Shadow Panel

In a flash, make a shadow with a life of its own.

Normally, the life of your shadow is at your mercy. If you move, your shadow moves. In this snack, you use a luminous screen and a disposable flash camera to create a shadow that hangs around for awhile.

Materials

- 1 sheet of Glow Max phosphor-coated glow-in-the-dark paper (available in some office supply, stationery, and art supply stores; contact Riverside Paper Co., 920-991-2210, www.riversidepaper.com, for the nearest retail outlet). **Note:** If you have trouble finding this paper, you can make good shadow panels using poster board or foam core and luminous paint (see Alternative Construction).
- used disposable flash camera without film (Ask a one-hour photo facility to save some used disposable cameras for you; many places will do this for teachers and students at no cost.)

ASSEMBLY

1 Tape a sheet of Glow Max paper to a wall, or lay it on a table. This is your luminescent shadow panel. Make sure the room can be fully darkened.

2 Figure out how to set off the flash on the camera. Different brands work differently. If you have any trouble, follow these steps:

a. Remove the camera back if it's not already off (a little prying will be necessary).

CAUTION: If removing the back exposes any electronic parts (other than the battery), be careful not to touch them. They are capable of giving a nasty shock. (If the front of the camera comes off also, exposing electronic components, tape it back on with masking tape, so that the electronic parts are covered.)

b. With the back of the camera removed, you should be able to see a portion of the sprocket wheel, which has teeth that fit in the holes along the edge of the film when the camera has film in it. Turn the sprocket wheel slowly until you feel it click into a cocked position. (The sprocket wheel should not be confused with the serrated wheel used to advance the film. This latter wheel is visible even when the camera back is still on and is now useless with no film in the camera.)

c. Be sure there is a working AA battery in the camera and that it is oriented properly. Activate the flash-charging button until you see the flash indicator light glow. (The flash-charging button is normally located on the front face of the camera, and the flash indicator light is usually located on the back of the camera near the viewfinder window.) Press the shutter button to set off the flash. (If you can't get the flash to work, try advancing the sprocket wheel a little past where you first think it is cocked.)

Alternative Construction

Luminous paint brushed onto white poster board or foam core works just as well as glow-in-the-dark paper. Luminous paint, also known as "glow-in-the-dark" paint, may be found at art supply stores, craft stores, hobby shops, stationery stores, novelty stores, and at art supply stores on the Internet. Some specific brands are listed below:

- Edmund Scientific Luminous Acrylic Paint (#V31-806, 2-ounce bottle), 800-728-6999, www.edsci.com
- Golden brand Acrylic Phosphorescent Green Glow in the Dark Acrylic Paint (Phosphorescent Medium, #4900, various sizes), 510-649-4800. For locations of stores that carry this product, see www.goldenpaints.com.
- Palmer Luminous Paint (#628612). This brand is available in 2-ounce quantities.

Depending on the consistency of the individual paint, an ounce of luminous paint will cover from two to five $8\frac{1}{2}$-×-11-in pieces of foam core or poster board.

To Do and Notice

Cock the camera so that it is ready to take a flash picture. Darken the room and wait about ten seconds so that the paper's glow dims. Place your open hand (or an object of your choosing) on the luminescent panel or very close to it. Hold the camera about 12 inches (30 cm) away from the panel, point the camera at the panel, and press the shutter button to set off the flash.

Take your hand away or remove the object.

You should see a black shadow image on the luminescent green background of the panel. The shadow should persist for several seconds before fading.

What's Going On?

The glow-in-the-dark paper contains a phosphorescent material. When the electrons in a phosphorescent material absorb light, they jump up to higher energy levels. When they fall back to their original energy levels, they release the energy they absorbed in the form of light (see figure 1).

The flash is a burst of light that reaches the glow-in-the-dark paper only where it is not obscured by the hand (or other object) in front of it. The light is absorbed by the phosphorescent material in the paper and then released over a period of time as a greenish glow. The glow lasts for a while because not all the electrons make the transition back to lower energy levels at the same time.

Darkening the room for a brief time before setting off the flash allows most of the electrons that absorbed energy from the light in the room to fall back to their ground energy states. If you don't let the luminescent panel sit in the dark, even the area where your hand is placed will still be glowing from the room light, and the contrast between the shadow area and the background will not be so great.

So What?

Phosphorescent pigment is used in everyday life, sometimes for fun and sometimes to serve a purpose. There are glow-in-the-dark stars that can be stuck to the walls or the ceiling to create a nighttime sky in your bedroom. Inflatable "star balls" absorb the light of the sun when you play with them during the day, and at night, you can enjoy their luminescent green glow. Some clocks and some watches have phosphorescent pigment-coated hands that glow in the dark.

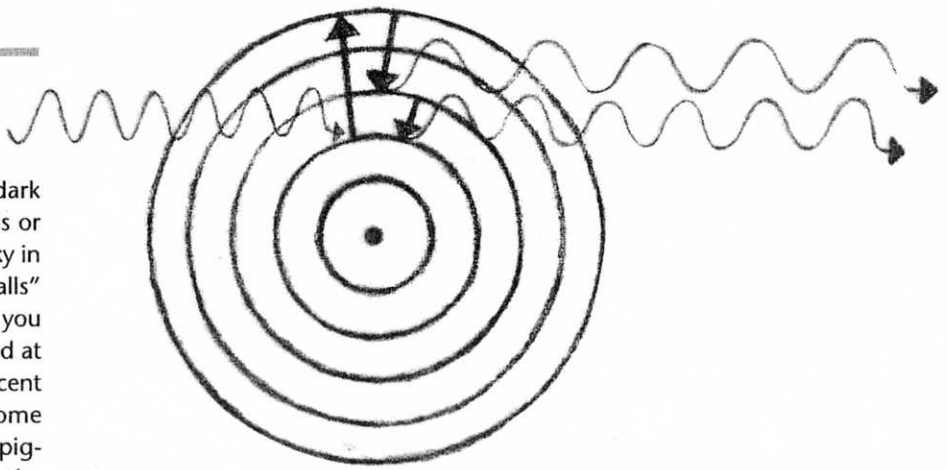
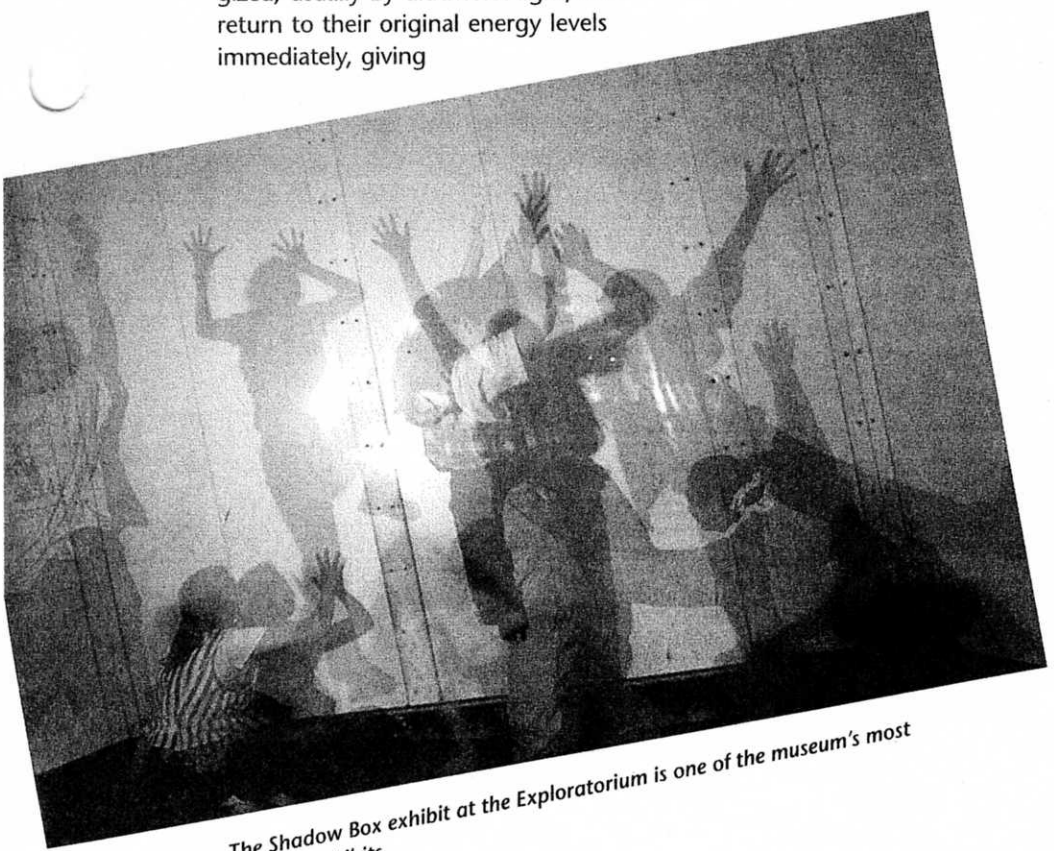


Figure 1 *This energy-level diagram shows electrons excited to higher energy levels, then falling back down to release light.*

Did You Know?

Another Kind of Glow

The phenomenon called *fluorescence* is similar to phosphorescence. Fluorescence occurs when electrons are energized, usually by ultraviolet light, but return to their original energy levels immediately, giving off visible light in the process. A fluorescent material, therefore, glows only when light is striking it, whereas the glow of a phosphorescent material persists for some span of time—sometimes several hours.



The Shadow Box exhibit at the Exploratorium is one of the museum's most popular exhibits.

Going Further

In a Box

Try making a shadow box that works in a lighted room. Tape a luminous panel to an inside wall of a cardboard box, place an object in the box up against the screen, put the lid on the box, cut a small hole in the wall of the box opposite the screen, snap the flash through the hole, and then open the lid a bit to view the shadow.

Credits

This snack is based on the Exploratorium exhibit Shadow Box.