

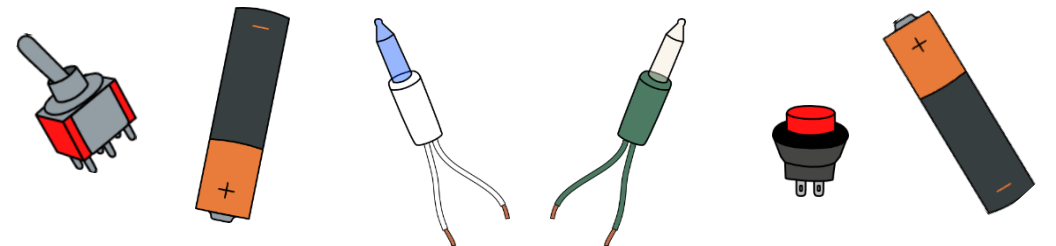


BAKKEN

MUSEUM

Batteries, Bulbs, & Wires: low-cost, low-tech learning through making

André Phillips & Eileen King
The Bakken Museum





Introduce yourselves:

- Name & context
- Favorite invention that uses electricity
(other than phone/tablet/computer!)
- Why you're here this morning

Eileen King

- Youth Programs Coordinator;
former classroom teacher
- Coffeemaker!
- My CS degree was woefully
inadequate prep for teaching
tech/design/makerspace



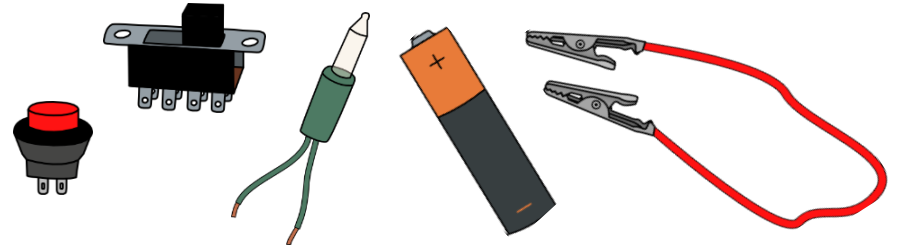
André Phillips

- Youth and Family Programs Manager; occasional planetarium educator
- Synthesizers!
- I love how rewarding it is to teach this activity; I've personally learned so much about teaching just from this



Batteries, Bulbs, and Wires at the Bakken

- **What:** increasingly difficult circuit challenges, using AA batteries, cut-up holiday lights, assorted switches, and alligator clip wires (*materials that feel “real” – not like a toy – but are also reusable*)



- **Where:** camps, field trips, outreach program, tabling activity



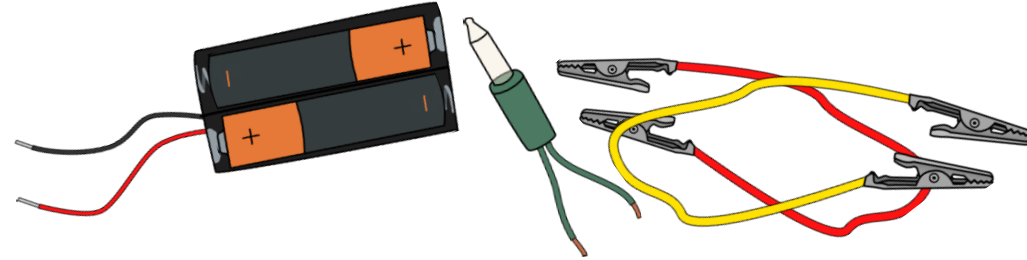
- **Why:** hands-on, challenge-based learning produces better learning (productive struggle!); self-differentiating

What's a circuit?

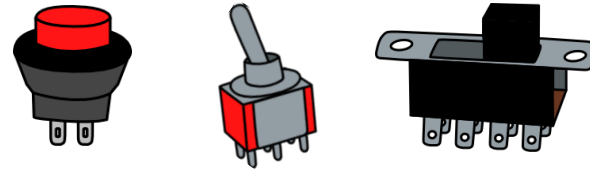
- Everything around us is made of atoms. Atoms have a nucleus containing protons and neutrons, and floating around the outside are electrons.
- When certain kinds of materials (like wires!) are connected in a loop to a source of power (like a battery), then electrons can be passed from one atom to the next, around and around in circles (like a big game of hot potato!). This is the current, or flow, of electricity.
- This closed loop that electricity can travel through is called a circuit. By designing and building different circuits, we can control the flow of electricity and use it to power things like lights, motors, buzzers, and more!
- The big idea: electricity needs to go in circles, from the battery, through other components, back to the battery.

CHALLENGES!

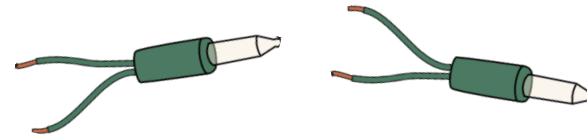
1) Light up a light bulb, using a battery pack & two alligator clip wires



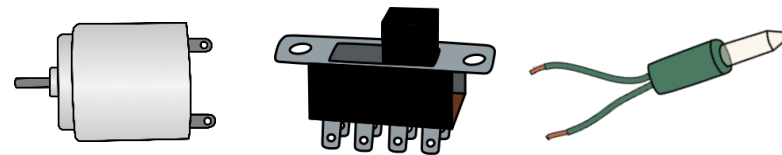
2) Control that circuit by adding a switch
(and then try other switches!)



3) Add another light bulb
(can you make them both bright?)



4) Switch between light and motor

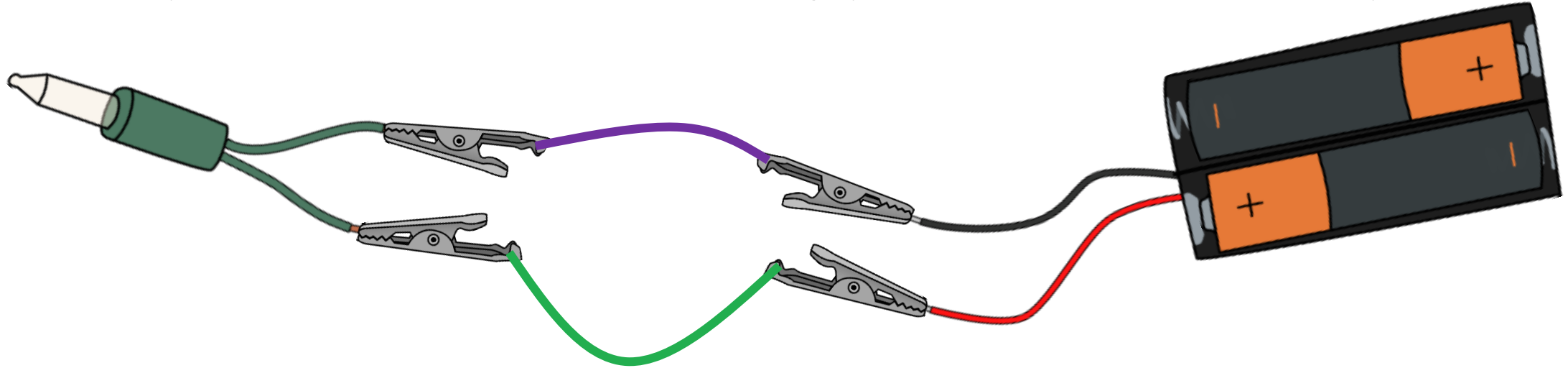


OTHER OPTIONS

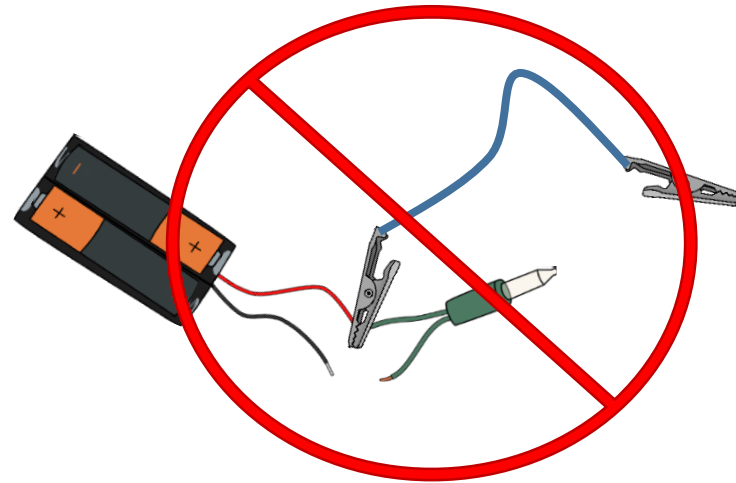
- Multiple buttons in one circuit: can you wire it so you have to press **both** to turn on the light? What about so you can press **either** button? (AND vs. OR gates!)
- How can you make the lights **brighter**? How **many** lights is it possible to put into one circuit?
- How can you use a switch to change the **speed** of a motor or **brightness** of a light?
- How can you make a motor spin in the other direction?
Can you wire a **switch** to make it able to **change directions**?
- How do you build a **hallway switch** (two switches that can each turn something on or off, regardless of what the other switch is doing)?

CHALLENGE SOLUTIONS

1) Light up a light bulb, using a battery pack & two alligator clip wires

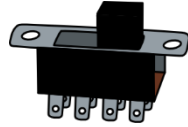
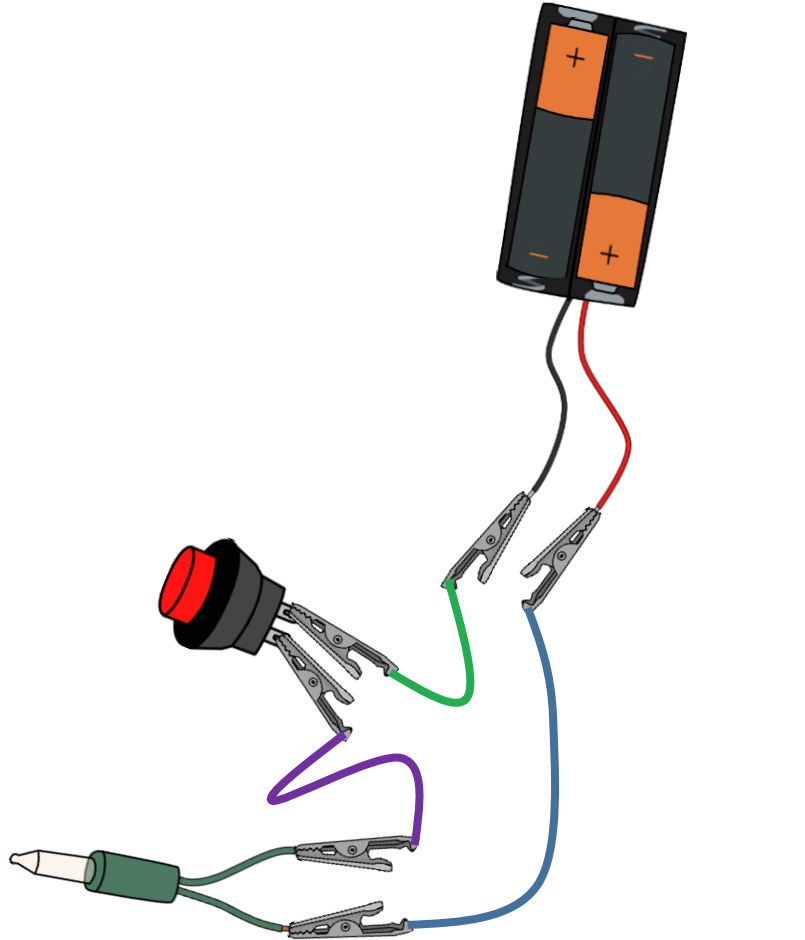


Remember: use alligator clips as extension cords - don't try to shove two wires into one alligator's mouth.

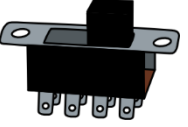


CHALLENGE SOLUTIONS

2) Control that circuit by adding a switch (*and then try other switches!*)



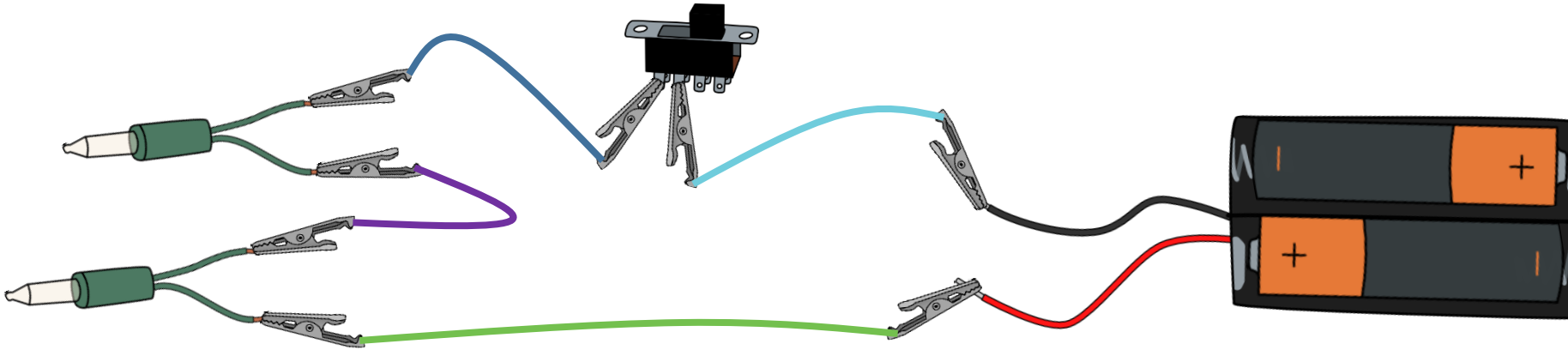
What's the deal with the slide switches?



As the sliding piece moves, it makes and breaks connections between legs that are next to each other (not across from each other) - the photo shows a model of how the inside works!

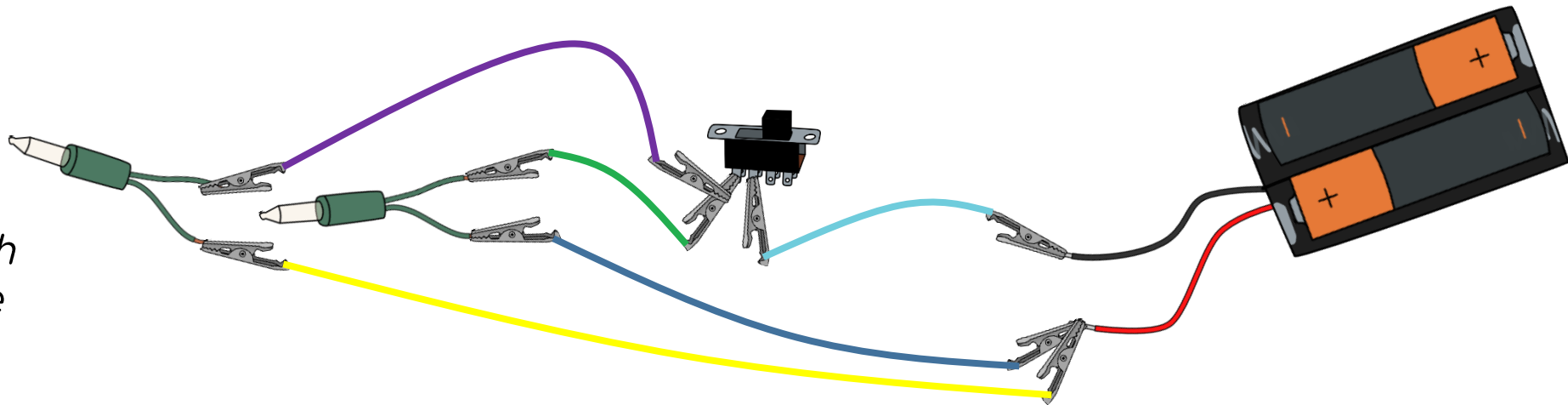
CHALLENGE SOLUTIONS

3) Add another light bulb (can you make them both bright?)



These will both turn on, but more dimly/with uneven brightness.

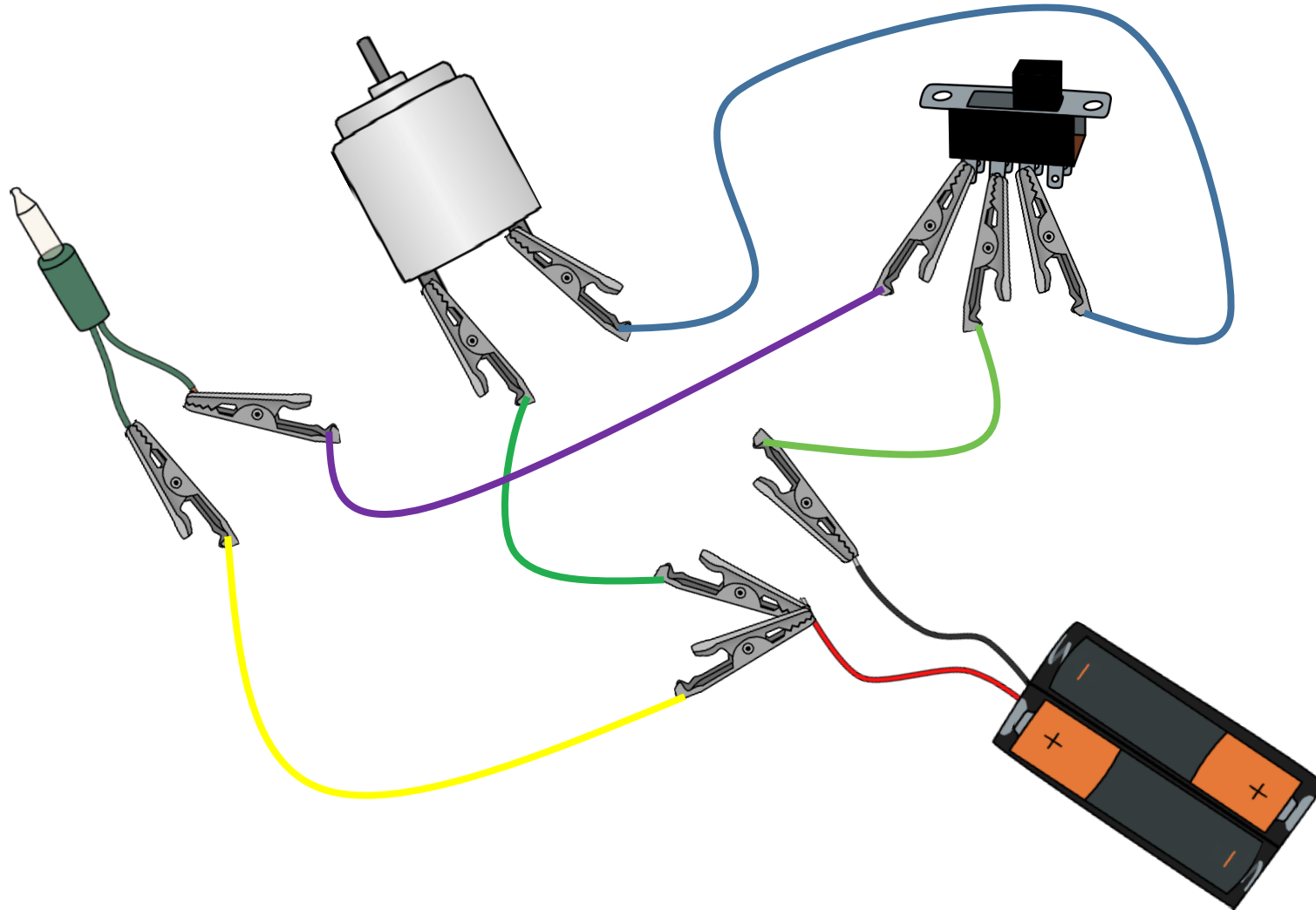
These will both be bright, because each has its own path to and from the battery pack.



Multiple alligators can clip to the same wire, or clip on to each other!

CHALLENGE SOLUTIONS

4) Switch between light and motor - when one is off, the other is on



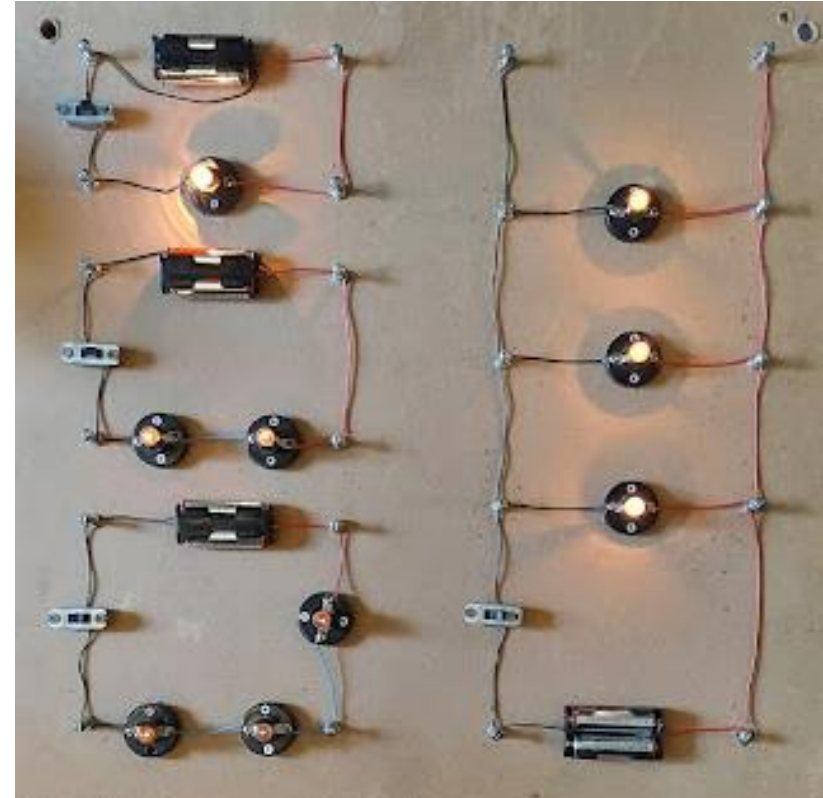
Note: this is just one of many possible solutions to this challenge!

DEBRIEFING

Everything we know about circuits, we learned from tinkering like this.

But...for *years*. And there are still tons of things we don't know. If you feel like you're still struggling, you're in good company – keep trying!

(And if having one of us introduce this to your students would be helpful, [here's info about booking the outreach program version](#)).



TROUBLESHOOTING

Not working the way you expect? Check for...

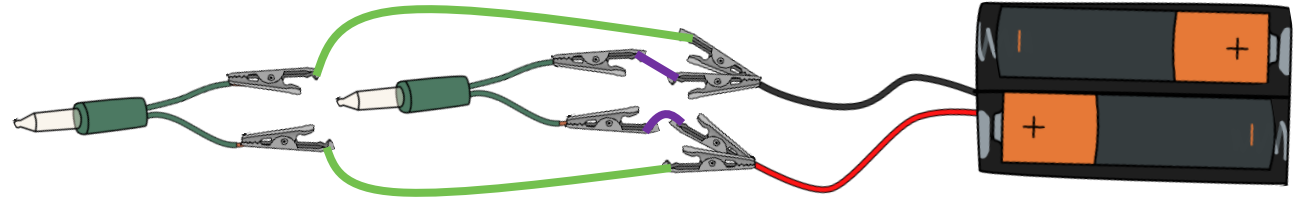
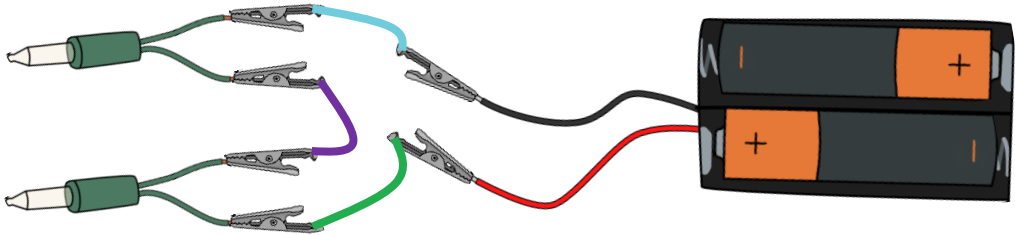
- **Metal touching metal** – if alligator clips are attached to plastic insulation, electricity can't flow!
- **A battery in the holder backwards** – this is surprisingly common, especially with younger students
- **Alligator clips touching where you *don't* want them to** – if there's a “shortcut” the electrons can take so they don't have to go through the lightbulb or motor, they will!
- **Individual broken components** – batteries can die, light bulbs can burn out, alligator clip wires can become broken inside the plastic insulation. Swapping out one component at a time can help you discover which one is the source of the problem.

*One other note: **buzzers and LEDs** – which we didn't use today, but you may want to include – will only work when electricity flows through them in the **correct direction**. If a buzzer makes no sound or an LED doesn't light up, try swapping the wires connected to it!*

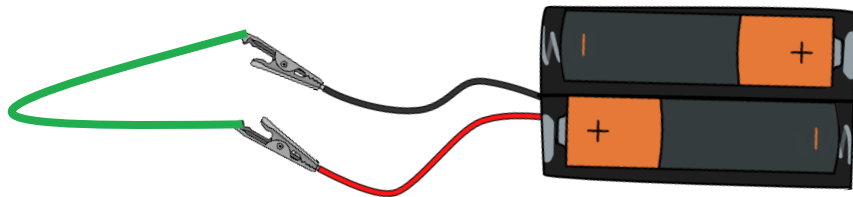


VOCAB

- Series vs. parallel circuits



- Short circuit (*bad! creates heat!*)

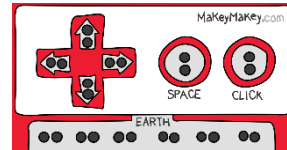


EXTENDING: WHAT NEXT?

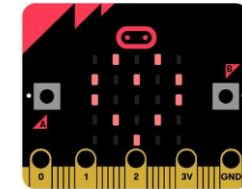
- Paper circuits/Make A Switch



- MakeyMakey



- [Micro:bits](#) (and other microcontrollers)



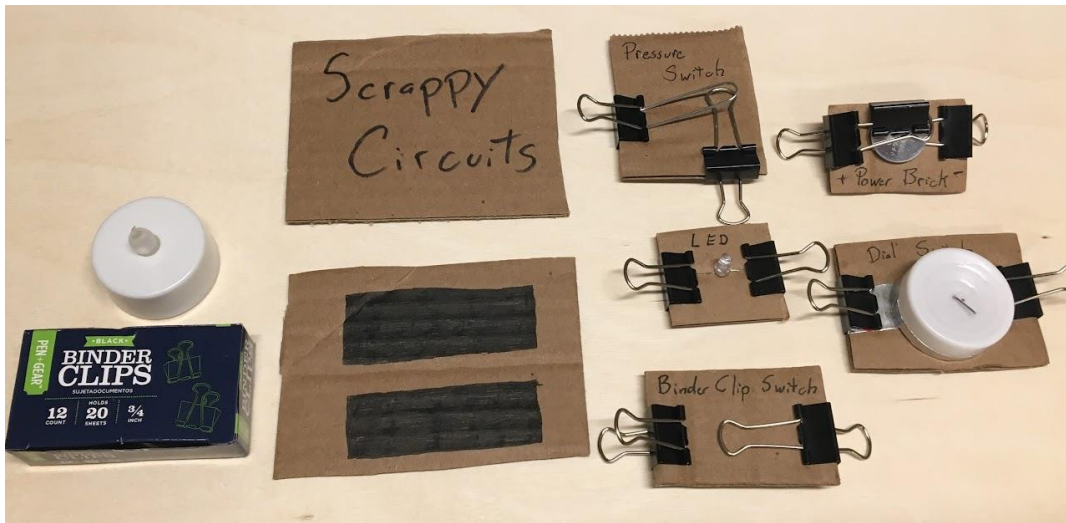
- Make a project!

STARTING YOUR OWN CIRCUIT CIRCUS

The basics: AA batteries and [battery holders](#), [alligator clip wires](#), [switches](#), old holiday lights (and a [wire cutter/stripper!](#)) (Digi-Key, Kelvin, Solarbotics)

Add-ons: [DC motors](#), [buzzers](#), [LEDs](#), weirder switches (*try Ax-Man!*)

Another option: [Scrappy Circuits!](#)



Our favorite online sources:
[Digi-Key](#), [Kelvin](#), [Solarbotics](#)

Questions? Suggestions?

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Eileen: king@thebakken.org

Or stop by & keep tinkering!

3537 Zenith Ave, Minneapolis MN 55414

10am-5pm, Tues-Sun

