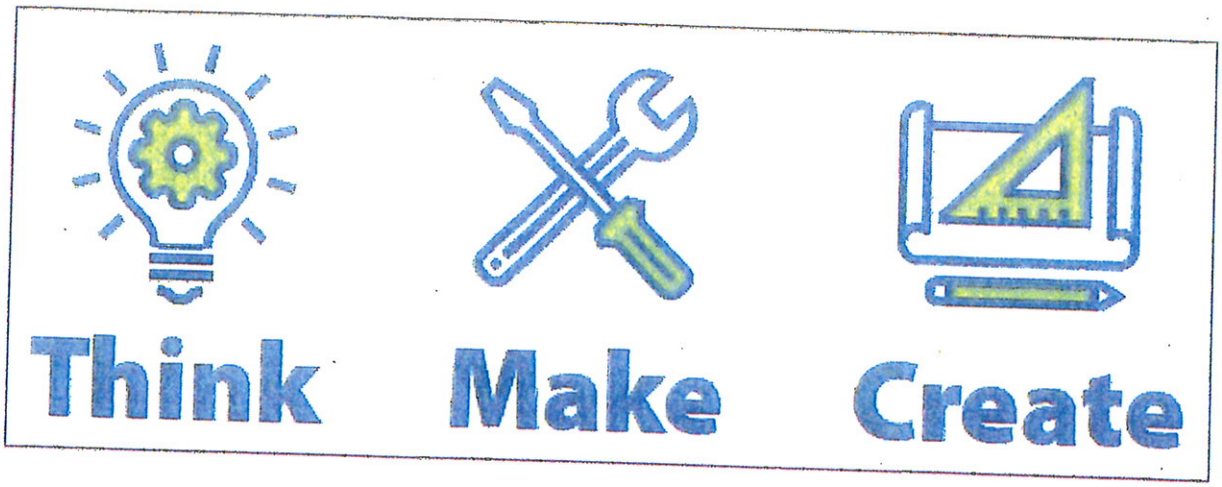



# Activity Guide

20 Makerspace Activities for TMC Labs

CIVIC NEBRASKA · MODERN & ROBUST DEMOCRACY ·

Beyond School Bells
nebraskachildren

# Table of Contents

# I. Activities

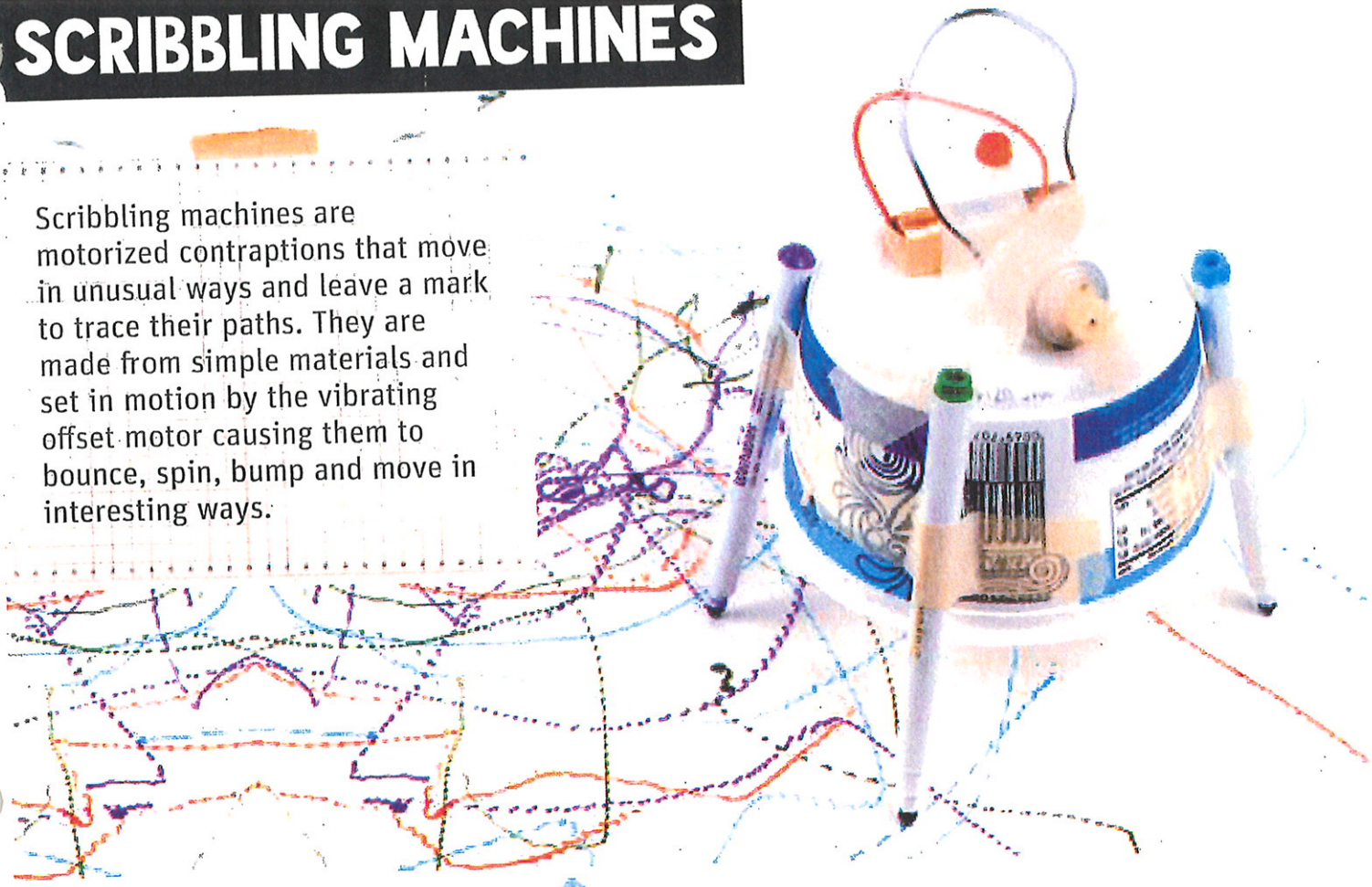
BELOW ARE 20 ACTIVITIES FOR THE TMC MOBILE MAKERSPACE. THESE ACTIVITIES INCORPORATE MANY OF THE SUPPLIES INITIALLY PROVIDED IN YOUR TMC LAB. A RANGE OF DESIGN/ENGINEERING, SCIENCE, ELECTRONICS AND ARTS/CRAFTS ACTIVITIES ARE OUTLINED IN THIS GUIDE. WHILE WE HOPE THESE ACTIVITIES WILL HELP YOUR PROGRAM GET STARTED IN UTILIZING THE LAB, IT IS NOT AN EXHAUSTIVE LIST. PLEASE TAKE TIME TO LOOK AT THE "MAKERSPACE RESOURCES" PAGE FOR MORE ACTIVITIES AND IDEAS.

1. Scribbling Machines
2. Paper Circuits
3. Strawkets
4. Penny Batteries
5. Craft Stick Catapult
6. Solar Oven
7. Cardboard Challenge
8. Nature Weave
9. Cardboard Automota
10. Animal Art
11. Hand Sewing Projects
12. Flowers from Mars
13. Paper Plate Bucky Balls
14. Spaghetti Art
15. Cardboard Creature Challenge
16. Knitting Loom
17. Pom Pom Crafts
18. Greeting Cards
19. Lego Challenge Activities
20. Knex Challenge Activities

# Scribbling Machines

# SCRIBBLING MACHINES

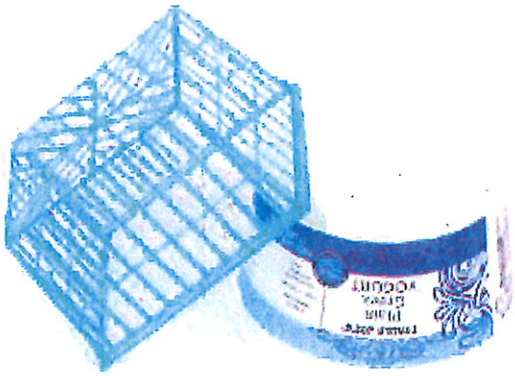
Scribbling machines are motorized contraptions that move in unusual ways and leave a mark to trace their paths. They are made from simple materials and set in motion by the vibrating offset motor causing them to bounce, spin, bump and move in interesting ways.



## TRY IT!

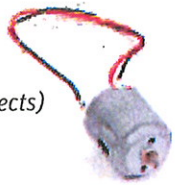
**Collect these things:**

Markers



Recyclable container such as a strawberry basket or yogurt cup

AA battery



1.5-3.0 volt motor
*(you can find motors in all sorts of toys and common household objects)*

A piece of hot melt glue stick

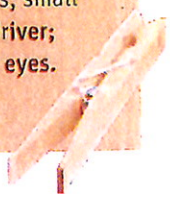
Broccoli band
(thick rubber bands used for produce)

Masking tape

Plus:
Paper for testing

**Some other helpful materials:**

Clothespins; Popsicle sticks; wood skewer sticks; pipe cleaners; wire; nuts, washers, or other small weights; wire stripper; scissors; small screwdriver; googly eyes.



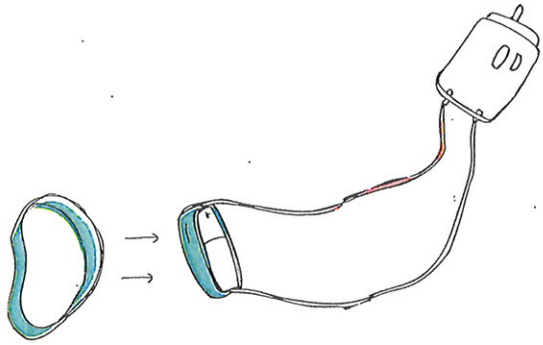
**the tinkering studio**

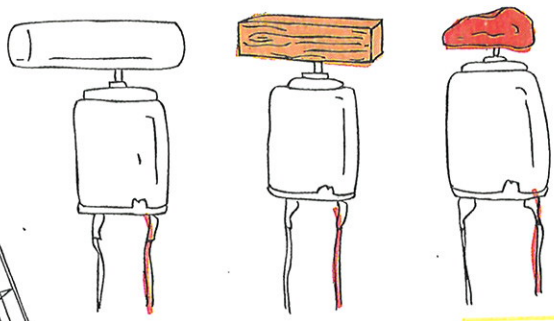


exploratorium

# GETTING STARTED

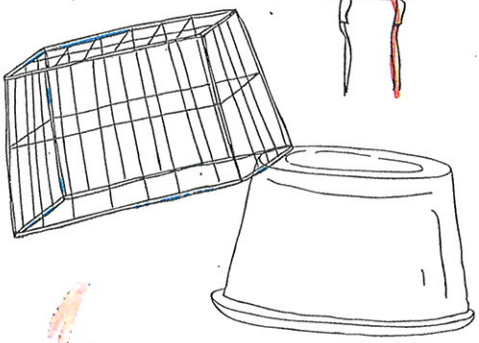
**Connect the motor to the battery**—a broccoli band is perfect for keeping the leads attached to the motor and still be able to disconnect them when you want to change the motor's position (masking tape can work too if you don't have a broccoli band).





**Experiment with ways to offset the motor:** try a piece of hot melt glue stick, wood, or clay.

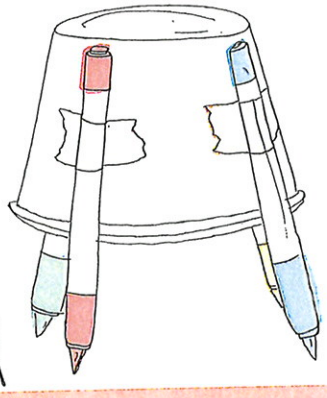
*What happens if you change the weight of the offset motor? Or change the length of the arm on the motor? Or change the orientation of the hot melt glue stick?*



**Find or build a base and attach your offset motor to it** (try a strawberry basket, yogurt container, or other recyclable container).

*TIP: Make sure there is enough clearance for your offset motor to spin*

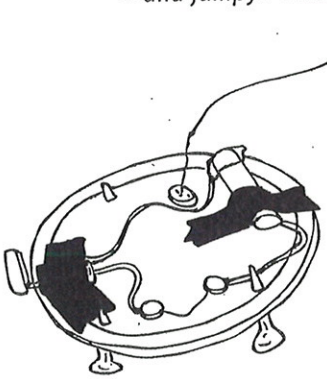
**Attach one or more markers** to trace the jittering movement of your scribbling machine. Turn it on and make some scribbles!



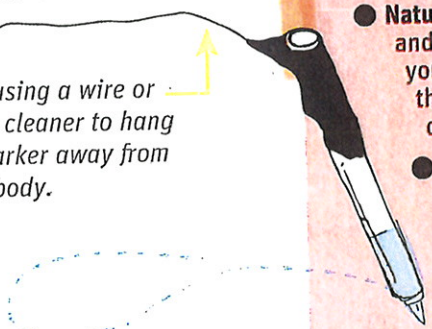
*Experiment with different designs: How could you make it go really slow and smooth? Fast and jumpy? Make big and small circles?*

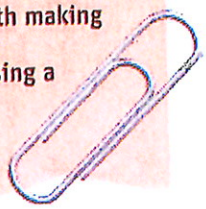
# TAKE IT FURTHER

- **Trace-making materials:** Experiment with using different materials such as paint and paintbrushes, chalk, or pencils to trace the patterns your scribbling machine makes. With chalk you can even scribble on the sidewalk!
- **Natural materials:** Collect items like sticks, leaves, bark, and pods from a park or your backyard. Add them to your machine and set it scribbling outside to see how the natural materials leave different pathways in sand or dirt.
- **Incorporating switches:** Experiment with making a switch to make it easer to turn your scribbling machine on and off. Try using a combination of clothespins, tinfoil, paperclips, brads, craft foam, or other materials.



*Try using a wire or pipe cleaner to hang a marker away from the body.*





# Paper Circuits

# PAPER CIRCUITS

Make simple or complex electrical circuits on a piece of paper! Copper tape and surface-mount LEDs allow you to turn a fully functional circuit into a light-up greeting card, origami animals, or three-dimensional pop-up paper sculptures that have working lights in them.

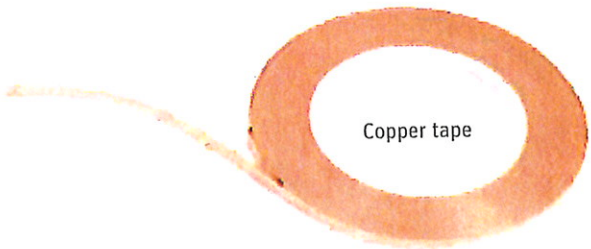
## BUILD IT!

**Collect these things:**

Cardstock or construction paper

Surface mount LEDs

3V coin cell batteries



Copper tape

*[TIP: You can get 5 mm copper tape, ready for use, from sparkfun.com (part #PRT-1-561). It is also often sold in hardware stores under the name of Slug Tape–it is taped to the lip of planters to prevent slugs and snails from climbing in. If you use slug tape, you might want to cut it into thinner strips before using it on your paper circuit.]*

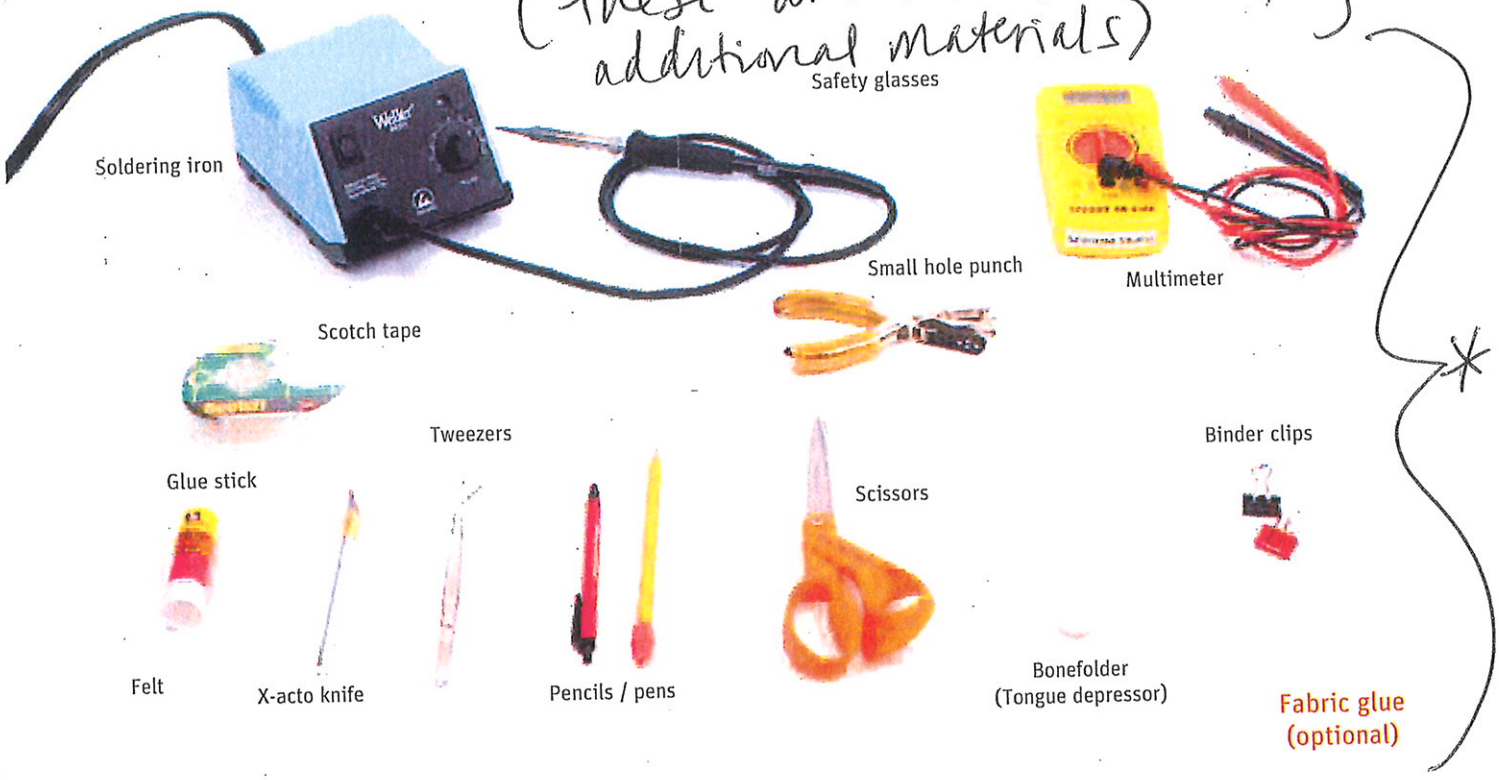
**the tinkering studio**



exploratorium

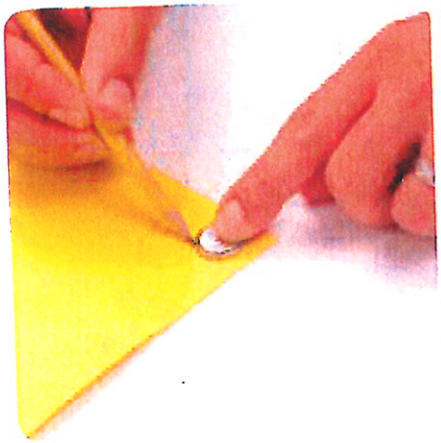
## Other Helpful Materials:

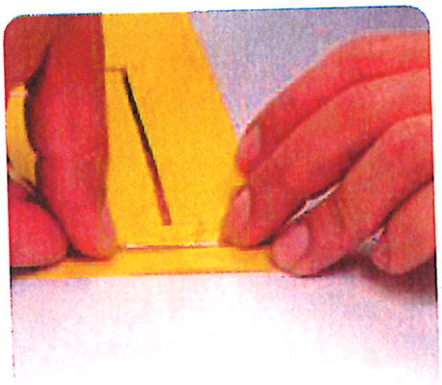
(these are not needed, just additional materials)




# TRY IT!

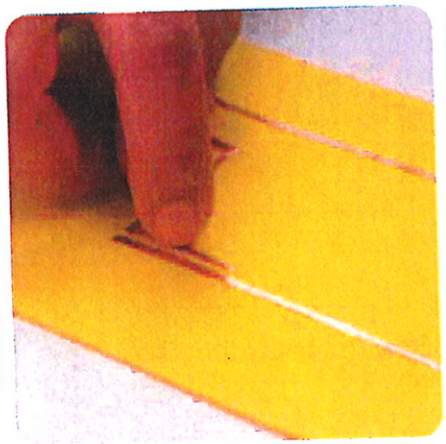
## Getting started:

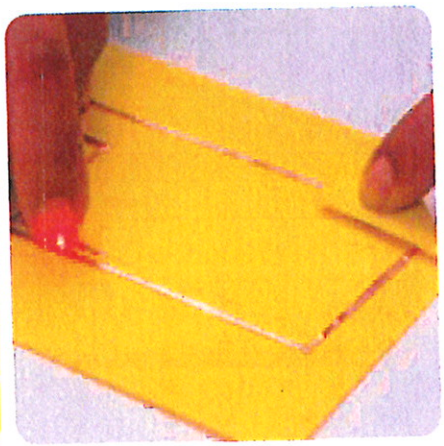


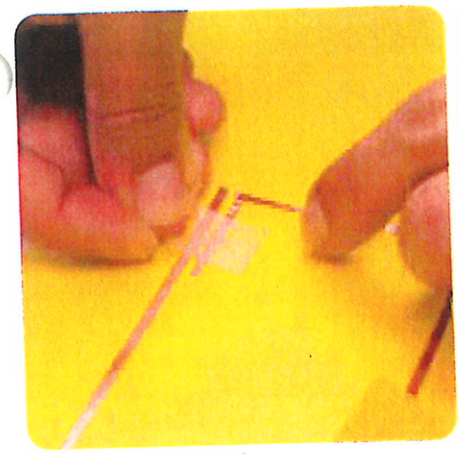


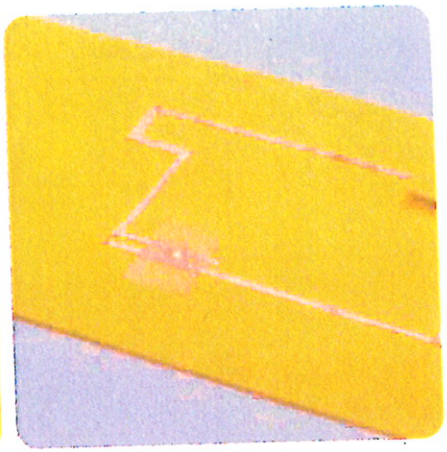
**Start simple** – fold over one corner of the paper and trace the battery on either side of the fold. Try taping down two strips of copper tape with each piece starting from one of the circles and ending about 1 mm apart (don't worry about how it looks for now).

**Place a surface mount LED in the gap.** Fold the battery in the tab you created earlier and see what happens. Does the light turn on? If not, try flipping the battery or gently pushing down on the light.



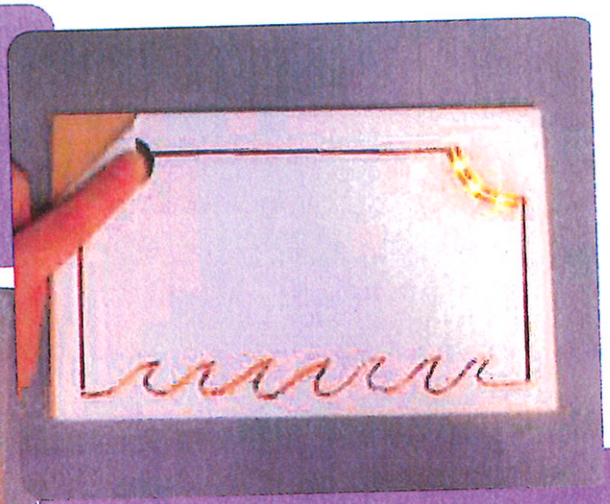


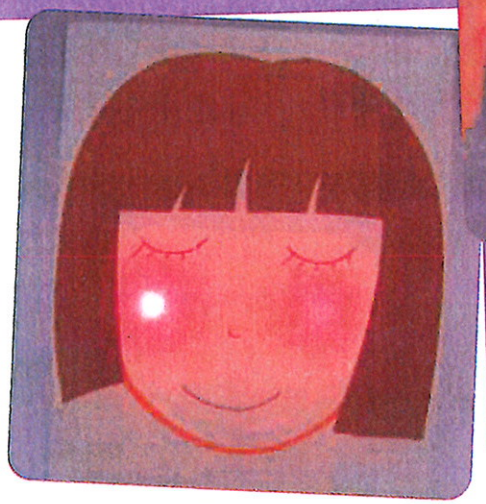




**You can lay a piece of Scotch tape over your LED** to secure it to the copper tape or solder the LED to the copper tape using a soldering iron. (See helpful techniques below for tips on soldering the lights.)

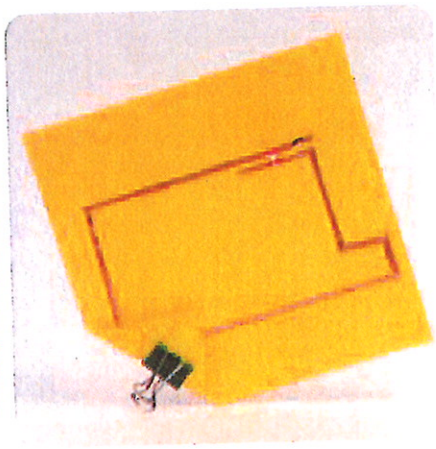
With these starting steps, the possibilities for creating your paper circuits are endless. You can **fold the copper tape into different designs** or make a collage that is lit by a hidden circuit on another piece of paper underneath.

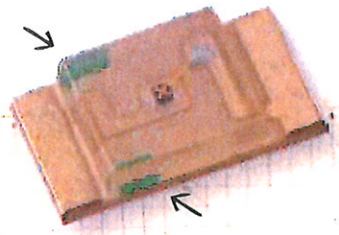




**Could you make a battery holder somewhere else on the paper besides the corner?** Or a switch that turns your lights on and off when pushed?

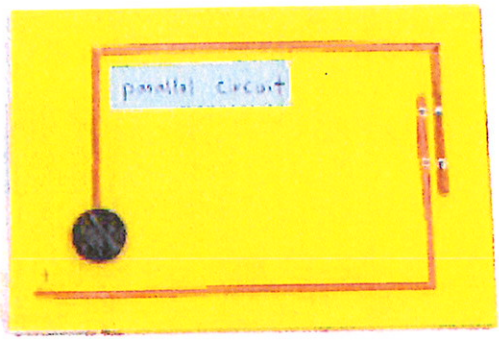
Binder clips are a great tool for holding the battery in place to keep the light turned on when displaying your circuit.

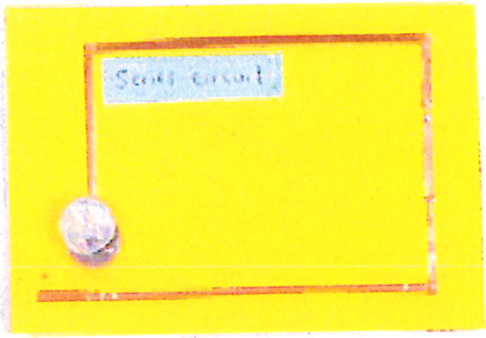




Look closely at your LED (a magnifying lens might help here). You'll notice one or two green markings on one side. These dots indicate the negative side of the LED. Being able to tell the positive from negative sides will come in handy later on, especially if you're using more than one light.

**You can make cards with one light or many lights.** When using multiple lights it's helpful to make a parallel circuit. It's possible to make series circuits, but you'll need an additional battery for each light.

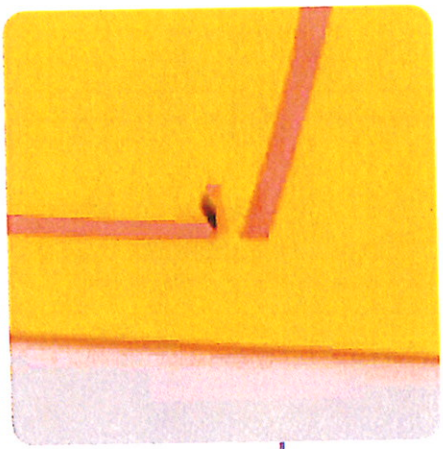


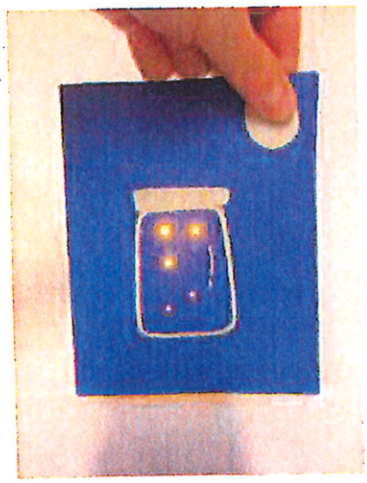

When making a parallel circuit, we like to **think of it as creating two copper tape pathways** that come very, very close together but don't touch. Your surface mount LEDs will have to bridge the gap between them, so we've found that placing them about 1 mm or less apart is ideal.

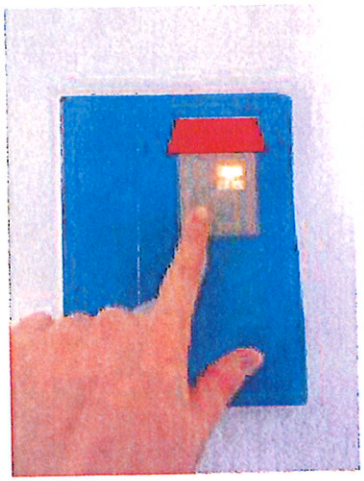
**Make sure your LEDs are all oriented in the same direction**, with all the positive leads touching the positive path, and vice versa. *(TIP: Many times if a light isn't working, it's oriented backwards.)*

When overlapping pieces of copper tape, **sometimes the adhesive acts like an insulator, blocking the electricity from flowing.** You can make a tiny solder "bridge" to fix the connection or fold a piece of copper back on itself (sticky side to sticky side) then Scotch tape that over the seam as a different type of "bridge."



Depending on the LEDs you buy, you might find that some colors work together and other colors don't (for us, red, yellow, and green work together, as do blue and white). This could become a feature of your circuit where by pushing a switch the lights change colors. You could also experiment with resistors to make incompatible colors (like blue and green) work at the same time.



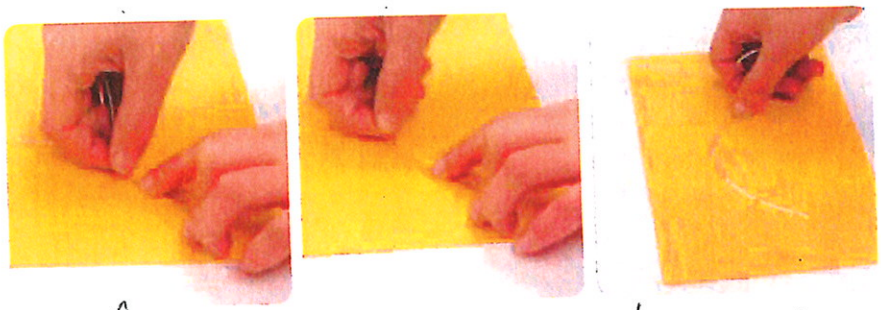


**The LEDs make diffuse circles when shined through thin, light-colored paper.** Cardstock can block the light, so poking holes in it with an X-acto knife or small hole punch will let the light shine through.

## Helpful tape folding techniques:

**Making a sharp corner:** Fold the copper tape back on itself and make a sharp crease. While holding down the crease, turn the tape the direction you would like it to go. Flatten the tape with a bone folder or Popsicle stick.

**Making a curve:** This works better with thinner tape. With one hand guide the tape along with curve you'd like to make. With the other hand, push down the tape to secure it to the paper. You might notice tiny puckers in the tape; you can smooth those out with a bone folder or Popsicle stick.



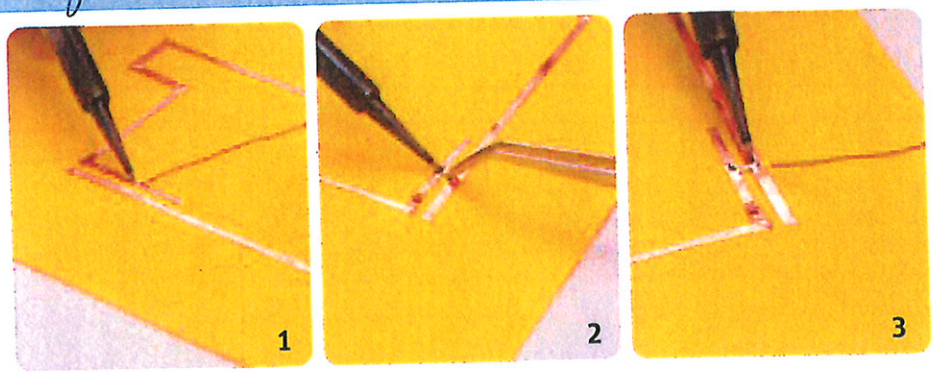
additional activity (if desired – will need to purchase the material

## Soldering an LED:

1) Place a dot of solder on one side of your copper tape where you would like the LED to be.

2) Pick up one of the LEDs with the tweezers and hold it right next to the blob of solder. With your other hand, melt the solder and stick the LED into the liquid metal. Hold the LED in place while the solder cools.

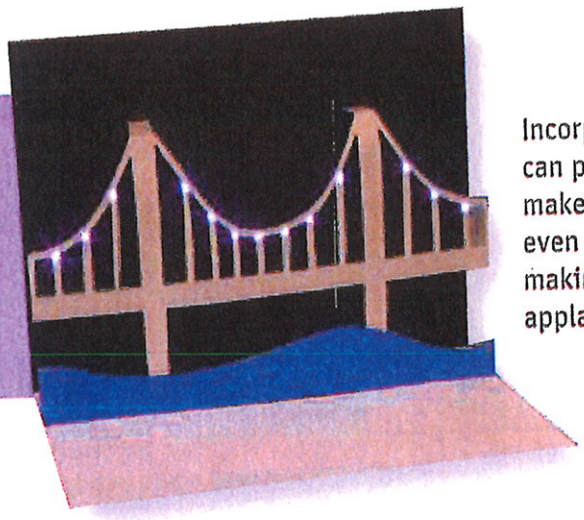
3) Now you should be able to solder the other side onto the other piece of copper tape. Make sure both the leg of the LED and the copper tape get hot enough for the solder to flow and connect to them.




Test your design! And remember, working with a soldering iron takes time and practice, so don't be too frustrated if you don't get it perfect on the first try.

# TAKING IT FURTHER

Origami and pop-ups: make your paper circuits three-dimensional by incorporating them into origami animals or pop up scenes.



Incorporate microcontrollers: You can program an ATTiny chip to make your lights blink, flicker, or even respond to sensors. Try making a circuit that responds to applause or changes in light.

# Strawkets

## Intro: Straw Rockets or Strawkets

Hello there,

ually do 10 projects in a school year (try to do a project a month for most classrooms, and do a few more for my child's classroom), and I try to mix it up so that kids I don't get bored. BUT this is one project that I go back to every year because kids ABSOLUTELY love this project.

collect $10/student/year to cover the material expenses, so I'm always searching for inexpensive materials. If you have any ideas, please let me know. Thanks in advance.

Before we start building our strawckets, I explain Newton's Second Law, which says Force = mass x acceleration (I use mass and weight interchangeably in the classrooms).

Over the years, I've learned one thing from the kids of all ages and grades - adults consistently underestimate their ability to create and problem-solve. So, I cover the Newton's Second Law in Kindergarten classes, too, but I use addition instead of multiplication and use visual aids. What I want them to understand is the relationship between the three variables.

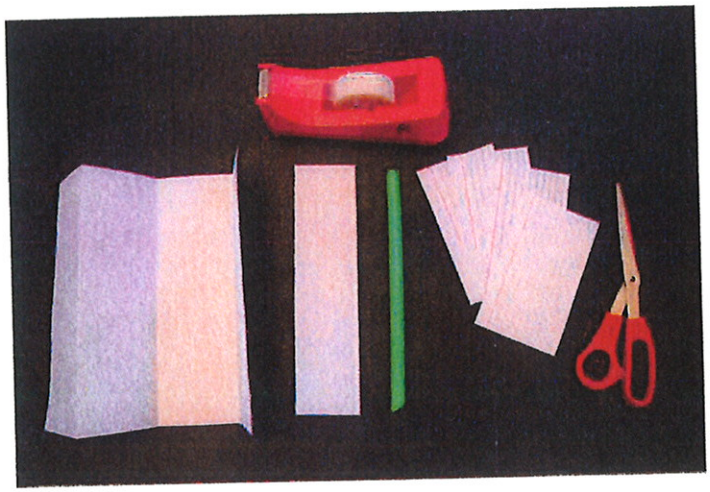
If the force is constant, then if mass goes up, then acceleration goes down. If the mass goes down, acceleration goes up.

The idea for the project comes from The Tech Museum in San Jose, but I've developed worksheets and background info that go with the project on my own. I usually take these into the classrooms, but I'll skip them here.


## Step 1: Gather your supplies

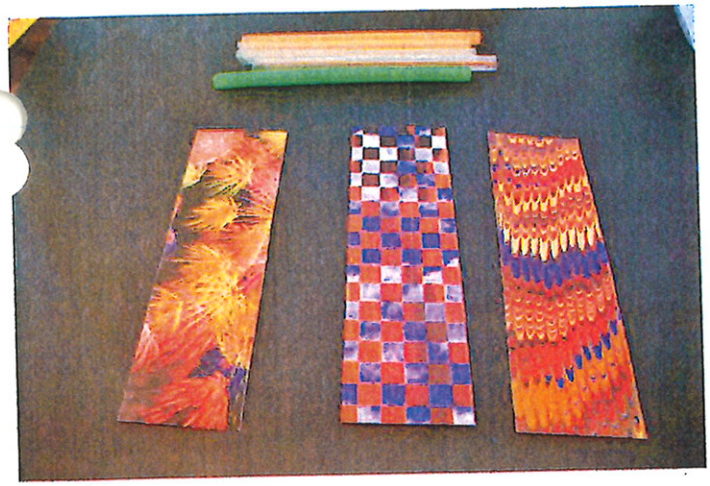
upplies List:

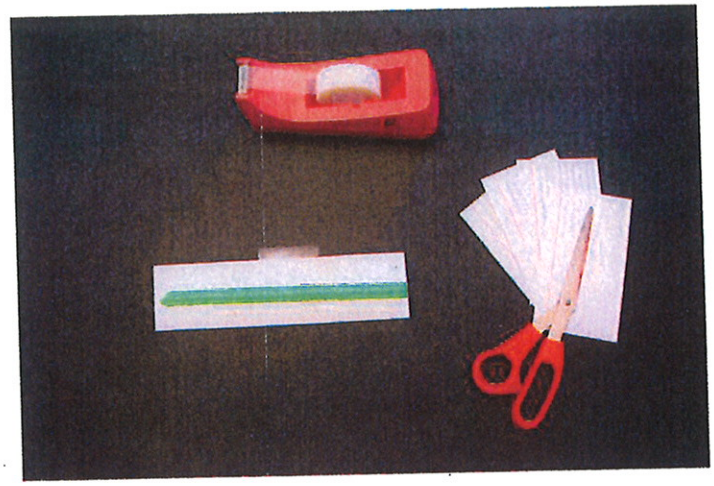
- Boba straws (these are wider straws for pearl drinks served at restaurants, and Asian smoothie shops)
- 8 1/2 in x 2 3/4in strips of paper (fold a copy paper width-wise half, and then half again, giving you four pieces of 8 1/2 in x 2 3/4in strips)
- Index cards or pieces of cardstock paper
- Scotch Tape
- Scissors



## Step 2: Fold, Cut, & Tape

1. Fold a piece of copy paper width-wise half, and then half again, giving you four pieces of 8 1/2 in x 2 3/4 in strips.
2. Cut a piece of 8 1/2 in x 2 3/4 in strip of paper.
3. Put a piece of tape on the paper (as see in the photo). This great idea came from a 1st grader two years ago. Before that, I used to tape it while rolled up around the straw.





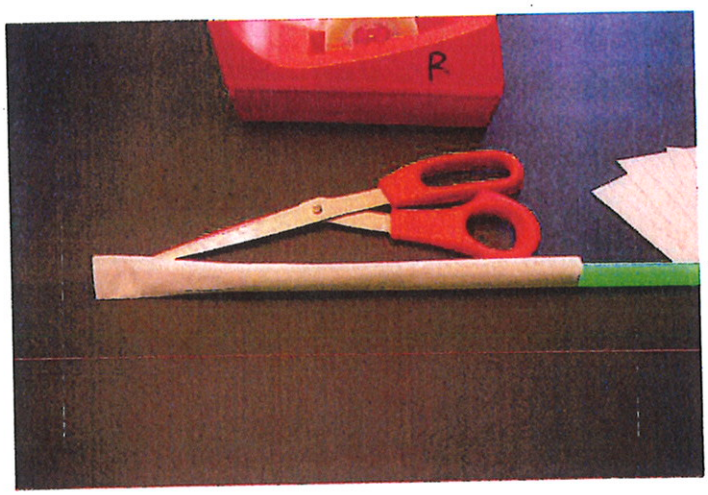
## Step 3: Roll & Tape

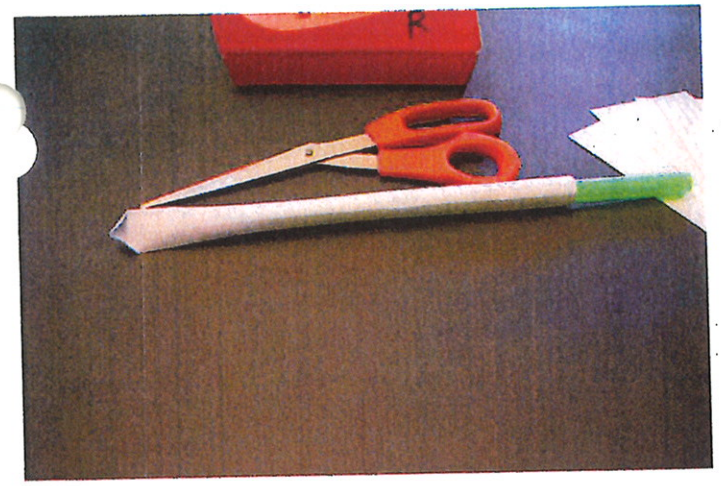
1. Wrap the paper around the straw and tape down the seam. Make sure it doesn't stick to the straw, and that the straw can slide in and out easily.

## Step 4: Making a nose cone

1. Flatten out one end.
2. Fold it in go create a triangular cone.
3. After creating the cone, put a piece of tape around it to prevent the air from escaping.

Now, put the partially built rocket on your straw and blow it. It won't fly very well.

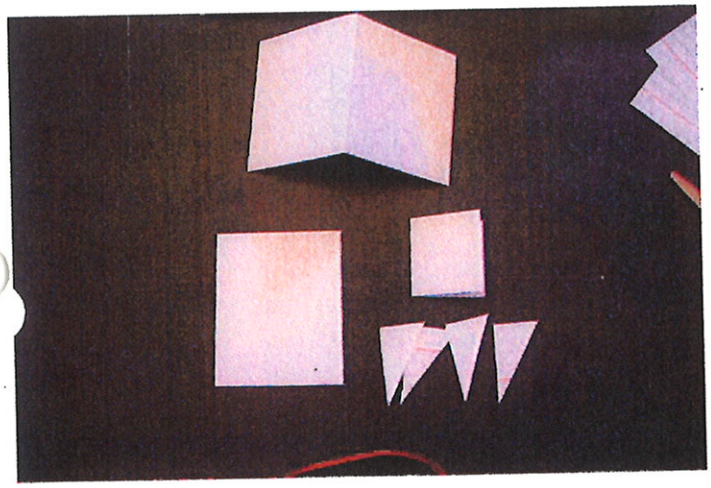


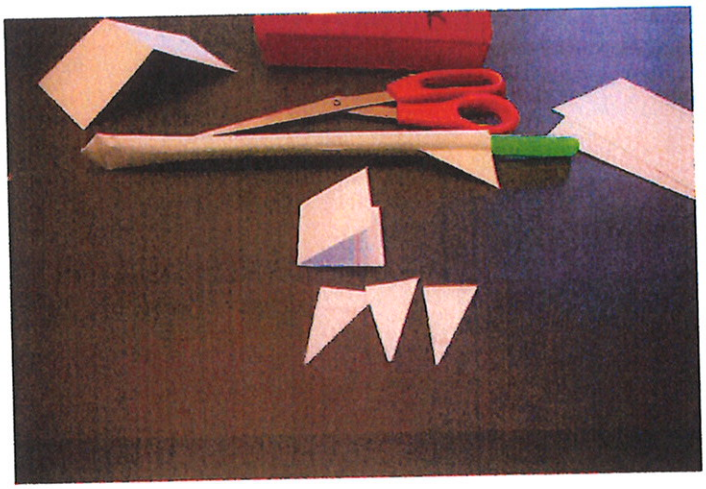


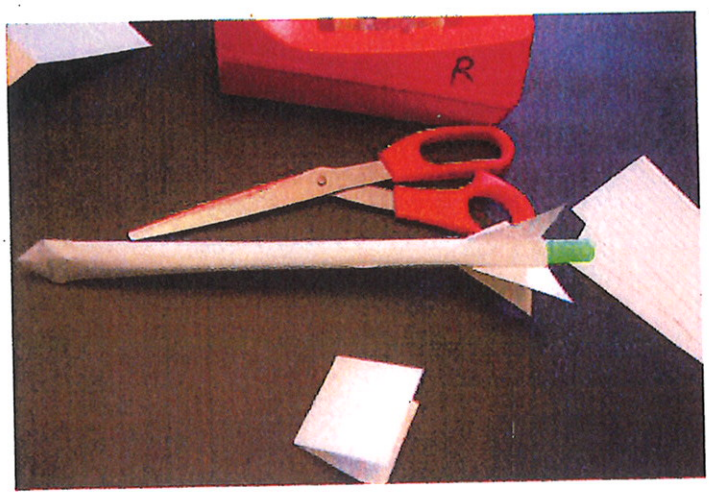
## Step 5: On to the fins

1. Now, cut out fins from a piece of an index card and tape it on the rocket. Any place you choose.

When I do this project with K to 2nd graders, I usually cut the index cards in half and hand them out. I want to restrict the size of the fins they can create.



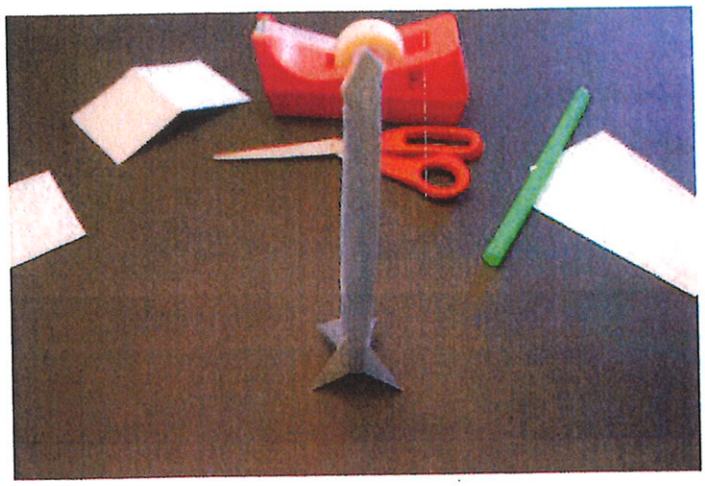




## Step 6: Done

1. Now, blow it and see how it flies.
2. If it doesn't fly well, tweak it. Take it apart or build another one to make it fly better.

neering is all about failure and overcoming that failure.



## Step 7: Additional Comments:

When I do this project, I give the students two challenges:

1. Farthest distance
2. Trickiest rocket - boomerang and tight spiral (what I'm looking for is an indication that there was some thought behind the design)

Sometimes I change things around by asking the kids for accuracy, but they kids are pretty challenged year after year by these two challenges.

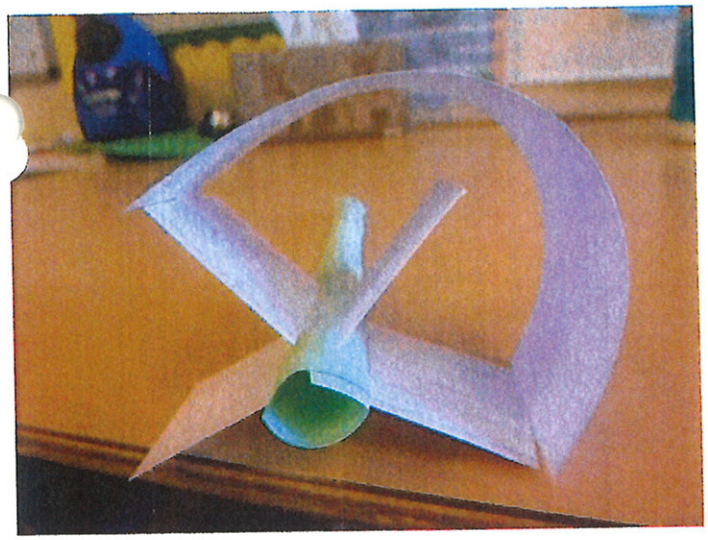
## Step 8: Some awesome designs from elementary school kids:

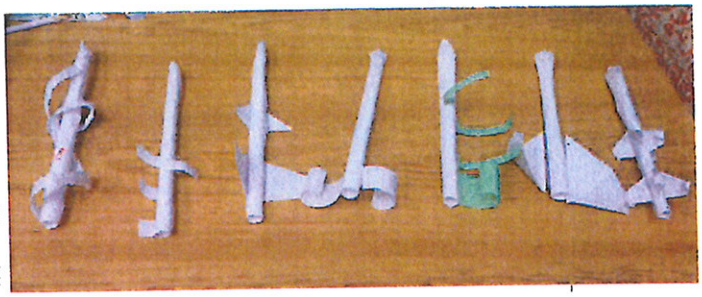
Curiosity. Imagination. Perseverance. And FAIL SPECTACULARLY!

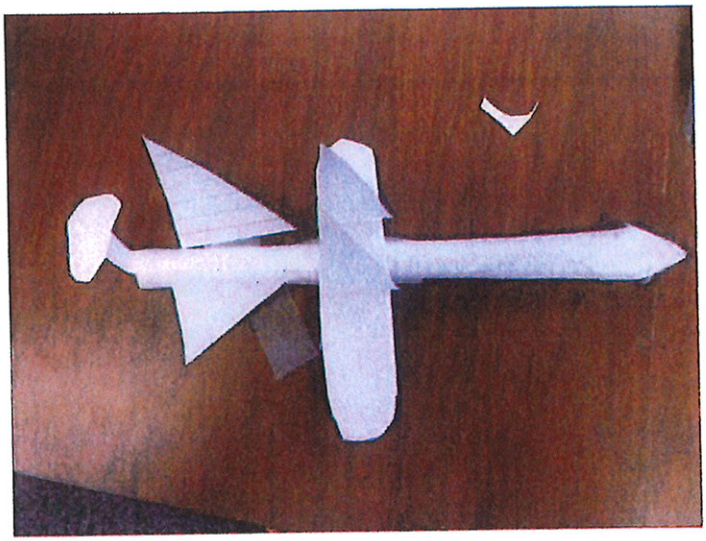
These are the things we talk about during our science project time. Failure is OK, as long as you learn from it and keep going. And if you're going to fail, push the envelope and fail spectacularly!

Students often come up to me and ask what the right answer is or how to do it right. And I tell them that there is no one right answer. There are many possible right answers, and they should try to find as many as they could. In a given class period, some highly self-motivated students design, test, and make more than five strawkets.

I hope you have a lot of fun with this project.



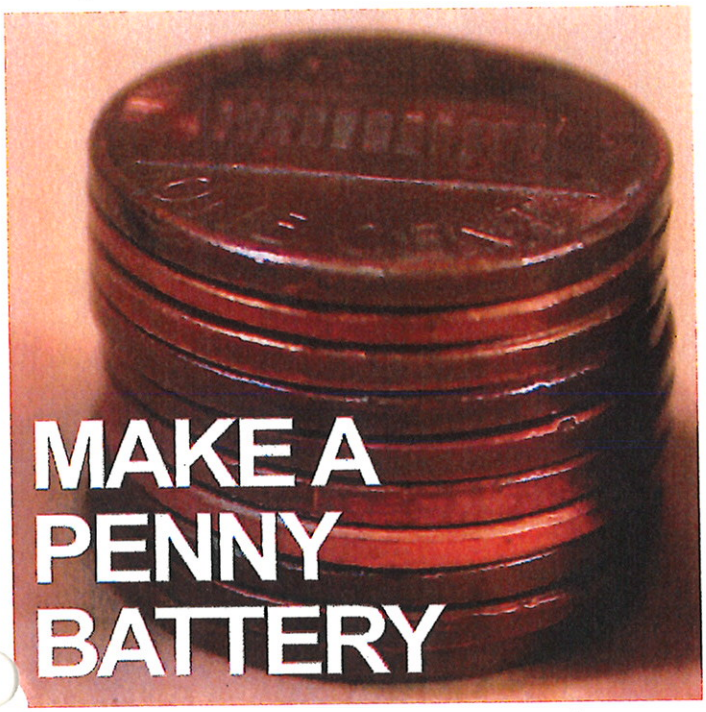




# Penny Batteries

Author:The King of Random www.thekingofrandom.com
Random Weekend Projects

## Intro: How to Turn Spare Pocket Change into DIY Batteries




### Step 1: See The Video!

What's a penny worth these days? Not much, but could there be some free energy hidden inside your spare pennies? You'd be surprised! Watch the video to learn how you can put together stacks of pennies to form makeshift batteries that can drive small-current devices like LEDs and calculators.

### Step 2: What Kind of Pennies?

US pennies that are newer than 1982 will work for both of these experiments, because they're nearly 98% zinc.

For more information on US pennies, including what date ranges contained what ratios of copper and zinc, click here !

## Step 3: Power a Calculator With 3 Pennies!

Here's a fun experiment!

' up a calculator from the dollar store and remove the screws on the back so you can get to the battery. Remove it, and save it for another project.

'v pull the negative and positive leads out of the casing and attach wires to the terminals if you can. I just twisted the wires to the battery leads, and used electrical tape ›ld them together.

Now it's time to make the penny battery.

I found the easiest way to make one is to combine the pennies with some zinc washers from the hardware store. A pack of 30 is about $1.

Get some cardboard, and cut circular pieces so that the edges are just bigger than the pennies. Let them soak in white vinegar for about 1 - 2 minutes.

Note: Any kind of vinegar should work, and if you don't have vinegar, try salt water, or lemon juice. They will all work just fine.

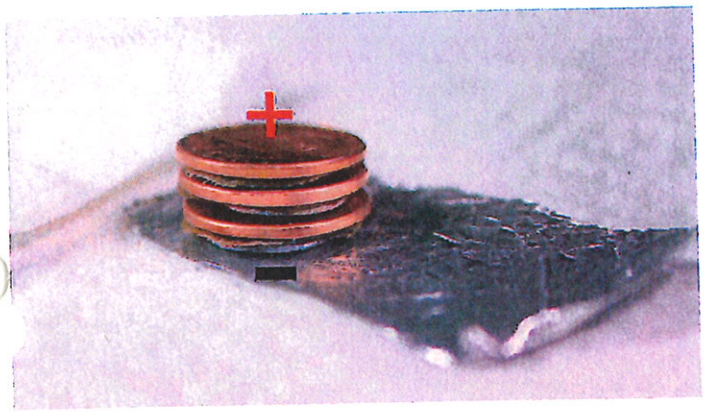
Start your battery cell by placing a piece of aluminum foil on your workspace, and place 1 zinc washer at the end. Next, take a piece of cardboard, soaked in vinegar, blot dry it on some paper towel, and place it on top of the washer. Lastly, place the copper penny on top of the cardboard, and the battery is done!

An individual battery cell is a zinc bottom, copper top, and separated by a material like paper or cardboard that's been soaked in an electrolyte.

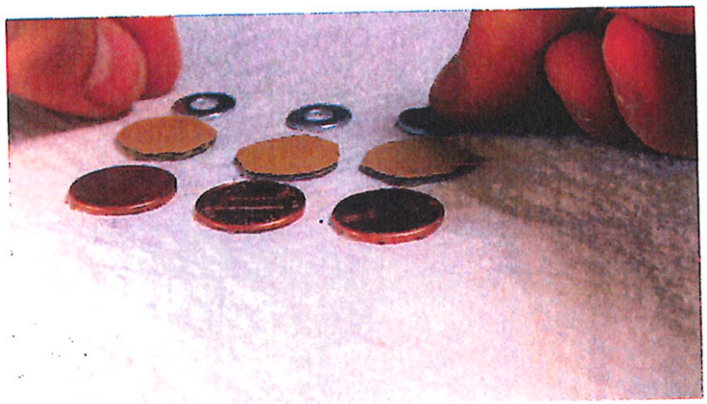
From my testing, each cell yields just over 0.6 volts, and around 700mA. The copper top is positive, and the zinc bottom is negative. This calculator needs around 1.5 volts, so I used 3 pennies, 3 washers, and 3 pieces of cardboard soaked in white vinegar. (3 cells x 0.6 volts = 1.8 volts approximately)

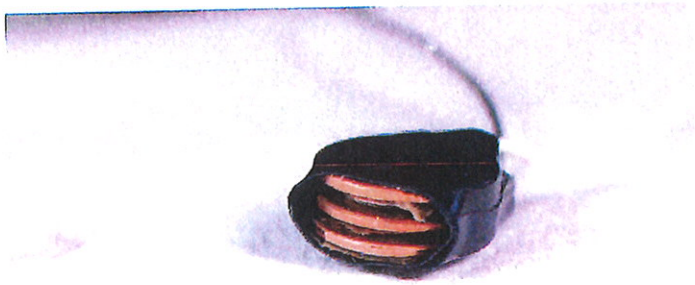
I added wires to the top and bottom for ease of use, then used some electrical tape to hold it together. The aluminum foil is no longer needed.

This type of battery cell is pretty much the same as the first one ever invented by Alessandro Volta in the early 1800's, which came to be known as the "voltaic pile".









## Step 4: It Works!

The wires can now be connected to the correct battery leads that were pulled out earlier, and when you press the "on" button the calculator will fire right up!

I tested out a few functions and everything calculated correctly.

It's amazing to think you can run low current electrical devices on this penny power hack! It works great, and as long as the cardboard is moist with electrolyte, it should work.

If your battery stops working, try re-soaking the cardboard in a little more vinegar to get it wet, then try again. It should fire right back up!