



Fun with a Spectrometer

Boys and Girls Club After School Science
NSF Center for Chemical Innovation
Chemistry at the Space Time Limit (CaSTL)
<https://www.castl.uci.edu/>

Standard(s) Addressed:

Children know an object is seen when light traveling from the object enters the eye.
Children observe the effects of a diffraction grating in a spectrometer on white light and the light from a laser pointer.

Lesson Objective:

Children will be able to know that light travels in a straight line but spreads out into its component colors when it strikes a diffraction grating within a spectrometer. They will notice the different effects the diffraction grating has on white light and the light from the laser pointer.

Materials Used:

For each child:

A homemade spectrometer (a small cardboard box with a slit cut vertically on the right side of the box, a slit cut diagonally along the top at the opposite corner where the broken CD disk will be inserted as a diffraction grating)

laser pointer/LED flashlight

Classroom Management:

Setting up: Before the lesson, assemble the spectrometers and laser pointers/flashlights.

During Explore: While the children are observing the effects of the diffraction grating in the two investigations, teacher will walk around, observe, ask questions, and supervise.

Signal: Stand silently in front of the room, raising hand in the air to get the children's attention.

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ENGAGE: *Connect to Prior Knowledge and Experience, Create Emotionally Safe Learning Environment, Preview New Vocabulary* **Estimated time: 5 – 10 minutes**

Description of Engage: Teacher will engage the children in a discussion regarding light by

asking them to remember the lesson from the previous week with the cups of water and pennies.

Teacher's Role	Teacher Questions	Children's Role
<p>Teacher gets the children interested in the lesson by asking what they learned last week with the cups of water and the pennies.</p> <p>Teacher scripts their words.</p> <p>Teacher asks students for evidence to support their statements.</p> <p>Teacher shows the children the spectrometer that they will use in today's investigation.</p>	<p>Remember last week's investigation with the cups of water and the pennies?</p> <p>What is one thing you learned about what happens to light when it passes through plastic and water?</p> <p>How do you know?</p> <p>Today we are going to investigate what happens to light when it passes through a spectrometer.</p>	<p><i>"Light changes direction and speed."</i></p> <p><i>"We saw different numbers of pennies."</i></p> <p><i>"The teacher pretended to be light and shook some of us as she was going down the aisle. She slowed down and moved to the side."</i></p>

EXPLORE: *Hands-On Learning, Contextualize Language, Use of Scaffolding (Graphic Organizers, Thinking Maps, Cooperative Learning), Use of Multiple Intelligences, Check for Understanding*
Estimated time: 10 – 15 minutes

Description of Explore: First the teacher shows the children the mixing of light colors in the large 'pixel' (red, green, and blue LEDs each with own intensity control). The children see that the 3 colors add to white light. Then teacher shows the children that the spectrometer has slits in it with the diffraction grating and this tool will let us look at white light.

Teacher's Role	Teacher Questions	Children's Role
<p>Teacher asks the children about their experience in mixing colors of paint.</p> <p>Teacher shows the children</p>	<p>Do you know what happens when you mix 3 colors of paint: red, green and blue?</p> <p>Yes. You get black paint.</p> <p>This box has 3 different colors</p>	<p><i>"Brown?"</i></p> <p><i>"Purple?"</i></p> <p><i>"Black?"</i></p> <p><i>"Purple light."</i></p>

<p>the box that holds three LED lights. The teacher changes the intensity of each and shows the children what happens when the lights are added together.</p> <p>Teacher shows that all three colors of light add to white light.</p> <p>Teacher transitions into the investigation.</p> <p>Teacher models what to do in each investigation using the spectrometer.</p>	<p>of light: red, green, and blue light. What do you think will happen when I mix red and blue light?</p> <p>What about if I add all the colors of light together?</p> <p>When I mix all these colors of light, I get _____.”</p> <p>How could I show that white light has all three colors of light in it?</p> <p>You are going to do two investigations: white light hitting the diffraction grating and then red laser light hitting it.</p> <p>As teacher walks around the room, teacher asks each child:</p> <ol style="list-style-type: none"> 1. What happens to the white light when it travels through the spectrometer? 2. What happens to the red laser light when it travels through the spectrometer? <p>Use this sentence frame:</p> <p>I see _____ when the</p>	<p>“<i>Black light?</i>”</p> <p>Children complete the teacher’s sentence, after seeing the results: “<i>Bluish white light.</i>”</p> <p>“<i>You need to split it apart.</i>”</p> <p>Children will shine their flashlights into the side slit and observe what colors they see after the light hits the diffraction grating.</p> <p>They will repeat the investigation with the red laser light.</p> <p>Children complete the worksheet with their observations.</p> <p>“<i>We see the colors of the rainbow.</i>”</p> <p>“<i>We see red light only.</i>”</p> <p>“<i>I see the colors of the</i></p>
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	<p>white light hits the diffraction grating.</p> <p>The red laser light _____ when it travels through the spectrometer.</p>	<p><i>rainbow when the white light hits the diffraction grating.</i></p> <p><i>“The red laser light changes direction when it travels through the spectrometer. I see only red light.”</i></p> <p>Ask questions if they are unclear or unsure.</p> <p>Children are responsible for their own safety and the safety of others.</p>
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EXPLAIN: *Listening, Speaking, Reading, and Writing to Communicate Conceptual Understanding* **Estimated time: 20 minutes**

Description of Explain: Children will present their findings to the class one at a time. The teacher will encourage discussion by asking questions about their observations of the light spreading into different colors or changing direction.

Teacher’s Role	Teacher Questions	Children’s Role
<p>Teacher asks the children probing and clarifying questions.</p> <p>The teacher reminds the children that the word that scientists use to talk about the spreading of white light into the colors of the rainbow is “diffraction.”</p>	<p>What did you observe happen to the white light when it hit the CD diffraction grating?</p> <p>Does the red laser light spread out into the colors of the rainbow?</p> <p>The word that scientists use to describe this spreading of white light into the colors of the rainbow is: diffraction.</p> <p>Can you say that word?</p>	<p><i>“It spread out into the colors of the rainbow.”</i></p> <p><i>“No. The red light only has red in it. It does not have the other colors.”</i></p> <p><i>“Diffraction”</i></p>

EVALUATE: *Thinking Maps, Summarize Lesson and Review Vocabulary, Variety of Assessment Tools, Games to Show Understanding* **Estimated time: throughout**

Description of Evaluate: The children will be assessed whether or not they learned the function of the spectrometer: to spread light into its component colors.

Teacher’s Role	Teacher Questions	Children’s Role
<p>Teacher monitors the children’s understanding to be sure they know the purpose of</p>	<p>What is this box called?</p>	<p><i>“Spectrometer”</i></p>

<p>the spectrometer: to spread white light into its different colors (diffraction).</p>	<p>What do scientists do with it?</p> <p>What do we call the property of light that describes the spreading of light into the colors of the rainbow?</p>	<p><i>“Spread out white light into the colors of the rainbow”</i></p> <p><i>“Diffraction”</i></p>
<p>EXTEND/ELABORATE: <i>Group Projects, Plays, Murals, Songs, Connections to Real World, Connections to Other Curricular Areas</i> Estimated time: 5 – 10 minutes</p> <p>Description of Extend/Elaborate: Teacher gives the children a spectrometer to take home. Their task is to find two or three other sources of light and use their spectrometer to see what colors make up the light they see.</p>		
<p>Teacher’s Role</p>	<p>Teacher Questions</p>	<p>Children’s Role</p>
<p>Teacher tells the children that they can take their spectrometer home.</p>	<p>OK. Now here is what you are going to do. You can take the spectrometer home with you. It is yours to keep.</p> <p>Find two or three other sources of light in your home and use your spectrometer to see what colors make up the light you see.</p>	<p><i>“Yay! We can really take the spectrometer home with us?”</i></p>

Name _____

Fun with a Spectrometer

First, describe your tool. What does a spectrometer do?

Describe the difference(s) between sending the white light vs. the laser pointer into your spectrometer.

Flashlight	Laser pointer
What I see:	What I see:

What do these differences tell you about the two sources of light?

The white light has _____.

The laser pointer has _____.

Common Characteristics of Lesson Plans

Get Children into the Learning--Connect to Their Prior Knowledge

Exploration/Investigation/Hands-On Learning

Making Meaning--Teachers and Children Together

Evaluation/Assessment

Extension to the Real World or Other Curricular Areas

Other Aspects to Consider:

The lesson is Child-Centered--the child is listening, speaking, reading, writing and drawing. The child is thinking.

The children talk more than the teacher talks.