXPLORATION GUIDE: STUDENTS
GRADE LEVEL 3-5

CONNECTICUT SCIENCE CENTER

NAME: _____

Activity Station: Test a Helmet Crash

Level 5, Sports Lab Gallery (continued)

RECORD your results from the helmet crash test here.

	TRIAL 1 G-FORCE	TRIAL 2 G-FORCE
HELMET 1		
HELMET 2		
HELMET 3		

ANALYZE: Which helmets were most likely to prevent concussions by reducing the g-force of this collision to below 60g? Why were those helmets successful?

PAGE 4 OF 9

STUDENT GUIDE:

EXPLORATION GUIDE: STUDENTS
GRADE LEVEL 3-5

CONNECTICUT
SCIENCE CENTER

NAME: _____

Activity Station: Design a River

Level 6, Stream Table, River of Life Gallery

OBSERVE: DRAW a diagram with labels to show how the flow of water is affected when it encounters a pebble or plastic bar. Use what you know about forces to explain what happens.

PLAN an experiment: Use the plastic bars to form streambeds that guide the water. What shape of streambed will maximize the force of the flowing water? (continued)

PAGE 5 OF 9

HINT: The more force the water has, the more pebbles it will move. Channeling as much water into as little space as possible will produce the most force.

STUDENT GUIDE:

NAME: _____

Activity Station: Design a River

Level 6, Stream Table, River of Life Gallery (continued)

TEST your design and DRAW a diagram of your final streambed.

DESCRIBE what happened to the pebbles in the stream's path.

HINT: Diagrams should show:
- the shape of the streambed they designed
- arrows showing how the water moved through and around their streambed
- labels of the different parts of their streambed experiment

STUDENT GUIDE:

EXPLORATION GUIDE: STUDENTS
GRADE LEVEL 3-5

CONNECTICUT
SCIENCE CENTER

NAME: _____

Activity Station: Find the Source of Spin

Level 4, Heliflyers, Forces in Motion Gallery

If you toss the flat heliflyer template into the air, it falls quickly to the ground. But when you cut and fold as shown, something different happens.

DRAW a diagram here to show the directions of different forces that are colliding with these paper "propellers."

HINT: Diagrams should show:
- arrows to represent air pushing up on the propellers.
- one arrow pulling down from the center, to represent gravity
- arrows under the propellers redirecting some blowing air toward the flyer center. The equal horizontal forces from both sides cause the flyer to spin rather than moving in one direction.

STUDENT GUIDE:

EXPLORATION GUIDE: STUDENTS
GRADE LEVEL 3-5

CONNECTICUT SCIENCE CENTER

NAME: _____

Activity Station: Play Airball!

Level 4, Bernoulli Blowers, Forces in Motion Gallery

When a ball collides with the air stream from a cannon, it creates forces that move in different directions. Can you determine how air is moving around the ball?

DESCRIBE in your own words or DRAW a diagram of how the air moves the ball.

HINT: While gravity pulls the ball down, air pushes it up. Air currents closest to the ball curve tightly around it. Air that doesn't collide with the ball pushes up with greater force, creating a barrier that holds the ball in place. This phenomenon is called the Bernoulli effect.

STUDENT GUIDE:

EXPLORATION GUIDE: STUDENTS
GRADE LEVEL 3-5

CONNECTICUT
SCIENCE CENTER

NAME: _____

Activity: I Spy – When Objects Collide

What examples of objects colliding did you see in any exhibit today?

1.

2.

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4.

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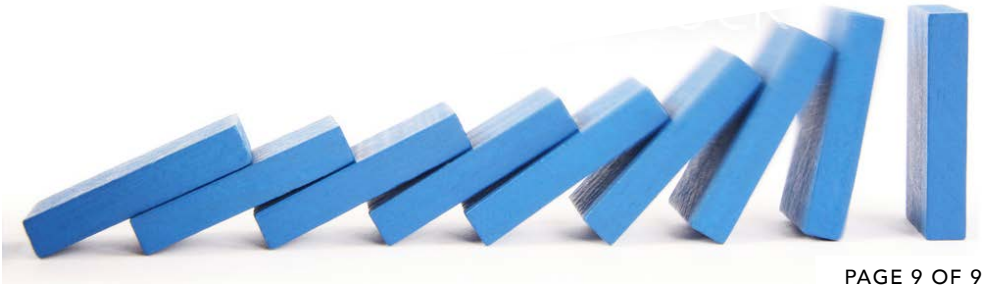

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STUDENT GUIDE:

GETTING STARTED:
Chaperones, these activities can be done in any order as you move through the galleries.

EXPLORATION GUIDE: STUDENTS
GRADE LEVEL 3-5

CONNECTICUT SCIENCE CENTER

NAME: _____

Activity Station: Play Newton's Air Hockey

Level 5, Exploring Space Gallery

PREDICT: *If you give one asteroid a gentle push on a clear path, what will happen?*

TEST your prediction. Notice the speed and direction of movement. DRAW a diagram or use your own words to describe how the asteroid moved.

PREDICT: *If a large and a small asteroid collide, what will happen?*

TEST your prediction. Notice the speed and direction of movement. DRAW a diagram or use your own words to describe how the asteroids moved. (continued)

STUDENT GUIDE:

EXPLORATION GUIDE: STUDENTS
GRADE LEVEL 3-5

CONNECTICUT SCIENCE CENTER

NAME: _____

Activity Station: Play Newton's Air Hockey

Level 5, Exploring Space Gallery (continued)

PREDICT: *If asteroids of similar size collide, but one is moving faster than the other, what will happen?*

TEST your prediction. Notice the speed and direction of movement. DRAW a diagram or use your own words to describe how the asteroids moved.

Nearby, look for the *Make a Crater* station. DRAW a picture with labels to show what happens when the asteroid slams fast into the loose surface material of the moon.

HINT: Diagrams should show multiple asteroids hitting the moon, and debris flying up. Arrows should indicate directions of motion for the colliding objects. Labels should indicate a cause and an effect.

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EXPLORATION GUIDE: STUDENTS
GRADE LEVEL 3-5

CONNECTICUT SCIENCE CENTER

NAME: _____

Activity Station: Test a Helmet Crash

Level 5, Sports Lab Gallery

The faster the brain moves, the more likely a person would be to get a concussion from the hammer's blow. Helmets lessen the forces that shake up your brain by spreading the force of an impact over a hard outer shell. They also have inner linings to absorb a blow's force.

PREDICT: *Examine each of the helmets. Which do you predict will absorb the most force from this hammer? Why?*

TEST: Pick the 3 helmets that you think will protect the head the best. Test them out. For each trial, hold the button to bring the hammer to the top. Release the button. After the hammer hits each helmet, look at the screen to find a number with a "g" after it. The g-force measures the amount of force that reached the brain. RECORD your results in the table on page 5. (continued)

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STUDENT GUIDE:

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Activity Station: Test a Helmet Crash

Level 5, Sports Lab Gallery (continued)

RECORD your results from the helmet crash test here.

	TRIAL 1 G-FORCE	TRIAL 2 G-FORCE
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ANALYZE: Which helmets were most likely to prevent concussions by reducing the g-force of this collision to below 60g? Why were those helmets successful?

STUDENT GUIDE:

EXPLORATION GUIDE: STUDENTS
GRADE LEVEL 3-5

CONNECTICUT SCIENCE CENTER

NAME: _____

Activity Station: Design a River

Level 6, Stream Table, River of Life Gallery

OBSERVE: DRAW a diagram with labels to show how the flow of water is affected when it encounters a pebble or plastic bar. Use what you know about forces to explain what happens.

PLAN an experiment: Use the plastic bars to form streambeds that guide the water. What shape of streambed will maximize the force of the flowing water? (continued)

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EXPLORATION GUIDE: STUDENTS
GRADE LEVEL 3-5

CONNECTICUT SCIENCE CENTER

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Activity Station: Design a River

Level 6, Stream Table, River of Life Gallery (continued)

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DESCRIBE what happened to the pebbles in the stream's path.

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EXPLORATION GUIDE: STUDENTS
GRADE LEVEL 3-5

CONNECTICUT SCIENCE CENTER

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Activity Station: Find the Source of Spin

Level 4, Heliflyers, Forces in Motion Gallery

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GRADE LEVEL 3-5

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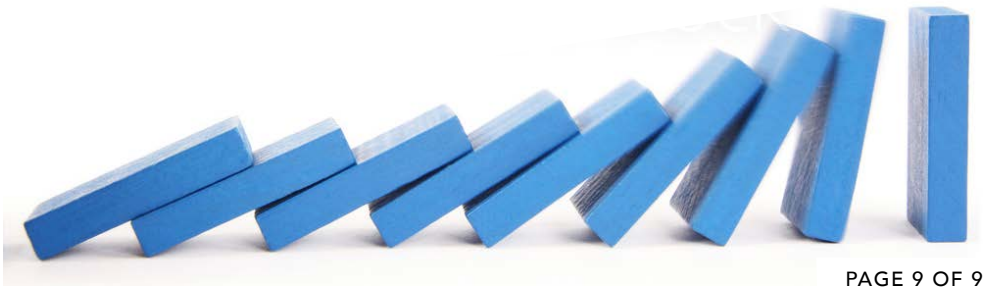

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CONNECTICUT SCIENCE CENTER

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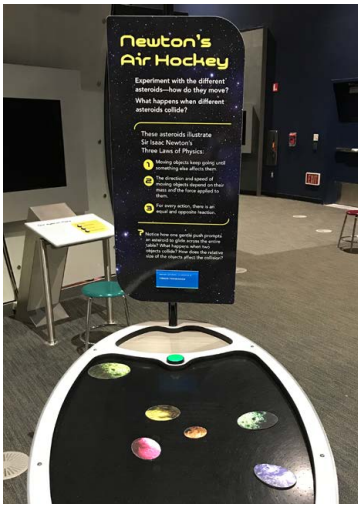
Activity Station: Play Newton's Air Hockey

Level 5, Exploring Space Gallery



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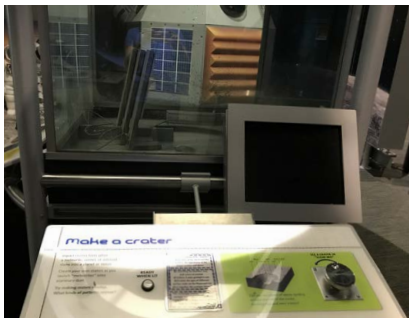

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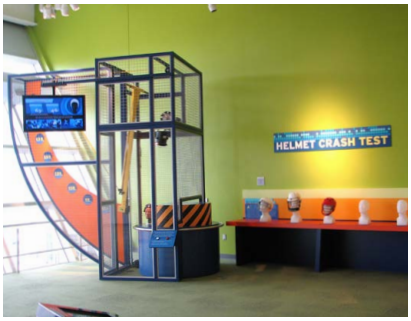
Activity Station: Test a Helmet Crash

Level 5, Sports Lab Gallery



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Level 5, Sports Lab Gallery (continued)

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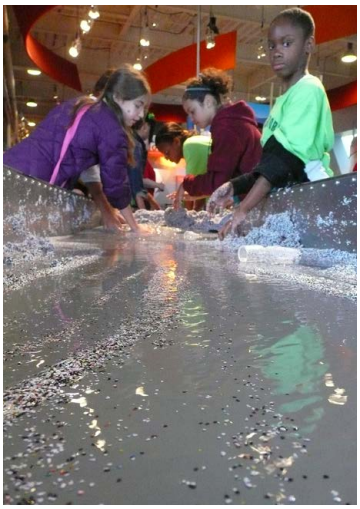
Activity Station: Design a River

Level 6, Stream Table, River of Life Gallery



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Activity Station: Design a River

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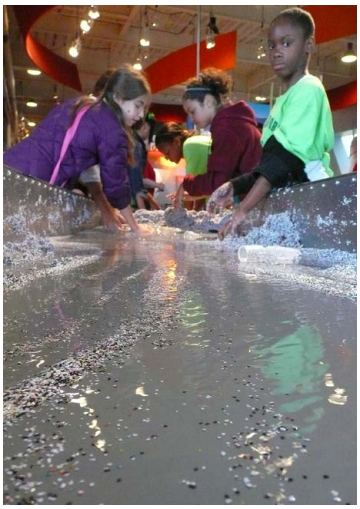

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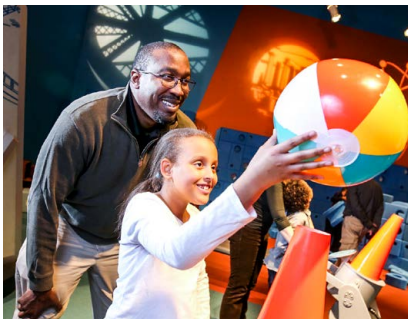

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