Name:	Target Grade:	Actual Grade:

BRIGHT CULTURE

LIGHT
MCQ and STRUCTURED QUESTIONS

READ THESE INSTRUCTIONS FIRST

INSTRUCTIONS TO CANDIDATES

1. Find a quiet, comfortable spot free place from distractions.

2. Spend one minute on each mark.

3. Time yourself for every single question.

4. Every chapter has their own question types. Ensure that you know the different question type for each chapter.

5. Make a conscientious effort to remember your mistakes, especially in terms of answering techniques. E.g Take a picture for the mistakes that you made, keep it in a photo album, and revise it over and over again.

6. Highlight question types that you tend to keep making mistakes and review them nearing exams.

7. Always review the common questions and question type that you tend to make mistakes nearing exams.

8. During exams, classify the question type and recall what you have learnt, how you need to analvse the questions for the different question type, what you need to take note of and answer with the correct answering techniques!

✨ **Wishing you all the best for this test!**

You've got this!

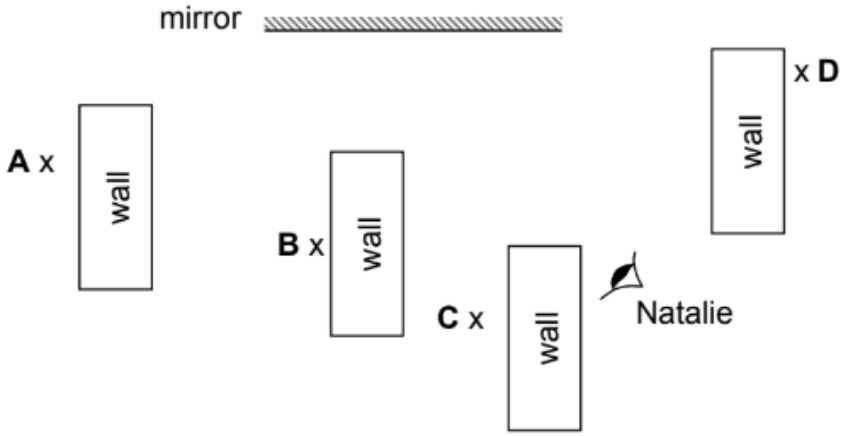
💡 **With lots of love,**
Bright Culture 💛

GOOD LUCK FOR YOUR EXAM!

MARKS

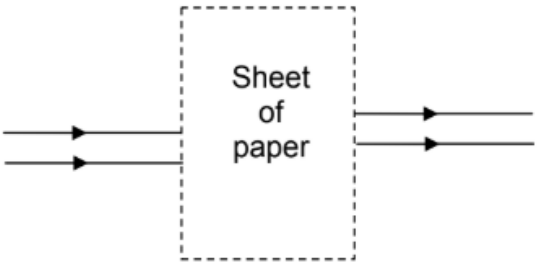
LIGHT MCQ

1 In a game of hide and seek, Natalie can only see one of her friends hiding behind a wall via a reflection from a mirror. The diagram below shows the top views of Natalie, each of her friends' positions shown by a cross x, and the walls.

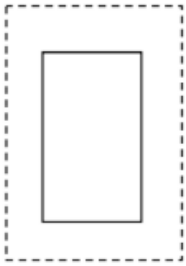


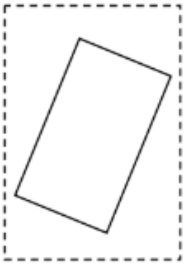
Which of her friends, A, B, C or D, can be seen by Natalie via a reflection from the Mirror?

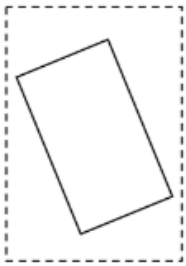
2 The diagram shows what happens to a parallel beam of light which passes through a piece of glass concealed under a sheet of paper.

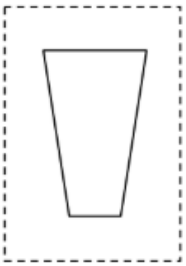


Which of the following pieces of glass is concealed under the sheet of paper?

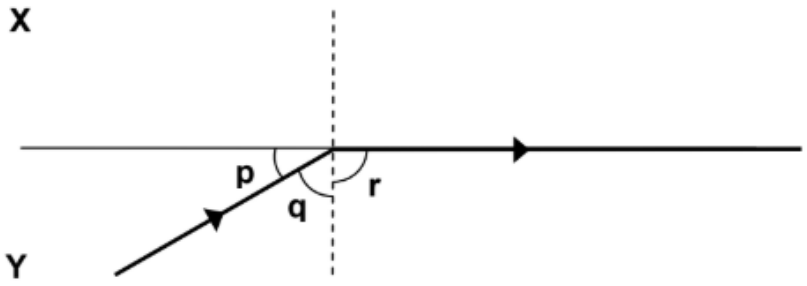
A 

B 

C 

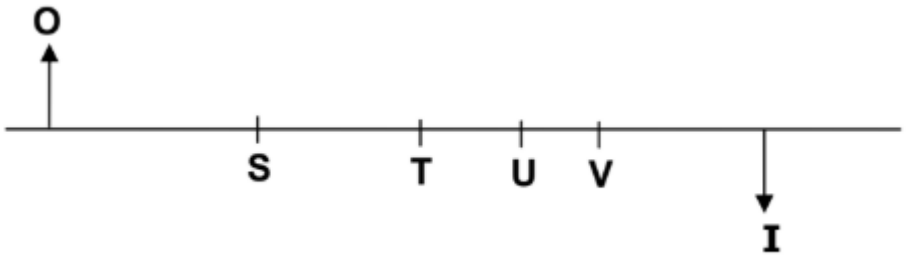
D 

3 The diagram below shows a ray of light going from one medium Y to another medium X. Given that one of the medium is air and the other is glass. Which one of the options below correctly states the critical angle of the ray in glass and the medium which is air?



	Critical angle	Air
A	r	X
B	p	Y
C	q	X
D	q	Y

4 The diagram below shows the positions of an object O and its image I formed by a convex lens.



Which of the following letters correctly indicates the position of the lens and its focal point?

	Position of Lens	Focal Point
A	S	U
B	T	V
C	U	S
D	V	T

5 Which type of image is produced by a converging lens on a screen?

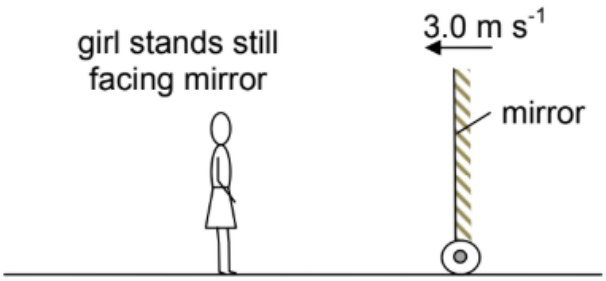
A inverted and real

B inverted and virtual

C upright and real

D upright and virtual

6 A plane mirror mounted on wheels is pushed towards a girl at a speed of 3.0 m s-1



If the girl stands still, she will see her image moving

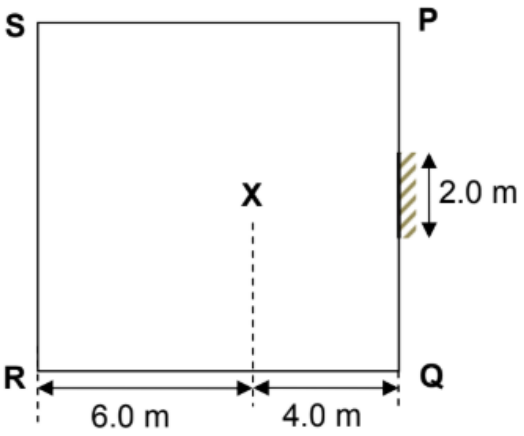
A away from her at a speed of 3.0 m s^{-1}.

B away from her at a speed of 6.0 m s^{-1}

C towards her at a speed of 3.0 m s^{-1}

D towards her at a speed of 6.0 m s^{-1}

7 A man standing at position X, looks at a 2.0 m wide mirror mounted on the wall PQ.



What is the maximum width of the opposite wall RS he can see through the mirror?

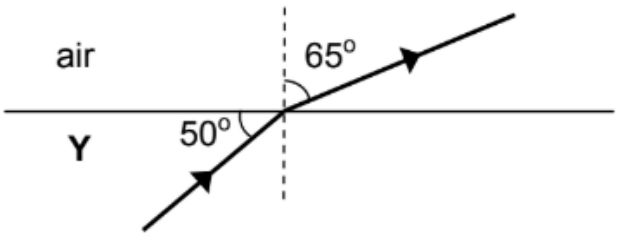
A 7.0 m

B 5.0 m

C 4.7 m

D 3.0 m

8 The diagram below shows a ray of light travelling from medium Y into air.



What is the angle of incidence and the angle of refraction?

	Angle of incidence	Angle of refraction
A	40°	25°
B	40°	65°
C	50°	25°
D	50°	65°

9 An object is placed in front of a convex lens. The image that is formed on the opposite side of the lens to the object is always

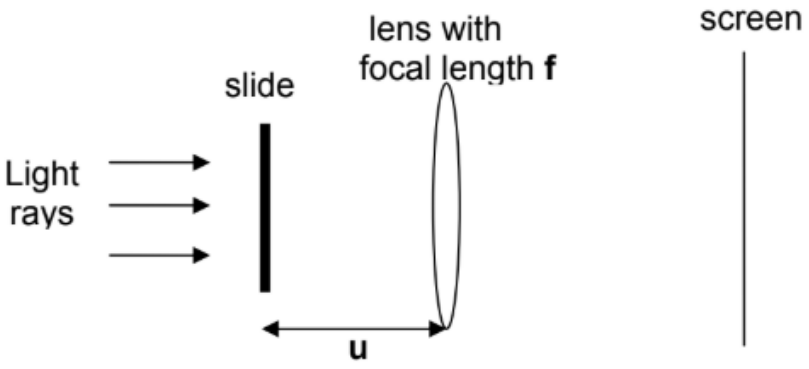
A upright and virtual.

B upright and real.

C inverted and virtual.

D inverted and real.

10 The diagram shows a slide projector that uses a converging lens with focal length f. It produces a sharp image of a slide that is placed at a distance u from the lens onto a screen.



To obtain a smaller sharp image on the screen, which of the following adjustment(s) can be made?

I Use the same lens and increase distance u

II Keep distance u constant and change the lens to one with shorter focal length f

III Keep distance u constant and change the lens to one with longer focal length f

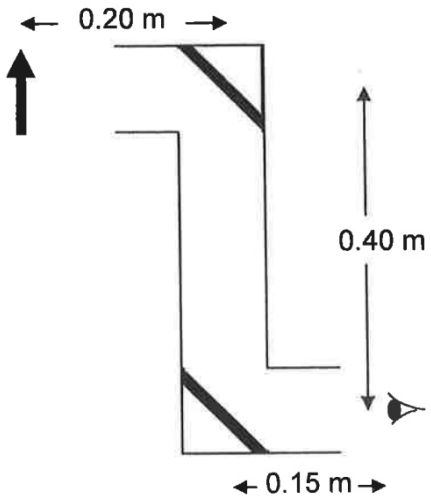
A I only

B III only

C I and II only

D I and III only

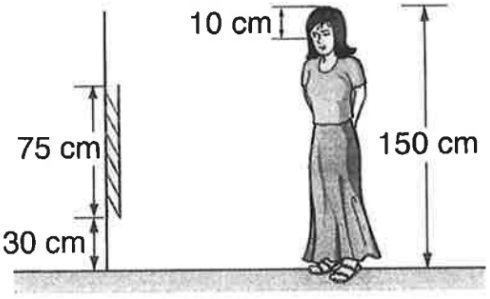
11 An object in the form of an arrow is placed in fron_tof a periscope as shown in the diagram below.



Which of the following correctly describes the image seen by the observer and the distance between the final image and the observer?

	description of image	distance between the final image and the observer
A	inverted arrow	0.35m
B	inverted arrow	0.75m
C	upright arrow	0.35m
D	upright arrow	0.75m

12 The diagram below shows a girl standing facing a long mirror.



The mirror is 75 cm long and its bottom edge is 30 cm above the floor.

If the girl is 150 cm tall and her eyes are 10 cm below the top of her head, which of the following statements is **not** correct?

A The girl's image can be photographed.

B The girl cannot see her whole image no matter how far she is from the mirror.

C The girl cannot see her whole image no matter how high she hangs the mirror.

D The distance between the girl and the mirror is the same as the distance between the girl's image and the mirror.

13 Which of the following phenomena is not a result of refraction?

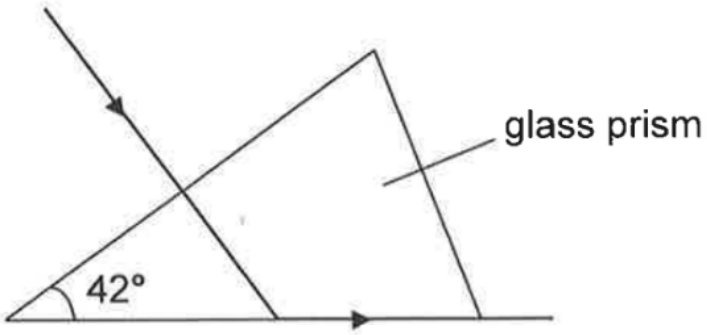
A A stick appears bent when dipped in water

B Image in a mirror is laterally inverted

C When you see the Sun setting on the horizon, the Sun has in fact already set below the horizon

D Water in a swimming pool appears to be shallow

14 A ray of light strikes a glass prism normally and is refracted as shown in the diagram below.



What is the critical angle of the glass?

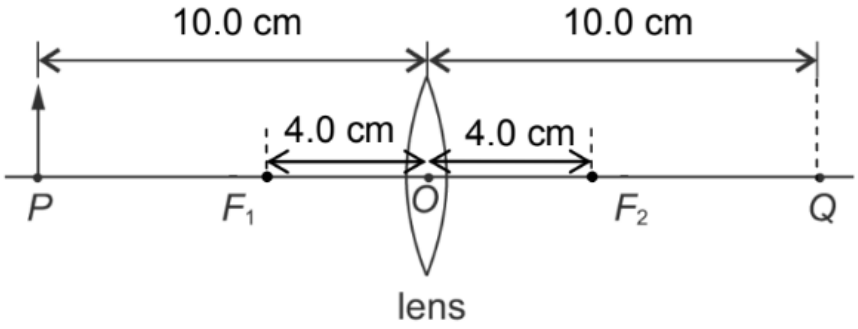
A 42°

B 48°

C 60°

D Cannot be determined because the other angles of the prism are not given.

15 The diagram shows an object at *P* placed 10.0 cm away from a converging lens which has a focal length of 4.0 cm. The points F_1 and F_2 are the principal foci of the lens.



At which point will the image of the object at P be formed by the lens?

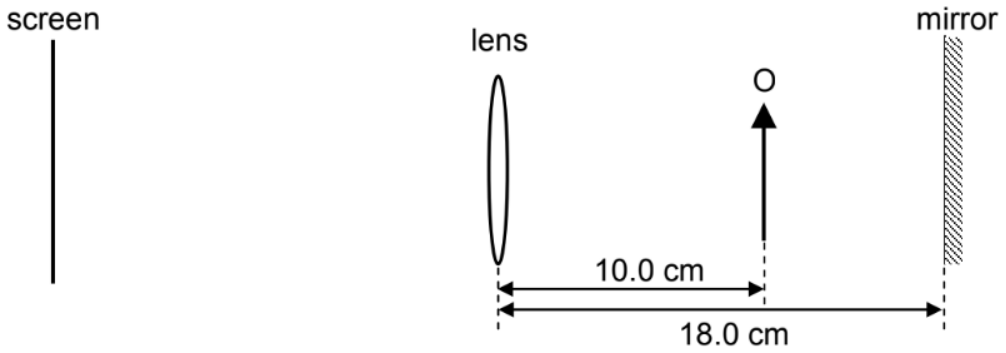
A at F_2

B between O and F_2

C between F_2 and Q

D at Q

16 A converging lens of focal length 12.0 cm, a mirror, a screen and an illuminated object O are arranged as shown in the diagram below. A student tried to obtain a sharp image by adjusting the position of the screen.



Which of the following statements is true?

A No image can be seen at any position because the illuminated object is nearer to the lens than the focal length.

B An illuminated and magnified image would be observed on the screen.

C An inverted and diminished image would be observed on the screen.

D An inverted image of the same size as the object would be observed on the screen.

17 A lens forms a real image three times the size of the object when the image is 0.120 m from the lens. How far from the lens is the object?

A 0.030 m **B** 0.040 m

C 0.090 m **D** 0.360 m

18 A lens is placed over a book to read some small print on the book as shown in the figure below.

Which of the following statements is incorrect?

A The image of the small print is real.

B The image distance is longer than the object distance.

C The object distance is shorter than the focal length of the lens.

D The small print and its image are on the same side of the lens.

19 Which of the following statements about a plane mirror is true?

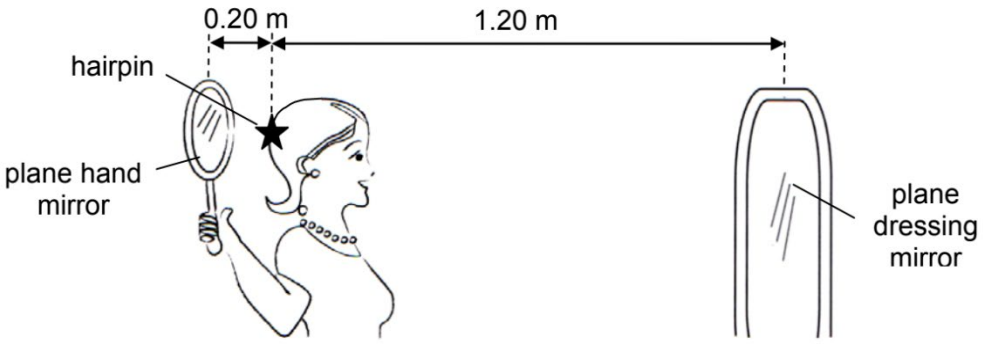
A A plane mirror gives an image which is smaller than the object.

B A plane mirror produces a bright image because it is a luminous object.

C A plane mirror does not absorb any light falling on it.

D A plane mirror is able to form an image because its surface is smooth.

20 A lady holds a plane hand mirror behind her head while standing in front of a plane dressing mirror as shown below. She looks into the dressing mirror to view the image of the hairpin that is formed in the hand mirror.



How far behind the dressing mirror is the image of the hairpin?

A 1.40 m **B** 1.60 m

C 2.80 m **D** 3.20 m

21 A ray of monochromatic light travels at a speed of 3.0×10^8 m s^{-1} in air. What is its speed in a medium with a refractive index of 1.9?

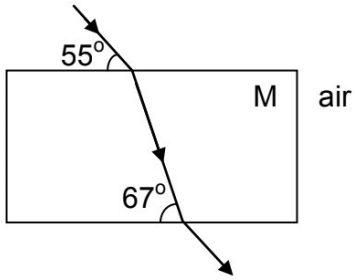
A 1.1×10^8 m s^{-1}

B 1.6×10^8 m s^{-1}

C 3.0×10^8 m s^{-1}

D 5.7×10^8 m s^{-1}

22 The figure shows the refraction of a ray of light by a rectangular block made of material M.



What is the refractive index of the material M?

A 0.89 **B** 1.12

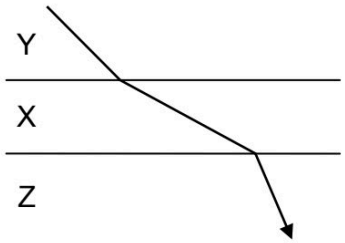
C 1.39 **D** 1.47

23 Three types of material X, Y and Z have refractive indices as shown in the table.

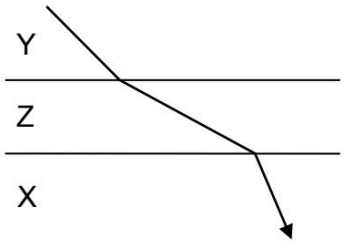
Material	X	Y	Z
Refractive index	1.00	1.52	1.90

Which of the following diagram **correctly** shows the path of a ray of light passing through them?

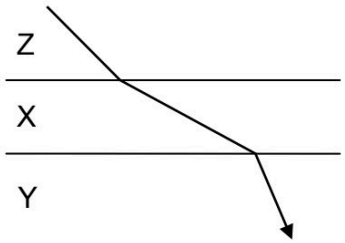
A



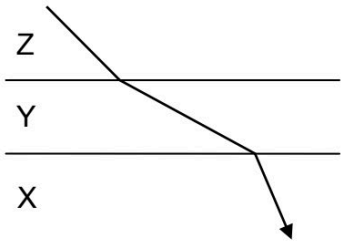
B



C



D



24 Which of the following **does not** involve total internal reflection?

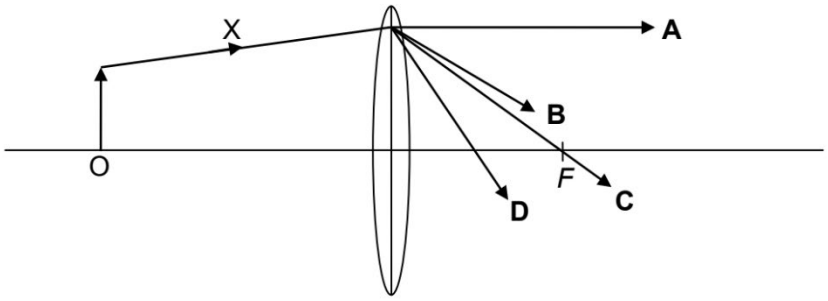
A Rainbow

B Sparkle of a diamond

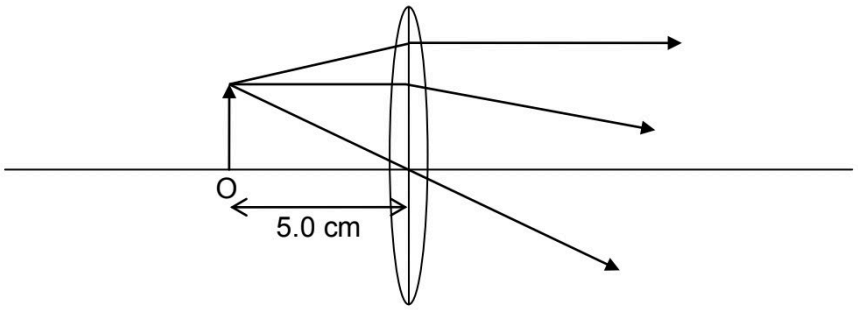
C Mirage

D Objects at the bottom of a pool appear to be closer to the water surface

25 An object O is placed near a converging lens. *F* is a principal focus of the lens. Which one of the following light rays **correctly** represents the path of the incident ray **X** after passing through the lens?



26 An object O is placed at a distance of 5.0 cm from a convex lens. The diagram shows the paths of three rays from the object O through the lens.



Which of the following statements is **correct**?

A The focal length of the lens is less than 5.0 cm.

B The focal length of the lens is equal to 5.0 cm.

C The image formed is virtual, magnified and upright.

D The image formed is real, magnified and inverted.

27 The surface of a table is rough.

Which of the following explains why no reflected image is seen in the table surface?

A The Laws of Reflection do not apply to a rough surface.

B The light rays are absorbed by the rough surface.

C The reflection of light rays incident on the table surface is diffused.

D The image is virtual.

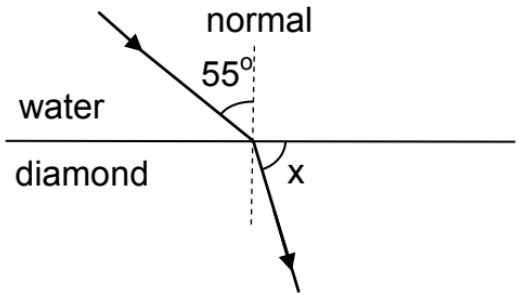
28 A girl stands in the centre of a rectangular room WXYZ at G facing a 2.0 m wide mirror mounted on the centre of wall WX.

What is the maximum width of the wall YZ (behind her) that she can see when she looks into the mirror?

A 2.0 m **B** 3.0 m

C 4.0 m **D** 6.0 m

29 The refractive indices of water and diamond are 1.3 and 2.0 respectively.

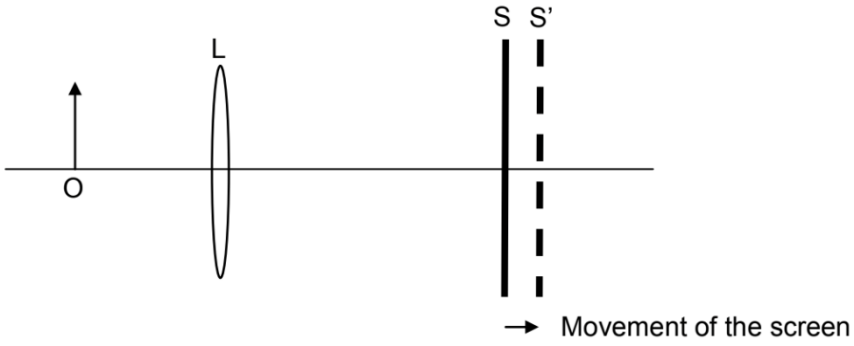


What is the angle x?

A 32° **B** 36°

C 54° **D** 58°

30 A simple projector uses a convex lens L to form a sharp, inverted and magnified image of an object O on a screen at S.



If the screen is moved slightly further away from the lens to S', how should the lens be moved to form a sharp image on the screen at S' and how will the magnification change?

movement of lens magnification

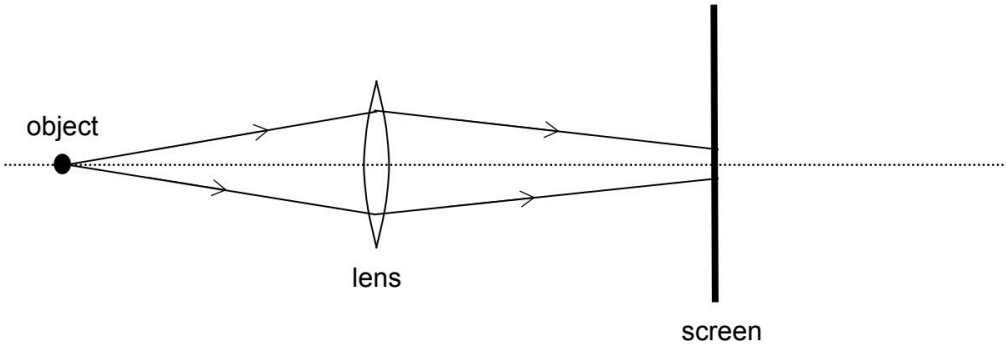
A towards the screen decreases

B towards the screen increases

C towards the object decreases

D towards the object increases

31 The diagram shows a lens forming a blurred image of an object on a screen.



How can a sharp image be obtained on the screen?

A By moving the object towards the lens and screen.

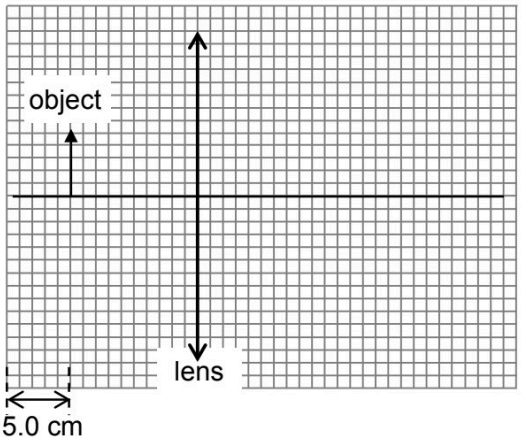
B By moving the screen towards the lens and object.

C By using a lens of shorter focal length.

D By using a lens of longer focal length.

32 The scaled diagram shows an object and a convex lens used to produce a real image.

The magnification of the real image is 1.5.



What is the focal length of the convex lens?

A 4.0 cm **B** 6.0 cm

C 8.0 cm **D** 10.0 cm

33 We can see things in the world because there is a converging lens system in our eyes.

Which of the following describe(s) the nature of the image formed on in our eye when we are looking at a distant object?

(1) real

(2) upright

(3) diminished

A (1) only

B (2) only

C (1) and (2) only

D (1) and (3) only

34 An image is formed of an object placed 24.0 cm from a converging lens of focal length 8.0 cm.

Which statement is true?

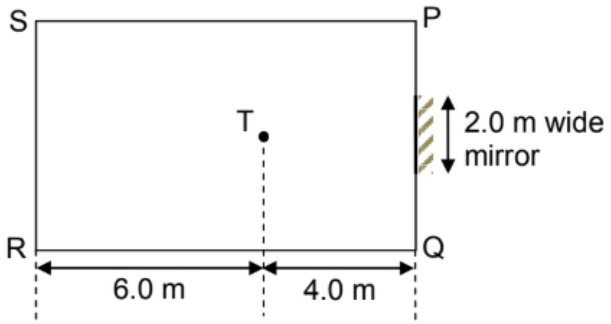
A The image is magnified.

B The image is virtual.

C The image is 10.0 cm from the lens.

D The magnification is 0.50.

35 A man standing at position T, looks at a 2.0 m wide mirror mounted on the centre of wall PQ.



What is the maximum width of the wall RS (behind him) he can see through the mirror?

A 3.0 m **B** 4.7 m **C** 5.0 m **D** 7.0 m

36 Which of the following does not involve total internal reflection?

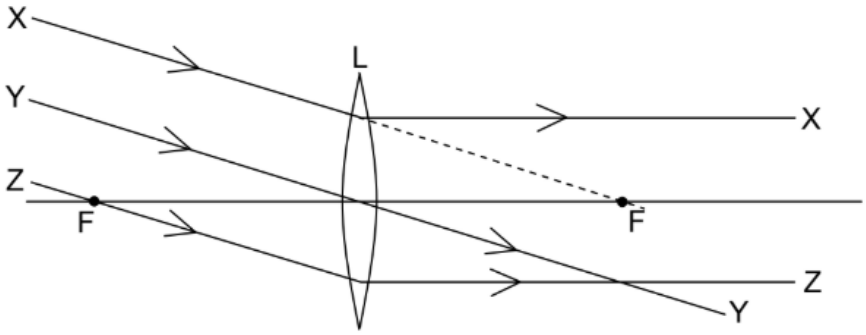
A Increasing brilliance in diamonds.

B Data transmission in optical fibres.

C Raised virtual images under glass blocks.

D Images viewed through prism periscopes.

37 Three parallel rays of light X, Y and Z pass through a thin converging lens L. F is the principal focus of the lens.



Which of the ray(s) after passing through the lens is/are not correctly drawn?

A X only

B X and Y only

C X and Z only

D Y and Z only

38 Diagram 1 below shows a microscope being used to observe smoke particles in a transparent box. Diagram 2 shows the path of a small point of light moving as seen under the microscope.

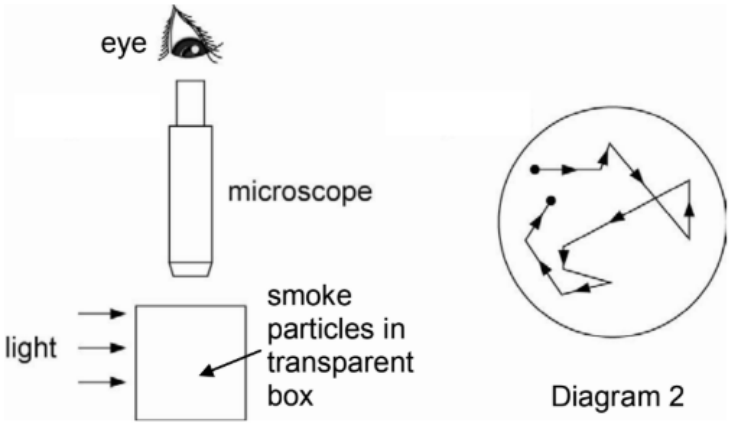


Diagram 1

What can be inferred about air molecules in this experiment?

A They are in continuous motion.

B They can be seen through a microscope.

C They move more quickly when they are heated.

D They move because of collisions with smoke particles.

39 A converging lens is used to produce a virtual image of an object that is 3 times its original size. Given that the focal length of the converging lens is 15.0 cm, what is the distance between the lens and the object?

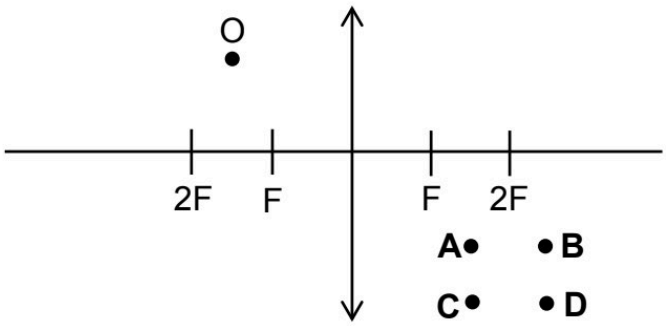
A 5.0 cm

B 10.0 cm

C 15.0 cm

D 30.0 cm

40 An object O is placed in front of a thin converging lens as shown. At which point will a sharp image of the object form?

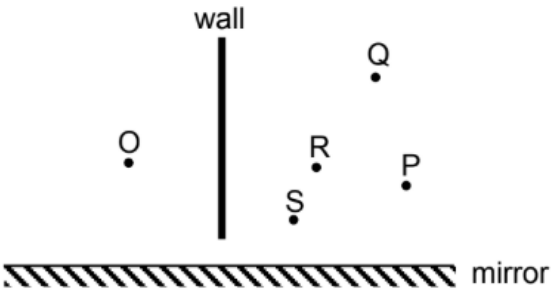


41 A man stands still while a plane mirror is wheeled away from him at a speed of 2.0 m s^{-1}

How fast does he see his image moving away?

A 1.0 m s^{-1} **B** 2.0 m s^{-1} **C** 4.0 m s^{-1} **D** 6.0 m s^{-1}

42 Four point objects, P, Q, R and S are concealed from an observer, O by an opaque wall as shown.



Which objects can O see from the mirror?

A Q, R and S only

B P, R and S only

C P, R and Q only

D Q, S, and P only

43 Light travels from a medium of refractive index 1.5 to a medium of refractive index n. If the critical angle observed was 57°, what is the value of n?

A 1.0

B 1.1

C 1.2

D 1.3

44 A converging lens has a focal length of 20.0 cm. If an object is placed at 10.0 cm away from the optical centre of the lens, what are the characteristics of the image formed?

A real, upright and magnified

B virtual, upright and magnified

C real, inverted and diminished

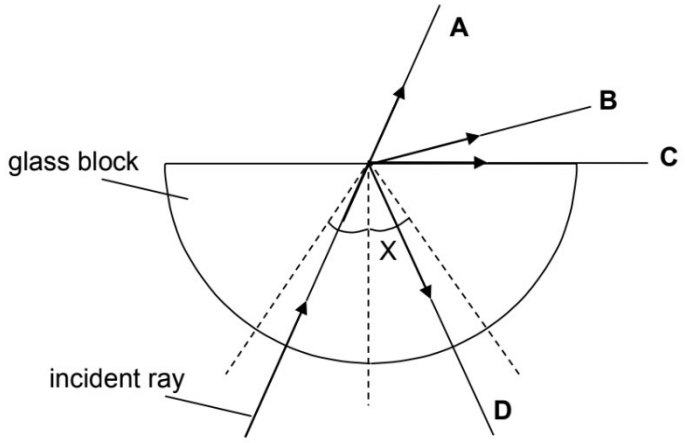
D virtual, upright and diminished

45 A converging lens is used to produce an image that is 3 times the size of an object. If the distance between the object and the image is 40.0 cm, what is the focal length of the lens?

A 7.5 cm **B** 10 cm **C** 13 cm **D** 15 cm

46 The diagram shows a semi-circular glass block with an incident ray shining towards the centre of the flat face as shown. The critical angle of the glass block is labelled as X.

Which line correctly shows the subsequent path of the light ray?



47 Total internal reflection is **not** applied in which of the following?

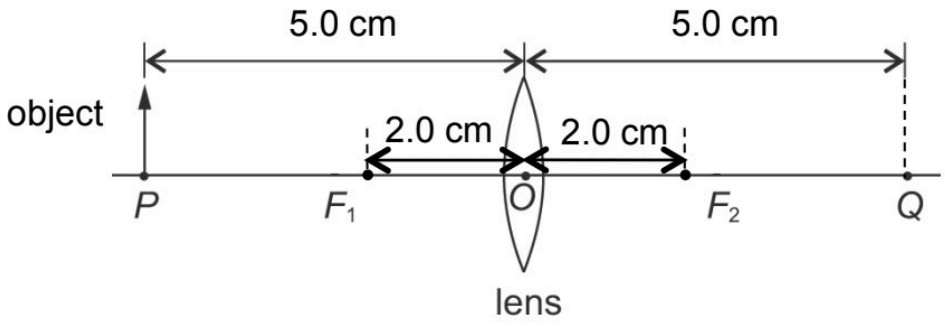
A reflecting prism in binoculars

B fibre optic cables

C reflecting prism in a periscope

D a plane mirror

48 The diagram shows an object at *P* placed 5.0 cm away from a converging lens which has a focal length of 2.0 cm. The points F_1 and F_2 are the principal foci of the lens.



At which point will the image of the object at *P* be formed by the lens?

A at F_2

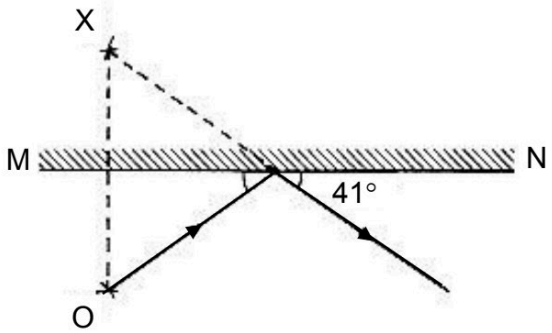
B between *O* and F_2

C between F_2 and *Q*

D at *Q*

49 The diagram shows an illuminated object O placed in front of a plane mirror MN.

X is the image of O.



Which statement describing the diagram is correct?

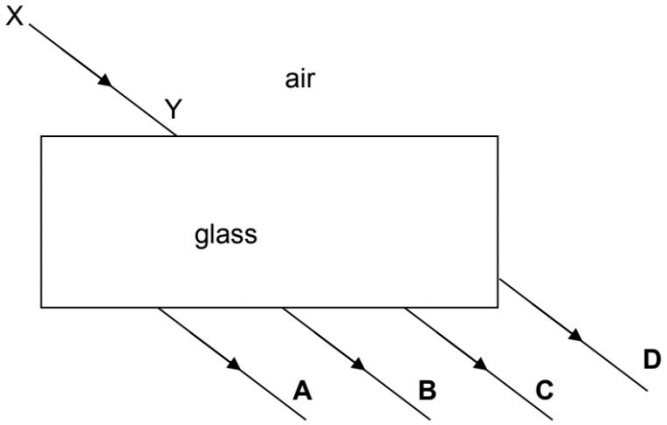
A X is a real image.

B X is brighter than O.

C The angle of incidence of the light ray from O at the mirror is 41°.

D X will move closer towards the mirror if O is placed closer to the mirror.

50 XY is a ray of light incident on a parallel-sided glass block. Which one of the light rays A, B, C or D most likely represents the path of the ray emerging from the block after refraction?



51 A ray of light hits a mirror at an incident angle of 28°. By how much must the mirror be rotated so that the angle of deviation between the incident and reflected rays equals 50°?

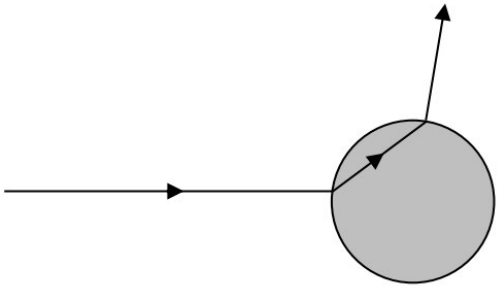
A 11° **B** 22° **C** 32° **D** 37°

52 A coin is placed between two mirrors angled at X° between them. The resultant photograph shows the coin and multiple images.

What is the likely value of X?

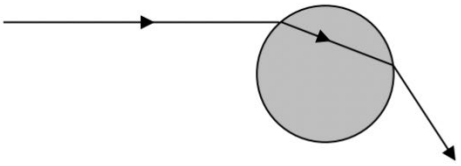
A 24.0° **B** 25.5° **C** 26.5° **D** 28.0°

53 A monochromatic light ray travels through water, through an air bubble, then through the water again.

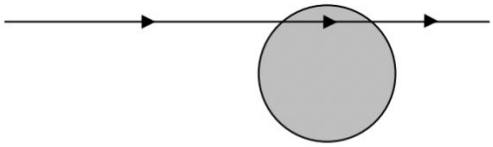


Which diagram shows the path of the light ray if it had hit the air bubble higher?

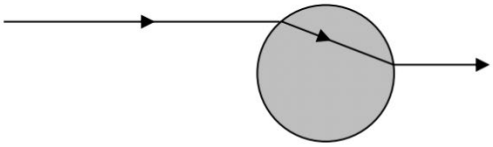
A



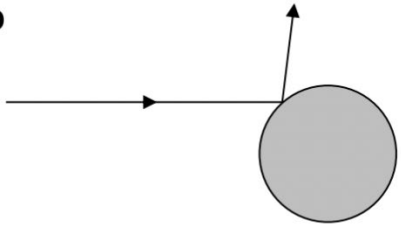
B



C



D



54 An object of height 15 cm is placed 20 cm in front of a converging lens. The image which is formed is the same size as the object but is inverted. What is the focal length of the converging lens?

A 5.0 cm **B** 10 cm **C** 20 cm **D** 40 cm

55 Which statement about the image formed by a plane mirror is **incorrect**?

A Light rays travel from the image to our eyes.

B The image cannot be projected on a screen.

C The image is as far away from the mirror as the object is in front.

D The size of the image is the same as the size of the object, no matter how far the object is placed from the mirror.

56 An object was placed 15.0 cm in front of a thin convex lens. The sharp image produced was magnified and upright.

What must be true about the focal length of the lens?

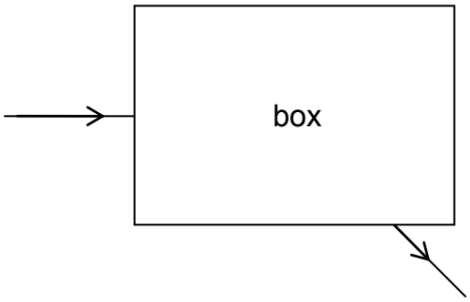
A It is less than 15.0 cm

B It is greater than 15.0 cm

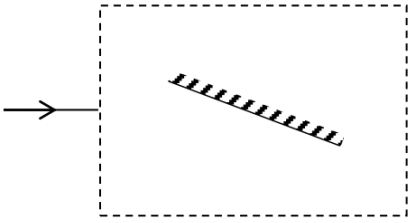
C It is between 15.0 cm to 30.0 cm

D It is greater than 30.0 cm

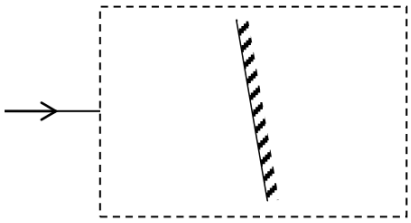
57 A light ray travels through a transparent box and emerges as shown. Which would be the correct arrangement of a mirror or glass prism or glass block placed in the centre of the box?



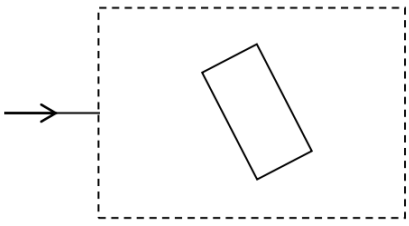
A plane mirror



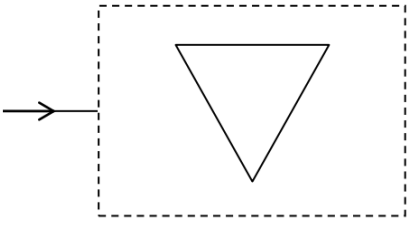
B plane mirror



C glass block

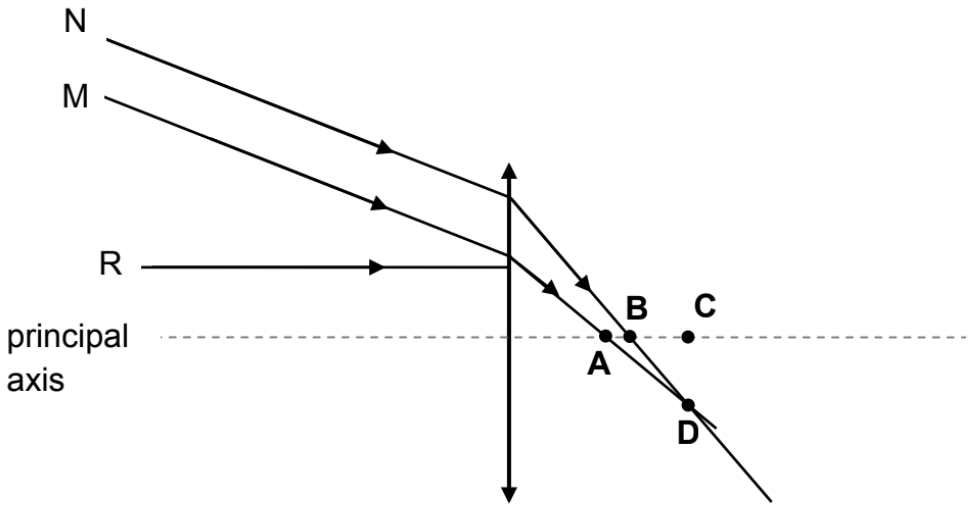


D equilateral glass prism

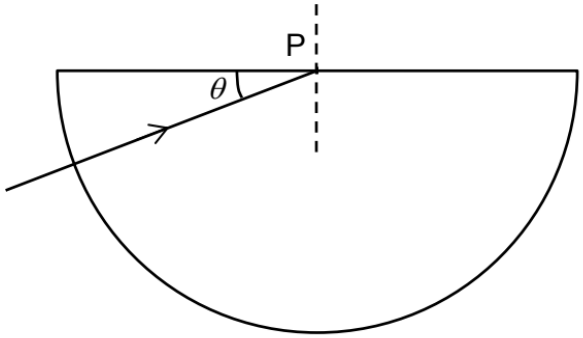


58 Two parallel rays of light M and N pass through a converging lens as shown below.

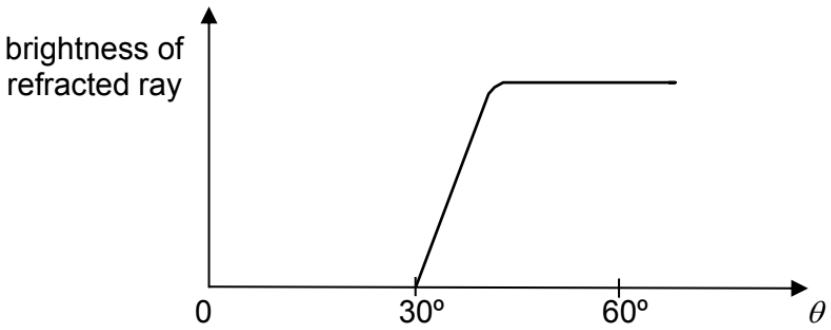
Which point will ray R pass through?



59 A light ray enters a semi-circular prism as shown in the diagram.



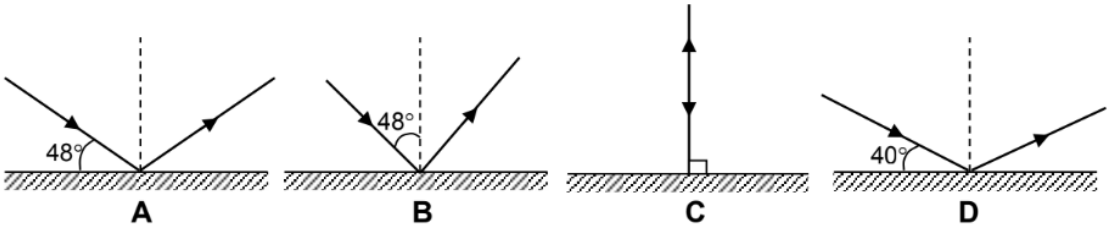
As θ is changed, the brightness of the refracted ray emerging through point P of the prism is measured and shown on the graph below.



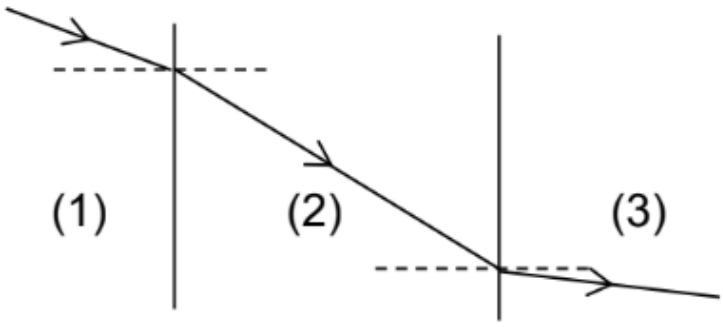
Which row correctly describes the critical angle and the refractive index of the prism?

	critical angle	refractive index
A	30°	2.0
B	30°	0.50
C	60°	0.50
D	60°	1.2

60 In the following figures, a light ray is incident on a plane mirror and then reflected away from it.



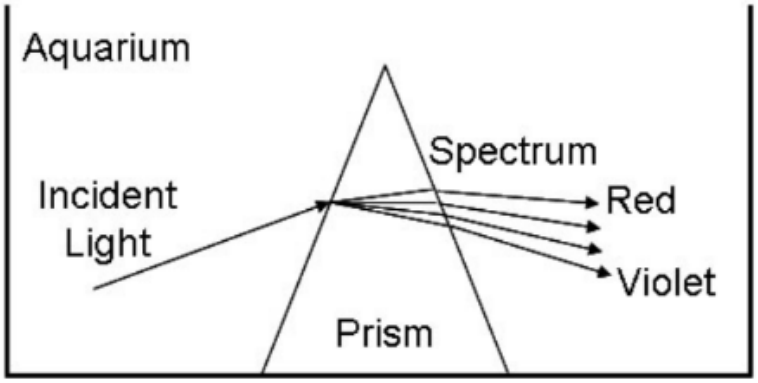
61 A ray of light passes through three media, (1), (2) and (3), as shown below.



Which of the above is a correct description of the three media?

	(1)	(2)	(3)
A	glass	water	air
B	water	air	glass
C	glass	air	water
D	water	glass	air

62 A beam of white light is incident on a triangular glass prism with an index of refraction of about 1.5 for visible light producing a spectrum. Initially, the prism is in a glass aquarium filled with air as shown below.



If the aquarium is then filled with water with an index of refraction of 1.3, which of the following is true?

A The spectrum produced has less separation between red and violet than that produced in air.

B The spectrum produced has greater separation between red and violet than that produced in air.

C The positions of the red and violet are reversed in the spectrum.

D The spectrum produced is the same as that produced in air.

63 The critical angle for light going from medium X into medium Y is θ.

The speed of light in medium X is v.

What is the speed of light in medium Y ?

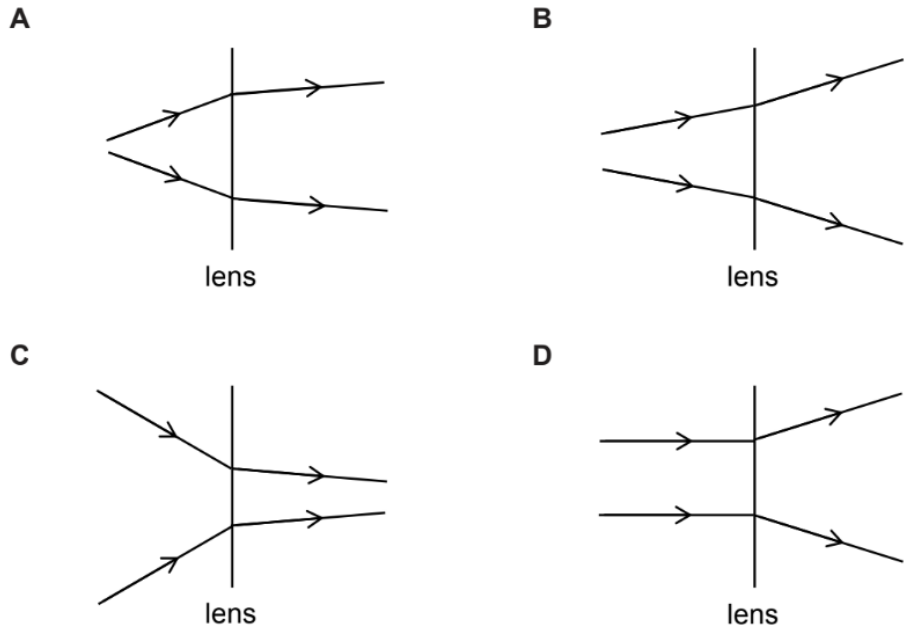
A $v / \cos \theta$

B $v \cos \theta$

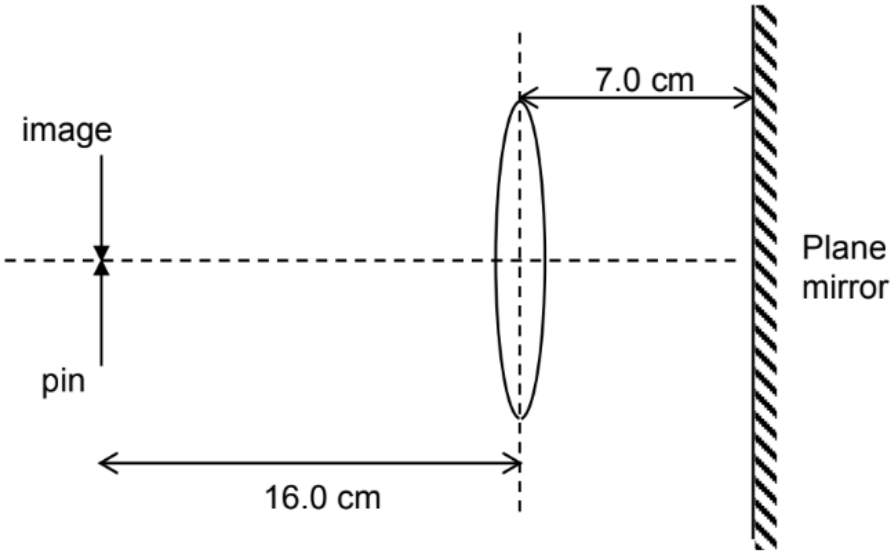
C $v / \sin \theta$

D $v \sin \theta$

64. Which diagram shows rays of light passing through a converging lens?



65 When a pin is placed in front of a convex lens and a plane mirror as shown below, a sharp image of the pin is formed at the same distance away from the lens as shown below.



What is the focal length of the lens?

A 23.0 cm

B 16.0 cm

C 8.0 cm

D 7.0 cm

LIGHT STRUCTURED QUESTIONS

1 Fig. 4.1 shows the top view of a thick mirror made from glass. The refractive index of the glass is 1.5. A light source is placed at point L. A light ray from L is incident on the thick mirror at an angle, as shown in the diagram (not drawn to scale).

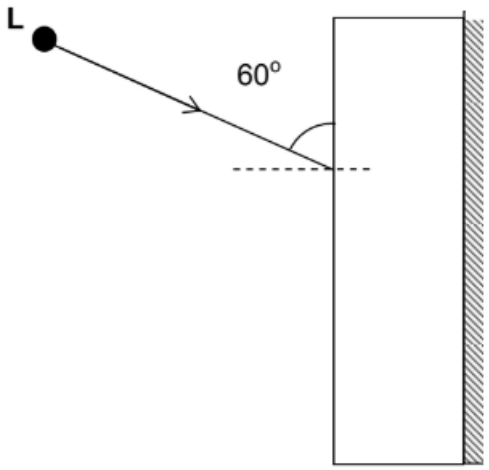


Fig. 4.1

(a) Calculate the angle of refraction of the ray as it enters the glass.

angle of refraction = ... [2]

(b) Complete the diagram to show the path taken by the ray until it leaves the glass.

[1]

2 Fig. 5.1 shows the path of a ray X from an object O as it passes through a convex lens, L.

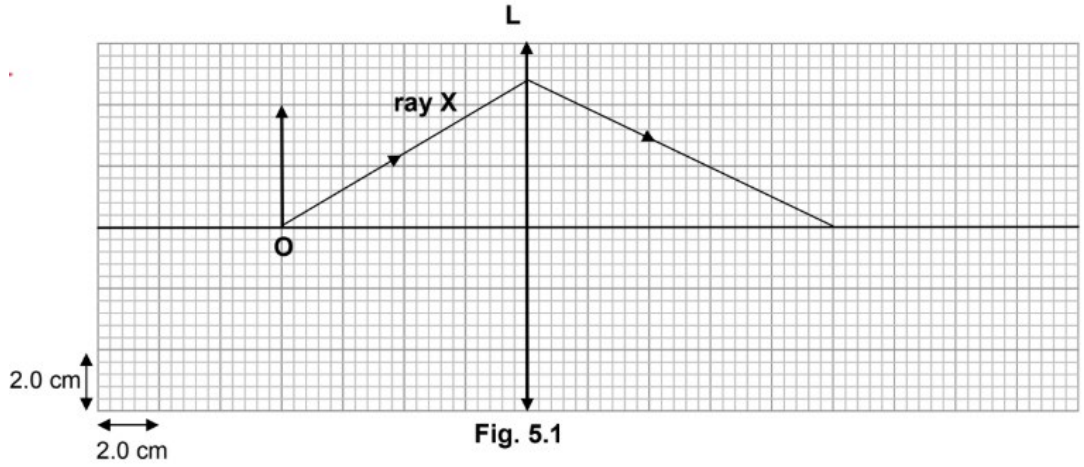


Fig. 5.1

(a) Describe the image formed.

..... [1]

Given that 1.0 cm on the grid represents 2.0 cm, draw necessary ray(s) on the diagram to

(b) locate the image. Label clearly the image formed, I [1]

(c) determine the focal length of the lens.

focal length = ... [2]

3 Fig. 18 shows a small bright particle P at the bottom of an empty tin can, which cannot be seen by a person with his eye at position E. Water is then poured into the can. The particle just becomes visible to the person when the can is filled to the brim.

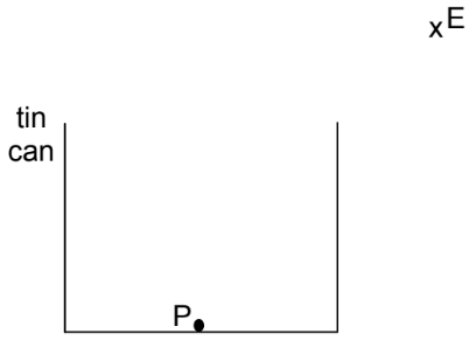


Fig. 18

(a) Explain why the person could not see the particle P before the water was added.

.....

.....

.....

..... [2]

(b) On Fig. 18,

(i) draw a light ray to show how the presence of water makes P visible, and

(ii) hence mark the position of the image of P seen by the eye at E. [2]

(c) Given that Fig. 18 is a scaled diagram, take appropriate measurements to calculate the refractive index of water. Indicate clearly the measurements taken.

Refractive index of water = ... [2]

4 Fig. 4 shows the air-glass surface AB of a piece of glass with a refractive index of 1.55.

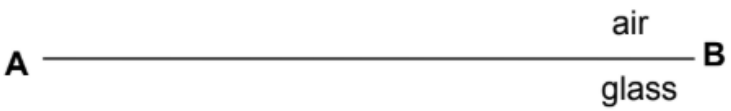


Fig. 4

(a) Sketch on Fig. 4, the path of a ray of light in glass, which strikes the air-glass surface at an angle of incidence equal to the critical angle and continues its path after it has struck the surface. Label the critical angle C. [1]

(b) Calculate the critical angle, C of the glass.

critical angle, C = ... [2]

5 Fig. 5 shows an object O placed in front of a converging lens, L.

1.0 cm on the grid represents 2.0 cm.

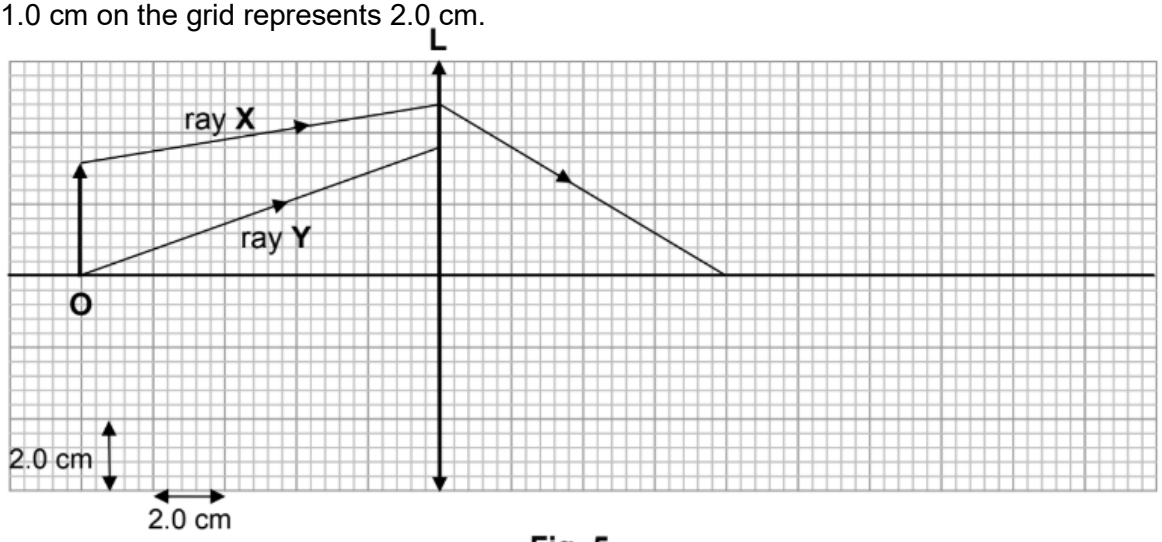


Fig. 5

(a) The path of ray X from the object O is shown as it passes through the lens.

Draw necessary ray(s) on the diagram above to determine the focal length of the lens.

focal length = ... [2]

(b) Draw necessary ray(s) on the diagram to complete the path of ray Y as it passes through the converging lens L. [2]

6 A small coin is placed in front of a convex lens of focal length 20.0 cm, such that the the object distance is 40.0 cm.

(a) Using the grid in Fig. 4.1, draw two rays from the coin to locate its image.

Label the image **I**. [2]

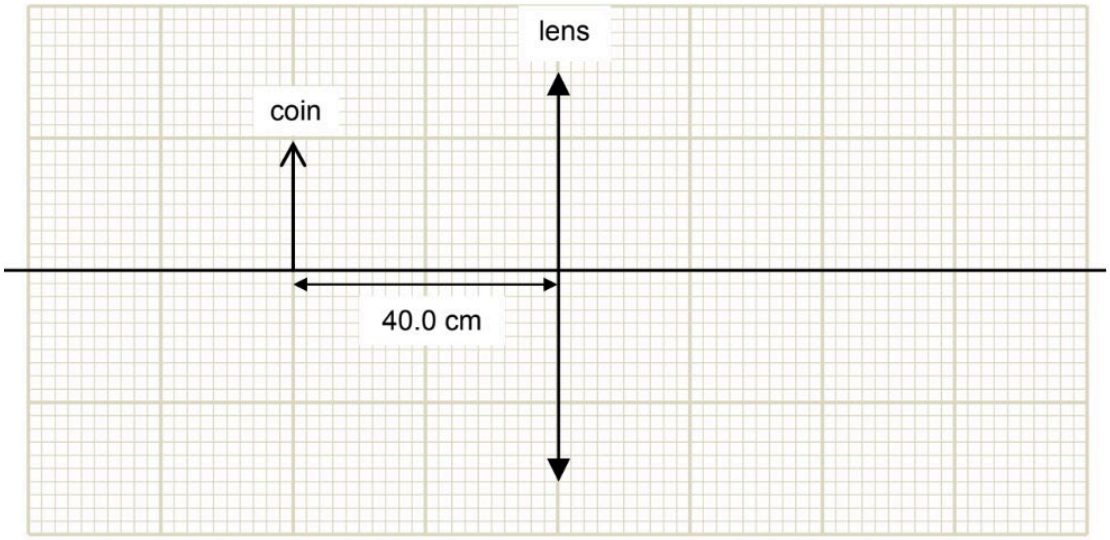


Fig. 4.1

(b) Determine the image distance.

image distance = ... [1]

(c) Determine the magnification of the image.

magnification = ... [1]

(d) State **three** characteristics of the image formed.

..... [2]

7 A small lamp is placed below the surface of the water, as shown in Fig. 3.1. Three rays from the lamp strike the surface at X, Y and Z.

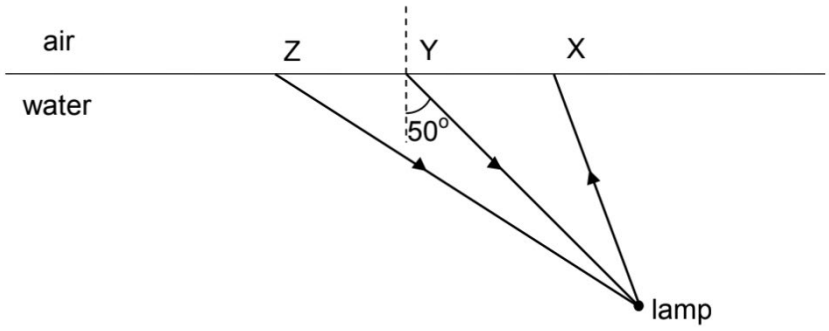


Fig. 3.1

The critical angle for light passing from water to air is 50°.

(a) Explain what is meant by *critical angle.*

.....

.....

..... [1]

(b) On Fig. 3.1, complete the paths of the three rays after they strike the surface at X, Y and Z. [2]

(c) Calculate the refractive index of water.

refractive index = ... [2]

(d) Explain why when viewed from above the water, the light from the lamp emerged only from a circular area of the water.

.....

.....

.....

.....

..... [2]

8 Fig. 4.1 shows a point object P that is placed in front of a plane mirror and two incident rays from P to the mirror.

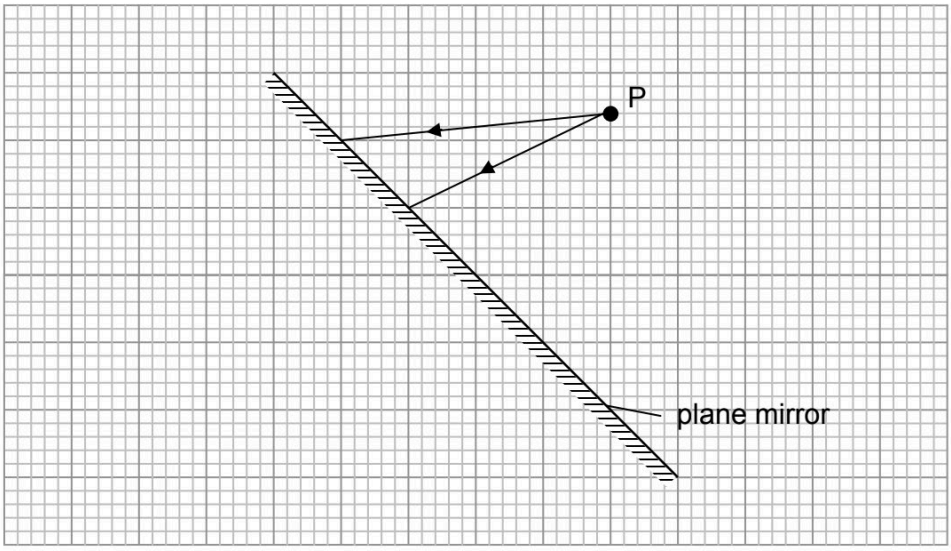


Fig. 4.1

On Fig. 4.1

(a) mark accurately the position of the image of P and label it with the letter I. [1]

(b) draw the reflected rays for the two incident rays to show how the image I is formed. [1]

9 Fig. 5.1 shows an eye that views an object O placed 80 mm away. The image I of the object O is captured on the retina which is 25 mm from the eye lens.

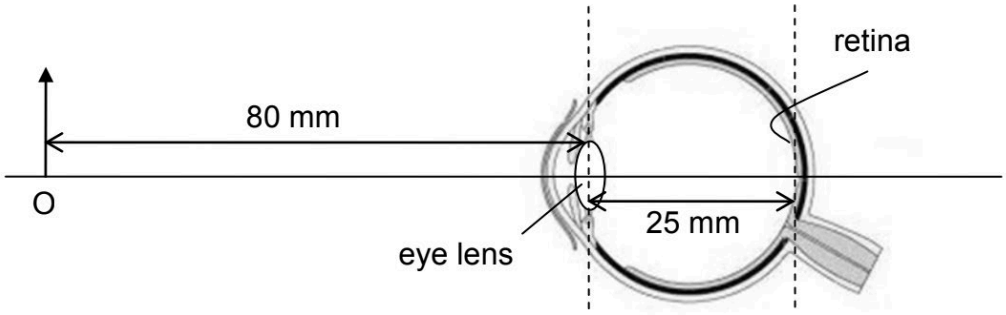


Fig. 5.1

(a) Using the grid in Fig. 5.2, draw two rays from the object O to show how the image, I is formed on the retina. [2]

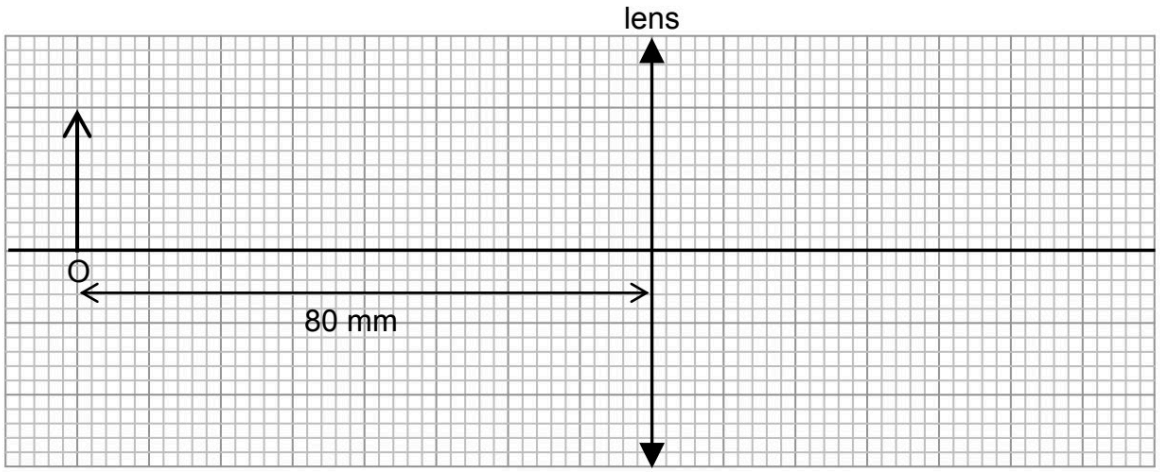


Fig. 5.2

(b) Determine the focal length of the eye lens from Fig. 5.2.

focal length = ... [1]

(c) Determine the magnification of the image.

magnification = ... [1]

(d) State three characteristics of the image formed.

.....[2]

(e) The eye focuses by adjusting the thickness and hence, the focal length of the eye lens.

State how the focal length of the eye lens should change, to enable the eye to see a sharp image of the object when it is moved further away from the eye.

.....[1]

10 **(a)** Fig. 10.1 shows a ray of light incident on the face AB of a glass block ABCD.

The refractive index of the glass block is 1.55

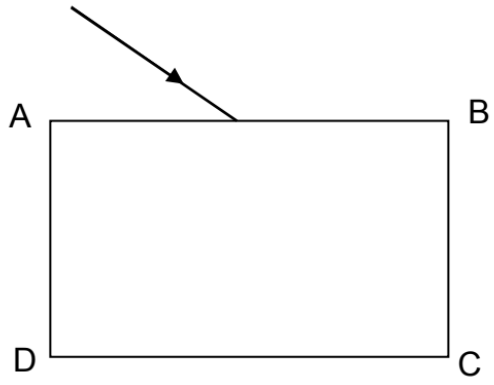


Fig. 10.1

(i) Calculate the critical angle of the glass.

critical angle = ...[2]

(ii) State the conditions necessary for total internal reflection to occur.

.....

.....

.....

.....

.....[2]

(iii) Explain why an incident ray entering the side AB and reaching the side DC can never be totally internally reflected at the face DC.

.....

.....

.....

.....

.....

.....[2]

(b) Fig. 10.2 shows the full-scale diagram of an object O and its upright, virtual and magnified image I. The object is placed in front of a convex lens.

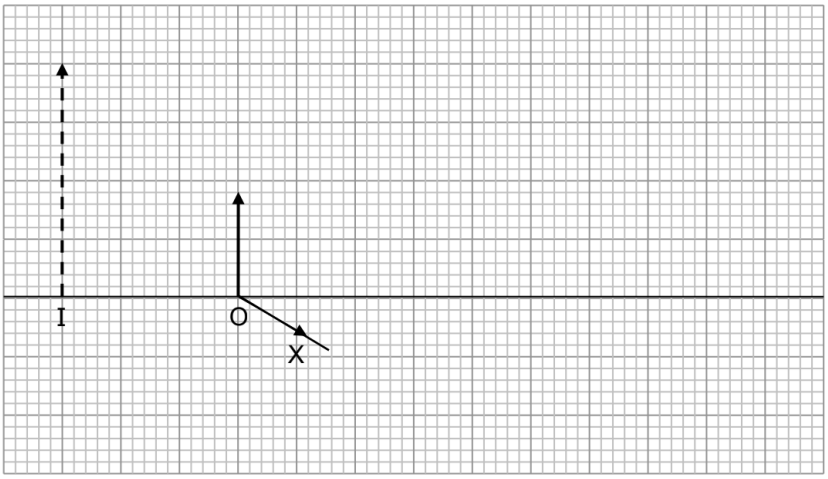


Fig. 10.2

(i) Draw necessary light rays on Fig. 10.2 to locate the position of the lens (label it L) and the principal focus (label it F). [2]

(ii) State the focal length of the lens.

focal length = ...[1]

(iii) Complete the path of the ray X through the convex lens L. [1]

11 An object is placed 12.0 cm from a convex lens as shown in Fig. 3.1. On the other side of the lens, a screen is placed 5.0 cm from the lens to obtain a sharp image.

The diagram is not drawn to scale.

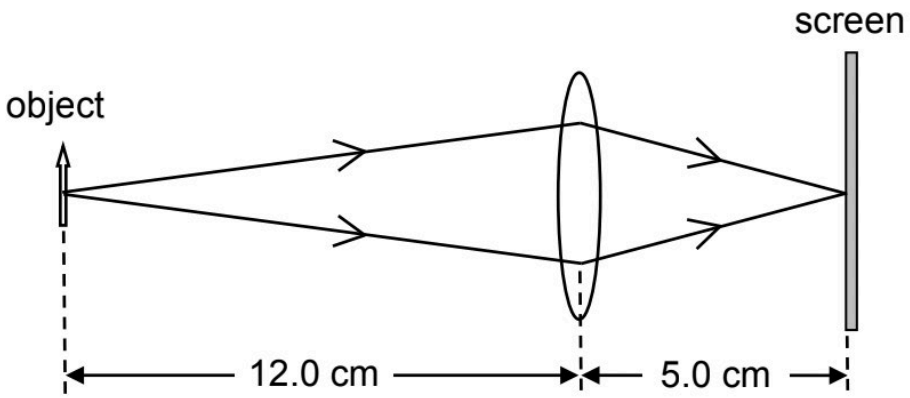


Fig. 3.1

(a) Calculate the magnification of the image.

magnification = ... [2]

(b) Determine the focal length of the lens.

focal length = ... [2]

(c) The positions of the object and the screen are fixed while the lens is moved towards the object.

Determine the distance the lens should be moved from its position in Fig. 3.1 towards the object, so that a sharp image can be obtained on the screen again.

distance moved = ... [1]

12 A point source of light P is placed near a prism ABC as shown in Fig. 4.1.

Due to partial reflection along the surface AB, a faint image of P is seen at P'.

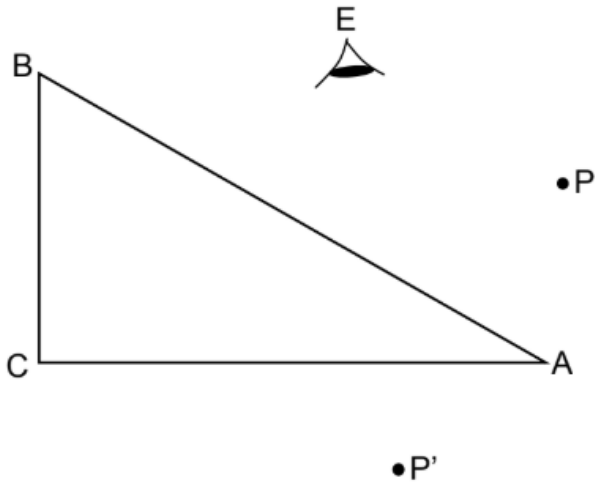


Fig. 4.1

(a) On Fig. 4.1, draw two light rays, to show how an eye at E sees the image P'. [2]

(b) Fig. 4.2 shows a scaled diagram of prism ABC. A ray of light from P, parallel to AC and incident on AB, is refracted to reach BC.

Given that the refractive index of the prism material is 1.49, complete the path of the light ray until it emerges from the prism. Show any calculation and label the angle to account for the path of this ray. [3]

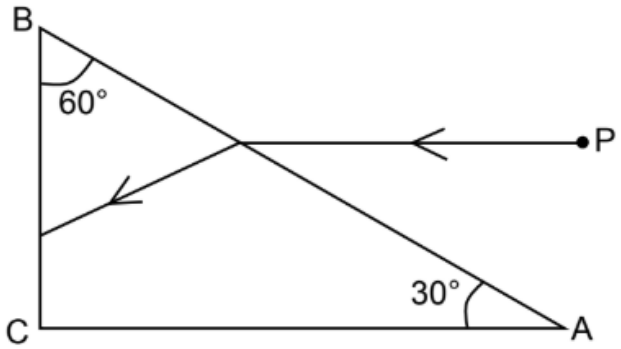


Fig. 4.2

13 An object O is placed in front of a thin converging lens of focal point F and a ray X is reflected off the object as shown in Fig 3.1.

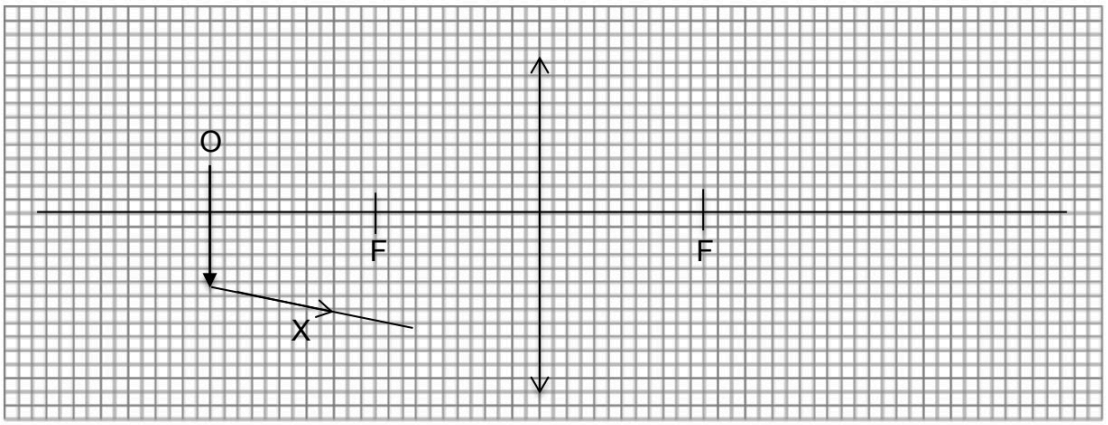


Fig. 3.1

(a) Draw rays to locate the complete image of O formed by the converging lens.

Label the image as I. [3]

(b) Complete the path of the ray X.

..... [1]

(c) Describe the characteristics of the image formed.

..... [1]

(d) Name an application for such an arrangement.

..... [1]

(e) The object is moved slightly nearer to the lens, state what will happen to the size of the image.

..... [1]

14 Fig. 3.1 shows a simple camera which makes use of a thin converging lens of focal length f (drawn to actual size). A sharp image of the object is formed on the film.

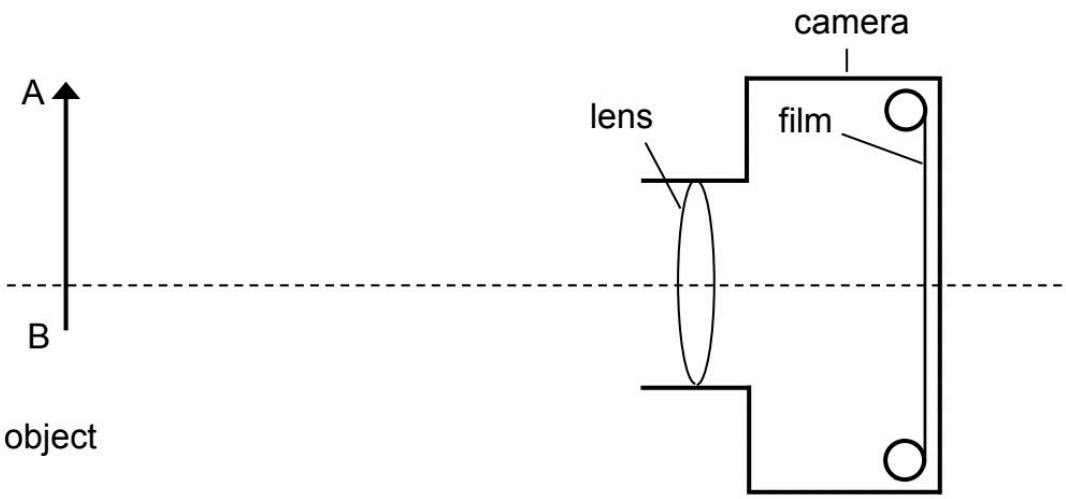


Fig. 3.1

(a) Explain what is meant by focal length of a lens.

.....

.....[1]

(b) Draw two light rays from the object AB to show how its image is formed on the film. Label the image as A'B'. [2]

(c) Determine the focal length of the lens by drawing another light ray.

..... [2]

(d) Determine the linear magnification of the object as shown in Fig. 3.1.

linear magnification = ... [1]

(e) Describe a situation where it may be necessary to move the lens towards the film when taking the photograph.

.....

.....[1]

15 Fig. 3.1 shows a ray of light incident on a piece of glass of refractive index 1.7.

(a) Measure and record the angle of incidence of the ray 1.

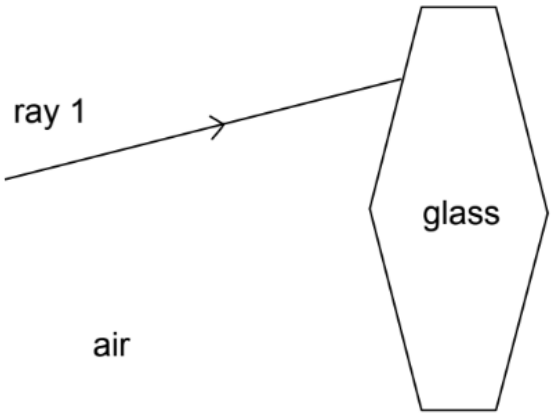


Fig. 3.1

angle of incidence = ...[1]

(b) Calculate the angle of refraction.

angle of refraction = ...[2]

(c) On Fig. 3.1, sketch the path of ray 1 until it emerges from the glass. [1]

(d) Explain if the parallel rays of light entering the glass would converge at a common point after passing through the glass.

.....

.....

.....

.....

..... [1]

16 A convex lens L and an object JK are shown in the light ray diagram in Fig. 3.1.

The path of one light ray from point J is drawn.

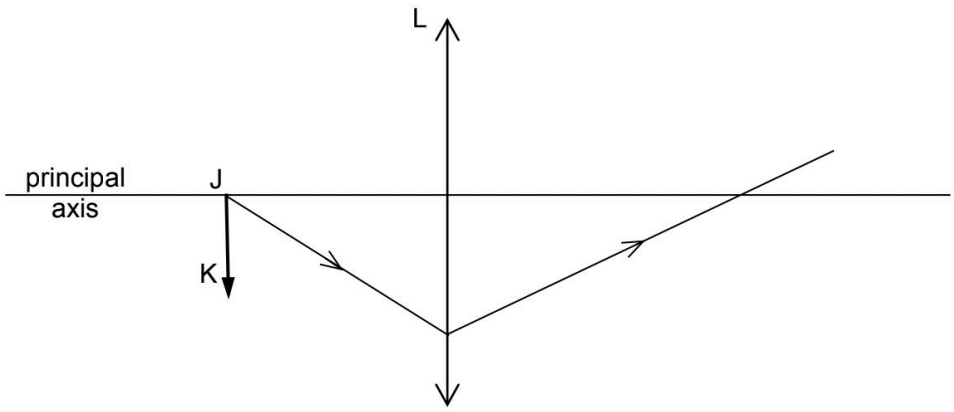


Fig. 3.1

(a) Draw accurately and label the position of the image J'K' on Fig. 3.1. [1]

(b) State the three properties of the image J'K'.

.....

..... [2]

(c) Given that Fig. 3.1 is one-quarter of its actual size, determine the focal length of the lens.

focal length = ... [2]

17 Fig. 2.1 is a scaled diagram that shows an incident ray of light entering a block of transparent material from air.

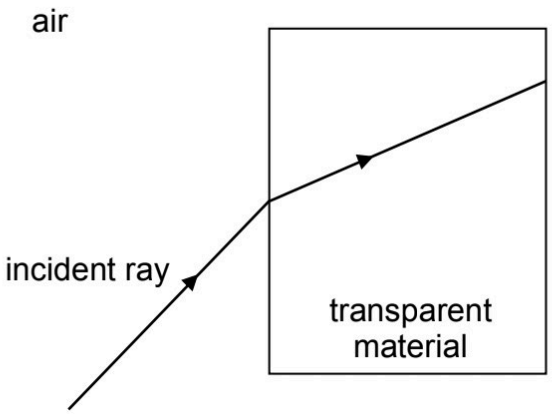


Fig. 2.1

(a) Measure and write down the angle of incidence i and the angle of refraction r.

angle *i* = ... angle r = ... [1]

(b) Hence, determine the refractive index of the material.

refractive index = ... [2]

18 Fig. 3.1 shows the path of a ray as it leaves object O and passes through a convex lens L.

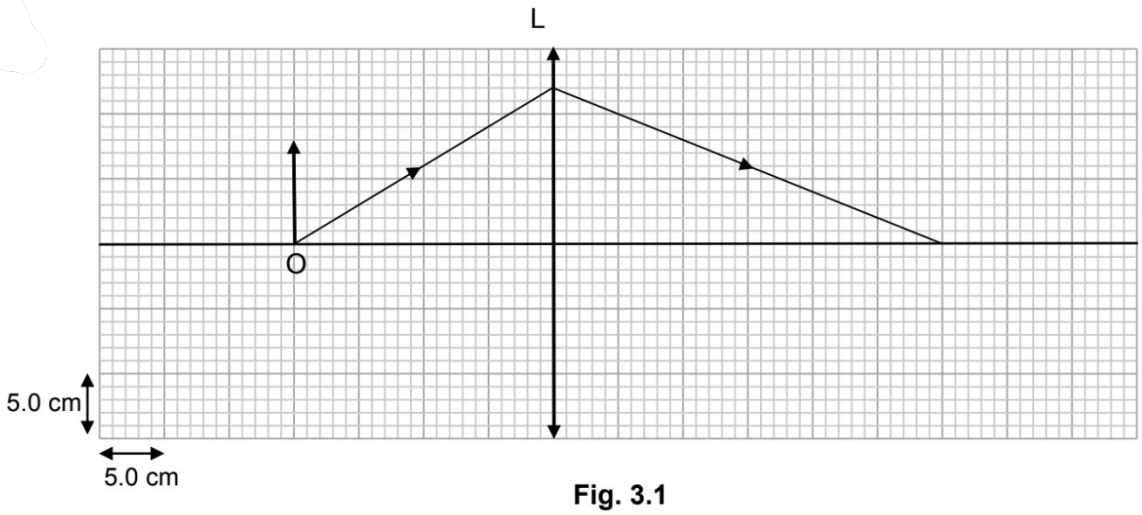


Fig. 3.1

1.0 cm on the grid represents 5.0 cm.

(a) Draw necessary ray(s) on the diagram to locate the image. Label clearly the image formed, **I**. [1]

(b) Determine the focal length of the lens.

focal length = ... [2]

(c) Describe three characteristics of image I.

..... [1]

19 **(a)** State the **two** conditions required for **total internal reflection** to occur.

Condition 1: .....

.....

..... [1]

Condition 2: .....

.....

..... [1]

Fig. 4.1 is a full-scale diagram. It shows a ray of light entering a triangular glass prism normally. The glass has a refractive index of 1.45.

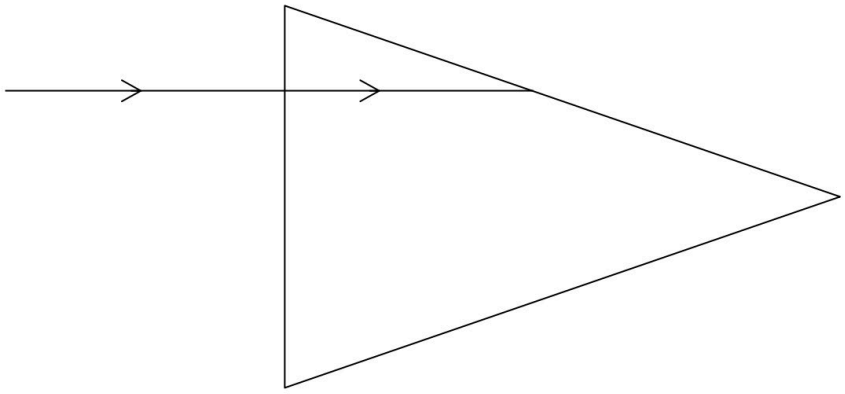


Fig. 4.1

(b) On Fig 4.1 above, accurately complete the path of the light ray as it passes through the glass block until it leaves. Show all calculations clearly.

20 An object JK and its image J'K' formed by a convex lens are shown in the light ray diagram in Fig. 5.1.

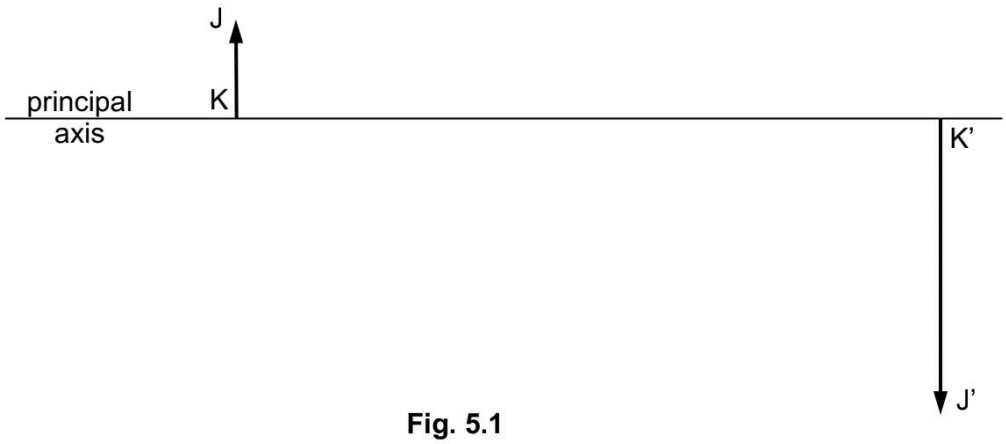


Fig. 5.1

(a) Draw accurately and label the position of the lens L on Fig. 5.1. [1]

(b) State the three properties of the image J'K'.

.....

.....

..... [2]

(c) Given that Fig. 5.1 is actual size, determine the focal length of the lens.

focal length = ... [1]

21 Fig. 11.1 shows a ray of light passing through two identical right-angled glass prisms.

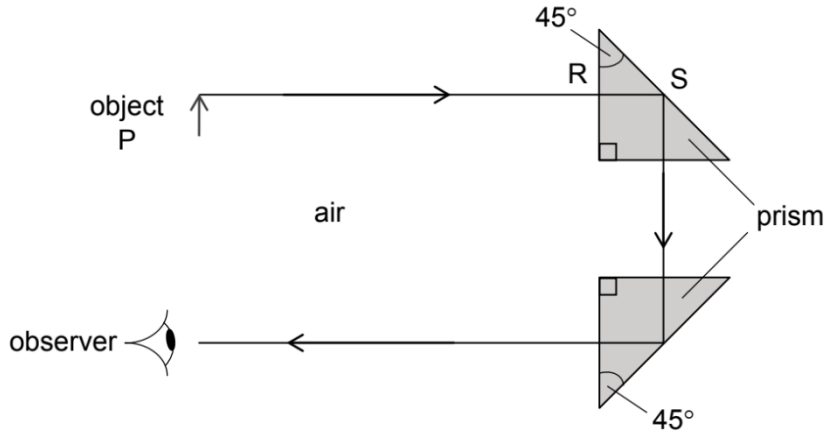


Fig. 11.1

(a) The refractive index of the glass prism is 1.55.

Calculate the speed of light in the glass prism. Take the speed of light in air to be 3.00×10^8 m s^{-1}.

speed of light in prism = ... [2]

(b) Calculate the critical angle of the glass-air boundary.

critical angle = ... [1]

(c) Explain why the ray

(i) did not bend as it entered the prism at surface R, and

.....

..... [1]

(ii) did not exit the prism upon hitting surface S.

.....

.....

.....

..... [2]

(d) Show, by drawing another light ray in Fig. 11.1, that the image of object P seen by the observer is inverted. [1]

(e) Explain if the image of P seen by the observer is virtual or real.

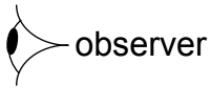
.....

..... [1]

(f) In the space below, show how the two prisms in Fig. 11.1 may be arranged so that the observer sees an upright image of object P.

Draw light rays to show that the image observed is upright. [2]

Diagram:



22 An optical fibre has an inner glass core surrounded by an outer glass cladding. Fig. 5.1 shows the path of a ray of light travelling along the fibre, striking the boundary between the core and the cladding at an angle .

The refractive indices of the core and the cladding are 1.60 and 1.10 respectively.

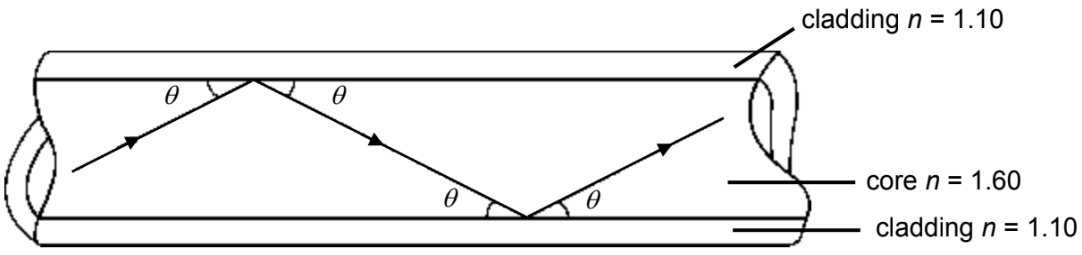


Fig. 5.1

(a) Explain the purpose of surrounding the glass core with the outer glass cladding shown in Fig. 5.1.

.....

.....

.....

.....

..... [2]

(b) State the angle of incidence of the light ray at the boundary between the core and the cladding if the angle is 35°.

angle of incidence = ... [1].

(c) Determine the maximum value of for which the light ray will remain within the inner glass core.

maximum angle of = ... [2].

core n = 1.60

cladding n = 1.10

cladding n = 1.10

23 A convex lens L forms an image I of a point object O placed on the principal axis, as shown in Fig. 6.1. The diagram is not drawn to scale.

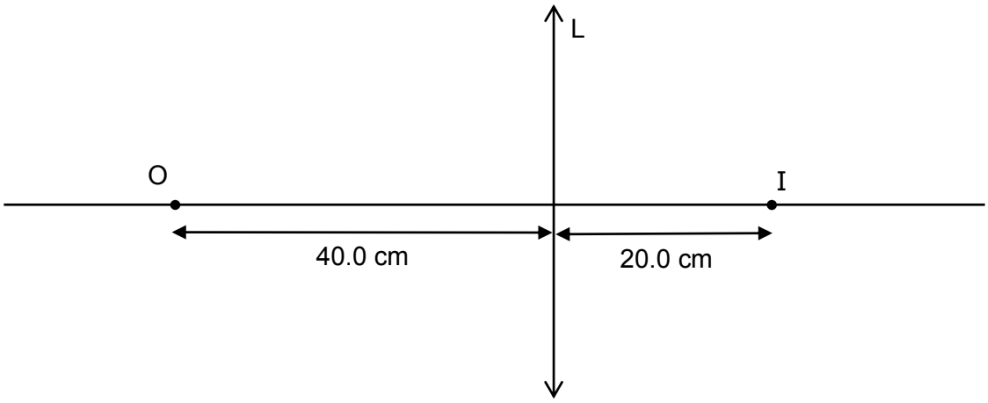


Fig. 6.1

(a) Calculate the focal length of the lens L.

focal length = ... [1].

(b) If the point object O is raised 5.0 cm vertically above the principal axis, determine the new position of the image. Show any working clearly.

Mark and label the position of this new image I' on Fig. 6.1. [2]

(c) If the object O on the principal axis (in Fig. 6.1) is moved a short distance further from the lens, state what would happen to the position of this image.

.....

..... [1]

24 Fig. 4.1 shows a ray of light passing into a right-angled prism at D.

After reaching E, the light travels along two paths, with one ray travelling along the surface of the prism and one ray along EF.

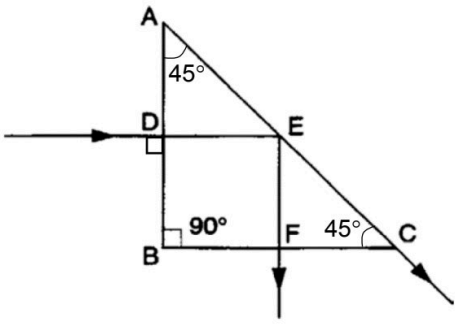


Fig. 4.1

(a) State one property of light that changes at D and whether it increases or decreases.

.....

..... [2]

(b) **(i)** On Fig.4.1, identify the critical angle and label with letter X. [1]

(ii) Hence, determine the refractive index of this glass.

refractive index = ...[2]

(iii) The prism is replaced with another one with a greater refractive index. Describe what happens to the path of light.

.....

…….....[1]

(c) Visible light is a type of electromagnetic wave. All electromagnetic waves transfer energy and travel through vacuum at a speed of 3.0×10^8 m/s.

(i) State one other property common to all components of the electromagnetic spectrum.

…… [1]

(ii) The wavelength of red light is 690 nm.

Calculate the frequency of this wave in vacuum.

frequency = …….. [2]

[Total: 9]

ANSWERS FOR LIGHT MCQ

Q1: C	Q11: D	Q21: B	Q31: C	Q41: C	Q51: D	Q61: B
Q2: C	Q12: C	Q22: D	Q32: B	Q42: A	Q52: C	Q62: A
Q3: C	Q13: B	Q23: A	Q33: D	Q43: D	Q53: D	Q63: C
Q4: B	Q14: A	Q24: D	Q34: D	Q44: B	Q54: B	Q64: A
Q5: A	Q15: C	Q25: B	Q35: D	Q45: A	Q55: A	Q65: B
Q6: D	Q16: C	Q26: C	Q36: C	Q46: B	Q56: B	
Q7: A	Q17: B	Q27: C	Q37: A	Q47: D	Q57: A	
Q8: B	Q18: A	Q28: D	Q38: A	Q48: C	Q58: C	
Q9: D	Q19: D	Q29: D	Q39: B	Q49: D	Q59: D	
Q10: C	Q20: B	Q30: A	Q40: D	Q50: B	Q60: C	

ANSWERS FOR LIGHT STRUCTURED QUESTIONS

1 Fig. 4.1 shows the top view of a thick mirror made from glass. The refractive index of the glass is 1.5. A light source is placed at point L. A light ray from L is incident on the thick mirror at an angle, as shown in the diagram (not drawn to scale).

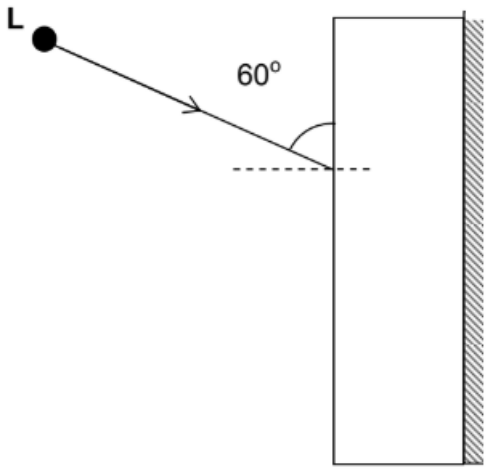


Fig. 4.1

(a) Calculate the angle of refraction of the ray as it enters the glass.

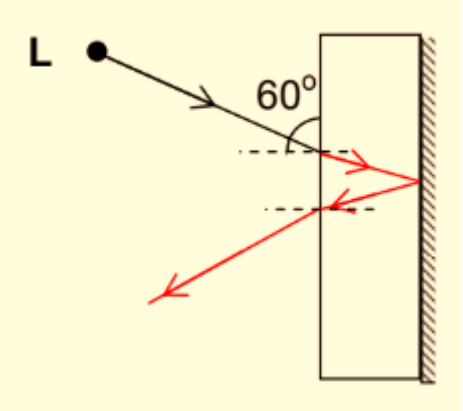
n = sin i / sin r

1.5 = sin 30˚/sin r [1]

r = 19.47˚ = 19˚ [1]

[2]

(b) Complete the diagram to show the path taken by the ray until it leaves the glass.



[1]

2 Fig. 5.1 shows the path of a ray X from an object O as it passes through a convex lens, L.

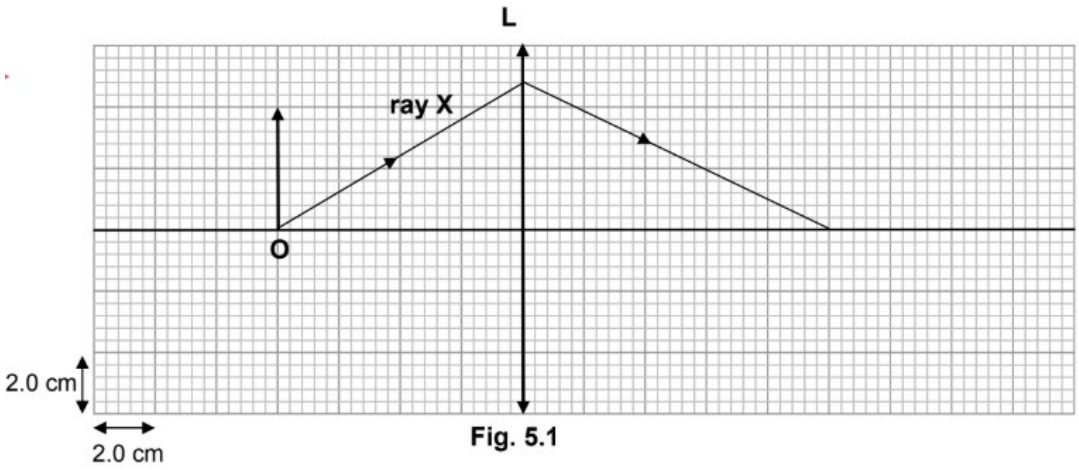


Fig. 5.1

(a) Describe the image formed.

Real and inverted. [1]

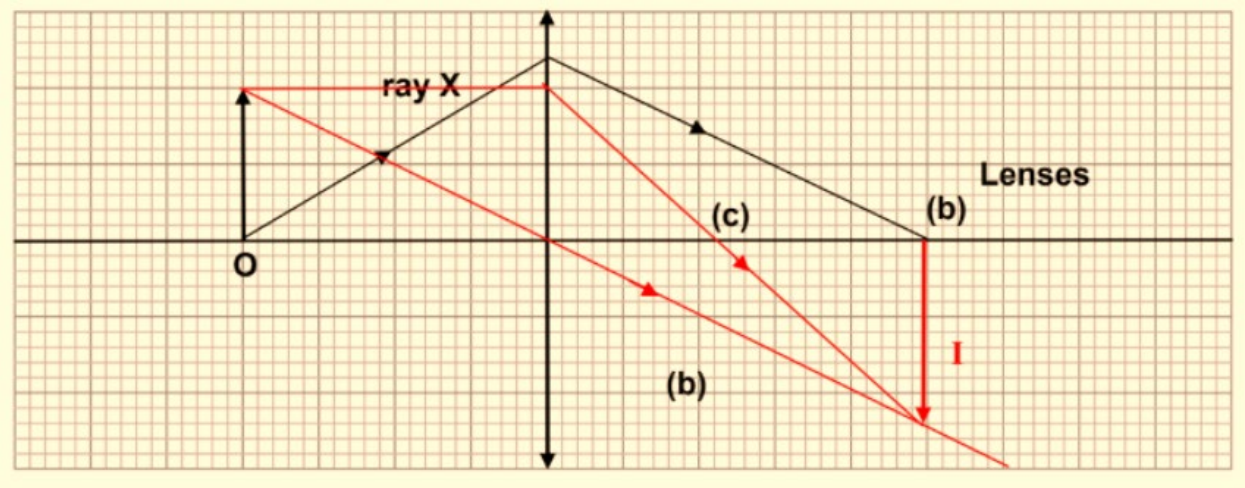
Given that 1.0 cm on the grid represents 2.0 cm, draw necessary ray(s) on the diagram to

(b) locate the image. Label clearly the image formed, I [1]

Correct height, position and labelled

(c) determine the focal length of the lens.

Focal length = 2.2 x 2 = 4.4 cm [1] correct ray, [1] correct caculation



[2]

3 Fig. 18 shows a small bright particle P at the bottom of an empty tin can, which cannot be seen by a person with his eye at position E. Water is then poured into the can. The particle just becomes visible to the person when the can is filled to the brim.

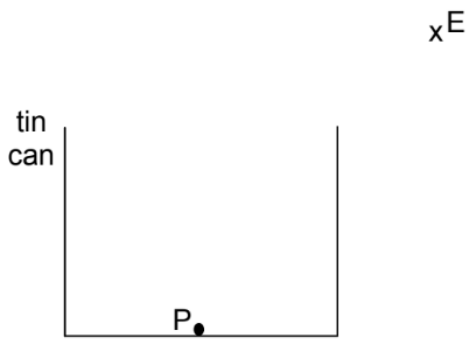


Fig. 18

(a) Explain why the person could not see the particle P before the water was added.

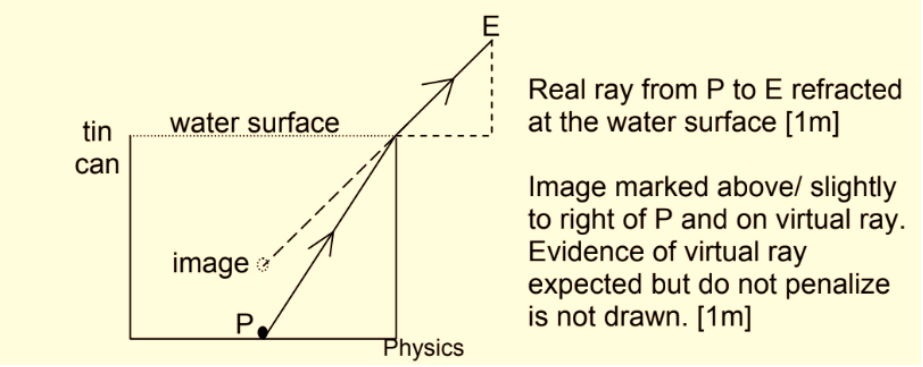
To see an object, light from the object must reach the eye. [1m]

Since light travels in a straight line in the same medium, the light from P cannot reach E. [2]

(b) On Fig. 18,

(i) draw a light ray to show how the presence of water makes P visible, and

(ii) hence mark the position of the image of P seen by the eye at E. [2]



(c) Given that Fig. 18 is a scaled diagram, take appropriate measurements to calculate the refractive index of water. Indicate clearly the measurements taken.

Correctly measures incident angle and angle of refraction. [1m]

sine i / sine r = sine 47 °/ sine 34 ° = 1.31 or sine 47 °/ sine 34 ° = 1.24 [1m]

OR students take measurements of length.

Accept values between 1.2 to 1.3.

Allow ecf for wrong angles measured if Snell's Law shown. Max 1m.

[2]

4 Fig. 4 shows the air-glass surface AB of a piece of glass with a refractive index of 1.55.

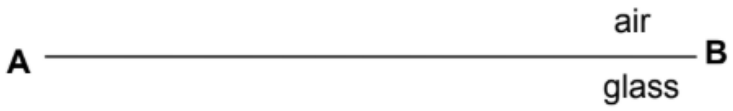


Fig. 4

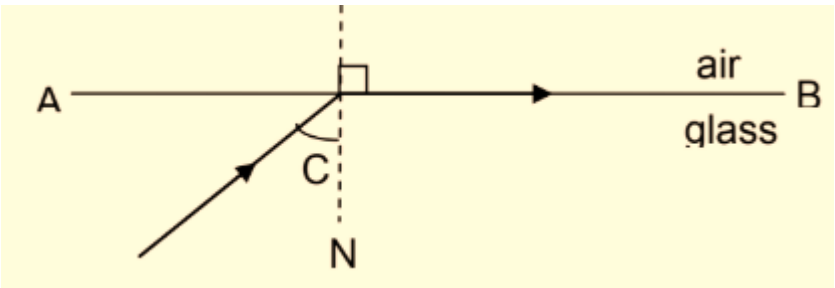
(a) Sketch on Fig. 4, the path of a ray of light in glass, which strikes the air-glass surface at an angle of incidence equal to the critical angle and continues its path after it has struck the surface. Label the critical angle C. [1]

Critical angle marked from the normal in glass medium and refracted ray at refracted angle of 90°

(b) Calculate the critical angle, C of the glass.

sin c = 1/ = 1/1.55

critical angle, c = 40.2°



[2]

5 Fig. 5 shows an object O placed in front of a converging lens, L.

1.0 cm on the grid represents 2.0 cm.

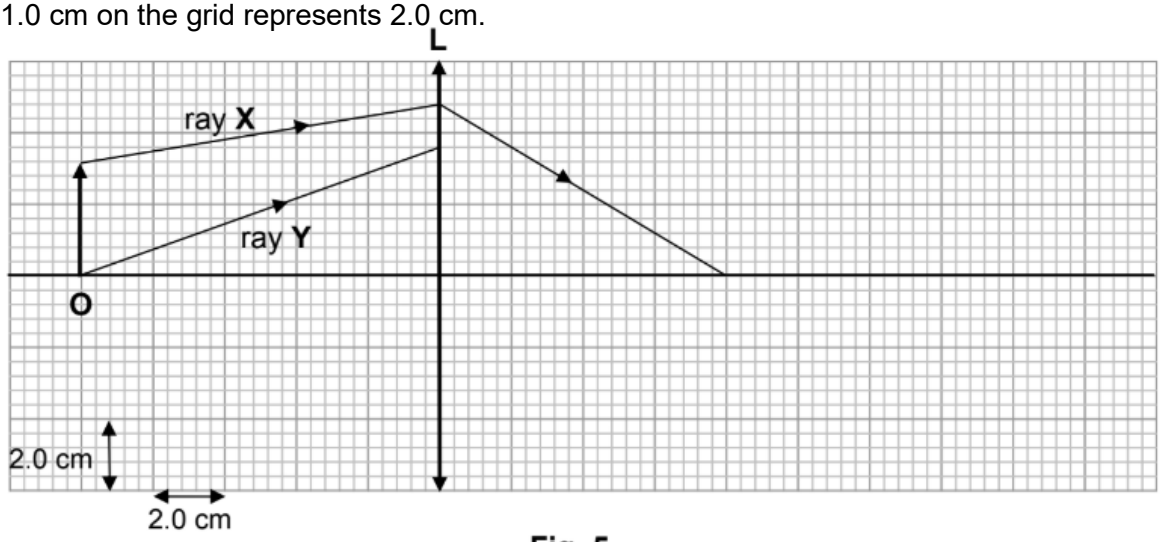
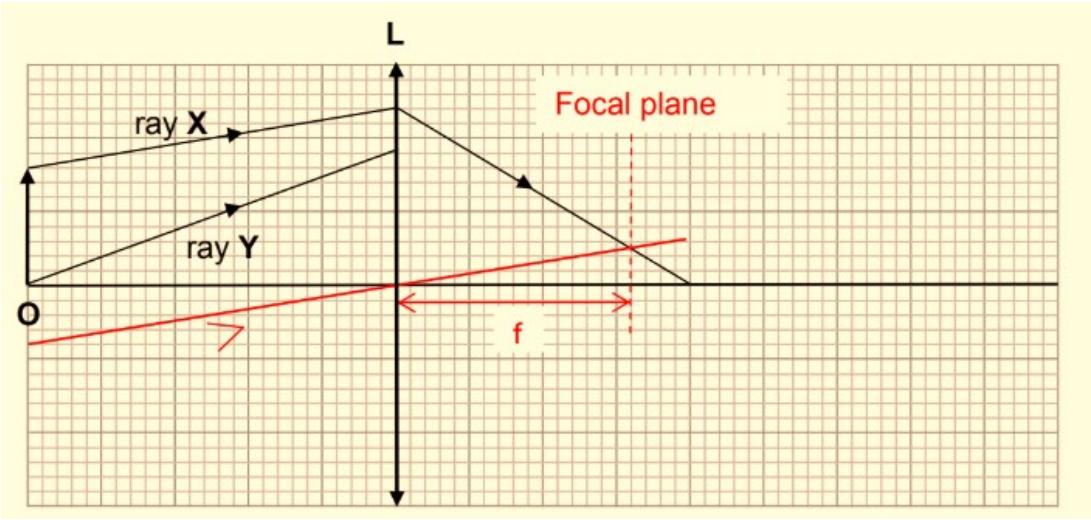


Fig. 5

(a) The path of ray X from the object O is shown as it passes through the lens.

Draw necessary ray(s) on the diagram above to determine the focal length of the lens.

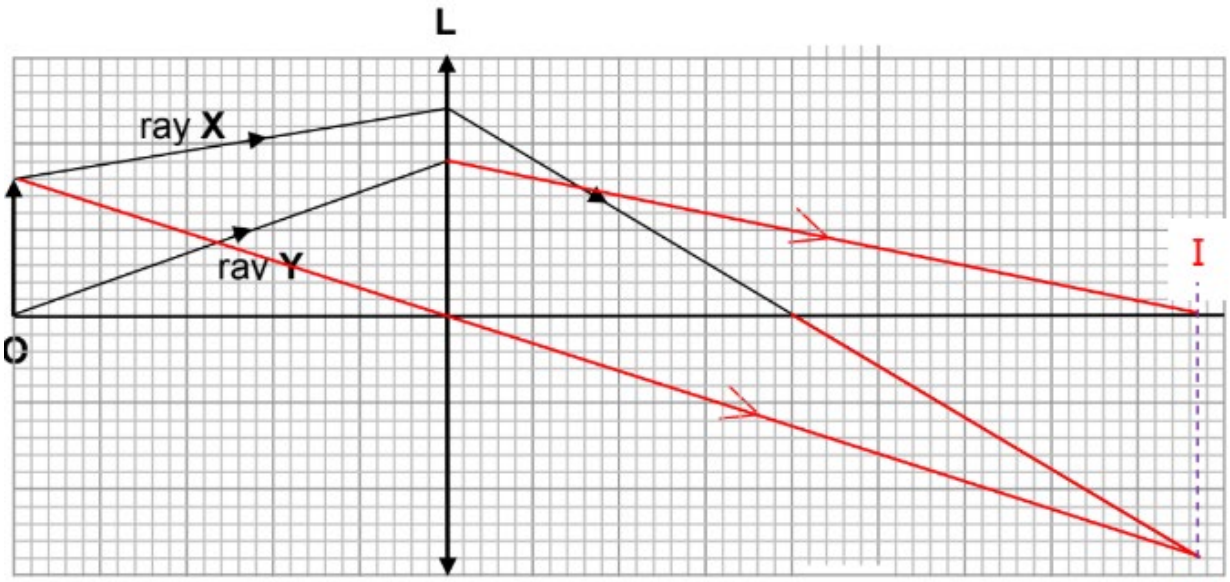


Evidence of any correct rays used to locate F.

Focal length = 3.2 x 2.0 = 6.4 cm (actual value accepted can vary depending on the drawing by the student.)

[2]

(b) Draw necessary ray(s) on the diagram to complete the path of ray Y as it passes through the converging lens L. [2]



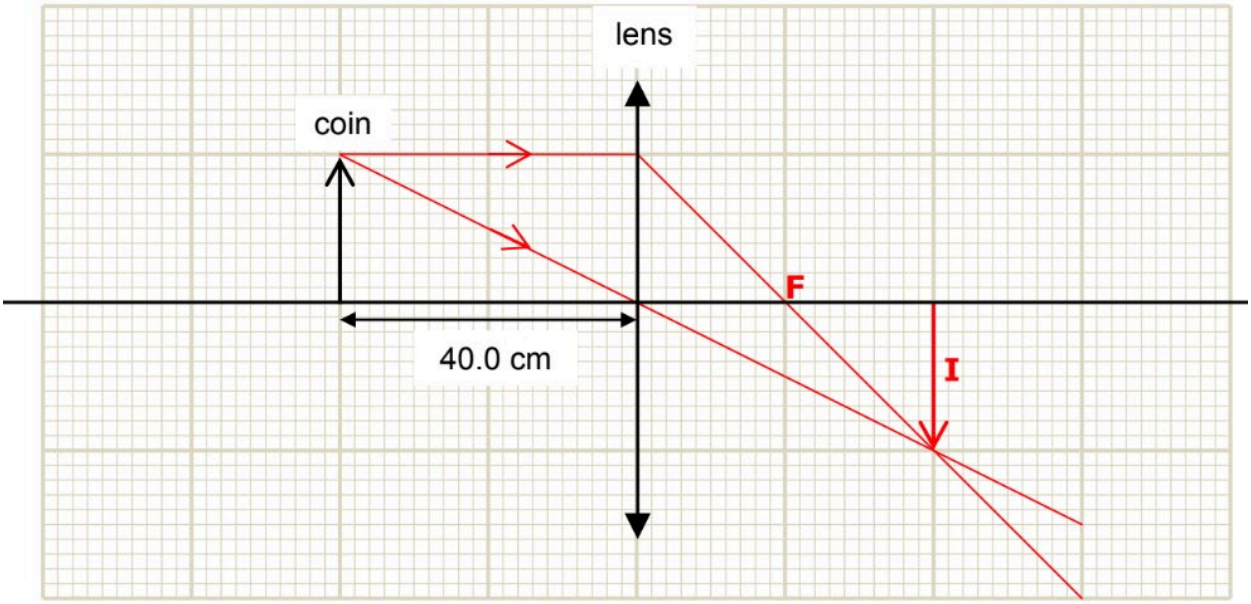
Evidence of any correct rays used to determine refracted ray of Y.

Accurately completed ray Y.

6 A small coin is placed in front of a convex lens of focal length 20.0 cm, such that the the object distance is 40.0 cm.

(a) Using the grid in Fig. 4.1, draw two rays from the coin to locate its image.

Label the image **I**. [2]



(b) Determine the image distance.

image distance = 40 cm (± 2 cm) [1]

(c) Determine the magnification of the image.

magnification = 1.0 (± 0.1) [1]

(d) State **three** characteristics of the image formed.

real, inverted, same size as object [2]

7 A small lamp is placed below the surface of the water, as shown in Fig. 3.1. Three rays from the lamp strike the surface at X, Y and Z.

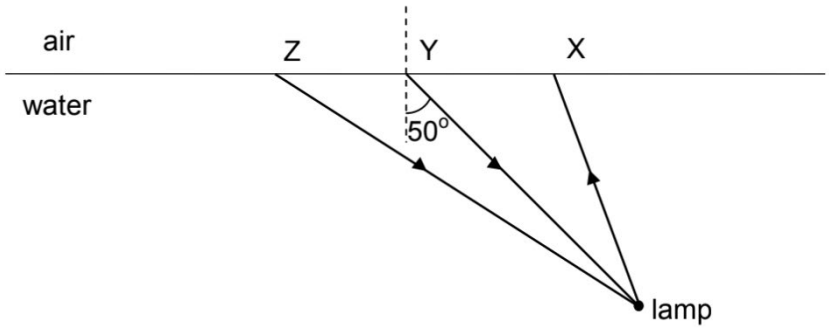


Fig. 3.1

The critical angle for light passing from water to air is 50°.

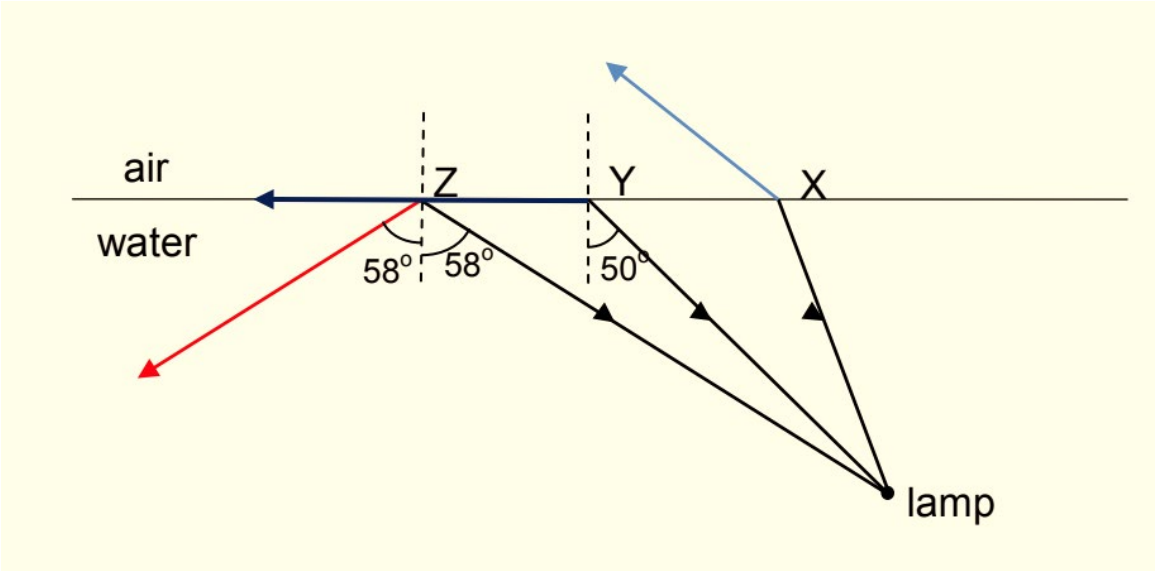
(a) Explain what is meant by *critical angle.*

Critical angle is the **angle of incidence** in the **optically denser medium** for which the **angle of refraction** in the optically less dense medium is **90°**.

[1]

(b) On Fig. 3.1, complete the paths of the three rays after they strike the surface at X, Y and Z. [2]

X – ray bends away from the normal; Y – ray travels along the boundary; Z – ray undergoes total internal reflection with angle of reflection = 58°.



(c) Calculate the refractive index of water.

Refractive index of water = 1/sin 50° = 1.31 (3 sf) or 1.3 (2 sf)

[2]

(d) Explain why when viewed from above the water, the light from the lamp emerged only from a circular area of the water.

The light that can be seen are from the refracted rays from rays that strike the water surface with angle of incidence **less** than the critical angle. Rays that strike the water surface with angle of incidence **greater or equal** to the critical angle will be **totally internally reflected** or travelling along the boundary and will not emerge from the water surface into air.

[2]

8 Fig. 4.1 shows a point object P that is placed in front of a plane mirror and two incident rays from P to the mirror.

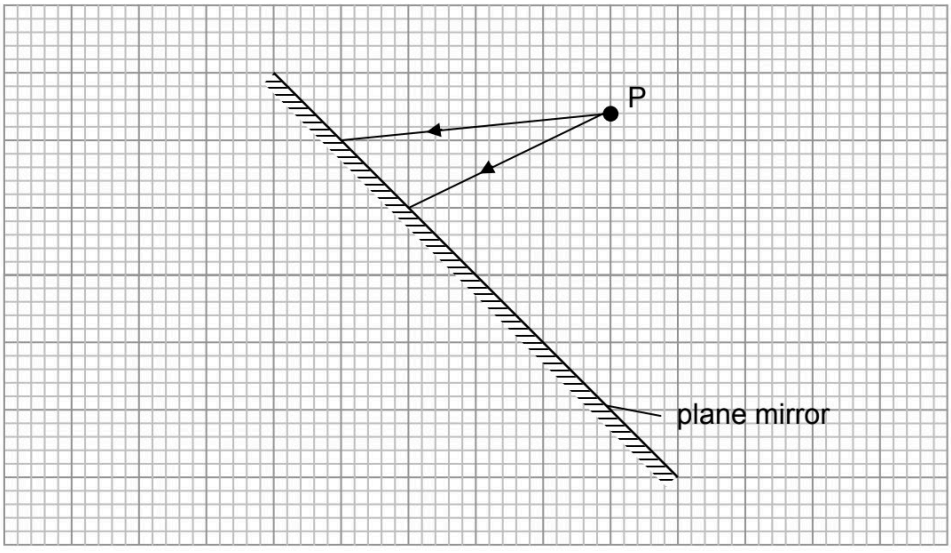
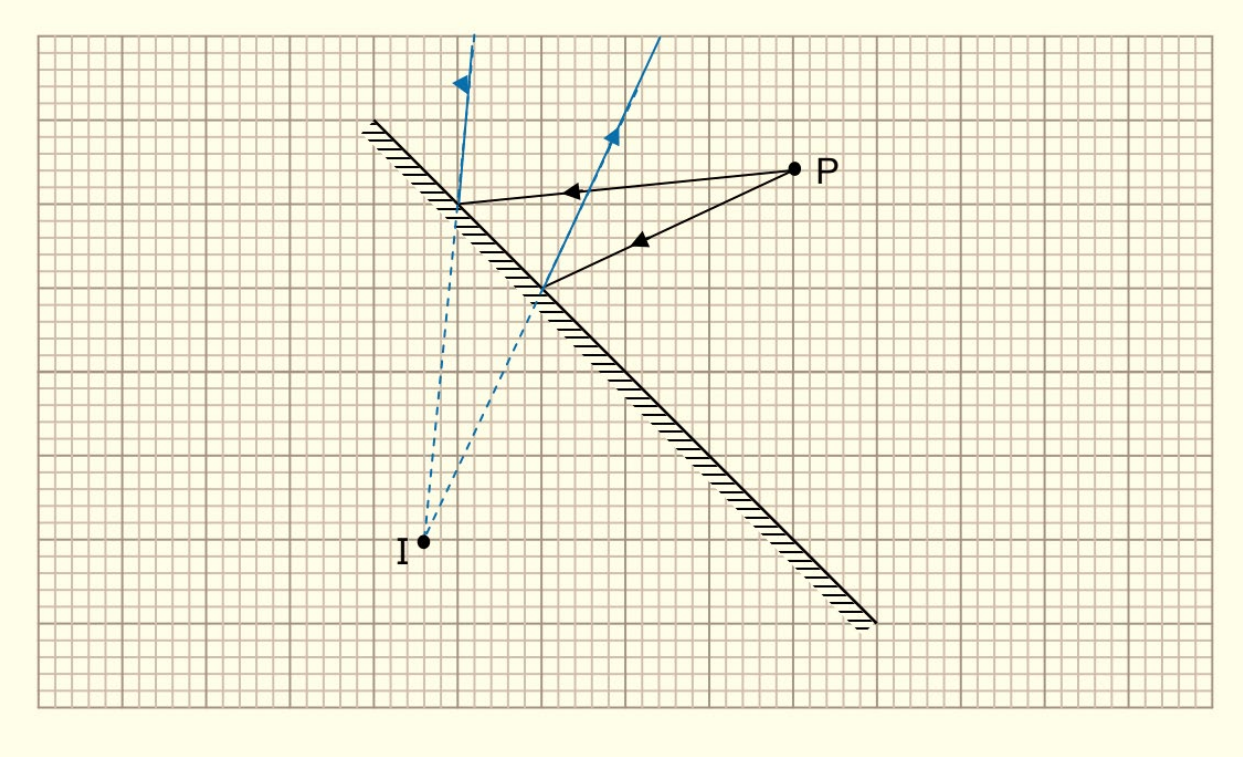


Fig. 4.1

On Fig. 4.1

(a) mark accurately the position of the image of P and label it with the letter I. [1]

(b) draw the reflected rays for the two incident rays to show how the image I is formed. [1]



9 Fig. 5.1 shows an eye that views an object O placed 80 mm away. The image I of the object O is captured on the retina which is 25 mm from the eye lens.

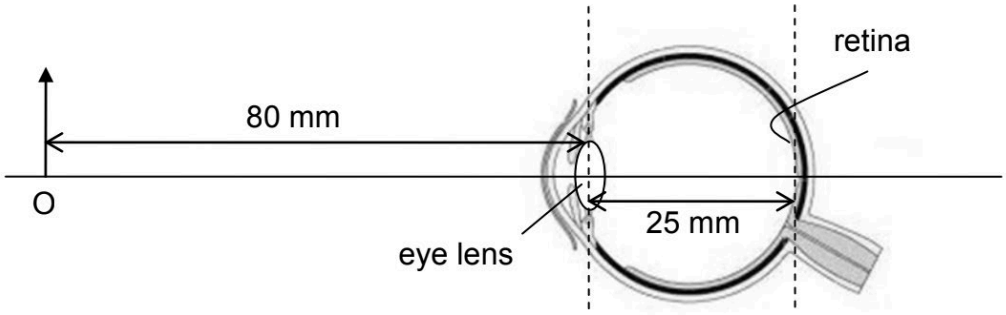
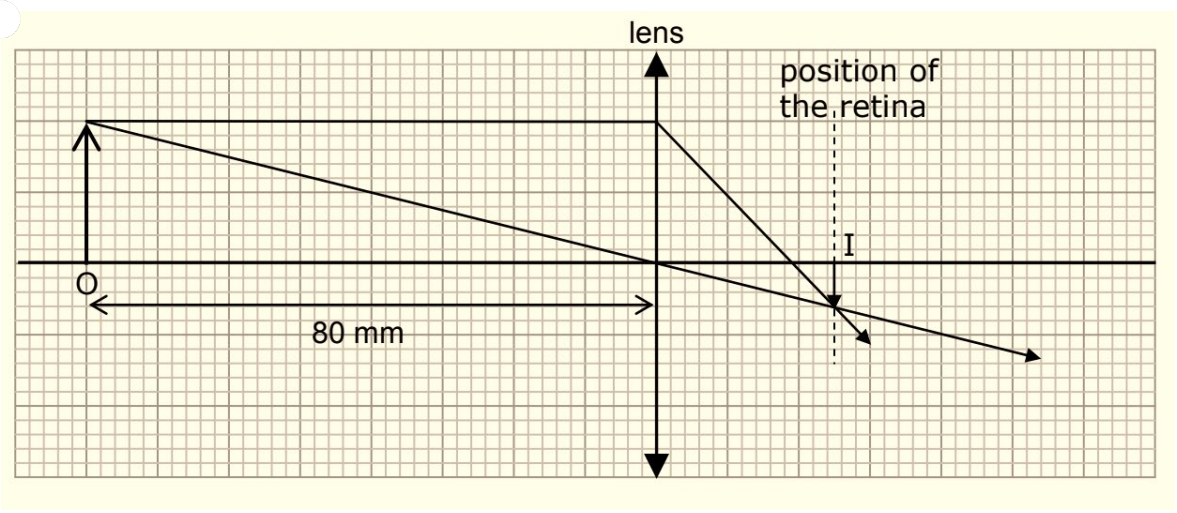


Fig. 5.1

(a) Using the grid in Fig. 5.2, draw two rays from the object O to show how the image, I is formed on the retina. [2]



(b) Determine the focal length of the eye lens from Fig. 5.2.

focal length = 19 mm ± 2 mm [1]

(c) Determine the magnification of the image.

magnification = 25 ÷ 80 = 0.31 [1]

(d) State three characteristics of the image formed.

Diminished, inverted and real [2]

(e) The eye focuses by adjusting the thickness and hence, the focal length of the eye lens.

State how the focal length of the eye lens should change, to enable the eye to see a sharp image of the object when it is moved further away from the eye.

The focal length should **increase**. [1]

10 **(a)** Fig. 10.1 shows a ray of light incident on the face AB of a glass block ABCD.

The refractive index of the glass block is 1.55

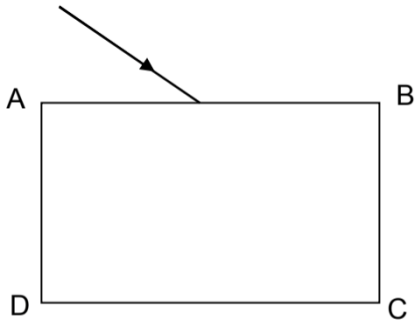


Fig. 10.1

(i) Calculate the critical angle of the glass.

Critical angle = $\sin^{-1}(1+1.55)$ = 40.2º (3 s.f.) or 40º (2s.f.)

[2]

(ii) State the conditions necessary for total internal reflection to occur.

For total internal reflection, the incident ray must be in the optically denser medium, and the angle of incidence must be greater than the critical angle. [2]

(iii) Explain why an incident ray entering the side AB and reaching the side DC can never be totally internally reflected at the face DC.

At any angle of incidence at the face AB (0° to 90°), the angle of incidence in the denser medium at CD will be less or equal to the critical angle. The ray will always refract out into the air and total internal refraction will never occur at the face CD. [2]

(b) Fig. 10.2 shows the full-scale diagram of an object O and its upright, virtual and magnified image I. The object is placed in front of a convex lens.

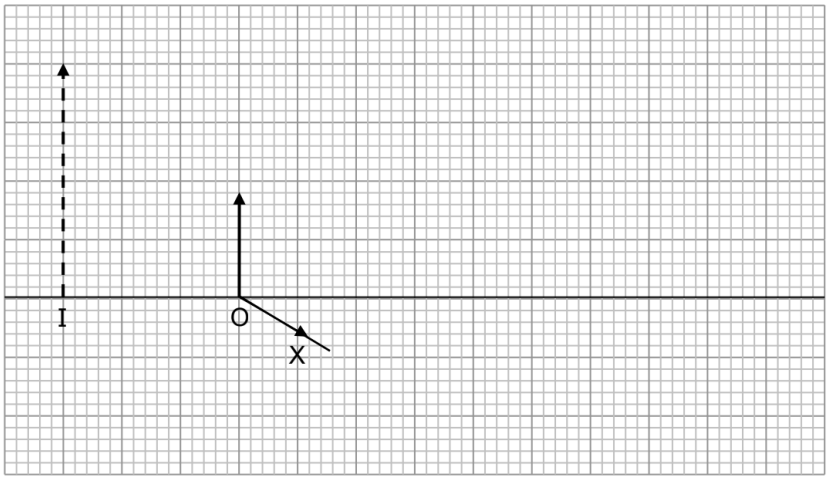
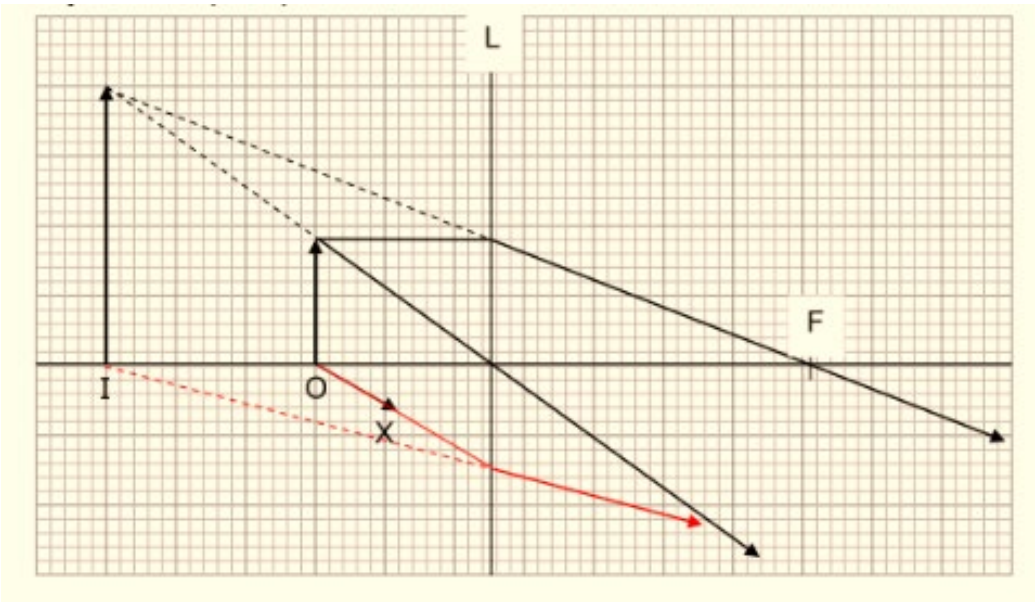


Fig. 10.2

(i) Draw necessary light rays on Fig. 10.2 to locate the position of the lens (label it L) and the principal focus (label it F). [2]

Ray to locate lens and labelled L

Ray to locate principal focus and label F



(ii) State the focal length of the lens.

Focal length = 4.6 cm ± 0.2 cm

(No mark given if focal length is calculated using the lens formulae)

[1]

(iii) Complete the path of the ray X through the convex lens L. [1]

Completed ray X as shown above (the ray only bends at the position of the lens).

11 An object is placed 12.0 cm from a convex lens as shown in Fig. 3.1. On the other side of the lens, a screen is placed 5.0 cm from the lens to obtain a sharp image.

The diagram is not drawn to scale.

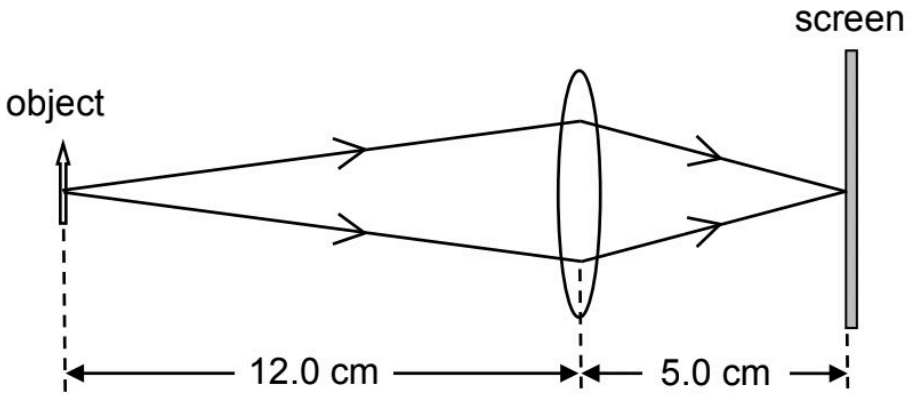


Fig. 3.1

(a) Calculate the magnification of the image.

Magnification = image distance / object distance = 5.0 / 12.0 [1]= 0.42 [1]

[2]

(b) Determine the focal length of the lens.

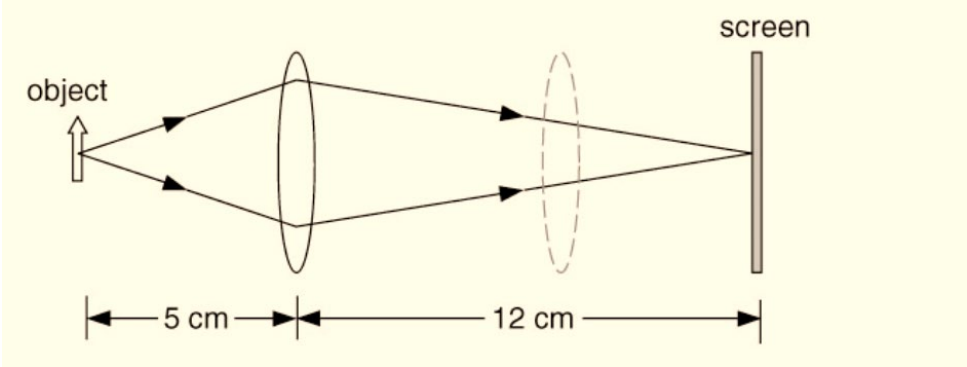
$1/f = 1/u + 1/v = 1/5.0 + 1/12.0 = 17.0/60$ [1]

$f = 3.529 \approx 3.5$ cm [1]

[2]

(c) The positions of the object and the screen are fixed while the lens is moved towards the object.

Determine the distance the lens should be moved from its position in Fig. 3.1 towards the object, so that a sharp image can be obtained on the screen again.



Move the lens towards the object by (12.0 – 5.0) cm = 7.0 cm. [1]

No mark if there is no working.

Note: $1/f = 1/u + 1/v$, the lens formula allows u and v values to be interchanged for the same *f*.

[1]

12 A point source of light P is placed near a prism ABC as shown in Fig. 4.1.

Due to partial reflection along the surface AB, a faint image of P is seen at P'.

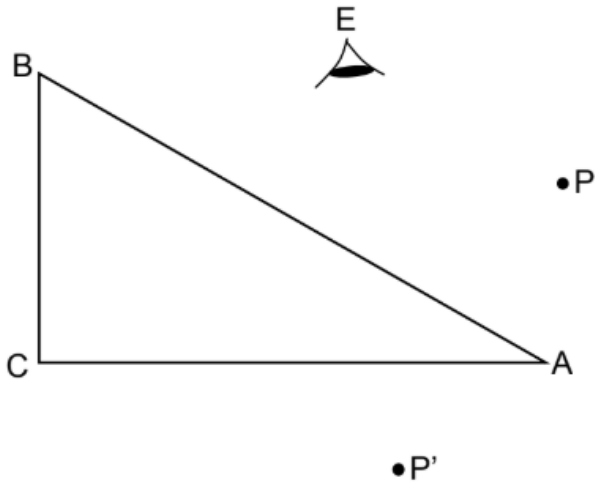


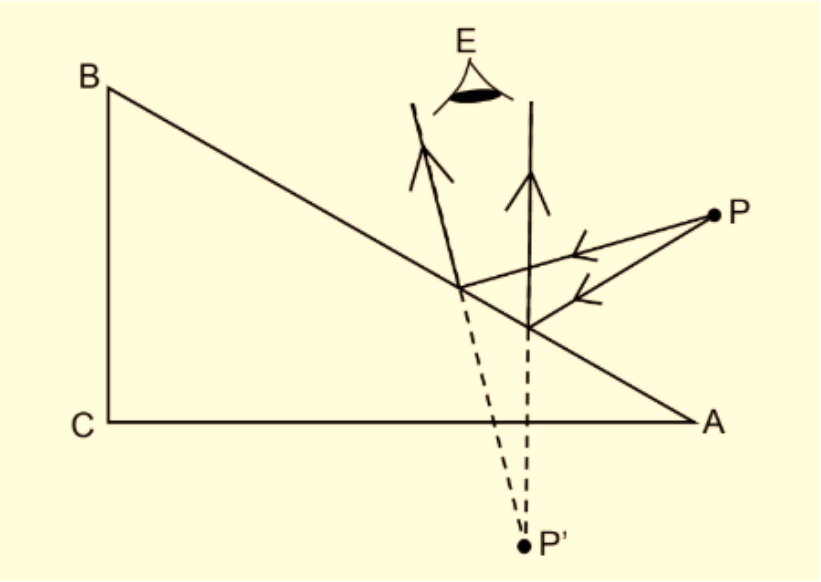
Fig. 4.1

(a) On Fig. 4.1, draw two light rays, to show how an eye at E sees the image P'. [2]

Cone of rays from P´ to eye.

Cone of rays from P to AB.

Direction must be correctly indicated and virtual rays marked out in dashed lines for full marks to be awarded.



(b) Fig. 4.2 shows a scaled diagram of prism ABC. A ray of light from P, parallel to AC and incident on AB, is refracted to reach BC.

Given that the refractive index of the prism material is 1.49, complete the path of the light ray until it emerges from the prism. Show any calculation and label the angle to account for the path of this ray. [3]

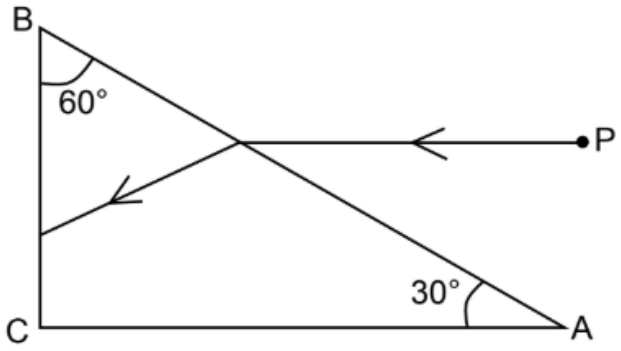


Fig. 4.2

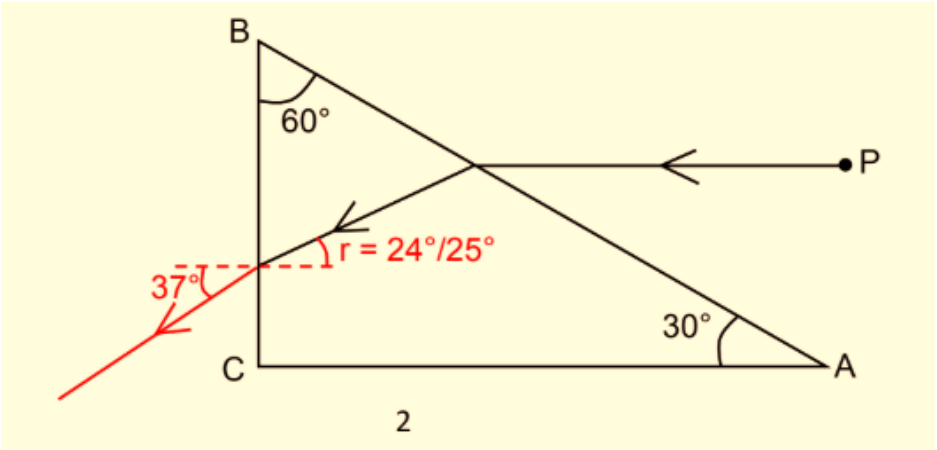
1/ sin c = n = 1.49 c = 42° clearly identified as critical angle

sin i / sin 24° = 1.49 i = 37.3° = 37°

OR

sin i / sin 25° = 1.49 i = 39.0° = 39°

emergent ray, arrow & angle of refraction must be labeled; emergent angle must be accurately constructed.



2

13 An object O is placed in front of a thin converging lens of focal point F and a ray X is reflected off the object as shown in Fig 3.1.

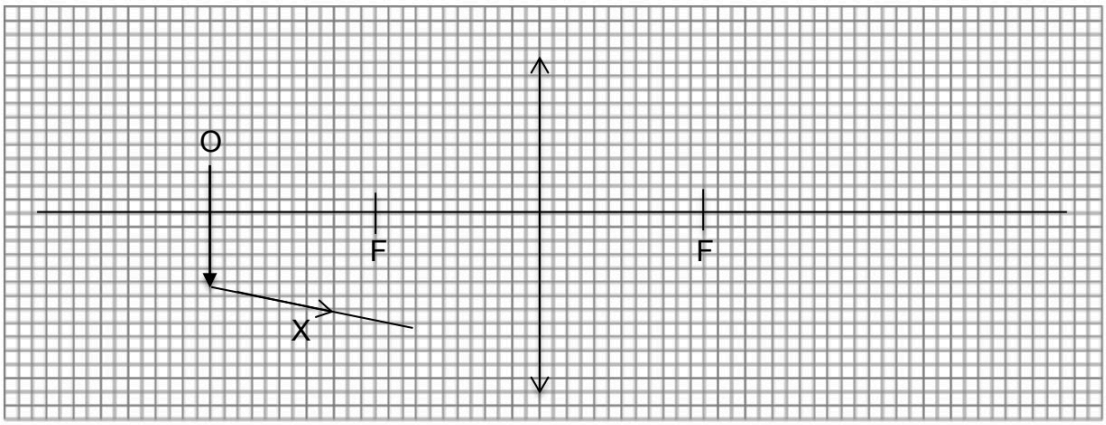


Fig. 3.1

(a) Draw rays to locate the complete image of O formed by the converging lens.

Label the image as I. [3]

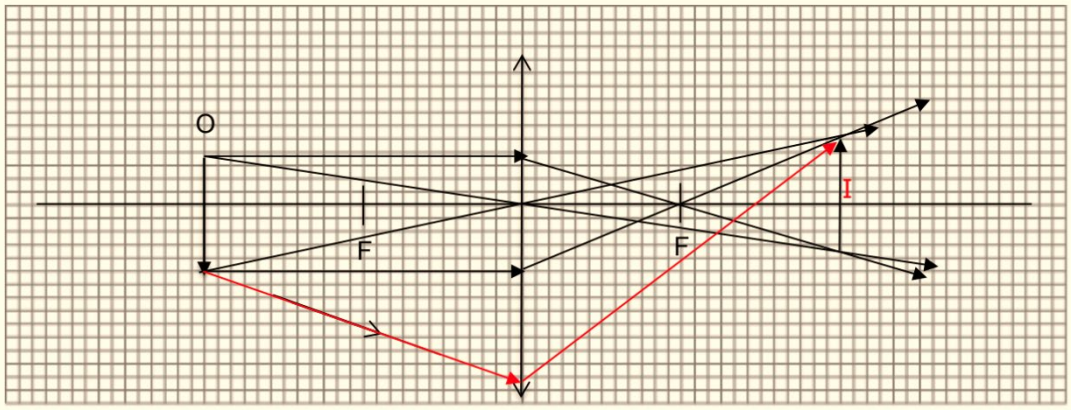


Fig. 3.1

(b) Complete the path of the ray X.

Completion of the given ray X. (ray must reach tip of image arrow) [1]

(c) Describe the characteristics of the image formed.

Image formed is inverted, real and of the same size as object. (all three must be correct to earn the mark)

[1]

(d) Name an application for such an arrangement.

Photocopier [1]

(e) The object is moved slightly nearer to the lens, state what will happen to the size of the image.

Image will be enlarged [1]

14 Fig. 3.1 shows a simple camera which makes use of a thin converging lens of focal length f (drawn to actual size). A sharp image of the object is formed on the film.

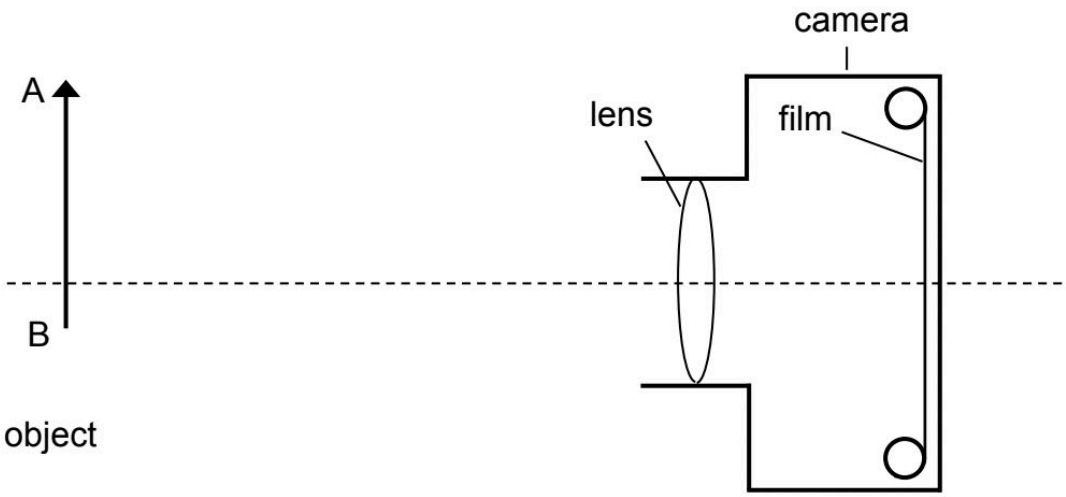
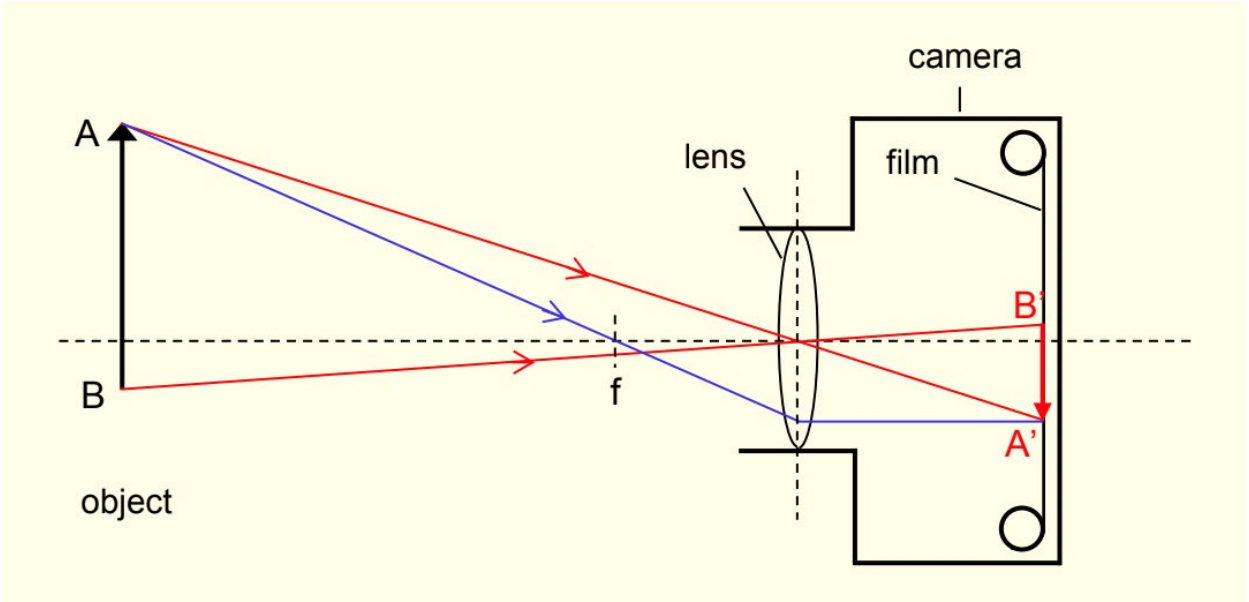


Fig. 3.1

(a) Explain what is meant by focal length of a lens.

The focal length is the distance between the optical centre and the principal focus (or focal point) of a converging lens. [1]

(b) Draw two light rays from the object AB to show how its image is formed on the film. Label the image as A'B'. [2]



Two correct light rays with arrows from the object.

[1] for each correct ray (grossly inaccurate rays are treated as incorrect).

Deduct

[1] if image is not drawn or wrongly labelled or if arrows are missing.

(c) Determine the focal length of the lens by drawing another light ray.

A third light ray with arrows that intersects the principal axis to give F.

Focal length = 1.9 cm to 2.2 cm (no mark for wrong d.p) [2]

(d) Determine the linear magnification of the object as shown in Fig. 3.1.

Image height = 0.9 cm to 1.2 cm Image distance = 2.7 cm to 2.8 cm

Object height = 2.9 cm to 3.0 cm Object distance = 7.6 cm to 7.7 cm

Linear magnification = image height/ object height or image distance/object distance (expressed in decimal)

No mark if working not shown or if lengths are measured to wrong d.p.

[1]

(e) Describe a situation where it may be necessary to move the lens towards the film when taking the photograph.

When taking photos of objects that are further away, the lens has to move towards the film in order for the light rays to converge at the film to give a sharp object.

[1]

15 Fig. 3.1 shows a ray of light incident on a piece of glass of refractive index 1.7.

(a) Measure and record the angle of incidence of the ray 1.

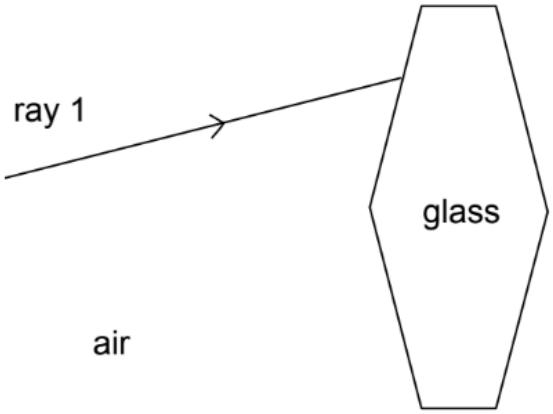


Fig. 3.1

angle of incidence = 28° or 29° [1]

(b) Calculate the angle of refraction.

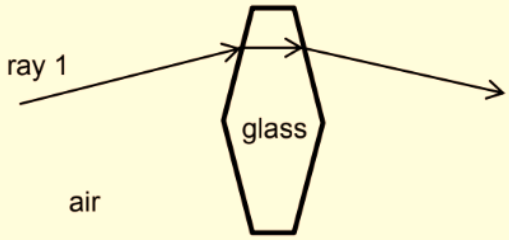
sin 28° = 1.7 sin r

r = 16° (r = 17° for i = 29°)

[2]

(c) On Fig. 3.1, sketch the path of ray 1 until it emerges from the glass. [1]

Ray should bend in the correct direction with arrows indicated.



(d) Explain if the parallel rays of light entering the glass would converge at a common point after passing through the glass.

The rays will not converge since the angles of incidence and hence the angles of refraction will be the same for parallel rays on each straight side of the glass block. The rays will emerge parallel to each other.

[1]

16 A convex lens L and an object JK are shown in the light ray diagram in Fig. 3.1.

The path of one light ray from point J is drawn.

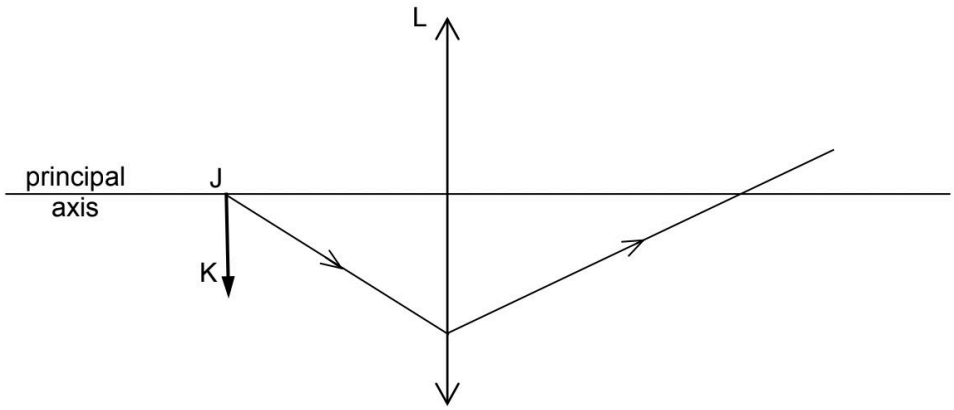


Fig. 3.1

(a) Draw accurately and label the position of the image J'K' on Fig. 3.1. [1]

J'K' correctly identified with use of suitable construction line(s)

(b) State the three properties of the image J'K'.

inverted, real, magnified

NOT *"inversed"* or *"laterally inverted"*

[2]

(c) Given that Fig. 3.1 is one-quarter of its actual size, determine the focal length of the lens.

construction on diagram

2.1 x 4 = 8.4 cm (also accept 2.0 x 4 = 8.0 cm) {do not accept 8 cm}

[2]

17 Fig. 2.1 is a scaled diagram that shows an incident ray of light entering a block of transparent material from air.

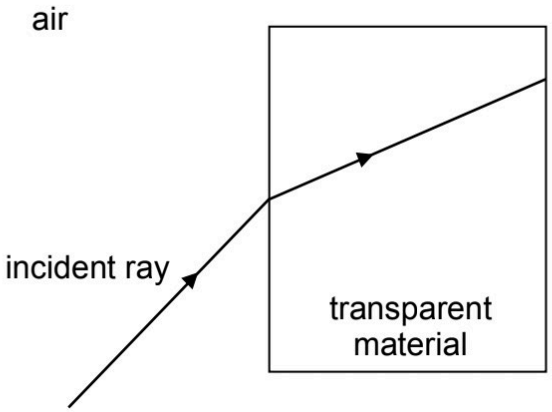


Fig. 2.1

(a) Measure and write down the angle of incidence i and the angle of refraction r.

angle *i* = 46°, angle r = 23° (±1° for both is allowed)

[1]

(b) Hence, determine the refractive index of the material.

n = sin i/sin r = sin 46°/sin 22° [1]

= 1.92 (2 or 3 s.f.) [1]

Also possible to use lens formula 1/f = 1/20.0 + 1/30.0

f = 12.0 cm

[2]

18 Fig. 3.1 shows the path of a ray as it leaves object O and passes through a convex lens L.

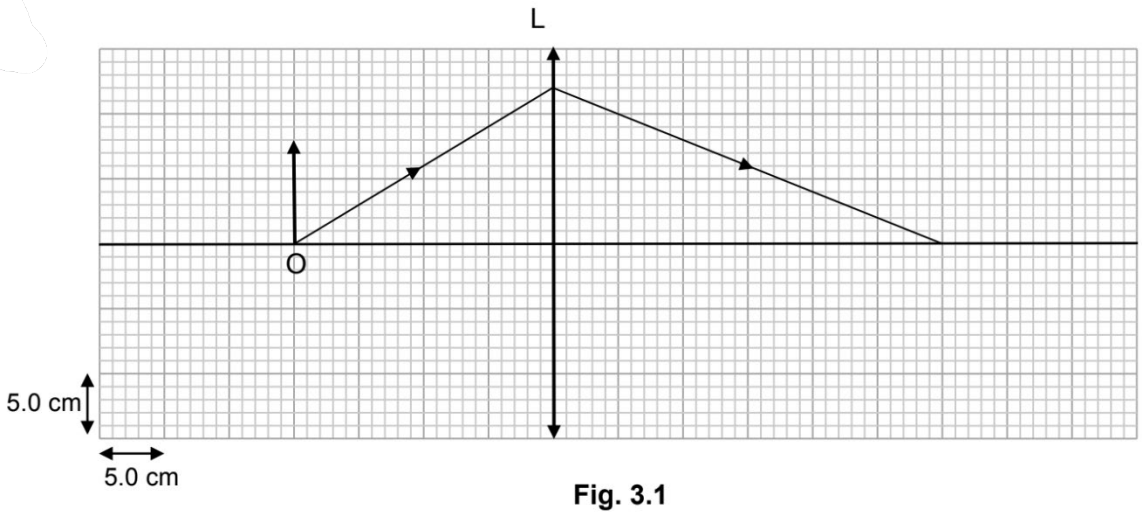


Fig. 3.1

1.0 cm on the grid represents 5.0 cm.

(a) Draw necessary ray(s) on the diagram to locate the image. Label clearly the image formed, **I**. [1]

Correct position of image shown on diagram with some attempt at construction indicated. Clear label **I**. [1]

(b) Determine the focal length of the lens.

Appropriate construction ray shown on the diagram. [1]

Focal length = 2.4 cm x 5.0 = 12.0 cm (±0.5 cm) [1]

[2]

(c) Describe three characteristics of image I.

Inverted, enlarged and Real [1]

19 **(a)** State the **two** conditions required for **total internal reflection** to occur.

Condition 1:

Light travels from an optically denser medium to an optically less dense medium. [1]

Condition 2:

Angle of incidence is greater than (or equal to) the critical angle. [1]

Fig. 4.1 is a full-scale diagram. It shows a ray of light entering a triangular glass prism normally. The glass has a refractive index of 1.45.

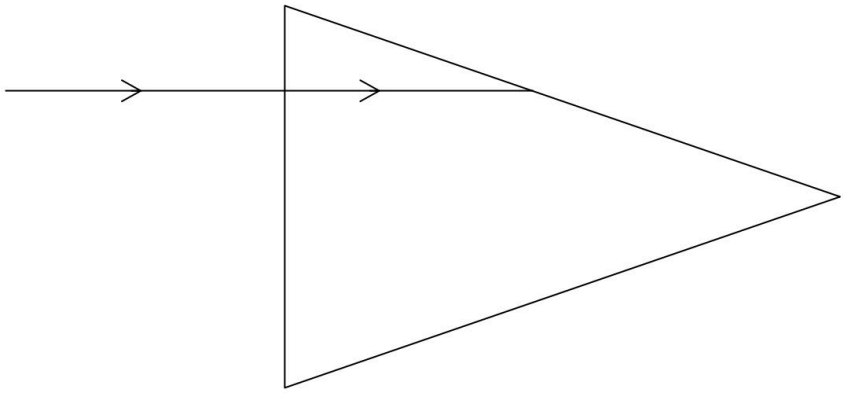


Fig. 4.1

(b) On Fig 4.1 above, accurately complete the path of the light ray as it passes through the glass block until it leaves. Show all calculations clearly.

Show calculations using sin c = 1/n to obtain critical angle c = 43.6°

Total internal reflection occurs at first surface. Draw rays and label angles of incidence & reflection, i = r =71°

Refraction occurs at second surface. Angle of incidence measured and used to determine the angle of reflection. Show calculations to determine i and r.

i = 34° and r = 54°

20 An object JK and its image J'K' formed by a convex lens are shown in the light ray diagram in Fig. 5.1.

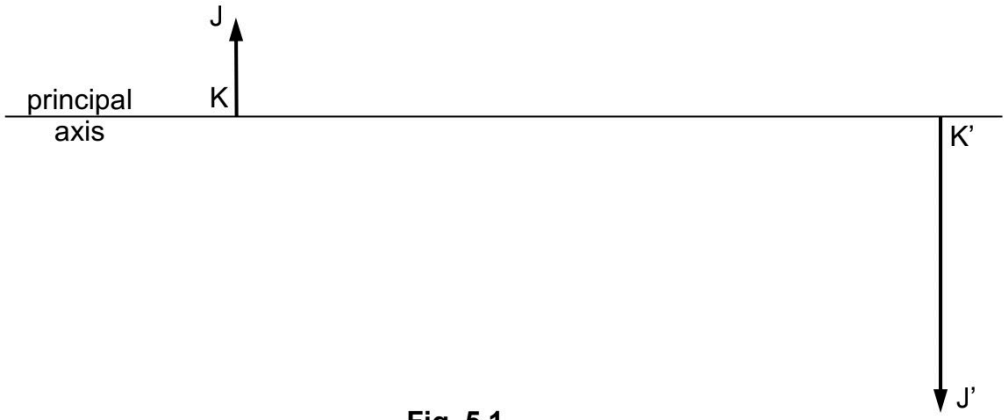


Fig. 5.1

(a) Draw accurately and label the position of the lens L on Fig. 5.1. [1]

Constructions line(s) used appropriately to determine the position of the lens

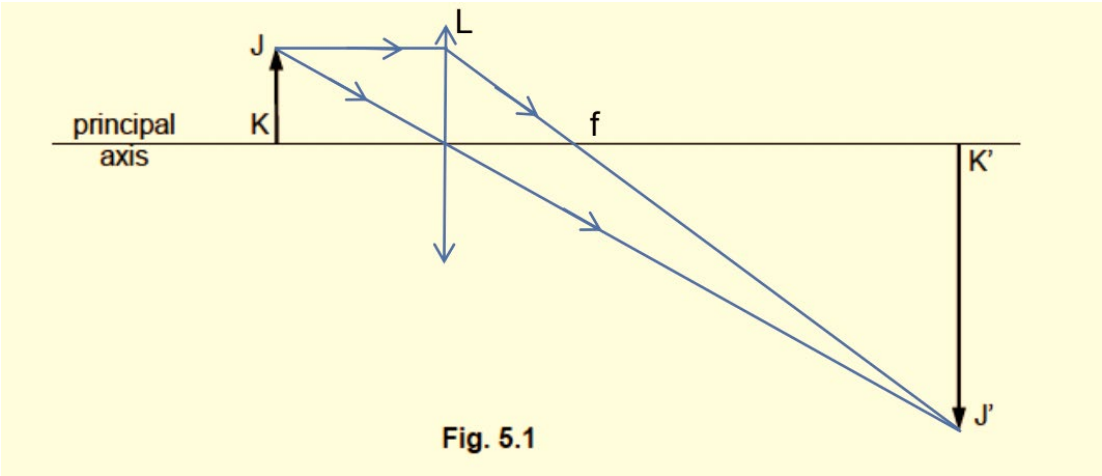


Fig. 5.1

(b) State the three properties of the image J'K'.

real, magnified and inverted

[2]

(c) Given that Fig. 5.1 is actual size, determine the focal length of the lens.

focal length = 2.0 cm

either accurately measured from the diagram in the exam booklet with construction lines, or accurately measured distance of object, (u = 2.6 cm) and distance of image, (v = 7.9 cm) from the lens and calculated using formula (1/f =1/u + 1/v)

[1]

21 Fig. 11.1 shows a ray of light passing through two identical right-angled glass prisms.

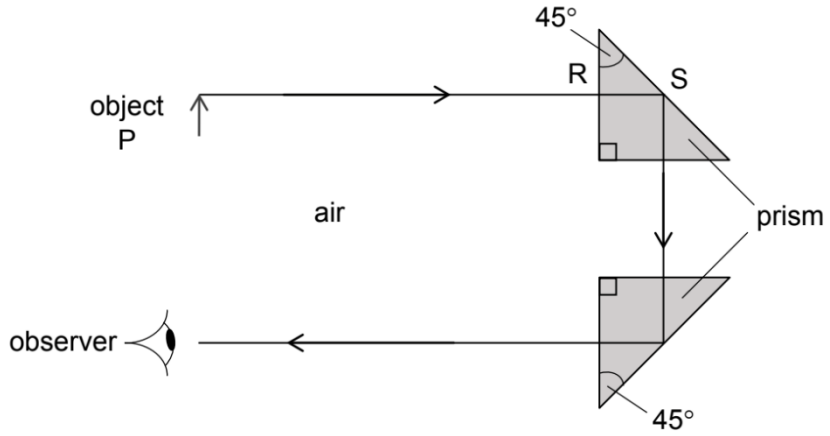


Fig. 11.1

(a) The refractive index of the glass prism is 1.55.

Calculate the speed of light in the glass prism. Take the speed of light in air to be 3.00×10^8 m s^{-1}.

Speed of light in prism = 3.00×10^8 m s^{-1}/ 1.55

= 1.94×10^8m s^{-1}

[2]

(b) Calculate the critical angle of the glass-air boundary.

Critical angle = $\sin^{-1}(1/1.55) = 40.2°$

[1]

(c) Explain why the ray

(i) did not bend as it entered the prism at surface R, and

As the angle of incidence is 0°, by Snell's law the angle of refraction is also 0°

[1]

(ii) did not exit the prism upon hitting surface S.

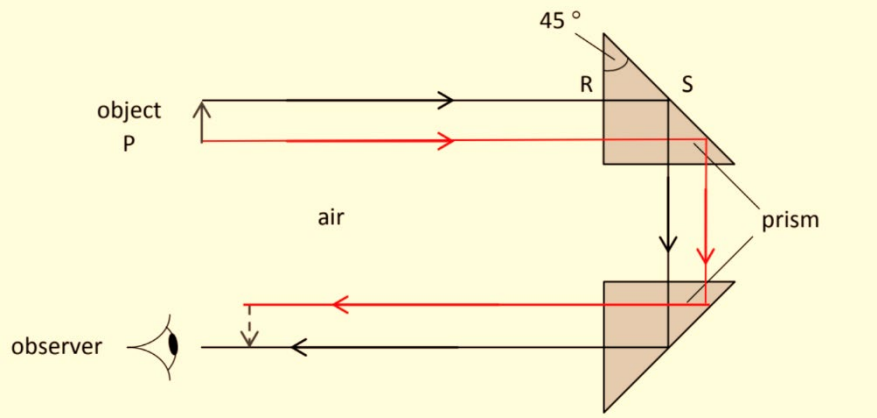
The angle of incidence at surface S was 45° which was greater than the critical angle of the glass-air boundary.

The refractive index of glass is also greater than air.

Or The ray was travelling from an optically denser medium into an optically less dense medium. Hence, ray was internally reflected.

[2]

(d) Show, by drawing another light ray in Fig. 11.1, that the image of object P seen by the observer is inverted. [1]

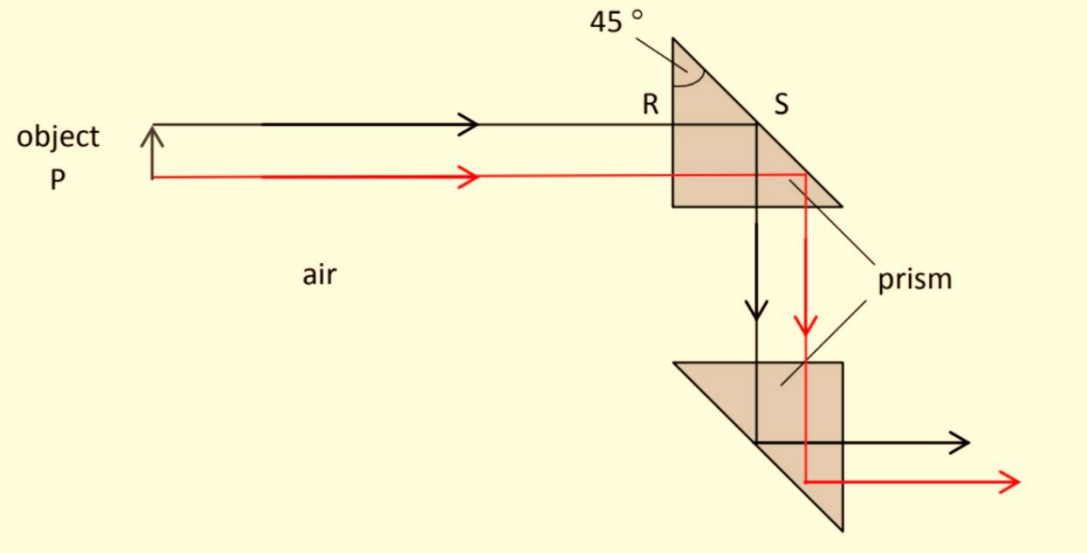


(e) Explain if the image of P seen by the observer is virtual or real.

The image of P is virtual as it cannot be captured on screen/ no real light rays from the image are reaching the observer's eye. [1]

(f) In the space below, show how the two prisms in Fig. 11.1 may be arranged so that the observer sees an upright image of object P.

Draw light rays to show that the image observed is upright. [2]



22 An optical fibre has an inner glass core surrounded by an outer glass cladding. Fig. 5.1 shows the path of a ray of light travelling along the fibre, striking the boundary between the core and the cladding at an angle .

The refractive indices of the core and the cladding are 1.60 and 1.10 respectively.

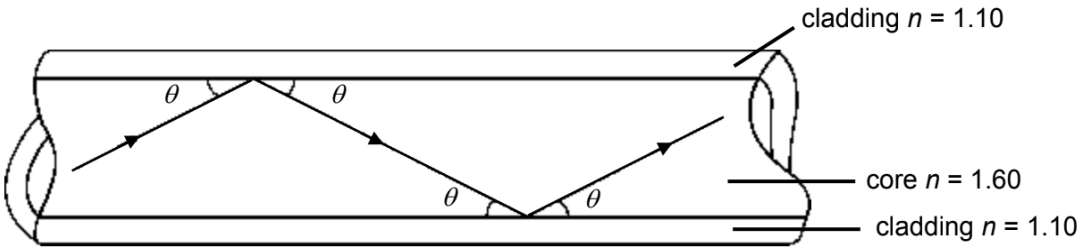


Fig. 5.1

(a) Explain the purpose of surrounding the glass core with the outer glass cladding shown in Fig. 5.1.

This ensures that light travels from optically denser medium towards a optically less dense medium (or smaller reflective index), [1] a condition for total internal reflection to occur, and transmit the light along the optical fibre. [1]

OR

- Total internal reflection can occur
- even if the fibre is placed in an external medium with higher optical density (or higher refractive index).

OR (only 1 mark)

- To protect/prevent the core from being damaged.

[2]

(b) State the angle of incidence of the light ray at the boundary between the core and the cladding if the angle is 35°.

$i = 55°$ [1] $i = 90 - \theta = 90° - 35°$ (working not required)

[1]

(c) Determine the maximum value of for which the light ray will remain within the inner glass core.

When i = critical angle = (90 - θ) between core & cladding, r = 90º

By Snell's law, n(core) sin (90 - θ) = n(cladding) sin (90)

→ 1.60 sin(90 - θ) = 1.10 → sin(90 - θ) = 1.10/1.60 [1]

→ 90 - θ = 43.43 → θ = 46.57 ≈ 46.6º or 47 º [1]

[2].

23 A convex lens L forms an image I of a point object O placed on the principal axis, as shown in Fig. 6.1. The diagram is not drawn to scale.

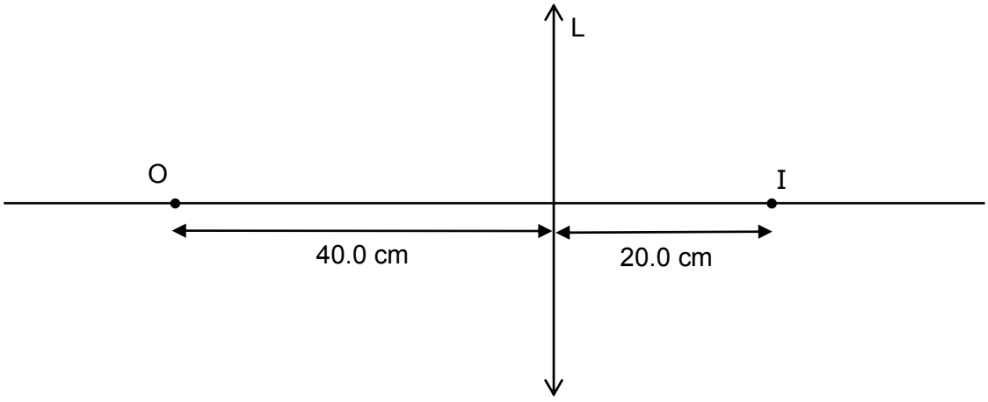


Fig. 6.1

(a) Calculate the focal length of the lens L.

1/f = 1/40 + 1/20 = 3/40 f = 13.33 ≈ 13 cm

[1]

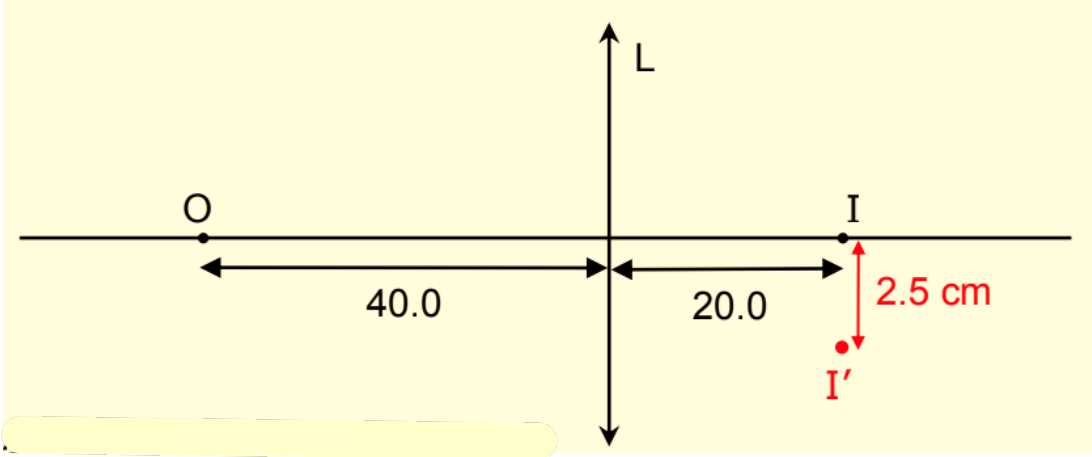
(b) If the point object O is raised 5.0 cm vertically above the principal axis, determine the new position of the image. Show any working clearly.

Mark and label the position of this new image I' on Fig. 6.1. [2]

hi/ho = v/u hi / 5 = 20/40 hi = 2.5 cm [1]

Must show value on diagram (2.5cm) if no calculation

Show on diagram the image is 2.5 cm vertically below axis.



(c) If the object O on the principal axis (in Fig. 6.1) is moved a short distance further from the lens, state what would happen to the position of this image.

The image will move nearer to the lens. [1]

OR move closer to the lens / move towards the lens / shift to the left.

[1]

24 Fig. 4.1 shows a ray of light passing into a right-angled prism at D.

After reaching E, the light travels along two paths, with one ray travelling along the surface of the prism and one ray along EF.

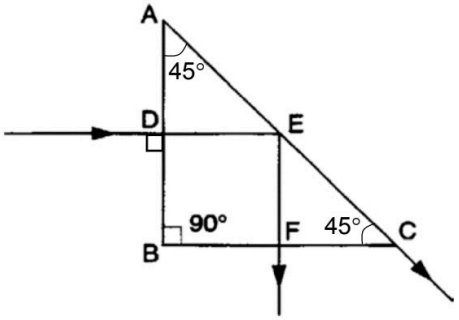


Fig. 4.1

(a) State one property of light that changes at D and whether it increases or decreases.

Speed of light

Decreases [2]

(b) **(i)** On Fig.4.1, identify the critical angle and label with letter X. [1]

Draw a normal at E, label with X

(ii) Hence, determine the refractive index of this glass.

Read c correctly

n = 1/ sin c

= 1/ sin 45° = 1.4 (2 sf)

allow ecf from 4(b)(i)

[2]

(iii) The prism is replaced with another one with a greater refractive index. Describe what happens to the path of light.

Angle of incidence at AC is greater than critical angle.

Total internal reflection occurs at E and there is no longer any ray travelling along EC. (describe)

[1]

(c) Visible light is a type of electromagnetic wave. All electromagnetic waves transfer energy and travel through vacuum at a speed of 3.0×10^8 m/s.

(i) State one other property common to all components of the electromagnetic spectrum.

Obeys laws of reflection

(accept other properties found in the textbook eg transverse waves) (not acceptable to mention 'does not require medium')

[1]

(ii) The wavelength of red light is 690 nm.

Calculate the frequency of this wave in vacuum.

$V = f\lambda$

$3.0 \times 10^8 = f\ (690 \times 10^{-9})$

$f = 4.3 \times 10^{14}$ Hz

[2]

[Total: 9]