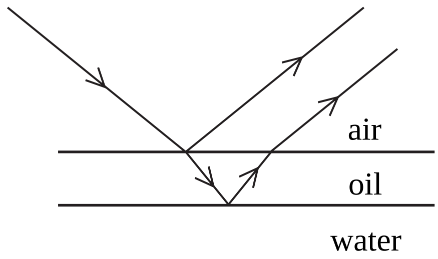
***1** When oil floats on water, coloured interference patterns are often seen. The interference patterns are formed because of the thin film of oil. A thin film of oil can also produce interference patterns with monochromatic light.
The diagram shows light from a monochromatic source, incident on a film of oil.

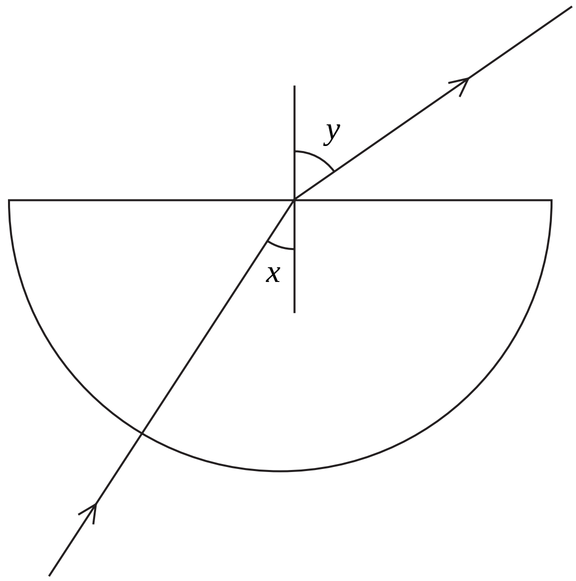
Explain why interference patterns may be seen.

(5)



(Total for Question = 5 marks)

***2** A student carries out an experiment to measure the refractive index of glass. She does this by shining a ray of light through a semicircular glass block and into the air as shown.



$x = 30°$
$y = 48°$

(a) Calculate the refractive index from air to glass $_a\mu_g$.

(2)

Refractive index =

(b) (i) The student steadily increases the angle *x* in glass and finds that eventually the light does not pass into the air. Explain this observation.

(3)

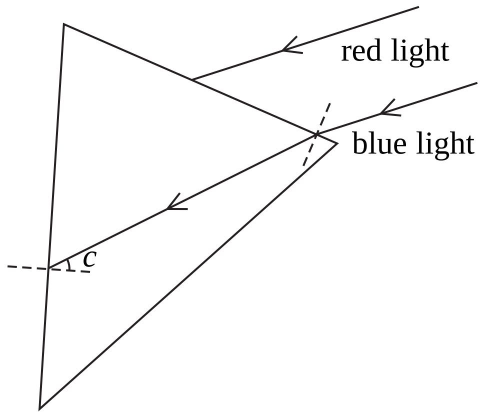
(ii) Calculate the largest value of angle *x* that allows the light to pass out of the block into the air.

(2)

Angle =

(Total for Question 16 = 7 marks)

3 Two parallel rays of light, one blue, one red, are travelling in air and are incident on one side of a glass prism. The blue light passes into the prism and meets the second face at the critical angle as shown in the diagram.



(a) Add to the diagram the path of the blue light after it meets the second face. Label this path X.

(1)

(b) (i) The speed of blue light in the glass prism is 1.96×10^8 m s^{-1}.

Calculate the refractive index of this glass for blue light.

(2)

Refractive angle =

(ii) Calculate the critical angle for blue light in this glass prism.

(2)

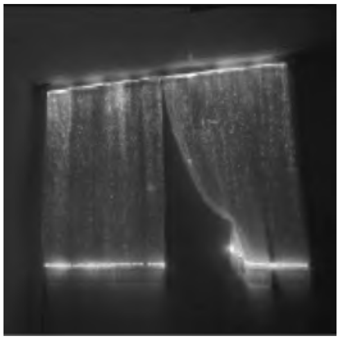
Critical angle =

(c) The refractive index of this glass for red light is less than for blue light. Add to the diagram to complete the path of the red light through the prism. Label this path Y.

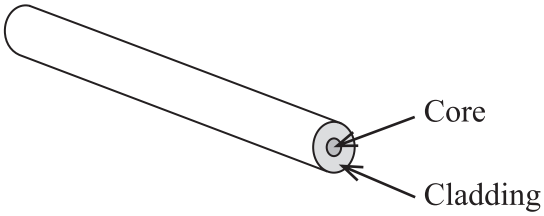
(2)

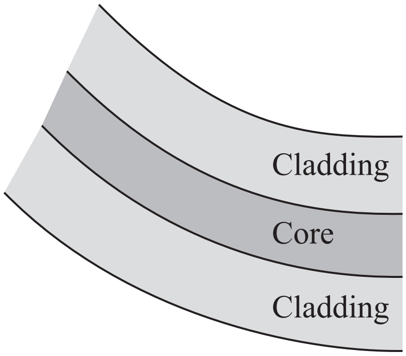
(Total for Question = 7 marks)

4 Optical fibres have many uses in medicine and communications. They can also be incorporated into items such as the curtains shown in the photograph.



Some optical fibres are made from a central core of transparent material surrounded by a material of a different refractive index as a cladding.





speed of light in the core 1.96×10^{8} m s^{1}
speed of light in the cladding 2.03×10^{8} m s^{1}

(a) Calculate the critical angle for the core-cladding boundary.

(3)

....

....

....

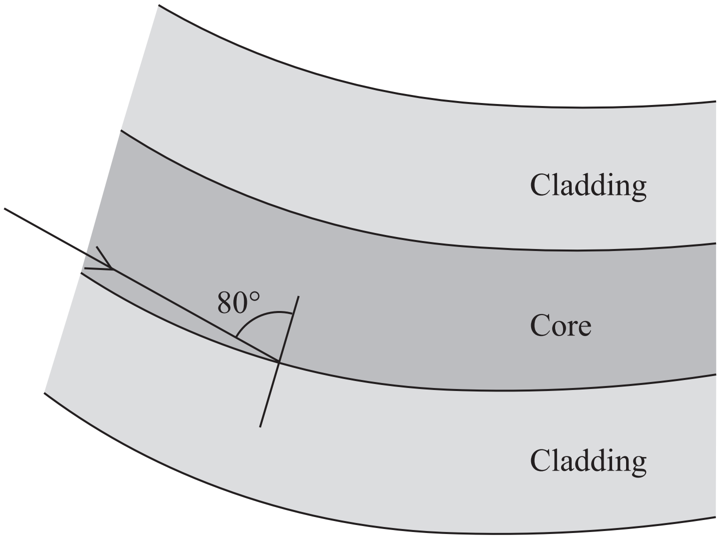
....

....

....

Critical angle ....

(b) The diagram below shows a ray of light inside the core of a fibre. The ray is incident on the core-cladding boundary at an angle of 80°.



State what happens to this ray of light when it is incident on the core-cladding boundary as shown.

(1)

....

....

....

(c) The light source for these curtains is at the top.

Suggest why the bottom of the curtain is much brighter than the rest of the curtain.

(2)

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....

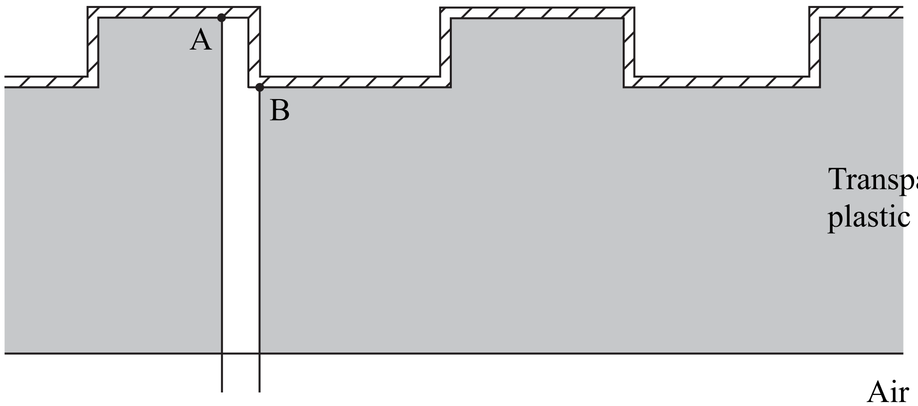
....

....

....

(Total for Question 6 marks)

5 A diagram shows the structure of a compact disc. A laser light beam is directed at right angles to the underside of the disc.



The wavelength of the laser light in the transparent plastic layer is 414 nm

refractive index of the transparent plastic layer 1.53

(a) (i) Calculate the wavelength of the light in air.

(2)

....

....

....

Wavelength ....

(ii) Light reflected from point A is 180° out of phase with light reflected from point B.

Calculate the minimum vertical distance from A to B.

(2)

....

....

....

....

Minimum vertical distance ....

(iii) Explain the effect when the light reflected from A and B is combined.

(2)

....

....

....

....

(b) Some of the reflected light will not hit the plastic-air boundary at 90°.

(i) Calculate the critical angle of the plastic-air boundary.

(2)

....

....

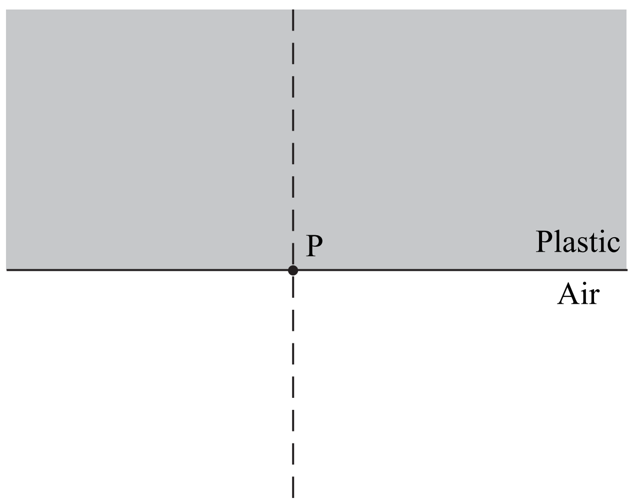
....

....

Critical angle ....

(ii) On the diagram below, show what happens to a ray of light which hits the plastic-air boundary at point P at an angle greater than the critical angle.

(2)



(Total for Question 10 marks)

6 A student has the equipment shown in Figure 1:

- protractor
- 15 cm ruler
- laser light source
- pencil
- sheet of paper
- rectangular block of plastic.

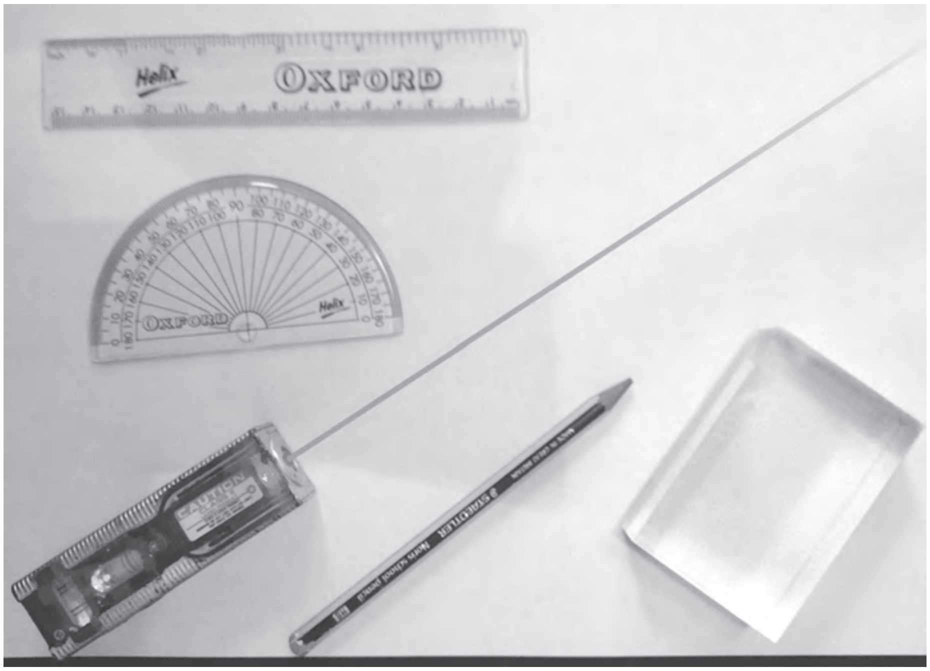


Figure 1

(a) The student uses the equipment shown in Figure 1 to take the measurements needed to determine the refractive index for light travelling from air into the plastic.

Explain **one** limitation of this equipment when used to obtain the measurements.

(2)

(b) The value of refractive index obtained by the student was 1.52.

(i) Calculate the speed of light in the plastic.

(2)

Speed of light in the plastic =

(ii) Calculate the critical angle for the plastic.

(2)

Critical angle =

*(c) The student was given the shape shown in Figure 2 made from the same plastic.

Figure 3 shows what happens when light from a laser was directed at one end of the shape.

Figure 2

Figure 3

Explain the path of the laser light through the plastic as shown in Figure 3.

(4)

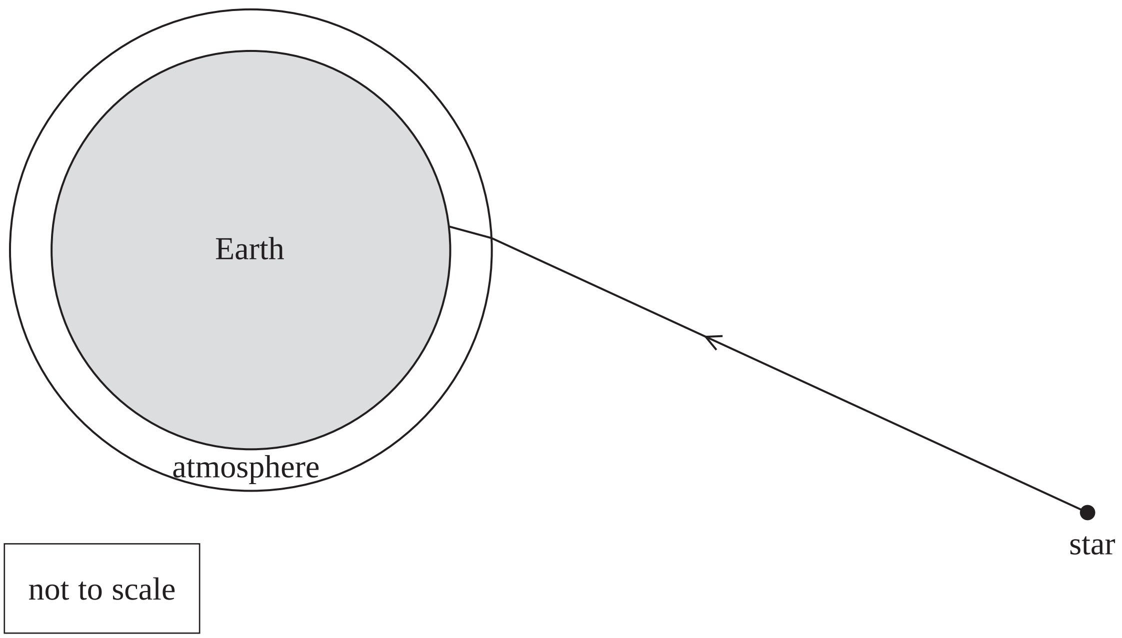
(Total for Question = 10 marks)

7 When light rays enter the Earth's atmosphere from space they undergo refraction. This can lead to a star appearing to be in a different position from its actual position.

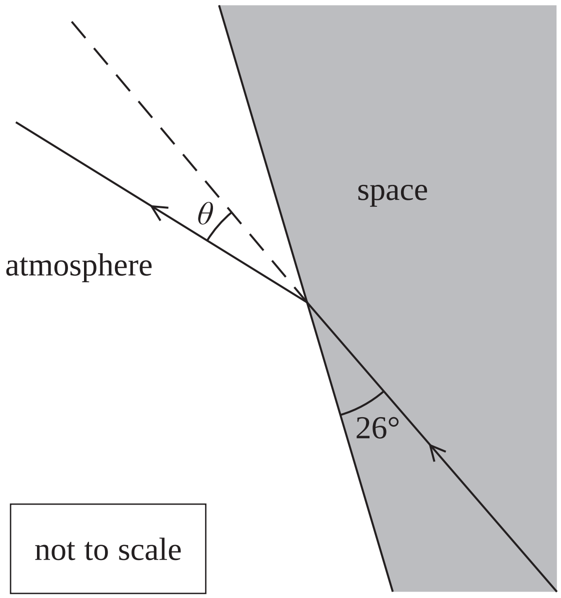
(a) Explain what is meant by refraction and why it occurs for light entering the Earth's atmosphere.

(3)

(b) The diagram shows a ray of light from a star reaching the Earth's surface.



The diagram shows in more detail the ray of light as it enters the atmosphere.



Calculate the change in direction θ of the ray.

refractive index of atmosphere = 1.001

(4)

θ =

(Total for Question = 7 marks)