FSTS@Home

A parent/student guidebook designed to help you have fun learning about science with simple household items

Note: These experiments require adult supervision

Brought to you by:
From Student to Scientist
Madison House
University of Virginia

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Introduction

Hello Reader,

We are students at the University of Virginia (UVA) and part of a Madison House Youth Mentoring program called From Student to Scientist (FSTS). Madison House serves as the volunteer center for students at the University of Virginia. FSTS is aimed at bridging the gap between the classroom and scientific applications to help students develop not only a passion for STEM (science, technology, engineering, and math) but also the ability to communicate their ideas.

On March 11th, 2020, UVA suspended in-class instruction and moved courses online due to the global pandemic caused by COVID-19. As such, all Madison House volunteering was suspended until further notice.

While we want to practice social distancing and understand its importance to the health of the Charlottesville community, we were also disheartened to have to give up our weekly science time with Johnson Elementary School first graders. **Despite schools closing and times uncertain, we wanted students to have an avenue in which they could continue to learn about science**. That is what inspired this guidebook, FSTS@Home.

We commend all parents for looking after their children while they are home from school. Many of you are probably working from home, and we recognize and applaud the challenge that comes from having to entertain small children and still work productively. **Even if science it is not your expertise, we believe you can still foster a STEM education from home during self-isolation.**

This guidebook contains many resources to help you engage with your children through science, such as:

- An overview of the Scientific Method and how to apply it during experiments
- Experiments organized by science concept. These experiments use simple household items and include questions you can ask your child and a simple explanation of the science behind the result. **Designed for adult supervision**.
- Additional Resources your child can explore. Children can use of these resources **independently**; we hope they offer you reprieve as needed.
- Note: Be sure to check out the Madison House YouTube channel. We will be hosting a From Student to Scientist **video project designed to supplement this guidebook**. Stay tuned!

Additionally, we feel immense gratitude towards parents that are on the front lines of this public health fight. Thank you to doctors, nurses, grocery store employees, janitors, and other essential personnel. **You inspire all of us here at FSTS.**

We are saddened by this pandemic, but see this as an opportunity to

- Provide science lessons for a wider audience
- Include science lessons we are unable to perform in classroom (those involving heat, food, etc)
- Expose parents to an in-depth look at the methods and ideals of FSTS

When we meet with new students for the first time, we like to ask them, “How many scientists in the room?”

They usually reply the number of volunteers in the room.

Then we tell them being a scientist is about asking questions. **If you have ever asked a question, then you are a scientist.** As we all know, children ask a *lot* of questions.

The main goal of FSTS is to show kids that anyone can be a scientist, and that science is about helping others. Scientists are asking a lot of questions right now, and many are also seeking answers, by developing vaccines, engineering ventilators, performing statistical analysis on the spread of infection, and more.

We hope your children continue to ask questions, and we hope that they realize that they are capable of finding the answers.

Please know that Madison House is working hard to transition to virtual volunteering for some of their programs. Our aim is to continue serving as a resource to the community while flattening the curve and practicing social distancing. We wish all of you safety and good health during this uncertain time.

If you have any questions about this guidebook or want to learn more about From Student to Scientist, please reach out to us!

All the Best,

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Scientific Method

What is the scientific method?

The **scientific method** is a way for scientists to ask a question and come up with guesses to the answer of that question. Guesses that we make are called a **hypothesis**. Once we make a hypothesis, we do **experiments** to see if the guess is right! If our guesses are not right, that's okay! Then, we do the experiment again with a new guess! During our experiment, we make **observations** of what is happening. This means using our senses of touch, sight, hearing, smell, and taste to try to understand what is changing. Remember, only use the senses that adult scientists tell us we can use! After we do the experiment, we show **results**. This is a way of showing what happened in the experiment. Lastly, we make a **conclusion**. This is a way of sharing if our guess was right or not. In other words, what did we find out at the end?

What are the steps of the Scientific Method?

1. Ask a question

2. Gather information and observe

3. Make a hypothesis (guess the answer)

4. Experiment and test your hypothesis

5. Look at your test results

6. Present a conclusion

How do I write a hypothesis?

A hypothesis is a **prediction**. It is a guess of what scientists think will happen in the experiment. A hypothesis should be written like this: "If I do this, then this will happen". Scientists make different guesses for each experiment they do by using an "If…then…" sentence.

Why do we use the Scientific Method?

Scientists are always looking for answers to their questions and ways to share their results. That is why scientists use the scientific method! It is also important that the scientific method allows us to repeat our experiments again and again. Each time, scientists can make new guesses and learn more and more!

You will get to practice using the scientific method by doing the experiments in this packet. Even at home, you can be a scientist too!

Chemistry

Orange Fizz:

In this experiment, you will make an orange fizz and bubble in your mouth.

Materials:

- An Orange or Clementine
- ½ Teaspoon of Baking Soda

Questions:

What does an orange taste like?

What do we use baking soda for?

What will happen if I mix an orange and baking soda?

What do you think it would taste like now?

Directions:

1. Cut the orange or clementine into slices or peel into separate sections.
2. Dip a slice or section into the baking soda so it is covered.
3. Take a bite! As you chew, it should start to bubble in your mouth.

Okay, But Why?

When acids and bases mix, you get some exciting chemistry! Oranges and other citrus fruits are filled with citric acid. They are **acids.** It is a safe acid, and it's what makes oranges, lemons, and limes so sour. Baking soda is a **base**, the opposite of an acid. It's also safe, but doesn't taste very good on its own, and will give you a tummy ache if you eat a lot of it. As the citric acid and baking soda mix, a **chemical reaction** occurs. It makes millions of **carbon dioxide bubbles**, the same gas you breathe out. These are the bubbles that you feel popping in your mouth and also make soda fizzy!

Lemon Volcano:

In this experiment, you will make a lemon fizz and bubble like a volcano using kitchen ingredients.

This is NOT an experiment where we are using TASTE.

Materials:

- Baking Soda
- Lemon Juice or a Lemon Cut into Quarters
- Liquid Dishwashing Soap
- Food Coloring (Optional)
- Small measuring cup & measuring spoon/straw
- Narrow Glass or Cup that is Clear
- Paper Towels or Napkins

Questions:

What do you think will happen if you mix lemon juice and baking soda?

Will it spill over the glass?

Would this same thing work with other fruits like an apple or banana?

How about using an orange or a lime?

Directions:

1. Lay paper towels or napkins down on a table or flat surface.
2. Put a spoonful (about a teaspoon) of baking soda into a glass.
3. Stir in a squirt of dishwashing liquid.
4. Add a drop or two of food coloring, if you want colored bubbles.
5. Roll a lemon out on the table with your hand (like dough) to prepare the lemon to be juiced!
6. Have an adult cut into the lemon, and squirt the lemon juice into a *separate* glass or cup.
7. Make sure both cups are over the paper towels or napkins. Pour lemon juice from the glass or cup into the other that contains the baking soda. Bubbles should form that will start to push up and out of the glass.
8. You can extend the reaction by adding more lemon juice and baking soda into the cup again.

Okay, But Why?

Baking soda is made of sodium bicarbonate, a **base**. This reacts with an **acid** (citric acid in lemon juice) to form **carbon dioxide bubbles**. This is what is called an **acid-base reaction**. The gas bubbles are trapped by the dishwashing soap, forming fizzy bubbles that you see rising up the cup. The liquid soap turns the bubbles into a foam that erupts right out of the glass.

Note: While we can't drink the mixture, we can wash dishes with it!

Plastic Milk?

Make “cheese” sculptures! Did you know milk contains solids that vinegar reacts with to let you make shapes?

This is NOT an experiment where we are using TASTE.

Materials:

- 1 Cup of Milk
- 4 Tsp of White Vinegar
- Bowl
- Strainer

Questions:

What are proteins? What do they do for our bodies?

How does milk make you strong?

When else have we seen acids cause chemical reactions?

Would other acids work for this, like lemon or orange?

Will our results be the same with low-fat milk? Soy Milk?

Directions:

1. Heat up the milk until it is hot, but not boiling.
2. Carefully pour the milk into the bowl.
3. Add the vinegar and stir for about a minute.
4. Pour the milk through the strainer into the sink – careful it may be hot! Left behind in the strainer is a mass of lumpy blobs.
5. When it is cool enough, you can rinse the blobs off in water while you press them together.
6. Now just mold it into a shape and it will harden in a few days. – Cool!

Okay, But Why?

You made a substance called **casein**. It’s from the latin word meaning “cheese.” Casein occurs when the **protein** in the milk (which helps your body heal cuts and scrapes) meets the **acid** in the vinegar. The casein in milk does not mix with the acid and so it forms blobs. This is not a plastic in the scientific sense, it just feels like one. True plastics, also called **polymers**, are a little different. If you have ever made slime before, you made a true polymer.

Fun fact! When you eat something spicy, milk is the best way to get rid of the spice because casein is similar in **molecular structure** to **capsaicin**, the molecule that causes spice. Water is not similar, so capsaicin will not **dissolve** in water as well as it would in milk.

Ice Cream Anyone?

A quick and easy way to make ice cream at home. Enjoy!

Materials:

- Ziploc bags (one gallon size and one quart size)
- Milk (or ½ and ½)
- Vanilla for vanilla ice cream
- Chocolate Syrup for Chocolate Ice Cream
- Sugar
- Rock salt
- Ice

Questions:

Why do we add the salt to the ice?

What can we do to make a different flavor?

Directions:

1. In the quart sized bag, mix 2 tablespoons of sugar, 1 cup of milk, ½ teaspoon of vanilla, and 1½ tablespoons of chocolate syrup.
2. Fill the gallon bag halfway with ice. Add ½ cup of salt and mix.
3. Put the small bag in the big bag.
4. Shake!! Now you have chocolate ice cream!

Options:

1. Instead of milk try soda
2. If you don't like chocolate don't add it
3. Mess around with the flavors and see what you get!
4. Sprinkles?

Okay, But Why?

If you were to put milk in the freezer by itself, the milk would take a really long time to **freeze** and would become very **solid.** But in this experiment, it froze so quickly. Why? By adding salt to the ice, the **freezing point** of water gets lower. This means that when the ice **melts** back to water, **heat energy** is absorbed to overcome the strong **chemical bonds** in the water. The **temperature** can drop from freezing or 0 °C to as low as -21 °C. As a result, the water is now much colder and you can make your ice cream!

Physics

Egg Drop:

In this experiment, you will try to make an egg not crack by having it fall straight into a glass of water.

Materials:

- 20-Ounce Drinking Glass
- Water
- Pie Pan
- Cardboard Toilet Paper Roll
- Ice (Optional)
- Egg
- Open Space

Questions:

What is gravity?

Do you know what inertia is?

What do you think will happen if I drop an egg straight onto the floor?

What if I drop it into a glass?

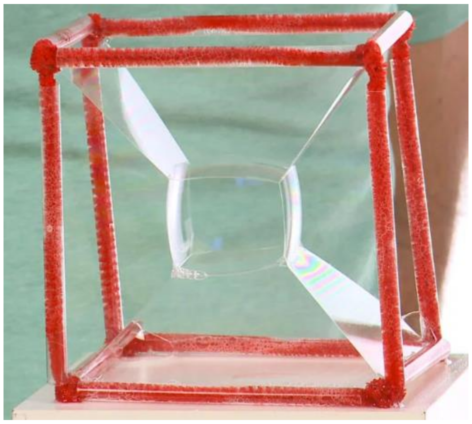
Directions:

1. Fill the glass with water.
2. Place a pie pan right side up on top of the glass.
3. Place toilet paper roll vertically in the middle of the pie pan.
4. Balance egg on top of the toilet paper roll so the egg is lying on its side.
5. Once everything is balanced on top of each other, with one swift and quick motion hit the side of the pie pan with your hand. This is a horizontal swing, not a vertical swing. This needs to be enough force to push it off the glass without knocking over the glass.
6. Watch in amazement as your egg falls into the glass unbroken. If it breaks, that's okay! Clean up the mess and retry by moving your hand faster to move the pan and toilet paper roll away from the glass.

How does it work?

It's all about **Inertia**! Inertia says an object (the egg) will stay at rest, unless an outside force acts upon it (your hand). **Gravity** is a **force** that attracts our body to the center of the Earth and also toward any other physical body with mass. When you move the pie pan with your hand, gravity takes over and pulls the egg straight down into the glass of water. If done correctly by moving your hand fast enough, the egg should not crack and fall right into the graph. These concepts are part of the field of science called **physics**.

Square Bubbles:
In this experiment, you will break the rules and learn how to blow a *square bubble!* Okay, so there is a little bit of a trick to it because, as we know, bubbles really like to be spheres and convincing them otherwise is going to require something special.
Note: this experiment is popularly called square bubbles, but the bubbles we make are actually cubes.



Materials:
- Water
- Dish Soap
- Straws
- Pipe cleaners
- Paper Towels (for cleanup!)
- Scissors

Questions:
What Shapes are bubbles usually in? How do you think we can make a bubble that is a different shape? Why do bubbles usually look like spheres/circles?

Directions:
1. Use the scissors to cut all of the pipe cleaners in half. While the bubble wand can be any size, it needs to be able to be fully immersed in the container of bubble solution.
2. Next, twist three of the pipe cleaners together to form a corner. Repeat this for the other three pipe cleaners.
3. Slide the straws over the edges of the corners, covering most of the pipe cleaners.
4. Twist the corners together to make a cube, like the one in the picture.
5. Next, mix the soap and water together, if you have glycerin or a simple syrup, add it to the mixture to make stronger bubbles!
6. Dunk the cube into the solution, and pull it out. Make sure the bubble on the inside doesn't pop!
7. The bubble in the middle should look like two triangles put together. To make the cube appear in the middle, blow another bubble and place it on top of the cube. It should travel into the middle, and make a small bubble cube between the two triangles, like in the picture!

Okay, But Why?
Bubbles form because soap makes water **molecules** behave differently than they usually do. This makes water molecules only attach to soap molecules now instead of each other. This allows the solution to get really stretchy and lets the bubble hold itself together! When the bubble is on its own, it wants to connect in the easiest way possible, which is usually a **sphere**. Our experiment, however, makes the easiest way for the bubble to connect to itself a **cube** instead of a sphere! Isn't that cool? You can look up the words ***surface tension*** if you want to learn more!

Blast Off with Straw Rockets:

Make paper rockets that blast off using just the air in your lungs!

Materials:

- Straws
- Pipette
    - Alternative: Straws of a larger diameter
    - Alternative: Index card
- Tape or Glue Dots
- Markers, Crayons, etc.
- Scissors
- Computer Paper
- Rocket Template (Below)

Questions:

How do rockets launch?

What do you think forces are? Can you name any?

Have you ever heard “every action has an equal and opposite reaction?” What do you think it means?

How does the angle at which you launch your rocket affect the distance it travels? Try out different angles and find the best one.

Try adding another fin to your rocket with tape. How does it affect the flight of your rocket?

Directions:

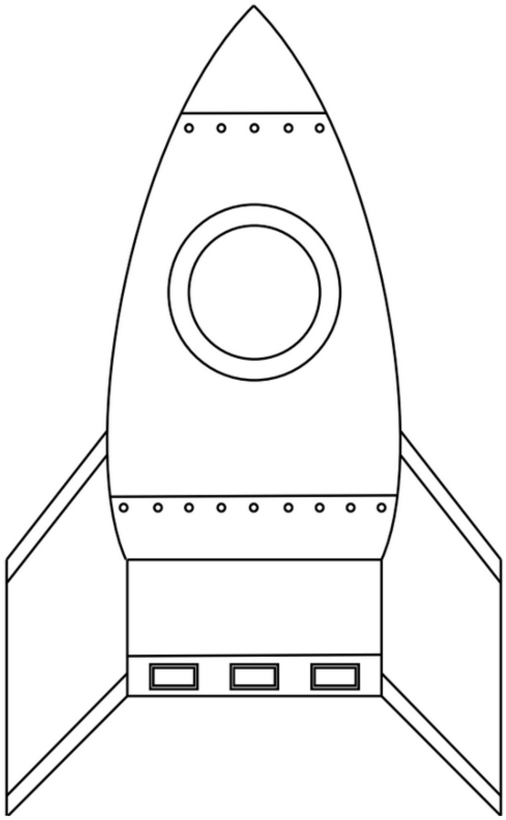
1. Print out the Rocket Template **OR** trace the design onto paper **OR** design your own rocket freehand
2. Color! Make the coolest rocket ever, give it a name, be proud of your design!
3. Cut the bottom off a plastic pipette **OR** Cut the wider straw to fit the length of the rocket and tape one end so it’s completely sealed **OR** Tape the index card into a cylinder (don’t leave gaps), trim to fit the length of the rocket, and tape one end so it’s completely sealed.

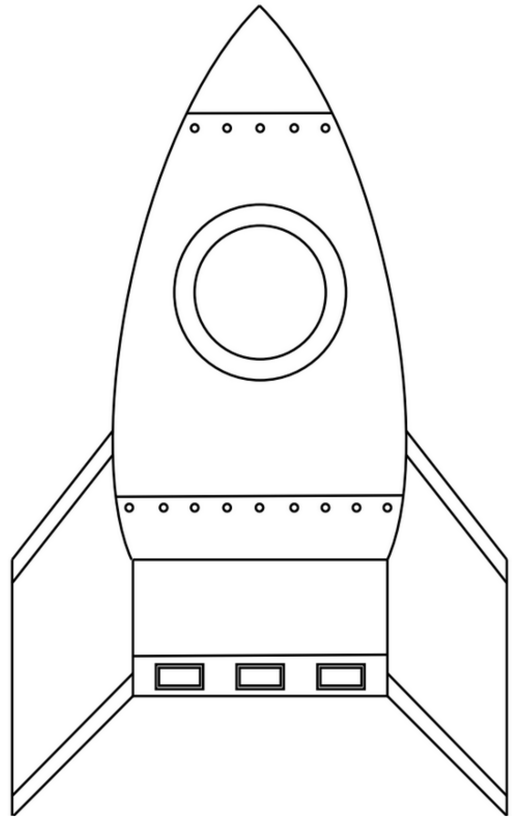
4. Attach the pipette/bigger straw/index card to the back of the rocket with tape or glue dots
5. Slip a straw into pipette/bigger straw/index card, and you're ready to launch!
6. Give the straw a big puff of air and watch the rocket launch!!

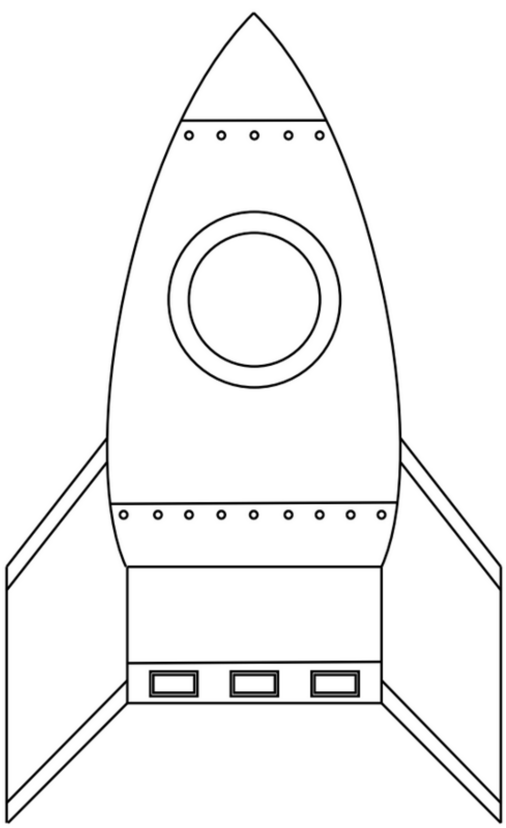
Okay, But Why?

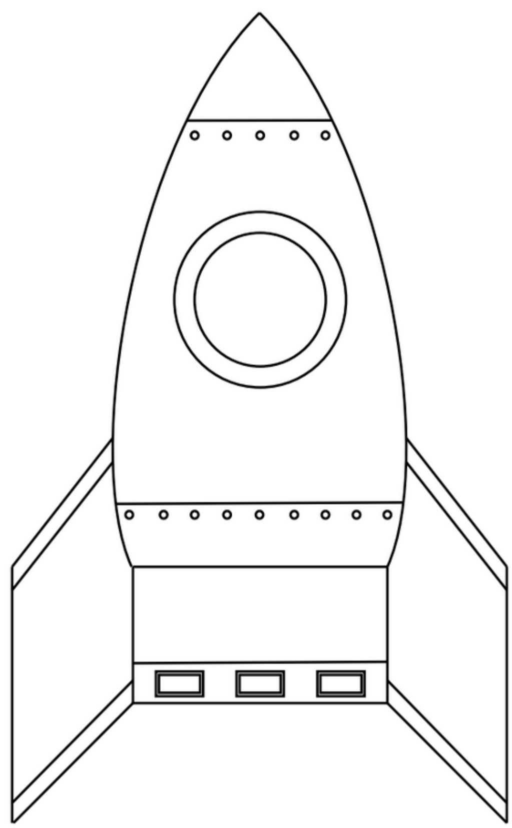
Real rockets launch using **fuel**, just like an adult's car. When the fuel exits the rocket, it's moving *really* fast, and it applies a **force** into the ground. This force pushes the rocket forward with the same force, but in the opposite direction, into the air. This phenomenon we observe is called **Newton's Third Law**. This law states "for every action there is an equal and opposite reaction." In science, a **Law** is a generalized rule that is always true under the same conditions. Here on Earth, Newton's Laws (there's three!) always apply. These laws are named after Sir Isaac Newton, he came up with three **Laws of Motion**, a field of mathematics called **calculus**, and a **Law of Gravity**.

Newton's Third Law also applies to these straw rockets. When you blow air into the straw, you apply a force to the rocket (try changing the force applied by changing how strongly you blow). In return, the rocket pushes back on the straw. The air you blow does not have anywhere to go because we sealed the piece attached the rocket. Therefore, this equal and opposite reaction sends the rocket forward into the air.









Rube Goldberg Machine

In this experiment, we will learn the basics of a Rube Goldberg Machine and the physics behind them! To start, a Rube Goldberg Machines use a long string of events in order to accomplish a simple task, like turning a light switch on or popping a balloon. To accomplish this, we will analyze Newton's Three Laws of Motion. This experiment focuses more on creativity than some of the others, so have fun with this and make it your own!

Materials:

Note: Feel free to add to this list and make a more complex Rube Goldberg Machine!

- Dominoes
- Marbles
- Strings
- Books
- Stuffed Animals

Questions:

1. What happens when you roll a ball? Does it roll far? How far does it roll? Does the ball ever come to a stop? Why?
2. What happens if you make a domino fall into another domino? Do they both fall down? Does only one fall down? What do you think is happening when the dominoes fall?
3. Have you heard of friction? What is it? Rub your hands together for a few seconds. Did they get warm?

Directions:

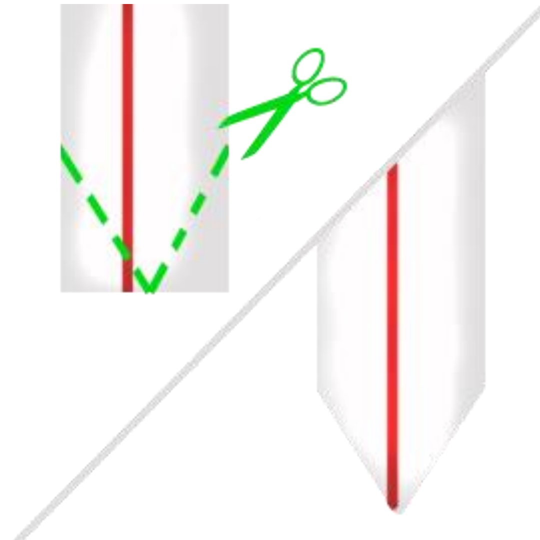
1. To start, we need to figure out what we want our Rube Goldberg Machine to "do." For example, let's have our machine turn on the light switch. Now, we have to figure out a "silly" way to pull the switch, like having a stuffed animal fall off a shelf and hitting the switch as it falls.
2. Next, we need to think of a silly way to make the animal fall off the shelf. What if it was tied to a string that could pull it down?
3. How are going to make the string move? Let's tie the other end of the string to a book, and stand the book up. Let's put a few books in a line like dominoes.
4. How are we going to knock the books down? Well, you get to decide!

Okay, But Why?

The **forces** behind most of the actions of a normal **Rube Goldberg Machine** are **Newton's Laws of Motion**. The three laws are: (1) things that move continue moving unless something makes them stop, and things that aren't moving don't move unless something makes them move, (2) it takes more force to move a heavy object than it does to move a light object, and (3) for every action, there is an equal and opposite reaction. See if you can identify the three Laws while you test your machine!

Sound/Vibration

Make a Duck Call:



In this experiment, you will make your own instrument that sounds like a duck "quacking" by cutting a plastic straw.

Materials:

- 1 Plastic Straw
- Pair of Scissors
- Your Lungs (Don't Worry, You've Got Those!)

Questions:

Does a straw make noise if you just blow into it?

What shapes could you cut a straw into?

Would it make a sound if you cut it?

How many different noises could you make by cutting the straw differently?

Why can we make sounds with our mouths?

What is a vibration?

Directions:

1. Use your fingers to press on one end of the straw to flatten it – the flatter the better.

2. Cut the flattened end of the straw into a point (see above).

3. Make sure it is as flat as possible!

4. Now take a deep breath, put the pointed end of the straw in your mouth and blow hard into the straw. If all goes well you should hear a somewhat silly sound coming from the straw. The smaller you are, the harder it may be to get a good sound – sometimes adults can get more of a sound thanks to their bigger lungs. If you still have trouble, try flattening it out some more or cutting the straw in half.

5. Don't stop there – try cutting the straw different sizes to see how the sound changes, or make another identical straw and add the pointed end of the new straw to the uncut end of the first straw (to make the first straw longer) The sound

will be very different, (more like a moose call!) and you will have to blow even harder, but give it a try.

How does it work?

This is science? Yes, it sure is! All sounds come from **vibrations**. The little triangle you cut in the straw forced the two pieces of the point to **VIBRATE** very fast against each other when you blew through the straw. Those vibrations from your breath going through the straw created that strange duck-like **sound** that you heard. Now you will never be bored again when you go to a fast food restaurant! Have fun with it!

Try to answer these questions:

1. Which size straw call sounds the most like a duck?

2. Which length of straw is the easiest to get a sound? Which is hardest?

3. Does the size of the straw hole (called **diameter**) affect the sound it produces?

Secret Bells:

Listen to chimes with a sound system that no one else can hear!

Materials:

- Unpainted Metal Clothes Hanger, Baking Sheet, Metal Tongs, etc.
- String
- Scissors

Questions:

What do you know about sound?

How do we make sounds louder or softer?

Does sound travel at the same speed in air and in water?

Directions:

1. Cut two lengths of string, about 2 feet long
2. Tie one end of each string to the metal hanger
3. Wind the free end of one string around your index finger a few times. Wind the other string around the index finger on your other hand.
4. Place your index fingers (with hanger assembly attached) gently on the small flap of skin just in front of your ears, closing off the ear canal without putting your fingers into your ears.
5. Swing the hanger so that it bangs lightly against something hard, like the edge of a desk or a door frame, and then let the hanger hang free.
6. As the hanger vibrates, you should hear the resulting sound ring through the strings like chimes. People around you won't hear something this nice!
7. Try other metal objects, like baking sheets.

Okay, But Why?

Did you know when you hear a noise, it is something physical that had to travel to you for you to hear it? **Sound** is a series of mechanical **vibrations** that our ears know how to capture. Those vibrations are **waves**, just like in the ocean. Ocean waves travel from the sea to the shore. Sound travels similarly. The **speed** of a sound wave depends on the material, or **medium**, in which it is traveling.

Air is not the only carrier of sound waves, nor is it the best. A ticking clock can be heard through the air if you're close enough – but put your ear to the table with the clock on it and the ticking will sound much louder. The **amplitude** of a sound is its loudness, which is directly related to the height of the sound waves.

When you hit the coat hanger against another object, it starts vibrating. The vibrations in the metal travel through the string and into your fingers. The vibration is transferred to your head through **solid** objects, not air.

But why is it different? The **molecules** in air, which is a **gas**, are more spaced out than in a solid, like string. This means the molecules in air don't bump into each other as often, so they communicate more slowly, making sounds travel slower.

Environmental Science

Create a Storm in a Glass:

In this experiment, you will create a "storm" inside of a clear glass and show how clouds hold onto rain and, eventually, release it.

Materials:

- Shaving Cream
- A Large Clear Glass
- Water
- Food Coloring
- A spoon

Questions:

What are clouds?

What happens during a storm?

Why do we have storms?

What is precipitation?

What are the different kinds of precipitation?

Directions:

1. Fill the glass 1/2 full with water
2. Spray some shaving cream on top of the water to fill the glass to ¾ full.
3. Use your finger or a spoon to spread the shaving cream evenly over the top of the water. The top of the shaving cream should be flat.
4. Mix ½-cup water with 10 drops of food coloring in a separate container. Gently add the colored water, spoonful by spoonful, to the top of the shaving cream. When it gets too heavy, watch it storm!

How does it work?

Clouds in the sky hold onto water. They can hold millions of gallons! The layer of shaving cream is our pretend cloud in this experiment. The shaving cream layer can also hold onto water. Clouds can't keep storing more and more water forever, eventually they get too heavy. When that happens, the water falls out (**precipitates**) as rain, snow, sleet, or hail. These are four kinds of **precipitation**! This is what happens with the shaving cream (the cloud) and food coloring (the rain) in this experiment! It really was a storm in a glass!

Let's Make Rock Candy:

Since we'll be stuck inside for a little while, why not make a treat that will be both scientific and tasty!

Materials:

- Water
- Bottle/Jar
- Vanilla (optional)
- Sugar
- BBQ Skewers/ Chopsticks
- Clothespin

Questions:

We're making a "super-saturated" solution with the sugar and water. What does that mean?

Let's compare it to clouds! Clouds are made of tiny specs of water and when the cloud becomes so full it rains. The cloud when it rains is super-saturated.

Why do you think we put sugar on the bamboo stick?

Similar to how water sticks to dust to make clouds, the sugar acts as a base to make our candy. Yum!

Directions:

1. First, boil 2 cups of water.
2. Once it is boiling add, 4 cups of sugar and any flavoring that you would like. I prefer vanilla, but peppermint is also good! This is also a good time to add food coloring if you want.
3. Once the sugar is fully dissolved, remove it from the heat. This is your super-saturated solution. Let it cool for 15-20 minutes.
4. While our solution is cooling, grab the bamboo sticks and fully wet them. Then roll them in sugar to coat the stick so that the super-saturated solution can stick to it and form the rocks. (I know even more sugar!)
5. Pour the super-saturated sugar solution into your jar or bottle and put the sugar-coated sticks in the solution.
6. In order to make the rocks, the sticks have to remain still for a long time so secure the stick in the middle of the jar with a clothespin or some other device. You can cover it with a paper towel additionally if you want to.
7. All that's left is to wait! This experiment will take about 2-3 week to finish, but it's also fun to check its progress too every now and then!

Okay, But Why?

In this experiment, we show a physical representation of how many things in nature, like pearls and clouds, are made by building up layers from a source **solution**. To make these sugar "rocks" the sugar will need something to hold on to, called a **dendrite**, and the solution has to be **super-saturated** for the rocks to form.

An easy comparison is cloud composition and formation. **Clouds** are made up of tiny droplets or frozen crystals of water. Dust or dirt in the air allows a water vapor to **condense** into a water droplet, and as many more droplets come together, they form a cloud! This is just like the candy that we made!

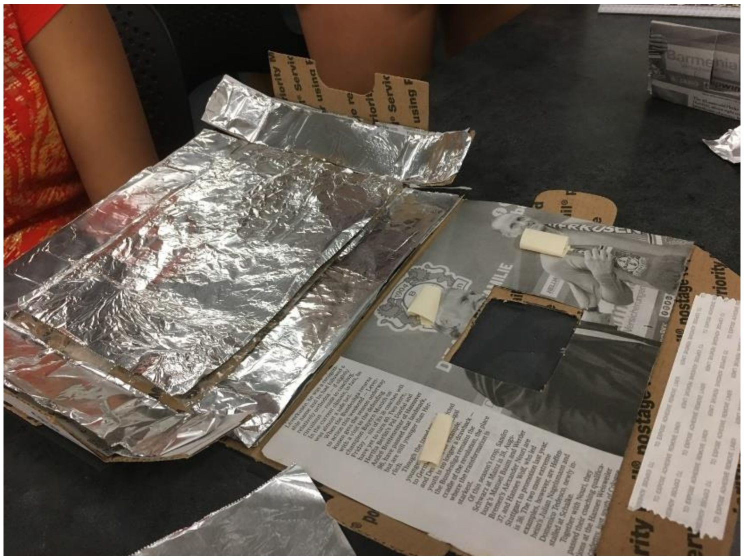
Solar Oven Snacks:

Do some cooking outside with this oven that can make s'mores, nachos, and more! The image below is a solar oven I made as a first-year engineering student! This experiment focuses more on creativity than some of the others, so have fun with this and make it your own!

Note: This is also an engineering project, so if you are lacking some materials, encourage your children to come up with creative solutions to produce similar results.

Materials:

- Pizza Box
- Clear Sheet Protectors/Binder Sleeves/Saran Wrap
- Black Construction Paper
- BBQ Skewer/Chop Sticks
- Tin Foil
- Ruler
- Pen
- Glue
- Clear Tape & Duct Tape
- Exactoknife, scissors, etc
- Thermometer (optional)



Questions:

What do you know about the sun? What is solar power?

Can you name an example of something that uses the sun's energy?

What kinds of energy have you heard of? What powers our home?

What do you think you need to make an oven?

How would you build an oven with these materials?

What do these materials do in the kitchen? How can we use that to decide how to construct an oven that uses the sun as its heat source?

Directions:

1. Mark 2 inches from each side of the pizza box on the top and mark with a pen
2. Cut out 3 sides of the square to create a flap
3. Measure and cut tin foil to line the bottom of the box (including up the sides)
4. Glue cut tin foil to the bottom of the box and smooth it down
5. Apply glue to the inside of the flap, and attach a piece of tin foil
6. Cut a piece of black construction paper that is smaller than the bottom of the box. Tape it to the bottom with clear tape (i.e. packing)

7. Separate the sheet protectors/binder sleeves so they are one layer of plastic, and tape these layers together, forming a square sheet with 4 pieces **OR** measure and cut a piece of saran wrap that will fit on the inside of the flap
8. Tape the plastic as tight as possible to the <u>inside</u> of the pizza box, in the <u>opening</u> created by the flap.
9. Poke small holes about 2 inches apart on the top of the box on the side of the flap.
10. Wrap a thin piece of tape around the skewer. Tape the skewer to the side of the flap to create a kick stand for the lid.

11. Load up the oven with treats! We recommend s'mores and nachos – but get creative! Cooking is also a science!
12. Add a thermometer to record the temperature (optional)
13. Set your solar oven in a sunny spot, with the lid propped up. Food heats up!

Okay, But Why?

This solar oven directs **heat** from the sun and traps it in the pizza box so that it heats up your food. The solar oven is more effective than leaving food in the sun without a solar oven. This is because of the materials used. **Light**, and therefore heat, interacts with material in a few ways: such as **reflection** and **insulation**. Light is a type of **energy**, which means it can be used to create **power**, such as **electricity**.

The tin foil allows light to **reflect**; this means the sun's rays bounce off the tin foil. If you angle the lid correctly, they will bounce into the box. Mirrors work in the same way; light in your bathroom bounces off the mirror and allows you to see your reflection.

The black construction paper is an **insulator**; this means the sun's rays get trapped in the black paper. This means the paper **absorbs** and **retains** the heat from the sun. As heat is retained, the air inside the oven also heats up, and the plastic makes sure the heat doesn't escape. If you see water droplets appear on the plastic, that means your oven is hot enough to make water that exists in the sky as a **gas** (or **vapor**) turn into a **liquid**. This is called **condensation**. The oven is sweating, just like you on a warm day!

Fun Fact! If you adjust the flap and the position of the box as the sun moves across the sky, you can harness as much heat as possible. Doing this would make your solar oven very **efficient.**

Solar power is considered a very efficient type of **renewable energy**. Unlike other forms of energy, called **fossil fuels**, renewable energy will not run out as quickly and are nicer to the environment. If you've ever seen big black panels on a roof or in a field, they are capturing energy from the sun and converting it to electricity!

Computer Programming:

Code For Lunch

You don't need a computer to learn how coding works! This activity teaches kids how important it is to tell computers exactly what to do.

Materials:

- Bread
- Butter knife (or spoon if you'd rather spread with that)
- Peanut Butter
- Jelly
- Plate
- Paper towels (in case of mess)

Note: Can make any kind of sandwich, just sub PB&J for cold cuts, lettuce, hummus, etc.

Questions:

What can computers do?

How do you tell a computer what to do?

How do computers know what they're supposed to do when you tell them?

Can you think of anything else that requires code besides a typical "computer" (i.e. a coffee maker knows that each button is a different size drink)?

Directions:

1. Lay out all the materials on the counter
2. Decide who will be the "programmer" and who will be the "computer" (I recommend having parent be computer first)
3. The programmer will give the computer instructions about how to make a PB&J sandwich
4. The computer MUST follow the programmer's instructions *exactly*, just like a computer would (i.e. "place peanut butter on bread" means that the jar of peanut butter should be placed on the bread, since no instruction was given about opening it)
5. The programmer will catch on and begin to provide more detailed coding instructions
6. Continue until a sandwich is made. You can switch places to make another if you'd like, or pick a new house member to play programmer that isn't "in on it"

Okay, But Why?

Computers know that typing the “F” key is supposed to display that letter because the computer is **programmed** to do so. A **programmer** writes lines of **code** that are stored in the computer so that a particular **command** will always produce the desired result. For example, the “F” key commands the computer to display the letter F.

Programmers write in **coding languages** in order to talk to computers. Each coding language has its own set of commands, and **syntax** acts like grammar by telling you how the commands need to be presented so the computer understands.

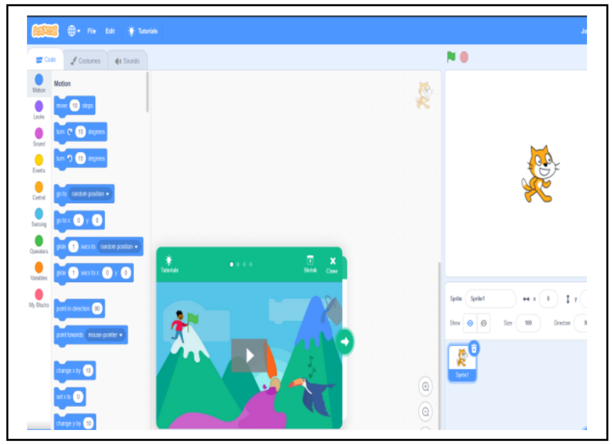
Since computers don’t think like humans, they need to be told exactly what to do. If the person making the sandwich did something silly, it’s because even though they understood you as a human, the command became lost in translation for a computer.

Video Games!

In this tutorial, we will learn more about programming! The goal is to make your very first video game! We will go over some basics of programming using Scratch, a block coding language! Provided is a link to the main scratch website as well as a link to a project with example code.

Materials:

- Computer
- https://scratch.mit.edu/
- https://scratch.mit.edu/projects/380677261/



Questions:

How do computers know what to do?

What is code?

How many different things do you think it is possible to create with code?

What are some games you like to play?

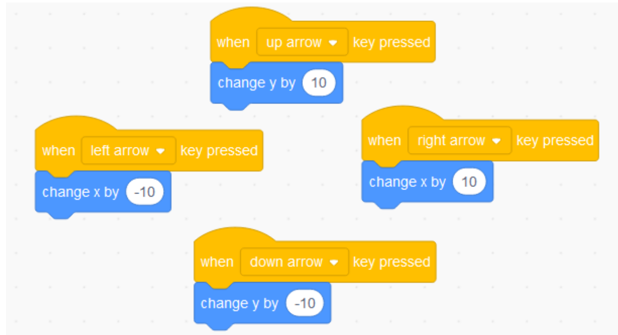
How do you think a video game works?

Directions:

1. Go to https://scratch.mit.edu/ listed in the materials, and click "get started"
2. You'll see a screen similar to the one in the picture to the right.
3. First, follow the tutorial in the green box. That will help you learn the very basics of coding in Scratch!
4. Next, lets figure out what "things" we want to include in our basic game! For our first game, we are going to make a maze! The goal is to reach the end of the maze without getting lost or touching the walls!
    a. Character
    b. Walls
    c. Finish Line
5. Next, let's figure out what each "thing" needs to be able to do!
    a. The character needs to be able to move
    b. The walls need to stop the character from moving
    c. The finish line needs to know when the character has reached the end
    d. What else do you think we may need? It's your game, you can add anything!

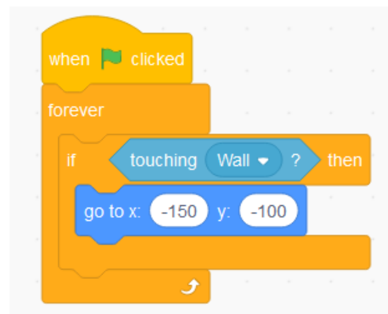
The Character:

For this game, we will use the cat, Scratch, as the player. We need to tell him what to do when a key is pressed. This is called an *if.* Ifs are used in programming to make things happen after something else happens. In this case, **If** the right arrow key is pressed, **then** Scratch moves to the right. The code to the side shows one way you can code Scratch to move in different directions! You can find these code blocks in the Events and Motion Category.

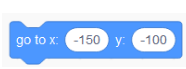


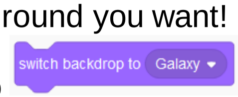
The Walls:

Next up, we want to draw some walls for scratch to move around, and we don't want scratch to be able to cross the walls so that he can solve the maze. To do this, click in the bottom right on the  button. This will let you draw anything you want! If Scratch touches the wall, he has to start all the way at the beginning. This section uses two concepts: *loops* and *ifs.* Loops are a way to make things happen multiple times. In this case, we want Scratch to go back to the beginning *every* time he touches the wall, so we use a **forever** loop. So, **Forever, if** Scratch touches the wall, **then** go back to the beginning. If you add more walls, you can repeat this code for each wall, or you can use an **Or** statement, as shown in the project at the example link.



The Finish Line:

Making the end area is very similar to making the wall. We will again draw a sprite that scratch needs to touch, and we will again make a loop that plays forever with an if statement inside of it. The only thing we need to change is what happens when Scratch touches the Finish Line. You can make the finish line the same way you made the walls. The new thing you need to do is choose a background to show when he finishes! To make a new background, click the  in the bottom right corner, and choose/create whatever background you want! Now, copy the code for the Walls, and change 

to 

, where Galaxy is the backdrop you just made!

Okay, But Why?

Computers don't know what to do unless we tell them exactly what we want them to do. They speak a different language than us, so it is important to learn the basics of those languages if we want to interact with them effectively. Learning a language like Scratch helps students learn how to think logically and build creative problem solving skills, while also helping them learn math concepts like variables and number interactions.

Wrap-Up

On behalf of all volunteers with From Student to Scientist, thank you to Madison House and the University of Virginia for doing their part to promote social distancing within these communities and for encouraging the creation and distribution of this guidebook.

Most importantly, we would like to thank you for participating in science with your children during this time away from school. We appreciate you continuing to show your kids how fun science is! We hope that your family is healthy and safe, and we look forward to teaching science with the kids next year! Below are some additional resources for more science-related lessons, games, and websites to explore.

Thank You for helping promote your child's interest in science!!

All the Best,
From Student to Scientist
Spring 2020 Volunteers

References:

Here are websites we like to pull experiments from! Some are included in this book.

https://www.exploratorium.edu/snacks/
https://sciencebob.com/
https://www.stevespanglerscience.com/
https://buggyandbuddy.com/

Additional Resources

Below is a range of media centered around science for your child to consume. We understand that some of these sources require a subscription. However, each source is denoted as to whether it requires a subscription or not, to help you facilitate your child's entertainment and learning.

Note that some of the TV shows below may have episodes posted to YouTube, which you're welcome to explore, but we don't want to condone internet searching without parental supervision.

TV Streaming	
Netflix *(Subscription)*	Bill Nye the Science Guy
	Magic School Bus
	Project MC^2
Disney Plus *(Subscription)*	Brain Games
	Shop Class
National Geographic – Kids *(Free)* https://kids.nationalgeographic.com/	Spectacular Science
	How Things Work
PBS *(Free)*	Science-Kids
	https://pbskids.org/

Youtube Channels	
Channel	**Link**
Minute Physics	https://www.youtube.com/user/minutephysics
Science with Sophie	https://www.youtube.com/channel/UCOJz0IhQZOH07fNIdVqWx1Q
SciShow	https://www.youtube.com/user/scishowkids
WhizKidScience	https://www.youtube.com/user/WhizKid8881

Description	**Website**
Play a game but write lines of code to do it!	https://codecombat.com/
Play some fun math games!	https://www.coolmathgames.com/
Learn more about the Scientific Method (for kids)!	https://littlebinsforlittlehands.com/using-scientific-method-ments-kids/
Learn more about Acids & Bases!	https://www.ducksters.com/science/acids_and_bases.php
Learn more about Sound & Vibration!	https://www.dkfindout.com/us/science/sound/
Learn more about Weather!	https://www.weatherwizkids.com
Learn more about Gravity & Inertia in Earth's Solar System!	http://studyjams.scholastic.com/studyjams/jams/science/solar-system/sgravity-and-inertia.htm https://www.ducksters.com/science/gravity.php