Investigating Ultraviolet (UV) Radiation with UV Sensitive Beads

Essential Question(s)
What does UV radiation do to humans?
Do sunscreens effectively block UV?

At a Glance:
Learners observe the presence of UV light by making a bracelet of UV beads, exposing the beads to sunlight, and experimenting with the color change reaction of the beads by blocking light with different strengths of sunscreen and other materials.

Background:
The sun emits radiation of different wavelengths. Some radiation, such as that which makes up the colors of rainbow, has wavelengths to which our eyes respond. Beyond these wavelengths is radiation in the ultraviolet (UV) and infrared range that our eyes cannot see.

UV radiation is of concern to us because unprotected exposure to it can cause skin and eye damage. UV radiation can be broadly subdivided into UV-A, UV-B and UV-C. Their main characteristics are shown in Table 1.

Table 1 – Main Characteristics of UV-A, UV-B, and UV-C Radiation

	UV -A	UV-B	UV-C
Wavelength (nanometer, nm)	315-400	280-315	100-280
Absorption by the ozone layer	Penetrates the ozone layer	Mostly absorbed by the ozone layer	Almost all absorbed by the ozone layer
Amount reaching the Earth's surface	>98% of UV radiation is UV-A	<2% of UV radiation is UV-B	Negligible
Effects on humans and the environment	Generates photochemical smog	Overexposure induces skin cancer and eye cataracts	None

Location: Indoors and outdoors

Objectives: *Learners will*
1) understand that solar radiation can be harmful.
2) apply scientific information to their daily decisions.
3) explain preventive measures that can be taken to reduce the risks associated with exposure to solar radiation.

Skills: observation, communication, control of variables, prediction, data collection, analysis

Supplies:
- sunscreens (SPF 5, 20, 40)
- lotion with no UV protection
- UV beads (source: www.stevespanglerscience.com/product/1350)
- string/pipe cleaner
- sealable bags
- sunshine
- tray (or other flat surface for transporting bracelets outside
- digital camera (optional)

Subjects: language arts, science

Time: 25 minutes

There are many factors that influence UV intensity at the Earth's surface:

- **Position of the sun which varies with time of the year, time of the day and the latitude.**
  - The higher the sun's position, the higher the UV intensity.

- **Amount of ozone in the atmosphere**.
  - Ozone absorbs UV radiation. The more abundant the ozone in the atmosphere, the less the amount of UV radiation reaching the Earth's surface.

- **Clouds and haze**.
  - UV radiation is both absorbed and scattered by clouds and haze.

- **Ground reflection.**
  - Most natural surfaces such as grass, soil, and water reflect less than 10% of UV. However, fresh snow strongly reflects (80%) UV. Sand also reflects 10-25% of UV.

- **Altitude above the sea level**.
  - The higher the altitude, the higher the UV intensity. This is because the depth of the atmosphere and therefore the amount of ozone available to absorb UV radiation is reduced.

Your skin is an excellent detector of ultraviolet (UV) radiation. When you expose bare skin to sunlight, your skin will either turn brown (a suntan) or red (a sunburn). These responses by your skin are a signal that the cells under your skin are being assaulted by UV radiation. UV radiation wavelengths are short enough to break chemical bonds in your skin tissue, and with prolonged exposure, your skin may wrinkle or skin cancer may develop.

There is a safer way to detect UV…by using UV Beads. These plastic beads contain a harmless chemical which changes color when exposed to UV radiation. The colors that develop depend on the wavelength of the UV radiation.

Getting Ready:
Decide how many learners you want to have in each group and which procedure you want to follow. Procedure One lets the learners design their own experiments using the beads, and Procedure Two is a more structured experiment.

Procedure One:
1. Distribute 30 UV beads to each learner group.
2. Ask each group to take the beads outside and observe what happens.
3. Return to the classroom and let the beads return to a white color.
4. Share conclusions.
5. Learners should design and carry out investigations using materials such as sunscreens or sunglasses that claim to shield out UV radiation.

Ideas for experiments include:

- Does fluorescent light give off UV?
- Is there UV radiation in the shade?
- Does the glass in your car shield you from UV radiation?
- Is the glass in the windshield the same as the glass on the side windows?
- Do sunglasses shield you from UV? Do they all work equally well?
- Devise experiments to see how well sunscreen works to protect you from UV.
- Experiment with different types of materials, like paper, sandwich bags, etc., to see what blocks UV and what does not.

Procedure Two:

1. Distribute three beads and a pipe cleaner (or string) to each learner in the group.
2. Let them make the beads and pipe cleaner into a bracelet, although it should not be fastened yet.
3. Ask each group to take the beads outside and observe what happens.
4. Return to the classroom and let the beads return to a white color
5. Share conclusions.
6. Distribute sunscreens with varying sun protection factors (SPF), some moisturizer/lotions with no SPF, and sealable bags to the groups.
7. Each learner's bead bracelet will be a sample. They will all go into the sealable bags. You may be able to fit two samples in a bag. If you close the bag's sealable fastener on the end of the bracelets, they will be held in place.
   Sample 1 – Control
   Sample 2 – SPF 5
   Sample 3 – SPF 20
   Sample 4 – SPF 40
   Sample 5 – Lotion without UV protection.
8. Smear a sunscreen or lotion on the outside of each plastic bag. Placing the bags on a tray or other hard surface will make it easier to transport them in and out of the sun.
9. Place all bags in the sun being careful to let only the side of the bags with the sunscreen or lotion face the sunlight.
10. Leave for one minute and check the coloration of the beads by lifting the bag up and looking from the other side. This will decrease the effects of the sunlight on your results. Note the coloration for all samples. Ask learners to write down which were darker and which were lighter. If you have the use of a digital camera it may aid the observations.

Discussion/Assessment

How did you design your experiment?
Does sunscreen efficiently block UV radiation?
What materials can stop UV radiation?