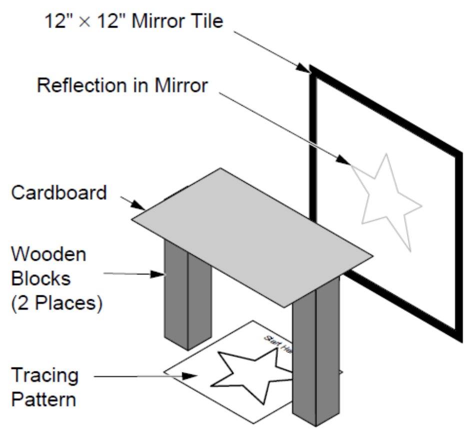
Fibre Optics– Teacher Resource

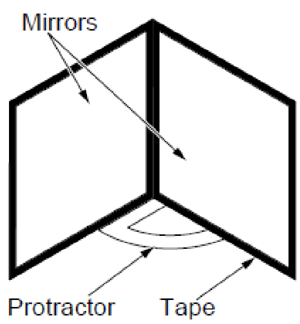
Investigating Reflections

After the medical optoelectronics experiment on Lab in a Lorry, the students should know that fibre optics can be used to send light long distances and round bends. They will also have seen a couple of demonstrations of how this might be useful e.g. for endoscopes to look in a body, or to look down a drain.

This follow-up is focused on reflection and uses of fibre optics.

Looking at reflections	
Reflections	Flat mirrors (or plane mirrors) can be used to look at reflection. Light rays that fall on a plane mirror are called **incident rays**. The angle that the light ray touches the mirror is called the **angle of incidence.** The angle in which light rays are reflected is called the **angle of reflection.**
Tracing Challenge Equipment: Mirror Paper Cardboard	Draw a large shape on a piece of paper. Set up your shape and the mirror like the diagram. The challenge is to trace your finger around the shape while looking in a mirror. What did you notice when tracing the patterns? Did your eyes and your brain give you different information? Where did it feel like your hand was located when you looked at it in the mirror? Was it harder to trace the pattern with your finger or with a pencil?
Two plane mirrors Equipment: 2 mirrors Protractor	When you use 2 plane mirrors, the reversed image that you see from the first mirror gets reversed again, so you end up with a **true image**. Set up 2 mirrors, standing at a 90 degree angle, like the diagram. Now look into the mirror, and follow these instructions: A) Hold up your right hand as it looks in the mirror B) Use your left index finger to touch your right thumb C) Wink your left eye D) Raise both hands, then bring them together so your fingers touch E) Touch your right shoulder with your left hand F) Give instructions to each other to follow





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Two plane mirrors continued	What did you notice about your reflection in the mirror? Did your reflection do what you expected it to do? Why was the activity difficult?
Two mirrors, many images Equipment: 2 plane mirrors Protractor Tape	With the last experiment you were working with the mirrors at an angle of 90 degrees. When you change the angle you may see more images in the mirrors. At some angles you will also see partial images. Try changing the angles and fill out the table on the right. There is a calculation you can do to work out the number of images you should see, although as the experiment is not perfect your results may differ. **Number of images observed = $\frac{360 \text{ degrees}}{\text{Angle}}$** Calculate the number of images observed using this calculation, and see if it matches what you actually observed.
Reflection off of water	Although we have been looking at reflections in mirrors, light can also be reflected off of other surfaces. Try this: ⇒ Fill a large glass bowl (casserole dish size) with water ⇒ Put a spoon in the bowl ⇒ Look down on the bowl from above – you can see the spoon in the bottom of the water ⇒ Now bend down and look up at the surface of the water - you can see a reflection of the spoon The light reflects very well off of the water even at a small angle.

Angle	Number of mirrors observed	Number of images observed
10 degrees		
20 degrees		
30 degrees		
40 degrees		
50 degrees		
60 degrees		
70 degrees		
80 degrees		
90 degrees		
100 degrees		
110 degrees		
120 degrees		
130 degrees		
140 degrees		
150 degrees		
160 degrees		
170 degrees		
180 degrees		

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Total Internal Reflection	Light travels more slowly in water (a more dense material) than in air (a less dense material). This change in speed makes the light **refract**. As we change the angle of incidence, the angle of reflection also changes. At some point, the refracted light actually ends up reflecting back inside the water. This is called **total internal reflection.**
Fibre optics	Fibre optics also use reflection. There are no mirrors in fibre optics, and no water either. The fibre optic strands are made up of 2 materials, a transparent core, surrounded by a plastic cladding that has a **lower refractive index**. This way, light is kept in the core by **total internal reflection.** One optical fibre is the width of a human hair, but the light signals can travel along the fibre for over 1000 metres with no data loss.
Uses of fibre optics	On the lorry, you will have seen that fibre optics can be used together to carry images. The endoscopes that you were using had bundles of 7000 fibre optics in them! Endoscopes were initially created to allow people to see inside the human body, without having to cut a large opening. They can also be used to see round corners and in small places– perfect for checking why the drains are blocked! More recently, fibre optics have been used to send other signals as well. Sound signals can be converted to light signals. So telephone messages, and modern stereo systems use fibre optic cables. Broadband internet can also use fibre optic cables, which can send signals quicker than previous methods. The government decided that the first areas to get fast fibre optic broadband internet should be the major cities. Some people have objected, saying that rural areas deserve priority. What do you think?