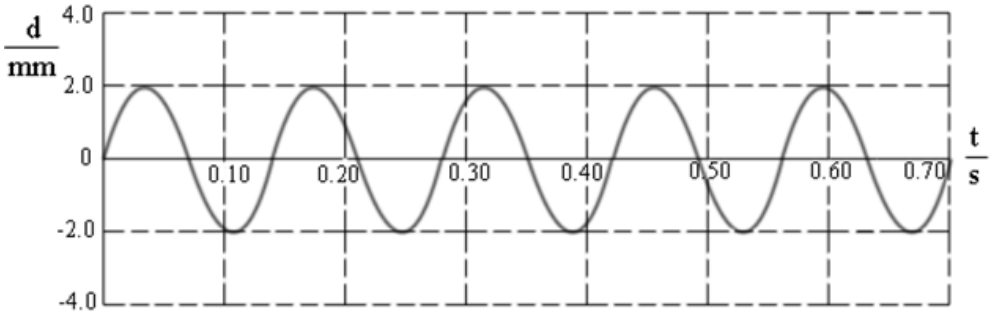
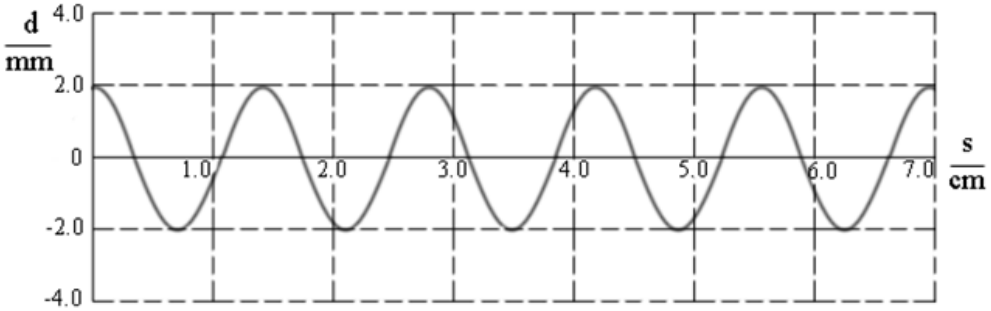
1 The figure shows a graph of the variation of time ***t*** with respect to the vertical displacement ***d*** of the ripple tank vibrator.



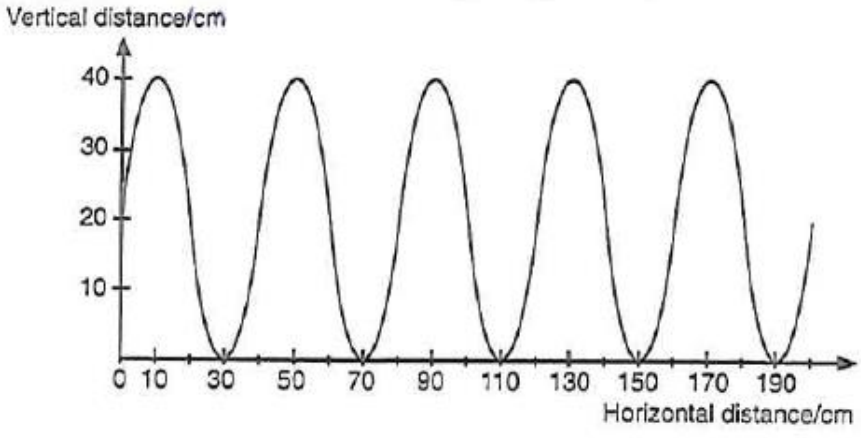
The second figure shows a graph of the variation of ***d***, the vertical displacement, with respect to ***s***, the horizontal displacement of the wave from the vibrator, for the same ripples on the surface of water in a ripple tank.



(a) What is the amplitude of the ripples?
(b) Determine the wavelength of the ripples.
(c) Find the period of the oscillation of the vibrator.
(d) Calculate the frequency of the vibrator.
(e) Hence, or otherwise, calculate the speed of the wave.
(f) What is the difference between a transverse wave and a longitudinal wave?

2 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.

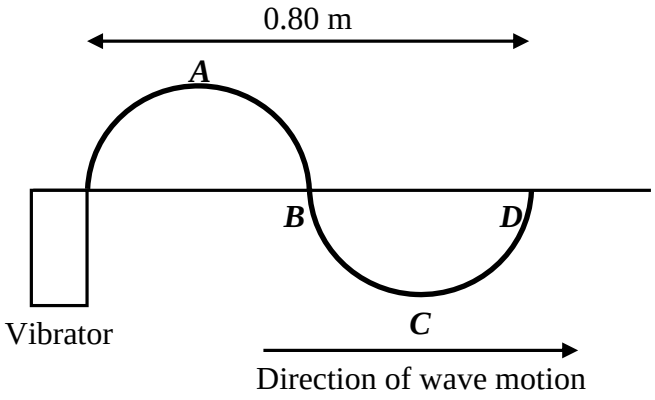
(a) What is the wave which travels along the rope called? Explain.
(b) Name two examples of this type of wave.
(c) What is the wave's
  (i) amplitude?
  (ii) frequency?
  (iii) wavelength?
  (iv) speed?



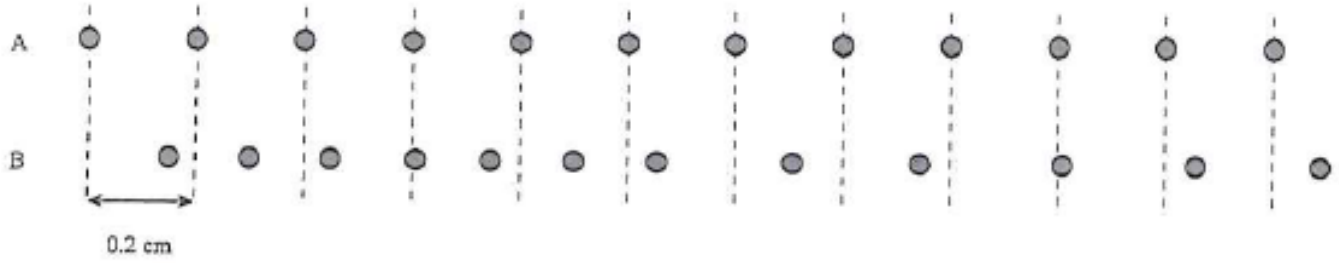
3 A vertical vibrator generates waves on a string. It takes 0.25 s to produce a complete wave of wavelength 0.80 m on the string.

(a) Find the
  (i) frequency of the waves on the string.
  (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***.



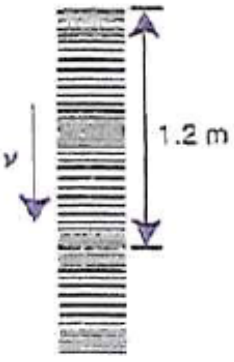
4 The diagram consists of two parts ***A*** and ***B***. Part ***A*** shows the undisturbed position of air particles at time t_1 while part ***B*** shows the positions of these air particles at a time t_2 when a sound wave passes from left to right. The distance between the air particles during time 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.

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.
(d) Hence, calculate the frequency of the wave if ***v*** is 100 m/s.

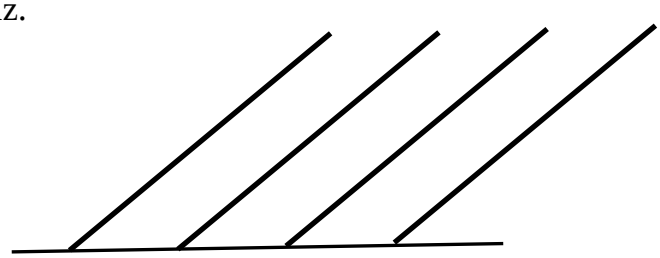


6 A water wave travels from a deep region to a shallow region as shown. The speed of the wave in the deep region is 0.18 m/s and its frequency is 15 Hz.

(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) What is the wavelength of the wave in the shallow region if it is known that the speed has decreased by half?



7 Microwaves travel at a speed of 3.0×10^8 m/s in a vacuum and have a frequency of 1.5×10^{10} Hz.

(a) Calculate the wavelength of the microwaves.

(b) List two differences between radar waves and ultrasonic waves.

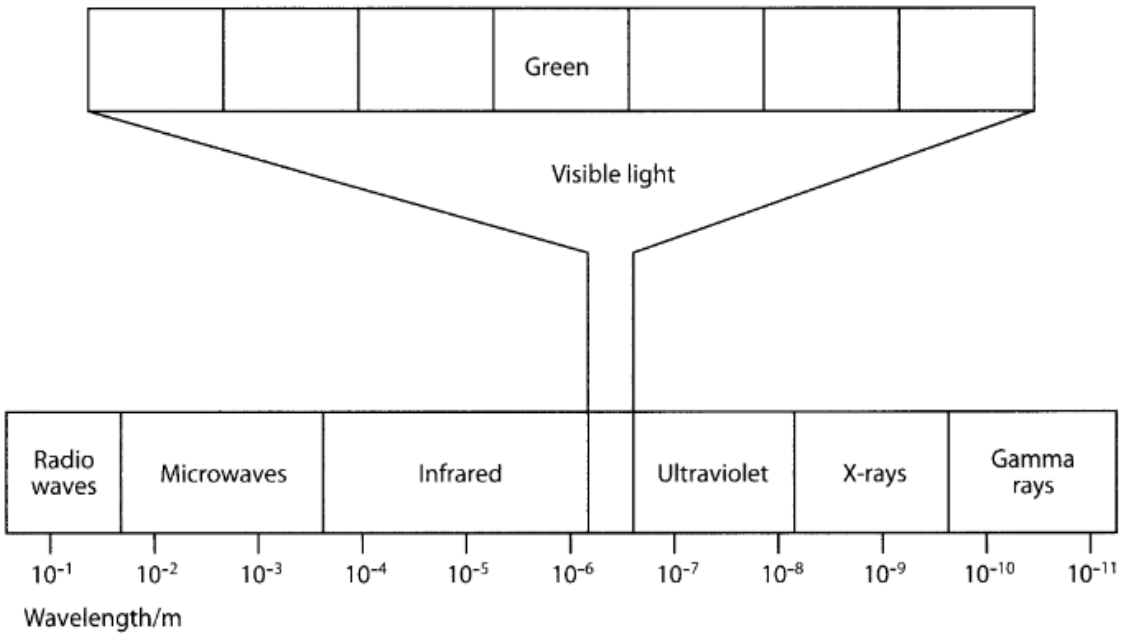
8 Remote controls are widely used nowadays to control domestic appliances.

(a) What kind of electromagnetic waves is used in remote controls?

(b) Could we determine the colour of it with our naked eyes?

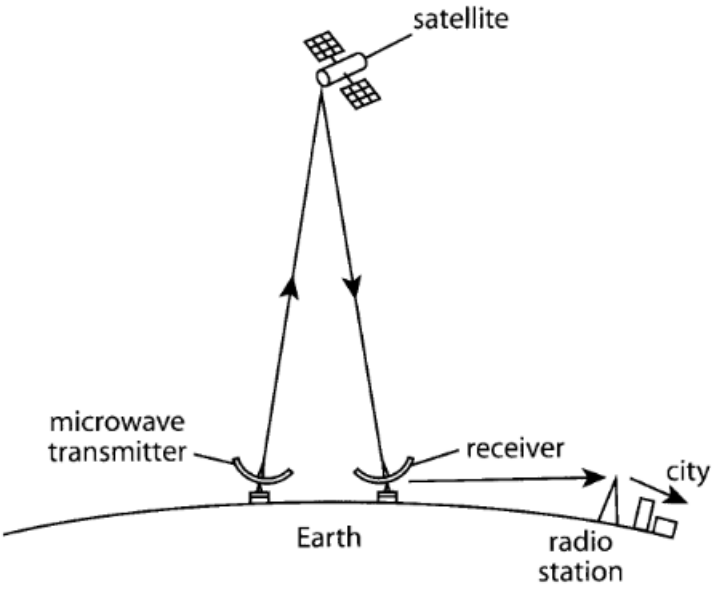
(c) If the wavelength of the signal is 1.0×10^{-4} m, what is the frequency of the signal, given that it travels at a speed of 3.0×10^8 m/s?

9 Pam notices a chart on the electromagnetic spectrum pinned up in her school laboratory. The chart has faded with age. Only the green part of the visible light spectrum is clear.



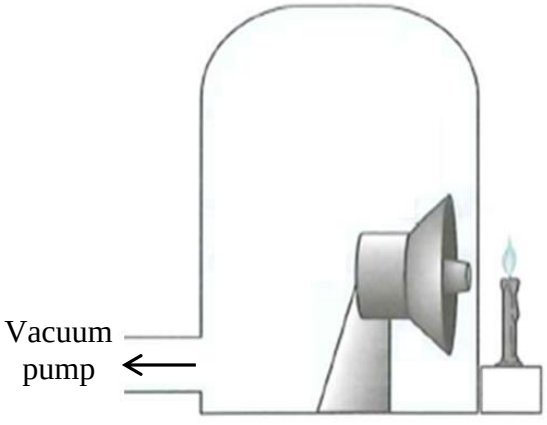
(a) Complete the visible light spectrum in the diagram.
(b) Using data from the diagram, calculate the approximate frequency of infrared in vacuum.
(c) Which component of the electromagnetic spectrum
  (i) has the lowest energy?
  (ii) can be reflected?
(d) On the diagram, mark with a line the position of the wave that has a frequency of 30 GHz. Show your calculations.
(e) Write down one application each for X-ray and infrared.
(f) Gamma rays are known to cause ionisation. Explain ionisation and describe one hazard of gamma rays to living things.

10 Nelson is reading an article on satellite communications systems. He learnt that ground-based communication signals are first converted into microwave signals. These microwave signals are then transmitted from Earth to a satellite as shown. The satellite transmits the signals back to Earth. Microwaves have a frequency of 6 GHz and a wavelength of 0.05 m. The satellite is typically at a distance of 36 000 km above Earth.



(a) Radiowaves are also used in telecommunications. Explain why radiowaves are not used in this instance.
(b) Calculate the speed of the microwaves.
(c) What is the least time it takes for the microwaves to be transmitted and returned to Earth?
(d) The receiver station converts the signals it receives into radiowaves before they are sent out to ground radio stations which boost the signals, before they are further transmitted to users in cities. Explain why radio
  (i) stations are needed to boost the radio signals from the receiver stations.
  (ii) waves are used to transmit communication signals from the signals from the receiving station to users in cities.

11 A student sets up an experiment to investigate the properties of sound waves. A burning candle is placed next to a glass jar with an opening connected to a vacuum pump. A loudspeaker is placed inside the glass jar. The loudspeaker is now switched on and it plays music with its maximum volume. The vacuum pump is off



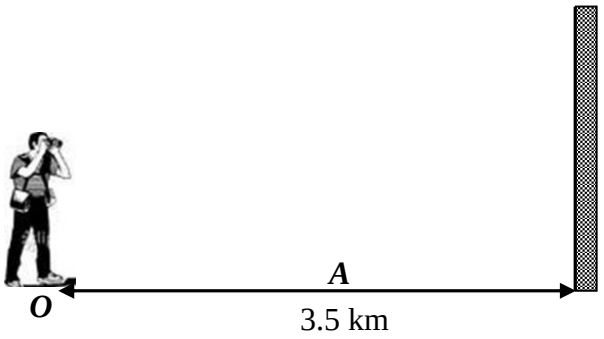
(a) What will happen to the candle flame?
(b) How do air particles around the candle flame move due to the sound wave produced by the loudspeaker?
(c) Hence, determine and explain whether sound wave is transverse or longitudinal?
(d) After the vacuum pump has been switched on, what happens to the candle flame? Explain briefly.
(e) What can you conclude about the transmission of sound waves from the result of (d)?

12 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 the

(a) speed of the ultrasound in water.
(b) wavelength of the ultrasound waves in water.
(c) depth of the shoal of fish below the boat.

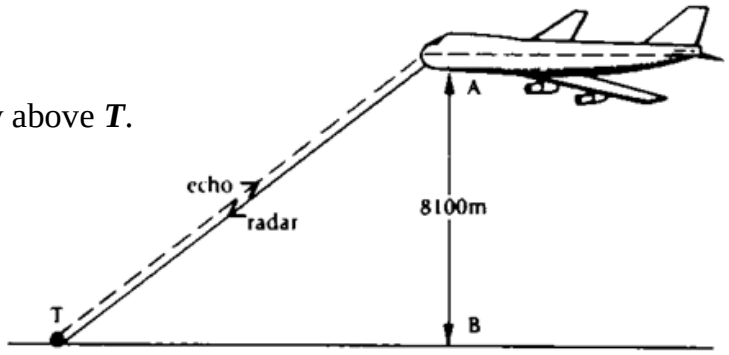
13 A gun is fired at point ***A*** between an observer, ***O*** and a vertical wall which is 3.5 km away from the observer. After seeing the flash of the gun, the observer hears the sound followed by another 5.0 s later.

(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.

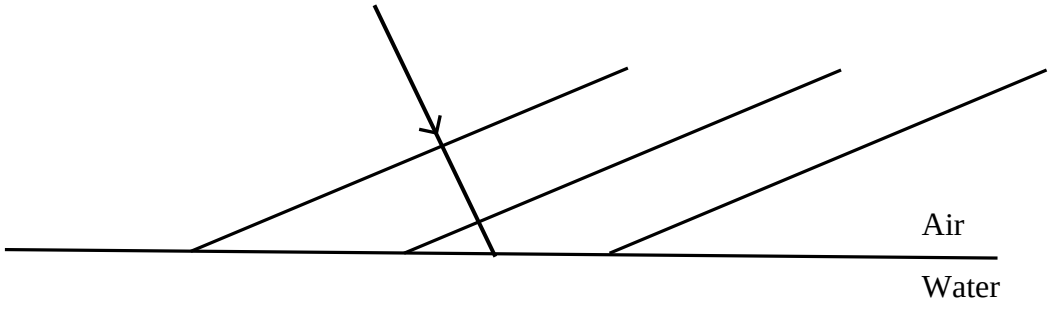


14 An aircraft ***A*** is flying at a constant speed of 270 m/s at a constant height of 8 100 m above the surface of the earth. The aircraft directs a radar beam of wavelength 1.0 cm at a target ***T*** on the Earth's surface. After 90 μs, an echo from the target is detected on the aircraft. If the frequency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

(a) speed of the radar waves.
(b) distance ***AT*** between aircraft and target.
(c) time which elapses before ***A*** is vertically above ***T***.



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



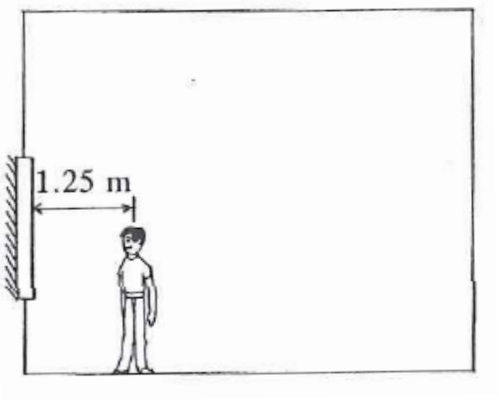
16 The room shown in the figure is 5.00 m long and 4.00 high. A mirror is hung on one of the walls. A boy 1.60 m tall stands 1.25 m from the mirror. His eyes are 0.10 m below the top of his head.

(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) How high above the ground should the mirror be hung?

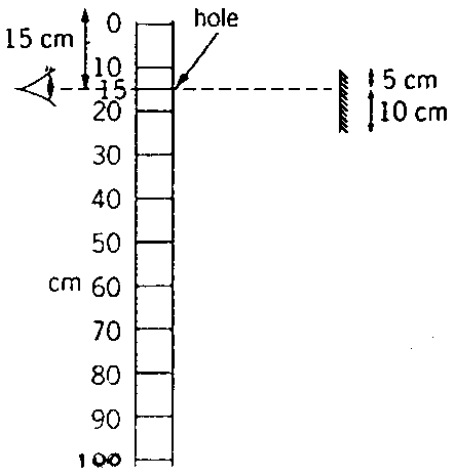
(d) If the boy walks further away from the mirror, can he see the whole height of the opposite wall?



17 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.

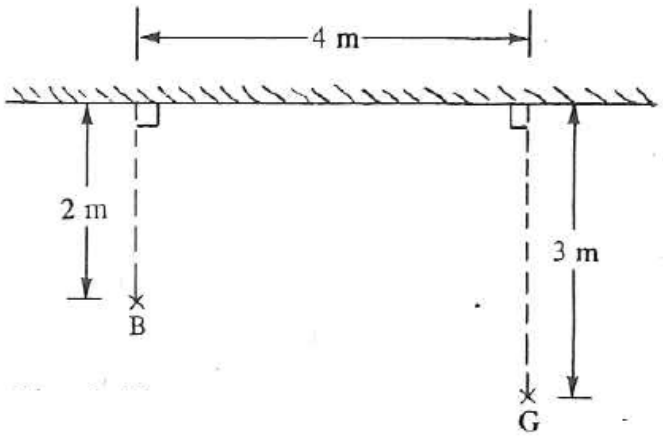


18 A boy sitting in a battery operated car looks into a plane mirror 8.0 cm long which is placed 40.0 cm in front of him. If the rear window is 600.0 cm away from the mirror, sketch a diagram to find the length of the rear window that he can see whenever he looks into the mirror while he is driving?

19 In the figure, a boy stands at point ***B*** in front of a plane mirror. A girl stands at another point ***G*** in front of the same plane mirror. How far is the image of the

(a) girl from the boy?

(b) boy from the girl?



20 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.

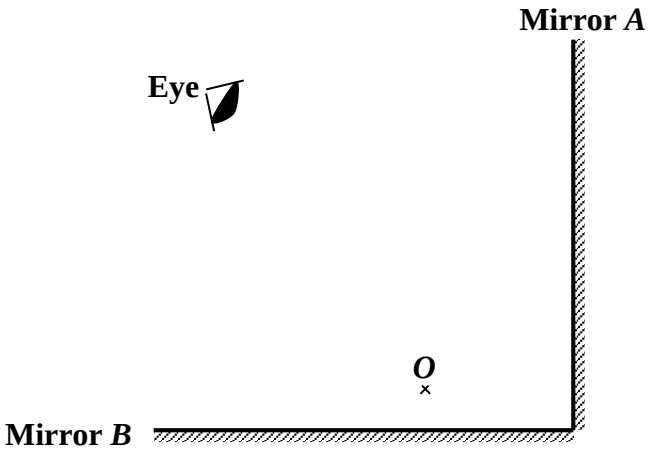
(c) Complete the diagram to show the images of the object ***O*** formed by the mirrors, as seen by the eye.

(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.



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

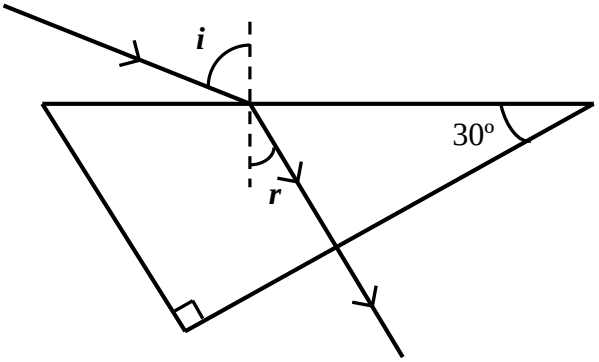
(a) Write down the angle of refraction, ***r***.

(b) Given that the refractive index of the glass is 1.50, calculate the angle of incidence, ***i***, of the red light in the prism.

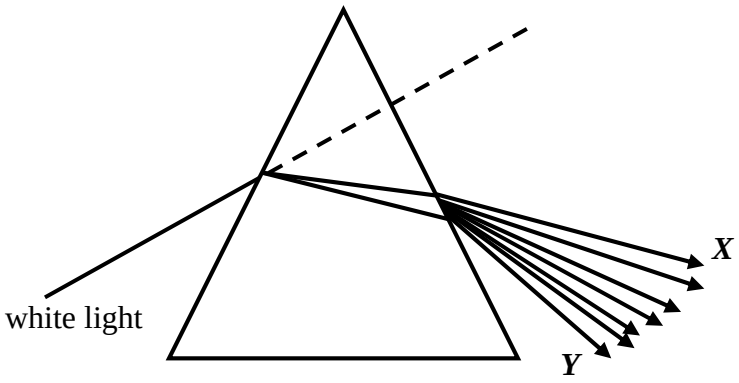
(c) If a ray of blue light is incident on the prism at the same angle,

(i) sketch its emergent ray.

(ii) explain your answer.



22 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) State the colours at ***X*** and ***Y***?

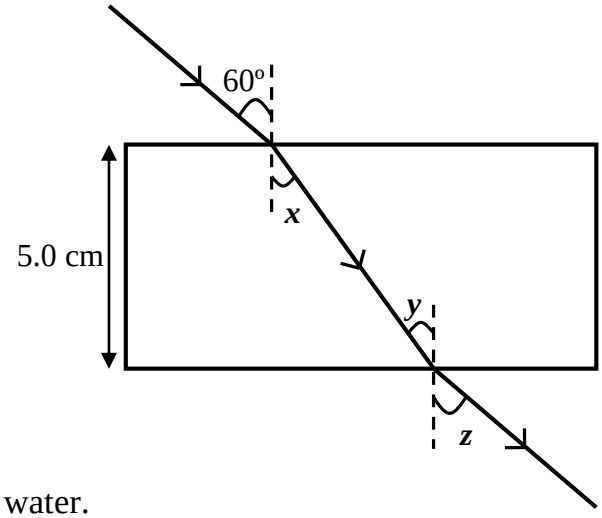
(c) Why does the white light split into its component colours in the manner shown when it enters the glass prism?

23 A light ray enters a 5.0 cm thick parallel-sided glass block at an angle of 60º as shown. (Refractive index of glass is 1.5)

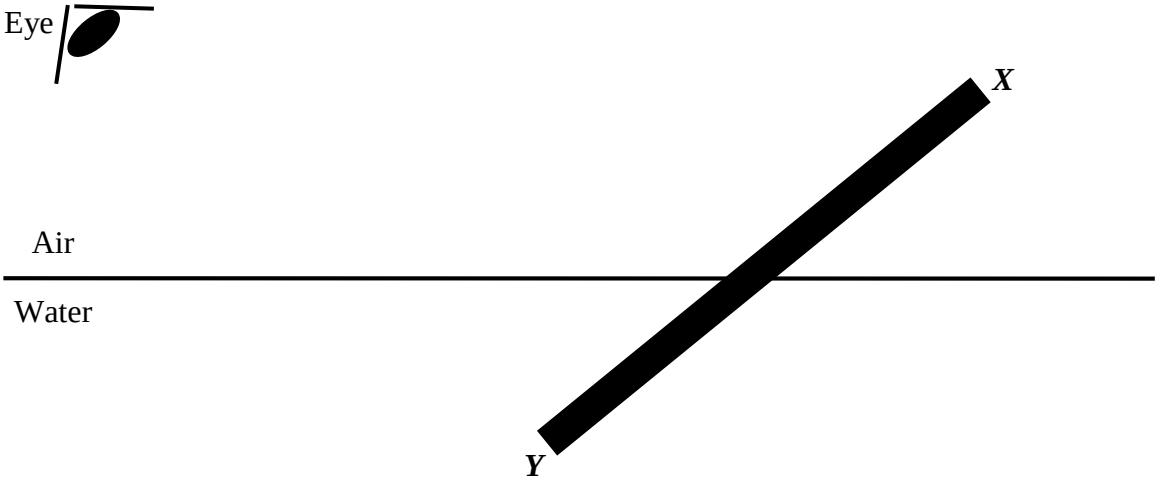
(a) Find the angles ***x***, ***y*** and ***z***.

(b) Are the incident ray and the outgoing ray parallel?

(c) Find the lateral displacement of the ray.



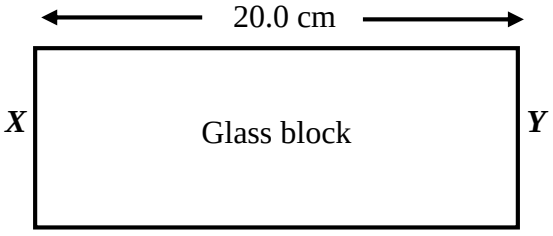
24 The diagram shows a stick ***XY*** held partly immersed in water.



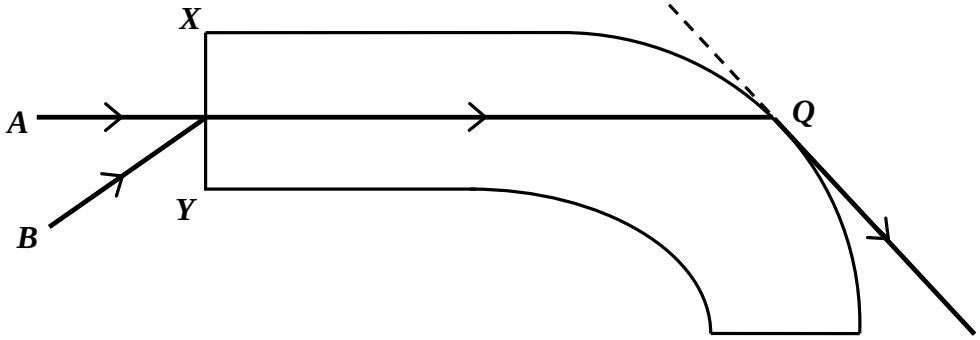
(a) Show on the diagram the apparent position of the immersed part, ***Y***, of the stick as seen by the eye.

(b) Justify your answer by drawing two rays from ***Y*** to the eye.

25 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***?

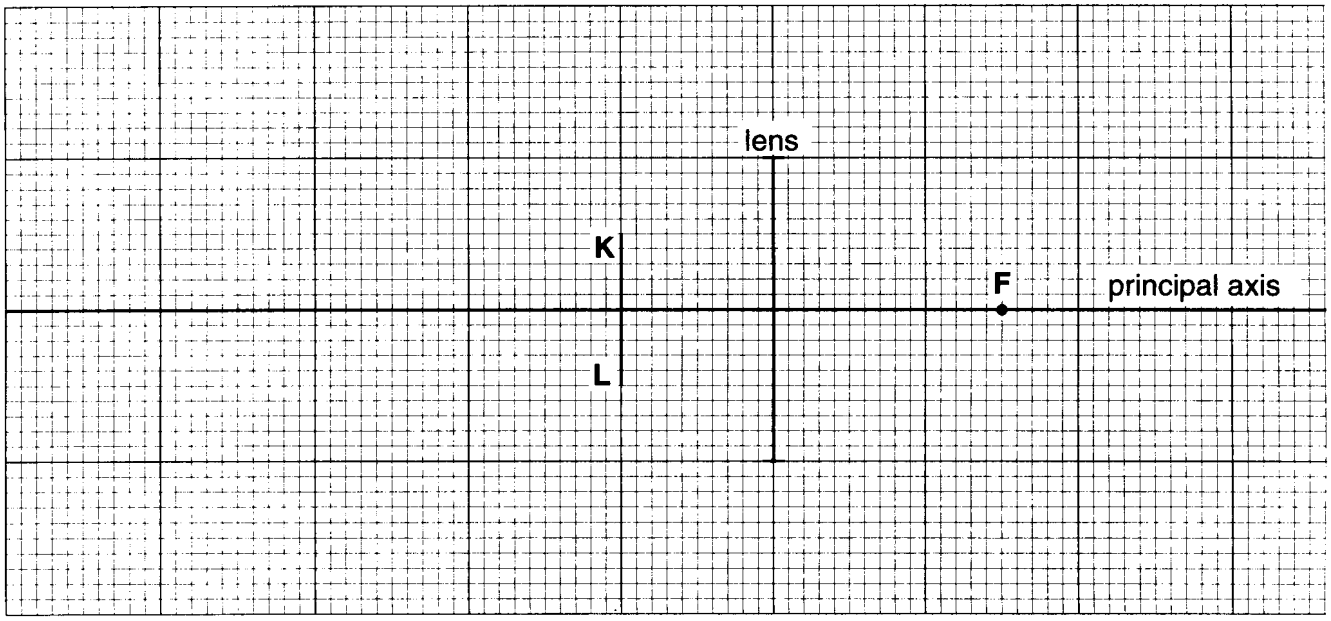


26 The diagram shows a section of an optical fibre which has a refractive index of 1.50. Two rays, ***A*** and ***B***, are incident on surface ***XY*** of the fibre. Ray ***A*** emerges into the air along the tangent of the optical fibre at point ***Q***.

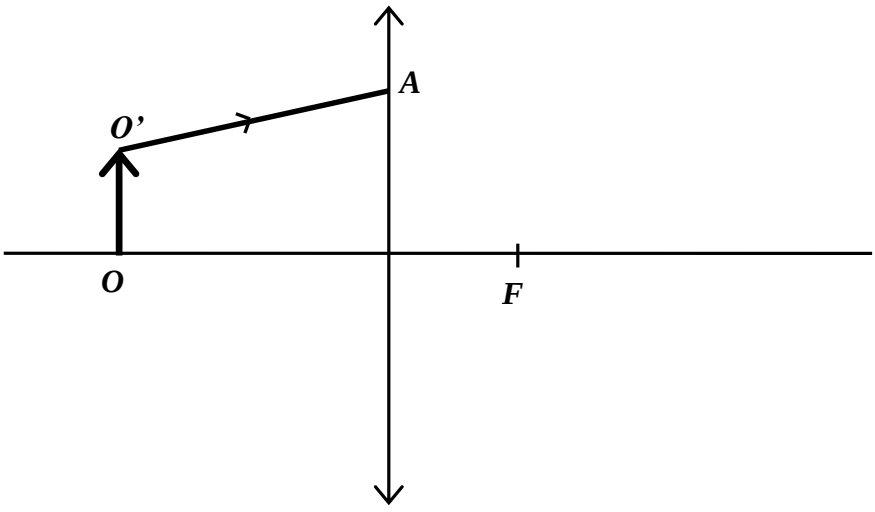


(a) Explain why there is no change in the direction of light when ray ***A*** enters the optical fibre.
(b) State two conditions for ray ***A*** to emerge into the air along the tangent of the optical fibre at point ***Q***.
(c) Calculate the critical angle of the optical fibre.
(d) Would the value of 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.

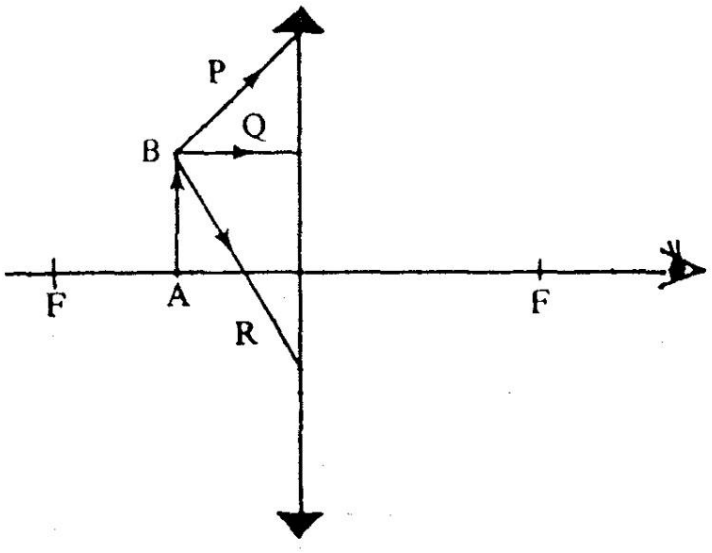
27 The diagram shows a small object ***KL*** to the left of a thin converging lens. The principal axis and the principal focus ***F*** are also shown. Draw rays which will enable you to find the positions of the images of points ***K*** and ***L***. Label these images ***K'*** and ***L'*** respectively.



28 The diagram shows a converging lens as used in a camera to form an image of the object ***OO***'.
(a) Draw construction rays from ***O***' to locate its image ***II***'.
(b) Complete the path of the ray ***O***'***A*** to the image.
(c) From measurements on the diagram, find the linear magnification of the lens.



29 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.

30 (a) A converging lens is placed horizontally under the sun. A match is lighted when it is placed 10 cm below the lens. What is the focal length of the lens?

(b) A parallel beam of light making an angle of 30° with the principal axis is incident on the lens of part (a) as shown.

(i) Draw the refracted rays.
(ii) If the light rays come from the top of a distant tree, what is the height of the image of the tree?
(iii) Would the height of the image be affected if the lens is moved forward a few centimetres?