Optoelectronics in Medicine
Quick Start Guide

What's it all about then?

This experiment lets you investigate how we manipulate light using electronic devices and optical fibres.

What you can explore through this experiment

- Light is a wave
- Light travels in straight lines
- Light reflects off objects, enabling us to see them
- Light is a form of energy, which can be "transduced" into electrical energy, and vice versa
- Total Internal Reflection (TIR) and the "critical angle"

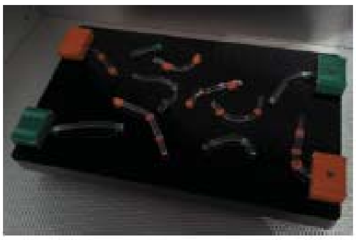
How to present this experiment:

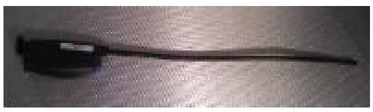
This is a guide suggesting how to present the experiment to the students. You do not have to follow it exactly, as long as you allow the students to explore the concepts involved.

You can expand or shorten this experiment as necessary to fill the time allocated.

The kit:

- Samples of Optical Fibres
- Light Guide Tank
- Laser
- Dummy
- Various remote viewing devices, e.g. endoscopes
- UFO lamp
- Light Puzzle board + pieces
- 3D Maze Box + random objects
- Retreival tools
- Sample X-ray





Images of equipment

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Introduction

Start the experiment by showing the students the slide show. This experiment looks at how optical fibres work, and what we use them for.

Hand out the different types/examples of optical fibres. Use the LED torch to shine light down the fibres and observe it being emitted at the opposite end. Try the same with the bendy pipe - does it work? Light travels in straight lines and to change direction it needs to reflect off the inside of the pipe. Since the inside isnt very reflective the light fails to make it all the way through. So how come it can travel through the optical fibre?

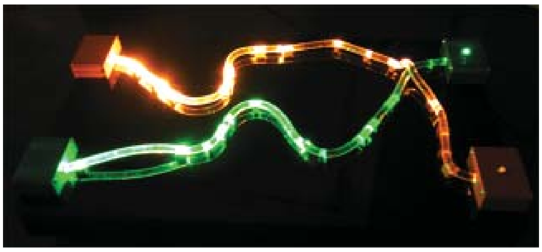
Part 1: The Light Guide Tank

1.1 Demonstrating TIR and the Critical Angle

Switch on the laser and start with it shining horizontally straight across the tank. The students can investigate moving the laser, observing the effect on the beam as it passes through the solution. When the beam hits the liquid/air boundary at an angle of greater than 50 degrees a reflected ray can be seen inside the solution. This phenomenon is called "total internal reflection" and 50 degrees is said to be the "critical angle" for it to happen.
It might be useful to sketch and label the angles on the board.

Part 2 : The Light Puzzle

Switch on the board. Using the colour coded pieces the students need to complete two paths, joining the opposite sides of the board. The paths will need to cross at some point and there is a special piece to enable this. Once the path is completed the LED on top of the sensor will light up.



Part 3 : Endoscopes and Inspection Cameras

NOTE: The endoscopes are relatively strong, but overbending them can cause permanent damage. They are quite costly so make the students aware of this and stress the need for them to be handled with care.

Hand out the endoscopes to the students. Demonstrate how to use them and then give them a minute to explore and play. The endoscope is made from around 7000 individual optical fibres, bundled together. Now demonstrate the endoscope attached to the TV.
Note: this is the most fragile and most expensive piece of kit - handle with care
Next bring out the inspection camera attached to the laptop.
The endoscope transmits light along the fibre utilising total internal reflection (TIR).
This light is then converted into an image by a small optoelectronic device called a CMOS (complimentary metal oxide semiconductor) in much the same way that a basic digital camera works.
In the case of the inspection camera the image is transferred electrically, after being transduced at the far end of the cable.

The advantage of this is that the cable is no-longer fragile and can be bent without fear of breaking the optical fibres. The downside of course is that the diameter of the camera is much larger than that of the endoscope.

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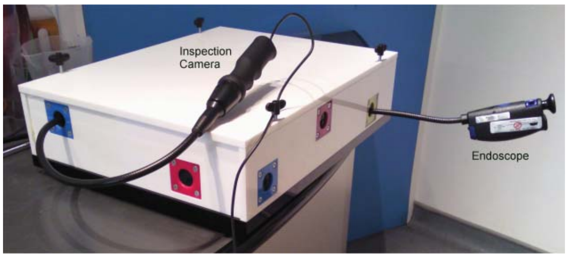
3.2 Using the endoscopes and inspection camera

The Puzzle Box

The large white puzzle box is a 3D maze with random objects hidden in it. The task for the students is to try and identify as many objects as they can in the alloted time. They can use either the single person endoscopes or the inspection cameras. ***Do not use the LCD endoscope as it could easily be damaged.***



Part 4: Simulated Gastroscopy

Gastroscopy is a medical application of the endoscope whereby doctors insert a scope into the stomach of a patient. The story is that the patient has swallowed a battery which is causing pain and inflammation of the stomach. We need to see inside the patient to assess the problem and if possible remove the battery.

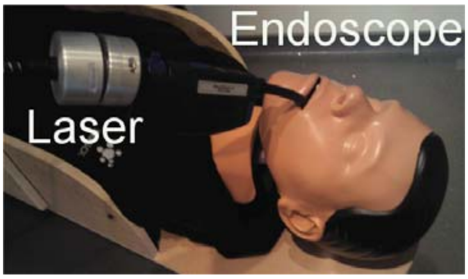
4.1 The Dummy

Arrange the dummy on the desk, and then place the battery inside the stomach via the hatch located on the side. Which is the best to use endoscope or camera?
Thinner is better and it would be good if everyone could see the image so the TV endoscope is the best option.
The students need to insert the endoscope into the mouth of the dummy - down into the stomach, find the battery and remove it using the tools provided. Supporting the head and neck of the dummy will make it easier so get more students involved. Try to get them to treat it like a real person, so discourage ramming the scope down quickly, as this could cause internal bleeding and serious pain. *This also minimises the risk of damaging the endoscope.*

4.2 Cauterising the bleed (additional)

Surgeons often use lasers to cauterise bleeding. In this process the tissue is essentially burnt together, to seal the wound. We can simulate this process by directing a laser beam down the endoscope.
Start by pressing the green button on the case of the dummy. This activates LEDs inside the dummy which flash. The LEDs are there to simulate internal bleeding, perhaps from heavy handed use of the endoscope, or from the irritation caused by the leaking battery acid.

Arranged around the flashing LEDs are a number of sensors. When the sensors are illuminated by the laser light they will begin to turn off the flashing LEDs. The task is to turn off all of the LEDs, thereby 'stopping the bleed'



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