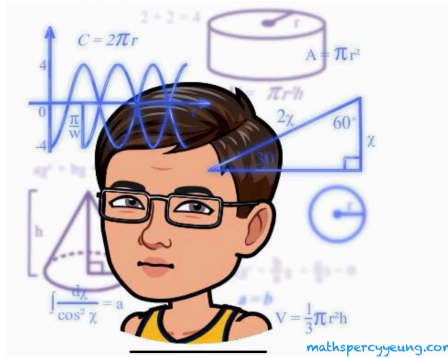


Marks	
Section A	/30
Section B	/30
<b>Total</b>	<b>/60</b>

2023-24 S3  
 2<sup>nd</sup> Term Exam  
 Science (PHY)



2023 - 2024 S3 2<sup>nd</sup> Term Examination

S3 SCIENCE (PHYSICS)

17<sup>th</sup> June 2024

9:45am-10:45am (1 hour)

This paper must be answered in English

**GENERAL INSTRUCTIONS**

**SECTION A - Multiple-choice Questions**

1. Read carefully the instructions on the Answer Sheet and insert the information required in the spaces provided.
2. **ANSWER ALL QUESTIONS.** All the answers should be marked on the Answer Sheet.
3. Note that you may only mark **ONE** answer to each question. Two or more answers will score **NO MARKS**.
4. All questions carry equal marks. No marks will be deducted for wrong answers.

**SECTION B**

1. **ANSWER ALL QUESTIONS.**
2. Write your answers in the space provided in this Question-Answer Book.

Question No.	1	2	3	4
Marks	9	7	9	5

Useful Formulae and data:

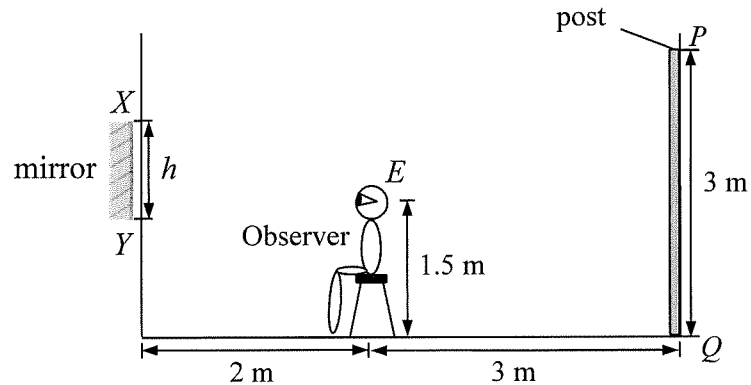
**Refractive index n of medium:**  $n = \frac{c}{v}$

**General Snell's law:**  $n_1 \sin \theta_1 = n_2 \sin \theta_2$

**Speed of light in vacuum:**  $3 \times 10^8 \text{ m s}^{-1}$

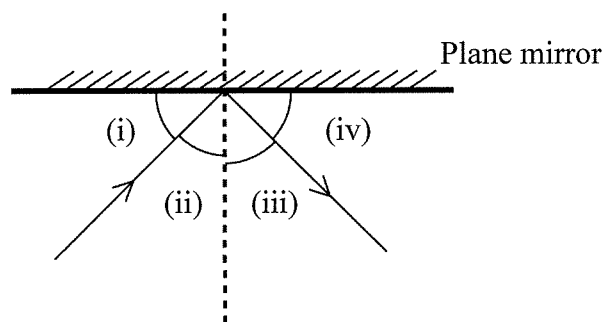
**Section A: There are 30 questions.**

1. In the figure below, a plane mirror  $XY$  of height  $h$  is mounted in an adjustable vertical position on a vertical wall.  $E$  is an observer's eye which is 2 m from the wall and 1.5 m above the ground.  $PQ$  is a vertical post of height 3 m and is 3 m behind the observer. Looking into the mirror the observer can see the whole image of the post. What is the minimum value of  $h$ ?



Find the minimum height  $h$  of the mirror.

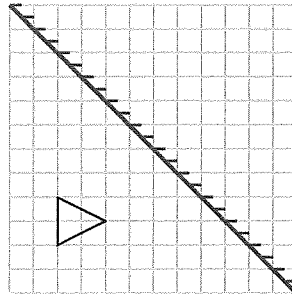
- A. 0.86 m
  - B. 1.08 m
  - C. 1.84 m
  - D. 1.98 m
2. The diagram below shows the reflection of a light ray by a plane mirror. (i), (ii), (iii) and (iv) are the angles formed.



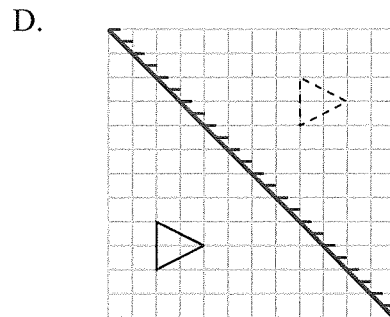
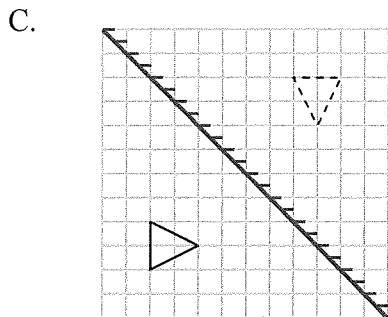
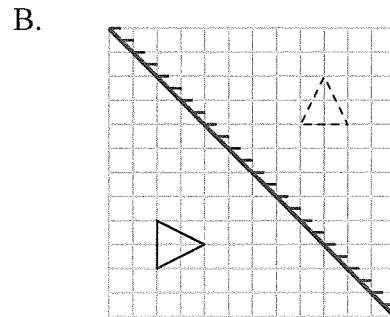
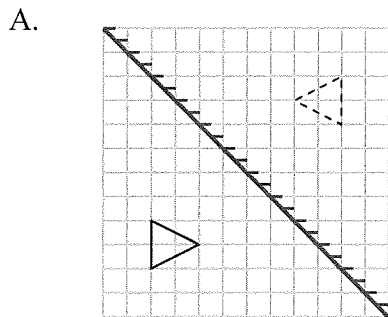
Which of the following about the above angles is correct?

- |    | <u>Angle of reflection</u> | <u>Angle of incidence</u> |
|----|----------------------------|---------------------------|
| A. | (i)                        | (iv)                      |
| B. | (ii)                       | (iii)                     |
| C. | (iii)                      | (ii)                      |
| D. | (iv)                       | (i)                       |

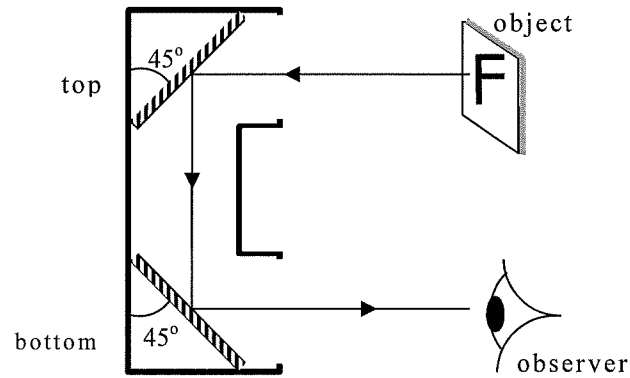
3. The figure below shows an object placed in front of a plane mirror.



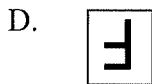
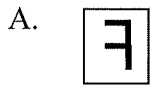
Which of the following figures correctly shows the image of the object?



4. The figure below shows a periscope designed by a student. An object is observed via the periscope.



Which image will the observer see?



5. Which of the following optical devices can form a virtual and magnified image?

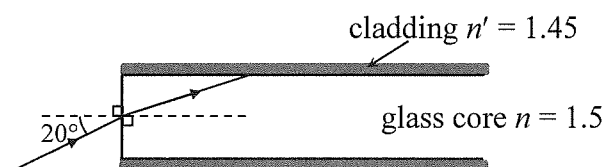
- (1) Convex lens
  - (2) Concave lens
  - (3) Plane mirror
- A. (1) only  
 B. (2) only  
 C. (1) and (3) only  
 D. (2) and (3) only

6. Which of the following statements about a concave lens is/are correct?

- (1) It diverge parallel light rays.
- (2) It is thinner at the centre than at its edges.
- (3) It forms an image by reflection.

- A. (1) only
- B. (1) and (2) only
- C. (2) and (3) only
- D. (1), (2) and (3)

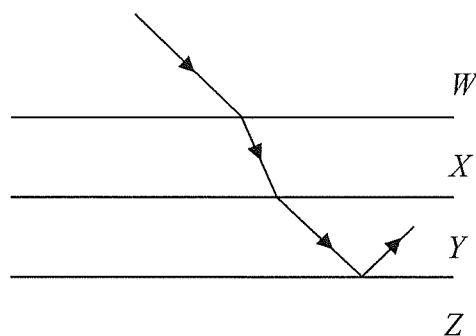
7. An endoscope is made of a bundle of optical fibres with each optical fibre having a glass core surrounded with a cladding as shown in the figure below. The refractive index of the glass core  $n$  and that of the surrounding cladding  $n'$  are 1.5 and 1.45 respectively.



What is the critical angle for the interface between the glass core and cladding?

- A.  $55^\circ$
- B.  $60^\circ$
- C.  $75^\circ$
- D.  $80^\circ$

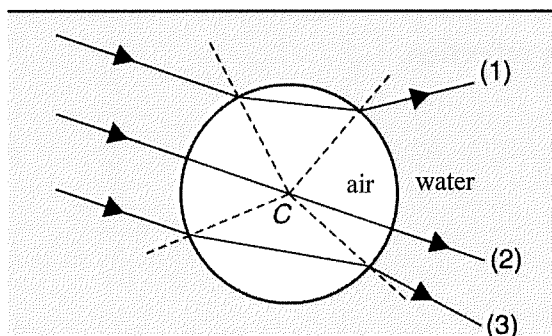
8. The figure below shows a light ray passing through the horizontal boundaries between media  $W$ ,  $X$ ,  $Y$  and  $Z$ . The light ray in  $W$  is parallel to that entered into  $Y$  from  $X$ . Total internal reflection occurs at the boundary between  $Y$  and  $Z$ .



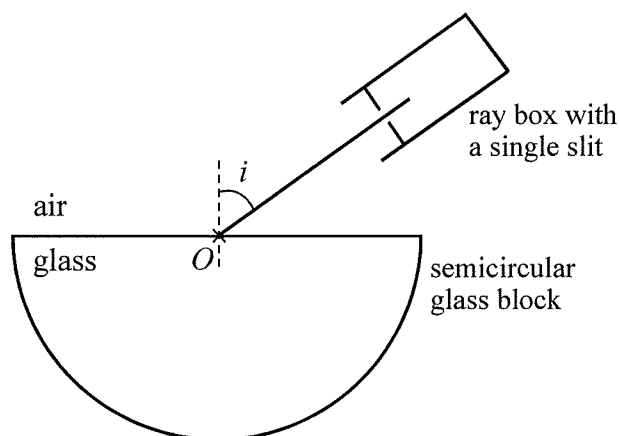
Which medium has the highest refractive index ?

- A.  $W$
- B.  $X$
- C.  $Y$
- D.  $Z$

9. Three light rays enter an air bubble in water.  $C$  is the centre of the bubble. Which of the paths shown below are correct?



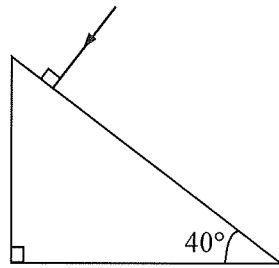
- A. (1) and (2) only  
 B. (1) and (3) only  
 C. (2) and (3) only  
 D. (1), (2) and (3)
10. A light ray travels towards the centre of a semi-circular glass block as shown below. The angle of incidence  $i$  increases from  $0^\circ$  to  $90^\circ$  gradually. The refractive index of glass is 1.61.



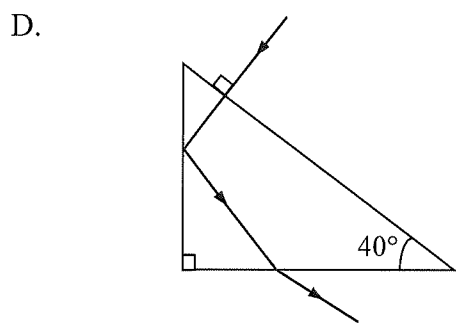
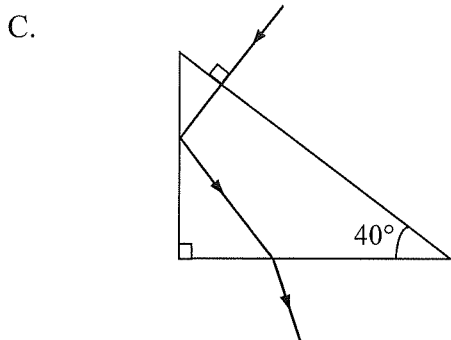
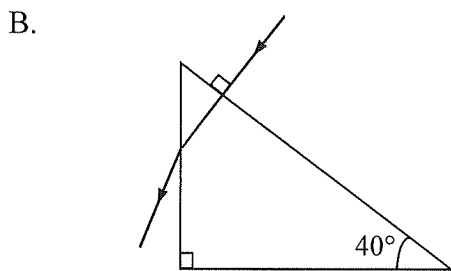
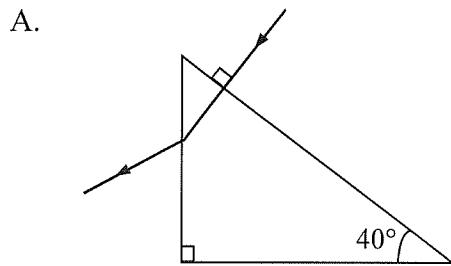
Which of the following statements is/are correct?

- (1) The speed of light in glass is  $1.86 \times 10^8 \text{ m s}^{-1}$ .  
 (2) The speed of light in air is larger than that in glass.  
 (3) Total internal reflection occurs when  $i > 38.4^\circ$ .
- A. (2) only  
 B. (1) and (2) only  
 C. (1) and (3) only  
 D. (1), (2) and (3)

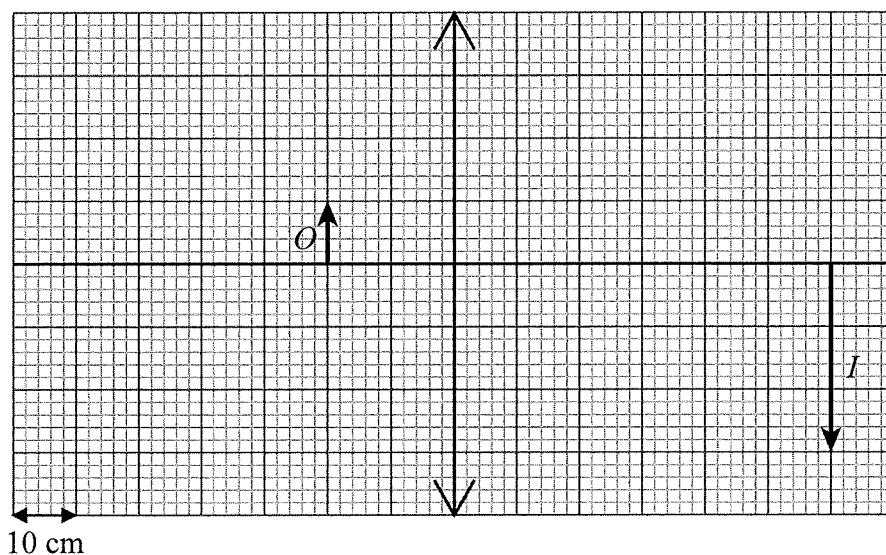
11. A light ray travels from air to a prism as shown below. The refractive index of the prism is 1.4.



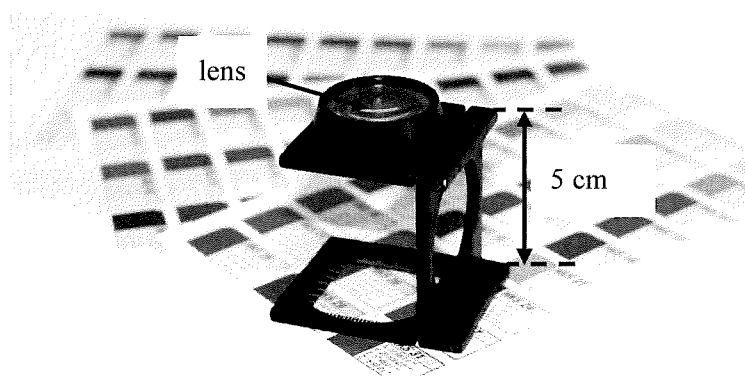
Which of the following ray diagrams is correct?



12. As shown in the figure below, an object  $O$  is placed 20 cm in front of a convex lens. The image  $I$  is formed at 60 cm on the other side of the lens. What is the focal length of the convex lens?

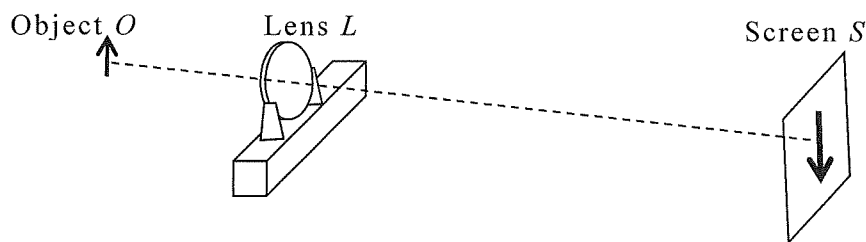


- A. 5 cm  
 B. 10 cm  
 C. 15 cm  
 D. 20 cm
13. A folding magnifier with a linear magnification of 4 is shown below. It consists of a single lens supported by a stand of height 5 cm. The object to be viewed is placed below a square opening. What is the focal length of the lens?



- A. 1.3 cm  
 B. 2.2 cm  
 C. 4.5 cm  
 D. 6.7 cm

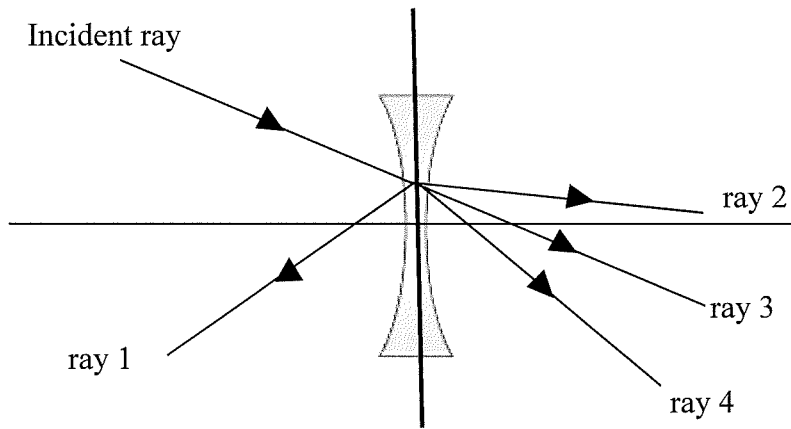
14. The figure shows an enlarged sharp image of an object  $O$  formed on a screen  $S$  by a convex lens  $L$ .



Which of the following can give a diminished sharp image on the screen?

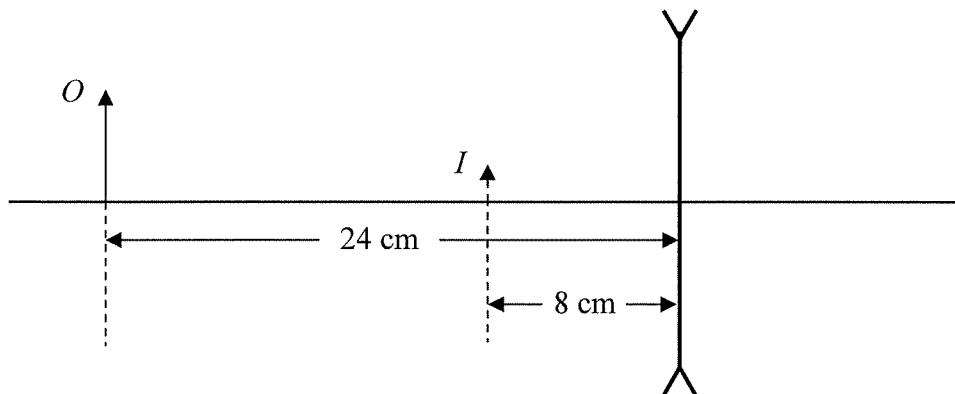
- (1) Keeping the positions of  $O$  and  $S$  unchanged, move  $L$  suitably closer to  $S$ .
  - (2) Keeping the positions of  $L$  and  $S$  unchanged, move  $O$  suitably farther away from  $L$ .
  - (3) Keeping the positions of  $O$  and  $L$  unchanged, move  $S$  suitably closer to  $L$ .
- A. (1) only  
B. (3) only  
C. (1) and (2) only  
D. (2) and (3) only
15. Which of the following statements about the image formed by a convex lens is/are correct?
- (1) If the image is real, it can be either erect or inverted.
  - (2) If the image is real, it can be either magnified or diminished.
  - (3) If the image is virtual, it must be erect.
- A. (1) only  
B. (1) and (3) only  
C. (2) and (3) only  
D. (1), (2) and (3)
16. An object is placed 10 cm from a convex lens of a focal length 20 cm. What is the image distance?
- A. 10 cm  
B. 20 cm  
C. 30 cm  
D. 40 cm

17. A light ray is directed to a concave lens as shown below. Which ray represents the path of the incident ray after it passes through the concave lens?



- A. ray 1
- B. ray 2
- C. ray 3
- D. ray 4

18. What is the magnification of the image  $I$  formed by the concave lens as shown below?



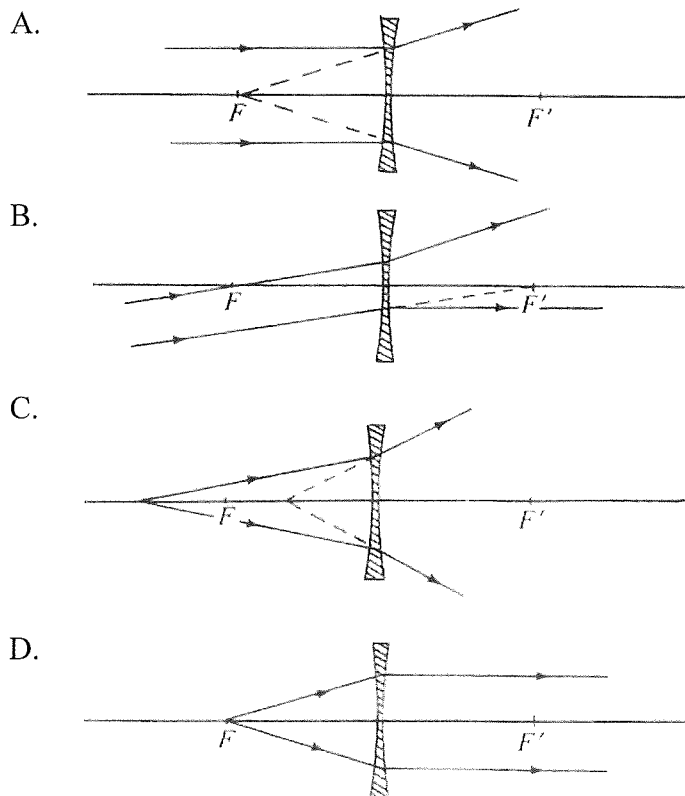
- A. 0.33
- B. 0.5
- C. 3.0
- D. 5.0

19. An object is 5 cm in front of a convex lens of focal length 10 cm. Which of the following statements about the image formed is/are correct?

- (1) The image cannot be captured on a screen.
- (2) The image can be photographed.
- (3) The magnification of the image is 2.

- A. (1) only
- B. (1) and (2) only
- C. (2) and (3) only
- D. (1), (2) and (3)

20. If  $F$  and  $F'$  are the foci of the concave lens, which of the following ray diagrams is **incorrect**?



**END OF SECTION A**

**Section B:** Answer ALL questions. Write your answers in the spaces provided.

1. Peter uses the set-up shown in Figure 1.1 to study the image formation of a convex lens. He puts an illuminated letter 'F' in front of the lens and an image is formed on a translucent screen. He finds that the object distance  $u$  is larger than the image distance  $v$ .

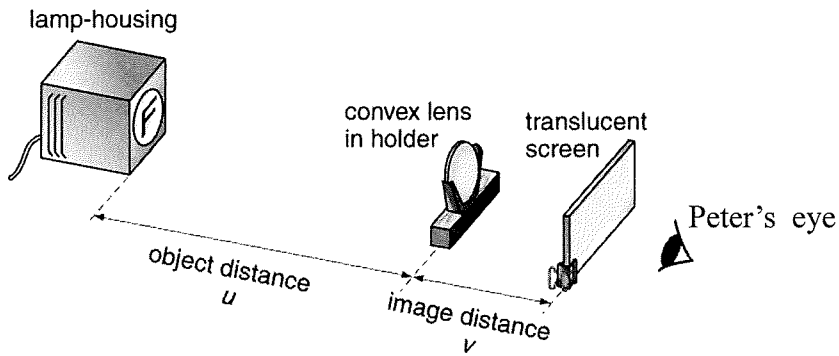
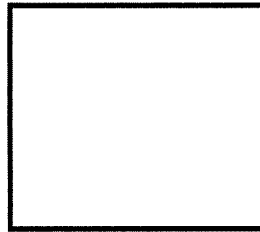


Figure 1.1

- (a) Sketch the shape of the image seen by Peter.

(1 mark)



- (b) Peter changes the object distance  $u$  and measures the values of  $v$ . After obtaining several sets of data, he constructs the graph shown in Figure 1.2

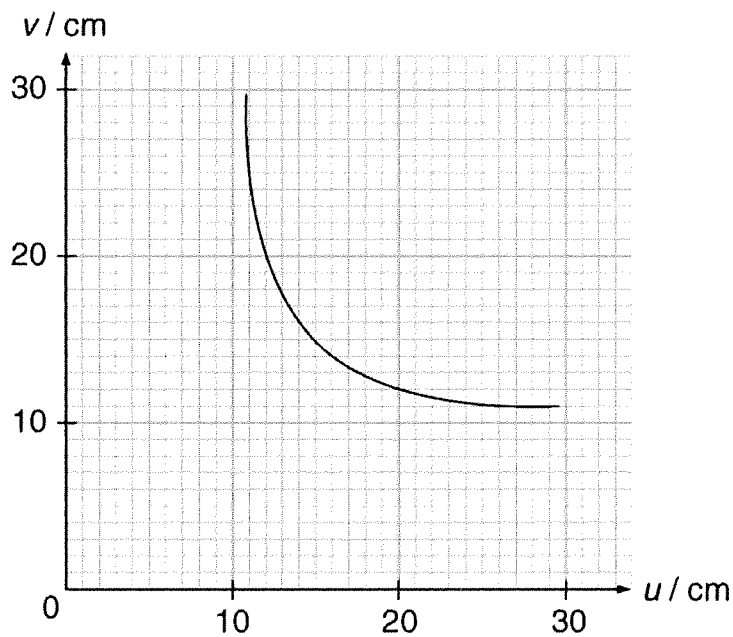


Figure 1.2

(i) Find the magnification of the image when  $u = 20$  cm. (2 marks)

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(ii) If the object is moved closer to the lens, how will the image size change? (1 mark)

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(iii) Find the value of  $u$  when  $u = v$ . Hence find the focal length of the lens. (3 marks)

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(c) What will happen to the image if the upper half of the lens is covered by a piece of opaque paper? (2 marks)

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2. Figure 2.1 shows the image of 'SLIPPERY FLOOR' projected on the floor in a shopping mall. The image is formed by a projector on the ceiling right above it (see Figure 2.2).

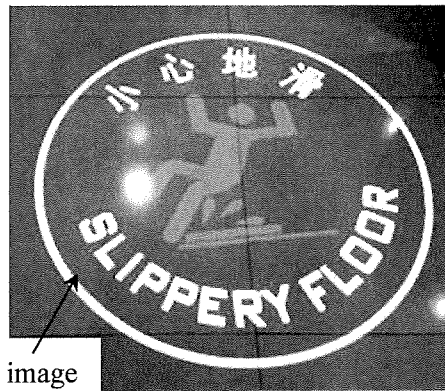


Figure 2.1

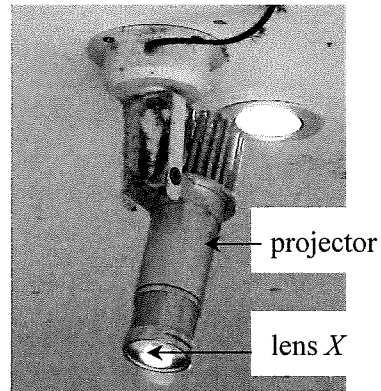


Figure 2.2

- (a) There is a lens  $X$  in the projector to form the image. State the kind of lens  $X$ . Explain your answer. (2 marks)

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- (b) Figure 2.3 shows an object  $O$  placed at 30 cm in front of the lens  $X$  with focal length 20 cm. The height of the object is 10 cm. Construct the image  $I$  formed by the lens  $X$ . (3 marks)

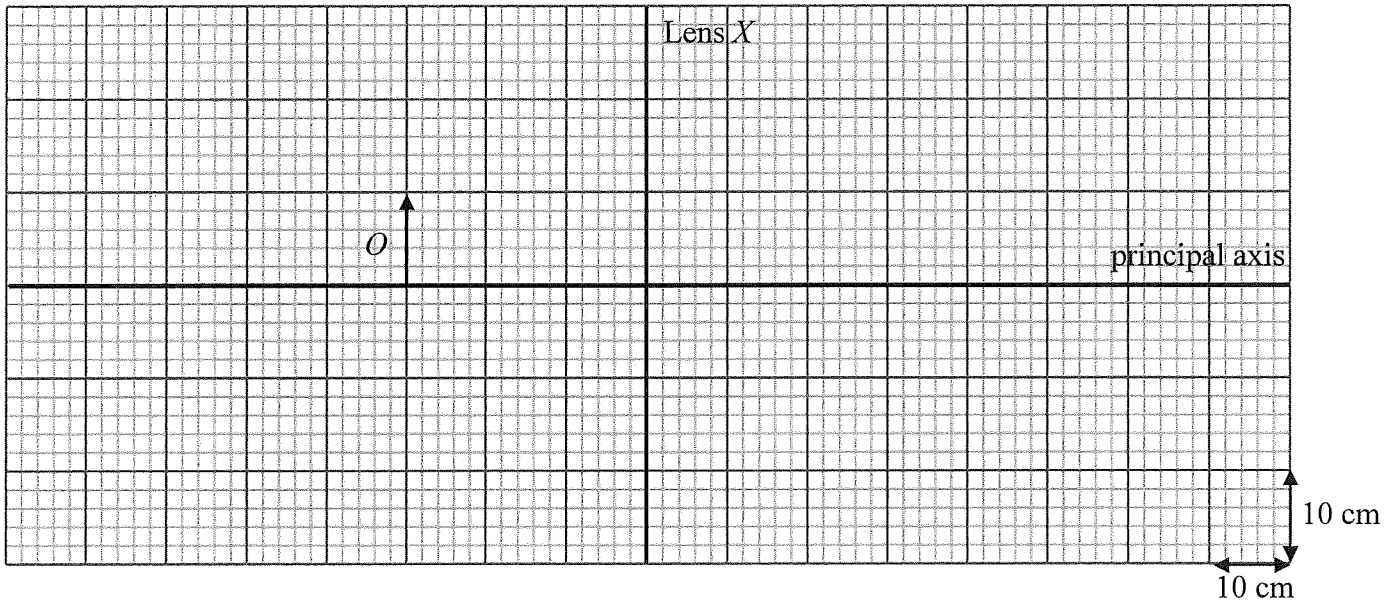


Figure 2.3

- (c) Find the magnification of the image. (2 marks)

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3. A lens  $L$  of focal length 20 cm is placed 30 cm in front of a photo of a bird. The image of the bird formed by the lens is shown in Figure 3.1.

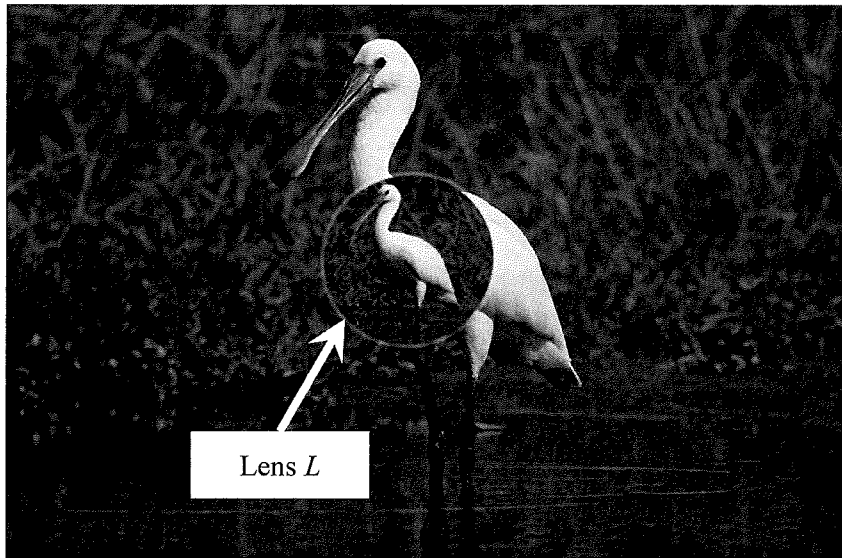


Figure 3.1

- (a) What kind of lens is  $L$ ? Explain briefly. (2 marks)

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(b) Figure 3.2 shows the position of the bird in front of lens  $L$ .  $F$  and  $F'$  are the foci of lens  $L$ .

(1) Draw light rays in the diagram to construct the image formed by lens  $L$ . (3 marks)

(2) Complete light rays  $P$  and  $Q$ . (2 marks)

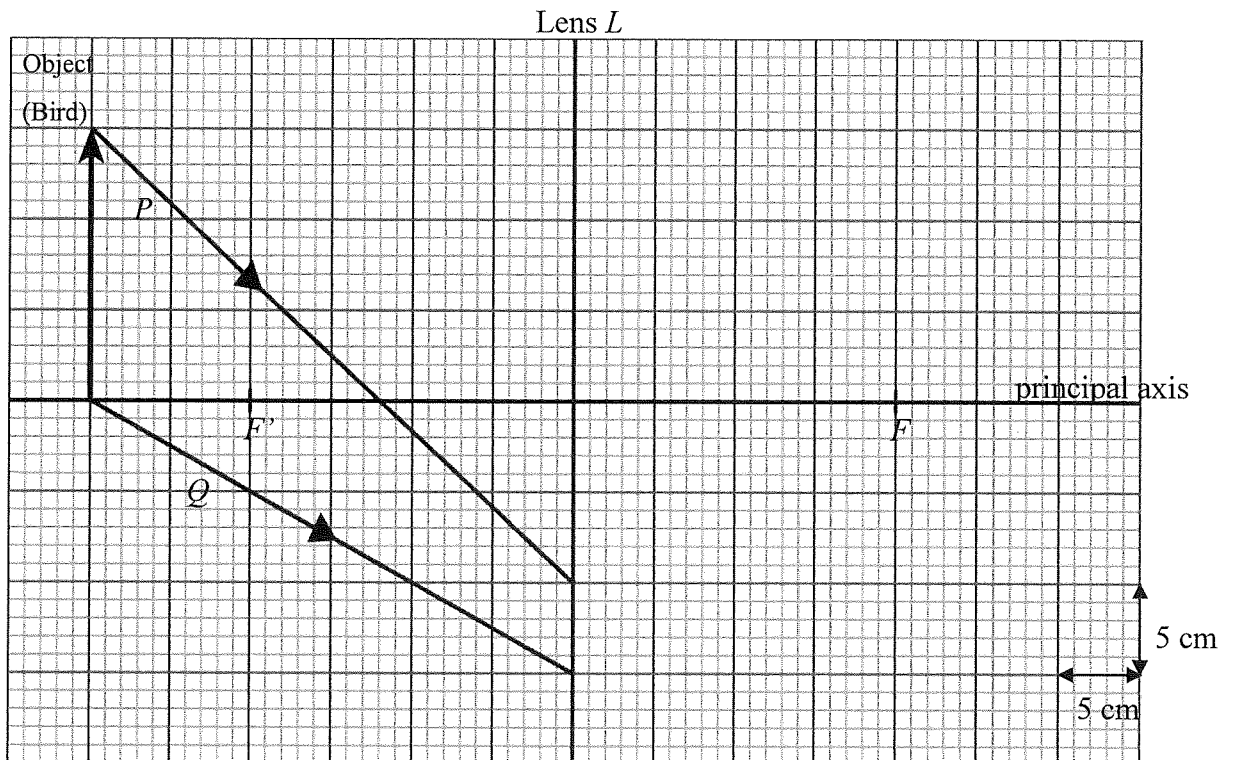


Figure 3.2

(c) Lens  $L$  is then moved 30 cm further away from the photo. Use the lens formula to find the image distance. (2 marks)

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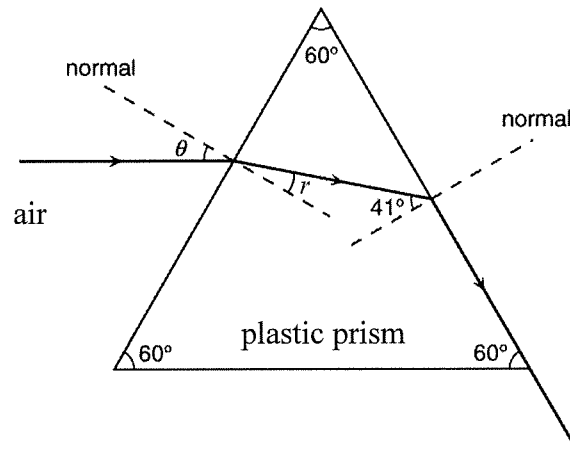
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4. Figure 4.1 shows how a beam of red light travels through a  $60^\circ-60^\circ-60^\circ$  plastic prism from air.



**Figure 4.1**

(a) What is the refractive index of the plastic? (2 marks)

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(b) Find angle  $r$  and hence find angle  $\theta$ . (3 marks)

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**END OF PAPER**