CRISP Kit Teacher Module

Title of Module:

Ultraviolet Light

Grade Level(s):

6 – 8 +

Subject(s) or Unit of Study:

Ultraviolet light, Electromagnetic Radiation, Structure-Property Relationships

Est. Length of Activity:

Est. length of activity

Student Objectives:

Students will understand that:

- The way a material behaves on the macro scale is affected by its structures on the nanoscale
- The UV beads in this activity change color as a result of nanoscale shifts in the shapes of their molecules
- There are ways to protect our skin from the damaging effects of the ultraviolet rays from the sun

Vocabulary:

Photochromic Dyes, Ultraviolet (UV), Molecules, Polarized, Zinc Oxide, Electromagnetic Spectrum

Materials:

- Ultraviolet (UV) beads
- UV flashlight
- Pipe cleaners
- SPF 15 sunblock
- SPF 50 sunblock
- Polarized sheet
- Black construction sheet
- Q-tips or similar
- Small portion cups
- Glass beaker with water (optional)

Learner Background:

Ultraviolet (UV) light is a type of electromagnetic radiation from the Sun. UV light is all around us but our eyes can't see it because the wavelength is so small. Even though it comes from the Sun, too much exposure can cause painful sunburns and even cancer. Although too much UV light can be dangerous, it is used in many ways. For example, UV light is strong enough to kill viruses and bacteria, so it is used to sterilize medical and biological research facilities and to sanitize much of our food and water. UV light is also used to identify biological materials, like blood, at crime scenes and in places where sanitation is important.

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The UV beads in this activity contain a UV sensitive material called a photochromic dye. ("Photo" means "light" and "chromic" means "color.")

The molecules of this special dye change shape when exposed to ultraviolet light, which results in a color change. When the UV light hits the bead, it causes a bond in the molecule of the dye to break, which lets the molecule to move into a new shape. This new shape makes the molecule absorb light differently than before, so it now has a different color.

The sunblock contains tiny, nanosized particles of zinc oxide. (A nanometer is a billionth of a meter.) The nanoparticles of zinc oxide are so small that they absorb UV radiation and don't reflect visible light, which is why the sunblock is transparent on skin. The SPF on sunscreen bottles stands for **Sun Protection Factor**, and refers to how well the sunscreen protects against one type of UV radiation, called UVB – these are the rays that cause sunburns and several types of skin cancer.

Learning Activity or Procedure:

- Give each student pair 9 beads on a pipe cleaner (this will stop the beads from rolling away)
- Set up the following stations throughout your classroom, each station should have a UV light and a small cup labeled **Used Beads**

Station 1: Black sheet
Station 2: Polarizing sheet
Station 3: Beaker of water
Station 4: Sunblock (in labeled portion cups)

Station 1
Have students make observations about their bead before doing anything to it, and make a prediction about what the light will do to it.
Shine the UV light directly on the bead, and then place the black sheet over the bead while still shining the UV light on it. Record observations

Station 2
Have the students make their predictions then place the polarizing sheet over the bead and shine the UV light onto it. Record observations

Station 3
Have students make their prediction and then put the bead into the water. Shine the UV light into the water and record observations.

Station 4
Have students predict what will happen if they apply the SPF 15 sunblock to a bead and what will happen if they apply the SPF 50 sunblock. Have them apply SPF15 to one bead and SPF 50 to another. (Make sure they keep the beads separated so they know which one is which!)
Shine the light on the beads and record observations.

Have the students work in pairs and go through each station, filling out their worksheet as they go.

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Assessment:

See last pages

Additional Resources:

https://www.loc.gov/rr/scitech/mysteries/sunscreen.html
http://science.howstuffworks.com/innovation/everyday-innovations/sunglass6.htm

Teacher Notes:

Safety:

UV flashlights can be harmful to the eyes. Have students use caution when using these flashlights. Do not shine light into eyes.

STEM Careers:

Materials Scientist
Optical Engineer
Engineer
Environmental Engineer
Optician
Solar Energy Systems Engineers
Materials Engineers
Mechatronics Engineers
Nanosystems Engineers
Nanotechnology Engineering Technologists
Nanotechnology Engineering Technicians

Standards:

Next Generation Science Standards:

NGSS Performance Tasks	**MS-PS4-2.** • Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen. • Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.
NGSS - (DCI) Disciplinary Core Ideas	**PS4.A: Wave Properties** • A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude. **PS4.B: Electromagnetic Radiation** • An object can be seen when light reflected from its surface enters the eyes. • When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object's material and the frequency (color) of the light. • However, because light can travel through space, it cannot be a matter wave, like sound or water waves.
NGSS - (CC) Cross-Cutting Concepts	**CC-2 Cause and Effect** • Cause and effect relationships are routinely identified. **CC-6 Structure and Function** • Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used. **Interdependence of Science, Engineering, and Technology** • Science and engineering complement each other in the cycle known as research and development (R&D). • Influence of Engineering, Technology, and Science on Society and the Natural World
NGSS - (SEP) Science and Engineering Practices	**SEP 2 – Developing and Using Models** • Use models to describe phenomena. **SEP 7- Obtaining, Evaluating and Communicating Data** • Communicate technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).

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Student Worksheet

- Before you do anything at a station, be sure to write down your predictions on your worksheet.
- You will use 2 beads at each station (3 at the last station), one bead will be your control (always in direct UV light) while the other will be your variable (your test bead)
- Keep your unused beads on the pipe cleaner, this will help prevent them from rolling away!

Station 1: Shade vs direct sun

You will be using the sheet of black paper as shade (think of it as leaves on a tree blocking the sun).

1. Make your predictions and write them below
2. Take 2 beads off of your pipe cleaner
3. Place one bead under the black sheet (you can hold the sheet above the bead or lay it on top of the bead)
4. Shine the UV light over the beads for 15 seconds and think about what you are seeing with each bead
5. Put your beads in the "used beads" cup

Make your prediction: What do you think will happen when the bead is directly in the UV light (sunlight)? What do you think will happen to the bead when the black sheet blocks the direct UV light (shade)?

Check out your beads and what they look like. Fill in the table below

	Before	**After**
Direct light bead		
Shaded light bead		

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Station 2: Sunglasses

The dark plastic sheet you see is the same material used for sunglasses. This is a polarized sheet of plastic – which means it has a chemical coating that blocks out certain light waves

1. Make your predictions and write them below
2. Take 2 beads off of your pipe cleaner
3. Place one bead under the polarized sheet (you can hold the sheet above the bead or lay it on top of the bead)
4. Shine the UV light over the beads for 15 seconds and think about what you are seeing with each bead
5. Put your beads in the "used beads" cup

Make your prediction: What do you think will happen to the bead when it is underneath the polarized sheet (sunglasses)? Why?

Check out your beads and what they look like. Fill in the table below

	Before	**After**
Direct light bead		
Sunglasses bead		

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Station 3: Under water

This station will help you decide if water will protect you against the UV rays that give you sunburn.

1. Make your predictions and write them below
2. Take 2 beads off of your pipe cleaner
3. Place one bead in the beaker of water and the other on a dry area
4. Shine the UV light over each beads for 15 seconds and think about what you are seeing
5. Put your beads in the "used beads" cup

Make your prediction: What do you think will happen to the bead when it is in the water? Why?

Check out your beads and what they look like. Fill in the table below

	Before	**After**
Direct light bead		
Under water bead		

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Station 4: Sunblock

Here you will be testing 2 different SPF sunblock lotions, SPF15 and SPF50. Be sure not to mix up the 2 different beads or sunblock.

1. Make your predictions and write them below
2. Take 2 beads off of your pipe cleaner
3. Place one bead in each circle
4. Use the Q-tip to apply SPF 15 to the bead in the SPF 15 circle
5. Use a different Q-tip to apply the SPF 50 to the bead in the SPF 50 circle
6. Shine the UV light over each bead for 15 seconds and think about what you are seeing
7. Put your beads in the "used beads" cup

Make your prediction: What do you think will happen to the beads when coated in sunblock? Why? Do you think there will be a difference between the 15 and the 50, if so which one will work better?

Check out your beads and what they look like. Fill in the table below

	Before	**After**
Direct light bead		
SPF 15 bead		
SPF 50 bead		

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