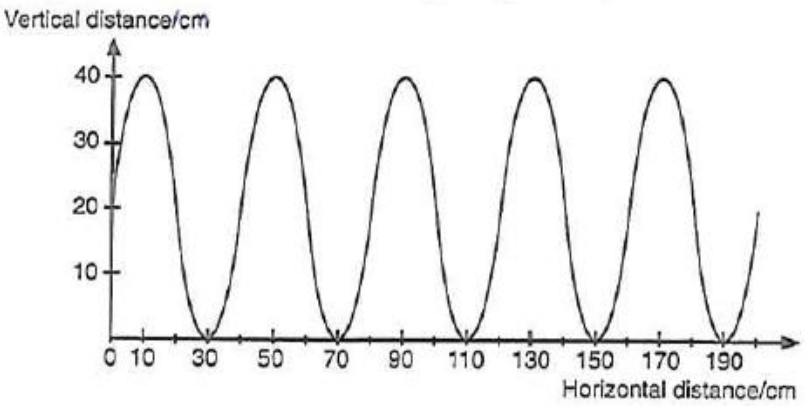
1 John holds the loose end of a rope which is fixed to a post and moves it up and down 25 times every 5 seconds. The graph shows the wave moving along the rope.

(a) What is the wave which travels along the rope called? Explain.

(b) Name ***two*** examples of this type of wave.

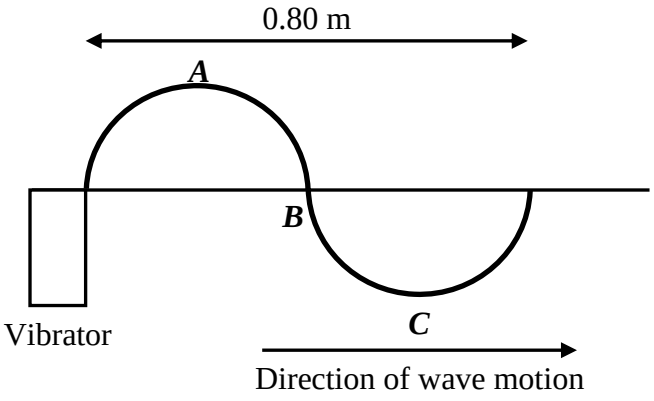
(c) What is the wave's
(i) amplitude
(ii) frequency
(iii) wavelength
(iv) speed?



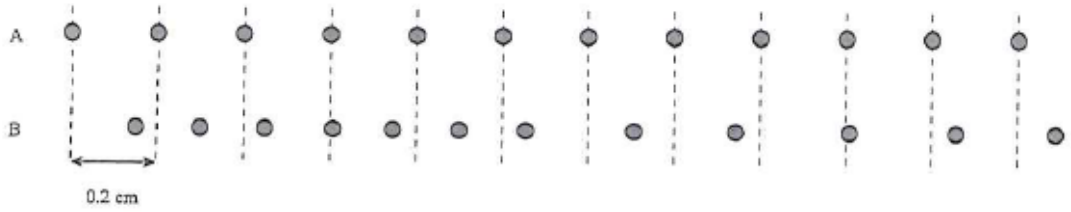
2 A vertical vibrator generates waves on a string. It takes 0.25 s to produce a complete wave of wavelength 0.80 m on the string.

(a) Find
(i) the frequency and
(ii) speed of the waves on the string.

(b) The diagram shows the shape of the string at the instant when the vibrator has made one complete vibration.
(i) Will the particle ***D*** start to move upwards or downwards?
(ii) Sketch the shape of the string 0.125 s later, showing the position of particles ***A***, ***B***, ***C*** and ***D***.



3 The diagram consists of two parts ***A*** and ***B***. Part ***A*** shows the undisturbed position of air particles at time t_1 while part ***B*** shows the positions of these air particles at a time t_2 when a sound wave passes from left to right. The distance between the air particles during time t_1 is 0.2 cm as shown by equal distance between the lines in the diagram.



(a) Define longitudinal wave.

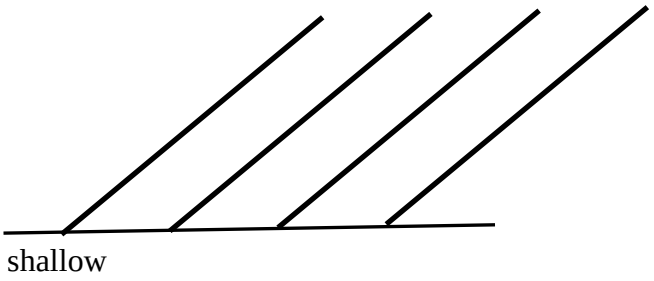
(b) Mark the centre of compression with a ***C*** and the centre of rarefaction with ***R*** in part ***B***.

(c) What is the wavelength of the sound wave?

(d) Given that the speed of the sound wave is 340 m/s, calculate the frequency of the sound wave.

(e) Sketch a displacement-time graph showing the amplitude and period of the wave clearly.

4 A water wave travels from a deep region to a shallow region as shown. The speed of the wave in the deep region is 0.18 m/s and its frequency is 15 Hz.

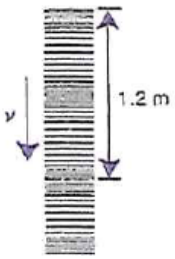


(a) Complete the diagram to show how the wave moves after entering the shallow region.

(b) Calculate the wavelength of the wave in the deep region.

(c) Calculate the wavelength of the wave in the shallow region if it is known that the speed has decreased by half.

5 The lines in the diagram represent the positions of particles on a wave. The wave is moving downwards.

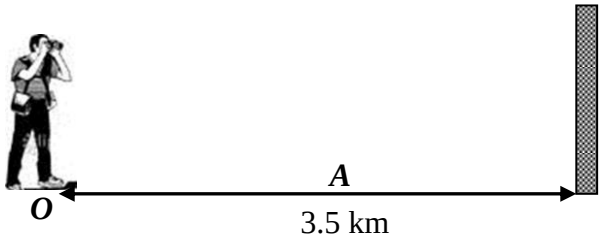


(a) State whether this is a transverse or longitudinal wave and explain how you can tell from the diagram.

(b) The wave is moving downwards. What is the direction of motion of a particle on the wave?

(c) Find the wavelength of the wave.

6 A gun is fired at point ***A*** between an observer, ***O*** and a vertical wall which is 3.5 km away from the observer. After seeing the flash of the gun, the observer hears the sound followed by another 5.0 s later.



(a) Why does the observer hear two sounds?

(b) State a difference between the two sounds that the observer hears after the gun shot.

(c) Calculate the distance between the observer and ***A*** if the speed of sound is taken to be 340 m/s.

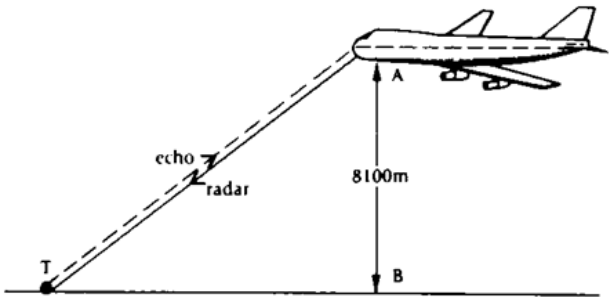
7 A fishing boat uses ultrasound of frequency 6.0×10^4 Hz to detect fish directly below. Two echoes of the ultrasound are received, one after 0.09 s coming from a shoal of fish and the other after 0.12 s coming from the sea bed. If the sea bed is 84 m below the ultrasound transmitter and receiver, calculate

(a) the speed of the ultrasound in water;

(b) the wavelength of the ultrasound waves in water;

(c) the depth of the shoal of fish below the boat.

8 An aircraft ***A*** is flying at a constant speed of 270 m/s at a constant height of 8 100 m above the surface of the earth. The aircraft directs a radar beam of wavelength 1.0 cm at a target ***T*** on the Earth's surface. After 90 μs, an echo from the target is detected on the aircraft. If the frequency of the radar waves is 3×10^{10} Hz, find



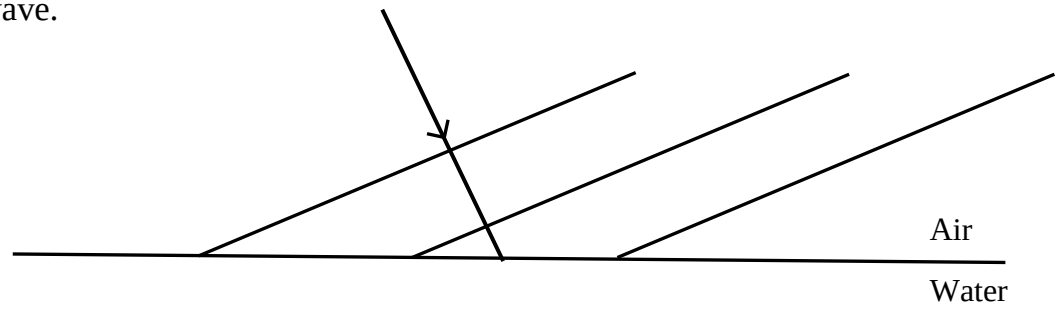
(a) the speed of the radar waves;

(b) the distance ***AT*** between aircraft and target;

(c) the time which elapses before ***A*** is vertically above ***T***.

9 A boy sitting in a battery operated car looks into a plane mirror 8.0 cm long which is placed 40.0 cm in front of him. If the rear window is 600.0 cm away from the mirror, sketch a diagram to find the length of the rear window that he can see whenever he looks into the mirror while he is driving?

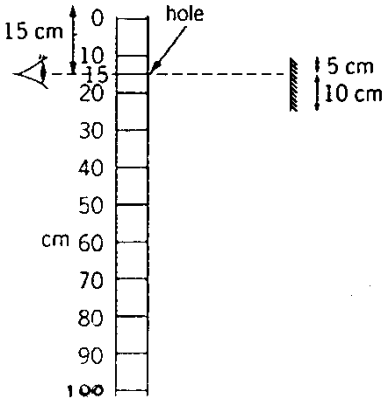
10 Plane sound wave is being directed towards water surface as shown. Include in the figure, the refracted wave.



11 The diagram shows an observer looking at a plane mirror through a small hole drilled through a metre rule.

(a) What is the marking on the metre rule as seen at the
  (i) top of the plane mirror?
  (ii) bottom of the plane mirror?

(b) Draw two rays to show how the eye can see the image of the top and bottom markings of the metre rule in the plane mirror.



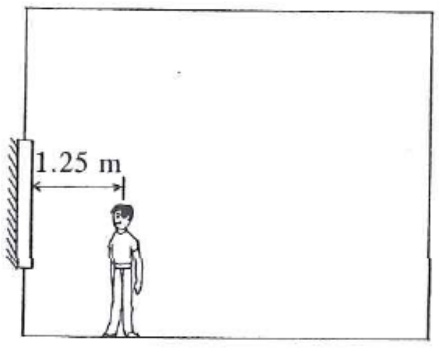
12 The room shown in the figure is 5.00 m long and 4.00 high. A mirror is hung on one of the walls. A boy 1.60 m tall stands 1.25 m from the mirror. His eyes are 0.10 m below the top of his head.

(a) Draw a ray to show how he sees the
  (i) top of the opposite wall
  (ii) foot of the opposite wall.

(b) What is the minimum length of the mirror in order to see the whole image of the opposite wall?

(c) Which should the mirror be hung?

(d) If the boy walks further away from the mirror, can he see the whole height of the opposite wall?



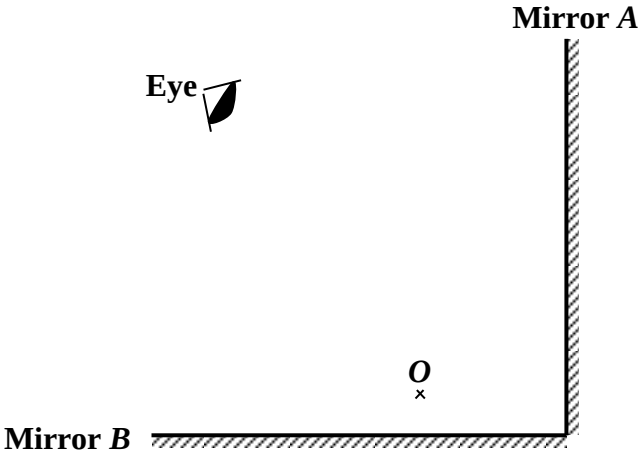
13 A point object ***O*** is placed in between two plane mirrors inclined at right angles.

(a) Mark the position of the image of the object ***O*** in mirrors ***A*** and ***B***, and label the images I_1 and I_2 respectively.

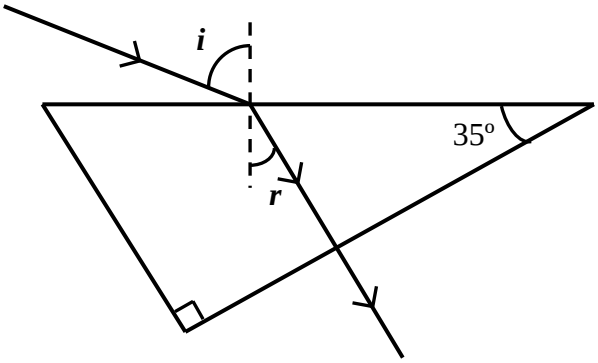
(b) A third image is known to exist, mark the position of this image and label the image I_3.

(c) Complete the diagram to show the images of the object ***O*** formed by the mirrors, as seen by the eye.

(d) The three images formed are said to be virtual.
(i) What does this statement mean?
(ii) Why is the image virtual?
(iii) State ***two*** other characteristics of the images formed.

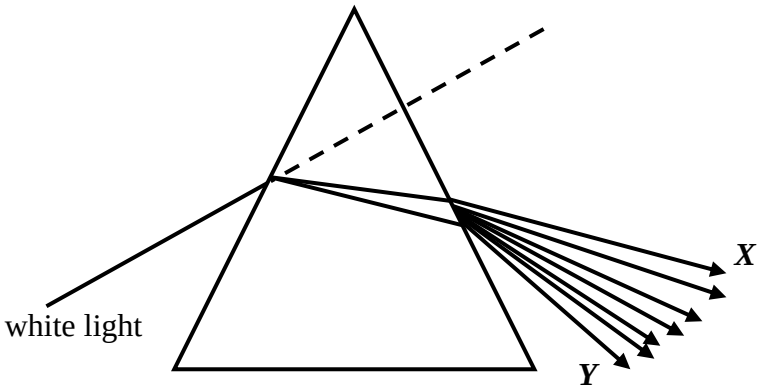


14 A ray of blue light is incident on a glass prism in such a way that the refracted ray strikes the second surface at right angles as shown.



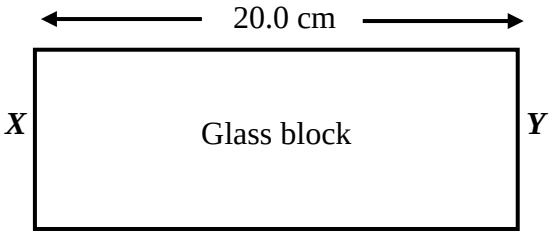
(a) Write down the angle of refraction, ***r***.
(b) Given that the refractive index of the glass is 1.45, calculate the angle of incidence ***i***, of the blue light in the prism.
(c) If a ray of red light is incident on the prism at the same angle,
(i) sketch its emergent ray.
(ii) Explain your answer.

15 When white light passes through a glass prism, it splits into a band of colours.

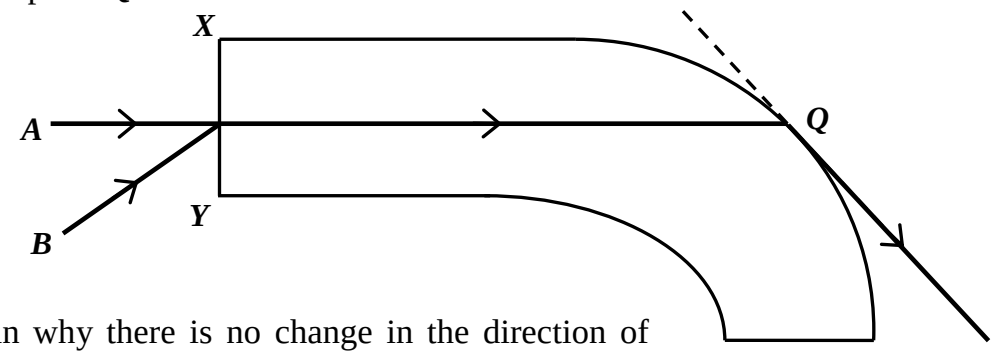


(a) What is the splitting of white light into its component colours called?
(b) What are the colours at ***X*** and ***Y***?
(c) Why does the white light split into its component colours in the manner shown when it enters the glass prism?

16 A glass block measuring 20.0 cm in length and having a refractive index of 1.5 contains a small air bubble. When the bubble is viewed from the side ***X***, it appears to be 6.0 cm from ***X***. If it is viewed from the opposite side ***Y***, what is the apparent distance between the bubble and the side ***Y***?



17 The diagram shows a section of an optical fibre which has a refractive index of 1.50. Two rays, ***A*** and ***B***, are incident on surface ***XY*** of the fibre. Ray ***A*** emerges into the air along the tangent of the optical fibre at point ***Q***.



(a) Explain why there is no change in the direction of light when ray ***A*** enters the optical fibre.

(b) State two conditions for ray ***A*** to emerge into the air along the tangent of the optical fibre at point ***Q***.

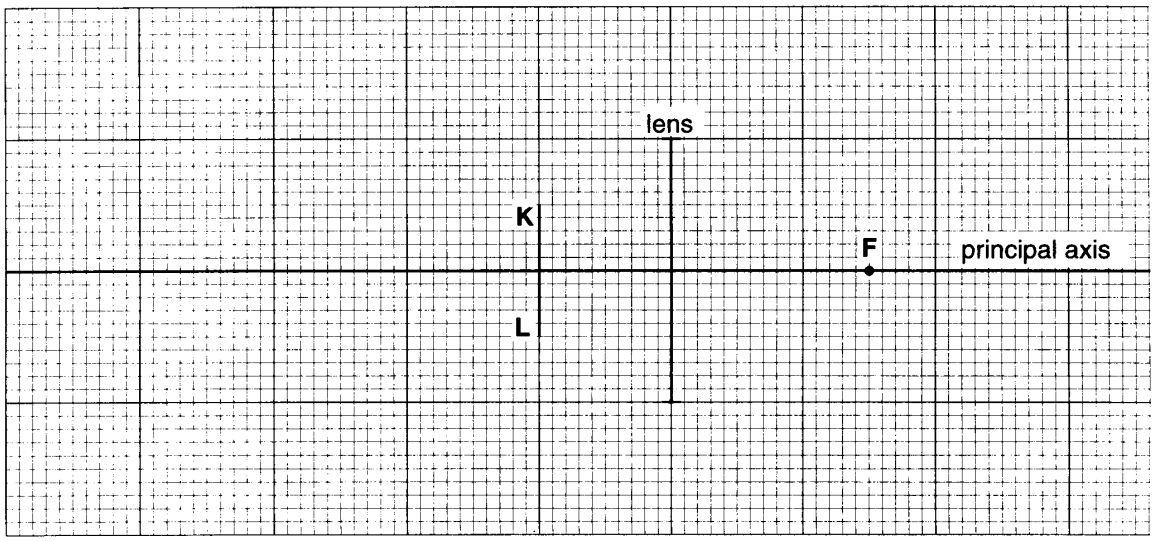
(c) Calculate the critical angle of the optical fibre.

(d) Would the value of critical angle measured in (c) decrease, increase or remain the same when the fibre is immersed in water? Explain your answer.

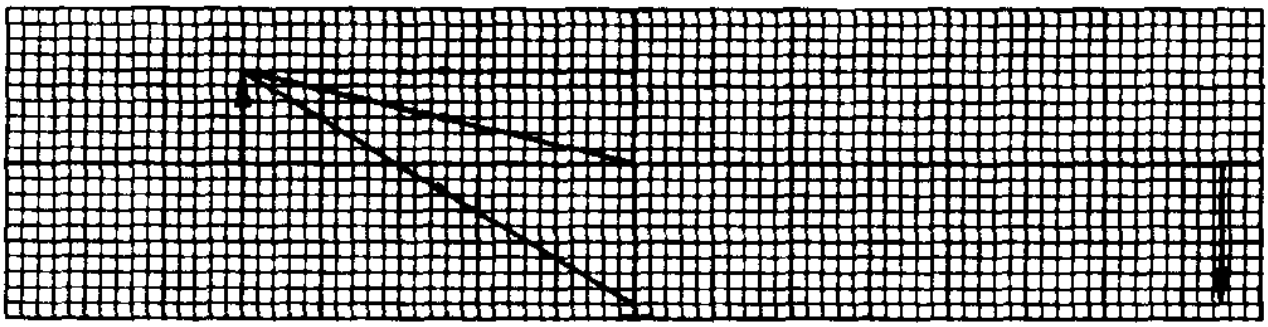
(e) Ray ***B*** meets ray ***A*** again at point ***Q***. On the diagram, continue the path of ray ***B*** in the optical fibre until it reaches point ***Q***.

(f) State **one** advantage of using optical fibres for endoscopy.

18 The diagram shows a small object ***KL*** to the left of a thin converging lens. The principal axis and the principal focus ***F*** are also shown. Draw rays which will enable you to find the positions of the images of points ***K*** and ***L***. Label these images ***K'*** and ***L'*** respectively.

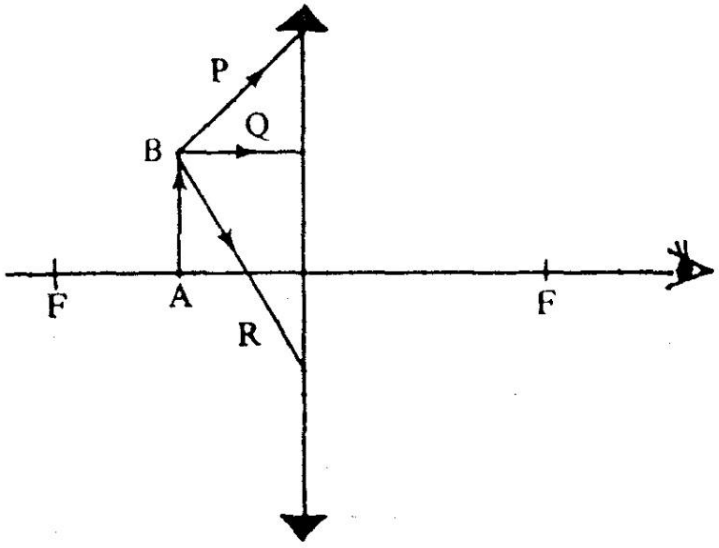


19 The diagram shows three rays of light passing from the top of an object to a thin converging lens. The object is 1.2 cm tall and is 5.0 cm from the lens. The image formed by the lens is also shown. It is 1.8 cm tall and is 7.5 cm from the lens.



(a) Show the paths of the three rays of light after they have passed through the lens.
(b) Use the diagram to determine the focal length of the lens. Give your value in cm.
(c) Draw a separate diagram to determine the position and size of the image formed when the 1.2 cm object is placed 2.0 cm from the lens. Describe this new image.

20 The figure shows an object ***AB*** placed in front of a convex lens. ***P***, ***Q***, ***R*** are rays incident on the lens.



(a) Draw the three refracted rays on the given diagram and locate the image.
(b) State the nature of the image.
(c) Draw a ray, in the diagram given, which goes from point ***B*** to the eye.