

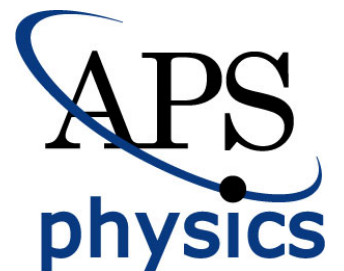
# Conquering Quantum Physics One Photon at a Time

**Jamie Garrett**

Southern Polytechnic State University in Marietta, Georgia

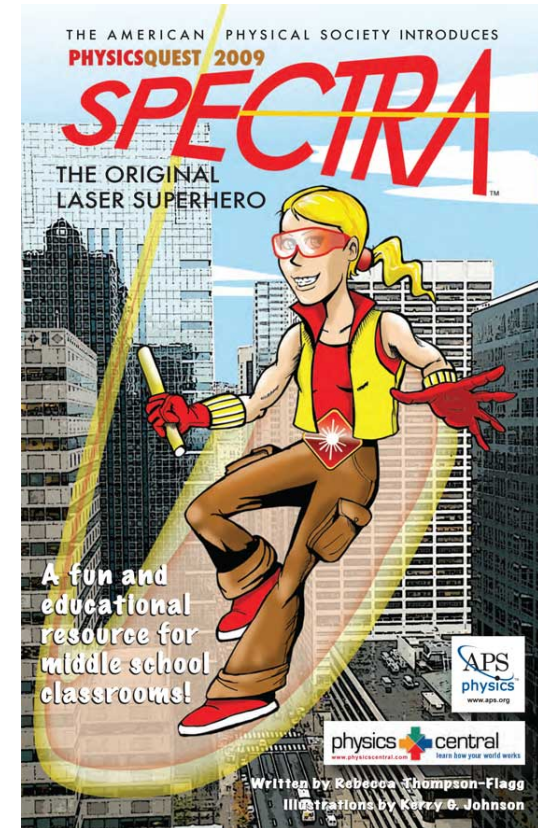
Physics Education – Junior

PhysicsQuest – Becky Thompson - American Physical Society



# What is PhysicsQuest?

- Story-based activity
- APS provides a free PhysicsQuest kit
- Kit includes:
  - Comic book
  - Materials for 4 experiments
- Students work together to complete four experiments to answer questions. They then submit their results to APS for a chance to win prizes.



# Meet Spectra

She is the PhysicsQuest  
Super Hero!

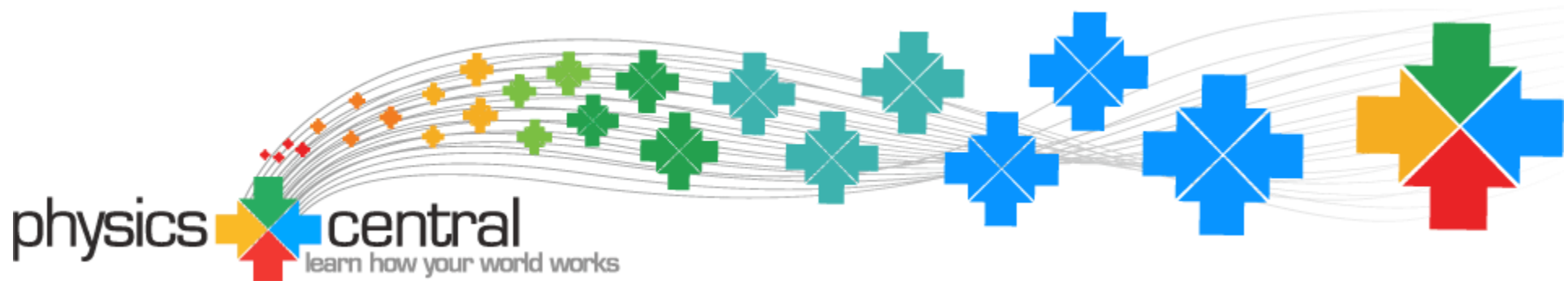


PhysicsQuest is sent out to

**3500** teachers

a total of

**13,000** kits!!



Her nemesis this year...

**THE QUANTUM MECHANIC**

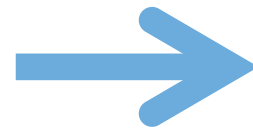
# What did I do?

The Photoelectric Effect

Spectroscopy



3



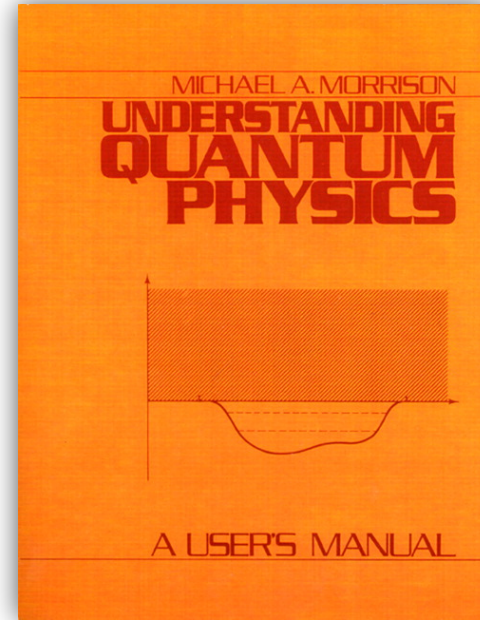
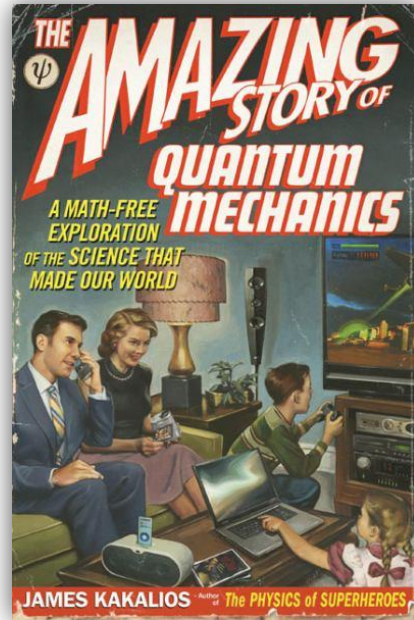
Angular  
Momentum and  
Rotation

**Each Contains:**

1. Teacher Edition
2. Student Edition
3. Key Term Sheet
4. Resources

Absorption Spectra

# TO TACKLE THIS PROJECT



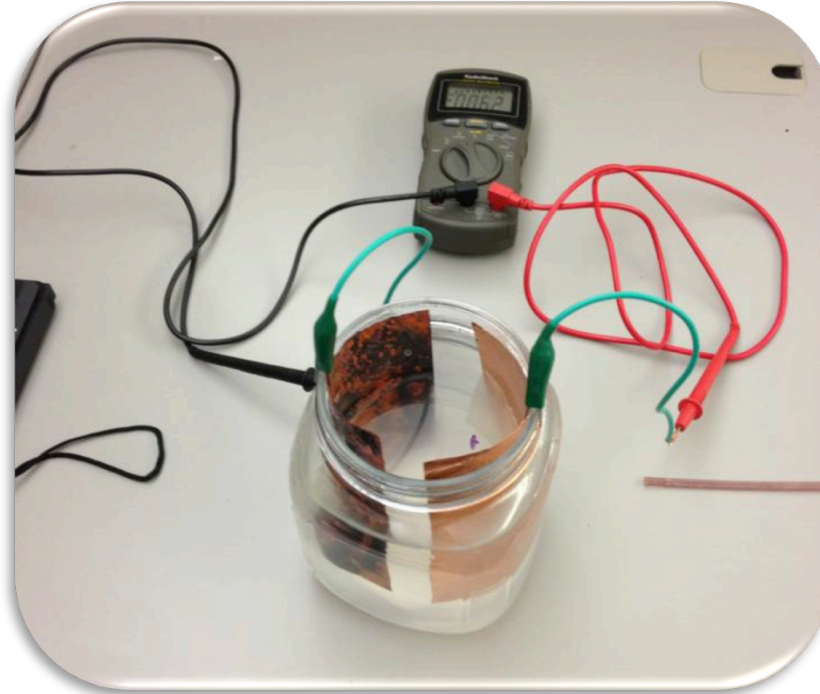
1. Read about my topics
2. Brainstorm ideas

**MY FIRST TOPIC:**

**The Photoelectric Effect**

# My activities include...

## The Photoelectric Effect



### **SOLAR CELL**

- Light gives the electrons on the cuprous oxide panel of the solar cell enough energy to become free to conduct electricity.
- The higher the energy of the light source the greater current in the solar cell.



## Photoelectric Effect: Activity 3

### Solar Cell

**Safety:** Ask for supervision during this activity. Be careful when cutting the copper, placing the copper on the stove, and washing the copper after it has been on the hot element. Use oven mitts and a grabbing utensil to remove copper from the stove.

#### Materials:

- A 6"x6" sheet of copper flashing from the hardware store.
- Two alligator clip leads
- A sensitive micro-ammeter that can read currents between 10 and 50 microamperes.
- An electric stove. At least 1100 watts. If you do not have an electric stove, a small one-burner hotplate will work.
- A large clear plastic bottle off of which you can cut the top or a large mouth glass jar
- Two tablespoons of table salt.
- Water
- Sand paper
- Sheet metal shears for cutting the copper sheet

#### Optional discussion materials:

- 3D glasses (one blue lens one red lens)
- Ultraviolet light source
- Flashlight

#### Instructions:

##### Part 1:

1. Cut the two pieces of copper sheeting to 3"x3"
2. Wash the copper sheets to remove any dirt or oil.
3. Use sandpaper to clean the copper sheeting
4. Place the cleaned and dried copper sheet on the burner and turn the burner to the highest setting
5. The copper will start to heat up and an oxidation pattern will form. Then, a black coating of *cupric oxide* will cover the copper. The element of the stove will begin to glow red and the last bits of the color should disappear from the copper, which should be now completely black.
6. Let it cook for about half an hour, under supervision, so the black coating will be thick.
7. After thirty minutes turn off the burner.
8. Leave the hot copper on the burner to cool slowly.
9. As the copper cools, it shrinks; the black cupric oxide also shrinks, but they shrink at different rates. The black cupric oxide will flake off. The little black flakes pop off the copper. They will fly a few inches, and you will need to clean up after everything is completely cool.
10. After about twenty minutes, the copper should be cooled to room temperature. Most of the black oxide will be gone.
11. Lightly scrub the copper plate under running water with your hands to remove small bits.
12. Do not try and remove all the black spots by hard rubbing or flexing the soft copper. (This may damage the red cuprous oxide layer we need to make the solar cell work.)



##### Part 2:

1. Bend both pieces, the cooked copper sheet and the clean copper sheet to fit into the plastic bottle or jar without touching one another. (The cuprous oxide coating that was facing up on the burner is usually the best side to face outwards in the jar, because it has the smoothest, cleanest surface.)
2. Attach the two alligator clip leads, one to the new copper plate, and one to the cuprous oxide coated plate.
3. Connect the lead from the clean copper plate to the positive terminal of the meter.
4. Connect the lead from the cuprous oxide plate to the negative terminal of the meter.
5. Mix two tablespoons of salt into hot tap water.
6. Stir the saltwater until all the salt is dissolved.
7. Pour the saltwater into the jar, careful not to get the clip leads wet. Leave about an inch of plate above the water so you can move the solar cell around without getting the leads wet. (The saltwater should not completely cover the plates)
8. Turn the switch on the ammeter to measure the current in micro amps.
9. Using 3D glasses and a black light, try different light sources to see the change in current under: red, blue, and ultra violet light.



#### Discussion Questions:

1. What does amperage measure?
2. What is current?
3. Will using different colors of light change the current measured?

#### Let's find out:

Shine a flashlight on your solar cell and measure the current under white light. Next, use the filter from the 3D glasses to measure the current through the solar cell under red and blue light. Finally, measure the current under ultraviolet light.

Light Source	Current Measured - milliamps (mA) or microamps ( $\mu$ A)
White light	
Red Light	
Blue Light	
Ultraviolet Light	

# To demonstrate fluorescence



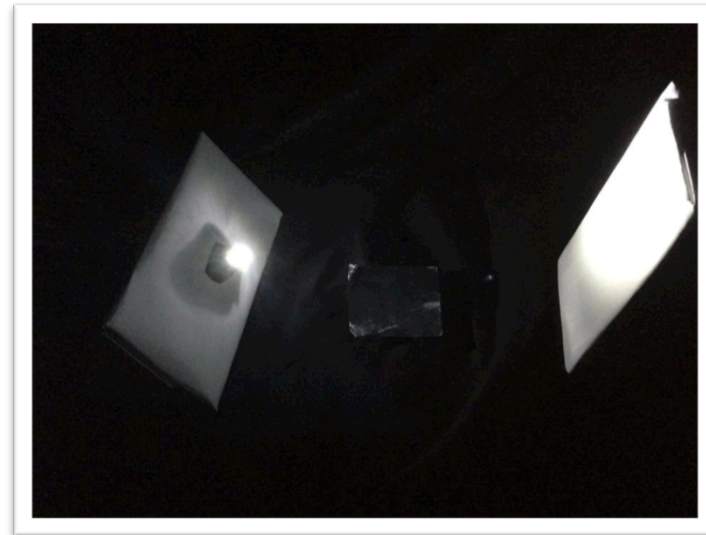
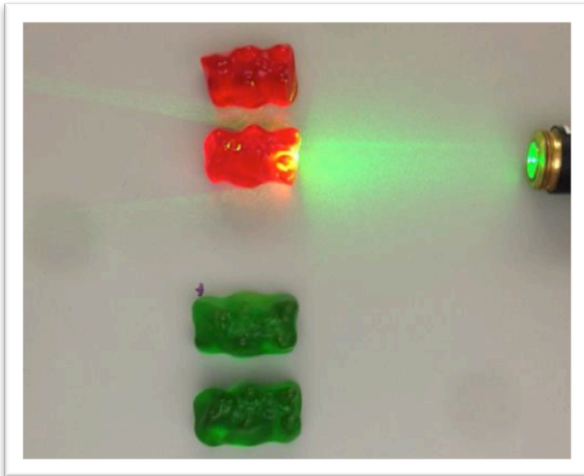
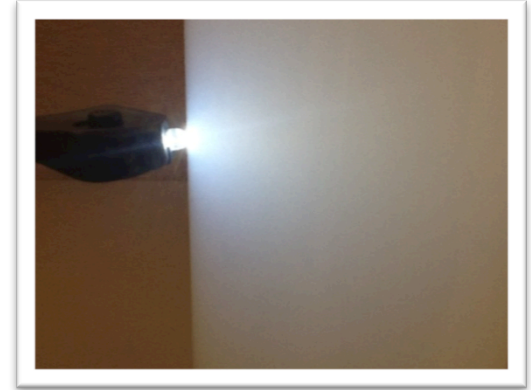
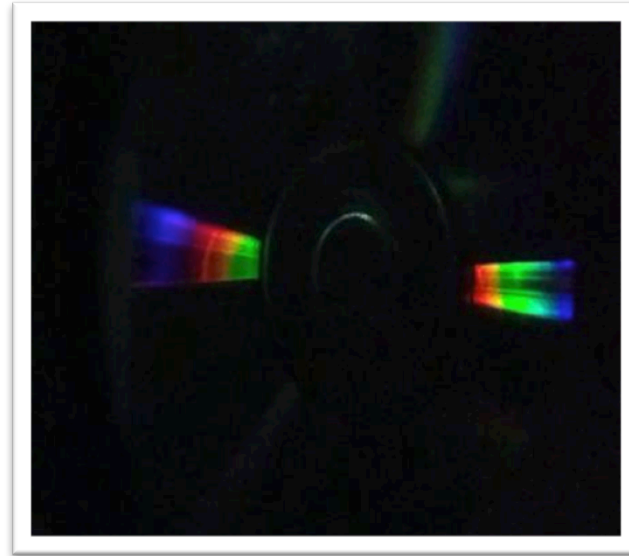
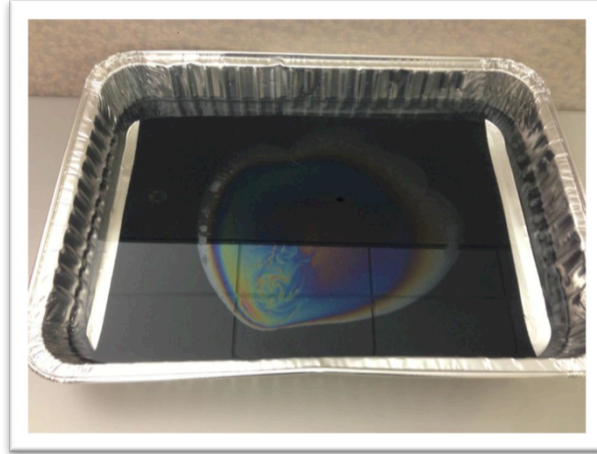
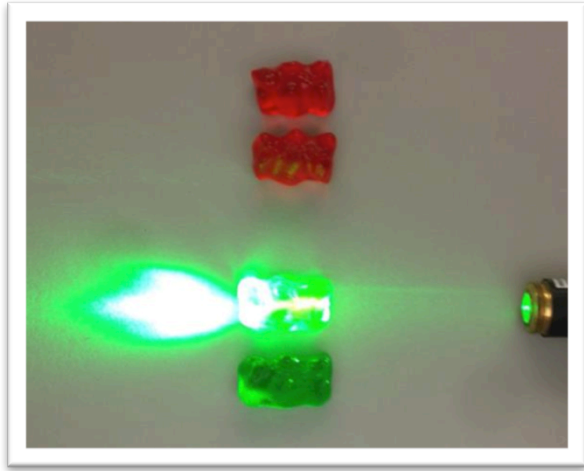
MY OTHER TOPICS:

**Spectroscopy**

Angular Momentum and Rotation

**Absorption Spectra**

# More Activities...





Einstein  
Fellowship  
Poster Session



Tuckahoe  
ELEMENTARY SCHOOL



Newton's Apple  
Tree Clone at NIST



**NIST Summer Institute**  
for Middle School Science Teachers



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