

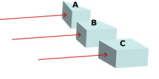
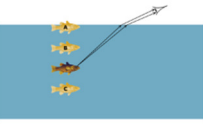




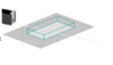
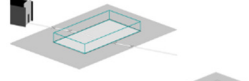
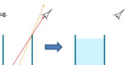

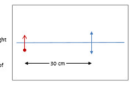



Physics > Big idea PSL: Sound, light and waves > Topic PSL3: Making images

**Progression toolkit: Refraction and lenses**

<b>Learning focus</b>	All light from each point of an object that passes through a converging lens is bent (refracted) to a corresponding point in a sharp image.				
<b>As students' conceptual understanding progresses they can:</b>					
	Recall that light can change direction (refract) when it passes across a boundary between transparent media.	Describe how the angle light passes across a boundary between two transparent media affects how much it is bent (refracted).	Explain why water can appear shallower than it really is.	Explain how the shape of a lens enables it to focus light.	Explain how light from an object can be focused by a converging lens to form a sharp image.
<b>Diagnostic questions</b>	Magic finger	Bending light	How deep?	Lens bend	Through a lens
<b>Response activities</b>	Refraction		On the bottom	Getting focused	
			Seeing the bottom		Half a lens

<p><b>Magic finger</b></p> <p><b>BEST</b> STUDENT WORKSHEET</p> <p><b>Magic finger</b></p> <p>A school teacher shows her class how to do a magic trick. She presses the middle of her finger with a glass block!</p>  <p>How can you explain the magic trick? Put a tick (✓) in the box next to the best answer.</p> <table border="1"> <tr> <td>A</td> <td>Light changes direction as it moves through the glass.</td> <td><input type="checkbox"/></td> </tr> <tr> <td>B</td> <td>Light changes direction as it enters and leaves the glass.</td> <td><input type="checkbox"/></td> </tr> <tr> <td>C</td> <td>The glass moves the image to one side.</td> <td><input type="checkbox"/></td> </tr> <tr> <td>D</td> <td>The glass hides the image.</td> <td><input type="checkbox"/></td> </tr> </table> <p><small>Developed by the University of York Science Education Group and the Salters' Institute. This resource has been created, reviewed and updated for copyright and best practice following the Department of Education's Education Inspection Framework (EIF) 2024. Version 2.0 (2024) 1</small></p>	A	Light changes direction as it moves through the glass.	<input type="checkbox"/>	B	Light changes direction as it enters and leaves the glass.	<input type="checkbox"/>	C	The glass moves the image to one side.	<input type="checkbox"/>	D	The glass hides the image.	<input type="checkbox"/>	<p><b>Bending light</b></p> <p><b>BEST</b> STUDENT WORKSHEET</p> <p><b>Bending light</b></p> <p>Light can bend when it enters or leaves a glass block.</p> <p>a. Which glass block do you think bends the light the most?</p>  <p>b. What is the best reason for your choice of glass block? Put a tick (✓) in the box next to the best answer.</p> <table border="1"> <tr> <td>A</td> <td>Light goes through the most glass.</td> <td><input type="checkbox"/></td> </tr> <tr> <td>B</td> <td>Light goes through the least glass.</td> <td><input type="checkbox"/></td> </tr> <tr> <td>C</td> <td>It is the most unusual shape.</td> <td><input type="checkbox"/></td> </tr> <tr> <td>D</td> <td>Light hits at the biggest angle.</td> <td><input type="checkbox"/></td> </tr> <tr> <td>E</td> <td>Light hits at the smallest angle.</td> <td><input type="checkbox"/></td> </tr> </table> <p><small>Developed by the University of York Science Education Group and the Salters' Institute. This resource has been created, reviewed and updated for copyright and best practice following the Department of Education's Education Inspection Framework (EIF) 2024. 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Version 2.0 (2024) 1</small></p>	<p><b>Lens bend</b></p> <p><b>BEST</b> STUDENT WORKSHEET</p> <p><b>Lens bend</b></p> <p>Light can bend when it enters or leaves a glass block.</p>  <p>A lens is a specially shaped glass block. Most lenses are circular. The flat surface of each lens shows how shapes more clearly.</p> <p>a. Which lens do you think bends light the most?</p>  <p>b. Why do you think this lens bends light the most? Put a tick (✓) in the box next to the best answer.</p> <table border="1"> <tr> <td>A</td> <td>Light takes longer to move through the lens.</td> <td><input type="checkbox"/></td> </tr> <tr> <td>B</td> <td>More light can pass through the lens.</td> <td><input type="checkbox"/></td> </tr> <tr> <td>C</td> <td>Light hits the lens at bigger angles.</td> <td><input type="checkbox"/></td> </tr> <tr> <td>D</td> <td>There is more glass to interact with the light.</td> <td><input type="checkbox"/></td> </tr> </table> <p><small>Developed by the University of York Science Education Group and the Salters' Institute. This resource has been created, reviewed and updated for copyright and best practice following the Department of Education's Education Inspection Framework (EIF) 2024. 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For each statement, tick (✓) or leave boxes to show what you think.</p> <table border="1"> <thead> <tr> <th></th> <th>Light moves from the penguin to the image.</th> <th>Light moves from the image to the penguin.</th> <th>Light moves from the penguin to the penguin.</th> <th>Light moves from the image to the image.</th> </tr> </thead> <tbody> <tr> <td>A</td> <td>Light from each point of the penguin moves in just one direction towards the lens.</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> <tr> <td>B</td> <td>Light from each point of the penguin moves in many directions towards the lens.</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> <tr> <td>C</td> <td>Each point on the image is lit up by light moving along just one ray from the penguin.</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> <tr> <td>D</td> <td>Each point on the image is lit up by light moving along many different rays from the penguin.</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> </tbody> </table>  <p><small>Developed by the University of York Science Education Group and the Salters' Institute. 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<p><b>Refraction</b></p> <p><b>BEST</b> STUDENT WORKSHEET</p> <p><b>Refraction</b></p> <p>A thin beam of light can be made using a ray lamp and a slit. This can be used to observe how light moves through a glass block.</p>  <p><b>Apparatus and materials</b></p> <ul style="list-style-type: none"> <li>Ray lamp (R27)</li> <li>Slit card</li> <li>Coloured paper</li> <li>Slit</li> <li>Rectangular glass block</li> <li>White paper (A4)</li> <li>White card</li> <li>Ruler (30 cm)</li> </ul> <p><b>Procedure</b></p> <ol style="list-style-type: none"> <li>Place the glass block in the middle of the paper.</li> <li>Draw round the glass block.</li> <li>Observe how the light beam moves inside the glass.</li> <li>Set up the ray table to make a narrow beam of light.</li> <li>Join the narrow beam of light so it becomes one straight line.</li> <li>Draw two lines across the beam on each side of the block.</li> </ol>  <p><b>To answer</b></p> <ol style="list-style-type: none"> <li>Show how the angle the beam hits the glass block changes how much it is bent?</li> <li>What happens when the beam hits the glass block at a right angle?</li> <li>Exactly where does the beam refract?</li> </ol> <p><small>Developed by the University of York Science Education Group and the Salters' Institute. This resource has been created, reviewed and updated for copyright and best practice following the Department of Education's Education Inspection Framework (EIF) 2024. Version 2.0 (2024) 1</small></p>	<p><b>On the bottom</b></p> <p><b>BEST</b> STUDENT WORKSHEET</p> <p><b>On the bottom</b></p> <p>There are two coins on the bottom of a mug. Tyler can see a silver coin. He cannot see the gold coin.</p>  <p>Tyler fills the mug with water. The coins do not move. Tyler does not see.</p> <p><b>Predict</b></p> <p>What will Tyler be able to see at the bottom of the mug?</p> <p><b>Explain</b></p> <p>Why do you think he will see that?</p> <p><b>Carry out the investigation</b></p> <p><b>Observe</b></p> <p>Describe what you can see when the mug is full of water.</p> <p><b>Explain</b></p> <p>Were your prediction and explanation correct? Try to improve your first explanation to explain what happens more clearly.</p> <p><small>Developed by the University of York Science Education Group and the Salters' Institute. This resource has been created, reviewed and updated for copyright and best practice following the Department of Education's Education Inspection Framework (EIF) 2024. Version 2.0 (2024) 1</small></p>	<p><b>Seeing the bottom</b></p> <p><b>BEST</b> STUDENT WORKSHEET</p> <p><b>Seeing the bottom</b></p> <p>Also jump into a rock pool. It's a bit deeper than it looked from the edge!</p>  <p>Alvin's friends are talking about what she did. They are talking about why the water looked shallow.</p> <p><b>Katie:</b> Light from the bottom bends as it moves through the water.</p> <p><b>Lucy:</b> The image of the bottom changes direction as it leaves the water.</p> <p><b>Niamh:</b> Light from the rocks changes direction as it moves into the air.</p> <p><b>Megan:</b> The water magnifies the rocks on the bottom.</p> <p><b>To answer</b></p> <ol style="list-style-type: none"> <li>Who is right about why the pool looks shallow? Explain your answer.</li> <li>Who is wrong about why the pool looks shallow? What would you say to help them understand?</li> <li>How can a diagram show what happens more clearly?</li> </ol> <p><small>Developed by the University of York Science Education Group and the Salters' Institute. This resource has been created, reviewed and updated for copyright and best practice following the Department of Education's Education Inspection Framework (EIF) 2024. Version 2.0 (2024) 1</small></p>	<p><b>Getting focused</b></p> <p><b>BEST</b> DEMONSTRATION NOTES</p> <p><b>Getting focused</b></p> <p>This demonstration explains why you can't see light rays from each point of an object reflected by a lens so they all cross over at a corresponding point on the other side of the lens. Having the demonstration for light rays from another point of the object shows how a sharp image is formed on a single focal plane.</p> <p><b>Safety</b></p> <p>Some demonstration ray boxes can leave light!</p> <p><b>Apparatus and materials</b></p> <ul style="list-style-type: none"> <li>Power supply</li> <li>Ray box</li> <li>Coloured lens</li> <li>Single slit</li> <li>A3 sheet of paper (or two A4 sheets stuck together)</li> <li>Cardinal converging lens (focal length of approximately 10 cm)</li> <li>30 cm ruler</li> </ul> <p><b>Procedure</b></p> <ol style="list-style-type: none"> <li>Set up             <ul style="list-style-type: none"> <li>On a sheet of A3 paper rule a line along the centre.</li> <li>Place one edge of an object, with a height that is less than the width of the lens being used.</li> <li>Draw a line for the lens about 30 cm in front of the object.</li> </ul> </li> <li>Shooting rays from the top of the object             <ul style="list-style-type: none"> <li>Use a ray box with a single slit to get three or four different rays of light through the slit.</li> <li>Use the whole width of the lens.</li> <li>Each ray should pass through the top of the object that has been drawn.</li> <li>Each ray should cross at one point behind the lens.</li> <li>Slight movement of the lens can easily make spots miss the cross over point and small adjustments may be necessary to ensure a convincing demonstration.</li> </ul> </li> </ol>  <p><small>Developed by the University of York Science Education Group and the Salters' Institute. This resource has been created, reviewed and updated for copyright and best practice following the Department of Education's Education Inspection Framework (EIF) 2024. Version 2.0 (2024) 1</small></p>	<p><b>Half a lens</b></p> <p><b>BEST</b> STUDENT WORKSHEET</p> <p><b>Half a lens</b></p> <p>A lens can form an image. The image is clearer if the object is lit up brightly.</p>  <p><b>Predict</b></p> <p>Half of the lens is covered up. What would happen to the image of the penguin?</p> <p><b>Explain</b></p> <p>Why do you think you will see this?</p> <p><b>Look at an image formed by a converging lens. Cover up half of the lens.</b></p> <p><b>Observe</b></p> <p>Describe or draw what you see when half the lens is covered.</p> <p><b>Explain</b></p> <p>Were your prediction and explanation correct? Try to improve your first explanation to explain what happens more clearly.</p> <p><small>Developed by the University of York Science Education Group and the Salters' Institute. 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