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| **TEAM Lesson Plan Template** | |
| Teacher: Dr. Jason Alexander | |
| Subject/Grade: 7th & 8th grade science | |
| Lesson Title: Shoebox Spectroscope | |
| **STANDARDS** | **Identify what you intend to teach.** State, Common Core, ACT College Readiness Standards and/or State Competencies; Enduring Understandings and Essential Questions. |
| 7.PS1.1 Develop and use models to illustrate the structure of atoms, including the subatomic particles with their relative positions and charge.  8.PS4.1Develop and use models to represent the basic properties of waves including frequency, amplitude, wavelength, and speed.  8.PS4.2 Compare and contrast mechanical waves and electromagnetic waves based on refraction, reflection, transmission, absorption, and their behavior through a vacuum and/or various media.  8.ETS1.2Research and communicate information to describe how data from technologies (telescopes, spectroscopes, satellites, and space probes) provide information about objects in the solar system and universe.  This lesson emphasizes:  Science practices: Planning and carrying out controlled investigations; Constructing explanations  CCC: Pattern observation and explanation  Learning performance: Students will construct a spectroscope and will identify a gas from its spectrum. | |
| **OBJECTIVE(s)/Sub-Objectives** | **Connect prior learning to new learning.** Clear, Specific, Observable, Demanding, High Quality, Measurable, Aligned to Standard(s), and Integrated with other subjects, build on prior student knowledge  Student-Friendly (I Can Statement) |
| I can build a spectroscope.  I can identify a gas from its spectrum using a spectroscope and a reference chart. | |
| **MATERIALS AND RESOURCES** | **Content-related:** Clearly supports lesson objective(s); rigorous & relevant; Incorporates multimedia & resources beyond the textbook. |
| **Activities & Materials**  11.75”x8”x4.75” box (shoebox), packing tape, masking tape, 1.5”x1.5” diffraction grating, 3”x5” index card, ruler, box cutter or X-ACTO knife, pen, calculator, chart of element emission lines (or project from internet), access to sunlight (window or walk outside), incandescent light source, fluorescent light source, Gas Tubes and Gas tube power supply  Computer, Projector  \_x\_Internet Resource (Include urls) Image of elements emission lines:  <http://astro.u-strasbg.fr/~koppen/discharge/> or <http://www.umop.net/spctelem.htm>  \_x\_Worksheets  **What if the technology is not working?** Building the spectroscope and initial observations requires boxes, tape, and sunlight, which will presumably work. If the gas tubes are not working, skip the second “I can statement” and just make observations of different light sources.  **Routine for distributing materials** Close and tape box bottoms before distributing the boxes. Place materials *except for diffraction gratings* at each groups’ workstation before class. Pass out diffraction gratings after demonstrating how to handle them. | |
| **ACCOMMODATIONS/ADAPTATIONS** | **Learning styles and interests.** Anticipate learning difficulties, regularly incorporate student interests & cultural heritage; differentiate instructional methods. |
| **Modifications/Plans for Diverse Learners *(NOTE: Clearly identify where you will use each of these in your lesson; do not just check the box!)***  **Differentiation**  **----- Content**  **--x--- Process** For some students it may be appropriate to have them do some initial research to determine the wavelengths to use in Table 1 rather than providing these wavelengths. Google or Wikipedia will provide the numbers, but remind students to round to the nearest 100 nanometers.  **--x---Product** For some students it may be appropriate to provide an index card with marked lines. These students would then make observations using the completed spectroscope.  **----- Tiered Assignments ----- Flexible Grouping**  **----- Learning Centers \_\_\_\_ Other \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**  **Accommodations**  **\_\_\_ Preferential Seating \_\_\_ Extended Time** \_\_\_ **Small Group \_\_\_ Peer Tutoring**  **\_\_\_ Modified Assignments \_\_\_ Other**  **Early Finishers:** Look for images of emission lines in a textbook or on the internet. Give an explanation why some elements have so many more emission lines than others. | |

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| **MOTIVATING STUDENTS/ANTICIPATORY SET** | **“Hook”: Engage students’ attention and focus on learning.** Personally meaningful and relevant. |
| Open with an image of a rainbow such as one found at <https://en.wikipedia.org/wiki/Rainbow>  Discuss the fact that white sunlight is a mixture of many colors. Raindrops, prisms, or diffraction gratings can separate white light into colors. Today we will use a diffraction grating.  **Caution** students only to handle the diffraction grating by the edges. Oil from fingers can prevent the diffraction grating from working. | |
| **INSTRUCTIONAL PROCEDURES** | **Step-by-Step Procedures-Lesson Sequence: Basic to Complex.** Lesson includes visuals, modeling, logical sequencing and segmenting (beginning, middle, ending); essential information; concise communication; grouping strategies; differentiated instructional strategies to provide intervention & extension; seamless routines; varied instructional strategies; key concepts & ideas highlighted regularly. |
| ***Introductio*n**  Sunlight, as well as light from most other sources, consists of light of many different colors mixed together. This fact is apparent when one observes the colored patterns that appear on the water-oil mixture on a parking lot following a rainstorm. Another example of the presence of various colors in sunlight is a rainbow, which appears when raindrops separate the sun's light into its component colors, i.e. when they create a spectrum. Raindrops can be thought of as nature's spectroscope. The light that comes from the sun and other sources like fluorescent lamps or flashlights can tell us what combination of atoms and molecules are inside those sources because that light comes in a unique mixture, called a spectrum. One way to think of it is like an atom or molecule’s fingerprint.  A spectroscope or spectrometer is an optical device used to produce this separation of colors, a spectrum. Early spectroscopes and some modern ones use a prism to separate light into individual colors. Another type of spectroscope, a grating spectroscope, replaces the prism with a piece of plastic or glass on which an extremely large number of parallel lines have been scratched. This piece of plastic or glass is called a diffraction grating; hence the name grating spectroscope. The lines on the grating take advantage of the property of waves called interference.  Ultimately we will discuss how the spectrum helps us understand the universe.  **Motivating Students**  \_x\_ Relate to Real World: The introduction discusses rainbows and colors on oil slicks.  \_x\_ Other: This is a mostly hands-on activity to construct a scientific instrument.  **Presenting Instructional Content**  \_x\_Hands-On construction of the spectroscope  \_x\_ Worked Examples appear on the worksheet  \_x\_ Guided practice: the teacher will model construction of the grating spectroscope step by step.  \_x\_ Discussion: Students will discuss how a spectroscope allows us to understand the universe [ light travels a long way; the spectroscope allows us to know which elements make up distant stars ]  ***Instructional strategies:***  **Check for Understanding (CFU) –**  ***What am I doing for students that progress at different rates?***  ***What do I do if they get it?***  ***What do I do if they don’t get it?*** | |
| **QUESTIONING/THINKING/PROBLEM SOLVING (embedded throughout)** | **Balanced mix of question types.** Utilizes Blooms Taxonomy/Webb’s Depth of Knowledge; high frequency; purposeful & coherent; require active responses; balance based on volunteers/non-volunteers, ability, & gender; lead to further inquiry & self-directed learning.  **Implement four types of thinking (Analytical, Practical, Creative, & Research-based) & Teach/Reinforce problem-solving types**. Provide opportunities for students to generate ideas & alternatives; analyze, evaluate & explain information from multiple perspectives& viewpoints. |
| **Questioning**  **Knowledge:**  What colors do you see when you look into the spectroscope?  **Comprehension:**  Does the spectroscope make the light that we see?  Does the spectroscope make the colors that you see? [ *no, the colors are present in the light entering the spectroscope* ]  Which color has a longer wavelength, red or blue?  **Application:**  Measure the length of the box and use Table 2 to calculate the values a, b, c, and d.  **Analysis:**  On the worksheet, in Table 1, where does the constant multiplier, 0.200 for violet, 0.250 for Blue-green, etc. come from? Does this number depend on light or on our shoebox?  How can a spectroscope help us understand the what distant stars are made of?  **Synthesis:**  **Evaluation:**  **Thinking*(NOTE: Clearly identify where you will use each of these in your lesson; do not just check the box!)***    \_\_ **Practical** –***Students use/apply/implement real life scenarios***  Construction (A)-(C) **Creative**– ***Students Create/design/imagine/suppose***  1,2 **Analytical** – **Students analyze /compare contrast/evaluate/explain**  \_\_ **Research-based** – ***Students explore/review variety of ideas, models, solutions to a problem***  **\*What am I going to do to give Ss opportunity to?**  **1. Generate variety of ideas:**  **2. Analyze problems from multiple viewpoints:**  **Problem Solving *Note: Teach 2 or more types of problem solving (NOTE: Clearly identify where you will use each of these in your lesson; do not just check the box!)***  **\_x\_ Abstraction** Students are asked to extend design to include a camera. Students also discuss using starlight to study the composition of stars.  **\_x\_\_ Categorization** Students have to categorize Hydrogen, Helium, and Nitrogen based on their emission lines. They also determine which light source most closely resembles the sun.  **\_x\_\_ Observing and Experimenting** Students observe spectra from the sun, incandescent light, fluorescent light, and the gas tubes. | |

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| **GROUPING** | **Maximize student understanding & learning** Varied group composition (race, gender, ability, & age); clearly understood roles, responsibilities & group work expectations; accountability for group & individual work; student opportunities for goal setting, reflection & evaluation of learning. |
| * Heterogeneous groups of 3 or 4 * Roles: 1 or 2 builders ( cut, fold and tape the box), Measurer (measures the box and marks the index card), Calculator/recorder (makes table entries and calculations). All students should make observations throught the spectroscope. * Students select roles within the group and write their names in the appropriate blank. * Students should begin class arranged in their groups. * Each group will submit a spectroscope and completed worksheet. | |
| **ASSESSMENT** | **Formative and/or summative assessment.** A variety of assessments, including rubrics, measure achievement of objectives and informs instruction. |
| ***Assessments: aligned with state stds; measurement criteria; measure student performance in more than 2 ways (project, experiment, presentation, essay, short answer, multiple choice test) (NOTE: Clearly identify where you will use each of these in your lesson; do not just check the box!)***  **\_x\_\_ Teacher Made Test** Questions on a test at a later date could ask students to describe ways to separate light into a spectrum [ rainfall, oil slick, diffraction grating, prism ] or which of two basic colors has a longer wavelength.  **\_x\_\_ Exit Ticket** described below  **\_x\_ Completed worksheet**  **\_x\_\_Teacher Observation** of activity  *\****Students should achieve \_\_\_\_\_% mastery of this objective: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** | |
| **CLOSURE** | **Reflection/Wrap Up.** Summarizing, reminding, reflecting, restarting, connecting. |
| **After collecting the completed worksheets, gain the whole groups attention and discuss:**  **Today we build a spectroscope and looked at a variety of light sources. What were the gasses that we looked at? (Hydrogen, helium, nitrogen)**  **One of the things we assume about hydrogen or helium or any other element is that the element works about the same way whether it is here on earth or somewhere else in the galaxy. One of the things that light can do is travel a long way. When we use a spectroscope to look at starlight, we see that stars dozens or hundreds of light years away are made of the same elements that we encounter on earth. This is a way that a spectroscope can help us understand the universe.**   * ***Review/Summary: wrap up what has been learned and accomplished in the lesson (even if they are in the middle of an exercise, it is still important to summarize to the point where they are now). Ideally involve students in this synthesis.*** * ***Preview for next lesson: link what they did to day with where they are going next.*** * ***Upcoming assignments: remind them of any upcoming assignments.***   ***Today we…. Turn to your partner and…. Let’s review our I Can statements……***  ***Here is your exit ticket for today…..***Of the gasses we looked at, which has the simplest emission spectrum?  **Follow-up Activities/Extension *These may be designed to create a longer or more intense lesson. For example, if the class is able to cover the material in a lesson much faster than expected, extensions may prove helpful. Extensions may also be useful in various parts of a lesson where the teacher (and class) decides they should spend more time on a skill or topic.***  ***Reflection: You must reflect on every lesson you teach.*** | |

**NOTES:**

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