Simple Science From Salvaged Stuff

STEAM Activity Packet

This packet of activities is supported by Fermilab Friends for Science Education. For more information about this organization, please visit FFSE (https://ed.fnal.gov/ffse).

The science of Fermilab begins with our passion to want to know more! How we learn about our world starts with our investigation of how things work, and why. That's science!

What can you make from a plastic spoon, rubber bands, and sticks? In this fun packet, you will use everyday items to do cool science activities. You will create a catapult and a spectroscope as well as discover some science magic that you can share with your family and friends. The packet includes most materials needed with only a few additional common household items required. When you complete your science project, you will have the opportunity to upload a photo of it or artwork that will be posted on the Fermilab Virtual Family Open House website.

Why science from salvaged stuff?

Fermilab is our country's premier high-energy particle physics and accelerator laboratory. The experiments that are performed at Fermilab are huge in scale and require a lot of specific electronics and equipment. Fermilab has a special space on site that is called "the boneyard." This is a place where salvaged pieces from previous experiments, and even other labs from around the world, are documented and saved to be reused for other scientific, educational, and commercial purposes. Check out this article to see other ways that Fermilab uses salvaged stuff for science (https://www.symmetrymagazine.org/article/november-2008/where-old-physics-stuff-goes-to-live).

Fermilab is also known for its beautiful architecture and artwork, which were originally imagined by the founding director, Robert Rathbun Wilson, and one of the laboratory's first employees, artist Angela Gonzalez. Throughout Fermilab are sculptures and buildings that have been created using salvaged items.

The sculpture Broken Symmetry is made of metal from the retired U.S. Navy aircraft carrier USS Princeton, which was the prime recovery ship for the Apollo 10 lunar mission.

The sculpture Tractricious is composed of 16 stainless steel outer tubes, made from scrap cryostat material from the Tevatron dipole magnets, and 16 inner tubes, made from carbon steel pipes from the Fermilab boneyard.

Send It Flying With a Homemade Catapult

Introduction

How can a simple catapult teach us about potential energy and kinetic energy?

Many of the machines around us work by harnessing and using the two main types of energy: potential energy and kinetic energy.

Materials

Included materials:

- 6 craft sticks
- 3 rubber bands
- 1 plastic spoon
- 2 pompoms

Additional materials:

- Markers or paints and anything else you can think of to make your project look cool

Procedure

Stack five of the craft sticks. Secure one end of the stick stack with one of the rubber bands. Wrap the rubber band around the sticks several times to make a tight fit.

1) Slide one stick between the bottom stick and the rest of the stick stack.

2) Secure the other end of the stick stack with a rubber band.

3) Place the spoon on top and attach the end of the spoon to the end of the single stick with the last rubber band. Decorate it however you want. You can even mount it on wheels or a toy car for a moveable catapult!

4) Place a pompom in the bowl of the spoon. Push down on the bowl of the spoon and let the pompom fly! Since the spoon is flexible, when you pull back on it, you transfer energy into the spoon causing potential energy to be stored in the arm of the spoon.

Questions

1. Does your pompom travel the same distance every time you launch it?
2. What might be the reason for these differences in distance?

3. Can you control the potential (stored) energy in the spoon by how far you push it down?

More activities

Try making changes to your catapult and see how it affects the flight of your pompom.

- Slide the stick stack up and down along the single stick. How does the position of the stick stack affect the flight of the pompom?
- If you have more plastic spoons at home, see if you can find one that is a different stiffness. You can also stiffen the spoon by adding an extra stick to the arm of the spoon. How does stiffness affect flight? What about a longer or shorter spoon?
- Experiment with other catapult designs.
- Make a game by placing a bowl on the floor or drawing a target on the sidewalk and see how many shots you can get into the bowl or target. If you play with a friend, you could both make your own catapults and share them. Make up your own game!

The science behind this

Potential energy is stored energy. The amount of potential energy depends on how far you pull the spoon back. When you release the spoon, the potential energy is converted to kinetic energy, sending the pompom flying through air. Kinetic energy is the energy that an object has due to its motion.

A lot of energy (potential) is added in the huge particle accelerators at Fermilab to make the particles move (kinetic energy) at almost the speed of light. To learn more, visit Fermilab's Accelerator Complex at https://fnal.gov.

The Ice Cube Lift Dilemma, or How to Trick Your Friends

Introduction

Do you think that you could lift an ice cube using just a piece of string?

By manipulating temperatures, you can trick your family and friends. Then you can teach them the science behind why this works!

Materials

Included material:

- 12-inch piece of string

Additional materials:

- Glass of water with an ice cube floating in it
- Salt shaker (hide the salt at first)

Procedure

1. Challenge a friend to pick up the ice cube using only the string. They will probably try to loop the string under the ice cube but will not be able to do it.
2. When they give up, wet the string and lay it over the top of the ice cube.
3. Sprinkle a small amount of salt on the cube and the string, and wait about one minute.
4. Lift the ice cube out of the water using the string!

Questions

1. How did sprinkling salt cause the string to stick?
2. Why do you think that salt is put on roads when they are icy?
3. How could you teach your friend what happened?

Another activity

See if other compounds like sugar or baking soda will do the same thing as the salt.

The science behind this

An ice cube floating in water stabilizes at a temperature of 32 degrees Fahrenheit, which is the freezing point of water. Salt lowers the freezing point of water. When you sprinkle salt on the ice cube, the top of it melts because of this. It takes energy to melt the ice and the energy must come from somewhere. As the ice melts, it takes enough heat away from the unsalted water in the string so that it freezes and sticks to the ice cube.

Some of Fermilab's experiments require very cold temperatures. In fact, the laboratory has attained some of the coldest temperatures ever recorded! Imagine something like your refrigerator or freezer, only way colder.

To find out more about how and why scientists do this, visit Fermilab Cryogenics (https://td.fnal.gov/cryogenics/).

Make a Rainbow

Introduction
Is it possible to hold a rainbow in your hand? It is with a homemade spectroscope!

A spectroscope is an instrument that splits light into the spectrum, the colors of the rainbow.

Materials
Included material:

- Salvaged CD

Additional materials:

- Empty paper towel tube
- Small piece of cardstock or cardboard
- Markers, crayons, colored pencils, stickers, etc.
- Pencil
- Cellophane tape or masking tape
- Scissors or craft knife (adult supervision required for cutting)

Procedure

1. Decorate the cardboard tube, which will become your spectroscope.
2. Cut a slit that looks like a frown on the front side of the tube near the bottom. Leave enough space for your hands to hold the spectroscope. Only cut on the front side of the tube. This is where the CD will be placed.

3. Cut a small square on the other side of the tube, directly opposite from the slit. This is the peephole.

4. Stand the tube upright on the piece of cardstock or cardboard and trace around the circular end.
5. Cut out the traced circle.
6. Cut a narrow opening that is 1 inch long and 1/16 inch wide in the middle of the cutout cardboard circle.
7. Tape the circle with the narrow opening over the open end of the tube (the end where you did not make the slit).

8. Hold the tube upright with the narrow opening on the top. Insert the CD into the slit on the side of the tube with the shiny side facing up.

9. Point the opening on the top toward the sunlight coming through the window, or if you are using it outside, point it at the sky. **Do not point it directly at the sun**. Look through the peephole! What do you see?

Questions

1. Try using your spectroscope with other light sources, such as a fluorescent bulb, an incandescent bulb, candlelight, a neon light, or a streetlight. Are the spectra the same or different?
2. Which colors appear lighter or darker from each source?
3. Which source of light was your favorite, and why?

Another activity

Vary the width of the slit on top to see if that changes the appearance of the spectrum.

ART **activity**

Draw each spectrum from your different light sources with your colored pencils or markers and compare them. How could you use these drawings to create a work of art? Take a photo of your decorated spectroscope and/or your artwork and send it to edreg@fnal.gov.

The science behind this

Sunlight is white light, which is made of many colors. We cannot see all of the colors unless they are separated.

The shiny side of the CD is a mirrored surface with many circular grooves that are very close together. When the light waves are reflected off the grooves, they interact and separate into the color spectrum.

Scientists can determine what stars are made of by using spectroscopes. All matter is made up of basic units called elements, and each element has a unique pattern of colors. By looking at a star's light with a spectroscope, scientists see which colors are there and which are not. The unique pattern tells them the composition of the star.

Scientists at Fermilab contributed to the design and building of important components of the Dark Energy Spectroscopic Instrument. This instrument is mounted on a telescope at the Kitt Peak National Observatory, located on a mountaintop in Arizona. It gathers the light from millions of galaxies and splits that light into its spectrum. This information will help scientists create a 3D map of the universe. Learn more at DESI (https://astro.fnal.gov/tag/desi/).

There are two processes that can create the color spectrum. Your spectroscope uses diffraction; the other process is refraction. In a rainbow, the spectrum forms when light shines through water droplets. The water droplets act as little prisms. The light is refracted and separated, which results in all of the amazing colors that you see!

Color Combos

Introduction

How can you use a coffee filter and water to mix colors?

Water molecules have the ability to move from place to place because of special properties that they possess. As the water moves through the coffee filter, see what happens to the dissolved colors.

Materials

Included materials:

- 6 coffee filters

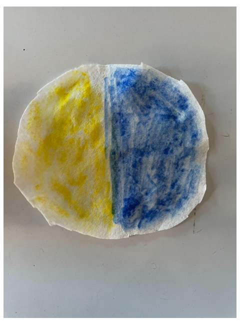
Additional materials:

- 3 empty cups
- Water
- Washable markers

Procedure

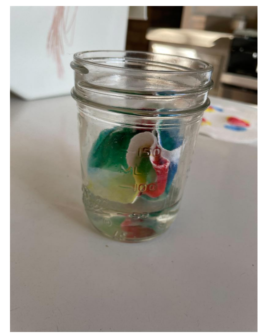
1. Flatten out the coffee filters.
2. Color each half (see photo) of the first filter red and yellow, the second filter red and blue, and the third filter yellow and blue.
3. Fold each filter in half and then in half one more time.
4. Fill each cup with 1 inch of water and place one coffee filter in each of the cups, pointing down.
5. Wait 25 seconds for the water to be absorbed into the coffee filters.
6. Take out the filters and place them on a piece of paper or cardboard to air dry.

Steps 1 and 2



Step 3

Step 4



Fill in the table below:

Colors that mixed	**New color**
Red and yellow	
Red and blue	
Yellow and blue	
Choose your own colors:	

Questions

1) How did the colors change as they moved through the coffee filter?
2) Did you see any new colors form or any colors disappear?
3) Why do you think that this happened?

More activities

1) Color your other three coffee filters with just one color or a variety of colors. This is where you can experiment. Try putting different colors next to each other to see what will happen. Be sure to use clean water in the cups.
2) You can also experiment using paper towels.

ART activity

Once your coffee filters have fully dried, you could make flowers, snowflakes, or butterflies out of the filters! See what art you can create, take a photo, and send it to **edreg@fnal.gov**.

The science behind this

Water moves along the tiny gaps in the fiber of the coffee filter because water molecules stick together (cohesion) and to the surfaces surrounding them (adhesion). This process is called capillary action. Where does capillary action occur in the real world?

- Plants suck up water through their roots, and capillary action is what moves the water up through the roots and throughout the plants.
- Your tears use capillary action to move through your tear ducts.

As the water moves through the coffee filter, it spreads out the ink from the markers in a process called chromatography. These colors then mix on the filter to create other colors. You may have seen that red, yellow, and blue, which are called primary colors, can mix to create orange, green, and purple, which are secondary colors.

Fermilab has over 1,200 acres of restored prairie. The prairie is full of grasses and forbs (flowering plants) with deep and complex root systems. These roots allow the plants to absorb lots of water and to survive a wide range of weather conditions. Capillary action, which is similar to what is happening with the coffee filters, brings water to all parts of the plants. Learn about Fermilab plants and restoration at Nature and Ecology (https://ecology.fnal.gov/).

Ready, Set, Go: All About Acceleration and Inertia

Introduction

How can you get a coin in a cup without touching it?

Over 300 years ago, a scientist named Isaac Newton created a set of three rules that describe motion. According to Newton's first law, for an object to start moving, go faster, slow down, or stop, a force is needed. When an object is moving, it will continue to move in a straight line unless a force acts on it. Acceleration is any motion in which speed or direction varies. Often, speed is not constant. Think of how a car can speed up, slow down, or change direction. When an object resists a change in motion, it is called inertia.

Materials

Included material:

- 3”x5” index card

Additional materials:

- Plastic cup (length of index card must be longer than the diameter of the opening of the cup)
- Coin
- Additional nonbreakable materials (rock, Lego tile, bead, etc.)

Procedure

1. Place the card on top of the cup.
2. Center the coin on top of the card.
3. Make a guess about what will happen to the card and to the coin when you flick the card with your fingers.
4. Flick the card away from you.
5. Repeat three times, each with a different amount of force to change the acceleration.
6. Determine what happens if you flick too slow, flick too fast, or flick the card with just the right amount of force to get the coin into the cup.
7. Experiment using other small objects in place of the coin.

Questions

1. Was your guess correct?
2. Why did the coin fall into the cup and not move with the index card?

Another activity

Center the cup on top of the index card at the edge of a table, so that the index card is partially hanging off the table. Pull the card quickly from the edge of the table. What happens to the cup?

The science behind this

You have just witnessed Newton’s first law (the law of inertia) in action! By flicking the card, you added energy to it. If your flick created the right amount of force, the card sailed away (accelerated) but the coin did not. The inertia of the coin (resistance to change in motion) resulted in the coin not moving until the force of gravity pulled it down into the cup.

At Fermilab, accelerators are used to propel particles, like protons, to near the speed of light. Scientists do this to create new particles and to study rare ones. The physicists at Fermilab study these particles to learn about the origin and fate of our universe. Visit Fermilab's Accelerator Division (https://ad.fnal.gov/) to learn more!