Spectroscopy worksheet high school

Students build a working spectroscope to study the nature of light. The curriculum includes study guides for different class groups, PowerPoints for explaining concepts, a cartoon that describes spectroscopy, age-appropriate practical activities, and videos. Class sets of spectroscopes and grates are available from Astronomers Without Borders. The installation instructions are supplied with the spectroscopes. Another version is also available: Spectroscope Collection and Simple Lesson Plan Curriculum Resources Associated with This Activity: PowerPoint Presentation/Introduction to Spectroscopy. The presentation was designed to introduce spectroscopy and follow the Stanford spectroscope, but can be used standalone. Steps 4-14. Secrets in Sunlight Comic A cartoon aimed at the characters 4-8 that explains spectroscopy in similar terms to the PowerPoint presentation above. Available in pdf and epub (for iPads and iBooks) Colors of the Sun video. Filmed at the Wilcox Solar Observatory on the Stanford campus, this 16-minute video explains spectroscopy and shows that the observatory is nothing more than a giant spectrograph! Designed for grades 5-8, but also suitable for older students. Colors and gestures of Sun Video. An introduction to solar science and how spectroscopy is used to study the sun. Includes information about solar telescopes and spacecraft. Produced by Jay Pasachoff. (Second edition, 16 minutes; ratings 9-12) Fingerprints in sunlight. An extended version of the initial Powerpoint presentation mentioned above, designed for grades 9-12. Includes more extensive demonstrations and activities to be used to introduce spectroscopy and the nature of the atom to high school students. Designed to follow spectroscopes, but can be used standalone. Fingerprints in Starlight. A chemistry-related enchanted version of the fingerprints in the Sunlight presentation. Designed to introduce spectroscopy to an AP Chemistry high school class. Includes a more thorough understanding of the nature of the atom, a teacher's guide, additional activities and assessments. Study guide for grades 2-4 (using only shakes; does not require spectroscopes) Study guide for grades 5-8 (requires spectroscopes) The goal of Project Spectra! is to promote knowledge of solar system exploration by providing students with actual spectroscopic data in an accessible format. (Courtesy LASP) Project Spectra! is a NASA approved product and is developed with NASA funding. We have used the materials on this page to provide teacher science development workshops, but we have no workshops planned at this time; please contact us at epomail@lasp.colorado.edu for more information. Introduction Project Spectra! is a science and engineering program for 6. Spectra! emphasizes practical activities, such as building a spectrograph, as well as using real data to solve scientific questions. Here you will find lessons for middle school students that can also be easily adapted for high school students or changed for elementary school students. Each lesson has a front page that shows national standards in science and mathematics, prior knowledge students need for lesson, material, and time to complete the lesson. We have also provided tables that show national standards the lessons are consistent with, and a scope and sequence. We have included fun and informational links to explore the nature of light and spectroscopy further. What is a computer story? A data history is a request driven, standard-based lesson using real data from the spacecraft itself! Each computer story is a compelling, well-delineated story of solar system exploration that is available to students. Activities (* Denotes data history lesson; ** Denotes engineering lesson, Note: A spectrograph, is a tool used in spacecraft and modern telescopes that use a detector to detect light properties. Technically, students build spectroscopes where the human eye directly observes light. We consider the student to be the detector when building their space-worthy spectrographs, but leave further explanation at the instructor's discretion.) Other Materials Light – A presentation for high school students (434 KB PDF) Interactive lessons Teacher Workshop Material presentations from previous years teacher workshops. Fun and educational links UPDATED 12/1/20This three-part introduction to spectroscopy is designed to help students: • conceptually connect the electron energy level to the emission spectrum • understand why each element has a unique emission spectrum • perform simple spectroscopy tasks and understand the reasoning underlying such tasksThis lesson was originally designed for 9. After setting up the activity by spending a 50-minute period of getting students to look through spectroscopes on different emission pipes, the activity and follow-up discussion should take between two and a half and a half 50-minute period (although I also use it as a fast, single block activity with my 12th and two-and-a-half-minute periods). To present the basics of spectroscopy without devices, mathematics or wave vocabulary become barriers to understanding, the activity makes some simplifications / fictions: 1) Ten imaginary elements are used instead of real elements (to keep emissionspesta simple / manageable without misrepresenting real elements.) The elements are named after astronauts who have walked on the moon.2) Differences in electron energy levels are represented as distances to be measured on the atomic diagrams with a ruler. (This was made to emphasize to students the connection between unique energy level structure and unique emission range. In an effort to prevent students from confusing units of distance with units of energy, they are informed that the charts are drawn in a way where distance measurements correspond to energies.) 3) A fractured energy unit, MilliSchwan (mŠ) is used to correspond to emission color (instead of using frequency or wavelength and to keep the calculation simple.) 4) All elements have exactly six emission lines, and all emission lines fall into the visible part of the EM spectrum (with the exception of Gearium which has a line falling off-scale into the infrared.) PART 1: Connect the electron energy level to the emission spectrum. What you need:*All the documents you need are in the PDF attached to the bottom of this page.*• Energy level charts for the 10 different elements (p9-p18)• Full spectrum bookmarks (p2) - FARGE printing• Color pencils• RulersWhat to do: Provide one or two item energy level charts to each student and have them measure every possible distance between energy levels , in cm. There are four energy levels for each element, so there are 6 possible distances to measure. Invite students to use full range bookmarks to correlate energy level gap distance to color - the diagrams scale so that a 1 cm gap corresponds to an energy of 10 mŠ (MilliSchwans.) Use the colored pencils to draw in the emission spectrum for each item on the spectrum scale at the bottom of the page. (Note: Gearium will only have 5 emission lines, as the lowest energy line will be of scale.) PART 2: Identify items by their spectra. What you need:• Energy level charts completed by students in part 1, posted on the wall• Emission Spectra of 10 Elements Spreadsheet (p3-p4) - This must be a COLOR printing• Emissions Spectra of 10 Elements Svartast (p5) What to do: Get students to examine the posted energy level charts that they completed, and match the range of each item to the spectrum on the spreadsheet. PART 3: Identifying the composition of starsWhat you need:• Emission spectra of 10 Elements (completed by students in section 2)• Emissions Spectra of 7 Different Stars Spreadsheet (p6-p7) - This must be a COLOR printing• Emission Spectra of 7 Different Stars Svartast (p8)What to do: Get students to use their completed Emission Spectra of 10 Elements spreadsheet to deduce what elements exist in each star. Standards: SC.6.E.7.5 Explain how energy from the sun affects global patterns of atmospheric movement and temperature differences between air, water and land. SC.7.P.10.1 Illustrate that the sun's energy comes as radiation with a wide range of wavelengths, including infrared, visible and ultraviolet, and that white light consists of a of many different colors. SC.7.P.10.2 Observe and explain that the light may be reflected, broken and/or absorbed. SC.7.P.10.3 Realize that light waves, sound waves and other waves move at different speeds in different materials. SC.7.P.11.3 Cite evidence to explain that energy cannot be created or destroyed, only changed from one form to another. Suggested resources to strengthen background knowledge of waves, waves' energy and the electromagnetic spectrum: Review vocabulary by visiting and choosing flash cards. Test content knowledge by completing the wave concept map, slides 3-8. Review concepts on the Star Light Star Bright website by copying and pasting the link into your browser: Misconceptions about light and waves (for teacher use): An object gets its visual image because that's what it is. No - An object gets its visual image by the way the light interacts with it. If the object's surface is smooth and the light reflects, it looks shiny. If the surface is irregular and light spreads, it looks rough. If the object's surface absorbs all light, it looks black. Blue gel filter or cellophane changes the white when it passes through the filter. No - the filter does not change the white light. The filter absorbs some wavelengths or colors of light and other wavelengths are transmitted. Those who are transmitted travel forward to the wave interact with material. The colors of light mix just like the colors of paint. No - Light and pigment are not the same. When the light is mixed, more light is added and it becomes brighter. Red and green filtered light is yellow. Pigment, on the other hand, absorbs light. When more pigment is added, each color of paint absorbs its original wavelength and the mixture absorbs even more light. If enough paint is added, the results will absorb all the light and become black paint. If all colors are added together, the results will be white light. We see objects because our vision comes from our eyes to the object. No - Eyes get light through the opening of the eye, the pupil, and treat the light as an electrical signal in the optic nerve. The light enters our eyes by direct, reflected or refracted light. Procedure Teacher asks students to answer the BellRinger questions and then lead the discussion about the answers. The teacher leads the student to complete the wave concept map, slide 2. The teacher reviews the answers after about 5 minutes. Introducing today's Spectra activity, the teacher says: We will examine the color of the lights and how it gives us information about material. The activities will allow students to experience the phenomena of spectra before they are lectured about the spectra. The teacher should not be overly concerned that students know all the answers, as the answers will be presented in the attached spectra power point and built-in video. The teacher uses the spectra activity suggestions answer key to lead the class in the two activities and one demonstration. The teacher divides students into groups of 3 to 4 students. (Teacher note: Grouping depends on the dynamics of the class. Typically, each group will have one student who may need help with one or two students who are more academically successful, but not students who are particularly skilled. The very talented students are usually with students who are a little less talented. Behaviorally challenged students can work well within a highly focused group. To promote successful group situations, the teacher must introduce group work with academic goals and participation goals and expectations.) See material list. Each group needs a flashlight, 3-4 prepared c-spectra squares in a plastic bag, a pack of gel color filters and colored marker or crayons. The teacher asks students to handle the material with care and not to fold or crinkle cellophane/plastic squares. Safety reminders: (1) Never look at the sun directly. (2) Do not shine the flashlight in other people's eyes. The teacher must darken the room. Invite one student to turn the lights on and off or leave a small table lamp on so that students can sign the activity. The teacher reads directions for activities 1 and 2 and allows students to start taking observations. The teacher can walk around to assess whether students observe the visible range of filters. After students complete activities 1 and 2, the teacher reads the instructions for Activity 3, which is a demonstration of the different gases in the spectral power supply. The teacher gives directions on how to observe and record the emission spectrum of ordinary gases. Safty Reminder: The teacher should wear goggles and gloves. Wearing gloves when handling the gas pipes will avoid getting oil on the glass which may cause the glass to warm up unevenly and break. Activity 3 Suggestions: Announce the gas in the pipe (such as hydrogen) and carefully the pipe in the power supply according to the operating instructions of the machine. Turn on the power supply and leave it on for just a few minutes because it can get hot. Once the students have made their observation and drawing, turn off the power supply. Use heat-resistant gloves to remove the gas pipe. Repeat until the gas pipes of hydrogen, helium, neon and mercury are shown. After the observations are complete, students will compare their emission spectrum with another group's observations. Drawings should be similar. The teacher leads a discussion after the activity that will include a comparison between the colored gel filters and the gas in the pipes. Teacher explanation to the class: Both the gel filter and the gas pipes block some colors seen through the c-spectra. The material that blocks the light absorbs that of light. The gel filter is a concrete example of absorption while the gas pipe is more abstract. Each gas pipe looks the same before it enters the power supply. Afterwards, the gas glows and may be different as detected by the human eye. But when we change the detector to c-spectra, what happens? (c-spectra detects the different wavelengths of light.) Were any of the gas emission spectra the same? (No) why? Each gas is a different element with different properties. The emission spectrum of an element is unique to that element, just as human fingerprints are unique to each person. End of activity 3 Teacher explanation to class: Once students have realized that each element's emission spectrum is different from any other element, the teacher leads a discussion that will make the cognitive leap from the activity to the stars. Put hydrogen gas back into the power supply. Ask what if a star in the night sky has this emission spectrum? What can we tell about the composition of that star? (The star has hydrogen gas in the atmosphere.) So, by looking at the emission spectrum of a star, we can predict which element is present. The teacher asks students to take notes while the teacher uses EM Spectra and Stars Power Point to lead a content discussion about the electromagnetic spectrum, emission spectrum, and absorption spectrum of planetary images and satellite images. The lecture will be more interesting because students now have some experience with color and interpretation of color with regard to the frequencies of waves. The power point has a built-in video produced by NASA that will thoroughly explain the science concepts, After Power point presentation, students complete the EM Summative Assessment. See the attached files for the spreadsheets. Bell Ringer Question: Students will finish individually. Wave concept map: Students complete the concept map individually and request an assistant for team members as needed. Spectra Activity 1 and 2: Students will complete the emission spectrum of light sources individually, and request an assistant for team members as needed. Summative assessment: Students will complete four multiple choice questions and answer the indicative questions individually. When you look at the night sky, the colors of the stars and their absorption spectrum give us information about the elements of far away celestial bodies. Elements are everywhere in our everyday lives, and it is important for students to make a connection to how we examine our world. Students should return to the guiding questions to reflect on the knowledge gained in the lesson. Open and print the EM Sum Assessment file or use the following questions. What two characteristics of a wave determine the location of a spectrum? Circle the correct two properties: (Answer is 4.) amplitude and frequency frequency and speed and wavelength frequency and wavelength Which is a correct statement about electromagnetic energy emitted by our sun? (The answer is 2.) All waves in the electromagnetic spectrum have the same wavelength. All waves in the electromagnetic spectrum have different frequencies. All waves in the electromagnetic spectrum have the same frequencies. All the waves in the electromagnetic spectrum move at different speeds in space. Light waves can reflect, break or diffract when interacting with a surface. When we look up at the night sky, and we see a distant planet using only our eyes, what is the main behavior of light that allows us to see the light of the planet? (The answer is 1.) Reflection Refraction Diffraction None of the above What can we learn about a star by analyzing the emission spectrum? (The answer is 3.) The spectral lines show the apparent size of a star. Spectral lines indicate the apparent brightness of a star. The spectral lines identify the elements that compose the star's atmosphere. The spectral lines show the relative age of a star. Students answer indicative questions with short answers. Bellringer Formative Assessment (completed individually): Print the attached file and display on a document camera or view the file digitally on a projector. What does this chart show? (Answer: the electromagnetic spectrum) Which waves carry the most energy? Why? (Answer: gamma rays. Gamma rays have the highest frequency and shortest wavelength, so they are able to carry more energy.) Which wave has been associated with skin cancer? (Answer: UV or ultraviolet waves) Previous knowledge-formative assessment (completed in groups of 3-4 students): After the teacher has reviewed and presses students to understand the chart, groups of 3-4 students complete the Wave Concept Map (slide 2). The answers are on slide 1 of wave concept map. If students have difficulty completing the concept map, the teacher must mediate the concepts again before proceeding with the activities in this lesson. See pre-knowledge section for possible sources of remediation. Bellringer Feedback: When students record their answers in their notebooks, the teacher can walk around the room to read their answers and look for the correct use of vocabulary and understanding. The discussion of answer 1 may include the definition of electromagnetic (EM) spectrum. The discussion of answer 2 must include students' prior knowledge of how much energy travels in waves and the inverse relationship between frequency and wavelength. The discussion of answer 3 must include the use of the different waves in the electromagnetic spectrum. The teacher may wish to include the discussion that each frequency is assigned for a specific use by the US Department of Commerce and to display the chart at the frequency website: Possible misunderstandings will be revealed during class discussion of bell-ring responses. Information about common misconceptions is included in the prior knowledge portion of this lesson. Feedback on spectral activity: Students will draw the emission spectrum of ionized elements. Students will peer review their observations. After students complete their drawings, students receive feedback immediately by comparing the observation to another group. Students will see if they observed the same colors as the other group. Group.