NEWSHOUR A NewsHour with Jim Lehrer special for students
EXTRA

LESSON PLAN: STELLAR FINGERPRINTS: THE SPECTRA OF STARS

Answers to Activity Sheet 2: Identifying Emission Spectra

1. Use the space provided to sketch the emission spectra of the elements. Then write the name of the element on the line provided next to "emission spectrum."

violet

red

hydrogen emission spectrum

Students may have trouble picking out the violet lines in the hydrogen spectrum.

For examples of other spectra, see:
http://home.achilles.net/~jtalbot/data/elements/

2. Explain how the bands of light are produced in the emission spectra.

   The bands of color are produced when the electron drops from a higher energy level to a lower energy level. For hydrogen, the electron is dropping to the second energy level.

3. Explain how you were able to identify the unknown element contained in the discharge tube.

   The identification of the element was based on a comparison of the pattern of bright lines with a reference spectrum.

4. Why would astronomers need to know how to identify elements?

   Astronomers can determine the composition of an object if they know how to identify the elements.

Answers to Activity Sheet 3: Comparing Emission and Absorption Spectra

1. After studying the emission and absorption spectra for hydrogen, predict the absorption spectrum for element X given the following emission spectrum. Use the space provided below the emission spectrum to draw your predicted absorption spectrum. http://home.achilles.net/~jtalbot/data/elements/ (element is Lithium)

Emission spectrum for element X

Predicted absorption spectrum for element X

2. Identify the wavelengths that correspond to each bright (or dark) band for the emission (or absorption) of hydrogen in the visible range of 400 –700 nanometers. Describe the relationship between the wavelength and the color.

   The wavelengths for the absorption or emission of hydrogen are approximately: 410 nanometers, 430 nanometers, 485 nanometers and 655 nanometers. Answers that vary by up to 10 nanometers would also be acceptable since students are reading a graph.

3. Explain why the positions of the dark bands on the absorption spectrum for

   The same amount of energy absorbed by an electron that jumps to a higher energy level is also released when it falls back down. When an electron jumps to a higher energy level, a certain quantity of energy must be absorbed. The electron must absorb that exact amount of energy. This process can be related to ascending and descending a staircase. You must move from one step to another. You cannot take half a step or one and a half steps. It must be one step at a time. For light, a particular amount of energy corresponds to a particular wavelength of light. Wavelengths of visible light correspond to certain colors. Violet light has more energy than red light

4. How would knowing the wavelengths at which hydrogen emits and absorbs light energy help astronomers?

By knowing the wavelengths, astronomers can identify whether hydrogen is present based on the emission or absorption lines in the spectrum of stars.

Answers to Activity Sheet 4: Interpreting Stellar Spectra

1. The stellar spectrum above shows dips in the line. The dips are points where atmospheric gases absorb the light coming from the star These points correspond to particular wavelengths. List the wavelengths that show absorption in the visible range of 400 –700 nanometers.

   The absorptions occur at 410 nanometers, 430 nanometers, 485 nanometers and 655 nanometers, and 690 nanometers. Answers that vary by up to 10 nanometers would also be acceptable since students are reading a graph.

2. Explain the significance of the wavelengths recorded above.

   All four absorption lines for hydrogen are present in the 400 –700 nanometers portion of the spectrum. One, therefore, can conclude that hydrogen is present in the atmosphere of the star. The wide absorption line at 690 indicates that another element (or molecule) that absorbs energy at those wavelengths is present.

3. Is hydrogen the only element present in the atmosphere of this star? Explain. What additional information would you need to identify any other element(s) that might be present? Where might you find this information?

   Based on the absorption spectrum, there is more than one element in the atmosphere of this star. Between 400 and 700 nanometers, there are only four lines for hydrogen absorption. The spectrum shows at least nine absorption lines (four of which correspond to hydrogen's pattern). To identify the element(s) present, students must know the characteristic absorption patterns for other elements. They could find this information in a chemistry reference book – perhaps even a textbook.

4. Explain why astronomers can use spectroscopy to identify the composition of objects that emit light.

   Each element has a unique set of absorption/emission lines. The presence of this set of lines indicates the element is present.