

4th Grade STEM DESIGN CHALLENGE

CORRESPONDING ENGINEERING DESIGN PROCESS STAGE IN RED

Unit 5: Investigating Circuits

Topic: Design a Light-up Greeting Card

Subject/ grade level: STEM/ Grade 4

Materials:

For each team of 2 students

- Design logs
- Card stock
- Two brass fasteners
- A paper clip
- Clear tape
- Scissors
- 1 LED (3 volt) light, per team
- 1 Coin battery (CR 2032)
- A variety of art supplies to artistically design the card (markers, glue, construction paper, glitter, etc.)
- Optional: copper tape to make more elaborate cards
- “Electrical Power Survey” handout
- 21 Century Skills rubric for grading project
- Websites:
 - <http://tinkering.exploratorium.edu/paper-circuits>
 - <http://www.learningcircuits.co.uk/flashmain.htm>
 - <http://www.andythelwell.com/blobz/guide.html>
 - http://www.bbc.co.uk/schools/scienceclips/ages/6_7/electricity_fs.shtml
 - http://www.bbc.co.uk/schools/scienceclips/ages/8_9/circuits_conductors_fs.shtml
 - <http://www.educationandsafety.com/shared/Louies/games/hazards.html>
 - http://www.bbc.co.uk/schools/scienceclips/ages/10_11/changing_circuits_fs.shtml
 - <http://vimeo.com/36388753#at=0>
 - <http://www.instructables.com/id/Fun-circuits-with-conductive-paint/>
 - <http://tinkering.exploratorium.edu/tinkering/2013/10/22/choose-your-own-adventure-circuit#.U2EABvldXnj>
 - <http://hideousdreadfulstinky.com/2013/12/l-e-d-reindeer-greeting-card.html>
 - <http://www.evilmadscientist.com/2008/edge-lit-holiday-cards/>
 - <http://makezine.com/projects/led-pop-up-cards/>

(Teacher Note: copper tape can be bought at any hardware store and is also called “slug” or “snail” tape)

TEKS

Science

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

*SCI 4.6C Demonstrate that electricity travels in a closed path, creating an electrical circuit, and explore an electromagnetic field.

Math



MATH 4.1A Apply mathematics to problems arising in everyday life, society, and the workplace.



MATH 4.1E Create and use representations to organize, record, and communicate mathematical ideas.

4th Grade STEM DESIGN CHALLENGE

CORRESPONDING ENGINEERING DESIGN PROCESS STAGE IN RED

ELPS

C3D Speak using grade-level content area vocabulary in context to internalize new English words and build academic language proficiency

C3E Share information in cooperative group interactions.

CCRS

Science

8I2B Describe the concept of electrical charge

4A1A Recognize how scientific discoveries are connected to technological innovations.

Math

6B2A Organize and construct graphical displays of data (e.g., line plots, bar graphs, histograms, box plots, scatter plots) to describe the distribution of data.

6B2B Read and interpret graphical displays of data.

Cross-Disciplinary

1C1C Apply previously learned knowledge to new situations.

1E2C Work in small groups to investigate a problem or conduct an experiment.

Lesson objective(s):

Students will use what they have learned about electric circuits and apply that information to the design of a light-up card.

Differentiation strategies to meet diverse learner needs:

In all stages, the teacher can

- Model what students are expected to do.
- Demonstrate how new information relates to previously learned information for students.
- Require verbal responses from students to monitor/demonstrate comprehension.

IDENTIFY THE NEED



Working in teams of 2, let students play with and explore how the materials work on their own. Give the teams 1) the LED light and 2) a battery without any explanation and challenge them to make the LED light up.

After students have experimented and completed the task, ask them to verbally describe how they got the LED to light up in their teams. (*The LED only lights up if the long wire of the LED makes contact with the positive side of the battery, while the short wire should match up with the negative side of the battery to complete the circuit.**)

Next, share with students the details of the design challenge below.

Design Challenge:

Working in teams of 2, students will design a greeting card (e.g., a thank-you or birthday card, etc.) that lights up. They will give this card to a staff member on the campus (only one card per staff member, so students will have to be thoughtful and in agreement about whom they will make their card for (e.g., a previous teacher, a teacher aide, a custodial staff member, etc.). Students will also be expected to explain how it works to the card's recipient.

(Teacher Note: Instead of giving students a choice, the teacher could instead use this design challenge as a holiday

4th Grade STEM DESIGN CHALLENGE

CORRESPONDING ENGINEERING DESIGN PROCESS STAGE IN RED

project. In this manner, it becomes a way to combine art and holiday festivities with the teaching of content.)

Differentiation:

Show students a website like those that follow to give them ideas for possible designs (although they will not solder or use multiple LEDs as in some depicted).

<http://tinkering.exploratorium.edu/paper-circuits>

Formative Assessment :

Following a Q & A class discussion about the design task, have students as a team decide what the theme of their card will be and who will receive it. This information should then be written into their design logs in a format similar to the one that follows:

Card Design Task Analysis		
What is the theme of our product?	Who are we designing for?	Why did we choose this person?

*Sometimes through an error in the manufacturing process, the wire leads on a LED will be reversed; alert students who experience this.

RESEARCH THE PROBLEM

Websites for kid-friendly research:

Excellent interactive games to review, reinforce, and extend student knowledge of circuits can be found here.

Resource #1- <http://www.learningcircuits.co.uk/flashmain.htm> (team-friendly website)

Resource #2- <http://www.andythelwell.com/blobz/guide.html> (team-friendly website)

Resource #3- http://www.bbc.co.uk/schools/scienceclips/ages/6_7/electricity_fs.shtml

Differentiation:

For students who need extra practice, this website provides a good review of conductors and insulators.

Resource #4- http://www.bbc.co.uk/schools/scienceclips/ages/8_9/circuits_conductors_fs.shtml

This is a fun game for kids to review electrical safety around the home.

Resource #5- <http://www.educationandsafety.com/shared/Louies/games/hazards.html>

Math Connection:

Have students complete the “Electrical Power Survey” handout and then turn the collected data into bar graphs.

Students can also write questions about the 5 bar graphs in their design logs for others to answer to demonstrate their ability to interpret the data depicted.

Extension:

This website is a great resource to teach students about electrical diagramming. It has great visuals and explanations!

Resource #6- http://www.bbc.co.uk/schools/scienceclips/ages/10_11/changing_circuits_fs.shtml

Formative Assessment:

Using the following “Look Back” technique and the resources listed above, students will recount what they have learned over this research stage. (**Teacher Note:** It is important to model for students how to use this technique by

4th Grade STEM DESIGN CHALLENGE

CORRESPONDING ENGINEERING DESIGN PROCESS STAGE IN RED

doing one example with the whole class prior to assigning this task.)

Look Back	
What I Learned	Where I Learned It

Differentiation:

For students that need extra support, the teacher can make the “Look Back” template above into a handout.

DEVELOP POSSIBLE SOLUTIONS

Teams will watch this short kid-friendly video on how to create a switch.

<http://vimeo.com/36388753#at=0>. Teams will then make their switch with the following materials and directions:

Materials:

2 paper fasteners, Card stock (thin cardboard), a paper clip, tape, scissors, an LED light, and a coin battery.

General Directions:

1. Push the two leads of the LED through the cardstock and bend them down in opposite directions so they don't touch.
2. Push each fastener through the cardstock, each close to one of the LED leads, and no further apart than the paperclip.
3. Tape the long lead of the LED to the + side of the coin battery. Tape the LED lead / coin battery to one leg of a fastener.
4. Tape the short LED lead to one leg of the other fastener.

Teams will build and then test to make sure their LED lights up. *(When the paper clip is connected, the switch is considered to be “on” and completes the circuit.)*

Formative Assessment:

Have teams complete a “Justified T/F” chart like the one that follows into their design logs to show their understanding of why their switch works.

Justified T/F Chart			
Statement	T	F	Why We Think So
It does not matter what side the battery is on to complete the circuit.		X	<i>(Positive lead must touch positive battery side)</i>
Paper fasteners must touch only other paper fasteners for the LED to light up.		X	<i>(Must touch LED and battery, too)</i>
The paper clip serves as the switch	X		

4th Grade STEM DESIGN CHALLENGE

CORRESPONDING ENGINEERING DESIGN PROCESS STAGE IN RED

Differentiation:

For students that need extra support, the teacher can make the “Justified T/F” template above into a handout.

SELECT THE MOST PROMISING SOLUTION

Using the switch made in the previous stage as a basic format for their circuit, teams will create two outside cover designs for their card that utilize a circuit. (**Teacher Note:** Teams can depict their chosen staff member’s favorite hobbies or interests to display on the card, their roles on the campus, or come up with other illustrations related to their chosen theme.)

In their design logs, each member of the team will complete 1 possible design for the card using either words or drawings. Details must be labeled in the drawings or described in the written explanation, depending on which method they chose.

Differentiation:

For those who might have difficulty drawing, the teacher can allow students to use cutouts found in magazines to make a collage, or use other artistic means besides drawing to design the card (e.g., tissue paper art).

Formative Assessment:

Students will come together and discuss their two designs and make a decision about the one they will build. The main goal is for students to sharpen their decision-making skills by making a choice between two designs, reaching consensus, and adequately justifying their final choice. Their chosen design and why they chose it should be documented in each team member’s design log.

Extension:

Students can be required to include both a design sketch and a written description in their log, if desired. As an added level of complexity, advanced students can also be encouraged to make an electrical diagram, using the correct symbols as depicted in videos from the research stage, into their design log.

CONSTRUCT A PROTOTYPE

Students will use art and engineering as well as all materials and tools necessary to build their chosen light-up card.

Differentiation (see image):

Electrical paints are available now and can be used instead of paper fasteners for students that are struggling with building their circuit. This option can add more cost to this design challenge, however, and may significantly reduce the complexity of the evaluation of the final product. Remember, evaluating each team’s ability to setup a working circuit is an important outcome of this project. See the following link for more information about this adaptation:

<http://www.instructables.com/id/Fun-circuits-with-conductive-paint/>

Formative Assessment:

The end-product should incorporate the switch to light up the one LED, a thoughtful note inside addressed to the recipient, and student-created artwork on the cover that is neat and pleasing to the eye.

Extension:

Encourage students to come up with ideas on their own for incorporating the fasteners and the LED into the art image in creative ways. For example, the LED could be the light at the top of a Christmas tree, or the flame at the



4th Grade STEM DESIGN CHALLENGE

CORRESPONDING ENGINEERING DESIGN PROCESS STAGE IN RED

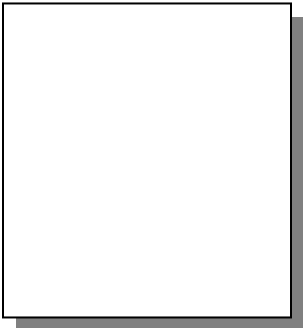
top of a candle while a fastener's typically brass prong cover could be incorporated into a picture of bells.

TEST AND EVALUATE THE PROTOTYPE

Students will conduct tests to make sure their LED consistently lights up when the switch is connected and make sure all of the complete circuit is connected and securely taped to the card. Once the card is complete and is shown to be electronically sound, teams will evaluate their final product.

Formative Assessment:

In their design logs, students should copy the following evaluation template and fill in the areas for the good points of their design and for its improvement. A hand drawn picture of their final card product should also be included.

Evaluation		
Good Points	Picture of Final Product	Improvements
		

Differentiation:

For students that need extra support, the teacher can make the "Evaluation" template into a handout for students.

Extension:

Have students take a digital picture of their card and print it out to include it in the middle of the evaluation template.

COMMUNICATE THEIR DESIGN

Students will give the completed card to the intended recipient on campus and communicate their design process to that person.

(Teacher Note: The teacher should notify the recipient *ahead of time* about the meet up, so that campus personnel will expect the students, and will be patient and courteous with them as they explain their design product.

Formative Assessment:

When teams give their card to its recipient, the team should share the following information with its recipient. Have them compose and finalize the information to share in their design logs before the meet up.

1. How they thought of and decided upon the design.
2. The materials used and steps they took to make it.
3. How it works and why.

4th Grade STEM DESIGN CHALLENGE

CORRESPONDING ENGINEERING DESIGN PROCESS STAGE IN RED

REDESIGN

Students should brainstorm an idea for a redesigned card. There are many redesign ideas for students to choose from! Here are just a few to explore.

1. Push switch design: <http://tinkering.exploratorium.edu/tinkering/2013/10/22/choose-your-own-adventure-circuit#.U2EABvldXnj>
2. Copper tape design: <http://hideousdreadfulstinky.com/2013/12/l-e-d-reindeer-greeting-card.html>
3. Pop-up card design: <http://makezine.com/projects/led-pop-up-cards/>
4. Edge-lit card design: <http://www.evilmadscientist.com/2008/edge-lit-holiday-cards/>
5. Slider design <http://hideousdreadfulstinky.com/2013/12/l-e-d-reindeer-greeting-card.html>

Formative Assessment:

Students will not build this redesigned card, but optimizing, improving, and adapting designs to new criteria requires students to be flexible thinkers, an important 21st century skill. Have students explore the resources in the list above, discuss each idea in teams and then share out the one redesign idea they liked best with the class.

Differentiation:

The teacher could break students into groups according to the 5 options listed above and have these newly-formed teams research only 1 of the redesign websites to share with the class, 1) how the circuit is completed in the new design, and also 2) a redesigned card idea of their own creation that incorporates the new innovation.

Extension:

Groups could write a description and sketch of their favorite redesign idea in a poster display to share with the class.