imagination STATION

pure science. pure fun.

Forces

Exhibit Guide

Grades 6-8

Educators

Forces

Grades 6-8

Dear Educator,

Welcome to the Imagination Station's field trip resource! With the assistance of area K-12 educators, the Imagination Station has created learning guides to help structure a field trip that aligns directly to the concepts you are teaching in the classroom.

Students will explore forces with three Imagination Station exhibits:
the High Wire Cycle, the Giant Lever and the Tennis Ball Launcher.

Your Forces Exhibit Guide contains:

- Introduction- suggestions for using the guide, with key concepts included
- State Standards Alignment for both Ohio and Michigan
- Chaperone Page(s)- tips for facilitating exhibit explorations with students
- Student Data Recording Pages that guide your students through exhibit-based explorations
- Post-Visit Activity to do back in the classroom

How to Use This Guide:

- Review the guide.
- Customize the guide for your needs. You can have your students complete the entire guide or just a particular component, depending on your field trip objectives.
- Print off sufficient copies of the Student Data Recording Pages for each student.
- Print off copies of the Chaperone Page for each of the chaperones. Divide your class into groups of 5-7 students and assign a chaperone to each group.
- Review the guide and your expectations with students and prepare for a day of fun science learning at Imagination Station!
- Science Suggestion: Use this guide in combination with a science notebook so students can record observations and data throughout the day.

Content Standards

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Ohio's New Learning Standards

Grades 6 - 8

GRADE 6 PS:
Topic: Matter and Motion
There are two categories of energy: kinetic and potential.
An object's motion can be described by its speed and the direction in which it is moving.

GRADE 7 PS:
Topic: Conservation of Mass and Energy
Energy can be transformed or transferred but is never lost.
Energy can be transferred through a variety of ways.
Mechanical energy can be transferred when objects push or pull on each other over a distance.

GRADE 8 PS:
Topic: Forces and Motion
Forces between objects act when the objects are in direct contact or when they are not touching.
Magnetic, electrical and gravitational forces can act at a distance.

Forces have magnitude and direction.
The motion of an object is always measured with respect to a reference point.

Forces can be added. The net force on an object is the sum of all of the forces acting on the object. The net force acting
on an object can change the object's direction and/or speed.

When the net force is greater than zero, the object's speed and/or direction will change.

When the net force is zero, the object remains at rest or continues to move at a constant speed in a straight line.

INQUIRY 5 - 8

- *Identify questions that can be answered through scientific investigations.*
- *Design and conduct a scientific investigation.*
- *Use appropriate mathematics, tools and techniques to gather data and information.*
- *Analyze and interpret data.*
- *Develop descriptions, models, explanations and predictions.*
- *Think critically and logically to connect evidence and explanations.*
- *Recognize and analyze alternative explanations and predictions.*
- *Communicate scientific procedures and explanations.*

Content Standards

Forces

Michigan Grade Level Content Expectations

Grades 6 - 8

Science Processes:

S.IP.E.1 and S.IP.M.1 Inquiry involves generating questions, conducting investigations and developing solutions to problems through reasoning and observation.

S.IA.E.1 and S.IA.M.1 Inquiry includes an analysis and presentation of findings that lead to future questions, research and investigations.

S.RS.M.1 Reflecting on knowledge is the application of scientific knowledge to new and different situations. Reflecting on knowledge requires careful analysis of evidence that guides decision-making and the application of science throughout history.

Physical Science:

P.FM.M.2 Force Interactions: Some forces between objects act when the objects are in direct contact (touching), such as friction and air resistance, or when they are not in direct contact (not touching), such as magnetic force, electrical force and gravitational force.

P.FM.M.4 Speed: Motion can be described by a change in position relative to a point of reference. The motion of an object can be described by its speed and the direction it is moving. The position and speed of an object can be measured and graphed as a function of time.

P.EN.M.1 Kinetic and Potential Energy: Objects and substances in motion have kinetic energy. Objects and substances may have potential energy due to their relative positions in a system. Gravitational, elastic and chemical energy are all forms of potential energy.

P.EN.M.4 Energy Transfer: Energy is transferred from a source to a receiver by radiation, conduction and convection. When energy is transferred from one system to another, the quantity of energy before the transfer is equal to the quantity of energy after the transfer. *

*Revised expectations.

Post Activity

Forces

Grades 6-8

Inclined Planes

Discover how inclined planes can be used to help us do work.

An inclined plane is a simple machine with no moving parts. It is simply a sloping, slanting surface that is used to move objects up and down.

Materials:

Cardboard tube (paper towel, toilet paper or wrapping paper)
Paper cups, various sizes
Tape
Miscellaneous small objects: marbles, ping pong balls, paper clips, metal washers, buttons, cotton balls, etc.

Procedure:

1. Turn a cup upside down on a flat surface. Rest one end of a tube on the bottom of the cup and tape it in place. The other end should be resting on the table.

2. Place the objects, one at a time, into the tube. Observe: Do the objects roll down? Using the chart, record the objects and if they rolled down the tube in your investigations.

Object	Did the object roll?	Why or why not did the object roll down the tube?

4. If you use an inclined plane to transport these materials, which ones would you transport?

_____

Design your own investigation:

Now that you have observed how different objects behave on the inclined plane, think of some variables you would change and do some further testing.

- Try using larger tubes
- Try using different kinds of tubes
- Try changing the angle of the tube

Use a stopwatch, protractor or ruler to take some measurements like speed and angle.
Create a chart to record your results and start testing. How do your new results compare with your initial investigation?

Student Recording

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Grades 6-8

High Wire Cycle

1. Make a simple drawing of the High Wire Cycle. Identify the **fulcrum, load** and **effort.**

2. Predict what would happen if the load was greater than the effort (i.e. the rider weighed more than the 275 pound weight)?

Back in the Classroom:

1. The High Wire Cycle is a Class One Lever because the fulcrum lies between the weight and the load. Can you name two other simple machines that are considered Class One Levers?

2. Think about a ruler balanced on a pencil with two erasers of equal weight an equal distance from the fulcrum. In your head, this ruler is perfectly balanced, right? Now, double the weight of one of the erasers (eraser A). Without touching eraser A, how can you get the ruler to balance again? Try testing this experiment in the classroom to see what will work!

3. Think again about the scenario above: two erasers of equal weight balanced an equal distance from the fulcrum. If you cut eraser A in half, where would you need to move eraser B to get the ruler to balance again?

Student Recording

Forces

Grades 6-8

Giant Lever

This large exhibit is actually a simple machine! After completing the High Wire Cycle activity, you know a that fulcrum is a fixed point where a lever pivots and turns. The longer the lever, the easier it is to move a load.

1. Make a simple drawing of the Giant Lever. Locate the fulcrum and mark this point on your drawing. Place a star on the side of the Giant Lever that you predict will win in a game of tug-of-war if an equal number of people are on each side.

2. Now test your hypothesis (educated guess) with a game of tug-of-war! Make sure you have an equal number of people on each side of the lever. Which side won? Mark this on your drawing.

3. Test again! Have the groups switch sides and play again. Which side won? Mark this second trial on your drawing.

Back in the Classroom:

1. Did the side win that you predicted? Why or why not?

_____

_____

2. What was different about the position of the rope on the lever of the team that won?

_____

_____

3. Simple machines make work easier. Create a statement that explains how a giant lever such as this could make it easier to lift a car.

_____

_____

Student Recording

Forces

Grades 6-8

Ball Launcher

Potential energy is the energy an object has based on its relative position or its chemical composition. Think about a boulder at the top of a hill, it has a great amount of potential energy. At the bottom of the hill, it has little potential energy. When the boulder rolls down the hill, it has energy of motion or **kinetic energy.**

1. Draw a sketch of the Ball Launcher. Observe it in operation several times.

2. Draw arrows to explain the **FLOW OF ENERGY** through the exhibit. In other words, draw arrows to show how objects move through the Ball Launcher.

3. On your drawing, sketch a star where the bowling ball has the greatest amount of potential energy.

4. Place an X where the bowling ball has the least potential energy.

Back in the Classroom:

1. When the tennis ball was at its highest point in the air, does it have a lot of potential energy? Why or why not?

_____

_____

2. Think about the shape of the tubes that air traveled through in the Tennis Ball Launcher. How does the shape of the tubes help to launch the tennis ball high in the air?

_____

_____

Chaperone

Forces

Grades 6-8

Dear Chaperone,

We're glad you're here! Thank you for volunteering to be a chaperone on your school's visit to the Imagination Station. This page explains field trip procedures and offers tips on how to facilitate an Imagination Station Exhibit Guide.

The Imagination Station requires students and chaperones to remain together at all times. Group size should be 7 students or less per one adult.

Student Names:

1.

2.

3.

4.

5.

6.

7.

Schedule for the day:

Lunch Time:

Demonstration Time(s):

Departure Time:

Imagination Station Exhibit Guides:

- Students should fill out the their Data Recording pages while at the science center. The 'Back in the Classroom' section of the Data Recording pages can be completed when the students return to school.
- It should take about 1 hour to complete the activities.
- For older students, remind them to return their Data Recording pages to their teacher.
- For younger students, collect the Data Recording pages and hand them to the teacher at the end of the day.
- Have fun! A field trip is a great chance to interact with young people and see the wonder of science through their eyes.
- Ask open-ended questions. You don't have to be the science expert! Tell students to look up information when they return to the classroom or ask an Imagination Station Team Member about a specific exhibit.
- If a student is struggling with a portion of the Data Recording Sheet, ask questions like 'What have you done so far?' or 'What were you thinking about doing next?' These types of questions can help a student work through challenges and find their own solutions.

Visitor Guide

Attractions

High Wire Cycle – This thrill ride hovers over 18 feet above the ground, suspended on a 1-inch cable with a 275 pound counterweight that enables any person to defy gravity.
- *You must be 54" to ride*

BOYO – Using science similar to that of the classic yo-yo, a rider is propelled up to 13 feet in the air using his or her own strength and some basic science principles.
- *You must be 54" to ride*

Simulator Theater – Over The Edge!
Experience every turn, jolt, twist and drop. With HD visuals, surround sound and a responsive platform, you have an adventure without leaving your seat!
- *Imagination Station members ride FREE! You must have a token to ride. Tokens are $2 and available at Simulator entrance or Visitor Service.*
- *You must be 42" to ride.*
- *Elevator available. Please contact a team member.*

Demonstrations

Extreme Science Theater
Interactive demonstrations with an exciting EXTREME twist! Check monitors located at Visitor Service or at elevators for times.

Learning Worlds

Eat It Up! – This Learning World is focused on nutrition and exercise and tells the story of how the choices you make affect your body. Eat Smart. Play Hard. Have Fun.

Energy Factory – Get a glimpse into the abstract world of oil refining and solar energy.

Flex Space – This ever-changing space features some of the best exhibitions from North America and great experiences that we've created right here at Imagination Station.

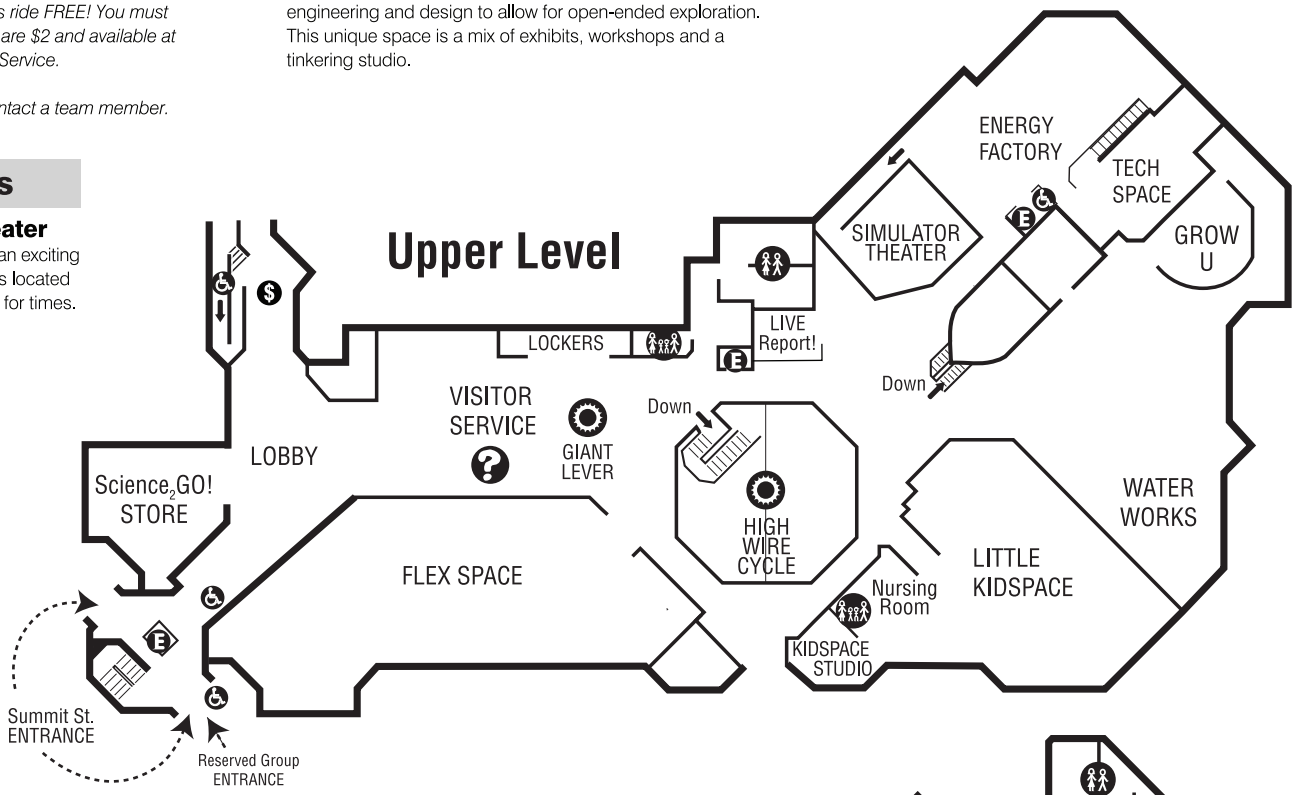
Grow U – Let Mother Nature be your guide as you take on FARM 101: Know It to Grow It.

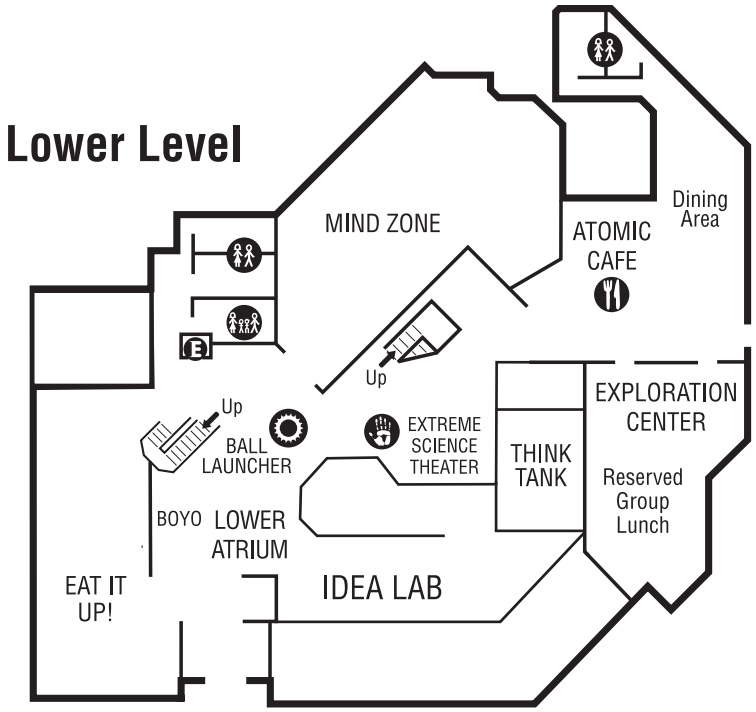
IDEA Lab – This Learning World combines science, art, engineering and design to allow for open-ended exploration. This unique space is a mix of exhibits, workshops and a tinkering studio.

Little KIDSPACE™ – Our littlest adventurers (kindergarten and under) can hop aboard our fire truck, shop in the grocery store or climb on our favorite tree house while learning science fundamentals.

Mind Zone – Home to the Distorted Gravity Room, discover how the mind processes, interprets and creates illusions and perceptions.

Water Works – Discover the slippery science of water and explore nature's most powerful resource.





- FORCES Exhibits
- Information
  Lost Persons/First Aid
- Wheelchair Accessible
- Elevator
- Demonstration
- Restaurant/Vending
  Food & beverages permitted only in Atomic/H2O Cafe.
- Men's & Women's Restroom
- Family Restroom
  Special needs accessible & baby changing facilities.

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Chaperone

Forces

Grades 6-8

High Wire Cycle

Student Data Recording Page Questions:

1. Make a simple drawing of the High Wire Cycle. Identify the **fulcrum, load** and **effort.**

2. Predict what would happen if the load was greater than the effort (i.e. the rider weighed more than the 275 pound weight)?

IN THE KNOW

Gravity works to your advantage on the High Wire Cycle as you take a ride across a one-inch thick wire nearly 18 feet above the ground! *Note: Students must be 54" tall to ride the High Wire Cycle.*

Simple machines make work easier by changing the size or direction of the force. There are many different types of simple machines, including levers, inclined planes, wedges, wheel and axles, pulleys and gears.

A **lever** is a bar that rests on a turning point or **fulcrum** that is used to lift a **load**. The High Wire Cycle is a great example of a **Class One Lever.** This means that the fulcrum lies between the load and the effort.

A quick reminder of the terms:

- The **fulcrum** is the point where the lever pivots and turns. For the High Wire Cycle, this is the point where the bike meets the cable.
- The **load** is the thing being lifted. In this case, it is the High Wire Cycle rider.
- The **effort** is the force (push or pull) that makes the load move. A 275-pound weight is the effort on the High Wire Cycle.

Activity:

While students are completing the activity or if they are struggling to identify fulcrum, load and effort, use these tips to assist them:

- Students should identify the fulcrum as the point where the cable meets the bike on the High Wire Cycle. Have students think about the point where the bike rocks.
- Have students imagine what would happen if the High Wire Cycle (complete with rider) was placed on the ground like a teeter-totter. This will probably make it easier for students to visualize the effort (the 275 pd. weight) and load (the rider).

Chaperone

Forces

Grades 6-8

Giant Lever

Student Data Recording Page Questions:

This large exhibit is actually a simple machine! After completing the High Wire Cycle activity, you know a fulcrum is a fixed point where a lever pivots and turns. The longer the lever, the easier it is to move a load.

1. Make a simple drawing of the Giant Lever. Locate the fulcrum and mark this point on your drawing. Place a star on the side of the Giant Lever that you predict will win in a game of tug-of-war if an equal number of people are on each side.

2. Now test your hypothesis (educated guess) with a game of tug-of-war! Make sure you have an equal number of people on each side of the lever. Which side won? Mark this on your drawing.

3. Test again! Have the groups switch sides and play again. Which side won? Mark this second trial on your drawing.

IN THE KNOW

This exhibit allows students to experience mechanical advantage in a fun and engaging way. Simple machines make work easier. We use the word 'work' in a lot of different ways. Physicists have a very specific way of defining work. **Work occurs when an object moves in the direction that a force is exerted.**

In mathematical terms, this means WORK= FORCE x DISTANCE.

In regards to the Giant Lever, this means that if we increase the distance (i.e. the location of the rope from the fulcrum) then we can decrease the force exerted and still get the same amount of work (i.e. winning the tug of war). Conversely, we would have to increase our effort (pull A LOT harder) to make up for the fact that our distance from the fulcrum is much shorter on the other side of the lever.

Here is how one side wins again and again…
The leverage that one side has over the other is known as **mechanical advantage.** One rope is 6 feet from the fulcrum while the other is 2 feet. This means on the side further from the fulcrum, because the distance is 3 times greater, the force needs to be only 1/3 as much to equal the work on the other side. This makes it far easier for one side to win, again and again.

Make sure the students try the tug-of-war multiple times with your group switching sides each time. It should be clear to students by the end that one group is not stronger than the other. The lever, a simple machine we use everyday, is making work easier!

Ball Launcher

Student Data Recording Page Questions:

Potential energy is the energy an object has based on its relative position or its chemical composition. Think about a boulder at the top of a hill, it has a great amount of potential energy. At the bottom of the hill, it has little potential energy. When the boulder rolls down the hill, it has energy of motion or kinetic energy.

1. Draw a sketch of the Ball Launcher. Observe it in operation several times.

2. Draw arrows to explain the **FLOW OF ENERGY** through the exhibit. In other words, draw arrows to show how objects move through the Ball Launcher.

3. On your drawing, sketch a star where the bowling ball has the greatest amount of potential energy.

4. Place an X where the bowling ball has the least potential energy.

IN THE KNOW

This exhibit offers students a great opportunity to observe the flow of energy through a closed system. Interactions with the Tennis Ball Launcher deal with energy in two forms, kinetic and potential.

- **Kinetic energy** is energy of motion, the energy an object has when it is moving.
- **Potential energy** is the energy an object has based on its relative position or chemical composition.

For example, a boulder at the top of a hill has a lot of potential energy. When the boulder is rolling down the hill, it has kinetic energy. Lastly, when it sits at the base of the hill, it has no kinetic energy (it's not moving) or potential energy (it's not likely to).

Activity

It is great if students can understand that energy travels from the bowling ball through the narrowing tubes to the tennis ball. Because the tubes narrow, the air is forced to move faster. This fast moving air forces the tennis ball high into the air.

Gravity can be a difficult concept for some of the younger grades. This is the force that 'pushes' the bowling ball down.

The bowling ball has its greatest potential energy when it is pulled to its highest point. It has no potential energy when it is done falling.

Encourage students to pull the bowling ball to different heights before releasing it. Does this have an impact on how far the tennis ball travels?