**Refraction**

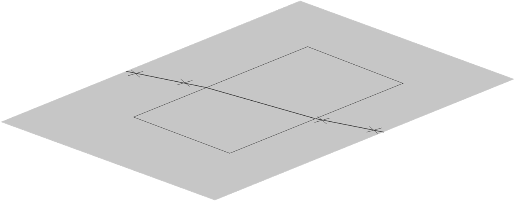
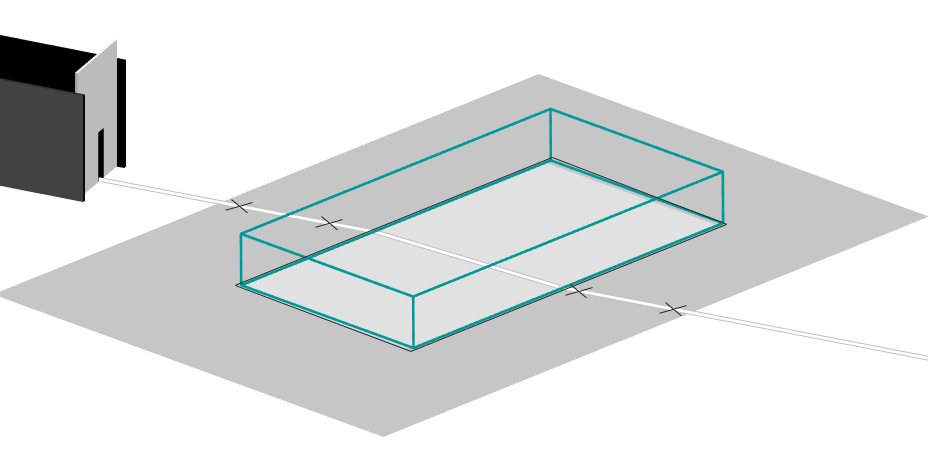
A thin beam of light can be made using a ray lamp and a slit.

This can be used to observe how light moves through a glass block.

**Apparatus and materials**

* Power pack (12V)
* Ray box
* Collimating lens
* Slit
* Rectangular glass block
* Plain paper (A4)
* Sharp pencil
* Ruler (30 cm)

**Procedure**

1. Place the glass block in the middle of the paper.
2. Draw round the glass block.
3. Always keep the glass block inside the lines.
4. Set up the ray box to make a narrow beam of light.
5. Aim the narrow beam at the block so it leaves the side opposite.
6. Draw two crosses on the beam on each side of the block. 
7. Remove the block and ray box.
8. Join up the crosses to show how the light moved through the block.

**To answer**

1. How does the angle the beam hits the glass block change how much it is bent?
2. What happens when the beam hits the glass block at a right angle?
3. Exactly where along its path does the beam refract?

*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** |
| **Refraction** |

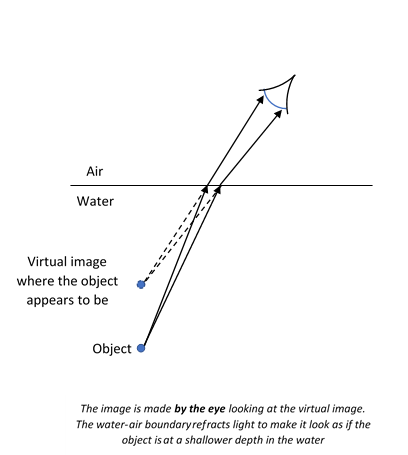
**Overview**

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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: | 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). |
| Activity type: | Clarifying - practical |
| Key words: | Refract, refraction, ray box |

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

* Diagnostic question: Magic finger
* Diagnostic question: Bending light

**What does the research say?**

A common strategy for teaching students about refraction is to demonstrate examples of refraction phenomena and to explain the observations using ray diagrams that show how light is bent by glass blocks. In this approach students may use a ray box to explore how light travels through a parallel sided glass block to understand the nature of refraction. They change the angles of incidence to establish: a change of direction only occurs at an interface; light travelling perpendicular to the interface is not refracted; and light bends towards the ‘normal’ when entering more dense medium and vice versa (Tear, 2011).

**Ways to use this activity**

This practical gives students the opportunity to understand a challenging concept, and to practise plotting light moving through a glass block, following a structured set of instructions.

If students are unfamiliar with using ray boxes, or with plotting the movement of light, you might choose to demonstrate the plotting of one thin beam of light through the glass block.

Some of the common errors students make are:

* Moving the glass block from its original position during the practical
* Not putting crosses in the centre of the thin beam
* Not ruling lines right up to the lines drawn around the glass block.

*Differentiation*

If some students are working with a teaching assistant, then a list of prompt questions for the TA could help to make this activity more purposeful.

**Equipment**

For each student/pair/group:

* Power pack (12V)
* Ray box
* Collimating lens
* Slit
* Rectangular glass block
* Plain paper (A4)
* Sharp pencil
* Ruler (30 cm)

**Technician notes**

Collimating lenses can be placed in the ray box to make the thin beam more parallel, in order to prevent it from spreading out. The investigation works reasonably well without collimating lenses.

Glass or Perspex blocks may be used. Ideally these should be approximately 12 cm by 6 cm and about 2 cm deep. Painting the bottom face white makes it easier to observe the path of a thin beam of light moving through the glass block.

**Health and safety**

Power packs plug into the mains, and all plugs should be checked for cracks and loose wires each time they are used.

Ray box bulbs can get very hot.

Battery operated ray boxes can be purchased that use low power lasers. These should only be used in close adherence to local health and safety requirements, guidance from manufacturers and suppliers, and guidance available from CLEAPSS.

**Expected answers**

1. The steeper the angle (the further it is from 90o), the more the thin beam is refracted (bent).

2. At 90o the thin beam continues in a straight line through the glass block.

3. The thin beam refracts at the surfaces between air and glass, and not as it passes through the glass.

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: Peter Fairhurst (UYSEG).

**References**

Tear, C. (2011). Sound, light and waves. In Sang, D. (ed.) *Teaching secondary physics.* London: Hodder Education.