**Through a lens**

A lens can form an image.

The image is clearer if the object is lit up brightly.

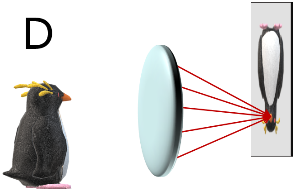
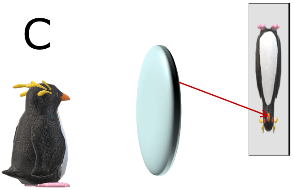
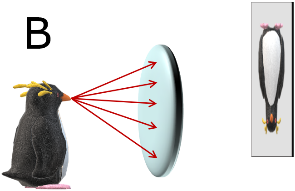
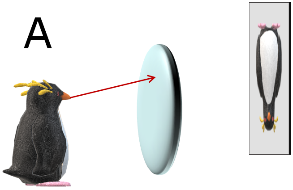
Light reflects off the penguin.

The lens refracts light from the penguin to form an image.

How does light move from the penguin to the image?

For each statement, tick (✓) **one** column to show what you think*.*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | | I am **sure** this is right | I think this is right | I think this is wrong | I am **sure** this is wrong |
| **A** | Light from each point of the penguin moves in just one direction towards the lens |  |  |  |  |
| **B** | Light from each point of the penguin moves in many directions towards the lens |  |  |  |  |
| **C** | Each point on the image is lit up by light moving along just one ray from the penguin |  |  |  |  |
| **D** | Each point on the image is lit up by light moving along many different rays from the penguin |  |  |  |  |

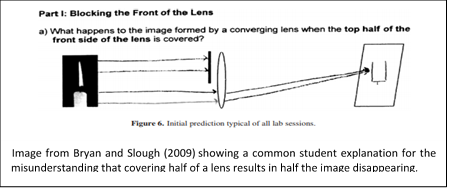


*Physics > Big idea PSL: Sound, light and waves > Topic PSL3: Making images > Key concept PSL3.2: Refraction and lenses*

|  |
| --- |
| **Diagnostic question** |
| **Through a lens** |

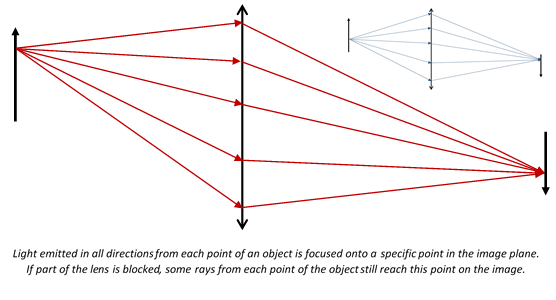
**Overview**

|  |  |
| --- | --- |
| Learning focus: | 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. |
| Observable learning outcome: | Explain how light from an object can be focused by a converging lens to form a sharp image. |
| Question type: | Confidence grid |
| Key words: | Refract, lens, lenses, image |

**What does the research say?**

Bryan and Slough (2009) found it common for students aged 12-15 (n=73) to draw single parallel rays of light from each point of an object in order to explain a prediction that covering half of a lens results in half the image disappearing. Part of the reason students form this misunderstanding may be due to their being shown how a lens refracts three parallel rays of light from a ray box.

The misunderstanding that covering half of a lens results in half the image disappearing is held by the majority of students of all ages (Goldberg and McDermott, 1987; Galili and Hazan, 2000; Ceuppens et al., 2018; Favale and Bondane, 2013).

Bryan and Slough (2009) tested a range of computer simulations designed to improve understanding of image formation with students, in order to identify features that improved learning. They found that the number of rays included from each point did not have an effect on student predictions about image formation when part of a lens is covered. By contrast simulations in which rays were shown originating from different parts of the object had a positive effect on student understanding.

The diagram shown here illustrates rays of light form two points on an object being focused by a converging lens to corresponding points on the image. If part of the lens is blocked off then it can be seen that some rays of light from each point of the object will still be able to be focused by the lens to form part of a complete image.

**Ways to use this question**

Students should complete the confidence grid individually. This could be a pencil and paper exercise, or you could use an electronic ‘voting system’ or mini white boards and the PowerPoint presentation.

NB A diagram has been include to illustrate each of the statements. If you use the PowerPoint presentation, these appear on the slides following the response grid.

If there is a range of answers, you may choose to respond through structured class discussion. Ask one student to explain why they gave the answer they did; ask another student to explain why they agree with them; ask another to explain why they disagree, and so on. This sort of discussion gives students the opportunity to explore their thinking and for you to really understand their learning needs.

*Differentiation*

You may choose to read the questions to the class, so that everyone can focus on the science. In some situations it may be more appropriate for a teaching assistant to read for one or two students.

**Expected answers**

B and D are correct.

Light from each point of the penguin moves in many directions towards the lens. Each point on the image is lit up by light moving along many different rays from the penguin (but each from the same starting point).

**How to respond - what next?**

Answer A contradicts earlier learning that light reflects in all directions off a rough surface. It is likely that most students will correctly identify this as wrong.

Answer C is more likely to be wrongly identified as being correct. It is very common for students to associate each point on an image with one light ray from a source. This is perhaps because students are typically familiar with individual pixels that make up the pictures on television or computer screens.

If students have misunderstandings about how light from each point of an object can be focused by a converging lens to form a sharp point on the image, it can help for students to be shown a demonstration (or carry out a class practical) to clarify how light from each point of a source moves through a lens along many rays simultaneously. The following BEST ‘response activity’ could be used to do this:

* Response activity: Getting focused

If students have a reasonable understanding of how an image is formed by a converging lens, the following BEST ‘response activity’ could be used to challenge students to apply their understanding, in order to explain an unexpected observation:

* Response activity: Half a lens

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: Peter Fairhurst (UYSEG).

**References**

Bryan, J. A. and Slough, S. W. (2009). Converging lens simulation design and image predictions. *Physcis Education,* 44(3)**,** 264-275.

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Goldberg, F. M. and McDermott, L. C. (1987). An investigation of student understanding of the real image formed by a converging lens or concave mirror. *American Journal of Physics,* 55**,** 108-19.