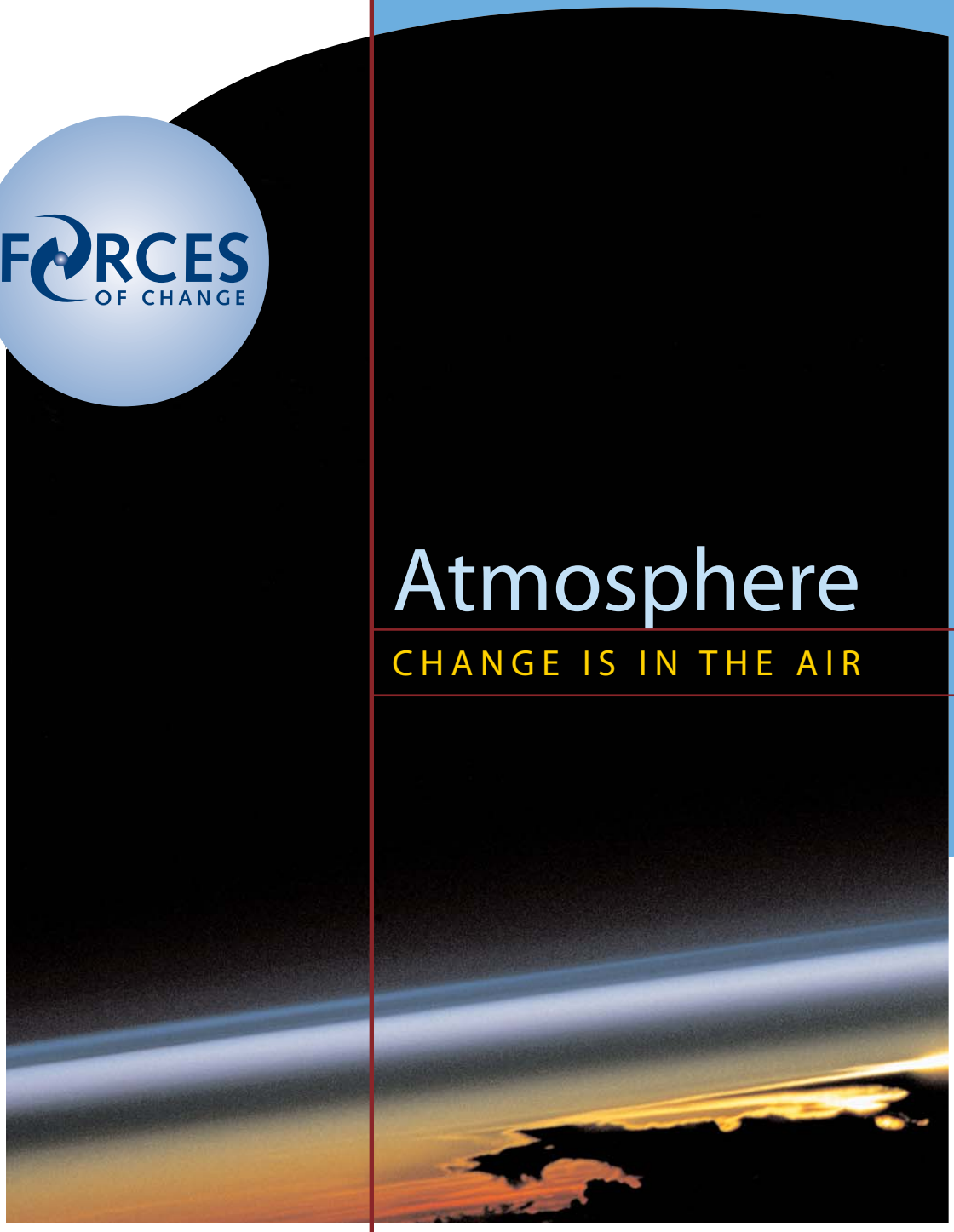
Activity 8

UVs and Frisbees

FORCES OF CHANGE

Atmosphere

CHANGE IS IN THE AIR



Smithsonian
National Museum of Natural History

ACTIVITY 8

UVs and Frisbees

Overview

This experiment will help students understand that ultraviolet radiation is present in natural outdoor light and that the intensity of the light varies with season and time of day.

Grade Level

5–9

National Standards Alignment

National Science Education Standards

Physical Science, Transfer of Energy, Grades 5–8, pg. 155, Item #6, The sun is a major source of energy for changes on the earth's surface. The sun loses energy by emitting light. A tiny fraction of that light reaches the earth, transferring energy from the sun to the earth. The sun's energy arrives as light with a range of wavelengths, consisting of visible light, infrared, and ultraviolet radiation.

Physical Science, Interactions of Energy and Matter, Grades 9–12, pg. 180, Item #1, Waves, including sound and seismic waves, waves on water, and light waves, have energy and can transfer energy when they interact with matter.

Physical Science, Interactions of Matter and Energy, Grades 9–12, pg. 180, Item #2, Electromagnetic waves result when a charged object is accelerated or decelerated. Electromagnetic waves include radio waves (the longest wavelength), microwaves, infrared radiation (radiant heat), visible light, ultraviolet radiation, x-rays, and gamma rays. The energy of electromagnetic waves is carried in packets whose magnitude is inversely proportional to the wavelength.

Benchmarks for Science Literacy, Project 2061, AAAS

The Physical Setting, Motion, Grades 6–8, pg. 90, Item #1. "Light from the sun is made up of a mixture of many different colors of light, even though to the eye the light looks almost white. Other things that give off or reflect light have a different mix of colors."

The Physical Setting, Motion, Grades 6–8, pg. 90, Item #5. "Human eyes respond to only a narrow range of wavelengths of electromagnetic radiation-visible light. Differences of wavelength within that range are perceived as differences in color."

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Time

Time for this activity is highly variable and depends on the level of sunlight and type of test selected. This activity would serve well as a scientific inquiry project for even younger students. Allow students to work in teams. Have teams select an experiment to run on the Frisbees (plastic shields, sunscreen, etc.), determine and describe their own procedure and carry out their experiment. This will take at least two class periods. Simpler demonstration activities will take correspondingly less time.

Time

- five UV-sensitive Frisbees (small), or one large one cut up into pieces (UV-sensitive Frisbees are available in Sun Wise kits from the Environmental Protection Agency http://www.epa.gov/sunwise/tools.html).
- squares of plastic of various thickness 25 mm to 1 cm (1/8 to 1/2 inch) thick. Plastic scraps may be obtained at hardware stores or glass companies.
- tray
- cover
- black light may be used on cloudy days

Vocabulary

ULTRAVIOLET (UV) LIGHT — a portion of the light spectrum with shorter wavelengths and more energy than visible light. UV light enables cells in the skin to make Vitamin D, but it can also cause wrinkles, skin cancer, and cataracts over the lens of the eye.

UVA AND UVB LIGHT — the portions of ultraviolet light from sunlight that are not completely blocked by the ozone layer in the stratosphere. UVB gives you a suntan and can cause skin cancer. UVA makes skin age prematurely.

VISIBLE LIGHT — the portion of the light spectrum that you can see

WAVELENGTH — light travels in the form of waves. The distance between waves is called the wavelength.

ACTIVITY 8

OBJECTIVES

Students will be able to:

1. Explain that ultraviolet radiation is present in natural outdoor light.
2. Demonstrate that UV radiation can be blocked or filtered by various substances.
3. Illustrate that the amount of UV radiation varies with time of day.

Background

Energy from the sun includes not only visible light but also wavelengths longer (infrared) and shorter (ultraviolet) than visible light. The wavelengths of visible light increase from the blue to the red end of the spectrum. Shorter than blue are wavelengths referred to as ultraviolet (UV). Ultra means beyond, so ultraviolet means beyond (or shorter than) violet.

The amount of UV radiation reaching Earth's surface depends on the distance it travels through the atmosphere. During morning hours, UV radiation must travel through more of Earth's atmosphere because the sun is lower on the horizon. At noon the rays travel a shorter distance through the atmosphere because the sun is more directly overhead.

Activity

1. Place Frisbees on tray.
2. Leave one Frisbee uncovered. Cover each of the others with plastic sheets of various thickness.
3. Make a data sheet to record the thickness of plastic used and the color at two-minute intervals.
4. Cover the entire tray with a cloth to block all light. Carry the tray outside and place in direct sunlight.
5. Remove cover in sunlight and expose for at least twenty minutes (the longer the exposure the more dramatic the results).
6. Complete the data sheet.

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Questions and Observations

1. Did the Frisbees change color when exposed to normal room lighting? (Not usually.) Why or why not? (Because there is very little UV radiation in indoor lightning.)
2. What happened to the color of the Frisbees in sunlight? (They turned pink.) Why do you think these results occurred? (The UV light causes a photochemical reaction that causes the Frisbee to turn pink.)
3. What effect did the various pieces of plastic have upon the color of the Frisbees? (The Frisbees did not turn color.) Why do you think these results occurred? (Probably the plastic blocked the UV light so the photochemical reaction was unable to occur.)
4. If you needed to protect something from UV light, what material would you use? Why?

Extensions

1. Test the effectiveness of different types of filters, such as different types of plastics (acrylic, Lucite, Plexiglas), glass (you can use glass slides; stack a number together for different thicknesses), water, different types of cloth, sunscreens with different SPF numbers and/or different brands, different types of artificial lights (fluorescent, incandescent, heat lamp, black lights, etc.).
2. Test the Frisbees at different times during the day, under different degrees of cloud cover, and at different seasons. Can you relate the amount of UV radiation to different amounts of atmosphere that solar radiation travels through?

Notes to Teacher

Suggestions to implement this activity through an inquiry approach:

1. Collect an assortment of substances such as: sunscreens and tanning lotions, lip balm and/or face creams, UV protective additive for paint (hardware stores should carry these), sheets of various plastic films (food wrap, mylar, acetate), and small pieces of clear acrylic and polycarbonate.
2. To avoid reliance on clear, sunny days as your UV source, you may use commercial UV lamps of various types (many are sold as 'mineral-lights' and are used to identify fluorescent minerals), but whenever using UV lamps, use great caution in limiting student exposure to the lamps.
3. Use any acceptable form of a lab write-up or oral lab report. Students should have the opportunity to explain what the question is and why it's important, describe in detail their experimental procedure, report their results in text and graphic form (graphs, tables), and explain how the data they collected answers the question