OCR
Oxford Cambridge and RSA

Monday 8 January 2018 – Morning

LEVEL 1 CAMBRIDGE NATIONAL IN SCIENCE

R072/01/I How scientific ideas have developed

INSERT

Duration: 1 hour

INSTRUCTIONS TO CANDIDATES

- This Insert contains the case study required to answer Question 1. Question 1 accounts for 25% of the total marks.

INFORMATION FOR CANDIDATES

- This document consists of **4** pages. Any blank pages are indicated.

INSTRUCTION TO EXAMS OFFICER/INVIGILATOR

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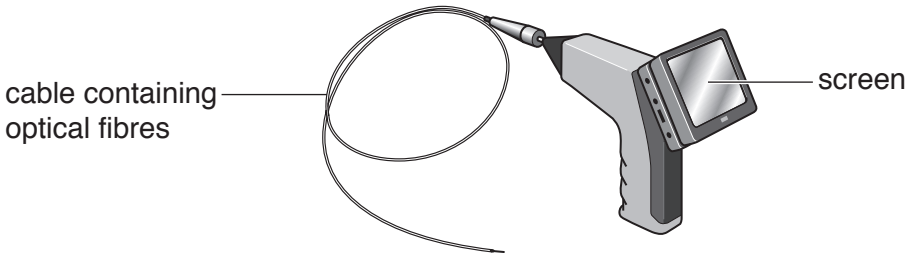
Optical Fibres

Optical fibres are used in endoscopes and for telecommunication.

Endoscopes

Endoscopes (**Fig. 1**) have many uses. One use is by surgeons to see the inside of a patient's body. An endoscope has a cable which contains a bundle of very thin optical fibres. The surgeon makes a tiny hole in the skin of the patient for the cable to pass through.



An endoscope

Fig. 1

Some of the fibres pass light into the body, other fibres transmit images back so that the surgeon can see inside the patient's body. The images can be shown on a small screen or transferred to be looked at and stored on a computer. Endoscopes are used both for diagnosis and during operations. Compared to the surgical techniques used previously, the use of endoscopes has reduced the time needed to do operations and the time needed for patients to recover.

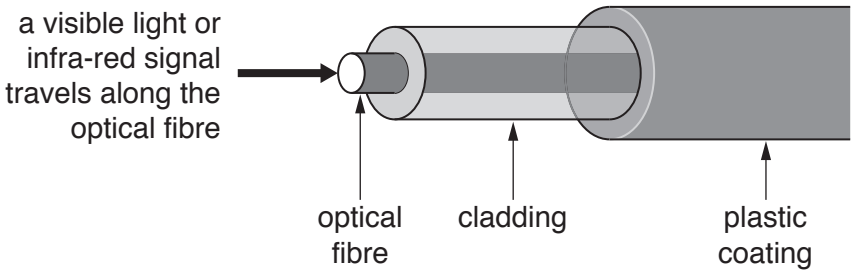
Telecommunication

Telecommunication means transmitting information over long distances. Many different types of electromagnetic waves are used for telecommunication. These include radio waves, microwaves, visible light and infra-red. Each type of wave is different because it has a different wavelength.

Radio waves and microwaves can be used to send signals directly from a transmitter to a receiver through the air. This method is **not** used for signals that travel over very long distances, such as between Britain and America. Another method sends light or infra-red signals along optical fibres. Optical fibres can be used to transmit high quality, digital signals over very long distances. Digital signals are used for radios, telephones, televisions and the internet.

How does an optical fibre cable work?

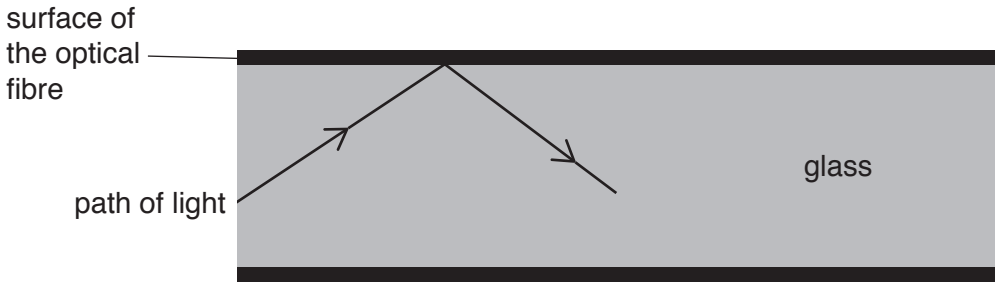
The optical fibre is a long, thin glass strand surrounded by cladding. It is covered with a plastic protective coating, as shown in **Fig. 2**. The cladding and the plastic coating stop the glass strand from being scratched. Optical fibres with scratches do not work as well. A visible light or infra-red signal travels along the optical fibre. Very little of the signal is 'lost' as it travels, which is one reason why optical fibres are useful for very long distance communication.



An optical fibre
Fig. 2

Light travels at 300 000 000 m/s in air. In an optically denser material, such as glass, light travels a lot more slowly. In glass light travels at 200 000 000 m/s. This is still very fast. The distance between Britain and America is about 7000 km. An optical fibre can transmit messages between these countries very quickly.

Inside the optical fibre, the light reflects off the surface of the optical fibre and no light escapes. This is called 'total internal reflection' and is shown in **Fig. 3**. The walls of the fibre need to be very smooth so that they act like a perfect mirror to reflect the light and to make sure that the quality of the signal is not lost. The light travels along the optical fibre by 'bouncing' off each surface of the optical fibre.



Total internal reflection in an optical fibre
Fig. 3

Optical fibre cables have a very high capacity when used for communications. Electrical signals, travelling along copper wires, can also carry information, but an optical fibre has a much higher capacity than a copper wire of the same thickness.