

# SCOPE, SEQUENCE, and COORDINATION

A National Curriculum Project for High School Science Education

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# SCOPE, SEQUENCE, and COORDINATION

## **SS&C Research and Development Center**

Gerry Wheeler, *Principal Investigator*  
Erma M. Anderson, *Project Director*  
Nancy Erwin, *Project Editor*  
Rick McGolerick, *Project Coordinator*  
Arlington, Va., 703.312.9256

### **Evaluation Center**

Frances Lawrenz, *Center Director*  
Doug Huffman, *Associate Director*  
Wayne Welch, *Consultant*  
University of Minnesota, 612.625.2046

## **Houston SS&C Materials Development and Coordination Center**

Linda W. Crow, *Center Director*  
Godrej H. Sethna, *School Coordinator*  
University of Houston-Downtown, 713.221.8583

### **Houston School Sites and Lead Teachers**

Jefferson Davis H.S., Lois Range  
Lee H.S., Thomas Ivy  
Jack Yates H.S., Diane Schranck

## **California Coordination Center**

Tom Hinojosa, *Center Coordinator*  
Santa Clara, Calif., 408.244.3080

### **California School Sites and Lead Teachers**

Sherman Indian H.S., Mary Yarger  
Sacramento H.S., Brian Jacobs

## **Iowa Coordination Center**

Robert Yager, *Center Director*  
University of Iowa, 319.335.1189

### **Iowa School Sites and Lead Teachers**

Pleasant Valley H.S., William Roberts  
North Scott H.S., Mike Brown

## **North Carolina Coordination Center**

Charles Coble, *Center Co-Director*  
Jessie Jones, *School Coordinator*  
East Carolina University, 919.328.6172

### **North Carolina School Sites and Lead Teachers**

Tarboro H.S., Ernestine Smith  
Northside H.S., Glenda Burrus

## **Puerto Rico Coordination Center\***

Manuel Gomez, *Center Co-Director*  
Acenet Bernacet, *Center Co-Director*  
University of Puerto Rico, 809.765.5170

### **Puerto Rico School Site**

UPR Lab H.S.

\* \* \* \* \*

### **Pilot Sites**

*Site Coordinator and Lead Teacher*  
Fox Lane H.S., New York, Arthur Eisenkraft  
Georgetown Day School, Washington, D.C.,  
William George  
Flathead H.S., Montana, Gary Freebury  
Clinton H.S., New York, John Laffan\*

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## **Project Associates**

- Bill G. Aldridge**  
SciEdSol, Henderson, Nev.
- Dorothy L. Gabel**  
Indiana University
- Stephen G. Druger**  
Northwestern University
- George Miller**  
University of California-Irvine

## Student Materials

Learning Sequence Item:

# 949

## Sun, Spectra and Stars

*March 1996*

*Adapted by: Sherry Duceck, Bill Roberts, Gary Freebury, Dorothy Gabel, and Linda W. Crow*

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Science as Inquiry

## **Las Vegas Lights**

### **Why are marquee lights different colors?**

**Overview:**

Lights used for advertising are frequently many different colors. How can this be explained?

**Procedure:**

Your teacher will pass an electric current through discharge tubes that contain different elements. Record your observations.

1. Describe the differences in color that you observed in the demonstration.
2. Account for the differences in color observed.
3. What gas is commonly used in the red-light retail district of large cities?
4. Do you think that two different elements would produce the same color?

## Science as Inquiry

**Through the Eyes of the Beholder****What causes the colors in fireworks?****Overview:**

Observe the flames produced by different solutions and note the color of the flames produced.

**Procedure:**

Light and adjust the Bunsen burner to create a hot blue flame. Observe the flame as the wire (or wooden splint) is held in the hot part of the burner flame (or over the burner). Record the chemical name and symbol and the color of the flame. Return the wire to the tube from which you took it, and continue until you have tested all the solutions. (If using splints, do not allow them to burn. Extinguish all splints in a beaker of water.)

1. What is similar about each of the compounds used?
2. Each solution contains two or more elements in a combined form. Which element produces the color? Provide evidence for this.
3. If you were to place two splints into the flame at one time, write a prediction as to what colors might be seen in the flame.
4. Check your prediction.
5. Describe how fireplace logs that produce colored flames are produced.
6. What chemicals do you think are used for producing the colors in fireworks? Why?
7. How could you distinguish between solutions containing lithium, calcium, and strontium?

## Science as Inquiry

**Fingerprints of the Elements****How can scientists tell which elements exist in the sun and other stars?****Overview:**

One of the spectacular shows of nature is the rainbow of colors that occurs when sunlight shines on raindrops. In this experiment you will learn some of the properties of light and how we can use the light spectrum to help identify elements.

**Procedure:**

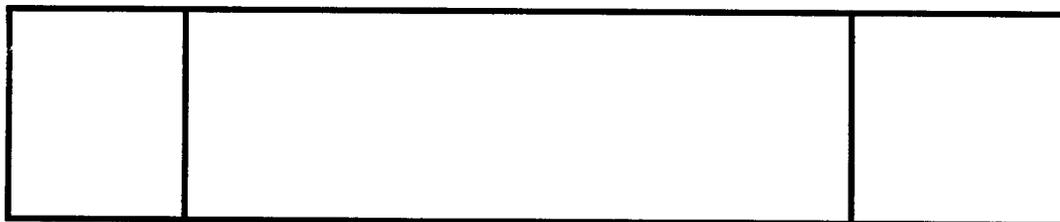
Observe the light produced by gases in discharge tubes as you did in Activity 1. This time, however, view it through a spectroscope. Record both the color and the location of the lines. Then repeat the flame tests that you did in Activity 2, but view the flames through a spectroscope. Record both the location and the color of the lines.

The spectral colors in stars indicate the composition of the star. By identifying what spectral lines are associated with each element, and by comparing the spectral lines found in stars with the spectrum of the elements, the specific elemental composition of a star can be determined.

Stars have two types of spectra: emission (part III) and absorption (dark line spectra). The dark line spectra are lines that form on the continuous spectrum.

The clear Mylar pieces have spectral colors or absorption lines from six different elements: hydrogen, helium, lithium, sodium, potassium, and calcium. Use these spectra to answer the following questions:

1. Which element has the most spectral lines? The least?
2. Excluding the potassium spectrum, do any of the spectral lines overlap?
3. The sun consists mainly of hydrogen and helium. Draw what you would expect the solar emission spectra to look like.
4. Combine elements to form a spectrum with exactly seven lines. Which elements did you use? Draw your spectrum.
5. A star contains the elements sodium and hydrogen. What color would you expect it to be?
6. Overlay the hydrogen absorption (dark line) spectrum on the hydrogen bright line spectrum. What do you observe?

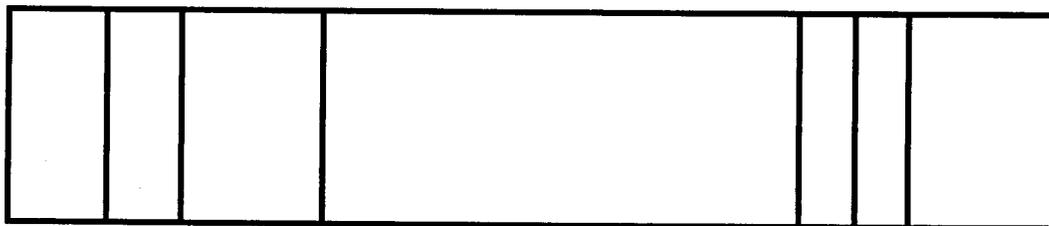


Use the dark line spectra over the full spectrum to answer these questions:

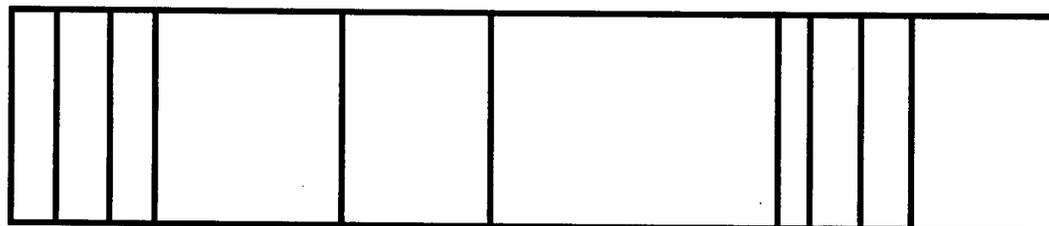
7. Form a dark line spectrum with exactly nine lines. Which elements did you use?

8. Identify the element(s) in the dark line spectra below.

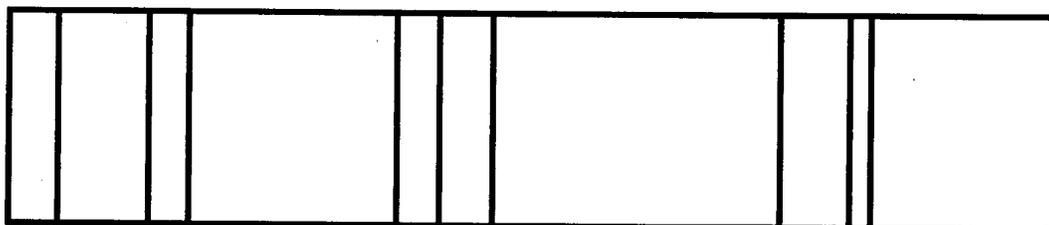
a.



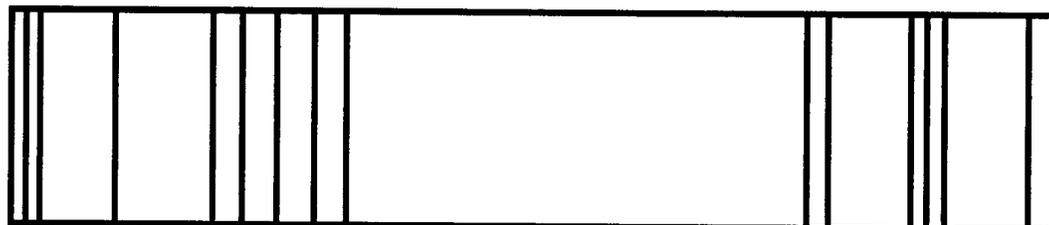
b.



c.



d.



## Science as Inquiry

**Seeing the Sun Without Looking at It****Procedure:**

**Student A.** Stand with your back to the sun so that you see your shadow directly in front of you.

**Student B.** Place a sheet of white paper or cardboard in the Student A's shadow.

**Student A.** Bring the prism up to one side—so that the prism is not in your shadow.

If the base of the prism is placed in the direct rays of the sun, a spectrum will be produced. Rotate the prism on its longitudinal axis to project the colored spectrum on the white paper, adjusting the prism so that the spectrum is fairly large and clear.

All students in the group: Sketch the spectrum and label the colors. Remember: Do not to look directly at the sun.

Make a diagram showing the path of light energy from the sun to the paper.

**Questions:**

1. Note the appearance of the spectrum. What do you see?
2. What happens when the distance between your prism and the paper varies? Describe what you observe.
3. What happens if your prism is rotated on its longitudinal axis?
4. What do you think the earth receives from the sun?

## Science as Inquiry

**Another Look at the Sun!****Procedure:**

You will be provided with a holographic defraction grating. Hold the grating by the edges only.

**Student A.** Stand with your back to the sun so that you see your shadow directly in front of you.

**Student B.** Place a sheet of white paper or cardboard in the Student A's shadow.

**Student A.** Bring the holographic defraction grating up to one side—so that the prism is not in your shadow, and it is one to two feet above the ground. Hold the grating so that the direct rays of the sun go straight through the device.

The shadow cast by the edges of the grating should make a nearly perfect rectangle on the paper. Keep adjusting the grating until you get the best spectrum. Sketch the spectrum. Remember: Do not to look directly at the sun.

Make a diagram showing the path of light energy from the sun to the paper.

**Questions:**

1. Note the appearance of the spectrum. Describe what you see.
2. What happens when the distance between your grating and the paper varies? Describe what you observe.
3. What happens when you rotate the grating  $90^\circ$ ,  $180^\circ$ , etc.?
4. What do you think the earth receives from the sun?
5. How did the results of this activity compare with Activity 1?

## Science as Inquiry

**Earth's Energy Supermarket****Procedure:**

Using the materials provided by your teacher, produce the sun's spectrum on black paper instead of white. To insure that the spectrum moves as little as possible, steady your device on a lab stool.

**Method 1.** If using the thermocouple, place the probe in the violet portion of the spectrum, observing how the temperature changes (the temperature remains the same for a minimum of one minute). Record the final temperature reading. Repeat the same steps for the middle spectrum, and for the point just beyond the red end of the spectrum.

**Method 2.** Place one thermometer in the violet portion of the spectrum, one in the middle of the spectrum, and one just beyond the red. Record the final temperature reading for each of the three thermometers (the temperature remains the same for a minimum of one minute).

**Questions:**

1. What are the three final readings? Why do the readings differ?
2. What exists beyond the visual red?
3. Why types of technology might change the spectrum from just beyond red to visible red?

## Science as Inquiry

**Changing Color****Procedure:**

Wrap one end of a 4-in. piece of wire around one battery terminal and tighten the nut. Touch the free end of the wire to the other terminal. As soon as you feel heat, remove the wire from the second terminal. Try various lengths of wire to determine what length has to do with heat production.

Using a shorter length of wire, attach one end of the wire to one of the terminals. Hold the free end, so that the wire goes directly across to the other battery terminal. Do not do this for too long. Observe the glowing wire with a spectrometer. Record any spectral changes occurring as the wire heats.

**Questions:**

1. What happened to the longer piece of wire when you touched it across both terminals? Why did this happen?
2. What part of the spectrum was produced with the longer wire?
3. What happened with the shorter wire? What part of the spectrum was produced?
4. Compare the spectrum produced by the wire with the spectrum you observed from the sun. Were all parts of the spectrum present in both?

## Science as Inquiry

**Sunlight, Sunbright****Procedure:**

Cut out a circle (approximately 5 cm diameter) from the center of one sheet of cardboard. Center and tape the prepared sheet of black paper (provided by your teacher) to this sheet cardboard. Next, tape the sheet of grid paper (also provided) to the other piece of cardboard, to make a sturdier “grid.” Turn on your lamp when the classroom lights are turned off. Place the cardboard with the single square opening approximately 10 cm from the bulb of the lamp. Make sure that the cardboard is held perpendicular to the bulb’s filament, and that the end of the filament is pointed towards the opening.

Place your grid behind the cardboard with the opening, lining up one of the squares on the grid with the square opening. Notice the light coming from the bulb illuminates 1 cm<sup>2</sup> on the grid paper from a distance of 10 cm. Create a data table and record that 1 square is illuminated from a distance of 10 cm. Predict what will happen if you move the grid away from the light source—then move the grid further away as follows: 20 cm, 30 cm, 40 cm and 50 cm. Record each move, and the corresponding number of grid squares illuminated by the light source.

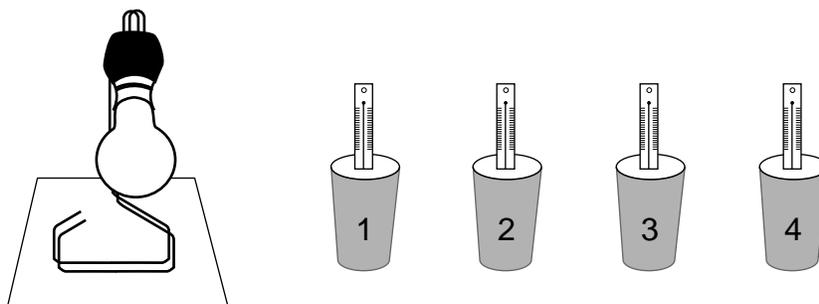
**Questions:**

1. Did your results agree with your prediction? If so, why? If not, why not?
2. What happened to the brightness as you moved the grid sheet further away?
3. If our sun were only  $\frac{1}{3}$  its present distance from the earth, what would its brightness be? Could life on earth exist as we know it today?
4. How many times brighter than our sun would a star that is seven times further from the earth have to be in order for us to receive the same amount of energy?
5. How bright would a star that is one-quarter closer to the earth than the sun have to be in order for us to receive the same amount of energy?

## Science as Inquiry

**How Hot is It?****Procedure:**

Do not handle the materials provided by your teacher any more than necessary—body heat will warm the cans and can affect the experiment. Insert the thermometers into the lids and place the lids on the cans. Place the first can 10–15 cm from the light source, the second can twice as far, the third can three times as far, and the fourth can four times as far. Read and record the temperature inside each can before the lamp is turned on. This is the beginning temperature (BT). Now, turn on your lamp and observe temperature changes—until the temperature stabilizes. Record this stabilized temperature (ST) for each can. Subtract the BT from the ST to get the observed temperature change (OTC) for each can. Plot the OTC for each can on a graph vs. the number of distance units between the light source and each can.

**Questions:**

1. Why did the temperature of each can eventually stabilize?
2. Your second can was twice as far from the light as the first. What relationship do you notice about the temperature changes between the two cans?
3. The third can was three times as far away as the first can. Do you see a similarity in the relationship of the temperature change in the three cans? Explain.
4. In what state would most of the earth's water exist if a) the earth were one-half its present distance from the sun? and b) twice its present distance?
5. Regarding the cans' temperature changes and distance: Can x changed temperature by  $12^{\circ}\text{C}$ , and is 5 cm away. Can y changed by  $3^{\circ}\text{C}$ . How far away is can y?