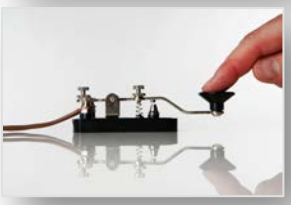
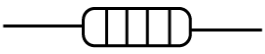
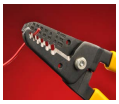
Morse Code Transmitter

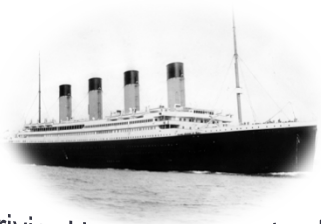
Scenario: You are the captain of a **yacht**, and you have **lost power** on board your ship – including your radio. Build a Morse Code transmitter to use **light signals** to signal to a nearby boat that you need help. (Or just send secret messages to your friends!)

You will build a **circuit** that you can use to send Morse Code messages to friends and family.



Parts Review:

	picture	*circuit symbol*
2 AA Batteries – the power source		
LED – A small light (LED stands for "light-emitting diode")		
Switch – On/off control for the flow of electricity, like a light switch in your house. We will make one out of cardstock and foil.		
Wire – Something that carries a electricity – a "current" – through a circuit.		
Resistor – Something that reduces the amount of current by "resisting" the flow of electricity. Used to prevent parts like LEDs from being burnt out by too high current		
Battery holder – an easy way to connect your batteries to a circuit		
Tape – To attach your wires together and to the switch (not included)		
Aluminum Foil – To make the inside layers of your switch to conduct electricity (not included)		
"Wire Connectors" – Bread board, alligator clips (included), or binder clips, metal buttons, more tin foil,…	 	
Cardstock – Thick paper for the switch		
Paper – For the "spring" that holds the switch open unless you press down to close it		
Wire Stripper		



Trivia: How many smokestacks did the Titanic have?

Answer: Three. One was just for looks.

Suggestions for approaching projects in engineering areas that can seem intimidating to both grown-ups and kids:

The activities in this project could be spread out over multiple days. For example,

Day 1: Build with alligator clips, transmit Morse Code

Day 2: Experiment with foil, buttons, binder clips

Day 3: Use the breadboard like “real” engineers

The approach we take is to:

1. Start with something fairly **simple** and achievable to let the kids build some familiarity, experience, and **confidence** in the area, then:
2. **Extend** the project into something to deepen the knowledge
3. Extend the project to get kids (or adults!) a bit **outside** of their **comfort zone**. Engineering is a problem-solving domain. Getting comfortable with not knowing the solution, and being willing to work to find it is a good mental disposition to build.

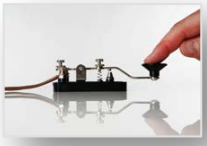
In this case, the “simple” effort is to connect the circuit using alligator clips, which are easy to use and keep good connections.

Then they experiment with other conductive metal items (foil, binder clips, buttons) to better understand conductivity.

And then, they use some typical “tools of the trade” for circuits, such as a breadboard and a wire stripper – just like engineers use.

1. Build a Push Button Switch

Nugget O' Knowledge: A ***switch*** is just something that can **connect wires** so that **current** can **flow**



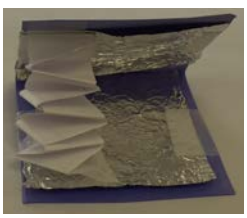
1. Take out your cardstock piece, cut it to a 2-inch by 4-inch rectangle, and fold it in half

2. Attach one foil piece to the inside top of the card stock. Hint: You want as little tape covering the foil as possible, so roll up a piece of tape and place it **under** the foil to attach it

3. Attach the other foil piece to the inside bottom of the folded cardstock, making sure the two pieces of foil ***do not touch***

4. Build your paper spring, by taking the strip of paper and folding it back and forth into a little stack

5. Tape the spring to each side of the switch – cover as little of the foil as possible. Foil will conduct electricity. Tape will not!

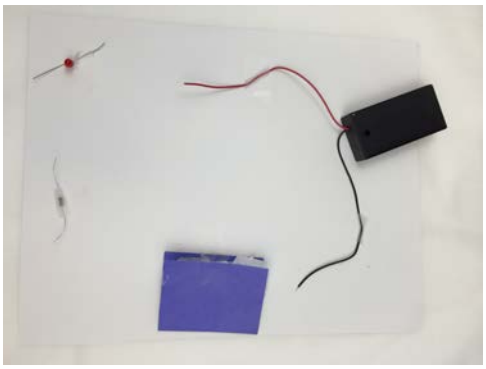


6. You are ready to lay out your circuit!

2. Lay Out Your Circuit Elements

Nugget O' Knowledge: A diode (like this LED) has a **direction**; if your circuit doesn't work, try switching it around. **Loose wiring** can also make your circuit not work

1. Load the batteries into the battery holder. Pay attention to which way to load the batteries. Place your battery holder on a plain sheet of paper and spread the two wires to the left and right of the battery holder



2. Look at the two different legs of your LED. Do you see that one is longer than the other? Spread the two legs into two directions. Place your to the left of your battery holder with the LONG leg from your LED toward the battery holder, and the short end of the diode facing the other way.

3. Lay the resistor on your paper to the left of your LED with one end near the LED and the other in the other direction, like shown in the picture.

4. Now, put your switch to the left of the battery holder, to the right of the resistor, and under the LED, like shown. Your circuit should look a bit like a square or circle.

5. Make sure the red wire from the battery holder points toward the LED, and the black wire points toward the switch

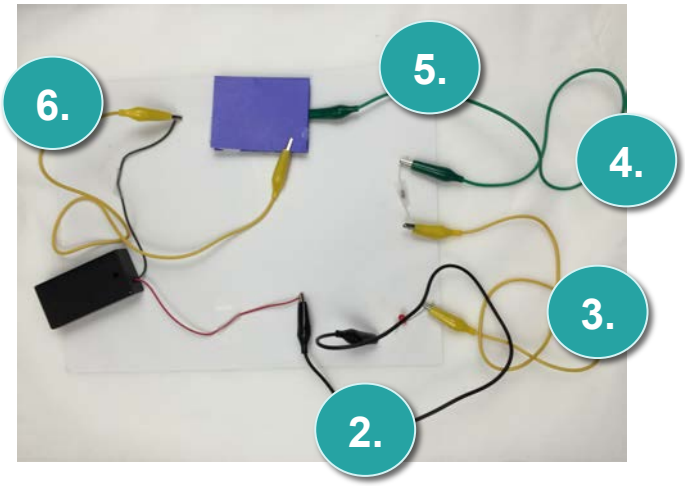
6. Double-check that the long leg of your LED is pointing toward the positive (RED) wire coming out of the battery holder

7. You are ready to connect your circuit!

3. Connect Your Circuit

Nugget O' Knowledge: You can **connect** your circuit multiple ways – anything that can **conduct** electricity can work. But, some "connectors" work better than others. We will show **multiple ways** that this circuit's elements can be connected.

1. First we will use alligator clips to connect everything. Alligator clips are nice because they are easy to use and keep good connections.



2. Take your first alligator clip and connect one side to the red lead from your battery holder, and the other side to the long leg of your diode.

3. Take a second set of alligator clips to connect the short leg of the diode to the resistor .

4. Connect one end of a third set of alligator clips to other end of the resistor.

5. Connect the other end of the third alligator clip to the foil on one of the switch. Make sure that the metal of the alligator clip is firmly connected to the foil on the switch.

6. Take a fourth alligator clip out. Connect one side to the foil on the opposite side of the switch from where the resistor was connected. Connect the other end to the black wire coming out of the battery holder.

7. Press down on your switch – does your LED light up? If not, check the wiring and the LED direction. Did the long leg of the LED go toward the positive (red) wire from your battery back?

4. Use Your Morse Code Circuit

Nugget O' Knowledge: Morse code is one way that information can be sent. The old telegraph systems used short and long **sounds** to send Morse Code. In your transmitter, you will use short and long **pulses of light**. Any signaling mechanism – and **any code** – can be used as long as both the sender and receiver know how to interpret the code!

1. Using your push button switch, you will send short flashes and long flashes of light to send your Morse Code.

2. In the Morse Code table at right, the symbols are called "dots" and "dashes". For example, the code to send the letter "A" is "dot dash." The dots are the short signals, and the dashes are long signals. So, to send the letter "A", you would send a short flash of light followed by a long flash of light.

3. Try sending "SOS." As the table shows, SOS is three short flashes, then three long flashes, then three short flashes.

Morse Code

A	•–	N	–•
B	–•••	O	–––
C	–•–•	P	•––•
D	–••	Q	––•–
E	•	R	•–•
F	••–•	S	•••
G	––•	T	–
H	••••	U	••–
I	••	V	•••–
J	•–––	W	•––
K	–•–	X	–••–
L	•–••	Y	–•––
M	––	Z	––••

4. Working with a partner, try sending different letters and seeing if they understand. Let them use the same circuit to send you a signal back to indicate whether they understood the letter you sent:

- One flash back from them means "I understood what you sent"
- Two flashes: "send that letter again"

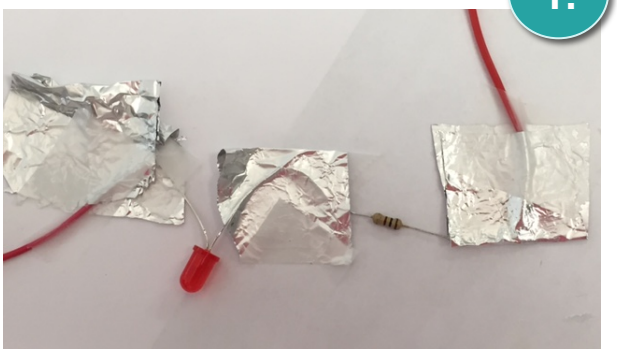
Using this, can you and your partner send a whole word successfully? How about a whole sentence? Trade off roles between sender and receiver and see if you can have a small conversation with them.

5. Experiment with Connections

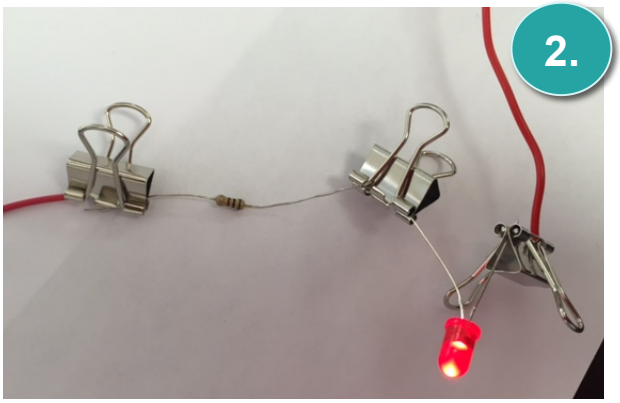
Part 1. Foil, binder clips, and fabric snaps

Nugget O' Knowledge: Anything that **conducts electricity** can be used to **connect** a circuit. But some things work better than others!

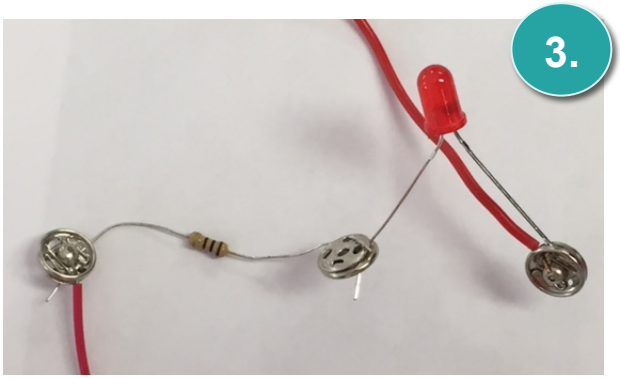
1. Instead of using alligator clips, try replacing each connection with a simple piece of foil. Tape the foil to a piece of paper from underneath the foil. Tape the legs or wires of the circuit elements to be connected onto the foil. For example, you can tape the long leg of the LED and the red wire from the battery pack onto the same piece of foil to connect them. Connect your elements this way and see if your circuit still works.



2. Replace your foil connections with binder clips. Remove the foil squares, and use binder clips to connect the elements together. For example, one binder clip for the red wire and long LED leg. Another clip for the short LED leg and one side of the resistor – and so on. Does it still work?



3. Now try metal fabric snaps to connect the circuit elements together. Careful – these can be flaky connections! Does it work?



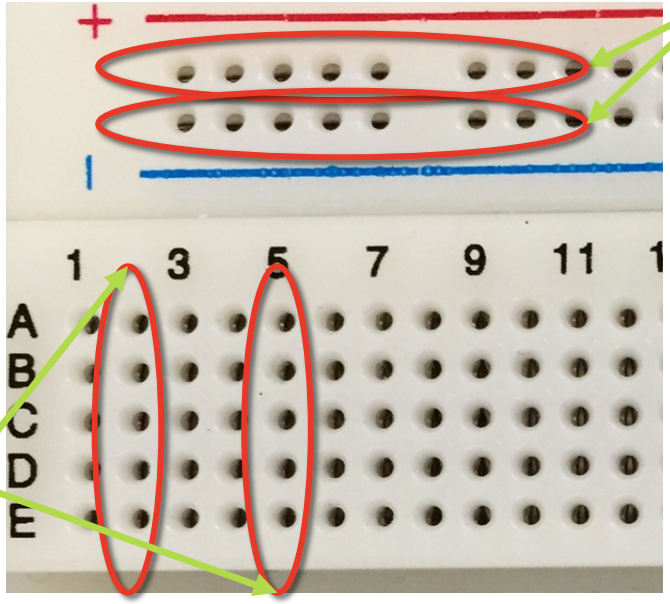
4. If that was all easy, then try reordering all your circuit elements. The order doesn't matter! It only matters that the long LED leg points in the circuit direction that the red battery wire comes from. Does it still work?

Part 2. Using a Breadboard

Nugget O' Knowledge: A **breadboard** is a tool engineers use to connect circuits to **try** them out. In the old days, they connected circuit pieces on real boards for bread.

1. How to use a breadboard:

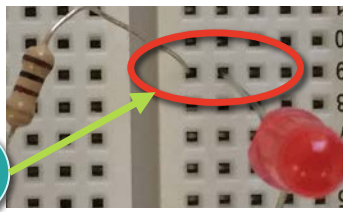
Each of these rows are connected underneath. So, if you put a wire or circuit element in one hole of the row, and another element in a second hole in the row, these elements are connected in the circuit. You connect wires by putting the "in" wire and the "out" wire in the same row (for example, row 1 or row 5)



By convention, the power source (your batteries in this circuit) is usually connected on the sides. The positive terminal of the battery is wired to the "+" side on the breadboard, and the negative terminal of the battery is wired to the "-" side of the breadboard. The two columns on each side of the breadboard are called ***power rails****.*

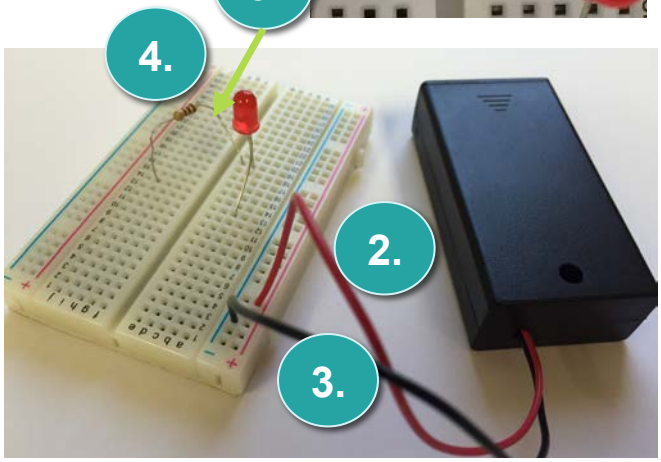
2. Take the red lead from the battery pack and put the end of the wire in any hole on the "+" side of the breadboard.

3. Take the black lead from the battery pack and put the end of the wire in any hole on the "-" side of the breadboard. Your breadboard now has power.



4. Place the two ends of resistor in any two rows on the breadboard. The two ends should not be in the same row.

5. Look at your LED to identify which leg of the LED is longer. Take the short leg of the LED and put it into the same row as the one end of the resistor. Put the long leg of the LED in an unused row.



Part 2. Using a wire stripper

6. How to use a Wire Stripper:

Round holes are used to strip the plastic off the end to expose the copper (so you can plug it in to something)

Flat section is for cutting the wire into segments

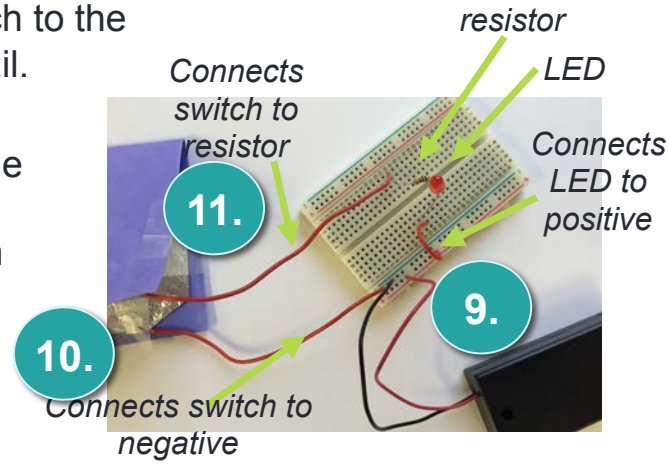
7. Use the flat sharp edge of your wire stripper to cut five segments of wire, each about 2 to 3 inches long.

8. Use the round holes on the wire stripper to strip off just a little bit of the plastic on the ends of each piece of wire. If you accidentally cut the wire instead of stripping it – no worries! We've been there… Just try again.

9. Take one of the wires and place one end into the positive side of the power rail. Take the other end and place it in the row that has the long leg of the LED.

10. Place your switch near your battery pack and run a wire from one side of the switch to the negative (black) part of the power rail.

11. Take a wire and place one end in one of the holes in the row that contains the end of the resistor that is NOT in the same row as the short leg of the LED. Connect the other end of the wire to the other side of the switch.



12. Press down on your switch – does your LED light up? If not, check all your wiring and whether the LED was connected in the right direction. Also, make sure each wire and circuit element is firmly connected in its breadboard slot.

6. Recap

- **We built a *circuit***
  - A circuit is a connection of electric elements that do something
  - When the circuit is closed (switch is “on”), current can flow
  - When the circuit is open (switch is “off”), current can not flow
  - When you turn on the light in your kitchen, you are using a **switch** to **close** a **circuit**

- **We learned wires can be *connected* many ways**
  - We used alligator clips, binder clips, metal snaps, and a breadboard

- **We sent messages using *light signals***

- **We used *signals* to tell the sender whether the message was received correctly or not**
  - You can find methods like this (e.g., “send again”, “I got it”), in real world communications, like computer networks
  - They are called “Ack” (acknowledgement) and “Nack” (negative acknowledgment

- **We learned that Morse code can still used for backup communications**
  - If a boat’s radio is not working, the captain could use light signals to send a message
  - You could probably use it with your siblings to pass messages your parents cannot understand!