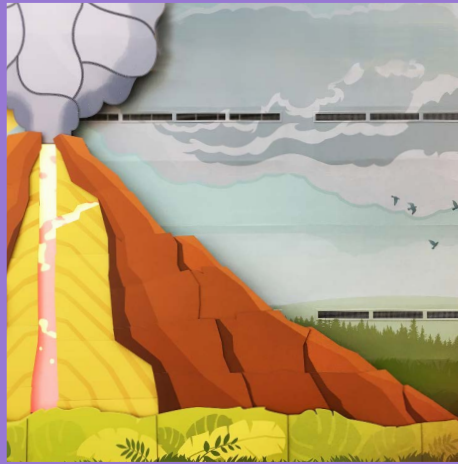


# CONNECTICUT SCIENCE CENTER



## EXPLORATION GUIDE

2017-2018



**CTScienceCenter.org**  
250 Columbus Blvd.  
Hartford, CT 06103

Connecticut  
Science Center





NAME: \_\_\_\_\_

## FORCES: WHY DO THEY MATTER?

### Objectives

- Students will conduct an experiment and create a graphical display of data to investigate how changes in mass affect how forces lift an object.
- 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 compare potential energy and kinetic energy
- Students will conduct an experiment and create a graphical display of data to investigate how changes in mass affect the potential energy of an object.

### Overview

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

*Introduction:* Raise your hand if you've ever kicked a soccer goal. Or seen an airplane fly overhead. Or if you've charged a cell phone in the last few days. None of these things would be possible without an understanding of how forces move objects and energy through our world. Force is the power to make things move, and forces take different forms, such as gravitational pull, wind, and electrical currents.

*The energy unleashed through these forces is not created or destroyed, it is just moved from place to place. "Potential energy" is the energy stored in an object, based on its position. For example, when I pull back the string on a bow (show the motion), I have increased its potential energy. When I release the string, it springs into motion, launching an arrow forward. Objects in motion always have energy. This energy is called "kinetic energy." As we go through the museum today, be on the look out for:*

### Focus Questions

- How does the mass of an object affect the amount of force needed to keep it in motion?
- How does a larger force affect motion?
- What are some ways in which potential energy is stored?
- How does mass affect the potential energy of an object?
- What are different ways that forces and energy intersect your everyday life?



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

..... **NAME:** \_\_\_\_\_

## **FORCES: WHY DO THEY MATTER?**

### **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 the relationship between an object's mass and how forces put it in motion? (phenomenon examples: a dandelion seed floats in wind, but a rocket needs a tremendous amount of fuel to launch; a bowling ball requires more force to throw than a tennis ball.)
- What is the difference between potential and kinetic energy? What are some examples of each?
- What are different ways that forces and energy intersect your everyday life?

### **Concept Summary**

- Potential energy is energy that is stored based on the position of an object.
- Kinetic energy describes the energy of an object in motion.
- Kinetic energy increases with an increase in the force that moves an object.
- The more mass an object has, the stronger the force needed to move it.
- Kinetic energy can be transformed into other kinds of energy, such as electricity.
- Energy can be released in different forms, such as light and heat.

### **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 in Motion

PS3.A Definition 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

NAME: \_\_\_\_\_

## STUDENT GUIDE:



### GETTING STARTED:

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

**EXPLORATION GUIDE: STUDENTS**  
**GRADE LEVEL 6-8**

**CONNECTICUT  
 SCIENCE CENTER**

NAME: \_\_\_\_\_

### FORCES: WHY DO THEY MATTER?

Force is the power to make things move. Understanding the laws of physics that control force helps us design machines that fly, predict the effects of objects colliding, and power up cities.



**Activity Station: Test the Factors of Flight**  
 Level 4, Heli-flyers, Forces in Motion Gallery

#### EXPERIMENT A



**PREDICT:** Where do you think the force of the wind at the air stream station is strongest?



**TEST:** Create a heli-flyer and launch it over different areas of the air stream station.

Chart the height of your flights.

HEIGHT



TRIAL 1

TRIAL 2

TRIAL 1

TRIAL 2

TRIAL 1

TRIAL 2

center of  
 airstream

midway between  
 center and edge

edge of  
 airstream

(continued)

PAGE 1 OF 11

NAME: \_\_\_\_\_

## STUDENT GUIDE:

NAME: \_\_\_\_\_

### Activity Station: Test the Factors of Flight Level 4, Heliflyers, Forces in Motion Gallery (continued)



ANALYZE: Which location gives you the most lift? Why?

#### EXPERIMENT B



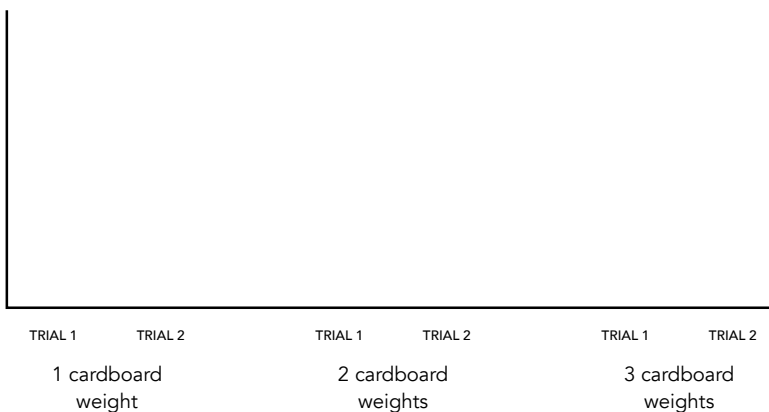
PREDICT: How do you think a change in mass will affect your Heliflyer?



TEST: Create three heliflyers with different weights. Launch each over the center of the air stream to ensure a consistent amount of force. Chart the height of your flights.



HEIGHT



(continued)

PAGE 2 OF 11



NAME: \_\_\_\_\_

## STUDENT GUIDE:

NAME: \_\_\_\_\_

Activity Station: Test the Factors of Flight  
Level 4, Heliflyers, Forces in Motion Gallery (continued)



ANALYZE: How does changing the mass of the heliflyer affect its lift? Why?

NAME: \_\_\_\_\_

## STUDENT GUIDE:

EXPLORATION GUIDE: STUDENTS  
GRADE LEVEL 6-8

CONNECTICUT  
SCIENCE CENTER

NAME: \_\_\_\_\_

Activity Station: Play Airball!  
Level 4, Forces in Motion Gallery



When a ball collides with the air stream from a cannon, forces are pushing and pulling it in different directions.



**IDENTIFY:** All the forces that push and pull the ball. What suspends the ball? Why does the ball not fly even higher? Draw a diagram with labels and explain in your own words how these forces move the ball. Test your predictions by using the air stream to get the beach ball through the hoop.



**HINT:** While blowing air pushes up or forward, gravity is constantly pulling down. Without the effect of gravity, the ball would fly much further. Without the effect of the blowing air, gravity would pull the ball to the ground.



**HINT:** Air curving around the ball creates a low-pressure zone. Air that doesn't collide with the ball maintains a high-pressure zone that holds the ball in place. This phenomenon is called the Bernoulli effect.

(continued)

PAGE 4 OF 11



NAME: \_\_\_\_\_

## STUDENT GUIDE:

NAME: \_\_\_\_\_

### Activity Station: Play Airball!

Level 4, Forces in Motion Gallery (continued)



PREDICT: What do you think will happen if you move the blower faster?  
Why?



PREDICT: What do you think will happen if you move the blower slower?  
Why?



TEST your predictions by using the air stream to get the beach ball through  
the hoop.

NAME: \_\_\_\_\_

## STUDENT GUIDE:

EXPLORATION GUIDE: STUDENTS  
GRADE LEVEL 6-8

CONNECTICUT  
SCIENCE CENTER

NAME: \_\_\_\_\_

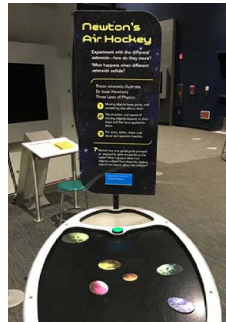
Activity Station: Play Newton's Air Hockey  
Level 5, Exploring Space Gallery



PREDICT: If you give just one asteroid a gentle push on a clear path, will it make it across this table?



TEST your prediction. Use the laws of motion to explain what happened.



PREDICT: If a larger and a smaller asteroid collide, which will be knocked the most off of its original path?



TEST your prediction. Use the laws of motion to explain what happened.



PREDICT: If asteroids of similar size collide, but one is moving faster than the other, which will be knocked the most off of its original path?



TEST your prediction. Use the laws of motion to explain what happened.



**HINT:**

Explanations should reference Newton's Laws of Physics, which are outlined on the exhibit label.

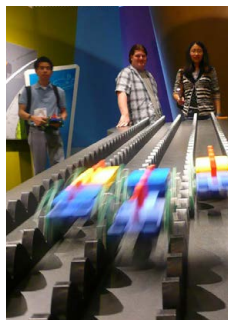
NAME: \_\_\_\_\_

## STUDENT GUIDE:

NAME: \_\_\_\_\_

### Activity Station: Design a Racecar Level 4, Square Wheels Exhibit, Forces in Motion Gallery

These cars don't have engines, so they rely on the force of gravity to pull them down the hill. Objects can store energy as a result of their position. Thus at the top of the slope, the cars have potential energy, which turns into kinetic energy as they roll downhill. What can you change in a car's design to increase its potential energy so that it wins the race?



DESIGN: Collaborate with classmates and use the blocks to create cars with different weights and shapes.



PREDICT: Which car do you think will be the fastest? Why?



TEST: Record the 1st-place, 2nd-place, etc. race winners on the chart on the following page.

(continued)

PAGE 7 OF 11

NAME: \_\_\_\_\_

## STUDENT GUIDE:

NAME: \_\_\_\_\_

### Activity Station: Design a Racecar

Level 4, Square Wheels Exhibit, Forces in Motion Gallery (continued)



TEST: Record the 1st-place, 2nd-place, etc. race winners on this chart:

# OF BLOCKS ON CAR	TRIAL 1	TRIAL 2
0 BLOCKS		
2 BLOCKS		
____ BLOCKS		
____ BLOCKS		

(continued)

PAGE 8 OF 11

NAME: \_\_\_\_\_

## STUDENT GUIDE:

NAME: \_\_\_\_\_

Activity Station: Design a Racecar  
Level 4, Square Wheels Exhibit, Forces in Motion Gallery (continued)



DRAW a picture of the winning car, showing how many blocks are on the front and back.



ANALYZE: Why do you think the winner was the fastest?

NAME: \_\_\_\_\_

## STUDENT GUIDE:

NAME: \_\_\_\_\_

### Activity Station: Harnessing Hydropower Level 6, Energy City

Flowing water can spin a turbine to generate electricity. The water in a dam represents stored energy. This potential energy turns into kinetic energy when the water is released into motion. A run-of-the-river system can divert a portion of a river's ongoing current through a turbine.



**PREDICT:** Which hydropower system do you expect will produce the most electricity? Why?



**TEST:** Spin the dials on this exhibit to test your theory. What happens? Explain why.



**ANALYZE:** What other factors might influence the choice to use a dam or a run-of-the-river system for hydropower?



**HINT:** Dams produce more electricity. When they increase the depth of the water, they are also increasing its potential energy, and the kinetic energy when the water is released. However, dams cause great changes to an ecosystem. Run-of-the-river systems rely on the energy of a smaller stream of water and cause fewer changes to an ecosystem.

..... NAME: \_\_\_\_\_

## STUDENT GUIDE:

..... NAME: \_\_\_\_\_

### Activity: I Spy

What other examples did you see in any exhibit today that demonstrate how forces are at work in our world?

1.

2.

3.

4.

5.





NAME: \_\_\_\_\_

## FORCES: WHY DO THEY MATTER?

### Focus Questions

- How does the mass of an object affect the amount of force needed to keep it in motion?
- How does a larger force affect motion?
- What are some ways in which potential energy is stored?
- How does mass affect the potential energy of an object?
- What are different ways that forces and energy intersect your everyday life?



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



**TRIP TIP:** Giving your students some free exploration time when entering a new exhibit area will help them concentrate when you invite them to a focal point.

NAME: \_\_\_\_\_

## STUDENT GUIDE:



### GETTING STARTED:

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

**EXPLORATION GUIDE: STUDENTS**  
GRADE LEVEL 6-8

**CONNECTICUT  
SCIENCE CENTER**

NAME: \_\_\_\_\_

### FORCES: WHY DO THEY MATTER?

Force is the power to make things move. Understanding the laws of physics that control force helps us design machines that fly, predict the effects of objects colliding, and power up cities.



**Activity Station: Test the Factors of Flight**  
Level 4, Heliflyers, Forces in Motion Gallery

#### EXPERIMENT A



**PREDICT:** Where do you think the force of the wind at the air stream station is strongest?



**TEST:** Create a heliflyer and launch it over different areas of the air stream station.

Chart the height of your flights.

HEIGHT



(continued)

PAGE 1 OF 11

NAME: \_\_\_\_\_

## STUDENT GUIDE:

NAME: \_\_\_\_\_

### Activity Station: Test the Factors of Flight Level 4, Heliflyers, Forces in Motion Gallery (continued)



ANALYZE: Which location gives you the most lift? Why?



#### EXPERIMENT B

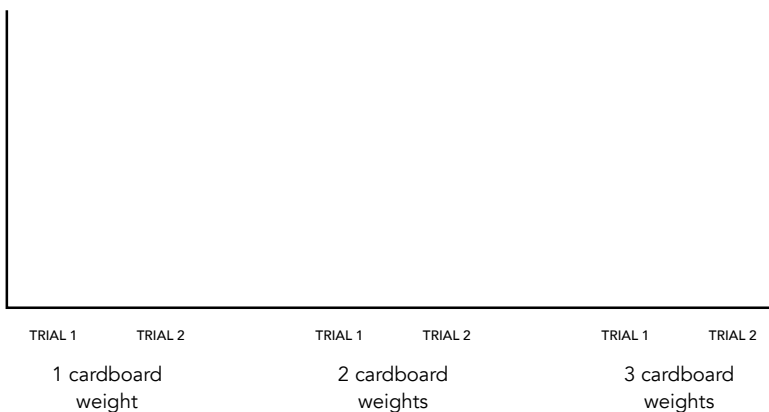


PREDICT: How do you think a change in mass will affect your Heliflyer?



TEST: Create three heliflyers with different weights. Launch each over the center of the air stream to ensure a consistent amount of force. Chart the height of your flights.

HEIGHT



(continued)

PAGE 2 OF 11

NAME: \_\_\_\_\_

## STUDENT GUIDE:

NAME: \_\_\_\_\_

Activity Station: Test the Factors of Flight  
Level 4, Heliflyers, Forces in Motion Gallery (continued)



ANALYZE: How does changing the mass of the heliflyer affect its lift? Why?

NAME: \_\_\_\_\_

## STUDENT GUIDE:

EXPLORATION GUIDE: STUDENTS  
GRADE LEVEL 6-8

CONNECTICUT  
SCIENCE CENTER

NAME: \_\_\_\_\_

Activity Station: Play Airball!  
Level 4, Forces in Motion Gallery



When a ball collides with the air stream from a cannon, forces are pushing and pulling it in different directions.



IDENTIFY: All the forces that push and pull the ball. What suspends the ball? Why does the ball not fly even higher? Draw a diagram with labels and explain in your own words how these forces move the ball. Test your predictions by using the air stream to get the beach ball through the hoop.



**HINT:** While blowing air pushes up or forward, gravity is constantly pulling down. Without the effect of gravity, the ball would fly much further. Without the effect of the blowing air, gravity would pull the ball to the ground.



**HINT:** Air curving around the ball creates a low-pressure zone. Air that doesn't collide with the ball maintains a high-pressure zone that holds the ball in place. This phenomenon is called the Bernoulli effect.

(continued)

PAGE 4 OF 11

NAME: \_\_\_\_\_

## STUDENT GUIDE:

NAME: \_\_\_\_\_

### Activity Station: Play Airball!

Level 4, Forces in Motion Gallery (continued)



PREDICT: What do you think will happen if you move the blower faster?  
Why?



PREDICT: What do you think will happen if you move the blower slower?  
Why?



TEST your predictions by using the air stream to get the beach ball through  
the hoop.



NAME: \_\_\_\_\_

## STUDENT GUIDE:

EXPLORATION GUIDE: STUDENTS  
GRADE LEVEL 6-8

CONNECTICUT  
SCIENCE CENTER

NAME: \_\_\_\_\_

Activity Station: Play Newton's Air Hockey  
Level 5, Exploring Space Gallery



PREDICT: If you give just one asteroid a gentle push on a clear path, will it make it across this table?



TEST your prediction. Use the laws of motion to explain what happened.



PREDICT: If a larger and a smaller asteroid collide, which will be knocked the most off of its original path?



TEST your prediction. Use the laws of motion to explain what happened.



PREDICT: If asteroids of similar size collide, but one is moving faster than the other, which will be knocked the most off of its original path?



TEST your prediction. Use the laws of motion to explain what happened.

PAGE 6 OF 11



**HINT:**

Explanations should reference Newton's Laws of Physics, which are outlined on the exhibit label.

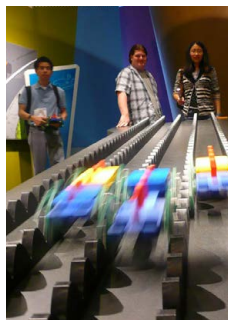
NAME: \_\_\_\_\_

## STUDENT GUIDE:

NAME: \_\_\_\_\_

### Activity Station: Design a Racecar Level 4, Square Wheels Exhibit, Forces in Motion Gallery

These cars don't have engines, so they rely on the force of gravity to pull them down the hill. Objects can store energy as a result of their position. Thus at the top of the slope, the cars have potential energy, which turns into kinetic energy as they roll downhill. What can you change in a car's design to increase its potential energy so that it wins the race?



DESIGN: Collaborate with classmates and use the blocks to create cars with different weights and shapes.



PREDICT: Which car do you think will be the fastest? Why?



TEST: Record the 1st-place, 2nd-place, etc. race winners on the chart on the following page.

(continued)

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NAME: \_\_\_\_\_

## STUDENT GUIDE:

NAME: \_\_\_\_\_

Activity Station: Design a Racecar  
Level 4, Square Wheels Exhibit, Forces in Motion Gallery (continued)



TEST: Record the 1st-place, 2nd-place, etc. race winners on this chart:

# OF BLOCKS ON CAR	TRIAL 1	TRIAL 2
0 BLOCKS		
2 BLOCKS		
____ BLOCKS		
____ BLOCKS		

(continued)

PAGE 8 OF 11

NAME: \_\_\_\_\_

## STUDENT GUIDE:

NAME: \_\_\_\_\_

Activity Station: Design a Racecar  
Level 4, Square Wheels Exhibit, Forces in Motion Gallery (continued)



DRAW a picture of the winning car, showing how many blocks are on the front and back.



ANALYZE: Why do you think the winner was the fastest?

NAME: \_\_\_\_\_

## STUDENT GUIDE:

EXPLORATION GUIDE: STUDENTS  
GRADE LEVEL 6-8

CONNECTICUT  
SCIENCE CENTER

NAME: \_\_\_\_\_

### Activity Station: Harnessing Hydropower Level 6, Energy City

Flowing water can spin a turbine to generate electricity. The water in a dam represents stored energy. This potential energy turns into kinetic energy when the water is released into motion. A run-of-the-river system can divert a portion of a river's ongoing current through a turbine.



**PREDICT:** Which hydropower system do you expect will produce the most electricity? Why?



**TEST:** Spin the dials on this exhibit to test your theory. What happens? Explain why.



**ANALYZE:** What other factors might influence the choice to use a dam or a run-of-the-river system for hydropower?



**HINT:** Dams produce more electricity. When they increase the depth of the water, they are also increasing its potential energy, and the kinetic energy when the water is released. However, dams cause great changes to an ecosystem. Run-of-the-river systems rely on the energy of a smaller stream of water and cause fewer changes to an ecosystem.

..... NAME: \_\_\_\_\_

## STUDENT GUIDE:

..... NAME: \_\_\_\_\_

### Activity: I Spy

What other examples did you see in any exhibit today that demonstrate how forces are at work in our world?

1.

2.

3.

4.

5.

NAME: \_\_\_\_\_

## FORCES: WHY DO THEY MATTER?

Force is the power to make things move. Understanding the laws of physics that control force helps us design machines that fly, predict the effects of objects colliding, and power up cities.

### Activity Station: Test the Factors of Flight Level 4, Heliflyers, Forces in Motion Gallery



#### EXPERIMENT A



**PREDICT:** Where do you think the force of the wind at the air stream station is strongest?



**TEST:** Create a heliflyer and launch it over different areas of the air stream station.

Chart the height of your flights.

HEIGHT



TRIAL 1

TRIAL 2

center of  
airstream

TRIAL 1

TRIAL 2

midway between  
center and edge

TRIAL 1

TRIAL 2

edge of  
airstream



..... **NAME:** \_\_\_\_\_

**Activity Station: Test the Factors of Flight**  
 Level 4, Heliflyers, Forces in Motion Gallery (continued)



**ANALYZE:** Which location gives you the most lift? Why?

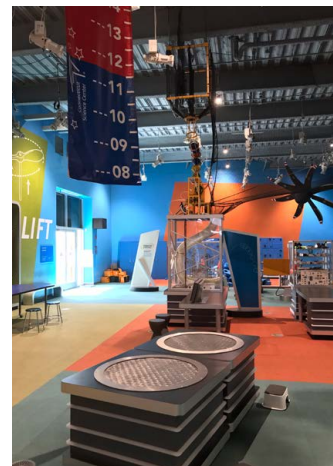
**EXPERIMENT B**



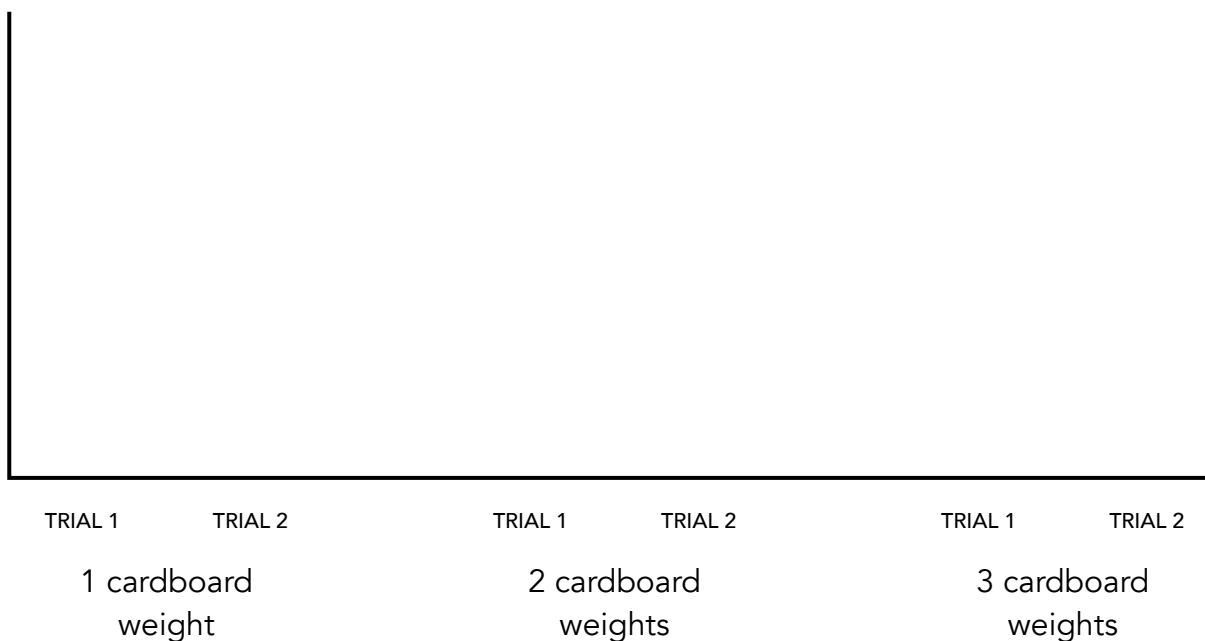
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HEIGHT



..... **NAME:** \_\_\_\_\_

**Activity Station: Test the Factors of Flight**  
Level 4, Heliflyers, Forces in Motion Gallery (continued)



**ANALYZE:** How does changing the mass of the heliflyer affect its lift? Why?

NAME: \_\_\_\_\_

**Activity Station: Play Airball!**  
Level 4, Forces in Motion Gallery



When a ball collides with the air stream from a cannon, forces are pushing and pulling it in different directions.



**IDENTIFY:** All the forces that push and pull the ball. What suspends the ball? Why does the ball not fly even higher? Draw a diagram with labels and explain in your own words how these forces move the ball. Test your predictions by using the air stream to get the beach ball through the hoop.

..... **NAME:** \_\_\_\_\_

## Activity Station: Play Airball!

Level 4, Forces in Motion Gallery (continued)



PREDICT: What do you think will happen if you move the blower faster?  
Why?



PREDICT: What do you think will happen if you move the blower slower?  
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TEST your predictions by using the air stream to get the beach ball through the hoop.

NAME: \_\_\_\_\_

## Activity Station: Play Newton's Air Hockey

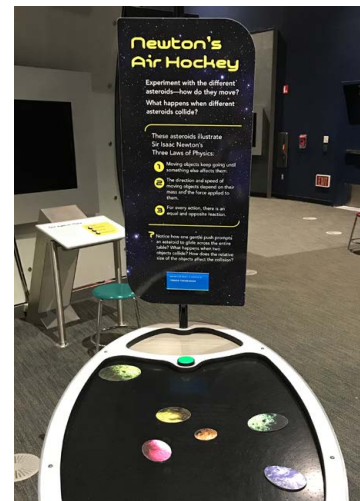
Level 5, Exploring Space Gallery



PREDICT: If you give just one asteroid a gentle push on a clear path, will it make it across this table?



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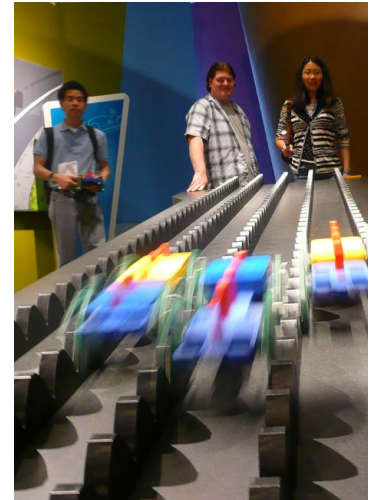
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NAME: \_\_\_\_\_

## Activity Station: Design a Racecar

Level 4, Square Wheels Exhibit, Forces in Motion Gallery

These cars don't have engines, so they rely on the force of gravity to pull them down the hill. Objects can store energy as a result of their position. Thus at the top of the slope, the cars have potential energy, which turns into kinetic energy as they roll downhill. What can you change in a car's design to increase its potential energy so that it wins the race?



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..... NAME: \_\_\_\_\_

## Activity Station: Design a Racecar

Level 4, Square Wheels Exhibit, Forces in Motion Gallery (continued)



TEST: Record the 1st-place, 2nd-place, etc. race winners on this chart:

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0 BLOCKS		
2 BLOCKS		
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____ BLOCKS		



..... NAME: \_\_\_\_\_

## Activity Station: Design a Racecar

Level 4, Square Wheels Exhibit, Forces in Motion Gallery (continued)



**DRAW** a picture of the winning car, showing how many blocks are on the front and back.



**ANALYZE:** Why do you think the winner was the fastest?

..... NAME: \_\_\_\_\_

## Activity Station: Harnessing Hydropower

### Level 6, Energy City

Flowing water can spin a turbine to generate electricity. The water in a dam represents stored energy. This potential energy turns into kinetic energy when the water is released into motion. A run-of-the-river system can divert a portion of a river's ongoing current through a turbine.



**PREDICT:** Which hydropower system do you expect will produce the most electricity? Why?



**TEST:** Spin the dials on this exhibit to test your theory. What happens? Explain why.



**ANALYZE:** What other factors might influence the choice to use a dam or a run-of-the-river system for hydropower?

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