Detection and Absorption of Ultraviolet Light

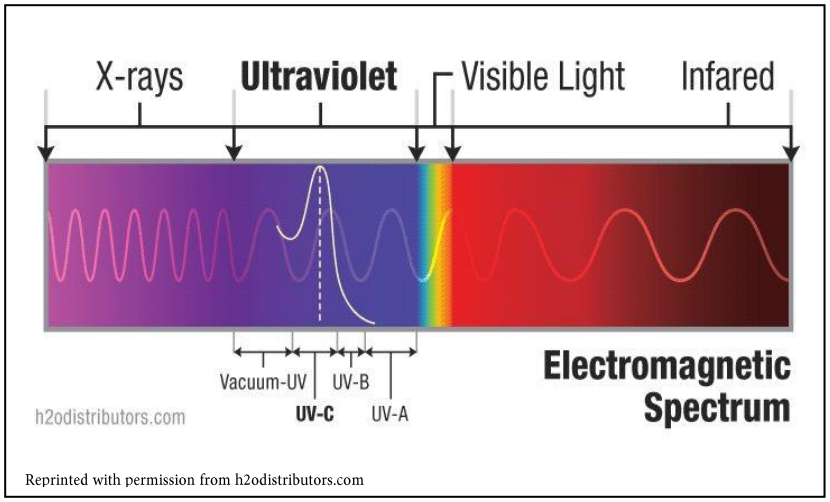
Objectives

The objectives of this laboratory are:

a) Understand what ultraviolet (UV) light is
b) Understand the different types of UV light
c) Test the abilities of materials to absorb UV light
d) Understand relationship between UV light and sun protection factor (SPF)

Background

Solar energy (sunlight) contains light we can see, and some we can't. **Visible light** has wavelengths of 750 to 400 nm. **Ultraviolet (UV) light** has shorter wavelengths, *cannot be seen*, and has *higher energy*. **Infrared (IR) radiation** is the major source of heat for Earth. Though UV is a fraction of sunlight, it can be damaging to living organisms. All of these are forms of energy in the **electromagnetic spectrum**.



Reprinted with permission from h2odistributors.com

Just as visible light components have names (red, orange, yellow, green, blue, indigo, violet), so do the types of UV light: UV-A, UV-B, UV-C and vacuum-UV. **UV-A** has lowest energy and is least damaging; UV-A is also called "black light." **UV-B** and **UV-C** have higher energies and can cause break bonds of molecules, causing changes in DNA and thus skin cancers.

UV light type	wavelength	relative energy	comments
UV-A	320 – 400 nm	lowest energy	reaches Earth in greatest amount
UV-B	280 – 320 nm	higher energy than UV-A, but less than UV-C	most is absorbed by ozone
UV-C	200 – 280 nm	highest energy	absorbed by ozone and oxygen

The majority of UV-B is absorbed by ozone in the stratosphere. Though UV-C is most damaging, it is totally absorbed by oxygen and ozone. In recent years, depletion of the ozone layer has allowed more UV light to reach us, resulting in more cases of skin cancers. Consequently, we have become aware of the need to protect ourselves from UV light.

What protects us from UV light? One strategy would be to avoid exposure to any type of sunlight. Since we cannot avoid sunlight while outdoors, we can physically or chemically block the sun. A wide variety of commercial sunscreens are available with **sun protection factors (SPF)** ranging from SPF 2 to SPF 100. These lotions contain organic molecules that absorb UV light. Some materials, such as glass and plastic also absorb UV light, while still allowing visible light through.

Procedure

Safety

Your eyes should not be directly exposed to the indoor lab UV light source. No materials used in this experiment should be ingested.

Personal protective equipment (PPE) required: lab coat, safety goggles

Materials and Equipment

UV-sensitive beads, sunscreen lotions with various SPF ratings, sunblock, sunglasses, clear and opaque plastic, glass plate, foil, cloth, small plastic bags, laboratory UV light, UV intensity meter card

Part A: Detecting UV light

1. Place 3-5 UV-sensitive beads in two small plastic bags. These beads will turn color in the presence of UV light. The higher the intensity of UV light the stronger the color change.
2. Make two bags: one labeled "Control" and one labeled "Experiment". Record the color of the beads when exposed to *indoor light* (lighting in the lab). The control bag will remain at your bench, and should be used for comparison to color changes in experiment.
3. Take the experiment bag outside, in an area of direct sunlight. Record the color of the beads after 10 seconds of exposure to outside *sunlight*.
4. Find a shaded area (e.g. under a tree or in a corridor). Record the color of the beads in *shade*.

Part B: Absorption of Outdoor UV light by various materials

1. Place on a tray: control and experiment bags from Part A and one of each of the materials from the front bench (clear plastic, opaque plastic, sunglasses, glass plate, foil and cloth). Take the tray outside to an area of direct sunlight.
2. Use each type of material to block the sunlight by holding directly above the experiment bag. Record the color of the beads when shielded by each sample. Note the colors of both control and experiment beads.

Part C: Absorption of UV Light by lotions

1. Place 3-5 UV-sensitive beads into a small plastic bag; make four bags. Label with the SPF numbers, and one sunblock. Note the color of the beads under indoor lighting.
2. Add <u>one small drop/dab</u> of each lotion onto each bag. Lightly coat/spread to cover one side of the bag. <u>Allow lotion to dry</u>. Bring the bags to a *laboratory UV light* setup. Leave bag for 10 seconds. Look into the front of the setup (but not directly at the light) to record the color of the beads under UV light.
3. Empty the beads into beaker at front bench. Discard coated plastic bags.

Part D: UV Light at SMC

1. Obtain a UV Intensity Meter card from the front bench. Go outside to the same area of sunlight you had been working in previously. Record the reading on your report sheet.