Designing Electric

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NSF DRL #1502755

Art

Lesson 2

3 Days

Driving Question: How can we design and power electric art circuits?

Objectives:

Students will design an electric art circuit.

I Can Statement:

I can optimize an electric art circuit using engineering for sustainable communities principles.

Overview:

In this lesson, students apply the engineering for sustainable community principles to their first engineering design challenge: create electric art. Through this design challenge, students will understand how circuits work, including load (power requirement of the load, such as an LED light), switch, power source and the conductive element. As part of this, they will learn that circuits with more than one light bulb can carry different power requirements. The iterative engineering design cycle will allow students to investigate how circuits work, design their own electric art, and share what they learn with each other and then optimize their design. This is a process that students will utilize multiple times throughout this unit.

Lesson Standards:

MS-PS3-5 Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.

MS-ETS1-1 Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-ETS1-3 Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

Materials:

- Copper Tape
- Cardstock
- Construction Paper
- LED Lights
- 3V Batteries
- Scotch Tape
- Masking Tape
- Glue Sticks
- Markers
- Craft Sticks
- Washi Tape
- Pipe Cleaners
- Yarn

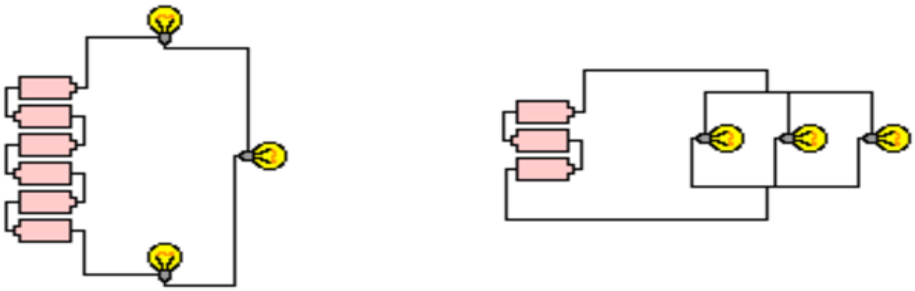
Equipment:

- Scissors
- Markers
- Colored Pencils

Background for Teachers

In this lesson, students will be creating circuits, or closed loops through which electricity travels. Every circuit requires a power source. Electrons travel from areas of high electric potential to areas of low electron potential along a conductive path. The conductive path will be copper tape in this lesson, and the power source will be small coin batteries.

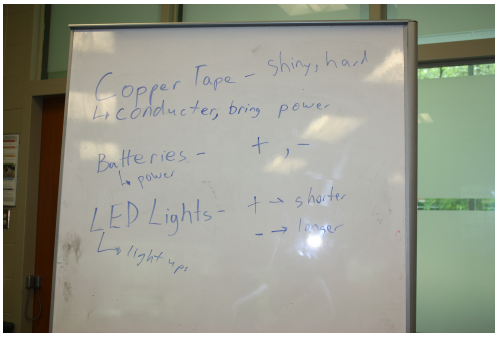
Series Circuit **Parallel Circuit**



From: http://www.physicsclassroom.com/Class/circuits/u9l4b.cfm

Key Terms:

- Circuit → the path that electrons flow, that begins and ends in the same place.
- Current→ how much electricity is flowing through the circuit. A higher current means more electricity is flowing. Current is measured in amperes. The symbol for amperes is A.
- Simple Circuit → a circuit that only has a single load, such as one lightbulb or one noisemaker.
- Parallel Electric Circuit→ the current divides as it flows through separate branches and then is combined again
- Series Electric Circuit→the current passes through each load in a single branch in consecutive order
- Switch→ small device that is used to allow or interrupt the flow of electrons in a



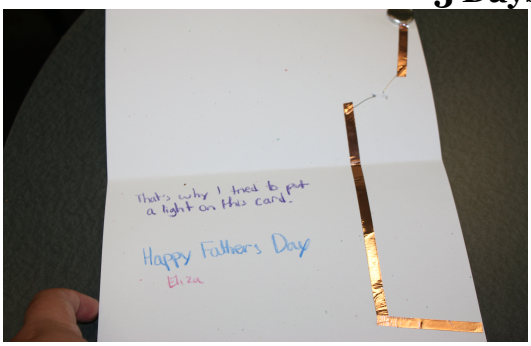
Co-constructed observations of the materials before the electric art is made.

Electric art can be two-dimensional like this card.

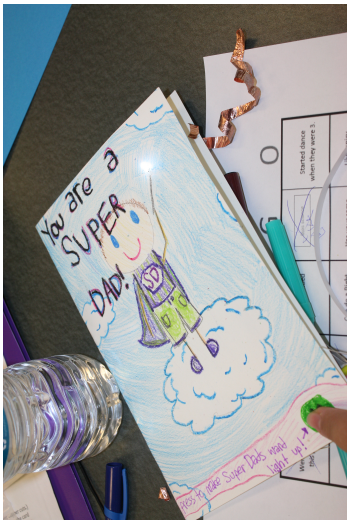
circuit

- Key Parts of a Circuit: Power Source, Load, Pathway, Switch
- Voltage→ how hard electricity is being "pushed" through a circuit. A higher voltage means the electricity is being pushed harder. Voltage is measured in volts. The symbol for volts is V.

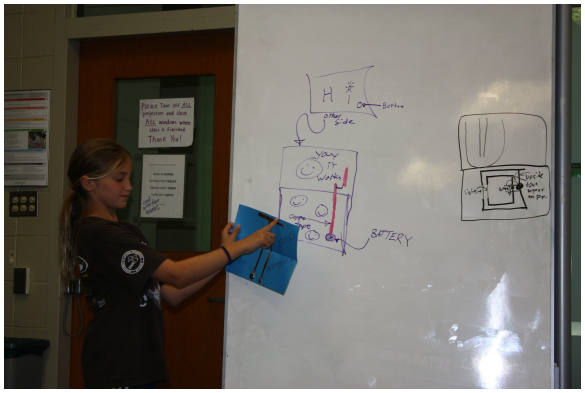
Electric art can be three-dimensional like this origami bird.



All of the electric art needs to have switches. Here is one simple example. When the card is closed, the copper tape touches the battery and there is a complete circuit.



This electric art's switch requires the user to press the button to complete the circuit.



After students complete their initial prototyping, have students show their working electric art. Then have them draw and explain how it works on the class's board.

Lesson Sequence

Day 1

I. Design challenge introduction
II. Prototype 1: Electric art

Day 2

III. Draw circuit
IV. Prototype 2: Build electric art

Day 3

V. Continue Prototype 2: Build electric art
VI. Share solutions and engineering discussion

Assessment: Drawing and explaining electric art cards

I. Design challenge introduction

A. Introduce the electric art challenge

- Begin by saying, "You realized that you wanted to give a present to a friend or family member, but you forgot to buy something for them. You searched around your home and you found some odds and ends, including:

  i) LED light bulbs
  ii) small batteries
  iii) copper tape
  iv) lots of craft supplies.

B. Show the students the materials

- Hold up the different items and ask students if they have seem them/used them before. What could these materials be used for?

C. Connect this engineering challenge to the engineering design cycle by pointing out different aspects of the engineering design cycle while asking:

- How will you design the card to helps the person you give the electric art card now and in the future?
- How will you balance the technical dimensions of your electric art design with community needs?

D. Observations

- Have students take a couple of minutes to explore and observe the copper tape, lights and battery.
- Have students share their observations and ask them how those observations might help them in their electric art circuit building.
- On the board record the student's responses.

It is important that students notice the + on the battery, understand that copper tape conducts electricity and understand the different LED leads are +/-. Explain that the LED lead length shows positive(longer) and negative(shorter) ends.

- Ask students, how they will turn their lights on and off? If they do not talk about switches, have them look at the light switch in their room. Show examples of switches on electric art cards.
- A good prompting question is: What do you think it means for your circuit if there is a + on the battery, and there are negative and positive leads?

Students should come up with two answers: there must be a negative side of the battery and there must be a reason why there are + and – in the circuit design. At first, have them explore this, but you may need to explain that electricity flows from high potential to low potential. Therefore, a +-+- pattern is necessary.

Example of chart to record student's responses on the board:

Copper Tape:
Observations: shiny, metal, sticky
Used for: connecting the batteries and LED lights, electricity travels through the copper tape

Battery: 3V, + on one side, the – must be on the other sides
Used for: power source

LED lights: Long wire, short wire
Used for: long wire (+), short wire(-)

- Then ask students to brainstorm: What could you do with these materials? Generate a list of possible ideas. Explain to the students that they can make an electric card.

II. Prototype I: Electric Art

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3 Days

Tip: Have a "ask 3 before me" norm. This positions students as experts.

A. Have students form groups of 3
B. Show students the different electric art templates (simple, 2 lights in parallel and 2 lights in series circuits) and show the video in the slide show about how to complete the electric art circuit on the templates
C. Explain to the students that they are going to look at how the three different circuits are similar and different. Their differences will matter when they design their own electric art card.
D. Have students complete all three of their electric art templates in their groups.
E. In groups, have students complete the observations on the hand-out. This work will help students to understand:
   - The flow of electricity through circuits
   - The differences between series and parallel circuits
   - The necessary components of a circuit
F. Group discussion: have a student show how the simple, parallel and series circuits work. Have the class discuss:
   - What do all of the circuits have? *They have: a pathway (copper tape), power source (battery), load (lightbulb), switch. All of the circuits needed to be completed or closed for the lights to light.*
   - How are the circuits different?
     - *The parallel circuit only needed 1 battery. The electrons only pass through 1 light not two.*
     - *The series circuit needed 2 batteries. The electrons had to travel the whole pathway, and pass through both light bulbs.*
     - *The simple circuit only had 1 light bulb.*
   - How does the electricity flow through the circuit?
   - What are the affordances of each circuit?

NOTE: have groups store their templates in the storage bags and keep them in the classroom. They will use those materials in the next class.

Day 2

III. Prototype 2: Build electric art cards

A. Group discussion: Generate a list of the necessary parts of a circuit and the affordances of series and parallel circuits. Ask students to brainstorm: what would they want to change to their original templates to turn them into a gift? (They will generate ideas like use different colors, make the circuit different shapes and personalize it. Fold it like a card) Tell students that is what they will get to do now.

B. Show the slide that provides examples of electric art circuits that will not work. Have students explain why they do not work.

Example responses

A. The battery needs to be connected to the copper tape not wrapped around by the copper tape
B. The battery can't connect directly to the battery
C. The copper tape needs to go in on loop
D. Copper tape must touch the bottom and top of circuit

Often kids just put the LED light leads on the battery and make it work. This is a good first step, but push them further by having them include copper tape.

C. Show the three examples of different cards and put them in places for youth to go and see the cards, but not take them back to their work areas. Make sure to point out the 3 different types of switches.

D. Prototyping:

- Have students draw their circuit on the electric art card. Have them include the switch, power source, light and pathway. Have students check their design with their classmates then show the design to teacher.
- Once students have their design approved by the teacher, they should receive about 20 inches of copper tape and get the light bulbs and batteries off of their templates.
- Have students build and test their electric art card.

Guidelines:
i) Like electric art prototype 1, draw the circuit on your electric art. Raise your hand to have your teacher check your design and get the materials.
ii) Must use copper tape
iii) Light cannot be directly attached to the battery
iv) Must have an on/off switch
v) Can use up to two LED light

E. Early finishers:
- Have students help other students
- Complete their analysis hand-out
- Have students try:
  i) Using different switches

ii) 3D art instead of 2D art

Tips to share with students

- Cut tape with scissors to avoid copper tape cuts
- Press hard and rub the copper tape when it is over the light wires
- The longer lead on the LED light is the positive connection; the shorter lead is the negative connection

Note: Building will take most students two lessons. Have students store their works in progress in their bags.

III. Share solutions and engineering discussion

A. Showcase: Have students show their cards to the class. Then draw and explain their designs at the same time. Make sure students answer these questions:
   - Who did you make it for and why?
     i) Have students pair-share their answers to this.
   - How did you get your circuits to work?
   - Where is the switch?
   - In what direction does the electricity flow?
   - What problems did you encounter and how did you solve them?

Tip: Have as many students share their designs as possible so they can be recognized for their work.

IV. Drawing and explaining electric art cards

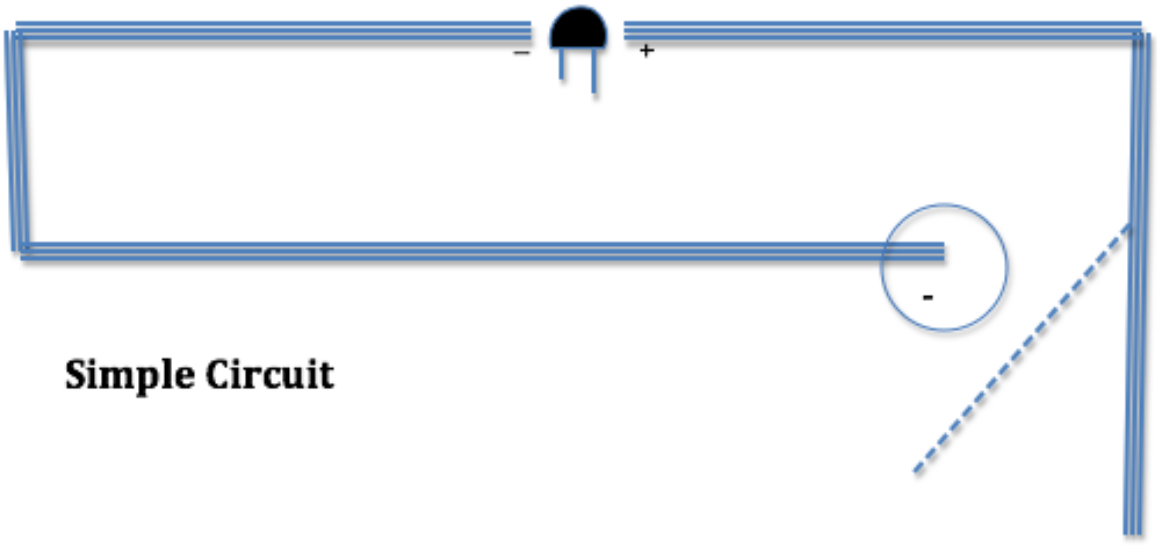
A. Explain to students that engineers need to share their designs. Ask them what they think makes a good design. *Answers should include things like: it needs to be clear, labeled, specific. Others should be able to take your design and build it.*
B. Have students draw and label their design
C. Have students write down how their circuit works (technical specifications).
D. Have students explain why they think the person who is getting the electric art will like it (social specifications).

Tip: Encouraging and valuing the encountering and solving of problems recognizes students

Group Members _____

Lesson 2 Electric Art

Electric Art Design

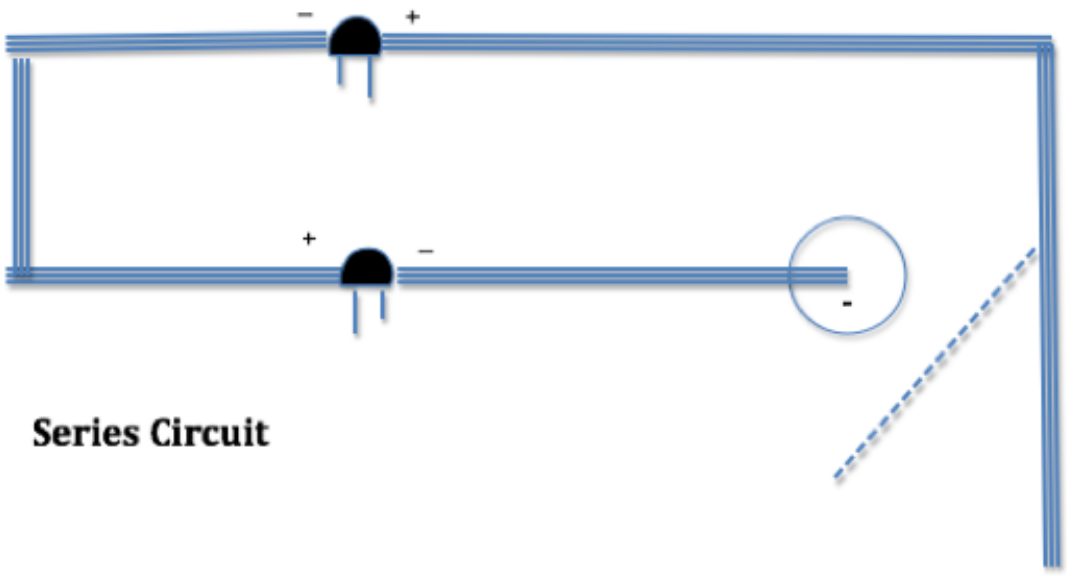


Simple Circuit

Group Members _____

Lesson 2 Electric Art

Electric Art Design

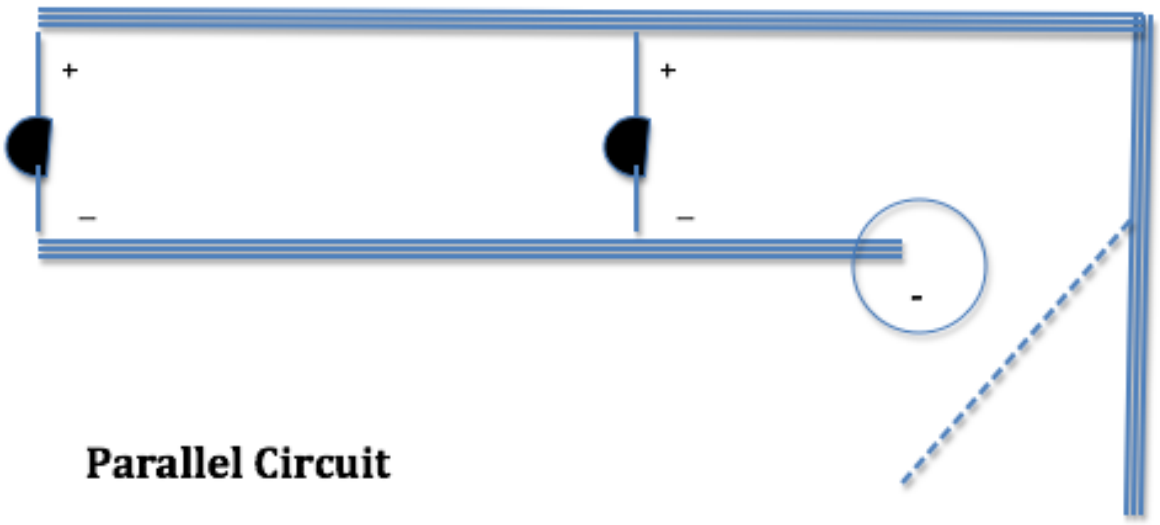


Series Circuit

Group Members _____

Lesson 2 Electric Art

Electric Art Design



Parallel Circuit

Group Members _____

Lesson 2 Electric Art

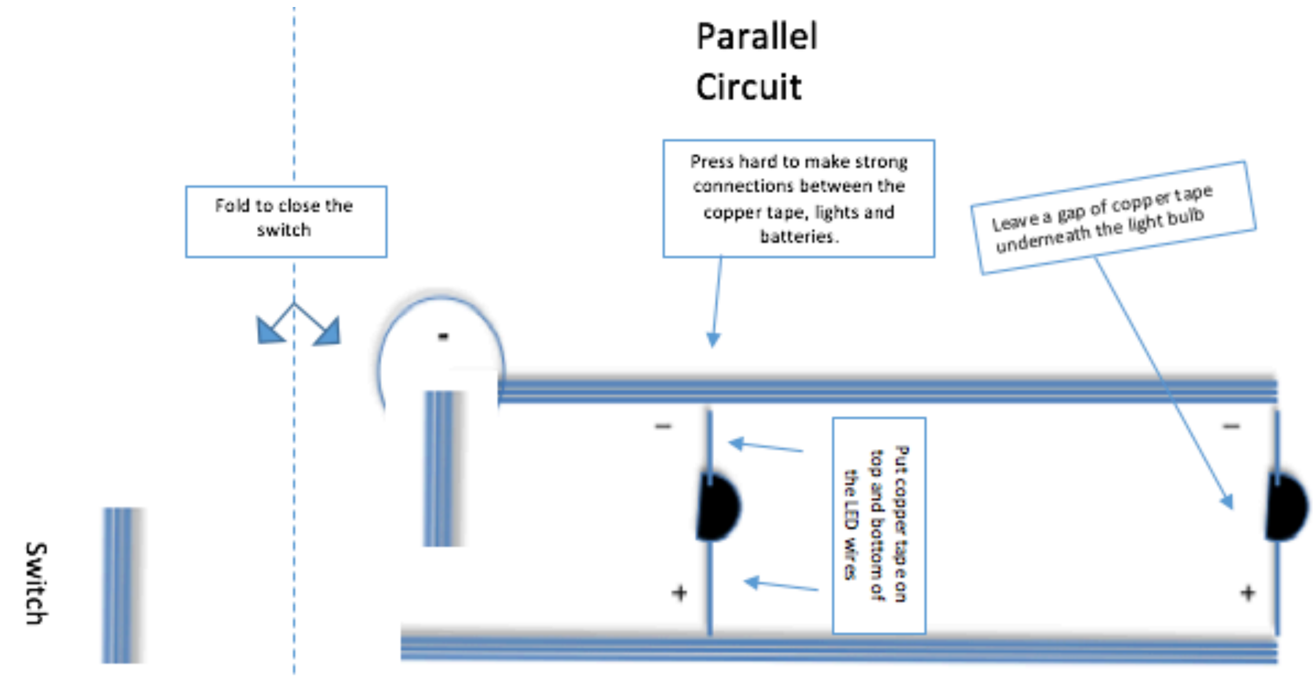
Electric Art Design

Directions:	**Simple**	**Series**	**Parallel**
Could you light the circuit with 1 battery?			
How bright were the lights with just 1 battery? (no light, dull, bright, really bright)?			
Draw an example of each type of circuit.			
Draw the flow of electricity in each circuit with an arrow →			
Label the components of each circuit: **power source**, **load, switch**, and **electron pathway**.			

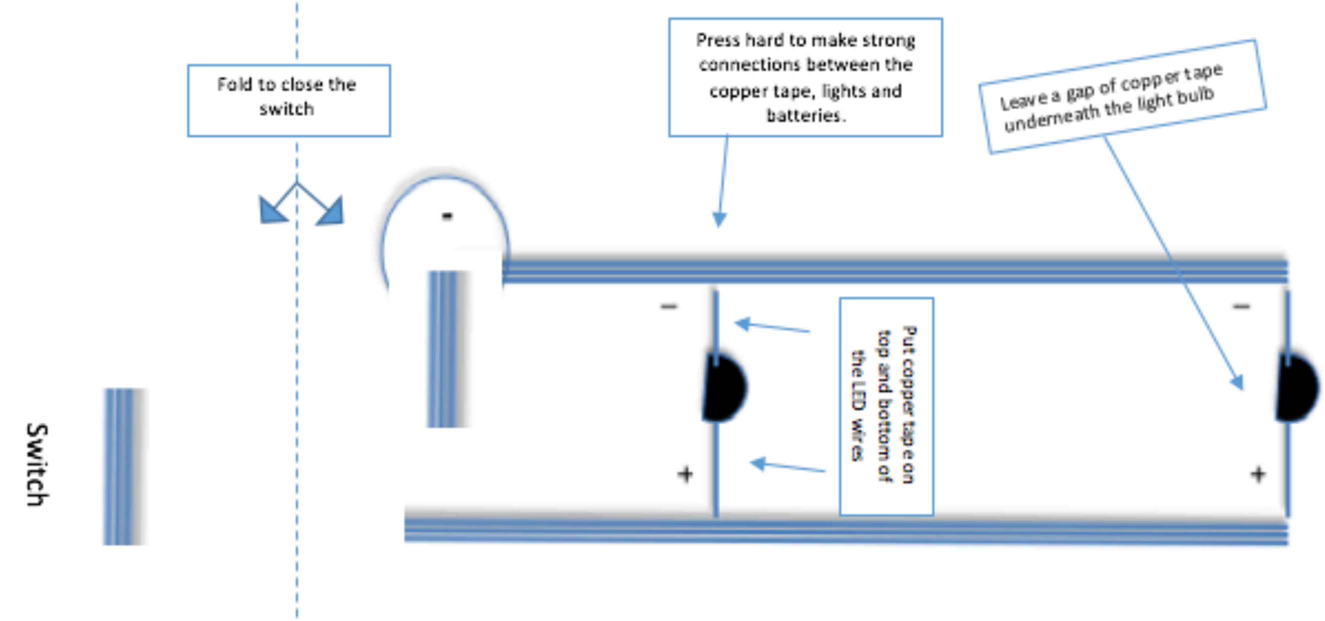
If you have copper tape, 2 lights and 1 battery, what circuit will you make? _____

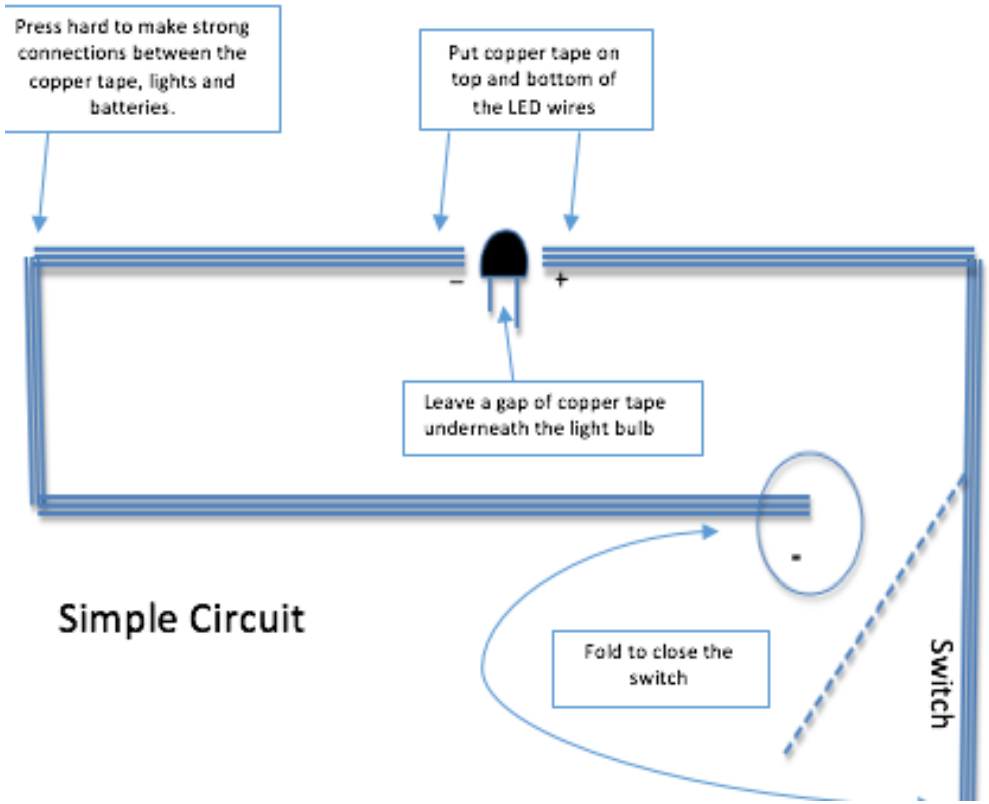
Why?_____

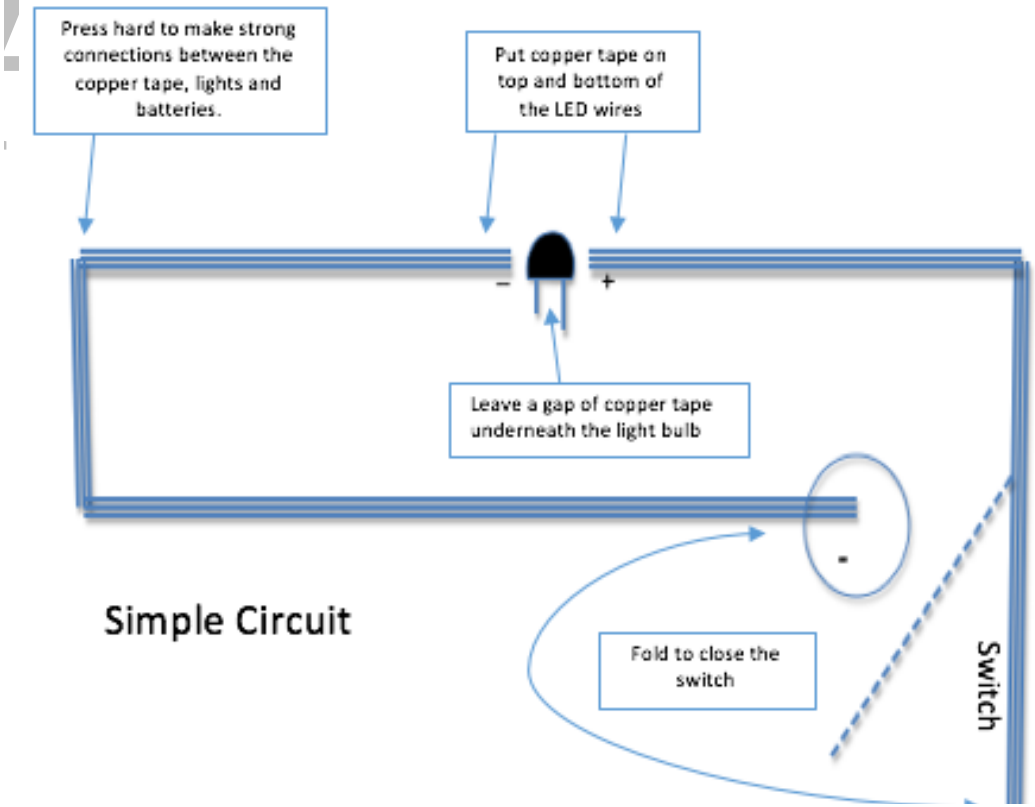
Parallel Circuit



Parallel Circuit




Press hard to make strong connections between the copper tape, lights and batteries.
Put copper tape on top and bottom of the LED wires
Leave a gap of copper tape underneath the light bulb
Fold to close the switch
Switch
Simple Circuit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Put copper tape on top and bottom of the LED wires
Leave a gap of copper tape underneath the light bulb
Fold to close the switch
Switch
Simple Circuit

Name_____

Lesson 2 Electric Art
Electric Art Design

Check List:

My design uses:

- A battery _____
- A LED light bulb _____
- Copper tape _____
- Has a switch _____

1. Draw and label your electric art circuit.
2. Label: Copper tape, LED light, battery, switch, current flow (use arrows).

Explain how your design works:

Who is going to receive your electric art?

Why do you think they will like your electric art?