Light: The Astronomer's Friend!

Geology Mr. Traeger

Name: ______________________ Period: ____ Date: ___________________

Purpose

The purpose of the following activities is to acquaint the student with the aspects of light and the electromagnetic spectrum that are necessary for studying stellar astronomy.

Materials

▪ Fluorescent and Incandescent Light Bulbs	▪ Colored Pencils	▪ Spectroscopes
▪ Prism	▪ Projector	▪ Light Boxes (unknown elements)

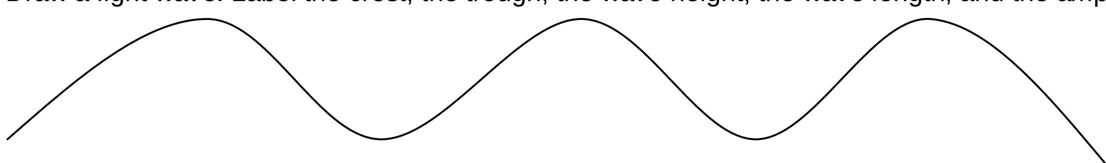
Part 1: Visible Light

1. The teacher will shine white light through a prism using a slide projector.

2. Draw what you see. Include the light source, the prism, and the resulting colors in their correct order. State the ordering of colors.

3. Light has dual properties. What are these properties?

4. Draw a light wave. Label the crest, the trough, the wave height, the wave length, and the amplitude.



5. What are some other ways that visible light can be divided into its separate colors?

6. How does electricity and magnetism combine to form light? How does this enable light waves to travel through the vacuum of space? Draw a picture below to tell me that you know what you're talking about.

7. Mr. Traeger has a good friend named ROYGBIV from the visible part of the electromagnetic spectrum. Who is ROYGBIV and what does each letter in his name signify in terms of color?

8. What is the associated wavelength (in nanometers) for each color of light named in #7?

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Part 2: Infrared Radiation Video

1. What is infrared radiation?

2. What kinds of things in the video give off infrared radiation? List at least 3.

3. How might we use infrared radiation to ñseeò things in the universe?

4. What are some other technological items that you know of that are used to sense infrared radiation?

Part 3: The Electromagnetic Spectrum

1. Sketch the diagram of the Electromagnetic Spectrum as seen on page 613 of your textbook. Make sure to include the wavelengths of each type of radiation and also give an example of something that you use in every day life that uses each part of the spectrum. (ex. Your eyes use visible wavelengths.)

2. Albert Einstein found that the energy of a photon (packet of light) is inversely proportional to the wavelength of light. His equation for this is E = (h x c) / ə, where E is Energy in joules, h = Planckôs Constant of 6.626 x 10^{-34} joules x seconds, c = speed of light = 3 x 10^{8} meters/second, and ə is the wavelength of the light wave in meters. According to this equation, what happens to the energy of a light wave that has short wavelength (ə) like Gamma radiation? What happens to the energy of a light wave that has long wavelength (ə) like radio radiation?

Energy of light with short wavelength?	Energy of light with long wavelength?

Part 4: Spectra of Stars

1. Using your spectroscope, look at each one of the light boxes. **Do not touch the light boxes! You will get zapped with 5,000 Volts of electricity!** Draw and **color** the spectral lines that you see for each type of light on the attached page. Write in the corresponding wavelengths for each color.

2. Identify the element that each light box tube is and place the name of this element next to the spectra that you drew. Use the following website to help you identify what each element is. http://phys.educ.ksu.edu/vqm/html/emission.html It would probably be easier to Google ñksu spectroscopyò and then click on the first link called ñemission spectroscopy.ò

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3. How do your spectra compare? How might astronomers use this spectral difference to find a star's chemistry?

4. How do daylight and the incandescent bulb compare? Why are these spectra called “continuous”?

5. What chemical element(s) are fluorescent bulbs and compact fluorescent bulbs made out of? Point your spectroscope at a fluorescent bulb, record the colors seen, and then compare to element #4.

6. Wien's Law says that the wavelength of maximum emission of a star ($\lambda_{maximum}$) = 2,900,000 divided by the temperature of a star in degrees Kelvin. Given this formula, what would the wavelength of maximum emission be for the following stars? Answer this by giving a number and then also telling me what type of light this is (infrared, visible, ultraviolet, etc.) and the most likely visible color that the star would appear in the night sky (blue, white, yellow, red).

Star Name	**Rigel**	**Sol (Our Sun)**	**Betelgeuse**
Temperature (Kelvin)	11,000	5,800	3,600
Wavelength of Maximum Emission (nanometers)?			
Spectrum band of peak emission (infrared, visible, ultraviolet, X-rays, gamma rays)?			
Most likely color of the star in the visible part of the spectrum (blue, white, yellow, red)?			

7. Define the following:

Continuous Spectrum	Emission Spectrum	Absorption Spectrum

8. Describe the Doppler Effect and then fill in the chart regarding a star's motion relative to Earth.

What is the Doppler Effect? How have you experienced it before?

Object Motion	**Toward Earth**	**Away from Earth**	**Sideways to Earth**
Change in Wavelength (shorter or longer or nothing)?			
Change in Frequency/Pitch (higher or lower or nothing)?			
Change in Color Spectra (more red or more blue or nothing)?			

Drawing Spectra

Red	Orange	Yellow	Green	Blue	Violet

Element 1: ____________

Red	Orange	Yellow	Green	Blue	Violet

Element 2: ____________

Red	Orange	Yellow	Green	Blue	Violet

Element 3: ____________

Red	Orange	Yellow	Green	Blue	Violet

Element 4: ____________

Red	Orange	Yellow	Green	Blue	Violet

Element 5: Fluorescent Light Bulb

Red	Orange	Yellow	Green	Blue	Violet

Element 6: Daylight or Incandescent Light Bulb
(Do not point directly at sun!)