What you'll need

Here is a list of the items needed to complete this activity.

- 1 Red Laser Pointer
- 1 Flashlight
- 1 UV Germ Light
- AAA Batteries
- 1 Empty Aluminum Can
- Sandpaper
- PVC Pipe
- Construction Paper
- 20 Icicle Tinsel Strands
- Paper clips
- Adhesive Tape

Before you start…

Safety. You're going to do some experiments with different sources of light, including lasers and UV lights. It's important that you don't shine these lights in your own eye or anyone else's! Lasers especially can cause significant eye damage if you aren't careful. Avoid directly exposing your skin to UV light for more than a minute at a time.

In this photoelectric effect experiment you'll observe how light can behave as a particle, how light can interact with metals, and how this relates to quantum computing.

In classical physics light always behaves like a wave, but in the quantum world it can behave as both a wave and a particle, this is called the particle-wave duality. White light is made up of all the different colors of visible light, these colors can be sorted by energy. Red light has the least amount of energy, while violet light has the most energy.

When light interacts with microscopic matter it behaves like a particle, this particle of light is called a photon, and since they are particles photons can only have one value for their energy. A very well-known example of photons interacting with matter is the photoelectric effect, first discovered in the early 1900s. In the photoelectric effect photons with high enough energies are able to knock out electrons from a metal. Shining a light with the right energy on a negatively charged metal results in electrons being ejected, surprisingly, the intensity of the light used does not matter, only its energy. So light with the right energy will cause electrons to be ejected even if it's very dim.

The photoelectric effect was one of the first examples of something that could only be explained using quantum mechanics, it has many applications such as solar panels, photography, light meters, and sensor technology. For quantum computing applications, scientists make use of the photoelectric effect to study properties of exotic, fragile materials without handing or damaging them, these materials are then used for the construction of machines and parts that form quantum computers.

Activity Instructions

Photoelectric Effect
In this activity you will observe the photoelectric effect and how it depends on the light source being used.

Steps

1) Before starting the activity, think about what you expect to happen. Write your predictions below.

You will use three light sources in this activity, what is the main difference between these light sources?	

What effect will each of these lights have on the aluminum can?	

2) Lightly sand one side of the aluminum can, stretch the paperclip into a straight line, tape one end of the paperclip to the can, and attach the tinsel strand onto the other end. Make sure the tinsel strands do not touch the table.

3) Now charge up the can and tinsel by rubbing the PVC pipe with the construction paper for 10 seconds, then transfer the charge to the can putting the pipe near the tinsel. You should see the tinsel strands start to repel each other.

4) Now shine the red laser pointer directly onto the aluminum can for 50 seconds. Look at the tinsel while shining the red laser pointer and write down what you observe.

5) Discharge the aluminum and tinsel by tapping the can with your finger, charge it again with the PVC pipe and construction paper. Now shine the flashlight directly onto the aluminum can for 50 seconds. Look at the tinsel while shining the flashlight and write down what you observe.

6) Discharge the aluminum and tinsel by tapping the can with your finger, charge it again with the PVC pipe and construction paper. Now shine the UV light directly onto the aluminum can for 50 seconds. Look at the tinsel while shining the UV light and write down what you observe.

Discussion Questions

After completing the activity, discuss these questions with your group for about 10-15 minutes. The class will then come together to discuss.

Did your observations match your predictions?	
Why do the tinsel strands move away from each other when the can is charged?	
You should have seen the red laser pointer and the flashlight have no effect on the tinsel. Why do you think that is?	

You should have seen the UV light have the effect of bringing the tinsel down. Why do you think that is?	
What differences between the laser pointer, flashlight, and UV light make one able to discharge the tinsel and the other two unable to?	

Funding and Support