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On Target

Do you think you can create a device that carries a marble down a zip line to land on a target? In this fun challenge, learn about potential and kinetic energy and how they can help you get your marble on the target. Does the angle of the zip line affect the speed? Can you land your marble in the same place twice? Try out different designs in this hands-on experiment to create the fastest, most accurate vehicle possible.

TEKS:
6.8B Identify and describe the changes in position, direction, and speed of an object when acted upon by unbalanced forces.
6.8E Investigate how inclined planes and pulleys can be used to change the amount of force to move an object.

How To:
1. Your challenge is to create a vehicle that will carry a marble down the zip line. The marble must be able to leave the vehicle on its own in order to land on the target zone.
2. Zip line set up: tie the smooth twine between two objects (e.g. two chairs or a table and a chair). Make sure the line is taut and that one end is about 20 inches (50 cm) below the other. Then, tape the target zone beneath the end point on the lower side of the zip line.
3. First, test different options to transform the paper cup into a zip-lining vehicle. Do you need to modify the size? Or add anything to it?
4. Then, think about where the marble should ride on your vehicle: Inside? Outside? Underneath? Does something need to be added to help hold it in place? Place your marble in this location and make any adjustments as needed.

Materials:
- 1 yard of smooth twine (fishing line or kite string)
- Target zone (attached below)
- 3 paper cups
- 6 index notecards
- 15 paperclips
- 1 marble
- Masking tape
- Scissors

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How To (continued):

5. Next, add a remote release. Design a method for removing (dropping) the marble from your vehicle at the perfect moment (time) to land on the target. Will you *dump the marble out of the cup or create a device using notecards and paperclips that knocks it off the outside of your vehicle*?

6. Then, clip the vehicle to the zip line. Figure out how to hook the cup and paperclip onto the line so that the vehicle slides down smoothly.

7. Design 2-3 different models so that you can test and see which vehicle might work the best.

8. Launch your vehicles down the zip line to see how successful each one is. If they don’t work exactly as you wanted, redesign and see if you can make the vehicles work better.

9. Once you have a working vehicle, change the angle of your zip line to see if you can make the marble reach the target zone faster.

The STEM Explanation:

Both your cup and marble possess potential energy, the measure of how much possible energy an object has to do something, when you clip your vehicle onto the zip line. This means that when you let go of your cup and it begins to travel down the line, potential energy transfers into kinetic energy, the energy of an object in motion. However, the marble still has potential energy because it is not moving on its own. When you activate your release mechanism, the marble then uses kinetic energy as it moves from the cup towards the target below. When you increase the angle of the zip line, the line becomes steeper, causing the force and speed of your vehicle to increase.

Career Connection:

*Aerospace engineers* are responsible for the design, construction, and application of the science behind the forces and physical properties of aircrafts, rockets, and spacecraft. For any aircraft or spacecraft, an aerospace engineer must understand its *aerodynamic* characteristics and behaviors, *airfoil, control surfaces, lift, drag*, and other properties.

Resource:

- PBS Kids: [http://pbskids.org/designsquaddesignsquad/parentseducators/resources/on_target.html](http://pbskids.org/designsquaddesignsquad/parentseducators/resources/on_target.html)
Heavy Lifting

Have you ever noticed how materials are lifted up to build a tall building? How would you lift wood and supplies to make a tree house? Explore how simple machines can help make a challenging task easier. Design a crane, using simple machines, to test how heavy a load your crane can lift!

**TEKS:**
6.8E Investigate how inclined planes and pulleys can be used to change the amount of force to move an object.

**How To:**

1. First, let’s explore how cranes work by building a simple crane arm. Cut a piece of string about 2 ft. long and tie one end around the center of a pencil. Stick the other string end through a hole at the end of a ruler, then tie a paperclip here so that when you pull the pencil and string, the paperclip stops the string from falling out of the hole.
2. Hold the ruler at an upright 45-degree angle facing away from you. The pencil should lay perpendicular across the base of the ruler with the string running up along the center of the ruler to the hole with the paperclip hanging from the string straight down from the hole. If you start rolling the pencil between your fingers, you will notice the paperclip move up or down. This is very similar to how real cranes work. The arm (ruler) needs to be stiff so that it can hold the heavy load while the take-up reel (pencil) winds the cable to actually lift it.
3. Now, examine the materials you have available to build your crane and brainstorm how you would like to design your own. Think about the simple model we just created and what materials you could use for the arm and take-up reel of your crane.

**Materials:**
- Cardboard box (shoebox size or bigger)
- 3 strips of corrugated cardboard (2”x11” or 5cm x 28cm per strip)
- Paperclips
- Large plastic cup
- 3 sharpened pencils
- Spool
- Scissors
- Smooth string (e.g. fishing line or kite string)
- Ruler
- Scotch tape
- Weights (e.g. batteries, pennies, marbles, or gravel)
How To (continued):

4. Think about these questions as you design your crane:
   - How will you keep the crane’s arm from breaking off the box as it lifts a heavy load?
   - How will you stop a heavy load from pulling the arm to the left or right?
   - How will you wind and unwind the cable so the hook can go up and down?

5. Design your crane, then test it by seeing if it can pick up various weights!

6. If your crane does not work exactly as you had planned, redesign and test your crane until it does.

The STEM Explanation:

Simple machines are tools that are used to make work easier. They require less input to create a bigger output. For example, by using an inclined plane or ramp, you can push a heavy cart to a higher location with less force. A crane can be made using a combination of three simple machines – a lever (the arm), a pulley (the arm’s crosspieces), and a wheel and axle (the take-up reel). These simple machines work together against forces, like gravity, that are affecting how hard it would be to lift the load in the cup. Other simple machines are wedges (chisel), screws (jar lids), and inclined planes (ramp).

Career Connection:

Structural engineers are concerned with the design and construction of all types of structures such as bridges, dams, tunnels, power plants, offshore drilling platforms, and space satellites. Structural engineers research the forces that will affect the structure and then develop a design that allows it to withstand these forces.

Resource:

Amazing Birds

Have you ever noticed the similarities and differences between birds’ wings and an airplane? Explore the adaptations that help birds fly and investigate the wingspans of an albatross, falcon, and vulture. Determine how a bird’s wingspan affects flight and design an airplane that will remain in flight for as long as possible.

TEKS:
4.10A Explore how adaptations enable organisms to survive in their environment such as comparing birds’ beaks and leaves on plants.
5.10A Compare the structures and functions of different species that help them live and survive such as hooves on prairie animals or webbed feet in aquatic animals.
7.12A Investigate and explain how internal structures of organisms have adaptations that allow specific functions such as gills in fish, hollow bones in birds, or xylem in plants.

How To:
1. Using the Wing Model Template (attached below), print each template on cardstock and cut out each wing model.
2. Peregrine falcon wing setup: fold the template in half, then fold the wings and tail flaps down so that they lay flat.
3. Try throwing the peregrine falcon model like you would a paper airplane. Measure and record the distance traveled and the time it stayed in the air.
4. Attach a binder clip to the front of the wing model and try throwing it again. Compare the time and distance traveled.
5. Follow the same procedure for the wandering albatross model and the turkey vulture model (do not cut the three finger slots until next step).

Materials:

• Scissors
• 3 small binder clips
• Stopwatch
• Measuring tape
• Wing model template for each bird (attached below):
  o Turkey Vulture
  o Wandering Albatross
  o Peregrine Falcon

For airplane design:
• Cardstock or construction paper
• Straw
• Scotch tape
How To (continued):

6. Did you notice the turkey vulture model did not fly very smoothly? This time cut out the three finger slots at the tip of each wing. Notice that the finger slots help the wing shape glide more smoothly just like the feathers would on an actual bird.

7. Now that you have explored how different types of birds have different shaped wings and how wing shape affects birds’ ability to stay in the air, use this knowledge to design an airplane that can stay in the air for the longest period of time. Use cardstock or construction paper, a straw, scissors, and tape to design your airplane.

8. Think about which birds’ wing design worked the best and cut out the shape of the wings you want for your airplane using cardstock or construction paper. Make sure that your wings are symmetrical, try folding your piece of paper in half to make your wings symmetrical.

9. Tape a straw underneath the center of the airplane wings (along the line of symmetry or fold line) with the end of the straw sticking out about three inches from the front of the wing.

10. Cut out 2 small triangles from the cardstock or construction paper to make the tail of your plane. Cut a slit in the top of the straw about 1 inch from the back end of the straw. Slide one of the triangles into the slit so that it is vertically sticking out of the straw and tape it down. This is the rudder to help steer the plane and keep it from spinning.

11. Tape the other triangle to the bottom of the straw so that it is oriented horizontally (perpendicular) beneath the rudder - make sure it is centered so that when you look down the length of the straw, everything on your plane is symmetrical. This is the elevator to help the plane get high into the air.

12. Now test your plane and modify if necessary to keep it in flight as long as possible.

The STEM Explanation:

Wings are important to flight, but wing shape helps determine how a bird will fly. The longer and straighter birds’ wings are, the easier it is for them to glide through the air rather than flap their wings, since the heavy weight of their wings would be exhausting to continuously flap. Gliding helps birds, like the albatross, move slower through the air as they are searching for food on the ground. Birds with a shorter wingspan, like falcons, have wings that look bent that allow them to maneuver quickly to catch food.

Career Connection:

Ornithologists study the biology and habits of birds. Studies may focus on bird species’ instinct or learning abilities, anatomy, ecosystem development and conservation, or individual and group behavior. Many ornithologists work with other professionals to apply their research to other disciplines, such as incorporating bird adaptations into the design of aircraft.

Resources:

- All About Birds: [http://www.allaboutbirds.org](http://www.allaboutbirds.org)
- Amazing Birds: [http://www.birds.cornell.edu/physics/lessons/elementary/pdfs/tm](http://www.birds.cornell.edu/physics/lessons/elementary/pdfs/tm)
- Bird Adaptations: [http://projectbeak.org/adaptations/skeletal_hollow.htm](http://projectbeak.org/adaptations/skeletal_hollow.htm)
Turkey Vulture
Wandering Albatross
Cooking Conversions

Do you know how many tablespoons are in a cup? Or the number of teaspoons in a tablespoon? Use your math skills to learn about different types of measurements and how to convert between them to make these tasty pudding cookies.

TEKS:
4.4H Solve, with fluency, one- and two-step problems involving multiplication and division, including interpreting remainders.
6.4H Convert units within a measurement system, including the use of proportions and unit rates.

How To:
1. Preheat oven to 176.67 °C. Use the ‘Conversions You Need To Know’ below to figure out what 176.67° Celsius is in °Fahrenheit.
2. Combine flour and baking soda in mixing bowl and set to the side.
3. In another mixing bowl, beat the softened butter and brown sugar until it is light and fluffy. Next, add the dry pudding mix and beat until the mixture is well blended. Then, add the eggs and mix well.
4. Gradually add the flour mixture from step 2, continuously stirring until you have added the entire mixture. Stir in chocolate.
5. Scoop about 3 teaspoons of dough at a time and roll the dough into balls. Place the dough balls about 2 inches apart on the baking sheet.
6. Bake cookies for 600-720 seconds or until the edges of the cookies are lightly browned.
7. Take the cookies out and let them cool. Ask an adult for help because the pan will be hot.

Materials:
- 2 mixing bowls
- Baking sheet
- Measuring cups and spoons
- Spoons (for stirring)
- Ingredients:
  - 32 Tbls of flour
  - 1 tsp of baking soda
  - 16 Tbls of butter (softened)
  - 16 Tbls of brown sugar
  - 1 package (3.9 oz.) JELL-O chocolate instant pudding
  - 2 eggs
  - 6 oz. of BAKER’S white chocolate, chopped
Conversions You Need To Know:

- °C (9/5) + 32 = °F
- 16 Tbls = 1 cup
- 3 tsps = 1 Tbl
- 60 seconds = 1 minute

The STEM Explanation:
Working in the kitchen can require lots of conversions! What if your recipe only makes enough cookies for 2 people but you have 10 friends? What would you do if you only have tablespoons to measure with and no measuring cups? It is helpful to know how to convert different measurements to make your recipe easier to read and ensure that it turns out the way you want it to.

Career Connection:
Mathematicians use mathematical principles to solve real-world problems. Some mathematicians work with theoretical mathematics to make new laws for mathematics. Other mathematicians deal with applied mathematics. These mathematicians take the laws given by theoretical mathematicians and apply them to help in the real world, like in businesses and engineering.

Resource:
Did you know that you can turn a toothbrush into a robot? Use a battery, vibrating motor, and a toothbrush head to create a robot that can move across a smooth, flat surface. Then, use your creativity skills to decorate your robot to look like your favorite winter animal.

**TEKS:**
6.8B Identify and describe the changes in position, direction, and speed of an object when acted upon by unbalanced forces.
6.9C Demonstrate energy transformations, such as when energy in a flashlight battery changes from chemical energy to electrical energy to light energy.
8.6A Demonstrate and calculate how unbalanced forces change the speed or direction of an object’s motion.

**How To:**
Note: If you purchased a bristlebot kit, follow the instructions included in the kit and skip to Step 5.

1. To start, you will need to remove the toothbrush head from the rest of the toothbrush. Using pliers or wire cutters, cut the handle off from the head, leaving no more than ½ inch of the handle. This will be known as our “stalk.”
2. Strip the end of the motor’s wires so that the wire showing is ¼-inch long. Test the motor by touching one wire to the top of the battery and the other wire to the bottom. You should see the motor spin quickly.
3. Using a piece of electrical tape, attach the motor to the top of the toothbrush bristles over the stalk, making sure the motor can spin without hitting the toothbrush. Wrap one of the wires around the brush so that the exposed part of the wire is on top of the bristles (you may need to wrap the wire several times depending on how long it is).

**Materials:**
- Copy paper
- Cardstock
- Construction paper
- Markers and/or crayons
- Scotch tape
- 1 bristlebot kit (can be purchased [here](#)) OR purchase the following materials separately:
  - 1 micro vibration motor (this can be purchased [here](#))
  - 1 lithium battery (1-3 volts)
  - 1 toothbrush with bristles set at an angle
  - Wire strippers
  - Electrical tape
  - Googly eyes
  - Pipe cleaners
How To (continued):

4. Place the battery over the exposed wire (the bottom of the battery should touch it) and attach it to the toothbrush head using electrical tape, making sure that some of the battery is still exposed so the top wire will still be able to complete the circuit.

5. Decorate the bristlebot like your favorite winter animal, such as a penguin or polar bear. You can use different materials, including copy paper, cardstock, or construction paper. Use googly eyes or pipe cleaners to add detail. Once you’re done, tape the exposed end of the second wire to the back of the picture using Scotch tape.

6. Make sure your winter animal decorations are securely attached to your bristlebot.

7. Verify that your exposed wire makes contact with the top of the battery to make the motor spin. If the motor does not spin, recheck to make sure the battery and wires make a complete connection.

8. Place the bot on a smooth, flat surface to test the bot’s ability to move across it. If your motor is spinning, but your bot is not moving, adjust the angle of your bristles. (You can set a heavy weight on top of the brush for a few minutes if they aren’t angled enough). If your bot is spinning in one spot, shift the position of your motor, battery, and/or winter animal decorations to make sure that the weight is evenly distributed on all of the bristles.

The STEM Explanation:
The electrical energy from the battery causes the motor to vibrate, which creates mechanical energy (the energy of motion). The vibrations cause the toothbrush head to move along the surface. Because the motor bounces the bristlebot up and down on the tilted bristles, the bot scoots in the direction that the bristles lean.

Career Connection:
Careers in artificial intelligence (AI) involve automation, robotics, and the use of sophisticated computer software and programs. People pursuing jobs in this field require specific education based on math, technology, logic, and engineering knowledge and skills. Working with artificial intelligence requires an analytical thought process and the ability to solve problems with cost-effective, efficient solutions. AI specialists need technical skills to design, maintain, and repair technology and software programs. They must also communicate effectively and possess the ability to work with colleagues on a team.

Resource:

- http://pbskids.org/designsquadr/build/bristle-bots/
Miner Rescue

In 2010, 33 miners were trapped 2,300 feet underground for 69 days in a coalmine in Chile. All of them survived owing to many factors, including well-designed rescue equipment. Your challenge is to create a tool that will help rescue a person (a ping-pong ball) from a mining shaft (a paper tube).

TEKS:

4.2A Plan and implement descriptive investigations, including asking well-defined questions, making inferences, and selecting and using appropriate equipment or technology to answer his/her questions.

How To:

1. Tape the paper tube upright to the table so that it will not move and place the ping-pong ball inside of it.
2. Examine the paper tube and ping-pong ball. Brainstorm ideas that a rescuer might use in this situation and sketch your designs for a tool to help remove the ping-pong ball.
3. Create your rescue device using pipe cleaners, straws, craft sticks, rubber bands, a cup, and/or string. Make sure your device is light, portable, and durable.
4. Now it’s time to test your device! Try to remove the ping-pong ball from the tube. Does the tool drop the ball? How could you increase the friction to make it easier for the tool to grip the ball?
5. If your device does not work exactly how you planned, modify your tool to make it work. Redesign and test until your device works.
6. Once you have successfully made your device work, see if you can make your tool work even better.

Materials:

- 1 ping-pong/table tennis ball
- 1 paper tube that is 6-inches long with a 2-inch diameter (toilet paper tube or cardstock rolled and taped)
- 6 pipe cleaners
- 6 straws
- 6 craft sticks
- 6 rubber bands
- 1 3.5 oz. paper cup
- String
- Masking tape
- Scissors
The STEM Explanation:
Engineers who design rescue equipment need to test their equipment to make sure it works, but they do not want to wait to test until an actual rescue. In order to be confident that the tool or device will work in an emergency, it must be tested under a wide variety of circumstances before a real-life emergency. Rescues have to be quick and efficient, yet each one is somewhat unique. If you are designing rescue equipment for a client, you want to make sure your equipment is versatile, durable, lightweight, and portable.

Career Connection:
*Engineers* design and develop many different things that help solve everyday problems. They use advanced math skills to design machines, bridges, electronics, and much more. There are several different types of engineers that specialize in certain areas such as electrical engineers, mechanical engineers, structural engineers, robotic engineers, etc.

Resource:
Gold Diggers

Rocks that contain large amounts of minerals are called mineral deposits. Silver and gold are examples of mineral deposits people mine for a profit, however, mining companies have to take into consideration the impact their mining practices have on the environment. Using yummy chewy chocolate chip cookies, practice your mining skills and calculate if mining for chocolate chip “mineral deposits” is worth the cost to the environment.

TEKS:
6.1A Apply mathematics to problems arising in everyday life, society, and the workplace.
6.3D Add, subtract, multiply, and divide integers fluently.

How To:
1. To start, set a cookie on top of your paper plate. Just looking at the top surface of the cookie, count how many chocolate chips (minerals) you see and record the number on the Gold Diggers Activity Sheet (attached below).
2. Using toothpicks, carefully dig out the “minerals” starting at the top of the cookie and working your way down.
3. Then, “process” your mineral deposits by separating the chocolate chips from the cookie crumbs. Record your start and stop times so you know exactly how long it takes you to mine and process the cookie. Multiply your total minutes by $20.00 for the ‘Mining and Processing Fee.’
4. Next, calculate the ‘Total Land Damage Fee.’ Do this by multiplying the number of cookie pieces by $100.00 for “land damage” and adding this product to the ‘Environment Impact Fee’ ($100.00).
5. Using a straw, pick up each mine mineral so that you see the chocolate chips stacking up inside of the straw. Use the centimeters side of your ruler to measure the amount of “mineral material” in the straw and multiply this number by $500.00 to get the ‘Value of Minerals.’

Materials:
- Chewy chocolate chip cookies
- Toothpicks
- Clear straws
- Ruler with centimeters
- Paper plates
- Watch or clock
- Gold Diggers Activity Sheet (attached below)
How To (continued):

6. Finally, determine your overall ‘Profit.’ Add the ‘Total Land Damage Fee’ and the ‘Mining and Processing Fee’ together to get your ‘Total Cost.’ Then, subtract the ‘Total Cost’ from the ‘Value of Minerals’ to see how much you profited off of your mining skills!

The STEM Explanation:

Some rocks, called mineral deposits, contain large amounts of minerals. A mineral deposit that can be mined for profit is called an ore, such as silver and gold. Sometimes there are problems with the mining of ores. A mine may reach deep into the earth’s surface, making these minerals very difficult and costly to retrieve, or can cover a large area that, when dug up, may cause environmental problems.

Career Connection:

As worldwide demand for minerals and metals soars, more pressure than ever before is being placed on the earth’s fundamental resources. Using sophisticated processes and technological advances, mineral process engineers extract and refine valuable minerals from raw ores. They also work to protect and restore the environment. Mineral process engineers create new products from materials that were once considered waste, cleaning up the landscape while promoting economic growth.

Resources:

- The Mailbox, Intermediate, June/July 1998, p. 31
Gold Diggers Activity Sheet

Mining and Processing

1. Number of minerals you can see on the surface of your cookie

2. Start time

3. Stop time

4. Total mining time

5. Mining and Processing Fee $20.00 for every minute used for mining.

\[ \text{Total mining time} \times 20.00 = \text{Mining and Processing Fee} \]

Land Damage and Mineral Value

1. Environmental Impact Fee = $100.00

2. Land Damage: number of cookie pieces that broke off as you mined

\[ \# \text{ of cookie pieces} \times 100.00 = \text{Land Damage} \]

3. Total Land Damage Fee: Impact Fee $100.00 + Land Damage = $

4. Gather the mined chocolate chips with a straw.

5. Use centimeters to measure the chocolate in the straw

6. Calculate the value of your mineral ($500.00 for every cm of mineral in the straw)

\[ 500.00 \times \text{cm} = \text{Value of minerals} \]
Gold Diggers Activity Sheet

Profit

Mining and Processing Fee $ ________________

+ 

Land Damage Fee $ ________________

Total Cost $ ________________

Value of Minerals $ ________________

- 

Total Cost $ ________________

Total Profit $ ________________
Human Battleship

Do you think you could handle playing a life-size version of Battleship? Create your own coordinate grid, grab a few friends, and learn about coordinate planes while sinking “ships” as you go!

TEKS:
5.8A Describe the key attributes of the coordinate plane, including perpendicular number lines (axes) where the intersection (origin) of the two lines coincides with zero on each number line and the given point (0, 0); the x-coordinate, the first number in an ordered pair, indicates movement parallel to the x-axis starting at the origin; and the y-coordinate, the second number, indicates movement parallel to the y-axis starting at the origin.
6.11 Measurement and data. The student applies mathematical process standards to use coordinate geometry to identify locations on a plane. The student is expected to graph points in all four quadrants using ordered pairs of rational numbers.

How To:
1. Beforehand, make a coordinate grid on the floor using taped-down yarn that is 6 squares by 6 squares. Each square should be approximately 2-feet by 2-feet in size.
2. Use numbered index cards to label the X- and Y-axes. Number the lines on each axis 1-6. See the STEM Explanation for clarification on X- and Y-axes.
3. Use a sheet or something you can’t see through to divide the area.
4. Repeat steps 1 & 2 on the other side of the sheet. Make sure that you cannot see the grid on the other side of the sheet.
5. Color a handful of index cards to create “color counters” to be used to record when you land on a coordinate, but do not hit anything.

Materials:
- Interactive dice (can be found here)
- Yarn
- Masking tape
- Sheet, blanket, or something you can’t see through
- Index cards
- Markers
How To (continued):

6. Divide your friends into two teams. Have no more than 10 members from each team pick a coordinate to stand or sit in, depending how tall your middle divider is. Do not allow the other team to see your placements.

7. Now, have someone from team 1 roll the dice. The first value rolled will be the x-coordinate and the second value rolled will be the y-coordinate. If someone is standing on the coordinate pair rolled, they yell, “hit” and they are out! If no one is standing on the coordinate pair, place a color counter to mark the place and the team yells, “miss”.

8. Teams take turns rolling the dice. The game is over when all members from one team have been ‘torpedoed’!

The STEM Explanation:

The coordinate plane is formed by two number lines. The horizontal number line is called the x-axis and the vertical number line is the y-axis. They intersect at a point called the origin or (0,0), which is given in the (x,y) format. The first value is the x-coordinate, which is how many spaces to move right (positive), or left (negative). The second value in a coordinate pair is the y-coordinate. This coordinate describes how many spaces you move up (positive) or down (negative).

Career Connection:

Urban planners create plans for the use of land within a city. After they understand the goals of a project, urban planners collect a lot of data. Using coordinates, they make decisions on the best locations for their plans. After they determine the best use of the land, urban planners normally meet with architects and engineers to start designing the project.

Resources:

- http://resources.alljobopenings.com/urban-planners
Balloon Boats

Be a structural engineer and create a boat that moves through water! Using a Styrofoam plate, a balloon, and a straw, see how far and fast you can make your boat go!

TEKS:
5.6D Design an experiment that tests the effect of force on an object.
6.8B Identify and describe the changes in position, direction, and speed of an object when acted upon by unbalanced forces.

How To:
1. Fill the kiddie pool or large plastic bin with water.
2. Make one hole punch along the edge of the Styrofoam plate.
3. Insert about an inch of the straw inside the balloon and secure tightly with a rubber band.
4. Stick the other end of the straw through the Styrofoam plate hole keeping the balloon end on top of the plate.
5. Hot glue around the straw on both sides of the hole to prevent leaking.
6. Once the glue is dry, blow up the balloon using the opposite end of the straw. Hold the end of the straw tight to keep the balloon filled up until you are ready to release in the water.
7. Take your balloon boat to the kiddie pool or plastic bin to test!
8. After the first trial, measure the distance the boat traveled. What could you change to make the boat move faster or farther? What would happen if you tried two straws, two balloons, less weight, etc.?
9. Make modifications and test to see if your new design goes faster and/or farther.

Materials:
- Kiddie pool or large plastic bin to hold water (a larger surface area is more important than depth)
- Straw
- Rubber band
- Hole puncher
- Styrofoam plate
- Hot glue gun and glue
- Measuring tape
- Stopwatch
- Pencil
- Balloon
The STEM Explanation:
Friction is the force that resists motion between two objects or surfaces. When you put your boat in the water, friction prevents it from moving very much. After blowing up the balloon, attaching it to the straw, and releasing it, the air in the balloon travels through the straw and out the open end. This pushes the boat forward overcoming the friction of the water that is pushing back against it. The boat moves forward because the force of the released air pushing the boat is greater than the force of the friction that is resisting its movement.

Career Connection:
Structural engineers are concerned with the design and construction of all types of structures such as bridges, boats, dams, tunnels, power plants, offshore drilling platforms, and space satellites. Structural engineers research the forces that will affect the structure and then develop a design that allows it to withstand these forces.

Resource:
Candy Quality Control

Have you ever purchased a product and been so excited to open it just to learn it is broken or something is missing? Manufacturers want to ensure their products satisfy their customers and meet the standards they claim. These quality standards are sometimes regulated and are referred to as quality control. Mars Inc. has hired you as a quality control specialist to use your math skills to inspect a bag of M&Ms™ to determine if the bag meets the company’s standards.

TEKS:
6.1A Apply mathematics to problems arising in everyday life, society, and the workplace.
6.4G Generate equivalent forms of fractions, decimals, and percentages using real-world problems.

How To:
1. You have just started working for Mars, Inc. in the M&M™ Department. You have been assigned to the Quality Control division. As with all new employees, your supervisor provided you with the following facts about M&Ms™:
   - The six-color blend in M&Ms™ should include:
     - 30% brown
     - 20% yellow
     - 20% red
     - 10% orange
     - 10% green
     - 10% blue

2. First, make predictions about what you think you’ll find in the bag. What percentage of M&Ms™ do you think will be chipped or broken? What percentage of each color do you think you’ll find? Record your predictions on your Quality Control Activity Sheet.

Materials:
- Bag of M&Ms™
- Quality Control Activity Sheet (attached below)
- Calculator
- Pencil
How To (continued):

3. Next, open the bag and count the total number of M&Ms™. Record this number in the ‘Total Number of M&Ms™ row. Separate the chipped or broken M&Ms™ from the rest and count the number of unbroken M&Ms™. Record this number on the sheet in the ‘Actual Numbers of M&Ms™ column.

4. Then, sort all of the M&Ms™ (including chipped/broken) into the 6 color groups. Count and record these numbers.

5. Finally, find the percentage of each color for the ‘M&Ms™ Quality Control Check’ column. Take the ‘Actual Number of M&Ms™ for a color and divide it by the ‘Total Number of M&Ms™ and multiply by 100. Compare this number to the ‘M&Ms™ Quality Standard’ percentage and determine if the standard was achieved.

The STEM Explanation:
Percentages are the rate of an event out of 100. For example, if you were to flip a coin 100 times, you could tally the number of times it lands heads up and that number would be the percentage of time the coin lands heads up. When you can’t observe something 100 times (because a bag of M&Ms™ doesn't contain 100 pieces), you can count your observations and divide your event by the total number and then multiply by 100. Did you find that the percentages of each color in your bag matched the percentages for M&Ms™ Quality Standard? Unfortunately, there are too many bags of M&Ms™ in the world to verify that every bag has the correct blend of colors. Quality control specialists test a few bags and then use the average results to predict the quality of the rest of the bags.

Career Connection:
The main function of a quality control specialist is measuring whether or not a current product meets a set of quality standards. They are also involved in planning how often sampling will be performed, determining the standards by which quality will be judged, and make recommendations as to how products and the quality control process can be improved. Quality control specialists work in a variety of industries; they monitor quality standards for nearly all manufactured products, including foods, textiles, clothing, glassware, motor vehicles, electronic components, computers, and structural steel.

Resources:
- [http://www.m-ms.com](http://www.m-ms.com)
## Quality Control at the M&Ms™ Factory Activity Sheet

<table>
<thead>
<tr>
<th>What color of M&amp;M™ is your favorite?</th>
<th>M&amp;Ms™ Quality Standard</th>
<th>Unopened Package Predictions</th>
<th>Actual Number of M&amp;Ms™</th>
<th>M&amp;Ms™ Quality Control Check</th>
<th>M&amp;Ms™ Quality Standard Achieved</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Provided by factory</td>
<td>Make predictions before opening the bag of M&amp;Ms™</td>
<td>Count your M&amp;Ms™ and record your data</td>
<td>Calculate the % Divide the # of colored M&amp;Ms™ by the total # of M&amp;Ms™. Then, multiply by 100.</td>
<td>Answer Yes or No</td>
</tr>
<tr>
<td>Total Number of M&amp;Ms™</td>
<td>100%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Number of chipped/broken M&amp;Ms™</td>
<td>0%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Number of brown M&amp;Ms™</td>
<td>30%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Number of yellow M&amp;Ms™</td>
<td>20%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Number of red M&amp;Ms™</td>
<td>20%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Number of orange M&amp;Ms™</td>
<td>10%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Number of green M&amp;Ms™</td>
<td>10%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Number of blue M&amp;Ms™</td>
<td>10%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
</tbody>
</table>

**What color of M&M™ is your favorite?**

**M&Ms™ Quality Standard**

- Provided by factory

**Unopened Package Predictions**

- Make predictions before opening the bag of M&Ms™

**Actual Number of M&Ms™**

- Count your M&Ms™ and record your data

**M&Ms™ Quality Control Check**

- Calculate the % Divide the # of colored M&Ms™ by the total # of M&Ms™. Then, multiply by 100.

**M&Ms™ Quality Standard Achieved**

- Answer Yes or No
Pipeline Design Challenge

Civil engineers need your help! They need you to design an aboveground pipeline system to transport oil from Alaska. Using straws and craft sticks, can you create a system that reduces the environmental impact around your pipeline?

TEKS:
5.9C Predict the effects of changes in ecosystems caused by living organisms, including humans, such as the overpopulation of grazers or the building of highways.
7.8A Predict and describe how different types of catastrophic events impact ecosystems such as floods, hurricanes, or tornadoes.

How To:
1. Print both pages of the attached Ecosystems Map and set them side-by-side so that there is a line connecting the ‘Start’ and ‘Finish’ areas.
2. Construct a pipeline that goes from the ‘Start’ circle to the ‘Finish’ circle using straws. Add craft sticks and modeling clay to create structures that support your pipeline. Your pipeline should follow the path indicated on the map and cause as little damage to the ecosystems as possible.
3. On the ‘Start’ circle, construct a funnel that will prevent water from spilling on the ground when you pour it into the pipeline. The Styrofoam cup should be placed on the ‘Finish’ circle to catch water that drains from the pipeline.
4. To test, pour one Dixie cup of water through the funnel on the ‘Start’ circle. Make sure that the water flows freely through the pipeline and drains into the cup on the ‘Finish’ circle.
5. If the water can’t get through your pipeline or you have a leak, think about how you could make it work better and add these new modifications. Redesign and test your pipeline as needed.

Materials:
- Flexible straws
- Duct tape
- Craft sticks
- Modeling clay
- 3 oz. Dixie cups
- 10 oz. Styrofoam cup
- Water
- Ecosystems Map (attached below)
The STEM Explanation:
In order for oil to travel through a pipeline, one end is usually elevated to allow gravity to pull the oil down to a refinery, an industrial process plant where crude oil is processed and refined into more useful products, at the end of the pipeline. This design is more cost efficient and safer than using trucks to transfer all the oil. However, as civil engineers design these above ground pipelines, they must figure out a way to transport the oil most efficiently without losing any along the way, as well as protect the environments surrounding these pipelines.

Career Connection:
Civil engineers plan, design, construct, and maintain structures such as buildings, roads, bridges, dams, tunnels, and pipelines. Civil engineers analyze how building the structures will affect the environment.

Resources:
- Pipeline 101: http://www.pipeline101.com/overview/crude-pl.html
- The Mammals of Texas: http://www.nsrl.ttu.edu/tmot1/Default.htm
Plains
The land here has mostly flat, grassy land and plains. The land is mostly treeless. Some areas are divided by deep canyons carved by rivers.

Deerl Mountains
The land here includes wide-open spaces with rugged plateaus and desert mountains. The mountains are covered with short grasses and trees along the slopes. The desert is dry and hot in the day and cool at night.

Mountain Lion
Population - 10,000

Coyote
Population - 25,000

Roadrunner
Population - 15,000

Prairie Dog
Population - 100,000

Rattlesnake
Population - 100,000

Pronghorn Antelope
Population - 15,000
Gingerbread Architecture

The Gingerbread Man needs your help adding a border to his house! Candy canes, peppermints, twizzlers, or red hots - how many pieces of candy will it take to go around your gingerbread house? Would you need the same number of pieces for every type of candy? In this activity, learn about perimeter and discover how the size and shape of your candy determines the number of pieces you will use to make your own gingerbread house.

TEKS:
4.5D Solve problems related to perimeter and area of rectangles where dimensions are whole numbers.
6.3D Add, subtract, multiply, and divide integers fluently.

How To:
1. Place the small carton or box on a plate to act as the base of your house.
2. Use the ruler to measure each side of the carton and add these numbers together. The sum of all the sides is the perimeter of the house. This number will tell you how much candy you will need to make a border around the house.
3. Use one piece of whichever candy you want to use as your border to see if this perimeter is correct. Measure the length of one candy and divide the perimeter by that length. This is the number of candies you should need to go around the entire house. Check your math by counting out the candies and placing them around the edge of your house.
4. To build your house, use frosting to stick the graham crackers to the side of your box or container for the walls and one on top to be the base of your roof.

Materials:
- 1 can of frosting (not whipped)
- 1 package of graham crackers
- 1 small box or carton to serve as the house foundation
- Plate
- Ruler
- Items to decorate your house:
  - Gum drops
  - Mini candy canes
  - Mini marshmallows
  - Peppermints
  - Pretzel sticks
  - Twizzlers
  - M&Ms
  - Red hots
  - Sprinkles
  - Powdered sugar
  - Shredded coconut
How To (continued):

5. On top of the base of the roof graham cracker, lean two graham cracker squares together to make a pointy roof and use lots of frosting to hold them in place.
6. Now it’s time to decorate! Add your candy border and other food items to make your one-of-a-kind gingerbread house.

The STEM Explanation:

The perimeter is the line that forms a closed boundary around the outside of a 2-dimensional shape, like a rectangle or a triangle. To calculate it, you measure the length of each side of the shape and add the lengths together. The formula is $P = length_1 + length_2 + length_3$, etc. (the number of lengths depends on how many sides your shape has). If you are working with a square, it has 4 equal sides; so instead of having to measure each side and add them together, you can do $P = length \times 4$.

Career Connection:

Architects plan and design buildings for various uses. They use their scientific and mathematical knowledge of physics to understand building construction combined with their artistic abilities to design visually appealing structures. Architects are scientists, mathematicians, and artists. To become an architect you need a four-year degree and a professional degree from an architectural program.
Time Zones

Have you ever wondered what someone on the other side of the world is doing while you are waking up or eating dinner? Understanding the different time zones is really important for people that travel or work with others outside of their respective time zone. This activity will help identify what time it is around the world by creating clocks to represent each time zone.

TEKS:

4.8C Solve problems that deal with measurements of length, intervals of time, liquid volumes, mass, and money using addition, subtraction, multiplication, or division as appropriate.

5.1A Apply mathematics to problems arising in everyday life, society, and the workplace.

How To:

1. Begin by watching this YouTube video to introduce time zones.
2. You are going to make 24 clocks, one for each time zone. On each of your circular clock surfaces, mark the 12 hours just as you would see on a clock.
3. Cut out 2 arrows for each clock from construction paper or cardstock to represent the hour and the minute hands. You will need a total of 48 clock arrows.
4. Use a brad to secure the two arrows to the center of each clock face so that the arrows can move around the clocks easily.
5. For each clock, label it with a significant place in that time zone and the time difference in relation to where you live. If you live in Texas, Central Time Zone, and you know someone that lives in another time zone, use that person to label the clock. For example: “Grandma’s House in New York, +1 hour” or “Grand Canyon in Arizona, -1 hour.” You should have 24 clocks labeled for each of the 24 time zones.
6. Use a small nail or thumbtack to hang up the clocks at a level where they can be easily adjusted.
7. Adjust each clock, accordingly, at various times throughout the day.

Materials:

- 24 circular flat surfaces for clock faces (e.g. plastic lids off yogurt containers, paper plates, or construction paper)
- Construction paper or cardstock
- 24 metal brads or brass fasteners
- 24 small nails or thumbtacks
- Scissors
- Sharpies
The STEM Explanation:
Time zones may be a hard concept to understand, however, relating time zones to everyday life makes it a little easier. Adjusting the clocks at various times throughout the day can bring up several conversations. For instance, if you adjust the clocks during your lunchtime, you can compare and talk about how while you are eating lunch, people in Germany may be eating dinner or getting ready for bed, but in Hawaii they may be eating breakfast or just waking up.

Career Connection:
_Air traffic controllers_ direct aircraft on the ground and through controlled airspace, planning flight schedules for flights across time zones to provide pilots safe takeoff and landing times without interfering with other planes.

Resources:
- [https://youtu.be/widWLh11bzs](https://youtu.be/widWLh11bzs)
Are you ready to put your “thinking cap” on? Learn about the four lobes of the brain while you create your own paper mâché hat that allows you to see where the different lobes are on your own head.

TEKS:
6.12A Understand that all organisms are composed of one or more cells.
7.12B Identify the main functions of the systems of the human organism, including the circulatory, respiratory, skeletal, muscular, digestive, excretory, reproductive, integumentary, nervous, and endocrine systems.

How To:
1. Before beginning, cut or rip the newspaper into strips about 1 inch wide. Then, mix a paper mâché paste inside a large bowl using the ratio of 2 parts glue to 1 part water.
2. Start making your “thinking cap” by blowing up your balloon until it is roughly the size of your head or slightly larger than your head. It is better to make your hat a little too big rather than too small.
3. Dip the strips of newspaper into the paper mâché paste and cover the top half of the balloon. Make sure you put on at least three layers to help provide a strong structure, but remember that the more layers you add, the longer it will take to dry. Also make sure that you don’t see any holes in the newspaper layers once you are done.
4. Place your hat in a cardboard box and set it outside to dry.
5. Once your hat has dried, pop the balloon and remove it from the inside of your hat.

Materials:
• Balloon (at least 9 in. diameter)
• White school glue
• Water
• Measuring cup
• Newspaper
• Large bowl
• Cardboard box
• Paper plate
• 4 different colors of paint
• Paint brushes with bristles
• Sharpie
• Lobes of the Brain Picture (see below)
How To (continued):

6. Next, draw lines on the outside of your cap to indicate the 4 lobes of the brain. Use the diagram below as a guide. The cap should be divided into 5 different sections: 1 for the frontal lobe, 1 for the parietal lobe, 1 for the occipital lobe, and 2 for the temporal lobes (one on each side) because the 2 temporal lobes aren’t connected.

7. Paint each lobe a different color. Remember that the temporal lobes aren’t connected but you should still paint them the same color. Place your hat back in the box to dry.

8. Once the paint has dried, your “thinking cap” is ready to go! You can use a sharpie to label each of the lobes or you can leave them unlabeled to quiz yourself.

The STEM Explanation:

The brain is made up of four lobes: frontal, parietal, temporal, and occipital. Each of the lobes has a different task that it is responsible for performing.

- The frontal lobe is where higher brain functions take place like reasoning, critical thinking, decision-making, speech, movement, and emotions.
- The parietal lobe is responsible for touch. It tells the brain whether something is hot, cold, soft, hard, rough, etc.
- The temporal lobes are in charge of hearing. That’s why they are located on each side of the brain near the ears.
- The occipital lobe is used for vision and helps the brain decipher what is being seen through the eyes.

Career Connection:

A neurologist is a medical doctor or osteopath who has trained in the diagnosis and treatment of nervous system disorders, including diseases of the brain, spinal cord, nerves, and muscles. Neurologists perform neurological examinations of the nerves of the head and neck; muscle strength and movement; balance, ambulation, and reflexes; and sensation, memory, speech, language, and other cognitive abilities.
Directions: Type these coordinate numbers into Google Earth to learn about the famous zoos that these animals are found at. Zoom in and out of the image and click on the picture available for each site to further explore these amazing places. You can see the answers on the next page. Happy Travels!

Coordinates:

1. 39.9408715, 116.3315857 ________________ Zoo is best known for its collection of rare animals native to China, including its most popular animal, the giant panda.

2. 29.4636734, -98.4726768 ________________ Zoo was one of the first “cageless” zoos in the U.S. and is home to a wide variety of animals, including elephants.

3. 32.7369019, -117.1504578 ________________ At the ________________ Zoo, Masai giraffes are given onions as a special treat. When the first giraffes arrived at the zoo in 1938, onions were the only food they would accept to make them leave their traveling crates!

4. 43.81788, -79.1855186 ________________ Zoo houses two types of rhinoceroses, the Great Indian rhinoceros and the White rhinoceros, and puts on several events throughout the year to raise awareness and money for rhino conservation.

5. 35.7154865, 139.7701375 The ________________ Zoo, found in Tokyo, is the oldest zoo in Japan. Over 2,600 animals live here, including polar bears.

6. 48.8321371, 2.417813 ________________ Zoo (known as ‘Parc Zoologique de Paris’ in French) works with conservation groups to increase the number of river otters found in France since their near extinction in the 20th century.

7. 51.5358177, -0.1527126 ________________ Penguin Beach at ________________ Zoo is the largest penguin pool in England. The exhibit holds 450,000 liters of water in its 1,200 square meter pool!
The STEM Explanation:
Google Earth allows you to virtually fly to anywhere on Earth, view satellite imagery, maps, terrain, 3D buildings, landmarks, and more! You can view Earth from as close as the front door of your house and as far away as if you are looking at Earth from space. How does this technology work? The Google Earth software simplifies the Earth into a sphere covered by a polygon of flat tiles on the surface. As you zoom in on Google Earth, the larger tiles explode into smaller tiles with higher resolution. This allows for the computer to transmit less data across the Internet so users can quickly move about Earth’s surface at different angles and altitudes. Take some time to explore the many exciting features Google Earth has to offer!

Answers:

1. Beijing
2. San Antonio
3. San Diego
4. Toronto
5. Ueno
6. Paris
7. London
Animal Habitats

Yesterday, you looked at different zoos around the world and learned a little about them and some of the animals that they house. In today’s activity, you will research some of the animals you learned about and determine what kind of zoo habitat your animal would thrive in best.

TEKS:

5.9A Observe the way organisms live and survive in their ecosystem by interacting with the living and non-living elements.
7.10A Observe and describe how different environments, including microhabitats in schoolyards and biomes, support different varieties of organisms.

How To:

1. Select an animal from the following list to learn more about. You can choose your favorite animal or pick several to research. Make sure to print an Animal Habitats Page (attached below) for each animal you plan to research.
   - Alligator, Bear, Butterfly, Cheetah, Crab, Dolphin, Electric Eel, Elephant, Flamingo, Fox, Frog, Giraffe, Hippo, Iguana, Jellyfish, Koala, Lemur, Lion, Monkey, Ostrich, Owl, Panda, Parrot, Peacock, Python, Rhino, Shark, Tiger, Turtle, Zebra

2. Using the sites found in the ‘Resource’ section, answer the questions found on the Animal Habitats Page for each of your animal(s).

3. Once you’ve finished, sketch a design of a zoo habitat that you think would be appropriate for your animal(s). The more details you add, the better!

Materials:

- Computer or tablet with an Internet connection
- Pencil
- Paper
- Animal Habitats Page (attached below)
The STEM Explanation:
When designing zoo habitats, zoologists and architects must work together to make sure that the habitat suits the animal’s needs. The habitat should allow the animal to have plenty of room (especially if it’s a group of animals) and replicate the environment and climate that the animal is used to living in. It’s important that the habitat is as close to the animal’s real home in nature as possible in order to help the animal live a long and healthy life.

Career Connection:
Zoologists study animal life and the interactions of animals with other organisms and their environment. Zoologists work to understand animal behavior in their natural habitats and do their best to recreate these habitats for animals in captivity. They work to provide animals with enrichment activities and protect threatened and endangered species. They also may work to breed certain endangered animals and train them to be reintroduced in the wild. In addition to studying animal behavior, zoologists often focus on genetics and ecology.

Resources:
- http://nationalzoo.si.edu/animals
- http://zoo.sandiegozoo.org/animals
- http://www.aqua.org/explore/animals
Name of your animal:
_______________________________________

Animal Class (circle yours):
Mammal   Reptile   Fish   Bird

Describe the environment and climate that this animal lives in:
_____________________________________________________________________________
_____________________________________________________________________________

List types of food that this animal eats:
_____________________________________________________________________________
_____________________________________________________________________________

Describe the place where this animal sleeps:
_____________________________________________________________________________
_____________________________________________________________________________

When does this animal sleep?
Day       Night

Do this animal live alone or in a group?
 Alone       Group

Describe how much space this animal needs. Are there other types of animals it can live with?
_____________________________________________________________________________
_____________________________________________________________________________

List any objects that can be used to occupy the animal’s time throughout the day (balls, toys, etc.):
_____________________________________________________________________________
_____________________________________________________________________________

On the back of this page or on a separate sheet of paper, sketch a design of a habitat you think would be appropriate for your animal.
3-D Design

Now that you’ve seen some zoos and learned about the habitat your selected animal lives in, it’s time to design a zoo habitat for your animal! Explore the basic tools within SketchUp and create your own 3-D zoo habitat model.

TEKS:
3.6C Create two-dimensional figures, including circles, triangles, rectangles, and squares, as special rectangles, rhombuses, and hexagons.
5.9A Observe the way organisms live and survive in their ecosystem by interacting with the living and non-living elements.
7.10A Observe and describe how different environments, including microhabitats in schoolyards and biomes, support different varieties of organisms.

How To:
1. Start by downloading SketchUp onto your computer by going to the link below (ask permission from your parents or school before downloading software):
   http://www.sketchup.com/
2. Click on the red ‘Download SketchUp’ button. Select that you are using SketchUp for ‘Personal Products’ and follow the download instructions. It should take 1-2 minutes for the download to complete. Follow the steps through the set up wizard. When you finish these steps SketchUp is ready to use.
3. Now that you have SketchUp downloaded and installed, it’s time to learn the basics. Click on the SketchUp icon on your desktop. When the application opens click ‘Start using SketchUp’. If this is the first time you are using the application, a screen will pop up asking you to choose a template before you can begin using SketchUp.

Materials:
- Computer
- Mouse (not required but is easier to use SketchUp with)
- Access to the Internet (only if SketchUp isn’t already downloaded)
How To (continued):

4. To begin creating in SketchUp you can use the built in shape tools to create a circle, rectangle, or polygon (then click on polygon). You can also freehand your own shape by using the pencil tool; just make sure any shape you create with the pencil tool is fully connected, otherwise SketchUp will not create a face for it. You now have a two-dimensional shape! To make it three-dimensional, use the pull/push tool. You now have a three-dimensional object. You can move or rotate a face or edge of the shape you created using the move or rotate tools. To move or rotate the whole shape you must use the select tool and select the whole shape (make sure every face and edge is highlighted blue otherwise some part will be left behind) before using the move and rotate tools. If you make a mistake and want to erase something you can use the erase tool or go to the edit menu and click undo. To change your view of your object without changing the object itself you can use the pan, orbit, and zoom tools. For more details on how to use each of the tools above you can click on the menu and select ‘Instructor’, which will open a window that will give you more information about each tool you click on.

5. Now that you know the basics to SketchUp, channel your inner zoologist and architect to design a zoo habitat. Here are a few examples Girlstart’s Summer Campers created:

![Butterfly Habitat (Front and Top View)](image)
![Panda Habitat (Front and Top View)](image)
The STEM Explanation:
When designing zoo habitats, zoologists, architects, and engineers must work together to make sure that the habitat suits the animal’s needs. From your research yesterday, you learned the importance of creating an environment and climate the animal is used to living in. However, before construction begins on the habitat, the architects and engineers typically design a 3-D representation of the desired environment. These 3-D plans help everyone visualize and modify the design before building has started. 3-D or 3-dimensional provides a more realistic representation of the habitat verses a 2-dimensional drawing. If we were to draw lines to connect the coordinate points on one plane, then we would have a flat, two-dimensional figure. To create a 3-dimensional shape, you use three planes with an x-, y-, and z-axis. The z-axis travels through the origin point where the x- and y-axis intersect but does so at a different angle to create a third dimension, giving an object its depth in addition to its height and width.

Career Connection:
Architects plan and design buildings for various uses. They use their scientific and mathematical knowledge of physics to understand building construction combined with their artistic abilities to design visually appealing structures. Architects are scientists, mathematicians, and artists. To become an architect you need a four-year degree and a professional degree from an architectural program.

Engineers use a coordinate system to create engineering drawings of products. When an engineer designs a part, the engineer specifies where each point on the part is located using computer software such as a Computer Aided Design program (CAD). A CAD drawing file can be sent to a machine that is designed to read the file and create the part.

Resource:
Ice Excavations

Gather your shovels, brushes, and chisels to find the hidden treasures frozen in the glacier. Discover how careful archeologists have to be when they unearth fragile fossils. Using household items, excavate and examine the ‘prehistoric pieces’ in this fun Lego dig!

TEKS:
4.2A Plan and implement descriptive investigations, including asking well-defined questions, making inferences, and selecting and using appropriate equipment or technology to answer his/her questions.

How To:
1. Fill the small plastic container half way with water and place the Lego figurine on the water’s surface. Place the container in the freezer for a few hours. Remove the container from the freezer, add more water to fill the container to the top, and place it back in the freezer to freeze overnight. Take your container out of the freezer and ask an adult to try and remove the ice from the container so that your ice block can sit on a plate.
2. Using household items (e.g. magnifying glass, salt, toothpicks, or chopsticks) brainstorm the best method to excavate and dig out your Lego figurine fossil from the ice.
3. Test your plan by trying to carefully remove the Lego figurine. Try different methods to see which one works best. If one method fails, redesign your tools or come up with a new plan and remember, your Lego figurine is a very fragile fossil and you must be able to excavate the fossil without causing any damage.

Materials:
- Small plastic container
- Water
- Lego figurine
- Plate
- Salt
- Magnifying glass
- Pipette or turkey baster
- Toothpicks, chopsticks, or any other household items that can be used to dig through the ice
The STEM Explanation:
Part of the fun in this experiment is that everyone could do it a little differently, yet still accomplish the same goal! If one method doesn't work to free your Lego, there are more ways to try. For instance, you can use water or salt to help the ice melt. This is because they impact the melting point, or the temperature that ice changes to water, of the ice. When you put water with a higher temperature next to ice, molecules from the ice start to move faster, or melt, at a higher rate. Salt will help melt the ice because the salt molecules disrupt the equilibrium of the ice molecules and break them apart. If your ice still isn't melting fast enough to rescue your Lego, you can use some tools to physically break up the ice into chunks. This increases the surface area of the ice exposed, thus allowing more of it to melt.

Career Connection:
An archeologist is a scientist who studies past peoples and cultures by excavating and examining material remains. These remains can be as simple as an arrowhead or as complex as the ruins of a prehistoric village. Archeologists study ancient cultures as well as recent historic occupations. Archeologists are interested in animal bones, plant remains, and certain stone materials when these things occur at archeological sites and have a clear relationship to human activity.

Resources:
- http://lemonlimeadventures.com/lego-science-ice-excavation-experiment/
Homemade Seismograph

Have you ever experienced an earthquake? Create a model of a seismograph and replicate an earthquake to see how seismologists use this machine to record when and where earthquakes take place and how intense they are.

TEKS:
3.7B Investigate rapid changes in Earth's surface such as volcanic eruptions, earthquakes, and landslides.

How To:

1. Spread out your newspaper or scratch paper on the table.
2. Uncap the marker and tape the end of it to one end of the ruler so it makes a long L-shape and the two are perpendicular. The tip of the marker should be facing away from the ruler.
3. Place the soup can near the scratch paper. Tape the ruler to the side of the soup can so that the tip of the marker is just touching the newspaper.
4. Try gently shaking the table: What happens on the paper? What happens with smaller versus bigger shakes?
5. Real seismographs have rolls of paper that rotate slowly as a needle moves with the shaking. Have one person try to slowly move the paper as another person shakes the table. Can you see seismic (earthquake) waves being recorded?
6. If you shake the table horizontally (forwards and backwards) and vertically (up and down), how does that affect the image of the waves on the paper?
7. If you feel really adventurous, make two seismographs. Place one in a tub of sand or water and the other on the hard table surface. How does what the seismograph rests upon affect the readings on the scales?

Materials:
• Marker or felt-tip pen
• Plastic or metal ruler that is flexible
• Masking tape
• Something heavy (a can of soup is perfect!)
• Newspaper or other large scratch paper
• Table with a hard surface
The STEM Explanation:
Scientists measure seismic waves produced by an earthquake using devices such as a seismograph (or seismometer). An earthquake is caused by a sudden slip on a fault. When the always-moving tectonic plates get stuck due to friction, stress builds up on the edges of the plates until it overcomes the friction, suddenly releasing in an earthquake. An earthquake releases energy in waves that travel through the earth’s crust and causes the shaking we feel. A seismograph records these ground vibrations or shaking. With a sensor attached to the ground, a seismograph records the arrival of seismic waves at that point. The height of the largest waves indicates the size of an earthquake. Given the length of the earthquake record and the arrival time of each wave, the distance of the earthquake’s focus point, or origin, from the recording point can be determined.

Career Connection:
Seismologists are geoscientists who study earthquakes and related phenomena, including the effects of explosions and the formation of tsunamis. These professionals gather data about shifts in the earth's crust through the use of seismographs and other instruments. While many seismologists are uncertain about the possibility of predicting earthquakes, their research has been instrumental in the development of advancements in tsunami warning systems.

Resources:
- [http://study.com/articles/Seismologist_Job_Description_Salary_and_Requirements.html](http://study.com/articles/Seismologist_Job_Description_Salary_and_Requirements.html)
Robot Arm

Are you ready to be a robotics engineer?! Examine your arm, wrist, and hand, and brainstorm how you could reverse engineer these body parts to design your own robot arm prototype. Reverse engineering is when engineers design an object based on an existing object. Compare your “robot arm” to your arm and note their similarities and differences.

TEKS:
7.6A Demonstrate basic relationships between force and motion using simple machines, including pulleys and levers.
7.12B Identify the main functions of the systems of the human organism, including the circulatory, respiratory, skeletal, muscular, digestive, excretory, reproductive, integumentary, nervous and endocrine systems.

How To:

1. Before you begin, go to http://pbskids.org/designsquad/parentseducators/guides/mission_robo_arm.html and watch the Robo Arm video. In Robo Arm, kids substitute a mechanical system for bones, joints, and muscles. In your prototype, you’re going to substitute cardboard for bones, a brad for a joint, and string for muscles.
2. Place the pieces of cardboard in an “L” shape so that the holes line up in the corner of the “L.” Attach the pieces of cardboard with a brass fastener at this “joint.”
3. Tape straw pieces at intervals along the back of each cardboard strip. The straw pieces should be centered on each strip and run length-wise. You can add as many or as few straw pieces as you like.

Materials:
- 1 large strip of corrugated cardboard (2”x 8” or 5cm x 20 cm) with a hole punched in one corner
- 1 small strip of corrugated cardboard (2”x 4” or 5cm x 10cm) with a hole punched in one corner
- One 1-inch brad or brass fastener
- 1 straw, cut into 1 inch (2.5cm) lengths
- 39 inches (100 cm) of smooth string (e.g. kite string)
- 2 large paperclips
- One 3 oz. paper cup
- Small, somewhat heavy items such as pennies, washers, or paperclips
- Tape
How To (continued):

4. Run your string through all of the straw pieces. At the top (by the nonattached end of the larger strip of cardboard), knot your string multiple times so that it doesn’t slide back through the straws.
5. Take a paperclip and bend it so that it makes an “S.” Tie it to the bottom of your arm (by the nonattached end of the shorter strip of cardboard). Secure the string and paperclip to the shorter piece of cardboard, with the paperclip extending beyond the edge like a hook.
6. Test your arm by pulling on the string at the top. You should see the shorter piece of cardboard pivoting upward like your forearm does when you pick up a cup.
7. To give your arm a challenge, completely unfold the second paperclip and curve it so that it looks like a handle. Tape it to the top of the paper cup so it resembles a bucket, then fill the cup with small, somewhat heavy items like pennies or washers. Loop the handle of the cup through the paperclip at the end of your cardboard arm and pull the string to see how much your arm can lift!

The STEM Explanation:

When engineers design an object based off an existing object it is called reverse engineering. How do you think making our robot arm is an example of reverse engineering? Hopefully, you thought about how your arm and hands work to build your mechanical version, your robot arm. If you compare your robot (cardboard) arm to your own arm you will notice both have flexible parts (string and muscles) to move rigid parts (cardboard and bone). When you pull on the string or flex your muscles they are directed by a guide (the straws and your tendons), and the guide’s position affects the arm’s efficiency. Finally, the brass fasteners mirror our joints. Another example of joints is a lever system. A lever converts a little effort into a lot of force. What part of your robot arm acts as the fulcrum, which is the point at which a lever pivots? The brass fastener is the fulcrum and the cardboard is the lever arm. Changes will alter the force required to move the lever.

Career Connection:

A robotics engineer creates robots and robotic systems that are able to perform duties that humans are either unable or prefer not to perform. At NASA, a robotics engineer designs and builds humanoid robots to work alongside astronauts. The robots have impressive dexterity, strength, and intelligence. These robots are useful because they can accomplish tasks and function in conditions that humans cannot withstand, as well as complete tasks that would otherwise be unsafe for humans to perform.

Resources:

- www.pbskids.org/designsquard
- www.pbskids.org/designsquard/links/solarsystem

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Solar Power

Can you create a music box that is powered by the sun? Learn how solar panels convert light from the sun into electrical energy. Explore how the electrical energy can power a motor to add a spinning figurine to your music box design - as your figurine rotates you will see the energy at work!

TEKS:
4.6A Differentiate among forms of energy, including mechanical, sound, electrical, light, and heat/thermal.

How To:
1. With the help of an adult, cut a small hole in the middle of one of the cardboard squares. The hole should be large enough for the motor shaft to fit through and turn without hindrance. This is going to be the top of your music box.
2. Use the other cardboard squares and tape to complete the box, making sure to only attach one side of the top square so that it can flip open like a lid.
3. Slide the motor pulley onto the motor. Attach the alligator clips of the solar panel to the two metal terminals at the back of the motor. Solar panels produce direct current electricity, so you should be able to take your solar panel outside and see the motor start to spin instantly. If it doesn’t, make sure that your alligator clips are attached correctly.

Materials:
- 6 cardboard squares (1 ft. x 1 ft. works best)
- Small wooden dowel (3 in. long)
- Small wooden wheel (minimum 1 in. diameter)
- Hot glue gun and glue replacements
- X-acto knife
- Tape
- Materials to decorate your music box:
  - Foam shapes/sheets
  - Pom poms
  - Pipe cleaners
  - Felt
  - Sequins/rhinestones
  - Paper
  - Sharpies/markers
- Sunnyside Up Solar Car Kit (can be purchased here). From the kit, you will need:
  - 1 motor
  - 1 red motor pulley
  - Solar panel with alligator clips
How To (continued):

4. Tape (or hot glue with adult assistance) the solar panel to the top of the box so sunlight will reach it. You may want to hold the solar panel in place with tape until you find the angle and location that catches the most sun, and then glue it permanently once you find the most effective position.

5. Run the wires and motor under the top square, and hot glue (with adult assistance) the motor to the inside of the top square so that the axle goes through the hole in the middle. Make sure you only put glue on the white plastic piece of the motor. If you get glue on the motor shaft, it won’t turn.

6. Glue the wooden wheel to the top of the red motor axle, while still ensuring no glue gets on the motor shaft. Glue the wooden dowel in the hole in the middle of the wheel. This is the platform and support for the spinning object of your music box.

7. Now it’s time to be creative! Using the remaining materials, design your spinning object and decorate your music box.

8. Once you’ve finished, take your music box outside to test it. If your object spins too fast, cover a small part of the solar panel with foam or felt so that the panel isn’t receiving as much sunlight. If your object doesn’t spin at all, your object may be too heavy for the motor to spin. Try removing some of the heavier materials to decrease the object’s weight. Redesign and test your music box as needed.

The STEM Explanation:

Solar energy is a renewable resource, which is beneficial for many reasons. A renewable resource is replaced naturally and can be used again and again. Solar energy is also beneficial because it does not produce air pollutants. Can you think of any difficulties about the process of collecting and converting solar energy into electricity? Solar panels collect varying amounts of solar energy based on the angle they are facing the sun and how long they are in sunlight each day. This can be affected by how cloudy it is or if the sun is blocked by something. Additionally, the Earth’s elliptical revolution around the sun changes the amount of sunlight we receive each day throughout the year. All of these complications are reasons that we must use a combination of solar energy and fossil fuels.

Career Connection:

Solar design engineers help people and buildings harness the sun’s energy potential using solar photovoltaic cells. Solar design engineers work for architecture, engineering, and design firms, as well as energy companies and solar equipment manufacturers. Solar design engineers design, review, and approve solar installations for commercial and industrial buildings, as well as government and utility projects.

Resources:

According to an ancient Greek legend, there was a woman of royalty by the name of Princess Dido. When her brother, Pygmalion, murdered her husband, Dido, along with some loyal supporters, fled to the coast of North Africa. She asked the local king to sell her some land so that she could build a new city there. When the king refused, she persuaded him by asking him to sell her the amount of land that she could enclose with the hide of an ox. As soon as the king agreed, Princess Dido told her servants to tan an ox-hide and cut it up into long, narrow strips. Then she sewed all of the strips together to make one very long leather strip. With this strip, she claimed enough land to build a new city!

Thinking like Princess Dido, do you think you can cut an index card in such a way that you can fit through it?

**TEKS:**

6.4 Expressing relationships and making predictions.
6.4B Generate formulas (perimeter, area, volume) from data.

**How To:**

1. Fold the index card in half so that the short edges meet.
2. Hold your card so that the fold is on your left. Start your first cut from the fold side about ¼ inch below the top of the card. (Use the image on the next page as a guide). Cut a straight line toward the non-fold side, making sure to leave about ¼ inch of the non-fold side uncut.
3. About ¼ inch below your first cut, start from the non-fold side and cut a straight line in toward the folded side. As before, leave about ¼ inch uncut.
4. Alternate your cuts on the folded and not folded sides until you have made cuts in the whole card. You should end up with an odd number of cuts (13 or 15 cuts works well). The closer together you make the cuts, the more cuts you’ll have and the bigger your rectangle will be.
5. When you are finished making the cuts, cut along the fold between the top cut and the bottom cut without cutting the topmost and bottommost ¼ inch along the fold.
6. Unfold the card and... surprise! You’ve created a large rectangle big enough to squeeze your whole body through!

**Materials:**

- Index cards
- Scissors
How To (continued):

Note: If you use a sheet of 8½ “x 11” paper, you will easily be able to fit a couple of people through the hole simultaneously. If you make the cuts closer together, you can make an even larger hole.

The STEM Explanation:
This activity demonstrates the difference between area and perimeter. The area of a flat object is the amount of space it takes up. The perimeter of a flat object is the distance around the edge of the object. When you made the cuts in the paper, you increased the perimeter of the paper, but the surface area remained unchanged.

Career Connection:
*Applied mathematicians* use theories and techniques, such as mathematical modeling, to solve practical problems. These mathematicians typically work with individuals in other occupations to solve problems. *Theoretical mathematicians* do research to identify and resolve unexplained issues in mathematics. They are primarily concerned with exploring new areas and relationships of mathematical theories to increase knowledge and understanding about the field.

Resource:
- [http://www.bls.gov/ooh/math/mathematicians.htm#tab-2](http://www.bls.gov/ooh/math/mathematicians.htm#tab-2)
Bottle Rockets

Three... Two... One... Lift off! Design your own bottle rocket and launch it high into the sky. Learn how the scientific force described in Newton’s 3rd Law of Motion makes your rocket launch possible.

TEKS:
8.6C Investigate and describe applications of Newton’s law of inertia, law of force and acceleration, and law of action-reaction, such as in vehicle restraints, sports activities, amusement park rides, Earth’s tectonic activities, and rocket launches.

How To:
1. First, decorate your bottle. You can use stickers, markers, construction paper, etc. Note: the opening of the bottle will be the bottom of your rocket.
2. Cut the piece of card stock in half “hamburger style.”
3. Create triangular wings out of one half of the cardstock. Fold the cardstock into two equal sections and draw a diagonal line across each section, creating four triangles. Cut them out, flip the bottle with the opening side down, and tape the wings to the base, approximately 2 inches above the nozzle of the bottle.
4. Use the second half of your cardstock to create a cone and tape it so that it covers the top of your rocket (bottom of the water bottle).
5. Now that you have finished creating your rocket, it’s time to test it! Fill the rocket ¼ of the way up with water.
6. To make your rocket launcher, stick the needle of a bicycle pump into one end of the cork. Stick the other end of the cork into the opening at the base of your rocket (the bottle opening).
7. Make sure the bottle is pointing away from anyone or anything, hold the end of the pump on the ground, and pump the rocket launcher until your rocket takes off!

Materials:
- 1 plastic water bottle
- 1 sheet of cardstock cut into fourths
- Scotch tape
- Scissors
- Things to decorate your rocket with like Sharpies or stickers
- Bicycle pump
- Cork (it must fit snugly inside the opening of the water bottle)
- Pitcher with water
The STEM Explanation:
As air is pumped into the bottle using the bicycle pump, the air pressure inside the bottle built up enough to propel the rocket off the launcher. You may have noticed that when you launched the rocket, the rocket went in one direction while the water went in another. There was an equal force in both directions, which is explained by Newton’s 3rd Law of Motion: for every action, there is an equal and opposite reaction. Once the air pressure built up in the rocket, the gasses exerted an equal but opposite force on the rocket, which then forced the rocket up into the air as the water was expelled out the bottom. This is described as the reaction force.

Career Connection:
Aeronautical engineers use their knowledge of aeronautics (science of flight) to design aircraft, supervise the construction of the aircraft, and test their designs in controlled flight tests.

Resource:
- [http://www.science-sparks.com/2012/03/12/making-a-bottle-rocket/](http://www.science-sparks.com/2012/03/12/making-a-bottle-rocket/)
Fighting The Fever

With flu season in full swing, it is important to take precautions to make sure infections and diseases don’t spread. Learn about differing reproductive numbers and use M&Ms™ to discover how fast a disease can spread if precautions aren’t taken.

TEKS:
5.1A Apply mathematics to problems arising in everyday life, society, and the workplace.
6.7A Generate equivalent numerical expressions using order of operations, including whole number exponents and prime factorization.

How To:

1. On Monday, a girl named Jackie comes to school with a fever. While working with her group in her first class, Jackie starts to feel sick and goes home for the day. Jackie goes to the doctor and finds out she has a contagious infection. Anyone Jackie recently came in contact with was put at risk for contracting the infection. The next day, two of the students in Jackie’s group come to school with a fever before going home in the middle of the day feeling ill. If those two students each infected two more students with the illness and this pattern continues, how many students will be sick by Friday?

2. Using the M&Ms™ to model the situation, empty the bag onto the plate. The healthy students will be represented by the “m” facing right side up, and the infected students will be represented by a flipped over M&M™.

3. Starting with day 1, all of the M&Ms™ should have the “m” facing right side up except for one. This represents a classroom full of healthy students and the one infected student, Jackie. Record these numbers in your chart on the Fighting The Fever Handout (attached below).

4. For Day 2, turn over two more M&Ms™ to represent the two healthy students that became infected. Since each infected student will get two more students sick, on Day 3 you should flip over 4 more M&Ms™.

Materials:
- Fighting The Fever Handout (attached below)
- One bag of M&Ms™
- Plate
- Calculators
- Pencils

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How To (continued):

5. Continue through the days of the week to find out how many students will be sick by the end of the week, and record your observations in the chart below.

6. You can repeat the process using different reproductive numbers. For example, suppose three students get sick the day after an infected student comes to school. Repeat the process for two more different reproductive numbers and record the results below. Compare how fast infections will spread through the classroom if they have different reproductive numbers.

The STEM Explanation:
A reproductive number is the average number of people an infected individual infects when they are introduced into a healthy population. The reproductive number causes infections to spread exponentially, describing something increasing quickly by large amounts. In our situation, the reproductive number is two because two students were infected each time the infection was transmitted. As this number increases, the infection will spread more rapidly.

Career Connection:
Epidemiologists are scientists who research the causes and consequences of illness and disease. Their research informs public health policies and disease management strategies around the world. By discerning how and why diseases and illnesses occur, epidemiologists help prevent their spread and recurrence. Epidemiologists study the relationship between medical conditions and their causes by collecting and analyzing data about public health, as well as the behavior of diseases.

Resource:
# Fighting The Fever Handout

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Magnetic Motor

Can you create a shape that spins around a battery? All you need is a copper wire, two magnets, and a battery! Discover how electromagnetism works and see it in action when you create your own homopolar motor!

TEKS:
4.6A Differentiate among forms of energy, including mechanical, sound, electrical, light, and heat/thermal.
4.6B Differentiate between conductors and insulators.

How To:
1. Place the magnets on top of each other under the positive terminal of the battery.
2. Use the uncoated copper wire to create a shape that will spin around the length of your battery. The shape can have angles and even cross over on top of itself, but it must be tall enough for the battery to fit inside it lengthwise. The top of your shape should dip down to make a point where it will touch the negative terminal. The bottom of your shape should extend so that it touches the magnets on the positive terminal of the battery. See the diagram to the right.
3. Set the point from the top of your shape on the negative terminal of the battery, making sure the bottom of your shape is touching the magnets. Once the copper wire comes in contact with the magnets, the shape should start spinning. If it doesn’t, redesign your shape until you create one that spins.

Materials:
- 18G uncoated copper wire
- 2 Neodymium magnets
- AA or AAA battery
The STEM Explanation:
A homopolar motor is a direct current electric motor with two magnetic poles, the conductors of which always cut unidirectional lines of magnetic flux by rotating a conductor around a fixed axis so that the conductor is at right angles to a static magnetic field. This results in an electromotive force, or the motion of our copper shape spinning in one direction. The copper shape is the conductor that rotates around our battery, or fixed axis. Conductors allow energy/electricity to travel through them. As energy travels through a conductor, it creates a magnetic field (the magnetic effect of electric currents and magnetic materials) around it in the direction the energy flows. This allows your copper shape to spin in the magnetic field. The spinning is continuous because the battery axis provides electrical energy to keep it moving.

Career Connection:
Physicists are scientists who study the natural world, from the tiniest subatomic particles to the largest galaxies. They conduct experiments that help discover and explain the laws of nature, including what things in the universe are made of (matter) and how/why they behave the way they do. Physicists also study energy and how it changes from one form to another.

Resources:
- http://skullsinthestars.com/2014/12/12/the-mystery-of-the-magnetic-train/
Prosthetic Prototype

You have been hired as a biomedical engineer to help design a prosthetic prototype. Remember, to help amputee patients, the prosthetic should be durable, comfortable, and life-like. Use your creativity to first sketch your prototype, then design your prototype to help your patient.

TEKS:
7.11B Explain variation within a population or species by comparing external features, behaviors, or physiology of organisms that enhance their survival.
7.12B Identify the main functions of the systems of the human organism, including the circulatory, respiratory, skeletal, muscular, digestive, excretory, reproductive, integumentary, nervous, and endocrine systems.

How To:
1. Your challenge is to design a prosthetic (replacement) limb that can be used by an amputee patient.
2. First, select a “patient” and determine which of their limbs needs to be replaced. Are you going to design a human leg? A monkey tail? A dolphin fin? Keeping your materials in mind, sketch a design of your prosthetic on paper.
3. Now you are ready to create a prosthesis! Think about the following factors in your design: Is it durable? Comfortable? Will you add a joint?
4. Test your limb. Does it move the way the limb is supposed to move? Can you add more features to make it better? Make modifications as needed.

Materials:
- 2 Q-tips
- 2 rubber bands
- 2 toothpicks
- 3 cotton balls
- 3 pipe cleaners
- 1 felt square
- 2 craft sticks
- 1 Nerf gun arrow
- 1 note card
- 1 plastic spoon
- Paper
- Pencil

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The STEM Explanation:
After a patient has had a limb surgically removed because of a traumatic event or disease, the limb is replaced with a prosthetic, which acts as the limb that the patient has lost. For many years, prostheses, the artificial devices that replace a missing body part, were made out of wood. Realizing that this was uncomfortable and did not look life-like, engineers began using a material called carbon fiber, which allowed them to create more realistic prosthetic limbs. Titanium is also used in modern prosthetics because it makes the limbs more durable. Just as you did when you designed your prosthesis, biomedical engineers have to continue evaluating their designs and materials to advance the field of prosthetics and further help the individuals who need them.

Career Connection:
Biomedical engineers design appliances to straighten or support body parts. They also use technology to engineer prosthetic limbs for people and animals that have suffered a serious injury that resulted in the loss of a body part.

Recently, biomedical engineers have been working on technology called targeted muscle reinnervation. This technology allows amputees to control their prosthetic using their brain, just as if it was their own biological limb. They have also engineered robotic knees, called microprocessor knees, which contain a computer within the prosthetic that allows amputees to have better control when walking, stopping, and moving on inclines.

Biomedical engineers make a positive difference in the lives of the people or animals they help by fitting them with prosthetics that make movement easier.

Resources:
Erupting Watermelon

Happy National Bicarbonate of Soda Day! Or Happy Baking Soda Day! Baking soda is used for many different things from baking to cooking to cleaning to creating explosions. Instead of creating a volcano model eruption we are using a healthier option, a watermelon. Grab a pack of Kool-Aid and some baking soda to create this unique chemical reaction.

TEKS:
6.7A Demonstrate that new substances can be made when two or more substances are chemically combined, and compare the properties of the new substances to the original substances.
8.5E Investigate how evidence of chemical reactions indicate that new substances with different properties are formed.

How To:
1. Cut the watermelon in half and scoop out the fruit from one half (you can save the fruit to eat at a later time), leaving only the rind. If you do not want to use a watermelon, use a plastic bowl.
2. Fill up the empty watermelon rind or bowl with baking soda. The more baking soda you add, the more times you can make the reaction occur.
3. Add about a teaspoon of dish soap to the rind or bowl to produce an even foamier reaction. (This step is optional.)
4. Fill a squeezable bottle with the packet of Kool-Aid and water. One packet of Kool-Aid will work for up to a 16 ounce bottle of water.
5. Squeeze the liquid into the watermelon rind or bowl and watch a watermelon eruption!

Materials:
• Watermelon or plastic bowl
• Watermelon Kool-Aid powder
• Baking soda
• Dish soap (optional)
• Squeezable bottle (like a ketchup bottle or travel shampoo bottle)
• Water

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The STEM Explanation:
This activity works because of a chemical reaction. Chemical reactions are reactions where two or more elements/substances combine to create something completely new. When the baking soda and Kool-Aid are mixed, carbon dioxide gas (CO₂) is released as a byproduct. This release creates the fizzing eruption you see in the watermelon. When soap is added, the CO₂ gas fills the soap bubbles, causing lots of suds.

Career Connection:
A chemist is a scientist who researches and experiments with the properties of chemical substances. They measure the effects of chemical compounds in various situations and study inter-chemical reactions.

Resources:
• [https://www.sokanu.com/careers/chemist](https://www.sokanu.com/careers/chemist)
• [http://www.learnplayimagine.com/2014/06/erupting-watermelons.html](http://www.learnplayimagine.com/2014/06/erupting-watermelons.html)
Dream Big

What better way to start the New Year than by thinking about your future? When dreaming and setting goals for our lives, we not only need to think big, but also consider the steps it will take to achieve success. Decorate a star to represent your career goals and include the steps you will need to take along the way. Write a letter to remind your future self of your current dreams and goals!

How To:

1. Think about what career you would like to have when you grow up. What steps do you need to take to get that career? Do you need to make good grades? Attend college or graduate school? Fulfill an internship? On your paper, write a letter to yourself that outlines your goals and the steps that you need to take to reach them.
2. Decorate your star! You can write your goals or draw pictures of them on the star. This is your star, so you can add as many designs as you want!
3. Put your star in a place where you can see it every day to remind you of your goals and to motivate you to follow the steps it will take to achieve them!

The STEM Connection:

Have you ever heard the saying “reach for the stars?” That is exactly what you want to do when you are setting goals for yourself: reach high and dream big! You have the power to make the right choices and work hard so that you can achieve your dreams.

Materials:

- Large wooden star (these can be found at any craft store)
- Sharpies
- Paper
- Pencil