



STEM Outreach Presents:

STEM Every Day Keeps the Boredom Away

Glow-in-the-Dark Edition

Always ask a trusted adult before starting a Science or Engineering project.

Glow Window Clings

**DIFFICULTY
LEVEL: NOVICE**

PURPOSE

To learn the difference between fluorescence and phosphorescence and use that knowledge to select the materials for this activity

MATERIALS

Fabric paint (glow in the dark: Fluorescent or Phosphorescent, see next page to learn about the difference)
Wax paper, freezer paper, or plastic freezer bag
Images to trace (optional)

INSTRUCTIONS

1. Read about fluorescence and phosphorescence on the next page and decide which glow-in-the dark paint would be best for this activity.
2. Print your images, if you choose to use them.
3. Cut a piece of freezer paper big enough for your design.
4. Carefully, trace the lines of your image with the paint or create your own images. Make the lines of paint fairly thick, so it will peel easily.
5. Let your designs dry where they will not be moved. The drying process can take several hours or a full day.
6. Carefully peel the designs from the paper or plastic. It is okay if the paper tears or sticks to the design.
7. Stick your designs on a window. If you have problems getting your cling to stick, try lightly wiping the back of your cling with a damp rag.

CONCEPT #1

Luminescence

A Luminescent object emits light (glows) and produces the light without the use of heat. One way to produce light is through

Photoluminescence.

Photoluminescent objects absorb energy from photons (light particles) and then release the energy in the form of light (glow-in-the-dark paint). The release of light can be really fast or really slow.



*Window clings:
made from fabric paint*

CONCEPT #2

Florescence vs. Phosphorescence

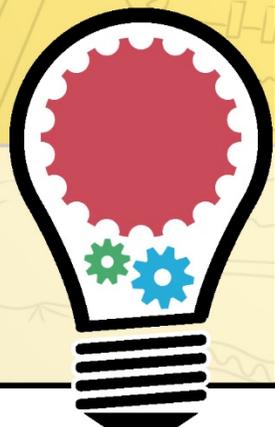
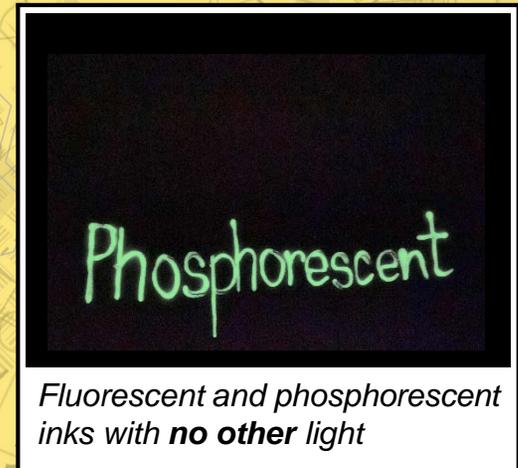
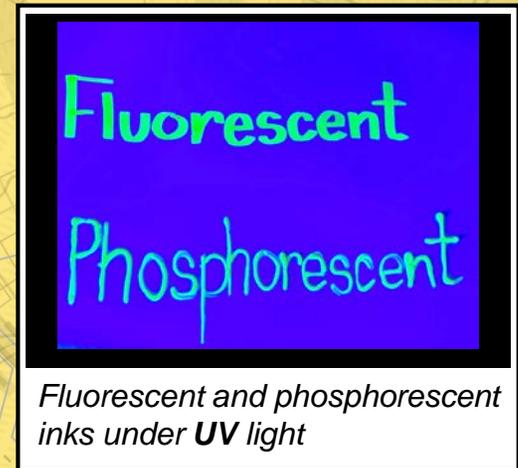
Glow-in-the-dark paint is photoluminescent. There are two types of photoluminescence: Fluorescence and Phosphorescence. Glow-in-the dark paint comes in both types. Both “charge” as they absorb light, but they release their light at different speeds.

Fluorescent objects release the stored energy as light almost *instantly*. They glow when the light source is present but have released all their light as soon as the light source is removed and therefore *no longer glow*.

Example: Highlighters

Phosphorescent objects release the stored energy as light over a *longer time* (a few seconds to a several hours). They glow when the light source is present and *continue to glow* after it is removed.

Example: Glow-in-the dark star stickers



Which type of paint would be best for your designs: fluorescent or phosphorescent?

REFERENCES

Adapted from: <https://kidsactivitiesblog.com/49213/snowflake-coloring-pages/>

Glow Stick Light Spectrum

**DIFFICULTY
LEVEL:
INTERMEDIATE**

PURPOSE

To use chemiluminescence to explore primary colors of light and how they mix

MATERIALS

- 1 Large red glow stick
- 1 Large blue glow stick
- 1 Large green glow stick
- 1 White sheet of paper

Aluminum foil
Digital camera (phone with camera)
A dark place

INSTRUCTIONS

1. Wrap each glow stick in aluminum foil. Leave one end flared open (as shown), it should resemble a flashlight.
2. In a dark place, activate the glow sticks (while still wrapped in foil).
3. Place the open end of your "glow stick flashlight" near the white paper. You should see the color of the glow stick shining on the paper.
4. Take a picture of each light individually with the digital camera. The colors will appear more vivid in the photos.
5. Unwrap the glow sticks from the foil. Rewrap them with two glow sticks in one foil "flashlight". Shine the light onto the white paper and take a picture. Repeat for every combination of colors (including wrapping all three together). What new colors did you get with the combinations?

CONCEPT #1

Chemiluminescence

Chemiluminescence

is a process of making light from a chemical reaction.

There is a liquid (diphenyl oxalate) inside the plastic casing of a glow stick. The glow stick also contains glass tubes filled with hydrogen peroxide and a dye (this gives the glow stick its color).

When the glow stick is bent, the glass tubes break and the two liquids mix, resulting in a chemical reaction. The molecules are put into an excited state from the reaction. As the excited molecules return to normal, they emit light.



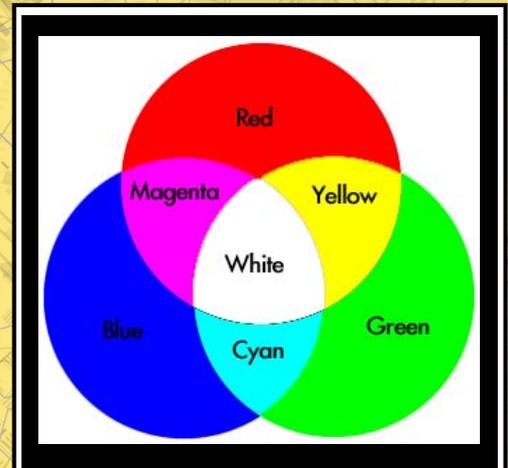
Colors of light with red, blue, and green glow sticks.

CONCEPT #2

Color Mixing

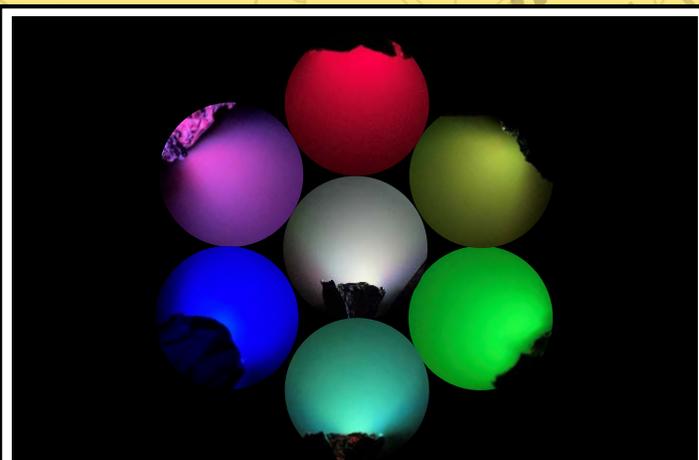
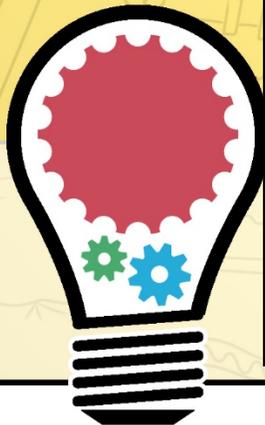
There are two types of color mixing:

1. Color mixing with materials (ink, paint, etc.): This is called subtractive color mixing. Some color printers use individual ink cartridges for each of the primary colors of pigment: **MAGENTA**, **CYAN**, and **YELLOW**. When these three colors are combined equally they create **BLACK**. This is the type of color mixing most people are familiar with from their experiences mixing paint.
2. Color mixing with light (TVs, Phone screens, glow sticks, etc.): This is called additive color mixing. When different colors of light are combined they produce new colors. The primary colors of light are: **RED**, **BLUE**, and **GREEN**. The pixels on computers, phones, and TV screens can emit these three colors of light. The amount of each of these three colors determines the color produced. All three of these colors combined in equal amounts creates **WHITE** light.



<https://lightandcolor2.weebly.com/mixing-colored-light.html>

Mixing colors of light.



Colors of light with red, blue, and green glow sticks and their combinations

REFERENCES

<https://www.scienceinschool.org/2011/issue19/chemiluminescence>

<https://lightandcolor2.weebly.com/mixing-colored-light.html>

ADULT ASSISTANCE REQUIRED

Origami Fireflies

PURPOSE

To learn about Bioluminescence and use simple circuitry and LEDs to create a model of a firefly.

MATERIALS

1 CR2032 Coin Battery

Tape

Paper (6"x6")

Paper or cardstock (1"x2")

Optional: materials to

decorate your firefly

(markers, googly eyes, etc.)

INSTRUCTIONS

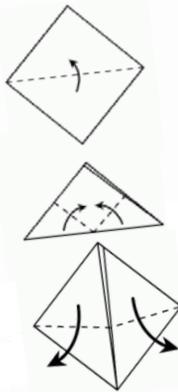
*If you are using LED string lights, have a trusted adult follow the instructions on the following website to separate and prepare the string lights to look like the ones shown here

<https://nittygrittyscience.com/stem-activity-holiday-light-circuits/>

1. Place the square sheet of paper in front of you, oriented like a diamond. Fold up the bottom half so the peaks meet at the top.
2. Fold up the two bottom corners so they meet at the top.
3. Then fold the same two flaps down, folding them in the middle, so the corners point away from each other. (They're the wings of your firefly.)

**DIFFICULTY
LEVEL:
ADVANCED**

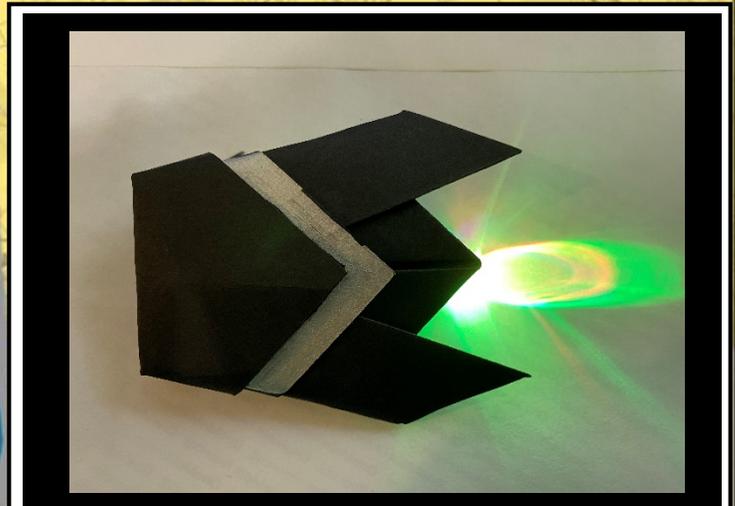
1 LED or LED string lights that can be destroyed*
*If using string lights, you will need scissors/wire cutters/wire strippers.



CONCEPT #1

Bioluminescence

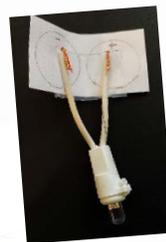
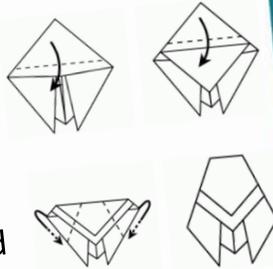
Bioluminescence is a living thing's ability to emit its own light. There are many living things in the world (both on land and in the ocean) that can create their own light, using a chemical reaction. Fireflies, angler fish, and foxfire (a type of fungus) are all bioluminescent. There are some species of bacteria, algae, and plankton that are also bioluminescent.



Origami Fireflies

INSTRUCTIONS

- Pick up the top layer at the unfolded tip (above the wings) and fold down, so the bug's bottom is sticking out a bit. Then fold down the bottom layer of the tip to about 1/4" from the middle layer.
- Finally, bend the two sides to the back and tape in place, as shown.
- Fold the 1" x 2" piece of cardstock in half. Flatten it out. With the pencil, trace around the battery on each half, as shown. Mark one circle with a plus (+) sign and the other with a negative (-) sign. This will be your battery holder.
- Test the LED by putting one wire on each side of the battery. If it does not light up, turn the battery around and try again.
- When you've gotten it to light up, note which wire is on the positive side and tape it to the positive side of the battery holder. Be sure to leave some of the wire exposed, so it can connect to the battery. Tape the other wire to the negative side of the battery holder, leaving some of the wire exposed.

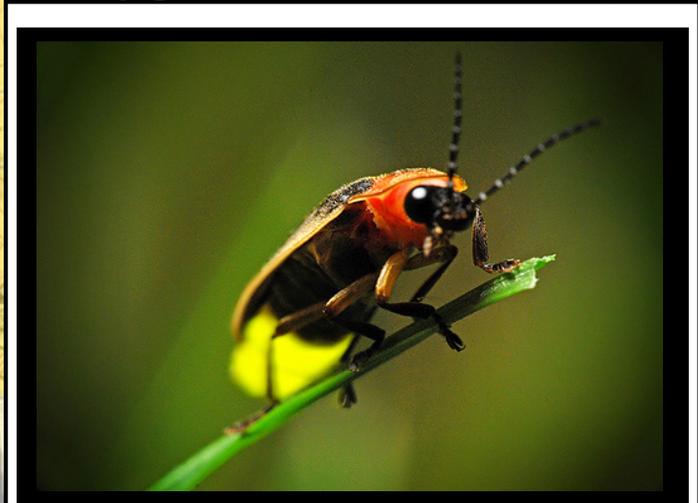


CONCEPT #2

How Do Creatures Create Bioluminescence?

For species to create their own light, their bodies must contain a luciferin, a molecule that produces light when it touches oxygen. There are many different types of luciferin that species can use. Some species also produce the catalyst luciferase, which helps to speed up the reaction.

Animals can control the release of these chemicals to control when they glow.



<https://www.firefly.org/facts-about-fireflies.html#:~:text=Fireflies%20talk%20to%20each%20other,only%20one%20sex%20lights%20up.>

Origami Fireflies

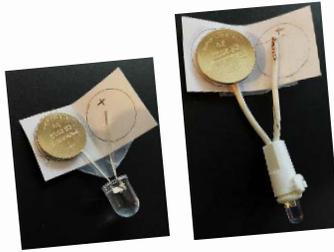
INSTRUCTIONS

9. Place the battery in the battery holder matching the positive and negative signs. Tape the battery holder shut.

10. Tape the battery holder and LED to the back of your firefly so that the LED barely sticks out past the bottom.

Tip: You may need to squeeze your firefly for the LED to glow.

11. Decorate your firefly!



<https://www.dismalscanyon.com/>

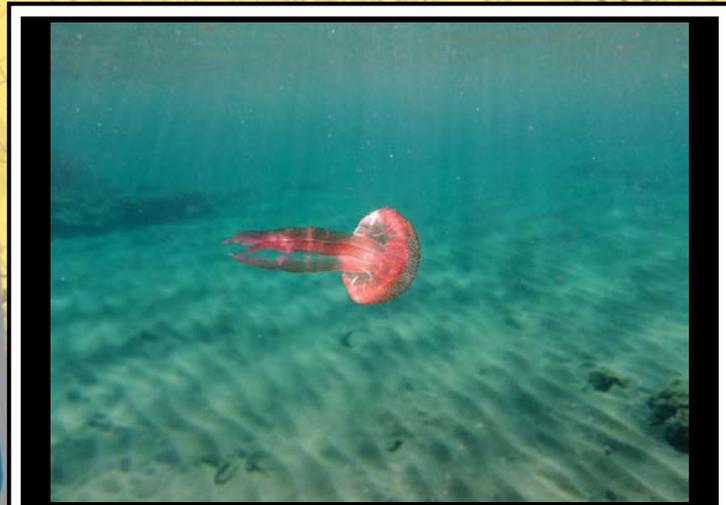
Day and Night photos of Dismals Canyon, in North Alabama. Dismals Canyon is one of the few places in the world that is home to insect larvae known as "dismalites". Dismalites use their light to attract tiny flying insects into a web.

CONCEPT #3

Uses of Bioluminescence

Bioluminescence can be used to avoid predators, attract prey, and communicate with others in their species.

Fireflies glow to attract mates, defend territory, and warn predators away.



The mauve stinger is a glowing jellyfish. (Fco. Javier Gallardo Álvarez, Flickr)

<https://ocean.si.edu/ocean-life/fish/bioluminescence>

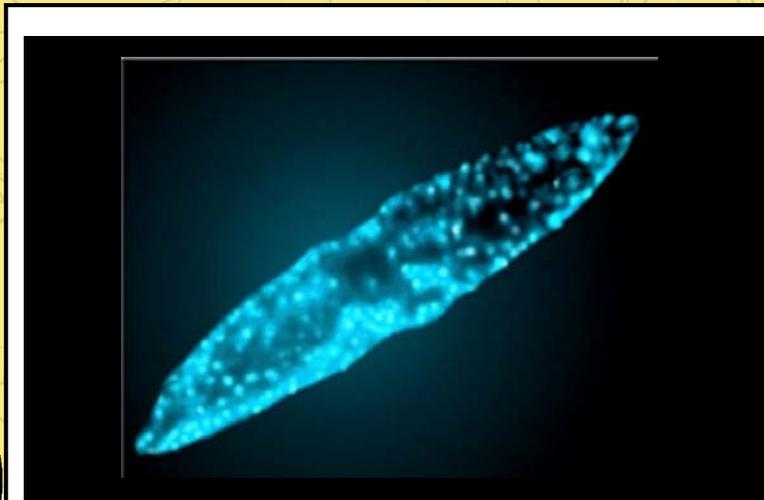
CONCEPT #4

Bioluminescence in Medicine

The two chemicals that allow bioluminescent creatures to glow (luciferase and luciferin) can be used to study medicine in humans. The types of these chemicals found in fireflies light up in the presence of ATP, a chemical in all living things. In healthy cells, the level of ATP is relatively constant, but the levels can fluctuate in some diseased cells. By injecting the bioluminescent firefly chemicals into diseased cells, doctors can detect changes in cells. This technology can be used to study diseases such as cancer and muscular dystrophy.



<https://www.firefly.org/facts-about-fireflies.html#:~:text=Fireflies%20talk%20to%20each%20other,only%20one%20sex%20lights%20up.>



*Sunset? Time to glow! A biological clock triggers bioluminescence in the dinoflagellate *pyrocystis fusiformis*. At dusk, cells produce the chemicals responsible for its light. (E. Widder, ORCA, www.teamorca.org)*
<https://ocean.si.edu/ocean-life/fish/bioluminescence>

EXTENSIONS

<https://www.dismalscanyon.com/dismalites>

Learn more about bioluminescent creatures here:

[https://fau.digital.flvc.org/islandora/object/fau%3A33109/datastream/OBJ/view/The bioluminescence coloring book 2nd edition.pdf](https://fau.digital.flvc.org/islandora/object/fau%3A33109/datastream/OBJ/view/The%20bioluminescence%20coloring%20book%202nd%20edition.pdf)

Learn how to attract fireflies to your backyard here:

<https://www.gardeningknowhow.com/garden-how-to/beneficial/attracting-lightning-bugs.htm>

REFERENCES

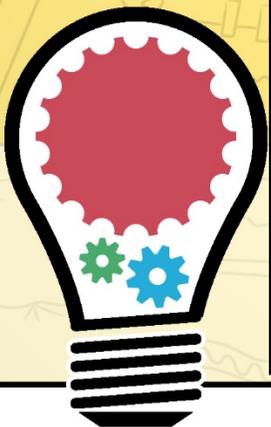
Adapted from: <https://nittygrittyscience.com/stem-activity-holiday-light-circuits/>

<https://makercamp.com/projects/origami-firefly>

<https://ocean.si.edu/ocean-life/fish/bioluminescence>

[https://www.firefly.org/facts-about-](https://www.firefly.org/facts-about-fireflies.html#:~:text=Fireflies%20talk%20to%20each%20other,only%20one%20sex%20lights%20up.)

[fireflies.html#:~:text=Fireflies%20talk%20to%20each%20other,only%20one%20sex%20lights%20up.](https://www.firefly.org/facts-about-fireflies.html#:~:text=Fireflies%20talk%20to%20each%20other,only%20one%20sex%20lights%20up.)





More Glow-in-the-Dark STEM Activities

Glow Salt Circuit

<https://www.steampoweredfamily.com/activities/glow-salt-circuit-steam-activity-for-kids/>

Glowing Flowers

<https://www.instructables.com/id/Glowing-Flower/>

Glow-in-the-Dark Bath Bombs

<https://www.steampoweredfamily.com/activities/glow-in-the-dark-bath-bomb-recipe/>

Glow-in-the-Dark Soap

<https://breagettingfit.com/glow-in-the-dark-soap/>

Glow-in-the-Dark Crystals

<https://www.thoughtco.com/glow-in-the-dark-crystal-geode-606233>

Glow-in-the-Dark Chalk

<https://www.growingajeweledrose.com/2013/07/glow-in-dark-chalk-recipe.html>

Glow-in-the-Dark Gelatin Snacks

<https://www.thoughtco.com/glowing-jell-o-recipe-607627>

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