

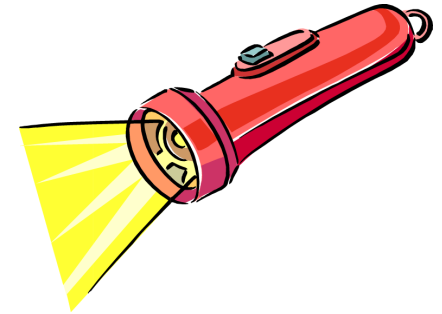
# Light Benders

**Background:** You have learned that light is a form of energy and is transmitted outward from its source. During our study of light, you saw many pictures of angles that were created with lines of reflection. You learned that light travels in straight paths, called rays. You learned that the effective use of reflective materials and an appropriate light source can change the direction of light. We discussed the similarities and differences of reflective surfaces, and we noticed that the angles apply to sunlight, creating shadows of objects.

**Design Challenge:** Design and build a maze through which light can travel to a designated target to demonstrate the concept of angles of reflection.

## Criteria:

- The path of light in your maze must include a 45-degree angle, an angle that is less than 45 degrees, and an angle that is between 45 and 90 degrees.
- Your maze must be at least one square foot in size.
- Your light source can be handheld, but it must remain motionless.
- You must write a paragraph explaining the path of light in your maze.



<b>Materials:</b> Select from the list below.	<b>Tools:</b> Select from the list below.
<ul style="list-style-type: none"><li>• aluminum foil</li><li>• duct or electrical tape</li><li>• glue</li><li>• plastic or paper cup</li></ul>	<ul style="list-style-type: none"><li>• flashlight</li><li>• protractor</li><li>• scissors</li><li>• yard and meter sticks</li></ul>
<ul style="list-style-type: none"><li>• recycled cardboard tubes and boxes</li><li>• small mirrors</li><li>• various items from around the room</li></ul>	

**Targeted Standards of Learning:** Science 5.3  
Supporting SOL: Science 5.1; Mathematics 5.8, 5.12; English 5.1, 5.2, 5.7

**Targeted Standard for Technological Literacy:** 8  
Supporting STL: 3, 9, 10, 11, 16

## Tips for Teachers

### Targeted Standards of Learning:

- Science 5.3 The student will investigate and understand basic characteristics of visible light and how it behaves. Key concepts include
- transverse waves;
  - the visible spectrum:
  - opaque, transparent, and translucent;
  - reflection of light from reflective surfaces; and
  - refraction of light through water and prisms.

Supporting SOL: Science 5.1; Mathematics 5.8, 5.12; English 5.1, 5.2, 5.7

### Targeted Standard for Technological Literacy:

8 Students will develop an understanding of the attributes of design.

Supporting STL: 3, 9, 10, 11, 16

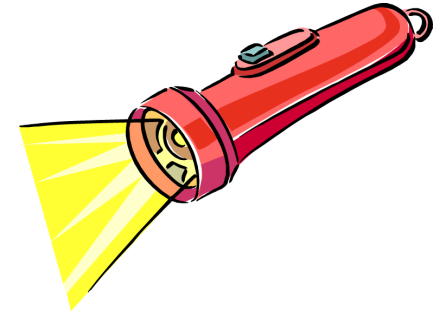
Prior Knowledge & Skill	Materials & Preparation	Safety Issues	Class Management	Materials Provided	Design Process
<ul style="list-style-type: none"> <li>Targeted Science Standards of Learning 5.3</li> <li>Some understanding of the design process</li> </ul>	<ul style="list-style-type: none"> <li>Provide various sizes of cups, cardboard rolls, empty boxes, and mirrors.</li> <li>Provide mirrors that are not made of glass.</li> </ul>	<ul style="list-style-type: none"> <li>Use of scissors</li> </ul>	<ul style="list-style-type: none"> <li>Partners or small groups of no more than four students (not intended for individual work)</li> <li>Each student keeps own Guided Portfolio</li> <li>Group members may work together to help write the required paragraph as long as each student hands in his or her own.</li> </ul>	<ul style="list-style-type: none"> <li>Design Brief</li> <li>Guided Portfolio (adapt as appropriate/optional)</li> <li>Rubric Assessment</li> </ul>	Follow the Design Process: <ul style="list-style-type: none"> <li>Restate the problem.</li> <li>Brainstorm solutions.</li> <li>Create the best solution.</li> <li>Test the solution.</li> <li>Evaluate the solution.</li> </ul>

**Extension Idea:** Students can use artistic skills to transform the maze into a work of art.

**Differentiation Option:** For students with more advanced reading skills, the following page is provided as an alternative to page 1.

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**Design Challenge:** Design and build a maze, at least one square foot in size, through which light can travel to a designated target to demonstrate the concept of angles of reflection. The path of light in your maze must include a 45-degree angle, an angle that is less than 45 degrees, and an angle that is between 45 and 90 degrees. Your light source can be handheld, but it must remain motionless. Write a paragraph explaining the path of light in your maze.

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**Targeted Standards of Learning:** Science 5.3

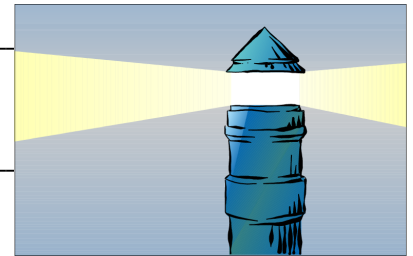
Supporting SOL: Science 5.1; Mathematics 5.8, 5.12; English 5.1, 5.2, 5.7

**Targeted Standard for Technological Literacy:** 8

Supporting STL: 3, 9, 10, 11, 16

Guided Portfolio, p1

Name \_\_\_\_\_



Group Members \_\_\_\_\_

**1. What is the problem?** State the problem in your own words.

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Guided Portfolio, p2

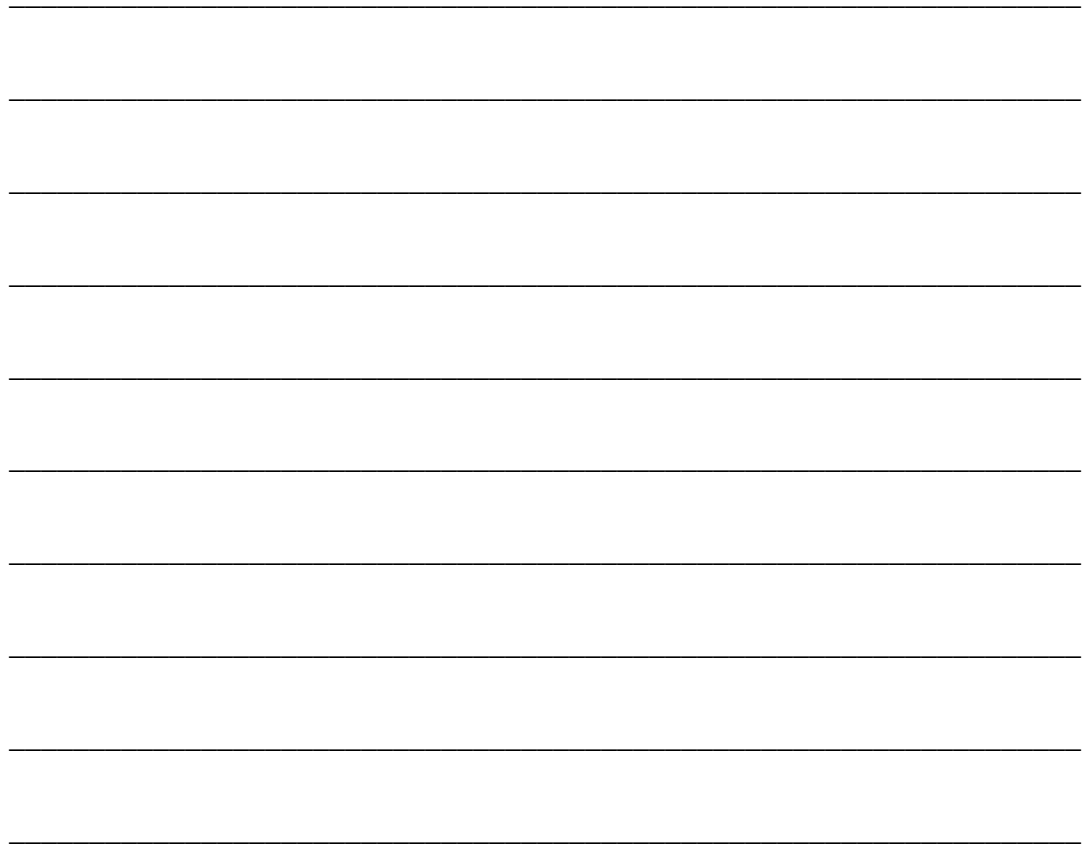
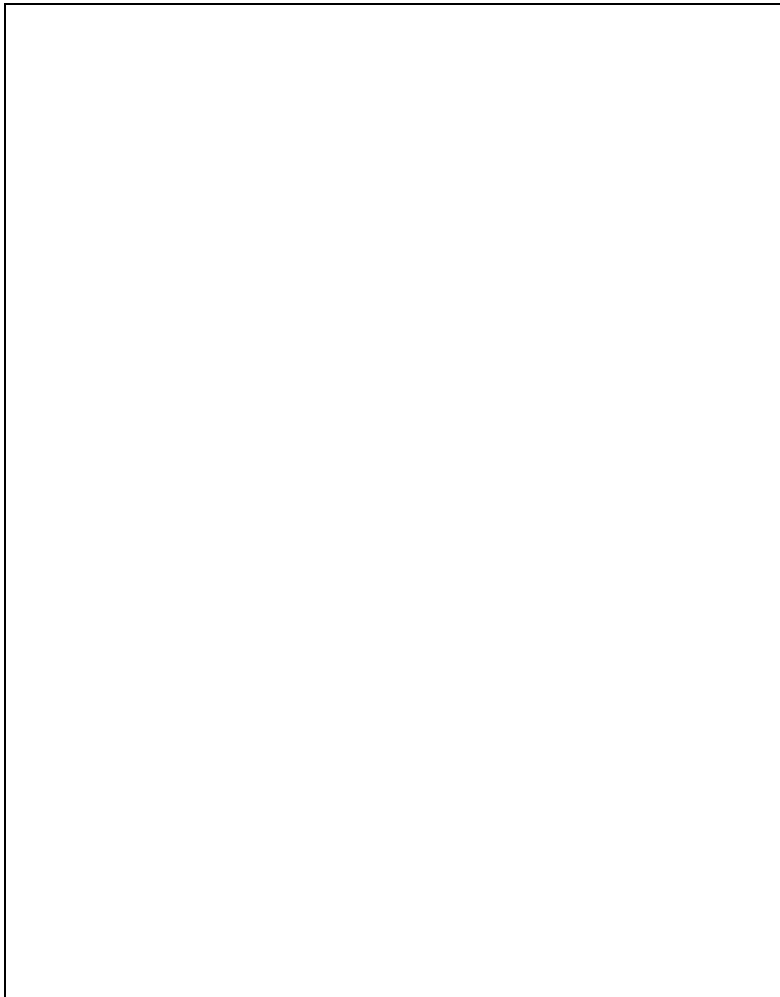
Name \_\_\_\_\_

- 2. Brainstorm solutions.** Sketch some possible light maze designs, showing at least three different angles in each maze. Be sure to label your light source location and the target.


Name \_\_\_\_\_

**3. Create the solution you think is best.**

Keep notes about your problems and how you solve them. Make sketches if they help.



Guided Portfolio, p4

Name \_\_\_\_\_

**4. Test your solution.**

Does your maze have the required three angles? YES NO

Does light hit the designated target? YES NO

Do the mirrors remain freestanding? YES NO

Can you change the direction of the light? YES NO

Did you write a paragraph explaining the path of light in your maze? YES NO

Guided Portfolio, p5

Name \_\_\_\_\_

**5. Evaluate your solution.**

Was your design the best solution? Would one of your other ideas have been better? Why, or why not?

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Describe one thing you could have done differently in the construction of your figure.

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Describe one thing you could add to your figure to make it better.

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## Rubric for Light Benders

Name \_\_\_\_\_ Date \_\_\_\_\_

0—no evidence; 1—limited understanding; 2—some understanding with room for improvement; 3—good understanding with room for improvement; 4—substantial understanding

<b>Design Brief Rubric</b>	<b>0</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>
The student restated the problem in his/her own words.					
The student brainstormed more than one idea.					
The student kept notes and/or made sketches while creating a solution, to include problems and how they were solved.					
The student tested to make sure <ul style="list-style-type: none"> <li>• three angles are shown in the design</li> <li>• the light hits the designated target</li> <li>• the maze fits the size requirements.</li> </ul>					
The student evaluated how he/she could make it better next time.					

## Rubric for Light Benders

Name \_\_\_\_\_ Date \_\_\_\_\_

0—no evidence; 1—limited understanding; 2—some understanding with room for improvement; 3—good understanding with room for improvement; 4—substantial understanding

<b>Communication: Speaking, Listening, Media Literacy Rubric</b>		<b>4</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>0</b>
5.1 The student will listen, draw conclusions, and share responses in subject-related group learning activities. a) Participate in and contribute to discussions across content areas. b) Organize information to present in reports of group activities. c) Summarize information gathered in group activities. d) Communicate new ideas to others. e) Demonstrate the ability to collaborate with diverse teams. f) Demonstrate the ability to work independently.						
5.2 The student will use effective verbal and nonverbal communication skills to deliver planned oral presentations. a) Maintain eye contact with listeners. b) Use gestures to support, accentuate, and dramatize verbal message. c) Use facial expressions to support and dramatize verbal message. d) Use posture appropriate for communication setting. e) Determine appropriate content for audience. f) Organize content sequentially around major ideas. g) Summarize main points as they relate to main idea or supporting details. h) Incorporate visual media to support the presentation. i) Use language and style appropriate to the audience, topic, and purpose.						

## Standards of Learning

### English (2010)

#### *Communication: Speaking, Listening, Media Literacy Rubric*

- 5.1 The student will listen, draw conclusions, and share responses in subject-related group learning activities.
- a) Participate in and contribute to discussions across content areas.
  - b) Organize information to present in reports of group activities.
  - c) Summarize information gathered in group activities.
  - d) Communicate new ideas to others.
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  - d) Use posture appropriate for communication setting.
  - e) Determine appropriate content for audience.
  - f) Organize content sequentially around major ideas.
  - g) Summarize main points as they relate to main idea or supporting details.
  - h) Incorporate visual media to support the presentation.
  - i) Use language and style appropriate to the audience, topic, and purpose.
- 5.3 The student will learn how media messages are constructed and for what purposes.
- a) Differentiate among auditory, visual, and written media messages.
  - b) Identify the characteristics and effectiveness of a variety of media messages.

#### *Writing*

- 5.7 The student will write for a variety of purposes: to describe, to inform, to entertain, to explain, and to persuade.
- a) Identify intended audience.
  - b) Use a variety of prewriting strategies.
  - c) Organize information to convey a central idea.
  - d) Write a clear topic sentence focusing on the main idea.
  - e) Write multiparagraph compositions.
  - f) Use precise and descriptive vocabulary to create tone and voice.
  - g) Vary sentence structure by using transition words.

- h) Revise for clarity of content, using specific vocabulary and information.
- i) Include supporting details that elaborate the main idea.

## **Mathematics** (2009)

### *Measurement*

- 5.8 The student will
- a) find perimeter, area, and volume in standard units of measure;
  - b) differentiate among perimeter, area, and volume and identify whether the application of the concept of perimeter, area, or volume is appropriate for a given situation;
  - c) identify equivalent measurements within the metric system;
  - d) estimate and then measure to solve problems, using U.S. Customary and metric units; and
  - e) choose an appropriate unit of measure for a given situation involving measurement, using U.S. Customary and metric units.

### *Geometry*

- 5.12 The student will
- a) angles as right, acute, obtuse, or straight; and
  - b) triangles as right, acute, obtuse, equilateral, scalene, or isosceles.

## **Science** (2010)

### *Scientific Investigation, Reasoning, and Logic*

- 5.1 The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which
- a) items such as rocks, minerals, and organisms are identified using various classification keys;
  - b) estimates are made and accurate measurements of length, mass, volume, and temperature are made in metric units, using proper tools;
  - c) estimates are made and accurate measurements of elapsed time are made using proper tools;
  - d) hypotheses are formed from testable questions;
  - e) independent and dependent variables are identified;
  - f) constants in an experimental situation are identified;
  - g) data are collected, recorded, analyzed, and communicated using proper graphical representations and metric measurements;
  - h) predictions are made using patterns from data collected, and simple graphical data are generated;
  - i) inferences are made and conclusions are drawn;
  - j) models are constructed to clarify explanations, demonstrate relationships, and solve needs; and
  - k) current applications are used to reinforce science concepts.

### *Force, Motion, and Energy*

- 5.3 The student will investigate and understand basic characteristics of visible light and how it behaves. Key concepts include
- a) transverse waves;
  - b) the visible spectrum;
  - c) opaque, transparent, and translucent;
  - d) reflection of light from reflective surfaces; and
  - e) refraction of light through water and prisms.

## **Standards for Technological Literacy**

- Standard 3: Students will develop an understanding of the core concepts of technology.
- Standard 8: Students will develop an understanding of the attributes of design.
- Standard 9: Students will develop an understanding of engineering design.
- Standard 10: Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.
- Standard 11: Students will develop the abilities to apply the design process.
- Standard 16: Students will develop an understanding of and be able to select and use energy and power technologies.

## Please give us some feedback.

Complete the form below to let us know how this design brief worked for you and your students. Please be specific so that we might use your suggestions to improve the activity. *You can fill this out on your computer, or you can print it, fill it out manually, and scan it.*

Teacher: \_\_\_\_\_

School: \_\_\_\_\_

School division: \_\_\_\_\_

Design brief title: \_\_\_\_\_

<b>Background</b>	<i>Put an X in the appropriate column:</i>	Needs to be rewritten	Needs minor adjustment	Is ready for classroom use
Does it set the context for the activity?				
Is it age-appropriate in language, length, and complexity?				
Does it reference prior learning and/or research that the students did that will facilitate designing a solution to a problem?				
Is it detailed enough that an adult will understand the purpose for the design brief?				
COMMENTS. <i>If any of the questions above are marked other than "ready for classroom use," please provide suggestions here.</i>				

<b>Design Challenge</b>	Needs to be rewritten	Needs minor adjustment	Is ready for classroom use
Does the challenge support your curriculum?			
Is it age-appropriate in language, length, and complexity?			
Is it detailed enough that an adult will understand the purpose for the design brief?			
COMMENTS. <i>If any of the questions above are marked other than "ready for classroom use," please provide suggestions here.</i>			

<b>Criteria</b> Criteria are part of the challenge. They set the limitations for the design. They are not directions.	Needs to be rewritten	Needs minor adjustment	Is ready for classroom use	N/A
Are the limitations age-appropriate?				
Do the limitations encourage critical thinking?				
Is the application of mathematic knowledge/skills integrated into the criteria? If not, should the skill area be addressed?				
Is the application of science knowledge/skills integrated into the criteria? If not, should the skill area be addressed?				
Is the application of social studies knowledge/skills integrated into the criteria? If not, should the skill area be addressed?				
Are language skills integrated into the criteria? If not, should the skill area be addressed?				
COMMENTS. <i>If any of the questions above are marked other than "ready for classroom use," please provide suggestions here.</i>				

<b>Materials</b> Materials help set the limitations for the design. The list should include materials that might work.	Needs to be rewritten	Needs minor adjustment	Is ready for classroom use	N/A
Does the materials list encourage a variety of design solutions?				
Does the materials list include a variety of choices for joining items?				
Does the materials list include materials that force students to make decisions?				
COMMENTS. <i>If any of the questions above are marked other than "ready for classroom use," please provide suggestions here.</i>				

<b>Tools</b> Tools can be used in the construction of the designed product. They are used to manipulate materials. They cannot become part of the product.	Needs to be rewritten	Needs minor adjustment	Is ready for classroom use
Are the tools listed age appropriate?			
Are all tools needed for the activity included?			
COMMENTS. <i>If any of the questions above are marked other than "ready for classroom use," please provide suggestions here.</i>			



<b>Standards of Learning</b>	Yes	No
Does the design brief reinforce the targeted Standard of Learning(s)?		
Are the supporting Standards of Learning appropriate?		
What Standards of Learning would you add or remove?		

<b>Standards for Technological Literacy</b>	Yes	No
Does the design brief reinforce the targeted Standard(s) for Technological Literacy?		
Are the supporting Standards for Technological Literacy appropriate?		
What Standards for Technological Literacy would you add or remove?		

<b>Tips for Teachers</b>	Yes	No
Are the tips listed in the chart helpful for a first-time teacher?		
What tips would you add?		

<b>Guided Portfolio</b>	Needs to be rewritten	Needs minor adjustment	Is ready for classroom use
Are the instructions and questions age appropriate and clear?			
In the "Test your solution" section, do the questions force students to thoroughly test their solutions?			
In the "Evaluate your solution" section, do the questions force students to honestly evaluate their solutions			
COMMENTS. <i>If any of the questions above are marked other than "ready for classroom use," please provide suggestions here.</i>			

<p><b>Additional Comments</b> Please use this area to provide general suggestions for improving this design brief.</p>