THE SCIENCE OF "FRINGE"

EXPLORING: SPECTROSCOPY

A SCIENCE OLYMPIAD THEMED LESSON PLAN
EPISODE 314: **6B**

Overview:
Students will learn about spectroscopy and how it can be used to determine certain characteristics of things.

Grade Level: 9-12

Episode Summary:
The Fringe team investigates an accident at an apartment building where several party attendees suddenly fell to their death. They quickly discover that there are many strange events taking place in the building and deploy a range of scientific equipment, including seismographs and spectrometers, to analyze the environment. When they witness another event, they are able to localize the source to a specific apartment and find a grieving widow interacting with a 'ghost' of her recently deceased husband. Walter quickly realizes that the cause is a hole between the two universes. The team then must work quickly to devise a way to close the hole before it turns into a vortex that causes enormous destruction.

Related Science Olympiad Event:
Optics - Teams compete in activities and answer questions related to geometric and physical optics.

Learning Objectives:
Students will understand the following:
- Spectroscopy is the measurement of radiation intensity as a function of wavelength
- Measured spectra can be used to determine the chemical composition and physical properties of objects ranging from microscopic to astronomical in size
- The color we perceive things is directly related to the spectral properties of the object

Episode Scenes of Relevance:
- Walter, Olivia and Peter discussing collecting data from the environment around the building (11:28 'I'm sorry' – 12:05 'precise science')
- Walter and Broyles watching as the vortex starts to form (33:27 'was that' – 34:10 'it's starting')

FOX CODE

FOR SMARTPHONES

Online Resources:

- Fringe "6B" full episode: http://www.fox.com/watch/fringe
- Science Olympiad Optics event: http://soinc.org/optics_c
- Introduction to Spectroscopy: http://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/Spectrpy/spectro.htm
- A CD Spectrometer: http://www.cs.cmu.edu/~zhuxj/astro/html/spectrometer.html
- Virtual Spectroscope: http://mo-www.harvard.edu/Java/MiniSpectroscopy.html

Procedures:

1. Tell your students that they are going to learn about spectroscopy and how it can be used to characterize materials.
2. Have your students research spectroscopy in resources such as chemistry and physics textbooks and websites and discuss what they have learned.
3. Divide your class into small groups. Have each group complete the following activity:
    a. Materials: small cardboard boxes (cereal works well), scissors, CD's, tape, a variety of light sources (fluorescent, LED, halogen, incandescent, candles, etc)
    b. Diagrams and pictures of a CD spectroscope can be found online at a variety of locations, including: http://www.cs.cmu.edu/~zhuxj/astro/html/spectrometer.html
    c. Cut a very narrow slit in one edge of the box (a few centimeters long and ~1mm wide).
    d. On the opposite edge of the box, cut a slot to fit the CD in at a 45 – 60 degree angle.
    e. Also cut a small 'window' around the CD that allows you to look in the box and see the light reflecting off the CD.
    f. Use tape to hold everything in place and seal the rest of the box except for the small slit and the viewing window.
    g. Hold the box near a light source so that the light shines through the slit. Look in through the window and adjust the angle until you see a spectrum of colors on the CD. This is the spectrum of the light source.
    h. Sketch a diagram of the spectrum.
    i. Repeat the process with other light sources and compare and contrast the spectra diagrams.
4. Discuss with the class the results of the activity. Be sure to address:
    a. If there were specific bright bands of color in a spectrum, how do those bands correlate to the underlying technology that creates the light?
    b. How did the size of the slot affect the spectrum that could be viewed?
    c. If LEDs or lasers were viewed, why were the spectra they generated different from other types of light sources?

Additional Discussion Suggestions:

- If DVDs instead of CDs were used, would there be a difference in the spectrum? If so, why?
- If there was a need to check for ultraviolet or infrared light in the spectrum, how could the spectroscope be modified?
- If the light entering the spectroscope were to pass through a liquid, what would happen to it and how would the spectrum change?

Extension to Other Subjects:

Biology: Many animals, particularly insects, are able to see wavelengths of light that humans can't. Research some of these abilities and discuss why the animals have developed sensitivity to those particular wavelengths.

Art: Art historians and restoration experts often utilize spectral imaging to 'peer beneath' the layers of paint on a masterpiece. Research the tools they utilize for this process and the principles behind why they work.

History: Many important scientific discoveries, ranging from elements of the periodic table to the Big Bang, were directly due to spectroscopy. Research some of these findings and how spectral analysis played a role.

National Science Standards Alignment:
B. Physical Science - Physical science focuses on science facts, concepts, principles, theories, and models that are important for all students to know, understand, and use.

H.B.6 Interactions of energy and matter

a. Waves, including sound and seismic waves, waves on water, and light waves, have energy and can transfer energy when they interact with matter.

b. 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, xrays, and gamma rays. The energy of electromagnetic waves is carried in packets whose magnitude is inversely proportional to the wavelength.

c. 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.

M.B.3 Transfer of Energy

e. In most chemical and nuclear reactions, energy is transferred into or out of a system. Heat, light, mechanical motion, or electricity might all be involved in such transfers.