**Half a lens**

A lens can form an image.

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

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**Predict**

Half of the lens is covered up.

What would happen to the image of the penguin?

**Explain**

Why do you think you will see this?

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| **Look at an image formed by a converging lens.**  **Cover up half of the lens.** |

**Observe**

Describe or draw what you see when half the lens is covered.

**Explain**

Were your prediction and explanation correct?

Try to improve your first explanation to explain what happens more clearly.

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

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| **Response activity** |
| **Half a lens** |

**Overview**

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| 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. |
| Activity type: | Predict, explain; observe, explain (PEOE) |
| Key words: | Refract, lens, focus, image |

This activity can help develop students’ understanding by addressing the sticking-points revealed by the following diagnostic question:

* Diagnostic question: Through a lens

It can also be used to challenge students to apply and consolidate understanding gained by the following response activity:

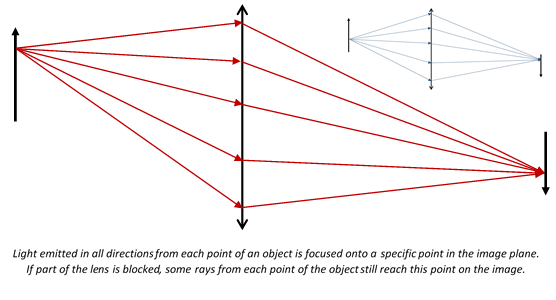
* Response activity: Getting focused

**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 activity**

Students should complete this activity in pairs or small groups, and the focus should be on the discussions. It is through the discussions that students can check their understanding and rehearse their explanations.

To begin, show the class how a spherical converging lens can be used to form an image of the view from the classroom.

* Part close blinds or curtains in the classroom and turn off lights so it is semi-dark, but there is still a clear view out of the windows.
* Pin a sheet of white paper to the wall opposite the window.
* Hold a spherical converging lens in front of the paper. If the focal length of the lens is 20 cm, the lens needs to be 20 cm in front of the paper, and so on.
* A sharply focused inverted image will be seen on the wall. Movement can also be seen on the image.

Each group should now discuss a situation in which half of the lens is covered over and use their scientific understanding, firstly to predict *what* they think will happen, and then to explain *why* they think they are going to be right. If students in any group cannot agree, you may be able to direct them with some careful questioning.

Students now carry out the practical, or watch a demonstration. You will need to decide whether it is better for each group to carry out the practical and risk some unexpected observations, or to demonstrate the activity so that everyone *observes* the same thing.

After the practical each group should be given the opportunity to change, or improve their explanation. A good way to review your students’ thinking might be through a structured class discussion. You could ask several groups for their *explanations* and put these on the whiteboard. Then ask other groups to suggest which explanation is the most accurate and the most clearly expressed, and through careful questioning work up a clear ‘class explanation’.

A useful follow up is for individual students to then write down explanations in their own words – without reference to the class explanation on the board (i.e. cover it up).

*Differentiation*

The quality of the discussions can be improved with a careful selection of groups; or by allocating specific roles to students in the each group. For example, you may choose to select a student with strong prior knowledge as a scribe, and forbid them from contributing any of their own answers. They may question the others and only write down what they have been told. This strategy encourages contributions from more members of each group.

**Equipment**

For each student/pair/group:

* Converging lens – focal length 20 cm
* Piece of card or paper to cover half the lens

For the class (optional):

* A large converging lens to demonstrate the formation of an image

**Technician notes**

To see a clear image of the view outside a classroom, the room needs to be semi-dark. It can be helpful to pin sheets of white paper on the wall opposite windows to project images of the outside view onto.

Spherical converging lenses are necessary – round ones (not rectangular lenses used with ray boxes).

**Health and safety**

Students will be walking around the lab in the semi-dark.

Practical work should be carried out in accordance with local health and safety requirements, guidance from manufacturers and suppliers, and guidance available from CLEAPSS.

**Expected answers**

The shape and size of the image of the penguin remain the same; the image will become less bright.

Light from each point of the object (the view out of the window) passes through every part of the lens. The lens refracts each light ray to a point on the image corresponding to the point it originated from on the object. Blocking half of the lens blocks half of the rays from each point of the object, but does not block the other half of the light rays from each point. Therefore each point on the image is formed with fewer light rays than originally. This makes the image complete, but dimmer.

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: Peter Fairhurst (UYSEG).

**References**

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