

# Build Your Own Sunglasses

Student Packet



## DESIGN CHALLENGE: Build Your Own Vacation Sunglasses

### LEARNING TARGETS:

- ✓ Undertake a design project, engaging in the design cycle, to construct a solution that meets specific design criteria and constraints.
- ✓ Apply scientific reasoning to show why the data or evidence is adequate for the explanation or conclusion.
- ✓ Compare two models/representations that can be used to construct an explanation of the same phenomenon and evaluate the benefits and limitations of each in constructing the explanation.

### 1. DEFINE THE PROBLEM

You and your family are leaving for vacation soon and you can't find your sunglasses. Sadly you have no money to buy new ones, but you are worried about protecting your eyes on vacation. You are going to use household materials to design a new pair.

### 2. DO BACKGROUND RESEARCH

Investigate the concepts and necessary background knowledge about the design topic. Read several of the articles below and take at least 15 bulleted notes from the readings in the Cornell Note template below.

- Timeline of Eyeglasses—  
[www.museumofvision.org/exhibitions/?key=44&subkey=4&relkey=35](http://www.museumofvision.org/exhibitions/?key=44&subkey=4&relkey=35)
- Prevent eye damage: Protect yourself from UV radiation—  
[www2.epa.gov/sites/production/files/documents/eyedamage.pdf](http://www2.epa.gov/sites/production/files/documents/eyedamage.pdf)
- More people need to wear sunglasses—[www.webmd.com/eye-health/news/20120517/more-people-even-kids-need-to-wear-sunglasses](http://www.webmd.com/eye-health/news/20120517/more-people-even-kids-need-to-wear-sunglasses)
- Five reasons to wear sunglasses—[www.foxnews.com/story/2007/06/11/five-reasons-to-wear-sunglasses](http://www.foxnews.com/story/2007/06/11/five-reasons-to-wear-sunglasses)
- Ultraviolet (UV) radiation and your eyes—  
[www.allaboutvision.com/sunglasses/spf.htm](http://www.allaboutvision.com/sunglasses/spf.htm)

- Let the sunshine in, but not the harmful rays—  
[www.nytimes.com/2011/01/15/health/15patient.html? r=0](http://www.nytimes.com/2011/01/15/health/15patient.html? r=0) .

Questions/Vocabulary	Notes
<b>References</b>	

FORMATIVE NOTES SCORE= \_\_\_\_\_

1	2	3	4
<input type="checkbox"/> Notes are poorly organized and rarely written in student's own wording <input type="checkbox"/> Identifies major events of the evolution of sunglasses <input type="checkbox"/> Lists less than 2 dangers of UV radiation- particularly concerning eye health <input type="checkbox"/> Partial or missing explanation of how sunglasses work <input type="checkbox"/> Partial or missing explanation of how eyes function and can be effected by UV radiation <input type="checkbox"/> Partial or missing explanation of why the sun shouldn't be viewed directly	<input type="checkbox"/> Notes are organized by topic and mostly written in student's own wording <input type="checkbox"/> Outlines basic evolution of sunglasses <input type="checkbox"/> Identifies structures of historically successful sunglasses <input type="checkbox"/> Lists at least 2 dangers of UV radiation- particularly concerning eye health <input type="checkbox"/> Explains how sunglasses work <input type="checkbox"/> Explains how eyes function and can be effected by UV radiation <input type="checkbox"/> Explains why the sun shouldn't be viewed directly	<input type="checkbox"/> Notes are synthesized by the student, well organized and include at least one picture <input type="checkbox"/> Outlines basic evolution of sunglasses, including different materials that lenses have been successfully made of <input type="checkbox"/> Identifies patterns of structures of historically successful sunglasses <input type="checkbox"/> Lists at least 3 dangers of UV radiation- particularly concerning eye health <input type="checkbox"/> Explains in detail how sunglasses work <input type="checkbox"/> Explains in detail how eyes function and can be effected by UV <input type="checkbox"/> Explains in detail why the sun shouldn't be viewed directly	<input type="checkbox"/> Notes synthesis research, are well organized, and cite references <input type="checkbox"/> Outlines evolution of sunglasses, including different materials that have been used in sunglasses→student then identifies traits of materials that help block light and UV radiation <input type="checkbox"/> Uses historically successful sunglasses to identify patterns of structures and explains their function <input type="checkbox"/> Explains through a labelled ray diagram how sunglasses work <input type="checkbox"/> Lists at least 4 dangers of UV radiation relating to eye health <input type="checkbox"/> Explains through a ray diagram how eyes function and can be effected by UV radiation <input type="checkbox"/> Explains through a ray diagram why the sun shouldn't be viewed directly

- ### 3. SPECIFY DESIGN CRITERIA AND CONSTRAINTS

- ☐ Stylish
- ☐ Reduces brightness
- ☐ Blocks UV radiation
- ☐ Sturdy (won't break if they fall off your face)

**Supplies needed for sunglasses:**

- #### 4. BRAINSTORM CREATIVE SOLUTIONS:

Design solution 1	Design solution 2
Blueprint (sketch) with labels:	Blueprint (sketch) with labels:

<p><b>Scientific Explanation (please draw a ray diagram illustrating how you think your lenses with reduce brightness and prevent UV radiation from reaching the eye, be sure to include labels and a description):</b></p>	<p><b>Scientific Explanation (please draw a ray diagram illustrating how you think your lenses with reduce brightness and prevent UV radiation from reaching the eye, be sure to include labels and a description):</b></p>
<p><b>Caption explaining idea:</b></p>	<p><b>Caption explaining idea:</b></p>

## 5. CHOOSE THE BEST IDEA/SOLUTION

Identify at least three pros and three cons for each solution. These pros and cons should connect with both the design criteria and your ray diagram. Then justify why the final solution was chosen using scientific evidence.

Design solution 1	Design solution 2
<p><b>Pros:</b></p> <p><input type="checkbox"/></p> <p><input type="checkbox"/></p> <p><input type="checkbox"/></p>	<p><b>Pros:</b></p> <p><input type="checkbox"/></p> <p><input type="checkbox"/></p> <p><input type="checkbox"/></p>

<b>Cons:</b>  <input type="checkbox"/>  <input type="checkbox"/>  <input type="checkbox"/>	<b>Cons:</b>  <input type="checkbox"/>  <input type="checkbox"/>  <input type="checkbox"/>
<b>Which design are you choosing and why? (Challenge: Write this decision in the format of a hypothesis.)</b>	

FORMATIVE NOTES SCORE= \_\_\_\_\_

1	2	3	4
<input type="checkbox"/> Identified a few pros and cons for each design <input type="checkbox"/> Few pros and cons connect with the criteria of the project <input type="checkbox"/> No pros and cons reference ray box and companion explanation <input type="checkbox"/> There is no consideration of: the path light travels, absorption, reflection, or transmission of various light waves <input type="checkbox"/> Final design choice explanation doesn't consider the properties of light, and overall structure and function of the sunglasses	<input type="checkbox"/> Identified some pros and cons for each design <input type="checkbox"/> Some pros and cons connect with the criteria of the project <input type="checkbox"/> Some pros and cons reference ray box and companion explanation <input type="checkbox"/> Pros and cons lack consideration of: the path light travels, absorption, reflection, or transmission of various light waves <input type="checkbox"/> Final design choice explanation reveals that the student didn't complete consider the properties of light, and overall structure and function of the sunglasses	<input type="checkbox"/> Identified 3 pros and 3 cons for each design <input type="checkbox"/> Pros and cons all connect with the criteria of the project <input type="checkbox"/> Frequently pros and cons reference ray box and companion explanation <input type="checkbox"/> Pros and cons show consideration of: the path light travels, absorption, reflection, and transmission of various light waves <input type="checkbox"/> Final design choice explanation reveals that the student took into consideration the properties of light, and the overall structure and function of the sunglasses	<input type="checkbox"/> Identified more than 3 pros and 3 cons for each design <input type="checkbox"/> Pros and cons clearly connect with the criteria of the project <input type="checkbox"/> Pros and cons reference ray box and companion explanation <input type="checkbox"/> Pros and cons show consideration of: the path light travels, absorption, reflection, color filters, unusual lens media to reduce brightness and the number of photons reaching the actual eye, and the transmission of various light waves <input type="checkbox"/> Final design choice explanation reveals that the student took into consideration the properties of light, and the overall structure and function of the sunglasses by writing a hypothesis for their glasses design

## 6. DEVELOPMENT WORK:

Plan, gather materials, and provide evidence of your plan.

## 7. BUILD A MODEL OR PROTOTYPE

Build and include photos of model or prototype here.

## 8. TEST THE PROTOTYPE

Conduct experiments to collect **some data** to support that idea that the design performs within the criteria.

Criteria tested	Trial 1	Trial 2	Trial 3	Average
Stylish rating				
Reduction in brightness (lumens)				
UV radiation protection				
Sturdiness				

## 9. REDESIGN/MODIFY

Make necessary changes to design to meet criteria and constraints.  
You may need to repeat steps 7 and 8.

## 10. COMMUNICATE THE RESULTS

Share final design with others by answering the following questions.

Using the class data and ranking system, determine your sunglasses' overall rank in the class according to the tested criteria. To do this, take your glasses' ranking in each category and find the average rank. (For example: Johnny was first in stylish, 14th in decreasing brightness, 30th in UV protection, and 6th sturdiness; therefore, his average ranking would be 12.3.) My overall glasses ranking is \_\_\_\_\_.

- A. Based on your data, which prototype was the most successful? Use data to support your decision.
- B. Explain adjustments that were made to your prototype. Why did you make these adjustments? What were the advantages and disadvantages of these changes?
- C. Explain at least two inconsistencies in the data collected and identify how these may have affected your design choices.
- D. How do the results of this design process support what you learned through background knowledge, research, and class concepts?

**Rubric**

<b>Design step</b>	<b>1 Not proficient</b>	<b>2 Approaching proficient</b>	<b>3 Proficient</b>	<b>4 Exceeds proficient</b>
<b>Research</b>	<ul style="list-style-type: none"> <li>Notes are incomplete and only answer one or two of the research questions.</li> </ul>	<ul style="list-style-type: none"> <li>Notes are almost complete and include basic information on the history of sunglasses, dangers of UV radiation, why people wear sunglasses, how sunglasses work, how eyes work, and whether people should look at the Sun, even with sunglasses on.</li> </ul>	<ul style="list-style-type: none"> <li>Notes include information on the history of sunglasses, dangers of UV radiation, why people wear sunglasses, how sunglasses work, how eyes work, and whether people should look at the Sun, even with sunglasses on.</li> <li>Notes include at least one diagram connecting research to how sunglasses work.</li> </ul>	<ul style="list-style-type: none"> <li>Notes are all in own wording and include information on the history of sunglasses, dangers of UV radiation, why people wear sunglasses, how sunglasses work, how eyes work, and whether people should look at the Sun, even with sunglasses on.</li> <li>Notes include several diagrams.</li> <li>Outside references are used and properly cited.</li> </ul>
<b>Brainstorm solution</b>	<ul style="list-style-type: none"> <li>Sketch is messy or difficult to understand.</li> <li>Labels are not present.</li> <li>Caption is incomplete.</li> </ul>	<ul style="list-style-type: none"> <li>Sketch is fairly neat.</li> <li>Includes labels for most needed materials.</li> <li>Caption is slightly unclear about special design elements.</li> </ul>	<ul style="list-style-type: none"> <li>Sketch is neat and done mostly to scale.</li> <li>Sketch is easy to understand.</li> <li>Labels identify needed materials for each part.</li> <li>Caption clearly explains special design elements.</li> </ul>	<ul style="list-style-type: none"> <li>Sketch is done to scale with personal facial measurements considered.</li> <li>Labels identify all needed materials for each part.</li> <li>Caption adds to understanding of complicated design elements.</li> </ul>
<b>Choose best solution</b>	<ul style="list-style-type: none"> <li>A few pros and cons identified.</li> <li>Unclear why final design was chosen.</li> </ul>	<ul style="list-style-type: none"> <li>Multiple pros and cons identified that are applicable for sunglasses.</li> <li>Final design chosen based on pros or cons.</li> </ul>	<ul style="list-style-type: none"> <li>Pros and cons relate to identified criteria.</li> <li>Final design chosen based on number of pros or cons.</li> </ul>	<ul style="list-style-type: none"> <li>Student performs preliminary tests to identify pros and cons of sunglasses as they relate to the criteria.</li> <li>Final design chosen based on number of pros or cons.</li> <li>Justification includes that final design based on number of pros or cons and makes a clear connection to properties of light.</li> </ul>



<b>Building</b>	<ul style="list-style-type: none"> <li>• Student needs multiple reminders of lab safety rules or direction to stay on task.</li> <li>• Student is unprepared to independently attempt building glasses.</li> </ul>	<ul style="list-style-type: none"> <li>• Student mostly follows lab safety rules.</li> <li>• Student needs frequent assistance from peer or teacher to build glasses.</li> </ul>	<ul style="list-style-type: none"> <li>• Student follows all lab safety rules and is on task throughout entire lab.</li> <li>• Student needs limited assistance building glasses.</li> </ul>	<ul style="list-style-type: none"> <li>• Student follows all lab safety rules and reminds others of these rules.</li> <li>• Student independently builds glasses.</li> <li>• Student assists others with the construction of their glasses.</li> </ul>
<b>Testing prototype</b>	<ul style="list-style-type: none"> <li>• Student receives low style ranking.</li> <li>• Student receives low reduction-of-brightness ranking.</li> <li>• Student receives low reduction-of-UV ranking.</li> <li>• Student receives low sturdiness ranking.</li> <li>• Student needs help calculating averages.</li> <li>• Student needs frequent help during testing.</li> </ul>	<ul style="list-style-type: none"> <li>• Student receives medium style ranking.</li> <li>• Student receives medium reduction-of-brightness ranking.</li> <li>• Student receives medium reduction-of-UV ranking.</li> <li>• Student receives medium sturdiness ranking.</li> <li>• Student calculates averages correctly with reminder.</li> <li>• Student completes all tests with brief redirection.</li> </ul>	<ul style="list-style-type: none"> <li>• Student receives medium style ranking.</li> <li>• Student receives medium reduction-of-brightness ranking.</li> <li>• Student receives medium reduction-of-UV ranking.</li> <li>• Student receives medium sturdiness ranking.</li> <li>• Student calculates averages correctly without help.</li> <li>• Student independently completes all tests using directions.</li> </ul>	<ul style="list-style-type: none"> <li>• Student receives high style ranking.</li> <li>• Student receives high reduction-of-brightness ranking</li> <li>• Student receives high reduction-of-UV ranking.</li> <li>• Student receives high sturdiness ranking.</li> <li>• Student helps peers correctly calculate averages.</li> <li>• Student helps peers understand testing instructions and spots potential errors in the system.</li> </ul>
<b>Communicating and evaluating results</b>	<ul style="list-style-type: none"> <li>• Student needs help answering most questions.</li> <li>• Student needs assistance seeing pattern between peer designs and the success of their design.</li> </ul>	<ul style="list-style-type: none"> <li>• Questions mostly correctly answered.</li> <li>• Student makes limited connections between peer designs and the success of their design.</li> </ul>	<ul style="list-style-type: none"> <li>• All questions correctly answered.</li> <li>• Student makes connections between peer designs and the science behind their design.</li> <li>• Student references research in one answer.</li> </ul>	<ul style="list-style-type: none"> <li>• All questions correctly answered fully with quantitative evidence used to support answers.</li> <li>• Student independently makes deep connections between peer designs and the science behind the design.</li> <li>• Student references research in two or more answers.</li> </ul>