Earth Systems
Standard 1, Objective 1

Title: Starlight

Description: Students will analyze light given off by glowing elements using a spectroscope. They will relate the spectrum given off by a stationary source to one that is "red-shifted".

Time Required: 60-70 minutes

Student Background: Students should know that elements are pure substances with distinct properties. One of the properties is the banding pattern seen through a spectroscope when the substance is burned or heated. The radiation is given off in various wavelengths which can be viewed with a spectroscope or diffraction grating. If the object giving off the radiation was moving away from the viewer the lines will shift toward the red end of the spectrum.

Note to Teacher: There are several ways to generate light for this experiment. The most difficult for the students is to burn small amounts of the various metal salts in a flame on a wire loop. The best way for students to see spectra is to buy the vapor tubes of each element or mixture of elements and the power source (a tesla coil also works) that runs electricity through them. This is more expensive but they last a long time. You can also find commercially made light bulbs with mercury vapor, argon, and neon in them. If you have tubes with "air" in them, students could figure out what gases are in air. You would also need tubes of nitrogen, oxygen and carbon dioxide for them to look at.

Materials: Salts or vapor tubes of several elements Sodium, Potassium, Lithium Strontium, hydrogen, helium, argon, mercury etc. , Student response sheet **(NOTE:** Two slightly different sheets are available, choose the one that best suits your needs), diffraction grating slides (easier to use for students) spectroscope, colored pencils or crayons, a very fun form of spectroscope can be ordered from Lightrix at *http://www.lightrix.com/spectrix/visors.htm* these are a wraparound pair of glasses with diffraction gratings built in. They show a nice spectrum.

Procedures:
1. Hand out student sheet and go over purpose and procedures with students.
2. Make sure students can see the spectrum on room lights.
3. Turn out the lights and use the light source you have chosen to create light spectra.
4. Have students color the spectra on their paper as they see it.
5. Students finish with analysis and conclusions.

Title: Starlight Name_____

Purpose: The **spectrum** of light is commonly observed in a rainbow. Prisms and diffraction gratings can also divide light into its colors. Light given off by a star is analyzed by astronomers and provides a great deal of information. In this lab you will observe the spectra of some elements and learn about **red shift,** a way that light can show what direction an object is moving. The lines on the spectrum of an object moving away from Earth are shifted toward the red end of the spectrum.

Materials: spectroscopes, light sources, colored pencils

Procedure:
1. Make sure you can see the spectrum through your spectroscope or diffractions grating.
2. Focus your scope on the light sources provided, draw the lines you see on the spectrum on your paper.

Prediction: Which element will have the most colorful spectrum?

Data: Write the elements name to the right of the spectra:

red orange yellow green blue violet name:

red orange yellow green blue violet

red orange yellow green blue violet

red orange yellow green blue violet

red orange yellow green blue violet

red orange yellow green blue violet

Analysis:

1. Which element had the most colorful spectrum?
Least?

2. What does the spectrum tell about a star?

3. When do elements give off colors?

4. Red shift occurs when the colors are shifted to the red end of the spectrum. It indicates that an object is moving away from the observer. Choose one of the spectra that you drew and redraw it showing a red shift:

What element did you use? _____

red	orange	yellow	green	blue	violet

Conclusion:

Name: _____ Date: _____ Period: _____

Analyzing Starlight and Stellar Motion

(or One Shift, Two Shift, Red Shift, Blue Shift)

Recently we have been examining the origin of the Universe and the idea that it is still expanding. A good question that scientists ask is, "What **proof** do we have that the Universe is expanding?" Luckily the answer lies in analyzing the light from stars!

Background: When astronomers observe starlight, the light can be spread apart into a strip of component wavelengths called a _____. Each wavelength is a different color. You may have noticed that sunlight is made of different colors when you have observed a rainbow. A _____ can also divide light into its colors. The tool scientists use works much like a prism, but is called a spectroscope. Using a spectroscope, observe the spectrum of white light from the overhead classroom lights and draw what you see below:

red orange yellow green blue violet

If an atom is energized enough, it will give off light. Also, each element will give off a unique spectrum (sort of like a fingerprint). When astronomers look at starlight and analyze it with a spectroscope, they can determine what elements the star is made of! Using your spectroscope again, observe the various gas tubes when energized, and draw the spectrum you see from each:

Hydrogen

red orange yellow green blue violet

Helium

red orange yellow green blue violet

Neon

red orange yellow green blue violet

Nitrogen

red orange yellow green blue violet

Doppler Effect: The next major concept we will cover is the idea that as an energy source is moving towards or away from an observer, the spectrum it emits will shift slightly. This happens when the waves compress as the object approaches or spread out as the object moves away. Draw what happens to sound waves in the diagram below:

Sound waves **Sound waves**

Car moving towards you **You!** **Car moving away from you**

This phenomenon is known as the Doppler Effect and is easily observed with sound waves. Listen to the ultra-high tech buzzer and describe what you hear and observe:

Now watch the car passing the observer in the Encarta clip and describe what you hear and observe:

Red Shift: In the world of astronomy, the Doppler Effect can be seen in the spectra of stars. Astronomers noted that as they observed the spectra from almost all objects outside our galaxy, the light emitted was shifted toward the red end of the spectrum. This is called _____. It was concluded that all these objects are moving away from Earth, so the Universe must be expanding!!! By the way, if an object were moving toward us, its light waves would compress, shifting it toward the _____ end of the spectrum (called a Blue Shift).

Once more, observe the Hydrogen spectrum in your spectroscope, and draw it below:

red orange yellow green blue violet

Now draw a Hydrogen spectrum that is showing a Red Shift:

red orange yellow green blue violet

Conclusions and analysis:

1. List two things that starlight can tell us:

2. What does it take to make an atom give off light?

3. In terms of energy and wavelengths, what does a moving car horn have in common with a moving star?

4. Based on what you know about the Universe, which two elements are most commonly observed in spectroscopes? Why?