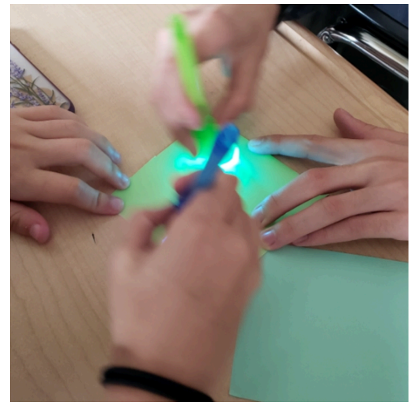
Activity 13. Glowing Stars



Lesson Overview

BIG IDEA:

Atoms emit light when electrons move to more stable configurations, but an input of initial energy is required to excite electrons.

Description:

Using the glowing stars, the audience observes and compares the effects of different sources of light. This is connected to the energy need to excite electrons and/or down-conversion of light.

Materials & preparation

- Glow-in-the dark stars
- Laser pointers, LEDs, and/or UV lights of different colors; At least one should cause light emission (e.g., UV, blue), and one should not (e.g., red or green)
- Identify preferred way to distribute materials to audience (e.g., baggies of lights and batteries, set up at stations, etc.)
- Consider if the room is dark enough or if you will need boxes to create darkness
- *Optional*: Handout prompting audience to record a model of what's happening

Teacher Directions

Warm-Up Question

- Ask audience to brainstorm as many sources of light as they can think of
  - Back-pocket prompts: in nature, in their home, in the classroom, in an emergency, etc.
- Using this list, ask audience to identify where the light comes from?
  - E.g., battery lights up wire, fire burns and releases light & heat, sun is nuclear reactions, chemical reaction in glow stick emits light
- Today we'll be looking at one particular source of light–glow in the dark stars.

Introduce Glowing Stars & Laser Safety (if using laser pointers)

- Introduce the source of light they'll be investigating today and try zoom in to what we can't see to better understand why it produces light
- Review safety protocols of laser pointers (if using)
- Distribute materials to each small group

Student Exploration

- Encourage students to observe how the glow in the dark stars respond to different types of light (red, green, and blue laser pointers; UV pen; sunlight; LED lights; etc.). Circulate and ask groups to share their observations as you visit with them (see example back-pocket questions below)
  - What similarities do you observe for the different lights? What differences?
  - How do you think the red and UV light are different?
  - If you had ____ light, what do you think it would do? Why?
  - What theories do you have to explain this?

        - Why do you think other material does or does not act the same way?
        - What do you think is happening inside the glow stars that we can't see?
- Optional: have students/groups record their theories on the handout. These are just initial observations and ideas, and so encourage students to not get caught up on "right" answers.
    - You will revisit and revise these models at the end of the activity.

Check-in as a whole class

- Ask audience to share what they observe happening (and/or recorded on their initial models)
    - What similarities do you observe for the different lights? What differences? (e.g., light on it is different, light coming off is always the same green).
    - How do you think the red and UV light are different?
    - What do you think is happening inside the glow-in-the-dark stars that we can't see?
    - Why do you think other material does or does not act the same way?
    - What theories do you have to explain this?
- As a class (or as individuals/groups) come up with an initial model for what you think is going on

Connection to Energy of Light

- If they have not already, ask audience to predict how they think the energy of the different light sources compare.
- Relate the different colors to their energy, using the electromagnetic spectrum.
- *Optional*: Discuss other forms of light on the EM spectrum, their applications, and their relative energies (hidden slides)

Connection to Material

- Point out we still don't know why the glow-in-the-dark stars glow green with enough energy, whereas other plastic doesn't glow at all. We need to figure out what's going on inside the material?
- Brief review/explanation of atomic structure:
    - Negative electrons that orbit a positive nucleus on different energy levels. (kind of like floors of a house)
    - Electrons are most stable and use the least energy when they are on lower energy levels.
    - When electrons change energy levels, they absorb or release energy
- This is what's going on in the nylon
    - Particles inside the material absorb the high energy light (blue and UV) and emit another, lower energy type of light

Revisiting Models

- If the audience developed an individual/group/whole-class initial model, revisit and revise based on the new ideas. (This can be done as part of the following whole-class sensemaking discussion.)

Whole-class Sensemaking Discussion

- **Activity:** What did we do?
    - You can provide this part and ask if they have any details to add
- **Patterns:** What patterns did we observe?

    - In general, don't record the first thing you hear–make sure students agree on ideas/summary before recording them
- **Meaning:** Why is this happening?
    - This may be more difficult for the audience; consider having them pre-think and/or pre-write about their ideas on a post-it
- **Clues & Questions:** How does this relate to quantum science? What do we still need to figure out?

Potential Modifications

Talk Moves:

- **Think, pair, share**: Ask students to think on their own and then discuss their ideas with a neighbor before sharing with the whole class
- **Small groups/whole class:** Have students work in small groups or demonstrate the affects of the light for the whole class
- **Ask for more:** During whole-class sensemaking, ask students to expand on their answers, break down jargon, or build on someone else's answers with the following moves:
    - Can you say more about that?
    - Can you explain what you mean by _____?
    - Did anyone else have a similar idea?
    - Can anyone rephrase or build on what ______ just shared?
    - Did anyone else notice something different happening?

Differentiation:

- **Audience:** This activity works best for grades 5 and up, with modifications (single lessons, lesson series, summer camp, etc.).
    - Selected talk moves above may help adapt for different audiences
    - The summary table will look different for different audiences and depending on the topic of consequential concern/phenomenon
    - For younger audiences, you can just address the relative energies of the light (skip/simplify the atomic structure) and talk about other forms of light on the spectrum
    - For more advanced audiences, you could add calculations about the wavelength absorbed and the wavelength emitted to identify the energy lost in the process
    - For more advanced audiences, you could introduce/revisit the two models of light and how they can both be used to explain the phenomenon. Ask for the pros/cons of each.
- **Booth:** You can have the different light sources at the table and ask people to compare what happens and connect to your research and/or optoelectronics more broadly.
    - Questions you can ask booth visitors:
        - Why do you think the blue light makes it glow, but not the red?
        - Why do you think this substance glows, but this other substance does not?
        - What do you think it always makes green light, even though it's hit with blue or UV light?
        - What do you think would happen in sunlight?
- **Example connections/applications:**

- Items in nature that fluoresce (rocks, plankton, jellyfish, etc.)
- Crime scene investigation- using blacklight to prompt left behind substances (e.g., blood, urine, etc.) to fluoresce
- Down-conversion of light can help convert wavelengths to a new and more useful form, such as when the UbiQD tarps absorb the sun’s UV light and convert it to light the plants can absorb so they grow more effectively.

Name:________________________

What's causing the stars to glow?

Directions: Share your theories for what you think is going on before the light is shined, when the red light is shined, and when UV light is shined on the glow-in-the-dark star. Use pictures, labels, and text to share your thinking.

No Light

Theory:__________________________

Red Light

Theory:__________________________

UV Light

Theory:__________________________