S.T.E.M. Challenge

Light Up Vest

Series and Parallel Circuits

The Owl Teacher

Created By The Owl Teacher

Materials

Materials (per student):

- Large brown grocery bag
- Two 3V button batteries
- 38 cm of copper tape
- Ten 3-5mm LED bulbs
- Markers
- Scissors
- Electrical tape

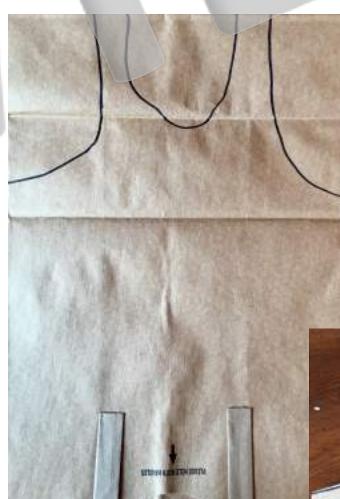
Preparation

Gathering Materials

While most of these materials seem “out of the ordinary,” you can indeed find them relatively inexpensively online through Amazon. I was able to buy many LED lights in one package for under $10. Ask a local grocery store if they are willing to donate large paper grocery bags. If you are really crunched for money, then have students use one battery to light both the series circuit and the parallel circuit. Another option is to have students create one as a group.

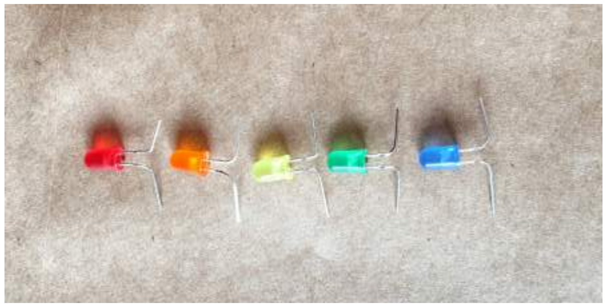
Cutting the Bags into Vests

To help your students cut the large brown grocery bags into vests, have students place them in front of them with the opening at the bottom. If there is any text, place it facing them (text side up). Draw lines like the picture shown. Have students cut out the neck and arm openings. Then, cut the line down the center but ONLY along the top side of the bag. This will be the opening in the back for students to allow a bit of “wiggle” room in size. Next, open the bag to look at the arm holes. If there is an extra paper there, then have students cut it out. (If there are handles, I just have the students cut them off.)



Helpful Hints

*Students can bend their LED lights (the leads) but they will need to treat them carefully. If they bend them too much, they will break off. When bending them, they should all bend in the same direction.



*Utilize anchor charts and reference them frequently during these activities.
*There are some students who are very visual and tactile. I would allow them to see the materials and manipulate them while in the planning stage, if desired.
*If you experience students arguing over whose turn it is, or that their idea is not being heard, then consider modeling to students how to share your idea, justify it, and work together as a team. I would also demonstrate good listening skills, asking questions, and taking turns – no matter what grade they are in.
*While some STEM challenges do not require **time limits**, I suggest having them. When they are broken up over several days, or when students have unlimited time, students tend to get off task and talk more instead of focus on the task at hand. I recommend considering giving time limits and **frequent reminders** of the time remaining.
*It's important to allow students to **make mistakes**; if students are struggling, then try scaffolding instead of stepping in and telling them what to do.
*If you are experiencing groups that **cannot get along**, then discuss why it is important for them to get along and work as a team. Also discuss the value of compromise.
*If you see students **feeling frustrated**, then suggest they discuss the problems with members of their group or circulate the room to other groups to hear how they discuss their problems.
*Remind students of the importance of lab safety. They should never eat or drink during any science lab.

You're Hired!

Congratulations! You have just been hired as an engineer to design a vest that lights up with both a series circuit and a parallel circuit so drivers can see road crew workers better at night.

1.) Create a plan on paper by yourself and sketch out your ideas to design a vest with both a series circuit and a parallel circuit that will solve the problem above. You may want to come up with more than one idea.

2.) Now that you have brainstormed several ideas and designs, you will need to choose an idea. Look over your choices and decide which will work best to solve the problem. Make sure you have good reasons why that plan is best.

3.) You will begin designing your light up vest to solve the road crew's problem. There may be times when you will hit a "snag" and need to problem solve. This is completely normal as an engineer.

4.) Make sure that you are following the orders of the mayor. Check the road crew permit sheet to verify as you work. Also make sure that you record all your information.

5.) As you work on your design, you will need to test it regularly to determine if your plan is working. You may need to stop and reevaluate what is working and what is not. You also may need to make adjustments or improvements. Most engineers do not get it right on the first try.

6.) When time is up, your teacher will be around to test your model. You will need to present to the class what you did, what worked, what didn't, and any other important information about your construction.

7.) Then, you will answer the questions on your reflection sheet.

Good luck and have fun!

Road Crew Permit

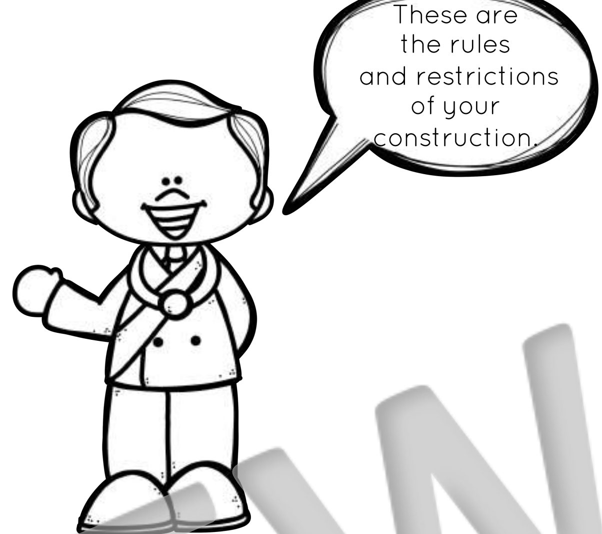
1.) The vest must have a series circuit and a parallel circuit on it.

2.) You only have 25 minutes total to design and create your light up vest. Timelines are realistic in the real world.

3.) You will only be given 10 LED lights, 38 cm of copper tape, and 2 batteries.

4.) The circuits must light up.

5.) The vest must be appealing.



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Name ______________________________

Light Up Vest

Problem: To create a vest that lights up with both a series circuit and a parallel circuit to help drivers see road crew workers better at night.

Was your plan successful? Why or why not?

What problems did you encounter?

How did you solve these problems?

What would you do differently next time? Why?

What did think was clever about others' designs?

Was your team's plan successful? Why or why not?

What problems did you encounter?

How did you solve these problems?

What would you do differently next time? Why?

What was your favorite part?

What was your least favorite part?

What did think was clever about others' designs?

Name ______________________________

Light Up Vest

	1 Point	2 Points	3 Points
Background	The student did not demonstrate the use of background knowledge in the challenge.	The student demonstrated some use of background knowledge in the challenge.	The student demonstrated the use of background knowledge in the challenge.
Planning	The student did not brainstorm ideas, and/or did not meet the design rules and requirements.	The student brainstormed some ideas and/or met some of the design rules and requirements.	The student brainstormed ideas and met the design rules and requirements.
Testing	The student did not problem solve, did not conduct the challenge carefully, did not record results accurately, and did not reflect on the successes and failures of the challenge.	The student problem solved some, conducted the challenge minimally, recorded some results, and/or reflected on some successes and failures of the challenge.	The student problem solved, conducted the challenge carefully, recorded results accurately, and reflected on successes and failures of the challenge.
Effort and Attitude	The student did not put forth his or her best effort and/or did not maintain a determined attitude.	The student put forth some best effort and/or did maintain some of a determined attitude.	The student put forth his or her best effort and maintained a determined attitude.
Presentation	The student did not explain the ideas of the challenge well.	The student explained some of the ideas of the challenge well.	The student explained all of the ideas of the challenge well.

Comments:

Total ______ / 15

Expert Engineer: 13 – 15 pts

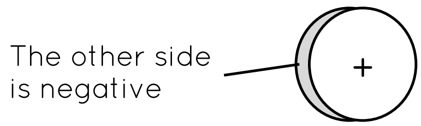
Skilled Engineer: 11 – 12 pts

Novice Engineer: 0 - 10 pts

Putting It Together

When you use your computer or turn on your bedroom light, you are creating a continuous flow of electrons, or an **electric current**. In order for an electric current to move continuously, it needs a source of electrons. A **battery cell** often supplies energy to move charges through a circuit or a generator and can be a source of electrons, too.

Inside a battery cell, two different metals in a chemical bath build up opposite charges. Opposite charges build up on the terminals of a battery. A **terminal** is where the electrons flow in and out of the battery. This is also where you will see the '**+**' and the '-' symbols.

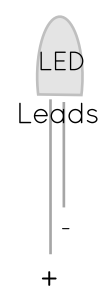


Electrons are attracted from one terminal to the other. When we connect the two terminals with copper tape, the electrical current can flow from one terminal along the copper tape to the other terminal where it is attracted. In order for the electrons to flow, the **circuit** (a path made for the electric current) must be a complete path between the two terminals of opposite charges. When the path is complete and electrons are able to flow without any interruptions, it is called a **closed circuit**.

Electric currents flow through many types of matter, if the **electric force** (the attraction or repulsion between charges) is strong enough. However, some matter conducts, or carries, electrons more easily than others. These are called **conductors**. **Insulators** are materials that don't carry electrons easily, such as rubber or plastic. This helps keep wires from touching each other and completing an electrical circuit before reaching a device. If this happens, it could become a short circuit.

Material that is neither a conductor nor an insulator is called a **resistor**, or a load. These materials don't completely stop the flow of the current but resist it. It also converts some of the energy into light or heat, for example. An example of a resistor would be the LED lights in this activity.

The LED lights have one lead that is longer than another. This is the positive side. The shorter side is negative. When trying to continue the flow of electrons, the positive (longer) lead will need to connect to the positive terminal of the battery, while the negative (longer) lead will need to connect to the negative side.



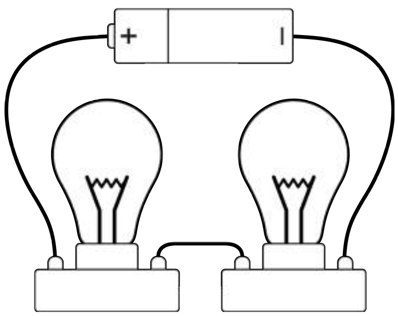
In this activity, these parts are connected in either a series circuit or a parallel circuit. Parts that are connected through a single path are called a **series circuit**, while those that have multiple pathways are called a **parallel circuit**.

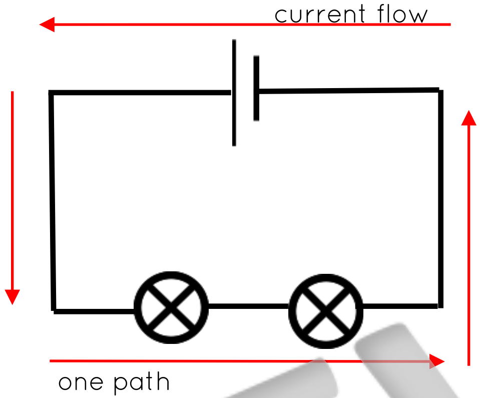
In a series circuit, the current can only flow along one path. That means that all the resistors on that path are sharing the same energy that is flowing. The resistors are one the path, one right after another. If one resistor was to go out, the flow would stop.

Parallel circuits are the complete opposite. There are multiple paths for the current to flow. This means that if one resistor was to go out, the current could just take an alternative path, usually along a parallel circuit.

The Two Types of Circuits

Series Circuits





Parallel Circuits