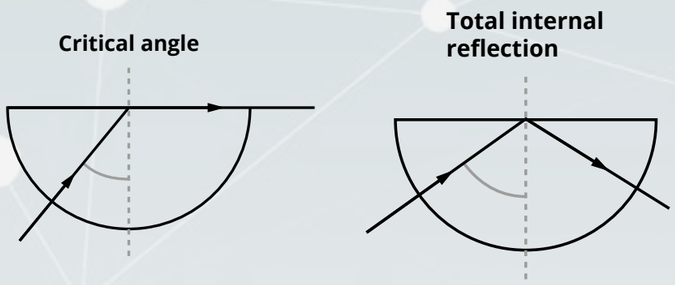


At the **critical angle**, the light bends **along the boundary**. If you increase the angle, the light will reflect. This is called **total internal reflection**.

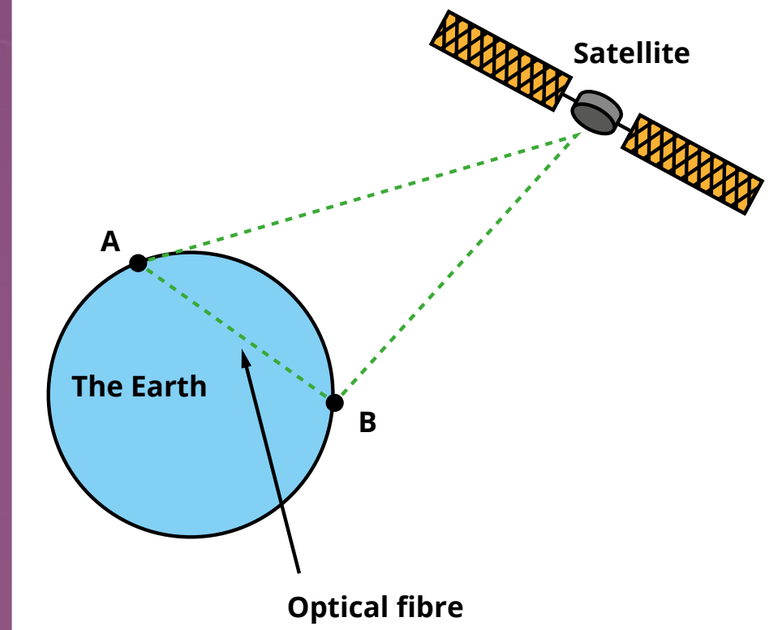
The two conditions required for total internal reflection to occur are:

1. The light must be travelling from a **higher** optical density towards a **lower** optical density, for example glass into air.
2. The angle between the normal and the ray of light must be **greater than the critical angle**.

Optical fibres
Total internal reflection is used in optical fibres.

Light is sent along a glass tube reflecting from the side of the tube until it reaches the end. This is very useful to send information quickly over long distances and is used in endoscopes.

Satellite or optical fibre communication?

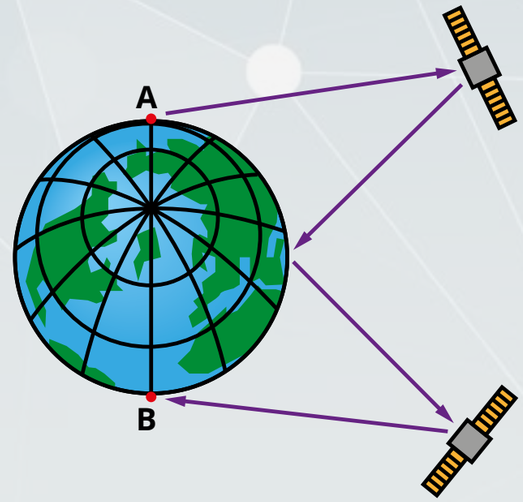


To communicate with Station B, Station A could send a message via satellite or along an optical fibre.

Satellite	Uses Microwaves Faster wave speed (300 000 000m/s) Larger distance = longer delay Can communicate anywhere
Optical fibre	Uses Infrared Slower wave speed (200 000 000m/s) Shorter distance = small delay Needs a connection to the fibre

Endoscopes
Endoscopes use total internal reflection to investigate specific areas of the body. Light is sent into the body through an optical fibre and reflected back along another optical fibre to a camera located outside the body.

They investigate specific areas in detail and are less harmful as no ionising radiation is used.



For a signal to travel from A to B via satellite, the signal must **travel to the satellite, back to Earth and then to the next satellite** as they cannot send signals directly to each other. This means that the distance the signal travels **is 4 times the distance** from the base station to the satellite. The total distance will be 4 × 36000km = 144000km.

Using the equation $time = \frac{distance}{speed}$ you can calculate the time it takes the signal to travel from A to B:

$$time = \frac{144\,000km}{300\,000km/s} = 0.48s$$

However, if an optical fibre was connected from A to B, the length would be 20 000km and although the light travels slower through the glass, 20 000km/s, **the time taken is much less**.

$$time = \frac{20\,000km}{200\,000km/s} = 0.01s$$

CT scans
CT scans can also be used to investigate the body. They use X rays to generate more overall images of the body and are in 3D.

They give a more overall picture but pose a higher risk due to the X rays.