

Energy Zone

Energy Zone has ball-propelling stations offering opportunities to test cause and effect relationships, energy forces and simple and complex machines. Each station offers a chance to analyze which path a ball must take to reach its destination and what simple machines or energy forces help get it there. If you hear a bell, watch out! It's time for the balls to come falling down!

It is important to understand the concept of work. In respect to moving an object, work is the product of the **effort you put into** moving the object and the **distance the effort is maintained**. There is no way to reduce the amount of work it takes to do something. For example, when climbing a hill, the steepest route requires the **most effort**, but for the **shortest distance**. On the other hand, the most gentle slope requires the **least effort** but for the **longest distance**. The amount of work is equal, no matter which way you go. Simple machines **do not reduce the amount of work** it takes to do something. They **alter the way the work is done** in order to make it easier on us.

VOCABULARY

WORK

- Work is the product of the **effort you put into** moving the object and the **distance the effort is maintained**.

LOAD

- Anything put in or on something to be moved or transported

FULCRUM

- The point where something pivots or spins around

LIFT

- When air travels over a curved surface, there's a difference in pressure between the top and bottom of the ball is created. Low pressure is created on top of the surface, while high pressure is created underneath the surface.

INCLINE PLANE

- A ramp. A flat surface that has one end higher than the other
- Raising an object to a specific height requires a certain amount of work. Since there is no way to reduce this amount of work, the inclined plane alters the way the work is done. Specifically, it reduces the amount of effort we put in, which in turn increases the distance the effort must be maintained. For example, let's say we have to lift a piano onto a balcony fifteen feet off the ground. Which would be easier, using ladders to carry the piano fifteen feet straight up, or pushing the piano up a thirty foot inclined plane? It would require you to cover more distance with the inclined plane, but you would be using considerably less effort.
- The wedge is a form of an inclined plane. When using a wedge, you are actually moving an inclined plane to raise an object, as opposed to the piano example where you moved

the object itself. Think about it: when you push a wedge underneath a door, it exerts a force on the door and raises it slightly. Other forms of wedges are axes and scissors.

- The screw is also a form of the inclined plane, this time wrapped around a cylinder. In this case, as the inclined plane turns it pushes the cylinder into some material, such as wood. The effort it takes to turn a screw is magnified by the inclined plane as it moves into the material

LEVERS

- A lever is a bar or rod that tilts on a pivot, or fulcrum. An effort is applied on one end in order to move a load. There are three different classes of levers.
 - A first-class lever is a lever where the fulcrum is between the effort and the load. Examples of first-class levers include balances and scissors.
 - In a second-class lever the fulcrum is at one end of the bar, the effort at the other end pushing up, and the load is in between. Examples of second-class levers include wheel-barrows and bottle openers.
 - In third-class levers, the fulcrum is at one end, the load is at the other end, and the effort is pushing up in between. Third-class levers include fishing rods, tweezers, and hammers.

WHEEL AND AXLE

- Wheels and axles all rotate around a fixed point. The wheel is the outer part of the machine; the axle is the inner part. As the device rotates, the wheel moves a greater distance than the axle, but turns with less force. The axle causes the wheel to move at a greater speed.
- Gears are often classified as a type of wheel and axle. There are four main types of gears. They act so that one gear turns faster or slower than the adjacent gear, or in a different direction. A large gear rotates with a greater force and is slower than a small gear.

PULLEYS

- A pulley is a wheel on an axle that is designed to support the movement of a rope over the wheel.
- For most people pulling something down is easier than lifting it up. When using a pulley system, a load can be raised by pulling down on a rope. Pulleys also reduce the amount of force required to lift an object. The more pulleys on the system, the less force needed to lift the object. Let's go back to the piano example. Would it be easier to use ladders and carry the piano fifteen feet off the ground, or to rig a pulley system and have several people pull down on ropes to raise the piano? Obviously the pulley system would make the work easier.

PULLEY & GEAR TRANSPORT

- Load balls into the silver bucket.
- How can we get the bucket to the top?
 - A pulley system is the best way to accomplish this task. With a pulley, all you need to do is pull down on the rope attached to the base to raise the bucket and

pull down on the red handle to dump the bucket. Once again, pulling something down is easier than lifting it up.

- What would be the best way to turn the big silver basin so that the balls will go down a different tube? What happens when you pedal? (Sit and pedal so the silver basin spins.)
 - Climbing up there and turning it by hand would take time and you would get tired after a while.
 - Using gears is the best way to accomplish this task. By using the bicycle pedals, you can turn the big silver basin so that the balls will fall into one of the three white tubes.
 - Notice how the gears inside the cage are turning vertically, but the red propeller and silver basin are turning horizontally. Remember, gears can change the direction of the effort applied to them.
 - Also notice how the pulleys and wheel and axle on the target help it move.
- How do we dump the balls?
 - Pull the green rope.
- How do we get the bucket back down?
 - Pull the green rope.
- What is moving?

THE BIG BUCKET

- The small grey boxes on the side of the Big Bucket are sensors. When the balls get up to the height of those sensors, a bell rings, a light flashes, the Big Bucket opens and the balls fall to the ground.

TREADMILL

- Place some balls into the yellow tray to load the red hopper.
- Then walk on the treadmill to raise the balls up to another tube leading to the big bucket.
 - The treadmill is another way of turning a conveyor belt.
 - Once again the conveyor belt is a big pulley. This time, however, it is operated by walking instead of turning a wheel. The result is the same. The balls end up in the big bucket.
- Where are the balls going after they reach the overhead tube?

BERNOULLI BLOWER

- When air travels over a curved surface, there's a difference in pressure between the top and bottom of the surface. In this case, low pressure is created on top of the ball, while high pressure is created underneath the ball. This can be called lift.
 - This lift is what keeps the ball from falling to the ground and being blown to the side.
 - Gravity keeps the ball from floating too high.
 - This is the same way bird and airplane wings function. The front edges of bird and airplane wings are curved, creating high pressure underneath the wing and low pressure above the wing.

- Collect balls and place them into one at a time over the blower.
- The blower can be moved in order to maneuver the ball into one of the metal funnels attached to the tubes.
- From here it flows down to a conveyor belt. If you look close, this conveyor belt is a giant pulley.
- By turning the wheel, the conveyor belt raises the balls to the tube, which runs to the big bucket. It is much easier to turn the wheel of the conveyor belt to get the balls to the tube as opposed to carrying a bag of balls up and down a ladder several times.
- Next, turn the wheel to move the balls to the top of the tube
- The balls will travel through the tube to the big bucket.

SILVER BUCKET

- Load balls into the silver bucket.
- How do we get the bucket to the top?
 - Pull the rope attached to the base.
- How do we dump the balls?
 - Pull the red handle.
- How do we get the bucket back down?
 - Pull the rope attached to the base.
- A pulley system is used to raise and dump the silver pail.

VENTURI

- The Venturi Blower is the end section of the Pressure Popper station.
- At the top of this tube is a blower creating airflow.
 - Fast air equals low pressure. Since the air is moving so fast at the top of the tube, there's low pressure.
 - The air is moving slower at the bottom of the tube, causing high pressure.
 - Objects tend to move down a pressure gradient (from high pressure to low pressure).
 - Because of this, the balls travel up the tube to the Big Bucket.
- At this station, place a ball into the tube and watch what happens.
- Ask older students why they think the balls move from the bottom to the top of the tube.

CATAPULT

- Shoot a ball into the basket
- Pull the rope with the black handle.
 - You are using a pulley system when you pull down on the red rope.
 - The pulley system is attached to a first-class lever.
 - The red rope is the effort, which pulls down on one end of the lever.
 - The load is the ball, which is propelled forward by pulling down on the rope.
 - The fulcrum is in between the effort and the load.
- The ball will go flying out of the cage or hit the cage and roll down to the floor.

PRESSURE POPPER

- Place a ball into the mouth of the tube or make a basket.
- Turn the wheel and watch the ball.
 - What will happen when the wheel is turned?
 - You can see that it is being pulled back into the tube.
- What simple machines do you see in use inside the pressure popper?
 - Well, you can see gears on the inside. You can also see an inclined plane. Doesn't the white structure sort of look like a screw? As you turn the wheel, the inclined plane is raising the inside of the pressure popper. This is what is pulling the ball back.
- When the inside of the popper gets to the top of the inclined plane, a weight drops off and falls back to the bottom of the machine. Air is pushed into to the tube behind the ball propelling it forward.
- Aim the target so the balls will bounce to the large funnel.
 - If one ball doesn't work, try two or three at a time.
 - The funnel leads to the Venturi Blower.
 - Notice that pulleys and a wheel and axle are present to help move the target.

SAFETY TIPS:

LISTEN FOR THE BELL!

- If you hear a bell, watch out! It's time for the balls to come falling down!

PAY ATTENTION TO MOVING PARTS

- The metal bucket can be raised or lowered, so be aware of its movement.
- There are working pulleys in this exhibit; be cautious of all hands in the area.

WALK

- This is a high-energy exhibit, please remind students to walk at all times.

MEETING SPOT

- Since it is often difficult to stay directly with your group, provide a meeting spot for students and do visual checks periodically. Find a staff member to help you locate lost students!

FIRST AID

- If you need first aid during your visit, please see a staff member. Staff can always be found at the entrance of the museum.

RULES OF THE EXHIBIT

NO CLIMBING

- Please remind students to keep their feet on the floor in this exhibit space.

NO THROWING

- Please ensure students do not throw balls at each other.

NO RUNNING!

- Please walk while in Energy Zone. If you see someone running, ask if they could please walk. If you feel as though you need assistance, please call a staff person.

STATE CONTENT STANDARDS (Ohio)

EARLY LEARNING AND DEVELOPMENT

- Social and Emotional Development
 - Peer Interactions and Relationships – Cooperative Play
 - Peer Interactions and Relationships – Socially Competent Behavior
- Physical Well Being and Motor Development
 - Small Muscle: Touch, Grasp, Reach and Manipulate
 - Sensory Motor
- Approaches Toward Learning
 - Initiative and Curiosity – Explore and Experiment
 - Initiative and Curiosity – Self Direction & Questioning
 - Planning, Action and Reflection – Planning & Action
 - Planning, Action and Reflection - Reflection
 - Innovation and Invention
- Cognition and General Knowledge
 - Reasoning and Problem-Solving
 - Group and Categorize
 - Spatial Relationships
 - Inquiry
 - Cause and Effect
 - Explorations of Energy -
- Language and Literacy
 - Receptive Language and Comprehension
 - Expressive Language

LANGUAGE ARTS

See National Common Core

MATH

See National Common Core

SCIENCE

K-PS-1 Objects and materials can be sorted and described by their properties.

1-PS-2 Objects can be moved in a variety of ways, such as straight, zigzag, circular and back and forth.

2-PS-1 Forces change the motion of an object.

5-PS-1 The amount of change in movement of an object is based on the mass* of the object and the amount of force exerted.

SOCIAL STUDIES

K-GV-9 Individuals have shared responsibilities toward the achievement of common goals in homes, schools and communities.

1-GV-9 Collaboration requires group members to respect the rights and opinions of others

2-E-14 Resources can be used in various ways.

NATIONAL CONTENT STANDARDS

LANGUAGE ARTS – Common Core

RL-K-1 With prompting and support, ask and answer questions about key details in a text

RL-K-4 Ask and answer questions about unknown words in a text.

RL-1-1 Ask and answer questions about key details in a text.

RL-2-1 Ask and answer such questions as who, what, where, when, why, and how to demonstrate understanding of key details in a text

RL-2-7 Use information gained from the illustrations and words in a print or digital text to demonstrate understanding of its characters, setting, or plot

RI-K-1 With prompting and support, ask and answer questions about key details in a text

RI-K-4 With prompting and support, ask and answer questions about unknown words in a text.

RI-1-1 Ask and answer questions about key details in a text.

RI-1-4 Ask and answer questions to help determine or clarify the meaning of words and phrases in a text.

RI-1-7 Use the illustrations and details in a text to describe its key ideas.

RI-2-1 Ask and answer such questions as who, what, where, when, why, and how to demonstrate understanding of key details in a text.

RL-K-1 With prompting and support, ask and answer questions about key details in a text

RL-K-4 Ask and answer questions about unknown words in a text.

RL-1-1 Ask and answer questions about key details in a text.

RL-2-1 Ask and answer such questions as who, what, where, when, why, and how to demonstrate understanding of key details in a text

RL-2-7 Use information gained from the illustrations and words in a print or digital text to demonstrate understanding of its characters, setting, or plot

RI-K-1 With prompting and support, ask and answer questions about key details in a text

RI-K-4 With prompting and support, ask and answer questions about unknown words in a text.

RI-1-1 Ask and answer questions about key details in a text.

RI-1-4 Ask and answer questions to help determine or clarify the meaning of words and phrases in a text.

RI-1-7 Use the illustrations and details in a text to describe its key ideas.

RI-2-1 Ask and answer such questions as who, what, where, when, why, and how to demonstrate understanding of key details in a text.

SL-K-1 Participate in collaborative conversations with diverse partners about kindergarten topics and texts with peers and adults in small and larger groups.

- a.** Follow agreed-upon rules for discussions (e.g., listening to others and taking turns speaking about the topics and texts under discussion).
- b.** Continue a conversation through multiple exchanges

SL-K-2 Confirm understanding of a text read aloud or information presented orally or through other media by asking and answering questions about key details and requesting clarification if something is not understood.

SL-K-3 Ask and answer questions in order to seek help, get information, or clarify something that is not understood.

SL-1-1 Participate in collaborative conversations with diverse partners about grade 1 topics and texts with peers and adults in small and larger groups.

- a.** Follow agreed-upon rules for discussions (e.g., listening to others with care, speaking one at a time about the topics and texts under discussion).
- b.** Build on others' talk in conversations by responding to the comments of others through multiple exchanges.
- c.** Ask questions to clear up any confusion about the topics and texts under discussion.

SL-1-2 Ask and answer questions about key details in a text read aloud or information presented orally or through other media.

SL-1-3 Ask and answer questions about what a speaker says in order to gather additional information or clarify something that is not understood.

SL-2-1 Participate in collaborative conversations with diverse partners about grade 2 topics and texts with peers and adults in small and larger groups.

a. Follow agreed-upon rules for discussions (e.g., gaining the floor in respectful ways, listening to others with care, speaking one at a time about the topics and texts under discussion).

b. Build on others' talk in conversations by linking their comments to the remarks of others.

c. Ask for clarification and further explanation as needed about the topics and texts under discussion.

SL-2-2 Recount or describe key ideas or details from a text read aloud or information presented orally or through other media.

SL-2-3 Ask and answer questions about what a speaker says in order to clarify comprehension, gather additional information, or deepen understanding of a topic or issue.

SL-3-1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher led) with diverse partners on grade 3 topics and texts, building on others' ideas and expressing their own clearly.

b. Follow agreed-upon rules for discussions (e.g., gaining the floor in respectful ways, listening to others with care, speaking one at a time about the topics and texts under discussion).

c. Ask questions to check understanding of information presented, stay on topic, and link their comments to the remarks of others.

SL-3-2 Determine the main ideas and supporting details of a text read aloud or information presented in diverse media and formats, including visually, quantitatively, and orally.

SL-3-3 Ask and answer questions about information from a speaker, offering appropriate elaboration and detail.

SL-4-1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher led) with diverse partners on grade 4 topics and texts, building on others' ideas and expressing their own clearly.

b. Follow agreed-upon rules for discussions and carry out assigned roles.

c. Pose and respond to specific questions to clarify or follow up on information, and make comments that contribute to the discussion and link to the remarks of others.

SL-5-1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher led) with diverse partners on grade 5 topics and texts, building on others' ideas and expressing their own clearly.

b. Follow agreed-upon rules for discussions and carry out assigned roles.

c. Pose and respond to specific questions by making comments that contribute to the discussion and elaborate on the remarks of others.

SL-6-1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher led) with diverse partners on grade 6 topics, texts, and issues, building on others' ideas and expressing their own clearly.

b. Follow rules for collegial discussions, set specific goals and deadlines, and define individual roles as needed.

SL-6-2 Interpret information presented in diverse media and formats (e.g., visually, quantitatively, orally) and explain how it contributes to a topic, text, or issue under study.

MATH – Common Core

K-CC-4 Understand the relationship between numbers and quantities; connect counting to cardinality.

K-MD-1 Describe measurable attributes of objects, such as length or weight. Describe several measurable attributes of a single object.

K-MD-2 Directly compare two objects with a measurable attribute in common, to see which object has “more of”/“less of” the attribute, and describe the difference. For example, directly compare the heights of two children and describe one child as taller/shorter

SCIENCE – Next Generation

K-PS2-1 Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.

K-PS2-2 Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.

3-PS2-1 Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.

3-PS2-2 Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.

3-PS2-3 Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.

4-PS3-3 Ask questions and predict outcomes about the changes in energy that occur when objects collide.

5-PS2-1 Support an argument that the gravitational force exerted by Earth on objects is directed down.

SOCIAL STUDIES – National Standards

NONE