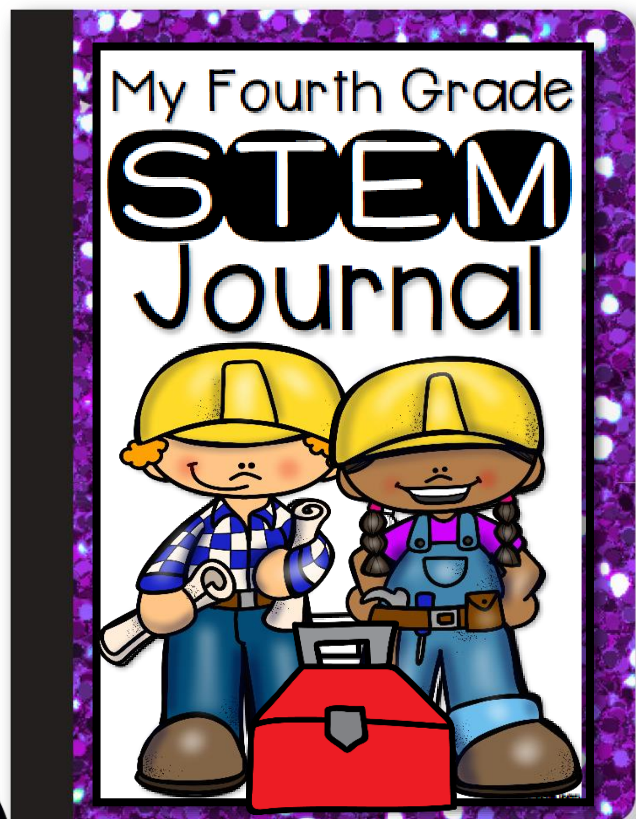
Fourth Grade STEM



by Brooke Brown

HOW TO USE

The following materials are designed specifically for fourth grade students and align with crosscutting NGSS science, engineering and math standards. Six challenges are provided to align with major NGSS content areas. Student booklets can be cut and glued into composition notebooks (main cover provided on Page 4) or can be used as stand alone booklets by copying front to back and folding in half. Suggested materials for each challenge are inexpensive and/or found in most early childhood classrooms. Parents can also be asked to donate needed supplies. Students are encouraged to work in partners or small groups. Each challenge should be allotted 45-60 minutes from start to finish, including a whole class discussion both before and after the challenge.

Each challenge in this package contains the following items:

*Challenge Description, Aligned NGSS Standards, Suggested Materials, and Detailed Lesson Plans

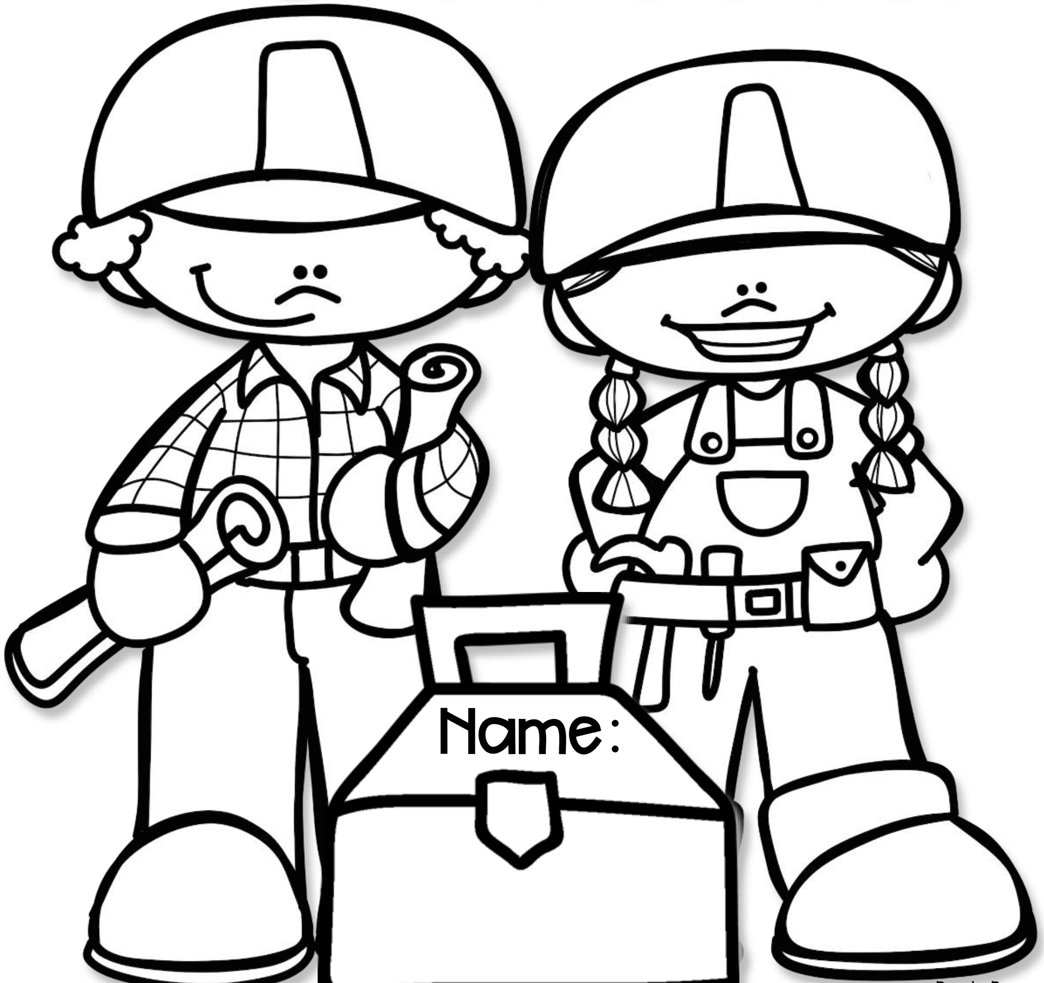
*Photos of possible student products

*Teacher Chart to guide whole class discussion for use on a document camera or interactive whiteboard

*Student booklet to record prior knowledge, ideas, observations, questions, materials, blueprints, and reflections

CONTENTS

My Fourth Grade STEM Journal



My Fourth Grade STEM Journal

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Pinball Machine

<u>NGSS Standard Alignment</u>: 4-PS3-1: Use evidence to construct an explanation relating the speed of an object to the energy of that object. 4-PS3-3: Ask questions and predict outcomes about the changes in energy that occur when objects collide. 3-5-ETS1-1: Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost. 3-5-ETS1-2: Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem. 3-5-ETS1-3: Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved. CCSS.MATH.CONTENT.5.OA.A.2: Write simple expressions that record calculations with numbers, and interpret numerical expressions without evaluating them.

Challenge Description: Students will construct a pinball machine using a box lid, a rubber band slingshot feature, and a variety of obstacles and traps. The rubber band slingshot should be stretched along the bottom edge of the box to shoot the marble into the "machine." Students can create a variety of obstacles and traps inside the box using cups, toothpicks, toilet paper rolls, holes, etc., and assign a specific point value to record on each area. As students play their machines and other groups' machines, they add up scores according to the point values. Students may also choose to elevate the box on the opposite end so that the ball flows freely from the back to the front.

Suggested Materials: Google images of pinball machines (projected or printed), box lids (office supply stores will often donate copy paper box lids), toothpicks, dixie cups/small cups, toilet paper rolls, rubber bands, marbles

LESSON PLAN

1. Have students define speed and energy on the first page of their student booklets using a dictionary or their own words. Prime students' background knowledge about pinball machines by projecting images and discussing the important features. You may also choose to show a short video of a machine in action. Discuss how the energy is transferred to the ball, how the speed of the ball changes throughout the game, and how the obstacles inside the machine affect the speed and energy when they collide with the ball. Discuss how a score in a pinball game is calculated based on which obstacles are struck with the ball. Record students' responses on the provided teacher chart and have them add ideas to their individual booklets.
2. Introduce permitted materials and share the challenge. Have students brainstorm possible ways to use the provided materials to construct a working pinball machine. Instruct them to assign/record point values for specific obstacles in their machine according to difficulty. Record their ideas on the teacher chart.
3. Allow students at least 45-60 minutes with partners or small groups to construct and test their pinball machines, as well as record in their individual student journals. If time permits, they can rotate around the classroom to play their classmates' machines.
4. Hold a whole class closing discussion and reflection, allowing students to share what they created and what they learned about speed and energy. Record their ideas on the provided teacher chart.

Pinball Machine
Possible Product

Pinball Machine

How is Speed Related to Energy?

How does Speed Change When Objects Collide?

Our Pinball Machine Design Ideas

What We Learned About Speed and Energy

How we constructed our Pinball Machine

How Speed and Energy are used in our Pinball Machine

Pinball Machine

Name:________________

THE CHALLENGE

Can you construct a working pinball machine?

What is ENERGY?

What is SPEED?

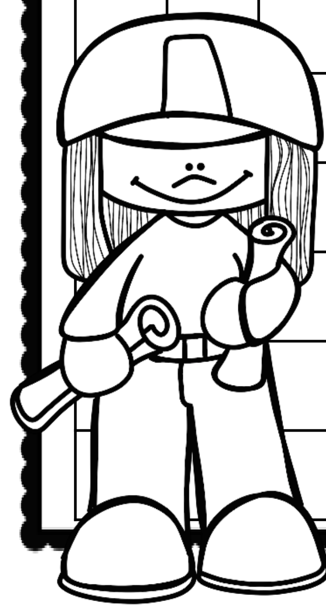
How is speed related to energy?

How does energy change when object collide?

What our pinball Machine Needs

Our Pinball Machine

Label the parts and point values.



Nifty Night Light

NGSS Standard Alignment: 4-PS3-2: Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents. 4-PS3-4: Apply scientific ideas to design, test, and refine a device that converts energy from one form to another. 3-5-ETS1-1: Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost. 3-5-ETS1-2: Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem. 3-5-ETS1-3: Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Challenge Description: Students will test and discover simple closed and open circuits using playdough, a battery pack, batteries, and LEDs. They will observe and discuss the transfer of electrical energy through conductive playdough and use it to construct a working "night light" with the LEDs. The plastic cup serves as a "shade" over their night light.

Suggested Materials: informational books about simple circuits/transfer of electric currents, playdough, LEDs, batteries, battery packs OR battery-operated Christmas lights with the wires cut (see photos of materials on page 11), clear plastic cups *****LEDs and battery packs are found at most electronics stores such as RadioShack and also on Amazon. I found battery operated Christmas lights for $1.99 per pack at Hobby Lobby and simply cut the wires. You can also find the materials at the following Amazon affiliate links:**

-LED Lights

-Battery-operated Christmas lights

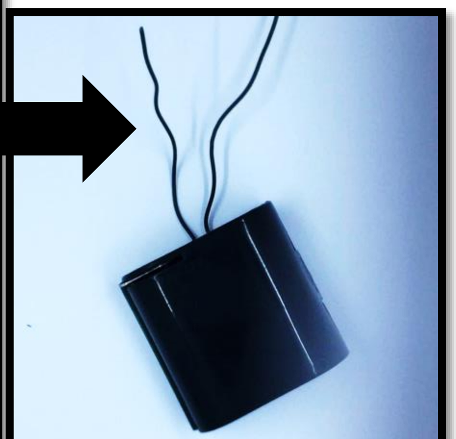
LESSON PLAN

1. Prime students' background knowledge about circuits and energy transfer by reading aloud an informational book of your choice. Discuss the difference between a closed circuit and an open circuit. A closed circuit is functional and has a complete path for an electrical current to flow, and an open circuit has an incomplete path and is not functional. Record their ideas and examples on the provided teacher chart and have them add ideas to their individual booklets.
2. Introduce permitted materials and share the challenge. Allow students to share ideas for how the materials work and might fit together in different ways to make the LEDs light up. Ask them to apply what they already know about closed circuits and open circuits.
3. Allow students at least 45 minutes with partners or small groups to follow the provided instructions in their student booklets, create and test circuit designs, and record in their STEM journals.
4. Hold a whole class closing discussion and reflection, allowing students to share what they created and what they learned about circuits and the transfer of energy. Brainstorm ways that these same concepts apply to tools and devices in our world. Record their ideas on the provided teacher chart and have them finish their individual booklets.

Nifty Night Light
Possible Product

Battery Operated
Christmas Lights

Cut Wires

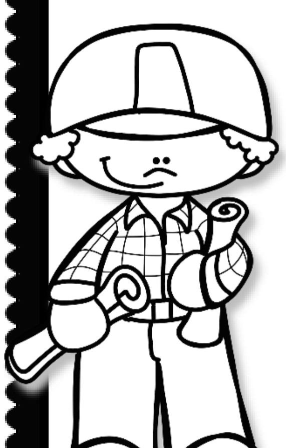


LEDs

Nifty Night Light

What is a Closed Circuit?	What is an Open Circuit?

How is Energy Transferred in Your Night light?	Tools and Devices That Require Circuits



Draw and label a diagram of an open circuit.

(Remove a piece from your closed circuit.)

Tools and Devices that Require Circuits

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Nifty Night Light

Name:______________

THE CHALLENGE

Can you construct a working night light?

What is a closed circuit?

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What is an open circuit?

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Ways That Energy is Transferred

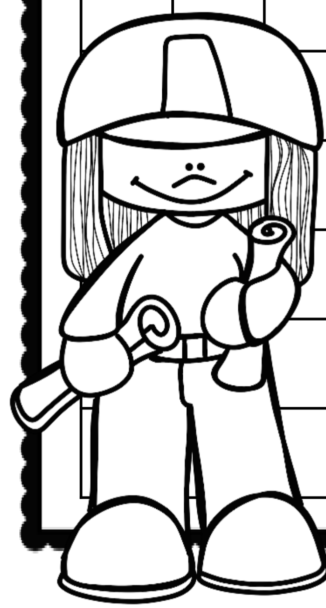
INSTRUCTIONS

<u>To create a SERIES CIRCUIT:</u>

1. Take two pieces of playdough.
2. Place a wire from the battery pack into each piece of dough. Make sure that the two dough pieces do not touch.
3. Place a wire from the LED light into each piece of dough.
4. If the LED does not light up, flip it around because LEDs only allow energy to flow in one direction.
5. Add your cup on top for a shade.

My Night Light

Don't forget to label the parts!



BRiCK bY BRiCK

<u>NGSS Standard Alignment</u>: **4-PS4-3: Generate and compare multiple solutions that use patterns to transfer information. 3-5-ETS1-1: Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost. 3-5-ETS1-2: Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem. 3-5-ETS1-3: Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.**

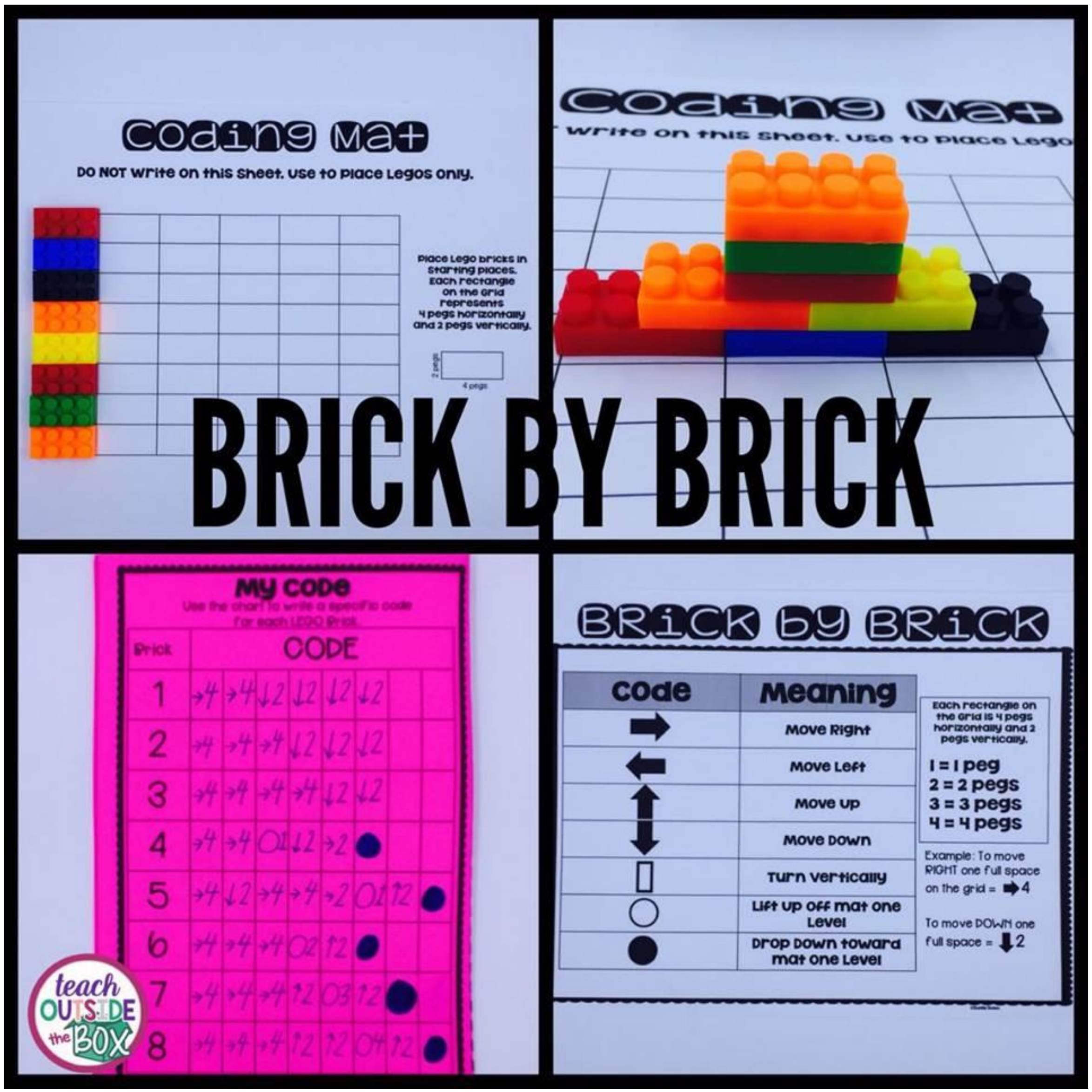
Challenge Description: Students will write a pattern or code that gives instructions for how to build a specific 8-brick LEGO structure. Placing their bricks on the coding mat on page 18, they will write a separate code for each of the 8 bricks inside their student journals to create a structure, then challenge classmates to follow their code to create the structure. Students will start with all 8 bricks placed flat (pegs facing up) in the starting rectangles on page 18. The code on page 19 shows students how to represent the different ways that their bricks will move. Note that students must always place a NUMBER (1-4) after their symbol to show how many pegs to move. One full grid space on the coding mat represents 4 pegs horizontally and 2 pegs vertically. **(SEE EXAMPLE ON PAGE 16 FOR A STRUCTURE AND MATCHING CODE.)**

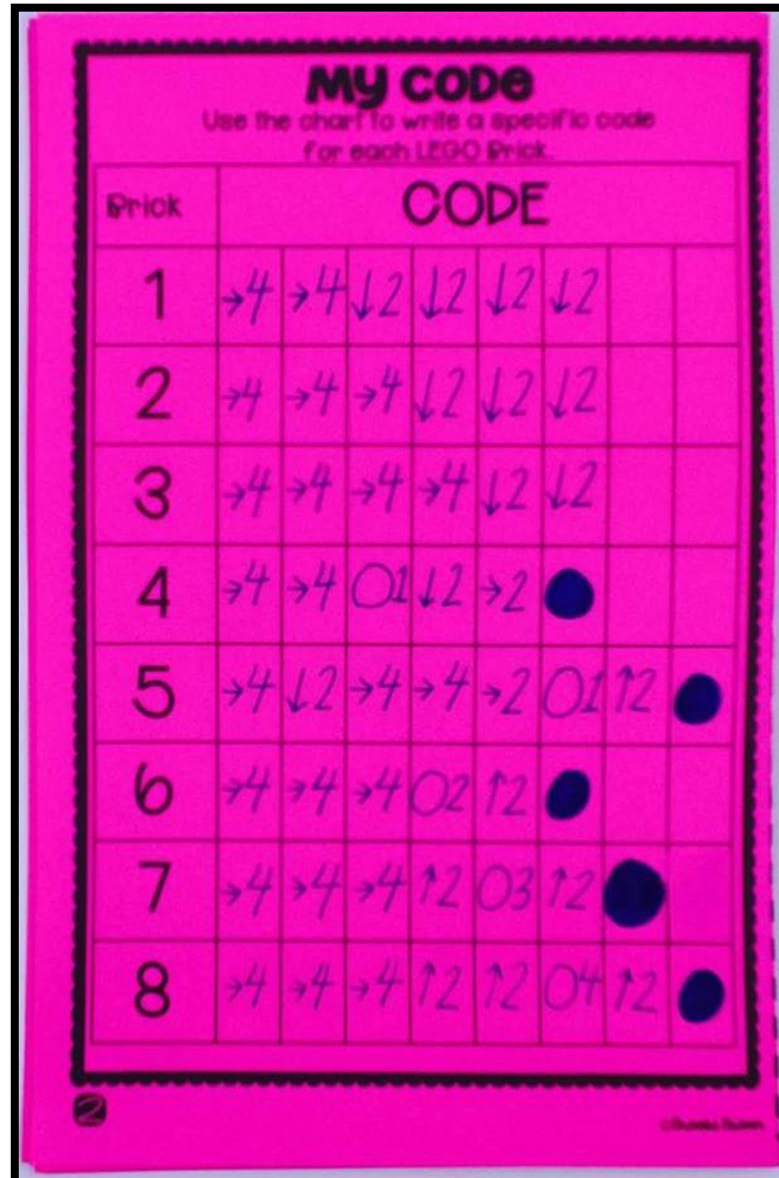
Suggested Materials: Coding mats for each group (page 18), coding sheet on page 18 (either projected or copied for each group), 8 LEGO bricks (8 pegs each) per student (Plastic building bricks can also found in Target party section.)

LESSON PLAN

1. Hold a discussion about different types of coding patterns that are used in our world, such as Morse code, binary code (1s and 0s) html code, etc. Have students brainstorm different ways that codes can be transmitted, such as through sound, light, text, or symbols. Record their ideas and examples on the provided teacher chart and have them add ideas to their individual booklets.
2. Introduce coding instructions to students and share the challenge. Model a simple LEGO structure and write a code as a class for how to build it.
3. Allow students at least 45 minutes with partners or small groups to follow the provided instructions in their student booklets, write codes, follow their classmates' codes and record in their STEM journals.
4. Hold a whole class closing discussion and reflection, allowing students to share what they created and what they learned about coding. Brainstorm ways that coding might apply to real life problems. Record their ideas on the provided teacher chart and have them finish their individual booklets.

Brick by Brick
Possible Product



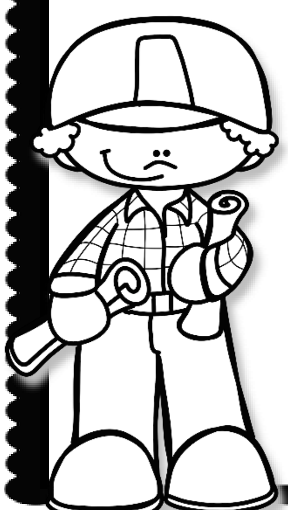


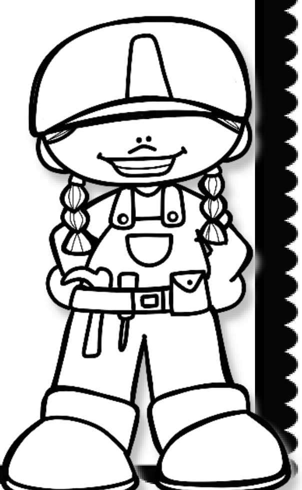
Brick by Brick

Types of Codes

How Codes Are Transmitted

Real World Uses for Coding



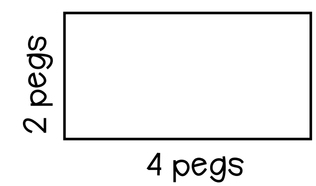


Coding Mat

DO NOT write on this sheet.
Build your structure FIRST.
Then, take it apart and place the Lego bricks in the starting places.
Beginning with Brick 1, write the coding instructions for each brick to rebuild your structure.

Brick 1 START					
Brick 2 START					
Brick 3 START					
Brick 4 START					
Brick 5 START					
Brick 6 START					
Brick 7 START					
Brick 8 START					

Each rectangle on the Grid represents 4 pegs horizontally and 2 pegs vertically.



Brick by Brick

Code	Meaning
→	Move Right
←	Move Left
↑	Move Up
↓	Move Down
▯	Turn Vertically
○	Lift Up off mat one Level
●	Drop Down toward mat one Level

Each rectangle on the Grid is 4 pegs horizontally and 2 pegs vertically.

1 = 1 peg
2 = 2 pegs
3 = 3 pegs
4 = 4 pegs

Example: To move RIGHT one full space on the grid = →4

To move DOWN one full space = ↓2

Draw your classmates' structures that you created.

Real World Uses for Coding

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Brick by Brick

Name:_______________

THE CHALLENGE

Can you write a code to show the steps for building a LEGO structure?

Types of Codes

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Ways that codes are Transmitted

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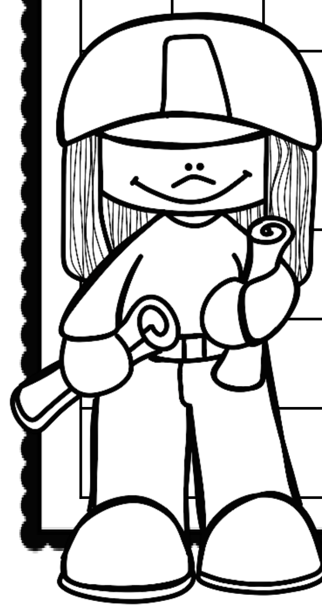
My Code

Use the chart to write a specific code for each LEGO Brick.

Brick	CODE							
1								
2								
3								
4								
5								
6								
7								
8								

My LEGO Structure

Draw your completed 8-brick structure.



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Map a Mountain

NGSS Standard Alignment: 4-ESS2-2: Analyze and interpret data from maps to describe patterns of Earth's features. 3-5-ETS1-1: Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost. 3-5-ETS1-2: Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem. 3-5-ETS1-3: Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Challenge Description: Students will construct a model of a mountain out of playdough or model magic, then create a topographic map of the mountain by slicing it into layers with dental floss and tracing each piece. They will also color their map according to a key.

Suggested Materials: Google images of topographic maps, small paper plates, playdough or model magic, dental floss, copies of map template on page 27 for each group

LESSON PLAN

1. Introduce topographic maps to students by showing them the video on the following website: http://study.com/academy/lesson/how-to-read-topographic-and-geologic-maps.html (There is also a transcript of the video on this website if you would rather print it for students to read and discuss.)
2. Project Google images of topographic maps, preferably ones that are specific to your state or region. www.topozone.com is an excellent website to search for specific regions and landforms in your state. Have students locate and discuss points of high and low elevation on the maps and record them on the teacher chart as they follow along in their student booklets.
3. Have students record the following definitions in their individual booklets as you record them on the teacher chart.

    Topographic map: a type of map that shows elevation (the altitude of a place above sea level)

    Contour lines: lines that connect points of equal elevation

    Explain that contour lines that are close together represent steeper slopes while lines that are spaced apart represent gentler slopes.

4. Introduce permitted materials and share the challenge. Allow students 45-60 to construct their mountains and follow the instructions in their students booklets to map their mountains. You may wish to model how to slice a layer of the mountain using the dental floss so that students better understand the procedure.
5. Hold a whole class closing discussion and reflection, allowing students to share what they created and what they learned about topography. Allow students to research regional topography if needed and complete their student booklets.

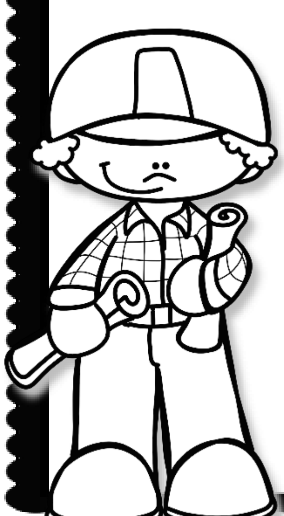
Map a Mountain

Map a Mountain

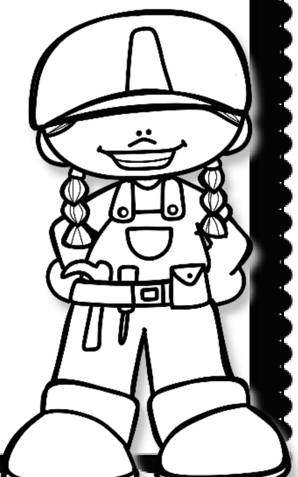
What is a Topographic Map?

What are Contour Lines?

Points of High Elevation in My State or Region



Points of Low Elevation in My State or Region



Points of Low Elevation in My State or Region

Points of HIGH Elevation in My State or Region

Map a Mountain

Name:________________

THE CHALLENGE

Can you create a topographic map of a mountain model?

What is a topographic map?

What are contour lines?

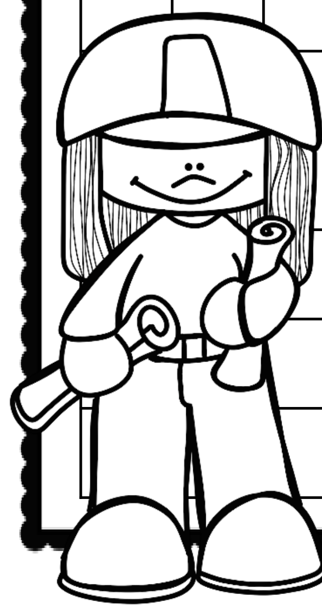
How Topographic Maps Might be Useful

INSTRUCTIONS

1. Construct a mountain out of playdough on top of your paper plate.
2. Move the mountain to your "Map a Mountain" paper and carefully trace around the outer bottom edge with your pencil.
3. Take a piece of dental floss and place it about a third of the way from the bottom of your mountain. It will help if one partner holds the floss while the other holds the mountain. Slice through the mountain horizontally and remove the bottom section.
4. Place the remaining dough sections in the middle of your first drawing and trace around the bottom edge again.
5. Take the dental floss and slice through about half the remaining dough so that only the peak of the mountain remains.
6. Place the peak in the center of your map and trace around the edges.
7. You should have drawn a set of three contour lines that match the elevations of your mountain.
8. Color your map and key with different colors to show the different elevations.

My Mountain

Draw a simple sketch of your mountain from a front-facing view.



Map a Mountain

MAP KEY

	= Lowest point of Elevation (Sea Level)
	= Middle point of Elevation
	= Highest point of Elevation (Peak)

SOLAR SNACK

<u>NGSS Standard Alignment</u>: 4-ESS3-2: Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment. 4-PS3-4: Apply scientific ideas to design, test, and refine a device that converts energy from one form to another. 3-5-ETS1-1: Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost. 3-5-ETS1-2: Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem. 3-5-ETS1-3: Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Challenge Description: Students will construct a solar oven out of a pizza box that allows them to "cook" a simple snack using heat and sunlight.

Suggested Materials: small empty pizza boxes, scissors (or sharp knife **for teacher use only**), aluminum foil, plastic wrap, scotch tape, black construction paper, newspaper, marker to prop up box, paper plates
For mini pizzas: bagels sliced in half, shredded mozzarella cheese, pepperoni
For nachos: tortilla chips, shredded Mexican blend cheese.

LESSON PLAN

1. Introduce solar power by showing the following Bill Nye video clip to students: http://viewpure.com/av24fEMhDoU?ref=search
2. Hold a discussion about the possibilities for solar power and record student ideas on the included teacher chart. Have them record ideas in their student booklets.
3. Ask students to brainstorm ways that we can cook food without a microwave, stove, or oven.
4. Introduce permitted materials and share the challenge instructions.
5. Allow students at least 45-60 minutes with partners or small groups to follow the instructions in their student booklets and create their solar ovens.
6. Allow students to test their designs by "cooking" a snack outside during the day (either mini bagel pizzas or nachos).
7. Hold a whole class closing discussion and reflection, allowing students to share what they learned about solar energy and finish recording in their student booklets.

SOLAR SNACK

Possible Product

Solar Snack

How Does Solar Power Work?

Why is Solar Power a valuable source of energy?

Things That can Be Solar-Powered

How My Solar Snack Oven Works

Things that can be solar-powered

How My Solar Oven Works

SOLAR SNACK

Name:______________

THE CHALLENGE

Can you construct an oven that uses solar power to cook a snack?

How Does Solar Power Work?

Why is solar power a valuable source of Energy?

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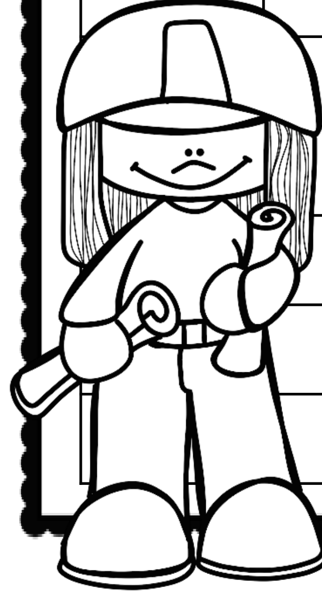
INSTRUCTIONS

1. Use scissors to cut a flap in the lid of the box. Leave about one inch between the flap and the edges of the lid.
2. Cover the inside of the flap by taping it with aluminum foil. This will allow the lid to reflect rays from the sun.
3. Tape clear plastic wrap across the opening in the flap you cut on the top section of the box. Try to tape it tightly to seal out all the air.
4. Put black construction paper in the bottom of the box. The color black will help to absorb more heat.
5. Roll up 4 sheets of newspaper around the bottom edges of the box to keep the box more insulated.
6. Place your snack on a paper plate inside the box during afternoon hours, usually between 11:00AM and 4:00PM.
7. Prop the flap on the lid open with a marker and place the box where the most amount of sunlight is reflecting off of the aluminum foil onto the plastic wrap.

My Solar Oven

Don't forget to label all the important parts and their functions.



Shaky Structure

<u>NGSS Standard Alignment</u>: 4-ESS3-2: Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans. 3-5-ETS1-1: Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost. 3-5-ETS1-2: Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem. 3-5-ETS1-3: Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
Challenge Description: Students will choose from a variety of materials to design a model of a home that will best withstand an earthquake simulation. After the home is constructed, they will test the stability and balance of the home by pounding on and shaking the table to observe the impact.
Suggested Materials: Informational books about earthquakes **Choices for house construction**: cardstock or construction paper, popsicle sticks, straws, uncooked spaghetti, plastic cups, playdough, scotch tape, masking tape

LESSON PLAN

1. Prime students' background knowledge about earthquakes by reading aloud an informational book of your choice. If possible, show the following video about earthquakes: http://pbskids.org/dragonflytv/show/earthquakes.html
2. Hold a class discussion about the causes and impacts of earthquakes. Record student ideas on the provided teacher chart and have them record in their student journals.
3. Introduce permitted materials and share the challenge instructions. Allow students 45-60 minutes for students to choose materials, create their house models, test by pounding and shaking the table, improve their models, and record in their STEM journals.
4. Hold a whole class closing discussion and reflection, allowing students to share what they learned about the impact of earthquakes. Record their ideas on the provided teacher chart and have them finish their individual booklets.

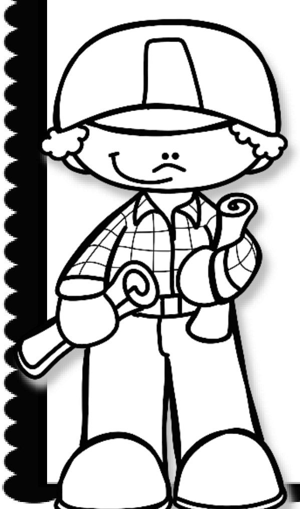
Shaky Structure
Possible Product

Shaky Structure

What causes Earthquakes?

What can be impacted by Earthquakes?

Ideas for Earthquake-proof Structures



If you could build an earthquake-proof house in real life, what building materials would you use and why? Draw a picture of your house and label the parts. Then describe the features of your house that would keep it as stable and balanced as possible during an earthquake.

Shaky Structure

Name:________________

THE CHALLENGE

Can you construct a model of a house that will withstand an earthquake simulation?

What causes Earthquakes?

What can be impacted by Earthquakes?

TEST 1

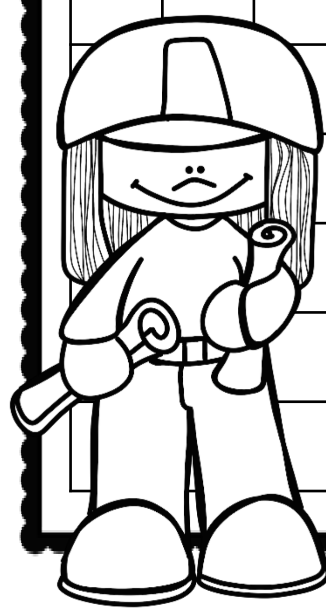
Impact (10 seconds per test)	What Happened
Pounding the table gently	
Pounding the table harder	
Pulling and pushing the table	

My Improvements

TEST 2

Impact (10 seconds per test)	What Happened
Pounding the table gently	
Pounding the table harder	
Pulling and pushing the table	

My Earthquake-Proof House



Credits

Thank you for your purchase!

Created by Brooke Brown

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EDUCLIPS DESIGN Dream it. Wish it. Do it.

https://sites.google.com/site/climatetypes

i teach. WHAT'S YOUR SUPER POWER?