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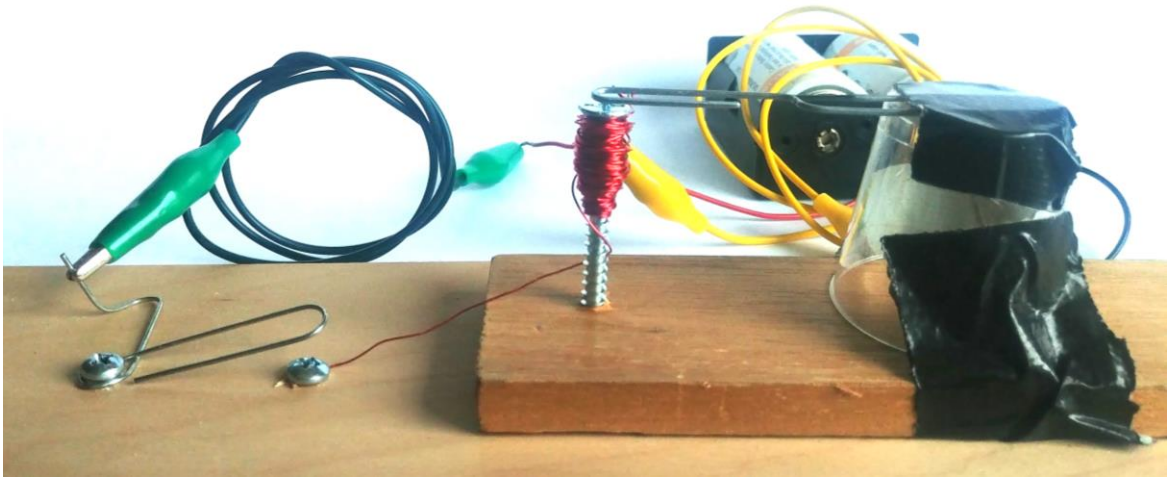
COREY BAKER

Investigating Distance Communication to Become a Great Engineer

STEM Lesson Plan for Grades 6-8



Helping all students, especially people who are underrepresented, to be interested in engineering as a possible future can be challenging. Research suggests that role models are important for helping students to see themselves in a jobs where they have been underrepresented. In addition, having challenging and fun engineering experiences help students to want to become engineers.

Many engineering projects though are focused on competitions, but that isn't the essence of engineering. The cycle of determining a problem, identifying what's needed to solve the problem, trying and testing possible solutions, and optimizing and iterating to find an adequate solution is what makes an engineering project.

In this lesson plan, students will watch a video where Corey Baker explains how he became a successful engineer. After figuring out what he says are some key factors to being a great engineer, the students will make a telegraph. By devising a method to use the telegraph, students will improve their understanding of digital communication.

NGSS Standards
CCC: Structure and Function
ETS1.A: Defining and Delimiting Engineering Problems
ETS1.B: Developing Possible Solutions
ETS1.C: Optimizing the Design

Part I: Watching the Corey Baker Video

Before the students watch the video, the teacher should explain that in this video an engineer will explain what makes him a successful engineer. The teacher should ask students to record what personality traits, desires, and behaviors are important to becoming an engineer.

For younger students, you may need to use sentence starters like

Corey Baker said that he had to overcome the obstacles of _____
Corey Baker said that he wants to _____

The video has on-screen icons that will help students when he is saying key components of her success. For some students, pausing the video at those moments will help them better record what is going on.

In small groups have the students summarize what they saw and then make sure that the entire class has all of the points. While they may have more than these, they should at least note:

- Corey Baker succeeded as an engineer because of his career path.
- Corey Baker helps other to be successful engineers through mentorship.
- Corey Baker likes engineering because he wants to help others.

Making a Great Engineer Checklist

Students now should now make a checklist of things for themselves to do if they want to be a good engineer. Then when they do something on the checklist, they should mark it off. For example

Activity	
I helped someone	𝍸 I
I didn't give up when something didn't go the way I planned	𝍸 II

Students will use this checklist several times in the following projects. Don't assign points or give too much praise, otherwise students will just game the system. We just want them noting when they are doing something a good engineer does, helping them to internalize that they can be an engineer. Alternatively, you can make it the task of one of the members of the group to note when their groupmates are being good engineers.

Part II: Engineering Cycle

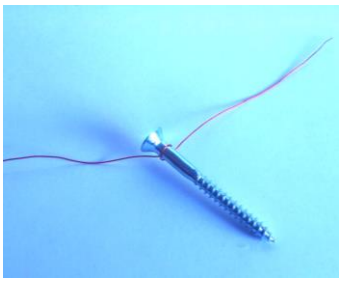
Communications have become an essential part of modern life. In this activity, students will make a simple telegraph, then they will examine other communication methods that might be used in an emergency.

Materials

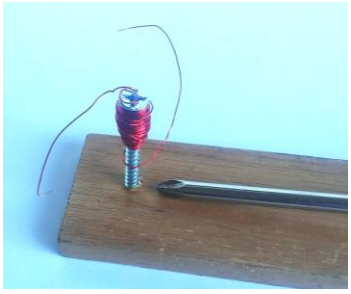
- 50 feet 22-gauge or similar magnet wire
- Approximately 2 inch x 2 inch piece of sandpaper
- 1 Steel #10 wood screw approximately 2 inches long and 2 ½-inch #10 pan head screws
- Screwdriver
- 2 small wooden board approximately 3 inches x 3 inches x ¾ inch or similar
- Small plastic cup
- 2 D-cell batteries and battery holder
- 2 large paper clips (no coating)
- Duct tape
- 4 test leads with alligator clips
- Small speaker
- 50 feet speaker wire or lamp cord
- Large spool of magnet wire
- Wire strippers
- Scissors

Assembly

1. Use the sandpaper to scrape the varnish off 1 inch of each end of the magnet wire.
2. Leaving approximately 4 inches hanging off, wrap the magnet wire around the smooth part of the steel wood screw. Tidiness helps but you don't have to be a fanatic about it. Keep wrapping until about 6 inches remain.



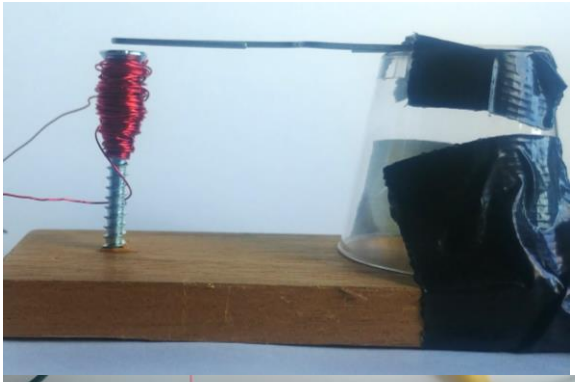

3. Screw the tip of the screw into the board until it stands on its own.

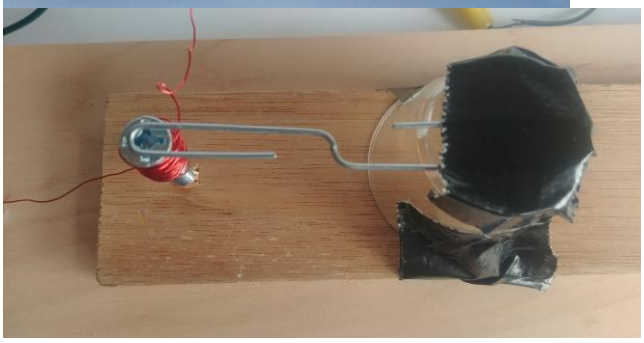


4. Unbend the paper clip until it makes a large S. Tape one end to the top of the cup.

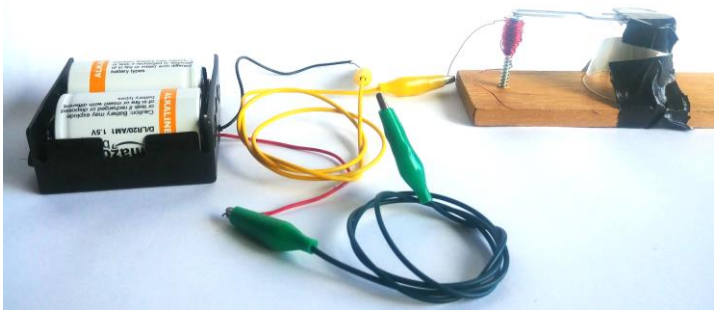
5. Bend the other end of the paper clip so that it is aligned just above the screw head but not touching it.

6. Tape the cup to the board. Adjust the bend in the paper clip.





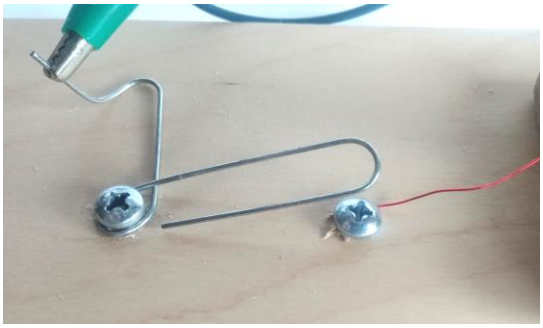
7. Insert the D-cells into the battery holder. Connect one alligator clip between one battery terminal and one of the ends of the magnet wire.
8. To test to make sure the electromagnet works, connect one end of another alligator clip to the other end of the magnet wire. Touch it to the exposed wire on the battery holder. The paper clip should bend down and make a click. Don't hold the connection for a long time. The wires can get hot and burn. It will also use up the energy in the battery. Disconnect this alligator clip.



9. Bend the other clip as shown in the picture.

10. Using the panhead screw, attach the paper clip to the wood.

11. Twist the free end of the magnet wire around the other panhead screw. Attach it to the board so that when the paper clip is pressed down it connects with the screw.
12. Connect the alligator clip between the free wire on the battery holder to paperclip key.



Using the Telegraph

A single telegraph can be used to send a signal to a distant location since a press of the key here can lead to a click there. However, it isn't obvious what a keypress should indicate. Ask students to develop a system for transmitting a short phrase. A common method translates every letter into a number from 1 to 26. Students might discover that this system is cumbersome, and how should it handle numbers. Allow students to work out a method that works well for them and have them share the system with their classmates, explaining its virtues.

Some students might recall Morse Code. An early system was International Morse Code (appended at the end) which used lengths of clicks to determine information. Morse code is an example of digital communication, although it isn't binary. Analog information is a signal that is continuous. In principle, it can have any value within certain boundaries. Digital information is discrete and can only have certain values. Techniques that send information based on the amplitude (size) of the wave are typically analog, while techniques that use the number of waves to determine the information are digital. Morse Code is a trinary system with three possible positions: off, dot, and dash.

Modern computers use one of many binary system with only two possible signals: on and off. An example, ASCII encoding, is appended at the end. Many students will notice that only the last four digits are needed to encode just letters. Binary system can be difficult to use, though. For example, if an encoding starts with a zero, how can that be separated from just space between letters? How do you know when one letter starts and another letter ends?

Ask students to send a short message using their telegraph. You might have them start with a lyric from a song that they know, then move onto a random line from their textbooks, and then a random group of letters, say the third letter from the first word of each row of text from a random page. They are likely to discover that it is easier to recognize things that they know.

These systems are called protocols and are one of the most important parts of computer systems. Ambiguous or flawed protocols can impede communication but overly complex systems can slow communication to a crawl.

Part III: Evaluation

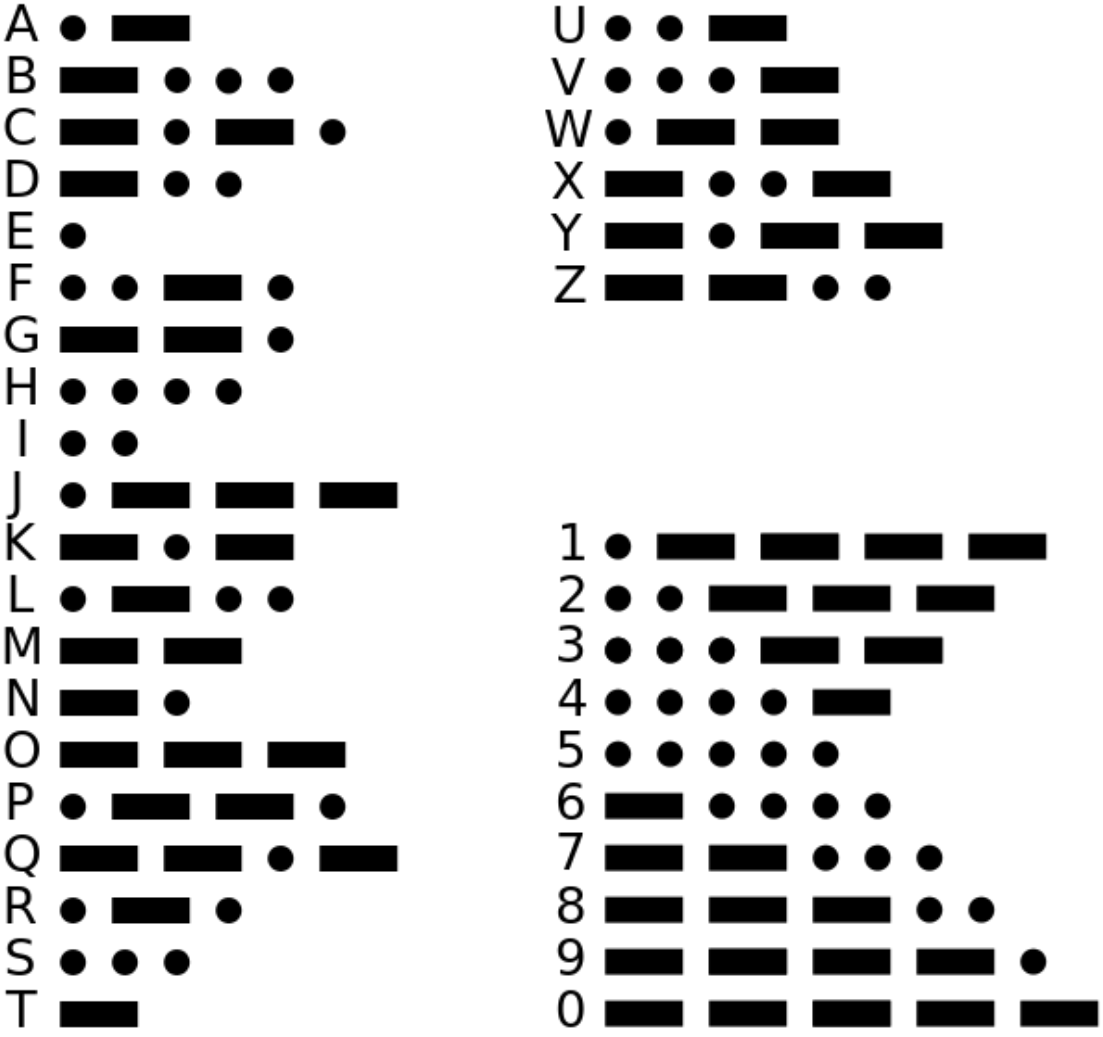
While many kinds of assessment work, the students and the teacher should assess how well they improved their rocket launch. You could write an assessment that offers possible changes and asks students to predict how that will improve or hurt rocket launch.

In addition, each group should report out on how well they worked together. Having the students briefly present their work to their classmates tends to give the best opportunity to figure out what happened in their group. They should explain

- What their problem/goal was
- What they tried
- Whether or not it was successful
- How they could tell if it was working
- What they did if they didn't all agree on what to do
- How often did they get to put a mark on their checklists

International Morse Code

1. The length of a dot is one unit.
2. A dash is three units.
3. The space between parts of the same letter is one unit.
4. The space between letters is three units.
5. The space between words is seven units.



ASCII Encoding

American Standard Code for Information Interchange is a character encoding standard for electronic communication using English character sets. ASCII codes represent text in computers, telecommunications equipment, and other devices.

0	00110000	A	01000001	K	
1	00110001	B	01000010	L	
2	00110010	C	01000011	M	
3	00110011	D	01000100	N	
4	00110100	E	01000101	O	
5	00110101	F	01000110	P	
6	00110110	G	01000111	Q	
7	00110111	H	01001000	R	
8	00111000	I	01001001	S	
9	00111001	J	01001010	T	