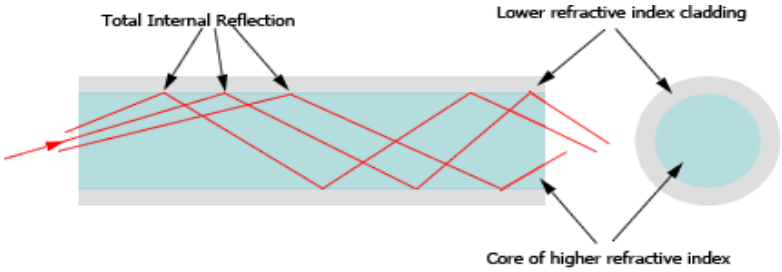
## State Examination Commission – Physics Higher Level, 2009

## Question 12c

Information is transmitted over long distances using optical fibres in which a ray of light is guided along a fibre. Each fibre consists of a core of high quality glass with a refractive index of 1.55 and is coated with glass of a lower refractive index.
Explain, with the aid of a labelled diagram, how is a ray of light guided along a fibre. (9)
Why is each fibre coated with glass of lower refractive index? (6)
What is the speed of the light as it passes through the fibre? (7)
Light passing through optical fibres must travel through an enormous length of glass. Impurities in the glass reduce the power transmitted by half every 2 km.
The initial power being transmitted by the light is 10 W.
What is the power being transmitted by the light after it has travelled 8 km through the fibre? (6)
(speed of light in air = $3.0 \times 10^8$ m $s^{-1}$)

---

Information is transmitted over long distances using optical fibres in which a ray of light is guided along a fibre. Each fibre consists of a core of high quality glass with a refractive index of 1.55 and is coated with glass of a lower refractive index.
Explain, with the aid of a labelled diagram, how is a ray of light guided along a fibre. (9)




Having entered the optic fibre, the rays of light strike the internal walls at an angle greater than the critical angle, and are totally internally reflected as a result. This happens at all points except at the end of the fibre.

Why is each fibre coated with glass of lower refractive index? (6)

Total internal reflection can only occur when light is incident on the boundary between one medium and another of lower refractive index. Otherwise, light will be transmitted into the medium.

What is the speed of the light as it passes through the fibre? (7)

$n$ = speed of light in vacuo /speed of light in medium = $3.0 \times 10^8$ / speed of light in medium

speed of light in medium = $3.0 \times 10^8$ / n = $3.0 \times 10^8$ / 1.55 = $1.94 \times 10^8$ m $s^{-1}$

Light passing through optical fibres must travel through an enormous length of glass. Impurities in the glass reduce the power transmitted by half every 2 km.
The initial power being transmitted by the light is 10 W.
What is the power being transmitted by the light after it has travelled 8 km through the fibre? (6)

Over 8 km, the power has been halved four times. The power being then transmitted is $(½)^4$ its original value, that is 1/16 x 10 = 0.625 W