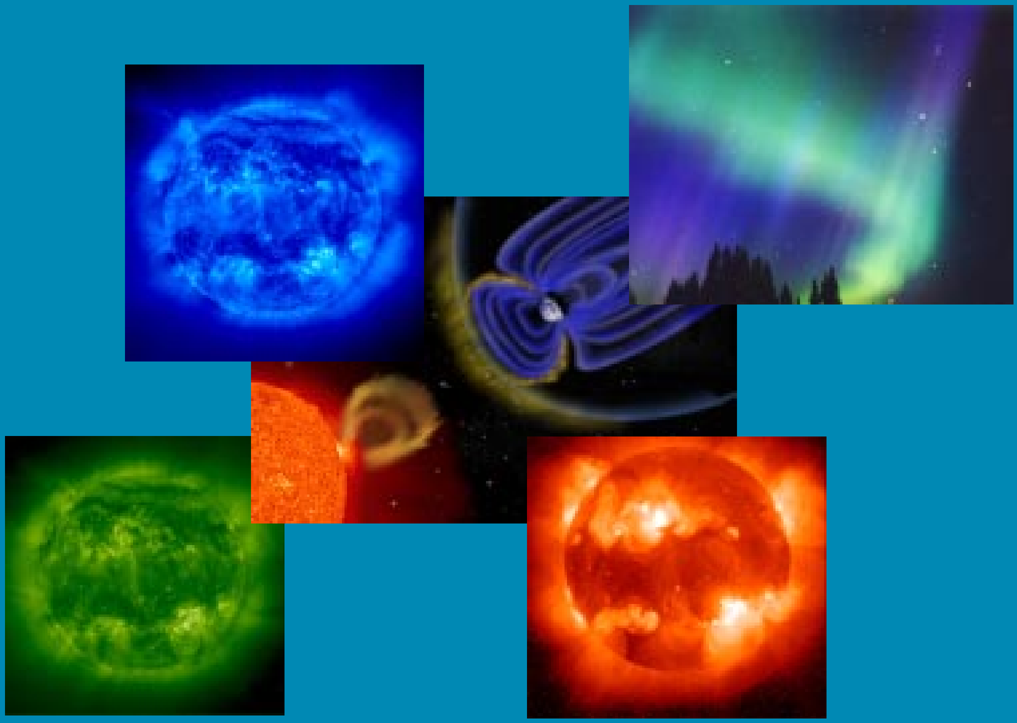
Seeing the Invisible



A Lesson Giving Students an Opportunity to Discover Ultraviolet and Infrared Radiation Coming from the Sun

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for the ISTP Mission

istp.gsfc.nasa.gov/istp/outreach/solar_observation.pdf
istp.gsfc.nasa.gov/istp/outreach/student_booklet.pdf

Seeing the Invisible

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ENGAGEMENT **(How students attention will be captured; stimulate thinking)**	Students will be instructed to make an observation of a flower (tulip) given the one stipulation that they will only be allowed to detect the parts of the plant that are green. Through observation and discussion, students will be led to understand that only seeing parts of the flower leads to an incomplete and even inaccurate understanding of its structure.
EXPLORE	Students will be shown an image of the Sun in visible light and asked to make observations. An analogy will be drawn between the flower observations and Sun observation. Given Sun product description labels, students will highlight what the products claim to protect consumers from i.e., UV radiation. Students will then be informed that the Sun emits light in all areas of the electromagnetic spectrum, not just the visible area, and will be invited to imagine what the Sun would look like if we could see it in other wavelengths, and what could we learn about its structure?
EXPLANATION **(What students will do to construct their own knowledge of the concept)**	Students will construct their own knowledge of the Sun emitting light above and below the visible spectrum by using UV beads to detect ultraviolet radiation coming from the Sun, and, in a second experiment, will record the temperature readings of thermometers placed in the visible and infrared region of a spectrum produced using a prism. An optional M&M Filter Activity is included in the lesson to demonstrate how filter work.
ELABORATION **(Opportunities to extend understanding, apply to real life)**	Now aware that the Sun emits radiation in addition to visible light, students are invited to observe four images of the Sun at different wavelengths collected by an Extreme Ultraviolet Imaging Telescope aboard the SOHO spacecraft observing the Sun at orbital point L1. Students should note differences of structural features seen at different wavelengths.
EVALUATION	Assessment should be on-going throughout the lesson by evaluating students' responses to questions, assessing, (1) the process of data collection, (2) the accuracy of data, (3) responses to data questions, and of course, (4) evaluating a persuasive newspaper writing assignment in which students try to convince readers that the Sun emits radiation that we cannot see.
Recommended Teacher Resources	• "Shedding a New Light on the Universe" - Maggie Masetti. Available FREE from NASA Teacher Resource Centers. • International Solar-Terrestrial Physics - website http://www-istp.gsfc.nasa.gov • The Solar and Heliospheric Observatory - website http://sohowww.nascom.nasa.gov/

Benchmark: 4A 9-12 #3

- Increasingly sophisticated technology is used to learn about the Universe. Visual, radio, and x-ray telescopes collect information from across the entire electromagnetic spectrum of electromagnetic waves.

Benchmark: 4F 6-8 #5

- Human eyes respond only to a narrow range of wavelengths of electromagnetic radiation – visible light.

Purpose: To provide students with an opportunity to discover that the Sun emits light in other wavelengths besides the visible region of the electromagnetic spectrum and to allow students to view unique features of the Sun that are only revealed by certain spectral wavelengths of light.

Behavioral Objectives: Students will be able to record a temperature reading from an invisible part of the Sun's spectra and use both experimental and observational data collected to write a persuasive article to argue the existence of invisible radiation coming from the Sun.

Engagement Activity #1: Students will be requested to observe a flower, such as a tulip, with one restriction: They are to pretend that the only parts of the flower they can detect with their eyes are the parts that are green. Guiding questions from the teacher could include:

Q. What parts of the tulip would you know about if you could only detect the parts that are green?

Q. What parts of the tulip would you not be aware of?

If we could only detect things that were green when studying plants, do you think we could understand as much as we do about plants?

Certainly not! If we could not detect flowers, it would be difficult to know how plants reproduce. If we could not see plant roots, we would be hindered from learning how plants get nutrition. Seeing only green gives us a very incomplete, and even incorrect, understanding of plants. There would be large gaps in our knowledge of how plants work if we could only see green. A similar situation exists in astronomy. Have students make an observation of a photo or website image of the Sun in visible light. **NEVER HAVE STUDENTS OBSERVE THE SUN DIRECTLY-EXTREMELY DANGEROUS!** At first glance, the Sun appears only to emit light in the visible spectrum; a quiet and inactive Sun that provides heat and light for the Earth. But what about the light that we cannot see?

Engagement Activity #2: Give each student a highlighter and the pre-assessment sunblock activity sheet with instruction to highlight what each product protects consumers from (ultraviolet radiation coming from the Sun) and where the danger is coming from.

Inform the students that the Sun emits energy at all frequencies of the electromagnetic spectrum. An instructional master for making an electromagnetic spectrum overhead may be found in the “Teacher Overhead Masters” section.

Since we are unable to see any other regions of the spectrum than visible light with the naked eye, other parts of the Sun’s light must be detected somehow. Today we are going to conduct two experiments to detect the existence of radiation, in wavelengths that are shorter and loger than those in the visible part of the electromagnetic spectrum, and then take a look at the Sun in different wavelengths of light.

Teacher Note: Explain both experiments in detail before going outside.

Explore/Explanation: Detecting Ultraviolet Radiation

Experiment #1: Using Ultraviolet (UV) Detecting Wrist Band Beads, students will detect the existence of ultraviolet radiation.

Teacher Background: Each UV detecting bead contains a special pigment which will change color when exposed to ultraviolet radiation from the Sun. The beads are not affected by visible light and will therefore remain white indoors. Note: the color of the beads do not indicate intensity — just the presence of UV radiation.

Materials: (per student)

- UV Detecting Beads/Wristband
- Data Collection Sheet found in Student Activity Booklet
- Pencil
- Sunny area outside

<u>Optional Observation Extension</u>: String one set of four UV beads of the same color in a row and tie a knot. Then, string four more UV beads of the same color onto the same string. Coat the last four beads on the string with UV Sunscreen lotion at least 20-30 minutes before going outside. If available, place a set of beads under UV protective Sunglasses. But remind your students that even with UV sunglasses, it is still too dangerous to look directly at the Sun.)

Procedure:

1. Place UV wristband detector on wrist.
2. Indoor Classroom Assignment: Make an observation and answer Question 1 on Student Data Sheet found in the student activity booklet.
3. Outside Observation: Note changes in the colors and record on the data sheet.

Fig. 1 Inside Observation

Fig. 2 Outside Observation

Helping Students Analyze their Observations Data:

Q. Was UV radiation detected? Yes No
If yes, where?

Q. Were there any differences observed between inside and outside observations of UV detecting beads? Explain.

Q. Does the Sun emit ultraviolet radiation? How do you know?

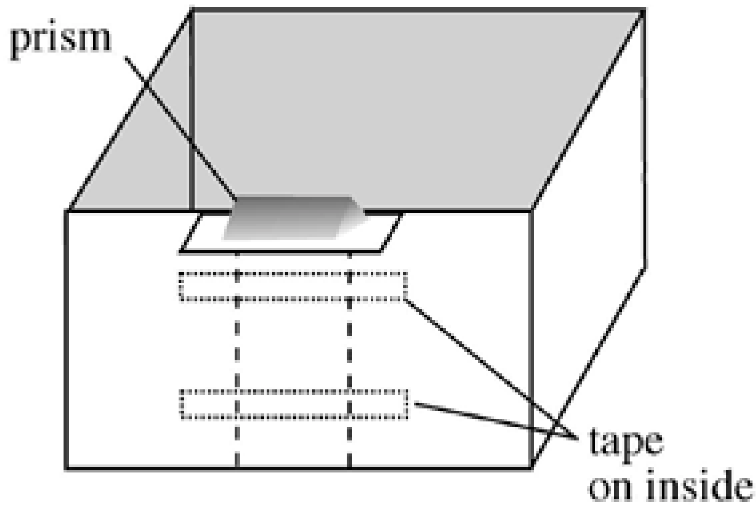
Experiment # 2: Duplicating Herschel's Experiment (1800's)
http://www.ipac.caltech.edu/Outreach/Edu/Herschel/backyard.html

Objective: Students will record temperature readings from various regions of the electromagnetic spectrum —particularly infrared— thus proving its existence.

Materials: (per group of 4 students)

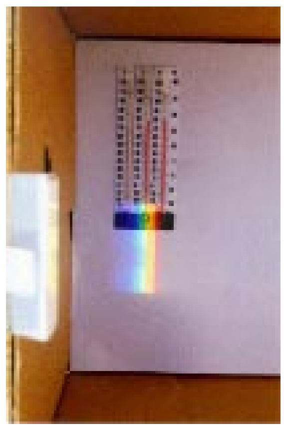
- Xerox copy box
- equilateral glass prism
- 3 thin alcohol thermometers and 1 thermometer on string to record a class air temperature
- clear mailing tape (to attach prism to box)
- 2 sheets of white paper ($8^{1/2}$ X 11") to line the inside of the box.
- sunny area outside
- small pieces of black construction paper or paint to blacken thermometer bulbs (will absorb more heat)
- Data Collection Sheet found in Student Activity Booklet
- Optional: place a block of wood under one end of the box to produce a wider spectrum

Teacher Preparation: It will be much easier for you (than the students) to tape the prisms to the copy boxes or permanently glue each prism to an insert that can be quickly taped to the boxes as shown below before conducting this experiment in class. Another time saver is to line the bottom of the boxes with white paper and place the thermometers in the boxes ahead of time so you will only have to give instructions the day of the experiment. Finally, make sure the thermometers for each group have the same starting temperature before conducting the experiment.



Outside Experiment Procedure:

1. Move the box until a good spectrum appears on the white paper at the bottom of the box. To get a good wide spectrum, place a block underneath the prism end of the box.
2. Place the thermometers in a shaded area of the box until all of the thermometers are reading the same temperature.
3. **Teacher Note**: Place the air temperature thermometer on a string in a designated location for all students to see.
4. Once the thermometers have reached the same temperature, students should place a thermometer bulb in the blue part of the visible spectrum, one in the yellow, and the third just past the red part of the visible spectrum, where there is no visible light hitting the thermometer. Again, consider that some students might be colorblind and need assistance distinguishing colors of the spectrum.



5. After 5 minutes, students should record the air and spectrum thermometer readings in the table provided in the Herschel Experiment Student Data Collection Sheet. If a digital camera is available, students could take a picture of the visible spectrum produced by their group.

6. Complete Data Sheet back in class

Helping Students Analyze Data:

Important Question: Why was there an increase in temperature beyond the red end of the spectrum when visible light was not hitting the thermometer?

Q. Does the Sun emit infrared radiation? How do you know?

Herschel's experiment was important not only because it led to the discovery of infrared light, but also because it was the first time someone showed that there were forms of light that we cannot see. The visible colors are only a very small part of the entire range of light that we call the, "electromagnetic spectrum".

Teacher Note: The temperature of the infrared thermometer will read higher than the termometers within the visible spectrum, as well as the air temperature. Even though visible light does not hit the thermometer, the temperature will increase. Therefore, light must be hitting it, light not visible to our eyes. By completing this experiment, students will have detected and recorded evidence of the existence of the infrared part of the Sun's spectrum.

Teacher Misconception Alert: Most adults would expect the visible and UV regions of the spectrum to have higher temperature readings than the infrared, as these wavelengths have greater energy. True. The wavelengths have greater energy than infrared wavelengths. However, the Earth's atmosphere absorbs and scatters most of the shorter wavelengths. Infrared has long wavelengths, and even though they have less energy than the others, there are more of them hitting the Earth and your thermometers. It is important to remember that the only purpose for this experiment is simply to have students gather evidence that the infrared part of the spectrum exists, which is proven by the infrared thermometer having a higher temperature reading than the air temperature reading.

Elaboration: From the past two experiments we have learned that the Sun does emit radiation above and below the visible spectrum we see. How different would the Sun look if we could see it in other wavelengths? What could we learn about the structure and activity of the Sun if we could see it in different wavelengths of the electromagnetic spectrum?

Background: Astronomers have built an array of telescopes to observe the Sun in different wavelengths of light and have learned so much more than we ever could have if we only looked at the Sun in visible light.

[An Optional M&M Filter Activity to be used at this point in the lesson has been included with the overheads in case students have not had prior experience using filters.]

Elaboration Experiment #3: Examining the Sun in Different Wavelengths: What Do You See?

Materials:

- **Observing the Sun in different Wavelengths: What Do You See?** (Overhead Teaching Master)
  Note: Other EIT images of the Sun at different wavelengths may be found at: http://sohowww.nascom.nasa.gov/summary/
- **Observing the Sun in Different Wavelengths: What Do You See?** Teacher Reference Sheet, which identifies wavelength, temperature, and names features of the Sun observed at each wavelength.
- **Observing the Sun in Different Wavelengths: What Do You See?** Student Data Sheet.

Make Sure Students Are Aware that the Sun, of course, does not change colors from orange to blue, green or gold and that each wavelength has been assigned a false color by astronomers so they may quickly assess which wavelength of light was used to observe the Sun.

Observation Analysis: What have you learned about the Sun that you would not have known just by making observations in visible light?

Writing Assignment: Assign students to write a persuasive newspaper article using what they have learned to convince skeptical readers that the Sun does in fact emit invisible radiation in other regions besides the visible region of the electromagnetic spectrum.

Lesson Extensions/Extra Credit: Students may investigate how parts of the electromagnetic spectrum are used in everyday life on Earth, i.e., Infrared remote controls turn on TVs, X-rays are used in hospitals, etc. A second extension would be to research the dangers of human exposure to UV radiation.

Modification of Herchel's Experiment
(Shortage of Materials - Teacher Demonstration)

A single diffraction grating slide and overhead projector can be used to display a colorful spectrum in the classroom.

Procedure:

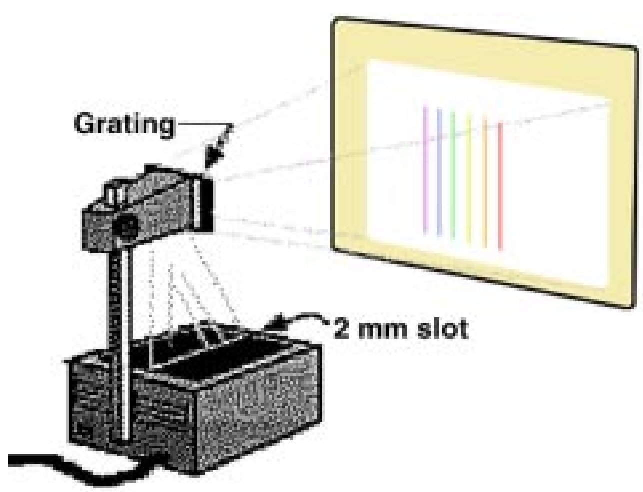
I. Cut a 2mm wide vertical slit down the center of a piece of black construction paper large enough to cover the glass top of the overhead projector.

2. Mount the diffraction grating slide on another piece of black construction paper.

3. Without cutting the diffraction slide cut a window the same size as the clear part of the diffraction slide.

4. Tape the slide mounted on the construction paper to the upper lens of the overhead as shown to produce a spectrum onto a projection screen.

5. Tape LCD thermometers found in most pet stores for aquariums or reptile tanks to record temperatures from parts of the visible spectrum, infrared, and the air room temperature.



Material Purchasing Information

UV Detecting Beads & Rawhide:
Ultraviolet Assorted Detecting Beads $6.95/pkg 240 beads
UV-Rawhide for stringing bead bracelets $1.00 per yard (3 bracelets per yard)
Educational Innovations: (1–888–912-7474)
www.teachersource.com

Equilateral Glass Prisms:
Item # V31-798 (25mm X 100mm) $6.95 each
Edmund Scientifics: (1-800-728-6999)
www.edsci.com

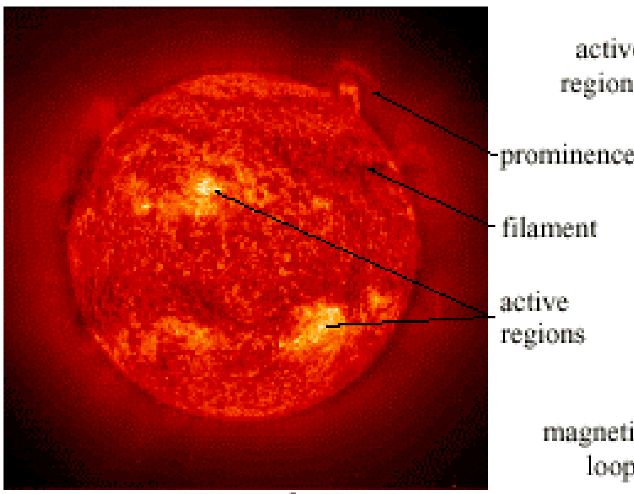
Plastic Back Thermometers:
Item # 46007-00 Low Range $1.95 each
Science Kit & Boreal Laboratories: (1-800-828-7777)
www.sciencekit.com

Pure Red & Green Theater Gels for M&M Filter Activity:
Rosco #26 – Primary Red
Rosco #91 – Primary Green
Sheets 20 X 24" $6.25 each plus shipping
R& R lighting Company
Silver Spring, Maryland
(301) 589-4997
Email: R&Rlights@aol.com
Website: http://www.rrlighting.com

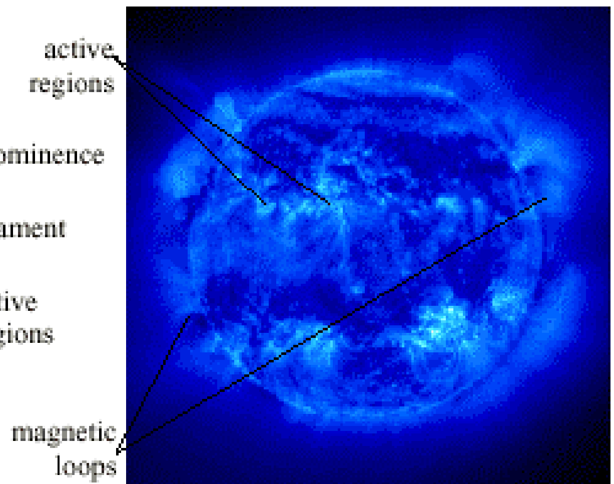
Observing the Sun in Different Wavelengths: What do You See?

The following images of the Sun were taken with the SOHO spacecraft Extreme ultraviolet Imaging Telescope. Most of the images were taken on the same date. The difference is what the Sun looks like in different wavelengths of light. See what you can learn about the Sun by studying the images below:

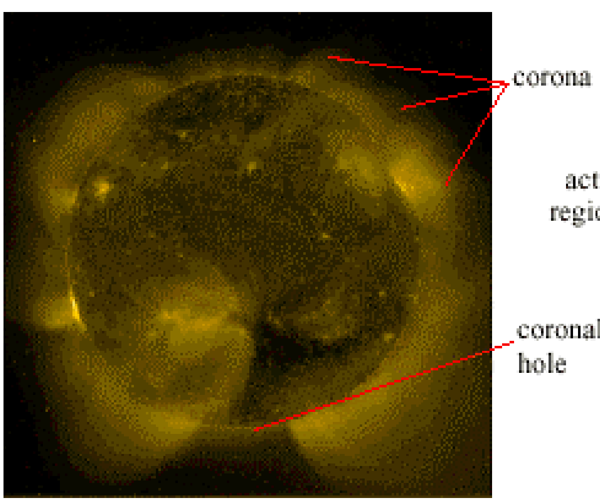
Sun viewed in visible light



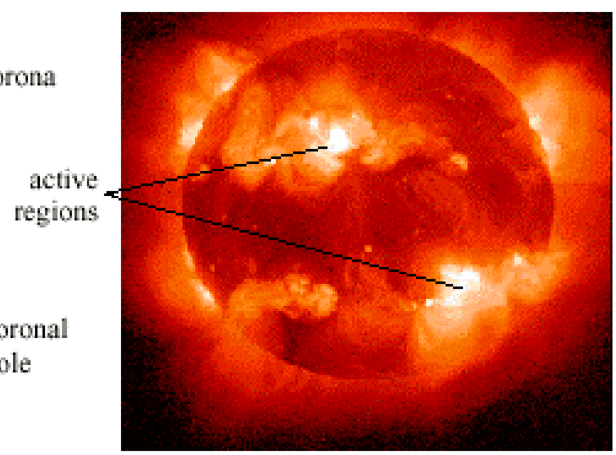
Wavelength 304Å (He II)



Wavelength 171Å (Fe IX/X)



Wavelength 284Å (Fe XV)

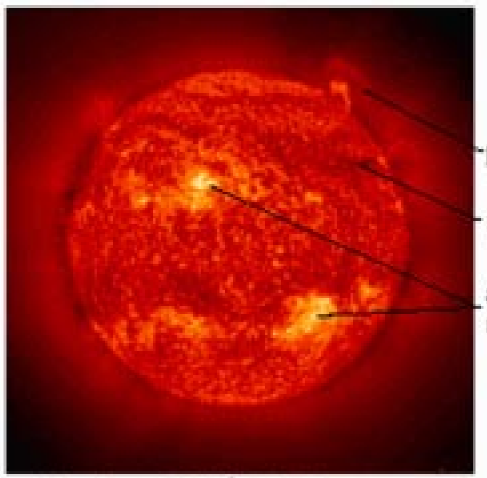


Soft X-Ray wavelengths

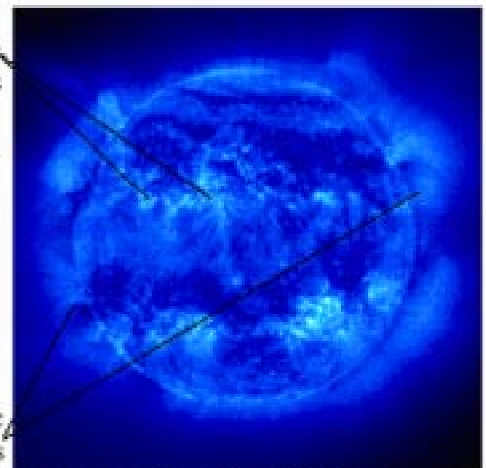
Observing the Sun in Different Wavelengths: What do You See?

The following images of the Sun were taken with the SOHO spacecraft Extreme ultraviolet Imaging Telescope. Most of the images were taken on the same date. The difference is what the Sun looks like in different wavelengths of light. See what you can learn about the Sun by studying the images below:

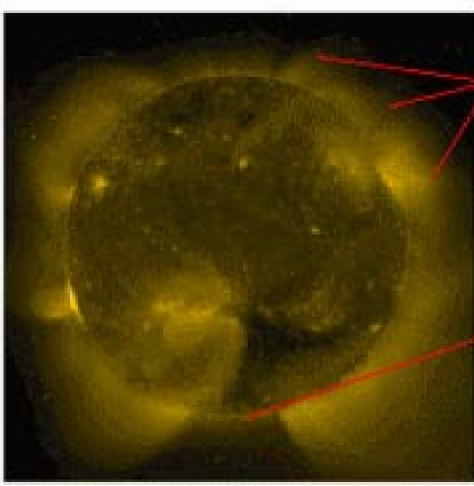
Sun viewed in visible light



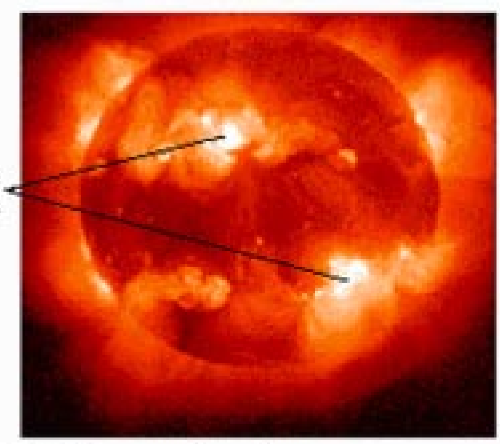
Wavelength 304Å (He II) -- observed features, such as prominences and active regions (indicating magnetic activity) have temperatures of ~80,000 K. Darker areas, such as filaments, are seen at temperatures ~60,000 K.



Wavelength 171Å (Fe IX/X) -- observed features in this wavelength include bright active regions and magnetic loops. Gases seen have temperatures of ~1 million degrees K.



Wavelength 284Å (Fe XV) -- the features of the solar corona (the Sun's outer atmosphere) can be seen. Gases that make up the corona have temperatures ~2 million degrees K.



Soft X-Ray wavelengths (Yohkoh spacecraft)-- observed features in this wavelength include bright active regions and coronal activity. Gases seen have temperatures of ~10 million degrees K.

Seeing the Invisible
Student Filter Exploration Activity

Materials: (per group of 4 students)

- Styrofoam plate
- Doctored bag of M&Ms (remove all colors except red, green, and brown)
- _ red, _ green filter to fit over plate

1. The Sun and other stars are made out of VERY HOT GASES. Pour M&Ms on plate.

Pretend:

- red M&Ms represent gases of the Sun with temperatures of 80,000 K.
- green M&Ms represent gases of the Sun with temperatures of 1.5 million K.
- brown M&Ms represent gases of the Sun with temperatures of 2 million K.

2. Astronomers use special filters to look at specific gas temperatures.

Place the red / green filter on top of the plate. Then, tilt the plate to slide the M&Ms to the Red (He II) filter to see features of the Sun with temperatures of 80,000 K.

Notice that the red M&Ms can be seen, while the brown and green M&Ms appear black.

3. Suppose you wanted to look at features on the Sun with higher gas temperatures.

Tilt the plate to slide all of the M&Ms to the Green (Fe XII) filter to see features of the Sun with temperatures of ~1.5 million Kelvin.

Notice that the green M&Ms can be seen, while the red and brown M&Ms appear black.

Now having some understanding of how filters work, we will observe images of the Sun taken with an Extreme Ultraviolet Imaging Telescope aboard the SOHO (Solar and Heliospheric Observatory) spacecraft which observes the Sun at different temperatures and in different wavelengths 24 hours a day.

Pre-Assessment Activities

NAME: ____________________ **DATE:** ____________________

"SEEING THE INVISIBLE"
Data Collection Sheet

Activity 1: Flower Observation

Suppose you could only detect the parts of the plant that are Green.

Draw a quick sketch of what your flower would look like, observing only the parts that are green.

Q. What parts of the plant would you know about?

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Q. What parts of the plant would you <u>not</u> know about?

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Conclusions:

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Activity 2: Observation of the Sun in Visible Light

Observational Notes:

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NAME: ____________________ **DATE:** ____________________

Seeing the Invisible Pre-Assessment

Directions: Please read each label below and highlight what each product claims to protect consumers from.

PreSun Block
SPF 28
The Skin Cancer Foundation recommends this product as a safe and effective UV Sunscreen.

PreSun Block SPF 28 cream contains titanium dioxide which physically blocks UVA and UVB rays. This product is appropriate for daily sun protection use for the whole family.

Neutrogena

Sensitive
Skin block
SPF 17

Neutrogena Sensitive Skin Sunblock SVF is a gentle, hypoallergenic formula for those who need full range UVB, UVA, and Infra-red Sun protection. It physically blocks out the Sun's damaging rays.

8 ALL Day UVA/ UVB Protection

Waterproof
Moistrizing
Sunscreen

SP 8 Lotion is clinically proven to provide protection from the Sun ALL Day long. Regular use helps reduce chances of long term sun damage like, premature agin, wrinkling, and skin cancer.

Banana Boat

Sun Screen Lotion
SP 15

Banana Boat lets you have fun in the Sun. That's because Banana boat gives you the protection you need from UVA and UVB rays.

Regular use of this product may help prevent premature aging of the skin and skin cancer, due to long-term over-exposure to the Sun.

Maximum UV protection for young eyes.
UV 400 Lenses block UVA and UVB

Q. What do all of these products promise to protect comsumers from?

____

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____

Q. Where does this danger come from?

____

____

____

Suggested Holistic Scoring Tool for
Student Activity 1:
"UV Detecting Bead Observations"

Part I: <u>Indoor UV Bead Observation</u> (Absence of Sun and other UV light sources)

<u>Teacher Note</u>: As long as sunlight or black light UV sources were not present, students should have identified the color of the UV Detecting beads as <u>white</u> for the indoor observation.

Holistic Score	Response Criteria
1	Student identifies correct color of beads
0	Color identified is incorrect
NSR	Non-Scorable Response (blank, off-topic, or illegible)

Q. Is Ultraviolet radiation present? Justify your answer using observational data.

Holistic Score	Response Criteria
2	Response indicates that UV was not present as the UV detecting beads did not change in color.
1	Response indicates that UV radiation was not detected however, the statement is not supported with data.
0	Incorrect information
NSR	Non-Scorable Response (blank, off-topic, or illegible)

Part II. <u>Outdoor UV Bead Observation</u> (Presence of Sunlight or Black UV light bulb)

<u>Teacher Note</u>: In the presence of Sunlight or a black light bulb, the UV detecting beads should have changed color. The exact change of color depends on the type of beads ordered and used in the experiment. In the presence of UV radiation the beads change from white (absence of UV radiation) to color.

Holistic Score	Response Criteria
1	Student response and observation color record note a change in color of the UV detecting beads.
0	Student response does not note a change in color of the UV detecting beads.
NSR	Non-Scorable Response **(blank, off-topic, or illegible)**

**Suggested Holistic Scoring Tool for
Student Activity 1:
"UV Detecting Bead Observations" (continued)**

Q. Is radiation present? Justify your answer using observational data.

Holistic Score	Response Criteria
2	Student response **indicates the presence of UV radiation** and **notes a change in color of the UV detecting beads**.
1	Student response **indicates presence of UV radiation** but **does not support the statement with data.**
0	Student response **does not acknowledge the presence of UV radiation**.
NSR	Non-Scorable Response (blank, off-topic, or illegible)

Q. Were there any differences between the indoor and outdoor UV detecting bead observations? Explain.

Holistic Score	Response Criteria
2	Student response **notes color change of UV Detecting beads** between indoor and outdoor observations.
1	Student response **indicates a difference between observations but does not specifically mention a change in UV bead color.**
0	Student **did not note changes** between indoor and outdoor detecting bead observations.
NSR	Non-Scorable Response (blank, off-topic, or illegible)

Suggested Holistic Scoring Tool for
Student Activity 1:
"UV Detecting Bead Observations" (continued)

Q. Does the Sun emit Ultraviolet Radiation? How do you know?

Holistic Score	Response Criteria
2	Student response indicates that the **Sun does emit ultraviolet radiation** and **statements are supported with evidence** such as noting the change in color of UV detecting beads in the presence of sunlight or using prior knowledge or experience i.e., Sunburn, etc.
1	Student response indicates that the **Sun does emit UV radiation but statements are not supported.**
0	Student response does not indicate an awareness that the Sun emits UV radiation.
NSR	**Non-Scorable Response** (blank, off-topic, or illegible)

Suggested Scoring Tool for
Student Activity 2:
"Herschel Experiment"

Q. What colors do you observe in the visible spectrum?

Teacher Note: If the students moved the prism box to produce a full spectrum, expected colors to be recorded should have been "Red", "Orange", "Green", "Blue", and "Violet". Although "Indigo" is a part of the visible spectrum – most humans are unable to observe it. (If a digital camera is available, have students take a picture of the spectrum produced by their group.)

Holistic Score	Response Criteria
2	Student correctly identified all the colors of the spectrum produced by their group. (R.O.Y.B. G. and V.)
1	Student correctly identified some colors of the spectrum produced by their group.
0	None of the colors listed are correct.
NSR	Non-Scorable Response The group was unable to produce a spectrum to observe. The response was blank, off-topic, or illegible.

Table Data:

Holistic Score	Table Criteria
2	**Student accurately recorded spectrum thermometer readings for their groups' produced spectrum as well as the class' air thermometer temperature reading.**
1	**Student recorded some of the temperatures correctly.**
0	**None of the data recorded is correct**
NSR	**Non-Scorable Response** (blank or illegible)

Suggested Scoring Tool for
Student Activity 2:
"Herschel Experiment" (continued)

Q. Why was there an increase in temperature for the thermometer placed just beyond the red end of the spectrum when visible light was not hitting it?

Holistic Score	Response Criteria
2	Student response indicates an awareness that unobserved light must be hitting the thermometer.
1	Student response attributes increase in temperature due to increased heat but does not attribute unobservable light as the source of energy.
0	Student response is incorrect
NSR	Non-Scorable Response (blank, off-topic, or illegible)

Q. Does the Sun emit infrared radiation? How do you know?

Holistic Score	Response Criteria
2	Student response acknowledges that the Sun does emit infrared radiation and justifies response citing the increased temperature reading of the thermometer placed in the infrared part of spectrum produced during class or cites another source from prior knowledge or experience.
1	Response acknowledges that the Sun does emit infrared radiation but the statement is not supported.
0	Response information is totally incorrect.
NSR	Non-Scorable Response (blank, off-topic, or illegible)

Suggested Scoring Tool for
Student Activity 3:
"Observing the Sun in Different Wavelengths"

Q. What have you learned about the Sun that you would not have known by viewing the Sun in only visible light?

Holistic Score	Response Criteria
2	Student response identifies or describes several features of the Sun, such as prominences, filaments, active regions, magnetic loops and coronal holes not typically observed in visible light.
1	Student identifies or describes at least one feature of the Sun typically not observed in visible light.
0	Student was unable to identify or describe any features of the Sun discussed in class.
NSR	Non-Scorable Response (blank, off-topic, or illegible)

Q. Using the five images of the Sun provided for study, which wavelength would be best to use if you wanted to observe the Sun's outermost atmosphere called the "Corona" and "Coronal Holes"?

Holistic Score	Response Criteria
1	Student identified Fe IX/X (wavelength 284Å) as the best wavelength to use out of the five wavelength images provided for observing the Corona and Corona Holes.
0	Student selected something other than Fe IX/X.
NSR	Non-Scorable Response (blank, off-topic, or illegible)

Teacher Note: Criteria for the Persuasive Newspaper Article and Extra Credit Assignments should be developed and shared with students prior to starting these assignments.

Background Information: State ________ Grade Level _______

How did you use this resource?
a. curriculum/supplement b. enrichment c. science club d. other_________

Reaction/Response of Students:

Teacher Comments /Modifications Made/Suggestions:

Would you recommend this resource to a colleague? Yes No

PLEASE RATE THE OVERALL QUALITY OF THIS PRODUCT

1	2	3	4
Do Not Reprint Resource	Satisfactory REPRINT	Good REPRINT	Excellent REPRINT

Please Send this Evaluation To: