THE EL PASO ELECTRIC

STEAM

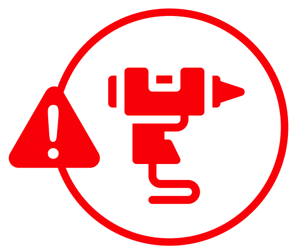
VIRTUAL CAMP

The Electric Company
El Paso Electric

United Way
United Way of
El Paso County

UNION PACIFIC
BUILDING AMERICA®

Dedicated by El Paso Electrics' **2020 Summer College Interns**



Some experiments in this workbook require the use of a hot glue gun. If not properly used, hot glue guns can result in burns when the heated tip of the glue gun or the glue itself comes in direct contact with skin. Please be aware of which materials will be hot in order to prevent injuries.

Table of Contents

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Hydraulic Robotic Arm

Introduction

Hydraulic engineering is the idea of using water (or any other liquid) to build pressure and using that to move something, like a gear or machine. In school you may have learned about Potential and Kinetic energy, and in much the same way, ***energy is conserved when using hydraulics.***

One of the sciences that most engineers learn is fluid mechanics, which by using conservation of mass and energy, we can calculate how much force and speed we can create using hydraulics. Many of these concepts are taught in middle school and can be used even for the most complex engineering. This project will allow you to see hydraulics in action and give you an opportunity to apply it in the real world!

Activity

In this activity, you will have to think like an engineer. You will be building a robotic arm using hydraulics.

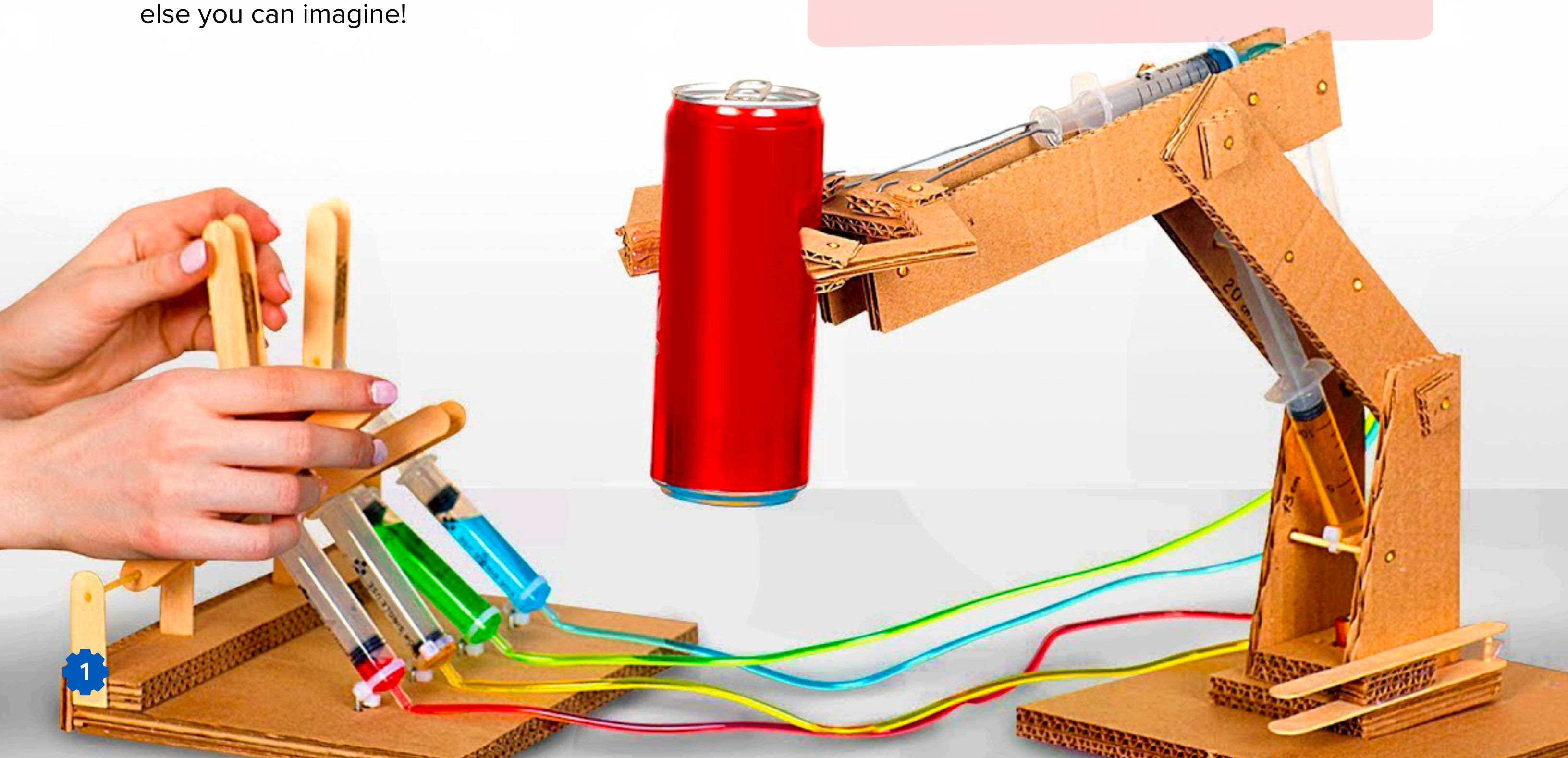
While this activity will have a clear procedure, you can use these principles to design all kinds of hydraulic tech!

This can be anything from a box that can open by itself or a bridge that can rise and fall, or anything else you can imagine!

The materials we have provided you will be enough to create this project but can be reused and repurposed for any type of hydraulic machine you can imagine!

⚠ Safety Disclaimer

A hot glue gun will be used, this can result in burns if your child directly puts the glue onto their skin, or if they touch the heated tip of the glue gun. Make sure they understand what materials will be hot in order to prevent injuries.

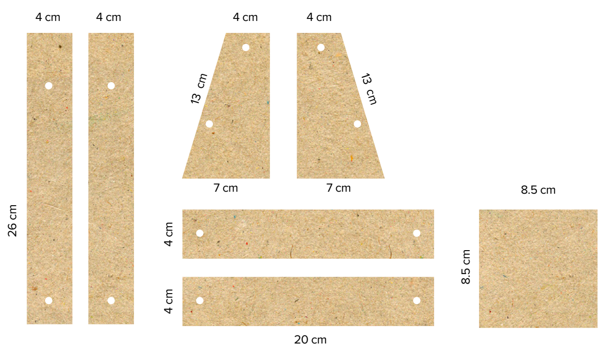


Materials

- Cardboard
- Toothpicks
- Rubber Cement or Hot Glue Gun
- Syringes 10 mL (x8)
- Tubing
- Paper Clips

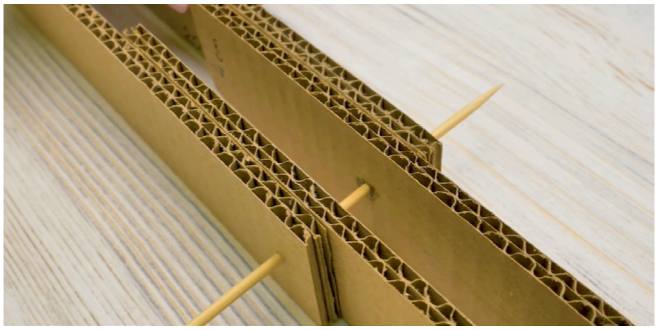
Step 1

Cut out 2 pieces of cardboard (20 cm long, 4 cm wide). Poke a hole near the long ends using a toothpick. Repeat this, now cutting out 2 pieces (26 cm long, 4 cm wide), 2 pieces (8.5 cm long, 8.5 cm wide) and 2 pieces in a trapezoidal shape (7cm long bottom edge, 4 cm long top edge, 13 cm long slanted edge). Make sure to poke holes!



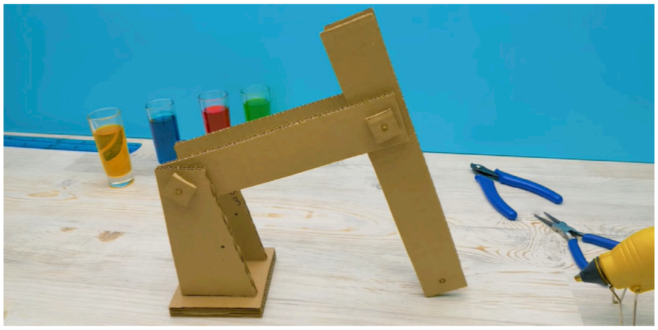
Step 2

Connect two 26 cm pieces with a toothpick. Glue the toothpick in its hole. Next, glue the two 20 cm long pieces on the outside of the two 26 cm, once again gluing the toothpick. Cut out a small square, 1 cm long, 1 cm wide and glue on the outside part of the toothpick.



Step 3

Next, take the two trapezoidal pieces and connect them by toothpick to the free end of the 20 cm cardboard pieces as follows. Place small 1 cm by 1 cm cardboard squares to glue the toothpicks to. Make sure to glue the toothpicks inside the cardboard the same as before.

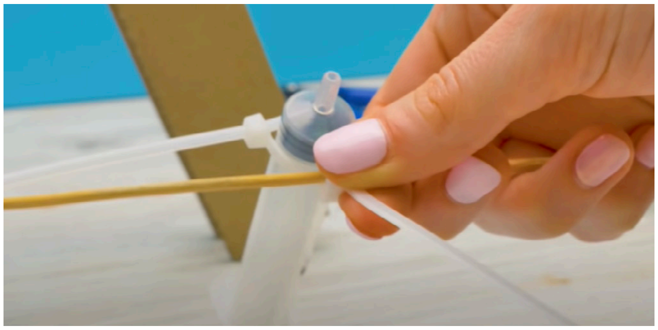


Step 4

Glue the long ends of the trapezoidal pieces to the 8.5 cm cardboard squares so they stand straight.

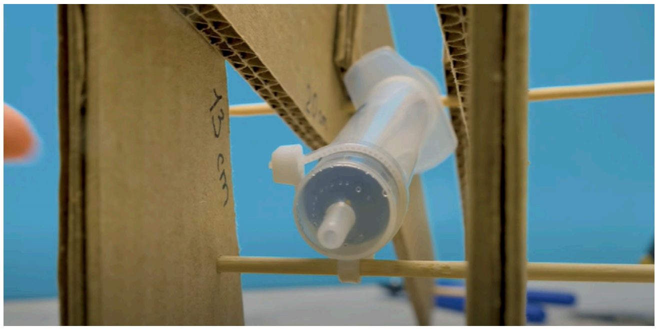
Step 5

Make a hole in a syringe large enough to hold a toothpick as follows. Tie two zip ties around the other end of the syringe, keeping an opening large enough for the toothpick. Cut off the excess parts of the ziptie.



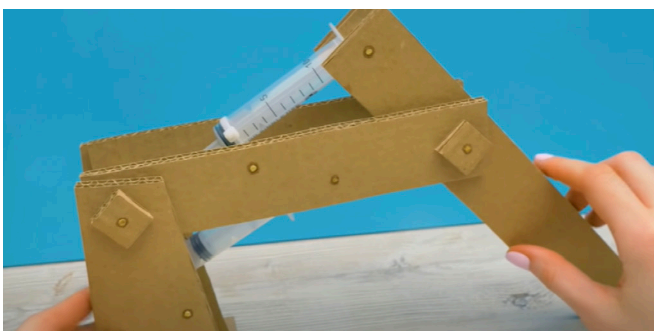
Step 6

Insert the syringe into the machine arm between the two 20 cm pieces, using the poked hole to place the toothpick into. Attach the other end where the zip ties are into the hole between the two trapezoidal pieces, once again using a toothpick to hold in place.



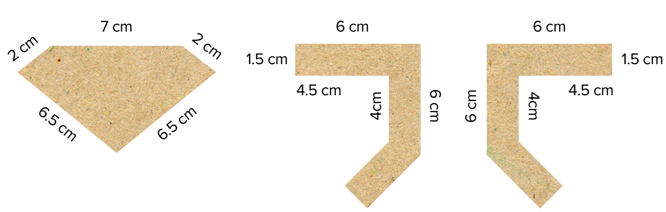
Step 7

Attach a second syringe in the same way as follows, except this time it will be between the 26 cm and the 20 cm pieces.



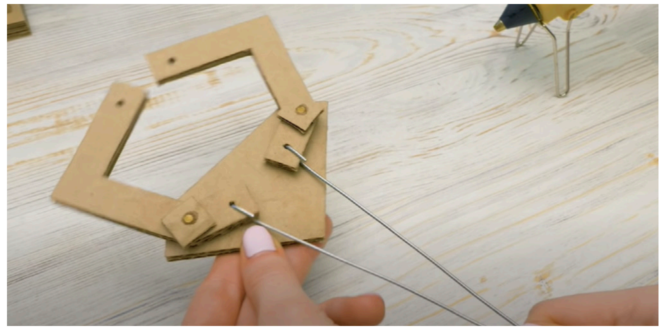
Step 8

Cut out three cardboard pieces in the following dimensions.



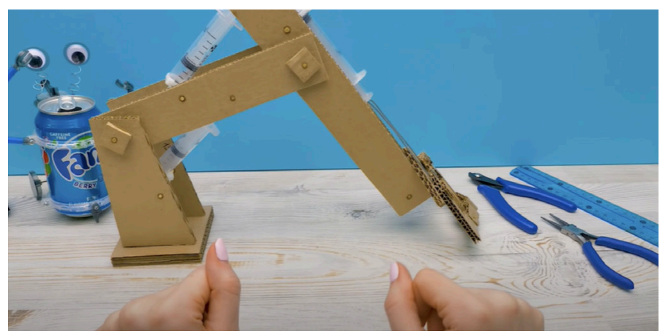
Step 9

Attach the pieces as follows. For the metal sections, you can use a paper clip or rolled up paper to hook around the hole. This structure will be the hand that allows us to pick up items. You can also bend a small piece of cardboard and glue in using a toothpick to create a larger end for the hand, but this is optional.



Step 10

You can now glue this robotic hand onto the end of the structure as follows. Place the ends of the paperclip into a syringe that is attached by toothpicks, as shown below.

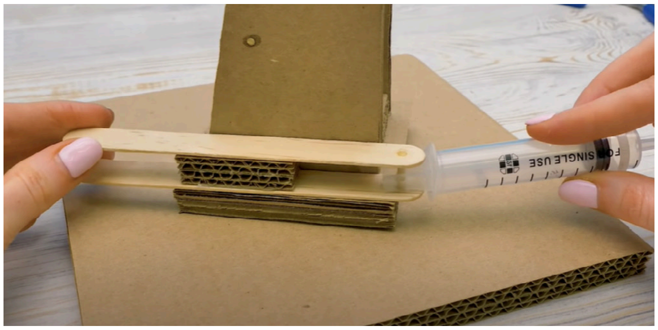


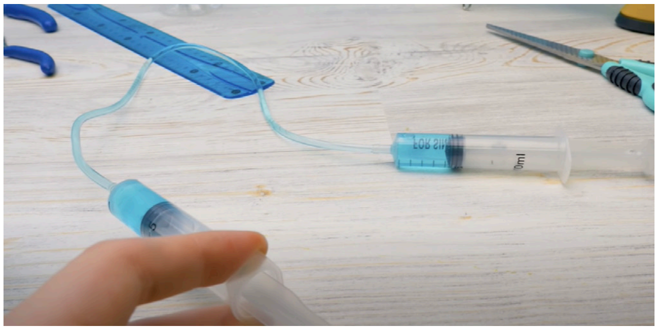
Step 11

Now glue the bottom of the structure to a larger piece of cardboard for stability, ***or anything that can help hold it down.***

Step 12

Following the same syringe procedure as before, make the following to move the entire arm (see photo on next page).





Step 13, Final Step

This next part will be up to you to create! We want to make a system where we can use syringes to move different parts of the arm.

Hint: by connecting rubber tubing from one of the syringes already on the system to another syringe that hasn't been used, partially filling it with water, you can push one syringe pump in to move the other.

With this in mind, by connecting one syringe in the arm to one not on the arm and having water moved between via tubing, you can cause the arm to move!

Experiment with this and find a way to make the arm move the way you want it to!

Post Activity Questions

Why did we use syringes and not something else? Did it work as intended?

What could you do to improve your design?

What other machines could you make using hydraulics?

Solar Oven

Introduction

The sun is at the center of our solar system and is one of the main reasons we are able to live. It provides heat to keep up from freezing and light to allow us to see alongside other functions. The sun is able to provide heat through its sun rays and these rays are ***extremely powerful*** and are some barely visible. The sun emits other kinds of ***rays and radiation***, except those are ***too small*** for us to see without special equipment. The ***heat*** the sun provides is very intense, however, the Earth happens to be placed within a ***specific region where life is allowed to exist.***

The sun provides ***solar radiation***, which is a ***combination of several types of waves***, all with different sizes. Anything ***larger*** or ***smaller*** than ***visible light rays is impossible for us to see*** with only our eyes, these waves and rays can be ***very harmful***, which is the reason sunblock is used if you're out in the sun for a while. The sun is able to provide this radiation by ***separating parts of atoms*** to create ***huge amounts of energy***. The Earth receives about 71% of the radiation from the sun and the rest is bounced back into space.

Activity

In this project, you will be using the sun's ***raw thermal energy*** to cook a s'more and see how ***strong*** that heat really is. Nowadays we use ovens, stoves, and microwaves to make food at home, but in this project, you will only be using a pizza box, crafting supplies, and sunlight to toast a s'more. you can imagine!

Certain materials and colors ***reflect the radiation*** less than others making the object a lot hotter. For example, you would be hotter in a black shirt than a white shirt because black absorbs a lot more light energy. Knowing that, our solar oven is going to take ***advantage*** of that in order to cook something with ***only the sunlight itself. Let's get started!***

Materials

- Pizza Box
- Aluminum Foil
- Black Construction Paper
- Thermometer
- Plastic Bags
- Paper Plates
- Scissors
- Graham Crackers
- Chocolate

Step 1

Cut three sides of the pizza box about an inch inside the top flap. The cuts should create another flap that opens like the pizza box.

Step 2

Cut a piece of aluminum foil slightly larger than the newly created flap. Wrap the inside side of the flap and tape it to the box.

Step 3

Open the pizza box and cover the top end with plastic wrap/bags. The plastic should cover the hole with about an inch of extra space. Tape the plastic to the box.

Step 4

Line the bottom side with the black construction paper. If the sheet isn't large enough to cover the bottom, overlap several sheets. Tape the construction paper down.

Optional: Line the edge of the bottom side with construction paper to help insulate the heat. Make sure the paper isn't in the way of the hole and allows the box to close.

Step 5

Place the thermometer inside the box so that it is visible from the window and write down what the starting temperature is.

Starting Temperature: ______________________

Step 6

Build the s'more however you like it and place it inside the box under the hole.

Step 7

With the box closed, prop the flap open with anything lying around, try to angle the aluminum so that the sunlight bounces towards the opening.

Step 8

Wait until the s'more is cooked and check the temperature inside the box. Depending on the temperature it should take around an hour or less. The best time to cook the s'more is around 11am-3pm.

Step 9, Final Step

Whenever the s'more looks ready, record the new temperature. Carefully remove the s'more, avoid touching the construction paper or aluminum foil as it can get very hot.

Post Activity Questions

How much did the final temperature change from when it first began?

Why do you think we used the plastic wrap for the window? How do you think it helps with the heat?

If possible, try the same experiment using white paper or no paper and see if there is any difference in how long it takes to cook the s'more?

Fun with Electricity

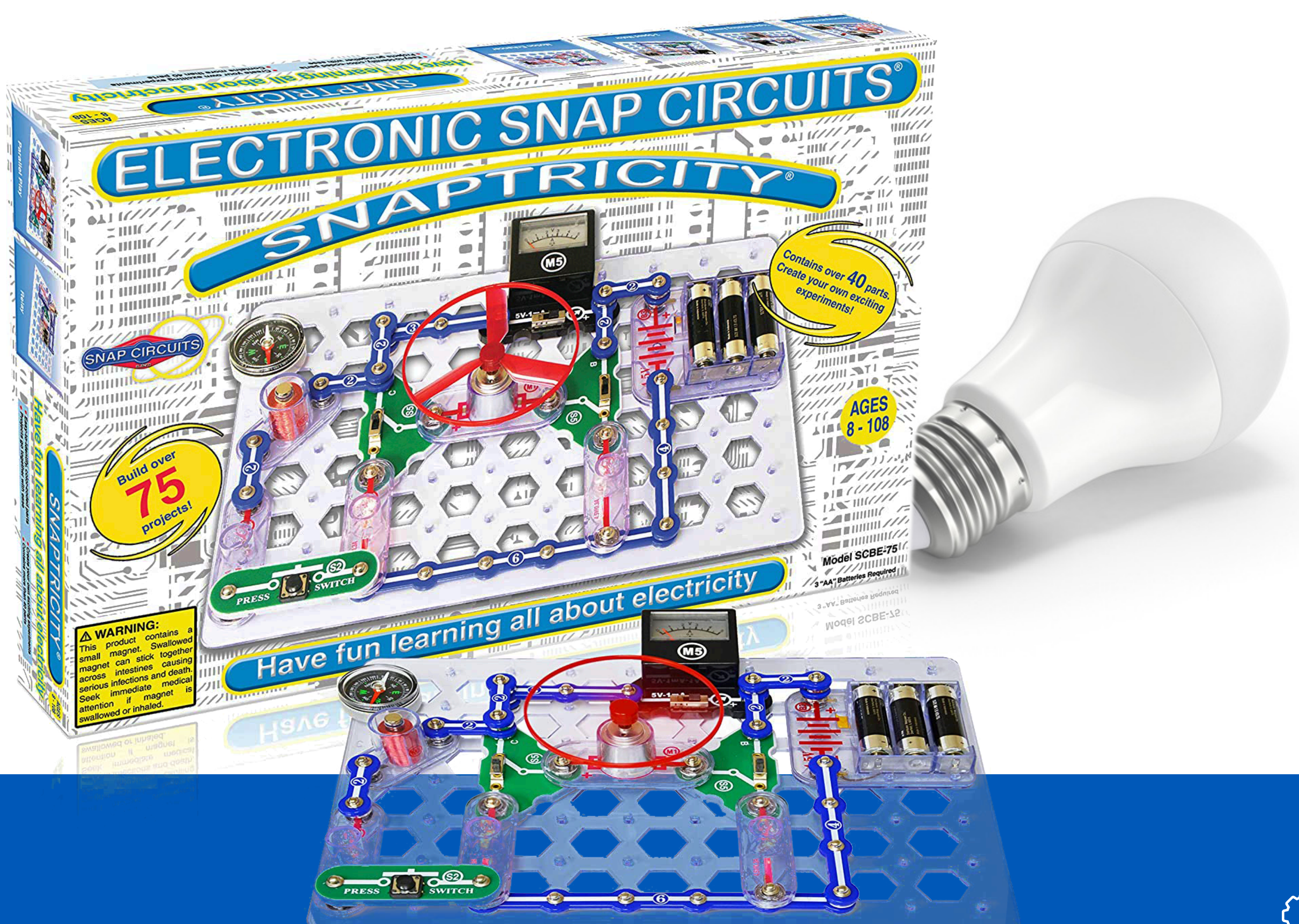
Parallel & Series

Introduction

Electricity is important to run a modern society as everyday objects now require electricity to function. This project will allow you to learn and explain how electric current flows in a circuit. You will be able to wire a basic circuit. You will be able to take measurements on a circuit. You will be able to explain the difference between series and parallel connections. A series circuit, all of the current flows through each part of the circuit. In a parallel circuit the current is divided into separate paths.

Activity

Electricity is all around us. Electric circuits provide a way to harness that electricity and make it perform a useful task. In this activity you will learn how an electric circuit is constructed. You will also discover the difference between series and parallel connections, and how to measure voltage and current in a circuit. In doing so, you will gain a better understanding of how electricity flows through the wires of a circuit.



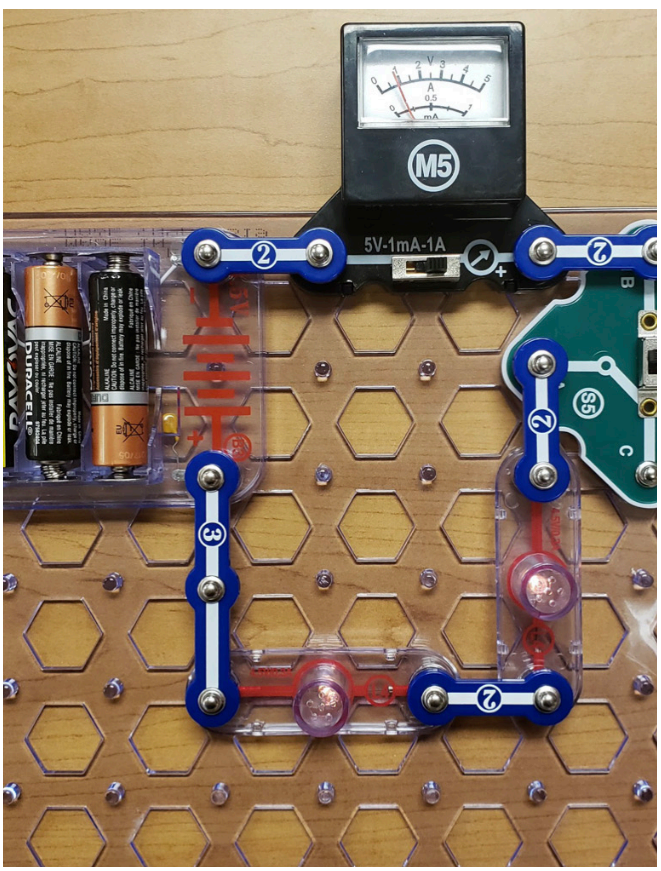
Materials

- Battery with Holder
- 2 Lamps
- Ammeter/ Voltmeter
- 9 Snaptricity Wires
- Long Snaptricity Wire (Red or Black)
- Switch (No A to C switch)

Step 1

Gather your materials as instructed. You will first build the series circuit. Connect the components as shown in ***Figure 1***. Use the clips on the wires to make the connections. To ensure that switch works properly connect the wires to A and C side of the switch. For the meters, make sure they both get connected in the same direction.

Fig. 1 - The series connection of the circuit



Step 2

Begin with the switch closed.

Step 3

Record the readings from the meter.

Ammeter (Have the switch on the meter set to Amp Setting [Set the switch all of way to the Right])

= ______________________________

Voltmeter (Have the switch on the meter set to Volt Setting [Set the switch all of way to the left])

= ______________________________

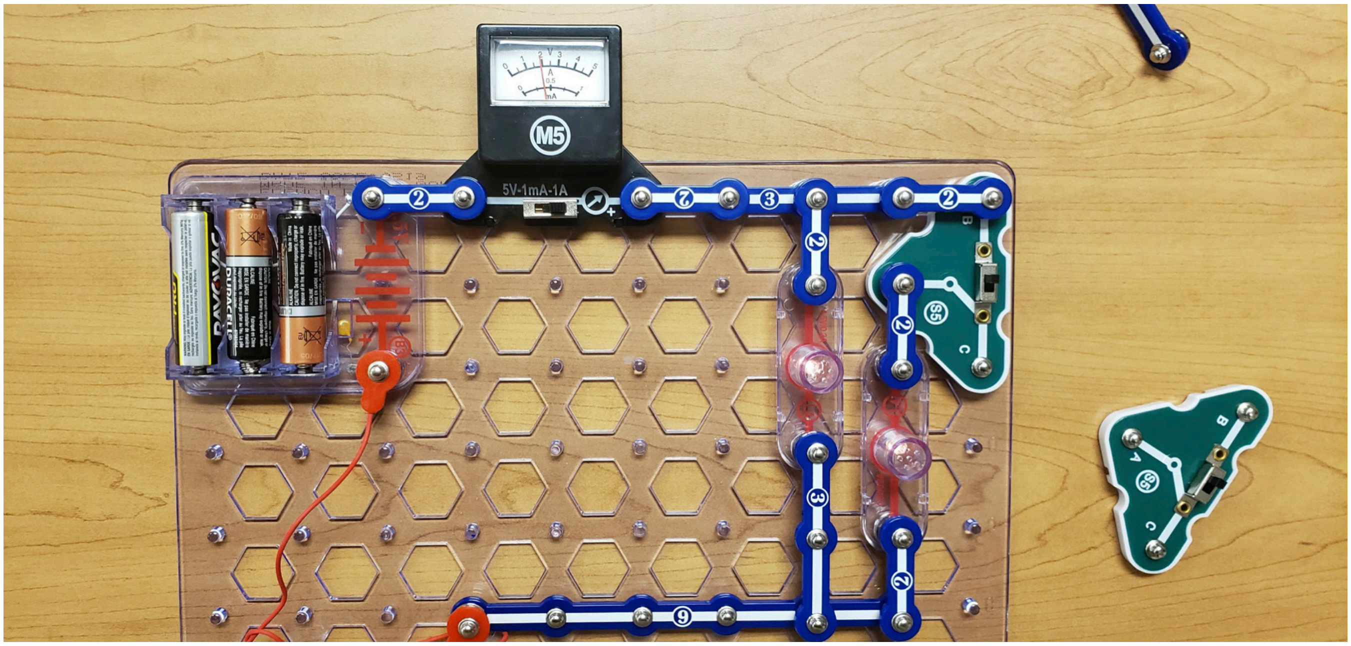
Step 4

Now open the switch. What happened?

Step 5

Now connect the circuit as shown in ***Figure 2***. This is the parallel circuit.

Fig. 2 - The parallel connection of the circuit



Step 6

Begin with the switch closed.

Step 7

Record the readings from the meter.

Ammeter (Have the switch on the meter set to Amp Setting [Set the switch all of way to the right])

= ______________________________

Voltmeter (Have the switch on the meter set to Volt Setting [Set the switch all of way to the left])

= ______________________________

Step 8

Now open the switch. What happened?

____

____

____

____

____

Note: For more complex and fun activities please look at the Snaptricity hand book. Book contains over 40 fun activities to explore.

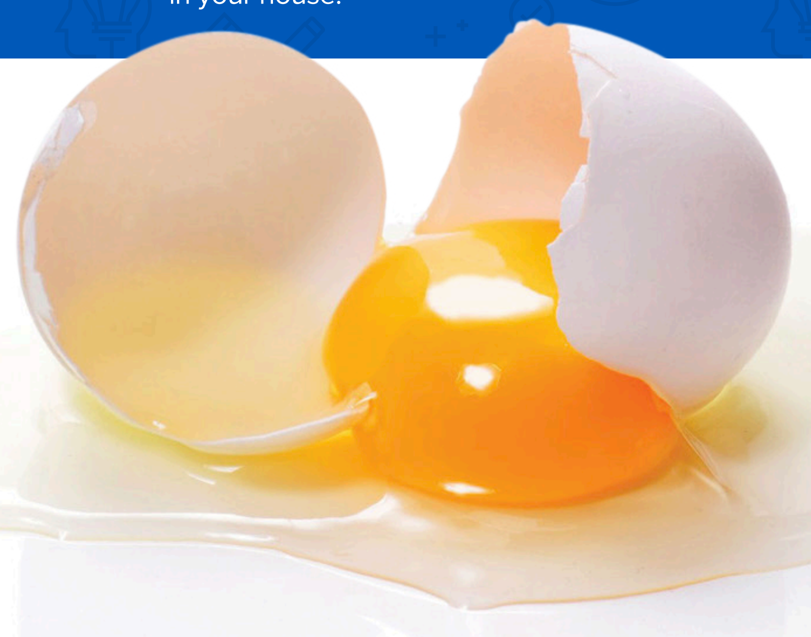
Don't Break The Egg!

Introduction

All energy in the universe will always be conserved! This means that you cannot create energy, and you cannot destroy it either. It always has to go somewhere... This includes potential energy (like stretching a rubber band or elevating a rock before dropping it), kinetic energy (like a car going 100 miles per hour), electrical energy (like a battery powering your cell phone), etc.

Materials

- Eggs
- Balloons
- Straws
- Paper Cups
- Cotton Balls
- Rubber Bands
- Anything else you find in your house!



Activity

In this activity, you will have to think like an engineer. You have but one simple task... Don't Break the Egg! We have given you preliminary materials to get started, but feel free to use anything you want to use in your home. You will drop the egg from different heights, and it is up to you to create a contraption to surround the egg that will not allow it to break.

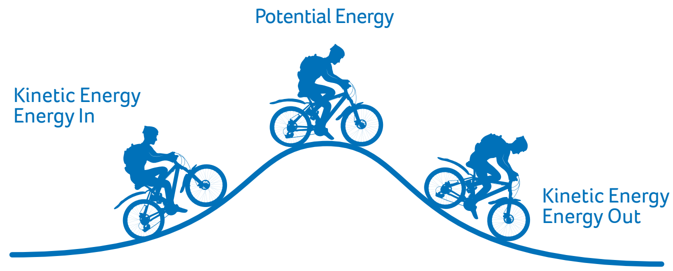
Remember what we taught you! It is all about energy conservation!

Think, what kind of energy does the egg have right before you will drop it?—refer to the abstract to help you out if you're stuck.

Write it down before continuing!

Now, once the egg starts to fall when you drop it, what kind of energy is the potential energy being transformed to?

Write it down before continuing!



Now, once again think... When the egg hits the floor, all that kinetic energy must go somewhere, right? According to our rule, energy is always conserved. Would you want the energy to go into the egg, or do you want that energy to be distributed somewhere other than the egg?

You're going to have to build a contraption that will absorb all of the energy from the drop. You are allowed to use all the materials provided as well as anything you can find. The sky's the limit and try to be as creative as you can be!

⚠ Safety Disclaimer

A hot glue gun will be used, this can result in burns if your child directly puts the glue onto their skin, or if they touch the heated tip of the glue gun. Make sure they understand what materials will be hot in order to prevent injuries.

Step 1

Brainstorm what you are going to use to prevent the egg from breaking and how you're going to use that material.

Step 2

Design your contraption! Use the space below to draw out and label what will surround your egg. When designing, please write down why your design will work.

Draw your design here!

Step 3

Build your contraption. Using your parent's help, make your design a reality! Make sure that the egg will fit in there.

Step 4

Following the data table provided, you will start to drop the egg at increasing height intervals. Don't worry about being precise, an approximation is good enough. You can ask an adult to help you reach the higher intervals. If your egg can survive every interval, then congratulations! You've beaten this challenge.

Step 5

Write down your observations and answer the post activity questions.

Height	Did the egg break? (Yes or no)
2 Feet	
4 Feet	
6 Feet	

Post Activity Questions

Why did you choose your material? Did it work as intended?

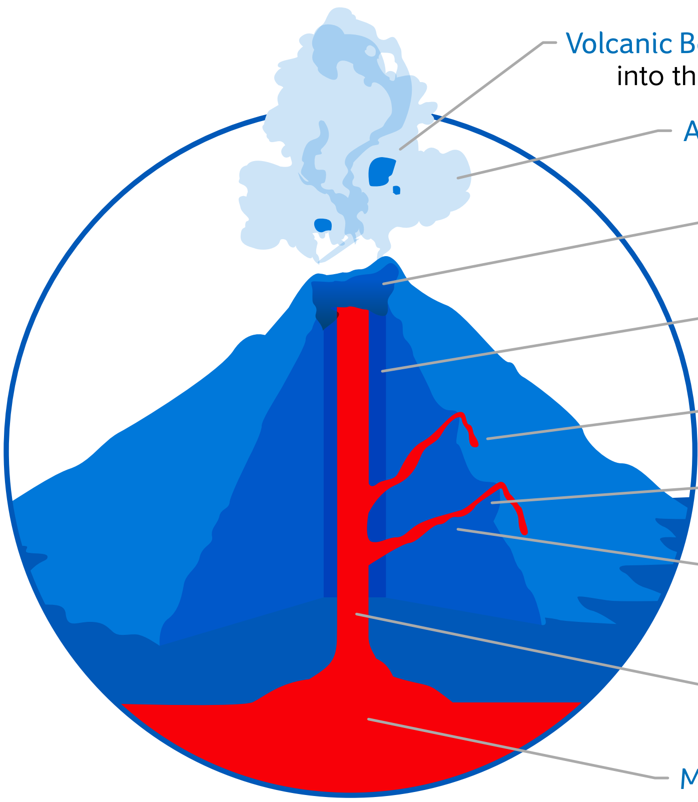
What did you add to your design to ensure the egg wouldn't break?

What could you do to improve your design?

Model Volcano

Introduction

In this activity, you will create a model volcano! A volcano is a vent that connects molten rock from within the Earth's crust to the Earth's surface. The molten rock below the Earth's surface is known as magma and is known as lava after it erupts. In the figure below, you can see some other volcano components and try to identify these components when you create your own volcano!



Volcanic Bombs - Rocks and larger debris that are thrown into the air during eruption.

Ash, Steam, & Gas - Cloud which is pushed out of the volcano.

Crater - Circular depression at the top of the volcano.

Main Vent - Main tube that connects the magma chamber to the surface.

Lava - Molten rock after it reaches the surface.

Secondary Cone - A cone that builds up around secondary vents.

Secondary Vent - Place where magma reacher the surface without going through the main vent.

Magma - Molten rock still underneath the ground.

Magma Chamber - Store of underground magma.

Materials

Sand

Empty Water Bottles

Vinegar

Baking Soda

Red Food Coloring

Activity

Perform this activity outside or inside in a space that can be cleaned after the volcano eruption. You will use acetic acid (vinegar) and sodium bicarbonate (baking soda) to create a chemical reaction simulating a volcano eruption! Acetic acid is a weak acid and sodium bicarbonate is a base. These materials will react together to neutralise each other and will release carbon dioxide, which creates the appearance of lava erupting from a volcano!

Step 1

Carefully cut the bottle of water in half. If needed, ask an adult to help you. The empty water bottle contains a few drops of red food coloring to produce red lava!

Step 2

Add five tablespoons of baking soda to the bottom half of the water bottle.

Step 3

Put the top part of the bottle into the bottom half of the water bottle, creating a shorter water bottle. Make sure the top part of the bottle has the cap on and using the sand, start building a volcano around your water bottle! If needed, add some water to the sand to make it more moldable.

Step 4

To make your volcano erupt, uncap the water bottle and pour one cup of vinegar onto the water bottle with baking soda.

Step 5, Final Step

Watch your volcano erupt! If there is unreacted baking soda left in the bottle after the eruption, more vinegar can be added to get it to react again. If there is unreacted vinegar left in the bottle, more baking soda can be added to get a reaction!

Post Activity Questions

Identify your volcano components.

What did the foam we created in our experiment represent?

When was the foam magma and when was it lava?

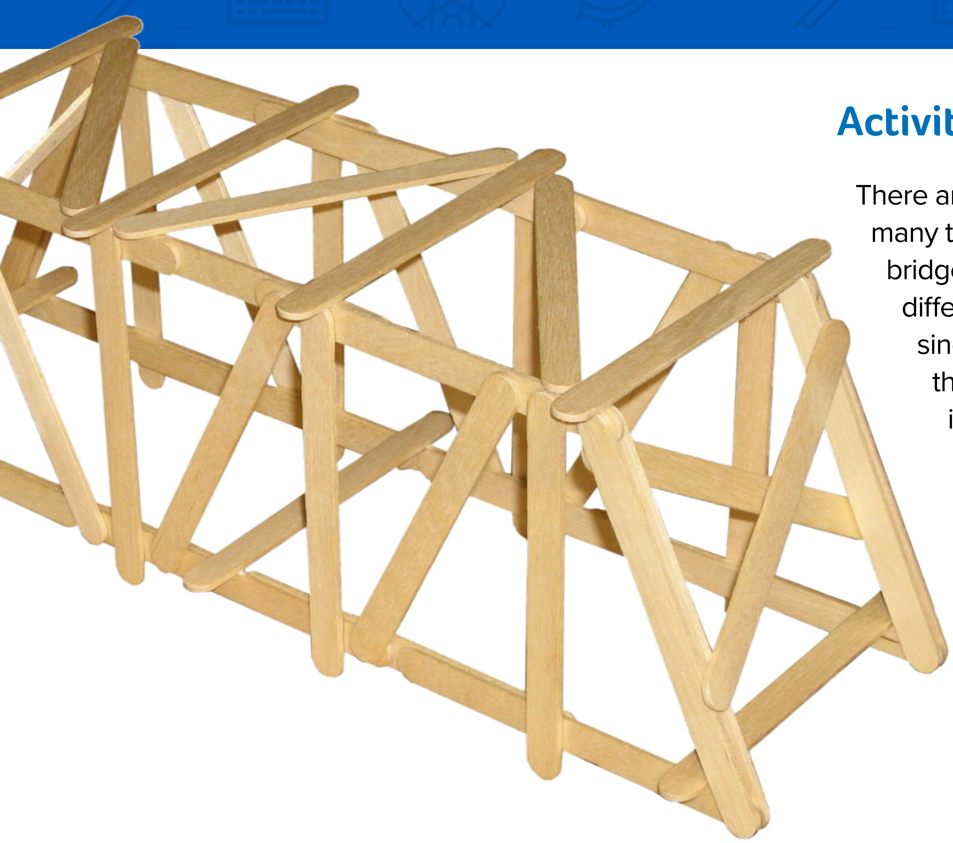
Popsicle Stick Bridge

Introduction

Students will create a 12-inch bridge that will be able to hold at least 1 action figure or small toy of theirs. This demonstrates how structures can handle loads of stress put onto them by spreading the weighted force over a various distance. Popsicle sticks and lots of glue will be used to get the sticks to hold together. While gluing parts together, it is advised to put paper towels or the parchment paper we will provide underneath the work area to prevent a mess.

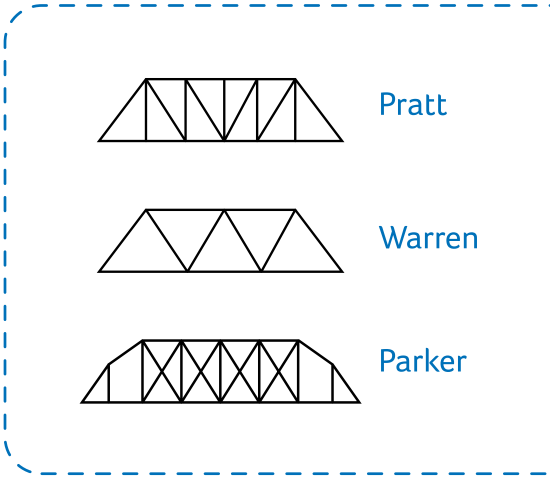
Materials

- Hot Glue Gun
- 30 Sticks of Hot Glue Gun
- 200 Popsicle Sticks
- Ruler
- Parchment Paper



Activity

There are many ways to build a bridge, as well as many types. Triangles are a simple way of creating bridges! Triangles spread out the weight in different directions, letting the pressure off a singular point so make sure you incorporate them in your bridge. Something to remember is that more popsicle sticks does not mean a stronger bridge; it's the design and sophistication of the build that will determine the weight a bridge can carry. Another major point to remember is that a bridge is only as strong as its weakest link, meaning once one of the joints breaks, other sturdier ones will most likely collapse as well.



For this activity we will be designing a truss bridge! There are three types of truss bridges as well, shown below in the leftmost picture. In this activity it is recommended that you do a Warren Truss bridge because it is easier to design and build, which will result in the strongest bridge. Below on the right is a picture of a real Warren Truss bridge, I'm sure you've seen a lot of them around. Now let's get building!

⚠ Safety Disclaimer

A hot glue gun will be used, this can result in burns if your child directly puts the glue onto their skin, or if they touch the heated tip of the glue gun. Make sure they understand what materials will be hot in order to prevent injuries.

Step 1

Choose a work area that is close to a wall outlet for the glue gun and has lots of space. You might be needing this space for an hour or two so make sure you have time to use this area.

Step 2

Place parchment paper on your designated work area. This will help any glue from damaging surfaces as well as speed up the cleaning process.

Step 3

Plug in the hot glue gun. Remember never to touch the tip because it will be heated, also the glue that comes out is hot enough to burn yourself, so be very careful while gluing.

Step 4

Start by making one of the sides of the bridge. The other side will need to be symmetrical to this one, so make sure to take note of your measurements.

Step 5

To make a side, design it by looking at the picture above on the left. This is a side view that can guide you on your design. You don't want the height of the bridge to be too high or too low, so put the popsicle sticks almost at a 45-degree angle. You might want them a little more vertical than 45 degrees to provide the best support. Just lay the sticks on one another to plan out what it looks like, then maybe make a sketch and mark points at where you will be placing and gluing the sticks together. When gluing, remember that you want to alternate the sticks on top. For example, this stick goes on top, this one underneath, this one on top, this one underneath, and so on. This makes sure that the sticks are relatively on the same plane.

Step 6

Now repeat step 5 for the other side of the bridge. It's important that it matches as closely as you can to the other side. And if you think you have enough sticks, double the layers on each side.

Step 7

Now you can connect the two sides starting with the floor. You can either have the floor be triangles or straight across to start with. It would serve the bridge best to only be 3-5 inches in width because this helps it keep super sturdy. No worries if you need to make it wider though.

Step 8

Add some floor beams that are parallel to the sides, and you can also add a floor with sticks that are either parallel or perpendicular to sides.

Step 9

A couple of sticks on the roof can be added for extra support as well.

Feel free to add extra sticks where you like and decorate the bridge in any way you want.

Step 10

Now's the time to test your bridge out. Find a place or create one with some boxes or books that span the length of the bridge. You want to place the bridge so that it overlaps a couple inches on both sides.

Step 11, Final Step

Have fun!

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VIRTUAL CAMP

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