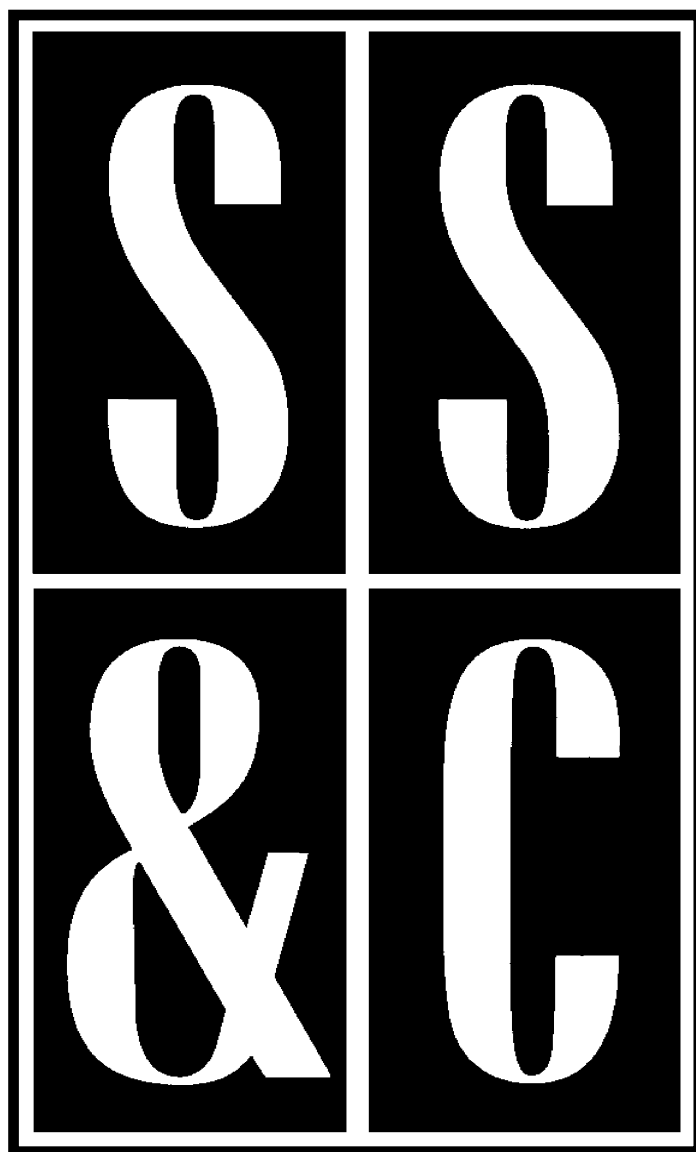


Scope, Sequence & Coordination

A National Curriculum Development and Evaluation Project for High School Science Education



A Project of the National Science Teachers Association



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Teacher 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

National Science Education Standard— Physical Science and Earth and Space

The Structure of Atoms

Matter is made of minute particles called atoms, and atoms are composed of even smaller components. These components have measurable properties, such as mass and electrical charge. Each atom has a positively charged nucleus surrounded by negatively charged electrons. The electric force between the nucleus and electrons holds the atoms together.

Interactions of Energy and Matter

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.

Each kind of atom or molecule can gain or lose energy only in particular discrete amounts and thus can absorb and emit light only at wavelengths corresponding to these amounts. These wavelengths can be used to identify the substance.

Energy in the Earth System

Earth systems have both internal and external sources of energy, both of which create heat. The sun is the major external source of energy.

The Origin and Evolution of the Universe

The origin of the universe remains one of the greatest questions in science. The "big bang" theory places the origin between 10 and 20 billion years ago, when the universe began in a hot dense state. According to this theory, the universe has been expanding ever since.

The Nuclear Atom and its Components: Electrons, Protons, and Neutrons. (a) Students should observe the visible spectra of light emitted from heated elements and compounds and interpret the differences in terms of the different electronic structures of atoms and molecules. They should distinguish between continuous, band, and line spectra. (*Chemistry, A Framework for High School Science Education, p. 74.*)

Photons, Electromagnetic Waves, and the Electromagnetic Spectrum. (b) At this level, students will have observed a visible spectrum of light passed through a prism and can develop the concept of a spectrum. (*Physics, A Framework for High School Science Education, p. 41.*)

Quanta: the Discreteness of Atomic and Molecular Energy. (c) Students can observe line spectra using spectrum tubes. They can also measure the wavelengths of prominent visible lines in the spectra. The important point for students is to note that the spectra are not continuous, as for a heated solid, and that no two elements appear to give the same sets of lines. They then can get at the idea of the line spectra being like the "fingerprints of the elements." (*Physics, A Framework for High School Science Education, p. 44.*)

Heat from within Earth and Heat from the Sun. (d) Students must be able to observe the sun and produce its spectrum with a grating or prism. They should understand the qualitative connection between the sun's spectral distribution and one produced by a thin wire that is heated by current from a battery, from the point that it just feels hot (deep, invisible infrared) until it is red in appearance (indicating a peak in the infrared). (*Earth and Space Sciences, A Framework for High School Science Education, p. 131.*)

The Evidence and Theories to Explain the Evolution of the Universe. (e) Using charts, students should identify actual objects in the sky, colors of stars, black holes, novae, and supernovae. (*Earth and Space Sciences, A Framework for High School Science Education, p. 156.*)

Contents

Matrix

Suggested Sequence of Events

Lab Activities

1. Las Vegas Lights
2. Through the Eyes of the Beholder
3. Fingerprints of the Elements
4. Seeing the Sun Without Looking at It
5. Another Look at the Sun!
6. Earth's Energy Supermarket

(Continued)

This micro-unit was adapted by **Sherry Duceck** (Fox Lane H.S., Bedford, N.Y.), **Bill Roberts** (Pleasant Valley H.S., Pleasant Valley, Iowa), **Gary Freebury** (Flathead H.S., Kalispell, MT), **Dorothy Gabel** (Indiana University, Bloomington), and **Linda W. Crow** (Baylor College of Medicine, Houston, Texas)

Contents (*continued*)

Lab Activities

7. Changing Color
8. Sunlight, Sunbright
9. How Hot Is It?

Assessment

1. Looking at Flames and Stars
2. Identifying Elements in Stars
3. Identifying Unknowns
4. Fires
5. Flames
6. Identifying Metals in Compounds

949

Learning Sequence

The Nuclear Atom and its Components: Electrons, Protons, and Neutrons. (a) Students should observe the visible spectra of light emitted from heated elements and compounds and interpret the differences in terms of the different electronic structures of atoms and molecules. They should distinguish between continuous, band, and line spectra. (*Chemistry, A Framework for High School Science Education, p. 74.*) **Photons, Electromagnetic Waves, and the Electromagnetic Spectrum.** (b) At this level, students will have observed a visible spectrum of light passed through a prism and can develop the concept of a spectrum. (*Physics, A Framework for High School Science Education, p. 41.*) **Quanta: the Discreteness of Atomic and Molecular Energy.** (c) Students can observe line spectra using spectrum tubes. They can also measure the wavelengths of prominent visible lines in the spectra. The important point for students is to note that the spectra are not continuous, as for a heated solid, and that no two elements appear to give the same sets of lines. They then can get at the idea of the line spectra being like the “fingerprints of the elements.” (*Physics, A Framework for High School Science Education, p. 44.*) **Heat from within Earth and Heat from the Sun.** (d) Students must be able to observe the sun and produce its spectrum with a grating or prism. They should understand the qualitative connection between the sun’s spectral distribution and one produced by a thin wire that is heated by current from a battery, from the point that it just feels hot (deep, invisible infrared) until it is red in appearance (indicating a peak in the infrared). (*Earth and Space Sciences, A Framework for High School Science Education, p. 131.*) **The Evidence and Theories to Explain the Evolution of the Universe.** (e) Uta charts, students should identify actual objects in the sky, colors of stars, black holes, novas, and supernovas. (*Earth and Space Sciences, A Framework for High School Science Education, p. 156.*)

Science as Inquiry	Science and Technology	Science in Personal and Social Perspectives	History and Nature of Science
<p>Las Vegas Lights Activity 1</p> <p>Through the Eyes of the Beholder Activity 2</p> <p>Fingerprints of the Elements Activity 3</p> <p>Seeing the Sun Without Looking at It Activity 4</p> <p>Another Look at the Sun! Activity 5</p> <p>Earth's Energy Supermarket Activity 6</p> <p>Changing Color Activity 7</p> <p>Sunlight, Sunbright Activity 8</p> <p>How Hot is It? Activity 9</p> <p>Identifying Unknowns Assessment 3</p> <p>Identifying Metals in Compounds Assessment 6</p> <p>Solar Spectrum Challenges Model of Earth Reading 2</p>	<p>Chasing the Origins of the Universe Reading 1</p> <p>Solar Gold Reading 3</p> <p>Looking at Flames and Stars Assessment 1</p> <p>Identifying Elements in Stars Assessment 2</p> <p>Fires Assessment 4</p> <p>Flames Assessment 5</p>	<p>Classifying the Stars Reading 4</p>	

Suggested Sequence of Events

Event #1

Lab Activity

1. Las Vegas Lights (15-minute demo)

Event #2

Lab Activity

2. Through the Eyes of the Beholder

Event #3

Lab Activity

3. Fingerprints of the Elements

Event #4

Lab Activity

4. Seeing the Sun Without Looking at It

Alternate or Additional Activity

5. Another Look at the Sun!

Event #5

Lab Activity

6. Earth's Energy Supermarket

Event #6

Lab Activity

7. Changing Color

Event #7

Lab Activity

8. Sunlight, Sunbright

Event #8

Lab Activity

9. How Hot is It?

Event #9

Readings from Science as Inquiry, Science and Technology, Science in Personal and Social Perspectives, and History and Nature of Science. Students should select two or three from the list.

- Reading 1 Chasing the Origins of the Universe
Reading 2 Solar Spectrum Challenges Model of the Earth
Reading 3 Solar Gold
Reading 4 Classifying the Stars

Readings can be found in the student version of this publication.

Assessment items are at the back of this volume.

Assessment Recommendations

This teacher materials packet contains a few items suggested for classroom assessment. Often, three types of items are included. Some have been tested and reviewed, but not all.

1. Multiple choice questions accompanied by short essays, called justification, that allow teachers to find out if students really understand their selections on the multiple choice.
2. Open-ended questions asking for essay responses.
3. Suggestions for performance tasks, usually including laboratory work, questions to be answered, data to be graphed and processed, and inferences to be made. Some tasks include proposals for student design of such tasks. These may sometimes closely resemble a good laboratory task, since the best types of laboratories are assessing student skills and performance at all times. Special assessment tasks will not be needed if measures such as questions, tabulations, graphs, calculations, etc., are incorporated into regular lab activities.

Teachers are encouraged to make changes in these items to suit their own classroom situations and to develop further items of their own, hopefully finding inspiration in the models we have provided. We hope you may consider adding your best items to our pool. We also will be very pleased to hear of proposed revisions to our items when you think they are needed.

Science as Inquiry

Las Vegas Lights**Why are marquee lights different colors?****Overview:**

In this demonstration, students will observe and record the color emitted by various elements when excited in gas discharge tubes.

Materials:**Per class demonstration:**

gas discharge tubes: hydrogen, mercury, neon, helium

energy source: telsa coil or special apparatus for discharge tubes

Procedure:

Insert tubes in a discharge tube apparatus or mount the discharge tubes on a ring stand and use a telsa coil to pass electricity through the discharge tube. Begin with neon, which is commonly used in Las Vegas lights. Students observe the difference in colors, but not the spectral lines at this time.

Background:

Why are different colors of light emitted by different elements when provided with energy? Electrons in the most stable condition are found in the lowest energy levels called ground state. When supplied with heat, light, or electricity, electrons absorb energy and are forced out of their stable state into a higher energy level. This is referred to as the excited state.

The electron in this condition is extremely unstable and falls back to lower energy levels. The electron releases photons or light with an energy equivalent to the distance of the drop between orbitals. Considering the colors of the rainbow, blue would be a product of a large drop in energy level while red would be observed when a smaller drop occurred.

Individual elements will release characteristic color distinguishable only by that element. Although this lab can lead into using spectrosopes to separate the wavelengths of light into bands or fingerprints, it will only concentrate on the visible light emitted to the eye of the observer as a blend of colors.

In the ninth grade SS&C curriculum, students are only introduced to the general structure of the atom. They will not have studied atomic mass, atomic number, or energy levels. These will be introduced in grade 10. Hence this introduction should be very general and address the existence of energy levels, but not the Bohr atom, a solar system model, the number of electrons in orbits, or electron configurations.

Safety: Warn students against touching the energy source and the tubes.

Science as Inquiry

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

Students observe the colors of flames produced by solutions of various metallic salts.

Materials:**Per lab group:**

Bunsen burner

matches

Labeled test tubes (about 10–15 mL) containing concentrated solutions of:

lithium chloride (LiCl), 45g/100 mL water;

sodium chloride (NaCl), 35g/100 mL water;

potassium chloride (KCl), 34g/100 mL water;

calcium chloride (CaCl₂), 59g/100 mL water;

strontium chloride (SrCl₂), 43g/100 mL water;

copper chloride (CuCl₂), 70g/100 mL water; and

copper sulfate (CuSO₄·5H₂O).

Labeled cork stoppers, into each of which has been inserted a piece of nichrome wire, that can be used for testing the solutions. These serve both as a closure for each test tube as well as a device for making the flame test.

180–240 wooden splints (for alternative procedure)

1 beaker of water (for alternative procedure)

Procedure:

Prepare in advance of the class concentrated solutions of each salt listed above. Place the solutions in separate labeled bottles that can be used to fill the test tubes. Prepare the stoppers by inserting a nichrome wire that goes to the bottom of the test tube when the cork has been inserted into the tube. A small loop on the end of the wire helps it retain more solution. These sets of test tubes can be kept from year to year and simply refilled from the stock solution. Their use is preferable to putting solids directly in the flame because the solid frequently drops into the flame and contaminates the barrel of the burner, thus producing an unwanted color.

Students test and record the flame color of various cations by placing the nichrome wire that has been stored in the solution into the hot part of the burner flame.

Alternative Procedure:

Prepare before class saturated solutions of each salt listed above. Place the solutions in separate labeled beakers. To each beaker add 30–40 wooden splints. Allow to stand for several hours.

Students test and record the flame color of various cations by placing wooden splints over the flame source. The splints are extinguished in a beaker of water.

Care must be taken to ensure that students observe the flame before the wood starts to burn.

Background:

Why are different colors of light emitted by different elements when provided with energy? Electrons in the most stable condition are found in the lowest energy levels called ground state. When supplied with heat, light, or electricity, electrons absorb energy and are forced out of their stable state into a higher energy level. This is referred to as the excited state.

The electron in this condition is extremely unstable and falls back to lower energy levels. The electron releases photons or light with an energy equivalent to the distance of the drop between orbitals. Considering the colors of the rainbow, blue would be a product of a large drop in energy level while red would be observed when a smaller drop occurred.

Individual elements will release characteristic color distinguishable only by that element. Although this lab can lead into using spectrosopes to separate the wavelengths of light into bands or fingerprints, it concentrates on the visible light emitted to the eye of the observer as a blend of colors.

Science as Inquiry

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

Students observe with a spectroscope the light emitted from gas discharge tubes and flame tests.

Materials:

(Identical with Activities 1 and 2, plus Mylar strips and spectroscopes)

Per lab group:

Bunsen burner

matches

Labeled test tubes (about 10-15 mL) containing concentrated solutions of:

lithium chloride (LiCl), 45g/100 mL water;
sodium chloride (NaCl), 35g/100 mL water;
potassium chloride (KCl), 34g/100 mL water;
calcium chloride (CaCl₂), 59g/100 mL water;
strontium chloride (SrCl₂), 43g/100 mL water;
copper chloride (CuCl₂), 70g/100 mL water; and
copper sulfate (CuSO₄·5H₂O).

Labeled cork stoppers, into each of which has been inserted a piece of nichrome wire, that can be used for testing the solutions. These serve both as a closure for each test tube as well as a device for making the flame test.

Mylar strips of elements (transfer the spectral lines from the attached sheet of elements to Mylar strips)

Per class:

gas discharge tubes: hydrogen, mercury, neon, and helium

energy source: telsa coil or special apparatus for discharge tubes

Per student:

spectroscope

Procedure:

In this activity, students view through a spectroscope the light emitted by gas discharge tubes and flame tests like they observed in Activities 1 and 2. They observe the light emitted from the gas discharge tubes first, and then observe the flames from the metallic salts.

Insert tubes in a discharge tube apparatus or mount the discharge tubes on a ring stand and use a telsa coil to pass electricity through the discharge tube. Begin with neon, which is commonly used in Las Vegas lights. Each student views the light emitted from each tube by viewing it through a spectroscope. It is best to darken the room while using the spectroscopes. Have students record both the color and

placement of the lines. Before beginning they should observe white light and note the continuous spectrum.

Have students repeat the flame tests from Activity 2 but observe the flames through a spectroscope. (See Activity 2 for directions on how to set up the activity.) They make observations of colors and positions of the lines.

Background:

This activity introduces students to three types of spectra: continuous, emission and absorption. Sunlight is a source of white light. When white light is passed through a prism a rainbow of colors is produced. This spectrum does not have lines and the colors blend into each other. This type of spectrum is called a continuous spectrum.

If white light passes through a blue source, such as a solution or plastic, all the colors are absorbed with the exception of blue, which is allowed to pass through the medium. If we have colored floodlights of the three basic colors—blue, red, and green—and we shine all three on a white surface in such a manner as to allow them to intersect, we will get white.

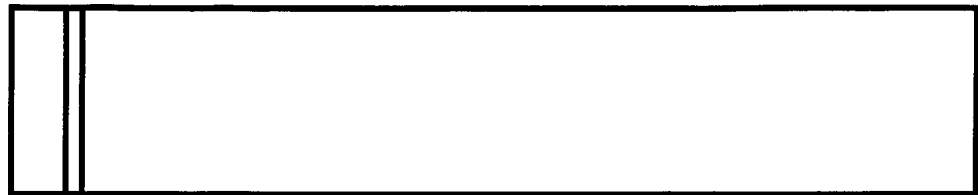
Students view white light through a spectroscope, which contains a diffraction grating that acts as a prism to break up the light into a continuous spectrum. A diffraction grating is a series of closely spaced parallel slits that separate colors of light by interference. It consists of a sheet of transparent plastic that has thousands of tiny grooves ruled on it. When white light is observed through the diffraction grating, a continuous spectrum is produced. When an element is excited, however, a series of lines of different colored light are produced; this is called a line spectrum.

When an element is excited by a flame or electric charge it will emit a certain color of light. When this light is examined using a spectroscope, it will appear as lines of certain wavelength and color in the visible portion of the spectrum.

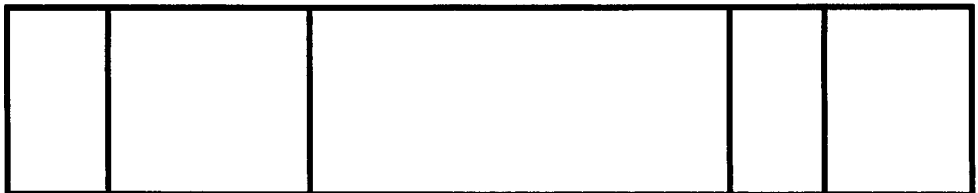
In the next part of the lab activity, students make observations using the diffraction grating with different elements. They observe the lines produced by different gases when an electric current passes through the discharge tubes containing them. They also observe the lines produced by the flames of metallic salts. As described in Activities 1 and 2, the electrons of a given element will absorb definite quantities of energy. As this energy is absorbed, electrons are excited to higher energy levels. When the electrons drop back to the ground state, they emit this same quantity of energy, thus producing definite lines (wavelengths) and colors.

The last part of the activity deals with the spectrum of the stars. If a gas, when excited, can give off light as it falls back to a lower level, then we should understand that gases will also absorb energy of the same wavelength.

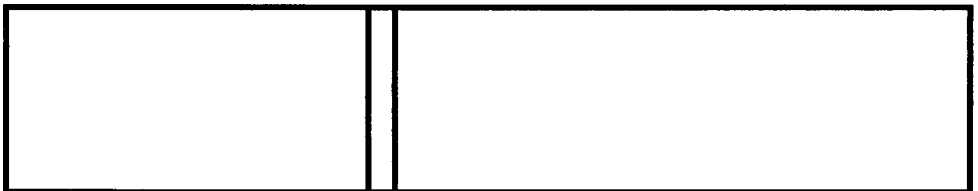
potassium



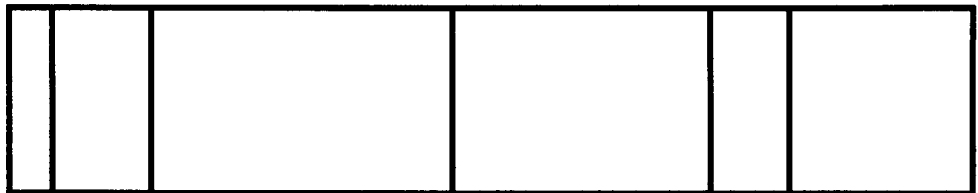
lithium



sodium



helium



calcium



hydrogen



full spectrum



Science as Inquiry

Seeing the Sun Without Looking at It**What are the characteristics of light coming from the sun?****Materials:****Per lab group:**

prism, triangular or other piece of white paper or cardboard
ruler

Procedure:

Have one member from each lab group stand with their back to the sun so that they can see their shadow directly in front of themselves. A second student should place a sheet of white paper or cardboard in the first student's shadow. The first student brings the prism up to one side—so that the prism is not in his or her 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. Have each student in the group sketch the spectrum and label the colors. Note: Remind students not to look directly at the sun.

Background:

White light is made up of many different wavelengths of light—from red to violet. When white light is directed through a glass prism, the different wavelengths of light from the light source are bent (defracted) and separated into the different colors of the spectrum. Defraction occurs because the glass prism has a different optical density than air. When light passes through a transparent substance, the light is bent and separated into its various wavelengths.

alternative activity for Event 4
Teacher Sheet

Science as Inquiry

Another Look at the Sun!

What are the characteristics of light coming from the sun?

Materials:

Per lab group:

holographic defraction grating

Procedure:

Instruct students to hold the gratings by the edges only. Have one member from each lab group stand with their back to the sun so that they can see their shadow directly in front of themselves. A second student should place a sheet of white paper or cardboard in the first student's shadow. The first student brings the the holographic defraction grating up to one side—so that the grating is not in his or her shadow, and is one to two feet above the ground. The grating must be held 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 rectangular shadow on the paper. Students should adjust the grating to get the best spectrum. Have students sketch the spectrum. Note: Remind students not to look directly at the sun.

Background:

The holographic defraction grating is designed in such a manner that you do not have to use it in an enclosed box with a slit for this experiment. Regular gratings made with etched lines do not work with this experiment.

Variations:

Have students conduct research to explore holographic defraction gratings. Their use is preferable to putting solids directly in the flame because the

Science as Inquiry

Earth's Energy Supermarket

Which end of the visual spectrum contains the greatest source of thermal energy?

Materials:**Per lab group:**

prism (or holographic defraction grating)
sheet of black construction paper
lab stool

Method 1. thermocouple digital thermometer with battery

Method 2. 3 alcohol thermometers

Procedure:

Students produce the sun's spectrum using the prism or holographic grating, except that the spectrum falls on the black paper. To insure that the spectrum moves as little as possible, use a lab stool or some other steadying device.

Method 1. Using the thermocouple, students 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). Have them record the final temperature reading. Students repeat the same steps for the middle spectrum, and for the point just beyond the red end of the spectrum.

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

Background:

As infrared is heat, students' results should show that the violet portion of the spectrum caused the least temperature while the infrared caused the greatest increase. They should understand that the total external energy received from the sun comes from different areas of the spectrum with the greatest amount concentrated just beyond the visual red.

Science as Inquiry

Changing Color**What causes spectral change?****Materials:****Per lab group:**

spectrometer

nichrome wire (one 4-in. piece per group, and shorter lengths)

9 v battery (lantern battery)

Procedure:

Students wrap one end of the 4-in. piece of wire around one battery terminal and tighten the nut. They touch the free end of the wire to the other terminal. As soon as students feel heat, they remove the wire from the second terminal. Students try various lengths of wire to determine what length has to do with heat production.

Students attach one end of a shorter piece of wire to one of the terminals. They hold the free end so that the wire goes directly across to the other battery terminal. Students observe the glowing wire with a spectrometer. They record any spectral changes occurring as the wire heats.

Background:

Students will observe through their sense of touch that a wire carrying a small amount of current will feel warm, and that as the current increases, the temperature increases. As more current is added, the wire will become visible and the spectrum will change. This change occurs because the wire resists the current which results in heat (infrared) production. With continued increase in the current, the emission of visible light occurs. Visible light begins at the infrared portion of the spectrum with red and ends with violet.

Science as Inquiry

Sunlight, Sunbright**How does brightness vary with distance?****Materials:****Per lab group:**

- lamp with 200-watt nonfrosted bulb
- meterstick
- sheet of black paper with a 1 cm² cut from the center of the sheet
- sheet of square grid paper
- two 20 x 25 cm sheets cardboard
- razor blade
- masking tape

Procedure:

Students cut out a circle (approximately 5 cm diameter) from the center of one sheet of cardboard. They center and tape the prepared sheet of black paper to this sheet cardboard. Students tape the sheet of grid paper to the other piece of cardboard (making a sturdier “grid”). Turn on the lamp and turn off the classroom lights. Students place the cardboard with the single square opening approximately 10 cm from the bulb. Make sure that the cardboard is being held perpendicular to the bulb’s filament and that the end of the filament is pointed towards the opening.

Next, students place their grids behind the cardboard with the opening, lining up one of the squares on the grid with the square opening. They should notice the light coming from the bulb illuminates 1 cm² on the grid paper from a distance of 10 cm. Have them create a data table and record that 1 square is illuminated from a distance of 10 cm. Next, ask them to predict what will happen if they move the grid away from the light source—then have them move the grid further away as follows: 20 cm, 30 cm, 40 cm and 50 cm. Students record each move, and the corresponding number of grid squares illuminated by the light source.

Background:**Variations:**

Students should graph their results and discuss why the slope of their graph changes. Based upon their results, have students determine how many suns it would take to produce as much light as our sun transmits to the earth—if the new sun were 0.5, 2, 3, 8, or 10 times the distance that our earth is from the sun.

Adapted from:
Baylor College of Medicine, 1992.

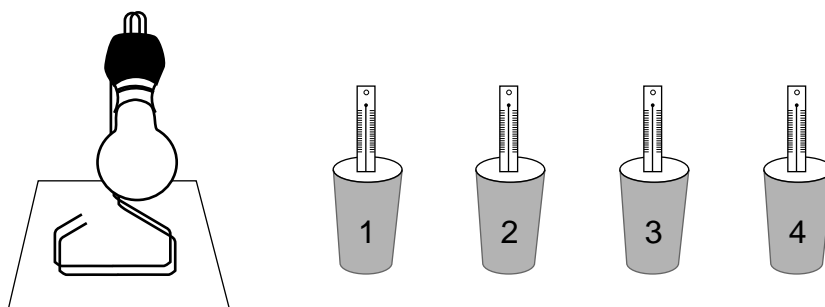
Science as Inquiry

How Hot is It?**How does the inverse square law apply to heat and distance?****Materials:****Per lab group:**

- lamp with 200–250 watt nonfrosted bulb
- 4 black cans (painted black or covered with construction paper)
- 4 styrofoam or plastic lids for cans (cut slit through lids for thermometers if necessary)
- 4 thermometers
- graph paper

Procedure:

Instruct the students to not handle the cans any more than necessary—body heat will warm the cans. Students insert the thermometers into the lids and place the lids on the cans. They then 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. Students then read and record the temperature inside each can before the lamp is turned on. This is the beginning temperature (BT). Students turn their lamps on and observe temperature changes—until the temperature stabilizes. They then record this stabilized temperature (ST) for each can. Students subtract the BT from the ST to get the observed temperature change (OTC) for each can. They then plot the OTC for each can on a graph vs. the number of distance units between the light source and each can.

**Background:**

The inverse square law would allow us to predict that the temperature change of each can would vary inversely with the square of the distance from the light source. For example, knowing the temperature

change in the nearest can, we can theorize that the change in the can that is twice as far away should be one-fourth as much as in the first—rather than one-half as much. In a can three times as far away, the temperature change should be one-ninth as much, and so on. Graphing the data should verify this. With this idea, we can predict the temperature change in the outer cans if we know the change in the first. The following formula can be used:

$$\text{Predicted Temperature} = \frac{\text{Observed Temperature Change}}{(\text{number of distance units to can } d)^2}$$

or

$$\text{PTC} = \frac{\text{OTC}}{d^2}$$

In earth science this concept can be related to the earth's temperature being a function of its distance from the sun. The earth's water cycle requires a temperature range that allows water to exist in all three states. The earth's distance from the sun gives it the right amount of energy for a climate favorable to our life form.

Science and Technology

Looking at Flames and Stars**Item:**

Scientists use special instruments to sort the light coming from flames and stars into its various colors. These colors can provide clues to the composition of the star or the gases in the flame.

Which of the following would not be essential to an instrument of this type?

- A. an entry slit
- B. a prism or diffraction grating
- C. a viewing telescope
- D. a photographic film or sensitive light meter

Justification:

Explain the function of the three essential components.

Answer:

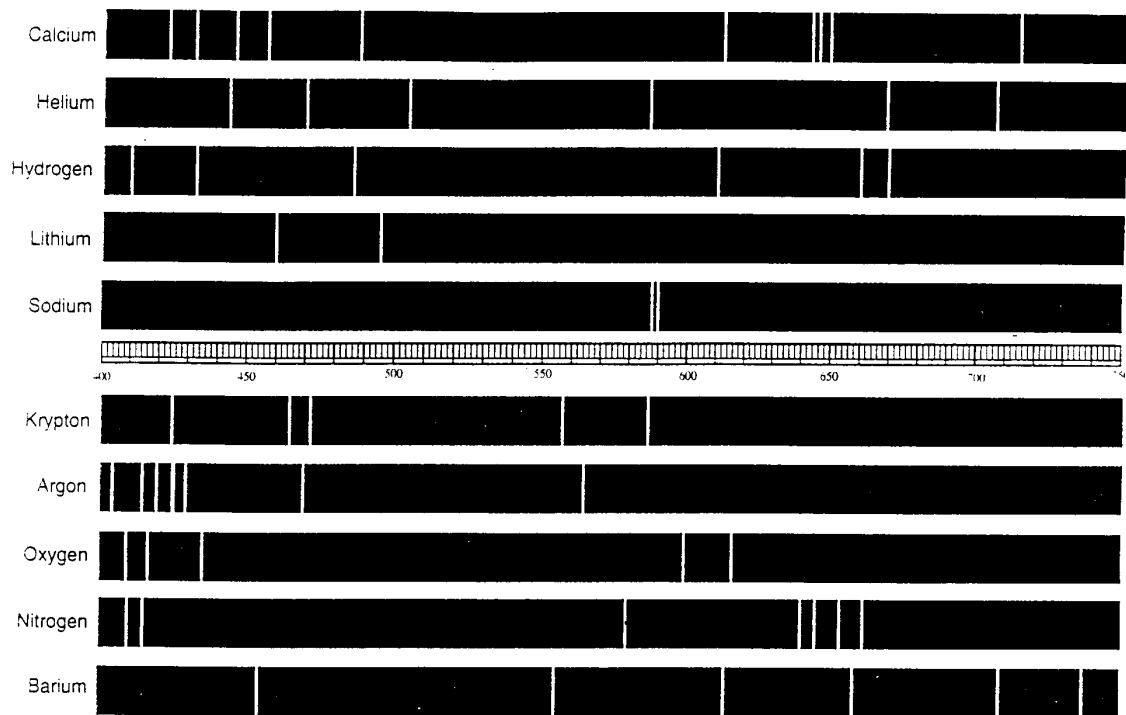
C. There is no requirement for a human eye to view color. Instrument detection is more sensitive. The entry slit is necessary for focus and to keep out surrounding light from other sources. The prism or grating provides the dispersion according to wavelength, and the film or light meter will record the intensity as a function of wavelength.

Science and Technology

Identifying Elements in Stars**Item:**

Spectroscopes are important tools for astronomy. They enable astronomers to analyze starlight. Knowing the “spectral fingerprint” of each element enables astronomers to identify the elements present in distant stars. The following are some spectral fingerprints of common elements found in stars

Spectra of Various Elements



This is a star spectrum. What elements make up this star? How did you determine the star’s composition?



Spectra of Unknown Composition

Answer:

calcium, helium, hydrogen, sodium, krypton, oxygen, nitrogen

Science as Inquiry

Identifying Unknowns

Item:

Design an experiment to distinguish between three bottles of solutions containing lithium chloride, sodium chloride, and potassium chloride. The unlabeled bottles are found to have identical densities.

Answer:

A flame test can be used to identify each of the solutions.

Science and Technology

Fires**Item:**

As a fire fighter entering a burning warehouse, you notice that in one section of the building flames are burning a bright pink color. Describe how you would use this information to change your firefighting method.

Answer:

The bright pink color is associated with a highly reactive group-one element. Water should not be used in this case. It would be better to extinguish the fire with a carbon dioxide extinguisher.

Science and Technology

Flames

Item:

When compounds are heated for a flame test, a distinct color is produced by each. Explain why the color of the flame can be referred to as the "fingerprint" of the element.

Answer:

Each element produces its own color when heated. This can be used to identify an element much like a fingerprint identifies a person.

Science as Inquiry

Identifying Metals in Compounds

Item:

Given two white crystalline soluble solids and a burner, water, beaker, wood splints, and matches, you are asked to find a property that can be used to identify the metal present in each compound. Which test would you perform? What information (data) would you gather from the procedure?

Answer: