**Experiments with light**

**Introduction**

This group of practical activities allow you to observe how properties of materials affect the propagation of light.

The range of activities detailed below cover both OCR Physics specifications, and your teacher will identify those which you should undertake.

You should be aware of the principles of reflection and refraction, and from Physics B (Advancing Physics) calculations related to the power of lenses.

**Aim**

* To demonstrate techniques and procedures used to investigate refraction
* To demonstrate techniques and procedures used to investigate total internal reflection of light
* To determine the power or focal length of a converging lens

**Intended class time**

* 60 to 90 minutes

**Equipment (per group)**

A) Refraction using a semi-circular block

* ray box or similar light source
* semi-circular glass or plastic block
* optical pins
* drawing pins
* photocopied sheets with protractor scale
* fibre board mat
* ruler and protractor

B) Refraction using a rectangular block (additionally)

* rectangular block

D) Investigating the power of lenses (additionally)

* at least two lenses with differing focal length
* lens stands
* plain white screen

**Health and safety**

* Note that lamp bulbs will be very hot

**Procedure**

**A) Refraction using a semi-circular block**

1. Place the photocopied sheet with the protractor markings on the soft fibre board if available. This allows the placement of two optical pins to denote the path of a ray of light.
2. Place the semi-circular block with the centre of its diameter at the central point of the protractor markings, and fully aligned.
3. A ray of light which is directed from beyond the curved edge of the block to the centre will always enter the block along a radial line, which is normal (at 90º to the surface) of the block and thus not deflected in any way.
4. At 0º to the normal the ray will emerge continuing in a straight line.
5. Move the ray box around to 10º from the initial position. The ray should still be aimed at the central point. Observe and mark its path.
6. Continue increasing the angle and observing and marking the path of each ray.
7. How do your observations match the theory of refraction?

**B) Refraction using a rectangular block**

1. Place the rectangular block on the soft fibre board and mark the position of the block.
2. Determine a point along the longer edge to be your target for directing the incoming ray. It is best to have this approximately 1 or 2 centimetres from a corner.
3. Start by aiming the beam along the normal perpendicular to the surface of the block. Observe and mark.
4. Move the beam 10º at a time, whilst still entering the block at the same point, marking and recording each path.
5. Use measurements of these paths to determine the refractive index of the block.

**C) Real and apparent depth**

1. Place the block on the board with a tall optical pin immediately behind it, at the midpoint of a longer side.
2. Look through the block to the pin and you will observe the apparent displacement of the pin as you move your head from the central position towards either side.
3. The image of the pin within the block stays at a fixed position. Put an upturned drawing pin on top of the block and adjust its position until the image of the optical pin is coincident with the drawing pin from all angles.
4. Measure the real depth of the optical pin from the front edge of the block and the apparent depth, as indicated by the drawing pin.
5. Calculate the ratio (real depth):(apparent depth) and compare this to your refractive index.

**D) Investigating the power of lenses**

1. Simple methods to determine the focal length of a lens.
2. Focus a distant object onto a screen. Place the lens close to a vertical white sheet of paper, with the lens angled towards a window. Adjust the distance of the lens from the screen to achieve the sharpest image. This distance is approximately the focal length.
3. Project an image a significant distance, for example with the lamp from the ray box, adjust the distance of the lens in front of the ray box to give a clear image of the filament on a wall or other distant surface. The distance from filament to lens is approximately the focal length.
4. Explain how these approximations can be used when the full formula is  .
5. Using combinations of lenses
6. Determine the power of two different lenses individually
7. Determine the power of the two lenses used together
8. Explain your observations.

**Recording**

As evidence for the Practical Endorsement you should have your observations and measurements in a clear and logical format. All work should be clearly dated.

In addition, in preparation for the assessment of practical work in the written examinations and to help develop your understanding of physics, you should have drawn conclusions from the measurements taken and presented your information in a scientific way.