

Western Engineering Outreach

Homemade Pulley Challenge

Grade K-2

Meet Today's ENG HERO!



James Johnson - Professor with Western Engineering

Dr. Johnson is a professor in the Mechanical and Materials Engineering Department at Western University. He works together with surgeons and doctors to develop systems to help people with upper arm injuries. One area his research looks at is motion of the joints and looking to see how movement can be supported by machines.

For more information about Dr. Johnson visit:

https://www.eng.uwo.ca/mechanical/faculty/johnson_j/index.html

Learning Goal:

- Students will explore force and movement as they make a simple machine.
- Students will learn about the types of simple machines and how they enable movement.

Materials Needed:

- String
- Cardboard
- 3 skewers
- 3 sheets of newspaper or 3 paper towel tubes
- Marbles or other small weights
- Tape
- Scissors



Engineering and Science Connections:

As soon as we are conceived, we experience lots of different forces. We can control many of these forces: moving your arms, walking around, and jumping are all examples of times where we manipulate forces to do what we want but there are many more which we can't really control. Ever since you were born you've been under an ocean of air which puts a lot of force on us all the time, we usually forget about it because we can see right through it and we are used to the force, but if you've ever been outside in a windstorm or have seen an airplane: you've already experienced some of the powerful forces that even normal mundane things can put on us.

But what even is a force?

Push and Pull - A simple definition of force is pushing or pulling on an object.

Can you think of things which you interact with that need a force to operate?

Gravity and Normal Force

Gravity pulls people, cars, and other objects downward toward the Earth. But people, cars, and buildings are not pulled into the ground nor does an object resting on a table display any sign of movement. When forces are going in opposite directions they cancel out, just like if you push your hands together: your left hand is putting a force on your right hand, but your right hand is kept where it is by the force you put into your arm. The opposing force for gravity is called the "normal force," the special thing about normal forces is that they are always *perpendicular to the surface that we are on*. We'll come back to that later.

The important thing to remember about these two kinds of forces is that we usually rely on normal forces on surfaces to stop us from falling to the center of the earth, and we rely on Gravity to keep us firmly pulled down to the surface of the planet instead of flying off to outer space.

Simple Machines

There are six types of simple machines, using them we can make:

Lever: A lever is a bar used for raising or moving a weight. A weight is placed at one end and a force pushes down the other end. All levers have a turning point (fulcrum), a place where an object is moved, and an area where force is applied. A hammer and crowbar are examples.

Wheel and Axle: When a wheel is turned, the axle (a bar attached to the centre of the wheel) turns too. A doorknob, pencil sharpener, and gears are examples of using wheels and axles.

Pulley: A pulley is a simple machine with one or more grooved wheels connected by a rope. A pulley makes it easier to move objects up and down, and across a long distance. The more pulleys you combine, the less force you need to move an object.

Inclined Plane: An inclined plane is a flat surface with one end raised higher than the other. It makes the work of moving things up and down easier. Inclined planes change the direction of the normal force, so instead of having to lift the object directly up against all the force that gravity puts on it, you only have to oppose part of its weight.

Screw: The screw is a specialized inclined plane that is used to raise or lower things and to hold things together. It is an inclined plane wrapped around a central axle.

Wedge: A wedge is also a type of inclined plane. It is wide at one end and tapers to a point at the other. Wedges separate things by cutting, piercing, or splitting.

Video Recommendation: <https://www.youtube.com/watch?v=LEs9J2IQJZY>

Intro:

Go through the lesson above and ask your students these guiding questions:

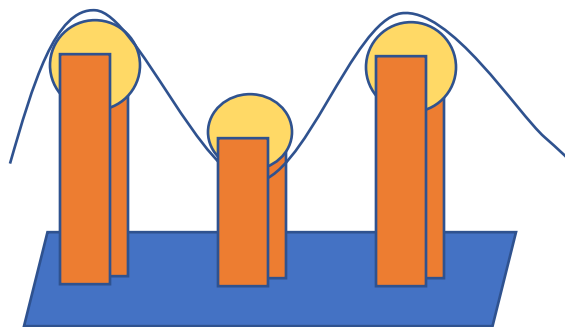
1. What causes things to move?
 - Forces
2. What are a couple forces?
 - Push, Pull, Gravity, friction
3. Why do we use simple machines?
 - They make movement easier by changing the amount or direction of force.
4. Name some simple machines or examples of simple machines.
 - Lever (like a seesaw or crowbar), wheel and axle (like on a car or wheelbarrow), pulley (like in a well to pull up a bucket), inclined plane (like a ramp), screw (like a screw to hold things together, or a bolt), wedge (like an axe to split wood or a doorstep to hold the door open).
5. Can you combine simple machines?
 - Yes! For example, a wheelbarrow has a lever and a wheel and axle. Another example is a tow truck - it has a wheel and axle and a pulley to lift another car! What are other combinations you can think of?

Game Time - Simple Machine Yoga

- Give each simple machine an action (you can make these up yourself!)
- Have your student repeat the action, so they learn them all
- Call out simple machines and have your student do the action that goes along with them.
- Make it competitive by getting other people to join. Last person to do the action is out!
- Play a few rounds.

Activity:

- Students will work to build a pulley
- Have your student start by building “towers”
 - 2 taller towers on the outside and one shorter tower in the middle
 - Towers can be created from cardboard tubes, cleaned used pop bottles, or rolled up newspaper. Secure to a cardboard base using tape.
 - Each tower will have 2 sides. Leave 5-10 cm between each side of the tower. See image below.
- Make holes in the top of the towers for the axle of the pulley to go through.
- Slide a skewer through the holes in one of the towers.
 - Slide two cardboard circles onto the skewer, and then proceed to stick the skewer through the holes in the opposite tower.
 - Repeat with the remaining two towers.
- Attach the string to the pulleys. It should go over the first pulley, under the second, and over the third.
- Have your student create baskets or handles the end of the pulley using string and cardboard. Add marbles/snacks/ or other small weights into the basket and test the pulley!



What Did You Learn?



- Name some forces. Push, pull, gravity, normal.
- What kind of simple machine did we build today? Pulley!
- What force does it use? Pull
- What other simple machines have you used today?

Future Learning



- Turn this chalk activity into an experiment! In order to do this, try three different chalk recipes. Use Have your student design and build their own simple machine. It could be another pulley that looks different, or maybe they will make a cardboard car with a wheel and axle, using bottle caps as the wheels. Encourage them to pick the simple machine they like best. Have them draw out their design and then try to build it. Let them know that it is okay if their final product does not look like their design. That's a part of the learning process!

Share your creations!

We would love to see what you made. Email as at discover@uwo.ca or tag us on social media.

Instagram: @westernueng

Twitter: @westernueng

Facebook: @westernueng

Thanks for discovering with us!