# Table of Contents

<table>
<thead>
<tr>
<th>Activity</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Balloon Bugs</td>
<td>3</td>
</tr>
<tr>
<td>Fashion Chromatography</td>
<td>6</td>
</tr>
<tr>
<td>Wind Bag Wonders</td>
<td>8</td>
</tr>
<tr>
<td>Constellation Light Box</td>
<td>10</td>
</tr>
<tr>
<td>Rainforest in a Bottle</td>
<td>12</td>
</tr>
<tr>
<td>Glaciers Galore</td>
<td>14</td>
</tr>
<tr>
<td>Coding</td>
<td>16</td>
</tr>
<tr>
<td>LEGO Language</td>
<td>20</td>
</tr>
<tr>
<td>Google Earth Scavenger Hunt</td>
<td>22</td>
</tr>
<tr>
<td>Edible Aquifer</td>
<td>24</td>
</tr>
<tr>
<td>Exploding Toothpaste</td>
<td>26</td>
</tr>
<tr>
<td>Invisible Sunblock</td>
<td>29</td>
</tr>
<tr>
<td>Project</td>
<td>Page</td>
</tr>
<tr>
<td>---------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Mimic Manufacturing</td>
<td>33</td>
</tr>
<tr>
<td>Shrinky Cells</td>
<td>41</td>
</tr>
<tr>
<td>Air Mail Challenge</td>
<td>44</td>
</tr>
<tr>
<td>Weather Flowers</td>
<td>46</td>
</tr>
<tr>
<td>Magnetic Slime</td>
<td>49</td>
</tr>
<tr>
<td>Prehistoric Puppets</td>
<td>52</td>
</tr>
<tr>
<td>Tic Tac Flashlight</td>
<td>55</td>
</tr>
<tr>
<td>Paper Plants</td>
<td>61</td>
</tr>
<tr>
<td>Plastic Rescue</td>
<td>64</td>
</tr>
<tr>
<td>DNA Sequencing Bracelet</td>
<td>69</td>
</tr>
<tr>
<td>Balancing Act</td>
<td>73</td>
</tr>
<tr>
<td>Paper Sundials</td>
<td>76</td>
</tr>
<tr>
<td>Pixel Picture</td>
<td>78</td>
</tr>
<tr>
<td>Jumping Jack Bugs</td>
<td>80</td>
</tr>
<tr>
<td>Lava Flow</td>
<td>82</td>
</tr>
<tr>
<td>Dream Big</td>
<td>84</td>
</tr>
</tbody>
</table>
Balloon Bugs

Make balloon bacteria models! Explore the shapes and structures of bacteria with different types of balloons and learn about their behaviors as disease-causing organisms.

TEKS:
2.5A Classify matter by physical properties, including shape, relative mass and relative temperature, texture, flexibility, and whether material is a solid or liquid.
5.10A(rs) The student knows that organisms undergo similar life processes and have structures that help them survive within their environments.

Materials:
- Hole punch
- Balloon bugs presentation (download [here](#))
- Balloons of different shapes and sizes, in particular: round, sausage and squiggly shapes
- Balloon pump(s)- (optional)
- Balloon bugs instruction cards (download [here](#))
- Double-sided tape
- Permanent markers (various colors)
- Tags for labeling the bacteria (download [here](#))
- Pipe cleaners, string and/or yarn (to represent flagella)
- Rubber bands
- Scissors (to cut around the tags)
How To:

How to make a *Campylobacter jejuni*:

1. Blow up one squiggly balloon and tie it off.
2. Create and attach the flagellum using a long piece of yarn, string, or pipe cleaner.
3. Complete and attach your nametag.

![Photo: © B. Wren, London School of Hygiene & Tropical Medicine](image1)

How to make a *Salmonella typhimurium*:

1. Blow up one long balloon and tie it off.
2. Use the tape to stick lengths of string, yarn or pipe cleaners to the balloon like flagella.
3. Draw markings on the side of the balloon.
4. Complete and attach your nametag.

How to make a *Streptococcus pneumoniae*:

1. Blow up three small round balloons and tie off the ends. Try to make each balloon the same size as the next. Use small pieces of double-sided tape to stick the balloons end to end; **OR**
2. Blow up one long balloon and leave a little room in the end. Twist the balloon at regular intervals and hold in place with a rubber band.
3. Draw markings on the side of the balloons as in the picture.
4. Complete and attach your nametag.

![Photo: © MicroAngela. Original image from Rocky Mountain Laboratories, NIAID, NIH.](image2)
Career Connection:

**Microbiologists** study microorganisms such as bacteria, viruses, algae, fungi, and some types of parasites. They try to understand how these organisms live, grow, and interact with their environments. There are many different fields of microbiology. Medical microbiology deals with the roles that microbes have in human illness. Other types include veterinary microbiology, environmental microbiology, food microbiology and pharmaceutical microbiology. All these deal with the way microbes or microorganisms affect animals, the environment, our food supply and the health care industry. Read more about microbiology here: [http://www.aboutbioscience.org/careers/microbiologist](http://www.aboutbioscience.org/careers/microbiologist)

Resources:

Wellcome Trust Sanger Institute’s yourgenome.org— [Balloon Bugs](http://www.yourgenome.org)  Courtesy of Genome Research Limited, Used under [CC BY 3.0](http://creativecommons.org/licenses/by/3.0) Content: Francesca Gale & Christine Hale, Graphics: Alex Bennett and Preeti Deshpande

Additional Resources:

Contamination Detectives:

Fashion Chromatography

Use a common chemistry practice to apply a custom design to fabric. Jazz up a white scarf, t-shirt or bandana and wow your friends with your knowledge of chemical chromatography!

TEKS:
2.5C Demonstrate that things can be done to materials to change their physical properties, such as cutting, folding, sanding, and melting.
3.5D Explore and recognize that a mixture is created when two materials are combined, such as gravel and sand or metal and plastic paper clips.
5.5D(ss) Identify changes that can occur in the physical properties of the ingredients of solutions, such as dissolving salt in water or adding lemon juice to water.

Materials:
- Isopropyl alcohol (90% or higher)
- Small medicine dropper or disposable pipettes
- Shallow container made of rigid material (e.g. cup, beaker or dish)
- Rubber bands
- White fabric: cotton t-shirt, bandana or scarf, washed & dried (do not use fabric softener)
- Permanent markers, various colors (dark and/or bright colors work best)
- Safety glasses
How To:

1. Pre-wash and dry fabric or t-shirt. Do not use fabric softener or dryer sheets.
2. Locate a container of your choice (cup, beaker, shallow container of any sort) and place on the inside or underside of the fabric. Flatten a section of the fabric over the opening of the container. Place a rubber band over the fabric section and the container.
3. Using one or more permanent markers, draw a small design of your choice (e.g. dots, shapes). The design should be no larger than ⅛” to ½” inch diameter and should be drawn in the center of the rubber-banded section.
4. Place several drops of isopropyl alcohol in the center of the design using the pipette or dropper. Observe as the alcohol flows onto the fabric and the marker inks spreads.
5. After a few seconds you may add more alcohol, if desired, to spread the pattern further.
6. Allow to dry and move to a new section of the fabric to decorate as desired.
7. When all fabric sections are completely dry, place fabric in a dryer on high for 15 to 20 minutes to set the colors.

Why Does It Work?
Chromatography is a process used to separate the parts of a mixture.
“Think of chromatography as a race and you’ll find it’s much simpler than it sounds. Waiting on the starting line, you’ve got a mixture of chemicals in some unidentified liquid or gas, just like a load of runners all mixed up and bunched together. When a race starts, runners soon spread out because they have different abilities. In exactly the same way, chemicals in something like a moving liquid mixture spread out because they travel at different speeds over a stationary solid.” --explainthisstuff.com  
...continue reading about chromatography

Career Connection:
Forensic Science: Forensic scientists use chromatography to separate the components of samples taken from crime scenes. Read more about “Separation Science” used by the FBI here: http://www.propertiesofmatter.si.edu/fbiscience.html

Wind Bag Wonders

Explore the findings of scientist Daniel Bernoulli and amaze your friends by using a single breath of air to fill a large bag.

TEKS:
8.10 The student knows that climatic interactions exist among Earth, ocean, and weather systems. The student is expected to:
8.10b Identify how global patterns of atmospheric movement influence local weather using weather maps that show high and low pressures and fronts.

How To:
1. Estimate (or make a hypothesis) on how many breaths it takes to blow up the bag. Explore your hypothesis by blowing into a small opening at the bag’s opened end a few times. Based on the sample, approximate how many more breaths would be needed to fill the bag entirely.
2. Do you think it might be possible to blow the bag up using just one breath?
3. It is indeed possible! Hold the bag open approximately at a 1 to 3-foot distance from your mouth.
4. Using only one breath, blow as hard as you can to fill it up, then quickly squeeze the bag’s end closed with your hands.
5. For more fun, have a race! One person can fill the bag using the traditional approach, and the second person can fill their bag by blowing into a large opening of the bag from approximately a two- to three-foot distance.

Materials:
For each participant:
- A Diaper Genie bag -OR-
- A 10-gallon or larger plastic trash bag -OR-
- Steve Spangler Windbag™ - available through Steve Spangler Science at www.stevespanglerscience.com
Why Does It Work?
In the early 1700s, a Swiss mathematician and scientist by the name of Daniel Bernoulli discovered that the faster air travels, the lower the pressure it exerts. In this experiment, the stream of moving air creates an area of lower pressure, which attracts high pressure air adjacent to the stream of air from your lungs. As a result, it is not just a single breath of air that fills the trash bag, but rather air from the surrounding area also. Our atmosphere is always trying to maintain steady air pressure. As a consequence, an area of high pressure will move toward an area of low air pressure in an attempt to restore balance. Pressure will never be steady around the Earth, however, no matter how hard the atmosphere tries to balance itself. This is due to the Sun’s uneven heating of the Earth’s surface, which creates ever-changing areas of high pressure and low pressure.

Career Connection:
**Atmospheric Research:** Meteorologists can have many different jobs, including daily weather forecasting, atmospheric research, and teaching. “Atmospheric research seeks to answer questions about our understanding of the atmosphere and how it works and impacts us.” Read more here: http://www.ametsoc.org/careercenter/careers.html

Resource:
- University Corporation for Atmospheric Research - [http://scied.ucar.edu/](http://scied.ucar.edu/)
Throughout the centuries, people have looked to the stars to navigate across open oceans or featureless deserts, know when to plant and harvest, and preserve their myths and folklore. To make it easier to ‘read’ the stars, they grouped the brighter stars into readily recognizable shapes known as constellations. Recycle a cereal box into a light box with your favorite zodiac constellation!

**TEKS:**

2.8 Earth and space. The student knows that there are recognizable patterns in the natural world and among objects in the sky. The student is expected to:

(D) observe, describe, and record patterns of objects in the sky, including the appearance of the Moon.

**How To:**

1. Open up the cereal box carefully. Mix the colors as you like and paint the inside all over. Don’t use water, just the paint. Let it dry. *Tip: Sunlight or hairdryer will speed up the drying process.*

2. Mark and draw the constellation on the cereal box. Also add extra nearby stars.

3. Punch holes in every marked star.

4. From the unpainted backside, poke the LED lights through the holes of the main constellation only. Tape the electric cord to the inside of the box, leaving the plug end trailing out.

5. Close the cereal box with the string lights inside and glue the two sides. Let it dry.

6. Put it on a shelf or hang it on the wall, as you like. It’s time to turn down the lights and watch the stars!

**Materials:**

- 10-bulb LED light strands (should be readily available at dollar store)
- Empty cereal box
- Picture of your chosen constellation
- Reamer/hole punch
- Acrylic paint: light blue, dark blue, and dark green (dark colors work best)
- Brush
- Palette (a bottle cap works well)
- White felt-tip pen
- Painters tape
- Glue
- Wall sticker (optional)
How Does It Work?
Constellations are groups of stars in the night sky. Throughout human history, people have looked at groups of stars and associated them with images and stories. Many well-known constellations can be identified because of their similarity in shape to people, animals, and objects. By choosing your favorite constellation and creating a light box, you will be able to enjoy the night sky all year long.

Career Connection:
**Astronomer:** Astronomers study planets, moons, stars, galaxies, meteors, comets and their interactions with each other. They must have an in-depth knowledge of physics in order to understand how forces such as gravity change throughout space. Astronomers work together sharing their knowledge in order to better understand how the universe works at microscopic and macroscopic levels.

Resources:
Rainforest In A Bottle

There are so many different kinds of ecosystems around the world – rainforests, deserts, grasslands, tundra, and more! Each of these ecosystems are made up of living species and non-living things that keep it together. You will make your own miniature ecosystems in a terrarium and observe the parts working together!

TEKS:
4.9 Organisms and environment. The student knows and understands that living organisms within an ecosystem interact with one another and with their environment.
5.9 Organisms and environment. The student knows that there are relationships, systems, and cycles within environments.
5.9A The student is expected to observe the way organisms live and survive in their ecosystem by interacting with living and non-living elements.

How To:
1. Prepare your terrarium – cut the soda bottle in half around the middle.
2. Cover the mouth of the bottle with window screen; secure it with a rubber band.
3. Fill the bottom half of the soda bottle with water halfway.
4. Put the top half of the bottle into the bottom half upside down.
5. Put a layer of pebbles into the top half of the bottle, cover the pebbles with two inches of soil.
6. Bury seeds in the soil; slightly dampen the soil.
7. Cover the top of the bottle (the widest part) with a sheet of window screen.

Materials:
- 3-liter soda bottle (one per girl)
- Gravel
- Soil
- Grass/other plant seeds
- Rubber bands
- Water
- Scissors
- Window screen – 2 sizes: one to cover the small mouth of the bottle and one to cover the thickest part of the bottle
Why Does It Work?

Ecosystems are made up of so many different living species and non-living things interacting. You have created a snapshot of an ecosystem. As your plants grow in the terrarium, observe how they interact with the soil, rocks, and water in order to survive. Think about all of the living things that are found in deserts, rainforests, grasslands, and tundras that interact with the non-living things around them!

Career Connection:

*Biologists or biological scientists* study life in all of its different forms, researching important processes and how organisms relate to their environment. Biologists research to explain the interactions and functioning of organisms.

Resources and Acknowledgments:

- Sarah Haegelin
Glaciers Galore

Did you know a glacier is made up of moulins, eskers, moraines, and crevasses? Create a 3-D model to explore how many years of fallen snow are compressed into a large, thick mass of ice.

TEKS:
3.7C Identify and compare different landforms, including mountains, hills, valleys, and plains.
4.7B Observe and identify slow changes to Earth's surface caused by weathering, erosion, and deposition from water, wind, and ice.

How To:
1. Download a cut-out 3-D model of the Icelandic glacier from the following website: http://www.bgs.ac.uk/discoveringGeology/geologyOfBritain/iceAge/glacierModel.html
2. Print the two pages on to heavy weight paper such as card stock
3. Cut around the two parts of the model
   a. Base:
      i. Cut out the curve in the middle of the base (it is easier if you push a pen tip through it first and make a hole to begin the cut)
      ii. Fold along the thick black lines
      iii. Glue tabs to make up the model like a box lid
      iv. Allow to dry
   b. Glacier Snout (the end of the glacier):
      i. Cut around the image
      ii. Fold tabs backwards
4. Glue the glacier snout to the base (glue the top to the back before gluing the bottom to the base)

Materials:
- Scissors
- Glue stick
- 2 sheets of heavy weight paper (such as white card stock)
- 1 cut-copy of the 3-D Icelandic Glacier Model
Why Does It Work?
Glaciers make up 10% of the world’s total land area and are the largest reservoir of fresh water on Earth. Additionally, they have the ability to move and flow like a slow river of ice. As the Earth continues to get warmer, the glaciers begin to shrink by melting, which directly influences variation in sea level.
In your model you can explore the different parts that make up a glacier including moulins, eskers, moraines, and crevasses. A moulin is a vertical cavity worn in a glacier by surface water. An esker is a long narrow ridge that marks the former location of a glacial tunnel. Moraines are linear accumulations of rocks and sediment that are deposited at or near the edges of a glacier. A crevasse is a deep crack in a glacier.

Career Connection:
*Geomorphologists* study landforms and the processes that shape them. Scientists in that field seek to understand why landscapes look the way they do, to understand landform history and dynamics, and to predict future changes through a combination of field observations, physical experiments, and modeling.

Resources:
- [http://www.bgs.ac.uk/discoveringGeology/geologyOfBritain/iceAge/glacierModel.html](http://www.bgs.ac.uk/discoveringGeology/geologyOfBritain/iceAge/glacierModel.html)
Coding Is Our Scratch

Use the programming power of Scratch to create your own moving mythical creature! Scratch is a programming language that can be used to design your own interactive stories, games, and animations. You can pick a creature from the library or draw your own, then program it to switch between different ‘costumes’ with the push of a button to watch your creature move!

TEKS:
6.4B Plan and manage activities to develop a solution, design a computer program, or complete a project.
FCS.4E Demonstrate coding proficiency in a contemporary programming language by developing solutions that create stories, games, and animations.

How To:

1. Log in to Scratch and click Create.
2. Delete the current sprite on the screen by right clicking the picture of it at the bottom and clicking delete.

Materials:
• Computer (with internet access)
• Scratch account (it’s really easy to make one if you don’t have one and it’s FREE: Go to http://scratch.mit.edu/, click Join Scratch and follow the instructions)

www.destember.org | #deSTEMber | © 2014 by Girlstart www.girlstart.org
DeSTEMber is a trademark of Girlstart
3. You will then want to add a new sprite, which will be your mythical creature at rest. To do this, either choose one from the library by clicking \( \text{add}\), or draw your own by clicking \( \text{draw}\). Click on the Costs tab to start editing.

   *Note: Each ‘costume’ for your creature changes its position so that your creature looks like it is moving when you switch costumes.

4. After you have finished your at-rest creature, right click on the picture of it under the ‘Costumes’ tab and click duplicate.

   *Note: sprites from the library may have more than one preset costume. If there are four costumes already and you wish to use those, then skip to Step 8. Otherwise, follow the instructions below (in order).
5. Another costume will appear that is exactly like your first one. Change one or more aspects of the costume.

6. Next, click on the first at-rest creature and duplicate it again.

7. Repeat steps 5 and 6 until you have the first at-rest costume, as well as four other different costumes.

8. Now click on the Scripts tab.

9. This is where we will begin the programming. First grab and drag an icon under the Events section.

10. Change where it says ‘space’ to one of the four arrow keys.

11. Then grab, drag, and attach a in the Looks to the bottom of the first block, as shown.

12. Next, grab and drag a from the Control section and place it under the first two blocks. Change the 1 to a 0.5.

13. Finally, grab and drag another and place it at the very bottom of your stack of blocks. Be sure to change the costume to the at-rest costume for your creature, otherwise it will not move back. Your block should now look like this:
14. Repeat steps 9 through 13, switching which arrow key and costume you use each time, until you have a block batch for each arrow key. When you are through, your screen should look something like this:

```
Congratulations, you have now finished programming your mythical creature. Now press the different arrow keys to switch between costumes and watch your creature move!

Career Connection:

**Computer programmers** write the instructions for software programs on computers. Once software developers and engineers create design specifications for a particular program, like an app or a game, computer programmers create directions for the program that the computer can understand. They will write code (the computer language), solve problems, debug, test, and rewrite the code until the program works effectively and efficiently. Some of the most common computer languages in existence include C++ and Python.

Resource:
- http://scratch.mit.edu/
LEGO Language

Have you ever wondered how a computer always knows how to respond to a command? Every click, backspace, letter, and arrow key means something to the computer — and someone had to teach it what to do in response! Computers don’t understand English; they speak their own type of languages. Because computers don’t have minds of their own, they can’t think for themselves in order to know what you want them to do. Instead, each command is programmed for a specific outcome — for example, when you click on the “x” at the top of your internet browser, the computer knows you want to close that page. The only problem is that since computers can’t think for themselves, they need very specific instructions or they might not give the response you were expecting. Just how specific should the instructions be? Test your ability to give clear instructions by giving another person step-by-step directions on how to build a LEGO design of your own creation!

TEKS:
5.27B Follow, restate, and give oral instructions that include multiple action steps.
6.12A Follow multi-tasked instructions to complete a task, solve a problem, or perform procedures.

How To:
1. Brainstorm a LEGO design with a specific function (for example, a doghouse that protects a tiny LEGO dog from the rain) and draw it on your paper.
2. Build your design using all the LEGO pieces in your baggie.
3. Using step-by-step instructions (and without showing your partner your LEGO structure), tell your partner how to build what you just created using their identical LEGO baggie. Compare the two structures — are they the same?
4. Switch roles and repeat.

Materials (per pair):
- LEGO baggies (two identical baggies with the exact same number of pieces of each size and color in each bag)
- Paper and pencil
Questions To Consider:

• Was the design built by your partner the same thing you imagined in your head?
• How could you alter your instructions to help your partner build exactly the same structure as what you created?
• Was it hard to follow your partner’s directions?

How Does This Relate To Computer Programming?

The computer can’t predict exactly what you want it to do any more than your partner could predict exactly what you created with your LEGOos! A computer programmer writes very specific language, called code, to tell a computer everything from simple commands to complex actions.

Career Connection:

Computer programmers write the instructions for software programs on computers. Once software developers and engineers create design specifications for a particular program, like an app or a game, computer programmers create directions for the program that the computer can understand. They will write code (the computer language), solve problems, debug, test, and rewrite code until the program works effectively and efficiently. Some of the most common computer languages in existence include C++ and Python.
Google Earth Scavenger Hunt

DIRECTIONS: Type these coordinate numbers into Google Earth and guess the famous place. Zoom in and out of the image and click on the pictures available for each site to further explore these amazing places. You can see the answers on the reverse side. Happy Travels!

Coordinates:

1. 25.1147000, 055.1378000 ___________ is an artificial archipelago off the coast of Dubai and one of only a few objects visible from space to the naked eye.
2. 32.1709000, -110.8552000 ___________, often called The Boneyard, is a United States Air Force aircraft and missile storage and maintenance facility in Tucson, Arizona.
3. -25.344375, 131.034401 ___________ or Ayers Rock, is a large sandstone rock formation in Australia that originally sat at the bottom of the sea, but is now standing 1,142 feet above the flat desert and 2,831 feet above sea level.
4. 38.4833778, -109.6813333 These ___________ are located in the middle of the Moab Desert, Utah. Potash is a type of salt that contains high levels of potassium. It is manufactured for use as fertilizers in big evaporation ponds like these.
5. 37.8197000, -122.4786000 ___________ is one of the most widely recognized bridges in the world and a modern marvel of engineering!
6. 19.6925000, -098.8438000 ___________ was one of the largest cities in the ancient world and is one of the most incredible constructions in America. It is evident that the builders had incredible knowledge in Mathematics, Geology, Astronomy, and Engineering.
7. -33.350534, -71.653268 ___________ is a private resort in Algarrobo, Chile recognized for having the largest swimming pool in the world!
8. -33.867886, -63.987 This ___________ located on the famous Pampas of Argentina is made up of over 7,000 cypress and eucalyptus trees and was planted by a farmer and his four kids as a memorial for his wife.
9. 36.0156000, -114.7378000 There is enough concrete in ___________ (4 1/2 million cubic yards) to build a 2 lane road from Seattle, Washington to Miami, Florida or a 4-foot wide sidewalk around the entire Earth at the equator.
10. 23.060642, 102.742349 ___________ feature more than 25,000 acres of rice fields built in levels of terraces to take advantage of local geography.
Why Does It Work?

Google Earth allows you to virtually fly to anywhere on Earth, view satellite imagery, maps, terrain, 3-D 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. The Palm Jumeirah
2. AMARG
3. Uluru
4. Potash Ponds
5. The Golden Gate Bridge
6. Teotihaucan
7. San Alfonso Del Mar
8. Guitar-shaped Forest
9. Hoover Dam
10. The Yuanyang Paddy Fields
Edible Aquifer

Everyone loves ice cream, chocolate cookies, and sprinkles! Discover the different layers of the earth as you make your own edible aquifer model. In this delicious activity you will explore how rain and snow flow through the layers of soil, called strata, and then collect below ground as groundwater. Lastly, the area where groundwater collects is called an aquifer. Enjoy your tasty aquifer model!

TEKS:
2.7B Identify and compare the properties of natural sources of freshwater and saltwater.
2.8C Explore the processes in the water cycle, including evaporation, condensation, and precipitation, as connected to weather conditions.
3.7C Identify and compare different landforms, including mountains, hills, valleys, and plains.
3.7D Explore the characteristics of natural resources that make them useful in products and materials such as clothing and furniture, and how resources may be conserved.
4.7A(ss) Examine properties of soils, including color and texture, capacity to retain water, and ability to support the growth of plants.

How To:
1. Layer some crushed ice, sprite, and blue dye at the bottom of the cup.
2. Add an ice cream layer.
3. Add a layer of crushed ice.
4. Add a chocolate cookie crumb layer.
5. Add a green sprinkle layer.
6. “Drill” a straw through your layers.
7. Slowly begin to “pump” the “water” out by sucking on your straw.

Materials:
- 1 plastic cup
- Crushed ice
- Sprite
- Blue food coloring
- Vanilla ice cream
- Chocolate cookie crumbs
- Green sprinkles
- Straws
How Does It Work?

Each edible layer represents a different layer of the earth. The first layer is the bottom of the cup, which represents the bedrock. Next is the layer of crushed ice, sprite, and blue dye, which is the lower aquifer layer. The ice cream layer represents the confining layer, which is significantly less permeable to water compared to the other layers. This helps protect the aquifer from contaminants and keeps the water clean. The second layer of crushed ice is the upper aquifer layer. The following layer is the cookie crumb layer, which represents the earth’s soil, while the green sprinkles represent all of earth’s plant life. The straw acts as a well casing and your mouth is the well pump.

Career Connection:

*Environmental engineers* assist with pollution prevention and control systems in water, air, and land. Environmental engineers help prevent fertilizer runoff, pesticides, and other contaminants from polluting the groundwater. This keeps the aquifer’s water safe for human drinking.

Resources:

- [http://www.cropinfo.net/OFD/presentations/Wateruse.php](http://www.cropinfo.net/OFD/presentations/Wateruse.php)
- [http://www.deq.idaho.gov/media/570193-iea-classroom-project.pdf](http://www.deq.idaho.gov/media/570193-iea-classroom-project.pdf)
Exploding Toothpaste

Ella the elephant is out of toothpaste and you’ve been hired to make a new batch! Use the recipe and instructions below to learn about exothermic reactions and catalysts as you prep a new batch of “toothpaste” for Ella.

TEKS:

3.5D Explore and recognize that a mixture is created when two materials are combined, such as gravel and sand, or metal and plastic paper clips.
4.6A Differentiate among forms of energy, including mechanical, sound, electrical, light, and heat/thermal.
5.5D(ss) Identify changes that can occur in the physical properties of the ingredients of solutions such as dissolving salt in water or adding lemon juice to water.
6.5D Identify the formation of a new substance by using the evidence of a possible chemical change such as production of a gas, change in temperature, production of a precipitate, or color change.
6.9B Verify through investigations that thermal energy moves in a predictable pattern from warmer to cooler temperatures until all the substances attain the same temperature such as an ice cube melting.

Materials:

- Optional: markers, paper, scissors, and tape to create an “elephant toothpaste” decorative decal for the bottle(s)
- Food coloring
- Liquid dish soap
- Funnel
- 1 liter plastic soda bottle (clean and empty)
- Measuring spoons
- Safety glasses
- Rubber gloves
- Tarp or other material to cover table --OR-- a foil pan with 2” sides
- Small plastic cups
- 4 oz. package of dry yeast (fast-rising works best) – if using a jar, you will need 2¼ teaspoon
- 3% hydrogen peroxide (found at grocery store) --OR-- for an improved reaction, 12% (40 volume) hydrogen peroxide (found at beauty supply store)
How To:

Note: Although this is a “kid-friendly” activity, adults should supervise appropriately.

1. If desired, create and apply a decorative “toothpaste” decal to the clean, empty 1-liter bottle.
2. Cover the demo table with a tarp or other protective cloth OR place the 1-liter bottle in a pan with 2” sides.
3. In a small plastic cup, mix 1 package (about 2½ teaspoons) of dry yeast with 4 tablespoons of warm water (warm water is important to activate yeast!). If the mixture is thick or paste-like, use additional water to thin out the mixture.
4. Put on rubber gloves and safety glasses.
5. Use a funnel to add 4 ounces (120 mL) of hydrogen peroxide to the liter bottle.
6. Add a few drops of food coloring and a squirt of liquid dish soap to the bottle.
7. Gently swirl the bottle around to blend the ingredients.
8. The final and fun step is to pour the prepared yeast mixture into the liter bottle and watch as Ella’s “toothpaste” is created!

Why Does It Work?

Ella’s toothpaste experiment includes the concepts of exothermic reactions and catalysts. The yeast acts as a catalyst to release the oxygen from the hydrogen peroxide. Catalysts are used to speed up a reaction. An enzyme called peroxidase in the yeast makes the reaction happen a lot faster than if we just used the peroxide and dish soap alone. The “toothpaste” reaction is an example of an exothermic reaction, which is a chemical reaction that releases energy by heat. As a result, the bottle will feel warm to the touch immediately after the reaction. This activity also shows that gases can be a product of a reaction. We usually can’t see gases being produced, but the dish soap added to the bottle traps oxygen as it is released from the hydrogen peroxide.
Career Connection:

*Chemical engineers* apply the principles of chemistry to solve the problems that affect our everyday lives. If you enjoy working in a chemistry laboratory and are interested in developing useful products for people, then a career as a chemical engineer might be in your future. Read more about chemical engineering here: [http://www.egfi-k12.org/-/cards/chemical](http://www.egfi-k12.org/-/cards/chemical) and here: [http://www.sciencebuddies.org/science-engineering-careers/engineering/chemical-engineer#whatdotheydo](http://www.sciencebuddies.org/science-engineering-careers/engineering/chemical-engineer#whatdotheydo)

Additional Resources:

Invisible Sunblock

One of the most common applications of nanotechnology is the use of nanoparticles in sunblock, yet most consumers don’t know about it! Explore the use of nano-scale particles in mineral sunblock to increase its transparency and discover the difference between sunscreen and sunblock in this hands-on activity.

**TEKS:**
3.5D Explore and recognize that a mixture is created when two materials are combined, such as gravel and sand, or metal and plastic paper clips.
4.5AC Compare and contrast a variety of mixtures and solutions such as rocks in sand, sand in water, or sugar in water.

**Materials:**
- Strips of black construction paper (2” x 4” is a good size)
- Non-nano sunblock (e.g. zinc oxide ointment, found at any drugstore)
- Nano-sunblock with zinc oxide; make sure the product is labeled as "goes on clear" (refer to the list at the bottom of the activity for common nano-sunblock brands)
- Paper towels
- Picture with large white dots/black background (included below)
- Picture with small white dots/black background (included below)
- List of common mineral sunblocks/sunscreens (included below)
How To:

1. Lay out all supplies. Discuss that the purpose of using sunblock/sunscreen is to protect the skin from ultraviolet light, which can cause short-term (sunburn) and long-term (pre-mature aging and skin cancer) damage.

2. Apply a small dot (half the size of a pea is more than enough) of both types of zinc oxide onto a strip of black construction paper. Rub each dab of sunblock into the paper until it disappears. Which dot disappeared more quickly?

3. Both sunblocks contain zinc oxide, a mineral that is very effective at absorbing UV radiation to prevent it from reaching your skin. The difference between the two sunblocks is in the size of the zinc oxide particles. The regular zinc oxide leaves a more visible film (a.k.a. “the lifeguard nose”) because the particles are large enough to reflect visible light. The nano-sunblock is transparent because the zinc oxide nanoparticles are too small to reflect visible light. They are still large enough to absorb UV radiation, so protection is equally effective. Based on this information, label the two dots on your construction paper as either “nano” or “non-nano”.

4. Look at the two pictures of large and small white dots. Which dots are easier to see? Right, the large dots. The image with the large dots represents regular sunblock – the large white dots reflect more visible light than the smaller dots, so they are more visible. The image of the small dots represents the nano-sunblock – each smaller particle reflects less visible light, so collectively they are harder to see and allow for the nano-sunblock to appear transparent. The large dot image has been scaled down and tiled to form the image of the small dots, so the ratio of black to white is the same in both pictures; only the distribution is different.
Why Does It Work?

Although the public and manufacturers often use the words “sunblock” and “sunscreen” interchangeably, they technically refer to two different types of sun protectants. Sunblocks refer to sun protectants that contain minerals such as zinc oxide or titanium dioxide. They block about 99% of UV radiation, but non-nano formulations are opaque in nature and users rarely apply the amount recommended for effective protection as a result. Sunscreens refer to chemically based sun protectants, few of which individually protect against both UV-A (320–400 nm) and UV-B (290–320 nm) radiation and are usually combined into broad-spectrum products. Although chemical sunscreens also degrade when exposed to UV light, they are more transparent than traditional mineral sunblocks when rubbed on the skin. In light of this, chemical sunscreens tend to be more popular than mineral sunblocks, even though mineral sunblocks are better at blocking UV radiation and are better for the skin because they do not degrade.

When the diameter of a zinc oxide molecule is reduced below the wavelength of visible light (380–780 nm), the nanoparticle no longer scatters visible light so the substance containing the mineral will look transparent. However, the particles are still larger than the wavelength of ultraviolet light and the chemical composition of the particle is not altered, so zinc oxide does not lose its ability to absorb UV radiation.

Nanoparticles used in sunblocks are some of the most extensively researched topics in nanotechnology. Although Australian and European governments have approved the use of nanoparticles in sunblocks, cosmetics, including sunscreens, are not regulated by the U.S. Food and Drug Administration (FDA). It is often difficult to tell which commercially available products contain nano and non-nano mineral formulations, since cosmetics companies are not required to indicate whether nanoparticles are present in their product.

To date, toxicity studies have shown that nano-zinc and titanium based minerals do not penetrate the outer layer of healthy skin and are largely safe to use. However, a possible penetration risk remains in areas where skin is thinner (i.e. lips, underarms, eyelids and at the joints) or if skin has been damaged by prior sun exposure or other physical trauma. Additionally, the elderly and young children may have a higher risk of skin penetration, as these age groups tend to have thinner skin. The primary health concern about nanoparticles is that if they are exposed to UV radiation they can generate oxygen free radicals; these can cause oxidative stress and inflammation as well as damage proteins, lipids, and DNA.
Career Connection:

**Nano Careers**: Check out fun careers in nanotechnology here: [http://www.wonderville.ca/asset/nano-careers](http://www.wonderville.ca/asset/nano-careers)

Resources:

- Adapted from **Invisible Sunblock Activity**, developed by NISE Network for the NISE Network, with funding from the National Science Foundation under Award Numbers 0532536 and 0940143. Any opinions, findings, and conclusions or recommendations expressed in this report are those of the authors and do not necessarily reflect the views of the Foundation. Used under **CC BY NC SA 3.0 US**, reformatted for DeSTEMber activity directory.

Additional Resource:

- Video – A Little Bit of Sunshine: [http://vimeo.com/73257929](http://vimeo.com/73257929)
Mimic Manufacturing

Grab a friend to create a device that mimics the hearing of animals with large ears! Your goal is to construct a device that helps your friend hear better when sounds are far away or very soft. Can you think of other products or designs that mimic plant and animal adaptations?
(Example: Velcro mimics how a sticker burr attaches to clothes and skin.)

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.

Materials:
To make different hearing devices
- (2) 3 oz. dixie cups
- (2) 6 oz. styrofoam cups
- (2) 12 oz. styrofoam cups
- (2) 24 oz. styrofoam cups
- Plastic headbands (one per hearing device)
- Heavy plastic tape or duct tape
- Scissors
How To:

1. Cut out the bottom of each cup.
2. With a partner, test the different sizes of cups to see which will funnel sounds better into the ear (make sure to conduct the hearing test in a quiet area with no outside noise). One person should hold a cup up to their ear, while their partner stands 5 feet away, either speaking or whispering the same phrase repeatedly.
3. The speaker should keep whispering or speaking the same phrase at the same volume, while the tester moves farther away from the speaker until no sound can be heard.
4. Test all four cup sizes, seeing which cup allows the tester to move furthest away from the speaker while still being able to hear.
5. Using the two cups that allowed for the best hearing, construct your hearing device by attaching the cups to a headband using tape. Make sure the cups are placed so that they cover your ears when the headband is worn.
6. Decorate your hearing device, give it a name, and wear your new device to hear soft or far away noises!

Why Does It Work?

Animals with large ears such as dogs, cats, rabbits and foxes have better hearing than people because the structure of their ears allows sound waves to be ‘funneled’ into their ears. The cups act exactly the same way, ‘funneling’ sound into your ears and allowing it to be heard more accurately.
Career Connection:

**Biomimicry Careers:** The field of biomimicry brings together teams of highly skilled people such as physicists, chemists, biologists, and engineers. Engineers must work with scientists to understand how natural occurrences and adaptations can be used to develop new inventions.

Resources:

**Additional Resource:**

- Explore biomimicry further with another fun activity! Cut out the cards below, mix them up, and try to match the product to the animal or plant adaptation that it is based upon!

<table>
<thead>
<tr>
<th>Product: Velcro</th>
<th>Plant: Cocklebur</th>
</tr>
</thead>
<tbody>
<tr>
<td>Velcro was invented by an engineer who got the idea from removing burrs from his dog’s hair. Velcro uses strips or patches of a hooked material opposite strips or patches of a loose-looped weave of nylon that holds the hooks.</td>
<td>The tiny hooks on the end of the burr’s spines catch on anything with a loop such as clothing, hair, or animal fur.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Product: Gecko Tape</th>
<th>Animal: Gecko Lizard</th>
</tr>
</thead>
<tbody>
<tr>
<td>This special tape is covered with tiny, flexible hairs that exert a special force to provide a powerful adhesive effect. Gecko tape is reusable and does not leave any residue behind. Will people be able to walk up walls in the future?</td>
<td>Millions of tiny nanoscopic hairs cover the lizard’s feet. The tiny, flexible hairs exert a force that provides a powerful adhesive effect and allows the lizard to stick to vertical surfaces.</td>
</tr>
<tr>
<td>Product: Wind Turbine</td>
<td>Animal: Whale</td>
</tr>
<tr>
<td>-----------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>Companies have developed turbine blades with bumps on the leading edge to increase the amount of energy that wind and hydroelectric turbines produce. The bumpy blades are able to cut through air more easily, making the turbines more efficient.</td>
<td>The bumps at the front edge of a whale fin greatly increase its efficiency, allowing it to move through water with less resistance. Whales are able to dive hundreds of feet below the surface of the water and stay there for hours.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Product: Glow sticks</th>
<th>Animal: Fireflies</th>
</tr>
</thead>
<tbody>
<tr>
<td>When the glow stick is twisted, a small vial breaks and releases chemicals. When the two chemicals inside the tube mix together, a chemical reaction occurs and produces light.</td>
<td>Fireflies glow because of bioluminescence, a chemical reaction that occurs when chemical energy is converted to light energy.</td>
</tr>
</tbody>
</table>
### Product: Swimsuit

The swimsuit is designed with built-in ridges that help reduce drag in the water, allowing the swimmer to swim faster.

### Animal: Shark Skin

The shark can swim quickly because of the ridges on its skin. The ridges decrease drag around the shark’s body allowing the surrounding water to pass over the shark more effectively.

### Product: Paint

A special paint has been developed that pushes away dust and dirt and reduces the need to wash the outside of a house.

### Plant: Lotus Leaves

The surface of the lotus flower repels (keeps away) dust and dirt particles, keeping the petals sparkling clean. The surface of a lotus leaf is bumpy, which causes water to bead, as well as pick up surface contaminates. When the water rolls off the leaf, it takes the contaminates with it.
Product: Airplanes
The wings on an airplane are curved so that the air passing over the top surface of the wing flows much faster than the air below the surface of the wing. The difference between the top and bottom surfaces creates a force that lifts the airplane off the ground.

Animal: Birds
The wings on a bird can take on a special shape that makes the air flow much faster over the top surface of the wing than it flows below the surface of the wing. The difference between the top and bottom surfaces creates a force that lifts the bird off the ground.

Product: Office Buildings
Engineers design buildings with chimneys and tunnels that allow air to circulate and flow so that a constant temperature can be maintained.

Animal: Termite Mounds
African termites construct air vents in their mounds. The vents constantly move air throughout the mound, cooling or heating it to a steady and comfortable temperature.
<table>
<thead>
<tr>
<th>Product: Radar</th>
<th>Animal: Bats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radar uses electromagnetic waves to determine the location, size, and shape of objects like planes and ships.</td>
<td>To echolocate, bats send out sound waves from their mouth or nose. When the sound waves hit an object, they produce echoes. The echo bounces off the object and returns to the bat’s ears. Bats listen to the echoes to figure out where the object is, how big it is, and its shape.</td>
</tr>
</tbody>
</table>

**Answer Key (Product ➔ Plant/Animal):**

1. Velcro ➔ Cockleburr
2. Gecko tape ➔ Gecko lizard
3. Wind turbine ➔ Whale
4. Glow sticks ➔ Fireflies
5. Swimsuit ➔ Shark skin
6. Paint ➔ Lotus leaves
7. Airplanes ➔ Birds
8. Office buildings ➔ Termite mounds
9. Radar ➔ Bats
Shrinky Cells

Discover the unique functions of plant and animal cells using this fun shrinking paper. Draw a large and colorful cell diagram, then shrink your design to the perfect wearable size and proudly sport your unique product – a creative blend of fashion, art, and science.

TEKS:
6.12A Understand that all organisms are composed of one or more cells.
7.12F(ss) Recognize that according to cell theory, all organisms are composed of cells and cells carry on similar functions, such as extracting energy from food to sustain life.

Materials:
- Permanent markers - variety of colors (bright, contrasting colors work best)
- Shrink film sheet (example here)
- Regular kitchen oven or toaster oven (for shrinking designs)
- Baking sheet
- Needle nose pliers
- Hole punch (handheld)
- Keychain and/or other jewelry findings to make cells wearable (example here)
- Plant/animal cell diagram of your choice (to serve as a guide). Below are a few FREE diagrams:
  - PLANT & ANIMAL CELL: Clipart and lesson links (free resources)
  - A shrinky cell kit is also available for order here: http://www.teachersource.com/product/shrinky-dink-cells/biology-life-science
How To:

1. Check the specifications on the shrink film to adjust the size of sheet based on the percentage of shrink (e.g. the example provided in the ‘materials’ section above shrinks by 50%). In most cases, only 1/2 sheet will be needed for each cell design.

3. Use a pre-drawn image of a plant or animal cell to create your own new diagram of one or both cell types. Cell images are provided above if you don’t have one.

4. Color the design with permanent markers (bright and contrasting colors work best) and discuss the name and function of each part of the cell with a partner.

5. Use a handheld hole punch to create a hole in the cell design prior to heating. This will become the location where the finding is attached. The hole should be within 1/2" of the outer border.

6. Follow the manufacturer’s instructions on heating and shrinking the sheets (depends on the shrink film you purchased).

7. After you’ve shrunk your cell(s), attach your keychain or jewelry findings through the hole and use your new shrinky cell!
**Why Does It Work?**
The sheets of plastic (i.e. shrink film) used in this activity are polystyrene—the same stuff as recycled plastic #6, which is commonly used for the clear clamshell containers you see in cafeterias. “By nature, the polymer chains within the polystyrene are bunched up and randomly clumped together, but the heating, rolling, and cooling process forces them to straighten out and get into a more orderly configuration.” Read more on this topic at [Smithsonian.com](http://Smithsonian.com).

**Career Connection:**

*Cytotechnologist*: “When a patient gets sick, his or her doctor will take sample cells from the affected part of his or her body and send them to a lab for testing to figure out what is wrong. This is where the cytotechnologist steps in. The cytotechnologist will take the sample cells, make slides from them, and examine the slides under a microscope. Cytotechnologists are trained to detect abnormalities in cells that come from all body sites in order to make a diagnosis of cancer or other diseases. These professionals help pathologists and doctors diagnose diseases early, thus saving lives.” Read more about this career at [sciencebuddies.org](http://sciencebuddies.org).

**Additional Resources:**

- PowerPoint by One Stop Teacher Shop: microorganisms, multi-celled organisms, single celled organisms, plant cell parts, and animal cell parts. [http://www.teacherspayteachers.com/Product/Animal-Cells-Plant-Cells-PowerPoint-Presentation-100-Editable-642276](http://www.teacherspayteachers.com/Product/Animal-Cells-Plant-Cells-PowerPoint-Presentation-100-Editable-642276)
Air Mail Challenge

Scientists on a remote island need your help! Design a container that can survive a drop from an airplane to their island below. Use the materials to create a package prototype that can withstand the conditions of being dropped – it must be waterproof, able to float, have the lowest mass possible, and protect the material (potato chip) inside from breaking. Gather your materials and start designing!

TEKS:
4.2 Scientific investigation and reasoning. The student uses scientific inquiry methods during laboratory and outdoor investigations.
5.5A Classify matter based on physical properties, including mass, magnetism, physical state (solid, liquid, gas), relative density (sinking and floating), solubility in water, and the ability to conduct or insulate thermal energy or electric energy.

How To:
1. Examine the material (potato chip) you will be packaging. Brainstorm designs that might protect it from breaking after a drop.
2. Design your package. Keep it light, waterproof, and able to float.
3. Test your package! Place your package in the tub of water. Does it float? Is it waterproof? Drop your package from knee-height and shoulder-height into the tub of water. Did your materials survive both drops?
4. Modify, update, and refine your design if needed.
5. Retest and redesign your package until it works.

Materials:
- Duct tape
- Potato chips
- Bubble wrap
- Cotton balls
- Packing peanuts
- Plastic cups
- Foam cups
- Paper cups
- Tub of water
How Does It Work?

Each material used to make the container has different masses and is made up of different materials. This affects your package’s ability to float. Some of the materials don’t absorb the force of hitting the water very well, and the chip may hit the sides of the container hard enough to break. Other materials cushion the chip as it hits the water, reducing the amount of force applied to the chip.

Career Connection:

Manufacturing engineers make things. They design, direct, and coordinate the processes and systems for making almost any kind of product – from beginning to end. Manufacturing engineers apply scientific principles in designing and producing quality products.

Resource:

Weather Flowers

Can you tell if the air around you is humid or dry? Although humidity cannot be seen, it has important effects on the weather. This moisture-detecting flower will display the color pink, purple, or blue based on the humidity in the air, giving you insight into the weather before you step outside!

TEKS:
2.5B Compare changes in materials caused by heating and cooling.
2.8B Identify the importance of weather and seasonal information to make choices in clothing, activities, and transportation.
3.5D Explore and recognize that a mixture is created when two materials are combined, such as gravel and sand, or metal and plastic paper clips.
4.5B Differentiate among forms of energy, including mechanical, sound, electrical, light, and heat/thermal.
5.5D(ss) Identify changes that can occur in the physical properties of the ingredients of solutions, such as dissolving salt in water or adding lemon juice to water.

Materials:
- Gloves
- Safety goggles
- Shallow aluminum foil pan
- Water in a spray bottle
- Coffee filters (one per flower)
- 10% (m/v) cobalt (II) chloride solution. This can be found at: http://www.hometrainingtools.com/cobalt-ii-chloride-15-g/p/CH-COCL2/
- Pipe cleaners (one per flower)
- Hair dryer
How To:

Preparation:

Note: Adults can demonstrate this portion of the procedure or prepare filters prior to the lab.

1. Cut the filter paper into a shape resembling flower petals. Put on safety goggles and gloves.
2. Pour a small amount of cobalt chloride solution into the shallow pan. The solution should be 10% cobalt chloride crystals and 90% water.
3. Dip the cutout into the solution of 10% cobalt chloride. Allow the dipped paper to dry by hanging it or laying it flat.
4. Continue using gloves when handling the paper until it is completely dry. Use a hair dryer to make sure that the filter paper shape is completely dry.

CAUTION: Cobalt chloride could be harmful if swallowed. Cobalt chloride could also cause skin irritation. If skin contact occurs, wash thoroughly. Once the humidity monitors are completely dry, it is safe to handle them.

Procedure:

1. Spray a small amount of water on the dried paper to demonstrate the blue to pink color change that would occur in high humidity conditions.
2. Use a hair dryer to completely dry the filter paper, watching the color change as the paper dries.
3. To form a flower, fold the dried filter in half twice and wrap a pipe cleaner around the point of the folded filter.
4. Open the folded filter to look like a flower.
5. You can now use the color change in your flower to take note of current humidity conditions wherever you are!

Why Does It Work?

The solution used to soak the coffee filter is cobalt chloride. When this blue colored solution reacts with water, it forms cobalt chloride hexahydrate (CoCl₂ • H₂O); the product of this chemical reaction is pink. For low humidity conditions the filter paper should appear blue, for moderate humidity the paper should appear purple, and for high humidity it should change to pink.
Career Connection:

Meteorologists study the Earth’s atmosphere by observing temperature, air pressure, water vapor, and their interactions and changes over time. They use simulations to help them predict the weather and to understand weather patterns so they can piece together climatic schemes, or focus on more complex weather such as hurricanes, tornados, etc. Meteorologists need an in depth knowledge of physics, geology, chemistry, and other sub-disciplines of atmospheric sciences including climatology, hydrology, and even oceanography. These scientists are important to the fields of energy production, transportation, agriculture, and more.

Additional Resources:

- Teaching Chemistry With Toys: http://www.amazon.com/Teaching-Chemistry-TOYS-Jerry-Sarquis/dp/1883822297/ref=lr_308_1_simpl?ie=UTF8&psc=1&smid=A38FX54YL3T3L3
Magnetic Slime

This activity is a new twist to an old favorite! Everyone loves making slime, but today we are going to make it magnetic. Mixing together different ingredients, you will create a slimy mixture that can move without you physically touching it.

TEKS:
3.6D Observe forces such as magnetism and gravity acting on objects.
5.5A(rs) Classify matter based on physical properties, including mass, magnetism, physical state (solid, liquid, and gas), relative density (sinking and floating), solubility in water, and the ability to conduct or insulate thermal energy or electric energy.
5.5C(ss) Demonstrate that some mixtures maintain physical properties of their ingredients such as iron filings and sand.
5.5D(ss) Identify changes that can occur in the physical properties of the ingredients of solutions, such as dissolving salt in water or adding lemon juice to water.

Materials (per magnetic slime batch):
- 1 teaspoon borax laundry booster - [http://smile.amazon.com/Borax-Mule-Team-Detergent-Booster/dp/B000VCFAXO/ref=sr_1_1?ie=UTF8&qid=1418069036&sr=8-1&keywords=borax](http://smile.amazon.com/Borax-Mule-Team-Detergent-Booster/dp/B000VCFAXO/ref=sr_1_1?ie=UTF8&qid=1418069036&sr=8-1&keywords=borax)
- 8 oz. bottle of white school glue
- Large, disposable mixing bowl
- Plastic cup
- 1 Neodymium (rare Earth) magnet (a regular magnet is not strong enough) - [http://smile.amazon.com/Craft-Hobby-Neodymium-Magnets-3x1-5mm/dp/B0065O63BK/ref=sr_1_2?ie=UTF8&qid=1417806678&sr=8-2&keywords=neodymium+rare+earth+magnets](http://smile.amazon.com/Craft-Hobby-Neodymium-Magnets-3x1-5mm/dp/B0065O63BK/ref=sr_1_2?ie=UTF8&qid=1417806678&sr=8-2&keywords=neodymium+rare+earth+magnets)
- Water
How To:

1. Pour the entire bottle of 8 oz. white school glue into a disposable mixing bowl.
2. Add water to the empty glue bottle, tighten the lid, and shake it up really well.
3. Pour the water and glue mixture from the glue bottle into the mixing bowl.
4. Add 2 tablespoons of iron filings to the bowl and stir the water, glue, and filings together until they are well mixed.
5. Measure ½ cup of water and pour it into the plastic cup.
6. Add 1 teaspoon of borax to the cup of water and stir the solution.
7. Add the borax-water solution to the mixing bowl.
8. Mix it up VERY well.
9. Use the Neodymium magnet to make the slime dance and move! Watch as it transforms before your eyes.

CAUTION:

- Neodymium magnets are extremely strong. Fingers can easily get pinched when trying to separate the magnets. It is okay to leave the magnets stuck together.
- Keep magnets away from cellphones, computers, and other electronics!

Why Does It Work?

The iron oxide powder in the slime is attracted to the magnet. Iron is one of three elements that is magnetic at room temperature. The other two elements that are magnetic at room temperature are cobalt and nickel. The mixture of school glue with borax creates the slimy substance that holds the iron. What prevents the iron filings from flying out of the slime and to the magnet? The slime is able to hold on to the iron filings by adhesion. Adhesion is the force that holds molecules of different substances together. The slime is also bonded together by cohesion, the force that holds molecules of the same substance together. This combination of magnetism, adhesion, and cohesion results in the stretchy, moving slime when a neodymium magnet is held near the mixture.
Career Connection:

*Chemical Engineers* combine natural sciences and life sciences together with mathematics and economics to produce, transform, and properly use chemicals, materials, and energy. They also design processes and equipment for large-scale safe and sustainable manufacturing of chemicals. Food, fuel, paper, plastics, and chemicals are some of the most common products that chemical engineers design processes for.

Resources:

- [http://www.stevespanglerscience.com/lab/experiments/magnetic-slime](http://www.stevespanglerscience.com/lab/experiments/magnetic-slime)
Prehistoric Puppets

Styracosaurus’, Pterosaurs, Velociraptors and more! How many dinosaurs do you know? Create unique puppet heads to explore the different physical characteristics dinosaurs developed to adapt to the environment they lived in.

TEKS:
3.10A Explore how structures and functions of plants and animals allow them to survive in a particular environment.
4.10A Explore how adaptations enable organisms to survive in their environment, such as comparing birds' beaks and leaves on plants.
5.10A(rs) 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.

How To:
1. Visit the British Geological Society’s website for templates of three different dinosaurs: http://www.bgs.ac.uk/discoveringGeology/time/puppets/home.html
2. Print the templates and cut out the different dinosaurs, according to the given directions.
3. Use construction paper to create the dinosaurs’ bodies.
4. Play with the dinosaurs and observe what features the dinosaurs have in common and what features are different.
5. Use the Dinosaur Facts on the next page to learn why each dinosaur has its specific physical characteristics.

Materials:
- Dinosaur head templates (can be printed out at: http://www.bgs.ac.uk/discoveringGeology/time/puppets/home.html)
- Cardstock or colored construction paper for body
- Scissors
- Glue
- Brass fasteners
- Markers or crayons (optional)
How Does It Work?
By creating dinosaur puppets, you are learning how different dinosaurs looked. Reading more about these creatures also helps you understand that they lived in different periods of time and why they needed to evolve differently from one another.

Dinosaur Facts!
There are three main geologic periods that dinosaurs lived in. All of these periods were part of the Mesozoic Era:
- Dinosaurs and mammals started to evolve during the Triassic Period (250 to 200 million years ago). These creatures were often small in stature. Pterosaurs started flying and early crocodiles began to evolve.
- Dinosaurs continued to evolve and started to get large during the Jurassic Period (200 to 145 million years ago). Well-known dinosaurs such as Allosaurus, Apatosaurus, Ankylosaurus and Stegasaurus roamed the earth.
- The longest and last period of time that dinosaurs roamed the earth was during the Cretaceous Period (145 to 66 million years ago). Some of the most recognizable dinosaurs to us appeared in this period. Triceratops, Tyrannosaurus Rex, Iguanodon, Velociraptors and Spinosaurus were common.

Dinosaur Types:
- **Styracosaurus**: These dinosaurs inhabited what is now North America. They lived 75 million years ago during the Cretaceous period. Even though they had large spikes on their heads, styracosaurus’ ate plants. They weighed nearly 3 tons and often lived in herds.
- **Pterosaur**: Pterosaurs were a class of flying reptiles that existed from the Triassic through the Cretaceous period. Pterosaurs ranged in size from the size of a modern small bird to a 30-foot long flying reptile. They mainly ate fish and smaller lizards.
- **Tyrannosaurus Rex**: These large carnivores lived for 2 million years during the Cretaceous period in what is now North America. They were over 42 feet long with teeth nearly 11 inches long. Their powerful legs helped them hunt by outrunning their prey.
Career Connection:

_Paleontologists_ study prehistoric life. They study fossils of extinct creatures such as dinosaurs, prehistoric plants, and small creatures like mollusks. They use fossils to understand the evolution of different creatures in relation to their environment. Paleontologists need a wide range of knowledge from various fields, including biology, geology, ecology, and chemistry.

Resource:
- [http://www.bgs.ac.uk/discoveringGeology/time/puppets/home.html](http://www.bgs.ac.uk/discoveringGeology/time/puppets/home.html)
Tic Tac Flashlight

Reduce, reuse, and recycle with this fun electronics project. Convert a Tic Tac candy container into a handy LED flashlight and never get caught in the dark again!

TEKS:
4.6A Differentiate among forms of energy, including mechanical, sound, electrical, light, and heat/thermal.
5.6B(rs) Demonstrate that the flow of electricity in circuits requires a complete path through which an electric current can pass and can produce light, heat, and sound.
6.9C(ss) Demonstrate energy transformations, such as when energy in a flashlight battery changes from chemical energy to electrical energy to light energy.

Materials (per flashlight):
- (1) Empty Tic Tac container
- (3) AA or (3) AAA batteries (both types are 1.5v)
- (1) 5mm LED light - example here: 25,000 mcd - 3.8 volt and 20 mA
- (1) Switch - example here: tact switch or slide switch
- (1) 27 ohm serial resistor - example here: resistor
- Aluminum foil (about 6 sq. inches per flashlight)
- Clear (scotch) tape or electrical tape (1 roll will cover at least 20 projects)
- Scissors
- Needle nose pliers and/or hemostats
- Drill with 3/16” diameter bit (ask for help from an adult when using this tool)
- Hot glue gun and glue sticks (only a dab is needed per project)
- Note: a multimeter is helpful to troubleshoot circuit problems, but it is not required.
How To:

1. Orient 3 batteries as shown and use tape to secure the batteries into a single “pack” as shown.

2. Fold the foil (edge over edge) to create foil conductive strips approximately 3/16” wide. You will create 4 strips of the lengths shown below: (2) ½” strips, (1) 4” strip, and (1) 3” strip. The foil should be folded about 10 times so that each strip has the thickness of 10 pieces of foil. If using heavier weight foil, 5 folds will suffice.
3. Attach the ½” conductive strips to “wire” the batteries in series. Place the foil over the terminals and secure the foil strips with tape.

4. Connect the 4” conductive foil strip to the bottom negative terminal and use tape to secure position.
5. Prepare the flashlight top by drilling two 3/16” holes in the cap. Note: you should adjust the size of this hole according to the size of the switch and bulb you are using.

6. Connect the LED bulb, resistor and switch as shown. Note that the short leg of the LED bulb should be connected to the 4” foil strip and the long leg of the bulb to the resistor. At this point, you may want to temporarily connect the 3” and the 4” foil strips to the battery pack to ensure that the LED bulb illuminates. If there are no issues with the circuit, move to step 7.
7. Temporarily disconnect the 3” and 4” foil strips from the battery pack if you would like to maximize flexibility in connecting the components into the flashlight cap. Fit the bulb and switch into their corresponding holes in the flashlight top and use a small amount of hot glue to secure them into place. This task may be best performed by an adult.

8. Once the glue has cooled in the flashlight top, connect (or reconnect) the LED bulb short leg to the 4” foil strip. Use a bit of tape to ensure the connection does not come loose.

9. Connect (or reconnect) the 3” foil strip to the top positive battery terminal of the battery pack. This will complete the electrical circuit once again and you should be able to use the switch to operate the flashlight.

10. Place all components in the plastic case and snap the top to the case.

11. You can embellish the outer case with your favorite decorative tape, decals, etc. or leave it unadorned to show off the science inside the flashlight.

Why Does It Work?
The 3 batteries are wired together in series to provide power to the LED bulb. Because aluminum is a conductive metal, the folded aluminum foil makes a great conductive material to carry electricity in the circuit. The 27-ohm resistor is required to step the power down in the circuit so the LED bulb is not burned out by excessive power. The switch completes the circuit when pressed, allowing electricity to flow through the circuit without interruption.

Career Connection:
**Electrical Engineer:** “As an electrical engineer you’ve got the power - and you’ll efficiently and safely channel it from turbines, fuel cells, or hydroelectric and solar plants to homes, factories, and businesses. Electrical engineers also develop wireless communication systems, develop the latest media displays like HDTV, design computer processors and other hardware, and work in robotics.” [Read more at egfi-k12.org...](https://www.egfi-k12.org)
Additional Resources:

- LED calculator: [http://led.linear1.org/1led.wiz](http://led.linear1.org/1led.wiz)
- Flashlight wiring schematic:
Paper Plants

Create a special holiday card from recycled paper that can also grow beautiful flowers. Many recycled items like paper, cans, bottles, cardboard, etc. can be made into new products. Recycling helps the environment by saving the earth’s natural resources and reducing pollution.

TEKS:
3.5D Explore and recognize that a mixture is created when two materials are combined, such as gravel and sand, or metal and plastic paper clips.
5.5D(ss) Identify changes that can occur in the physical properties of the ingredients of solutions, such as dissolving salt in water, or adding lemon juice to water.

Materials:
- 5-10 sheets of used printer paper, crosscut into tiny pieces manually or with a paper shredder
  - Note: these need to be prepped the night before beginning the project (see Step 1)
- Large bowl of warm water
- Window screen material (enough to cover a small embroidery hoop)
- Small embroidery hoop (Alternative: make a wooden frame out of popsicle sticks)
- Food coloring (optional)
- Blender
- 9 x 13-inch baking pan
- Packet of wildflower seeds or other seeds
- Old bath towels or several layers of felt squares (to soak up water)
- Waxed paper
- Colored markers
- Cookie cutters (optional)
- Flower pot
- Soil
How To:

1. Soak the used paper strips in a bowl of water overnight.
2. Put the soaked paper into the blender.
3. Fill the blender halfway with fresh water.
4. Blend until the paper mixture is soupy.
5. OPTIONAL: add food coloring of choice and blend some more.
6. Fill the 9x13-inch baking pan one-quarter full of water.
7. Pour the blended paper mixture into the 9x13-inch baking pan.
8. Slide the window screen material into the embroidery hoop. Then slip the embroidery hoop into the bottom of the pan from the side so that it slides beneath the paper mixture (If necessary, spoon some of the mixture over the screen so that the finished paper product will not be too thin once dried!).
9. Lift the screen gently, catching the paper mixture evenly on top and letting the water drain off.
10. Lay the screen on an old bath towel or felt layers to drain.
11. Sprinkle some seeds on top of the wet paper mixture.
12. Gently pat them into the surface of the paper mixture.
13. When the bath towel or felt has soaked up as much water as it can, pick up the hoop and turn it over onto a sheet of waxed paper to dry (seeds will be on the bottom).
   *You may have to gently hit the hoop on the table or counter surface to loosen the paper mixture from the screen. If the paper mixture does not stick together, try putting more paper mixture on the screen next time.
14. Let the paper dry for at least 24 hours.
15. OPTIONAL: use cookie cutters to make your paper and seed mixture into a desired shape.
16. If the paper does not lie flat, place a heavy object (like a book) on it for a few hours to flatten it.
17. Decorate it with markers on the un-seeded side.

Once you’re ready to plant your greeting card:

1. In a pot of your choice, firmly fill the pot with soil (leave about half an inch of room at the top).
2. Lay greeting card flat on top of the soil.
3. Place about a quarter-inch thick layer of soil on top of the greeting card.
4. Tap the soil gently.
5. Water soil lightly so that the soil and paper are damp.
6. Keep seeds wet until they sprout and have a couple of days to grow roots.
7. Once the sprouts appear, continue to keep the paper moist (make sure not to overwater).
8. Enjoy your new plant!
Why Does It Work?
When you plant your greeting card, the seeds will sprout and the paper will eventually biodegrade. Biodegrading is the process of certain materials being decomposed (or broken down) by bacteria. Once the paper biodegrades, it leaves the flowers (or whichever plant you decided to plant) behind and most importantly, it does not leave any waste.

Career Connection:
*Environmental scientists* work to regulate, control, and prevent air, land, and water pollution. They conduct research to find pollutants or hazards in our environment and then propose a plan to eliminate them. Environmental scientists work with various organizations and government agencies to conserve the local natural areas.

Resources:
- [http://climatekids.nasa.gov/seed-paper/](http://climatekids.nasa.gov/seed-paper/)
- [http://www.botanicalpaperworks.com/how_plantable_paper_works](http://www.botanicalpaperworks.com/how_plantable_paper_works)
Plastic Rescue

Earth’s oceans are home to billions of animals and plants, but millions of tons (1 ton = 2,000 pounds) of plastics pollute our oceans today. Learn about different physical properties of plastics and design a device that collects plastics and removes trash to help save animals and plants in the ocean!

TEKS:
6.2B Design and implement experimental investigations by making observations, asking well-defined questions, formulating testable hypotheses, and using appropriate equipment and technology.
7.4A Use appropriate tools to collect, record, and analyze information, including journals/notebooks, beakers, Petri dishes, meter sticks, graduated cylinders, hot plates, test tubes, triple beam balances, microscopes, thermometers, calculators, computers, timing devices, and other equipment as needed.
8.6B Compare and contrast potential and kinetic energy.

Materials:
- Scissors
- Markers
- Various types of plastic containers (one of each plastic type, by number)
- Shoe box and cardboard
- String/yarn
- Pool noodles
- Nets/mesh
- Rubber bands
- PVC pipes
- Toilet paper rolls
- Popsicle sticks
- Aluminum foil
- Duct tape
- Plastic tub (for density testing)

Types of Plastic:
- #1 plastic: clear bottle (soda, water, mouthwash, or salad dressing)
- #2 plastic: opaque bottle (milk, orange juice, shampoo, or lotion)
- #3 plastic: PVC pipe
- #4 plastic: lightweight bag (bread bag, sandwich bag, or grocery bag)
- #5 plastic: tub (yogurt, ketchup bottles, or butter containers)
- #6 plastic: Styrofoam products (disposable plates/cups, or plastic utensils)
How To:

1. Cut out a small sample of each type of plastic (#1-6). Use a permanent marker to label each sample by number.
2. Think about plastics. Name as many things as you can think of that are made of plastic. What do we use plastic for in our lives? Where and how do we dispose of plastics? Are all plastics the same or are some different than others? Notice the physical properties of each type of plastic, including transparency and rigidity. Write down the characteristics you notice in the chart on the next page.
3. Fill the plastic tub with water.
4. Using a pencil, push each sample down into the water and observe whether it floats or sinks. Record your results in the chart below.
5. Now that you know more about the differences in plastics, brainstorm ideas for a device that can remove trash, while not harming the environment and ocean wildlife any further. Ask yourself the following questions:
   a. What will your device look like?
   b. How will your device be fueled?
   c. How does your device affect marine life?
   d. Will your device pick up all plastics or only specific types?
6. Sketch a design for your device on a piece of paper.
7. Using the materials listed above, create your device. Remember to be frugal with your materials – you don’t want to create more trash that will pollute the ocean further!
8. Evaluate your device. Ask yourself these questions:
   a. How does it work?
   b. What are its pros and cons?
   c. Since this is a small model, what would need to be done to make it a large, to-scale usable device?
9. Make any necessary changes to your model and share it with family or friends!
<table>
<thead>
<tr>
<th>Plastic Sample</th>
<th>Transparency Clear or opaque?</th>
<th>Luster Shiny or dull?</th>
<th>Brittleness Breakable or not?</th>
<th>Rigidness Flexible or tough?</th>
<th>Density Sinks or floats?</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1 Clear bottle (soda, water, mouthwash, or salad dressing)</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>#2 Opaque bottle (milk, orange juice, shampoo, or lotion)</td>
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<tr>
<td>#3 PVC</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>#4 Lightweight bag (bread bag, sandwich, or grocery bag)</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#5 Tub (yogurt, ketchup bottles, or butter containers)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#6 Styrofoam products (disposable plates and cups or plastic utensils)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Why Does It Work?

Millions of tons of plastic debris currently pollute the world’s oceans. Plastic reaches the oceans mostly from land through rivers and waterways and then accumulates in 5 areas of high concentration, called gyres (see the picture below). Not only does plastic pollution directly kill hundreds to thousands of aquatic animals annually, it may spread harmful algae and other invasive species. It also serves as a transportation system for pollutants that accumulate in the food chain. Plastic pollution costs governments, companies, and individuals millions of dollars in damages per year, due to loss in tourism, vessel damages and inefficient beach cleanups.

A recent study found an average of 334,271 pieces of plastic per square mile in the North Pacific Gyre. The North Pacific Gyre occupies an area roughly twice the size of the United States. Plastic marine debris affects at least 267 species worldwide, including 86% of all sea turtle species, 44% of all sea bird species, and 43% of all marine mammal species. Mobile marine animals often ingest plastics that they mistake for food, or become entangled in debris that can cause serious injury, and delicate ecosystems (e.g. coral reefs) can be damaged by plastic debris suffocating or breaking coral.
Career Connection:

**Marine Engineers** design and oversee construction and repair of marine craft and floating structures such as ships, barges, tugs, dredges, submarines, torpedoes, floats, and buoys. They must evaluate the performance of the crafts they design during dock and sea trials and determine any design changes that must be made to conform to national and international standards.

Resources:

- [http://marinedebris.noaa.gov](http://marinedebris.noaa.gov)
- [www.scigirlsconnect.org](http://www.scigirlsconnect.org)

Additional Resource:

- Watch the Majestic Plastic Bag video to see what happens to plastics that aren’t recycled: [http://www.youtube.com/watch?v=GLgh9h2ePYw](http://www.youtube.com/watch?v=GLgh9h2ePYw)
DNA Sequence Bracelet

Create a colorful bracelet to discover the unique DNA sequence of a butterfly, chimpanzee, trout, or human. Learn about complementary base pairing, the genetic process that allows us to inherit traits, like hair color, freckles, or even if you can roll your tongue, from one generation to another.

TEKS:
4.10B Demonstrate that some likenesses between parents and offspring are inherited and passed from generation to generation, such as eye color in humans or shapes of leaves in plants. Other likenesses are learned, such as table manners, reading a book, or seals balancing balls on their noses.
7.14A Define heredity as the passage of genetic instructions from one generation to the next generation.
7.14C(ss) Recognize that inherited traits of individuals are governed in the genetic material found in the genes within chromosomes in the nucleus.

Materials (per bracelet):
- An organism sequence of your choice (look at different organisms’ DNA sequences here: http://www.yourgenome.org/downloads/pdf/teachers/seq/FT_sequence_bracelets.pdf)
- 44 colored round beads (four different colors: ideally red, yellow, green and blue)
  - Can purchase plastic pony beads online here: LINK
- Two pieces of elastic string (approximately 1’ long each)
  - Can purchase elastic string online here: LINK
How To:

1. Go to [http://www.yourgenome.org/downloads/pdf/teachers/seq/FT_sequence_bracelets.pdf](http://www.yourgenome.org/downloads/pdf/teachers/seq/FT_sequence_bracelets.pdf) (pages 3 and 4) to pick out an organism you want to make a bracelet of the genetic code of, such as a person, trout, chimpanzee or butterfly. Choose one DNA sequence to make.

   ![Chimpanzee DNA sequence]

2. Find or cut two pieces of elastic each about 1’ (30 cm) long. Tie a knot about 5 cm from one end of each string; then tie the two strings together at the knots.

   ![Elastic string tied with a knot]

3. Look at the first letter in your sequence and find the right color bead to thread. Each bead represents one letter of your organism’s genetic code.

   ![Chimpanzee DNA sequence with beads]

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31 Days of STEM Fun!

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4. Thread that bead onto string 1 and thread the bead for the matching base onto string 2 (see the Pairing Rules picture to the right for guidance). Keep threading beads according to your sequence until you’ve finished the sequence on your card.

5. Knot each string after the last bead, and then tie the two new knots together. Just like in DNA, there are four different kinds of units that make up the sequence - red, green, yellow and blue.

6. Your bracelet will contain two strands of beads that match up the same way the units (or bases) in DNA do. That means if you know the sequence of one strand, you can work out the sequence of the other.

7. Now tie the ends of your double-stranded sequence bracelet together and enjoy your new DNA sequence bracelet!
Why Does It Work?

Follow this link to learn about the basics of genetics:
http://learn.genetics.utah.edu/content/basics/

Play this fun game to learn the process of complementary base pairing:
http://learn.genetics.utah.edu/content/molecules/builddna/

Career Connection:

Synthetic biologist: “Synthetic biology takes genetic engineering one step further. Instead of changing or modifying living things by using only genes that exist in nature, synthetic biology involves redesigning sequences of DNA for new purposes or new opportunities.”
-- http://www.wonderville.ca/asset/whatissyntheticbiology

Resources:

• Wellcome Trust Sanger Institute’s yourgenome.org-- Sequence Bracelets, Courtesy of Genome Research Limited, Used under CC BY 3.0, reformatted for DeSTEMber activity directory.
• Genetic Science Learning Center, University of Utah Health Sciences.

Additional Resources:

• Introduction To DNA, Genes & Genomes: http://www.yourgenome.org/downloads/dgg_basic.pdf
Balancing Act

Is it possible to balance 6 or more nails on the head of a single nail? No glue, rubber bands, or welding allowed. Try it on your own first, and then use the instructions below to unlock this physics mystery!

Materials:
- Hammer
- 12 identical nails (3 inch long or larger work best)
- Block of wood (e.g. 3” square, ½” thick or larger)
  --OR--
- Steve Spangler Balancing Nail Puzzle – available through Steve Spangler Science at www.stevespanglerscience.com

TEKS:
3.6C Observe forces such as magnetism and gravity acting on objects.
6.8B Identify and describe the changes in position, direction, and speed of an object when acted upon by unbalanced forces.
7.7C Demonstrate and illustrate forces that affect motion in everyday life, such as emergence of seedlings, turgor pressure, and geotropism.
How To:

1. Nail one of the nails into the small block of wood to make a pedestal for the other nails. This nail should be nailed in perpendicular (at a 90 degree angle) to the block of wood, with most of the nail still exposed.

2. Take another nail and lay it down on the table. Lay the next nail across the first nail perpendicularly (at a 90 degree angle) with its head over the first nail. Lay the second nail in the opposite direction. Continue to do this with several nails, until it looks like the sketch below and you have the same number of nails on each side. (Note: the sketch represents what your nails should look like from above, looking down at the nails lying on the table).

[Diagram of nails arranged in a perpendicular fashion]

3. Lay the last nail on top of the others, parallel to the first nail, but with its head at the other end. The top and bottom nails keep the arrangement in place.

4. Carefully lift the arrangement by holding it at the ends of the top and bottom nails. Place it on the head of the nail in the block of wood.
Why Does It Work?

How can several nails balance on top of one nail head without falling over? When something is in balance (like the nails), in science we say it is in equilibrium. Equilibrium happens when two opposite forces pull or push against each other with the exact same strength so that something remains motionless. For example, face a friend and push your hands against each other. If you both push against each other with the same amount of force, you will both stay in the same place. If you push with more strength than your friend, you will create an imbalance of forces and they will fall backwards. With the balancing nails, each side of the nails pulls against the other side equally, so that the nails balance and remain in a state of equilibrium. In order for an object to move, there must be an imbalance of forces, causing it to no longer be in equilibrium. Observe the place where all the nails are balancing on one nail (i.e. balance point). This balance point is called an object’s center of gravity. The center of gravity is the place an object where it can balance because all the forces are in equilibrium. The center of gravity isn’t always in an object’s exact middle, however. Try to balance a pencil or baseball bat on your finger to prove this. The center of gravity is closer to the heavier end.

Career Connection:

Civil engineer: “Civil engineers design and supervise the creation of structures. Not just buildings – civil engineers work on everything from tunnels and dams, to highways and airports, to water and sewer systems. They use computer technologies and advanced materials to design structures that meet the needs of a growing population while protecting the environment, reducing the dangers from natural phenomenon like storms, and considering future needs of the community.” - Engineergirl.org. Read more about civil engineers here: http://www.engineergirl.org/cms/6069.aspx.

Resources:

Paper Sundials

Measuring time is essential in our daily lives. Before clocks were invented, individuals observed shadows and light created by the sun to determine time. Discover one of the ways civilizations told time by creating your own sundial. Compare your sundial to your watch to see how accurate it is!

TEKS:
2.5D Combine materials that when put together can do things that they cannot do by themselves, such as building a tower or a bridge, and justify the selection of those materials based on their physical properties.
3.6A Explore different forms of energy, including mechanical, light, sound, and heat/thermal in everyday life.

How To:
2. Cut out all templates along the edges.
3. Cut out the bottom of the face to create a notch, insert the red-triangle into the bottom of the face from the bottom, and glue it in place.
4. Glue the sides of the top and the bottom of the base, and fold in all the center tabs.
5. Fold the tabs around the edges of the bottom and the top of the face.
6. Cut out the inside of the thin red-edged rectangle in the middle of the top of the face, and place the top of the face over the bottom of the face to cover it (make sure the red triangle is sticking out).
7. Insert the face into the base, matching the shape of the face into the base opening. Match the “N” pointer on the base to the “12” on the face.
8. You are now ready to use your sundial!

Materials:
- Scissors
- Glue
- Top of face template
- Bottom of face template
- Gnomon template
- Top of base template
- Bottom of base template
- Angular adjustment sheets
- Directional compass
How Does It Work?

A sundial is a device that tells the time of day using the position of the sun. The red, triangular sheet sticking out of the surface of your sundial is called a gnomon. The shadow cast by the gnomon on a sundial indicates the time. The sundial you created is an example of a horizontal sundial. Place your sundial in a flat, horizontal location with good exposure to the sun. Place a compass next to the sundial to align the north, south, east, and west pointers on the sundial's base with those directions on your compass. The diagonal line created by the shadow of the gnomon indicates the time. Compare the time on your sundial with an actual clock and see how accurate it is!

Career Connection:

**Astronomers** study planets, moons, the Sun, stars, galaxies, meteors, comets and their interactions with each other. Heliologists focus on the study of the Sun, and the effects of the Sun on the Earth. They both must have an in depth knowledge of physics and mathematics in order to understand how forces work in space.

Resources:

Computer games, apps, and other devices store pictures by reducing them to numbers. Without reducing images into a grid, the file would be too large to store in memory. Create a paint-by-number image to explore how computers convert pictures into number grids.

TEKS:
126.32C The student understands technology concepts, systems, and operations as they apply to computer science.
126.48C6B The student demonstrates a sound understanding of technology concepts, systems, and operations, including graphics resolution, pixel depth, and compression.

How To:
1. Look at your copy of ‘Activity: Kid Fax’ sheet. On the side of each grid are numbers corresponding to the preceding line in the grid.
2. Each number represents a number of pixels, alternating between white and black. Each line ALWAYS begins with white!
3. Color in the grid line by line following the numbers on the side.
4. For example, a 2,1,3 line would correspond to 2 white pixels followed by 1 black pixel, followed by 3 more white pixels.
5. Fill in the ‘Kid Fax’ sheet following the numbers to discover the hidden pictures!
6. Create your own picture on the ‘Bonus’ sheet grid. Write the appropriate coded lines of numbers. Copy the lines of code to the blank grid on the bottom and give it to a friend to discover your picture!

Materials:
- Printed copy of ‘Kid Fax’ sheet (found at http://csunplugged.org/sites/default/files/activity_pdfs_full/unplugged-02-image_representation.pdf - page 4)
- Printed copy of ‘Bonus: Make Your Own’ sheet (found at http://csunplugged.org/sites/default/files/activity_pdfs_full/unplugged-02-image_representation.pdf - page 5)
- Pencils
How Does It Work?
Computers have to convert images into numbers in order to store them. Images are divided into grids and the pixels are stored with a corresponding string of numbers. In computers these numbers are all 0’s and 1’s in long, complex strings called binary code.

Career Connection:
Graphic designers create visual concepts using computer software to communicate ideas, information, and emotion. Graphic designers can work closely with advertising, public relations, website design, and even video game developers. Most graphic designers have a Bachelor’s degree in design or a related field, and additionally, develop a portfolio of their work.

Resources:
Jumping Jack Bugs

Explore the physical characteristics of a bee, dragonfly, or butterfly as you engineer a simple machine to make your insect’s wings move up and down as if it were flying.

TEKS:
2.5D Combine materials that when put together can do things that they cannot do by themselves, such as building a tower or a bridge, and justify the selection of those materials based on their physical properties.
3.6A Explore different forms of energy, including mechanical, light, sound, and heat/thermal in everyday life.
3.6B(ss) Demonstrate and observe how position and motion can be changed by pushing and pulling objects to show work being done, such as swings, balls, pulleys, and wagons.

How To:
1. Visit http://www.handmadecharlotte.com/diy-jumping-jack-bugs/ and follow the instructions to create your own jumping jack bug! You can either make a bee, butterfly, or dragonfly!
2. Now look at the different physical features of your bug. Do you know what qualities make it an insect? Read, the different characteristics of insects below.
3. Look at your bug move. Can you identify which type of simple machine is being used to make your bug move? Read about simple machines below.

Materials:
- Printable template (download here)
- Cereal box
- Toilet paper roll
- Yarn needle
- Strong thread or string
- Paint & brush (markers will work too)
- Scissors
- Glue
- Ruler
Why Does It Work?

Did you know that one million known species of insects exist, and every year more and more are discovered! There are two main types of insects, those with wings and those without. All insects are invertebrates, which means that they have no internal skeleton. Instead, they have a hard exterior body, also known as an exoskeleton. Their body consists of a head, a thorax (or middle section), and the abdomen. More characteristics of insects include antennae, six legs, and they are hatched from eggs. Many people think that spiders are insects, but they are actually arachnids, which are a different biological class of bugs. Arachnids have eight legs, while insects always have six legs.

The moving wings on your insect were constructed using a simple machine. There are six types of simple machines: pulley, lever, wedge, wheel and axle, inclined plane, and screw. All complex machines are composed of many different types of simple machines. These simple machines work together in order to make a large machine functional. For example, a wheelbarrow is an example of a complex machine. It’s long handles act as levers and the wheel it rolls on is a wheel and axle.

Career Connection:

Entomologists study insects. Entomologists have many important jobs, such as the study of classification, life cycle, distribution, physiology, behavior, ecology, and population dynamics of insects. Entomologists also study urban pests, forest pests, agricultural pests, and medical and veterinary pests and their control. These scientists may also work with beneficial insects like honeybees, silkworms, ladybird beetles, and parasitic wasps. Entomologists are researchers, teachers, consultants, and can work for private companies, universities, or government agencies.

Resources:

- [http://www.aboutbioscience.org/careers/entomologist](http://www.aboutbioscience.org/careers/entomologist)
Lava Flow

Have a blast exploring volcanic eruptions! Create your own volcano and watch the lava flow. Try this experiment several times and change variables to see if you can get different results.

TEKS:
3.3C Represent the natural world using models such as volcanoes or Sun, Earth, and Moon system and identify their limitations, including size, properties, and materials.
4.3C Represent the natural world using models such as rivers, stream tables, or fossils and identify their limitations, including accuracy and size.
3.7B Investigate rapid changes in Earth's surface such as volcanic eruptions, earthquakes, and landslides
5.5D Identify changes that can occur in the physical properties of the ingredients of solutions such as dissolving salt in water or adding lemon juice to water.

How To

Materials:
• 1 piece of copy paper
• Baking soda
• Crayons or markers
• Dish soap
• Flat tray or pan
• Red and yellow food coloring
• Scissors
• Spoon
• Tape
• Vinegar
• Vitamin jar or container of similar size

1. Cut a strip of copy paper in half lengthwise.
2. Form an open ended cone shape that is large enough to fit over the vitamin bottle. Make sure that the smaller opening (top of the cone) is large enough to fit your metal spoon through. Tape the ends of the paper to secure the cone shape. Trim the bottom of the cone so that it is straight and can stand up upright.
3. Decorate the cone so that it looks like a volcano.
4. Place the vitamin bottle on the tray with the cone over the top of the bottle.
5. Add two spoonfuls of baking powder.
6. Add about a spoonful of dish soap.
7. Add several drops of red and yellow food coloring.
8. Now that you are ready. Pour in about an ounce of vinegar.
9. Quickly set the lid of the container over the opening. Do not fasten it on the bottle.
10. Watch what happens!
Why Does it Work?

A volcano is produced over thousands of years as heat and pressure build up. A volcano consists of an opening, or a vent, through which magma and dissolved gases are released. Just underneath the Earth's crust is a layer called the mantle, which is made of up plates that are always moving and shifting. Sometimes the plates separate. That creates heat and causes the mantle to melt into magma. The magma comes up through the crack between the plates, and forms lava at the Earth’s surface. The lava spreads out, cools down, and becomes rock again.

How is this experiment like a volcanic eruption? This volcano model erupts due a chemical reaction between the baking soda and vinegar, and not due to heat and pressure as in a real volcano. Like some volcanoes, this model releases a gas (carbon dioxide) into the air and lava flows slowly over the sides of the vent to form a river or lake of lava. By placing the lid over the medicine bottle you can see how the force of the eruption pushes the lid away from the vent, allowing the lava to flow.

Career Connection:

A volcanologist studies the remains of either dead or dormant volcanoes and monitors currently present volcanoes that may be active. Volcanologists work to understand how and why volcanoes erupt, how to predict eruptions, the impacts of eruptions on Earth’s history and how eruptions affect humans and their environment.

Resources:
Dream Big

What better way to start the New Year than by thinking about your goals and dreams! When coming up with dreams and goals, we not only need to think big, but also think about the steps it will take to get there. Explore the exciting possibilities of your future as you make a puzzle to piece together your goals and dreams. Then, write a letter to yourself to remember your goals and dreams later on!

Materials:
- Puzzle template (attached to this activity)
- Scissors
- Paint pens/sharpies/markers/crayons
- Paper (cardstock or colored construction paper is best)
- Pencil

How To:
1. Start by looking inside yourself and think about your goals and dreams. Ask yourself these questions and jot down your answers on a piece of paper:
   - Can you think of any goals you set when you were younger? How have you achieved those goals?
   - What is your favorite subject in school? How could you apply that interest and excitement to a future career?
   - If you could be famous for one thing, what would it be?
   - What steps need to be taken to achieve the goals and dreams you have come up with?
2. Print out the puzzle attached to this activity (cardstock or thicker paper is best).
3. Cut out the 6 puzzle pieces.
4. Each puzzle piece represents a step in your education to get to your dream job. Label, color and decorate each puzzle piece following this guide:
   - Step 1: Elementary School
   - Step 2: Middle School
   - Step 3: High School
   - Step 4: College
   - Step 5: Graduate School/Professional Program
   - Step 6: Career
5. Now glue your puzzle pieces together onto another piece of paper. The glue that holds your puzzle together represents your family and friends who will support you through each step you take to achieve your goals and dreams.

6. Now write a letter about your hopes, dreams, and aspirations. You can either address it to your future self or talk about what you hope to have achieved by age 16, 25, or even 40. Or you can write it to yourself now, to remind yourself why you need to work hard every day in school. As you grow and change, so will your goals, and your letter can help you keep track of your changes.

7. Decorate your letter to represent your dreams.

8. Keep your letter and puzzle somewhere safe to look back on to remind you of your goals and dreams.

How Does It Work?

‘Piecing Together Our Dreams’ Puzzle

When you look at your puzzle, think about how each piece represents the education and goals you need to achieve your dreams. Some of us need more education than others or take different routes to accomplish our goals, but we all need support, such as friends and family, to achieve our goals. You need all these elements to achieve your dreams! Think about what education and support you need to achieve success.

Letter to Self

Did you know only 2% of people write down their goals? It is more likely you will accomplish your goals if you write them down! Writing down your goals can help you clarify what you want, help motivate your to take action, and allow you to celebrate your accomplishments! What are some things you need to know to be able to accomplish your dreams? What type of knowledge do you need to acquire? Where do you want to go to college?
31 Days of STEM Fun!

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