

Comparing Sunscreens

Sunscreens are available in many different types and with many different levels of protection. The most common measure of protection from UVB light is the SPF factor. SPF, or sun protection factor, describes the increased amount of time you can be in the sun before your skin starts to burn. For example, a sunscreen labeled SPF 8 means that you can be out in the sun eight times longer before burning than you would without using any protection. Products range from SPF 0 to SPF 50 or higher. But is SPF 50 really twice as protective as SPF 25? You will perform an experiment that will help answer that question.

Figure 1 shows the location of UV light in the electromagnetic spectrum. Notice that the ultraviolet band is broken into three types referred to as UVA, UVB, and UVC. The most harmful of these three, UVC light, is absorbed by the atmosphere and does not reach the Earth's surface. UVA light is deep-penetrating and causes tanning, wrinkles, and some forms of skin cancer. UVB light is also responsible for many skin problems such as sunburns and several forms of skin cancer.

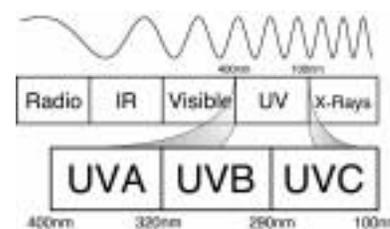


Figure 1

In this experiment, you will measure the amount of UVB light that passes through various sunscreens. You will then compare it with the amount of UVB light from direct sun and analyze the relationship between them.

OBJECTIVES

In this experiment, you will

- Use a UVB Sensor to measure UVB light.
- Determine the amount of UVB light allowed through five different sunscreens.
- Analyze the trend of UVB light vs. SPF values.

MATERIALS

TI-83 Plus or TI-84 Plus graphing calculator	ring stand and clamp
EasyData application	selection of sunscreens
data-collection interface	two 4 × 6 inch index cards
Vernier UVB Sensor	empty film canister
quarter	scissors
tape	plastic wrap

PRE-LAB PROCEDURE

1. Obtain the five different sunscreens assigned by your teacher.
2. In the spaces provided on the data table, fill in the SPF values, brand names, additional notes, and price per ounce.

PROCEDURE

1. Prepare your test cards.
 - a. Obtain two 4 × 6 inch index cards.
 - b. Using a quarter as your guide, draw three circles on each test card as shown in Figure 2.
 - c. Use scissors to cut out the circles.
 - d. On one test card, label the circle on the left as your control.
 - e. Using both test cards, label the remaining five circles with the SPF values of your five assigned sunscreens. Move from left to right and begin with the lowest SPF value. Note: Your SPF values may be different from those shown in Figure 2.

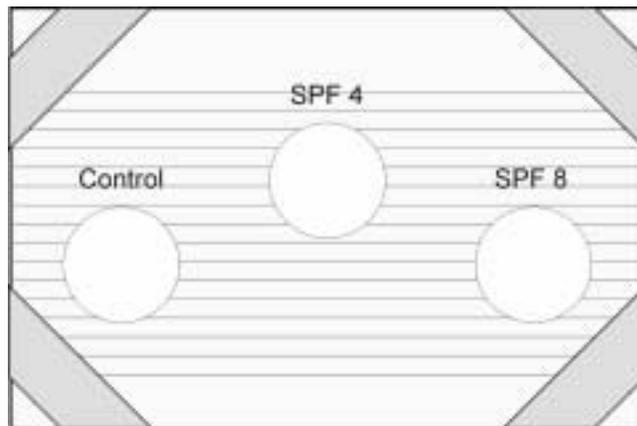


Figure 2

2. Cover the test cards with plastic wrap.
 - a. Cut out a 4 × 6 inch piece of plastic wrap. The person who does this should have clean hands with no sunscreen or lotion on them.
 - b. Lay the plastic wrap neatly on top of one of the test cards. Try to keep the plastic wrap flat so it is not wrinkled, but do not stretch it.
 - c. Tape the four corners as shown in Figure 2.
 - d. Repeat Steps a–c for the second test card.
3. Apply the sunscreens to the test cards.
 - a. Place the first test card in front of you with the plastic side facing up.
 - b. The circle labeled “control” should be kept clean. It will be used to measure the effect of the plastic wrap by itself.
 - c. Starting with the sunscreen that has the lowest SPF, squeeze a very small amount of sunscreen on your finger.
 - d. Spread the sunscreen thinly and evenly over the appropriate circle on the plastic wrap.
 - e. Wipe off your finger well with a paper towel.
 - f. Repeat Steps b–e for all the remaining sunscreens.
 - g. Let the sunscreens dry while you complete Steps 4–9.
4. If you are not already outside, gather all of your equipment and go outside at this time.
5. Turn on the calculator. Connect the UVB Sensor, data-collection interface, and calculator.
6. Use the shadow of the UVB Sensor to aim it correctly without looking directly at the sun.
 - a. Hold the sensor with your thumb and first finger, pointing the sensor in the general direction of the sun.
 - b. Find the sensor’s shadow and observe how it changes shape as you move the sensor around.

- c. Move the sensor around until the shadow becomes a small round circle. This indicates that the sensor is now pointing directly at the sun.
 - d. Keeping this sensor orientation in mind, clamp the UVB Sensor onto the ring stand as shown in Figure 3.
 - e. Once the sensor is securely on the ring stand, use the shadow again to make final adjustments to assure that the sensor is pointing directly at the sun.
7. Set up the calculator and interface for data collection.
 - a. Start the EasyData application, if it is not already running.
 - b. Select **(File)** from the Main screen, and then select **New** to reset the application.
 - c. Select **(Setup)** from the Main screen, and then select **Events with Entry**.
 8. You are now ready to collect UVB data.
 - a. Select **(Start)** from the Main screen.
 - b. Hold the test card with the control over the tip of the UVB Sensor. **Important:** The side with the sunscreen should be facing out, away from the sensor. Sunscreen should never come in contact with the UVB Sensor. It is okay if the plastic lightly touches the tip of the sensor.
 - c. When the reading has stabilized, select **(Keep)** to take a data point.
 - d. Type **0** (for SPF 0) and select **(OK)**. The first data pair has now been saved.
 - e. Repeat Steps b–d for each of the five sunscreens typing in their SPF values when prompted.
 - f. When you have tested all the samples, select **(Stop)** to end data collection.
 9. A graph of UVB light intensity vs. SPF value will be displayed. Use the **(D)** and **(C)** keys to examine the data points and record the UVB light values.
 10. Print a copy of your graph or make a sketch of it as directed by your teacher.



Figure 3

3. According to your data, did the price per ounce or any other factors such as being “waterproof” have any effect on the UVB measurements? Explain.

EXTENSIONS

1. Test a wider variety of sunscreens to confirm or deny your conclusions above.
2. UVA light is not only responsible for tanning your skin, but for wrinkles, cataracts and some types of cancer as well. If your school has a Vernier UVA Sensor, test the same sunscreens for their degree of UVA protection.

TEACHER INFORMATION**Comparing Sunscreens**

1. There are several different combinations of equipment that will work for measuring UV. The most common method, which uses the USB port on TI-84 Plus calculators, is to connect a UV Sensor to an EasyLink. For more information on EasyLink refer to *Appendix F*.

The other method, which works for both the TI-83 Plus and TI-84 Plus families of calculators, is to use a UV Sensor attached to a LabPro or CBL 2.

2. Encourage your students to be very careful when applying the sunscreens. Thick and/or uneven application will lead to poor experimental results.
3. This experiment must be done outside, in full sun.
4. If you are using a LabPro or CBL 2 be sure that it has fresh AA batteries for the day of the experiment.
5. The Vernier UVB Sensor has a built-in diffuser to minimize its directional specificity. Clamping the sensor in a ring stand is still preferable, however, as it eliminates all directional variation.
6. The Vernier UVB Sensor is built around a broadband UV sensitive silicon photodiode. The diode produces a current proportional to the UV intensity. A wavelength selective filter limits light striking the diode to only the UVB region, 280 to 320 nm. Figure 1 shows the spectral response of the Vernier UVB and UVA Sensors (sold separately). The signal from the diode is amplified and sent to the output.

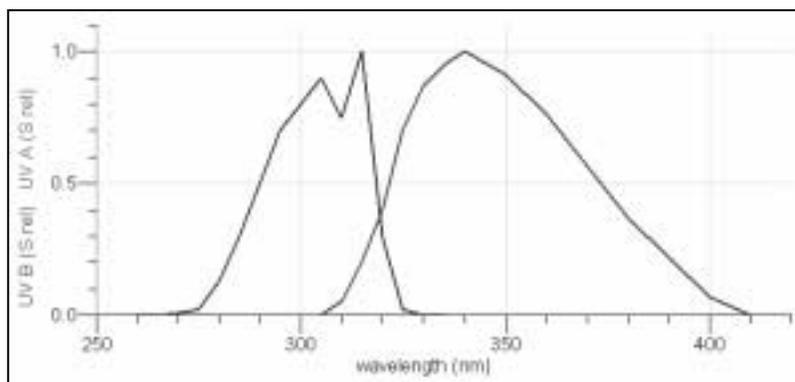
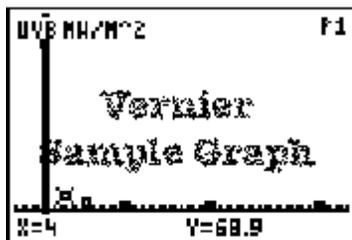


Figure 1 Spectral Response of Vernier UVA and UVB Sensors

SAMPLE RESULTS

SPF value on label	UVB intensity (mW/m ²)	Brand name (e.g., Coppertone)	Additional notes on label (e.g., waterproof)	Price per ounce (\$)
SPF 0 (Control)	xxxx	N/A	N/A	xxxx
SPF 4	xxxx	Coppertone	Dark Tanning	xxxx
SPF 8	xxxx	Solace (Rite-Aide)	Waterproof	xxxx
SPF 15	xxxx	Hawaiian Tropic	Oil-free	xxxx
SPF 30	xxxx	Banana Boat	Waterproof	xxxx
SPF 50	xxxx	Banana Boat	For Babies	xxxx



ANSWERS TO QUESTIONS

Answers have been removed from the online versions of Vernier curriculum material in order to prevent inappropriate student use. Graphs and data tables have also been obscured. Full answers and sample data are available in the print versions of these labs.