Columbia Gorge
STEM HUB
Science, Technology, Engineering & Mathematics

MY MAKER NOTEBOOK

NAME: _____

SCHOOL: _____

Makers + Mentors
NETWORK

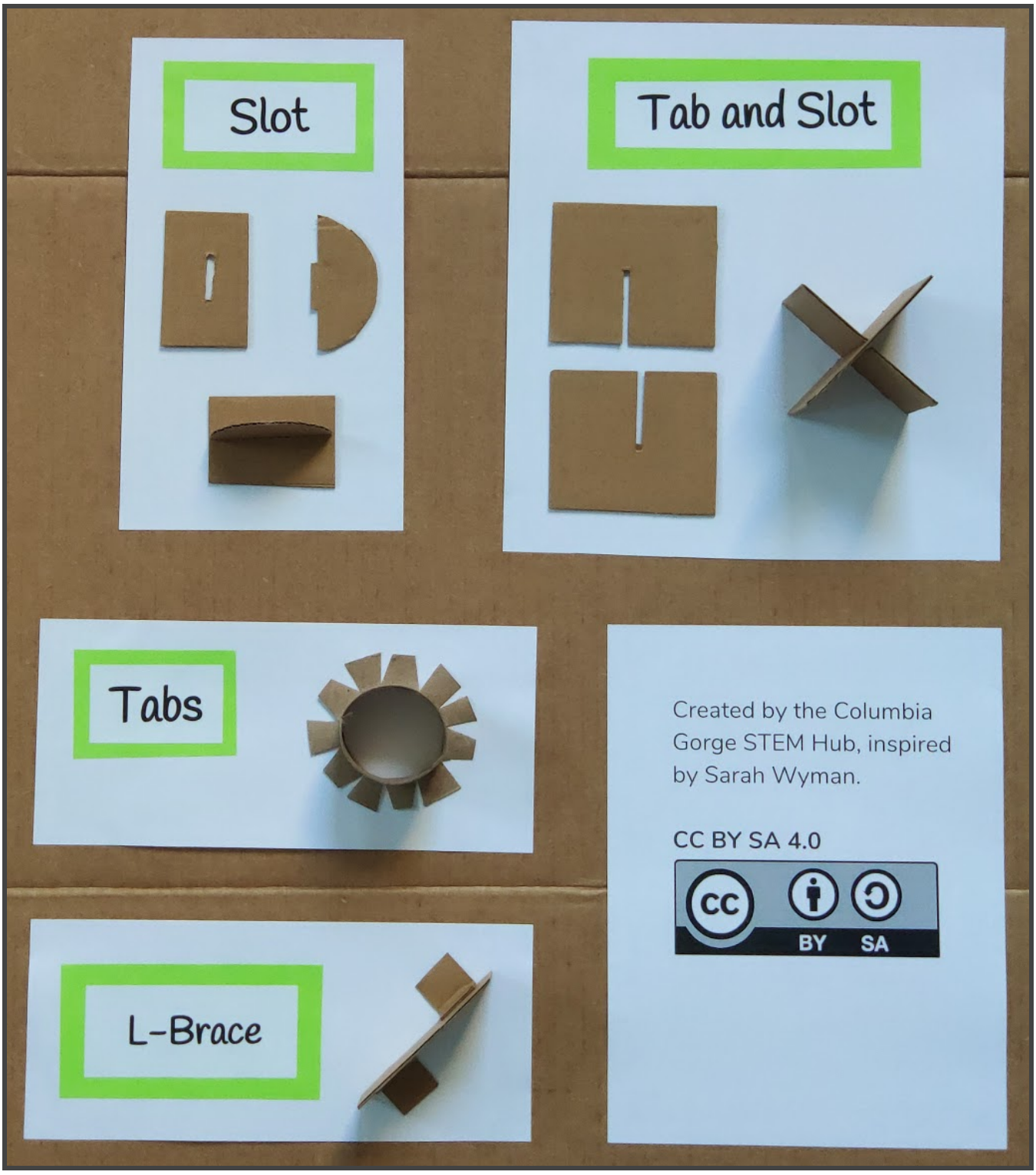
US 2020
STEM
Coalition
Challenge

Columbia Gorge
EDUCATION SERVICE DISTRICT

Maker Club Notebook

Safety Approval	Approved by:	Date:
Cardboard cutter		
Glue gun		

Cardboard Attachments



Backpack Challenge

MAKE A FRIEND:

(Empathize)

1) Ask your partner about their backpack:

Ask these questions to get started:

- What do you carry with you in your backpack?
- What do you like most about your backpack?
- Tell me about some problems you've had with your backpack.
- Is your backpack comfortable?
- Do you think your backpack makes you look good?
- *Make up your own questions!*

Write and Sketch *important* or **surprising** **things you learn:**

DECIDE what they need and want:

(Define the problem)

2) Write the important stuff

(Write your partner's name:) _____

What do they need? What will solve the problems their backpack has?

How do they want to feel? How will their backpack make them feel good?

THINK up some solutions:

(Ideate)

3) Sketch *lots* of **RADICAL** ideas:

Think of as many ideas as possible to create a backpack that is perfect for your partner! Write or draw **EVERY** **idea you have!** No idea is a bad idea. **Don't share them with your partner, yet!**

SKETCHES and NOTES:

05:00

4) See what your partner thinks of the ideas: (Capture feedback)

Ask these questions to get started:

- What do you think about these ideas?
- Which one is your favorite?
- Which part of it do you like best?
- Which part do you like least?
- How could it be better?

SKETCHES and NOTES:

MAKE IT:

(Prototype)

5) Prototype (make) the best idea:

[It should not be perfect! Go build a prototype!]

SHARE IT:

(Capture feedback)

6) Show your partner what you made them:

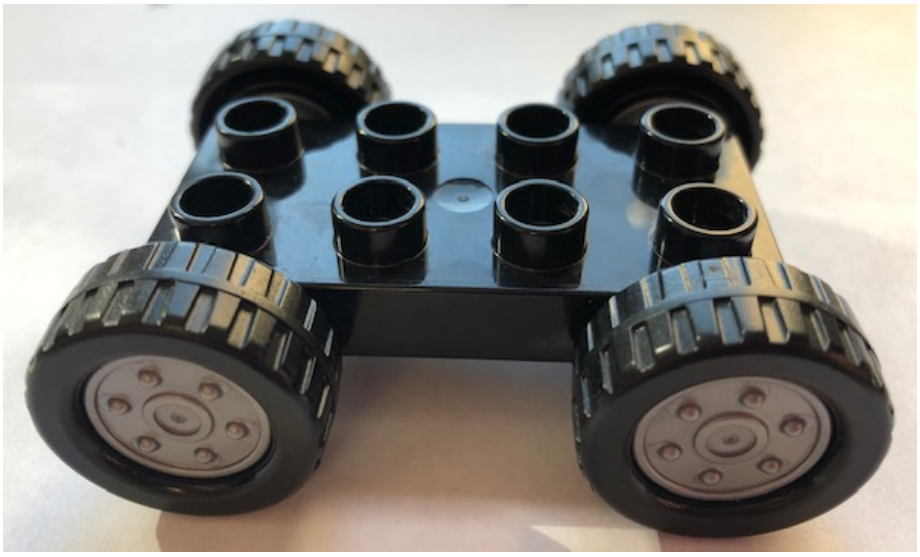
Let them try it out! See how they like it. Ask them what they think.

+ What did they like?	- What didn't they like?
? Do they have questions?	! Do they have ideas?

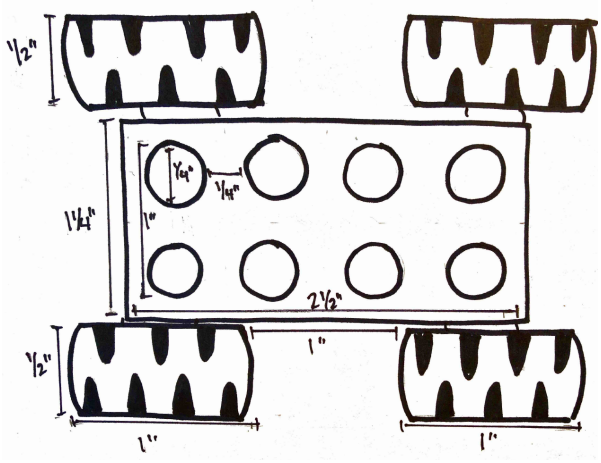
Blueprinting

Example

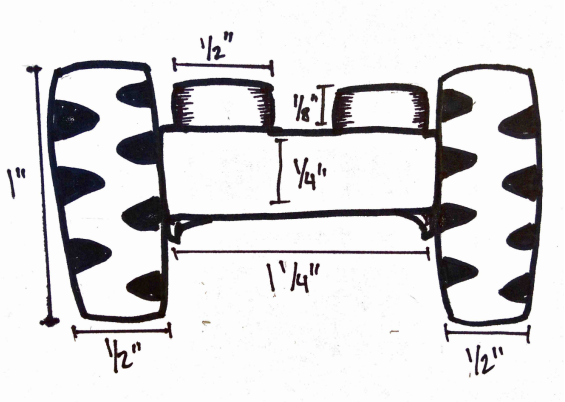
Item: LEGO Duplo car base



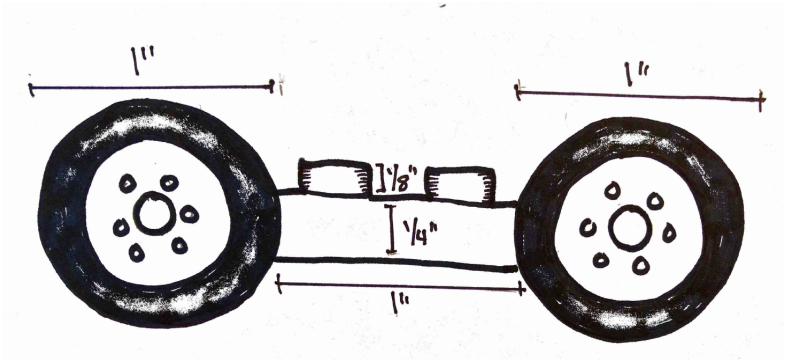
Top view:



Front view:



Side view:



hint: 1” = 1 inch

(“ is another way to write inches)

Item: _____

Top View:

Front View:

Side View:

Item: _____

Top View:

Front View:

Side View:

Item:_____

Top View:

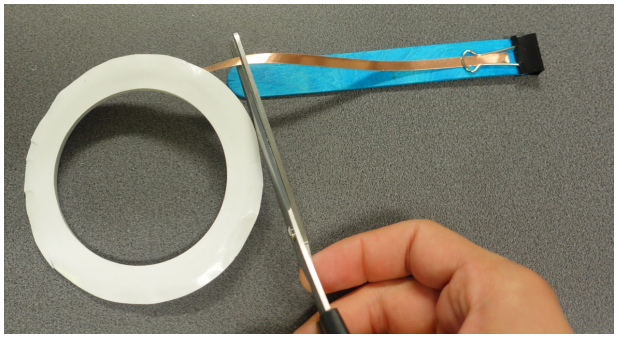
Front View:

Side View:

Step 1: Side one

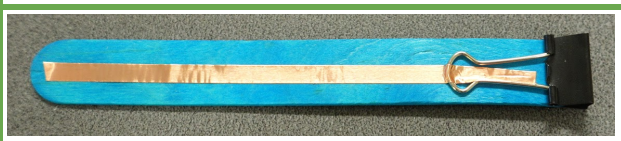
Put the binder clip on the end of the popsicle stick.

Cut a piece of copper tape a little shorter than the popsicle stick



Peel the backing off the copper tape.

Tape the copper tape down, **over the binder clip.**



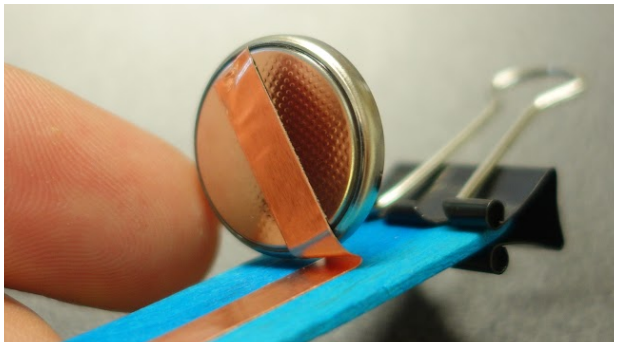
Step 2: Side two

Flip the stick over.

Cut a piece of copper tape that is **a little longer** than the popsicle stick. Tape it down, with some **extra sticking up.**

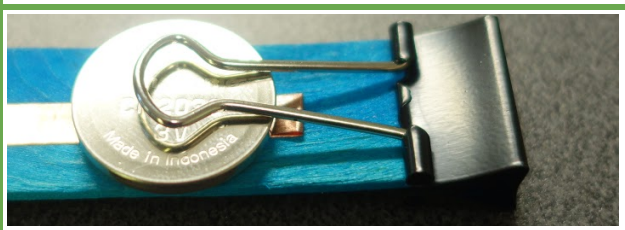
Step 3: Battery

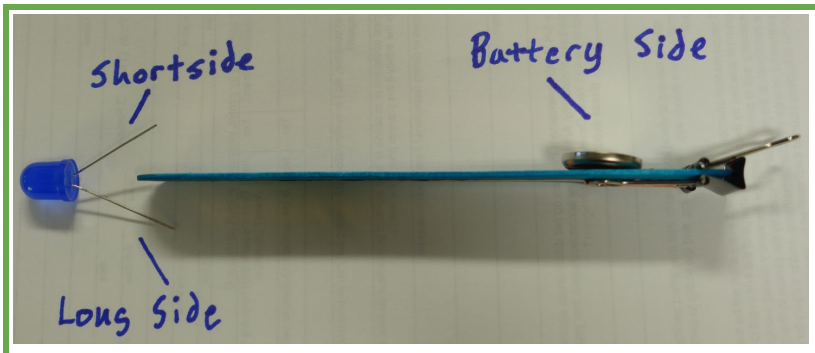
Stick the battery to the copper tape that's sticking up.
Make **sure** the side with a "**+**" is facing up!



Flip the binder clip over on top of the battery.

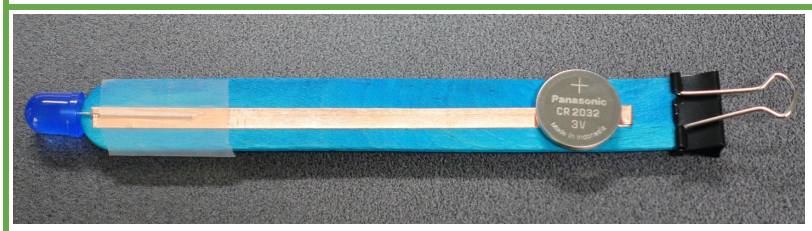
If you want, you can tape the battery down.



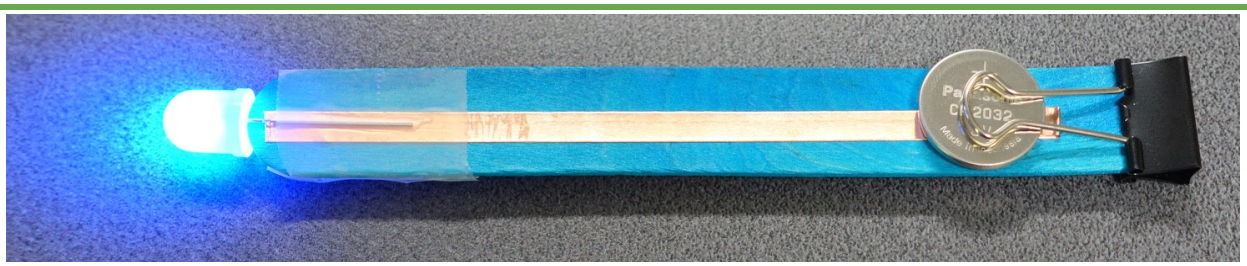


Step 4: Light

Look at the light.
Notice how there is a **short leg** and a **long leg**?



Tape the light on, with the **short leg** on the side with the battery.



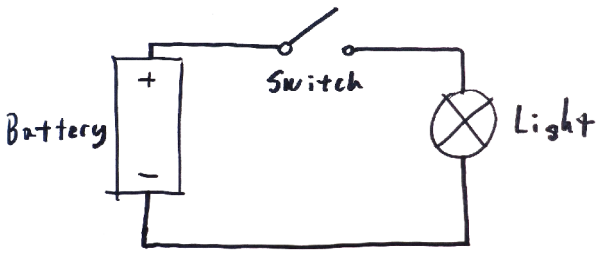
You're done! Flip the clip over to turn it on.

How does it work?

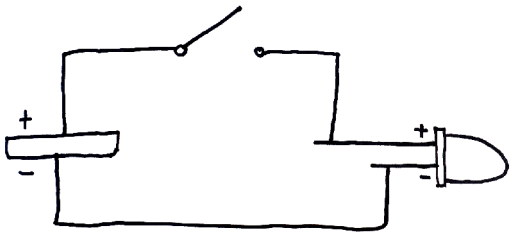
There are four pieces:

The **battery** makes the power.
The **switch** turns it on or off.
The **light** makes light!

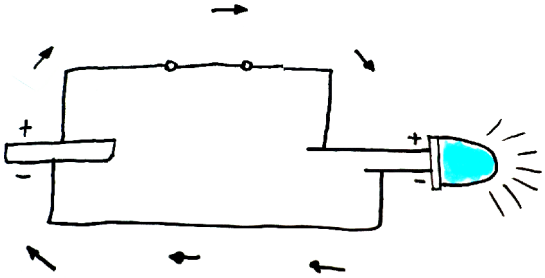
The **Copper tape** is what the power runs through.



When the **switch isn't touching** anything, the light is off, because **power can't flow** around the loop.



When the **switch is touching**, **power can flow**, and the light turns on.



Reflection Questions

1. What was easy about this project?

2. What was kind of hard?

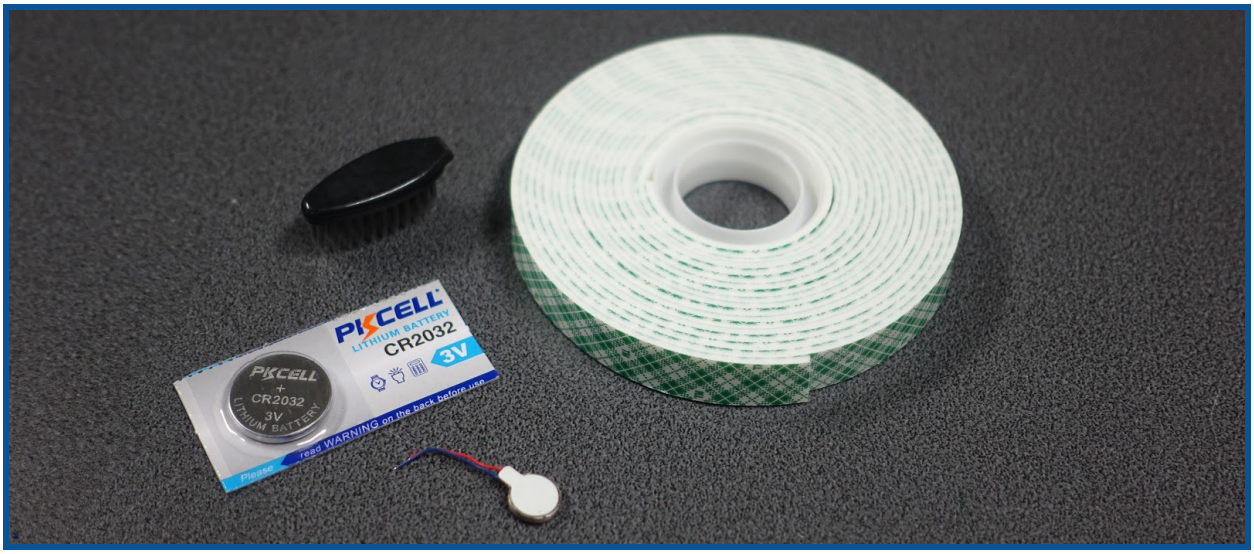
3. What new ideas did you discover?

4. Why do you think the LED only works one way?

5. Guess: Why is the battery marked with “ **+** “ and “ **-** “?

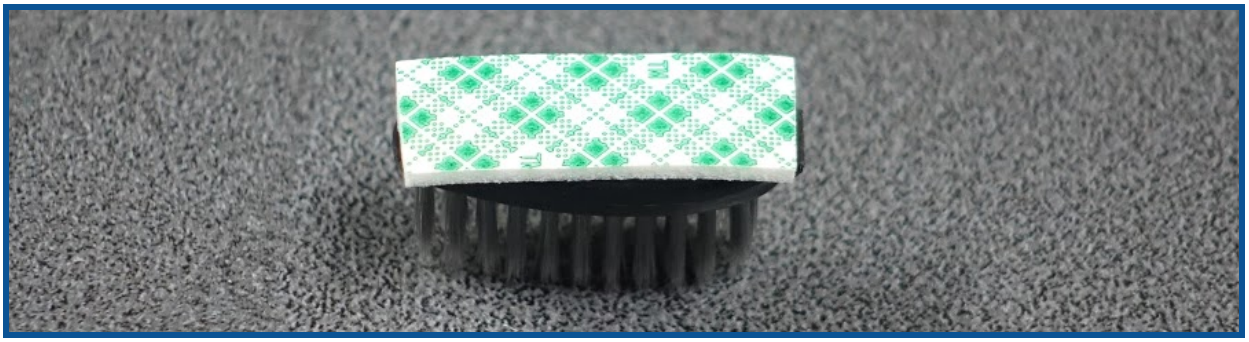
6. Do all flashlights work this way?

Bristlebots

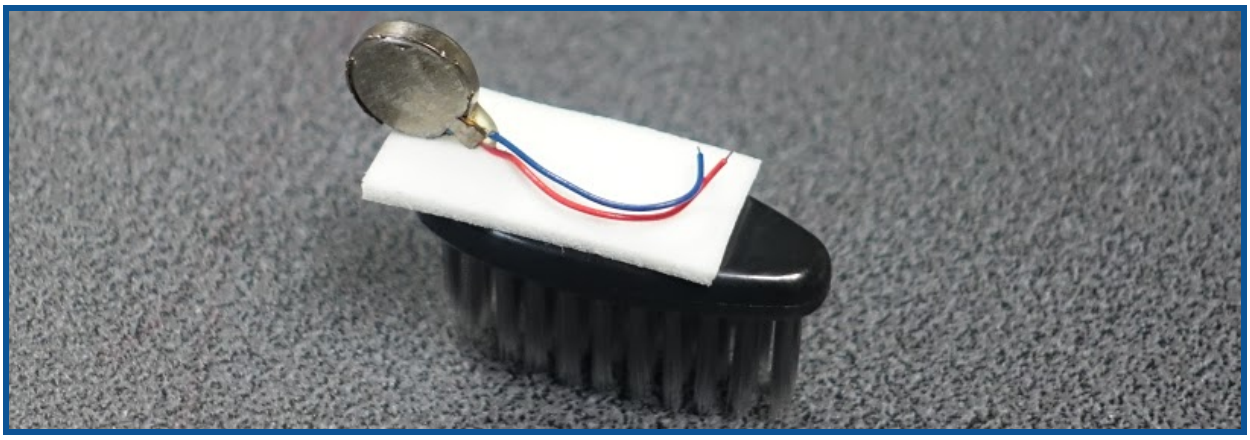


You will need:

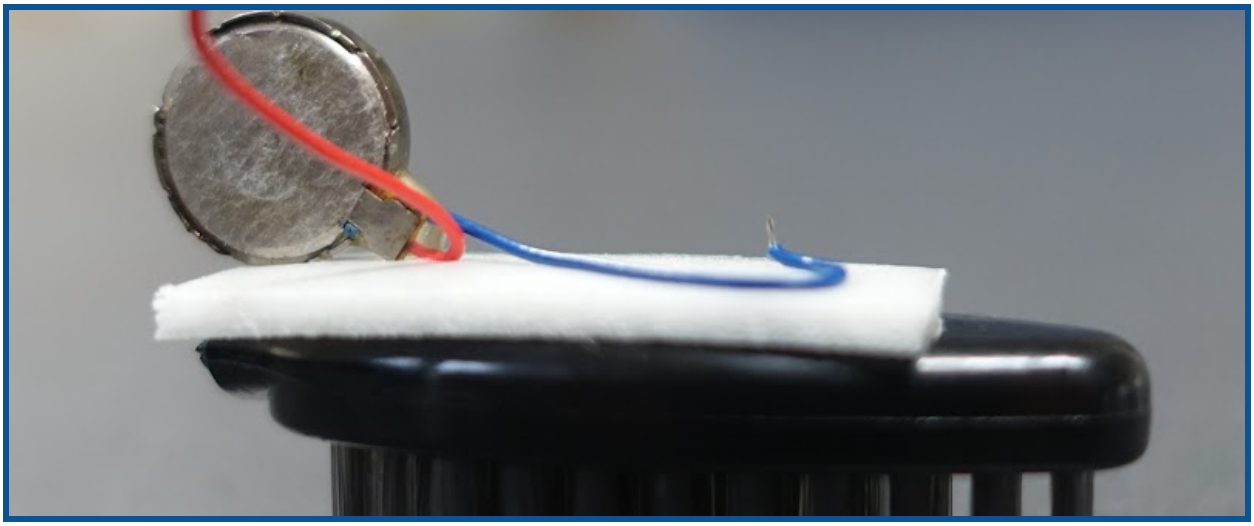
- 1 x toothbrush head
- 1 x vibration motor/pager motor
- 1 x CR2032 coin cell battery (or similar size)
- Double sided foam tape
- Normal tape and scissors



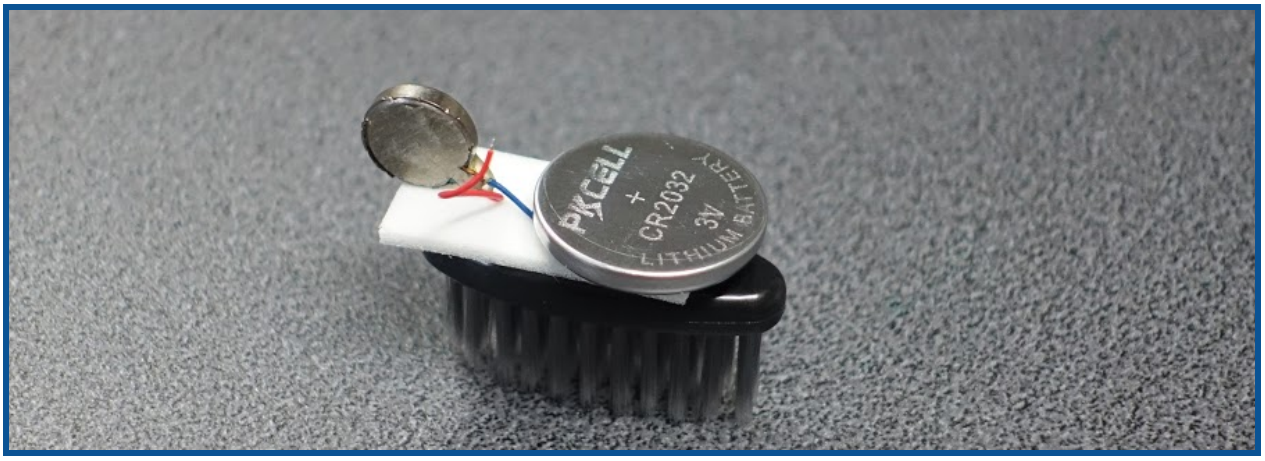
Cut a piece of double sided tape as long as the toothbrush head, then stick it to the top.



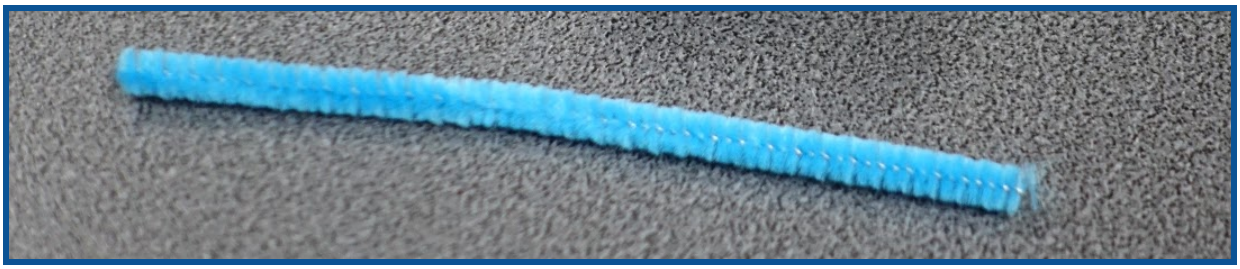
Remove the protective plastic and stick a motor to the front of the brush, on it's side as shown.



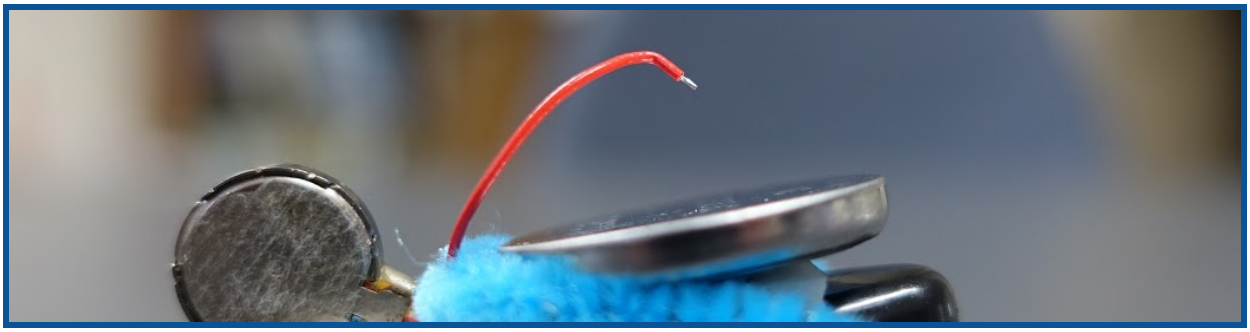
Stick the blue wire to the tape, but make sure the little tiny silver part is sticking straight up. It needs to touch the battery.



Stick the battery on, with the side marked with a “ + ” facing up.



Cut a piece of pipe cleaner about 3 times as long as the toothbrush head. Fold it and attach to the bristlebot, as shown.



Bend the shiny part on the end of the red wire down, like you want it to poke into the battery.

Now, put a piece of tape over it, but don't tape it completely down. You want to make a flap of tape that you can tape down/pull up to turn the bristlebot on and off.

Bend the pipe cleaner down so that the bristles are only touching the ground on the front of the bristlebot.
Attach googly eyes and other decorations you want.

Press the tape down, and watch your bristlebot go! When you want to turn it off, pull the tape back up part way.
If it doesn't go and isn't vibrating, make sure the shiny metal bits on the end of the wires are touching the two sides of the battery.

Experiment: Bend the pipe cleaners in different ways to see what happens.
Discuss: Why does it only go forwards? Why does it start moving when you tape down the wire?

Step 1: Idea (Write what you will build here)

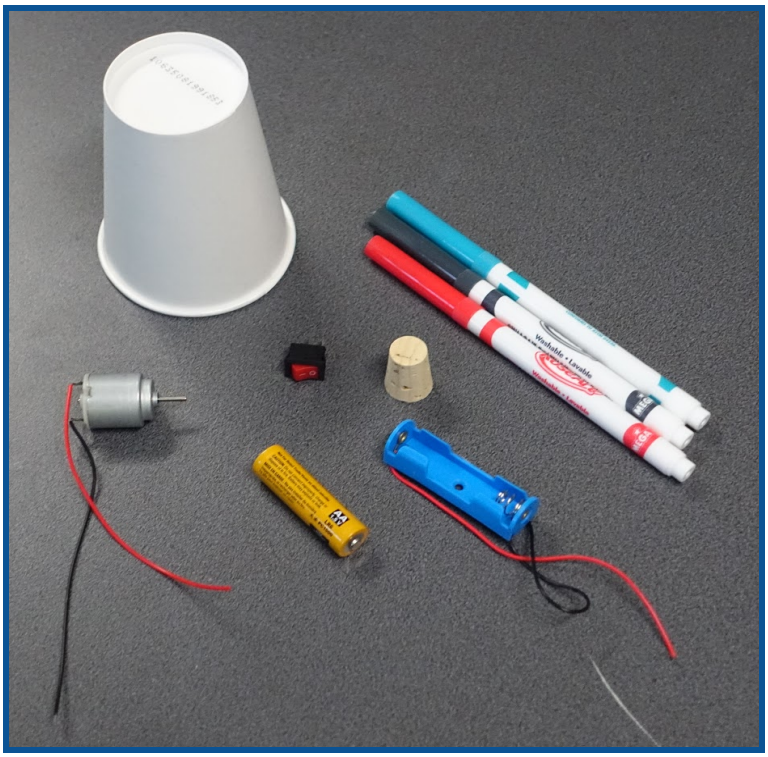
Step 2: Blueprint

You must:

- Draw a **top view**, a **side view**, and a **front view**.
- Include **labels** for important parts.
- Include **measurements** to show how big each part is.
- Make it **clear to understand** so someone else could build it.

Use the space below to blueprint:

DIY Artbot

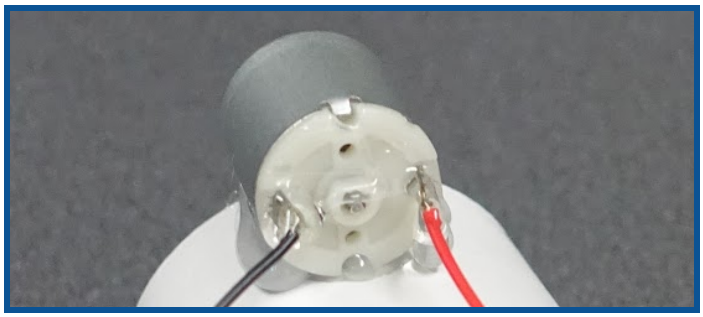


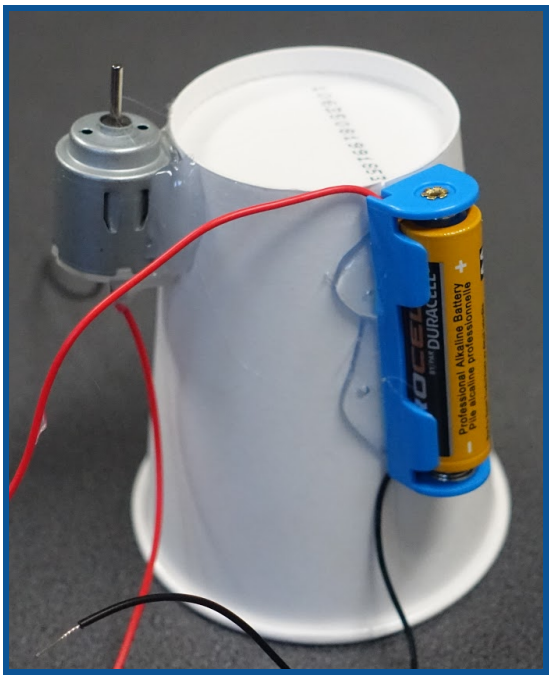
You'll need:

- 1 cork
- 1 motor
- 3 washable markers
- 1 AA battery holder
- 1 AA battery
- 1 switch
- Double-sided tape
- 1 paper cup
- Normal tape
- Scissors

Hot glue the motor to the top of the cup, with the shaft sticking up.

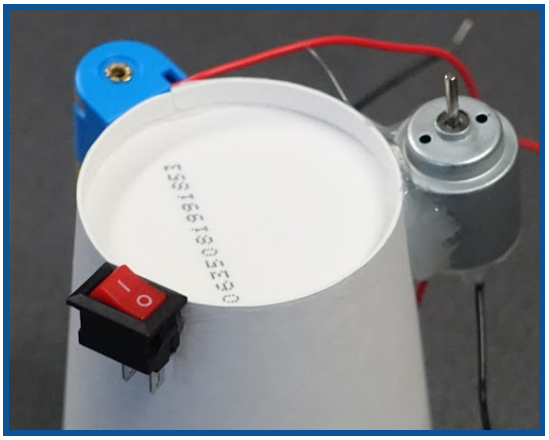
Then, put a dab of hot glue on each wire, to keep it from breaking off.





Put a battery in the battery box, and then hot glue it onto the cup.

Important! Make sure the battery is touching both ends of the battery box.

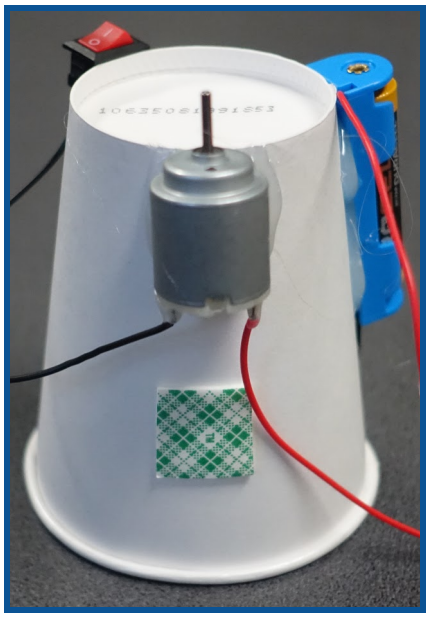


Use a small dab of hot glue to attach the switch to the top of the cup.

Warning! Don't get glue on the metal pins sticking out of the switch!

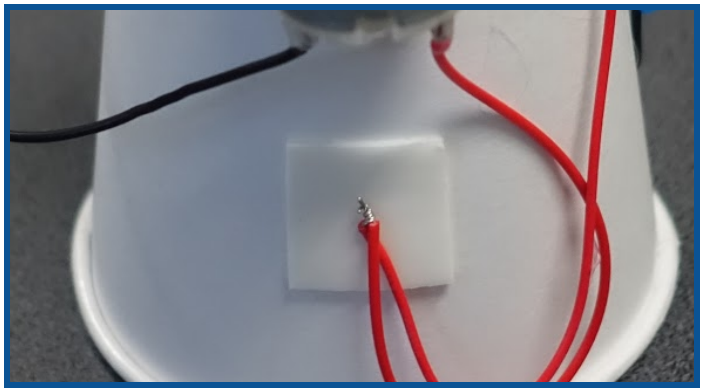
Take the black wires, and wrap/twist the metal ends around through the holes in the metal pins that are on the switch.

Important! These wires need to make good metal-to-metal connection.



Put a small square of double-sided foam tape below the motor.

Take the metal ends of the wires, and wrap them together.



Stick the red wire ends onto the square of foam tape.

Important! These wires need to make good metal-to-metal connection.

Stick the cork onto the motor shaft.

Turn the switch on to see if it works.

If it doesn't, something isn't connected. Check every place a wire connects to something, and check to make sure the ends of the battery are touching the battery box.

Hot glue the **washable** markers onto the cup, evenly spaced around.

Your artbot is finished!
Take the caps off, set it on some paper, and turn it on to see how it draws!

Experiment: Try putting the cork on in different positions to see how it affects the way the ‘bot draws.

Discuss: What is the purpose of the cork? Why does the position it’s in change how the bot draws?

Design a Light-up Card!

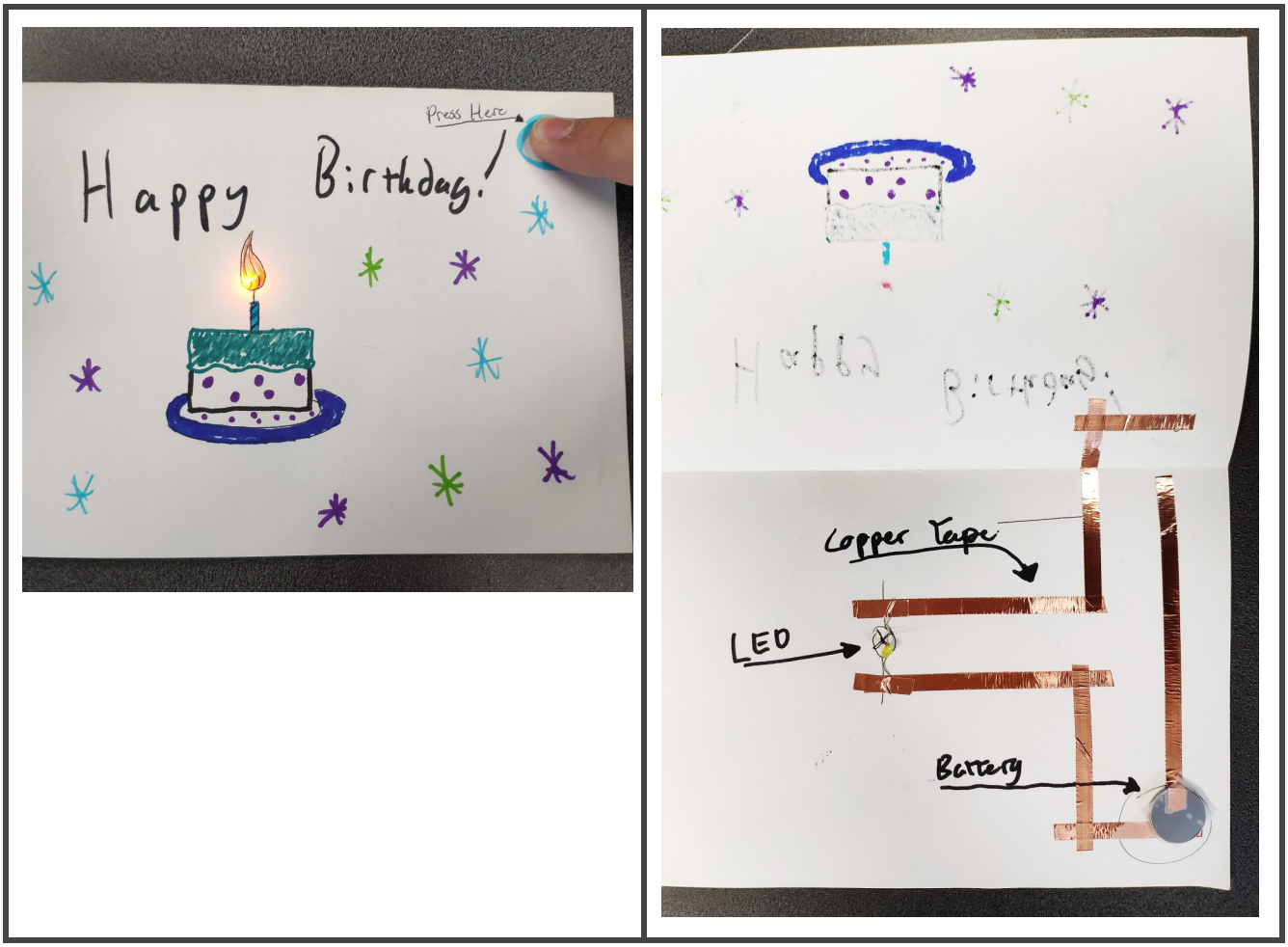
Steps:

1. Create the artwork
2. Review circuits
3. Design a schematic
4. Build the card!

Step 1: Artwork

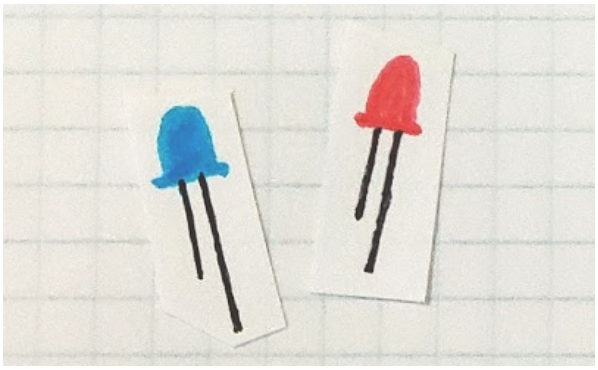
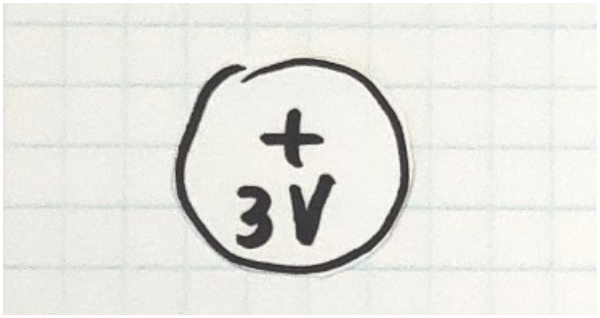
You'll need to design the artwork for your card first, so that you can know where to put the light.

Simple artwork is often easier and nicer! Below is an example in case you need ideas.

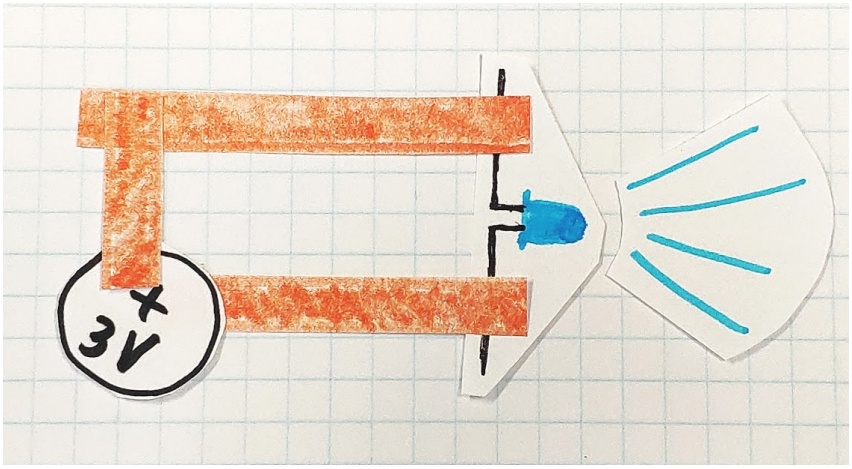


Card artwork design space:
Don’t worry about the circuit now, just the **overall card design**.

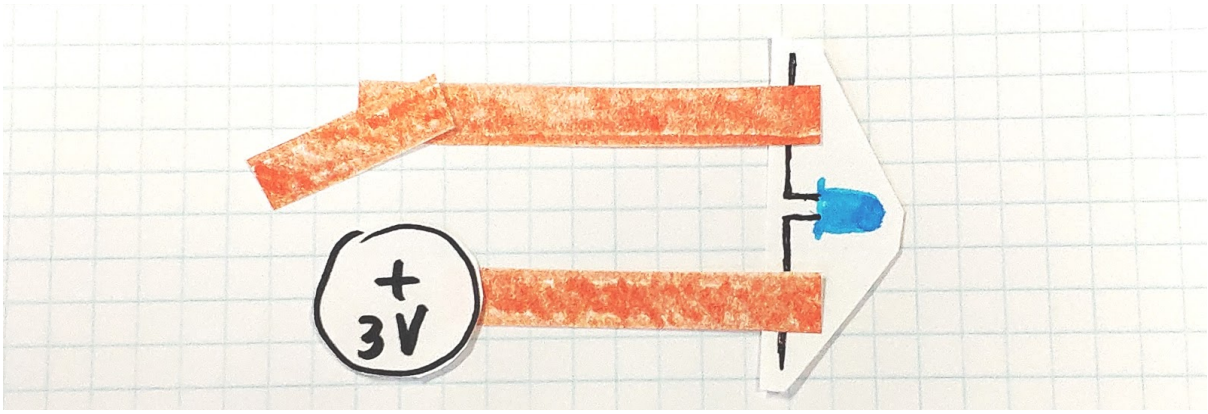
Step 2: Review Circuits

	**Circuit Pieces** **LEDs** (Lights)
	**Battery** (Power source)
	**Copper Tape** (Wires, transfers electricity)

How a Circuit Works



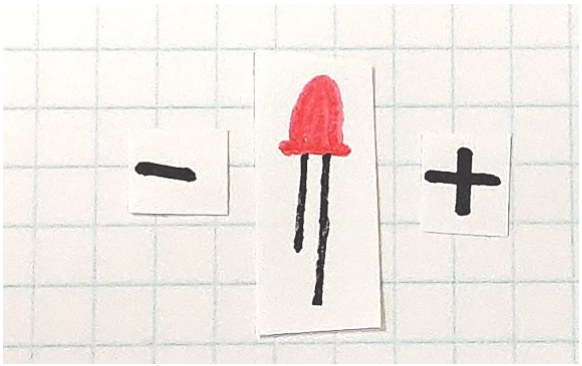
Electricity flows in a loop, from the “-” end of the battery, through the copper tape, through the LED, and then back to the “+” side of the battery.



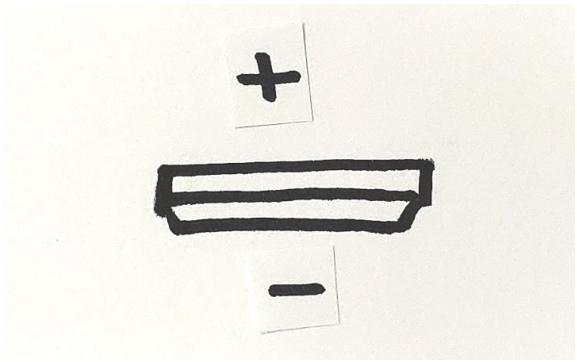
To turn the circuit off, you just make a gap in it.

Tips and Tricks

LED



Battery

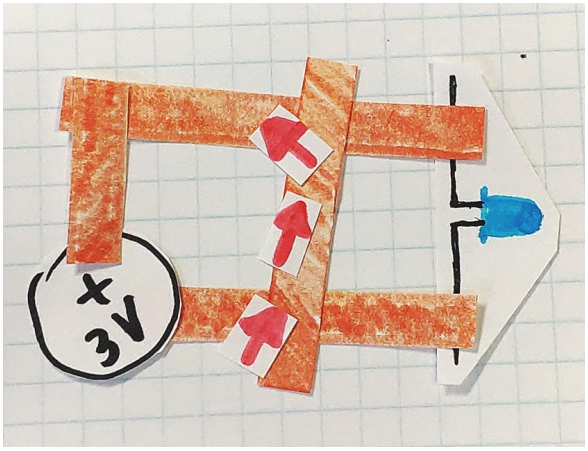


Notice how both the LED and Battery have a “+” side and a “-” side?

You need to match the sides of the LED and Battery for the circuit to work.

When you make your circuit, try flipping each one around. See what happens! (It won’t break it.)

Warning: Short Circuit!



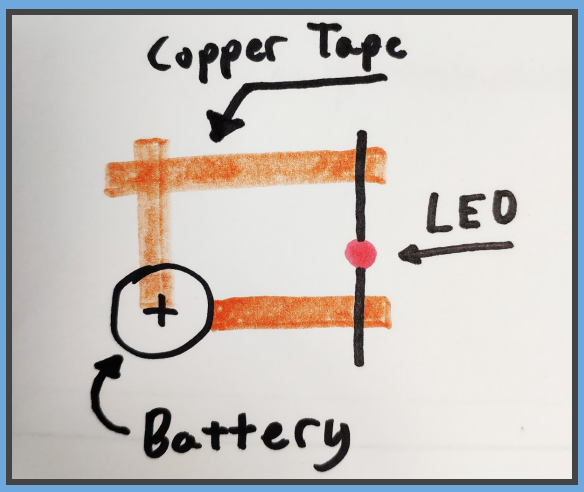
Be careful not to make a short circuit!

Electricity will take the easiest path it can, skipping the **LED** or **Motor** in your circuit.

When it does, it will make the circuit very hot, and it will kill the battery.

Making a Switch:	You don't have to make your circuit turn on and off, but you might want to. How can you make a gap in the circuit that you can open and close?

Step 3: Design a Schematic



Example schematic:

Notice how each part is labeled.

Your schematic should be clear enough that someone else could make the circuit.

Your schematic should look different than this!

Remember:

- Do you want to include a switch?
- Where should the lights be so they will light up the outside of the card?
- What colors do you want to use?

Use the space on the next pages to design your card's schematic.

Use this space to design the schematic:

(more space, if needed)

Step 4: Make it!

Bring this to the Maker Club leader and have them approve your artwork and schematic.

Now, put your plans in action and make your light-up card!

Ball Roller Coaster

Budget goal: $500

Price list

Item:	Price:		Number used:		Item total cost:
Cardboard tube	$50	x		=	
Paper cup, bowl, container, etc.	$25	x		=	
Cardboard piece or popsicle stick	$10	x		=	
Anything else	$5	x		=	
TOTAL PROJECT COST					

To figure out how much your roller coaster will cost, count how many of each piece you use, and write that number in the column named "**Number used**."

Now, multiply the price of each item by how many you used to get the **item total cost**.

Finally, add up all the **item total cost** numbers to get the **project cost**. That's how much your roller coaster costs!

Example:

Item:	Price:		Number used:	Parts cost:
Cardboard tube	$50		4	$50 x 4 = $200
Paper cup, bowl, container, etc.	$25		4	$100
Cardboard piece or popsicle stick	$10		15	$150
Anything else	$5		10	$50
TOTAL PROJECT COST				$500

Roller Coaster Reflection:

Write your answer to each question. Then, talk about your answers with the people around you.

1. **What was easy?**

2. **What wasn't easy?**

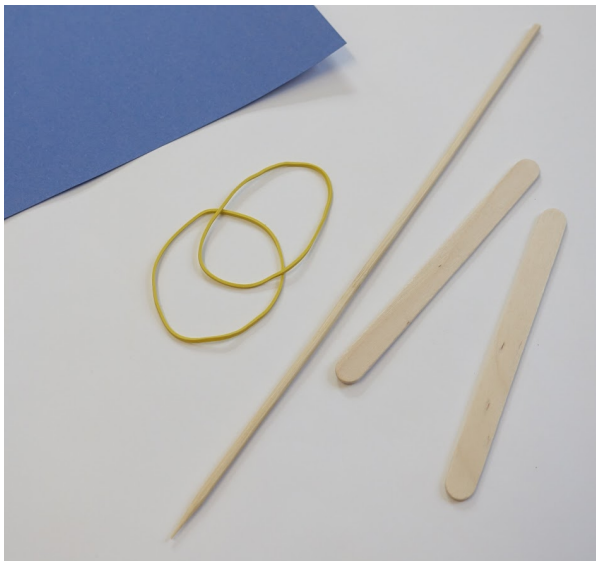
3. **Did you discover something you hadn't known before?**

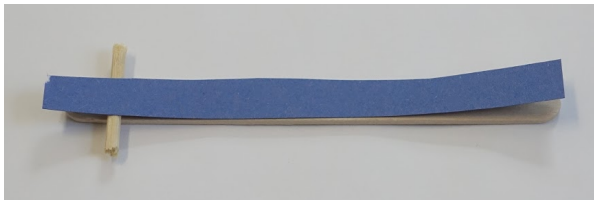
4. **What was it like building with a budget?**

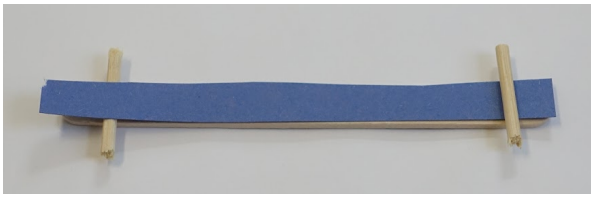
Make a Buzzer

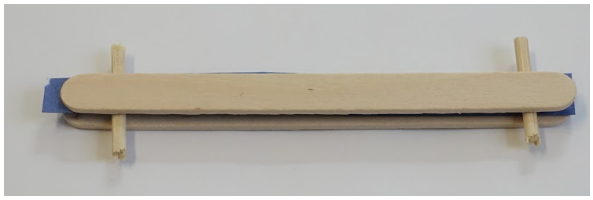
You need:

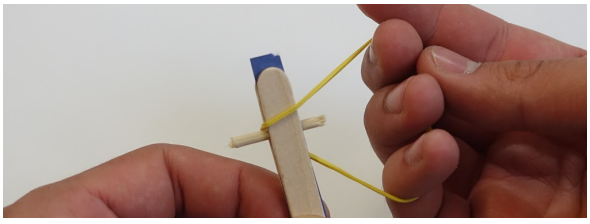
2 rubber bands
2 popsicle sticks
1 skewer
1 piece of paper

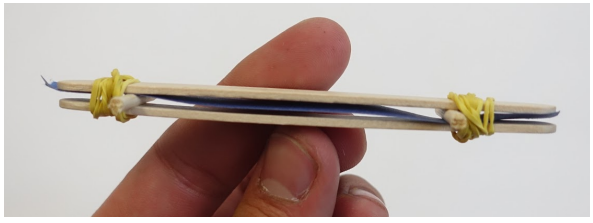








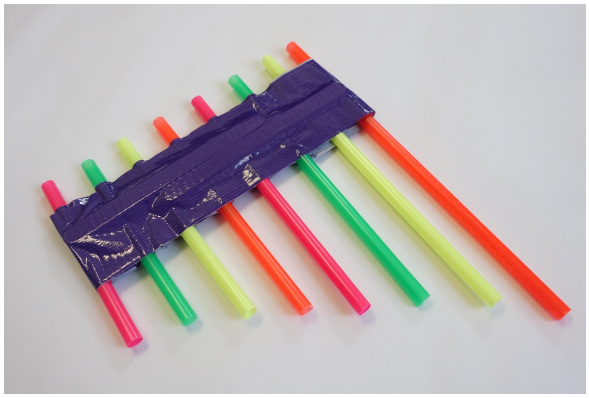




Play your buzzer by holding it up to your mouth and blowing through the popsicle sticks.

How does it make that noise?

Pan Pipes



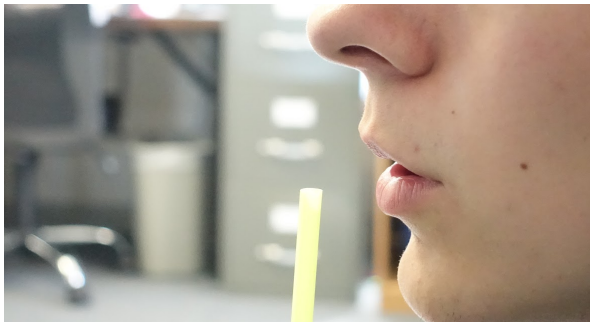
You need:

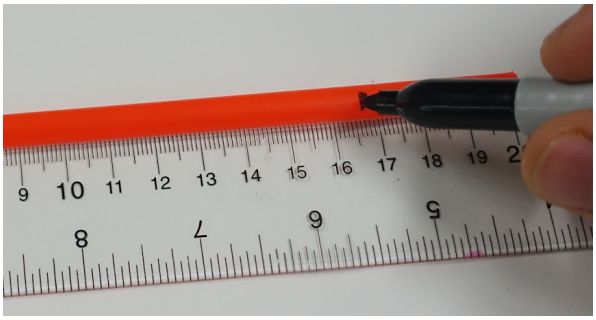
8 straws
Duct tape
2 popsicle sticks
Scissors

First, try this:

Blow across the top of a straw. It will make a faint note. If not, move the straw around until it does.

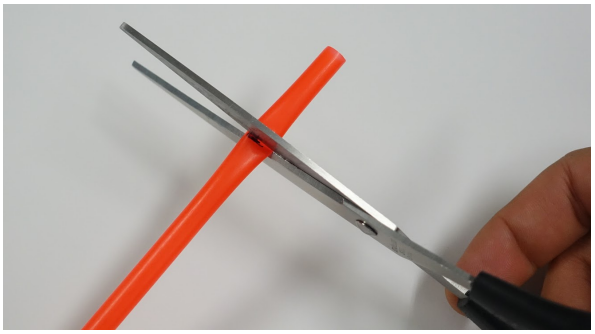
Put your finger over the hole on the bottom and try again.





Cut straws

Using a ruler, mark your first straw at 16.5 CM
(that's halfway between 16 and 17 CM).



Then, cut it at the mark.

Straw Number	Length
1	16½ cm
2	14½ cm
3	13 cm
4	12½ cm
5	11 cm
6	10 cm
7	9 cm
8	8 cm

Mark and the next 7 straws to the lengths shown in the table to the left.

Then, cut each one on the mark.

Can you guess why we're cutting the straws to different lengths?

Try blowing on the different lengths and see what happens...

When you're done, your straws should look like this.

You can use some tape to make your pan pipes, and some popsicle sticks to make them sturdy.

Try playing a simple song on your new pan pipes!

There are other types of instruments you can make, too!

Here are some ideas:

- Rattler/Shaker
- Guitar-like instrument
- Simpler pan pipes
- Drum or maracas

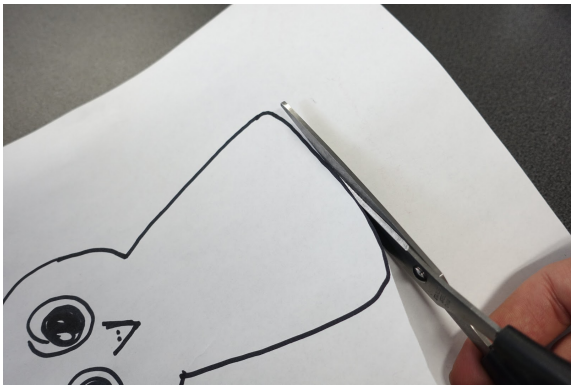
Cm Ruler:

Sew a Creature: Make a template

1. Draw the template

Draw your creature on a piece of paper.

Tip! Smoother lines will be easier to sew later.

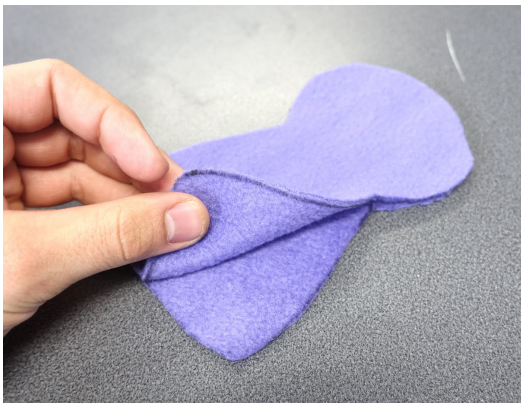


2. Cut out the template

Cut out around the edge of the creature.

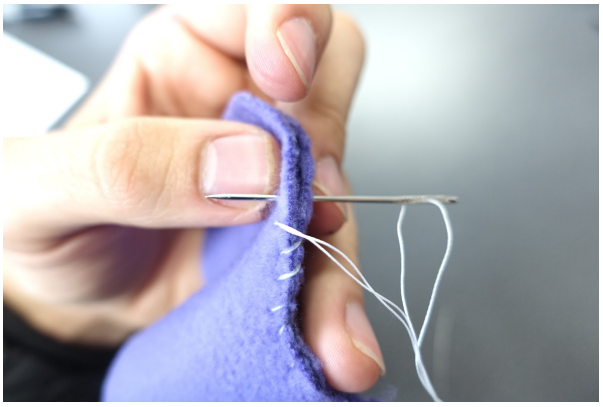
Sew a Creature: Make the Creature

1. Prepare the fabric	
Find a piece of fabric that is big enough to put the template on twice.	
Put the template on the fabric, and trace around it with a marker.	
Do it again, so you have two outlines.	
Cut around both of the outlines.	



2. Sew the creature

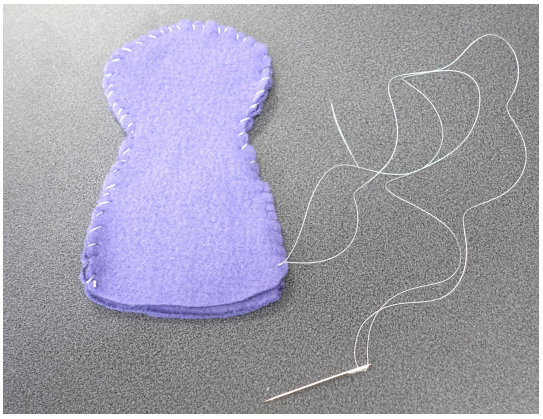
Put the two pieces of fabric together.



Prepare the needle and thread.

Pick which stitch to use:
Running or Whip stitch?

Begin sewing the edges together.



Keep sewing the edges till you have just one edge left.

Tip! You may not have enough thread for all the sides. Just finish the stitch, then prepare some more thread on your needle.

3. Stuff the creature

Make a bunch of small paper crumples out of scrap paper.

Stuff your creature full of paper crumples.

OR, you can use fabric scraps to stuff the creature. Using fabric to fill means your animal could go in the washing machine (depending on how you decorate it).

4. Finish sewing

Prepare your needle again.

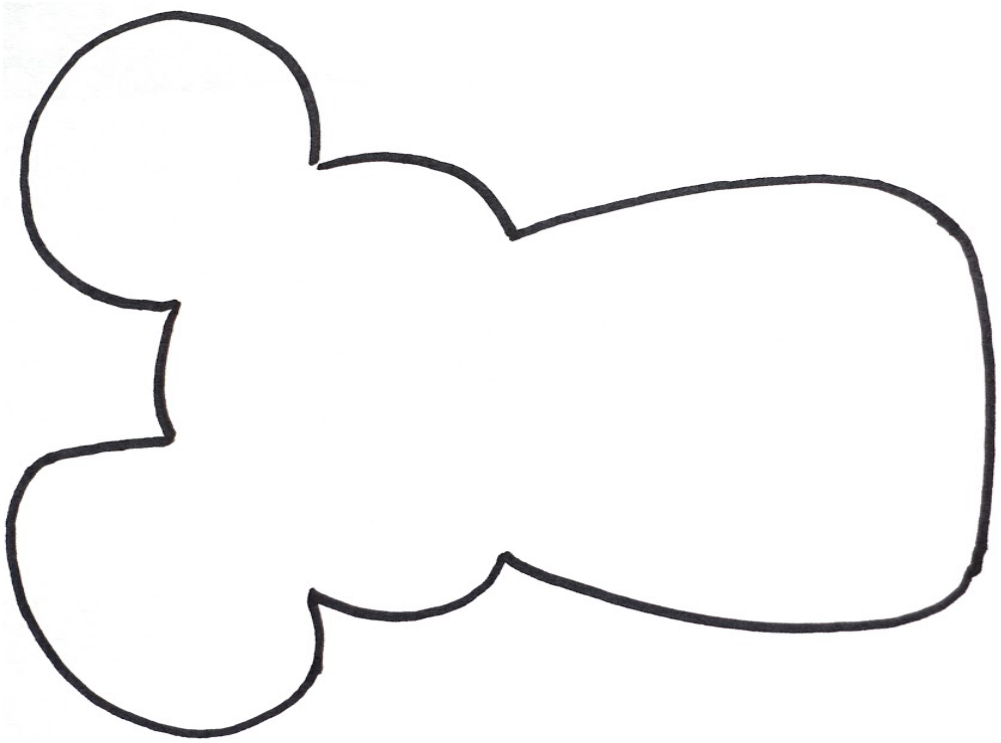
Sew up the edge that wasn't sewn yet to close the crumples inside the creature.

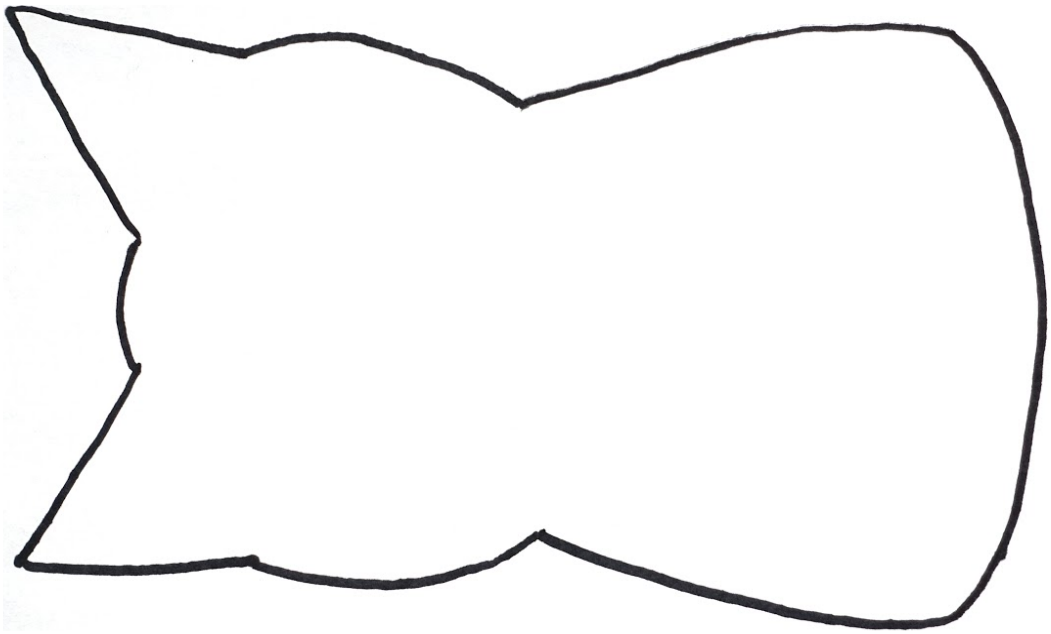
5. Decorate it!

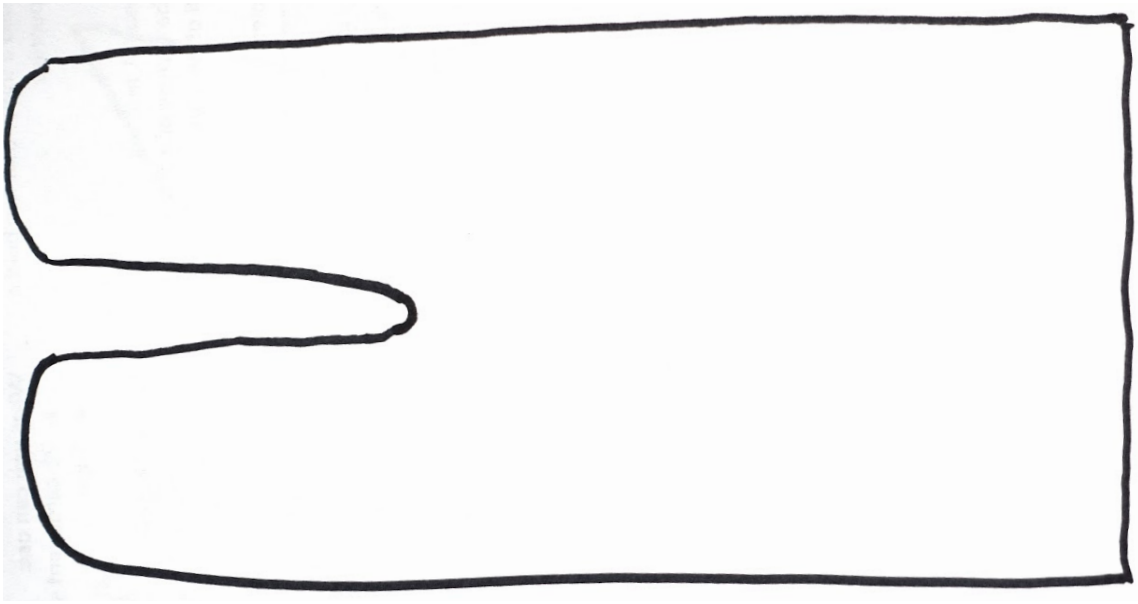
You could draw on it, glue or sew things onto it, decorate it with pieces of felt, buttons, pompoms...

After that, you're done!

Stuffed creature templates







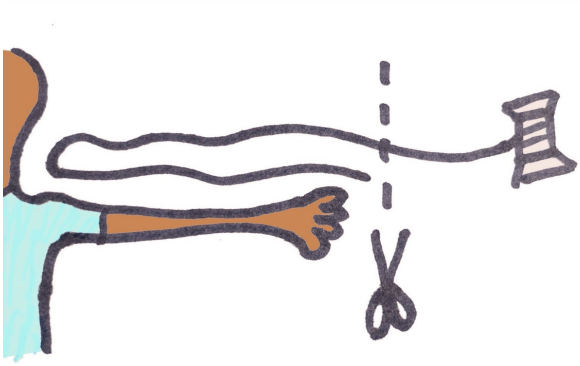
Cut one of these out along the solid lines, and use it as a template for your stuffed animal.

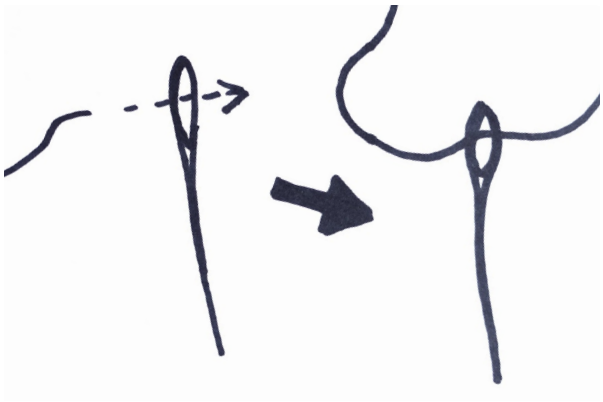
Or, make your own with a piece of blank paper and a marker!

Threading a needle

1. Cut the thread

Cut a piece of thread that is twice as long as your arm.



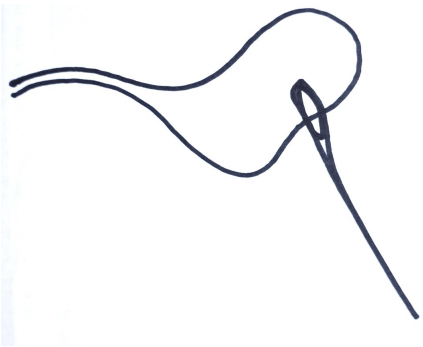


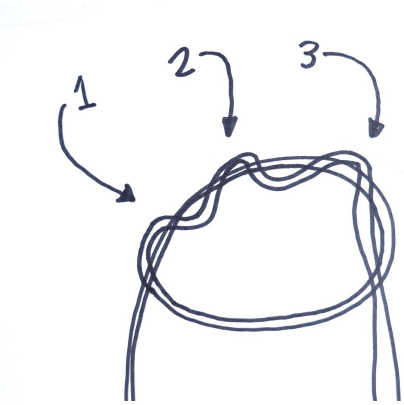
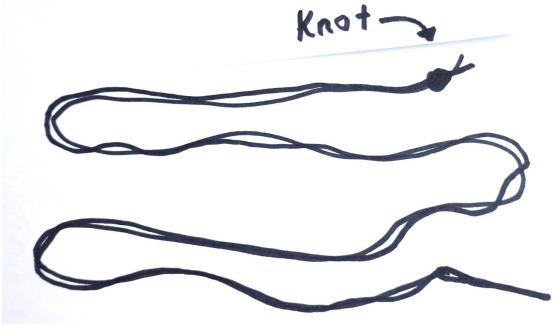
2. Thread the Needle

Take one end of the thread, and poke it through the hole in the needle.

3. Knot the thread

Hold the two ends of the thread together.

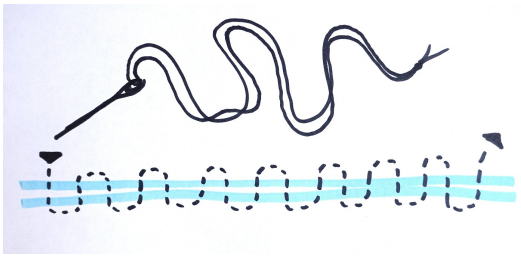


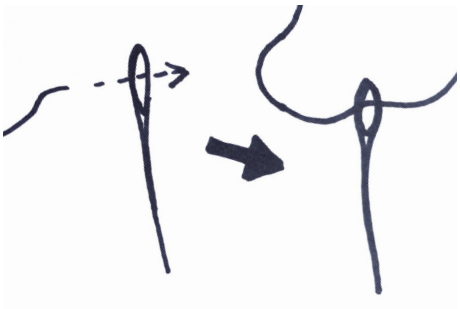
Make a circle near the ends of the thread. Loop the ends through the circle.	
Loop the ends through 3 times. The circle will look like this.	
Pull on the thread on both sides of the loop to tighten the knot.	
Your thread and needle will look like this.	

Sewing a running stitch

What is a running stitch?

It goes up and down through the edge of the fabric, like a zig-zag.



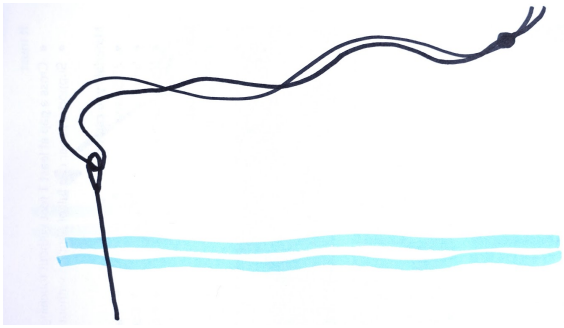


1. Thread the Needle

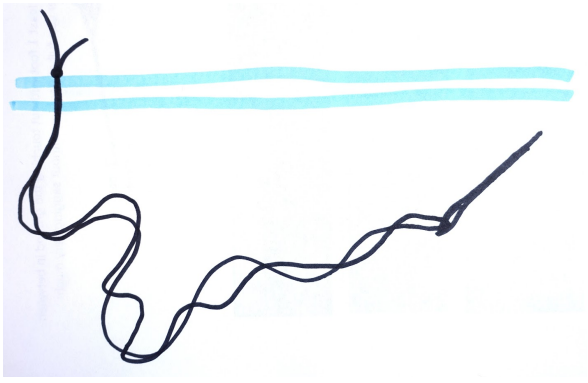
Follow the guide called “Threading a needle” to make sure you’re ready to sew.

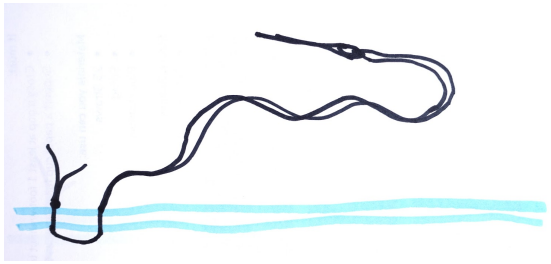
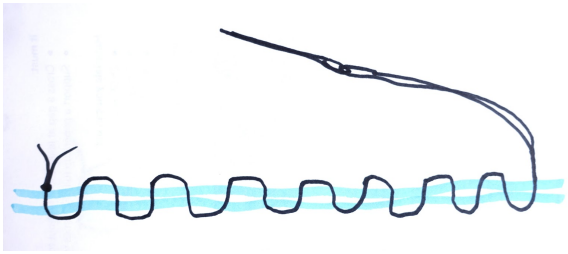
2. Sew it!

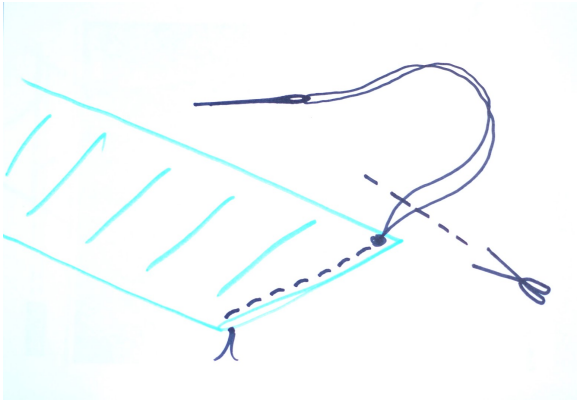
Push the needle through the fabric.



Pull it through till the knot is snug against the fabric.



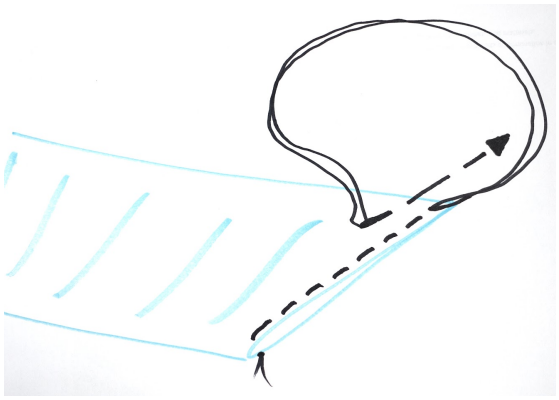
Push the needle through the other direction, and pull it tight.	
Keep pushing the needle through, up and down, until you're finished sewing.	

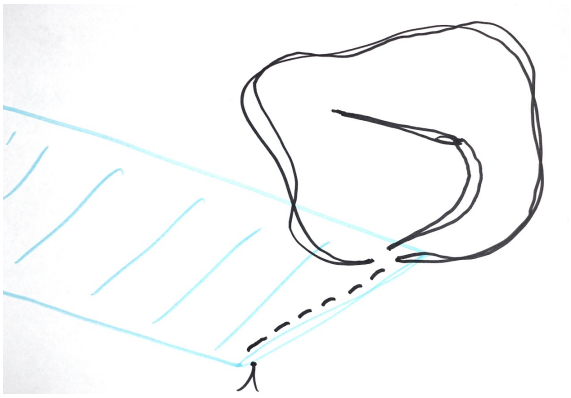
	**3. Finish the stitch** Follow the guide called "Finishing a stitch" to make a knot and cut off the extra thread.

Finishing a stitch

1. Make a loop

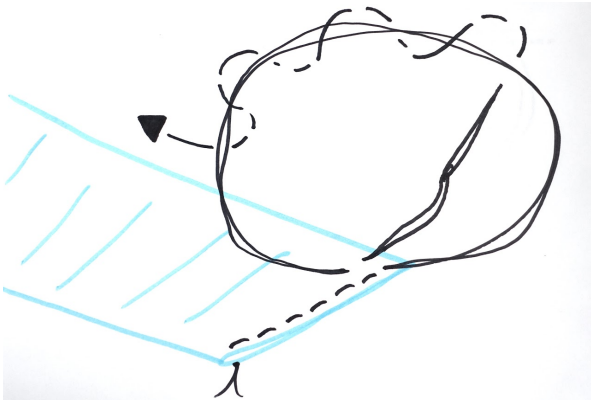
Take your needle, and poke it through just the top piece of fabric, so it comes out on top.



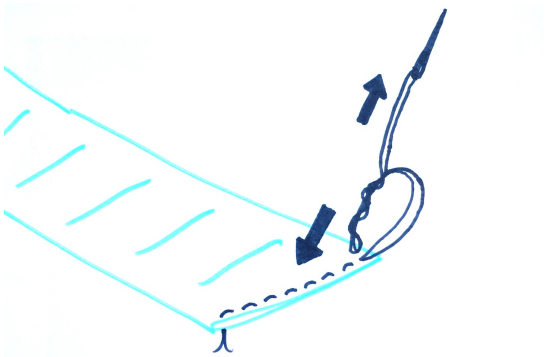


2. Tie a knot

Pull the thread part of the way through, but leave a circle.



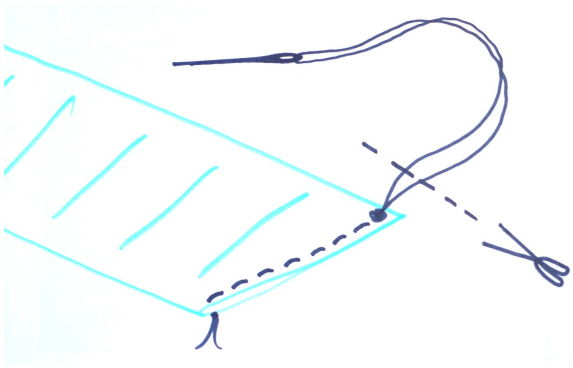
Just like when you tied the knot, loop the thread through the circle 3 times.



Pull on the needle and the fabric to let the knot tighten up.

3. Cut the thread

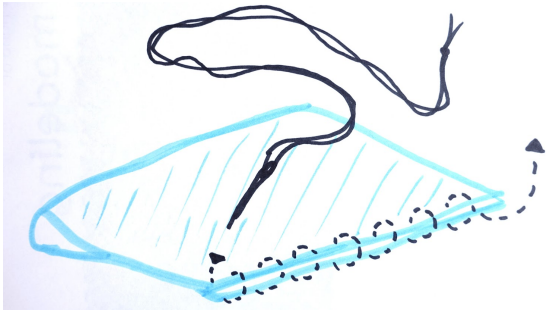
Cut off the extra thread.

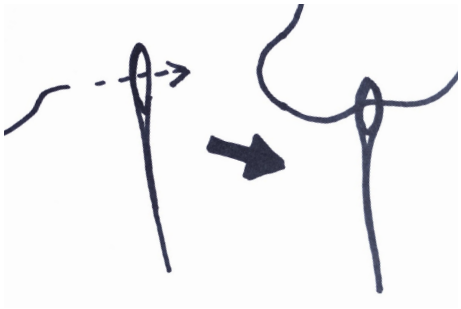


Sewing a Whip Stitch

What is a whip stitch?

It loops around the edges of the fabric, like the spiral metal wire on a notebook.



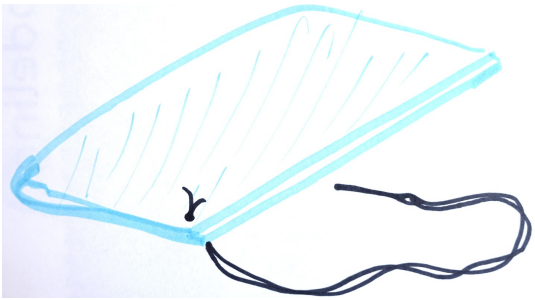


1. Thread the Needle

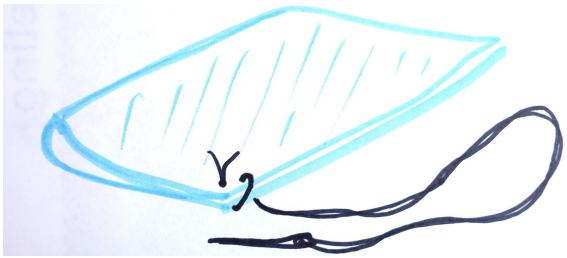
Follow the guide called “Threading a needle” to make sure you’re ready to sew.

2. Sew it!

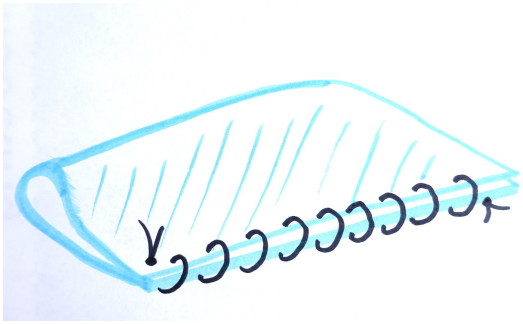
Push your needle through the fabric on one end.



Loop it around to the top of the fabric, and then push it through again.



Keep doing that until you finish sewing the edge.



3. Finish the stitch

Follow the guide called “Finishing a stitch” to make a knot and cut off the extra thread.

Your Goal:

Design a vehicle that goes as far as possible on the power from a single balloon.

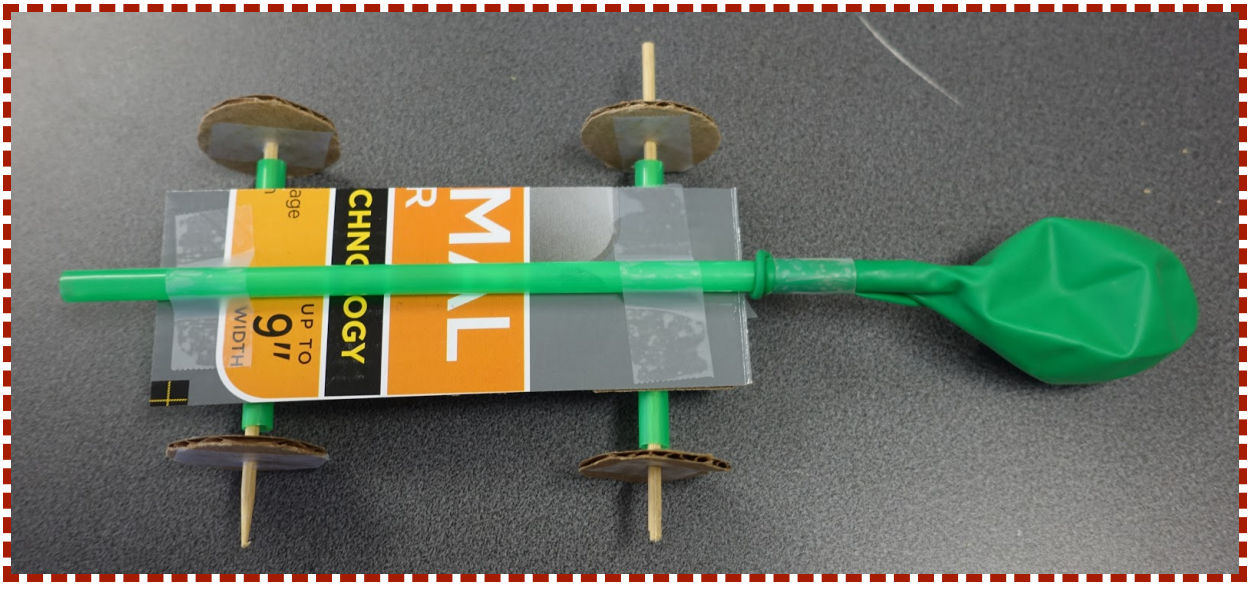
While you're designing, think about these things:

- Will it have wheels?
  - How will you make them?
  - How will they spin?
  - How will you keep them on?
- Are there vehicles that don't use wheels?
- How will you attach the balloon?
- How will you keep the balloon high enough so it doesn't hit on the ground?

Remember, your blueprint must:

- Show the design from several sides or angles
- Label each pieces of the design
- Show how big the design is with measurements

Example vehicle: Don't just copy this! You can make a ***much* cooler** vehicle.



Think about the supplies you have to use. Then, use the space on the next two pages to blueprint:

Balloon-powered vehicle: Blueprinting space

Balloon-powered vehicle: Blueprinting space

Bridge Challenge:

Goal: Design and build a bridge that meets the requirements below.

Requirements:

- The bridge must cross a gap of 1 ½ feet.
- It must support the weight of a cup full of popsicle sticks without touching the ground between the two ends.
- You may only use these materials: straws, popsicle sticks, paper, tape, and string.
- It may not cost more than $1000 to build. Prices for each piece are listed in step 4..

Project Steps:

1. Choose a kind of bridge to build from the examples below.
2. Blueprint the bridge
3. Get the blueprint approved
4. Prototype the bridge
5. Test the bridge
6. Budget the bridge
7. Modify, revise, or rebuild the bridge if needed
8. Reflect

Step 1: Choose a Bridge type

Look through the bridge types and examples, and decide which kind you want to build.

1. **Beam bridge**

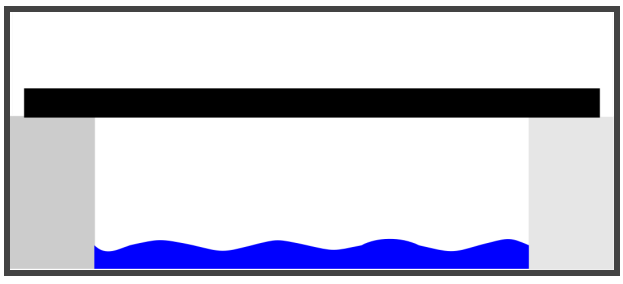


Image credit: TheMightyQuill (Via Wikimedia Commons)

Image: Public domain (Via Wikimedia Commons)

A beam bridge is made with a flat piece across two or more supports. This is the simplest kind of bridge.

2. Truss bridge

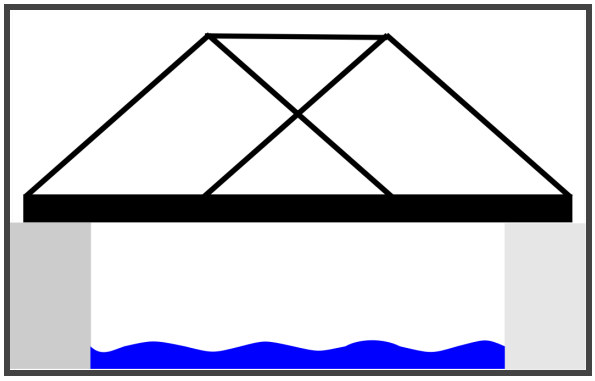


Image credit: TheMightyQuill (Via Wikimedia Commons)

Image credit: Silverije (via Wikimedia Commons)

A truss bridge is similar to the beam bridge, but is made out of triangle shaped “trusses” instead of being a flat beam. Adding diagonals (sideways slanting pieces) to create triangles helps to make a structure stronger.

3. Cantilever bridge

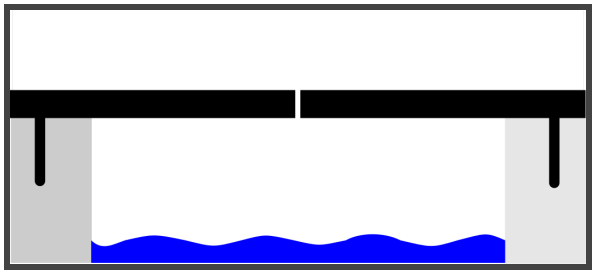


Image credit: TheMightyQuill (Via Wikimedia Commons)

Image credit: Mike McBey (Via Flickr)

Cantilever bridges are made with two pieces that meet in the middle, supported on each end. Often the supports are closer to the middle of the bridge, so that the weight on the far ends can help balance the bridge out.

4. Arch bridge (Ex. Sellwood bridge, Portland, OR)

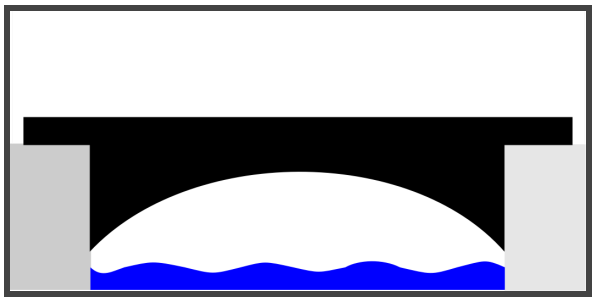


Image credit: TheMightyQuill (Via Wikimedia Commons)

Image credit: Steve Morgan (Via Wikimedia Common

The arch bridge is one of the oldest types of bridge. The weight in the middle of the bridge pushes down and out on the ends of the bridge, which holds it in place.

5. **Tied arch bridge** (Ex: Fremont Bridge, Portland, OR)

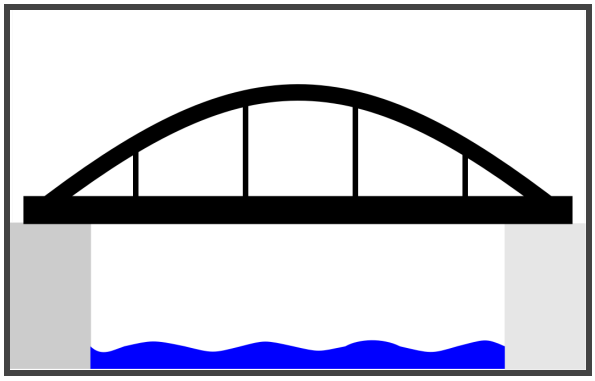


Image credit: TheMightyQuill (Via Wikimedia Commons)

Image credit: Cacophony (Via Wikimedia Commons

This is like an arch bridge, but instead, the arch is above the bridge. The center pulls down on the middle of the arch, which is supported at either end.
Why is this an arch instead of just a flat beam across the top?

6. **Suspension bridge** (Ex: St. John's Bridge, Portland, OR)

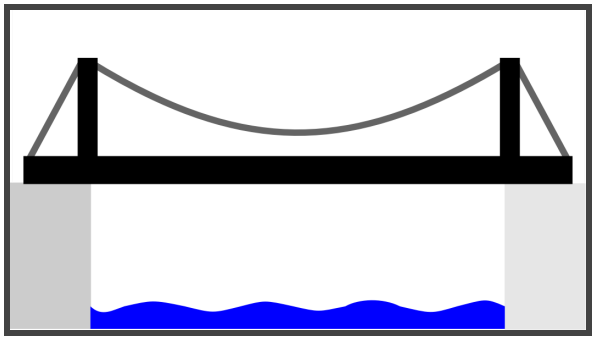


Image credit: TheMightyQuill (Via Wikimedia Commons)

Image credit: Cacophony (Via Wikimedia Commons)

This is a suspension bridge. It uses two towers, connected with a thick cable, with smaller cables running down to hold the road up. Often the towers are held up with cables on each end.

7. **Cable-stayed bridge** (Ex: Tilikum Crossing Bridge, Portland, OR)

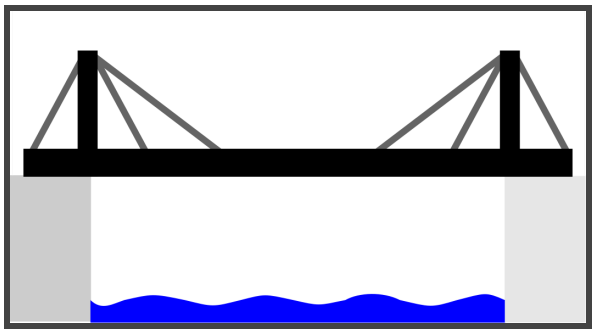


Image credit: TheMightyQuill (Via Wikimedia Commons)

Image credit: Steve Morgan (Via Wikimedia Commons)

Cable-stayed bridges are very similar to suspension bridges, but use less cable, so the towers must be higher to make up for that.

Step 2: Blueprint

Remember, your blueprint must:

- Show the design from several sides or angles
- Label each pieces of the design
- Show how big the design is with measurements

Bridge Type: _____

Use the space below and on the next page to blueprint your bridge.

Bridge Challenge Blueprinting Space

Bridge Challenge Blueprinting Space

Step 3: Test

Now, go test your bridge! Take notes on what works, and what doesn't.

Step 4: Budget

Price list:

Budget: $1000

Item:	Price:		Number used:		Item total cost:
1 Straw or Popsicle stick	$25	x		=	
1 piece of Paper	$20	x		=	
1 foot of Tape	$5	x		=	
1 foot of String	$10	x		=	
TOTAL BRIDGE COST					

How to figure out how much your bridge costs:

1. Count how many of each piece you use, and write that number in the column named "**Number used**."
2. Multiply the price of each item by how many you used to get the **item total cost**.
3. Add up all the **item total cost** numbers to get the **project cost**. That's how much your bridge costs!

Example:

Item:	Price:		Number used:		Item total cost:
1 Straw or Popsicle stick	$25	X	10	=	$25 x 10 = $250
1 piece of Paper	$20	X	10	=	$250
1 foot of Tape	$5	X	2	=	$10
1 foot of String	$10	X	3	=	$30
TOTAL BRIDGE COST					$540

Step 6: Modify, revise, rebuild

Step 7: Reflection

1. What was easy?

2. What wasn't easy?

3. Did you discover something you hadn't known before?

4. What was it like building with a budget?

Tower Challenge

Goal: Build a tower that will withstand an “earthquake”.

It must:

- Be at least 2 feet tall
- Be secured on the bottom to a piece of cardboard
- Withstand an “earthquake” - your teacher will shake the tower to imitate an earthquake
- Not cost more than $500 to build

What you can use:

- 20 straws OR popsicle sticks
- string
- tape
- 1 piece of cardboard (for the base/ground ONLY)
- 10 pipe cleaners

Strong Shapes:

- Arches and circles
- Triangles

Tower examples:

Public Domain: Wikimedia Commons

Credit: Jim Epler via Flickr

Credit: Joi Ito via Flickr

Notice how all the towers are wide at the base (the bottom of the tower), and thin at the top. This is like a triangle, which is a strong shape. Why else might they be this way?

Public domain, Wikimedia Commons

Credit: Sam Valadi, Flickr

Credit: Cyberdoomslayer, Wk. Commons

Credit: Baycrest via Wikimedia Commons

Credit: Morio via Wikimedia Commons

Credit: Joi Ito via Flickr

- What do these towers have in common?
- How are they the same? How are they different?
- Why?

Tower Challenge: Blueprinting:

Remember, your blueprint must:

- Show the design from several sides or angles
- Label each pieces of the design
- Show how big the design is with measurements

Remember to look at the supplies cost two pages away to make sure your tower plan isn't too expensive!

Use the space below and on the next pages to blueprint:

Tower Challenge: Supply costs
Budget: $500

Item	Price	Number used	Item total cost
Cardboard (for the base/ground ONLY)	$0	1	$0
Straws OR Popsicle sticks	$20 each		
String	$5 for one foot		
Tape	$15 for one foot		
Pipe cleaners	$10 each		
Scissors	$4.75/hr to rent		
Hot glue sticks	$25 each		
Paper	$5 per piece		

Project cost: $ _____

1. To figure out how much your tower costs, count how many of each piece you use, and write that number in the column named "**Number used**."
2. Multiply the price of each item by how many you used or how long you used it to get the **"Item total cost**."
3. Add up all the **item total cost** numbers to get the **project cost**. That's how much your roller coaster costs!

Space for calculations (use scratch paper too!):

Launcher Challenge

Goal: Design and build a launcher that launches a pompom into a goal 5 feet away.

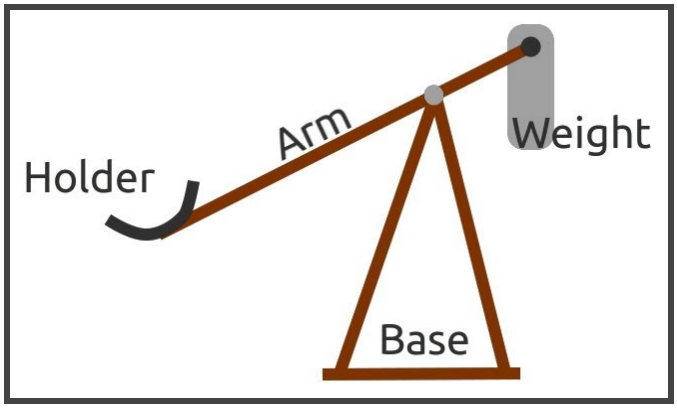
Project steps:

1. Look at launcher examples.
2. Blueprint a launcher.
3. Prototype and test the launcher.
4. Revise, rebuild, or modify as needed.

Step 1: Examples of Launchers

Look through the examples to learn how common types of launchers work. You don't need to make one of these types, but you can.

Trebuchet (pronounced treh-beeuw-shey):

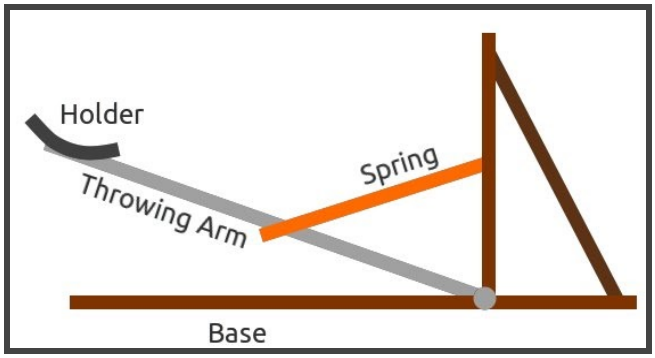


Credit: Jacob Field, CC BY 4.0

Credit: ChrisO via Wikimedia Commons

To launch the trebuchet, the arm is let go. The weight falls, swinging the arm up really fast and throwing whatever is in the holder.

Catapult:

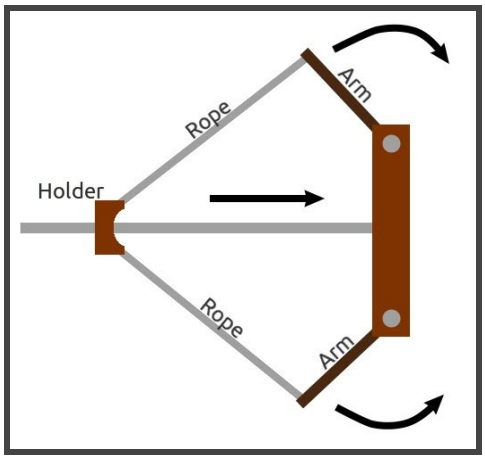


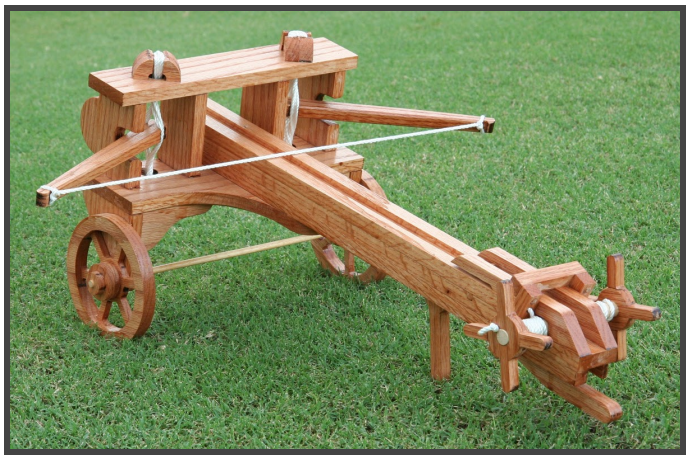
Credit: Jacob Field, CC BY 4.0

Public Domain via Max pixel

The arm is pulled back, storing energy in the spring. When the arm is let go, the spring pulls it up until it hits the base, and sends whatever is in the holder flying.

Ballista:





Credit: Jacob Field, CC BY 4.0

Credit: Ron L. Toms via Wikimedia Commons

The ballista works kind of like a bow and arrow, or crossbow. It has two arms that are attached to springs, which pull the holder forwards quickly when it's let go.

Step 2: Blueprint

Create a blueprint for your launcher on the next two pages. You don't have to use one of the designs shown above.

Remember, a blueprint must:

- Show the design from several sides or angles
- Label each pieces of the design
- Show how big the design is with measurements

Step 3: Prototype and Test

Once your blueprint has been approved by the Maker Club leader, you can build it! While you're building, don't forget to test often to make sure it still works.

Step 4: Reflection

1. **What was easy?**

2. **What wasn't easy?**

3. **Did you discover something you hadn't known before?**

Playground Machines

Goal: Design a playground toy that meets two requirements:

- It must use one of the 6 simple machines.
- It needs to actually work.
  (For example, if it's a see-saw, it has to work just like a see-saw.)

Steps:

1. **Pick** which of the 6 simple machines/playground toys you want to design.
2. **Blueprint** it.
3. **Build and test** it.
4. **Present** it to the rest of the class!

The 6 Simple Machines:

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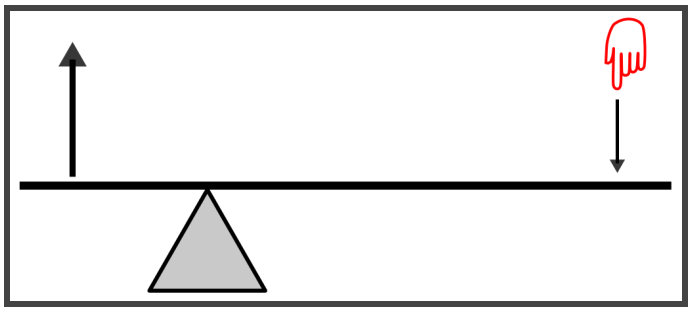
1. **Lever**

Credit: OiMax, via Flickr

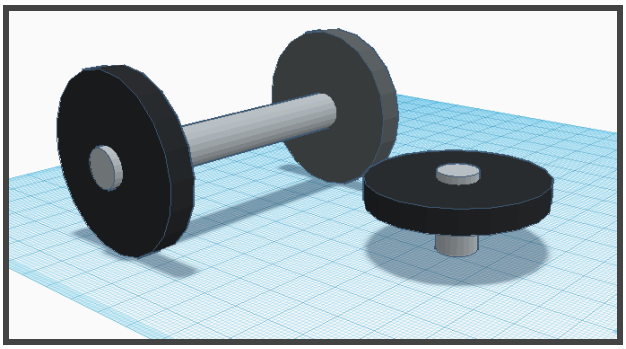


Credit: Iainf via Wikimedia Commons

Levers transfer force (like pushing) from one direction to the other.
Seesaws are great examples of levers. When one side goes down, the other goes up!

2. **Wheel and Axle**

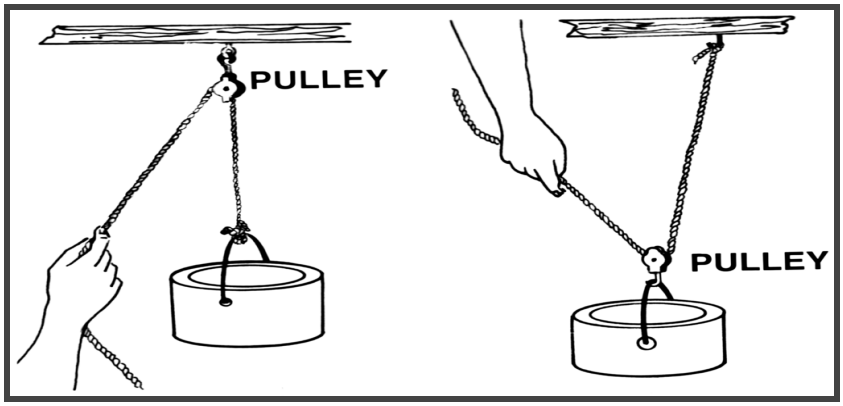
Credit: Micheal Rivera via Wikimedia Commons



Credit: Jacob Field, CC BY 4.0

Wheels and axles work together to reduce friction by rolling. Imagine if a car had no wheels- It would be really hard to move!

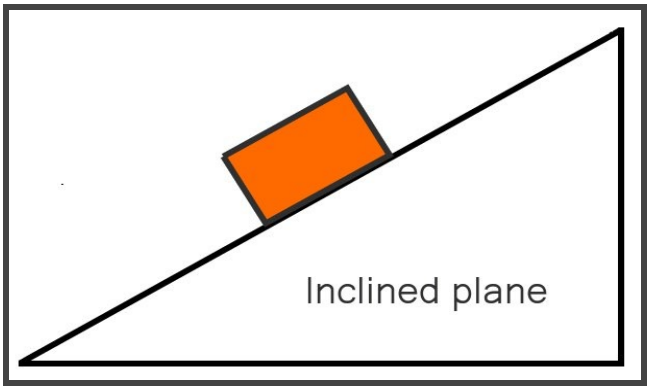
3. Pulley



Credit: Comrade King via Flickr Public domain via Wikimedia Commons

A pulley transfers force to a different direction.

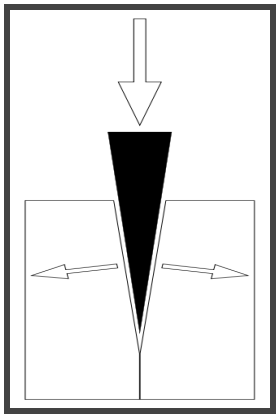
4. Inclined plane



Credit: Stilfehler via Wikimedia Commons Credit: Jacob Field, CC BY 4.0

Inclined planes, or ramps, make moving things up and down easier.

5. Wedge



Credit: Iainf via Wikimedia Commons Credit: Public domain via pxhere.com

A wedge makes it easier to push things apart. It's kind of like an inclined plane.

6. **Screw**



Credits: rjp via Flickr Tomasz Sieniki via Wikimedia; Public domain via PxHere

A screw transfers rotational motion (like turning) into linear (like a line) motion, or can be used to switch which direction the motion goes in.

Blueprinting:

Simple Machine Used: _____ **Playground toy name**: _____

Remember, a blueprint must:

- Show the design from several sides or angles
- Label each pieces of the design
- Show how big the design is with measurements

Use the space below and on the next pages to blueprint your design. When you are finished, get your blueprint approved by a Maker Club leader, and then build and test it!

Raft Examples

1. Barge

Large boats with flat bottoms, meant for carrying lots of stuff.

You've seen them on the river—those long green or brown things with smiley faces on them!

Credit: Jason Prat, Flickr

2. Inflatable raft

Blow-up boats with flat bottoms, usually used for whitewater rafting.

These are blown up with air! When deflated, they can be folded up.

3. Wooden raft

Basically a flat, thick piece of wood. The simplest kind of raft!

This raft was made just for these turtles at a zoo in Germany.

Credit: Adamantios, Wikimedia Commons

Most rafts have these things in common:

- They are flat underneath (flat-bottomed).
- They can carry a lot of weight.
- They are wide.
- They are (usually) a simple shape.

Houseboat Examples



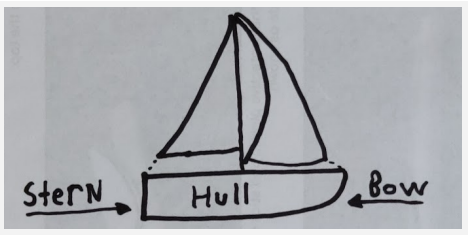




Image credits: 1: Beyond my Ken | 2: Waqcku | 3: Lian Chang | 4: Joe Futrelle | 5: PixaBay | 6: MaxPixel | 7: MaxPixelAll images are CC BY/BY SA 2.0-4.0 OR under CC0/Public domain licenses

Boat Examples

Why are boats shaped the way they are?



The shape of a boat can change how stable it is, or how fast it goes.
The **hull** is the main part of the boat.
The **stern** is the back part of the boat.
The **bow** is the front part of the boat.

Rowboat: Pointed bow, flat bottom and stern

Credit: Dennis Jarvis

Catamaran: Two hulls with pointed ends

Public domain via Wikimedia

Sailboat: V-shaped hull, flat stern, pointed bow

Credit: Yatchy4000 via Wikimedia

Canoe: Flat bottom, pointed stern and bow

Credit: Franklin.vp at en.wikipedia

- Why do you think the hulls are flat-bottomed or V-shaped?
- How might the shape of the stern and bow change how fast the boat goes?
- What might be the purpose of the thing sticking down on the sailboat's hull?
- Why do you think the catamaran has two hulls?
- Which boat might be the most stable? Most likely to tip?

Sail Examples

Sails are used to move boats through the water.

Windsurfing sail

Credit: Goldi64 via Wikimedia

"Gaff rig" sail

Credit: Oxyman via Wikimedia

"Sloop rig" sail

Public domain via PxHere

"Spinnaker rig" sail

Public domain via Wikimedia

- Which way do you think the wind is blowing in each picture?
- What is similar about the sails?
- What is different about the sails?
- What kind of material might make good sails? Why?

Cardboard Arcade

Goal: Build a cardboard arcade with your team!

Rules:

- No prizes or tickets—your game should be fun enough that is doesn't need them.
- No looking up "arcade games" on Google—this is your chance to make something unique!
- You get to use anything you want (besides the tools), even things from the supplemental supplies, **as long as your blueprint shows clearly how you will use it**.

Tips and Tricks:

- Remember to look at the "cardboard attachments" in the front of this notebook!
- Test the game **as much as you can**, even while building, to make **sure** it will work for your players! Remember, it needs to be easy for other people to play!

Steps:

1. Brainstorm with your team, and decide what kind of game to build.
2. Blueprint the game completely.
3. Build and test the game.
4. Play the game!

Step 1: Brainstorming

Get together with your team, and spend some time thinking up ideas for arcade games.

Try to write down as many games as you can think of (even your own ideas), and then decide as a team which one you want to make. Write them below:

Step 2: Blueprinting

Remember, your blueprint must:

- Show the design from every sides or angle
- Label each piece of the design
- Show how big the design is with measurements

It's really important to make a good blueprint for the cardboard arcade! That way, everyone on the team knows exactly how it should be built.

Use the space below, and the blank pages ahead, to blueprint your idea completely.

Step 3: Build and Test your Arcade

Once you get your group's blueprint approved by a Maker Club leader, you may begin building it.

To make building go quickly, each member of the group should focus on one part of the arcade. You may decide how to split the work up. Make sure it's fair!

Remember to test as much as possible. This will make sure that each piece you make works like it should, and that the Arcade game will be fun and work well.

Finally, if anything might break or get lost, try to make some extras for Game Day.

Step 4: Play the Game!

It's time for Game Day! Here are a few things to remember:

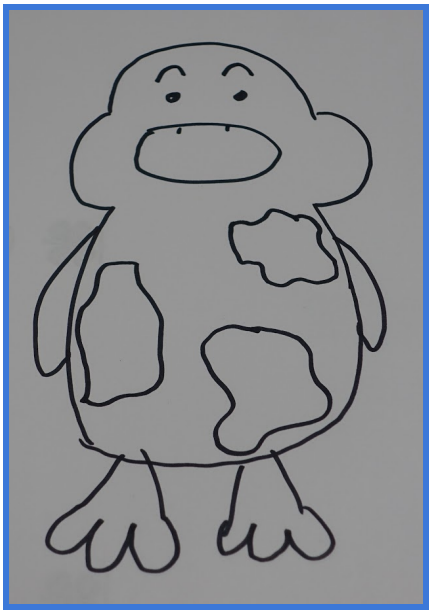
- Your game might break and that's ok! Professional arcade games break, too!
- Pleces might get lost, so make sure you have extras!

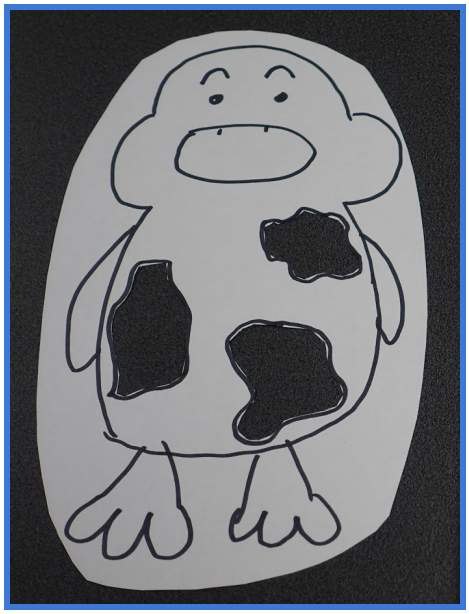
DIY Operation Game

You will need:

- 3 alligator leads
- 1 AA battery
- 1 AA Battery holder
- 1 pair of Metal Tweezers
- 1 Active Piezo Buzzer
- 1 file folder
- 1 piece of paper
- Scissors
- Tape
- Some aluminum foil
- Markers for decoration
- Pompoms, rubber bands, and other objects to extract

1. Make a shallow box out of your file folder, but don't actually tape it together yet.





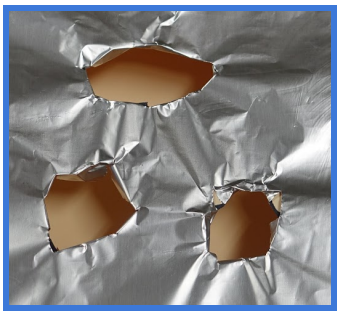
2. Draw your operation character on a piece of paper, then cut it out.

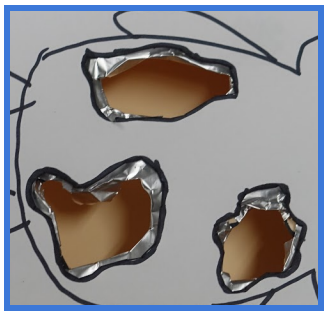
3. Use your character cutout to trace the holes onto the top of the box.

4. Cut the holes out.

Tip: if you fold the folder, it can be easier to cut. We don't recommend poking scissors through. (If you've ever made paper snowflakes, think about that folding & cutting).

5. Wrap a piece of tin foil around the box, then tape it down on the underside of the box.



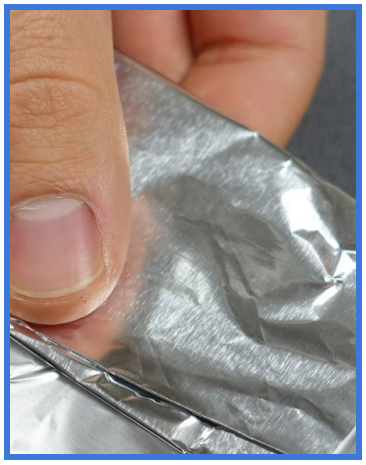


6. Poke holes in the foil where the holes in the box are.

Wrap the foil edges around the edges of the hole.

Tape your character cutout on top of the box.

7. Fold a piece of foil that will fit inside the box. Slide it in, leaving a little sticking out the end.

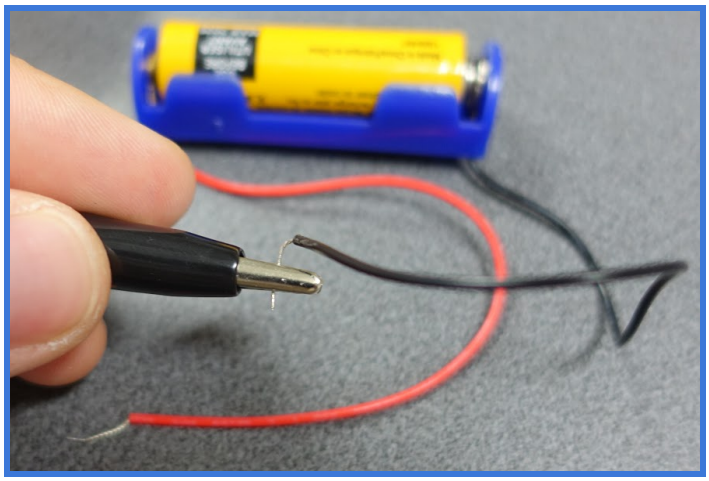




8. Fold the foil that's sticking out the end over onto the other foil, then tape it down.

9. Tape your character down, and make sure all the foil is securely taped down.

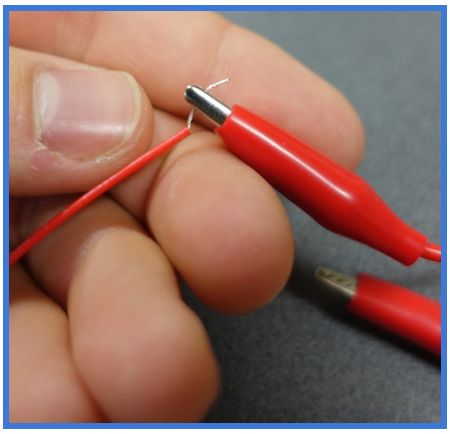
10. Attach one end of an alligator lead to the edge of the box, on top of the foil.

Note: The color of the leads don't matter, just make sure you connect them as instructed here.

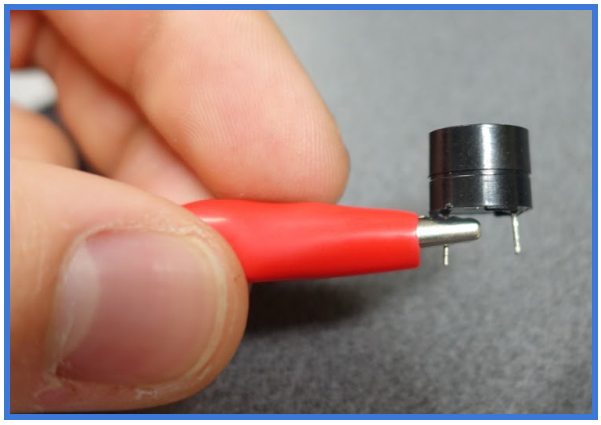


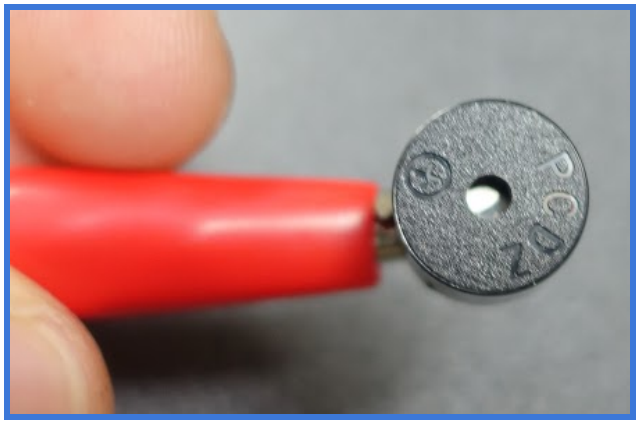
11. Put the battery in the battery box.

12. Attach the other end to the black wire on the battery box.

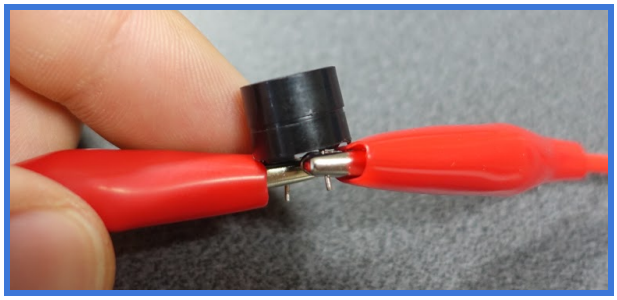


13.Attach one end of another alligator lead to the red wire on the battery box.





14. Attach the other end to the leg on the “ + “ side of the buzzer.

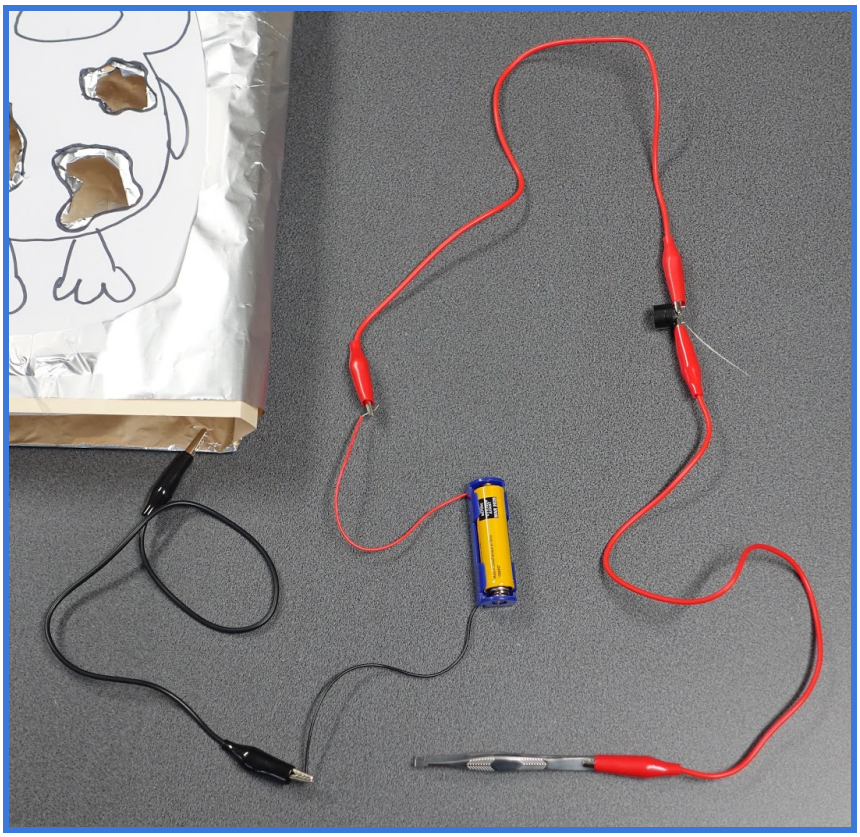


15. Attach one end of the last alligator lead to the short leg on the buzzer.

16. Attach the other end to the top of the tweezers.

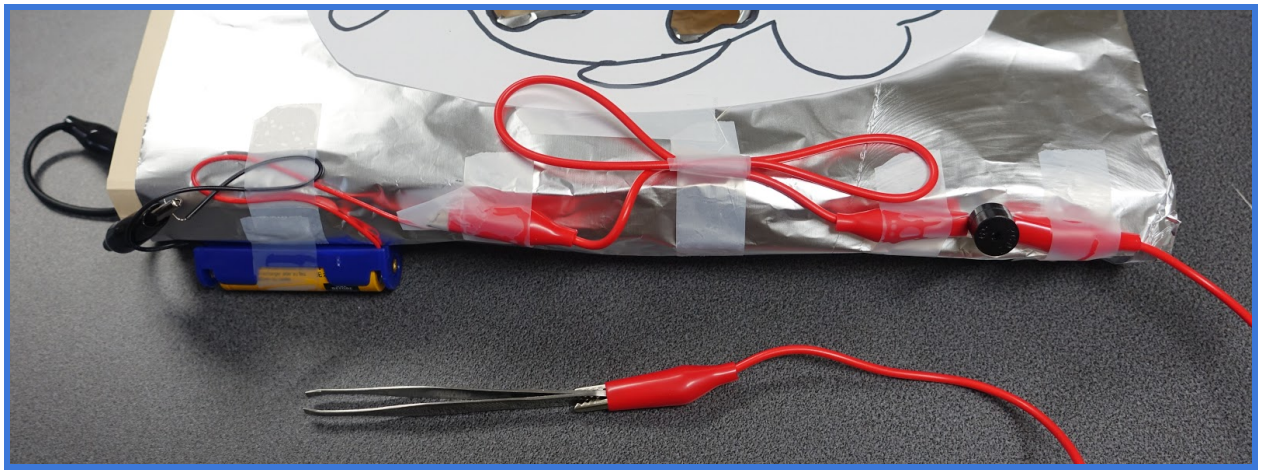
17. The finished circuit should look like this...

(see next page!)



18. Test it: If it beeps when you touch the tweezers to the foil, it works!

If it doesn't check all the connections and make sure the buzzer is connected right.

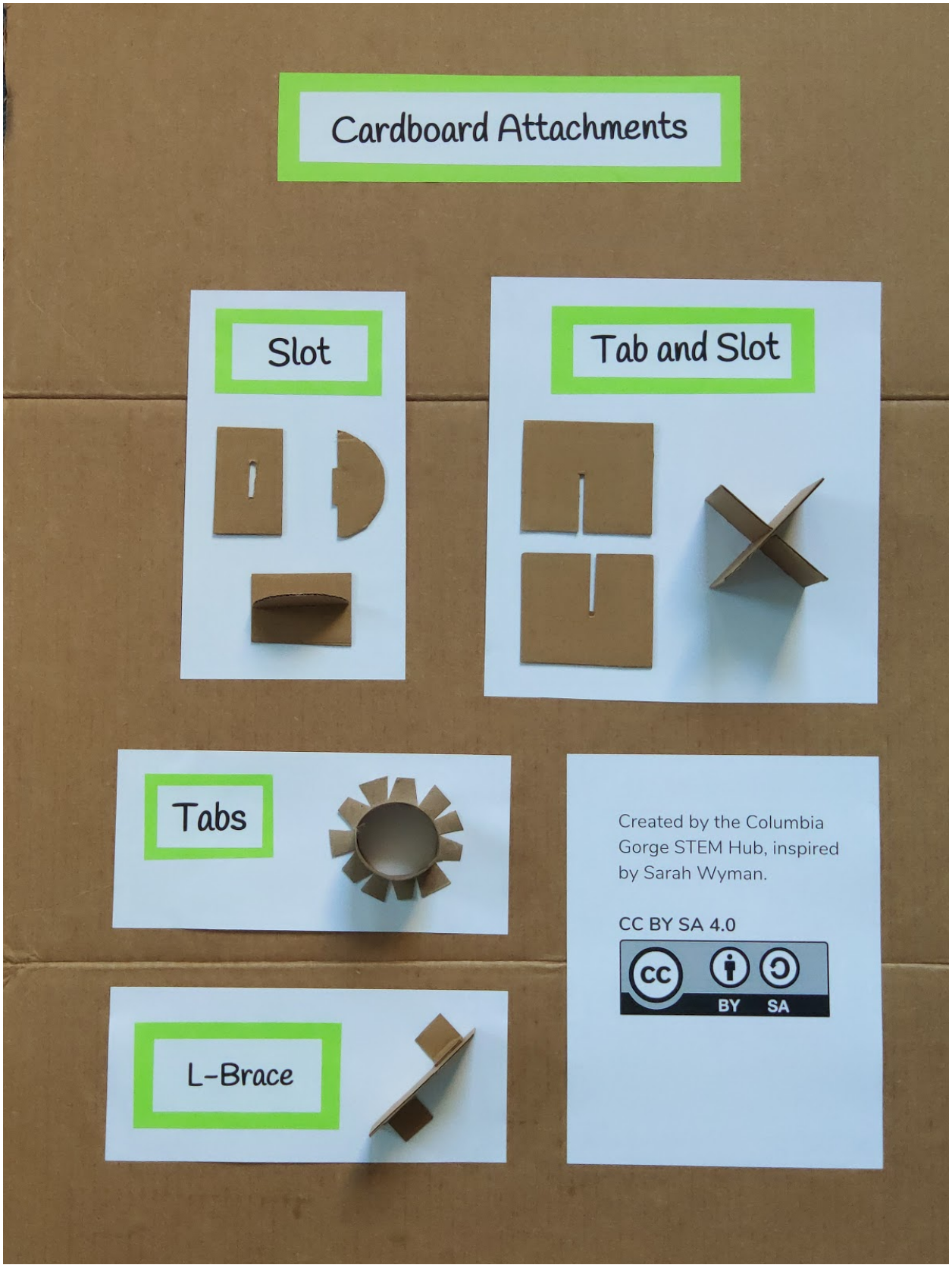


Now, wrap tape around the connections between the alligator leads and the other parts, to make sure they don't touch the foil.

Tape the extra wires, battery box, and buzzer to the side of the box.

Now, find some objects to extract, decorate your game, and have fun!

My other ideas, inventions, and thoughts...


Cardboard Attachments
Slot
Tab and Slot
Tabs
L-Brace
Created by the Columbia Gorge STEM Hub, inspired by Sarah Wyman.
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