
EASY
STEM CHALLENGES

INTRODUCTION

Every parent/teacher involved should create an account on the website Science Buddies- Science Fair Project Ideas, Answers, & Tools. It is free. MANY of the lessons come from here and if you have an account- you can access the lesson directly.

While most materials are in the stem room, please review ahead of time.

If you think we should buy a material or something that is running low- please let us know.

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Activity- Bridging the Gap (No Extra Materials Needed; also good for older kids)

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Activity- Paper Rocket Challenge (No Extra Materials Needed)

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Grade 5

Activity- Photosynthesis (No Extra Materials Needed)

Activity- DNA (No Extra Materials Needed)

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Activity- Paper Rocket Challenge (No Extra Materials Needed)

Activity- Figuring out the nutritional value of your lunch (No Extra Materials- Need to Photocopy a lot)

Build a Recycle Station (Extra Materials Needed)

Activity- Paper circuits (Extra Materials Needed- Coin Battery)

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Activity -How Do How Do Viruses React To Soap? (Extra Materials Needed)

Activity- The Great Flood Barrier (Extra Materials Needed)

All Activities (** - easier)

**Activity- Igloo Fun- (No Extra Materials Needed)

**Activity- Sinking Bruno the Bunny (No Extra Materials Needed)

**Activity- Chuckin Pumpkins (No Extra Materials Needed)

**Activity- Terrific Turbines part 1 (No Extra material Needed)

**Activity- Terrific Turbines part 2 (No Extra Materials Needed)

**Activity- Sun and Moon (No Extra Materials Needed)

**Activity- Constellations (No Extra Materials Needed)

**Activity- Cupid's Arrow (No Extra Materials Needed)

**Activity- Rocket to the Moon (No Extra Materials Needed)

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**Activity- Zippy's Zip Line (No Extra Materials Needed)

**Activity- Paper Towers (No Extra Materials; 4 Cans of Food is Good to Have)

**Activity- Figuring out the nutritional value of your lunch (No Extra Materials- must photocopy a lot)

**Cotton Ball Launcher (No Extra Materials Maybe Needed)

**Activity- Dancing Ghosts (Extra Materials Needed)

**Activity- Climbing Water (Extra Materials Needed- Food Coloring)

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Activity- Paper Ball Run Challenge (No Extra Materials Needed)

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Activity- Make a Virus from Clay? (No Extra Materials)

**Activity - Making Music (Extra Materials Needed)

**Activity- Acids and Bases (Extra Materials Needed)

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Activity- Stay A-Float (Extra Materials Needed)

Activity- Digest This (Extra Materials Needed)

Activity- The Carbon Cycle (Extra Materials Needed- Coins or Dice)

Activity- The Great Flood Barrier (Extra Materials Needed)

Activity- Bounce Around (No Extra Materials Needed)

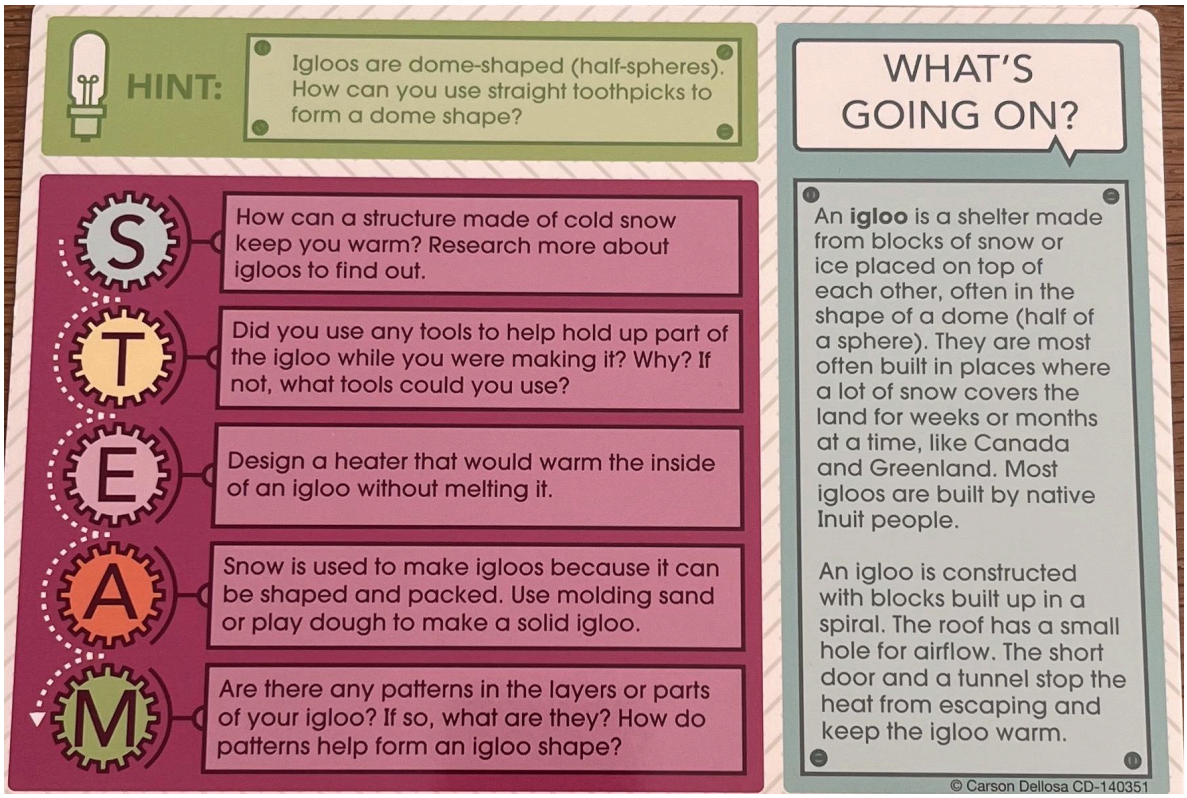
Activity- Straw Roller Coaster (No Extra Materials Needed)

Activity -How Do How Do Viruses React To Soap? (Extra Materials Needed)

Activity- Cinco de Mayo (Extra Materials Needed)

ACtivity- Build a Recycle Station (Extra Materials Needed)

Activity- Igloo Fun- Extra Materials Needed



Activity- Igloo Fun- Extra Materials Needed

Materials - marshmallows and toothpicks

Teaching Points

The Science Behind Feeling Cold

When our body loses heat, we feel cold. According to physics, a hotter body loses heat to a colder one. When the surrounding is not as hot as your body, you will lose heat and feel cold. On the contrary, when the surrounding is hotter than you, your body will absorb heat. It is then you will feel hot.

It means that heat is a form of energy that travels from a hotter body to a colder one. It happens until the temperatures of both bodies become the same. The process of transfer of heat happens to achieve thermal equilibrium.

How Does an Igloo Keep You Warm?

Now the real question arises. How will an igloo provide your warmth? You are still in a colder environment when you are inside an igloo. To understand this concept, let us find out what happens when you use a blanket in the winter season.

A blanket is made of insulating natural fibers. These fibers have air pockets between them. These air pockets trap air and create a more insulating cover you can use to keep yourself warm. It means that a blanket will not create heat on its own rather it will trap your body heat from escaping and

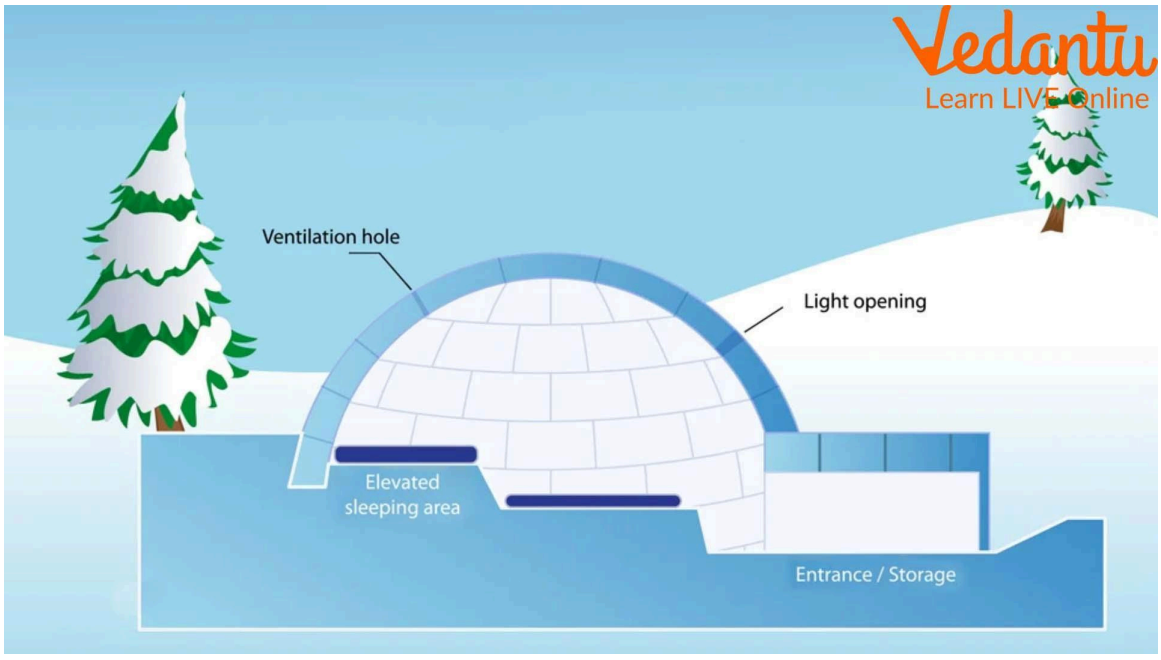
will make you feel warmer.

The same science applies to the warmth of an igloo house. It is made of ice scavenged from the colder surrounding. The ice is then compressed to form blocks trapping air inside. When these blocks are stacked one above the other, they form a house. The heat inside an igloo remains trapped and it helps to keep you warm even below the freezing temperature.

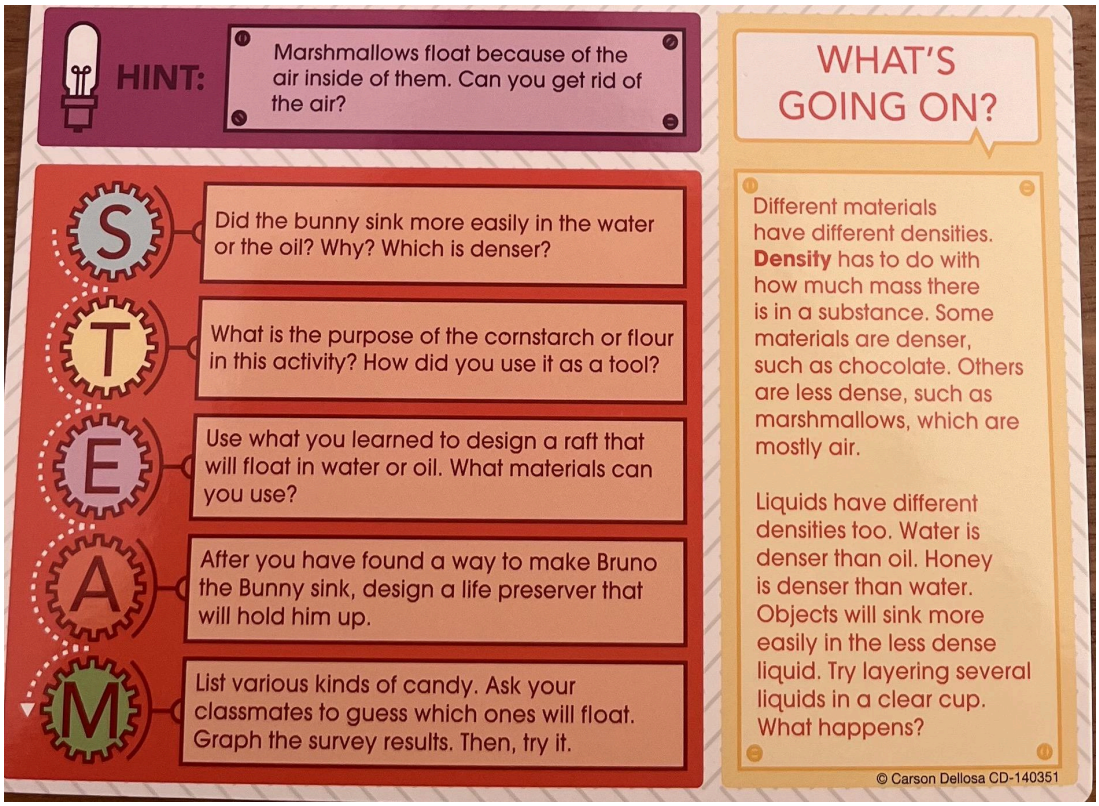
Igloo shape- hemispherical snow house with an entrance a little below the ground level. A ventilation hole is kept above the top of the snow house.

The igloo effect explains that the people inside will radiate heat. This heat will warm up the air inside causing a rise in the temperature inside an igloo. The hot air will rise and the colder air will settle down (hot air is less dense as there is more space between the molecules). Due to this, the hot air will pass slowly through the ventilation hole on the ceiling and cause a small difference in air pressure. Due to this difference, fresh air from the outside will enter gradually inside an igloo and deliver the required amount of oxygen.

The insulation effect of snow will automatically increase the temperature inside an igloo keeping the residents warm. This is how to make an igloo with compressed snow and stay alive in freezing temperatures with the help of compressed snow.



Activity- Sinking Bruno the Bunny (Extra Materials Needed)



Activity- Sinking Bruno the Bunny (Extra Materials Needed)

Materials- cups (clear plastic is best, but not necessary), water, oil (any type, corn/vegetable etc), marshmallows

Teaching Points

Marshmallows are light and fluffy because they are full of air. Air is less dense than water, so the marshmallow floats. When you squish the marshmallow, you squeeze out the air, making it denser than the water. Now the flat marshmallow will sink. The more you squish the marshmallow, the lower it will sink.

Oil is less dense than water, so try sinking the marshmallow in a cup of cooking oil (The molecules that make up the oil are larger than those that make up water, so they cannot pack as tightly together as the water molecules can. They take up more space per unit area and are less dense)

More Teaching Points on Density

Which is heaviest, 1 kilogram of gold or 1 kilogram of feathers?
I hope you didn't fall for it and say gold! The answer is, of course, that 1 kilogram of gold is just as heavy as 1 kilogram of feathers. They both weigh 1 kilogram! The 1kg bag of feathers would be much bigger than 1kg of gold. This is because the density of gold is higher than that of feathers.

If you had two boxes, both of the same size, and you filled one with gold and one with feathers, which box would be the heaviest?
Answer: the box filled with gold of course! Because feathers aren't as dense as the gold, the same volume of feathers would be much lighter.

What Is The Definition Of Density? Density is how compact an object is.
Density = Mass/Volume

Volume is the amount of space that something takes up (box's volume- multiply length, its width and its height). Mass is how heavy something is. However, mass is slightly different than weight. Weight is a force, and is affected by gravity. An object would weigh less on the moon than on the Earth, because there is less gravity there. **Mass stays the same wherever you are: the earth, the moon, or floating in outer space**

Demonstration- Sinking Bruno the Bunny (Extra Materials Needed)

Materials- honey, golden syrup (or corn syrup), dish soap, water and food coloring (any color- a different color than the dish soap), vegetable oil.

After you make the tower, you can find things to sing/float in the tower (lego, paperclip, coin)

Instructions:

DENSITY COLUMN

SCIENCE SPARKS

You'll need

Vegetable or sunflower oil
Water
Food colouring
Washing up liquid (dish soap)
Honey
Golden syrup/corn syrup
Buttons, coins and other small objects.

Instructions

Carefully pour the liquids into the glass one by one.

Start with the most dense and end with the least dense.

The order in our density column is honey, golden syrup, dish soap, blue water and oil.

Can you find a small object to float on each layer?

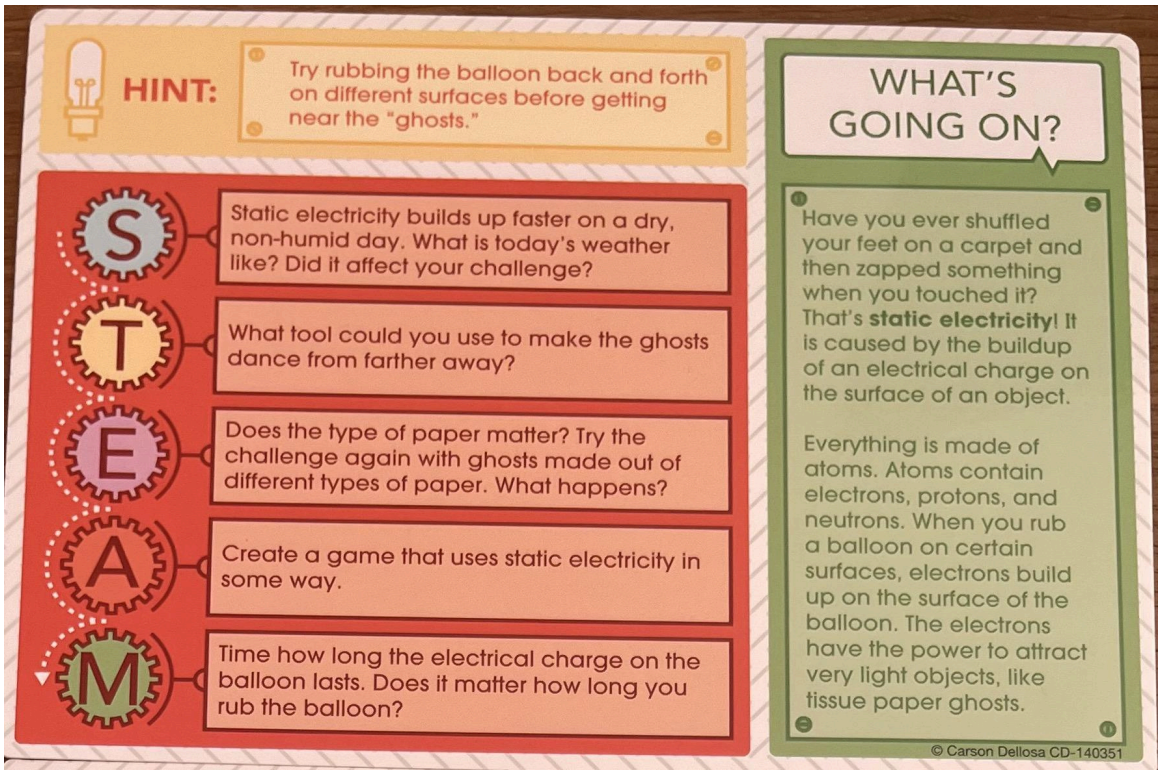
Why does it work?

Each of the liquids have a different mass of molecules or different numbers of parts squashed into the same volume of liquid. This means they have different densities meaning one can sit on top of the other - the more dense a liquid is the heavier it is.

Extension Task

Try other liquids, can you predict the order of density by pouring them into a container first?

Activity- Dancing Ghosts (Extra Materials Needed)



Activity- Dancing Ghosts (Extra Materials Needed)

Materials- balloons, thin paper, coke can, water coming from a sink, rice Krispies (optional)

Take a balloon, rub against hair, then hold it up next to thin paper, water from a sink, coke can, rice Krispies

Teaching Points – Static Electricity

TED Ed Video on Static Electricity

The science of static electricity - Anuradha Bhagwat - YouTube

Simpler Video

How Static Electricity Works - Stuff to Blow Your Kids' Mind #3

All things are made of matter, and matter is made up of teeny things called atoms, which are the building blocks of matter. Inside of atoms, there are even smaller particles called neutrons, protons, and electrons.

Now electrons can jump from one atom to another, like frogs do from lily pad to lily pad. This jumping is called electricity. There are two types of electricity: current electricity and static electricity. This lesson focuses on static electricity.

Static electricity occurs when there is a build-up of electrons on something, giving it an electric charge. The electrons will then be attracted to

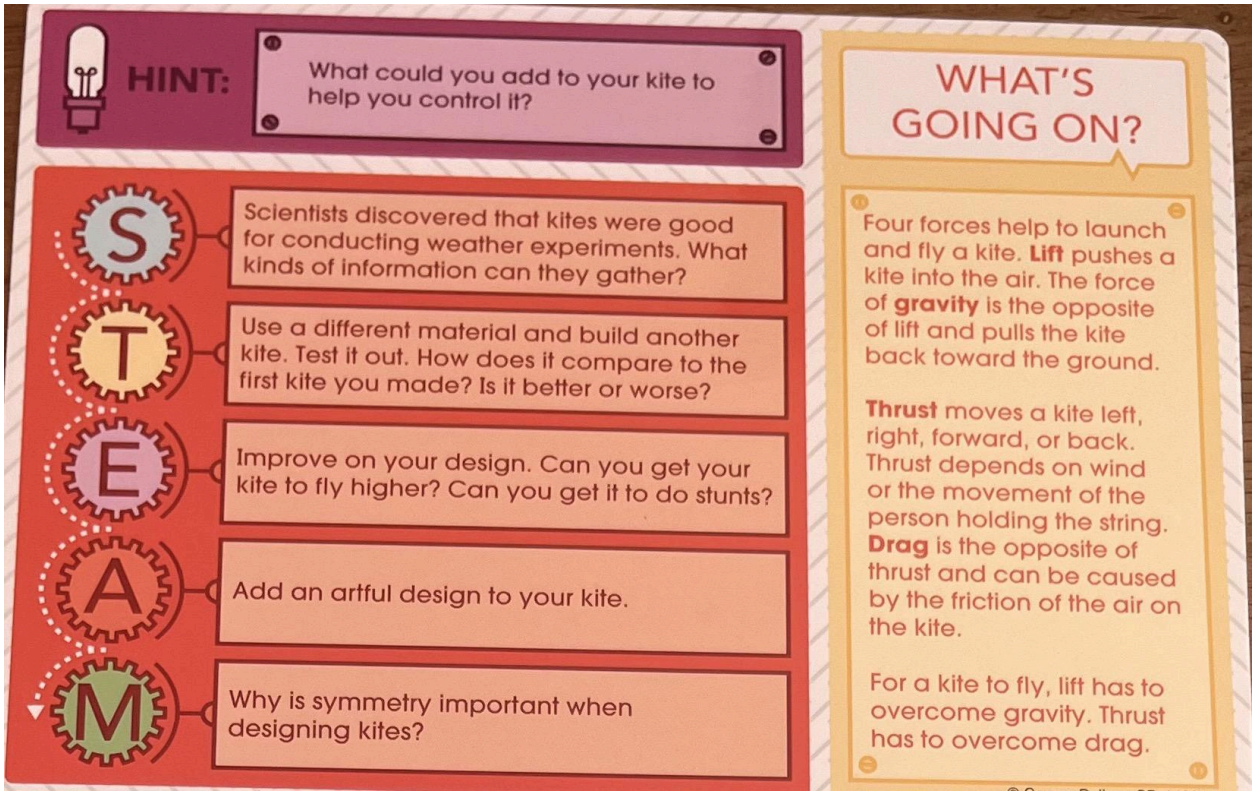
something with less electric charge, so they'll jump to an object that has fewer electrons. It's like students who are waiting for the bus home. If the bus they usually take home is full, they will look for an emptier bus that has more space.

Although you may love shuffling around the house in warm, fuzzy socks, you might get nervous every time you touch a doorknob, because you may be shocked. This shock is an example of static electricity.

As you walk across the floor with your socks rubbing against the carpet, electrons jump from the carpet to hitch a ride on you. Eventually those electrons get too crowded, and when you touch the doorknob, all the extra electrons jump from you onto the doorknob. The shock you feel is the static electricity. Ouch!

When you rub the balloon on your hair, tiny electrons are collected on the balloon. These electrons have a negative charge**.** Thus, your hair has a positive charge and the hair sticks up because they are repelling each other. The balloon itself to have an overall negative charge, therefore it is attracted to things with a positive charge (opposites attract!). The flow of water has a positive charge**,** therefore the attraction is strong enough to pull the water towards the balloon.

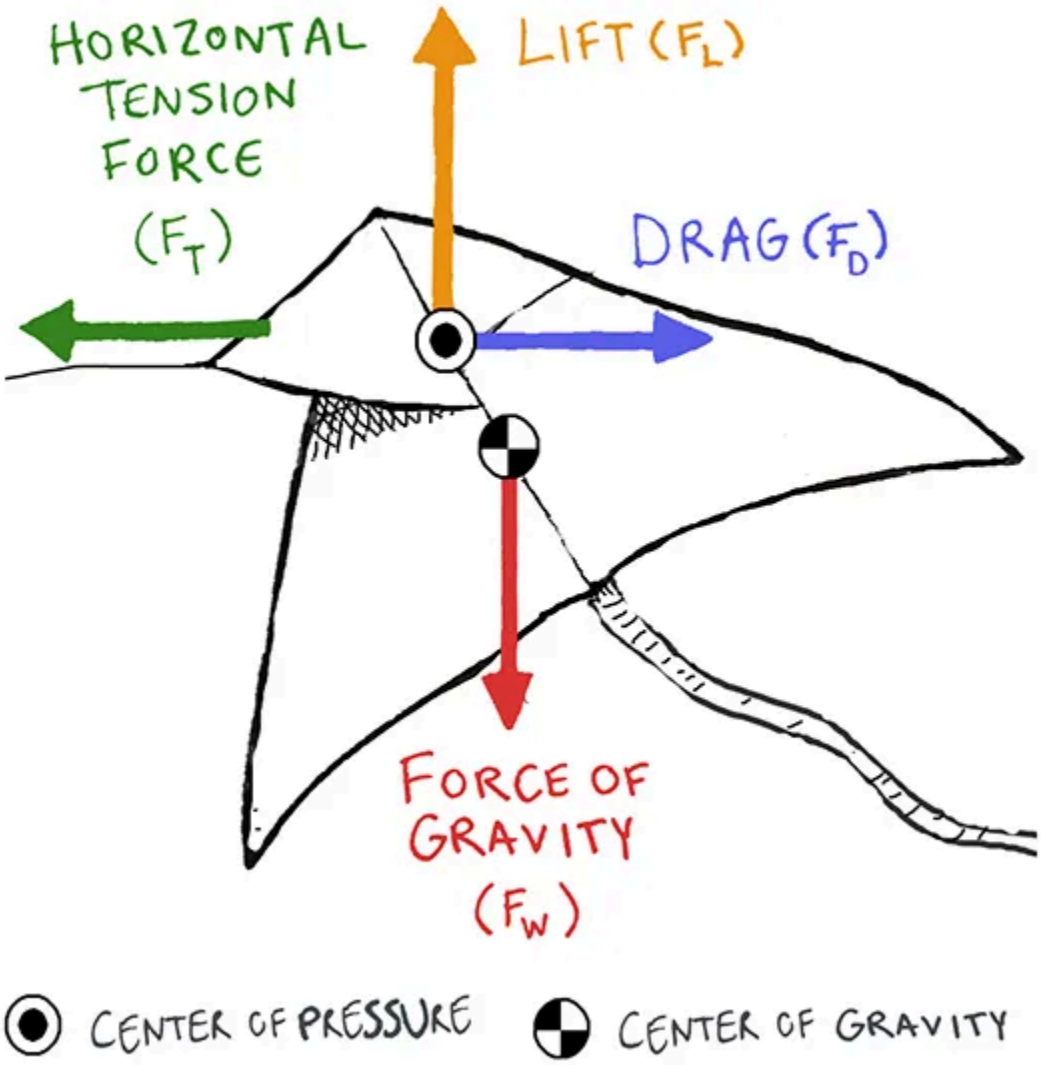
Activity- Oh, Go Fly a Kite (Extra Materials Needed)



Activity- Oh, Go Fly a Kite (Extra Materials Needed)

Materials- per the card on previous page

Teaching Points



The center of pressure is the average location of where the pressure force is applied. Think of it like the center of gravity, the location where the average weight of an object is, except this time it is the location of average pressure.

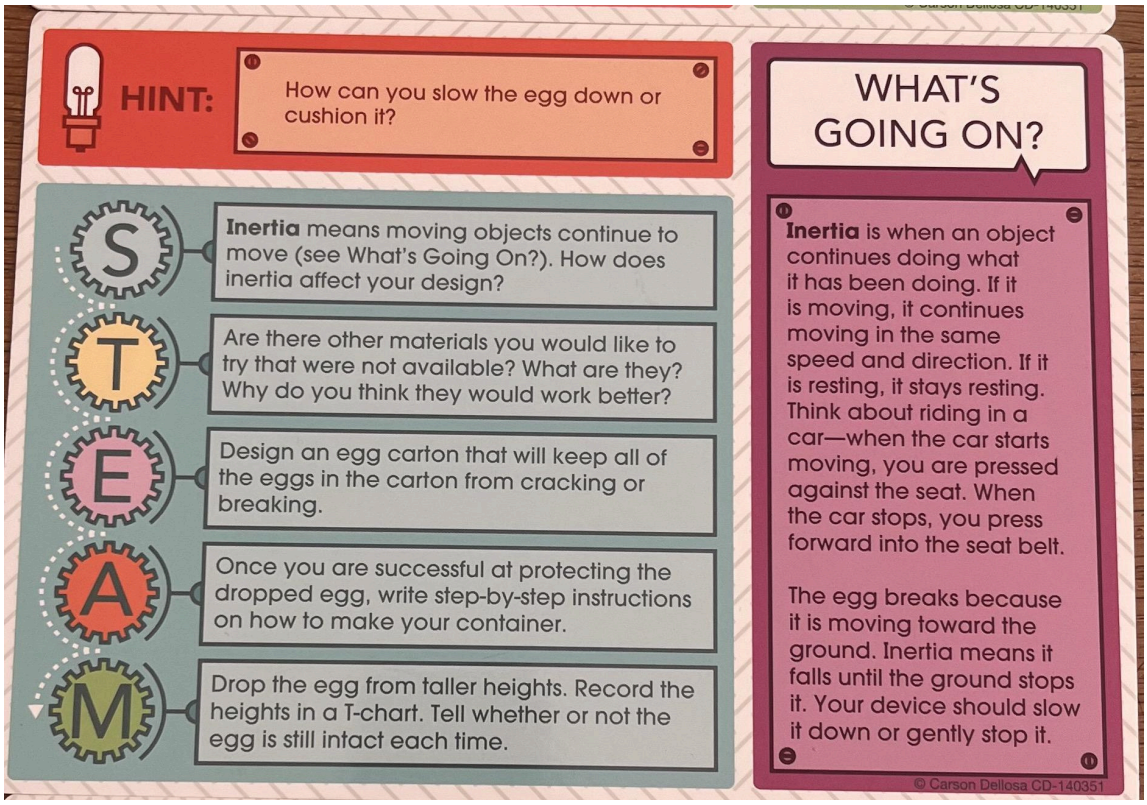
How does a kite fly? Just like rockets, jets, or birds, all kites experience a combination of forces as they fly. The main forces that determine whether or not a kite is able to fly are weight, lift, tension, and drag. Though these fundamental forces act on the kite together at the same time, they do not necessarily act on the same positions on the kite (more on this later).

- Weight (F_W) – the gravitational force of the earth pulling down on the kite
- Lift (F_L) – pushes the kite up and is the upward force acting on the kite
- Tension (F_T) – the pull originating from the person holding the string
- Drag (F_D) – the push of the wind against the kite

The forces of weight, lift, tension, and drag determine whether a kite stays aloft or plummets to the ground. When the kite is flying, these forces play tug-of-war with each other on three different axes: They pull or push the kite up or down, side to side, and forwards and backwards. On any given axis, one force might be bigger than the other, and will pull or push the kite in that direction.

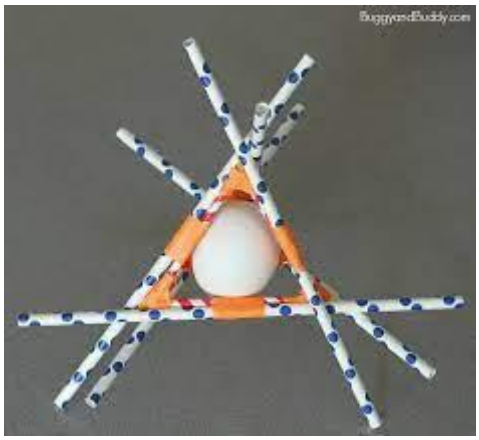
Why add a tail on a kite? Trying to fly a kite without a tail may result in the kite spinning and rolling a lot because the kite is unstable. Adding a tail to a kite helps make it fly more stably by adding some needed weight and drag to its lower end.

Activity- Egg (OR WATER BALLOON) DROP (Extra Materials Needed)



Activity- Egg (WATER BALLOON) DROP (Extra Materials Needed)

Materials you need – Egg (I like using eggs as they will actually break; if you use them you will need a tarp/large piece of plastic so as the kids drop them there is a place for them to land), materials to make the egg holder- cup, box, etc.. External protection materials, like balloons, rubber bands, craft sticks, straws, etc. Internal padding, like fabric, packing materials, paper, etc.



Teaching Points

Newton's 3 Laws that are demonstrated

1. Law #1- An object at rest tends to remain at rest and an object in motion tends to continue moving in a straight-line at constant speed, unless an outside force acts upon it. This is INERTIA (Inertia is the tendency of a body to resist a change in motion or rest. When a vehicle stops, you tend to jerk forward before coming to a complete

stop. In the same way, you will jerk backwards when the vehicle begins to move)

2. Law #2- Force = Mass times acceleration. The egg will accelerate based on the pull of gravity. How much it accelerates depends on the height from which the egg was dropped and the mass of the egg and protector. Force will increase with larger masses and higher heights.

Forces to consider during Egg Drop

a. Gravity: which will pull it toward the earth and cause its speed to accelerate.

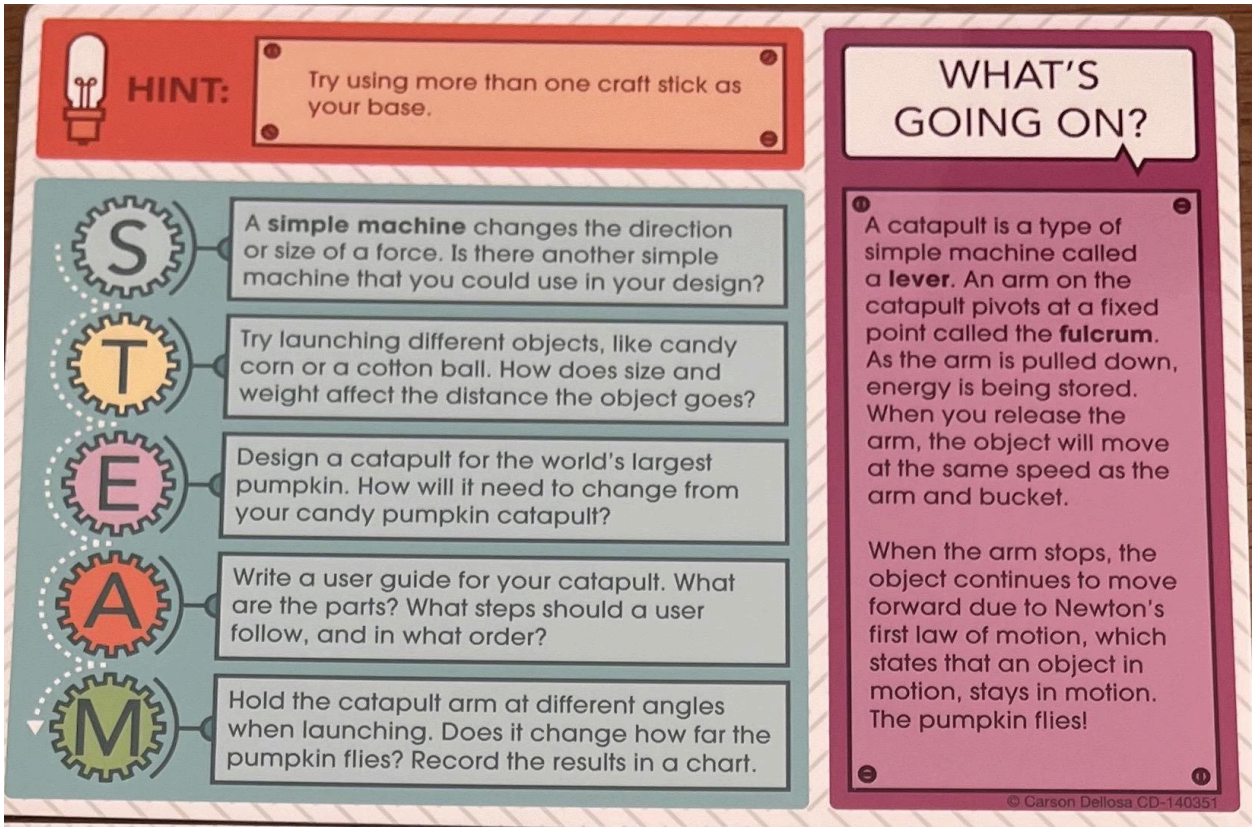
b. Drag: depending upon how the egg protector is built, this will vary, but drag will slow the fall of the egg down. Drag creates friction (between the air and the object creating drag)

Good video on Drag/Parachutes- Playtime with Parachutes | Physics for Kids (youtube.com)

c. Impact: ultimately, the egg (and its protector) will hit the ground. The size and amount of the impact will depend upon the speed with which the egg and protector were falling.

3. Law #3- For every action, there is an equal and opposite reaction. The egg will hit the ground. It will exert some amount of force on the ground when it hits (the impact force). The ground will, in turn, exert that same amount of force on the egg.

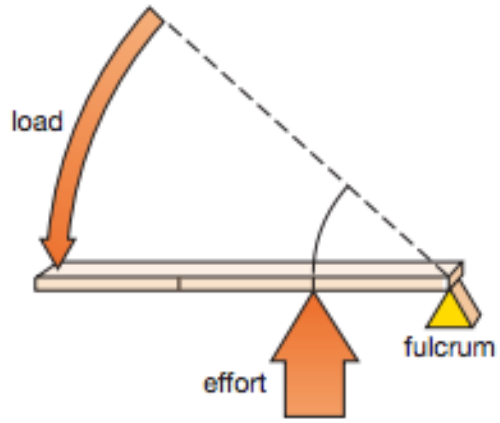
Activity- Chuckin Pumpkins (No Extra Materials Needed)



Activity- Chuckin Pumpkins (No Extra Materials Needed)

Materials- rubber band, craft sticks, plastic spoons, cups (can use candy or balls of paper or ping pong balls)

Teaching Points



Force

Fulcrum- support

Load- the weight you are launching (ping pong pall, ball of paper, candy)

Effort or force-how far down you push the load.

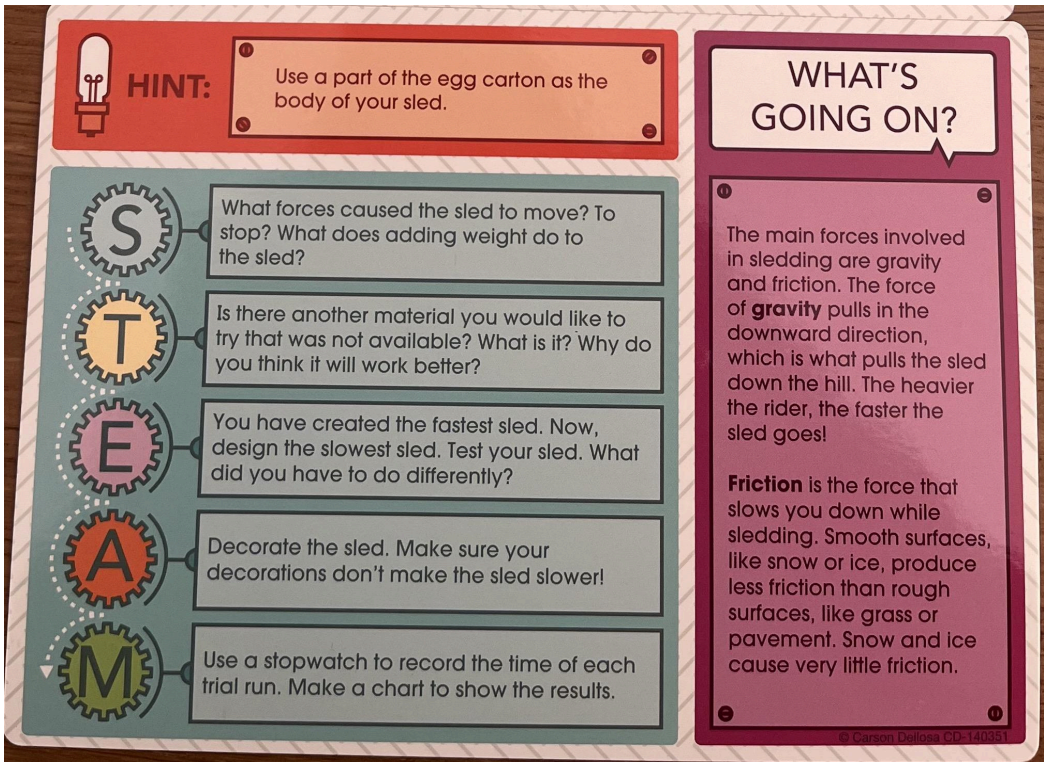
To make a projectile cover the most horizontal distance possible, it should be launched from a 45º angle.. If a projectile is launched from an angle greater than 45º, where will it go? (Answer: It will go higher, but not cover as much horizontal distance.) If the same projectile is launched from an angle less than 45º, where will it go? (Answer: It will not go as high and therefore is pulled to the ground more quickly by gravitational force, and thus, falls short.)

Lever- the stick that carries the load

When you push the load down- energy is being stored. When you release the load, the object will move at the same speed as the lever. The lever will eventually stop moving, but the object continues to move because of Newtons' first law- object in motion stays in motion

Have students make different catapults and change the launch angle- have them record results

Activity- Speedy Sleds (Extra Materials Not Needed)



Activity- Speedy Sleds (Extra Materials Needed)

Materials- egg carton, bags, pipe cleaners, paper, pennies or weight, clothes pin. Create a ramp- using books or a cardboard ramp (you can add material onto the ramp to change the friction)

Teaching Points- GRAVITY AND FRICTION

Gravity is the force by which a planet or other body draws objects toward its center. Anything that has mass has gravity. Objects with more mass have more gravity. Gravity also gets weaker with distance. So, the closer objects are to each other, the stronger their gravitational pull is.

Friction is a force that acts between two objects that are in contact with one another. It slows or stops movement between the two surfaces that are touching.

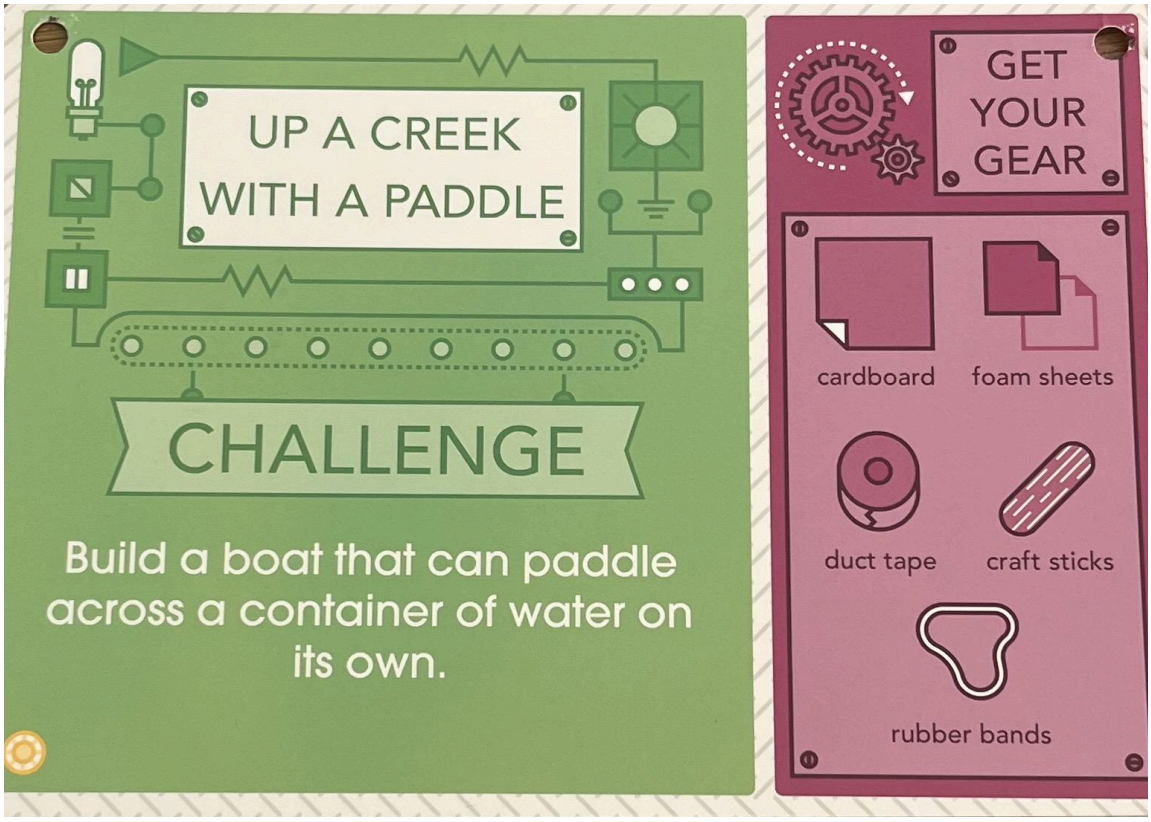
-Friction occurs between all types of matter—liquids, gases, and solids. Some substances cause more friction than others. Surfaces that slow movement down most are described as high friction, while those that allow more movement are described as low friction. Rough surfaces cause more friction than smooth ones.

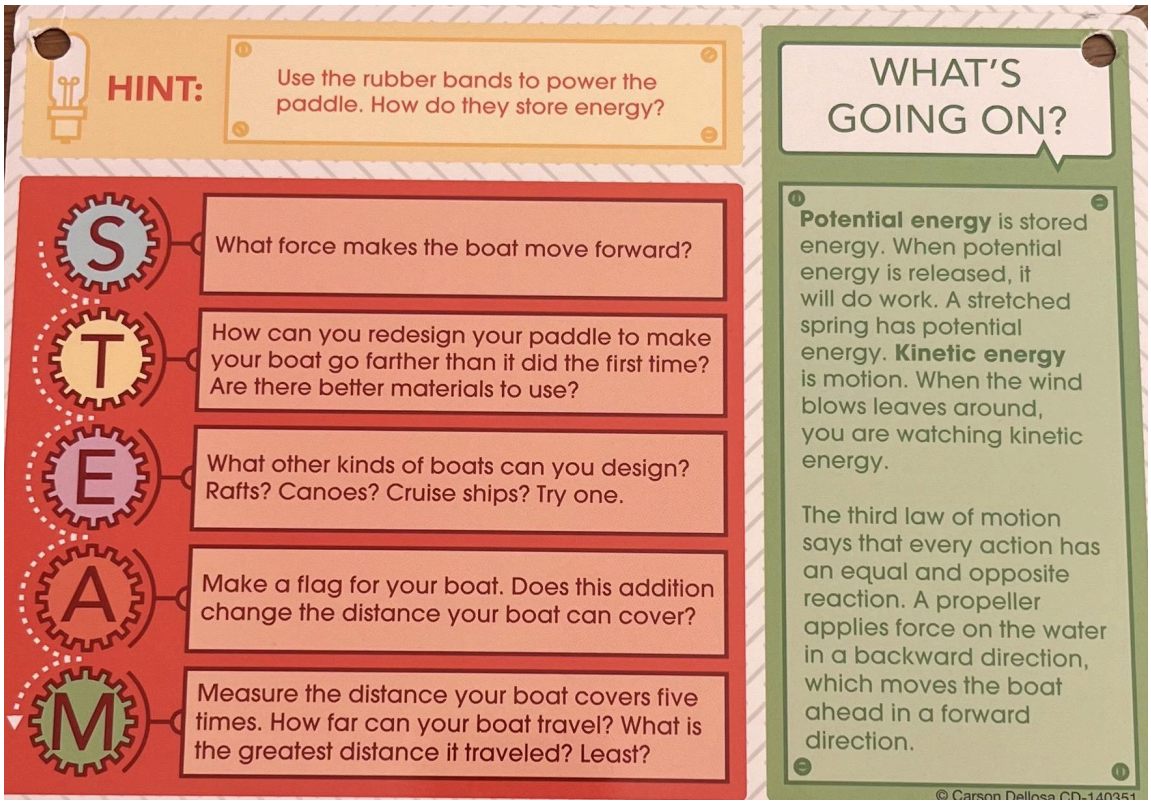
-Air resistance is a type of friction that occurs between a moving object and air. It slows down the movement of the object, but it can be reduced by changing the design of the object. This is called streamlining. Cars, trains, and airplanes, for example, are given smooth, curved surfaces to aid the flow of air around them.

-Friction can be useful. The rubber brakes on a bicycle slow down the wheels when they are applied, and friction between shoe soles and the ground prevent slipping. Friction also causes heat to be created, such as when you rub your hands together.

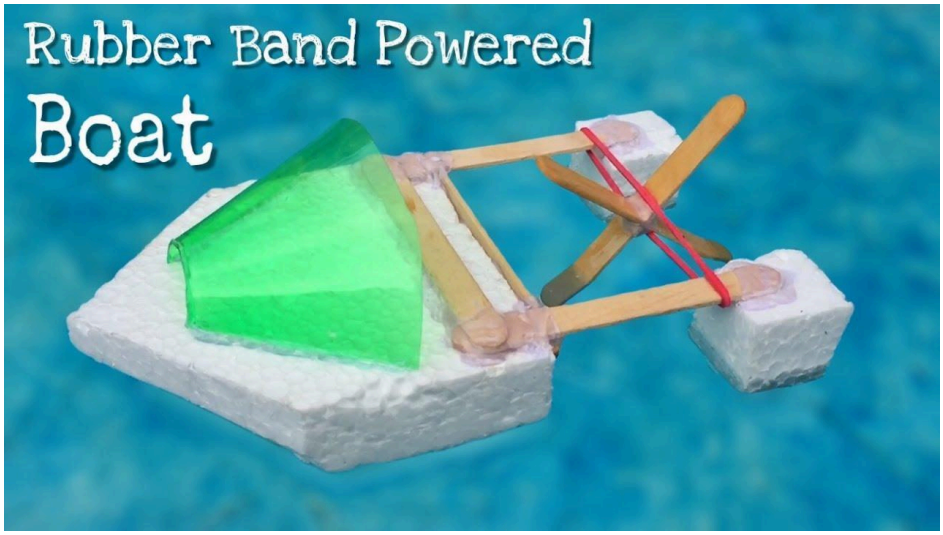
-Friction can also cause problems. When two parts of a machine rub against each other they can cause damage, and they lose energy in the form of heat. Using lubricants, such as oil, can reduce friction. Lubricants are substances that help surfaces move against one another more smoothly.

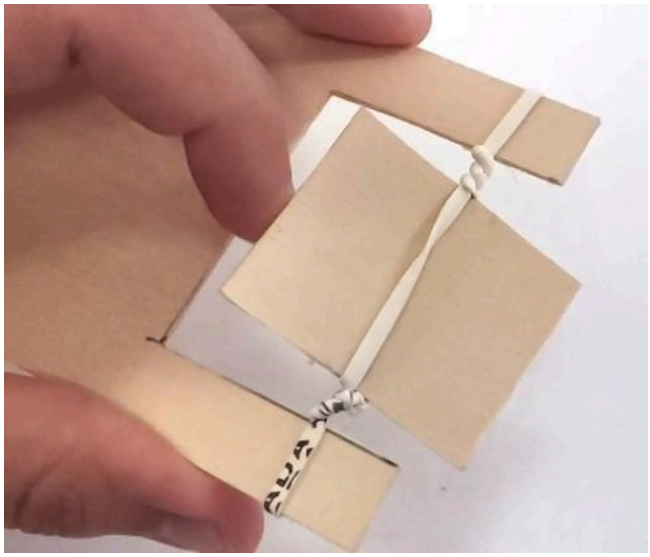
Activity- Up a Creek With a Paddle (Extra Materials Needed)





Materials- per the card; rubber bands are the key to make the boat move. It is ideal to have a large container full of water to test the boats

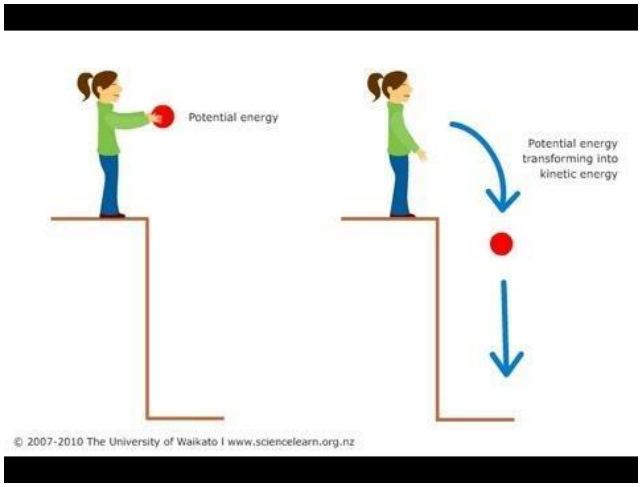




You can watch a YouTube Video on how to make a rubber band powered boat

Teaching Points- Potential Energy vs Kinetic Energy

The main difference between potential and kinetic energy is that one is the energy of what can be and one is the energy of what is. In other words, potential energy is stationary, with stored energy to be released; kinetic energy is energy in motion, actively using energy for movement.



The 2 laws of physics demonstrated with the boat

1. When you twist up the rubber band, it stores potential energy (the energy stored in a stretched material). When you release the rubber band, this potential energy is converted to kinetic energy (the energy of motion), and the boat moves forward.
2. When the paddle spins, it pushes on the water, pushing the water backward. According to Newton's third law of motion, for every action there is an equal and opposite reaction. This means that the water pushes back on the paddle, pushing the entire boat forward.

Activity- Terrific Turbines #1 (Extra material- cone paper cups)

Save these turbines for the next lesson.

Materials- pencil, thumbtack, tape, cone paper cups, straws

Design- see pictures below.

-center cone cup- hole in bottom. place on pencil. do not tape it, it needs to move (it eventually will stay in place when you get to step #3, the thumbtack will hold it)

-one each end of the straw- insert the cone cup (punch holes in the cups). You can use tape to secure

-criss cross straws, place in the center, and use a thumbtack to hold in place

Teaching Points

The Sun Makes the Wind Blow

The energy and wind comes from the sun. When the sun shines, it heats the earth's surface. The equator gets more sunlight (radiant energy) then the north or south poles. The Earth is not heated evenly.

Dark areas of land, like forests, absorb a lot of solar energy. Areas of water reflect solar energy. Light color, desert, sand, snow, ice reflect the sunlight too.

As the earth's surface absorbs the sun's energy, it turns the light into heat. The heat on the earth's surface warms the air above it. The air over the equator is warmer than the air over the poles. They are overland is warmer than air over water.

As air heats, it expands. Hot air rises. Cooler air rushes to take its place. This moving air is wind. Wind is caused by uneven heating of the earth surface.

Wind effects

The wind makes waves in lakes and oceans. The wind pushes desert sand into dunes and creates sandstorms. The wind spreads the sun's heat throughout the atmosphere. This keeps the earth warm enough for us to survive. The wind carries air pollution away from where it's made. Sometimes the wind creates violent storms out on the ocean and on land.

Storms

Sometimes, storms have very strong winds, especially over the oceans. These storms can be dangerous and have different names, depending on where they are located. In the Atlantic ocean, they are called hurricanes. In the Pacific Ocean, they're called typhoons. The Indian ocean, they are called cyclones.

A powerful storm on land can produce a tornado. A tornado develops from a giant thunderhead cloud. Air rises and falls inside the cloud. When cool air in the cloud sinks, it carries its spinning motion to the ground.

Ocean storms and tornadoes can be very dangerous. The strongest hurricane wins and 155 miles per hour, the most powerful tornadoes can blow over 300 miles an hour

Plants and animals

Some small plant seeds are very light. They are carried by the winter new places. This is an important part of nature. Plant seeds were carried away from their parents. They spread out across the land. As they grow in new places, they don't have to compete with other plants for nutrients, water, and sunlight. Any plant seeds, spores, and fruits use the winter to survive.

Animals also depend on the wind for survival. Many animals depend on smell to warn them of danger. The wind can carry smells a long way. Animals can stay away from predators and catch prey with help from wind.

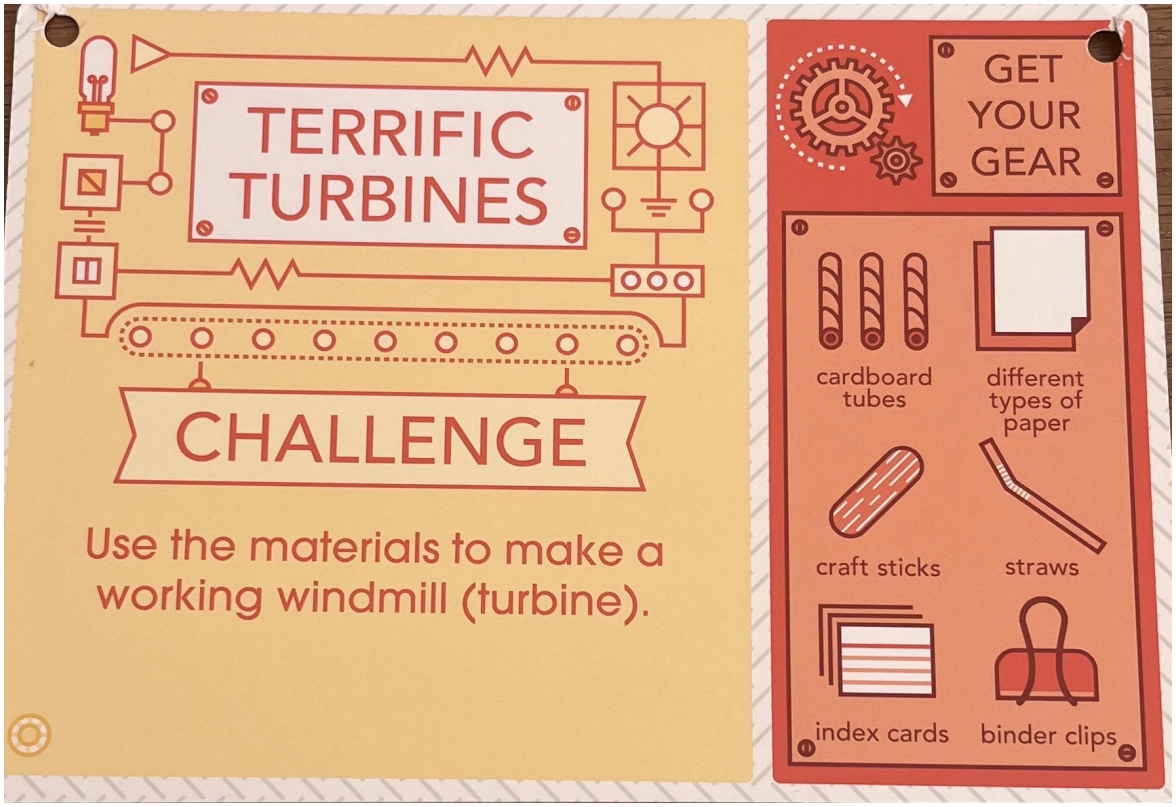
Birds soar in the sky and migrate with the help of the wind. Some tiny animals even depend on the wind to carry them from one living area to another. Some tiny animals even depend on the wind to carry them from one living area to another.

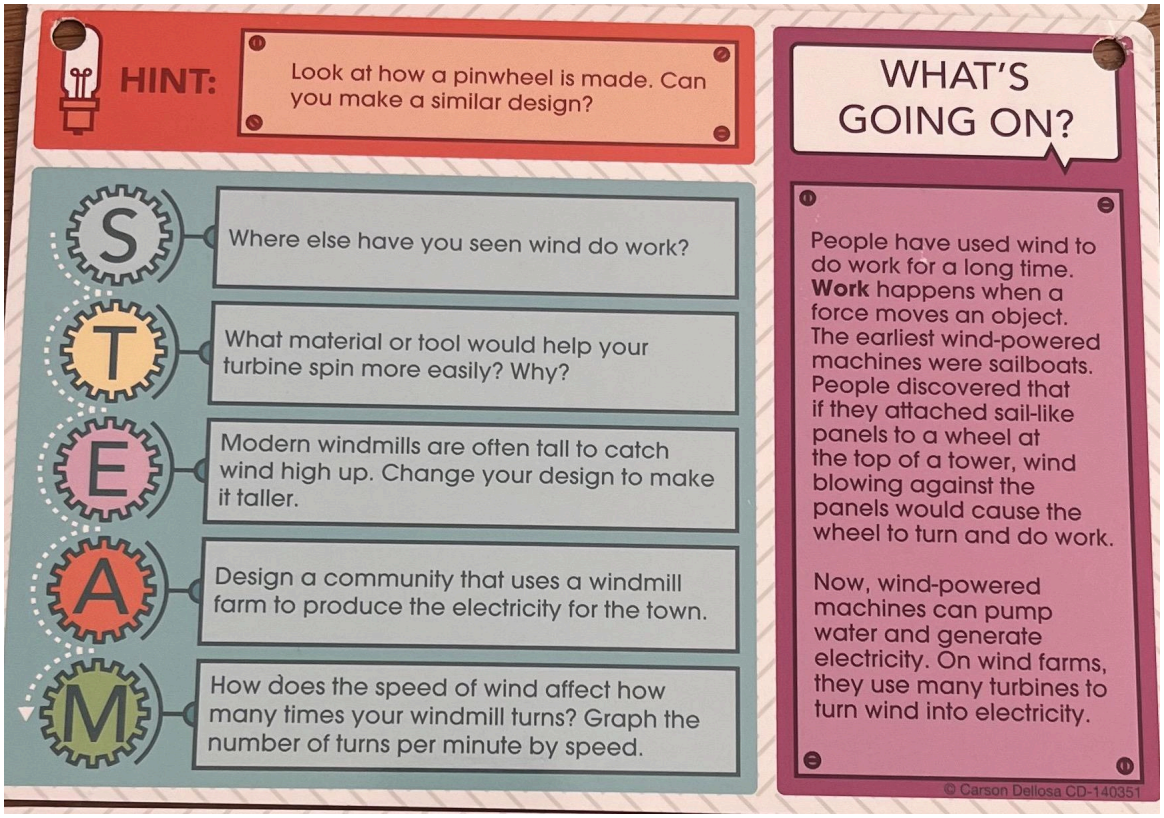
Wind used to create energy

In the 1200s, Europeans began to build windmills. Today, scientist, find new ways to capture energy and wind. They develop new wind turbines to make electricity.

In 2020- 88% of the energy came from non renewable sources (fossil fuels); 12% renewable (wind making up 8%)

Activity- Terrific Turbines #2 (No Extra Materials Needed)



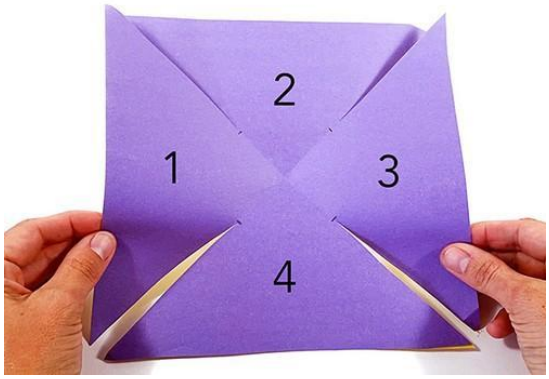


The purpose of this is to build on #1 and have students create their own wind turbines.

Materials- Per group - paper, 3 pencils, 3 thumbtacks, tape

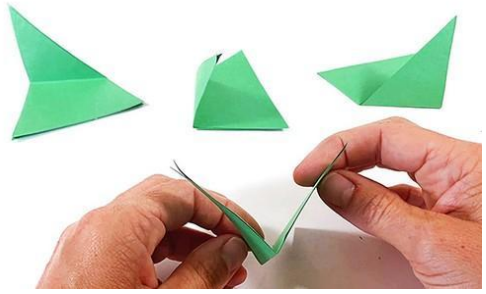
Make 3 pinwheel designs.

Design #1 (2 pieces of paper)



Design #2

Design #3



Teaching Points- Pinwheel Testing

Test each of your pinwheel designs. If it is windy outside, you can do this by taking them outside and holding them in the breeze. Or you can hold them each in front of a small fan or ceiling fan, or use a hairdryer on the lowest, cool setting to blow air at your pinwheel.

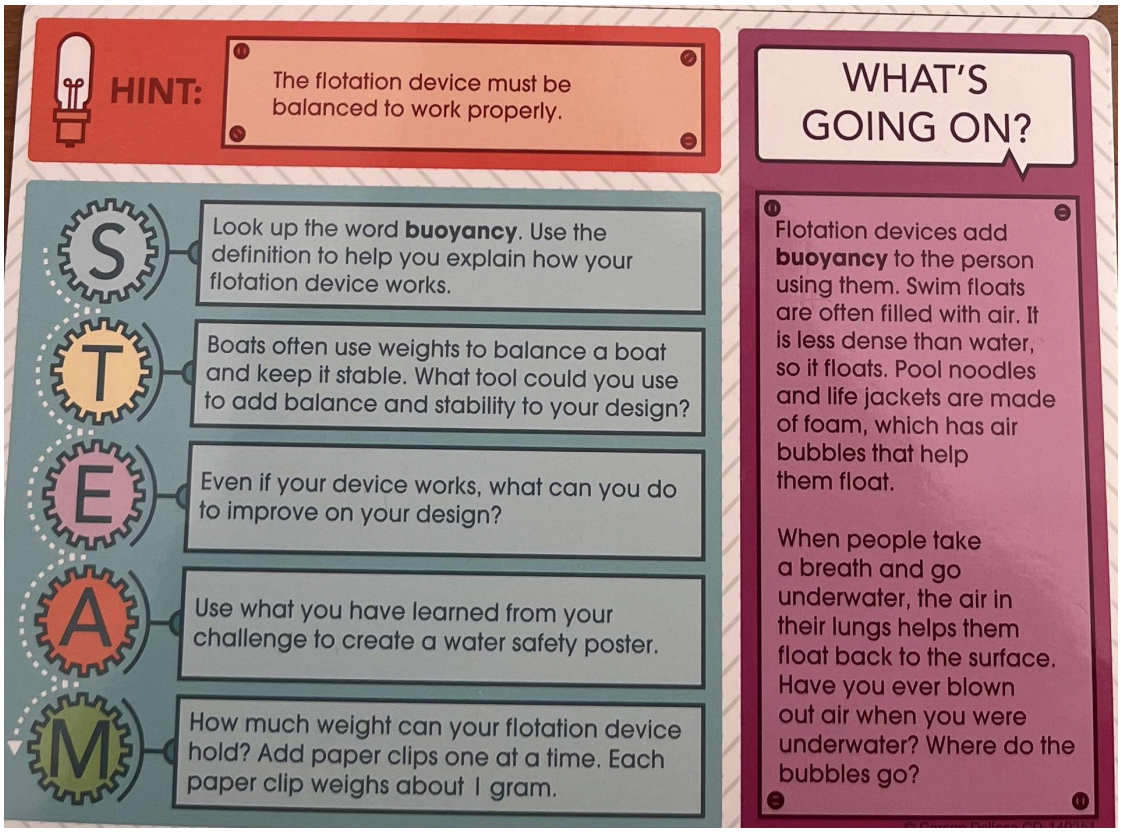
For each test, hold your pinwheel to the wind, and count the number of full rotations in 1 minute. Also observe how well the pinwheel performs in the wind. *Which pinwheel seems the sturdiest? Which one seems the weakest?*

The difference in performance of each pinwheel was the result of the different shaped rotor blades that you tested. The first pinwheel's blade design allowed each blade to capture the most air as it rotated. To understand why this made it move faster, imagine a swimmer, racing through the water. With each stroke, a good swimmer will keep their hand closed and slightly cupped, to try to capture the most water in their hand. This allows the swimmer to 'push' against more water, and propel themselves forward. You can imagine if they spread their fingers and allowed the water to flow through, they wouldn't be able to push themselves through the water as quickly.

Your first pinwheel design is based on the same principles. Because it's folded over, it acts like a pocket for collecting air. The more air it can collect, the more efficiently it will be pushed around the rod. The other two pinwheel designs did not collect air in the same way, therefore they weren't pushed as quickly or smoothly as the first design.

Wind Energy- Wind turbines machine that converts the kinetic energy (energy of the wind moving) of the wind often into electricity (a generator takes the kinetic energy and converts it to an electrical current)

Activity- Stay A-Float (Extra Materials Needed)



Activity- Stay A-Float (Extra Materials Needed)

Materials- per the card; container to test out your flotation device

Teaching Points

if the weight of the object being placed in the water is less that the weight of the water displaced, the object will float. This is known as buoyancy

Life Jackets

Life jackets use buoyancy too. Since your body is mostly water, holding on to a light life jacket is enough to keep you afloat in the deep.

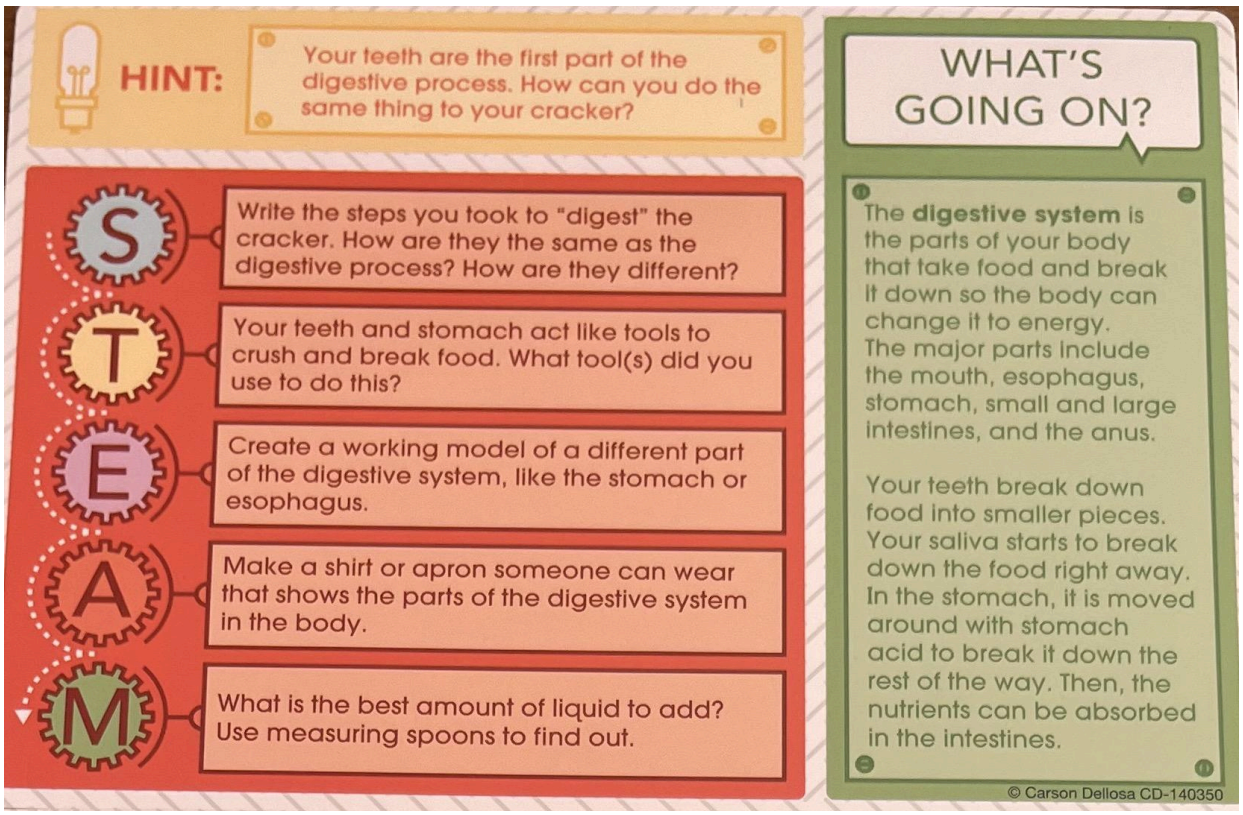
The material inside a life jacket traps air when the jacket is covered in water. This trapped air weighs much less than the water it displaces. So, the life jacket floats and its buoyancy is strong enough to support your weight too.

When we take a deep breath and go underwater, the air in our lungs helps us float.

Why do we blow bubbles out? If you exhale a steady stream of bubbles while swimming, the carbon dioxide doesn't build up in your system and you won't feel the anxiety to take a breath.

Question for the kids- The next time you are in a swimming pool, try floating. Lie flat on your back and try to keep afloat. You will notice that you are more buoyant when you inhale, than when you exhale. Can you figure out why?

Activity- Digest This (Extra Materials Needed)



Activity- Digest This (Extra Materials Needed)

Materials- one plastic zipper-top sandwich bag, 3 crackers , 1 tablespoon water, few drops of vinegar (acid), sponge or napkin

DIRECTIONS + TEACHING POINTS

1) Look at the crackers. Notice anything happening inside your mouth? Your body prepares for digestion—the process of breaking down food to absorb nutrients—even before you begin eating. When you see or smell food, saliva (or spit) forms inside your mouth.

2) Place the crackers and water inside your baggie. Seal it tightly and mash it with your knuckles. This is similar to how your teeth mash food up into a mushy ball—called a bolus—that is easy to swallow. The water inside your baggie works just like your saliva: as you “chew,” it softens the food particles and helps break down your meal so that your body can absorb the fats and sugars.

3) When you swallow, your tongue pushes the bolus down your throat and into your esophagus, a long tube that leads to the stomach. Your stomach is like a giant mixer. put a few drops of vinegar in and knead it again. The vinegar is acidic, similar to the gastric juices and enzymes in the walls of your stomach. Together, churning movements and these secretions turn the bolus into a thick liquid called chyme.

4) The chyme enters the small intestine. Open your baggie and dab at the mixture with a sponge. With a little help from digestive juices provided by the liver, gall bladder, and pancreas, your small intestine “sponges up” vitamins and nutrients from the chyme. Anything that your body can’t use is passed to the large intestine.

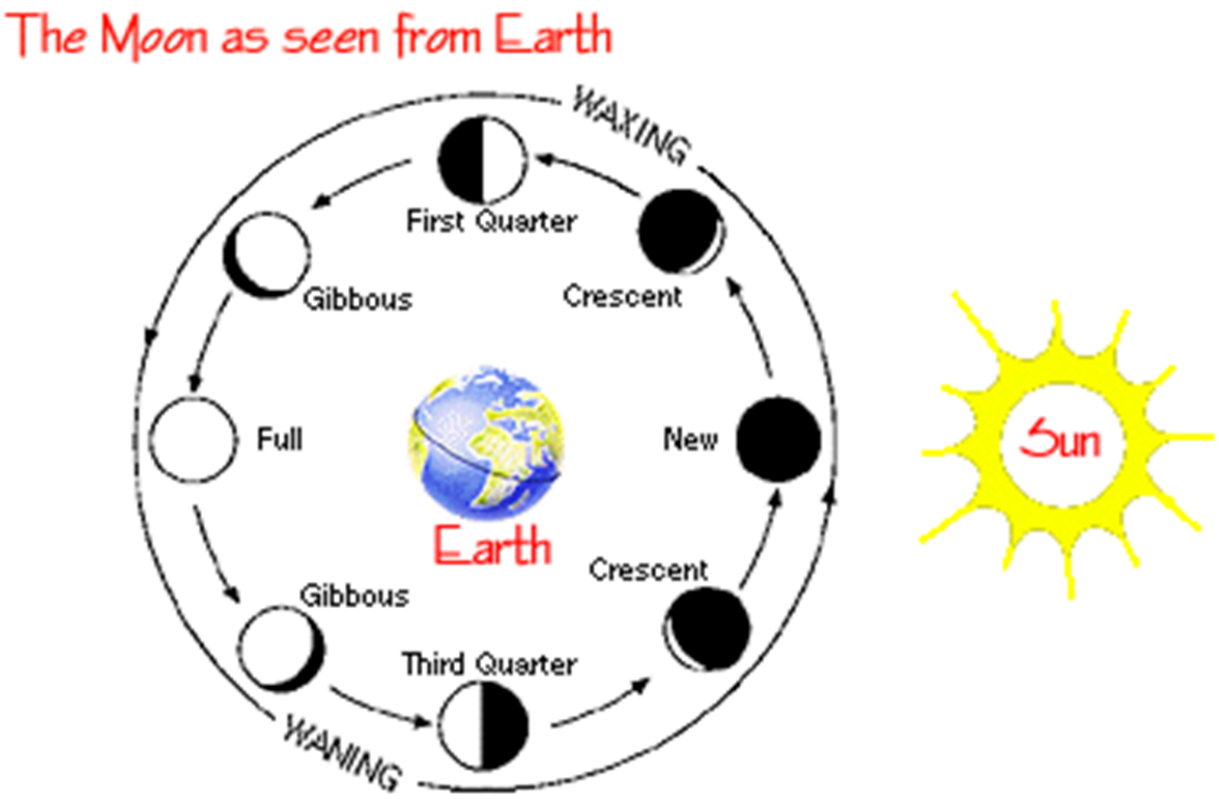
5) By now, the chyme is a thin, liquidy mixture. The large intestine absorbs the water from it, and what’s left exits your body…as poop! Press the air out of your baggie and snip off one corner, then squeeze out the contents into the bucket. The process of digestion is now complete

Video- How the Digestive System Works- Nemours KIdsHealth

Activity- Sun and Moon (No Extra Materials Needed)

Constellations (next activity) can be combined (No Extra Materials Needed)

Materials - Photocopy the SUn, Earth, Moon Model (1 per student), 2 brads paper fasteners



The Moon doesn't emit (give off) light itself, the '**moonlight**' we see is actually the Sun's light reflected off the lunar surface. So, as the **Moon orbits the Earth**, the Sun lights up different parts of it, making it seem as if the Moon is changing shape. In actual fact, it's just *our view* of it that's altering. When the Moon appears to be getting bigger, it's '**waxing**' and when it looks like it's getting smaller, it's '**waning**'. Once the face of the Moon is fully turned towards the Sun, it's a **Full Moon**, and we see it all. But, as the Moon moves around the Earth, the face pointing towards us gradually becomes hidden from the Sun until we can hardly see it at all – this is a **New Moon**.

10 Facts about Gravity (the force that attracts a body toward the center of the earth, or toward any other physical body having mass)

1. The Moon stays in place because of gravity.

If gravity didn't exist then the Moon would have probably floated away by now! It is kept in place by the gravitational force from Earth. Luckily the moon is traveling at the perfect speed. If the speed was any different, it would go off into another direction or come closer to Earth!

2. Isaac Newton discovered gravity.

Isaac Newton is the scientist who discovered gravity. It is believed that he came up with the gravitational theory after he watched an apple fall from a tree. It made him wonder why the apple fell straight down to the ground, rather than left or right… or even up into the sky! This was in 1665 or 1666.

3. Gravity causes the tides in the sea.

Did you know that gravity causes the tides in our seas and oceans? This is because gravity makes everything in the universe pull on each other. The Moon pulls on Earth and in turn, makes the water move! As Earth rotates, the water in our seas and oceans will build up on the side closest to the Moon. This is why we have high and low tides.

4. Gravity saves our lives!

Gravity is very important…If we didn't have gravity then we

wouldn't even be here…We would take off and be floating in space! All thanks to gravity we can stay grounded and go about our daily life!

5. The larger the mass of an object, the more gravity!

Mass is different to weight. Mass is made up from how many atoms are in the object.

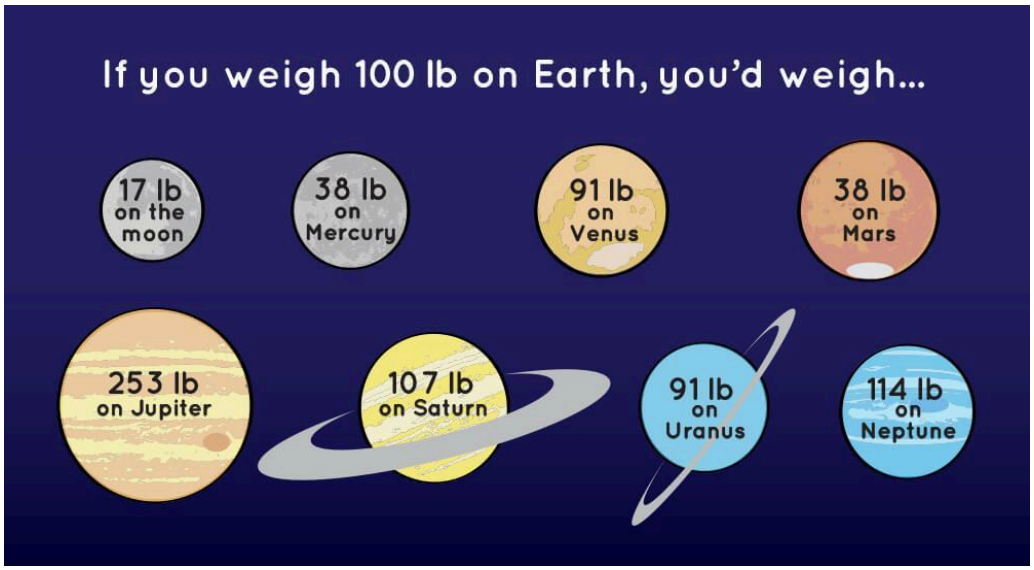
Weight is different because if you weighed yourself on Earth and then weighed yourself in space, it would be completely different! The mass of an object never changes. The larger the mass of an object, the more gravity there will be on that object.

6. In the whole universe, black holes have the biggest gravitational pull.

We need to stay away from black holes! They have the biggest gravitational pull in the whole universe. Don't worry, Earth is very far away from one. Nothing can escape their gravitational pull… and this even includes light!

7. Each planet has a different gravitational pull.

Gravity varies on each planet. This is because each planet has a different gravitational pull as each planet has a different mass. An object that weighs 100 pounds on Earth, would weigh 38 pounds on Mercury!



8. Without gravity, Earth wouldn't orbit the sun!

If gravity didn't exist then Earth wouldn't orbit the Sun. This time it's the Sun's gravity that keeps us orbiting it. We're very lucky as it keeps Earth at the perfect temperature so it's not too hot or cold!

9. Gravity isn't evenly spread on Earth.

That's right! Gravity isn't evenly spread on Earth. This is because Earth isn't a perfect sphere. The mass of Earth also isn't even. This means that gravity can vary slightly in different places.

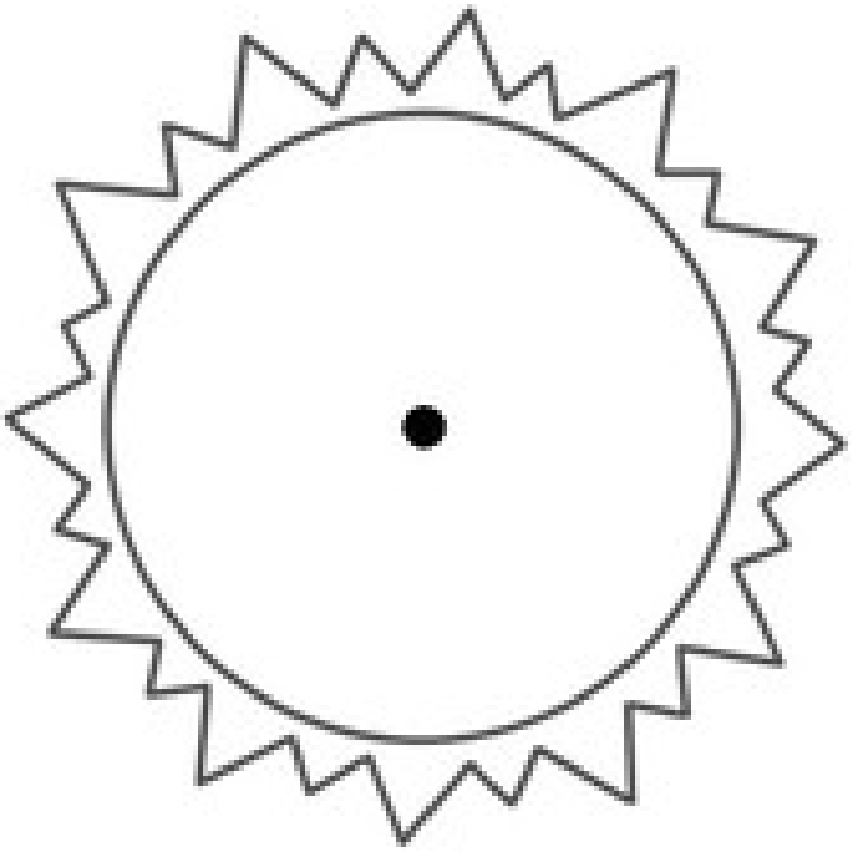
10. Gravity is making you shrink!

Did you know that you are taller first thing in the morning than when you go to bed at night? That's because gravity is pushing you down all day and is causing your spine to shrink. When you go to bed at night, your spine has a chance to stretch back out! You are about half an inch taller in the morning than you are at night. Get a tape measure and test it out!

Make a Model of the sun, earth, moon- it looks like this.

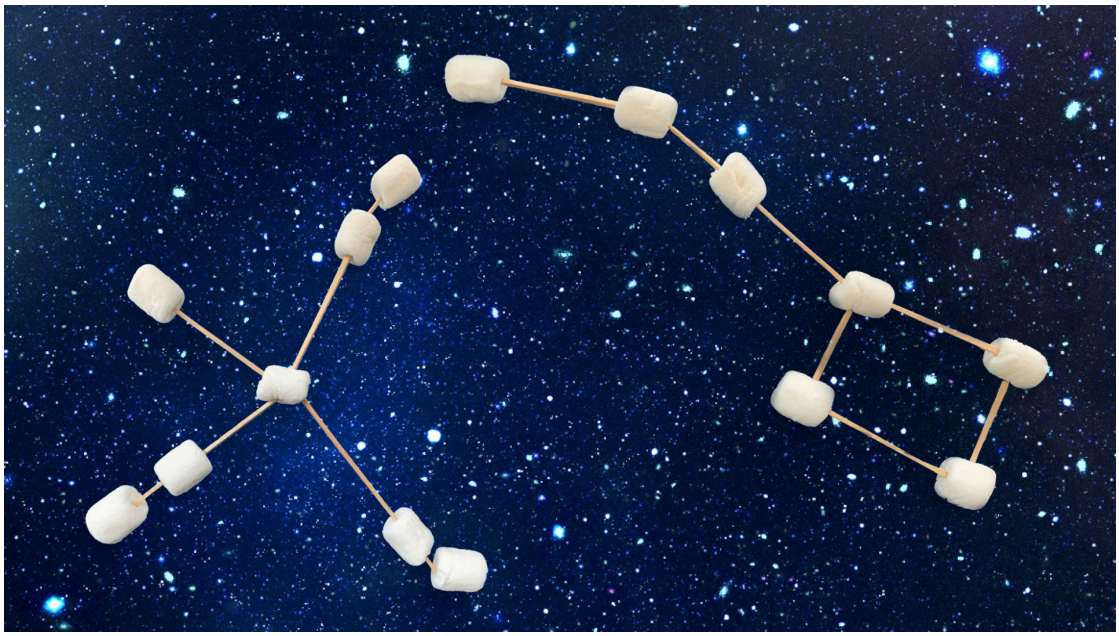
Sun, Earth & Moon Model

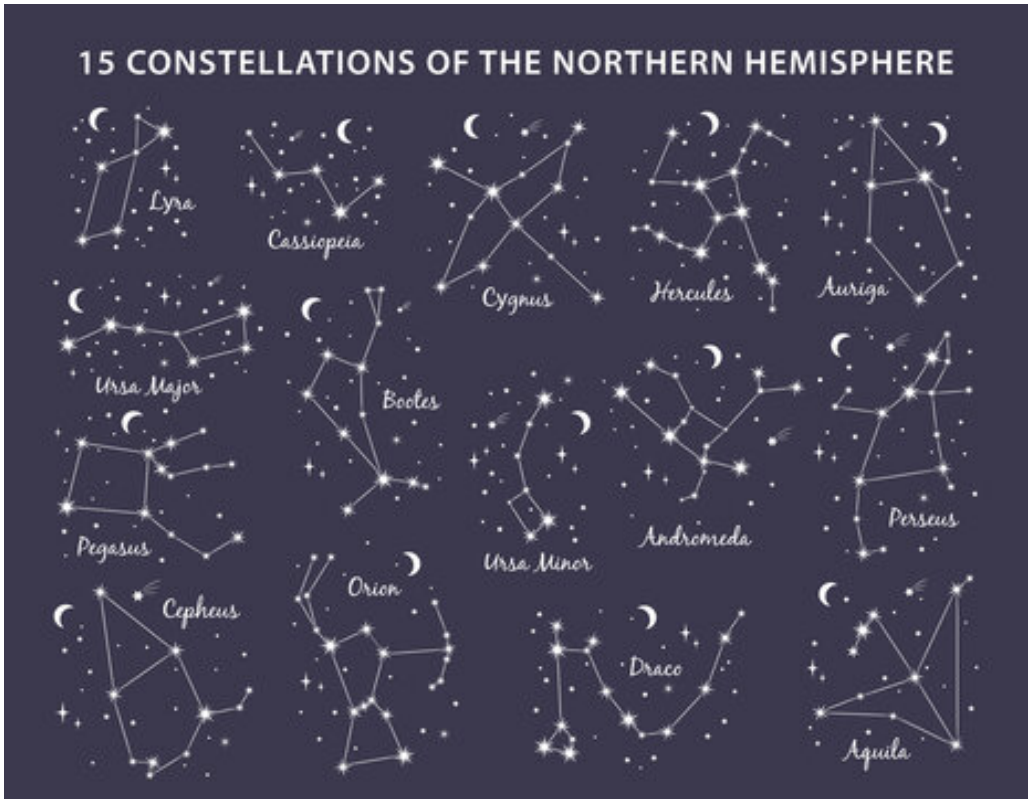
Directions: Color and cut out the Sun, Earth, Moon and cardstock strips. Attach with brads as shown.



Activity- Constellations (No Extra Materials Needed)

Materials- toothpicks, marshmallows or clay. Have the example constellations (constellations of the northern hemisphere) on a screen so the students can pick which ones they want to make





Teaching Points

The universe- 2 trillion galaxies. Our galaxy- milky way. Spins around, spiral shape. In the center is a black hole- region of space that is very dark/dense. In our galaxy are many stars (sun), all of the planets, moons

Milky Way has about 100 billion stars – 100,000,000,000. 4000 visible to the naked eye. 88 constellations

Stars are huge balls of burning gases, most of which are made of hydrogen. As the hydrogen gas in a star is squeezed due to gravity, it produces huge amounts of energy, which make it glow. The size, temperature, brightness, and color of stars vary.

The color of a star is determined by its temperature. Red stars are cooler in temperature, blue stars are hottest, and other stars like ours (which is yellow) are an in-between temperature.

Stars are really far away from Earth. A *light year* is how far light can travel in one year. Since light travels at 186,000 miles per second, it takes 8 minutes for light from the sun to reach the Earth. The next closest star to Earth is Proxima Centauri, which is a little over 4 light years away from Earth. That is 250,000 times farther away than the sun.

Our star, the sun, is average in terms of size and brightness. However, our star is extraordinarily important! Earth is the perfect distance from the sun.

The sun provides heat and light to our planet, supporting life on Earth. Earth is in the *habitable zone* of the sun. We are close enough to the sun to benefit from the light and heat, but far enough away to prevent Earth from being too hot and vaporizing all the water.

The sun is much larger than Earth. By comparison, if the sun were the size of a basketball, the Earth would be the size of a pencil point.

Specific constellations- Big and Little Dipper (Ursa Major and minor). The Little Dipper is used in navigation because the star that marks the end of the Dipper's handle or the tip of the Bear's tail is Polaris, the North Star, the closest bright star to the north celestial pole.

The story about Ursa Major and Ursa Minor

In Roman mythology, Jupiter, the greatest god of all, fell in love with one of the beautiful creatures called nymphs. This nymph was called Callisto, and she had a son named Arcas.

Jupiter had a wife called Juno, who was very jealous of Callisto.

That's why she turned Callisto into a bear—called Ursa in Latin—so that Jupiter wouldn't like her anymore.

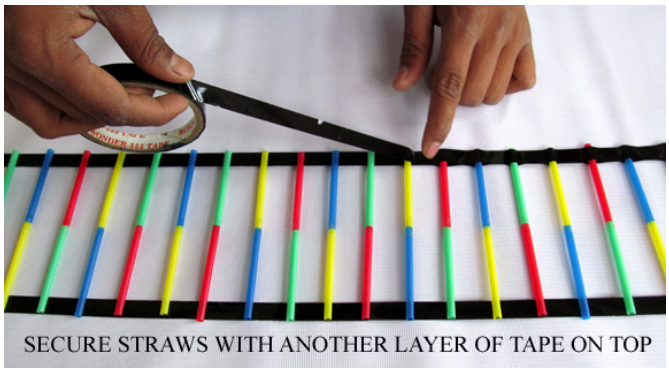
When Callisto was walking around in bear form, her son Arcas saw her and almost shot at her with his arrow.

To prevent the son from killing his mother, Jupiter intervened and turned Arcas into a bear as well so that he would follow his mother.

The two bears are known as Ursa Major and Ursa Minor.

Activity- DNA (No Extra Materials Needed)

Materials- 4 different colored straws or pipe cleaners or sticks that bend, masking tape



Different Cells in the Body - Our bodies have around 210 different types of cells. Each cell does a different job to help our body to function. There are blood cells, bone cells, and cells that make our muscles.

How do cells know what to do? Cells get their instructions on what to do from DNA. DNA acts sort of like a computer program. So DNA is found in every cell. DNA is short for deoxyribonucleic acid. Shape of DNA- double helix. On the outside of the double helix is the backbone (sugar and phosphate). DNA is a long thin molecule made up of something called nucleotides (nucleotides- sugar + phosphate + base). There are four different types of bases: adenine, thymine, cytosine, and guanine. They are usually represented by their first letter: A- adenine, T- thymine, C – cytosine, G – guanine. Each of the 4 letters have best friends they prefer to hold hands with. A likes T and G likes C and when put together they become instructions for the cells.

DNA comes together to form genes- genes become proteins and tell a cell what to do.

Interesting Facts about DNA

- About 99.9 percent of the DNA of every person on the planet is exactly the same. It's that 0.1 percent that is different that makes us all unique.
- If you unraveled all the DNA molecules in your body and placed them end to end, it would stretch to the Sun and back several times

Activity- Photosynthesis (Extra Materials Needed)

Materials- beads (3 colors, you need A LOT OF BEADS. Read the handout), pipe cleaners, Photocopy the handout below for all students and follow instructions

Lesson Extension

Life Science 22: Photosynthesis - The Game

Like all living organisms, plants need energy to grow! Plants get their energy by a process called photosynthesis. In this process plants take in sunlight, water, and carbon dioxide and create sugar (glucose) and oxygen.

Build a Balanced Equation of Photosynthesis

During photosynthesis, plants use sunlight, carbon dioxide, and water to make two products: glucose and oxygen. You can build a balanced equation of photosynthesis using beads and pipe cleaners!

Materials:

- 72 beads (12 black, 24 white, 36 red)
- 9 pipe cleaners (1 long, cut the other 8 into 1/4s to equal 32 short pieces, you will only need 30)
- Make an arrow out of the two leftover short pipe cleaners

Procedure:

1. Make 6 CO_2 reactant molecules. Create one by sliding beads on 1 short pipe cleaner: 1 red, 1 black, 1 red.

Carbon dioxide
CO_2

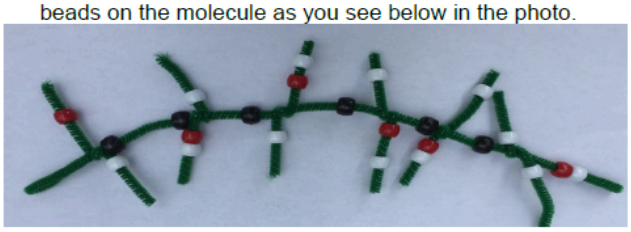
2. Make 6 H_2O reactant molecules. Create one by sliding beads on 1 short pipe cleaner: 1 white, 1 red, 1 white.

Water
H_2O

3. Make 6 O_2 product molecules. Create one by sliding beads on 1 short pipe cleaner: 2 red.

Oxygen
O_2

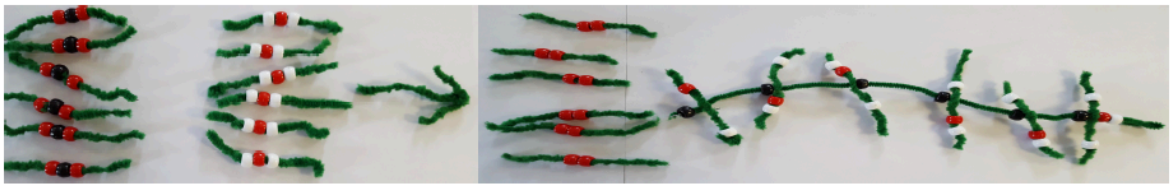
4. Make 1 $C_6H_{12}O_6$ product molecule by sliding beads on the long pipe cleaner: 6 black; space them out. Attach 12 small pipe cleaners to the long pipe cleaner (on either side of the black beads). Place the remaining red and white beads on the molecule as you see below in the photo.



Glucose
$C_6H_{12}O_6$

Congratulations! You just created a model of photosynthesis!

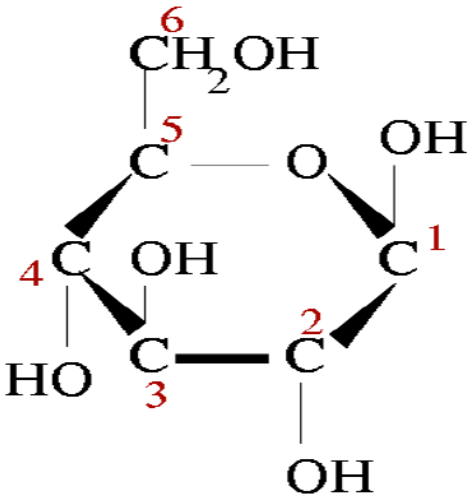
In a row, arrange all of the carbon dioxide molecules together and then the water molecules; follow with the arrow. Place the oxygen molecules together and then the glucose molecule.



Question: Fill in the table below by counting the number of carbon, hydrogen, and oxygen beads before ***and*** after the arrow. What do you notice?

Number before arrow		Number after arrow	
Carbon		Carbon	
Hydrogen		Hydrogen	
Oxygen		Oxygen	

Note: *The glucose molecule that plants make is a ring structure. If you would like a challenge, here is a diagram of glucose. Try to create a glucose ring!*



(Image source: https://commons.wikimedia.org/w/index.php?title=File:Beta-d-glucose.png&oldid=149839126)

Additional Resources:

- Photosynthesis game by Wonderville: http://www.wonderville.ca/asset/photosynthesis
- Crash Course Kids #5.2, Vegetation Transformation (simple explanation of photosynthesis) (2:59, sound) https://www.youtube.com/watch?v=EstPeBt9CyU

Activity- Acids and Bases (Extra Materials Needed)

Materials- Vinegar, Apple juice, Water, Milk, Soap, Carpet cleaner, Baking soda. Litmus paper and a pH scale- this scale comes with the litmus paper (put all liquids in a cup and have the students use litmus paper to figure out their pH). The items listed are in order of most acidic to basic.

In the end, when the kids mix acid + base, you will get a “small explosion” so you will need trays to put the cups in so clean up the mess

Teaching Points

Every liquid you see will probably have either acidic or basic traits. So what makes an acid or a base? When you put molecules into water, sometimes they break down and release an H + (hydrogen) ion. At other times, you find the release of an OH - (hydroxide) ion. When a hydrogen ion is released, the solution becomes acidic. When a hydroxide ion is released, the solution becomes basic.

Scientists use something called the pH scale to measure how acidic or basic a liquid is. Although there may be many types of ions in a solution, pH focuses on concentrations of hydrogen ions (H +) and hydroxide ions (OH -). The scale measures values from 0 all the way up to 14. Distilled water is 7 (right in the middle). Acids are found between 0 and 7. Bases are from 7 to 14. Most of the liquids you find every day have a pH near 7. They are either a little below or a little above that mark. When you start looking at the pH of chemicals, the numbers can go to the extremes.

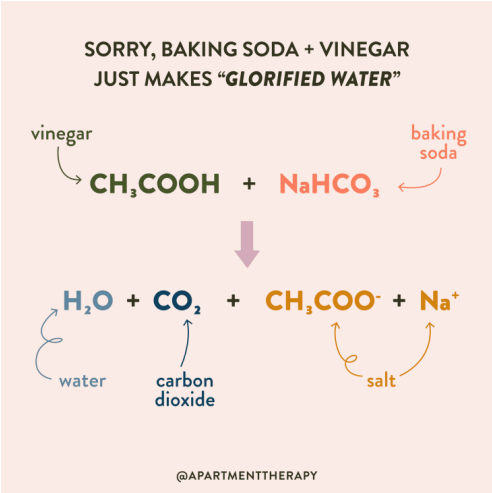
Buffers- Human blood needs to keep its pH right around 7.4, and avoid shifting significantly higher or lower – even if acidic or basic substances enter or leave the bloodstream. Buffers, solutions that can resist changes in pH. When there are too many

H ions, a buffer will absorb some of them, bringing pH back up; and when there are too few, a buffer will donate some of its own. For instance, one of the buffers that maintain the pH of human blood involves carbonic acid and its conjugate base, the bicarbonate ion.

H+ + HCO3- ←--> H2CO3

If too many H, the above will be pushed to the right, and bicarbonate ions will absorb the H. if there are too few H, the equation will be pulled the left and carbonic acid will turn into bicarbonate, donating H

To end- have kids mix the vinegar and baking soda



Baking soda is a base, and vinegar is an acid. When they're combined, acids "donate" protons to bases; in this case, it's acetic acid lending a hydrogen proton to the bicarbonate (the HCO3 portion). When bicarbonate gains a hydrogen proton, it forms carbonic acid (or H2CO3) which is unstable and eventually decomposes. Once that happens you're left with water, carbon dioxide, and acetate and sodium ions. The carbon dioxide gained in the reaction is what makes it bubbly, which looks appealing. But once the bubbles stop, you're left with what Morris describes as "glorified water."

Activity- The Carbon Cycle (Extra Materials Needed- Coins)

Materials- you need a copy of the Carbon Cycle Diagram to give to each student; after you review the carbon cycle there is a game to play.the game is below and instructions are included. To play the game, you print out the 5 stations and each student needs 2 coins

VIdeo- The carbon cycle - Nathaniel Manning | TED-Ed

Teaching Points

Climate change

Climate change describes a change in the average conditions — such as temperature and rainfall — in a region over a long period of time. NASA scientists have observed Earth's surface is warming, and many of the warmest years on record have happened in the past 20 years.

Weather describes the conditions outside right now in a specific place. Climate, on the other hand, is more than just one or two rainy days

Global climate change refers to the average long-term changes over the entire Earth. These include warming temperatures and changes in precipitation, as well as the effects of Earth's warming, such as: Rising sea levels, Shrinking mountain glaciers, Ice melting at a faster rate than usual in Greenland, Antarctica and the Arctic, Changes in flower and plant blooming times.

Some parts of Earth are warming faster than others. But on average, global air temperatures near Earth's surface have gone up about 2 degrees Fahrenheit in the past 100 years. In fact, the past years have been the warmest in centuries.

Certain gases in Earth's atmosphere block heat from escaping. This is called the greenhouse effect. These gases keep Earth warm like the glass in a greenhouse keeps plants warm.

Atmosphere- 78%nitrogen, 21%oxygen, 0.9%argon, and 0.1%other gases. Trace amounts of **carbon dioxide**, methane, water vapor, and neon are some of the other gases that make up the remaining 0.1%

Human activities — such as burning fuel to power factories, cars and buses — are changing the natural greenhouse. These changes cause the atmosphere to trap more heat than it used to, leading to a warmer Earth.

The carbon cycle is a process where carbon dioxide travels from the atmosphere into living organisms and the Earth, then back into the atmosphere. Plants/trees (those in the ocean and on land) take carbon dioxide from the air along with water and

photosynthesis from the sun and use it to make food. Animals then eat the food and carbon is stored in their bodies and released.

Most of the carbon they consume is exhaled as carbon dioxide. The CO2 then is returned to the atmosphere where the plants use it again.

When dead plants, animals, and animal waste break down or decompose, they also release carbon dioxide as well, known as methane.

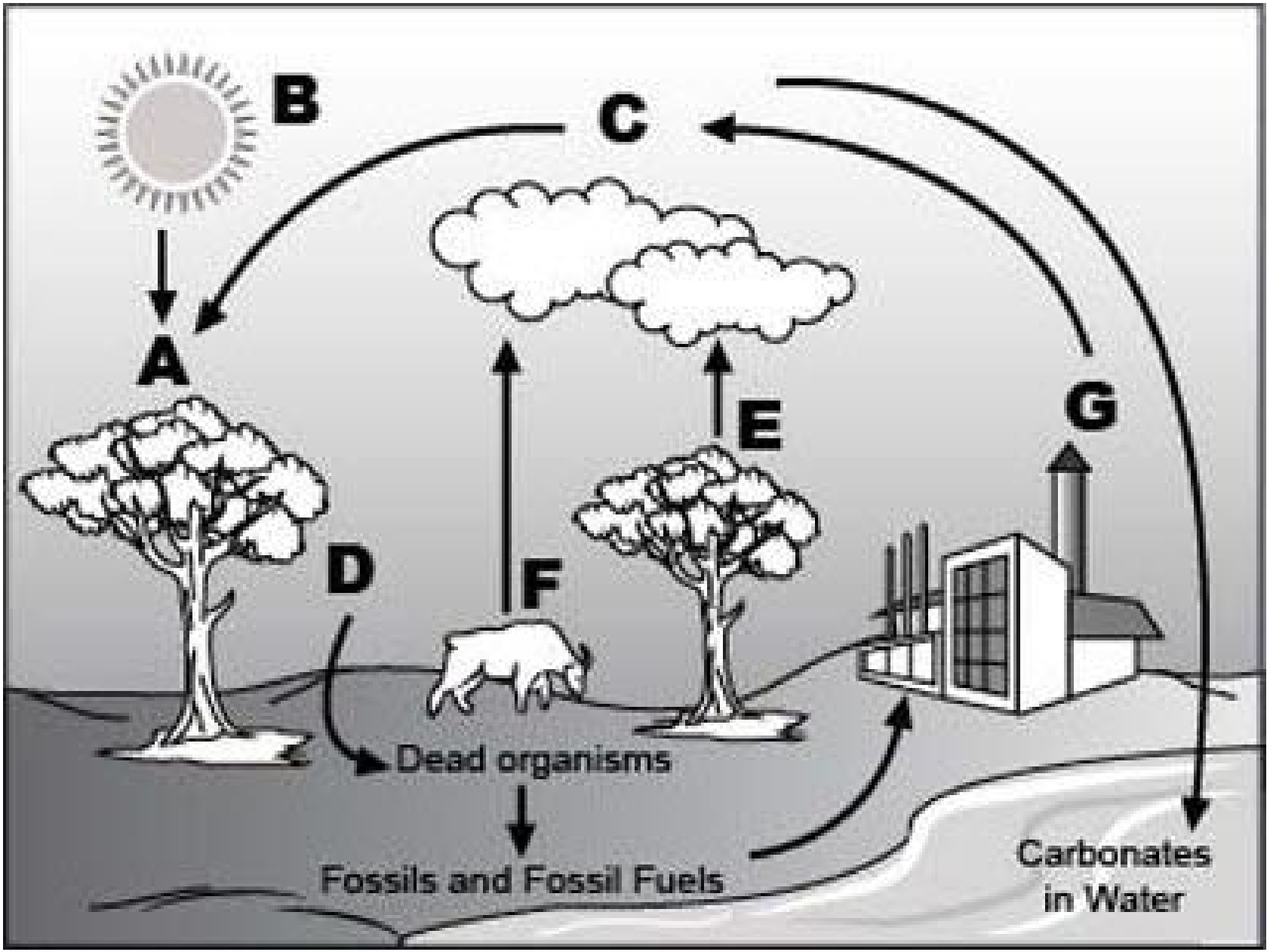
The ocean takes up carbon dioxide (30%) through photosynthesis by plant-like organisms (phytoplankton), as well as by simple chemistry: carbon dioxide dissolves in water. It reacts with seawater, creating carbonic acid.

The carbon cycle is the Earth's ultimate form of recycling and is a delicate balance. Carbon dioxide is a greenhouse gas and traps heat in our atmosphere. Burning more fossil fuels has created more than 30% more carbon dioxide in the atmosphere than 150 years ago – this is making the earth become warmer. Helping to keep our environment clean by burning fewer fossil fuels will assure this cycle keeps going for our future generations.

ANSWERS TO THE SCHEMA BELOW

A. photosynthesis
B. sun
C. CO2
D. plants and animals dying
E. plants releasing some CO2
F. animals releasing some CO2
G. Combustion

Highlight that The ocean absorbs about 30% of the CO_2 that is released in the atmosphere. It reacts with sea water creating an acid, affecting the animals


B
C
A
E
G
D
F
Dead organisms
Fossils and Fossil Fuels
Carbonates
in Water

Carbon cycle game

https://edu.rsc.org/download?ac=512702

Purpose

You are a carbon atom moving through the carbon cycle. Move around the different stations and record your journey!

How to play

There are five stations: FOSSIL FUELS, ATMOSPHERE, PLANT, ANIMAL, SEA

At each station you must flip two coins and then, depending on what combination of heads (H) or tails (T) you get, follow the instructions on the station card.

You will need

Two coins, The Carbo Cycle Passport to fill out (where did you start, what happened to you, and where do you go?). At the end, review the where everyone ends up (do most people end up in the atmosphere?)

Instructions

1. Pick a station to start at.
2. To move around, you must flip two coins and follow the instructions at each station depending on what combination of heads (H) or tails (T) you get:

HH = 2 heads **TT = 2 tails** **HT = 1 heads/1 tails**

3. Keep going until you get locked up (or for 10-15 min). Each person should count the number of items they are in FOSSIL FUELS, ATMOSPHERE, PLANT, ANIMAL, SEA

THE ATMOSPHERE– CO_2 molecule	
Flip two coins:	
TT	You have not been absorbed. Stay in the atmosphere for another round.
HT	You have been absorbed into the leaf of a plant. Move to the plant.
HH	You have dissolved into the sea. Move to the sea.

FOSSIL FUELS	
Flip two coins:	
TT	You have not been mined. Stay at fossil fuels for another round.
HT	You have been mined, and have been burnt as a fuel, releasing CO_2. Return to the atmosphere.
HH	

A PLANT	
STAGE 1: **The leaf** Flip two coins:	
TT	There is no sunlight. Photosynthesis cannot occur. The plant still respires – you must return back to the atmosphere as CO_2.
HT	Sunlight is present. Photosynthesis can occur, and you have been incorporated into a sugar molecule. Progress to the next stage.
HH	
STAGE 2: **Sugar/Carbohydrates** Flip two coins:	
TT	The plant has been eaten by an animal. Move to the animal.
HT	The plant has lived a long life and has died. After many thousands of years, the plant has decayed and been buried deep into the ground. It has been locked in as a fossil fuel! Move to the fossil fuels.
HH	

THE SEA	
Flip two coins:	
TT HT	The sea creature has respired. The carbon dioxide produced is released into the atmosphere. Move to the atmosphere.
HH	The sea creature has lived a long life and has died. After many thousands of years, the creature has decayed and been buried deep into the ground. It has been locked in as sedimentary rock!

ANIMALS	
Flip two coins:	
TT	Respiration has occurred. You have been released into the atmosphere as CO_2. Move to the atmosphere.
HT	The animal has lived a long life and has died. After many thousands of years, the animal has decayed and been buried deep into the ground. It has been locked up as a fossil fuel! Move to the fossil fuels.
HH	The animal has been eaten by a larger animal. Stay for another turn.

Carbon Cycle Passport - Have Students Fill This Out

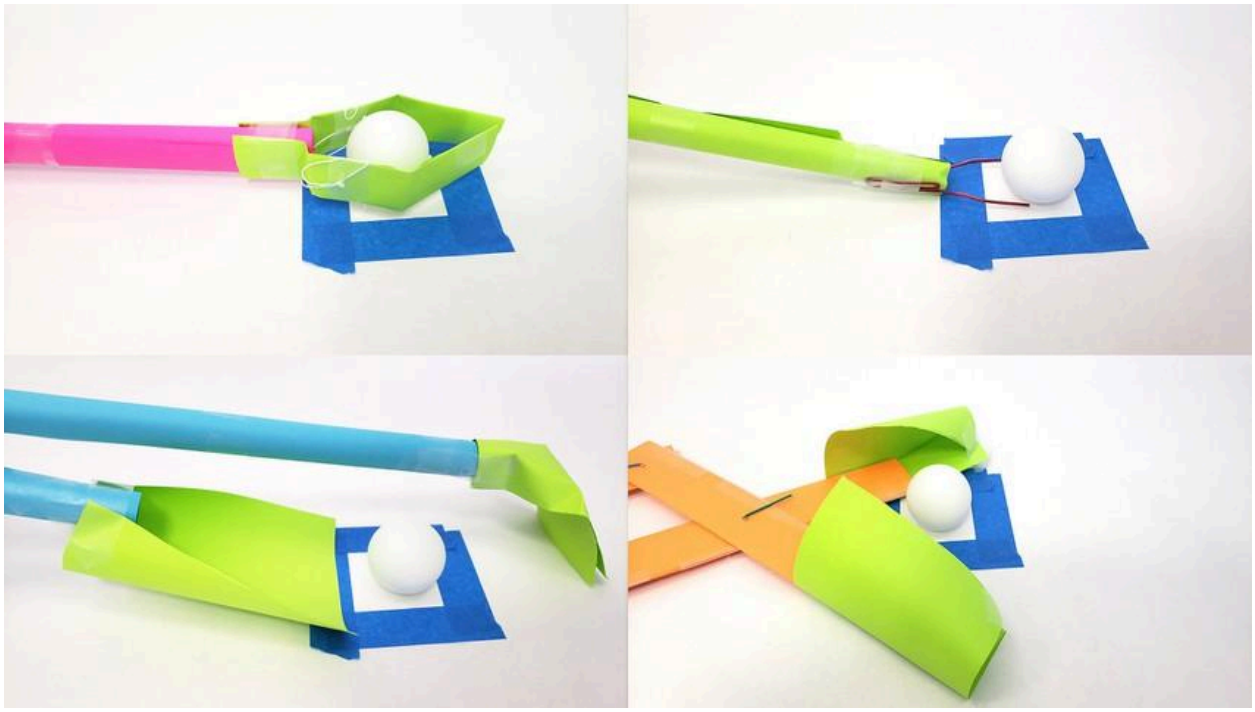
Where Did you Start	What Happened	Where Do You Go

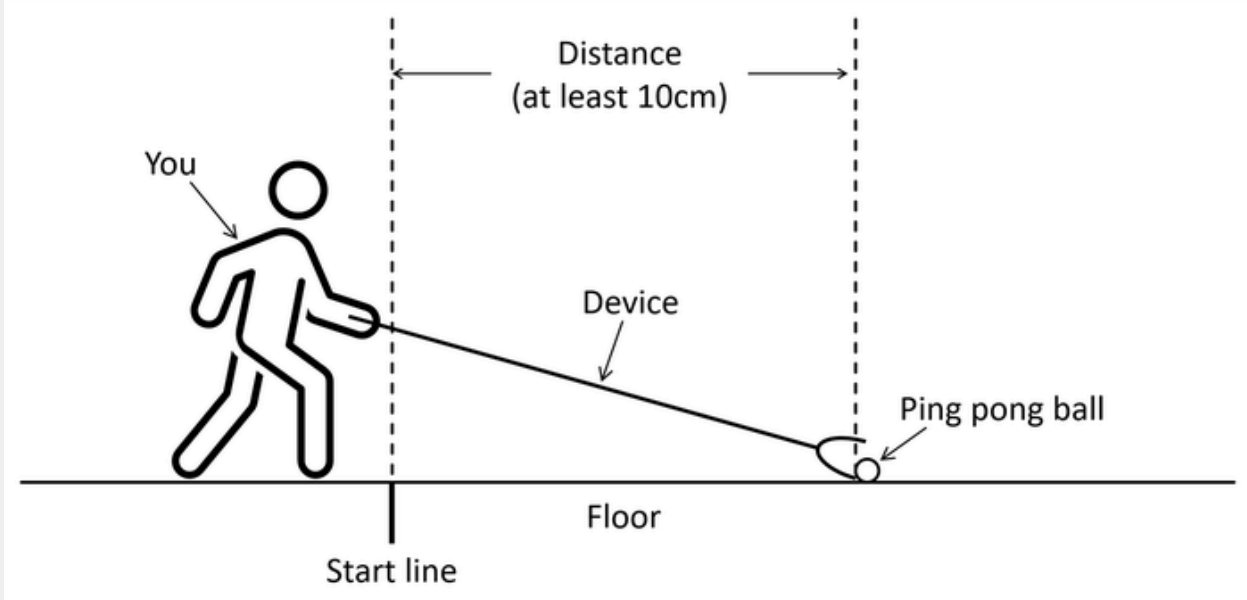
Activity- Ping Pong Ball Pick Up (No Extra Materials Needed)

Materials and Equipment Below. You can make this a class competition (there is a scoring rubric included). Aside from materials listed, you need a yard stick.

Goal- is to build a device that can pick up a ping pong ball and retrieve it by bringing it back over a start line and placing it on the floor.

Material	Dimensions/type allowed	Maximum quantity	Points Cost
Paper	Printer, construction, graph, or notebook paper (letter, A4 size, 9"x12" or 22x30 cm sizes are all allowed) Cardstock and newspaper are not allowed.	30 sheets	5 points per sheet, rounded up to the nearest whole sheet
Paper clips	Any size up to 50 mm (2 inch), metal (coated or non-coated)	10	1 point each
String	Any type up to 3 mm in diameter (dental floss, fishing line, cotton string, twine, yarn, etc.)	10 meters	1 point per 50 cm (must round up to the closest 50 cm)
Tape	Maximum 1 inch (2.5 cm) wide, clear office tape, masking tape, or painter's tape. Duct tape, packing tape, and electrical tape are not allowed.	One roll	Free
Ping pong ball	Standard	1	Free - required for testing





Distance between your hand and the ping pong ball has to be at least 10cm; it can be longer (the longer the distance the more points you get)

Scoring - Tally up the total quantity for each material used in your device. Materials used in previous iterations do not count

Material points cost using these values:

Paper: 5 points per sheet (rounded up to the nearest whole sheet)

Paper clips: 1 point each

String: 1 point per 50 cm (rounded up to the nearest 50 cm)

Tape: free

Scoring- distance in cm - materials points

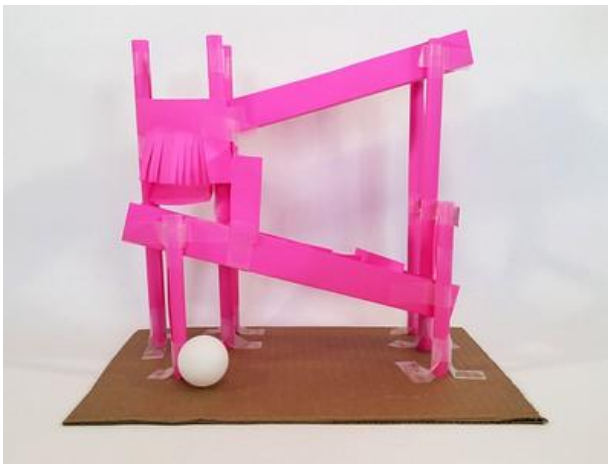
Activity- Paper Ball Run Challenge (No Extra Materials Needed)

Build a ball run from paper and tape, but there's a twist! You want to make your ball run as *slow* as possible.

Materials- 30 pieces of paper, Tape, surface (cardboard or desk)

Examples






RULES- The run must stand on a flat horizontal surface like the floor or a table/countertop/desk/ piece of cardboard. It can be taped to this surface. It cannot be taped to or supported by anything else (the ceiling, walls, furniture, a person, etc.).

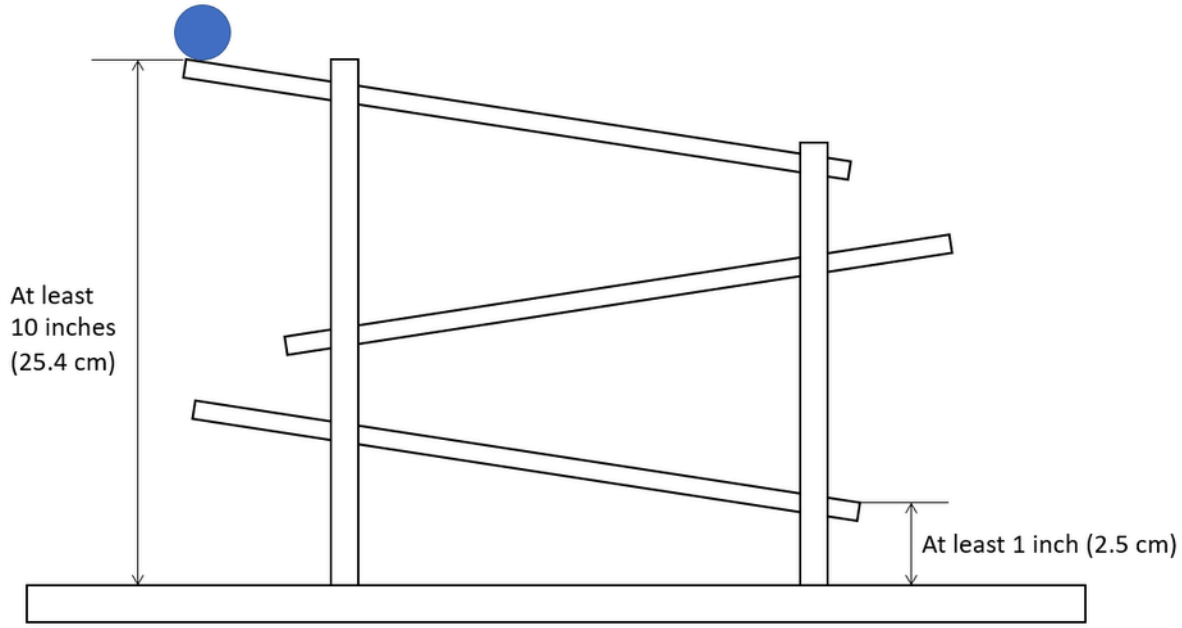
The run must have both an entrance point and an exit point for the ball. The entrance point is where the ball is placed into the run. It must be at least 10 inches (25 cm) above the supporting surface. The exit point is where the ball exits the run. It must be at least 1 inch (2.5 cm) above the surface. The ball cannot be modified in any way or have

anything attached to it. The ball must be gently placed into the run to start. It cannot be dropped from above the run, thrown, flicked, etc.

Time starts when the ball is placed in the run and ends when the ball exits the run.

After the ball has entered the run, you cannot touch the ball or the run, or influence their motion in any way (e.g., by blowing on the ball, shaking the table, or tilting the run, etc.).

If the ball gets stuck in the run, you must remove the ball and start over. A ball is considered stuck if it does not move for more than 10 seconds.



SCORING- 4 x time in seconds - sheets of paper

Teaching Points

Kinematics is the study of motion. How are quantities like distance, time, and velocity related? What do they have to do with the ball's path and how long it takes to travel through your machine?

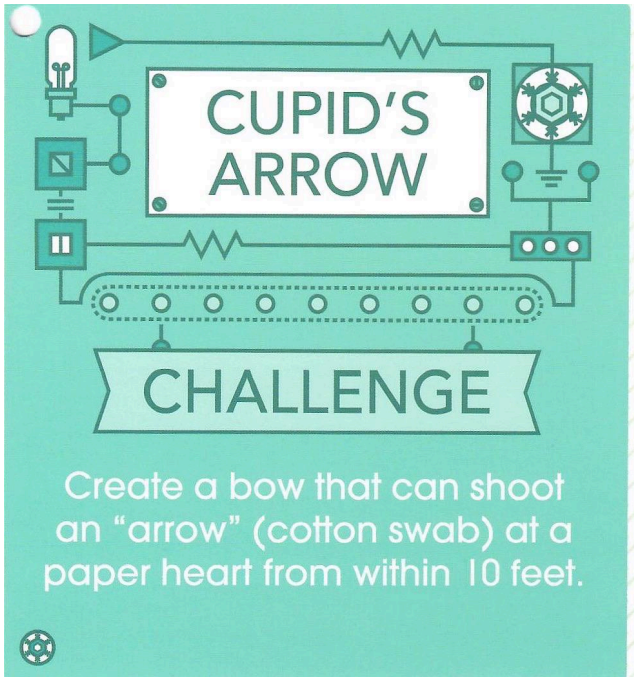
Your ball run uses different forms of energy. The ball has gravitational potential energy when it is placed at the top of the machine. Some of this energy is converted to kinetic energy (the energy of motion) as the ball gains speed. Some of this energy is lost to friction and converted to thermal energy (heat) as the ball moves. When the ball collides or bounces off something, some of the kinetic energy is converted to other forms, like acoustic energy (sound).

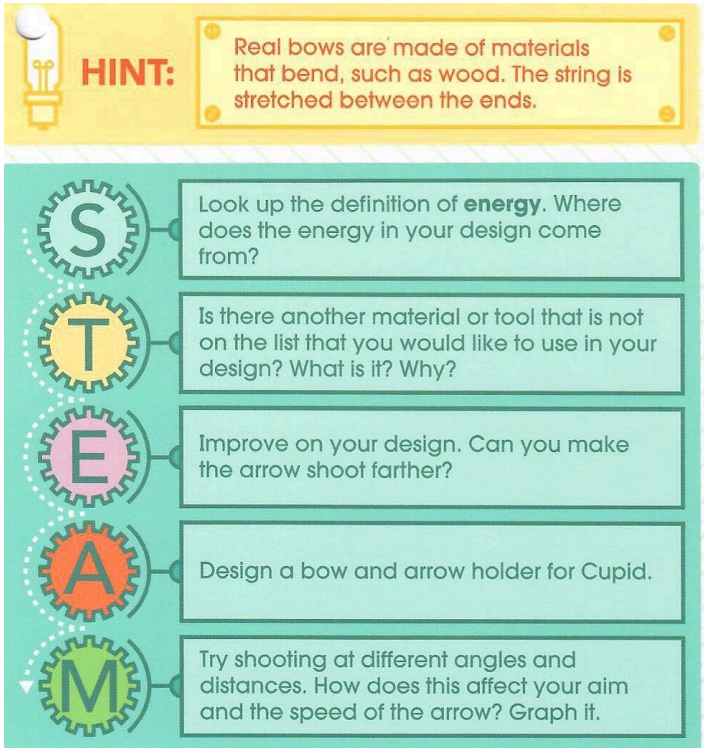
Your ball run might make use of different simple machines, like levers, inclined planes (ramps), or even a wheel and axle. How can you incorporate different simple machines into the design of your ball run? How can they slow the ball down?

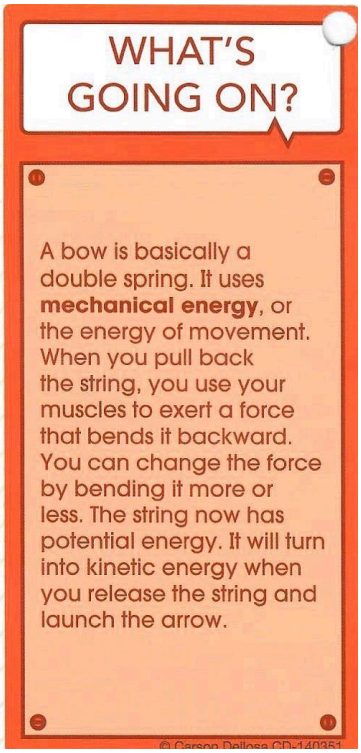
If you make your ball run taller, it can take longer for the ball to travel through it. However, building a taller ball run can be difficult. It needs to be sturdy so it does not fall over. For example, you might need to connect beams in triangular shapes to form trusses to support a tall ball run.

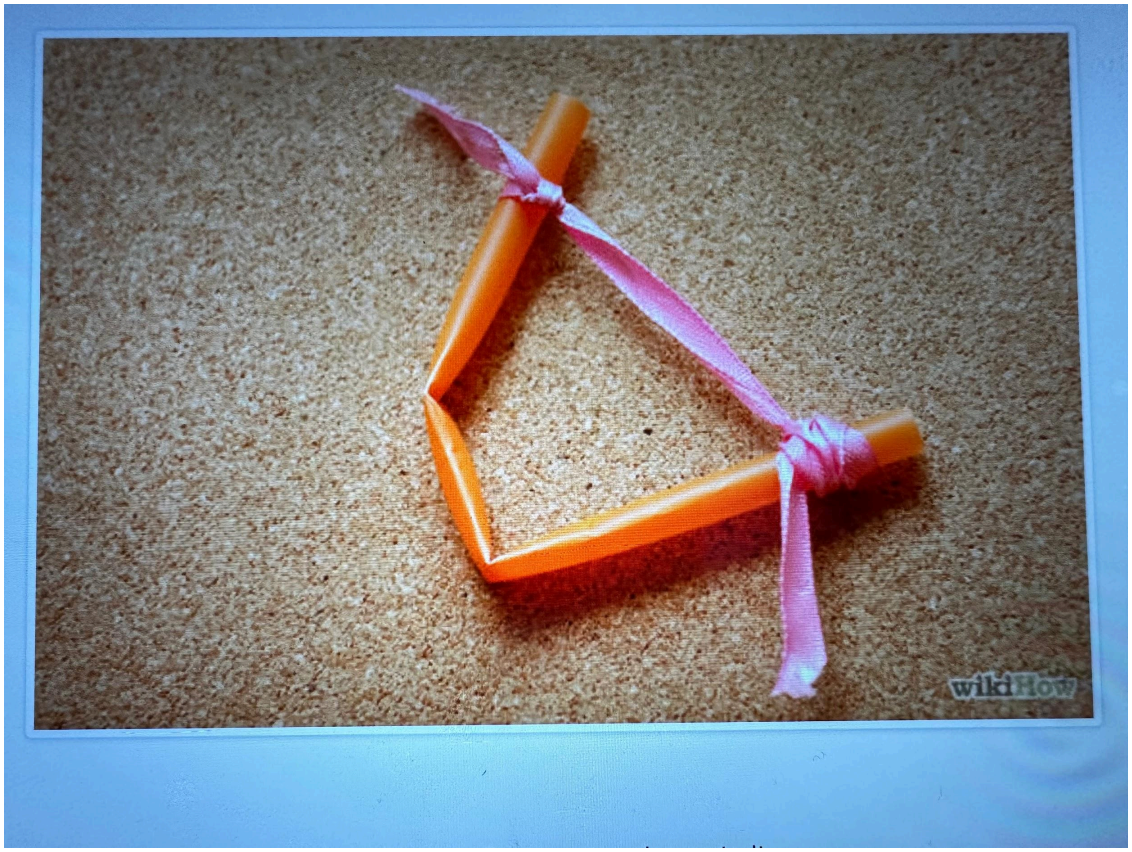
You can use this project to practice the engineering design process. You will need to design, build, and test your ball run, and then change it or make improvements, and test again. This process is called iteration.

Activity- Cupid's Arrow (No Extra Materials Needed)





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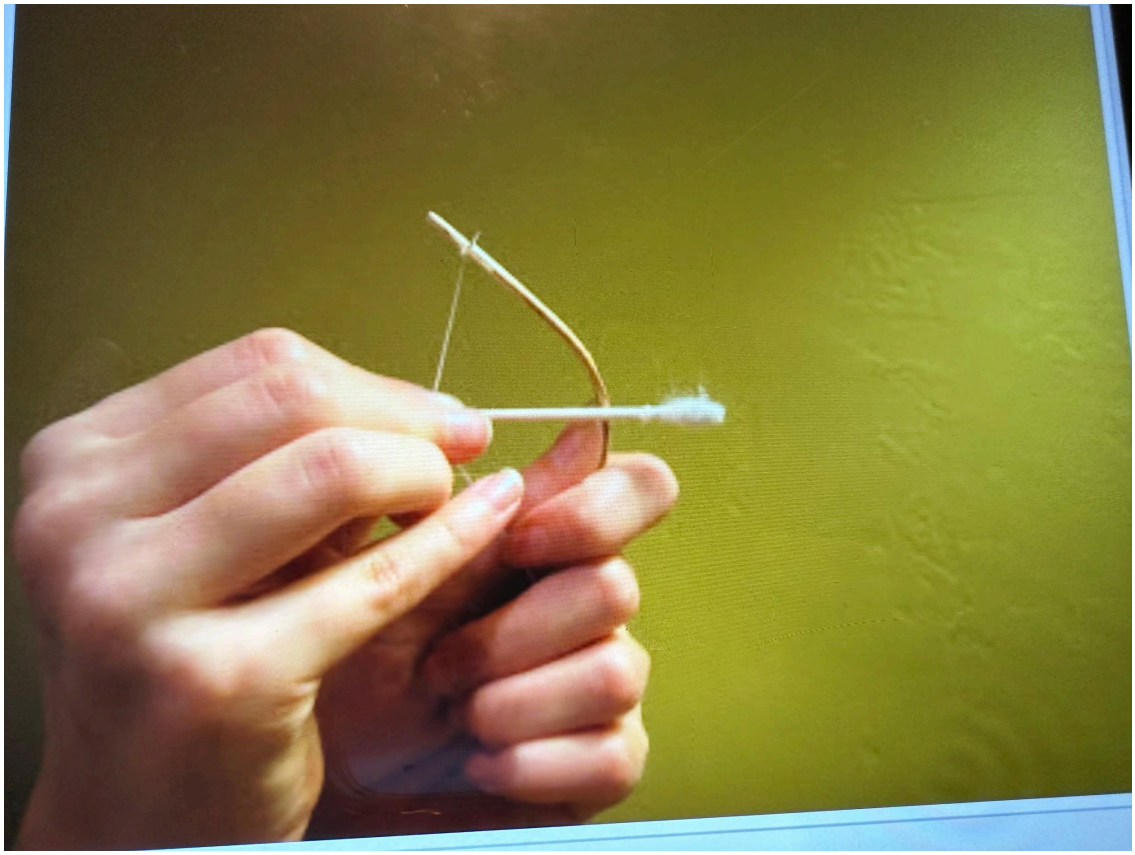
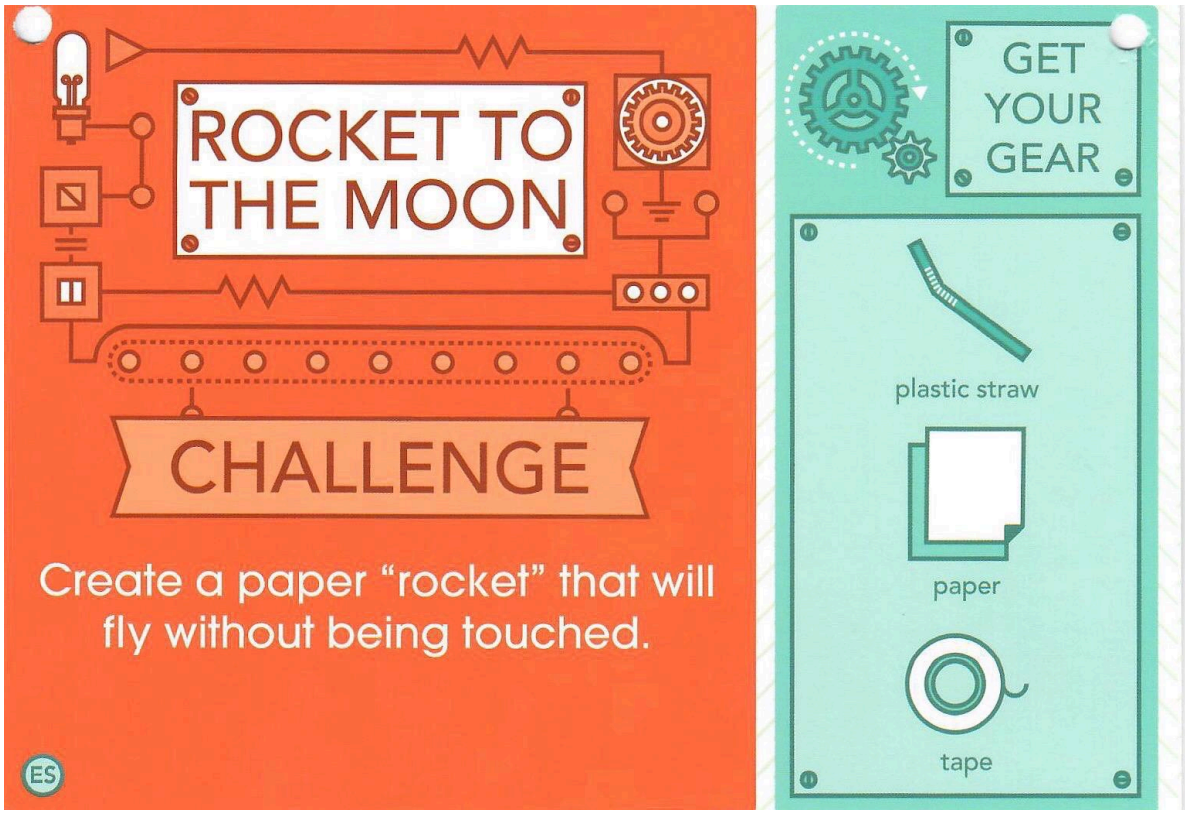
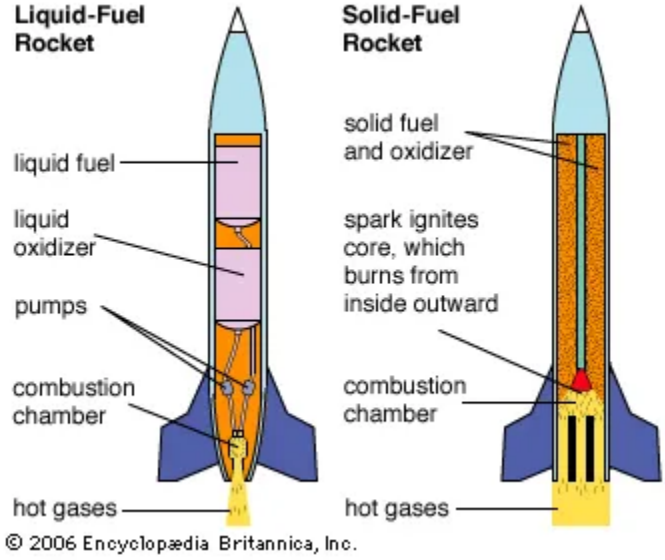


Activity- Rocket to the Moon (No Extra Materials Needed)



Teaching Points



Teaching points below focus on the Liquid-Fuel Rocket (not Solid Fuel Rocket)

Chemistry is at the heart of making rockets fly. Rocket propulsion follows Newton's Third Law, which states that for every action there is an equal and opposite reaction. To get a rocket off the launch pad, create a chemical reaction that shoots gas and particles out one end of the rocket and the rocket will go the other way.

What kind of chemical reaction gets hot gases shooting out of the business end of a rocket with enough velocity to unshackle it from Earth's gravity? Combustion.

Combustion (burning something) releases energy, which makes things go. Start with fuel (something to burn) and an oxidizer (something to make it burn).

Hydrogen, the fuel for the main engines, is the lightest element and normally exists as a gas. Gases – especially lightweight hydrogen – are low-density, which means a little of it takes up a lot of space. To have enough to power a large combustion reaction would require an incredibly large tank to hold it – the opposite of what's needed for an aerodynamically designed launch vehicle.

To get around this problem, turn the hydrogen gas into a liquid, which is denser than a gas. This means cooling the hydrogen to a temperature of -423 degrees Fahrenheit (-253 degrees Celsius). Seriously cold.

Although it's denser than hydrogen, oxygen also needs to be compressed into a liquid to fit in a smaller, lighter tank. To transform oxygen into its liquid state, it is cooled to a temperature of -297 degrees Fahrenheit (-183 degrees Celsius).

Once in the tanks and with the launch countdown nearing zero, the Liquid H2 and Liquid O2 are pumped into the combustion chamber of each engine. When the propellant is ignited, the hydrogen reacts explosively with oxygen to form: water! Elementary!

$$\mathbf{2H_2 + O_2 = 2H_2O + Energy}$$

This "green" reaction releases massive amounts of energy along with superheated water (steam). The hydrogen-oxygen reaction generates tremendous heat, causing the water vapor to expand and exit the engine nozzles at speeds of 10,000 miles per hour! All that fast-moving steam creates the thrust that propels the rocket from Earth.

History of Rockets

In the late 1800s a Russian scientist named Konstantin E. Tsiolkovsky got the idea that rockets could be used to travel into space. He did not build any rockets, but his ideas about them were useful. Robert H. Goddard, a U.S. engineer, built the first liquid-fuel rocket in 1925. In October 1957 the **Soviet Union** used a rocket to launch the first spacecraft, Sputnik 1, into orbit around Earth. Since then rockets have been used to launch thousands of other spacecraft.

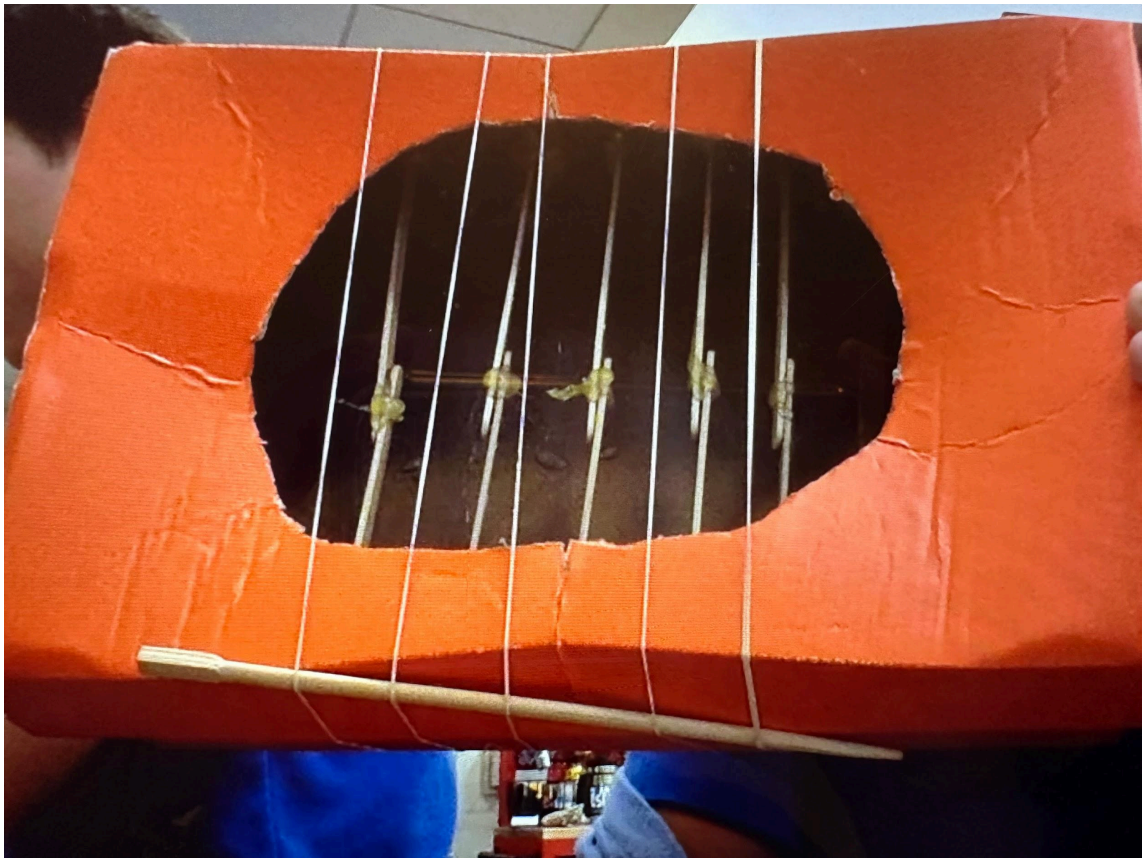
Good Video-
How Do Rockets Fly? | Let's Explore Mars! | SciShow Kids

Landing on the Moon

- 7/20/69- Astronauts Neil Armstrong and Buzz Aldrin were the first humans to land on the Moon during the Apollo 11 mission.
- From 1969 to 1972, total of **six Apollo missions** (Apollo 11, 12, 14, 15, 16, and 17) landed astronauts on the Moon. Total 12 astronauts have landed on the moon.
- **Since 1972- next mission to the moon - Artemis Mission - Artemis I** was the inaugural mission of NASA's Artemis program, marking the agency's return to lunar exploration. Launched on November 16, 2022, Artemis I was an uncrewed mission. **Artemis II/III**- 2026/2027- will send humans to the moon

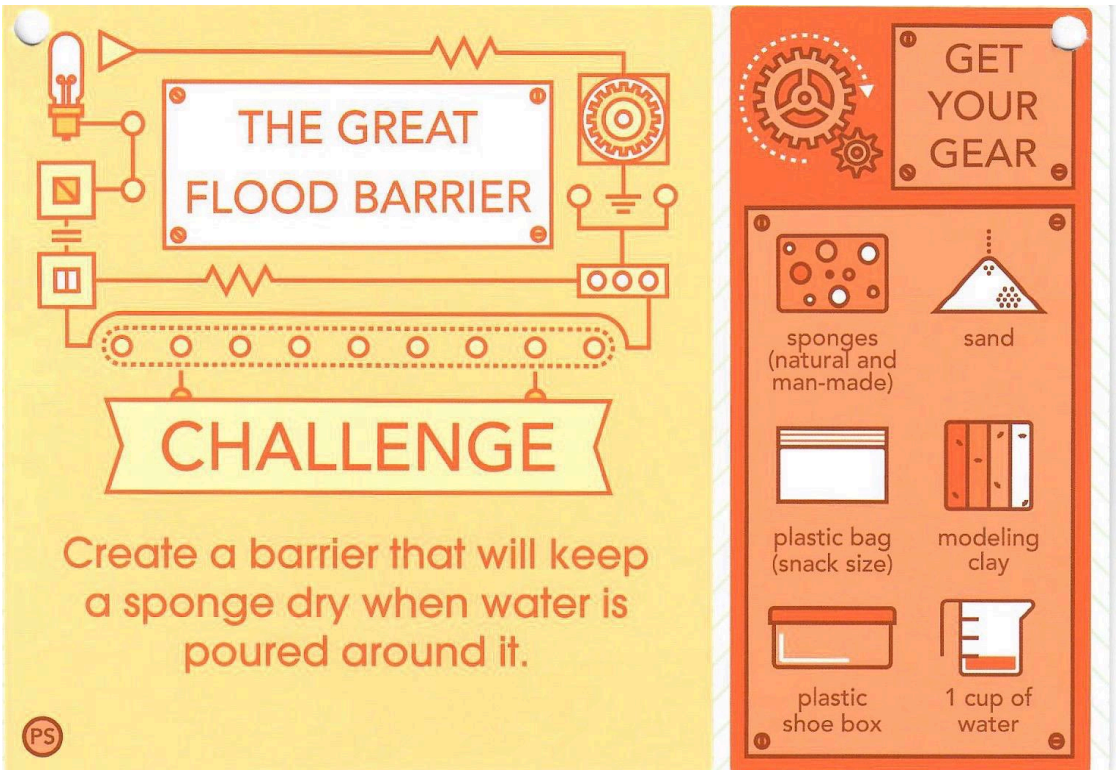
Aside from the Moon, we are exploring Mars
The Perseverance rover, which landed on Mars on February 18, 2021, as part of NASA's Mars 2020 mission, is tasked with searching for signs of ancient life in Jezero Crater, a site once believed to have hosted a lake. It is collecting rock and soil samples for future return missions, studying Mars' climate and geology, and testing new technologies that will help pave the way for human exploration. Perseverance is also carrying the Ingenuity helicopter, a small aircraft that made history by becoming the first to fly on another planet. Ingenuity's successful flights provide valuable data for future aerial exploration on Mars and other celestial bodies. Perseverance rover is still operational on Mars; Ingenuity is still flying on Mars!

Activity - Making Music (Extra Materials Needed)



****Can make shoe boxes out of loose cardboard; can use plastic cups**

Activity- The Great Flood Barrier (Extra Materials Needed)



HINT:

Water can't flow through some materials. Test your materials to see what stops water.

S Look up the definitions of **porous** and **non-porous**. Make a list of things that are porous and non-porous.

T Does the size and type of sponge make a difference? Try the challenge again with a different type of sponge.

E Improve on your flood barrier. Can you decrease the amount of water that reached the sponge?

A Write a news article about a flood and tell how workers were able to prepare flood barriers to stop the damage.

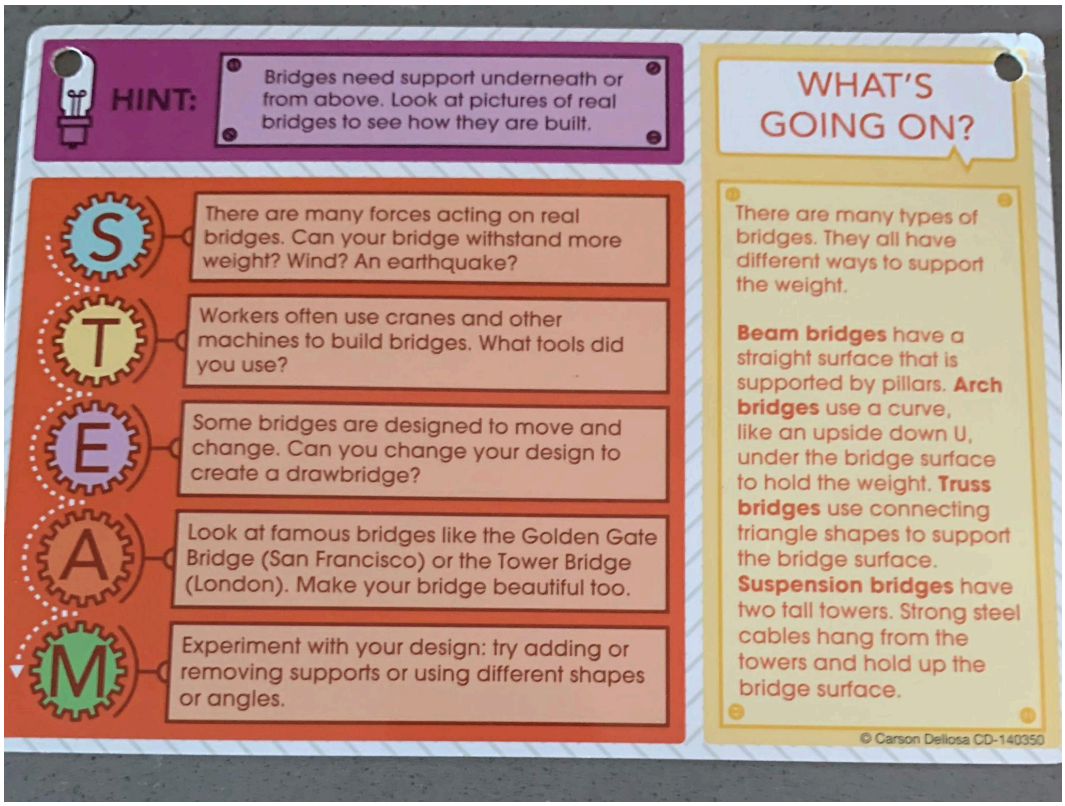
M Squeeze the sponge to measure the amount of water that it soaked up.

WHAT'S GOING ON?

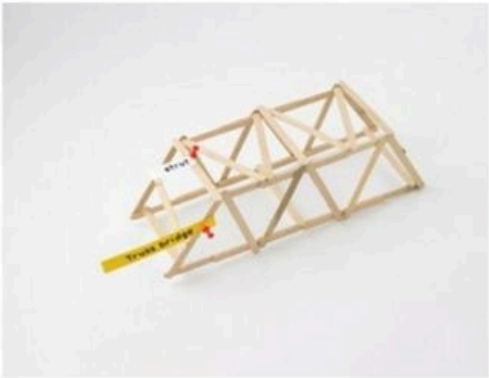
A **porous** material contains gaps between its molecules. The gaps may be either visible to the naked eye (like a sponge) or only seen through a microscope. Liquids or gases can pass through the connected spaces in a porous material easily.

A **non-porous** material is one that cannot absorb liquid or gas. It has no gaps that gases or liquids can pass through. Glass, metals, and hard plastics (like the shoe box) are examples of non-porous materials.

Activity- Bridging the Gap (No Extra Materials Needed- use washers or screws in place of pennies)



Example Bridges- Paper bridges



Teaching Points

PAPER BRIDGE- You probably found that a single, flat piece of paper could barely support its own weight, let alone any pennies. Folding the paper in half may have made it strong enough to support a few pennies. The more times you folded the paper in half, the stronger it got. Changing the shape of the bridge to give it vertical "walls" made it significantly stronger, and it could probably hold dozens of pennies. While a horizontal piece of paper is very easy to bend in the vertical direction, the vertical wall sections are very difficult to bend in the vertical direction, making the bridge very strong.

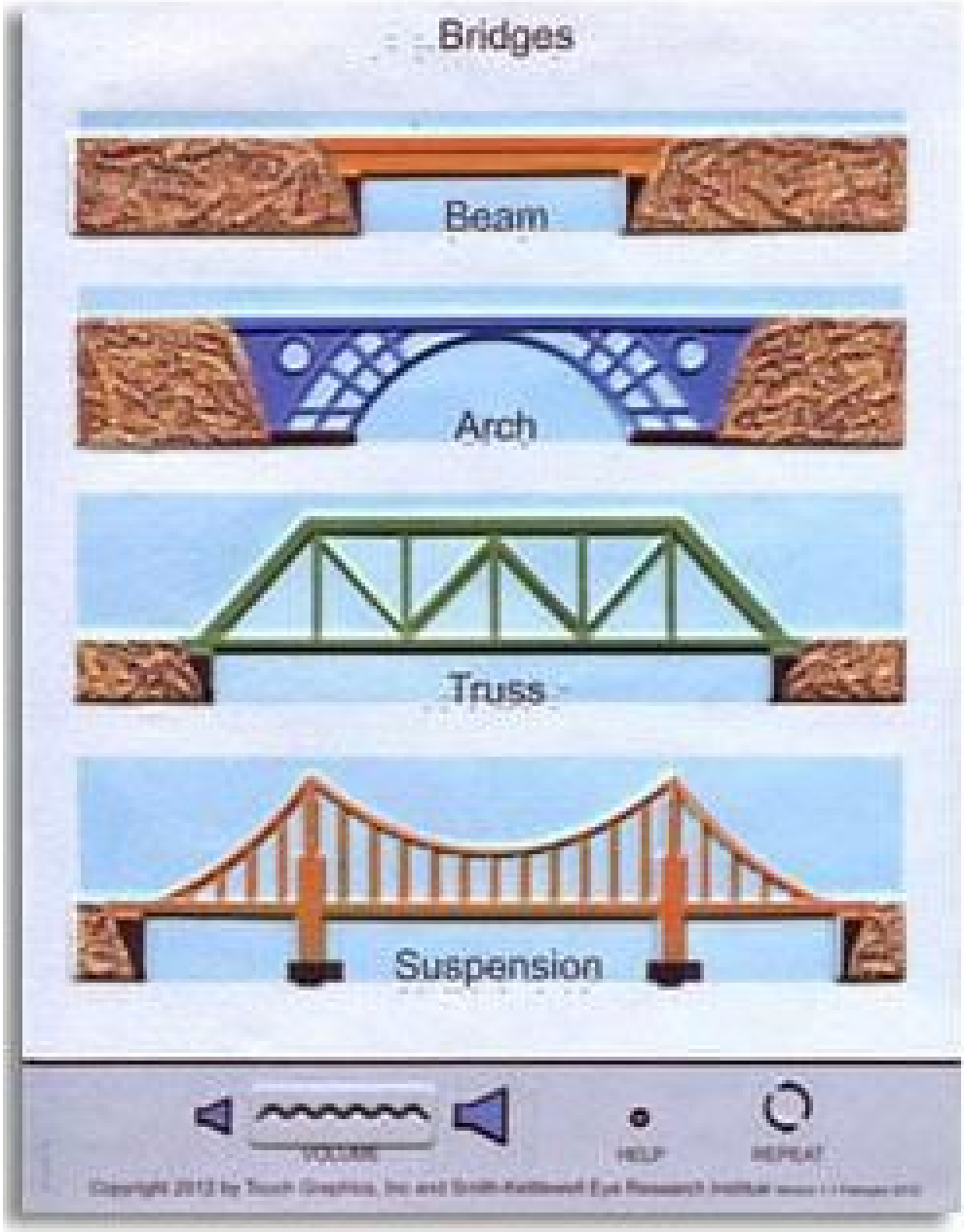
CROSS SECTION

Have you ever tried bending a ruler? If so, you probably bent it in the "thin" dimension and not the "thick" dimension. It is much easier to bend one way than the other! In general, the shape of a material can dramatically affect its strength. Engineers take advantage of this fact when building bridges or other large structures. Most of the metal beams that support them have hollow cross-sectional shapes like circles, squares, or letters like "C," "U," or "I." These beams are very resistant to bending, but require far less material than a completely solid beam. This makes them more lightweight and less expensive, since less material is required. Alternatively, given a limited amount of material, you can make it very strong depending on how you shape it. This is what you discovered when building a bridge out of a single sheet of paper in this project. A flat piece of paper is very easy to bend, so it makes a very poor bridge. By folding the paper into different shapes, you can make a much stronger bridge, even though you did not add more material.

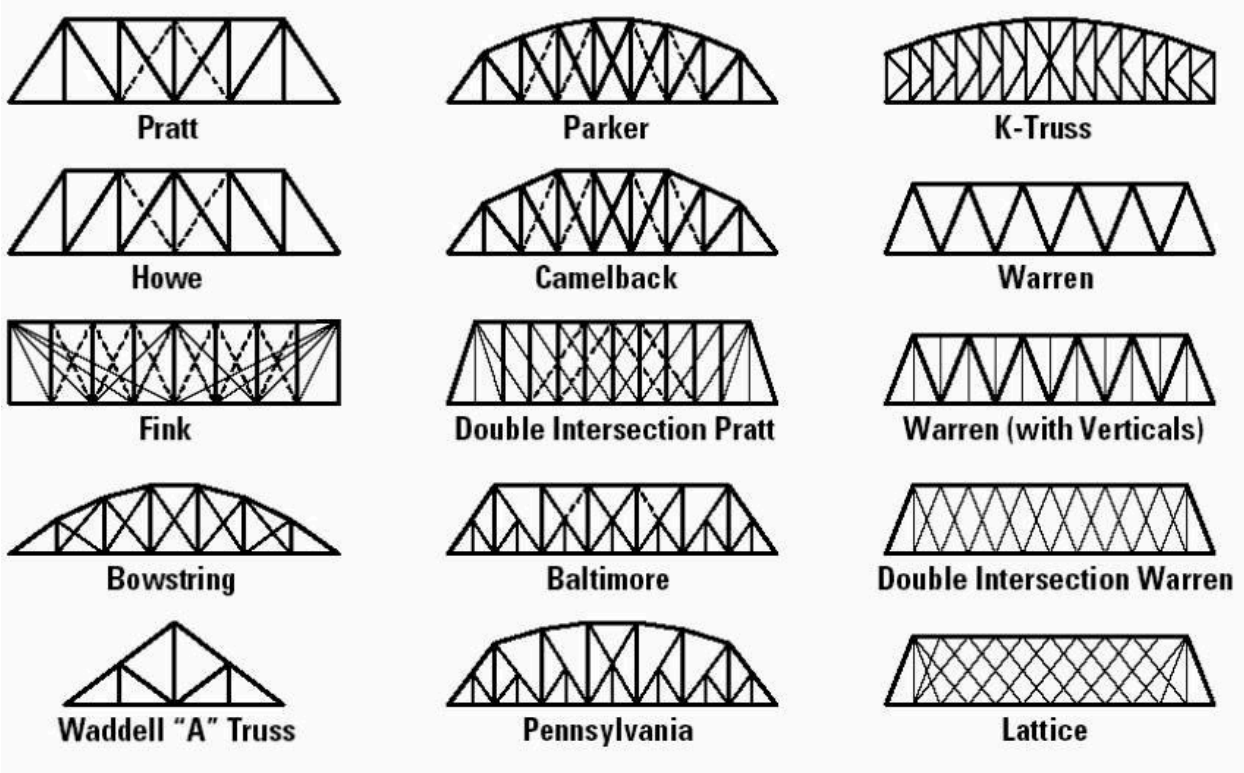
Types of Bridges

Video for younger kids- [What Makes Bridges So Strong? | Engineering for Kids | STEAM | SciShow Kids - YouTube]

Older kids- teaching points on how different bridges (Beam, Arch, Truss, Suspension) are built - Refer to this website
[How bridges work - Explain that Stuff]



Competition option for Older Kids- materials- popsicles sticks, glue, zip ties



Young Engineers: Triangle Truss Bridge - Simple and Strong Engineering Project for Kids- step by step video on how to make a bridge

Have kids build bridges, 50 popsicle sticks, max length is 4 popsicle sticks across (about 20 in). Height- under 8in. provide 12 zipties

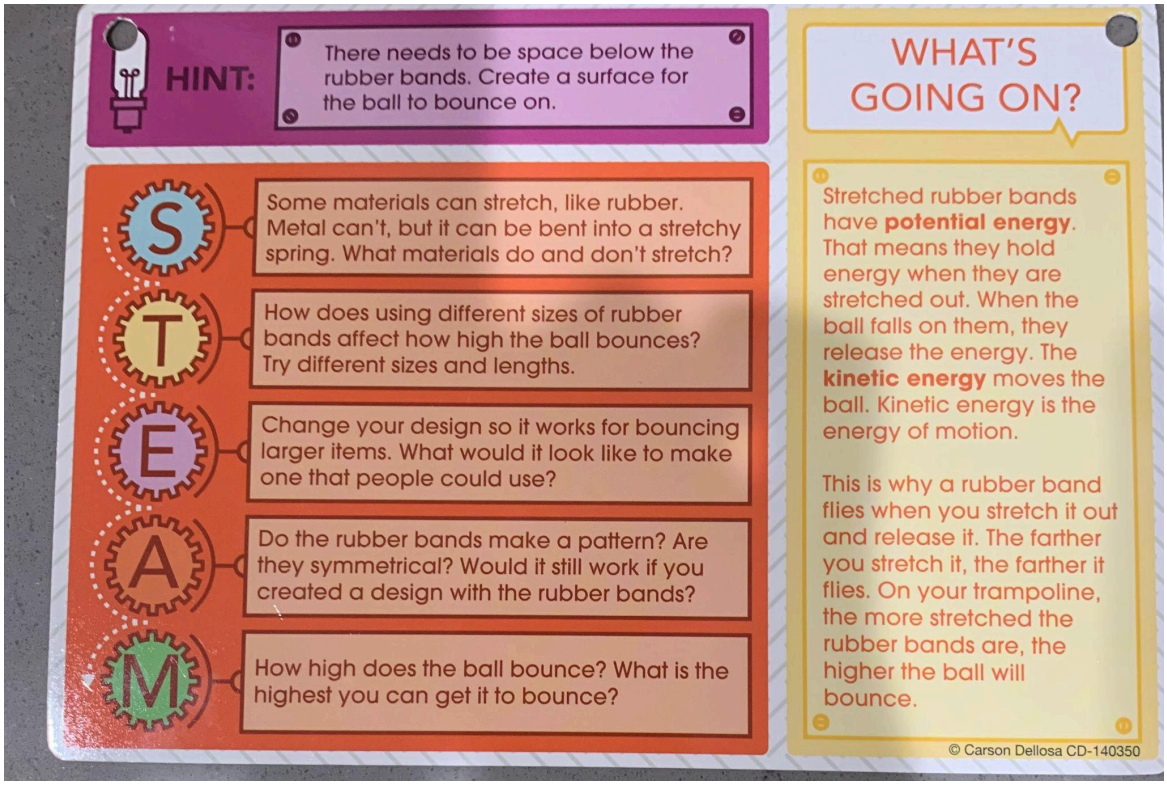
Scoring: **Performance Index**

Performance Index=Weight Held/Bridge Weight

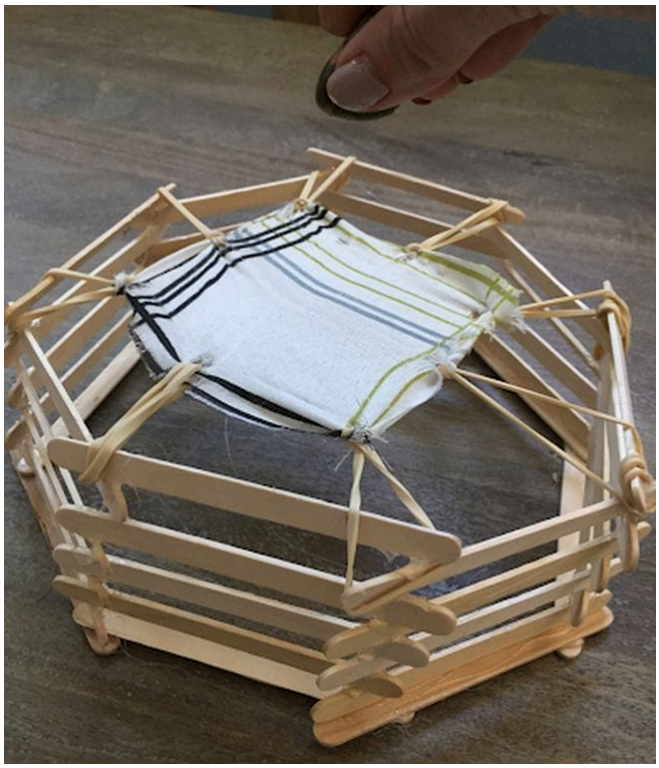
Bridge weighs 120 g and holds 18 kg → 18 000 g ÷ 120 g = 150 →

Performance Index = 150.

Activity- Bounce Around (No Extra Materials Needed)



Teaching Points



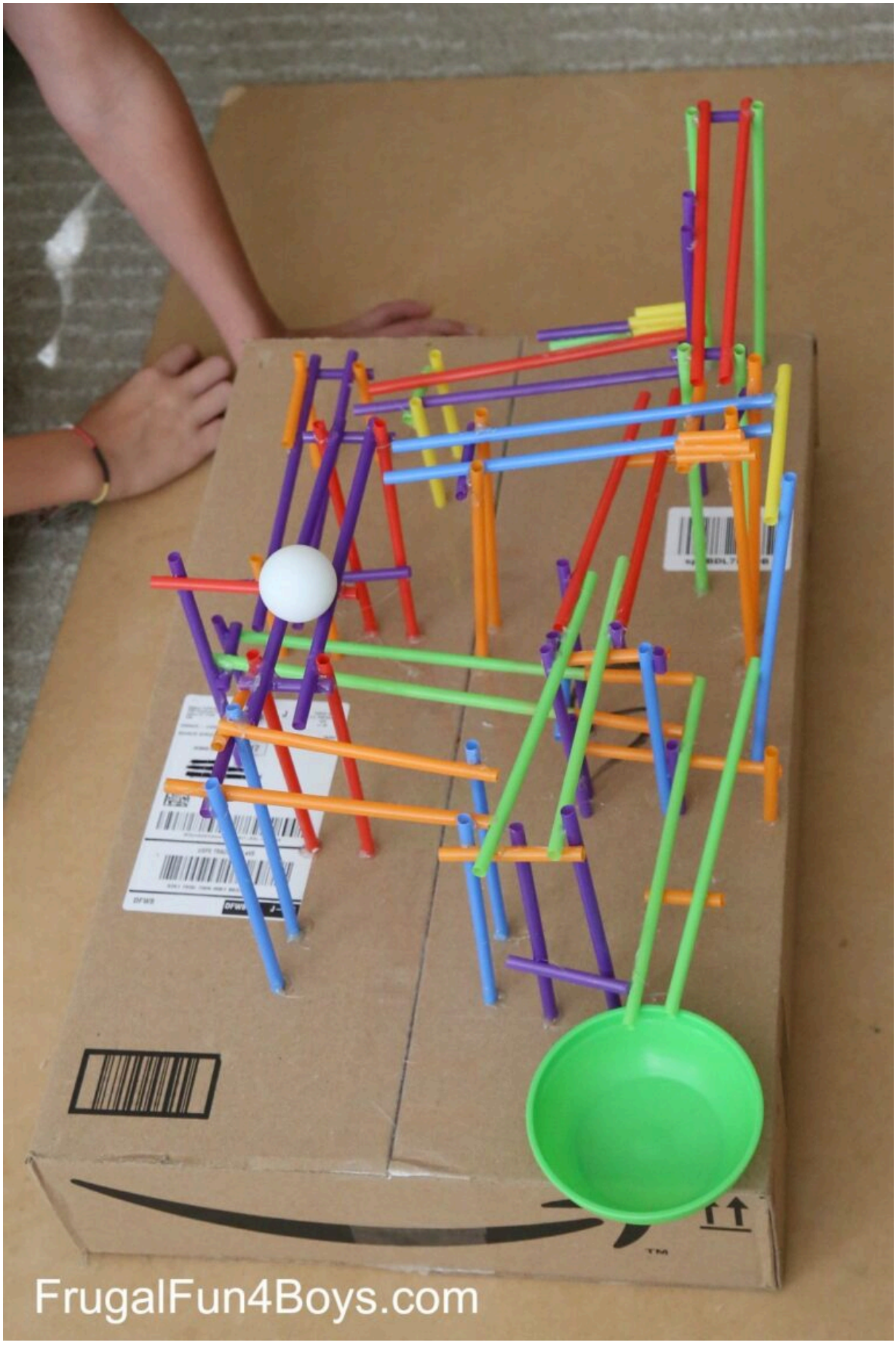
-How the rubber bands work- when a spring is coiled up or a rubber band is stretched, energy is stored in it (potential energy). When the spring uncoils or the rubber band snaps back (when an object lands on the trampoline), this energy is released. This stored energy is called potential energy because it has the potential to make things happen.

The stored energy pushes the ball back up- this is a transfer of potential energy to kinetic energy (energy of movement- ie moving the ball up into the air)
-how to translate this to humans jumping on a trampoline?
Springs have stored elastic potential energy. This kinetic energy of a human jumping is applied to the springs, forcing the trampoline downward. As a result of the springs having pressure, or kinetic energy exerted on it, Hooke's Law is applied. Hooke's Law - depending on the force you exert on a spring, you will receive the same distance or length of pushback returned. Essentially saying that the harder you jump on a trampoline, the higher you will bounce due to the springs reacting to your applied force (This law has many similarities to Newton's third law which states, "with every action, there is an equal and opposite reaction." However, Hooke's Law is concerned with the responses of elastic objects).

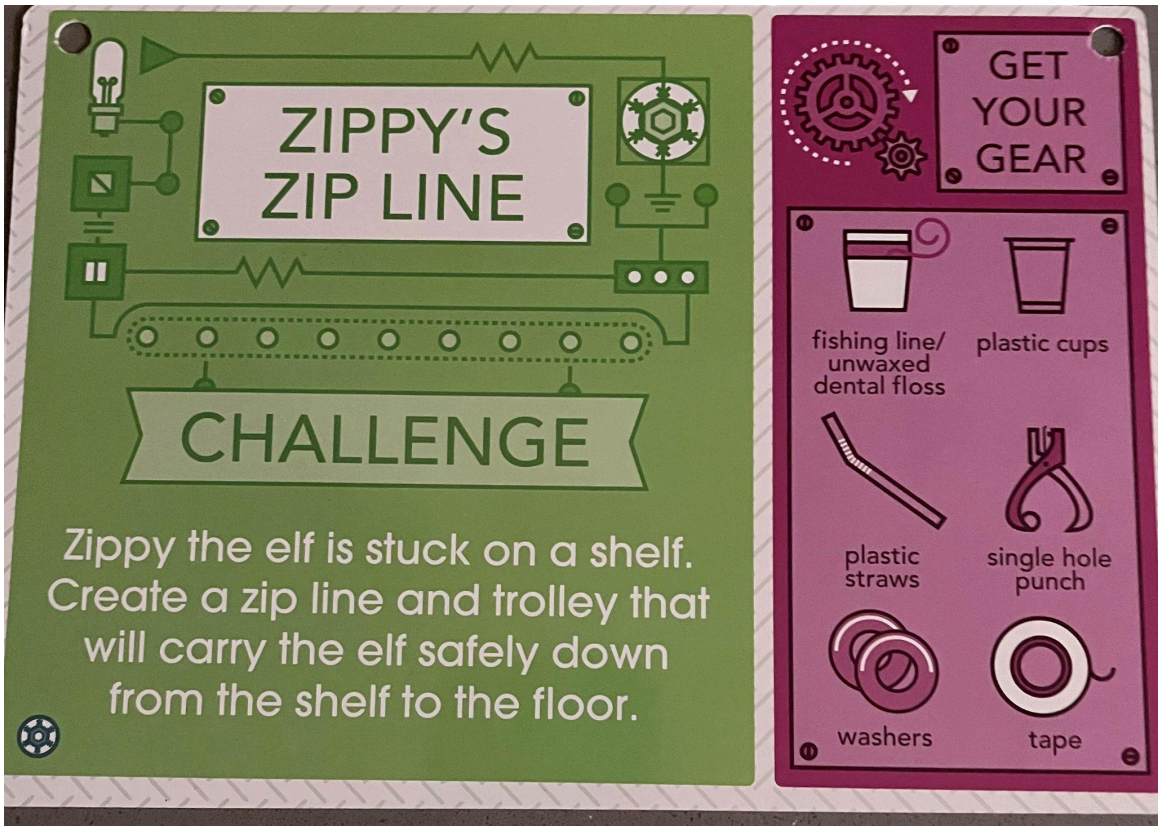
Activity- Straw Roller Coaster (Extra Materials Needed- Straws)

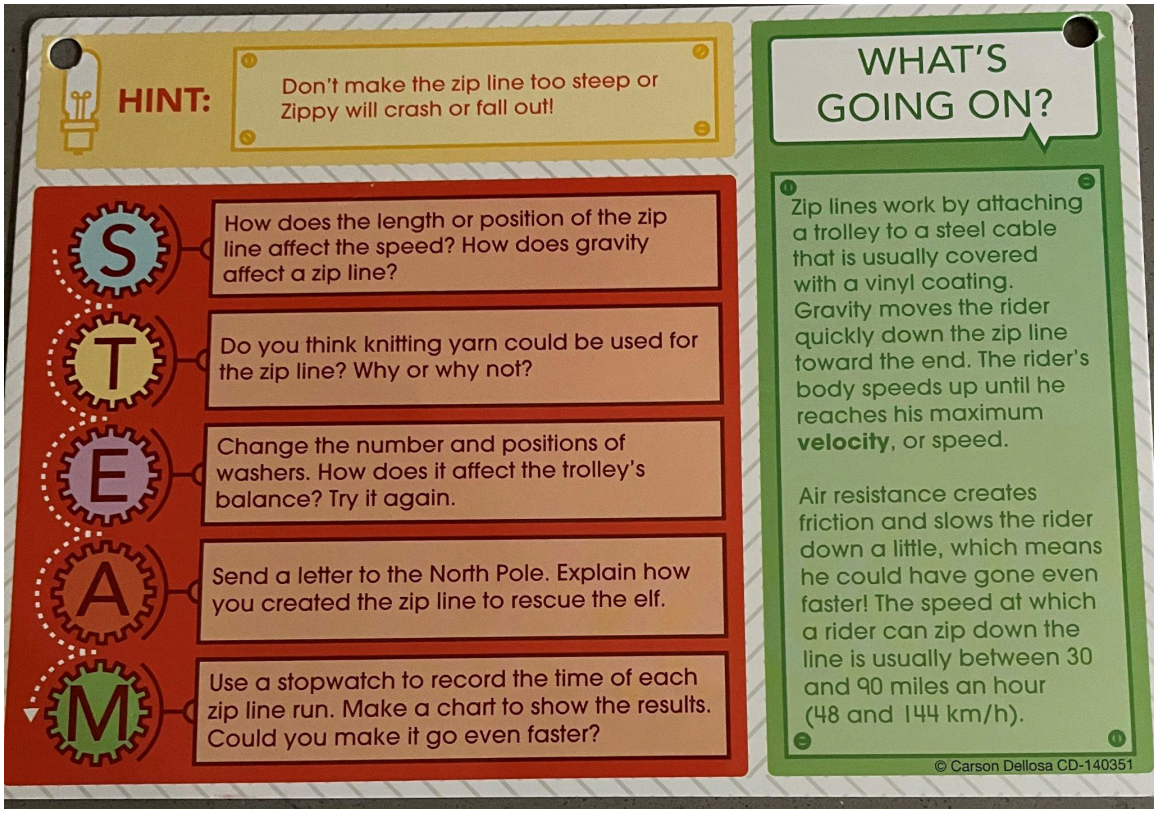
Materials

- **A cardboard box or a piece of cardboard for the base**
- **Straws – solid color ones are fun!**
- **Scissors**
- **A hot glue gun and glue sticks (or tape!)**
- **A ping pong ball**
- **A bowl to catch the ball at the bottom (optional)**


FrugalFun4Boys.com

Activity- Zippy's Zip Line (No Extra Materials Needed)

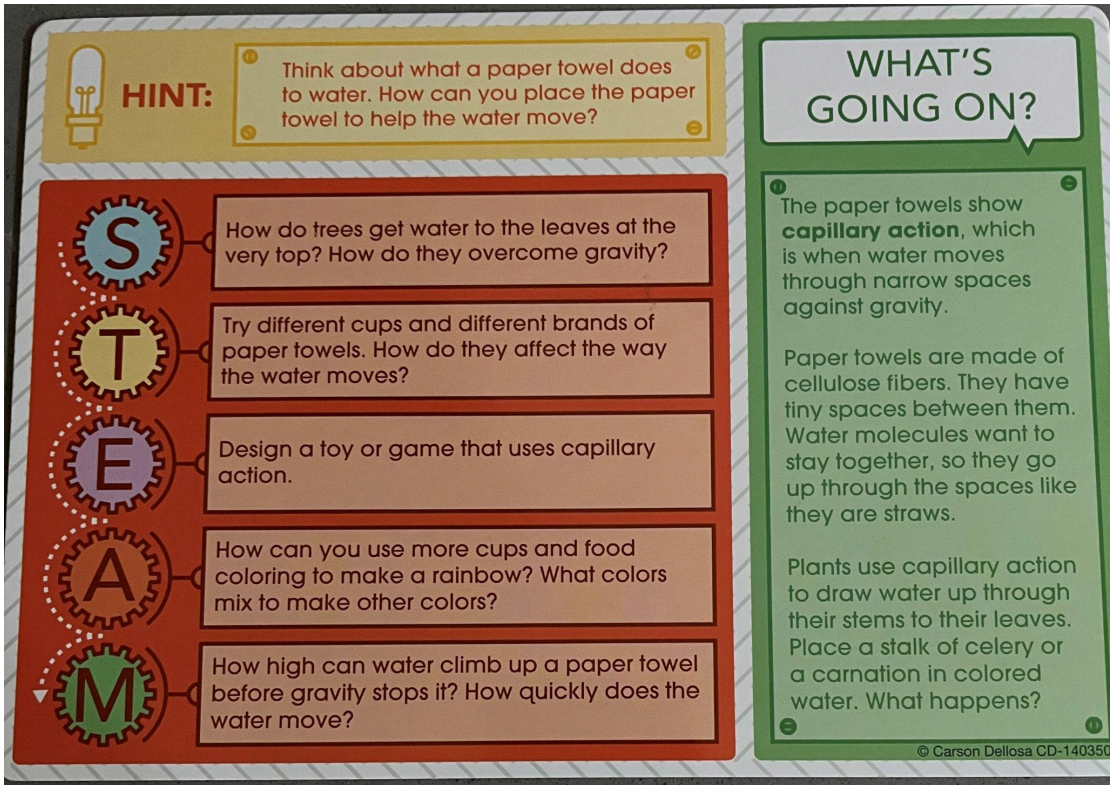




Some Examples

Depending on your age group, you will approach it differently. You have two math concepts you can incorporate: Time (use a stopwatch) and Angles (older students- you can take a look at angles. I would start off by measuring the angle of the zip line and then have the kids test different angles to see how it affects their egg going down the zip line)

Activity- Climbing Water (Extra Materials Needed- Food Coloring)



Teaching Points

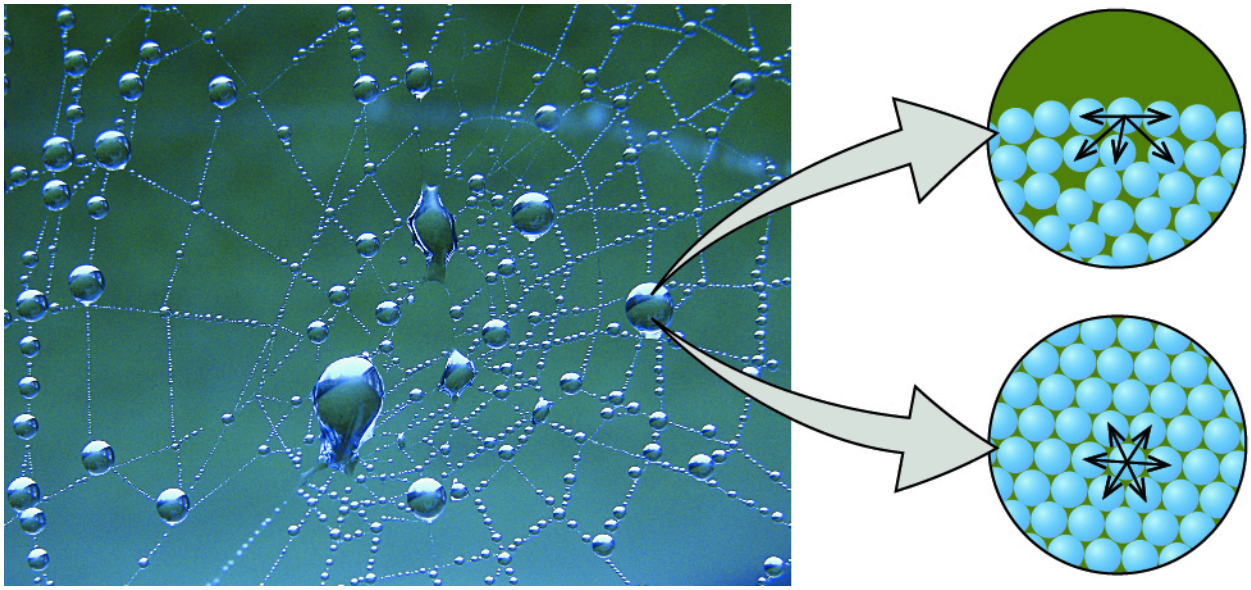
Capillary action is a process during which a liquid, like water, moves up something solid, like a tube, or into a material with a lot of small holes. This happens when three forces called cohesion, adhesion, and surface tension work together.

Water

Water is made up of two hydrogens and one oxygen atom, arranged in a tetrahedral shape. Oxygen is highly electronegative, which creates a partial negative charge on one end of the molecule, and a partial positive charge on the other. So, water molecules are able to form hydrogen bonds with one another, giving water many of its unique properties. SEE END OF THIS DOC FOR A MORE ADVANCED LESSON AND VIDEO ON POLARITY AND WATER MOLECULES

Cohesion refers to the attraction of molecules for other molecules of the same kind, and water molecules have strong cohesive forces thanks to their ability to form hydrogen bonds with one another.

Cohesive forces are responsible for **surface tension**, a phenomenon that results in the tendency of a liquid's surface to resist rupture when placed under tension or stress. Water molecules at the surface (at the water-air interface) will form hydrogen bonds with their neighbors, just like water molecules deeper within the liquid. However, because they are exposed to air on one side, they will have fewer neighboring water molecules to bond with, and will form stronger bonds with the neighbors they do have. Surface tension causes water to form spherical droplets and allows it to support small objects, like a scrap of paper or a needle, if they are placed carefully on its surface.

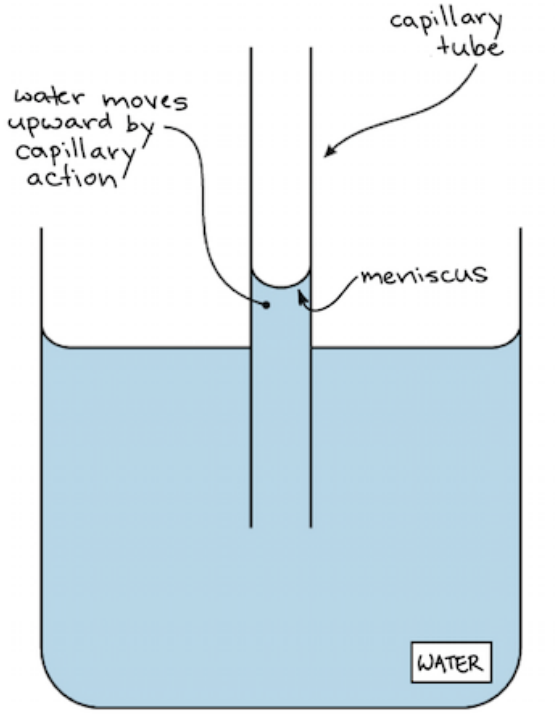


Water likes to stick to itself, but under certain circumstances, it actually prefers to stick to other types of molecules. **Adhesion** is the attraction of molecules of one kind for molecules of a different kind, and it can be quite strong for water, especially with other molecules bearing positive or negative charges.

For instance, adhesion enables water to “climb” upwards through thin glass tubes (called capillary tubes) placed in a beaker of water. This upward motion against gravity, known as **capillary action**, depends on the attraction between water molecules and the glass walls of the tube (adhesion), as well as on interactions between water molecules (cohesion).

The water molecules are more strongly attracted to the glass than they are to other water molecules (because glass molecules are even more polar than water molecules). You can see this by looking at the image below: the water extends highest where it contacts the edges of the tube, and dips

lowest in the middle. The curved surface formed by a liquid in a cylinder or tube is called a **meniscus**.

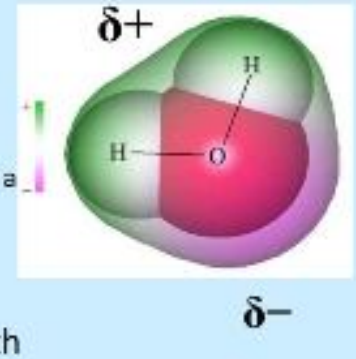


MORE ADVANCED LESSON ON POLARITY AND WATER MOLECULES

Polarity: Although the net charge of a water molecule is zero, water is polar because of its shape. The hydrogen ends of the molecule are positive and the oxygen end is negative. This causes water molecules to attract each other and other polar molecules.

Polarity of Water

- A water molecule forms when two hydrogen atoms form single polar covalent bonds with one oxygen atom
- **Oxygen** is more electronegative, the region around oxygen has a **partial negative charge.**
- The **region near the two hydrogen** atoms has a **partial positive charge**.

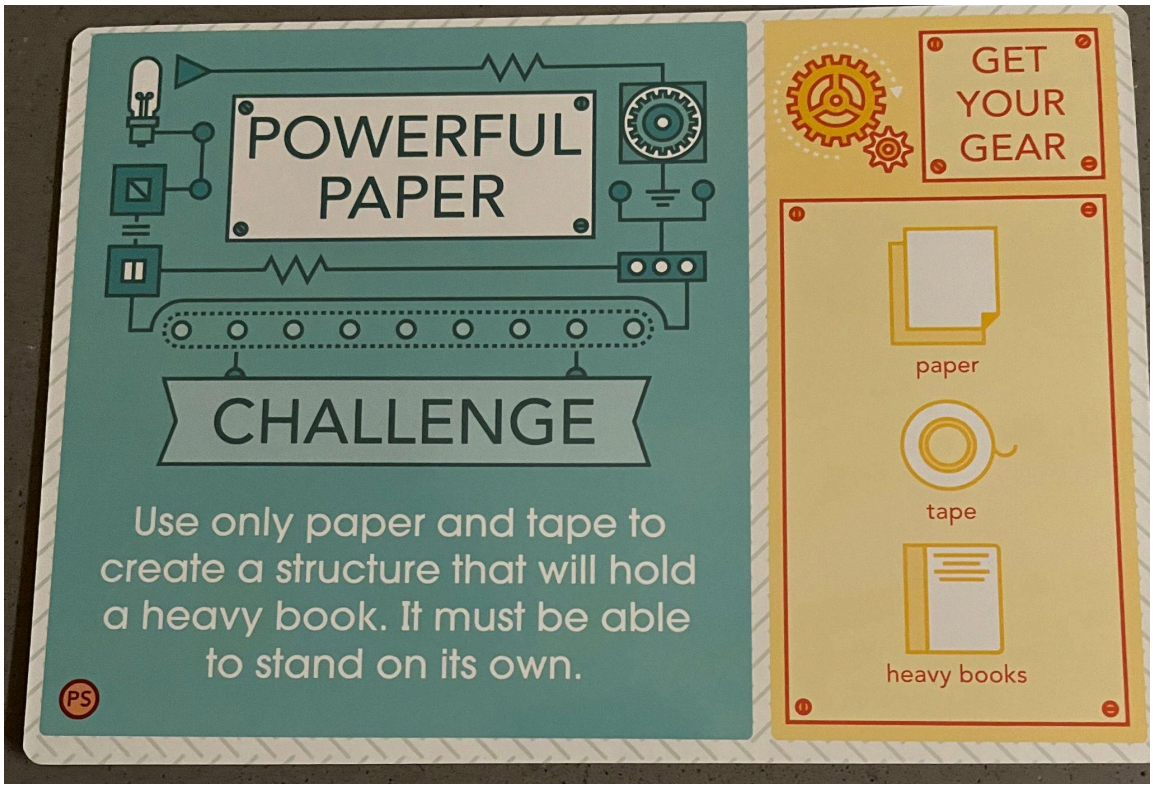


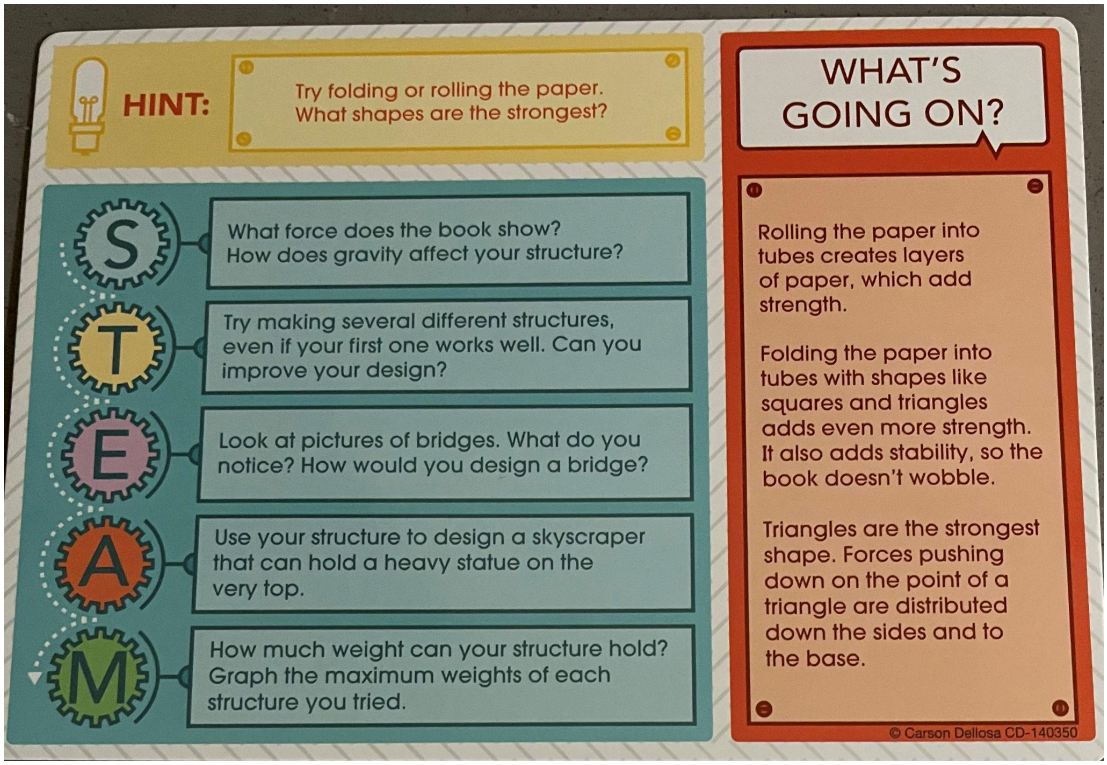
A **water molecule is a polar molecule** with opposite ends of the molecule with opposite charges.

AFTER THE LESSON, WATCH THIS TED ED VIDEO

https://ed.ted.com/lessons/how-polarity-makes-water-behave-strangely-christina-kleinberg

Activity- Paper Towers (No Extra Materials; 4 Cans of Food is an Option)





Materials- Paper (maximum 30 sheets per person/group). – any kind except card stock, Tape – unlimited (duct tape not allowed) and packing tape are not allowed, Can of beans or something heavy in the classroom

Goal- Can of beans have to rest on the tower for at least one minute.

Winner- highest score

TotalScore=(Distance To The Bottom Of The Can in Centimeters)−(2×number of pieces of paper)

Teaching Points

-A basic triangle truss unit is one form of a simple truss- they help distribute the weight of the from appoint to the outer edges.

-Guy wire (see on previous page, the tape is serving as a guy wire. Another picture below) is a tensioned cable that is both lightweight and strong. These cables add stability to free-standing structures. They can be seen on ship masts, radio towers, wind turbines, utility poles, and more.

How Do Viruses React To Soap?

Video to watch- BRAIN POP, Viruses (Viruses - BrainPOP)

This lesson is more about the lesson, the project is quick. Use the link below for instructions on the project

https://www.sciencebuddies.org/stem-activities/show-soap-kills-virus

I had kids make 1 virus each- the one with the lipid membrane (ie butter). I had a container of soap water

BACKGROUND

Virus vs bacteria - On a biological level, the main difference is that bacteria are free-living cells that can live inside or outside a body, while viruses are a non-living collection of molecules that need a host to survive.

Can the cold weather make you more sick? Not really. You get more sick in the cold weather b/c we are indoors. BUT-immune cells in the nose may not work as well in the cold weather

Viral transmission- From other people (through coughing, sneezing or close contact). From surfaces or objects that someone with a virus has touched (like countertops, door knobs or phones).

If you ever had a common cold or the flu, you had a viral infection! A virus is a type of germ that can cause diseases in people such as the cold (caused by rhinovirus, resp syncytial virus, some coronaviruses), the flu (influenza), or COVID-19. But how does a virus make a person sick? To make someone sick, a virus first has to infect a person, which means that it has to get inside a person's body. It often enters through the nose, mouth, or breaks in the skin. Once inside a person, or host, a virus attaches to the outer walls of the host's cells. When attached, the virus releases its genetic material (its DNA or RNA) into the cell and then hijacks its replication machinery to make more virus particles (Figure 1). The higher number of cells that get infected by the virus, the sicker a person gets.

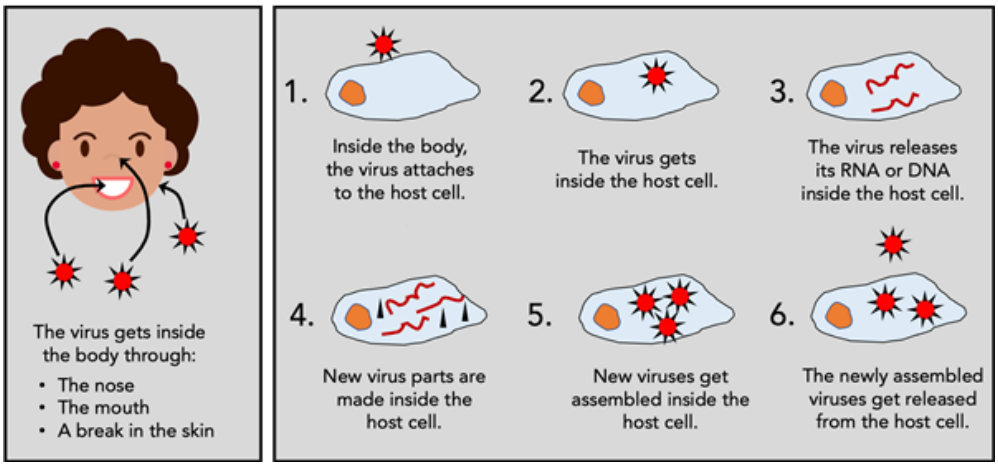


Figure 1. Diagram showing how a virus infects its host (left) and what happens inside an infected body (right).

So how can you protect yourself from being infected by a virus? Your first line of defense is to not allow a virus to enter your body to begin with. This means staying away from people who are or could be sick, avoiding touching your nose, mouth or face, and practicing good hand hygiene. The Center for Disease Control recommends scrubbing your hands for at least 20 seconds with water and soap to get rid of viruses such as SARS-COV-2. Why is hand washing so important and how does it affect the virus? The simple answer is that the mechanical action of hand washing dislodges and carries away most of the virus. But soap also plays an important part in killing some viruses.

Viruses come in many different shapes and sizes. All viruses consist of a nucleic acid core which includes their RNA or DNA, and an outer protein shell which is called the capsid. In addition to this basic structure, some viruses such as SARS-COV-2, the coronavirus that causes COVID-19, have an additional outer lipid membrane envelope that surrounds its capsid (Figure 2).

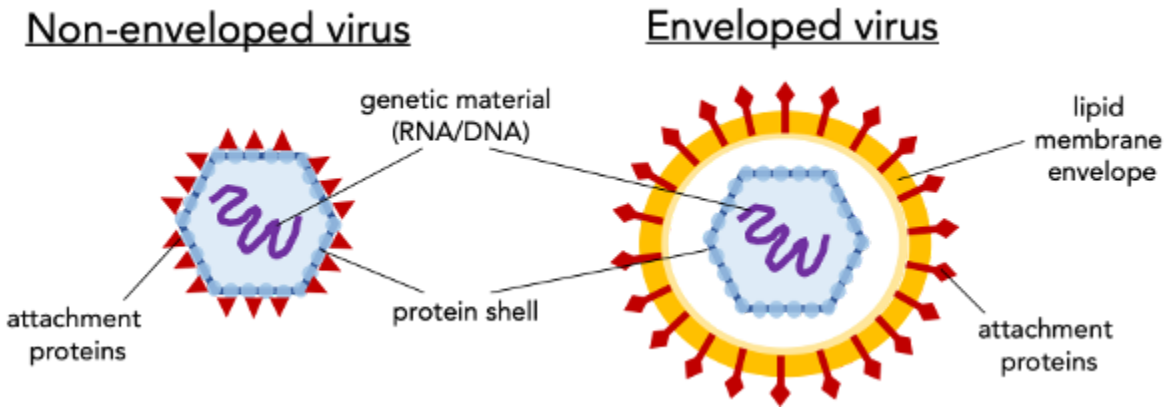


Figure 2. Structures of a non-enveloped virus (left) and an enveloped virus (right).

The attachment tools that a virus needs to hook onto the host cell are located on the outside surface of the virus. Many viruses use proteins to interact with its host cell. For non-enveloped viruses these proteins are located on the surface of the capsid whereas for an enveloped virus the attachment proteins are located on the surface of its lipid membrane envelope (Figure 2).

Enveloped viruses, such as SARS-COV-2, are much more susceptible to soap than non-enveloped viruses, like the viruses which cause polio and hepatitis A. This is because of their lipid membrane envelope. The lipid membrane is made of two layers of lipid molecules that have a hydrophilic (water loving) head and a hydrophobic (water hating) tail. Within this lipid bilayer the hydrophobic tails point toward the center of the sheet whereas the hydrophilic heads face to the outside (Figure 3).

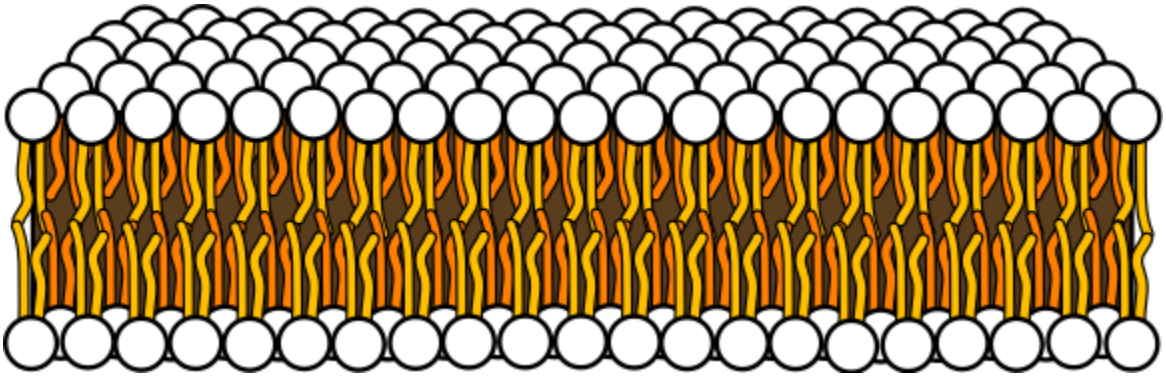


Figure 3. Structure of a lipid bilayer formed by lipid molecules with a hydrophilic head and a hydrophobic tail.

Detergent or soap molecules have a very similar structure to the lipids in a lipid bilayer. They also have a hydrophobic tail and a hydrophilic head but are usually assembled as a spherical structure (a micelle) in which the hydrophobic tails also point inward and the hydrophilic heads outward (Figure 4).

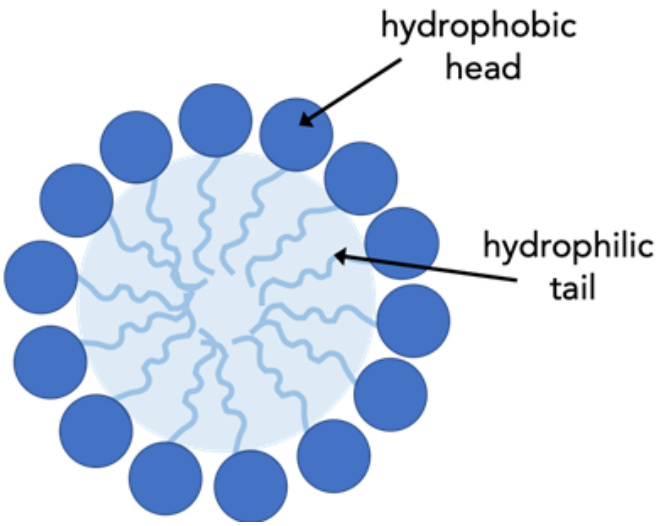


Figure 4. Structure of a detergent micelle.

When detergent micelles come into contact with a lipid bilayer, a process called solubilization happens. This means that the detergent disintegrates the lipid bilayer by incorporating its detergent molecules into the lipid bilayer and also pulling lipids from the bilayer into its detergent micelles (Figure 5). As a result, the lipid membrane dissolves, and the enveloped virus is left without its envelope. With its envelope, the virus also loses its host cell attachment machinery, which means that the virus cannot hook onto a host cell anymore. The soap has successfully inactivated the virus!

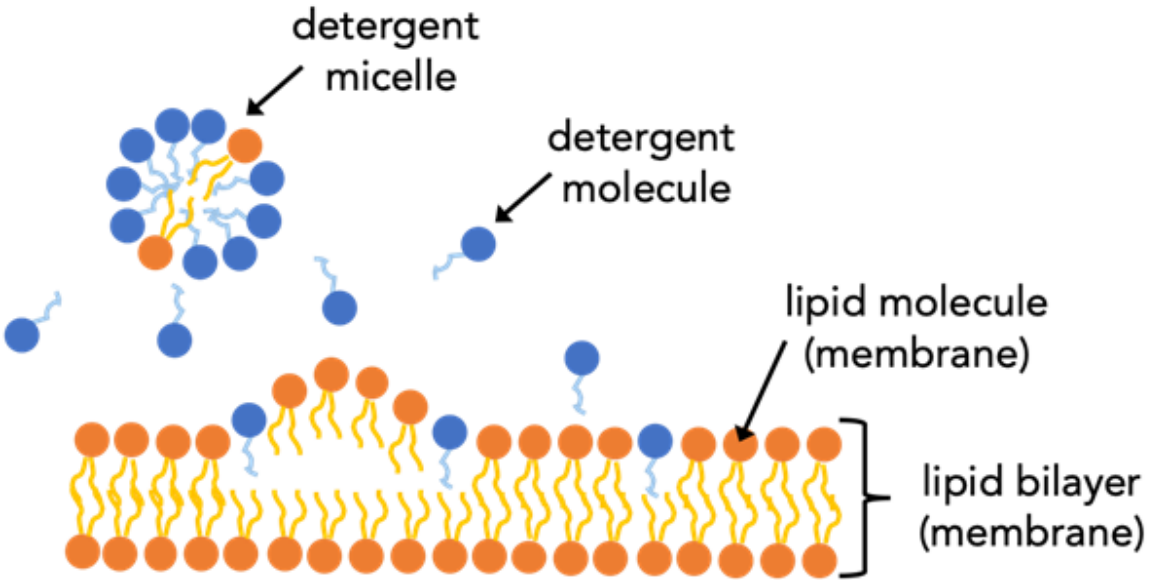


Figure 5. Schematic drawing showing how detergents solubilize lipid bilayers.

COVID 19

So … what is COVID-19? And what's a "coronavirus?"

The term "coronavirus" actually refers to a family of viruses that causes many different types of diseases, including the common cold. COVID-19 is a "novel coronavirus," which means it's a new disease unfamiliar to scientists and doctors. Its name is actually a mash-up of three words: CO stands for "corona," which means "crown" in Latin, and the viruses are named for the crown-like spikes on their surface; VI stands for "virus"; and D is for "disease." The "19" comes from the year 2019, when the disease was first detected.

How did COVID-19 start?

Scientists don't know the exact origin of COVID -19, and they might never have all the answers. But they do know that some diseases start in animals before spreading to humans. These types of diseases are called zoonotic. Cows, bats, and camels are among the animals that have spread diseases to humans in the past. The COVID-19 disease is also zoonotic, with the first cases popping up in December 2019 in Wuhan, China. The affected humans were all connected to a nearby market that sold live animals.

Make a Virus from Clay

Video to watch- BRAIN POP, Viruses (Viruses - BrainPOP)

This lesson is more about the lesson, the project is quick. Watch the video for instructions on how to make a virus out of clay

❤️ Clay art - how to make a virus 🦠/ Coronavirus/ playdoh model craft tutorial. DIY - YouTube

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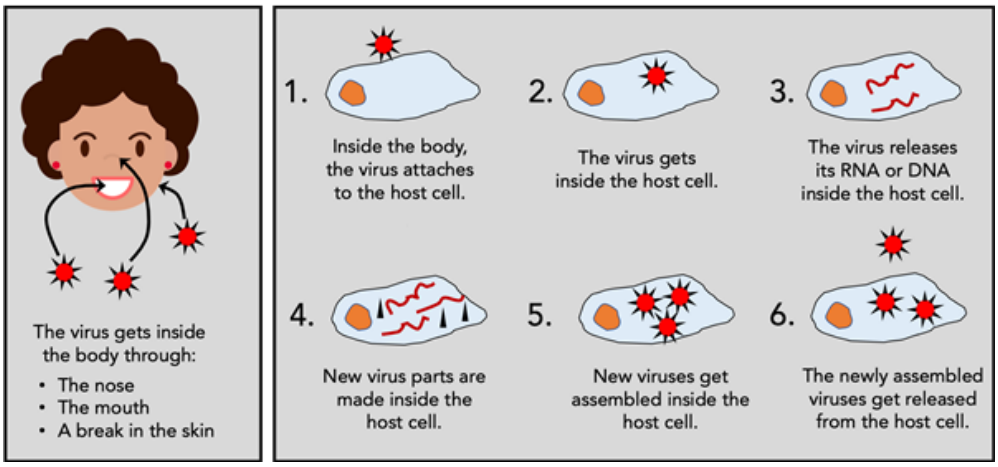

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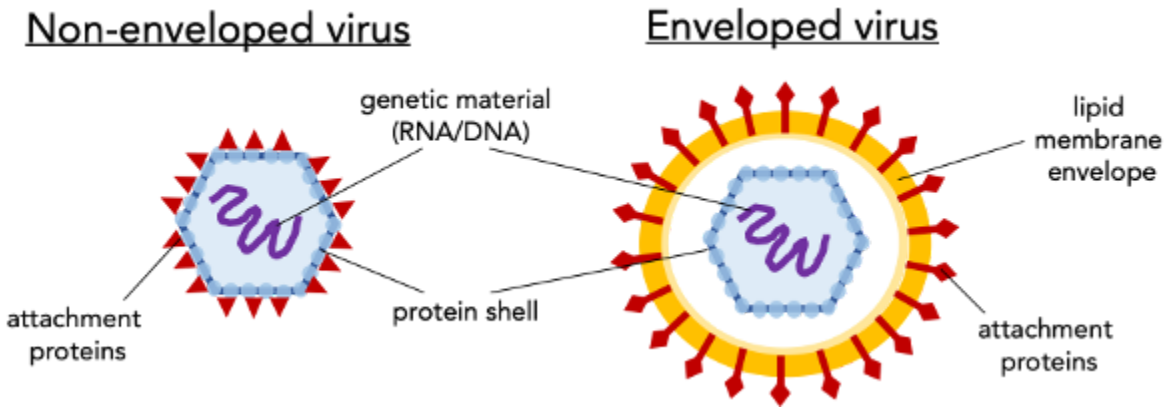

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COVID-19 disease- originated in bats and then jumped to humans with the first cases popping up in December 2019 in Wuhan, China. The affected humans were all connected to a nearby market that sold live animals. 700 million cases, 7 million deaths (1-2% fatality) . Despite having a lower fatality rate than SARS or MERS, COVID-19 caused far more deaths because it was much more contagious and spread worldwide, infecting hundreds of millions.

SARS (Severe Acute Respiratory Syndrome)- also a corona virus originated in bats
Intermediate host: Likely civet cats (sold in live animal markets)
Spread: Rapid global spread in 2003, infecting over 8,000 people in 29 countries, with

a case fatality rate around 9.6%

MERS (Middle East Respiratory Syndrome)- Start: Saudi Arabia, 2012
also a cornavirus (MERS-CoV). Originated in Bats - intermediate host- camels
Spread: Primarily in the Middle East, with occasional international travel-related cases. About 2,600 cases and a high fatality rate of around 34%

Activity Figuring- Out the nutritional value of your lunch (Additional Materials Not Needed)

Materials- packaged goods for each student so they can read the label

Goal - have each student calculate the calories they eat over lunch

Teaching Points

Calories- A calorie is a unit of measurement — but it doesn't measure weight or length. When you hear something contains 100 calories, it's a way of describing how much energy your body could get from eating or drinking it.

Total Fat

Unsat- plant foods and fish, these are seen as neutral or even beneficial to heart health.

Sat- Found in meat and other animal products, such as butter, shortening, lard, cheese, and whole milk and cream. Eating too much saturated fat can raise blood cholesterol levels and increase the risk of heart disease.

Trans- Trans fats are created when vegetable oils are hydrogenated (hydrogen atoms are added to the fat molecule so they remain solid at room temperature). Trans fats can raise cholesterol and increase the risk of heart disease.

Cholesterol - you eat it and it is also made by liver. Sat and Trans fats increase the liver's production of cholesterol. Chol can not travel alone- it needs a protein to travel (LDL/HDL are the protein names). HDL is considered "good" cholesterol, while LDL is considered "bad." This is because HDL carries cholesterol to your liver, where it can be removed from your bloodstream before it builds up in your arteries. LDL, on the other hand, takes cholesterol directly to your arteries.

Carbohydrates

1. Fiber- type of sugar found in natural foods; does not break down. Helps lower cholesterol and helps with bowel movements

2. Sugars – simple. When sugar is added to foods, such as sweets and soda, it supplies calories for energy but has no nutritional value. Added sugar also causes an unhealthy spike in blood sugar that can lead to weight gain and diabetes.

3. Starch-complex sugar (breaks down more slowly than a simple sugar). Healthy complex carbohydrates found in whole grains, vegetables, beans and

fruits. They break down more slowly during digestion, so they provide long-term energy and have less impact on blood sugar.

Protein - Your muscles, your organs, and your immune system are made up mostly of protein.

Elementary school child needs- Calories 1600

Fat- 50 gm (each gm fat has 9 calories = 450 cal)

Carbs- 200 gm (of which fiber 21 gm) (each gm carb is 4 cal = 800 cal)

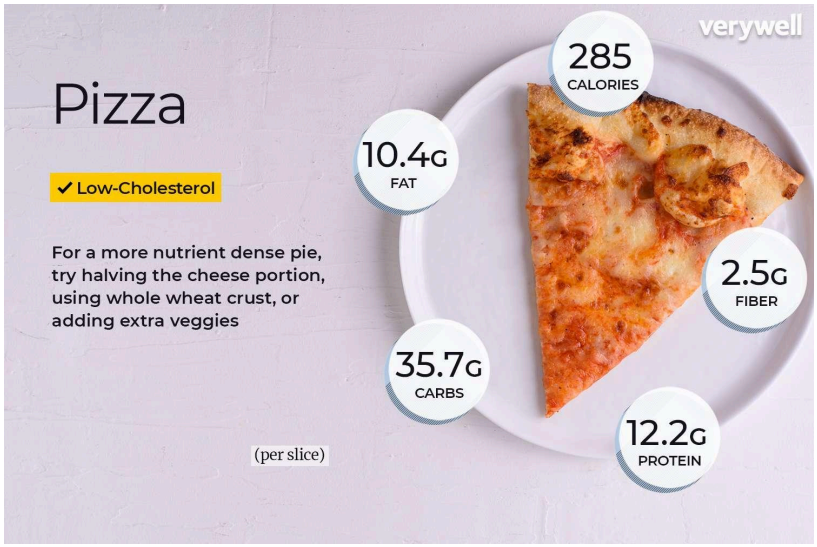
Protein 72 gram (each gm protein is 4 cal = 288 cal)

PRINT THIS OUT AND HAVE KIDS FILL OUT

Each meal should be 533 calories, 3 meals a day = 1600 cal

Each meal should have 17 gm fat, 3 meals a day = 50 gm

	Calories (533 x3 = 1600)	Total Fat (17 gm x3 = 50gm)	Trans fat (0)	Total Carbohydrate (67 gm x3 = 200gm)	Fiber (7gmx 3= 21 gm)	Added Sugar (0)	Protein (24 gm x3 = 72 gm)
Sandwich (main)							
Fruit or Vegetable							
Snack 1							
Snack 2							
Drink							
Total							



Pepperoni Pizza

Nutrition Facts

Serving Size 1/8 of a Pizza (87g)
Servings Per Container 8

Amount Per Serving	
Calories 270	Calories from Fat 80
	% Daily Value*
Total Fat 9g	**14%**
Saturated Fat 4.5g	**23%**
Trans Fat 0g	
Polyunsaturated Fat 1g	
Monounsaturated Fat 1g	
Cholesterol 20mg	**7%**
Sodium 390mg	**16%**
Total Carbohydrate 18g	**6%**
Dietary Fiber 1g	**4%**
Sugars 1g	
Protein 10g	

Vitamin A 6% • Vitamin C 0%
Calcium 20% • Iron 4%

*Percent Daily Values are based on a 2,000 calorie diet.

Peanut Butter and Jelly Sandwich

Nutrition Facts

1 servings per container
Serving size **1 Peanut Butter and Jelly Sandwich**

Amount Per Serving	
Calories	**390**
	% Daily Value*
Total Fat 18g	**23%**
Saturated Fat 3g	**15%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 400mg	**17%**
Total Carbohydrate 46g	**17%**
Dietary Fiber 5g	**18%**
Total Sugars 19g	
Includes 0g Added Sugars	**0%**
Protein 12g	**24%**
Vitamin D 0mcg	0%
Calcium 0mg	0%
Iron 0mg	0%
Potassium 190mg	4%

*The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

Bean and Cheese Burrito

Nutrition Facts

24 servings per container
Serving size **1 burrito (142g)**

Amount Per Serving	
Calories	**280**
	% Daily Value*
Total Fat 8g	**10%**
Saturated Fat 1.5g	**8%**
Trans Fat 0g	
Cholesterol 5mg	**2%**
Sodium 370mg	**16%**
Total Carbohydrate 44g	**16%**
Dietary Fiber 3g	**11%**
Total Sugars 1g	
Includes 0g Added Sugars	**0%**
Protein 9g	**18%**

Not a significant source of vitamin D, calcium, iron, and potassium

*The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

Gatorade

Nutrition Facts

Serving size 1 Bottle (360 mL)

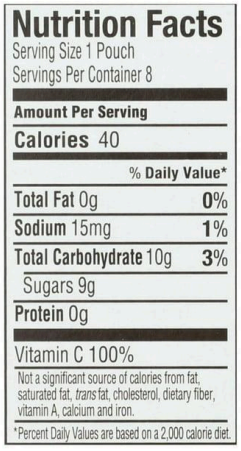
Amount per serving

Calories 80

	% Daily Value
Total Fat 0g	**0%**
Sodium 160mg	**7%**
Total Carbohydrate 22g	**8%**
Total Sugars 21g	
Includes 21g Added Sugars	**41%**
Protein 0g	
Potassium 50mg	0%

Not a significant source of saturated fat, trans fat, cholesterol, dietary fiber, vitamin D, calcium, and iron.

Annie's Juice Box



Nutrition Facts

Serving Size 1 Pouch

Servings Per Container 8

Amount Per Serving

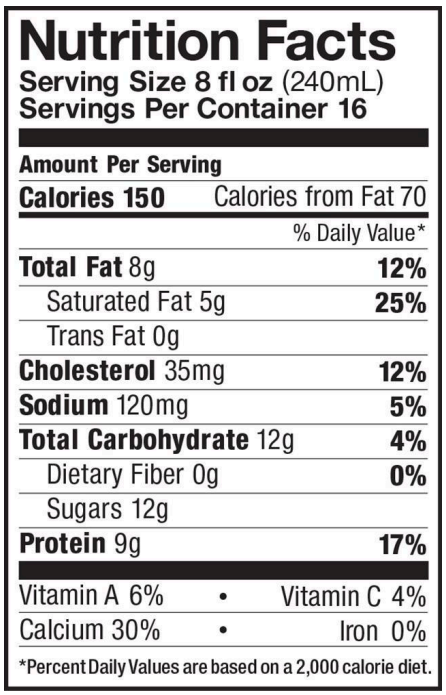
Calories 40

	% Daily Value*
Total Fat 0g	**0%**
Sodium 15mg	**1%**
Total Carbohydrate 10g	**3%**
Sugars 9g	
Protein 0g	
Vitamin C 100%	

Not a significant source of calories from fat, saturated fat, *trans* fat, cholesterol, dietary fiber, vitamin A, calcium and iron.

*Percent Daily Values are based on a 2,000 calorie diet.

Milk



Nutrition Facts

Serving Size 8 fl oz (240mL)

Servings Per Container 16

Amount Per Serving

Calories 150 Calories from Fat 70

	% Daily Value*
Total Fat 8g	**12%**
Saturated Fat 5g	**25%**
Trans Fat 0g	
Cholesterol 35mg	**12%**
Sodium 120mg	**5%**
Total Carbohydrate 12g	**4%**
Dietary Fiber 0g	**0%**
Sugars 12g	
Protein 9g	**17%**

Vitamin A 6% • Vitamin C 4%

Calcium 30% • Iron 0%

*Percent Daily Values are based on a 2,000 calorie diet.

Orange Juice

100% JUICE

Nutrition Facts

Serving size 1 Bottle

Amount per serving

Calories 160

	% Daily Value
Total Fat 0g	**0%**
Sodium 25mg	**1%**
Total Carbohydrate 40g	**14%**
Total Sugars 33g	
Includes 0g Added Sugars	**0%**
Protein less than 1g	

Vit. D 0mcg 0% • Calcium 20mg 2%

Potas. 350mg 8% • Vit. C 60mg 70%

Not a significant source of saturated fat, trans fat, cholesterol, dietary fiber and iron.

Almonds

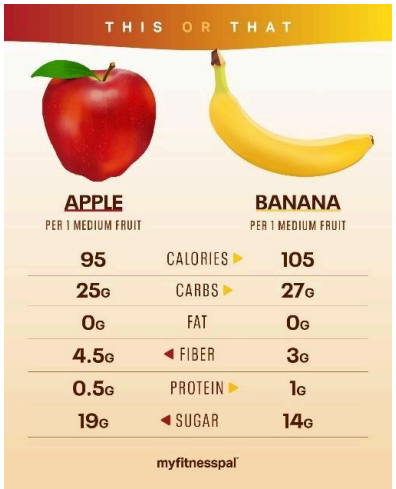
Nutrition Facts

Serving Size 1 ounce (28g)

Amount Per Serving	
Calories 161	Calories from Fat 116
	% Daily Value*
Total Fat 14g	21%
Saturated Fat 1g	5%
Trans Fat 0g	
Cholesterol 0mg	0%
Sodium 0mg	0%
Total Carbohydrate 6g	2%
Dietary Fiber 3g	14%
Sugars 1g	
Protein 6g	

Vitamin A	0%	• Vitamin C	0%
Calcium	7%	• Iron	6%

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs.



Cheezit

Ritz

TJ Fruit Wrap

Fig Newton

Famous Amos

Goldfish

Oreo

Annie's Gummies

Quaker Granola Bar

Nutrition Facts
Serving Size 1 Bar (24g)
Servings Per Container 8

Amount Per Serving

Calories 100 Calories from Fat 25

	% Daily Value*
Total Fat 3g	5%
Saturated Fat 1g	6%
Trans Fat 0g	
Polyunsaturated Fat 0.5g	
Monounsaturated Fat 1g	
Cholesterol 0mg	0%
Sodium 90mg	4%
Total Carbohydrate 17g	6%
Dietary Fiber 1g	4%
Sugars 7g	
Sugar Alcohol 1g	
Protein 3g	

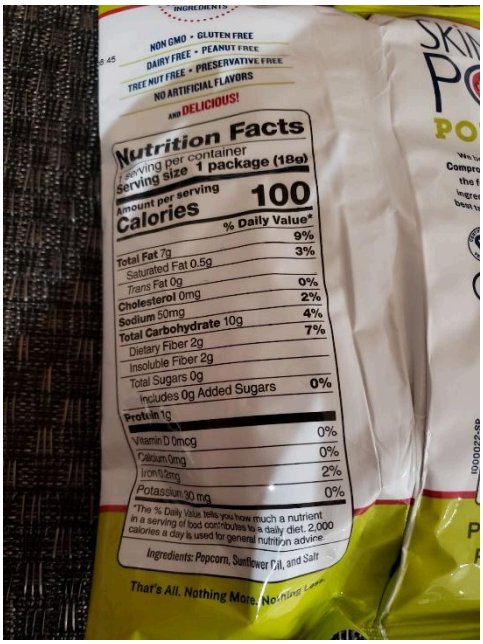
Calcium 10% • Iron 2%

Not a significant source of vitamin A and vitamin C.

* Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Skinny Pop- Popcorn



Activity- Paper circuits (Extra Materials needed)

Materials-Copper Electrical tape (I use ¼ in), 5mm LED lights, 3V Lithium Coin Battery

You can use the last few pages as a template; or have kids design their own!

Website for templates

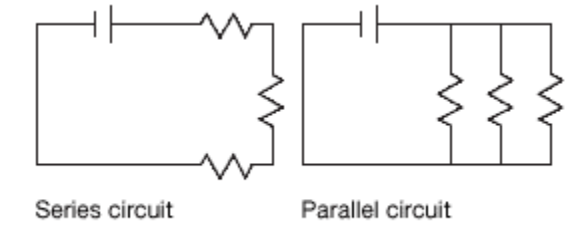
Christmas Light-up Cards w/ Paper Circuits | STEM Makerspace Projects (makerspaces.com)

I suggest using the reindeer k-3; and the xmas tree grades 4/5

Teaching Points - Circuit Review

1. conductor- wire (copper tape) 2. switch- opens/closes the circuit 3. resistor – load. Uses the power (light) 4. cell = power source (battery)

Series Circuit vs Parallel Circui



In a type of electric circuit called 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. In the illustration, the two upright lines in each circuit represent a power source, such as a battery. Each wavy line represents a device, such as a lightbulb, that uses electric current.

Examples

Xmas lights- If one light bulb goes out, all the other lights will go off because the electricity path in the broken bulb is cut off. Ie Xmas lights

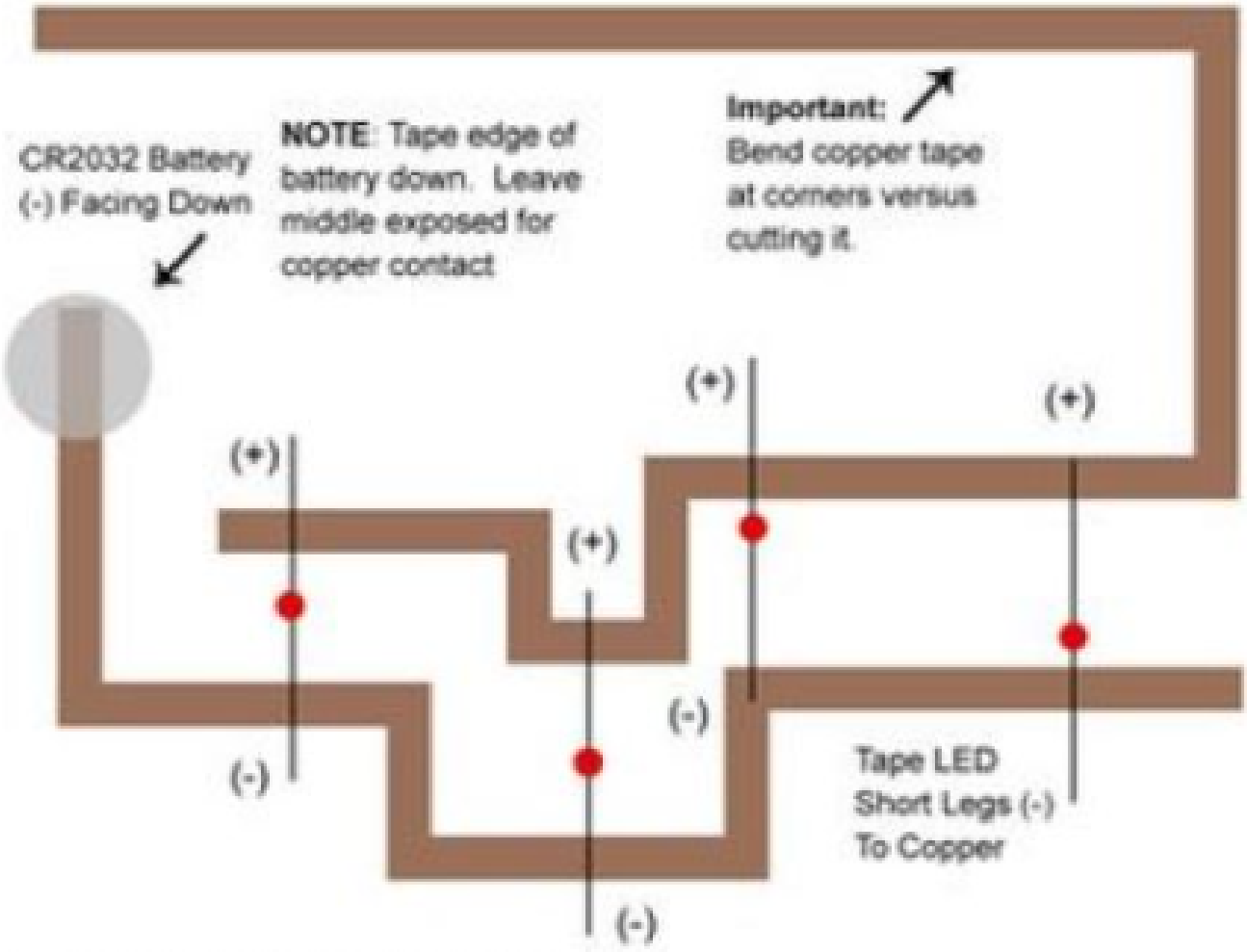
Lights at school or home- In your home, the bulbs are arranged in parallel. If one bulb burns out, the other bulbs in the rooms still work.

LED lights vs Incandescent bulbs

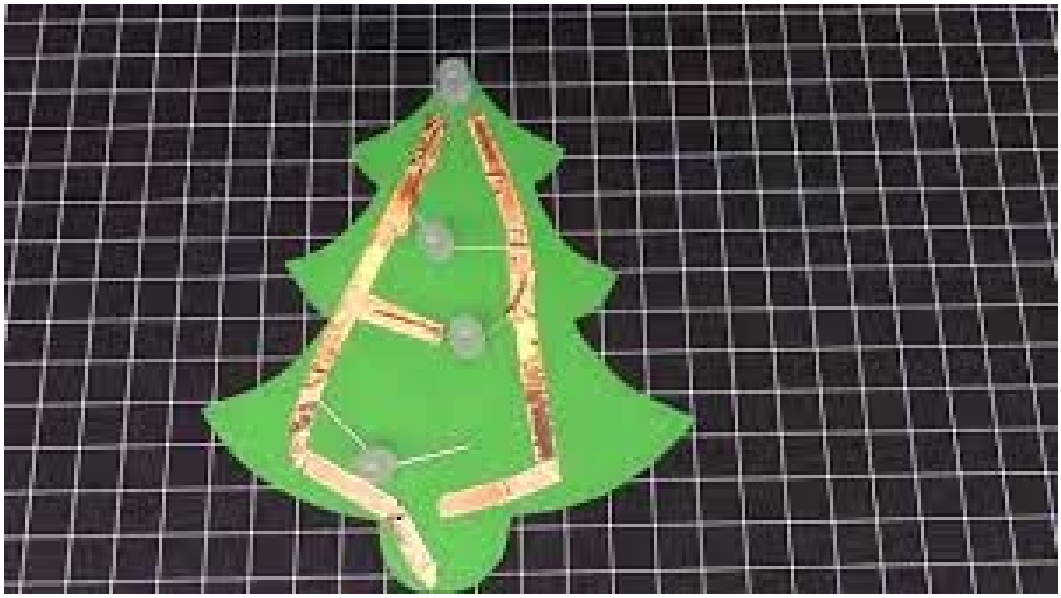
LED lights are energy efficient. They use much less power/energy to produce the same amount of light. Electricity can only pass in one direction through an LED (ie if the LED is backwards, the current will not pass)

BACK

NOTE: Cut tiny holes
for LEDs to fit through.



www.makerspaces.com/paper-circuits

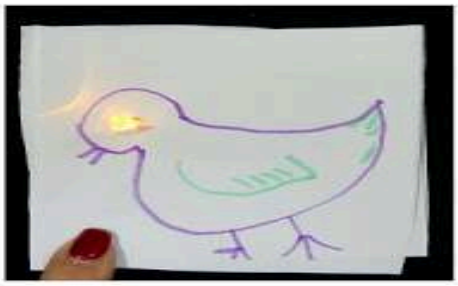


To increase the challenge- the kids design their own…they can use different switches

Different Types of Switches Can be tried with most of these circuits.
Challenge students to try these or come up with their own.

With any of these circuit activities, challenge students to come up with a switch which will open and close the circuit.

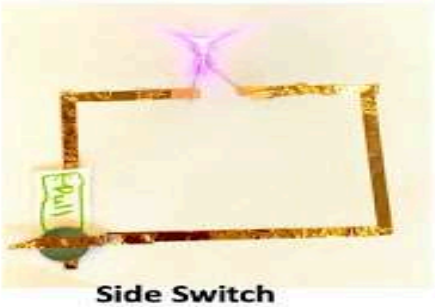
Paper Fold Over Switch
Brad and paperclip switch
Slide switch- small piece of paper inserted to disrupt the connection is pulled out to create connection
Pressure switch- Pressing on the spot where the battery is closes the circuit



Pressure Switch

Paper Fold Over Switch

Brad and Paperclip Switch



Side Switch

Activity- Cinco de Mayo Pinatas (Extra Materials Needed- Candy to fill the pinata)

YouTube Video- How To Make Mini Pull Pinatas!

This is more of a history lesson- what is Cinco De Mayo really about? After the fall of the Aztec Empire, Spain called their new lands the Viceroyalty of New Spain, and ruled over Mexico for the next 300 years. Miguel Hidalgo y Costilla, a priest, wanted to fight for independence from Spain (He called not only for liberation from Spain, but also for the end of slavery and the return of the lands to the indigenous inhabitants. - he made a declaration on 9/16/1810. This was the start of the 11-year war between Mexico and Spain, called the Mexican War of Independence. Mexico won the war 9/27/1827. After independence, Mexico was unable to pay debts to Europe. In the mid-1800s the French leader Emperor Napoleon III tried to take control of Mexico. The victorious battle (in 1862) celebrated on Cinco de Mayo was an important blow against the French. During the battle of Puebla a small army of Mexican soldiers defeated a much stronger French army.

Watch this - PBS LEARNING MEDIA | Cinco De Mayo | PBS KIDS (youtube.com)

Activity-Rubber Band Car Challenge (No Extra Materials Needed)

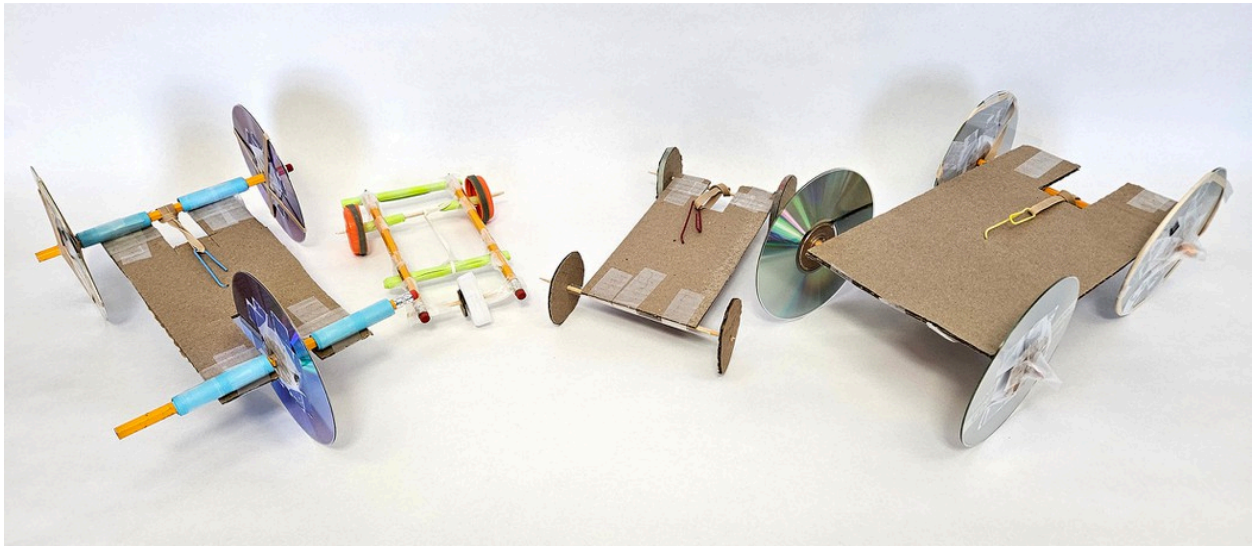
Make a Rubber Band-Powered Car | Science Project (sciencebuddies.org)

All instructions are in the above link (science buddies)

Materials

CD or DVD, plastic water bottle caps, paper, pencils, straws, skewers, paper clips, cardboard, rubber bands, tape

Rubber band-powered cars, like the ones below, can be made from a variety of materials, but they all have one thing in common. A rubber band is wound around an axle, a cylindrical rod that passes through the centers of the wheels. As you twist the axle and tighten the rubber band, it stretches and stores elastic potential energy. When you release the axle, the rubber band contracts, and this potential energy is converted to kinetic energy, the energy of motion, and the wheels will spin. Depending on the amount of friction with the ground, the wheels might propel the car forward, or they might just spin in place! The frictional force between the wheels and the ground depends on both the weight of the car and the coefficient of friction, which depends on the materials the wheels and ground are made of. That is a lot of physics in one little device!



Activity-Paper Rocket Challenge (No Extra Materials Needed)

Companies like SpaceX and Blue Origin are trying to make spaceflight cheaper by designing reusable rocket boosters. Instead of crashing or burning up in the atmosphere, these rockets must land gently and without damage so they can be reused. This means that engineers must carefully steer the rockets back to Earth while keeping them upright. Some rockets land upright on the ground (Figure 1- see below), and some are even caught by towers that grab them in midair (as shown in the video- WATCH: SpaceX catches Starship rocket booster back at the launch pad)!

Figure 1- The booster from Blue Origin's New Shepard NS-25 flight after landing in the desert.

Engineering Challenge

This engineering challenge is inspired by real-world reusable rocket landings like those shown above. Your students' goal is to build a device that can "catch" a falling rocket (a paper or cardboard tube) so it lands vertically. They can also modify the rocket and add features like fins, a nose cone, hooks, or other attachments. The farther they can drop their rockets and successfully catch them, the higher their scores. They can only use

certain simple materials, like paper and tape, and each material has a "cost." Figures 2 and 3 show a few example designs. These designs are just ideas to help your students get started. They can come up with their own ideas and build something totally different!

Figure 2. Example devices designed to catch a falling rocket (shown alongside the rockets).

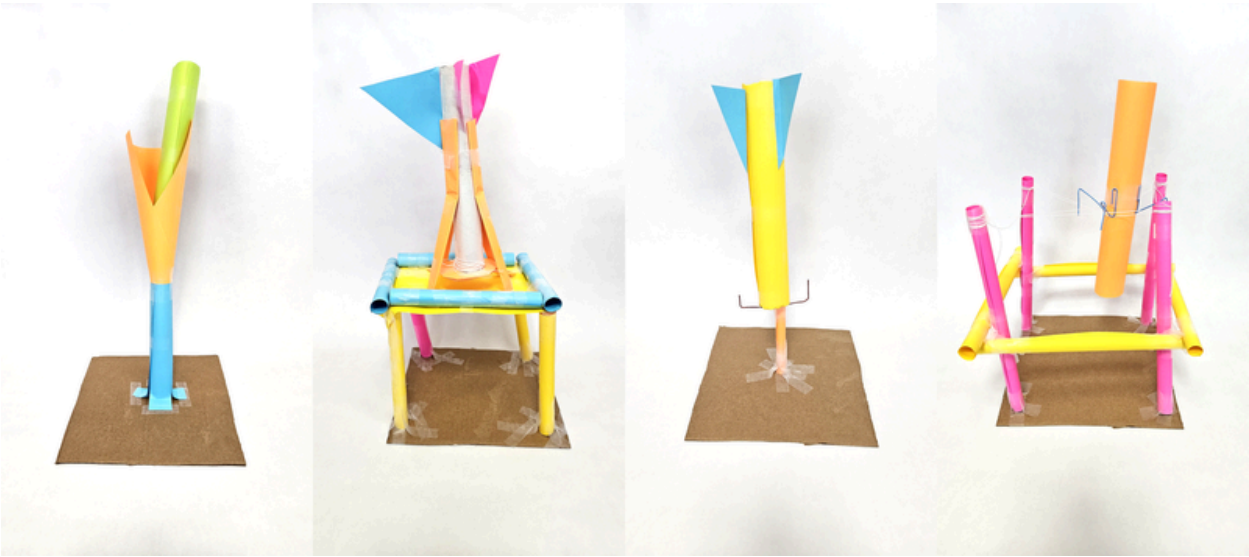


Figure 3. Example devices after the rockets have landed.

There are many physics and engineering principles you can connect to this project.

- This project uses the **engineering design process**, which includes steps like doing background research, defining criteria, and brainstorming before you start building anything. **Iteration**, or repeating some steps more than once, is a normal part of the engineering design process. Your students' devices might not work well on the first try, and that is OK! They can test their designs, learn from their mistakes and failures, and use that information to improve their designs.
- A falling rocket has both **kinetic** and **potential energy**. That energy does not disappear when the rocket hits the device. According to **conservation of energy**, it needs to go somewhere! It can transform into other forms, like **acoustic energy** (sound), **thermal energy** (heat), or **elastic energy** (bending, stretching, or compressing materials).
- A falling rocket experiences **aerodynamic forces**. **Drag** acts opposite the direction of motion, and **lift** acts perpendicular to the direction of motion. This may be confusing at first because we normally think of lift as acting *up* when referring to something like a flying airplane. But in this case, since the rocket is falling *down*, drag acts upward (opposite the direction of motion), and lift acts sideways! A rocket's shape, including any attachments like a nose cone or fins, will influence the aerodynamic forces on it and its **aerodynamic stability** (whether it tends to fly straight or tumble as it falls).
- Different materials have different **material properties**, like **density**, **stiffness**, and **strength**. Different materials that rub against each other also have different **coefficients of friction**. Your students need to take these material properties into account when building their devices. A device that is too weak may break when the rocket crashes into it. A design that is too springy may cause the rocket to bounce back out after landing.

Rules

1. The rocket must start above the rocket-catching device and be dropped into/onto the device. It cannot be thrown or launched upward.
2. The rocket and the rocket-catching device must be separate. They cannot be touching or attached to each other at the start.
3. The rocket-catching device must be freestanding on the ground or floor. It cannot be attached to the ground or floor or to any other supporting object or surface, such as a wall or furniture. It cannot start in the air with the rocket.
4. You may not remove material from the standard rocket body.
5. You may attach materials (from the approved list) to the rocket body.
    1. Anything that is attached to the rocket body counts as part of the rocket and must follow all of the other rules.
    2. Any materials you use to modify the rocket body count toward your total materials cost.
6. No part of the rocket may touch the ground or any other objects (walls, furniture, etc.) during a test.

7. Your rocket-catching device must catch the rocket on its own. After the rocket has been dropped, nobody can touch the rocket or the rocket-catching device, or somehow assist the device in catching the rocket.
8. After all parts have completely stopped moving, the lowest point of the rocket, including all attachments, must be at least 10 cm from the floor (measured perpendicular to the floor), as shown in Figure 4.
9. After all parts have completely stopped moving, the rocket's main body must be vertical. "Vertical" is defined as an angle at least 45 degrees from horizontal, as shown in Figure 4.
10. You must complete 2 successful drops in a row from the same start height, with the same rocket and the same rocket-catching device (repairs in between trials are allowed).

Figure 4. Diagram for challenge setup and measuring distances and the landing angle.

	Size/type restrictions	Maximum quantity	Cost
Paper	Printer, construction, graph, or notebook paper. Letter, A4, 9"x12", and 22x30 cm sizes are all allowed. Cardstock and newspaper are **not** allowed.	40 sheets	3 points per sheet, rounded up to the nearest whole sheet
Cardboard	12"x12" (30x30 cm) sheet. Can **only** be used as a horizontal base plate. Cannot be cut into smaller pieces.	1	5 points

String	Any type up to 3 mm in diameter (dental floss, fishing line, cotton string, twine, yarn, thread, etc.)	10 meters	2 points per meter, rounded up to the nearest meter
Paper clips	Any size up to 2" (50 mm), metal, coated or non-coated	20	1 point each
Tape	Maximum 1" (2.54 cm) wide, clear office tape, masking tape, or painter's tape are allowed. Duct tape, packing tape, and electrical tape are **not** allowed.	1 roll	0 points

Scoring

Your score is then calculated using this equation:

Equation 1: Score=fall distance in centimeters−total materials cost

1. If you measured your distances in inches, convert them to centimeters by multiplying by 2.54. For example, if your fall distance was 40 inches, that is 40×2.54 = 101.6 cm.
2. Count the total number of each material item that you used.
    1. **Material quantities are not prorated.** For example, even if you only use one quarter of a sheet of paper, you must count the entire sheet.
    2. Remember to count materials used for both your rocket-catching device *and* additions to your rocket's body.
    3. If you used a rolled sheet of paper for your rocket's body instead of paper towel or toilet paper tubes, that sheet of paper does *not* count toward your total.
    4. Only count materials used in your final design for both your rocket and rocket-catching device. Materials used for earlier prototypes do not count.
3. For each material, multiply the quantity by the point cost for that material to calculate the subtotal for that material. For example, if you used 6 sheets of

paper, which are worth 3 points each, that is 6×3=18 points. The material cost is 18.

4. Add up all of the subtotals to get your total materials cost. For example, a design that used the sheet of cardboard, 6 sheets of paper, tape, 2 paper clips, and 70 cm of string would have the following materials cost:
    1. Tape is "free" (0 points)
    2. 1 piece of cardboard = 5 points
    3. 6 sheets of paper × 3 points each = 18 points
    4. 2 paper clips × 1 point each = 2 points
    5. 70 cm of string:
        1. First, round *up* to the nearest 100 cm, so 70 cm rounds to 100 cm.
        2. 100 cm × 2 points per 100 cm = 2 points
    6. Total = 5 + 18 + 2 + 2 = 27 points
5. Plug your **fall distance** in *centimeters* and total **materials cost** into Equation 1 to calculate your score. For the design in the example above, with a fall distance of 101.6 cm and a total materials cost of 27 points, the score is 101.6 - 27 = 74.6.
6. Round your score to the nearest whole number. The score of 74.6 would round up to 75. If the score was 74.49, that would round down to a final score of 74. The score submission form will not accept decimals.

Cotton Ball Launcher (Extra Materials Needed)

Link to video instructions- Make a Cotton Ball Launcher | STEM Activity

Materials - Short pencil or popsicle stick, Thin rubber bands (2), Cardboard tube (2 empty toilet paper tubes or empty paper towel tube cut in half), Packing tape or other strong tape, Scissors, Cotton balls, Single hole punch

Teaching Points

When you stretch a rubber band, it stores elastic potential energy: the energy stored inside a material when it is stretched, squished, bent, or twisted. This is different from *gravitational* potential energy, which is the energy stored in an object lifted up off the ground. Both types of potential energy can be converted to kinetic energy, the energy of motion. All moving objects have kinetic energy, and an object that is not moving has no kinetic energy. When energy is converted between forms, the total amount of energy is conserved (some energy may also be converted to heat due to friction, but that is still a form of energy).

Instructions- per the link above; also below

Use your scissors to cut one of the toilet paper tubes in half lengthwise.

1. Squeeze the roll so that it becomes narrower, about half the original diameter, then tape it to hold in place.
2. Use your scissors or your hole punch to punch two holes in the skinny tube (if you are using a popsicle stick, use scissors to make narrower holes the same shape as the popsicle stick). Make the holes opposite one another, half an inch away from the end, so that you can poke your pencil or popsicle stick all the way through the tube.

3. Carefully push your pencil or popsicle stick through the holes.

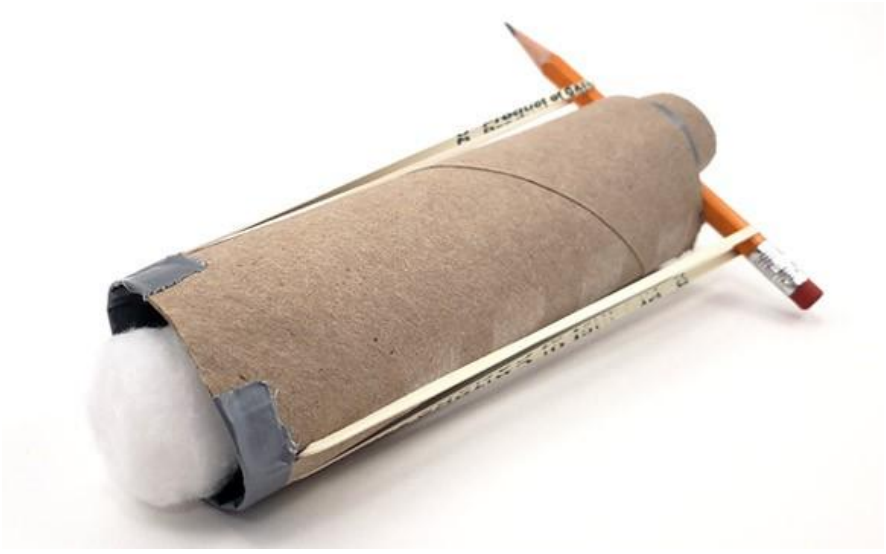
4. On your second toilet paper tube, cut two slits into one end of the tube, about 1/4 inch long and 1/2; inch apart.
5. Cut two more slits on the same end of the tube, directly across from the first two.

6. Carefully loop one rubber band through the slits on one side, so that it hangs from the cardboard piece in the middle. Put a piece of tape over the slits to reinforce the cardboard tab.
7. Loop the other rubber band through the slits on the other side of the tube. When you are finished, the tube should have a rubber band hanging from each side.

8. Holding the rubber band tube so that the rubber bands are at the top, slide the narrower tube into the wider one, with the pencil end at the bottom.

9. Carefully loop each rubber band end around the pencil.

10. Hold your launcher so that the pencil is at the bottom. Place a cotton ball on the top, so that it rests inside the narrower tube.

11. 

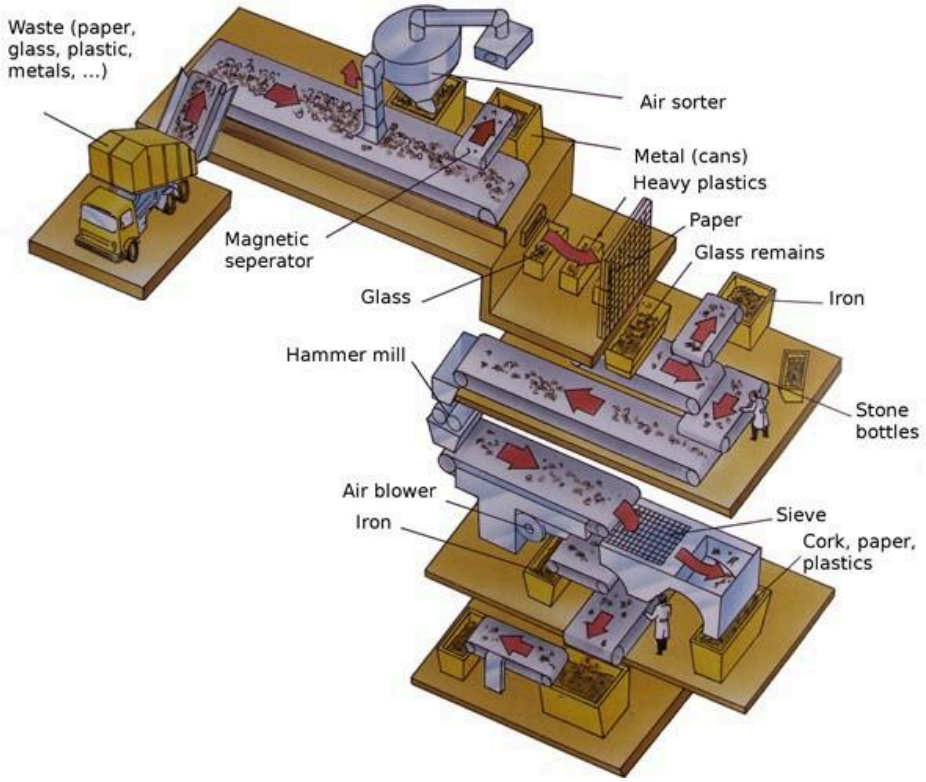
Build a Recycling-Sorting Machine (long lesson, but very good- older kids)

Video with project (REVIEW LINK)- Build a Recycling-Sorting Machine | Lesson Plan

Materials- magnets, paperclips, paper, scissors, cardboard, tape, cups, plastic water bottle, other construction/craft materials such as wooden craft sticks, glue, pipe cleaners, etc.

Teaching points

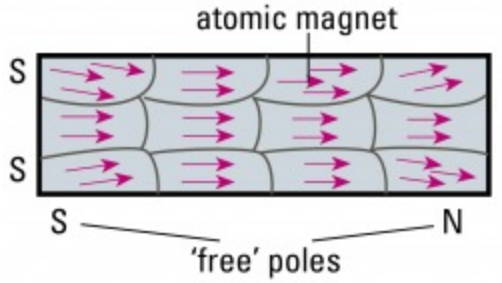
Single-stream recycling programs allow us to mix all of our recyclables—like paper, plastics, and metals—in a single container. These containers are collected by trucks and transported to Materials Recovery Facilities (MRFs). These facilities use a variety of machinery, combined with some manual sorting by humans, to separate all the different materials (Figure 1). For example, large magnets can pull ferrous metals (like tin cans) away from the rest of the waste. Puffs of air can blow lighter materials upward while heavier materials fall down. Sieves allow small objects to fall through the holes while larger objects keep going. Multiple videos listed in the Additional Background section show MRFs in action.



This lesson can be used to teach students about magnetic forces and magnetic fields. For example, students will notice that the magnets exert forces on each other, and the paper clips, even when they are not in direct contact. They can explore what parameters have effects on these forces, such as the distance or orientation of a magnet relative to the paper clips.

Finally, you can also use this lesson to spur conversation about the pros and cons of recycling, and ask students to do further research about recycling as a homework assignment or follow-up project.

Magnets: Because the atoms all point in the same direction, their effects add up, creating one big, strong, stable magnetic field outside the material.

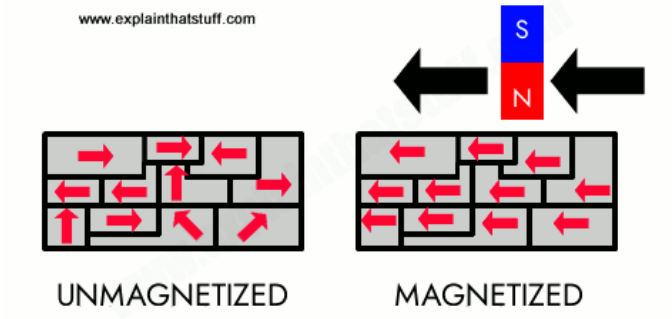


Paperclips are ferromagnetic but unmagnetized: A paperclip is made of steel or iron, which can *become* magnetic. But in its natural state, the domains point in random directions, so they cancel out.

When the magnet touches the paperclip: The magnet's field forces the domains in the paperclip to temporarily align. The clip is now *induced magnetic* and sticks to the magnet.

Why don't paperclips attract each other normally? Once the magnet is removed, the domains scatter again. A paperclip doesn't hold much residual magnetism, so two clips without a magnet won't pull on each other noticeably.

Cool twist: If you *leave a paperclip in contact with a strong magnet for a long time*, it can retain some magnetism. Then, it *can* attract another paperclip, though not nearly as strongly as a real magnet.



Then talk about plastic- what can be recycled and what is trash. See below. Almost all plastic bottle (water, 2L coke etc) can be recycled- these bottles are made from Polyethylene Terephthalate (PET or PETE), which is identified by the number '1' inside the triangular recycling symbol.

Drop Off For Recycling

Soft and Stretchy ♻ Empty and Dry ♻ Cut Out Labels

Grocery Bags

Produce Bags

Newspaper Sleeves

Case Wrap

Sandwich Bags

Bread Bags

Toilet Paper Wrap

Air Pillows

Mailers

Bubble Wrap

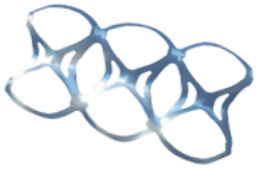
Trash

Crinkly or Dirty

Pet Food Bags

Bags of:
Chips
Salad Mix
Soil/Mulch

Frozen Food Bags



Six Pack Rings

Candy Wrappers

Then watch video- [The Big Sort: An Insider's Tour of a Recycling Plant]

Instructions for the Lesson- watch on science buddies- Build a Recycling-Sorting Machine | Lesson Plan