Lights Out
Facilitator Resources

Problem Cheat Sheet

Adventure 4: Facing the Frozen Tundra

Quest 1: Lights Out

Goal:

Design a device that will help Flynn see in the dark so that she can walk to the dock for a whale watching tour.

Setting/Background Story:

Flynn is in Canada on Baffin Island so her parents can help with a climate change study. They are so far north that the sun doesn't come up during the winter months. Flynn needs to walk to the dock so she can go on a whale watching tour to see orca whales. Without the sun, she brought a flashlight to see, but she slipped and fell, and now her flashlight is broken. She needs help making a new light source with the broken flashlight pieces so that she can find her way to the dock.

Quest Structure:

Session 1: GEERling(s) receive a supply of household materials and try to use them in creative ways to design a solution to Flynn's problem—making a light to see in the dark. At the end of the session, GEERling(s) share their solutions.

Session 2: Flynn shares with the GEERling(s) information about electrical circuits. She thinks an electrical circuit is a good starting point for making a light source. The GEERling(s) research these concepts to gather information that will help them plan their new designs.

Session 3: The GEERling(s) use their new knowledge to design a light source that will be bright enough and work for a long enough amount of time so that Flynn can walk to the dock.

Test for Success:

The light source must be bright enough to read a poster in a dark room. It must be able to turn off and on easily. In session 1, the light source must shine continually for 15 seconds without flickering, and in session 3, it must shine for 30 seconds.

Detailed Background on the Quest

In Lights Out, the GEERling(s) will design a light source. Flynn is on Baffin Island in the northern part of Canada so that her parents can participate in a climate change study. Flynn has decided to go see orca whales on a whale-watching tour. She has to walk to the dock in the dark with a flashlight because the sun doesn't shine this far north during the winter months. She slips and falls though and her flashlight breaks, so she has no way to see! The GEERling(s) will help Flynn by designing a light source with the broken flash light parts and other materials that Flynn has with her.

They will do so without any introductory information on the first day. They will be challenged to only use their creativity and problem solving skills. Their solution should be bright enough to light Flynn's way, be able to turn off and on, and shine continuously without flickering.

On the second day, the GEERling(s) will be introduced to electrical circuits. They will also learn about electrical engineers and conduct research about electricity using our online resources. They will be asked to use the online resources Growin'GEERS provides and to do their own research online as well.

On the last day, the GEERling(s) will build a new light source. They should try to use the concepts they learned from their research along with their own creative ideas to design their final solutions. They must pass the Test for Success for their solution to be considered successful!

Canada — Introduction and Wildlife Info

- Canada is the second-largest country in the world in terms of land mass.
- Canada is made up of 10 provinces and 3 territories.
- Most of the population lives in the south, close to the U.S. border. The other parts of the country have very few people living in them.
- In the south, Canada has four seasons. Farther north, there is an arctic climate.
- In the far north, Canada experiences midnight sun in the summer and polar night in the winter.
- Midnight sun — during the summer, the sun never sets at night
    - Polar night — during the winter, the sun never rises in the morning
- The two main languages spoken in Canada are English and French.
- Canada has great biodiversity—meaning there are many different types of plants and animals there.
    - Canada is home to many bird species, like the peregrine falcon, northern cardinal, bald eagle, and Atlantic puffin.
    - It is also home to many sea creatures, like orca whales, salmon, seals, and walruses.
    - Many interesting land mammals also live there, such as grizzly bears, polar bears, wolves, elk, moose, and caribou.
    - The largest land animal in North America, the wood bison, lives in Canada.
    - Canada is also home to the *smallest* mammal in North America — the pygmy shrew.

Materials List

The following materials can be purchased at any grocery store or dollar store. These materials were chosen for the sake of teaching of the GEERling(s) to imagine new uses for everyday objects and to make the preparation for this activity easier and more affordable for you.

Please gather the following materials prior to starting this adventure with the GEERling(s). As they work on their solutions, the GEERling(s) should only use the items listed below because they represent the materials that the character, Flynn, has to use in her environment.

Material:	**What it Represents:**
Small 2. 2 Volt Light Bulb (1)	⇒ From broken flashlight
Double D Batteries (2)	⇒ From broken flashlight
Insulated Wire (Three 5 inch long pieces with 1/2in of rubber stripped off)	⇒ From broken flashlight
Brads (10)	⇒ Flynn's earrings
Paper Cup (2)	⇒ Flynn's hot chocolate cup
Paper Towel Roll (1)	⇒ Empty snack container from Supply Sack
Duct Tape (1 Roll)	⇒ From Flynn's Supply Sack
Electrical Tape (1 Roll)	⇒ From Flynn's Supply Sack
Cardstock (1 Sheet)	⇒ Whale watching tour brochure
Paperclips (10)	⇒ From Brochure Packet

Please provide scissors for the GEERling(s) to use to alter the materials in any way they choose. You also need to have at least one pair of wire cutters available in case they are needed.

To test the solutions, you will need to use large pieces of paper or cardstock to prepare posters with words or letters that can be easily read from a distance. Please prepare these in advance. A cut out from a magazine or the newspaper also works.

Engineering Concepts

There are a few key principles that explain how circuits work. There are three main parts to a simple circuit. The first is a source of electrical power or voltage. A good example of a **power source** is a battery. The second is a **conductive path** which allows charges to move through it. This part allows the circuit to be connected, and wires are usually used to do this. The third is a **resistor** or something that uses an electricity to do work. A great example of this is a lightbulb.

With those three pieces in mind, there are also some basic rules that must be considered for a simple circuit to work.

1. A circuit **must be complete** for it to work properly. That means the conductive path or wires must connect the power source to the resistor and back again. If a circuit is not complete, electricity cannot run through it.
2. If you are using more than one power source, make sure that the **power sources are connected** appropriately to complete the circuit. For example, a battery has a positive and a negative end. If you are connecting two batteries, the positive end of one battery must be connected to the negative end of the other.
3. A **switch** can be added to an electrical circuit. Switches are helpful because they let you control the flow of electricity. A switch could be as simple as disconnecting one end of the conductive path from the power source. You can use different things to do this but it is as simple as disconnecting a reconnecting the power source.

Lastly, we wanted to talk about **conductors** and **insulators**. A conductor is a material that will allow electricity to travel through it. Steel, iron, and silver are all good conductors. An insulator is a material that does not allow electricity to travel through it. Rubber and plastic are good examples of insulators. Many wires that people use in electrical work are a mix of conductors and insulators. The conductor, which may be a copper wire, is surrounded by a rubber coating. The rubber insulator stops any electricity that is running through the wire to transfer to other objects that come in contact with the wire. This is very useful when you don't want to get an unexpected electrical shock!

A great way to get the kids thinking about circuits is to give them some examples of simple circuits they use every day. Turn the lights in the room on and off and explain that the switch is connecting and disconnecting the electrical circuit.

Timing and Pacing

The purpose of Growin'GEERS is to promote creativity, research, and engineering skills in young students. For this reason, we recommend spending several days working through each problem. At Growin'GEERS, we have found that **three two-hour sessions** work best for the participant(s) and the chaperones! Below is a general guideline for how you could run a problem, but keep in mind that this is merely a suggested plan and can be adjusted as needed for your group.

Session 1:

Flynn introduces the GEERling(s) to the problem, and the GEERling(s) use their creative ideas and play with the materials in the fun pack to design and build a solution. At the end of the session, the GEERling(s) share their solutions and talk about them. Growin'GEERS usually plans for a 2 hour block, but you can allow more or less time depending on the circumstances in your group.

Session 2:

The GEERling(s) watch the video and learn engineering principles related to the problem. The GEERling(s) research these principles independently on the computer and learn about how they can use this new information to improve on their original solution. Again, the time allowance can be adjusted based on the needs of your group. Since you'll be using computers, you may want to get them set up before the GEERling(s) arrive. Like Session 1, 2 hours will usually be enough time for Session 2.

Session 3:

This session is usually the most challenging because the GEERling(s) have to take the new information they've learned from their research and apply it to their solutions. This may take longer than 2 hours, so plan for a little more time.

***Please note that this setup is only a suggestion and can be altered to accommodate the needs of your group. The GEERling(s) should use the time in each session to its fullest potential. They should spend the entire session discussing, designing, building, researching, and having fun! You can use some of the guiding questions to stimulate a group that is working slowly or to slow down a group that is working quickly by getting them to think critically about their solution.**

Specifics for Space

The GEERling(s) solutions must be tested in a room in which the lights can be turned on and off easily. The room should be fairly dark when the lights are off. Before the GEERling(s) test their solutions, prepare a poster for each group with words or letters that can be easily read from a distance. You can use a magazine or newspaper if you have one. To test the brightness of their solutions, GEERling(s) will stand at a short distance and shine their light source on the poster. They will be considered successful if they can read the poster correctly. The poster can be placed on an easel or hung on the wall with tape. Mark a spot on the floor about 6 feet away from the poster; this is where the GEERling(s) will stand to test their solutions.

If possible, have separate areas for building the solutions and testing the solutions. This way, teams can test their solutions as they work without having to turn off the lights!

Guiding Questions for Each Session

SESSION 1

***If your GEERling is new to Growin'GEERS**, show Introduction Video. This video gives an overview of Flynn and Growin'GEERS.

1. Introduce the problem to the GEERling.

Welcome, GEERling(s)! Today we're going to hear from Flynn, a fourth-grader who travels the world with her parents. She has a problem that she needs our help solving. Let's hear what she has to say!

2. Show ***Video A*** to GEERling(s).

3. Check for understanding.

What is it that Flynn is asking us to do?

Why does Flynn need our help?

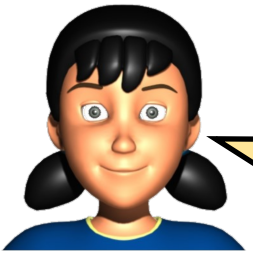
Have you ever had trouble seeing in the dark? How did you solve that problem?

Did Flynn mention anything that didn't make sense? What was it and why was that confusing?

What type of devices are used to see in the dark? Can you list them out?

4. Inventory the fun pack and set up the workspace.

Talk about each item one at a time so that the GEERling(s) understand the materials they have. (Repeat this step with all of the materials to ensure each pack has the materials that are needed.)



If you plan on using this Quest with a larger group, have them gather their own materials instead of putting the Fun Packs together yourself.

5. Prepare the area for GEERling(s) to test their solutions. Conduct the test in a room where the lights can easily be turned on and off. Hang posters, a magazine, or a newspaper with large-print words or letters in the dark room for them test with. Place them on an easel or use tape to hang these on the wall one at a time just before the GEERling(s) test their light sources. Mark a spot on the floor about 6 feet away from the wall where the GEERling(s) will stand to test their light sources. Make sure it is a room that can become pitch black!

In this first session, the GEERling(s) can use any ideas to create their solutions. Encourage them to be creative!

6. If working with a group, remind GEERling(s) to work cooperatively. ***Say: It's important for each team to work nicely together. As I walk around the room, I should see every person on the team contributing equally. Everyone needs to have a chance to share ideas, and make sure you listen respectfully to each person.***

If your GEERling is working individually, ask them to walk through their design process with you and how they arrived at a design to build. Don't rush the brainstorming process even if it is tough!

7. Allow 10-15 minutes of discussion and brainstorming for the GEERling(s). This time is meant for discussion and planning only. Everyone should have a chance to contribute!

8. Allow 50-60 minutes for building. Walk around to observe the GEERling(s) as they work. Make sure that the teams are working well together and using the fun pack materials appropriately. The GEERling(s) may want to test out their solutions while they work. If possible, allow the GEERling(s) to test solutions in a separate area where the lights can be turned off. Make sure the GEERling(s) do not get discouraged and try to ask probing questions to help!

If the GEERling(s) do appear to have trouble or get stuck during this time, don't be afraid to jump in! Encourage the GEERling(s) to think critically about their task without giving them any hints. Try these guiding questions:

What type of solution are you building?
What materials do you have that could solve the problem your having?
Have you included everything you need to solve the problem for Flynn?
How else could you use this material?
What do certain materials have in common or how do they connect? Is there a way they could be combined to help solve the problem?

9. All GEERling(s) or teams should share their solution swith the other groups or the facilitator. They will stand on the designated spot on the floor, and then the lights will be turned off. Hang the poster once the lights are off, and then have the GEERling(s) turn on their light source. The solution will be successful if the light source provides enough light for the GEERling to read the poster, can be turned on and off easily, and shines for 15 seconds without flickering. After the GEERling(s) test their solution, they should present their ideas to explain the methods they used to build their solution and why. This is a great way to practice presentation skills! Use the following questions to promote more critical thinking about the solutions.

What do you think worked well on your solution?
What would you have done differently if you had to solve this problem again?
If you could have any additional materials, what would you want?
How is your solution different from the solutions of other teams?
What did you learn from the planning process? How could you do better next time?
How could your team have worked better together?
What other thoughts do you have about the problem and your solution?

10. Show **Video B** to finish the session.

SESSION 2

1. Welcome the GEERling(s) to session 2!

Say: Hey GEERling(s)! Thanks for coming back to help Flynn find a way to make enough light for her walk to the dock. Once she builds a good light source, she can walk safely to her destination to see orca whales! Let's see what she's going to tell us today.

2. Show ***Video C*** to the GEERling(s).

3. Allow the GEERling(s) to research electrical circuits on the computer.

If they are having trouble getting started, you can suggest ideas for what to research. The GEERling(s) should work on answering the questions on their worksheets, and they should take notes on their research. This will help them retain the information so that they can remember it and easily access it later while they're designing their new solutions. Allow 45-50 minutes for research or more if needed. Younger GEERling(s) may need assistance operating the computers. Make sure they get the help they need, but they should be conducting their research as independently as possible. Ask questions to check their understanding of the material while they are researching. They should understand the information well enough to explain it in their own words. They should not write down notes about the information until they fully understand it. We recommend that younger GEERling(s) use videos and images rather than written text if they have trouble reading or if the content is too advanced for them to understand independently.

4. Have the GEERling(s) share their new information with their groups. Or the facilitator. You may want to go through the entire worksheet and ask for the response to each question, or depending on time, you might just want to highlight some of the questions. Use your discretion, but sharing is very valuable to the learning and engineering processes and should never be skipped over.

If you are working individually, have your GEERling practice their presentation skills! Have them stand up in front of the room and present their findings during their time researching. Engineers have to present information all the time, so it is a great skillset to have a nurture!

5. Show ***Video D*** to the GEERling(s) and wrap up for the day.
Say: You did good research today, GEERling(s)! In our next session, you'll be given materials to design a new light source for Flynn using the information you learned today. Please clean up before you leave. I'll see you next time!

SESSION 3
1. Welcome the GEERling(s) back to the final session.
Say: ***Hi, GEERling(s)! This is the last day we'll be working on a light source for Flynn. This should be a fun challenge! Let's hear what Flynn has to say before we get started.***

2. Show ***Video E*** to the GEERling(s). Give them time to review what they learned about electrical circuits. They may use their notes to review. Allow at least an hour for the GEERling(s) to design and build their new light sources. Encourage them to use what they learned during the previous sessions to design the solution.

3. If working with a group, have GEERling(s) stop working and share their finished light sources with the other teams. Test the solutions by having GEERling(s) try to read the large lettering from a designated spot on the floor while the lights are off, as in the first session. Their light source must be able to turn on and off easily, and it must shine without flickering for 30 seconds. We would love to see them test, so don't hesitate to post it on social media!

If the test was successful, ask them the following questions:

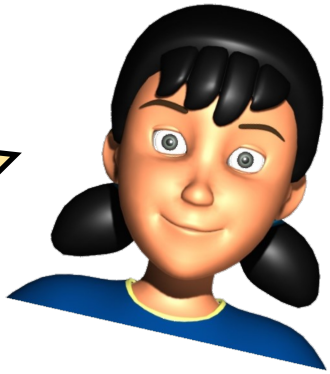
What made you successful throughout this quest?
Did you ever feel like giving up? Why did you decide not to?

Did you design change a lot from the creativity segment to the rebuild segment? Why or why not?
Do you think this solution is sustainable? Why or why not?
Even though your design was successful, are there any additional features you could add to your design to make it better?

If the test was unsuccessful, ask the following questions:

What part of the design was the most challenging?
What segment of the activity was most challenging and why? What could you do to make it less challenging?
What did you learn about electrical circuits? What piece of information do you think you were missing that would have made your design a success?
What do you plan to do differently in the next quest? Why?
How often do you think engineers fail? Can you think of any engineers that have failed in history? How did they handle it?

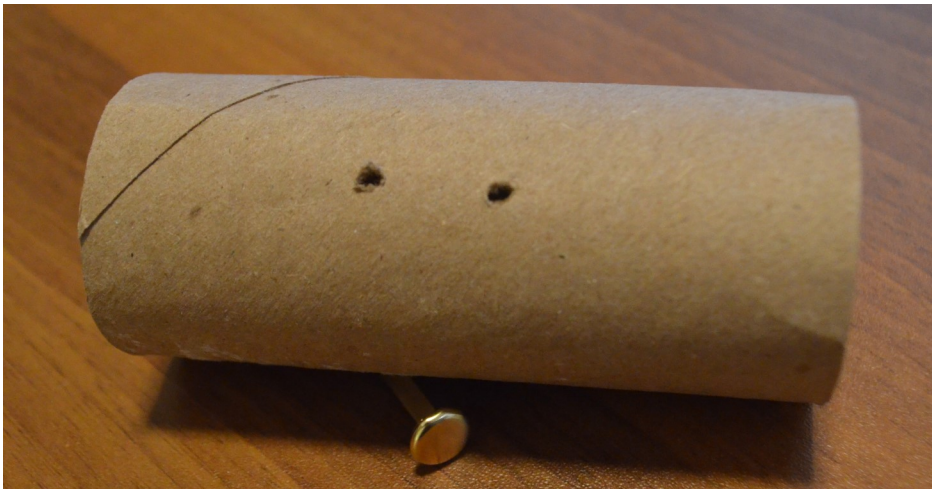
4. Show ***Video F*** and have the GEERling(s) clean up. Try to save any materials that could be used in the future.



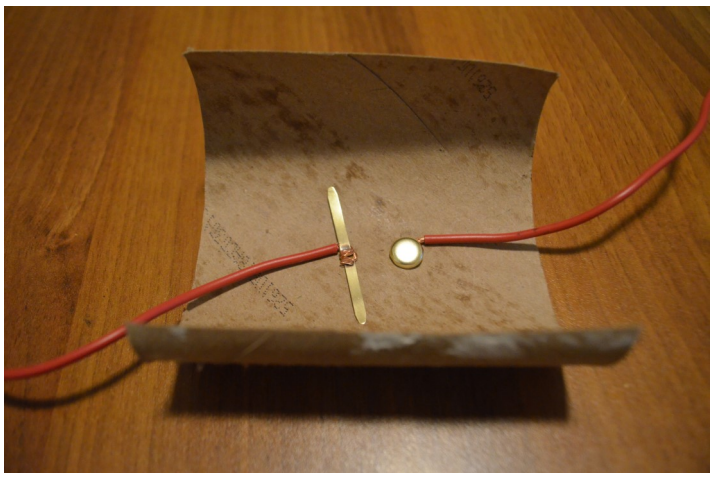
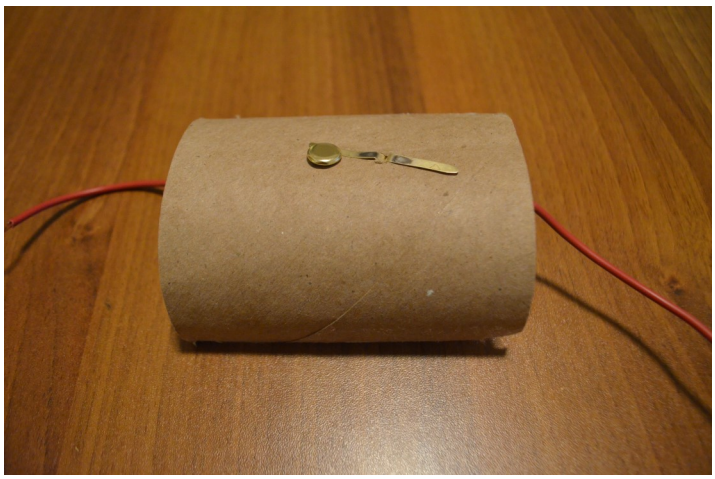
Potential Solution

1. Tape two D batteries together using electric tape. Make sure you connect a positive end (has a bump) with a negative end (without a bump).

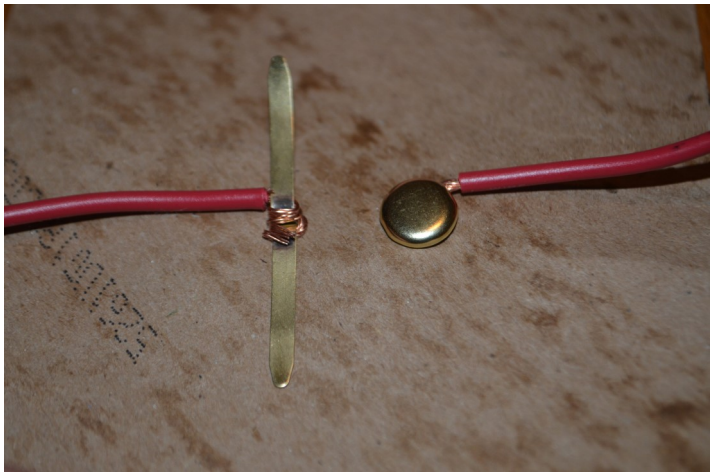
2. Cut the cardboard tube in half (long ways) to have better access to the inside of it.
3. Poke two holes in the side of the toilet paper or paper towel roll.



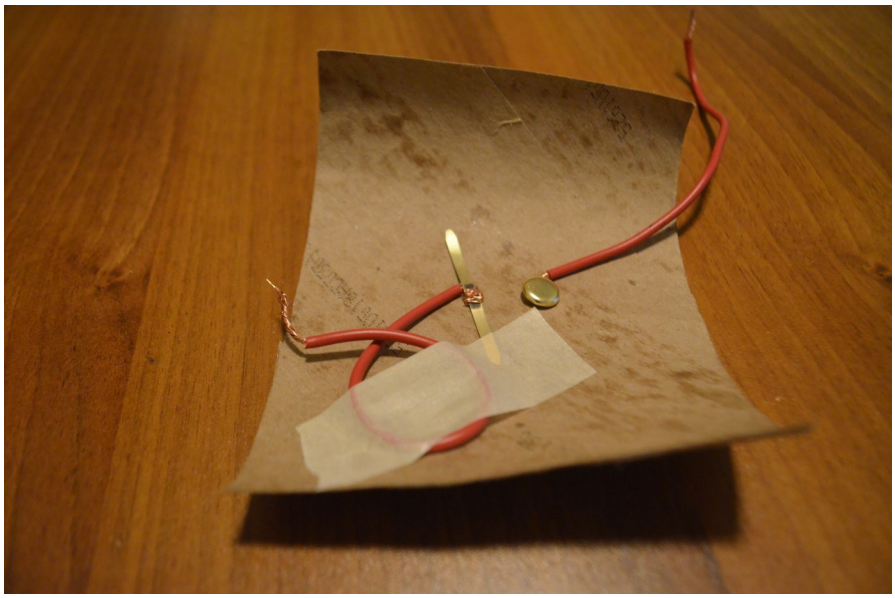
4. Stick one brad through one hole from the outside in and one brad in the other hold from the inside out.
5. The wires now need to be wrapped around each brad on the inside of the roll. Before securing the brads, take one of the wires and wrap it around the legs of the brad between the head of the brad and the roll.

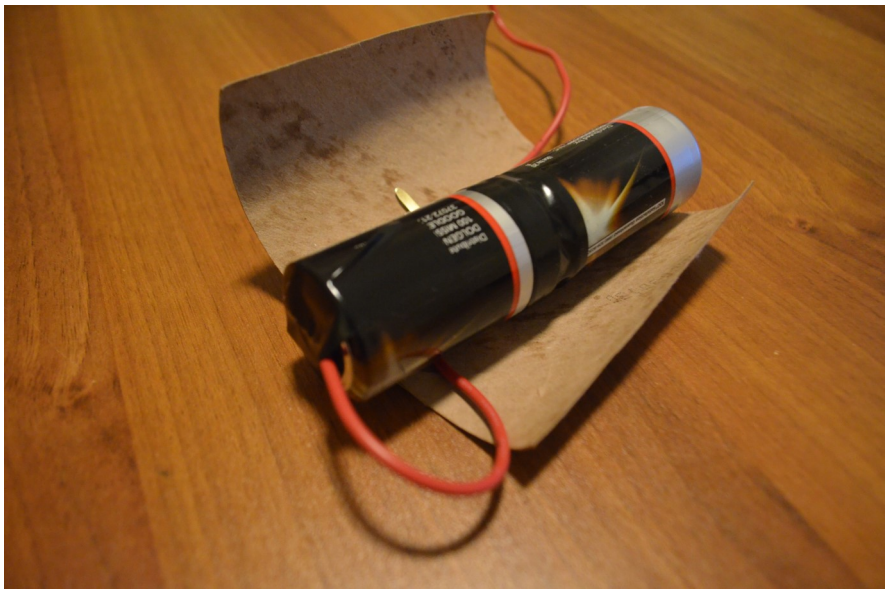
6. Then, take the other wire, and wrap it around the legs of the brad on the inside of the toilet paper roll.
7. Secure the brads on either side of the roll and make sure they can touch if turned from the outside.




8. Tape down excess wire and the legs of the inside brad to make sure the wire doesn't move and the brads don't touch on the inside of the roll.



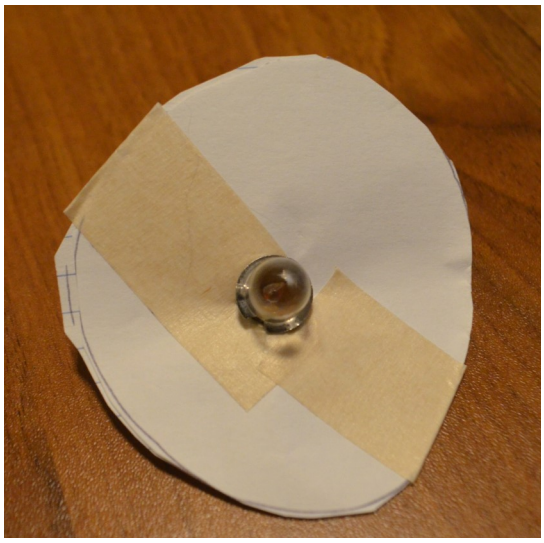
9. Put the batteries inside the cut toilet paper or paper towel roll.
10. Secure the other end of one of the wires to the negative end (the flat end) of the battery using electrical tape.



11. Tape the toilet paper or paper towel roll back together using masking tape or duct tape. Make sure that the end of the other wire is sticking out of the top of the tube on the same side as the positive end of the battery (with the bump).

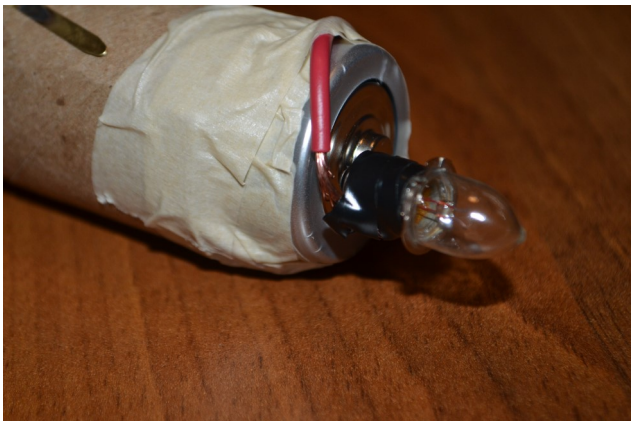
12. Fold cardstock in half and trace the top of the cup to create a circle to be cut out.

13. Cut out circle and tape together to secure. Cut two slits in the middle of the circle to create a lightbulb holder.



14. Tape down any extra wire to the roll to make sure it stays connected.

15. Using electrical tape, tape the copper part of the wire to the bottom metal portion of the lightbulb.



16. Securely tape the lightbulb holder onto the top of the flashlight. Don't be afraid to use a lot of tape! Double check that it is working by connecting the switch while you are taping it. You can also use an extra piece of cardboard to create a holder as well.

Potential Solution

17. Cut a hole in the bottom of the cup and slide it over the top of the flashlight.

18.Use the switch to turn it on and off.

Simplified Potential Solution

Was the first solution too much? Check out this simplified option for younger GEERlings!

1. If the GEERling(s) are having trouble, give them the objective of getting the lightbulb to light up.
2. Combine the two batteries.

3. Connect one wire end to the negative end of the battery with electrical tape.

4. Take the other end of the same wire and wrap it around the metal portion of the lightbulb.

4. Tape the lightbulb to the positive end of the battery.