Bending Light

Optic fibres can make light bend around corners, and when you look at your legs in a swimming pool, you can see how the light bends when it goes through the water, too.

Age Group: 6yrs +

Method: Group activity (up to 15 per facilitator)

Level: Introductory

Duration: 25 min

Key Learnings: Light travels in straight lines, but when it shines into different materials it changes speed. If it enters the new medium at an angle, the light ray gets bent, and different colours bend differently. If the angle is too shallow, the light will be reflected (like glare from a window pane)..

Materials and Equipment

* Opaque cup (I per participant)
* Small flat object that does not float (a coin or washer) (1 per pair)
* Water
* 100mm square flat acrylic mirror (1 between three participants)
* Shallow tray (1 between three participants)
* A4 White paper or card (1 between three participants)
* Clear plastic bottle (with a lid)
* Black paper or plastic (enough to cover the bottle)
* Torch
* Scissors
* Stickytape
* Convex lens

Preparation

 The facilitator should prepare for this workshop by using the instructions and materials provided to complete the tasks. Note critical angles and sources of light for viewing and advise participants accordingly.

Have a rubbish bin ready for the waste that will be generated, and a bucket for the water.

Recommendations

 The activities in this set are all brief. Be prepared to move things along reasonably quickly, but consider having time at the end for participants to return to things that have caught their interest.

 Further learning could include adding coloured cellophane between the light source and some of the demonstrations to see how this alters the effects.

Workshop Outline

(5 min) Introduction

 Introduce yourself, welcome participants and deal with housekeeping.

 Ask participants if they have ever tried to grab something underwater, and whether they had a problem with locating the thing they were reaching for. Explain that these activities will help them understand why they had a problem.

(5 min) The invisible washer

 Distribute cups and ask the participants to form pairs. Give each pair a washer, and have one member fill their cup with water.

 The participant with the empty cup puts the coin or washer at the bottom of the cup, and places it on the table. They then adjust their line of sight (by moving their head up or down) so they can no longer see the coin over the edge of the cup.

 While the viewer holds steady, their companion slowly pours water into the cup. At some point, the object will appear to the viewer.

 Explanation: You see the object in the bottom of the cup because light is reflected from the object into your eyes. When this light is going from water into air, it changes direction, and is bent at an angle. When the height of the water gets to the right level, the light from the object is bent into from your eye, and you can see it.

 This is why when you look at something under water, it appears to be further from to you than it actually is, because your brain is used to light travelling directly to you in a straight line, and the light has actually been bent towards you as it left the water.

(5 min) Bending light into a rainbow

 Distribute the mirrors, and shallow trays to each group of three participants. Place the shallow tray near a window or other light source, and hold the mirror at an angle as the tray is filled with water (see diagram below)



**White card**

 Hold the white card as shown, and a rainbow will be seen.

Explanation: The rays of light are bent as they enter and leave the water, but different colours are bent to varying degrees. This effect makes the colours spread out, and results in the rainbow effect. Similar effects are seen when light passes through fishtanks, hanging crystals or even the edge of a plate of glass.

 Try placing a sheet of coloured cellophane between the window and the dish of water, and the rainbow will disappear because only a single colour of light is being affected.

(5 min) Bending light around a corner (requires a darkened room for best viewing).

 Pierce a hole in the top of the plastic bottle using the scissors, or some other sharp tool, the rounder the hole the better. Use stickytape to cover the outside of the bottle with black paper, but leave the bottom clear. If you can cover the top of the bottle too (but not the lid), the effect will be better.

 Fill the bottle with water, and screw on the lid. Now take the bottle and the torch into a darkened room, and place the torch on the bottom of the bottle so the light shines through the water. Hold the bottle horizontally, and squeeze: the water will make an arc, and the light bend with it.

Explanation: The light is travelling through the water, parallel to the edges of the bottle. If the angle of the arc of water is not too great, the light inside the water skims off the boundary with the air surrounding it, and is reflected along inside the stream of water. This is the same effect that causes like to glare off a partly opened window, or a pool of water, even though these are transparent.

 This effect is used in optic fibres, to trap light inside a thin cylinder of glass.

(5 min) Bending light with a lens

 Hand around the lens provided and allow participants to examine it. It is helpful to have some printed material at hand that can be viewed through the lens. If the lens is moved closer or further away from the object being viewed, the image will move in and out of focus. At the right distance, the lens will act as a magnifier.

 Move to a window and hold the lens vertically, so the incoming light is focussed through it. Get an assistant to hold a piece of white paper or card about 20cm behind the lens, and observe that an image of the view outside the window is formed on the paper (move the paper slowly back or forwards to bring the image into focus). Is the image the right way up? Does this change if the paper is moved?

Explanation: The light coming from the object being viewed is bent as it passes from the air into the glass of the lens, and again as it moves from the glass back into the air. Because the surface of the glass is curved, the bending focuses the rays of light onto a single point (the focus of the lens). If a viewing screen is placed beyond this point, the rays of light cross over, and the image will be inverted (as shown in the diagram below)

Appendices: Materials suppliers list (attached)