5-E Model Unit Plan Lesson

Title	Introduction to Circuits
Name	**Anza Mitchell**
Purpose/Rationale	The students will be able to - Define and understand key concepts related to electricity. - Describe and identify the components of an electric circuit. - Describe an identify the different types of electric circuits. - Compare and contrast parallel and series circuits.
Virginia Science SOLs	PH.11 The student will investigate and understand how to diagram, construct, and analyze basic electrical circuits and explain the function of various circuit components. Key concepts include b) series, parallel, and combined circuits; c) electrical power;
NGSS Cross-cutting Concepts and Practices	4. Systems and System Models A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems. 6. Structure and Function The way an object is shaped or structured determines many of its properties and functions.
NGSS Disciplinary Core Ideas	4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.* [Clarification Statement: Examples of devices could include electric circuits that convert electrical energy into motion energy of a vehicle, light, or sound; Examples of constraints could include the materials, cost, or time to design the device.] [Assessment Boundary: Devices should be limited to those that use stored energy to cause motion or produce light or sound.]
Meetings needs of students: INTASC 1: Learner Development INTASC 2: Learning Differences INTASC 3: Learning Environments	Learner Development: Provide multiple levels of assessment strategies or tasks to be completed based on learners' needs. Example: For the final project students will be assessed based on their ability to create parallel and series circuits, an alternative is to have students identify the difference using their group's project or a circuit diagram. Learning Differences: Provide students with multiple ways to receive the content. Example: Printed out notes for students that needed them. Product: For the final presentation some students created a powerpoint and some created a poster. Learning environment: Students had the option to work in groups of 3 or 4. For some students, groups were rearranged to be smaller to meet their needs and allow them to work with a student that has been identified as supportive to their learning.

Materials		Activity Sheets, Squishy Circuits Materials, Electric Houses Materials.	
Community Resources			
Safety and Class Management Issues		Include in lesson plan and on activity sheet	
Procedures for Teaching			
Engage	**Time** **5 min**	**What will teacher be doing to capture students' interests and elicit prior knowledge?** Review of Electric Forces and Fields Brief introduction of Circuits and the Unit Plan	**What will the students be doing during the engagement phase?** Students will participate in review and prepare for the lab
		What open-ended (exploratory) questions will the teacher ask to engage students in the problem? (e.g. prediction, observation, inference) **1. Draw a picture of the field between a positive and negative particle** **2. What are some questions you hope to answer about circuits by the end of this unit?**	
Explore Squishy Circuits (Activity Sheet attached)	**Time** 1 hour, 15 minutes	**What will teacher be doing to facilitate student exploration?** Monitor student groups to make sure everyone is on task, working safely, and answer questions that may arise.	**What will the students be doing to explore?** Students will be exploring how electricity is transferred using conductive dough and LEDs
		What open-ended questions will the teacher ask during the exploration phase? **(e.g. prediction, observation, inference)** 1. Look at the ingredients for the conductive dough, which ingredients do you think help it conduct electricity? 2. Does it matter what size lumps of dough you use?	
Explain Introduction to Circuits Notes	**Time** 30 minutes	**What will teacher be doing to help students connect their explorations to the scientific and/or mathematical concepts?**	**What will the students be doing to connect their explorations to the scientific and/or mathematical concepts?**

<table>
<tr><td>(Lecture and Graphic Organizer Attached)</td><td></td><td>Explain the terminology and concepts needed to better understand circuits and transfer of electricity</td><td>Students will be taking notes, asking questions, and completing the graphic organizer.</td></tr>
<tr><td colspan="3">What questions (open-ended or expository) will be asked. List key vocabulary/concepts will be addressed in the lessons.
Series circuit, parallel circuit, current, voltage, battery, electricity, switch, electrical devices, wire, open circuit, closed circuit.</td></tr>
<tr><td>Elaborate
Electric Houses Project

(Project description and Rubric Attached)</td><td>Time

(3 days)</td><td>What will teacher be doing to help students to further expand their understandings?

Monitoring student groups for effective time management, team work, and meeting the project goals.</td><td>What will students be doing to elaborate their understandings?

Students will apply concepts related to circuits and electricity to design a model home.</td></tr>
<tr><td colspan="3">What open-ended questions will the teacher ask? (e.g. prediction, observation, inference)

How will you design you home keeping in mind the power constraints?
What materials will you use for the structure of your home and why?
How will you organize your circuits in a way that uses the least wire and still looks neat?</td></tr>
<tr><td colspan="4">Evaluation: INTASC #6, NSTA 5a-c</td></tr>
<tr><td colspan="2">Formative</td><td colspan="2">What information or data will the teacher collect to assess the development of students learning? Refer to activity sheets, quiz examples, etc.
Students will complete a circuits quiz (Included later)</td></tr>
<tr><td colspan="2">Summative</td><td colspan="2">How will students demonstrate that they have achieved lesson goals and objectives? Include at least one rubric. Final test can be included.
Students will complete the electric houses project. Rubric Included.</td></tr>
<tr><td colspan="2">Activity Sheets (attached)</td><td colspan="2">Includes at least two activity sheets with safety, open-ended questions, data recording and/or graphing included.</td></tr>
</table>

Squishy Circuits Activity Sheet

(adapted from Squishy Circuits Classroom Guide,
http://courseweb.stthomas.edu/apthomas/SquishyCircuits/PDFs/Squishy%20Circuits%20Classroom%20Guide.pdf)

Conductive dough recipe

[http://youtu.be/cpUFL5LZpv4]

- 1 cup (tap) water
- 1 1/2 cups flour
- 1/4 cup salt
- 3 Tbsp. cream of tartar
- 1 Tbsp. vegetable oil
- food coloring (optional)

Insulating dough recipe

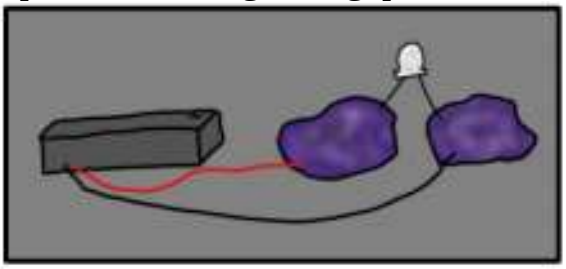
[http://youtu.be/Wz8rGNt-iEQ]

- 1 1/2 cup flour
- 1/2 cup sugar
- 3 Tbsp. vegetable oil
- 1/2 cup deionized (or distilled) water
- 1 tsp. granulated alum (optional)

Tips, tricks, and safety

- Don't connect the 9V battery directly to the LED, it may burn the LED out.
- Try not to mash the two types of dough into each other. This makes it difficult to separate them for future classes.
- The LED only works in one direction. This is called polarity. Notice how one "leg" of the LED is slightly longer than the other one. The longer leg should always be attached to the positive (red) wire from the battery.
- Don't cross the wires on the battery connectors – this will short out the battery! It may heat up and explode.
- **ALWAYS BE CAREUL WHEN EXPERIMENTING WITH ELECTRICITY**. High voltages and high currents can be deadly. NEVER stick wires or other objects into wall sockets.

1a. Begin with two lumps of the conductive dough. Plug one wire from the battery pack into each piece and bridge the gap with a LED.



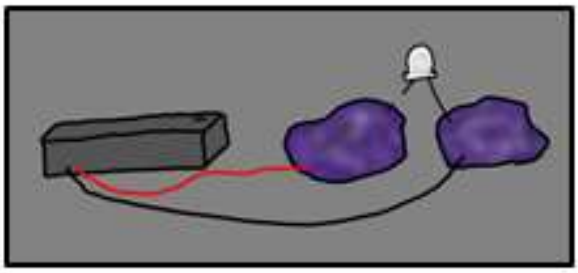
Does the LED light up? (circle one): YES NO

1b. Take the LED out and flip it around so that each "leg" is in the opposite piece of conductive dough.

Does the LED light up? (circle one): YES NO

The LED only works in one direction. The longer terminal should be attached to the positive (red) wire from the battery pack. This is called a ***closed circuit****.*

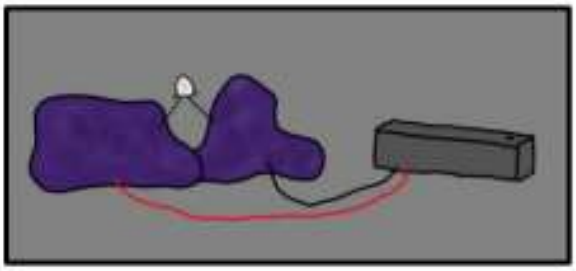
2. Next, pull one of the LED legs out of the dough.



Does the LED light up? (circle one): YES NO

In the last step, the LED went out because we broke the loop of electricity – this is called an ***open circuit****.*

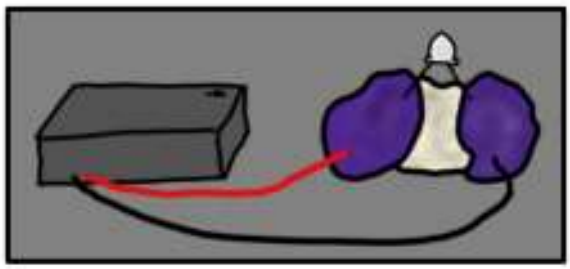
3. Put the LED leg back in, so your LED is on. Now, push the two pieces of conductive dough together.



Does the LED light up? (circle one): YES NO

In the last step, the LED went out – this is called a ***short circuit****.*

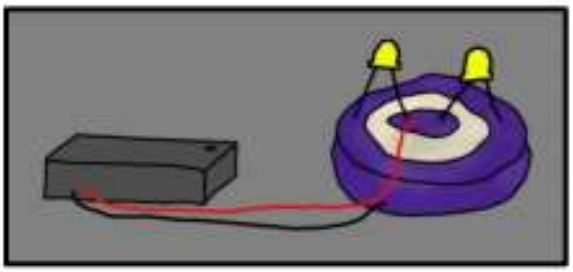
4. Separate the two pieces. The LED should once again light up, because the electricity must go through the LED to complete the circuit. Now, create a "sandwich" with the insulating dough between two pieces of conducting dough.



Does the LED light up? (circle one): YES NO

The insulating dough does not let electricity flow through it easily. It acts like a "wall" to electricity. Therefore, the electricity has to go around the insulating dough, and through the LED which lights up! There is one continuous path for the electricity to flow through – this is a ***series circuit****.*

5. Now, we can create Squishy Circuits that do not have to be separated, like "sushi circuits!"



There are multiple paths for the electricity to flow through – this is a ***parallel circuit****.*

6. Now, you can design your own circuit! Draw your design here:

Now, try to build and test your design with the materials provided**!**

Wrap up discussion

- Which types of circuits worked and which didn't?

- What is the difference between a series and parallel circuit?

- Why does one dough conduct electricity and the other doesn't?

Circuits Lecture Notes Power Point

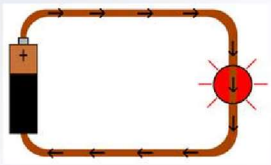
INTRODUCTION TO CIRCUITS

ELECTRICITY REVIEW

- Energy is contained within an electric field.
- This energy is called electric energy.
  - Electric energy is also known as ELECTRICITY.
- Electricity - can be transferred (move from one place to another)

CURRENT ELECTRICITY

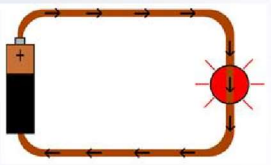
- Electricity that moves from one place to another.
- Current electricity results when charges move. The movement of charges is called current.
- In order for charges to move, they must have a path to travel. This path is called an electric circuit.



http://www.ruoanjo.com/Electricity.htm

ELECTRIC CIRCUITS

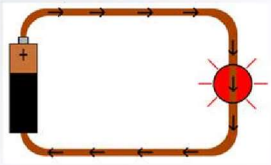
- An electric circuit consists of three components:
  1. Power source
  2. Wire
  3. Electrical devices



http://www.ruoanjo.com/Electricity.htm

POWER SOURCE

- Provides voltage or the force to push current through a circuit
  - Ex. a battery
    - A battery has a positive terminal and a negative terminal.
    - Current flows from the negative terminal, through the wire, across electrical devices, and back to the positive terminal of the battery



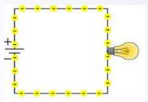
http://www.ruoanjo.com/Electricity.htm

WIRE

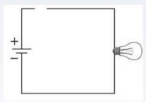
- Provides a path for current to travel and connects electrical devices to the circuit.
  - Closed Circuits - A circuit without any breaks is called a closed circuit. A circuit MUST be a closed loop in order for current to flow. The power source and electrical devices must be attached to the circuit so that current has a path to travel from the negative terminal to the positive terminal of the battery.
  - Open Circuit - A circuit with a break (or breaks) is called an open circuit. Current (and thus electricity) cannot flow through an open circuit.
  - Short Circuit – A circuit where the current flows in an unintended path or unwanted way.

WIRE

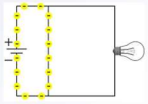
CLOSED CIRCUIT



OPEN CIRCUIT



SHORT CIRCUIT

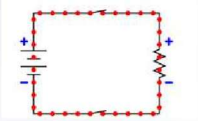


http://www.dummies.com/programming/electronics/components/closed-open-and-short-circuits/

ELECTRICAL DEVICES

- Devices that use electric energy (electricity).
- Electrical devices attached to the circuit "use up" voltage.
- Switch: a device that acts as an intentional circuit breaker - When the switch is open, the circuit is open and current will not flow - When the switch is closed, the circuit is closed and current will flow.

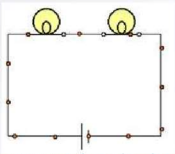
Direction of electron motion



http://www.bcsdk12.net/cms/lib01/GA01000598

SERIES AND PARALLEL CIRCUITS

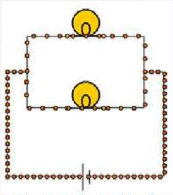
- Electrical devices can be linked together to form a closed circuit 2 different ways. The way in which devices are linked determines whether the circuit is a series circuit or a parallel circuit.
- Series Circuit - Devices are linked together in a row, one after the other
  - Current flows sequentially through electrical devices
  - Voltage is shared among devices



http://www.delsearegional.us/academic/classes/highschool/science/physics/firstyear/Units/Unit06/Notes/SeriesParallel.htm

SERIES AND PARALLEL CIRCUITS

- Parallel Circuit - Devices are linked together with separate pathways or loops
  - Current splits and has independent paths to take through each device
  - Voltage has multiple paths to travel and is NOT shared among devices



http://www.delsearegional.us/academic/classes/highschool/science/physics/firstyear/Units/Unit06/Notes/SeriesParallel.htm

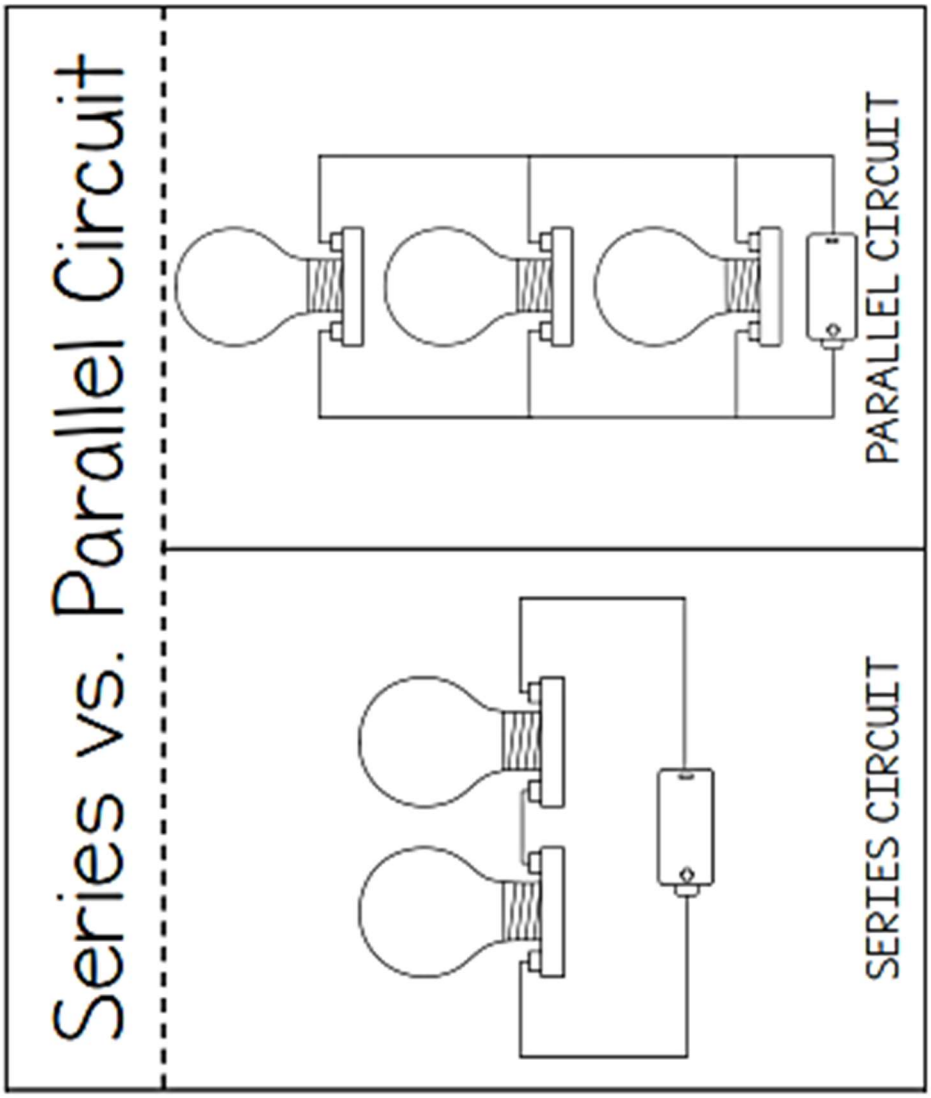
SERIES AND PARALLEL CIRCUITS

- The table summarizes important facts about series and parallel circuits. The table uses a circuit of light bulbs to describe differences in the circuits.

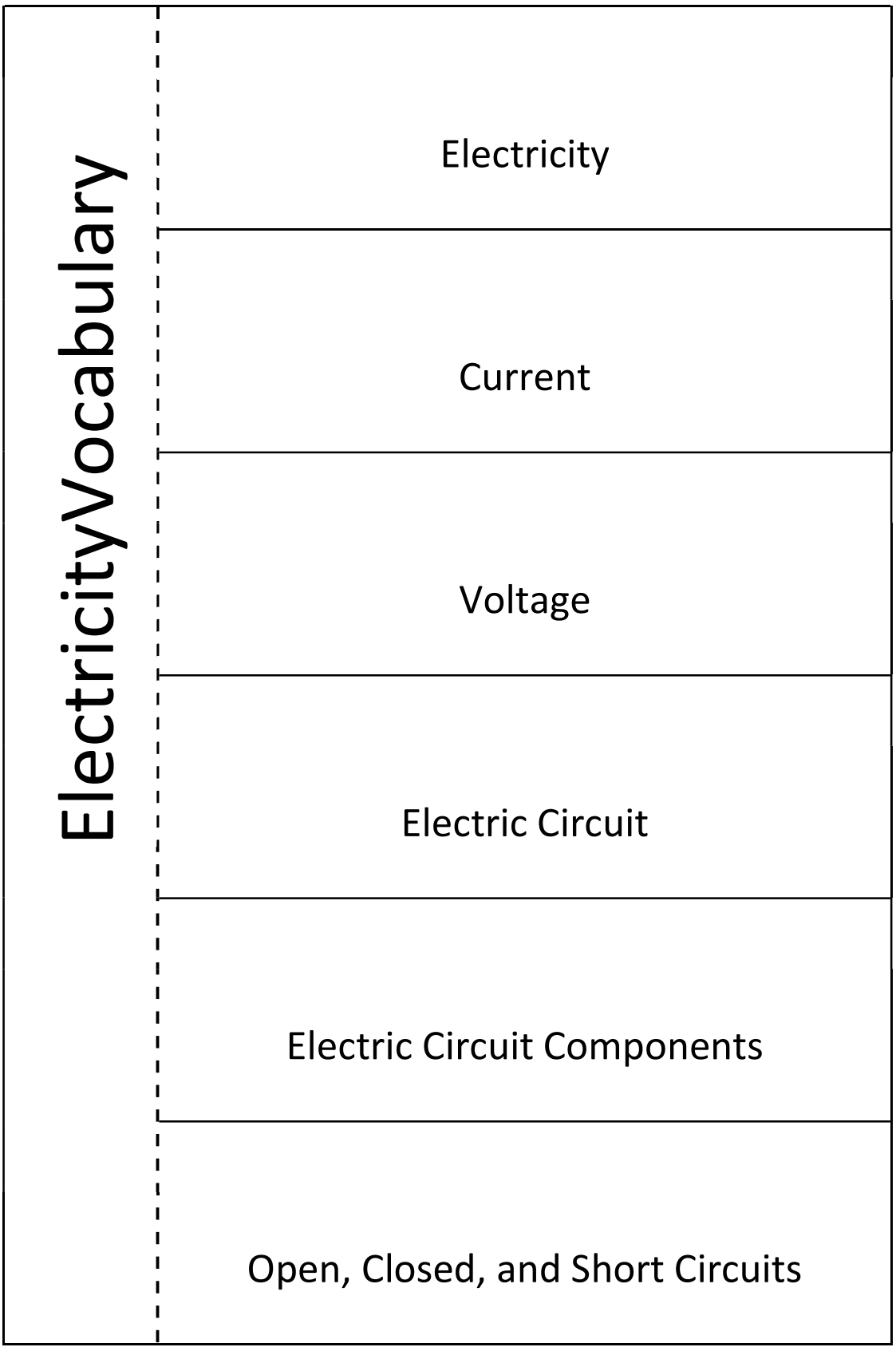
	SERIES CIRCUIT	PARALLEL CIRCUIT
What happens if one bulb in a circuit of 3 bulbs blows?	The circuit is open. The other bulbs will not glow.	Only the path of the blown bulb is open. The other bulbs will glow.
How does current flow across each electrical device?	The same amount of current flows across each device.	Current splits to flow across each device.
How much voltage is used up by each electrical device?	Voltage is shared among devices. This explains why increasing the number of bulbs in a series circuit causes bulbs to dim.	Voltage is not shared. The same voltage runs across each device. Increasing the number of bulbs does NOT cause bulbs to dim.

Lecture Notes Organizer

Directions: Cut out the foldable along the solid lines. Glue the top part of the foldable into your notebook. Fold along the dotted line. Describe a series circuit and a parallel circuit under the flaps.



Directions: Cut out the table below. Fold Along the dotted line and cut along the solid lines. Glue the flap into your notebook. Define each electricity vocabulary term under the flaps.



Electric House Project Description
Adapted from *http://cpphysics.homestead.com/houseg.html*

Your team will design and construct an electric house with separate series, parallel, and complex circuits.

The house will consist of one or two stories. Each house will contain at least the following areas: one bedroom, one bathroom, a kitchen, a porch, a front door, and a living room/dining room area.

Each individual room will be illuminated by its own light.

Materials:
Your team will provide the materials needed for the house frame, glue, additional tools, decorations, furniture and the batteries.
You will receive:
- Twenty Small Christmas Lights
Ten White Lights
Ten Colored Lights
Two of each: red, blue, pink, green, and orange
- Metal Paper Fasteners
- Paper Clips
- Insulated wire
- A motor
- Buzzer
- X-ACTO knife
- Soldering iron
- Hot glue gun
-Electrical Tape
- Wire cutters and strippers

Requirements:

- The house dimensions should be approximately: 24" by 36" horizontally or vertically.

Each house will be wired with 5 different circuits as follows:
- The living room area must have a chandelier with at least two lights in a SERIES CIRCUIT with a switch.
- The house must have one PARALLEL CIRCUIT consisting of a switch and at least two lights.
- The house must have one COMBINATION CIRCUIT consisting of two switches and at least three lights.
- The front door must have a doorbell (buzzer) and a switch.
- The use of the motor is open-ended, that is, you will incorporate the motor in the house in a creative manner. Some ideas are: an elevator, a ceiling fan or a garage door.

Scoring Rubric:

The score of your project consists of 200 points divided into three parts:

I. Group Project = 100 points

Meeting minimum construction requirements:

Neat house assembly, four rooms, and a porch =	**20 pts**
Successfully meeting series circuit minimum requirements =	**10 pts**
Successfully meeting parallel circuit minimum requirements =	**20 pts**
Successfully meeting complex circuit minimum requirements =	**20 pts**
Successfully meeting doorbell requirement =	**10 pts**
Successfully incorporating the motor =	**20 pts**

II. Individual Project = 40 points

- Drawing and schematic of every circuit combination	**20 pts**
- Creativity and/ or ingenuity	**20 pts**

III. Electric House Presentation = 60 points

You will design a poster or PowerPoint following the guidelines below

Group Members Names =	**5 pts**
Brief Description of the House =	**15 pts**
Physics information, diagrams, details =	**20 pts**
House information such as requirements, procedure, pictures and suggestions =	**20 pts**

Electric House Project Rubric

Requirement	Excellent	Good	Fair	Poor
Neat House Assembly **(20)**	House is constructed neatly and is decorated (20/20)	House has required rooms and is constructed neatly (15/20)	House has four/ five rooms and/ or a porch, but is not constructed neatly (10/20)	House has less than four rooms (5/20)
Series Circuit **(10)**	Has two or more lights connected in series with a switch (10/10)	Has two or more lights connected in series, but does not have a switch (5/10)	Has two or more lights connected but is not properly in series. (2/10)	Did not attempt a series circuit (0/10)
Parallel Circuit **(20)**	Has two or more lights connected in parallel with a switch. (20/20)	Has two or more lights connected in parallel, but does not have a switch (10/20)	Has two or more lights connected but are not parallel. (5/20)	Did not attempt a parallel circuit (0/20)
Complex Circuit **(20)**	Has three or more lights connected in a combination circuit with two switches (20/20)	Has three or more lights connected in a combination circuit with less than two switches. (15/20)	Has three or more lights connected but are not in a combination circuit. (10/20)	Did not attempt combination circuit (0/20)
Doorbell **(10)**	Has a buzzer / door bell and switch/button connected as a doorbell. (10/10)	Has a buzzer, but no switch/ button (5/10)	Buzzer is not connected properly (2/10)	Did not attempt doorbell (0/10)
Motor **(20)**	Motor is incorporated as a functional device and connected to a switch. (20/20)	Motor is connected as a functional device, but does not have a switch (10/20)	Motor is not connected in a meaningful way. (5/20)	Motor is not connected. (0/10)
Group Total				**/ 100**

Drawings and Schematics **(20)**	Has a circuit diagram for each room with components labeled. (20/20)	Has a circuit diagram for each room but is missing labels. (15/20)	Does not have a circuit diagram for each room. (10/20)	Is missing 3 or more circuit diagrams. (0/20)
Creativity and ingenuity **(20)**	Has a description and detailed drawing including dimensions of individual creative contribution to project. (20/20)	Has a description and drawing of individual contribution, but is missing dimensions. (15/20)	Has a description of individual contribution, but drawing is missing. (10/20)	Does not have a description nor drawing of individual contribution. (0/20)
Individual Total				**/ 40**
Group Members Names (5)	Group Members Names included (5/5)		Group Members names are not included (0/5)	
Description of the House **(15)**	House description is detailed and includes number of rooms, location of circuits, and description of individual members' creative contributions. (15/15)	House description is detailed, but does not include individual members' contributions. (10/15)	House description is missing key details about the house. (5/15)	Description is missing (0/15)
Diagrams and Details **(20)**	Has a circuit diagram for each room with components labeled. (20/20)	Has a circuit diagram for each room but is missing labels. (15/20)	Does not have a circuit diagram for each room. (10/20)	Is missing 3 or more circuit diagrams. (0/20)

House information such as requirements, procedure, pictures and suggestions **(20)**	Poster includes house diagrams with descriptions and dimensions for each room, procedure for building the house and circuits, and suggestions for improving the procedure or house. (20/20)	Poster is missing one of the requirements from the excellent criteria. (15/20)	Poster is missing two of the requirements from the excellent criteria. (10/20)	Poster is missing three or more requirements from the excellent criteria. (0/20)
Presentation Total				**/ 60**
Project Total				**/ 200**

Circuits Quiz

Name:

1. What is electricity?

a. Energy contained within a magnetic field

b. Energy contained within an electric field

c. The force that pushes charges around an electric circuit

d. The flow of electric charges

2. What is current?

a. The buildup of charges on an object

b. The amount of charge that builds up on an object

c. The movement of charges

d. The force that pushes charges around an electric circuit

3. What is a battery?

a. Provides current for a circuit

b. Provides voltage for a circuit

c. Connects electrical devices together

d. The flow of charge through an electric circuit

4. What is a switch?

a. A tool used to hook up electrical devices in a circuit

b. A device that opens and closes to form an open or closed circuit

c. A device that is used to change the battery in a circuit

d. A tool used to calculate how much voltage is used by devices

5. What determines if a circuit is a parallel or series circuit?

a. The number of electrical devices

b. How electrical devices are wired in the circuit

c. The number of batteries in the circuit

d. How the batteries are wired in the circuit

6. What happens to voltage in a parallel circuit?

a. It is shared among devices

b. It is the same among devices

c. It is highest for the first device and lower for other devices in the circuit

d. Voltage cannot push current through a parallel circuit

7. What happens to current in a series circuit?

a. It is the same for all devices

b. It splits and recombines

c. It changes depending on where the battery is located in the circuit

d. It cannot flow through a series circuit

8. What are the three components of a circuit?

a. _____

b. _____

c. _____

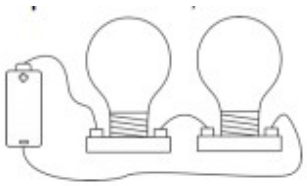
9. What is the purpose of the wire in an electric circuit?

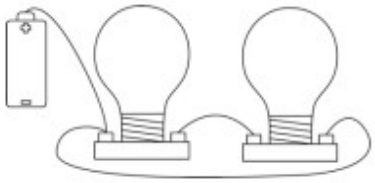
_____

_____

_____

10. Below are two circuits. Identify which circuit is open and which is closed.





11. Why do lights dim as you add more light bulbs to a series circuit?

_____

_____

_____

12. What happens when one bulb blows in a parallel circuit of 3 light bulbs?

_____

_____

_____