

Phosphors Lesson Plan

Grade: 2nd Grade

Time: 45 min-1 hr

Science Lesson Purpose:

Expose Ss to aspects of fluorescence by:

Introducing Ss to light concepts (UV light in specific).

Introducing Ss to the qualities of phosphors.

Lesson Objective:

Ss will identify characteristics of UV light.

Ss will identify characteristics of phosphors.

Ss will illustrate their observations about the effects black light has on fluorescent paint.

CA Common Core Science Standards 2nd Grade:

“... standards for K–5 reading in history/social studies, science, and technical subjects are integrated into the K–5 Reading standards. The CCR anchor standards and high school standards in literacy work in tandem to define college and career readiness expectations—the former providing broad standards, the latter providing additional specificity.”

<http://www.corestandards.org/ELA-Literacy/RST/introduction>

Vocabulary:

light

visible light

Ultraviolet (UV) light

phosphors

fluoresce

glow

Materials:

Multi-color fluorescent paint, Tempera Paint, Paint Brushes (optional), Black light(s), A dark space to use the black light, Black sheet of (construction) paper per student, Activity Sheet A per student, Napkin per student, Fluorescent balloons, Chart paper, Marker (for teacher to write Ss observations), Enough butcher paper to cover classroom windows

Pre-Lesson:

Prepare fluorescent paints and tempera paints how you see fit for Ss to use when given opportunity to paint of black sheets of paper. (It is optional to label each type of paint with an ‘F-fluorescent’ or a ‘T-tempera’ so that they can be easily distinguishable as

elaboration occurs). Cover classroom windows with butcher paper so that it is dark enough for the black lights later. Have outlets ready to plug in black lights. Blow up fluorescent balloons prior to lesson and keep out of sight until Experimentation.

Introduction: 15-20 min

Tell Ss that today you will be conducting science through painting.
Group Ss into groups of 5 (paint may be set between each group).
Hand each student a sheet of black paper and ask them to fold their sheet in half. (May want to have them write their name on their sheet of paper.)
Inform Ss that on the left side of their paper they will be painting with the fluorescent paints. On the right side, they will have the opportunity to use tempera paint.
Provide Ss ~10 minutes to paint (using their fingers or optional paint brushes)
Hand each student a napkin to wipe/clean their fingers against as they paint.
*Encourage Ss to spread paint thinly so that drying can occur quickly.

Experimentation: 10 min

While artwork is drying, inform students that you will now be looking at their artwork in the dark, with a special light.
Ask Ss what they think will happen with their art once the lights go off? Chart responses on chart paper in front of the room.
Plug in the black light(s) and turn off class lights.
Provide Ss a few minutes to make visual observations and discuss theories about what they see with their group.
Introduce fluorescent balloons to the group and allow students time to pass them around.
Regroup the Ss by collecting balloons, turning black light off, and turning on classroom lights .
Ask Ss what they observed in the black light and make theories about what they saw.
Chart observations on the chart paper.

Elaboration: 10-15 min

How black light is working-

Explain to Ss that the black light is a special light. It not only emits light we can see, it also emits light we cannot see (UV) Ultraviolet light. UV light is invisible to our eyes. The tubular light that looks 'black' is covered by things called phosphors. The phosphors are trapping all the visible light inside and only letting UV light out. Some blue and violet, or purple light, may escape in the process.

How fluorescent paint is working-

To fluoresce means to shine or glow brightly in reaction to a light source. Fluorescent paint is called fluorescent paint because it has phosphors in it. These phosphors are changing the UV light hitting them into more light we can see (i.e. visible light). There are many natural phosphors we have all around us.

‘...If you walked around all night with a portable black light, you would discover that there are phosphors all over the place. There are lots of natural phosphors, in your teeth and fingernails, among other things. There also a lot of phosphors in manmade material, including television screens and some paints,

fabric and plastics. Most **fluorescent colored** things, such as highlighters, contain phosphors, and you'll find them in all glow-in-the-dark products. Clubs and amusement parks use special black light paint that glows different colors. You can also buy fluorescent black light bubbles, invisible black light ink, fluorescent black light carpet and even fluorescent black light hair gel...'

‘... In fluorescence the visible light component -sometimes known as "white light"- tends to be reflected and perceived normally, as color; while the UV component of light is modified, 'stepped down' energetically into longer wavelengths, producing additional visible light frequencies, which are then emitted alongside the reflected white light. Human eyes perceive these changes as the unusual 'glow' of *fluorescence*...’

Assessment: 10-15 min

Hand out Activity Sheet A and allow students to fill it in, then illustrate their observations. Activity sheet may be done whole-group or individually. May be collected and kept to show evidence of work.

Supplemental Information:

How Black Lights Work

by [Tom Harris](#)

You have- probably seen **black lights** at amusement parks, science museums and [Halloween](#) displays. Black lights may look just like normal [fluorescent lamps](#) or [incandescent light bulbs](#), but they do something completely different. Switch one on, and white clothes, teeth and various other things **glow in the dark**.

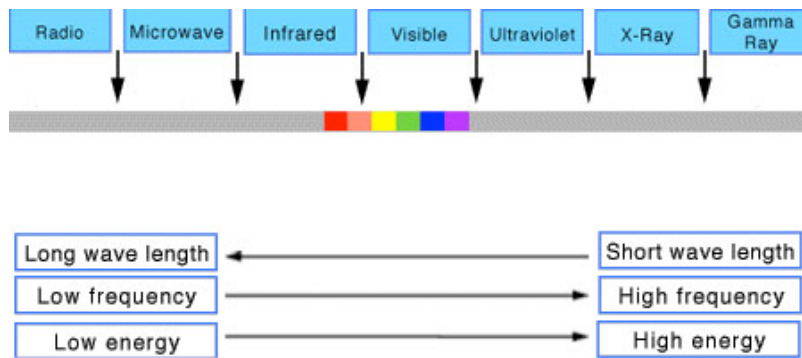
-For example, if you have a fluorescent poster and shine a black light on it in a dark room, the poster will glow brightly. You may have also seen pieces of paper that look blank in regular light but spell out a glowing message under a black light. Many amusement parks- use hand stamps that are invisible until you view them under black light.

In this article, we'll find out exactly what's going on here. We'll also see why black lights make some objects glow but not others, and we'll look at some interesting black light applications.

What Is "Black Light"?

If you turn on a black light bulb in a dark room, what you can see from the bulb is a purplish glow. What you cannot see is the **ultraviolet light** that the bulb is also producing.

Our [eyes](#) can see [visible light](#) in a spectrum ranging from red through orange, yellow, green, blue and violet. Above violet is ultraviolet light, which we cannot see. [How Sunburns and Sun Tans Work](#) discusses ultraviolet light and its effects on our skin. A black light bulb produces **UVA** light (as opposed to UVB light, which is much more harmful).



Ultraviolet light frequencies are above violet on the spectrum and are invisible to the human eye.

What you see glowing under a black light, whether on a fluorescent poster or an invisible hand stamp or a newly washed white T-shirt, are **phosphors**.

A **phosphor** is any substance that emits visible light in response to some sort of **radiation**. A phosphor converts the energy in the UV radiation from a black light into visible light.

In the next section, we'll see how phosphors are used in regular fluorescent lighting and in black lights.

Black Light Designs

The conventional black light design is just a **fluorescent lamp** with a couple of important modifications. Fluorescent lamps generate **light** by passing **electricity** through a tube filled with inert gas and a small amount of **mercury**. (See [How Fluorescent Lamps Work](#) for more information.)

When energized, mercury **atoms** emit energy in the form of **light photons**. They emit some visible light photons, but mostly they emit photons in the ultraviolet (UV) wavelength range. Because **UV light waves** are invisible to the human eye, fluorescent lamps have to convert this energy into visible light. They do this with a **phosphor coating** around the outside of the tube.

Phosphors are substances that give off light -- or **fluoresce** -- when they are exposed to light. When a photon hits a phosphor atom, one of the phosphor's electrons jumps to a higher energy level, causing the atom to vibrate and create heat. When the electron falls back to its normal level, it releases energy in the form of another photon. This photon has less energy than the original photon, because some energy was lost as heat. In a fluorescent lamp, the emitted light is in the visible spectrum -- the phosphor gives off white light we can see.

Black lights work on this same principle. There are actually two different types of black light, but they work in basically the same way.

- A **tube black light** is a basically a fluorescent lamp with a different sort of phosphor coating. This coating absorbs harmful shortwave **UV-B** and **UV-C** light and emits **UV-A** light (in the same basic way the phosphor in a fluorescent lamp absorbs UV light and emits visible light). The "black" glass tube itself blocks most visible light, so in the end only benign long-wave UV-A light, along with some blue and violet visible light, passes through.
- An **incandescent black light bulb** is similar to a [normal household light bulb](#), but it uses light filters to absorb the light from the heated filament. It absorbs everything except the infrared and UV-A light (and a little bit of visible light).

In both of these light designs, the emitted UV light reacts with various **external phosphors** in exactly the same way as the UV light inside a fluorescent lamp reacts with the phosphor coating. The external phosphors glow as long as the UV light is shining on them.

In the next section, we'll see what kinds of objects contain phosphors, and we'll look at some interesting uses for black lights.

Black Light Uses

If you walked around all night with a portable black light, you would discover that there are phosphors all over the place. There are lots of natural phosphors, in your teeth and fingernails, among other things. There also a lot of phosphors in manmade material, including [television screens](#) and some paints, fabric and plastics. Most **fluorescent colored** things, such as highlighters, contain phosphors, and you'll find them in all [glow-in-the-dark](#) products. Clubs and amusement parks use special black light paint that glows

different colors. You can also buy [fluorescent black light bubbles](#), invisible black light ink, fluorescent black light carpet and even fluorescent black light hair gel.



Ordinary highlighters work well as "black light pens." Under the black light, the fluorescent ink glows!

In addition to making people and fluorescent posters look cool, black lights have some practical applications. For example:

- Appraisers use them to detect forgeries of antiques. Many paints today contain phosphors that will glow under a black light, while most older paints do not contain phosphors.
- Repairmen use them to find invisible leaks in machinery -- they inject a little fluorescent dye into the fuel supply and illuminate it with a black light. For example, they might detect an invisible [air conditioner](#) leak by adding fluorescent dye to the refrigerant. **Black lights can be used to detect counterfeit bills.**
- Law enforcement officers can use them to identify [counterfeit money](#). The United States and many other countries include an invisible fluorescent strip in their larger bills that only shows up under a black light.
- Amusement parks and clubs use them to identify invisible fluorescent hand stamps for readmission.
- Forensic scientists use them to analyze [crime scenes](#). To pick out fingerprints, for example, they often dust with fluorescent dye under a black light. This makes it easier to pick the fingerprints out from surrounding dirt. Black lights can also identify semen and other bodily fluids that naturally fluoresce.

Most of these uses, as well as dozens of others, follow a common theme -- the black lights make the invisible visible or isolate one specific substance from everything around it. When you think about it, there are dozens of situations where you could put this phenomenon to work. The applications are potentially endless!

For more information on black lights and other sorts of light energy, check out the links on the next page.

WHY IS MY SHIRT GLOWING?

White T-shirts and socks normally glow under a black light because modern detergents contain phosphors that convert UV light into white light. This makes whites look "whiter than white" in normal [sunlight](#). What you are seeing in sunlight is the normal reflection of visible white light from the cloth, as well as the emission of white light that the phosphors create from UV light in sunlight. The T-shirt really is whiter than white!

<http://science.howstuffworks.com/innovation/everyday-innovations/black-light.htm>

Fluorescent paint

[Fluorescent](#) paints offer a wide range of [pigments](#) and [chroma](#) which also 'glow' when exposed to the long-wave "[ultraviolet](#)" frequencies (UV). These UV frequencies are found in sunlight and some artificial lights. But they- and their glowing-paint applications- are popularly known as [Black Light](#) and 'black-light effect', respectively.

In fluorescence the [visible light](#) component -sometimes known as "[white light](#)"- tends to be reflected and perceived normally, as color; while the UV component of light is modified, 'stepped down' energetically into longer wavelengths, producing additional visible light frequencies, which are then emitted alongside the reflected white light. Human eyes perceive these changes as the unusual 'glow' of *fluorescence*.

The fluorescent type of luminance is significantly different from the natural [bio-luminescence](#) of bacteria, insects and fish such as the case of the fire-fly, etc. This involve no reflection at all but true, living generation of light (via the chemistry of [Luciferin](#)).

There are both visible and invisible fluorescent paints. The visible appear under [white](#) light to be any bright color, turning peculiarly brilliant under black lights. Invisible fluorescent paints appear transparent or pale under daytime lighting, but will glow only under UV light- and in a limited range of colors. Since these can seem to 'disappear', they can be used to create a variety of clever effects.

Both types of fluorescent painting benefit when used within a contrasting ambiance of clean, matte-black backgrounds and borders. Such a "black out" effect will minimize other awareness, and cultivating the peculiar luminance of UV fluorescence. Both types of paints have extensive application where artistic lighting effects are desired, particularly in "black box" entertainments and environments such as theaters, bars, shrines, etc. Out-of-doors however UV wavelengths are rapidly scattered in space or absorbed by complex natural surfaces, dulling the effect. Furthermore the complex pigments will degrade quickly in sunlight.

http://en.wikipedia.org/wiki/Luminous_paint

Activity Sheet A:

Name _____

Date _____

Black Light Science

1. Our human eyes can see _____ (UV, white) light.
2. We cannot see _____ (UV, white) light.
3. _____ (UV, white) light comes out from a black light.
4. A _____ (rainbow , phosphor) glows under a black light.
5. A phosphor needs _____ (energy, water) to make it glow.
6. A phosphor changes the _____ (UV, TV) light from a black light into visible light.

Here is a drawing of what I observed under a black light:

