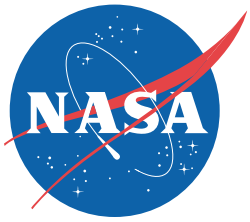
As the Sun Burns

Supplemental science materials

for grades 5 - 8

Stanford SOLAR Center

These supplemental curriculum materials are sponsored by the Standford SOLAR (Solar On-Line Activity Resources) Center. In conjunction with NASA and the Learning Technologies Channel.



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Teacher Overview

Objectives

1. Students will understand that the sun gives us more than just rays from the visible light spectrum, that the sun gives off light we can't see such as ultraviolet rays.

2. Students will be introduced to the electro-magnetic spectrum.

3. Students will develop an understanding of how to protect their bodies from the harmful effects of ultraviolet radiation.

4. Students will develop an understanding of how the Earth's atmosphere (stratosphere and ozone layer) shields the surface of the Earth from most of the ultraviolet rays that come from the sun.

5. Students will explore/demonstrate the effects of ultraviolet radiation on objects that react to ultraviolet rays.

6. Students will become familiar with the work of an ophthalmologist, dermatologist, meteorologist and solar scientist.

Teacher Overview

Correlation to the National Science Standards

This segment of the Webcast *All About the Sun,* "As the Sun Burns", is brought to you by a correlation to the National Science Standards for grades 2 - 4, 5 - 8 and 9 - 12 as delineated below.

Grades 5 - 8

Unifying Concepts and Processes

- Evidence, models, and explanation
- Changes, constancy, and measurement
- Form and function

Science as Inquiry

- Abilities necessary to do scientific inquiry
  - Identify questions that can be answered through scientific investigation
  - Design and conduct a scientific investigation
  - Use appropriate tools and techniques to gather, analyze and interpret data.
  - Develop descriptions, explanations, and predictions, and models using evidence
  - Think critically and logically to make the relationships between evidence and explanations
- Understandings about scientific inquiry

Physical Science

- Transfer of energy

Earth and Space Science

- Structure of the Earth system
- Earth in the solar system

Science and Technology

- Abilities of technological design
  - Identify appropriate problems for technological design
  - Design a solution or product
  - Implement a proposed design
  - Evaluate completed technological products or designs
  - Communicate the process of technological design
- Understandings about science and technology

Correlation to the National Science Standards (continued)

Grades 5 - 8 (continued)

Science in Personal and Social Perspectives

- Personal health
- Natural hazards
- Science and technology in society

History and Nature of Science

- Science as a human endeavor
- Nature of science

Teacher Overview

Segment Content/On-line Component Review

The sun gives off much more than just visible light. Students will learn in this segment that ultraviolet radiation is part of the sun's spectrum of non-visible light. They will become familiar with the Earth's atmosphere and the ozone layer that surrounds the Earth protecting it from the ultraviolet radiation. They will explore the effects of exposure to these rays on special UV beads. They will become familiar with the UV Index while learning about ways to protect themselves from the effects of exposure to UV rays.

The on-line segment will include interviews with a dermatologist, ophthalmologist and solar scientist about the sun's rays and how to stay safe from their harmful effects. Students will demonstrate proper solar protection behaviors. Students will also perform a demonstration/ experiment using special UV beads to determine the amount of exposure to ultraviolet rays from the sun.

Students can visit the Web site and read about the work of an ophthalmologist, dermatologist, meteorologist and solar scientist offered as a text-based interview. Students can also use the Web site to view illustrations of the following concepts: Earth's atmosphere (stratosphere with ozone layer) protecting the surface from UV rays, the electro-magnetic spectrum and the UV Index.

The Science Exploration section focuses on explorations with UV beads. These beads can be ordered from the following source:

Educational Innovations, Inc.
5 Francis J. Clarke Circle
Bethel, CT 06801

phone 203-748-3224 fax 203-229-0740

Catalog: UV-**AST** (assorted colors with approximately 240 beads per bag @$6.95, 1 bag should be enough for a class of 30 students)

http://www.teachersource.com/product/ultraviolet-detecting-beads/light-color

The UV explorations can be easily adapted to fit the classroom science pedagogy in use, but are structured in this document as a brief description of a teacher-led activity with an accompanying *UV Exploration Guidesheet* (student guidesheet) . The instructor can substitute the *Explorations Scientific Method Guidesheets* if a more formal investigation is desired of the students. These activities using UV beads should be preceded or followed with scientific content discussion as found in each exploration description.

Teacher Overview

Materials List

Note: Materials are indicated according to the "Exploration" activity in which it is needed. The amount of materials given is per one group.

- UV Rays
  - Ultraviolet Beads: About 5 beads per paper plate (Note: Ordering information given in the section "Segment Content/On-line Component Overview")
  - 3 sturdy, white paper plates
  - 3 dark colored, lightweight hand towels (to serve as temporary coverings)
  - desk lamp

- SPF Safe
  - Ultraviolet Beads: About 5 beads per paper plate (Note: Ordering information given in the section "Segment Content/On-line Component Overview")
  - 4 sturdy, white paper plates
  - 4 dark colored, lightweight hand towels (to serve as temporary coverings)
  - Sunscreen SPF 15+, 30+ and 45+ (1 small bottle of each)

- Undercover
  - Ultraviolet Beads: About 5 beads per paper plate (Note: Ordering information given in the section "Segment Content/On-line Component Overview")
  - 3 sturdy, white paper plates
  - black construction paper
  - 4" x 4" pieces of the following material: blue tarp, light colored cotton or linen, dark colored cotton or linen
  - 12 straight pins (4 per plate)

Materials List (continued)

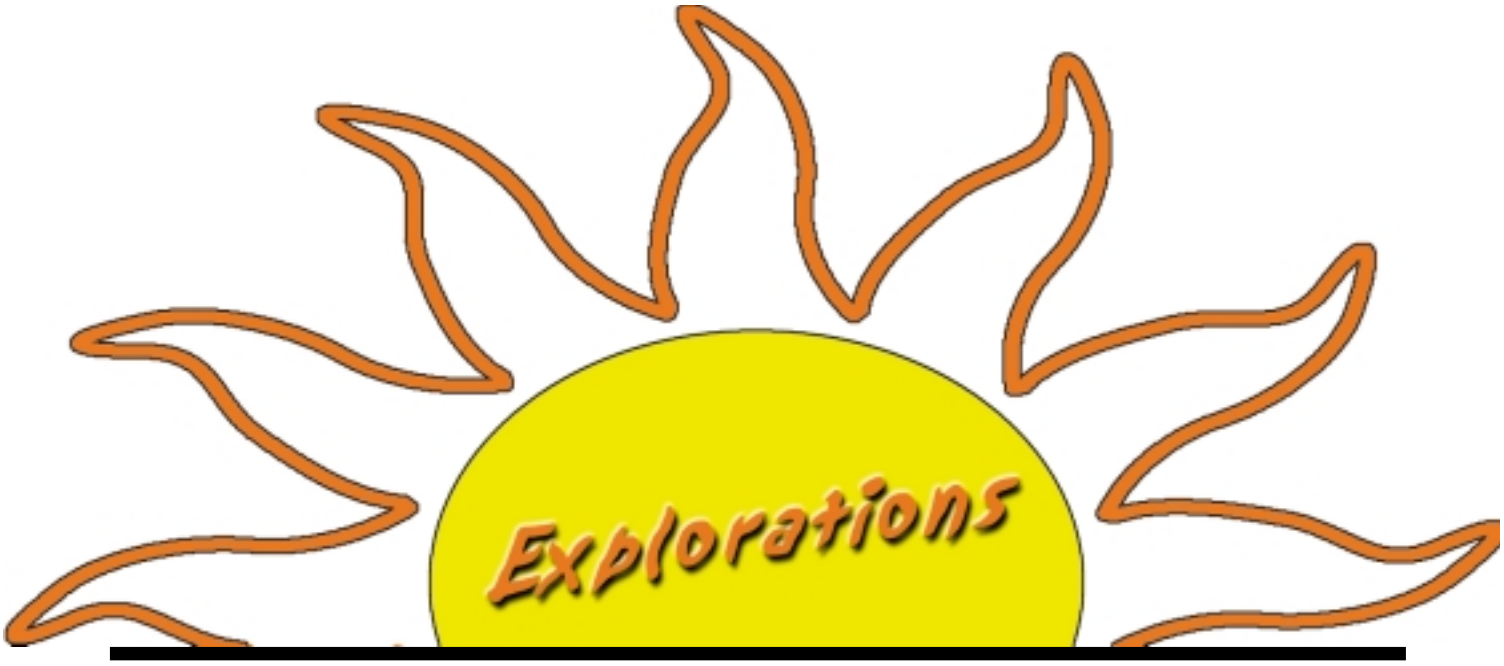
Note: Materials are indicated according to the "Exploration" activity in which it is needed. The amount of materials given is per one group.

- UV Reflection
  - Ultraviolet Beads: About 5 beads per paper plate (Note: Ordering information given in the section "Segment Content/On-line Component Overview")
  - 2 sturdy, white paper plates
  - black construction paper (enough to cover the top of one paper plate)
  - 2- 4" x 4" pieces of light colored fabric squares
  - ruler

- Got the Sun in My Eyes
  - Ultraviolet Beads: About 5 beads per paper plate (Note: Ordering information given in the section "Segment Content/On-line Component Overview")
  - 3 sturdy, white paper plates
  - black construction paper (enough to cover the top of each paper plate)
  - 2 pairs of sunglasses (one highly rated for UV protection and one that is poorly rated for UV protection)

- Tip your Hat to UV
  - Ultraviolet Beads: About 5 beads per tester (Note: Ordering information given in the section "Segment Content/On-line Component Overview")
  - Have students bring in their favorite hat or an old hat or a "funny" hat or a hat that they think will afford the most protection from ultraviolet rays.

- Student Handouts
  - Student Reading: *You Can Be UV Safe*
  - Student Worksheet: *You Can Be UV Safe*
  - Student Handout: *UV Chart*
  - Student Guidesheet: *UV Exploration Guidesheet*
  - Optional Worksheet: *Reading the UV Chart*



- Science Explorations
- Career Explorations

Explorations

Science Explorations

- UV Rays

Purpose: To demonstrate that the sun gives off energy that we can see (visible light) as well as energy that we cannot see (ultraviolet rays). To observe the effects of ultraviolet rays.

Take the beads (covered) out on a sunny day, expose them to the direct sunlight and have the students observe and record the beads' reaction. Discuss or hypothesize what has caused the beads' color to change.

Take another set of beads (covered) into the shade and expose them. Have the students observe and record the beads' reaction. Discuss or hypothesize what has caused the beads' color to change.

Using another set of beads (covered), hold them beneath lamplight from the classroom (away from any sunlight) and expose them to the artificial light source. Have the students observe and record the beads' reaction. Discuss or hypothesize what has caused the beads' color to change.

On the next overcast or cloudy day, take a set of beads (covered) outside and expose them. Have the students observe and record the beads' reaction. Discuss or hypothesize what has caused the beads' reaction.

This can lead to further exploration of UV rays and the full spectrum of energy that the sun emits.

- SPF Safe

Purpose: To demonstrate the effectiveness of sunscreen in protecting people from the harmful rays of the sun. To observe the differences in protection from among the different SPF ratings.

Take 3 sets of UV beads and soak one set each in sunscreen SPF 15, SPF 30+, and SPF 45+. Let each dry for about 60 minutes before beginning the exploration (This is optional, as the beads can be exposed to the sun while they are still wet with lotion.). Take another set of UV beads and do not apply any sunscreen to that set. Place each set of beads on a sturdy paper plate and cover each with a dark cloth as you position them outside. Do not tell students which beads have had which SPF sunscreen applied to them. Expose each set to direct sunlight and after 10 seconds have students observe and record the beads' reaction. Have them discuss the effects of sunscreen and try to identify which set of beads had had which SPF sunscreen applied.

Science Explorations

- Undercover

Purpose: To demonstrate the different amounts of protection from harmful ultraviolet rays that clothing can give humans.

Take 3 sturdy paper plates and cover the top of each plate with black construction paper. Take 3 sets of UV beads and place each set of beads on blackened, sturdy paper plate. Next, cover each set of beads with a 4" x 4" square of each of the following material: blue tarp material, light colored cotton or linen material, and a dark heavy cotton or synthetic material. Using straight pins secure each square no more than 1" above the surface of the paper plate. Take each plate and place outside in direct sunlight. Have the students observe and record the beads' reaction. Discuss or hypothesize what has caused the beads' reaction.

- UV Reflection

Purpose: To observe the effect of reflection of ultraviolet rays on the UV beads' absorption.

Take two sturdy white paper plates and cover the top of one with black construction paper. Leave the other one white. Take 2 sets of UV beads and place one set each on the plates. Cover each with a 4" x 4" piece of light colored cloth by securing it with straight pins to the plate no more than one inch above the beads (to form a tent). Take each plate and place outside in direct sunlight. Have the students observe and record the beads' reaction. Discuss or hypothesize what has caused the beads to react in the way each set did.

- Got the Sun in My Eyes

Take 3 sturdy paper plates and cover the top of each plate with black construction paper. Take 3 sets of UV beads and place each set of beads on a blackened, sturdy paper plate. Next, cover one set of beads with non or low- rated UV sunglasses. Cover the second set of beads with highly-rated UV sunglasses. Leave the third set unprotected from sunglasses. Take each plate and place outside in direct sunlight so that the sunglasses provide protection for the beads from the sun. Have the students observe and record the beads' reaction. Discuss or hypothesize what has caused the beads to react in the way each set did. Have the students discuss which sunglasses have the higher rating and remark upon the difference in color shade between protected and unprotected beads.

Science Explorations

- Tip Your Hat to UV

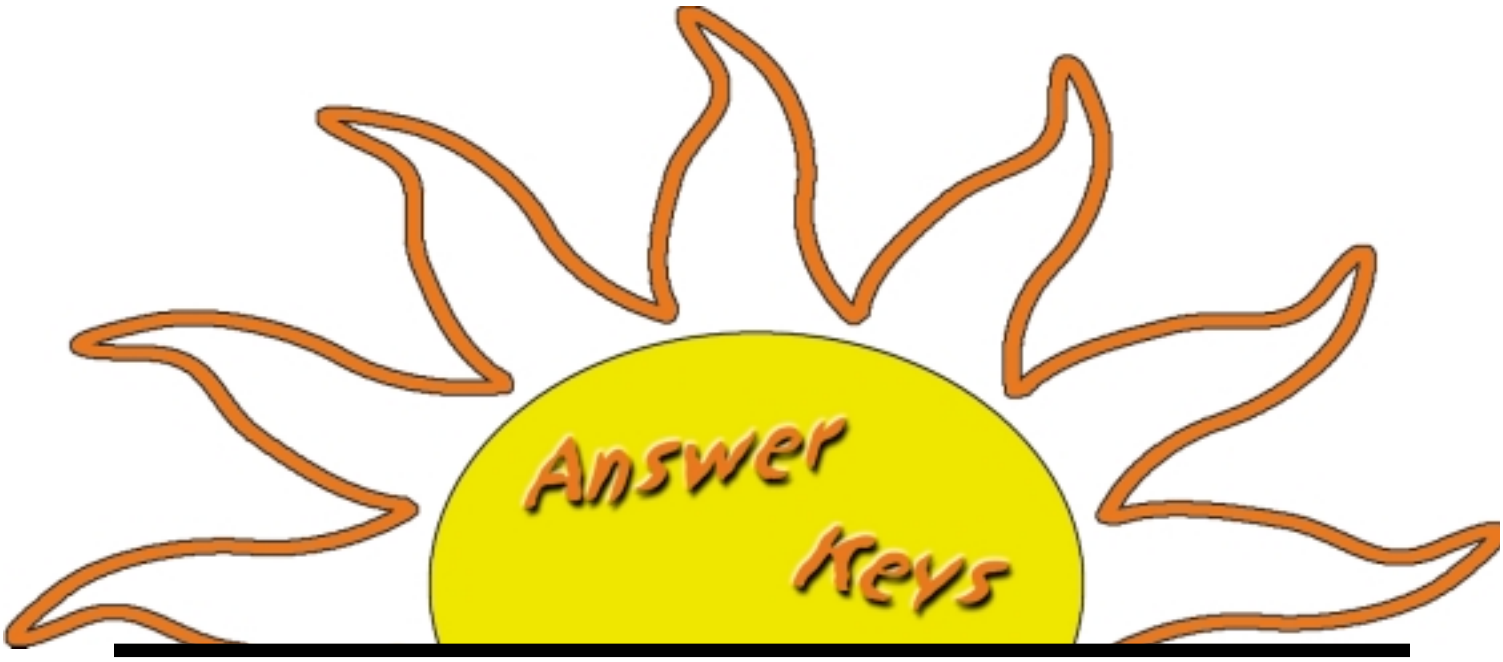
Purpose: To demonstrate how hats are an effective method of protection from ultraviolet rays. To develop an effective judging criteria and method of testing a theory of which hat would afford the best possible protection from ultraviolet rays.

Have students bring in their favorite hat or an old discarded/unwanted hat from home. Have the students in small groups or as a whole class set the criteria for judging which hat will give the best protection from UV rays. The students can judge using the UV beads, or base it upon amount of shadow the hat casts, or the "squint factor" of the wearer's eyes when facing towards the sun or facing away from the sun. Depending upon the criteria the test can be performed on an overcast/ cloudy day, a sunny day or both.

Career Explorations

- Career Comparison
  After viewing the Web cast or after reading a brief introduction on the Web site http://solar-center.stanford.edu of each of the careers represented, the students should be able to make a comparison between two of the careers related by ultraviolet rays.

  Students choose two of the careers and place each in the box at the top of the chart. In the box in the middle, students relate 3 ways in which these careers are similar. In the two boxes at the lower half of the page, the students will relate 3 ways in which each career is different from the other and select the appropriate criteria. For example, choosing dermatologist and ophthalmologist the criteria for a difference would be the part of the body to which each provides a service.



- Student Worksheet: *You Can Be UV Safe*
- Student Worksheet: *Reading a Chart: UV Index*

Student Worksheet

You Can Be UV Safe - Key

Directions: **After reading the Student Reading: *You Can Be UV Safe*, answer each question below by circling the correct response.**

1. Name the form of energy that the sun gives off which causes a sunburn.

   A.visible light B. gamma rays **C. Ultraviolet radiation**

2. Ultraviolet radiation can cause what kind of damage to your eyes?

   A. cataracts B. blindness **C. both A and B**

3. Ultraviolet rays can penetrate what percentage of the Earth's surfaceduring cloud days?

   A. 10% - 40% **B. 30% - 60%** C. 85%

4. This layer of the atmosphere protects the Earth's surface from UV rays.

   A. troposphere **B. stratosphere** C. magnetosphere

5. Decreasing levels of this will increase the incidence of skin cancer.

   A. UV rays B. gamma rays **C. ozone**

6. Long term exposure of the skin to the sun can reduce this in the skin.

   A. moisture B. elasticity C. freckles **D. both A and B**

7. Give the times for peak sun exposure hours.

   A. 8:00 AM - noon B. 10:00 AM - 2:00 PM **C. 10:00 AM - 4:00 PM**

8. To absorb 85% of UV rays, you can protect your skin with what factor of sunscreen?

   A. SPF 5 B. SPF 10 **C. SPF 15+**

9. If you are advised to stay indoors as much as possible what is the UV Index Value for that day?

   A. 10+ B. 7 - 9 C. 1 - 2

Student Worksheet

Reading a Chart: The UV Index - Key

Directions: Use the UV Index to answer the questions below.

1. What is the Index Value for an exposure of "Low"?

   0 to 2

2. What precaution should you take if the Exposure is "Very Low"?

   Wear a hat

3. What are the peak mid-day hours of sunlight?

   10:00 AM to 4:00 PM

4. What is the Index Value when the Exposure category is "High"?

   7 to 9

5. What precaution should people take if the Index Value is 8?

   Wear a hat and sunscreen (SPF 15+), stay in shady areas
   stay indoors during mid-day (10:00 AM to 4:00 PM)

6. What is the recommended Sun Protection Factor for the sunscreen?

   SPF 15

7. What article of clothing is recommended to always be worn for UV protection?

   A hat

8. What should you do if the Exposure Category is "Very High"?

   Stay indoors as much as possible

9. Which two exposure categories recommend to stay in shady areas?

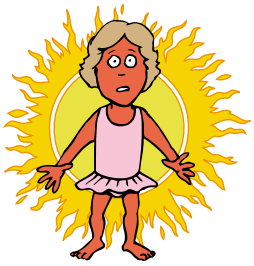
   5 to 6 and 7 to 9

Grades 5 - 8

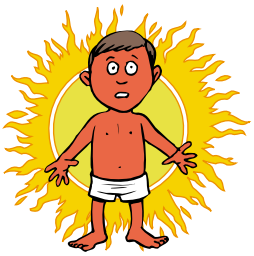
- Student Informational Reading: *You Can Be UV Safe*
- Student Worksheet: *You Can Be UV Safe*
- Student Worksheet: *Reading a Chart: The UV Index*
- Exploration Guidesheet
- Explorations: *Scientific Method Guidesheet*
- Explorations: *Career Comparison*

Student Informational Reading

You Can Be UV Safe



Have you ever been outside during the day and at the end of the day noticed that your skin is painful to touch? You have a sunburn! A sunburn causes the skin to turn red or become tender. It can also cause your skin to swell or blister.



Have you ever been outside for a long time on a cloudy or overcast day and gotten a sunburn? This can happen! It is not the sunlight we can see that gives us a sunburn. It is the energy from the sun we cannot see that can harm us.

The sun gives off energy. This energy reaches Earth in the form of light that we can see. It also gives off energy in ways that we might not notice. One type of energy that the sun gives off is ultraviolet rays. We cannot see UV rays with our eyes. We can see the effects of UV rays on our bodies. Too much exposure to UV rays on our skin can give us a sunburn. Even on an overcast day, 30% to 60% of the sun's rays can penetrate to the Earth's surface. It is the UV rays that can harm our skin and our eyes.

It is the Earth's atmosphere that protects us from overexposure to the sun's more harmful rays. The stratosphere (a layer of air 11 to 50 kilometers above the Earth's surface) contains the ozone layer. The ozone layer was formed when water vapor drifting in the Earth's upper atmosphere was chemically broken down by sunlight into oxygen and hydrogen gases. The hydrogen gas escaped into space because it is so lightweight. The oxygen atoms started to combine with each other to form another substance, ozone. A molecule of ozone is made up of 3 oxygen atoms joined together. This recombination resulted in a layer of ozone forming in the stratosphere.

The ozone layer protects us from the effects of ultraviolet radiation with a complex chemical reaction. As the ultraviolet radiation is absorbed by the ozone molecules, the oxygen molecules are broken apart. The freed oxygen atoms eventually recombine into ozone molecules, and the chemical recombination continues. The ozone layer through this absorption process shields us

Student Informational Reading

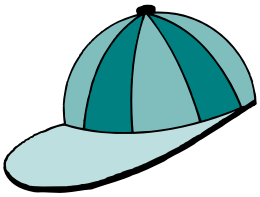
from the ultraviolet rays. Decreases in the ozone level of the stratosphere over a long period of time could cause increases in skin cancer and cataracts in people as less and less ultraviolet radiation is being absorbed by the ozone molecules.

Long term exposure to the sun can take away the skin's moisture or elasticity. It can make your skin feel dry and rough, not soft and smooth. It can also cause your skin to develop spots that are red, yellow, gray or brown. Our eyes can be affected by UV rays, also. Too much exposure to UV rays can cause a painful burn on the cornea of your eyes. This can cause cataracts and later on blindness.

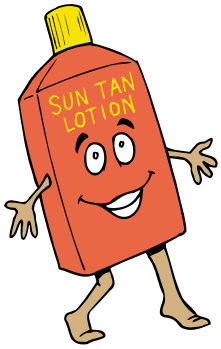
Student Informational Reading

Scientists measure how much UV rays reach the Earth's surface. They developed a special index to help make us aware of the level of radiation exposure expected for each day. We can use this as a guide to help us protect our bodies. See the chart below for a description of each rating.

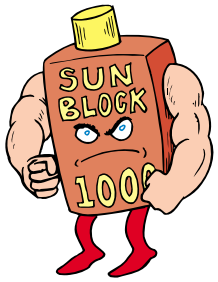
UV Index



UV Index Value	Exposure Category	Precaution
0 to 2	Minimal	Wear a hat
3 to 4	Low	Wear a hat and sunscreen (SPF 15+)
5 to 6	Moderate	Wear a hat and sunscreen (SPF 15+) Stay in shady areas
7 to 9	High	Wear a hat and sunscreen (SPF 15+) Stay in shady areas stay indoors during mid-day (10:00 AM to 4:00 PM)
10+	Very High	Stay indoors as much as possible



We can protect ourselves from the harmful effects of UV rays. We can wear sunscreen with an SPF (Sun Protection Factor) of no less than 15. This will absorb at least 85% of the UV rays before the rays reach your skin. Avoid being out in the sun for a long time during peak exposure hours (10:00 AM to 4:00 PM). Wear a hat and protective clothing to cover your skin. Wear sunglasses that are rated to block at least 99% of the UV rays.



Student Worksheet

You Can Be UV Safe

Directions: **After reading the Student Reading: *You Can Be UV Safe*, answer each question below by circling the correct response.**

1. Name the form of energy that the sun gives off which causes a sunburn.

   A. visible light B. gamma rays C. Ultraviolet radiation

2. Ultraviolet radiation can cause what kind of damage to your eyes?

   A. cataracts B. blindness C. both A and B

3. Ultraviolet rays can penetrate what percentage of the Earth's surfaceduring cloud days?

   A. 10% - 40% B. 30% - 60% C. 85%

4. This layer of the atmosphere protects the Earth's surface from UV rays.

   A. troposphere B. stratosphere C. magnetosphere

5. Decreasing levels of this will increase the incidence of skin cancer.

   A. UV rays B. gamma rays C. ozone

6. Long term exposure of the skin to the sun can reduce this in the skin.

   A. moisture B. elasticity C. freckles D. both A and B

7. Give the times for peak sun exposure hours.

   A. 8:00 AM - noon B. 10:00 AM - 2:00 PM C. 10:00 AM - 4:00 PM

8. To absorb 85% of UV rays, you can protect your skin with what factor of sunscreen?

   A. SPF 5 B. SPF 10 C. SPF 15+

9. If you are advised to stay indoors as much as possible what is the UV Index Value for that day?

   A. 10+ B. 7 - 9 C. 1 - 2

Student Worksheet

Reading a Chart: The UV Index

Directions: Use the UV Index to answer the questions below.

1. What is the Index Value for an exposure of "Low"?

2. What precaution should you take if the Exposure is "Minimal"?

3. What are the peak mid-day hours of sunlight?

4. What is the Index Value when the Exposure category is "High"?

5. What precaution should people take if the Index Value is 8?

6. What is the recommended Sun Protection Factor for the sunscreen?

7. What article of clothing is recommended to always be worn for UV protection?

8. What should you do if the Exposure Category is "Very High"?

9. Which two exposure categories recommend to stay in shady areas?

Exploration Guidesheet

Directions: **In your group, decide how you will explore the science ideas you have talked about in class.**

1. What is the question that you want to explore?

2. How will you find an answer to this question?
   Give a brief overview.

3. List the materials you will need.

4. List step-by-step how you will do this exploration.

5. After you follow your steps, write down what you observed.

6. What did you learn from this exploration?

7. Does this lead you to have other questions? Write down your question.

Scientific Method Guidesheet

State the Problem (question)

- What is it that puzzles you?
- What is the question you would like answered?

Form a hypothesis (prediction)

- Using what you know, write down an answer to your question.
- Using what you know, write down a prediction of what you think might happen.

Design an experiment (materials and procedure)

- Design an experiment that will help to prove or disprove your hypothesis.
- Write down a step-by-step procedure that tells how you will do the experiment.
- List what materials you will need to do the experiment.
- Tell what size and shape containers you need and what the materials are to be made of.
- Make sure your procedure is specific.

Perform the experiment (observe and record data)

- Follow each step of your procedure very precisely.
- Record what you observe and any measurements you take.
- Give details with lots of description

Scientific Method Guidesheet (continued)

Organize and analyze data

- Organize the data you collected:
  - make a graph or
  - make a chart or
  - draw a picture (before and after) or
  - draw and label a diagram

Draw conclusions

- Using the data you have gathered and what you know, explain why you think the experiment turned out like it did.
- Explain why you think your hypothesis was proved or disproved.
- Can you relate the results to anything else you have observed before?
- Do your conclusions generate any further questions or ideas?

Explorations Experiment Log - Page 1

Experiment Name:

STEPS	DATA
1. State the problem	

QUESTION

What do I want to know?

2. Form a hypothesis

PREDICTION

What do I think is going to happen?

3. Design an Experiment

MATERIALS & PROCEDURE

What steps will I take to do this experiment ?
What things will I need?

Explorations Experiment Log - Page 2

Experiment Name:

STEPS	DATA
4. Perform the experiment	
OBSERVE & RECORD *What information did I gather during this experiment?*	
5. Organize and analyze data	
Make a graph or chart or picture or diagram	
6. Draw conclusions	
What do my results mean? *Was my hypothesis right or wrong?* *Can I explain why?*	

Career Comparison

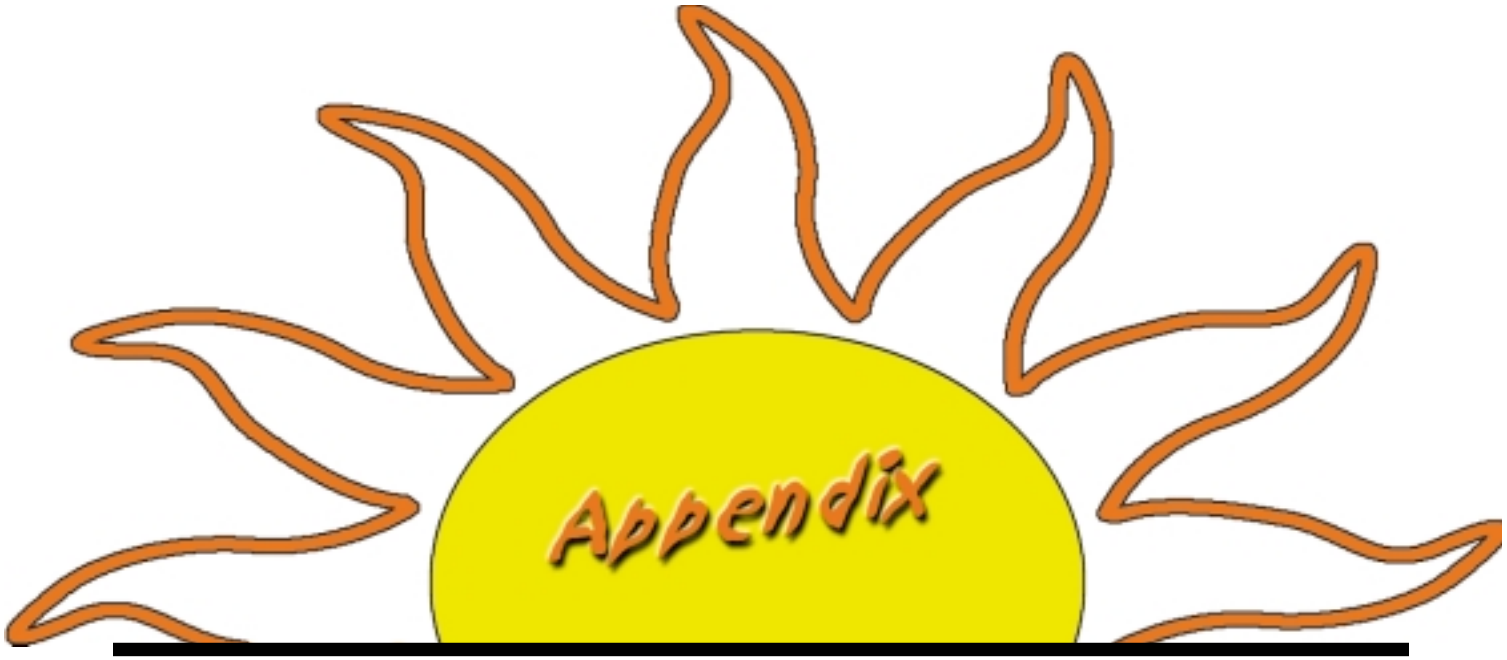
Directions: Choose 2 of the careers covered on the Web site http://solar-center.stanford.edu or during the Webcast, and list 3 ways in which the two careers are similar and 3 ways in which the two careers are different.

career

career

How Are They Alike?

In What Ways Are They Different?



- Solar Glossary
- Web Work

Appendix

Solar Glossary

Directions: **An interactive vocabulary crossword puzzle and word search can be found on the Web site: http://solar-center.stanford.edu using the following words and their definitions.**

atmosphere	A thick mass of air that surrounds the Earth contain many layers.
cataracts	A clouding of the lens of the eye that prevents light from passing through the membrane. Can cause blindness.
cloudy	Having many of a visible mass of particles of condensed vapor in the atmosphere.
cornea	The transparent part of the membrane that covers the pupil and allows light to enter the eye.
dermatologist	A doctor who studies the skin, its structure, its function and its diseases.
energy	The capacity for producing power such as heat or light.
exposure	To allow to be unprotected and risk harm from that.
meteorologist	A scientist who studies the weather
ophthalmologist	A doctor who deals with the structure, functions, and diseases of the eye.
overcast	A thick layer of clouds that obscure some of the sun's energy.

Appendix

Solar Glossary

ozone layer	A form of oxygen formed naturally in the atmosphere by a photochemical reaction and located mainly in the stratosphere.
solar	Having to do with the sun.
solar astronomer	A scientist who studies the sun.
SPF	Sun Protection Factor that is a number used to describe how much protection from ultraviolet rays a sunscreen will give.
stratosphere	A part of the Earth's atmosphere that extends from about 11 kilometers above the Earth's surface to about 50 kilometers and contains the ozone layer.
sunburn	An irritation of the skin caused by too much exposure to ultraviolet rays.
sun	The star nearest to Earth that gives off the energy (heat and light) that affects the Earth.
UV	Ultraviolet radiation or energy given off by the sun that cannot be seen.
UV Index	A special scale developed by the EPA that forecasts the amount of ultraviolet radiation that will reach the Earth's surface.

Appendix

Web Work

http://solar-center.stanford.edu

This site contains an interactive vocabulary crossword puzzle and word search using the solar glossary words.

http://www.epa.gov/ozone/uvindex/uvhealth.html

This site contains lots of information on the ozone layer, ultraviolet radiation, the effects of ultraviolet radiation on humans, the UV Index and how it is calculated.