Big Brothers Big Sisters

OF CENTRAL MASS & METROWEST

MENTORING YOUTH STEAM

SCIENCE • TECHNOLOGY • ENGINEERING • ARTS • MATH

In this tool-kit, you will find:

- About STEAM and MySTEAM
- STEAM Activities
- Online Resources

What is STEAM?

STEAM stands for **Science**, **Technology**, **Engineering**, **Arts,** and **Mathematics**. These subjects are often taught separately, but are all interconnected just as reading, writing, and speaking are; understanding in each of the STEAM fields deepens understanding in the others.

Science includes biology, chemistry, archaeology, physics, psychology, and any other subject which interprets the world through a logical lens.

Technology includes the use or investigation of any device used to make, learn, or do something.

Engineering, less taught in primary school but increasing in popularity, includes mechanical studies, chemical tinkering, aeronautics, or any other method by way innovation is tested systematically.

Arts is the various branches of creative activity, such as painting, music, literature, and dance.

Mathematics is the way by which the world is studied through numbers and logic.

What is MYSTEAM?

MYSTEAM is the organizational force behind all of our STEAM programming, which includes:

- STEAM activities available for all of our matches at sites
- Mentors from the STEAM fields inspiring the next generation of thinkers, makers, and learners
- Events held monthly at local museums, schools, and STEAM companies to meet STEAM professionals and do group STEAM activities

MENTORING YOUTH
STEAM
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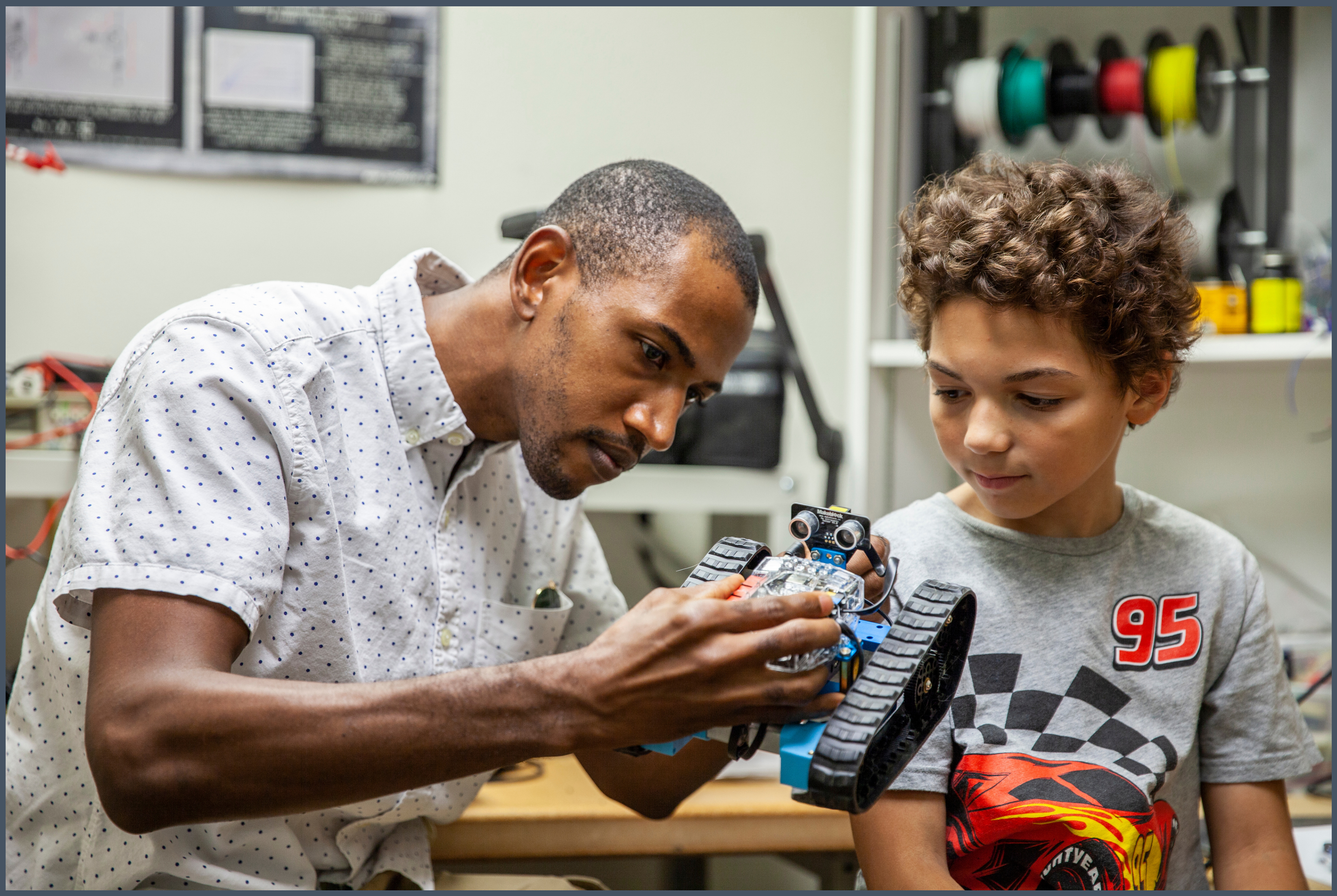
Why STEAM Mentoring?

The pathway to a rewarding STEM career is filled with barriers that can prevent youth, particularly girls and youth of color, from achieving a future in STEM. Many youth begin to steer away from STEM fields at an early age. Meanwhile, jobs in STEM fields in the U.S. are growing and many companies are finding it increasingly difficult to fill technical positions.

According to the National Research Council (NRC), caregivers, teachers, facilitators, and mentors play a critical role in supporting science learning. BBBSCM is using its expertise in lasting, inspirational mentoring to help children access the exciting world of STEM. We hope to engage kids who are naturally inclined toward STEM, as well as those who believe STEM is too difficult, boring, or inaccessible. We also strive to engage STEM passionate mentors who believed being a Big was not for them.



STEAM Activities

Balloon on a Bottle

Remember: All scientists have to protect themselves when experimenting, so always keep your goggles on during this activity!

Materials:
Plastic Bottle
Baking Soda
Vinegar
Balloon
Paper
Plastic Funnel

Let's Do this!
1. Using a piece of paper rolled up into a funnel, place a few teaspoons of baking soda into the bottle
2. Using a plastic funnel, pour a quarter of a cup of vinegar into the balloon
3. Attach the lip of the balloon over the plastic bottle, and pour the vinegar into the bottle
4. Observe what happens!
5. Repeat the process. What can you do to speed up the reaction? What can you do to make the balloon fill up more? Look at the materials you have around to make it a more successful experiment.

Let's Discuss!
What happened when the baking soda and vinegar met? What usually fills up a balloon? What is filling up the balloon now? Where did the air in the balloon come from? L

Let's Recap!
A chemical reaction happens when two substances meet and interact with each other. Sometimes they join together; sometimes their atoms are rearranged into many different substances. In this case, an acid (vinegar) and a base (baking soda) react to form a salt, water, and carbon dioxide.

Build a Bridge

A local city is looking for engineers to design a bridge to go over a canal. They need a bridge that can handle the heavy traffic in and out of the city during commuting hours, but they have limited materials. You have been asked to create a model to present to the city using only the materials provided. Your objective is to build a bridge at least 1 foot in length that supports the maximum amount of weight. After building your bridge, test it using the weights provided.

Materials: Popsicle Sticks Toothpicks String Glue

Observation Questions:

1. Look at some pictures of famous bridges. What kinds of patterns and shapes to you see? Why might those patterns and shapes work well on a bridge?

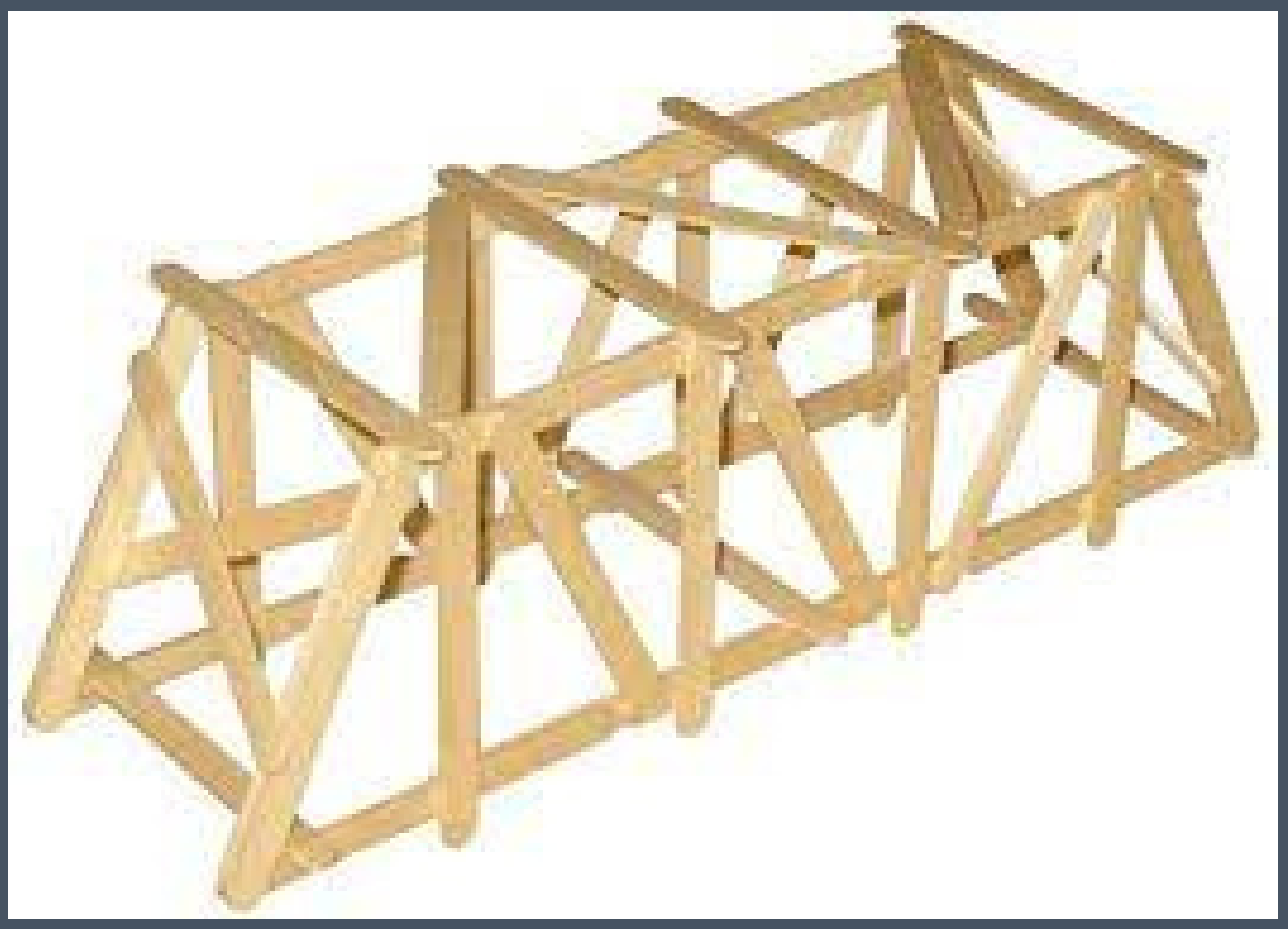
2. Draw a rough sketch of what your bridge will look like. What materials will you use?

3. Test your bridge with the weights. Record your results below.

Test Number	Weight Held

4. After testing the bridge with the weights: What worked well on your bridge? What could be improved to increase its weight-bearing capacity? Try making changes and testing their success. Record results below.

Test Number	Weight Held



Make Ice Cream

Safety: After the salt and ice have been mixed, please use the towel to hold the cold bags. The ice will get cold enough to damage your skin. This is one of the few activities where you are allowed to eat the science!

Materials: 2 quart-sized bags
1 gallon-sized bag
½ cup milk
2 tbsp sugar
½ tsp vanilla OR 1 tbsp cocoa powder
2 cups ice cubes
6 tbsp salt
1 towel or rag 1 spoon

Instructions:

1. Add milk, sugar, and vanilla OR cocoa into 1 quart-sized bag
2. Seal ingredients into bag with as little air as possible inside
3. Seal that bag into another quart-sized bag with very little air
4. Into the gallon bag, pour 2 cups of ice cubes, salt, and sealed quart bags
5. Seal the gallon bag with all the ingredients, hold with the towel, and gently shake the bag back and forth for five to ten minutes
6. Carefully remove your quart bag, and check to see if it's frozen and ready to eat! Use your spoon to eat ice cream right out of the bag!

Think About It!

Why use two quart-sized bags?

What changed about the milk? Is this permanent (chemical reaction), or temporary (phase change)?

Science!

Salt lowers the freezing/melting point of ice (the temperature at which water turns to ice, and ice to water). Water normally becomes ice at 32*F, but the salt allows the water to get down as far as 2*F before it turns to ice! The icy water in the bag is so cold that it quickly freezes the milk, turning it into ice cream.

Fireworks in a Jar

Materials:

Jar
Warm Water
Food coloring
Oil
Bowl
Fork

Instructions:

1. Fill the jar 3/4 full with warm water
2. Pour a thin layer of oil, about 3-4 tablespoons, into a separate bowl. Then, carefully dot the oil with different colored foods coloring
3. Gently mix the oil and food coloring together with a fork until there are smaller balls of color
4. *Answer question 1 before completing the next step.*
5. VERY CAREFULLY pour the oil/food coloring mixture onto the water. (Works best if you pour down the side of the jar)
6. Wait patiently and watch what happens!

Observation Questions:

1. Make a hypothesis, or an educated guess, about what will happen when the oil and food coloring get poured into the water.
2. Describe what happened during the experiment. Use words and a picture if you can!

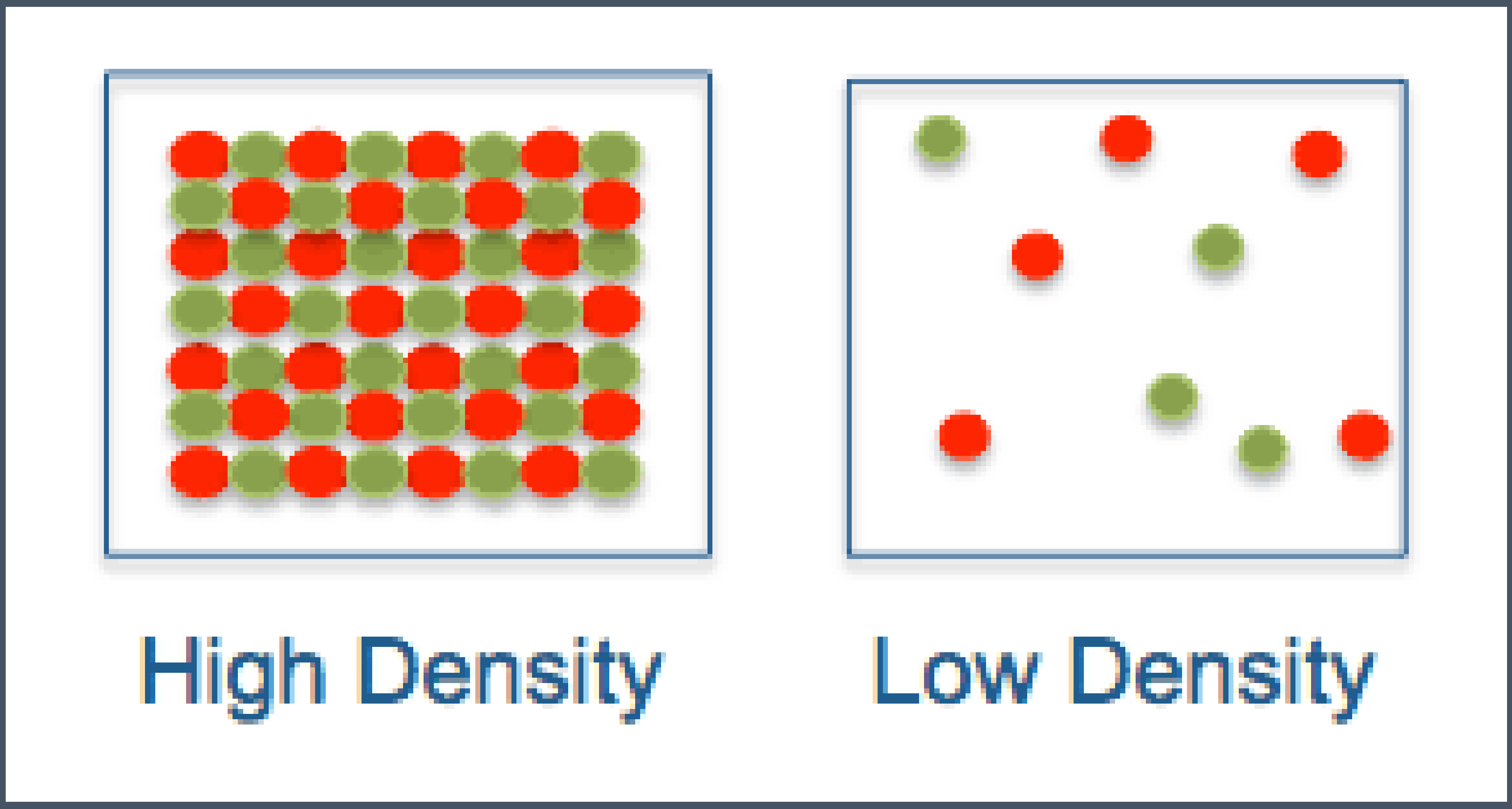
Fireworks in a Jar

3. Was your hypothesis correct? Explain why or why not?

4. What could you change in the experiment to get a different result? Try it out and record the results here.

The Science

It's all about density and solubility. Density is how tightly packed the molecules are in a particular substance. Substances with more molecules in a space are MORE dense than objects with LESS molecules in a given space. Food coloring dissolves (is soluble) in water, but not in oil. Since the oil is less dense than the water, it sits on top. The food coloring, however, is denser than the oil, causing it to sink into the water. Once they hit the water, they begin dissolving, which creates explosions of color.



Popsicle Stick Harmony

Materials:

2 popsicle sticks
1 Large rubber band
2 smaller rubber bands
I 1 inch tooth pick
1 1inch straw

Procedure:

1. Take the two popsicle sticks and lie them flat on top of one another
2. Take the large rubber band and use it to tightly secure one end of the popsicle sticks to one another
3. Slide the straw on the inside of the two popsicle sticks until it hits the rubber band
4. Using the two smaller rubber bands, repeat step 2 (When you are done both ends of the popsicle sticks should be secured to one another at each end)
5. In the small opening between the popsicle stick (that has been created by the straw) slide the toothpick to the other end of the popsicle stick

Play:

Blow into the opening between the popsicle sticks. What do you hear? Now, move the straw closer to the toothpick and then blow into the opening again. Has the sound changed? Continue to move the straw closer to the toothpick with each blow into the opening. What do you notice?

Science:

Pitch is the highness and lowness of sound. Vibrations that travel shorter distances produce sounds with higher pitches and frequencies, because of the short column of air. Inversely, long vibrations produce a low pitch because of the longer column of air.

Why does the pitch change when you move the straw closer or farther from the tooth pick? This is because the farther the straw is from the toothpick the longer the sound wave lengths are. On the other hand, when you move the straw closer, it shortens the wave lengths.

Popsicle Stick Catapult

Materials:

6 popsicle sticks

5 rubber bands

Safe projectiles (cotton balls, mini marshmallows)

Procedure:

1. Stack four popsicle sticks. Using a rubber band at each end, squeeze the bundle tightly together.
2. Place the remaining two popsicle sticks together. Bundle only one end together using an additional rubber band.
3. Pry the unbundled end open enough to be able to slide the set of four sticks in between perpendicularly to form a cross. Slide the bundle of four sticks down as closely as you can get it to the rubber band that's holding the two sticks together.
4. Finish your catapult by securing the body to the wings (diagonally at the point where the popsicle sticks intersect) by crisscrossing a rubber band from the back of the right wing to the front of the left several times. Repeat with the final rubber band.
5. Place your projectile at the end of the popsicle stick that is highest in the air. Hold the set of four sticks with one hand, and push down on the angled stick just behind the projectile.
6. Release your projectile!

Popsicle Stick Catapult

Science and Questions:

- A catapult uses stored energy to launch a projectile. In our catapult, the energy is stored by changing the shape of the popsicle stick from what it normally would be.
- Catapults were used in warfare for centuries, especially to damage structures, and are a great example of the power of a lever in action.
- Changing the construction of your catapult will change the way it works. For example, how far the cross bar is from the front, or how many popsicle sticks are used. Engineers try to build the best tools by thinking about what will work well, testing, measuring what happened, and changing their plans based on those experiments.

Energy needs to come from somewhere. Where does the energy come from to power your catapult?

What other materials might make good projectiles? Safely try a few different options and observe the differences.

What can you change in your catapult? Try two changes, and make two observations about what happens when you use it.

Coffee Filter Chromatography

Materials:

Small cup
Coffee filter
Marker
Water

Procedure:

1. Draw a circle with your marker about halfway up your coffee filter. The marker will bleed through!
2. Fold your coffee filter in half, then in half again. Open the folds of the filter so that it resembles a cone.
3. Put a small amount of water into your cup (it may fill about half an inch up in your cup).
4. Dip the cone into the water gently so that only the plain part of the coffee filter (not the colorful part) touches the water.
5. Wait approximately fifteen minutes and observe what happens!

Questions:

Is the color that moved the same color as the original? Why do you think the color moved?

This process is called **"chromatography."** Chroma means color, and graphy means writing. Why do you think it's called that? Scientists use this process to separate out different chemicals from one sample. The heavier chemical will move less than a lighter chemical. If you saw one band or different bands of color, what do you think that means about the ink in your marker?

Coffee Filter Chromatography

Safety:

Never fire your rocket at anyone else. Always pay attention to where you're firing your rocket, and ensure that it is safe to launch.

Materials:

1 straw
1 rubber band
1 paperclip
1 Popsicle stick
Masking tape
Cardstock
Scissors

Procedure:

1. Cut 4 fins for your rocket. First cut two rectangles less than half the length of your straw, then cut those rectangles diagonally to create two triangles each (4 total).
2. Take one small piece of masking tape and apply lengthwise to one of the fins so that half of the masking tape is off the fin. Attach the free end of the tape firmly to the straw so that the flat end of your fin is not quite at the end of the straw, and the pointy end is directed forward toward the middle of the straw. Attach the other 3 fins in the same way, all around the rocket.
3. Cut your straw to desired length.
4. Bend your paperclip into the launcher hook. First, put your finger between the two large loops of the paperclip and bend backwards to that it is flat. Then take one half of the paperclip, and fold that downward in a right angle to create a small hook.
5. Insert the paperclip into the front end of your rocket. You may have to unbend the second end. Put a small piece of tape around the front of the hook to secure it. If you cannot fit the hook inside the rocket, tape it to the outside of the front of the rocket very securely.
6. Tape the rubber band to the very top of the popsicle stick.
7. Hook your rocket onto the rubber band, holding it from the end behind the fins. Pull back, observe your surroundings, then launch safely.

Coffee Filter Chromatography

Questions:

How far can you make your rocket launch? Measure in your own units (e.g. footsteps, arm lengths, "you" lengths)

What parts of your rocket could you change to make it fly farther? Try it!

What do you think the fins do? Test your guess by making changes to your rocket and seeing how it flies.

Making Slime

Safety: Chemicals are being used. They may mildly irritate your skin and should not come in contact with your eyes. Like all chemicals, you should not taste or directly sniff the chemicals.

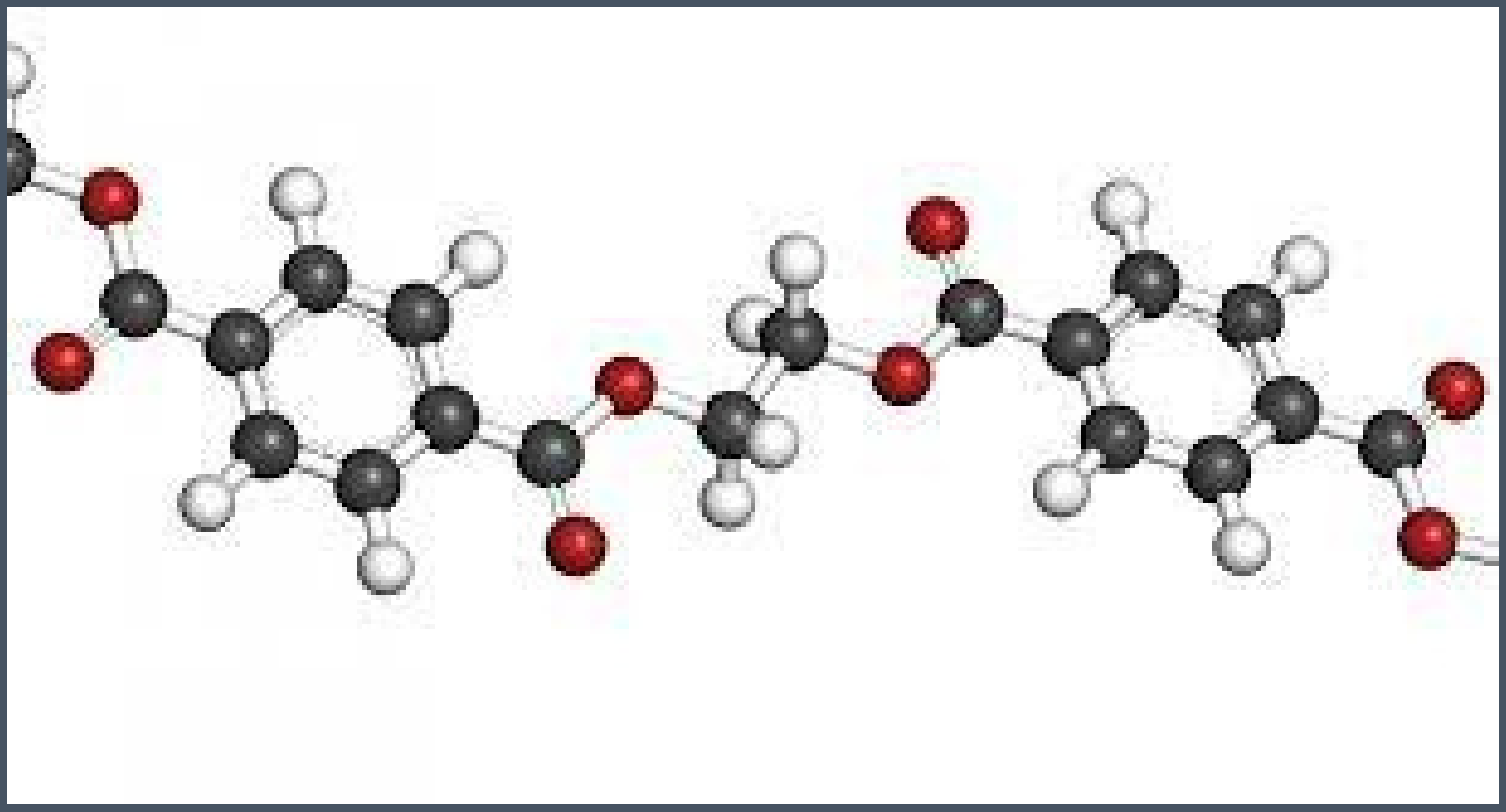
Procedure:

1. Wear googles and gloves
2. Take two small plastic cups
3. Label cup 1 and mark 1 inch from bottom. Fill with glue up to 1 inch mark of cup 1. Add one drop of food coloring to glue and stir
4. Label cup 2. Pour in ½ cup water to cup 2. Mix in 1 tablespoon borax into water.
5. Add a half spoonful of contents of cup 2 to cup 1. Mix. Keep adding small spoonful until slime consistency is achieved. You can choose how stiff you would like your slime! Feel free to use your gloved hands.

Science:

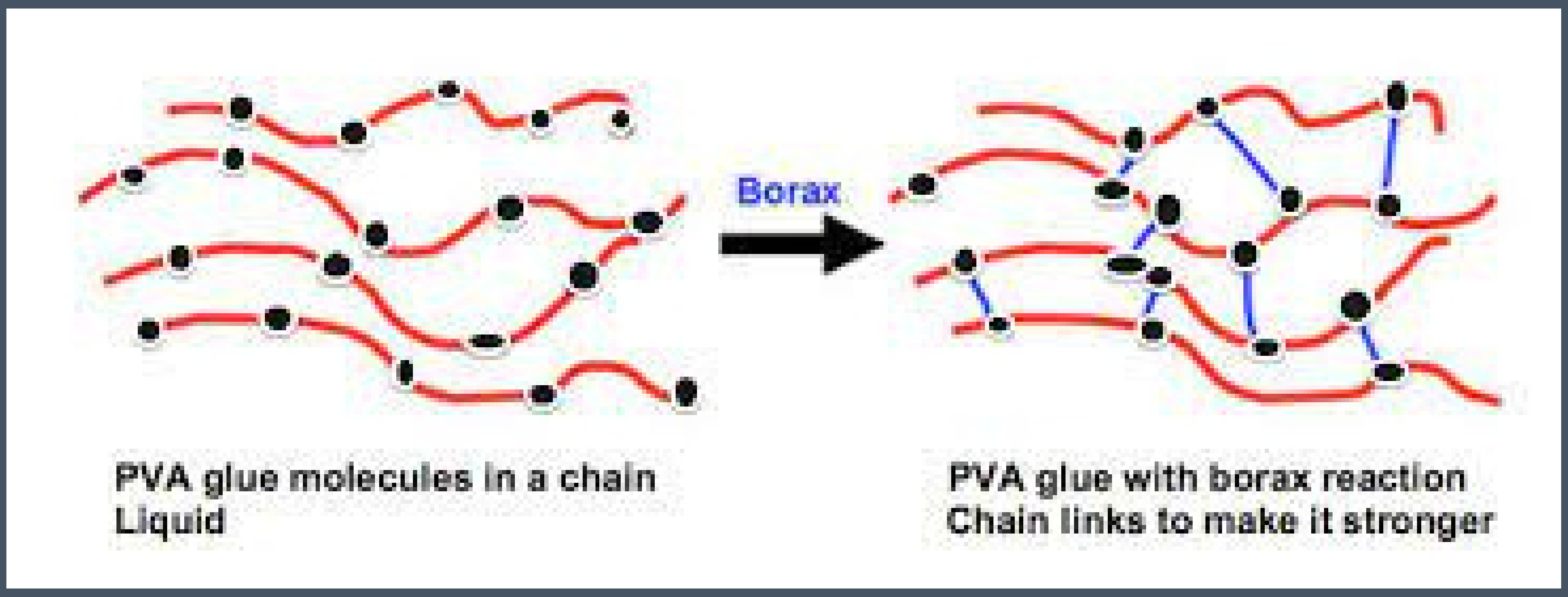
Polymer – a large molecule, or macromolecule, composed of many repeated subunits.

Do you see the repeated subunit in this polymer?



Coffee Filter Chromatography

The polymer in glue is formed of long strands, like noodles, so they can slide by each other and pour. When borax is added, it connects the noodle-shapes with little bridges. They can no longer as easily slide by each other, and stick together in a big mass of slime.



What are some characteristics of your slime? Make 3 observations. How is it different than glue? How is it the same?

1.

2.

3.

What happens when you pull it apart quickly? What happens when you pull it slowly?

Baking Soda Snowman

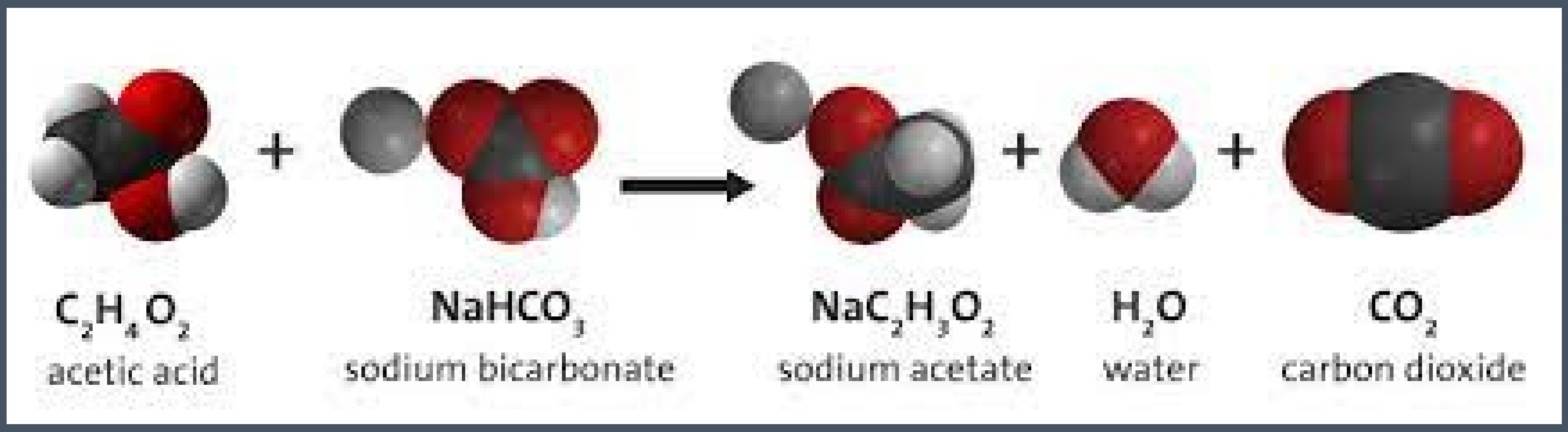
Safety: As with all chemicals, do not taste or sniff these materials directly. Do not let any materials touch your eyes. You may wear gloves and goggles to protect your skin, but it is not required.

Materials:

2 cups baking soda
2 tablespoons salt
1 teaspoon soap
8 tablespoons water
Vinegar
Foam pieces
Goggles & gloves (optional)

Instructions:

1. Make the dough: In a drip tray combine baking soda, salt, and soap. Mix well with fingers. Add water. Mix well again into crumbly dough.
2. Form into three balls to create your snowman (or whatever shape you'd like).
3. Cut foam pieces to decorate your snowman.
4. When you're ready to melt your snowman, take a squirt bottle of vinegar. Squirt a small amount at your snowman. Observe what happens.



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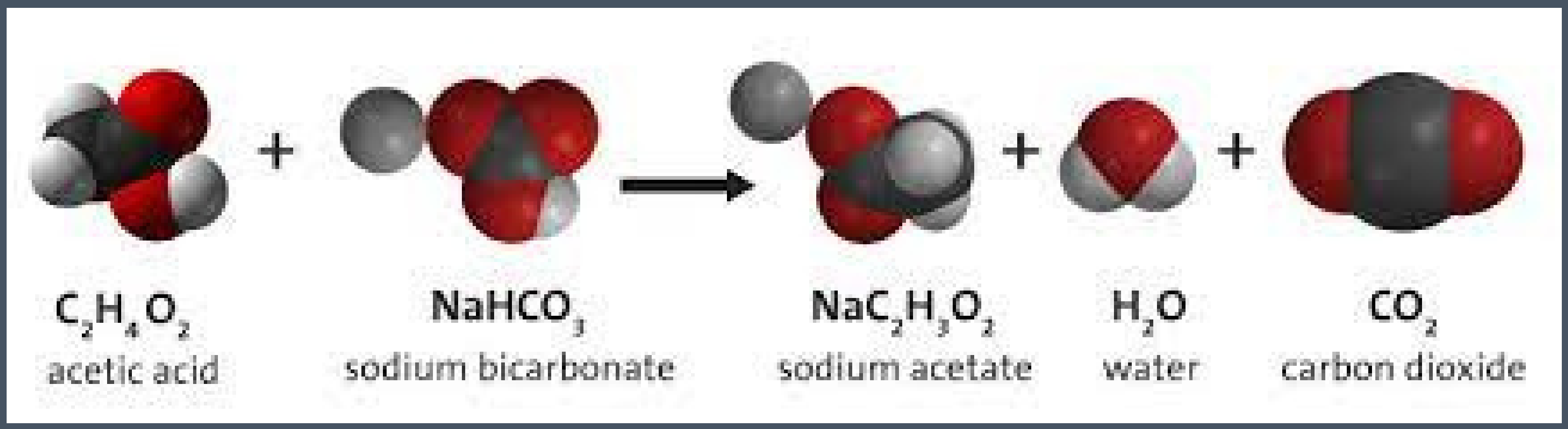

Baking Soda Snowman

Science and Questions

What you just saw was a chemical reaction! The acid in the vinegar (acetic acid) reacted with the base in baking soda (sodium bicarbonate) creating gas (carbon dioxide) and water.

Make an observation

Observations can describe what saw or felt:

Do you think this is a reversible reaction?

Could you get your snowman back?

How could you test your hypothesis?

Connect the Dots - Tyrannosaurus Rex

First draw an axis on the graph paper, then graph these points. Your image will appear! Color it in and draw your own background.

X range : -10 to -9

Y range: -14 to 14

T-Rex Body: (6,8) (5,6) (6,4) (2, -4) (0,-5) (-1,-6) (-2,-9) (-1,-11) (0,-12) (0,-13) (-3,-12) (-3,-11) (-4,-9) (-4,-6) (-6,-9) (-8,-11) (-8,-12) (-1,-14) (-7,-14) (-10,-13) (-10,-11) (-8,-9) (-6,-3) (-5,1) (-3,3) (2,6) (2,10) (3,11) (5,12) (9,10) (9,9) (6,9) (9,8) (8,7) (4,8)

T-Rex Arm 1: (6,3) (7,3) (7,2) (5,2)

T-Rex Arm 2: (3,3) (5,1) (7,1) (7,0) (4,0) (2,2)

T-Rex Front Leg: (2,-4) (3,-11) (4,-12) (4,-13) (1,-12) (1,-11) (0,-5)

Straw Whistle

Materials:
Several straws
Glue
Pencil
Paper

Procedure:
1. Pick out a straw and chew on one end of the straw until the end is completely flattened
2. Cut the flattened end into an "A" shape
3. Blow into the flattened end Change it up!
4. Now take other straws and experiment! Repeat steps 1 - 3-- but cut the straws into different lengths and then blow into them
5. Repeat 1-3 then glue one straw into another to make it longer and blow into it
6. Repeat 1-3 then expand the end of another straw with a pencil and slip another straw into the opening, repeat this process to see how long you can make the straw

Questions:
What whistle was the loudest and what whistle was the quietest? Why?

What whistle had the highest sound and what whistle had the lowest sound? Why?

Science:
Pitch is the highness and lowness of sound. Vibrations that travel shorter distances produce sounds with higher pitches and frequencies, because of the short column of air. Inversely, long vibrations produce a low pitch because of the longer column of air. Moreover, the volume of sound is based on the amount of energy restricted in the vibrations, as well as the rate of diffusion of that energy.

Online Resources

- Pinterest can be a great resource for fun, DIY STEM activities. Try this one, or any of the dozens of other boards devoted to STEM fun.
- The Ultimate STEM Guide for Kids
- iHomeschool Network has any number of activities, including STEM, which are easily done at home
- 100 Super-Fun STEM Resources for Kids by Colleen at Raising Lifelong Learners

Science

- Science Kids has all kinds of fun science games and activities, great for 3rd-5th graders.
- Neuroscience for Kids
- Skills for various industries from DIY.org
- Ask Dr. Universe - Q & A's for all of life's most burning STEM questions, asked by kids around the world.

Physics

- Bending light - Learn how to bend light using just water in a clear container.
- A2Z Physics for Kids - Links to all sorts of fun physics activities and learning opportunities.
- Astronomy Projects from DIY.org.

Biology

- Biologist Skills from DIY.org

Environment

- 100+ Ideas for Nature Study from Cindy at Our Journey Westward
- 100 Things to do Before, During, or After a Nature Walk from Jimmie at Jimmie's Collage

Online Resources

Technology & Engineering

- Scratch - Free coding program produced by MIT. Learn how to talk to computers simply with their drag-and-drop interface. No one is too young or too old to play with this software.
- Coding from DIY.org
- Code.org - Learn to make apps, or learn the basics of how computers think.

Engineering

- Go For It! - Links to everything from news to career advice on becoming an engineer
- DiscoverE - Fun activities celebrating Engineering. They also have free volunteer kits available to learn about being an engineering mentor.
- 100 Engineering Projects for Kids from Marci and The Homeschool Scientist
- 100 LEGO Learning Printables from Renee at Great Peace Academy
- Aviation Careers from Learn How to Become

Mathematics

- Fun math activities from Education.com
- 100 Living Math Activities from Cindy at Our Journey Westward

Museums and More

Free tickets to the Museum of Science, New England Aquarium, Zoo New England and many others are provided to anyone with a Boston Public Library card.
All of our Littles are eligible for a free membership to the Discovery Museums in Acton.
The website from San Francisco's famous Exploratorium has all kinds of fun activities. So does the Museum of Science and Industry in Chicago.
Check out NASA's info for young learners.