In Cincinnati Museum Center's *Science Interactives Gallery sponsored by Procter & Gamble*, you can discover the physics behind simple machines, explore energy, and see the invisible. Use this guide to check your knowledge and ensure you haven't missed any great content!

Simple Machines

Simple machines are devices that reduce the effort required to perform a task. There are six types: inclined planes; levers; pulleys; screws; wedges; and wheel and axles. These devices don't reduce the amount of work, but they do make our work easier.

- Pulley Chairs: The two chairs each use a different number of pulleys and rope segments. Assuming each of the participants weighs the same amount, who do you think will have an easier time pulling themselves up: the person with fewer pulleys and rope segments, or the one with more?

Check your knowledge!

Who had an easier time? That person used less force to pull, but had to pull a longer length of rope.

- Lever Tug-of-War: Observe the different locations where the ropes attach to the lever. Assuming each participant pulls with the same amount of force, who do you think will win: the participant whose rope attaches closer to the fulcrum, or the participant whose rope attaches farther from the fulcrum?

Check your knowledge!

Who won? The location of the rope for the winning participant gave them a mechanical advantage, so they only had to pull with half the force of their opponent.

- Gear Wall: Observe the distance between the drive gear, which is the gear we turn by hand and the output gear, which turns the pinwheel. How do the number of gears we insert between the drive gear and output gear determine which way the pinwheel spins? Does the output gear turn the same way or the opposite way as the drive gear?

Check your knowledge!

How many gears were added to connect the drive and output gears? Since gears change the direction of motion, one additional or one fewer gear would change the direction of the pinwheel.

Extra Challenge! Now that you've seen simple machines in action, where can you find them at home? Do you observe any objects that use more than one type of simple machine?

Energy

Energy is the capacity for doing work, and can be transferred in a variety of ways. Mechanical energy is transferred when objects push or pull on one other. An object has gravitational potential energy when it is positioned at a height where it can fall or move downward, becoming kinetic energy, which is the energy of motion.

- Ball Wall: We can create a loop where the air system provides gravitational potential energy by forcing the ball to the top, and the energy converts to kinetic energy as gravity pulls the ball down the track. How could you disrupt the loop? What would happen to the ball if we turned off the air system when the ball is at the top?

Check your knowledge!

How many pieces of pipe were used to complete the loop? If a piece were missing and the ball fell to the floor, or if the air system did not provide enough force to push the ball to the top, the loop would be broken.

- Tennis Ball Launcher: This apparatus uses the force of gravity to launch a tennis ball. Pulling the rope lifts a bowling ball, which provides gravitational potential energy. Do you think the tennis ball will go higher if the bowling ball is dropped from a greater height?

Check your knowledge!

What difference did you observe in the height of the tennis ball on the second attempt? Raising the bowling ball higher provided more gravitational potential energy.

Extra Challenge! Now that you have explored gravitational potential energy converting to kinetic energy, experiment at home with an object that bounces. What happens to the height of the bounce if you drop it from a higher distance?

Seeing the Unseen

Energy can be transmitted through the movement of liquid or gas, the motion of atoms and molecules and through waves. Our eyes may not see these energy transfers without special cameras, or by adding water vapor or fog to the air.

- Fog Rings: As energy is transferred through the atmosphere, it causes air to move. If the air starts to spin, it can create a vortex. One type of vortex is called a ring vortex, where air squeezes through a narrow opening and moves upward and out. Why does the vortex act different than a fan, or sneeze?

Check your knowledge!

Observe the difference in how quickly the ring moves toward the ceiling as the table is pushed with more and less force. This same effect can be seen above volcanoes and dolphin blowholes!

Seeing the Unseen *(continued)*

- Air Cannon: We may not be able to see air, but we can observe objects to see how much energy is transferred through air. What happens to an object when air pushes it?

Check your knowledge!

What happened when the presenter used different amounts of force to move different amounts of air? The less air the presenter moved through the cannon, the less energy transferred to the cups.

- Fog Tornado: As energy is transferred through the atmosphere, it causes air to move. If the air starts to spin, it can create a vortex. One type of vortex looks like a tornado spinning. Where does the spinning start when the vortex begins to form? Why does it speed up at the bottom?

Check your knowledge!

Observe where the spinning motion begins and how the air is spinning faster at the bottom of the vortex. How is this vortex different from an actual tornado?

- Infrared Camera: Instead of seeing visible light, this camera sees long-wavelength, low-energy infrared light (heat). Which areas on the presenter looked cooler? Why are those areas cooler?

Check your knowledge!

Changing temperatures affects the heat objects give off, and how they look to an infrared camera. What colors were the presenter's hands when he held them to the heated and cooled plates?

Extra Challenge! Can you observe "invisible" energy being transferred? How do leaves move as the wind blows? Can you find steam rising from certain objects on a cool, sunny morning?