

O Level Pure Physics Structured

Light Test 2.0

Q1

Fig. 6.1 shows a ray of light passing through a semi-circular plastic block. Q is the centre of the straight side of the block.

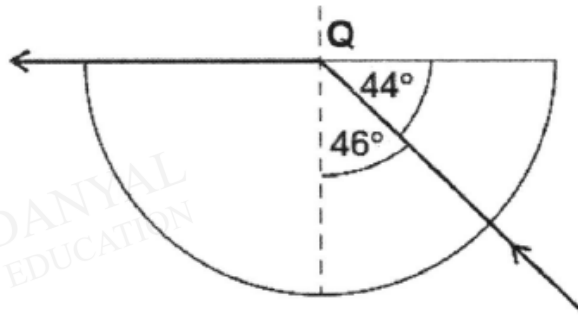


Fig. 6.1

(a) State the value of the critical angle in the plastic.

critical angle = [1]

(b) Define what is meant by *critical angle*.

.....
.....
..... [1]

(c) Calculate the refractive index of the plastic.

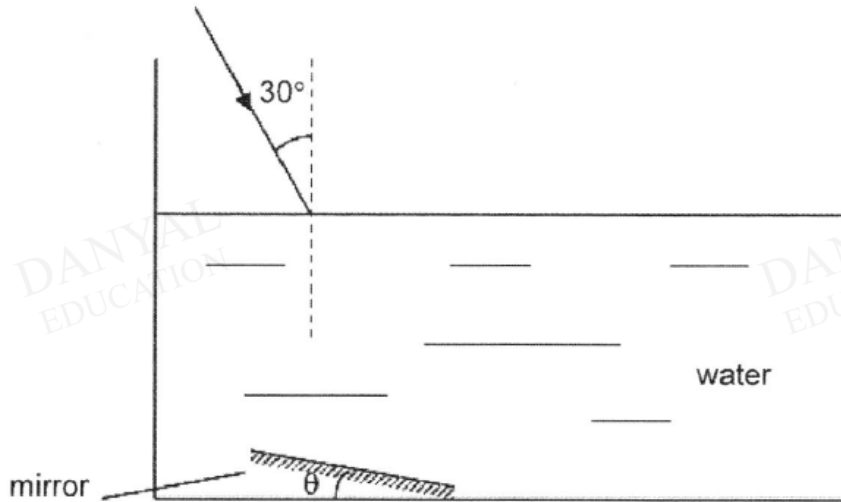
refractive index = [2]

(d) Another semi-circular block of identical dimensions as that shown in Fig. 6.1 is made of diamond. Diamond has a refractive index of 2.13. Suggest why more internal reflections occur inside this semi-circular diamond block than inside the piece of semi-circular plastic block shown in Fig. 6.1.

.....
.....
.....
.....
..... [3]

Q2

The figure below shows a horizontal rectangular tank containing water. A plane mirror is placed at an angle to the bottom surface of the tank. A ray of light is incident on the surface of the water at an angle of 30° as shown.



(a) If the refractive index of water is 1.33, calculate

(i) the angle of refraction for the ray as it enters the water,

angle of refraction = _____ [1]

(ii) the critical angle at water-air boundary.

critical angle = _____ [2]

(b) On the same figure, draw the path of the ray of light through the liquid and after it has emerged from the water surface, given that angle $\theta = 10^\circ$.

[2]

Q3

In a lighthouse, mirrors and lens are commonly used to focus the light in a certain direction. Fig. 11.1 shows a mirror on the wall behind a wall lamp. The mirror behind the lamp is modelled after lamps in a lighthouse.

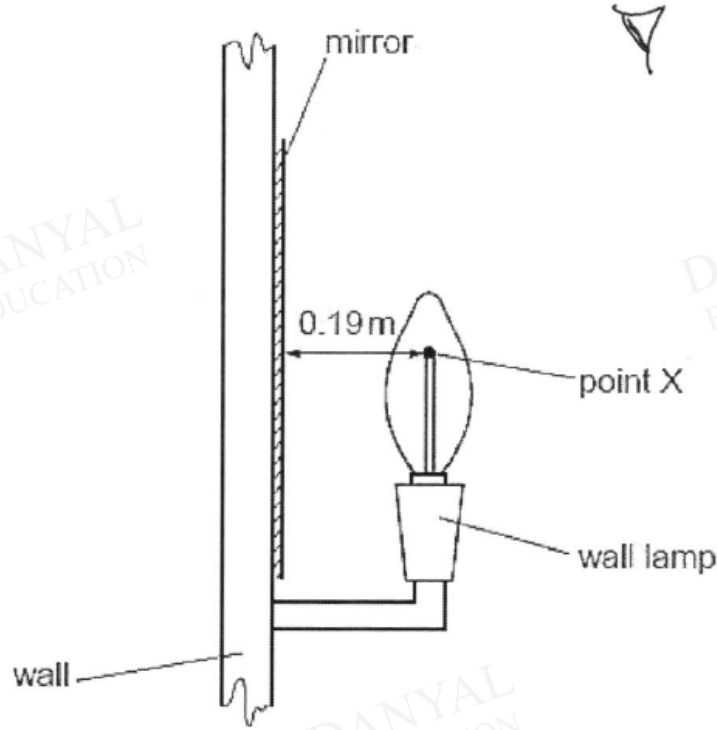


Fig. 11.1

X is a point on the filament of the lamp, 0.19 m in front of the mirror. Light from the lamp would reflect off the mirror on the wall

- (a) On Fig. 11.1,
- (i) draw and label the image of point X. [1]
 - (ii) draw a ray diagram to show how light rays reflects off the mirror into the eye. [2]
- (b) Explain how does the mirror makes the lamp seem brighter.

.....

..... [2]

Another technique used to focus light in a certain direction is achieved by using converging lens as shown in Fig. 11.2.

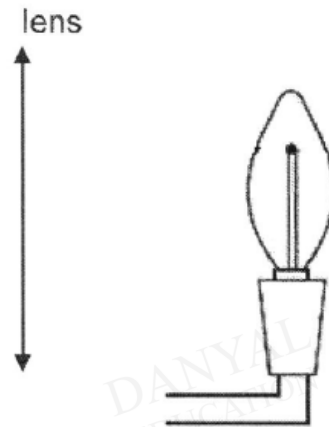


Fig. 11.2

- (c) Complete the ray diagram in Fig. 11.2 to show how the lens help to focus the light in a certain direction. Also label the focal length on the diagram. [2]
- (d) State and explain which type of lens is used.
.....
..... [2]
- (e) State whether the lens used should have a long or short focal length.
..... [1]

Q4

Fig. 12.4 is drawn to scale. The focal length of the converging lens is 4.0 cm.

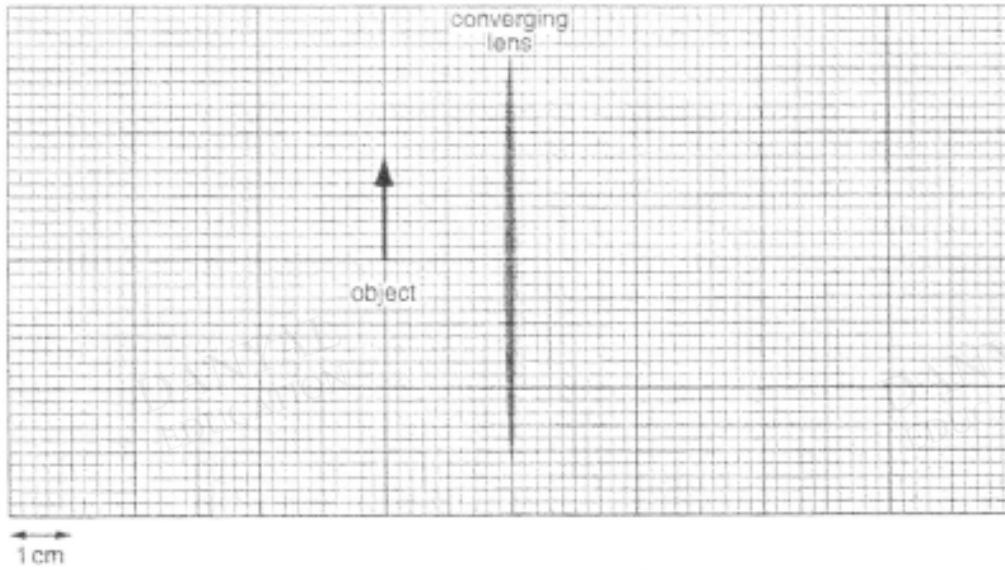


Fig. 12.4 (Drawn to scale)

(a) On Fig. 12.4 draw two rays from the top of the object to locate the top of the image. Draw the image of the object. [3]

(b) Describe the characteristics of the image. [2]

(c) The object is moved closer to the lens. State two changes that this causes to the image.

1.

.....

2.

..... [2]

(d) Given that the refractive index of the glass that is used to make the converging lens is 1.5, calculate the speed of light as it travels in the lens.

Speed of light in glass = [2]

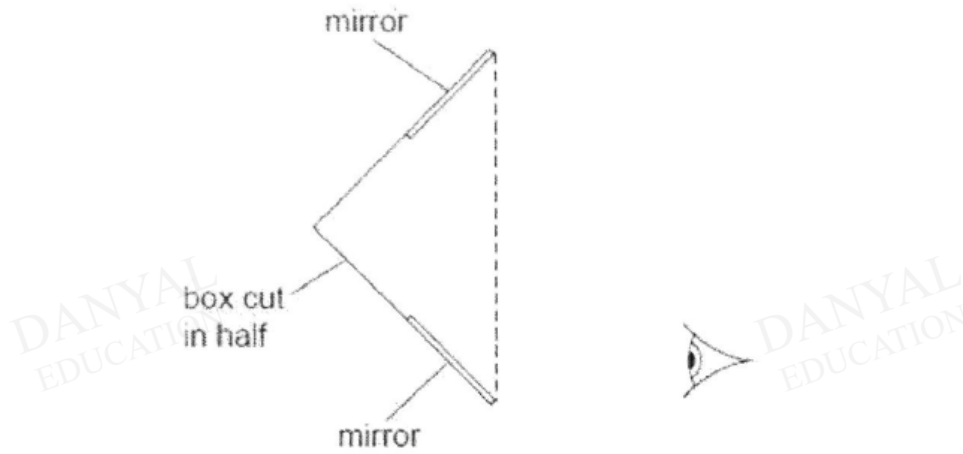
(e) The colour of the image formed is the same as the object. What is the physical difference between blue light and red light?

.....

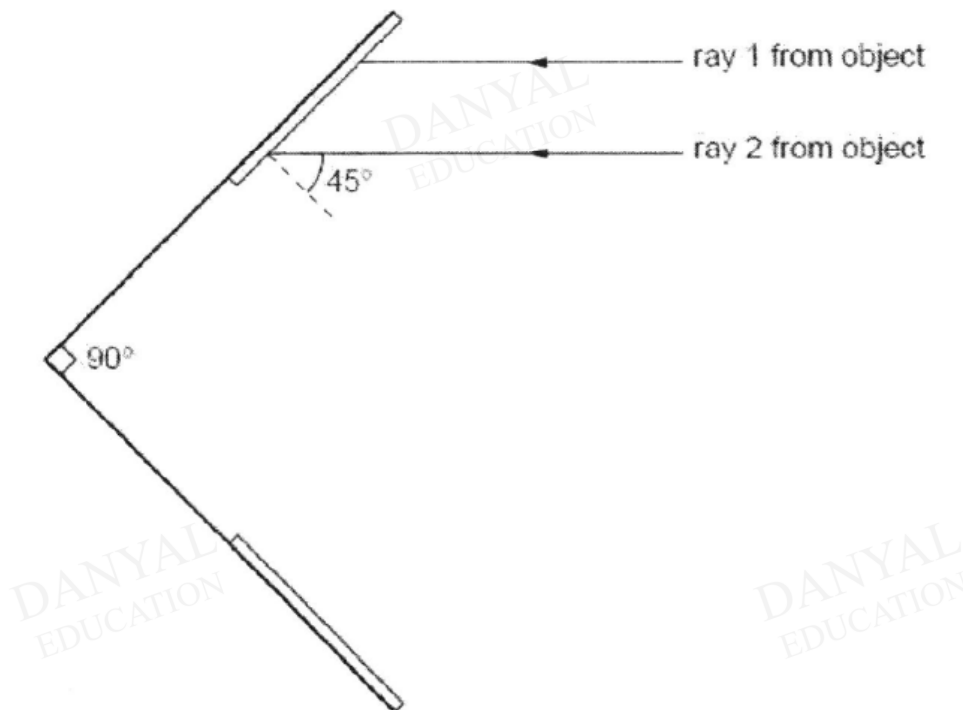
..... [1]

Q5

An inventor is trying to make a device to enable him to see objects behind him. He cuts a square box in half diagonally and sticks two plane mirrors on the inside of the box. A side view of the arrangement is shown in the figure below.



A second figure below shows the arrangement that is drawn with a larger view. Two parallel rays from two different points on a distant object behind the man are drawn in the figure below.



a. Continue the two rays to show how the rays of light will enter the eyes of the inventor. [2]

b. What can be said about the image seen by the inventor? [1]

Answers

Light Test 2.0

Q1

i(a)	46°	[1]
i(b)	Angle of incidence in optically denser medium where the corresponding angle of refraction in optically less dense medium is 90°.	[1]
(c)	$\sin c = 1/n$ $\sin 46 = 1/n \Rightarrow n = 1.39$ (to 3 s.f.) or 1.4 (to 2 s.f.)	[1]: W & C/F [1]: A & U
(d)	<ul style="list-style-type: none"> • Critical angle for diamond = $\sin^{-1}(1/n) = \sin^{-1}(1/2.13) = 28^\circ$ (to 2 s.f.) • Critical angle for diamond < critical angle for plastic (46° – allow for ecf) • Higher chance of incident light ray in diamond (with an incident angle above 28°) to undergo internal reflection in diamond than in plastic. 	[1] [1] [1]

Q2

- (a) (i) $1.33 = \frac{\sin(30)}{\sin r}$
 $r = 22.1^\circ$ [1]
- (ii) $1.33 = \frac{1}{\sin c}$
 $c = 48.8^\circ$ [1]
 [1]
- (b) Angle of incident at mirror is 32.1° [1]
 Light refracts out of water with angle of incidence 42.1° [1]

Q3

a	Correct position of I	B1
	Correct reflection	B1
	Correct arrow direction	B1
b	less/no light is absorbed by the wall more light is reflected back to the eye	B1 B1
c	correct ray of light	B1
	correct label of focal length	B1
d	converging lens	B1
	diverging lens will spread out the light and not converge/direct it into certain direction	B1
e	Short focal length	B1

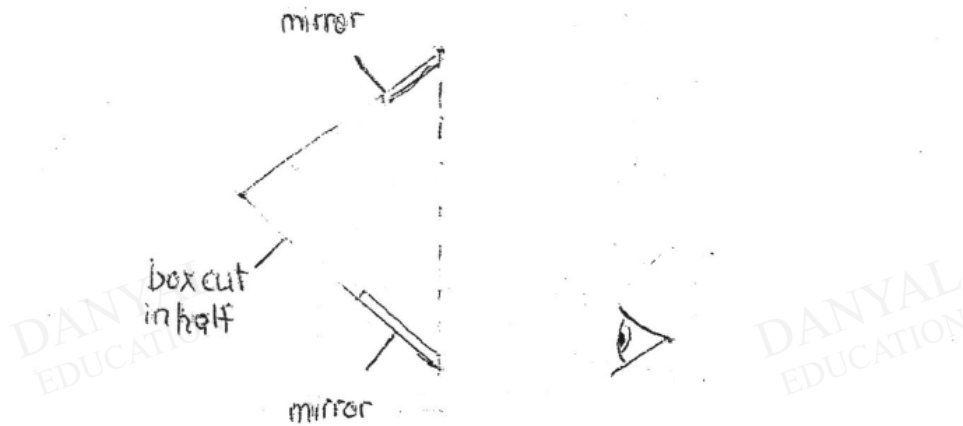
Q4

b		[3]
<p>for each correct ray drawn (dotted or solid where necessary with correct arrow), [1] for correct image drawn.</p>		

b	Upright, virtual, enlarged [1] if only 2 is correct [0] if less than 2 is correct	[2]
c	1. The size of the image will reduce. [1] 2. The image will be closer to the lens. [1]	[2]
d	$n = \frac{c}{v} \rightarrow v = \frac{c}{n} = \frac{3.0 \times 10^8}{1.5} = 2.0 \times 10^8 \text{ m s}^{-1} \text{ (2 or 3 s.f)}$	Working [1] Ans [1]
e	They have different frequencies. OR They have different wavelengths.	[1]

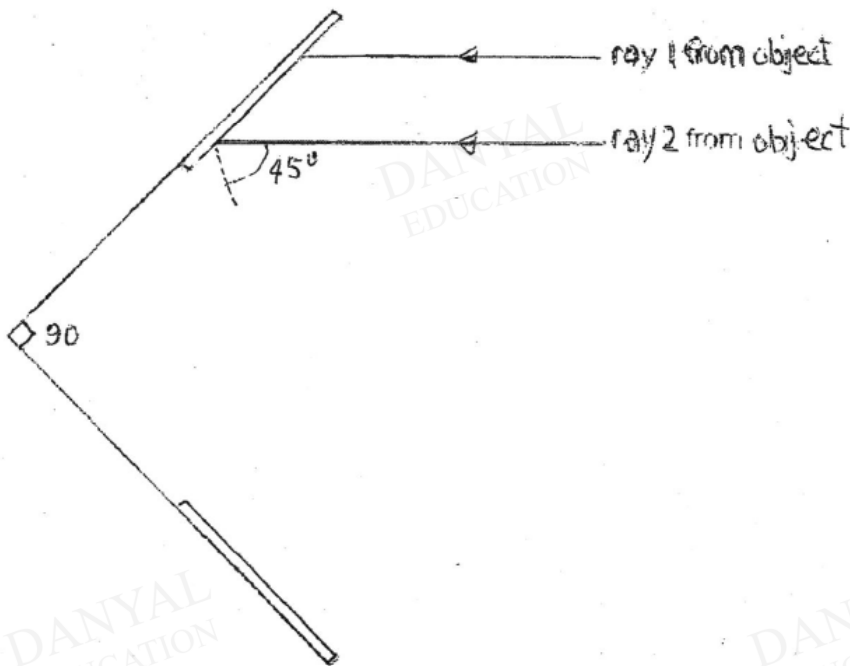
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- a. Continue the two rays to show how the rays of light will enter the eyes of the inventor. [2]
- b. What can be said about the image seen by the inventor? [1]

The image will be inverted

A1