

LIGHT AND THE NBN.  
WHY DID WE SWITCH TO  
THE NBN?

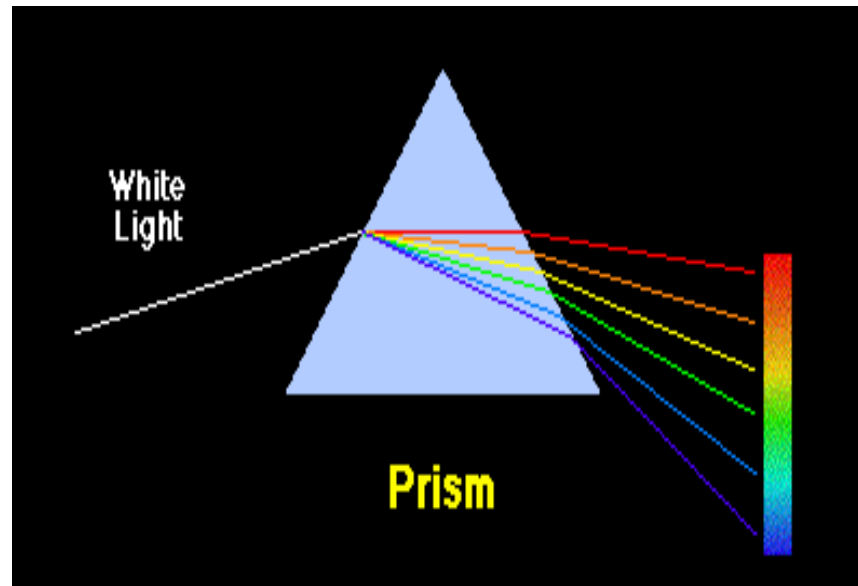
# TRANSMISSION OF MESSAGES

- There are two important reasons for switching from copper wire transmission to the optical fibre NBN.
- There are some disadvantages involving bending and other matters but the two advantages far outweigh these disadvantages.
- 1. In copper wire electrical transmission more energy escapes as heat etc than in optical fibre transmission; little light escapes (right-hand picture below).
- 2. Optical fibre can carry many more signals than copper wire. This is said to be a broader bandwidth, and results in an overall increase in speed.



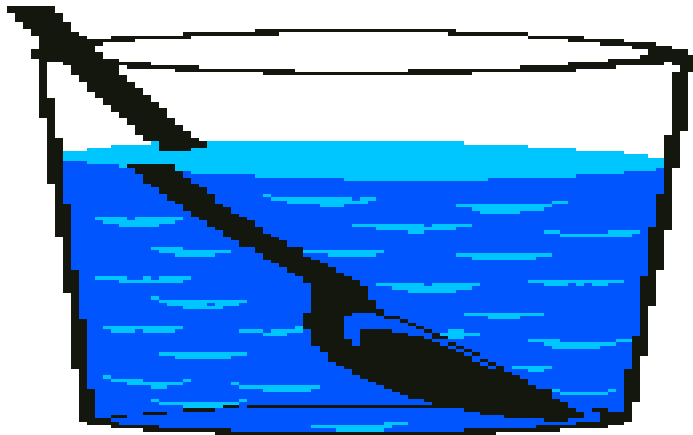
# Behaviour of light

- It is because light is refracted (bent) when it crosses a boundary that the NBN is possible.
- The amount of bending depends on the wavelength i.e. colour of the light as can be seen in the illustration of the passage of light through a prism.



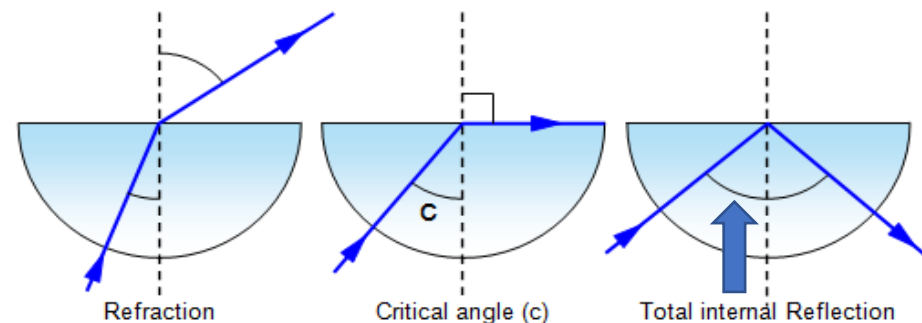
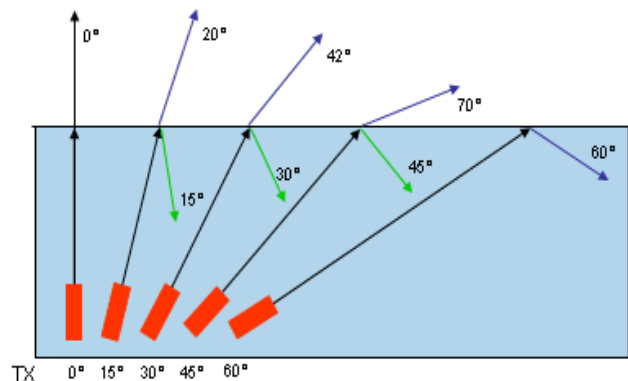
# Refraction

- Light is refracted because it travels at different velocities in different materials.
- It travels slower in water than it does in air, which produces the illustrations below.



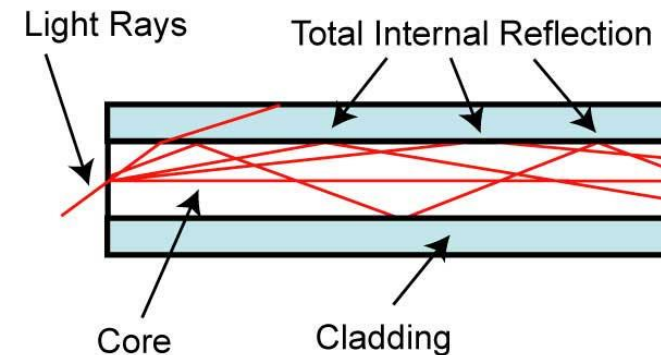
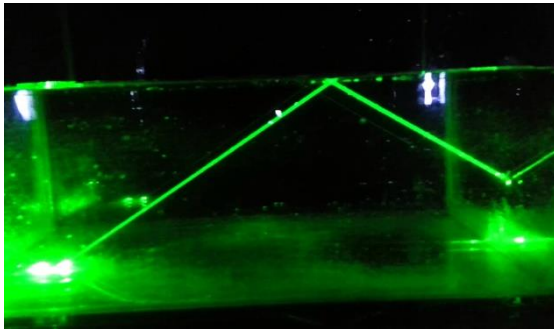
# Refraction towards the outer surface

- When light travels from an optically denser medium to a less optically dense medium it is refracted towards the outer surface as illustrated below (some of the light is internally reflected and is shown as green rays).
- If it strikes the inner surface at an (incident) angle  $c$  (which depends upon the differences of the refractive abilities of the two media) it travels along the boundary between the two media.
- If the incident angle (indicated by vertical arrow) is greater than  $c$  (the critical angle) the ray is “totally internally reflected”.



# A refraction effect: total internal reflection

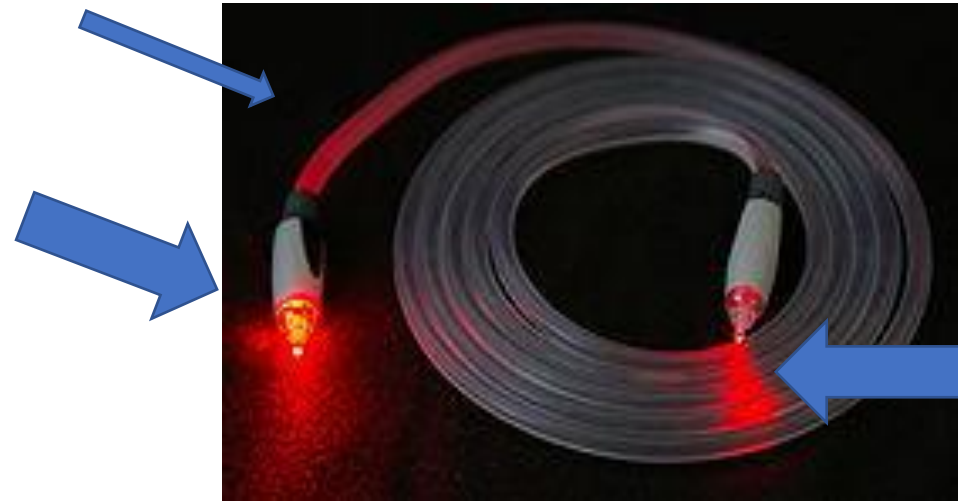
- If a beam of light inside a fibre optic cable meets the boundary surface at an angle greater than the critical angle it will be totally internally reflected.



# There is only a small loss of light energy if beam is “straight in”

- Optical fibre cable used in the body:
- If the light source were a parallel beam and of a single wavelength (colour) no light would escape from the ‘skin’ of the fibre, as seen at the top left corner.
- In surgery the emerging light can be reflected back by body parts.
- Some light escaping.

Light source.



Emerging light.

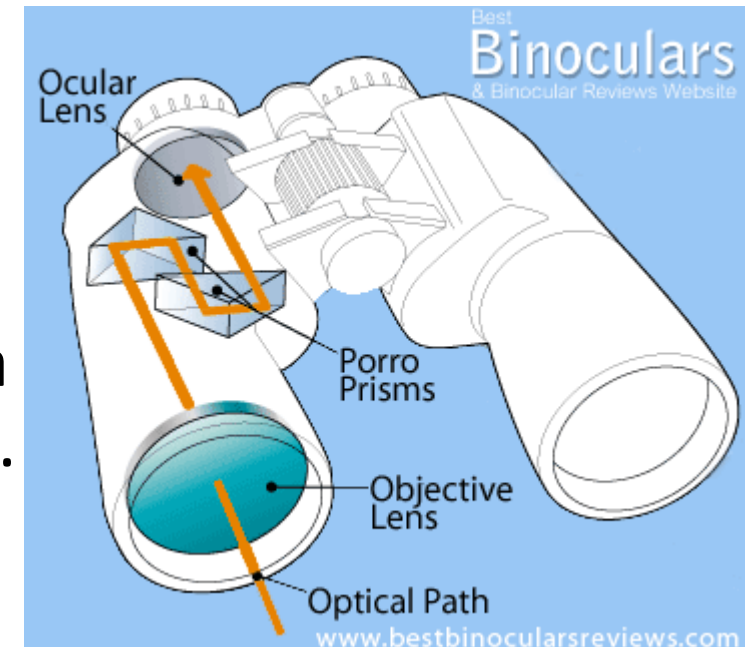
# Using total internal reflection 1

Total internal reflection makes optical fibres useful and prismatic binoculars possible.

It is also what gives diamonds their distinctive sparkle, as diamond has an unusually high refractive index.

The magnifying power of binoculars increases as the distance between the ocular lenses and the objective lenses increases.

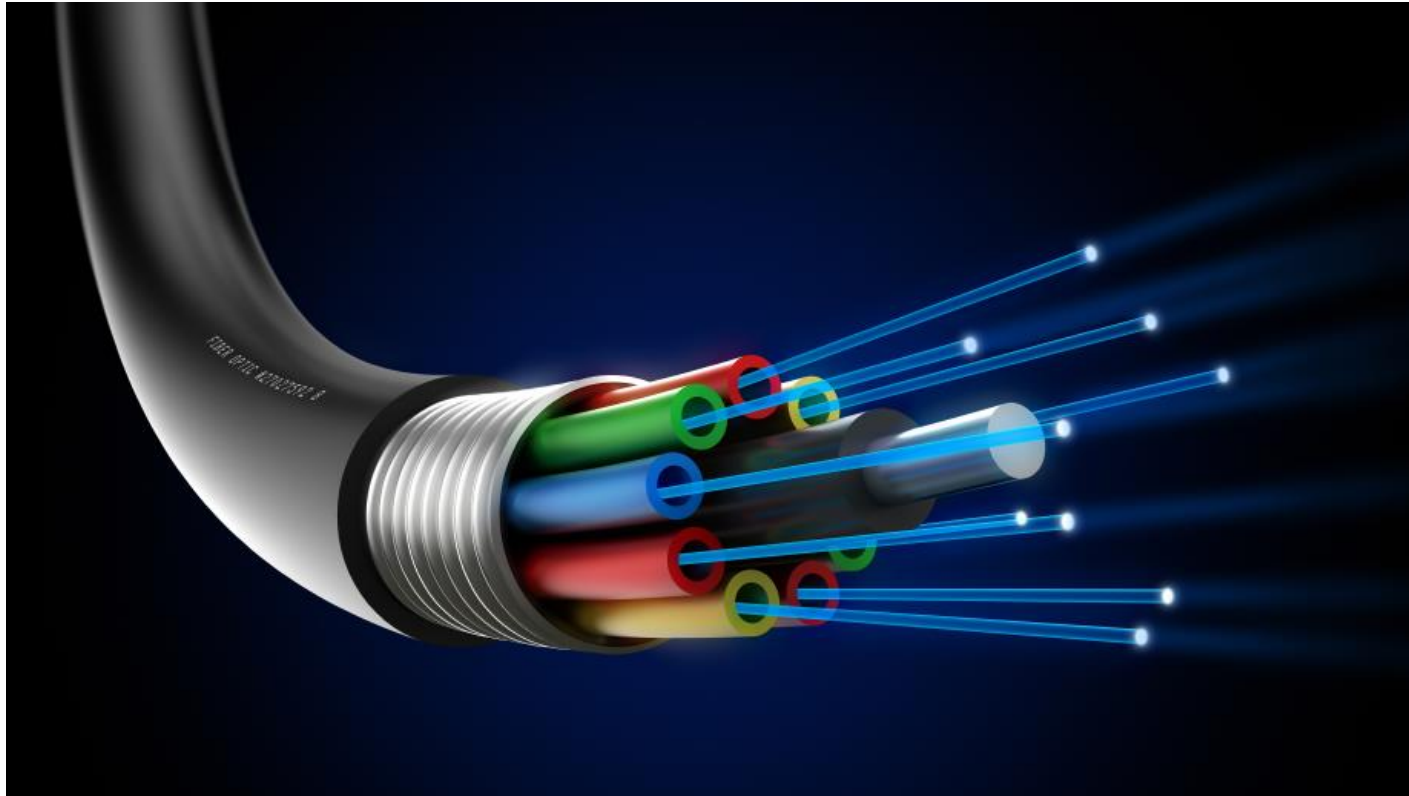
Also, travelling through the glass in the prisms, at a slower speed is equivalent to lengthening the path.





# Using total internal reflection 2

- The National Broadband fibre optic cable transmits light signals using total internal reflection.



# Copper from the node

When you use the NBN, the following happens:

1. Your device sends an electrical signal, via copper wire, to the node.
2. At the node, that signal is converted into a laser.
3. Within the NBN, signals are transmitted as laser beams.
4. At the destination, the laser is converted back to an electrical signal.
5. Blue lasers (blue ray) are marginally better than red lasers.