



# Stackable Instructionally- embedded Portable Science (SIPS) Assessments Project

## Grade 8 Science Unit 4 Sample Lesson “Bending and Bouncing Light Rays” Providing Solutions to Problems Using Simple Wave Properties August 2023

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## Science Grade 5

### Unit 4: Providing Solutions to Problems Using Simple Wave Properties

#### Sample Lesson: Bending and Bouncing Light Rays

**Suggested Time to Complete:** 300 minutes

**Purpose & Use Statement:** This sample lesson was developed for state and local administrators and teacher leaders (e.g., curriculum directors, instructional facilitators, professional learning specialists) to (1) illustrate an example of an instructional lesson developed using a principled design approach, and (2) support accompanying process documentation about how to use the SIPS unit as an instructional framework to intentionally design high-quality lessons in an aligned curriculum, instruction, and assessment system. This sample lesson should be evaluated and refined, as necessary, to align appropriately with a standards-based curriculum, instruction, and assessment system prior to its use. Additionally, teachers should refine this lesson to meet the local, cultural, and individual needs of the students.

### Desired Results

#### Overview of the Learning Goals

In this lesson, “Bending and Bouncing Light Rays”, students engage in a series of activities to use prisms and other objects to examine how light is reflected and refracted and how different properties of light are involved in the bending of light, and to generate questions based on those observations. Students design and carry out investigations to determine how light interacts with different materials with a focus on a specific property of light.

#### Connections to Prior Learning

*DCIs – PS4.A & PS4.B (from NGSS Appendix E: DCI Progression within NGSS)*

- **Prior learning from 3-5 (NRC Framework)**

- Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks). Waves can add or cancel one another as they cross, depending on their relative phase (i.e., relative position of peaks and troughs of the waves), but they emerge unaffected by each other. (Boundary: The discussion at this grade level is qualitative only; it can be based on the fact that two different sounds can pass a location in different directions without getting mixed up.)

#### *CCC - Patterns*

- **Prior learning from 3-5:** Students identify similarities and differences, identify patterns related to time, and use patterns to make predictions and categorizations.
  - Ten PEs in 3-5 use this CCC. Some uses are similar to the elements of the CCC used in this unit’s 2 PEs with the Patterns CCC (e.g., 3-PS2-2 involves making a prediction, which is possible because of cause-and-effect relationships; 5-ESS1-2 involves representing data in graphical displays to reveal patterns).
- **Prior learning from this grade band (e.g., Grades 6 & 7):** Students are expected to use graphs, charts, and images to identify patterns in data. They are also expected to use cause-and-effect relationships to identify patterns in data (Appendix G)
  - Multiple MS PEs use this CCC, so students will likely have some experience with the MS CCC elements before starting Grade 8 Unit 4.

#### *CCC – Systems and System Models*

- **Prior learning from 3-5:** Students are expected to understand that a system is composed of components that interact with one another and that the system can do things that depend on the different components, which may each have a unique function, and that the components operating together can enable the system to carry out functions that individual parts cannot.

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- **Prior learning from this grade band (e.g., Grades 6 & 7):** Students are expected to develop additional sophistication in identifying the way that components of a system interact with one another and with the environment (surroundings) of the system.
  - Multiple MS PEs use this CCC, so students will likely have some experience with the MS CCC elements before starting Grade 8 Unit 4.

#### *CCC – Cause & Effect*

- **Prior learning from 3-5:** Students become adept at identifying/testing causes and effects and become aware that events can be correlated but not causally related.
  - 13 Grade 3-5 PEs use this CCC, so students will likely have substantial experience with the CCC prior to MS. An example PE that uses the CCC in a way that presages this unit's PE's CCC element (*Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability*) is 4-ESS3-2 (*Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.*) because solutions' effectiveness can be impacted by multiple factors and their intended effects might be best described probabilistically.
- **Prior learning from this grade band (e.g., Grades 6 & 7):** Students gain experience with multifaceted causal relationships, distinguishing between correlation and causation, and using cause-and-effect relationships to make predictions.
  - 15 MS PEs use this CCC, so students will likely have substantial experience with the CCC during Grades 6 and 7. For example, MS-ESS2-5 (*Collect data to provide evidence for how the motions and complex interactions of air masses result in changes in weather conditions.*) implies examining multifaceted causes and probabilistic outcomes.

#### *SEP- Asking Questions and Defining Problems*

- **Prior learning from 3-5 (e.g., Grades 3 & 4 and/or prior SIPS G5 units):** During Grades 3-5, students should progress in their ability to define problem statements and to identify how objects or tools can be used to address the problem [Appendix F].
  - Define a statement of a problem that can be addressed by an object or tool.
  - Two PEs (3-PS2-3 and 3-PS2-4) focus on Asking Questions and Defining Problems in the domain of relationships of electrical and magnetic interactions.
  - One PE (4-PS4-3) focuses on generating solutions to use patterns to transfer information. (This also integrates Connections of Science, Engineering, and Technology).
- **Prior learning from this grade band (e.g., Grades 6 & 7):** Students progress to specify relationships between variables and clarify arguments and models.
  - Multiple MS PEs use this SEP, so students will likely have some experience with the MS SEP elements before starting Grade 8 Unit 4. MS-PS2-3 is an example MS PE that uses the same SEP element as this unit's PE (MS-ETS1-1).

#### *SEP - Developing and Using Models*

- **Prior learning from 3-5:** Students continue developing their modeling skills and abilities by developing and revising different types of models, along with beginning to consider that models can have limitations. [Appendix G]
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- PE 4-PS4-2 is an example of a 3-5 grade band PE that uses a Developing and Using Models SEP element that is very similar to the SEP element used in this unit.
- **Prior learning from this grade band (e.g., Grades 6 & 7):** Students develop, use, and revise models to describe, test, and predict more abstract phenomena and to design systems.
  - Multiple MS PEs use this SEP, so students will likely have some experience with the MS SEP elements before starting Grade 8 Unit 4. MS-PS2-3 is an example MS PE that uses the same SEP element as this unit's PE (MS-PS4-2).

#### *SEP – Planning and Carrying Out Investigations:*

- **Prior learning from 3-5:** Students should understand how to plan and conduct investigations that provide evidence to support explanations or designs and to include the control of variables. They will be able to evaluate methods and/or tools for collecting data.
  - In Grades 3-5, students will know how to carry out investigations to produce data to serve as the basis for evidence, using tests in which variables are controlled and the number of trials is considered.
  - Students should be able to make predictions about what would happen if a variable changes. [Appendix F]
- **Prior learning from this grade band (e.g., Grades 6 & 7 and/or prior SIPS G8 units):** During all MS grades, students will be able to plan and conduct investigations that use multiple variables and provide evidence to support explanations or solutions. This includes making decisions about the best way to get data that provides the evidence to meet the goals of the investigation.
  - Multiple MS PEs use this SEP, so students will likely have some experience with the MS SEP elements before starting Grade 8 Unit 4.
  - An example MS PE that uses the same SEP element (i.e., students will have had experience with this SEP if they were previously taught this MS PE) is MS-PS3-4. *Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.*

#### **Key Vocabulary**

Students build conceptual meaning with and use key tier II and tier III vocabulary terms as they make sense of phenomena and phenomena-based design problems. This is not an exhaustive list of terms, and should be reviewed and modified by educators, as appropriate.

- Reflection
  - Refraction
  - Absorption
  - Transmission
  - Dispersion
  - Angle of incidence
  - Angle of reflection
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#### Targeted Stage 1 Learning Goals

##### Acquisition Goals (AG)

A11: Examine how light is reflected and refracted when interacting with matter to develop questions about how properties of matter reflect or refract light waves.
A12: Use the ray model of light to explain how reflection and refractions of different wavelengths of light occur when interacting with a prism, lens, or other matter.
A13: Plan and carry out an investigation to explain how and why certain properties (wavelength, nature of materials) result in differences in the bending of light.
A15: Design and carry out an investigation to determine the way that light interacts with different materials, including the way different light frequencies are affected by a transition from one medium to another.
A16: Develop a model for the path of different frequencies of light through the interface of different media that uses the ray model of light.

##### Common Core State Standards (CCSS):

S.L.8.5	MP4
MP.2	

##### Enduring Understandings (EU)/ Essential Questions (EQ):

EU/EQ2	EU/EQ3
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Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<input type="checkbox"/> Analyze & Interpret Data <input checked="" type="checkbox"/> Ask Questions <input type="checkbox"/> Construct Explanations <input type="checkbox"/> Define Problems <input type="checkbox"/> Design Solutions <input checked="" type="checkbox"/> Develop & Use Models <input type="checkbox"/> Engage in Argument from Evidence <input type="checkbox"/> Mathematics & Computational Thinking <input type="checkbox"/> Obtain, Evaluate, & Communicate Information <input checked="" type="checkbox"/> Plan & Carry Out Investigations	<input checked="" type="checkbox"/> PS4.A: Wave Properties <ul style="list-style-type: none"> <li>• A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude. (MS-PS4-1)</li> </ul> <input checked="" type="checkbox"/> PS4.B: Electromagnetic Radiation <ul style="list-style-type: none"> <li>• When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object's material and the frequency (color) of the light. (MS-PS4-2)</li> <li>• The path that light travels can be traced as straight lines, except at surfaces between different transparent materials (e.g., air and water, air and glass) where the light path bends. (MS-PS4-2)</li> <li>• A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media. (MS-PS4-2).</li> </ul>	<input checked="" type="checkbox"/> Cause & Effect <input type="checkbox"/> Energy & Matter <input checked="" type="checkbox"/> Patterns <input type="checkbox"/> Scale, Proportion, & Quantity <input type="checkbox"/> Stability & Change <input type="checkbox"/> Structure & Function <input checked="" type="checkbox"/> Systems & System Models

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#### Formative Assessment Opportunities

Monitoring	Success Criteria	Possible Instructional Adjustments
<ul style="list-style-type: none"> <li>At the start of the lesson, as students share their thinking about examples of light interacting with objects, the teacher considers what examples are missing and poses questions that encourage students to consider other ways that light interacts with objects.</li> <li>While students are creating their organizer or noting their definitions for the key terms, the teacher observes student responses and considers questions and opportunities to challenge student thinking that will help them refine their terms while working on the stations.</li> </ul>	<p>Students can:</p> <ul style="list-style-type: none"> <li>Recall examples of light interacting with objects.</li> <li>Create initial definitions for key vocabulary terms based on prior knowledge.</li> </ul>	<ul style="list-style-type: none"> <li>The teacher provides organizer templates for students who struggle with organization.</li> <li>The teacher provides a sheet of paper with key terms listed.</li> <li>The teacher allows students alternative methods for sharing their thinking that does not require speaking in front of the class.</li> <li>Advanced students organize the examples in small groups, share their thinking within the group, and document their logic and reasoning.</li> </ul>
<ul style="list-style-type: none"> <li>As students explore the stations, the teacher cycles around the room, observing students and asking probing questions that challenge students to think deeply about how to design an experiment to understand how light interacts with different objects and how to look for evidence needed to answer their questions. The teacher challenges student misconceptions as they develop their experimental design.</li> <li>When students submit their experimental design for</li> </ul>	<p>Students can:</p> <ul style="list-style-type: none"> <li>Observe and document how light interacts with objects in different ways.</li> <li>Refine definitions based on new information from activities.</li> <li>Design an experiment to better understand how light interacts with different objects.</li> <li>Describe what evidence is needed to answer questions about a phenomenon related to the properties of light waves, lenses, and prisms, and how they help build toward an</li> </ul>	<ul style="list-style-type: none"> <li>The teacher provides sub-questions and additional guidance for students who may feel overwhelmed.</li> <li>The teacher utilizes heterogeneous groupings to support students of all levels.</li> <li>The teacher provides definitions for subject-specific language.</li> <li>Advanced students can utilize protractors and gather quantitative data as part of their</li> </ul>

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<p>feedback, the teacher should review the design to ensure that the procedure will help the students answer their questions and that they are properly limiting variables.</p>	<p>explanation of the phenomenon.</p> <ul style="list-style-type: none"><li>• Describe how to conduct an investigation to answer scientific questions about the way that light interacts with different materials, including the way different light frequencies are affected by a transition from one medium to another.</li><li>• Make observations and/or measurements to produce data to answer scientific questions about the way that light interacts with different materials, including the way different light frequencies are affected by a transition from one medium to another.</li><li>• Use observations and/or data to generate a conclusion about the frequency-dependent bending of light at a surface between media.</li></ul>	<p>procedure and experiment.</p>
<ul style="list-style-type: none"><li>• While students analyze their data and work on conclusions, the teacher walks around the room and continues to monitor for misconceptions, while also providing support and questioning students about patterns in the data and the impact of changes on how light interacts with different materials.</li><li>• While students are presenting their information, the teacher makes note of key information shared and considers what elements of</li></ul>	<p>Students can:</p> <ul style="list-style-type: none"><li>• Explain a conclusion based on experimental data.</li><li>• Develop a model to show the process of selective reflection and refraction as different wavelengths of light are passed through a prism.</li><li>• Describe and use the ray model as evidence to show how the path of different frequencies of light through the interface of different media can be predicted.</li><li>• Develop a model to show how the path that light travels can be traced as straight lines, except at surfaces between</li></ul>	<ul style="list-style-type: none"><li>• The teacher uses questions and sub-questions to assist students who need additional support.</li><li>• The teacher provides alternative methods for students to share their conclusions in a way that makes sense for them.</li><li>• The teacher creates a shared document for students to record key takeaways as a class.</li></ul>

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how light interacts with objects are missing from the students' conclusions. The teacher uses this information to adjust plans for future instruction.	different transparent materials (e.g., air and water, air and glass) where the light path bends.
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### Instructional Plan

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#### Lesson Overview

In this lesson, students observe and experience reflection, refraction, absorption, transmission, dispersion, and addition of light at a series of stations. The stations each have instructions and provide students with context on individual properties of light and familiarity with optics equipment that they may not otherwise be familiar with. While engaging in each of the activities, students create an annotated drawing for each activity that provides a beginning explanation about the particular property of light and create a list of questions that they have about the individual station. Students decide which station they are interested in experimenting with and then work in their groups to develop investigable questions to help them better understand how/why one-way mirrors can allow some light to pass and reflect other light.

Next, students utilize a one-way mirror, glass, a regular mirror, a prism, and other objects to conduct their experiments to understand how one property of light is impacted when light interacts with different materials. Using ray boxes, students shine beams of light onto objects in different brightness and at different angles to explore how light changes when it interacts with matter and collect qualitative data. Students who are performing above grade level may also collect quantitative data. Students write a conclusion based on their data and share their findings with their peers.

Students then build on their multimodal explanatory model of the phenomenon after finding as a class that the one-way mirror reflects some light and transmits some light, the regular mirror reflects most of the light, and the glass reflects a small amount of light and transmits most of the light. Using the prism, they will find that not all light is transmitted in the same way.

#### Materials & Set-Up

*This activity was written with a particular optics kit in mind, but that is not required. There are many options for equipment and the teacher. Below is a list of equipment with potential replacements. Some retailers will sell most of the equipment listed as a single kit.*

- Light ray box with options for single and multiple rays
    - Other light sources may work, but they need to emit a line of light, not just a single dot.
  - Assorted objects that are transparent, translucent, and opaque
  - One-way mirror
  - Standard mirror
  - Triangular prism
  - Rectangular prism
  - White screen or blank wall
  - Color filters for ray box
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#### Anchor or Investigative Phenomenon:

For Segment 3, students observe the phenomenon of a one-way mirror which allows one group of individuals to look into a room without being seen. Students are challenged to explain how an object can allow some people to see through and prevent others.

**Driving Question:** How does light interact with different materials?

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#### Teacher Does

#### Students Do

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#### Engage

- Introduce object, event, phenomenon, problem, or question
  - Build background knowledge
  - Facilitate connections
- 

#### Explore

- Explore object, event, phenomenon, problem, or question
- Guided exploration with hands-on activities

To open class, the teacher poses to students the driving question for the day, “How does light interact with different materials? What examples come to mind?” After providing wait time, students record their thoughts in their notebooks before the class discusses some initial ideas. Students share examples of light interacting with different materials by writing them on sticky notes and then sharing them out loud with the class. Then, students place the sticky notes on a board or other visible space. To model sorting and critical thinking, the teacher does a think-aloud where they sort the different examples into groups related to the key terms (refraction, reflection, absorption, transmission, dispersion, and the addition of light). *A think-aloud is when the speaker says what they are thinking out loud to model their thinking process for others. As the teacher decides how to group the examples, the teacher talks about why they are*



Students consider and then write their thinking in response to the opening prompt. They record ideas they have for examples of light interacting with different objects on a sticky note. After appropriate wait time, students share their examples with the class and place their sticky notes on a board or other common space. Students listen as the teacher models how to sort the sticky notes and the use of evidence to guide their thinking.

Students discuss the key terms with a seat partner and then record their thinking about the terms in their notebooks or utilize a vocabulary strategy such as Frayer model.

Students explore a series of activities using ray boxes that allow them to observe light interacting with a variety of objects. As they explore the activity, students record observations in their notebooks.

After they explore, students draw an annotated drawing for

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*grouping them. For example: "Mirrors and the surface of water both involve seeing something else on the object, reflecting, so I am going to put those together. But a window does both, sometimes I can see myself and sometimes I see through it, so I'm going to write that down again at put one with mirrors and one over here with I can see into my plastic sandwich bag."*

The teacher shares with students the key vocabulary for the lesson and places them with their associated examples. The teacher does not share a definition yet. (Angle of incidence and angle of reflection will likely not have any examples.)

The teacher poses to the students, "Which of these terms have you heard of? What do you think these terms mean?" The teacher provides students with an opportunity to think and then students turn and talk about the vocabulary terms with a peer. After chatting with the peer, the teacher asks students to record their thinking in their notebooks or another organizer such as a [Frayer model organizer](#).

The teacher instructs students about the last two key terms listed (angle of incidence and angle of reflection) if students are not familiar with these terms. Students will need knowledge of these terms for some of the activities. *Note:*

the activity and make note of any questions they or someone else may have after completing the task. They add information to their vocabulary terms that are related to the particular activity.



After completing all of the activities and drawings, students select one activity to focus on for designing an experiment. Students design an experiment to learn more about how light interacts with one-way mirrors in the ways seen at that station. For example, students may want to explore how different colors of light at different brightness levels interact with a one-way mirror and other objects. They may want to explore how the angle of incidence impacts the light that is reflected and the light that passes through the one-way mirror and other objects. After creating their design, students share their design with at least two peers for feedback before sharing it with the teacher for final approval.

Once their design is approved, students conduct their experiment.

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*Snell's law is above grade level. The purpose of this is to provide familiarity with the two terms and to help students speak in a common language when talking about the incoming and outgoing rays/angles as they qualitatively explore the activities. For students who are above grade level, the teacher may want to encourage them to explore the relationship between angles as part of their experiment later in the lesson.*

The teacher transitions to the station activities by explaining to students that they will explore more about how light interacts with a variety of objects and situations. As students go around, they should make observations and create annotated drawings for each situation. After they create their drawings, they write any questions they still have about the activity. Students also add information to their vocabulary organizers and refine their definitions of the key terms.

As the students explore the stations, the teacher moves around groups monitoring challenges and encouraging students to think deeply through probing questions, making note of topics that may need to be revisited before moving forward. Potential station instructions are included in *Appendix A*, and they should be modified based on the equipment available and the needs of students.

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Following the station activities, the teacher presents to students the next phase of the lesson; designing and conducting an experiment related to one-way mirrors and some of the different ways that light can interact with matter. Students select one of the activities to explore deeper and develop a question to investigate deeper. Students may want to refer to the questions they generated during the station activities to help them. Once students have a question, the teacher instructs them to design an experiment that involves a one-way mirror and other objects. After students create a procedure, they share their procedure with two other groups for feedback before finalizing it and submitting it to the teacher for review. After the teacher approves their procedures, students conduct their experiment and gather data. Students who are above grade level may be challenged to collect quantitative data such as angles of incidence and reflection and students at grade level may focus on qualitative observations.

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#### **Explain**

- Explain understanding of concepts and processes
- Introduce new concepts and skills to seek conceptual clarity

The teacher supports students as they analyze their data and write a conclusion. Students create an artifact or resource to share their conclusions with their peers such as posters, presentation slides, videos, or other aids. The teacher encourages students to find



After conducting their experiment, students review their data and draw conclusions based on their findings. Students create an artifact to share and present their findings to their peers.

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patterns within their data by using questioning strategies to help guide them and make clear challenging parts, without directly telling them what their data shows. The teacher may want to suggest different data analysis tools such as google sheets or [CODAP](#), depending on their needs.

Next, students present their findings to the class. As their peers share their findings students take notes of key takeaways and record them in their notebooks.

Students present their findings to peers, answering their questions and sharing key takeaways from their experiment as related to the segment phenomenon. As other students are presenting, students take notes and record key takeaways in their own notebooks to use later.

After all students have presented, students return to their multimodal explanatory model and make revisions and additions based on what they have learned about how light interacts with different objects in different ways.

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#### Elaborate

- Build on or extend understanding and skill
  - Apply concepts in new or related contexts
- 

#### Evaluate

- Self-assess knowledge, skills, and abilities
  - Evaluate student development and lesson effectiveness
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#### Closing

After all students share their conclusions, the teacher returns to the list of key terms from the start of the lesson. The teacher lists each of the terms, and the class discusses what each means and creates a class definition for each term that students can use in their phenomenon explanations.

Finally, students return to their multimodal explanatory model of the segment phenomenon (one-way mirror) and add information from the lesson to their explanations.

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#### Differentiation Strategies and Resources

“Universal Design for Learning (UDL) is a framework to improve and optimize teaching and learning for all people based on scientific insights into how humans learn” (CAST, 2022). Taking time to reflect on prior instruction when planning for accessible, differentiated, and culturally responsive instruction for diverse learners and culturally diverse classrooms serves to identify ways to improve future instructional practices. The UDL Guidelines provide a framework for this reflection. The guidelines include three principles as ways to focus on variety and flexibility in instructional practices:



Multiple Means of Engagement

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Multiple Means of Representation



Multiple Means of Action & Expression

By examining instruction and instructional materials through the lens of each of these principles, teachers can identify and thus reduce or remove barriers to diverse learners.




Learning Opportunities	UDL Principle	Example Differentiation Strategies & Resources
<b>Explore</b>		
<p><i>Students share examples of light interacting with matter and develop definitions for key vocabulary based on patterns in the examples.</i></p>		<ul style="list-style-type: none"> <li>● Use flexible ways to present information.                             <ul style="list-style-type: none"> <li>○ Wait time between a question and a person’s reply varies across cultures. Therefore, during brainstorming activities (e.g., how does light interact with different materials?) or classroom discussions (e.g., creating definitions for vocabulary words that describe properties of light rays), be aware of this and ensure everyone has the opportunity to contribute.</li> </ul> </li> </ul>
<p><i>Students explore activities in stations that provide opportunities to witness and experiment with some of the ways that light interacts with objects.</i></p>		<ul style="list-style-type: none"> <li>● Encourage collaboration with partners and in groups.                             <ul style="list-style-type: none"> <li>○ Be clear about the purpose and expectations of cooperative group activities (e.g., the task, student roles, expectation of contribution, freedom to share information within and across groups, cooperative and not competitive, etc.).</li> <li>○ Be intentional about how groups are formed so that they include a variety of students (e.g., race, national origin, socioeconomic status, disability, etc.).</li> <li>○ Ensure everyone has the means to contribute. For some this might be to assign a role that matches their strengths, for some, it might be to provide needed vocabulary on their <a href="#">AAC</a> system, and for some, it might be to reduce the size of the group and allow options for seating (e.g., exercise ball).</li> </ul> </li> </ul>
		<ul style="list-style-type: none"> <li>● Use flexible ways to present information.                             <ul style="list-style-type: none"> <li>○ Tactually enhance materials.</li> </ul> </li> <li>● Describe light to students who are blind or have a visual impairment (e.g., There is a glass half-filled with water. We have a pencil that is straight. When we put the pencil in the water, it looks like it bends in the water.) and provide a tactile example when feasible (e.g., a raised line outline of glass, the water line, and the pencil in the water).</li> </ul>

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<p><i>Students design and conduct an experiment on one of the ways that light interacts with objects.</i></p>		<ul style="list-style-type: none"> <li>• Support planning and strategy skills.               <ul style="list-style-type: none"> <li>○ Include prompts to check their thinking and strategy for solving a task.</li> <li>○ Check in with students to see if they understand the task and if they need support to understand a concept.</li> </ul> </li> </ul>
<b>Explain</b>		
<p><i>Students analyze their experimental data and develop a conclusion based on the results.</i></p>		<ul style="list-style-type: none"> <li>• Vary the ways for students to respond to questions or a task.               <ul style="list-style-type: none"> <li>○ Allow students to use their preferred mode of communication to respond to questions and present information (e.g., writing in the dominant language and then transcribing into a second language, providing in writing, using <a href="#">AAC</a>, etc.).</li> </ul> </li> </ul>
<p><i>Students share their conclusion and key takeaways with their class.</i></p>		<ul style="list-style-type: none"> <li>• Emphasize key information.               <ul style="list-style-type: none"> <li>○ Use graphic organizers, outlines, underline or highlight key information in print materials, etc.</li> </ul> </li> </ul>

### Resources

- [SERP: Frayer Model](https://www.serpoinstitute.org/rtls-strategy-2)  
[https://www.serpoinstitute.org/rtls-strategy-2]
- [SERP: Reading Strategies](https://www.serpoinstitute.org/reading-science/classroom-strategies)  
[https://www.serpoinstitute.org/reading-science/classroom-strategies]
- [NSTA: A Layered Approach to Scientific Models](https://www.nsta.org/science-teacher/science-teacher-septemberoctober-2020/layered-approach-scientific-models)  
[https://www.nsta.org/science-teacher/science-teacher-septemberoctober-2020/layered-approach-scientific-models]
- [TERC: Annotated Drawings](https://inquiryproject.terc.edu/curriculum/curriculum5/resources/annotated/index.html)  
[https://inquiryproject.terc.edu/curriculum/curriculum5/resources/annotated/index.html]
- [Science Buddies: 16 Lessons About Visible Light](https://www.sciencebuddies.org/blog/teach-visible-light-science)  
[https://www.sciencebuddies.org/blog/teach-visible-light-science]
- [Amazon: Deluxe Optics Kit](https://www.amazon.com/Deluxe-Optics-Kit-Components-Activities/dp/B00ANPF4CG) (This is provided as an example of a ray box that was utilized for the creation of the lab.)  
[https://www.amazon.com/Deluxe-Optics-Kit-Components-Activities/dp/B00ANPF4CG]
- [BBC: Reflection, Refraction, and Sound Waves](https://www.bbc.co.uk/bitesize/guides/zxk6v9q/revision/5) (Includes some advanced topics)  
[https://www.bbc.co.uk/bitesize/guides/zxk6v9q/revision/5]
- [The Physics Front: Light, Prisms, and the Rainbow Connection](https://www.compadre.org/precollege/items/detail.cfm?ID=8957)  
[https://www.compadre.org/precollege/items/detail.cfm?ID=8957]
- [The Physics Front: Nature and Behavior of Light Unit](#)

## Science Grade 5

### Unit 4: Providing Solutions to Problems Using Simple Wave Properties

#### Sample Lesson: Bending and Bouncing Light Rays

**Suggested Time to Complete:** 300 minutes

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[<https://www.compadre.org/precollege/static/unit.cfm?sb=13&course=1>]

- [Teach Engineering: Learning Light's Properties](#)

[[https://www.teachengineering.org/lessons/view/van\\_troll\\_lesson02](https://www.teachengineering.org/lessons/view/van_troll_lesson02)]

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#### Core Text Connections

- [CK 12: Visible Light](#)

[<https://flexbooks.ck12.org/cbook/ck-12-middle-school-physical-science-flexbook-2.0/section/19.1/primary/lesson/sources-of-visible-light-ms-ps/>]

- [Britannica: Light](#)

[<https://www.britannica.com/science/light>]

- [Let's Talk Science: Light and Its Properties](#)

[<https://letstalkscience.ca/educational-resources/backgrounders/light-and-its-properties>]

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## Science Grade 5

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## Appendix A

### Exploring the Properties of Light

#### *Introduction*

In this series of hands-on activities, you will have the opportunity to investigate the fascinating properties of light. As you experiment with the different setups consider what is happening with the behavior of light and what that means for its properties.

#### Materials:

1. Ray box (light source)
2. Various objects (transparent, translucent, and opaque)
3. Mirror
4. Triangular prism
5. Rectangular prism (transparent rectangular object)
6. White screen or blank wall
7. Colored filters
8. Notebook and pen/pencil

#### *Part One: Activities and Stations:*

1. Reflection of Light:
  - a) Set up the ray box to emit one light ray.
  - b) Position the flat mirror in front of the ray so that the light hits the mirror.
  - c) Observe the reflected light and then adjust the angle of incidence (angle between the incoming ray of light and the surface) and observe what happens to the angle of reflection (angle of reflected ray of light and the surface).
  - d) Write what you observe in your scientific notebook.
  - e) Write what questions you or someone else might have about what you observed.
  - f) Draw in your notebook an annotated drawing of your set up that explains what you think is the relationship between the angle of incidence and the angle of reflection. Be sure to include labels, arrows, and a key.
2. Refraction of Light:
  - a) Set up the ray box to emit one light ray.
  - b) Place a sheet of paper on the table under the light ray.
  - c) Place a rectangular prism in front of the ray so that the light enters at an angle.

## Science Grade 5

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#### Sample Lesson: Bending and Bouncing Light Rays

**Suggested Time to Complete:** 300 minutes

- d) Trace around the prism and then mark with dots where the light enters and exits the prism. Draw lines on the paper to represent the light going into the prism and the light coming out.
  - e) Remove the ray box and prism. Draw a line to connect the dots that would be inside the prism.
  - f) Observe and record the path of light as it enters and exits the prism.
  - g) Write what you observe in your scientific notebook.
  - h) Write what questions you or someone else might have about what you observed.
  - i) Draw in your notebook an annotated drawing of the setup that shows and explains what you think happens to the path of light when you place the prism in it.
3. Absorption and Transmission of Light:
- a) Gather a variety of objects with different optical properties (transparent, translucent, and opaque).
  - b) Remove the slit filter from the ray box and use it as a wide light source.
  - c) Place each object one at a time between the light source and a white screen or blank wall.
  - d) Observe and record in your notebook how objects affect the passage of light.
  - e) Write what questions you or someone else might have about what you observed.
  - f) Draw in your notebook an annotated drawing of objects in front of a light source that explains what you think occurs when light interacts with objects that are transparent, translucent, or opaque.
4. Dispersion of Light:
- a) Set up the ray box to emit a single ray.
  - b) Obtain a triangular prism and position it so that the ray enters the prism near a corner.
  - c) Observe and record the formation of a spectrum of colors (rainbow) as the light passes through the prism.
  - d) Observe and record what you notice about the angles of refraction for different colors.
  - e) Write what questions you or someone else might have about what you observed.
  - f) Draw an annotated drawing that explains what you think is causing the dispersion of light and how white light splits into its component colors.
5. Color Filters:
- a) Set up the ray box with color filters using the side and center doors. Place a red filter, blue filter, and green filter in each of the three openings. (Note that the side doors have mirrors on them to reflect the light forward. Check with your teacher if you need help with this setup.)
  - b) First, observe the colors of light coming out of each opening. Record your observations in your notebook.

## Science Grade 5

### Unit 4: Providing Solutions to Problems Using Simple Wave Properties

#### Sample Lesson: Bending and Bouncing Light Rays

**Suggested Time to Complete:** 300 minutes

- c) Then, experiment with mixing the colors, and adjust the angles of the mirrored doors to adjust how much light crosses and how the light mixes together. Consider changing and using other filters after you have experimented with red, green, and blue. Record your observations as you go along in your scientific notebook.
- d) Write what questions you or someone else might have about what you observed.
- e) Draw an annotated drawing that explains what you think is occurring when different colors of light are combined.