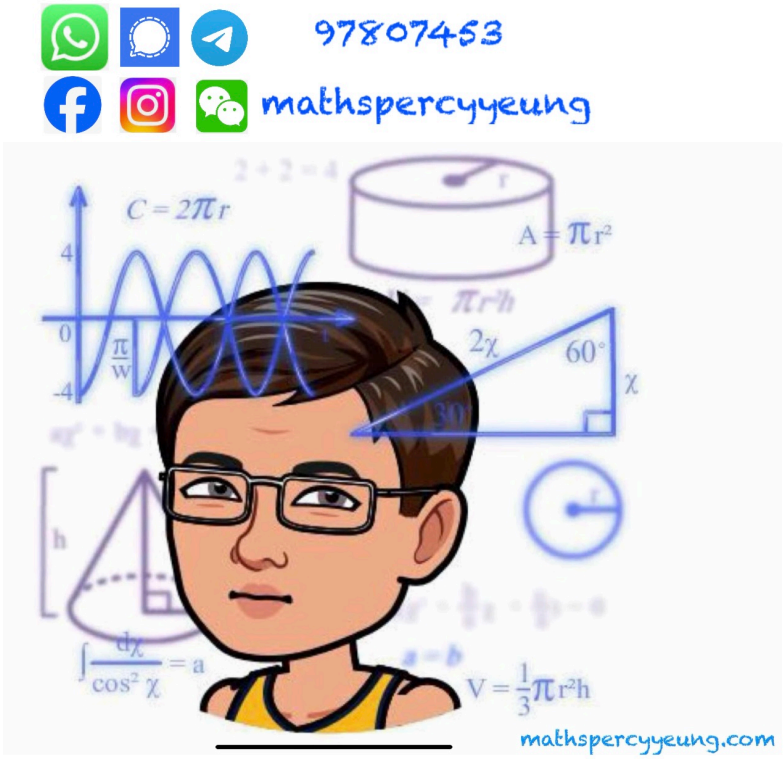
Fundamentals of F.3 Physics (2025-2026)



Name: _____( )

Class: _____

Book 1

Content

Light

Light Rays

Aim of studying light

How can we see an object? ⇢ Light enters _____.

Properties of Light

1. Light is energy.

2. Light can travel in _____.

3. Direction of light is reversible.

4. Speed of light is _____.

5. Light travels in _____. → Light rays

How to represent a light ray?

form → Straight line
Note: Please use ruler to draw it

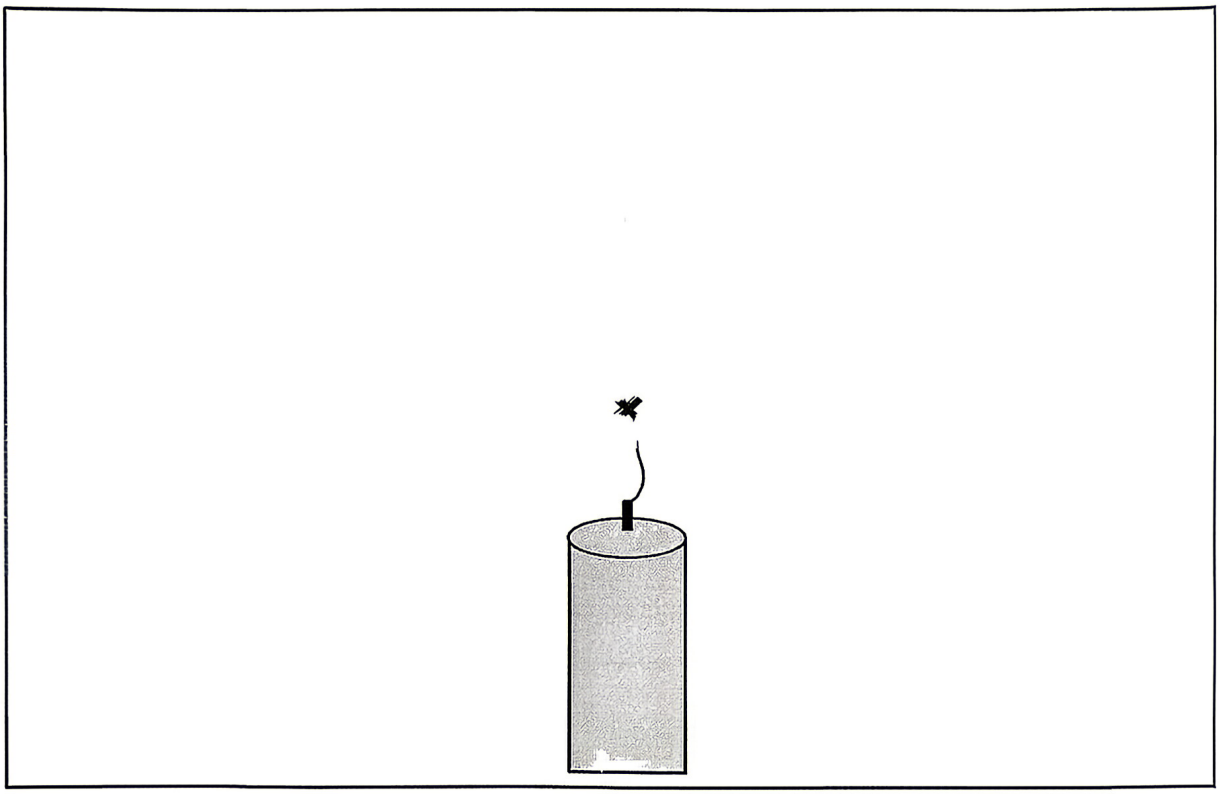
direction → With arrows
Note: to point out where does the light ray come from

Example

Laser pointer

How many light rays does a burning candle emit?

Try to draw out the light rays emitted from the top of the candle flame!



- Number of the light rays coming out from the burning candle:

  _____

- Direction of the light rays:

  _____

How light works:

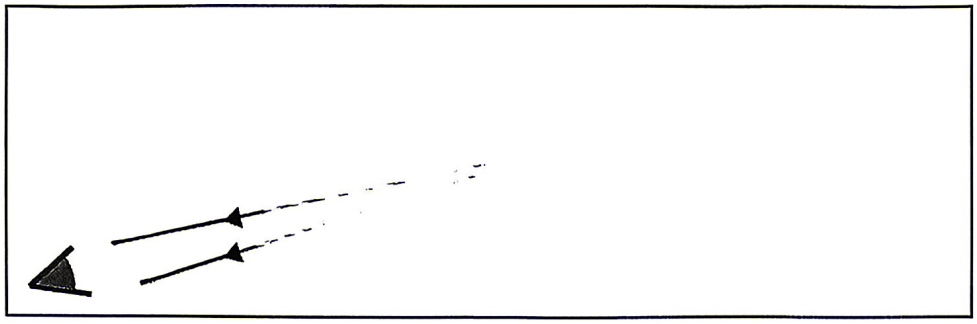
Cone of Rays

To represent how we can see an object

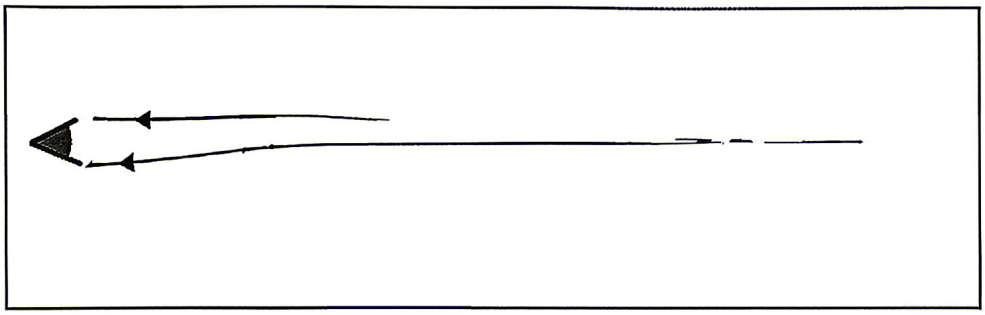
A: How to see a light source?

Exercise

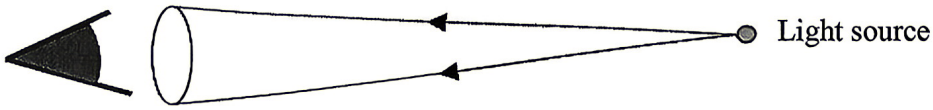
1. Find out the position of the object and give a label *O* to it.



2. Find out the position of the object and give a label *O* to it.



Summary



When we see an object, the object is at the vertex of the cone of rays.

Test your concept

Is the ray diagram below correct? Why?

Answer: _____

B: How to see an object with certain size?

1. To represent how we see an object, we draw _____(one / two / infinite) cones of rays.
2. Cones of rays come from _____ and _____ of an object.

C: Objects from various distance

Near object	
Far object	
Very far object	

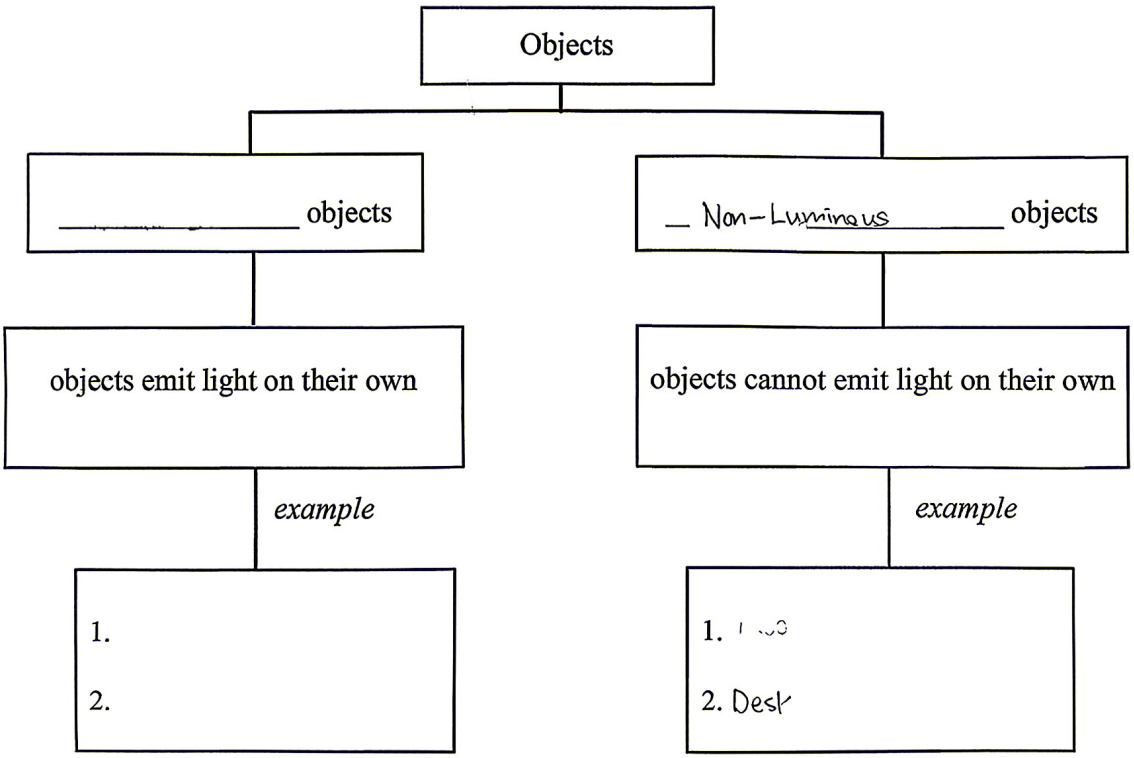
Summary

As the object moves farther away, the rays become _____.

Different types of light beam

_____ beam	_____ beam	_____ beam
ray box →	ray box →	ray box →

Luminous objects and non-luminous objects



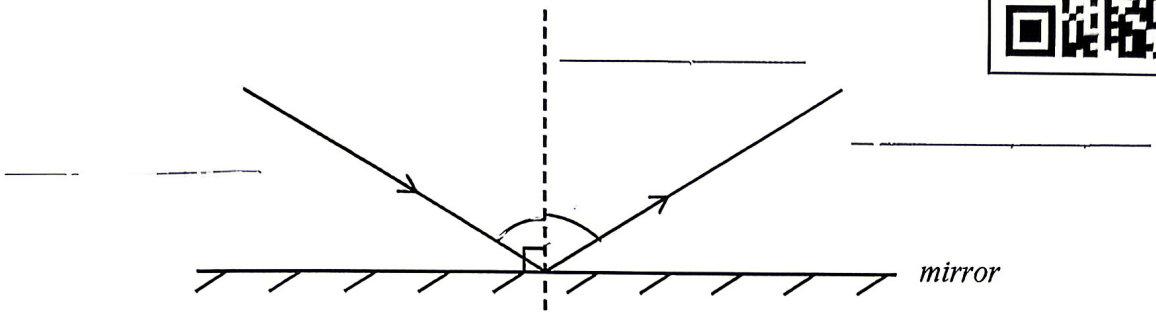
Remember: Not all objects can emit light!

Luminous & non-luminous objects:

Reflection

Laws of Reflection

Describe how a light ray is reflected by a plane mirror.



- normal – a dotted line **perpendicular to the surface**
- i – _____, angle between incident ray and the normal
- r – _____, angle between reflected ray and the normal

Laws of reflection

1. _____ _____ = _____ _____.

2. Incident ray, reflected ray and normal _____.

Steps of drawing the reflected ray on ray diagrams

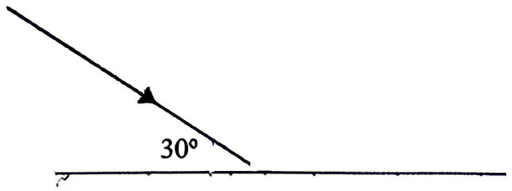
1. Locate the point P where the light ray incidents on the mirror surface.
2. Draw a **dotted line (normal)** passing through the point P and perpendicular to the surface.
3. Draw a line (with an **arrow**) from point P and keep $i = r$.

Example

Quick practice

Exercise

1. Complete the ray diagram below and answer the following questions.



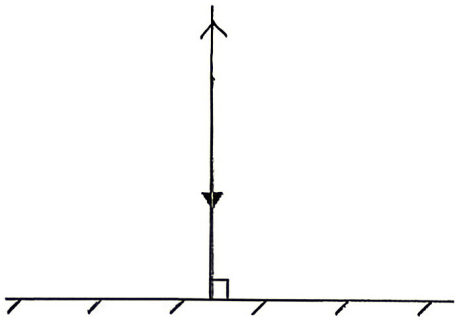
a) What is the angle of incidence?

_____

b) What is the angle of reflection?

_____

2. Complete the ray diagram below and answer the following questions.



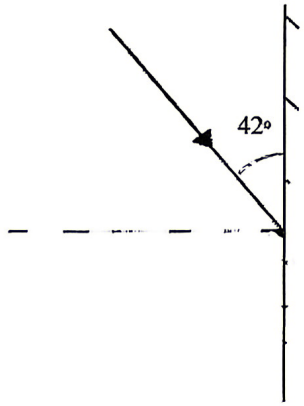
a) What is the angle of incidence?

_____

b) What is the angle of reflection?

_____

3. Complete the ray diagram below and answer the following question.



What is the angle between the incident ray and the reflected ray?

_____ _____

Test your concept

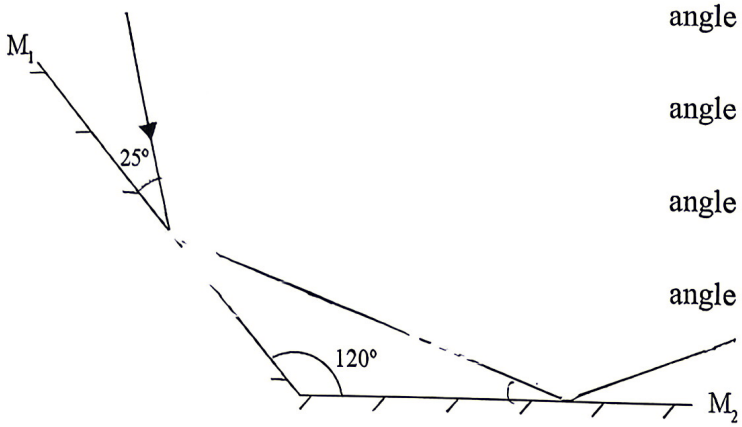
Can light pass through the plane mirror? Ans: _____

More on Reflection

Reflected by two mirrors

Complete the following ray diagrams.

1.



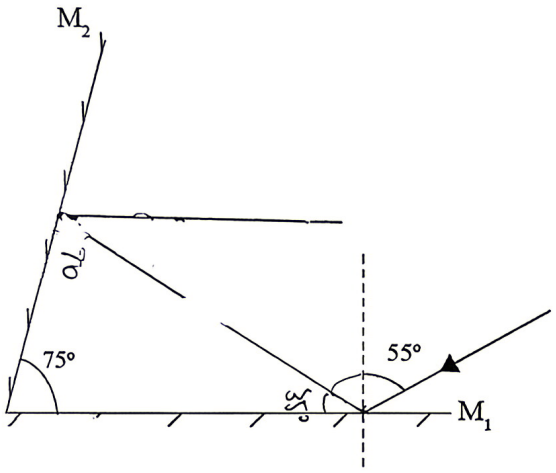
angle of incidence on the mirror M_1: _____

angle of reflection on the mirror M_1: _____

angle of incidence on the mirror M_2: _____

angle of reflection on the mirror M_2: _____

2.



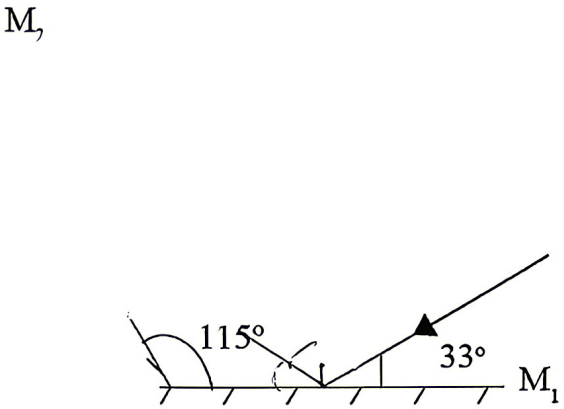
angle of incidence on the mirror M_1: _____

angle of reflection on the mirror M_1: _____

angle of incidence on the mirror M_2: _____

angle of reflection on the mirror M_2: _____

3.



angle of incidence on the mirror M_1: _____

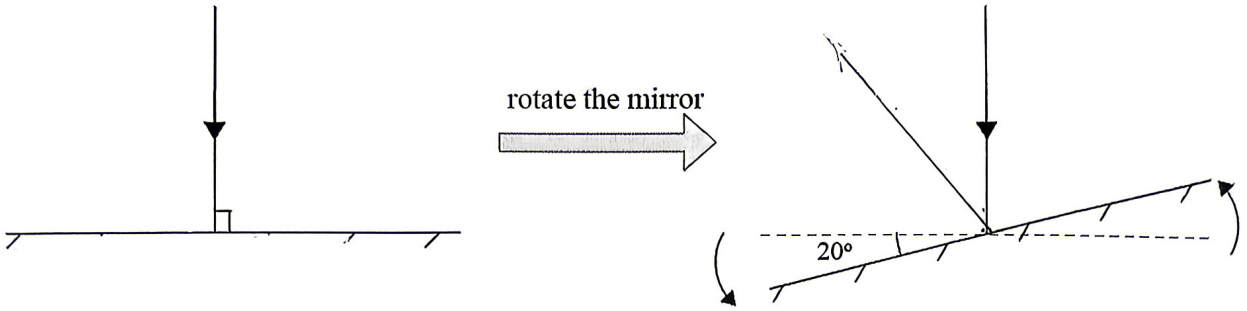
angle of reflection on the mirror M_1: _____

angle of incidence on the mirror M_2: _____

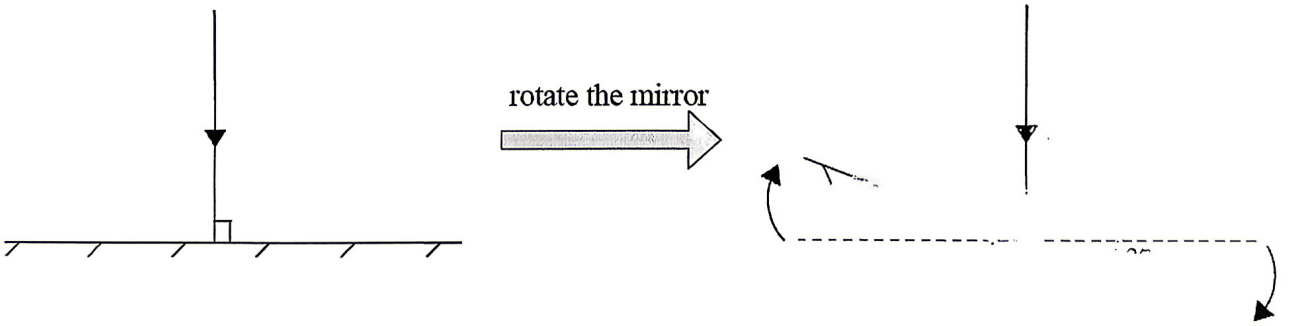
angle of reflection on the mirror M_2: _____

Rotating the mirrors

1. The mirror is placed horizontally and a light ray incidents on the mirror vertically. After rotating the mirror by 20° anticlockwise as below, what is the angle between the incident ray and the reflected ray? Ans: _____



2. The mirror is placed horizontally and a light ray incidents on the mirror vertically. After rotating the mirror by 32° clockwise as below, what is the angle between the incident ray and the reflected ray? Ans: _____



3. The mirror is placed horizontally and a light ray incidents on the mirror as shown below. After rotating the mirror by 18° clockwise as below, what is the angle between the incident ray and the reflected ray? Ans: _____

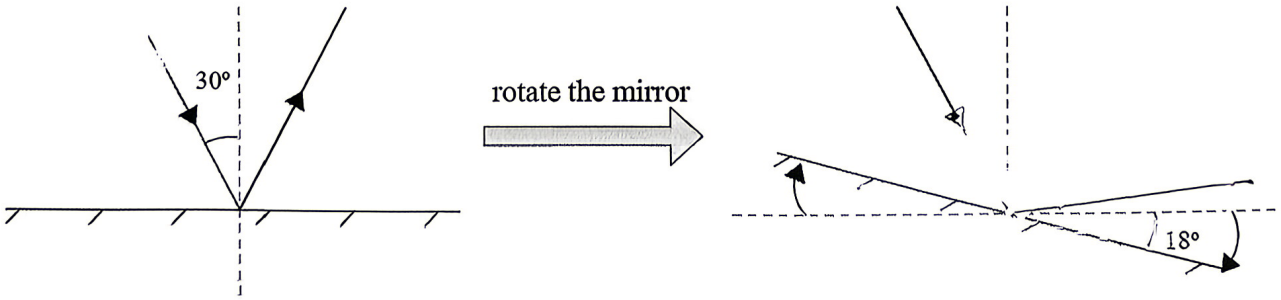
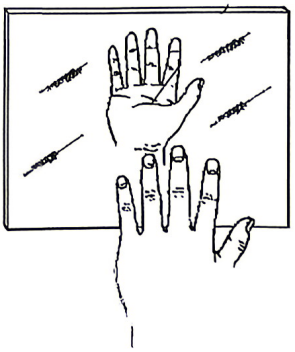


Image Formed by Plane Mirrors



Hold your left hand in front of a plane mirror. You can see the **image** of your left hand. What do you observe?

(a) Orientation of the image: _____

(b) Size of the image: _____

Where is the image formed by a plane mirror? _____ _____

Properties of the image formed by a plane mirror

_____

2. _____
3. _____
4. _____

Object distance and image distance

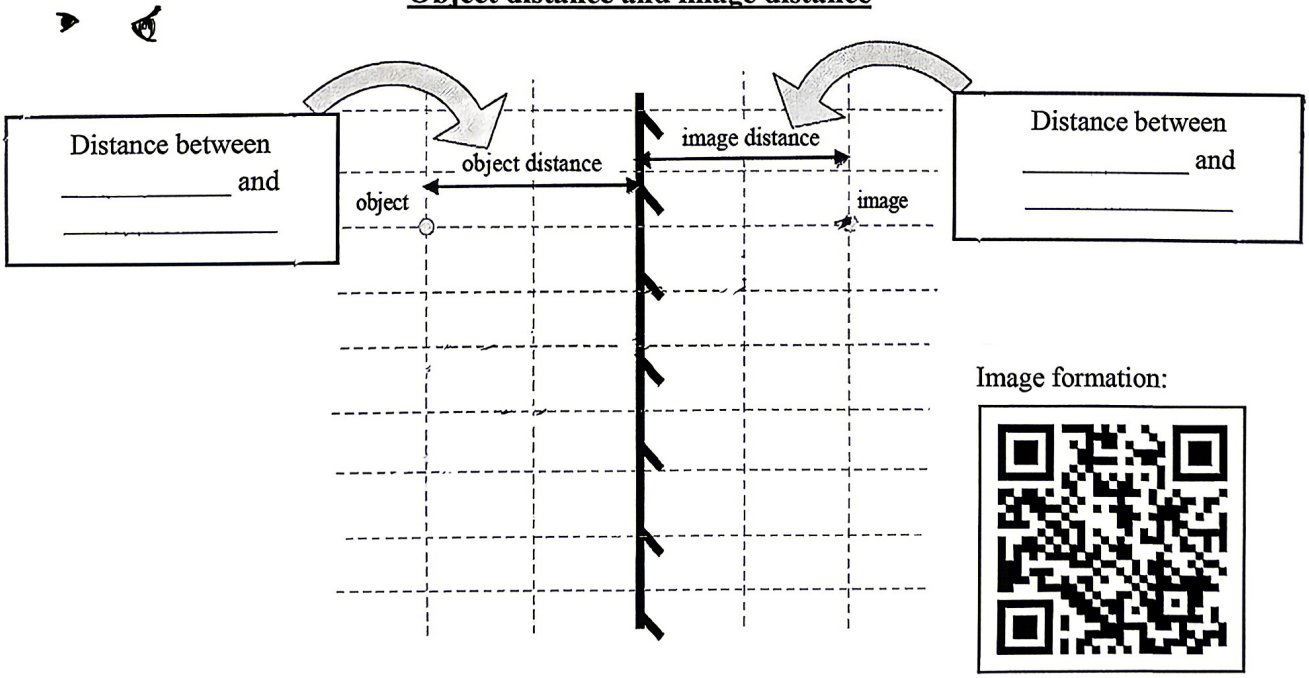


Image formation:

Exercise

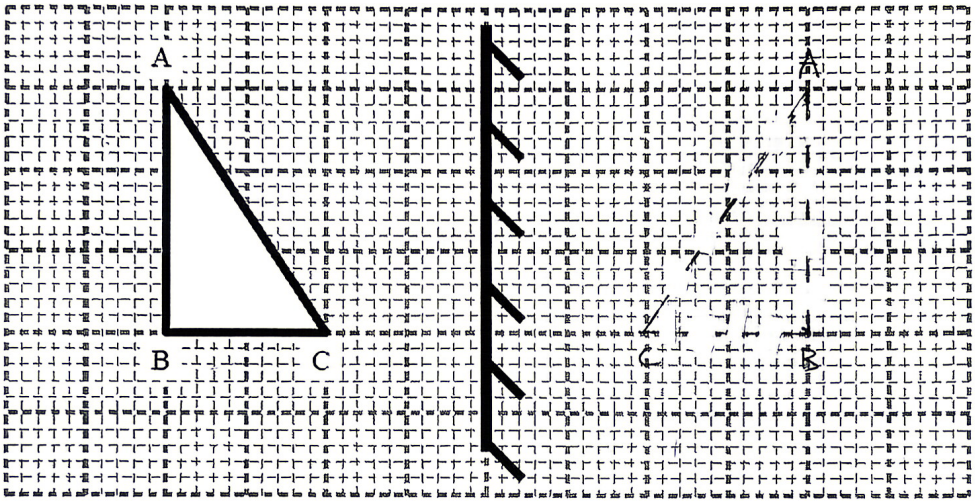
1. Leo is 2 m in front of a plane mirror. Where is his image? Answer: _____

2. What is the distance between Leo and his image? Answer: _____

3. If he walks 0.5 m towards the plane mirror, what is the distance between Leo and his image?

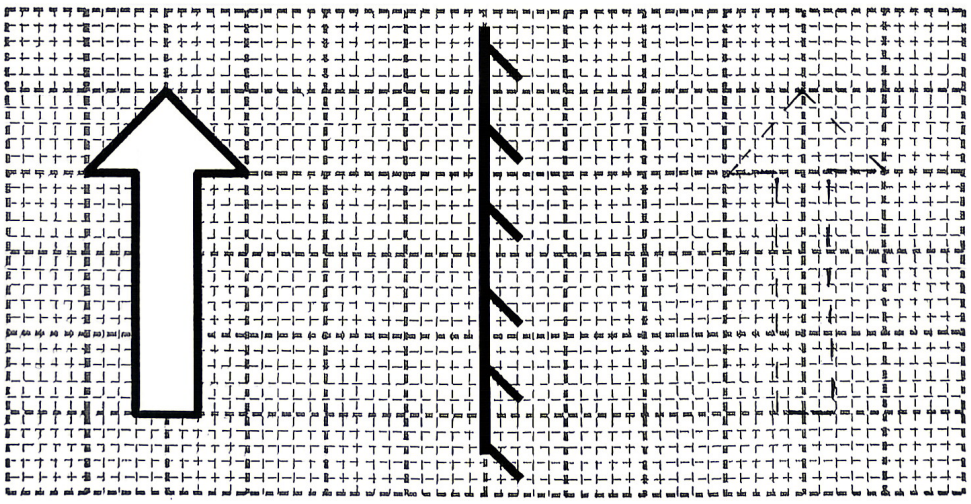
Answer: _____

Example. A triangle ABC is placed in front of a plane mirror, please draw its image.

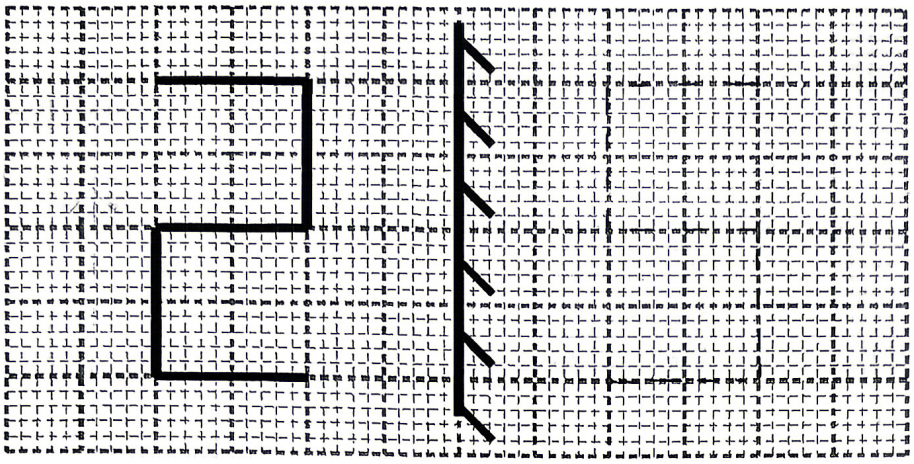


Exercise

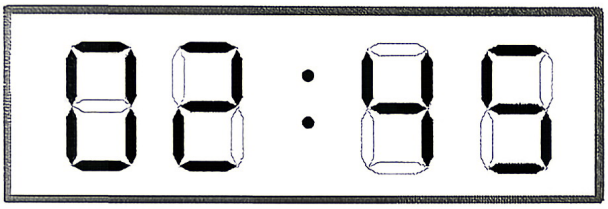
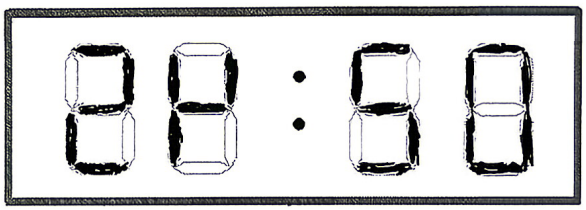
1. An arrow is placed in front of a plane mirror, please draw its image.



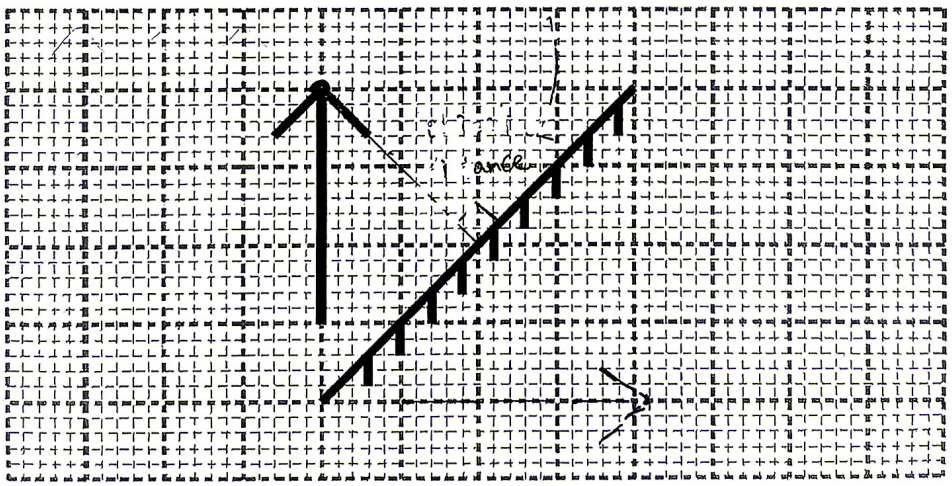
2. A number "2" is placed in front of a plane mirror, please draw its image.



3. A digital clock shows the time (02:45) as below. How does the image look like through a mirror facing the clock?

Digital clock	Image formed by the mirror
	

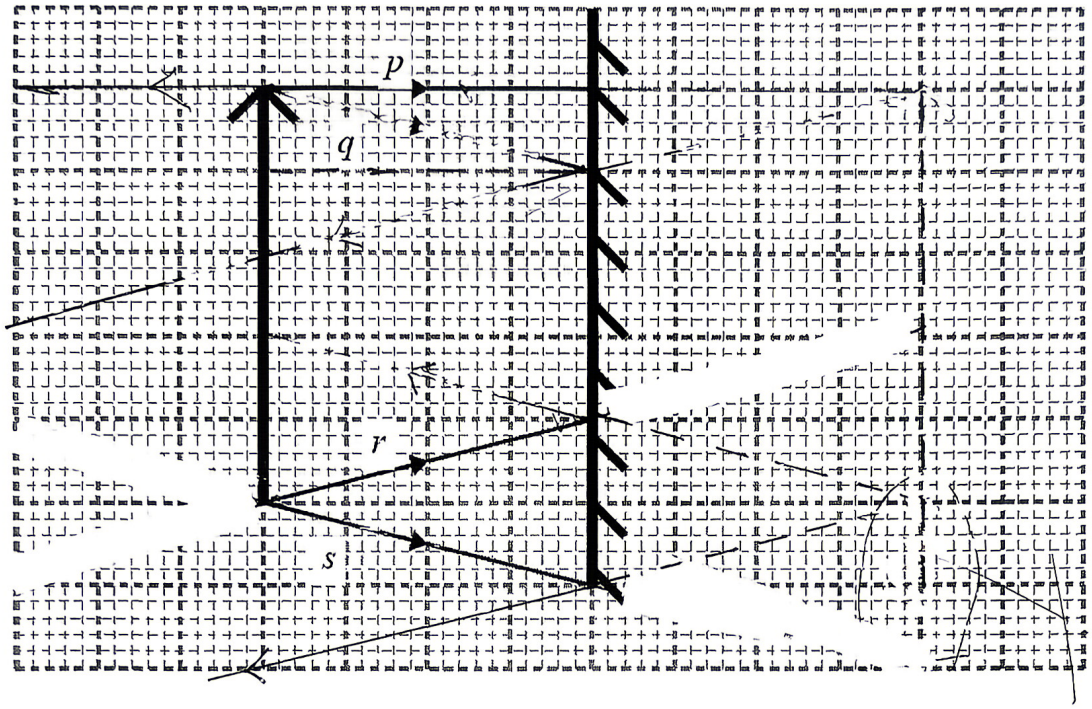
4. Draw the image formed by the plane mirror below.



Example.

a) Draw the image of the arrow formed by the plane mirror.

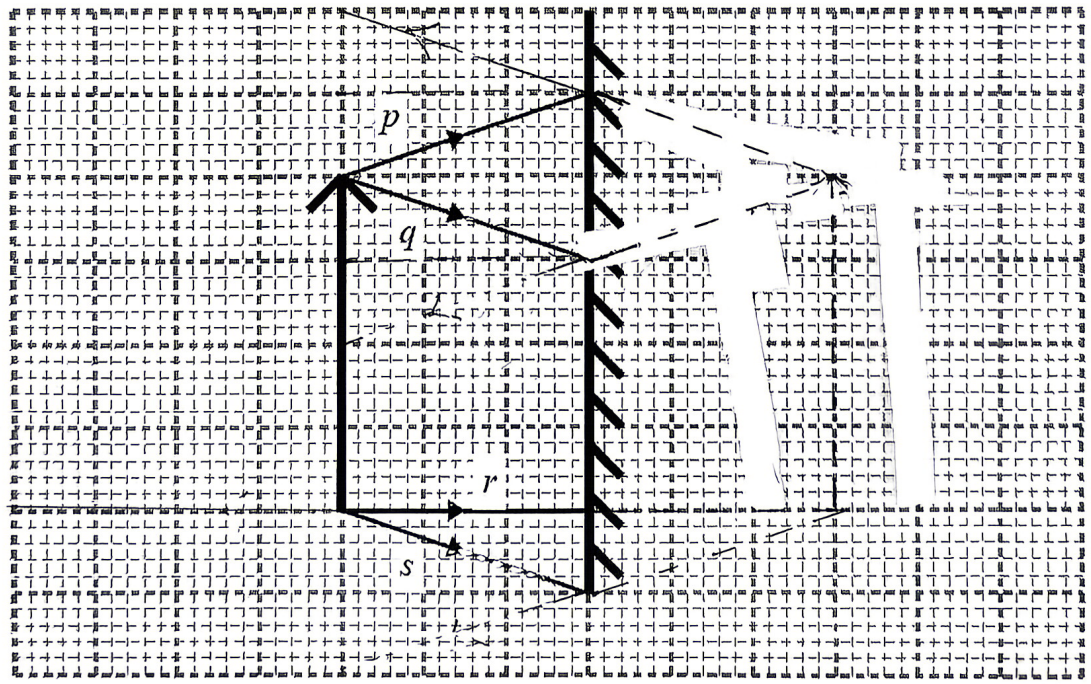
b) Complete the reflected rays of p to s.



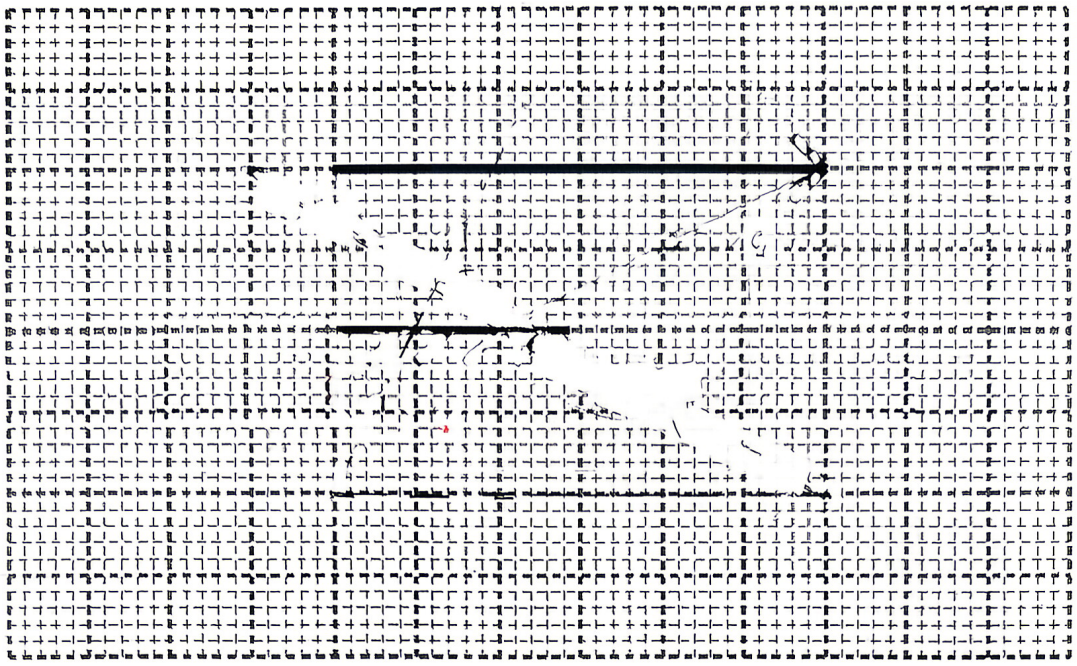
Exercise

1. a) Draw the image of the arrow formed by the plane mirror.

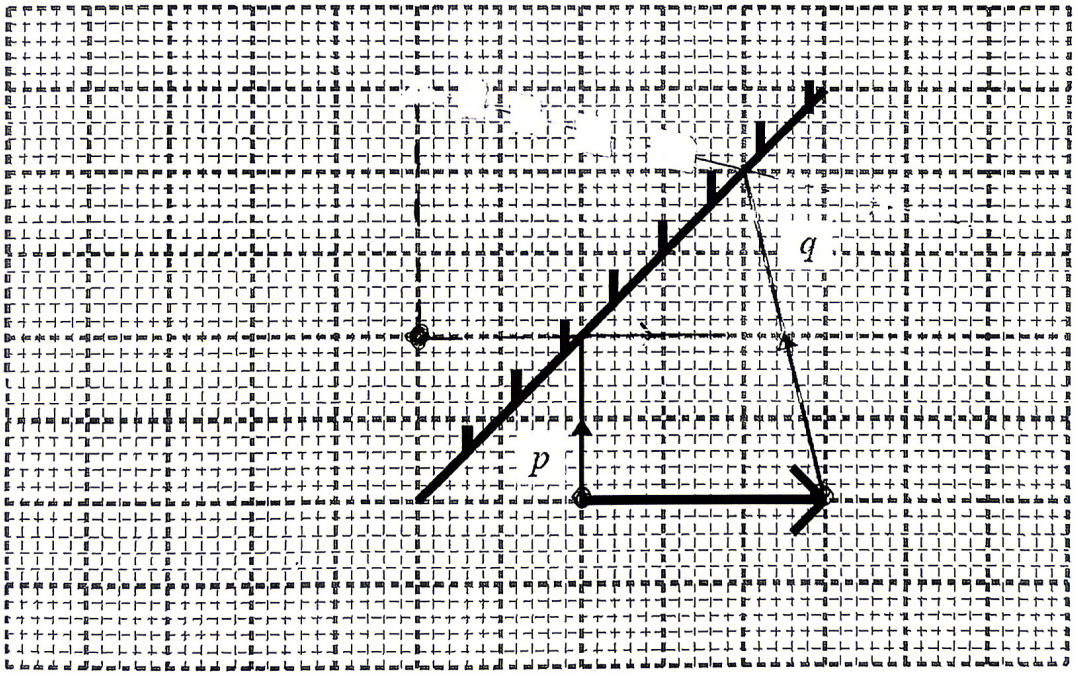
b) Complete the light rays p to s.



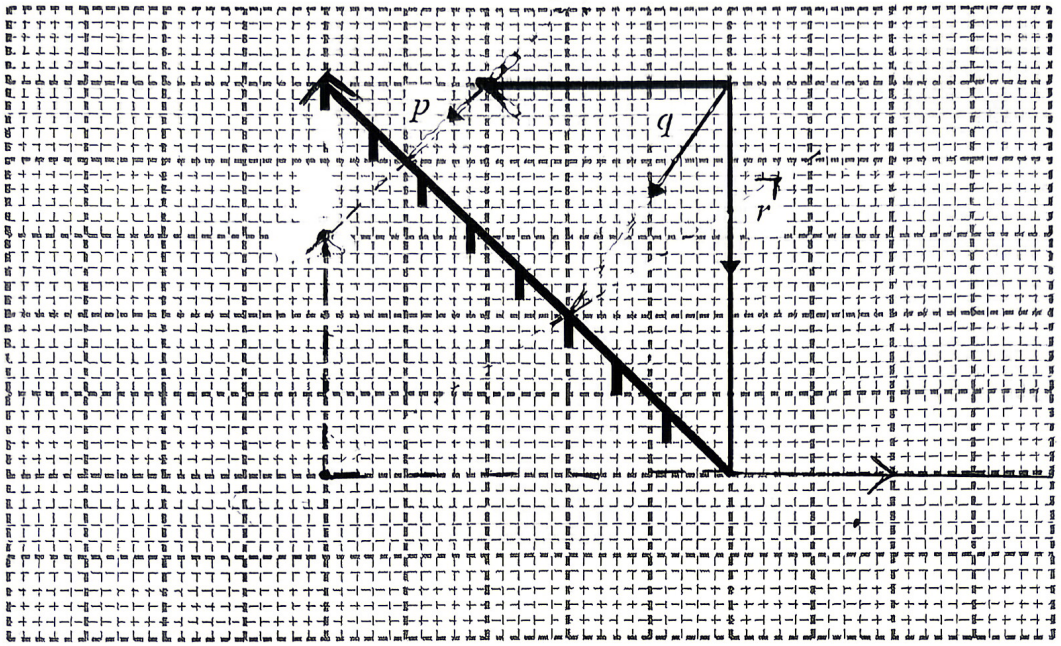
2. Draw the image of the arrow and complete the light rays p and q.



3. Draw the image of the arrow and complete the light rays p and q.



4. Draw the image of the arrow and complete the light rays p, q and r.



Choosing a mirror with minimum length

Mr. Lee wants to use a mirror to see his whole body. However, he does not have enough money to buy a large mirror. He needs to buy a mirror with minimum length.

Information
Mr. Lee's height: 180 cm
Distance between his eyes and the top of the head: 20 cm
Distance between Mr. Lee and the mirror is 120 cm

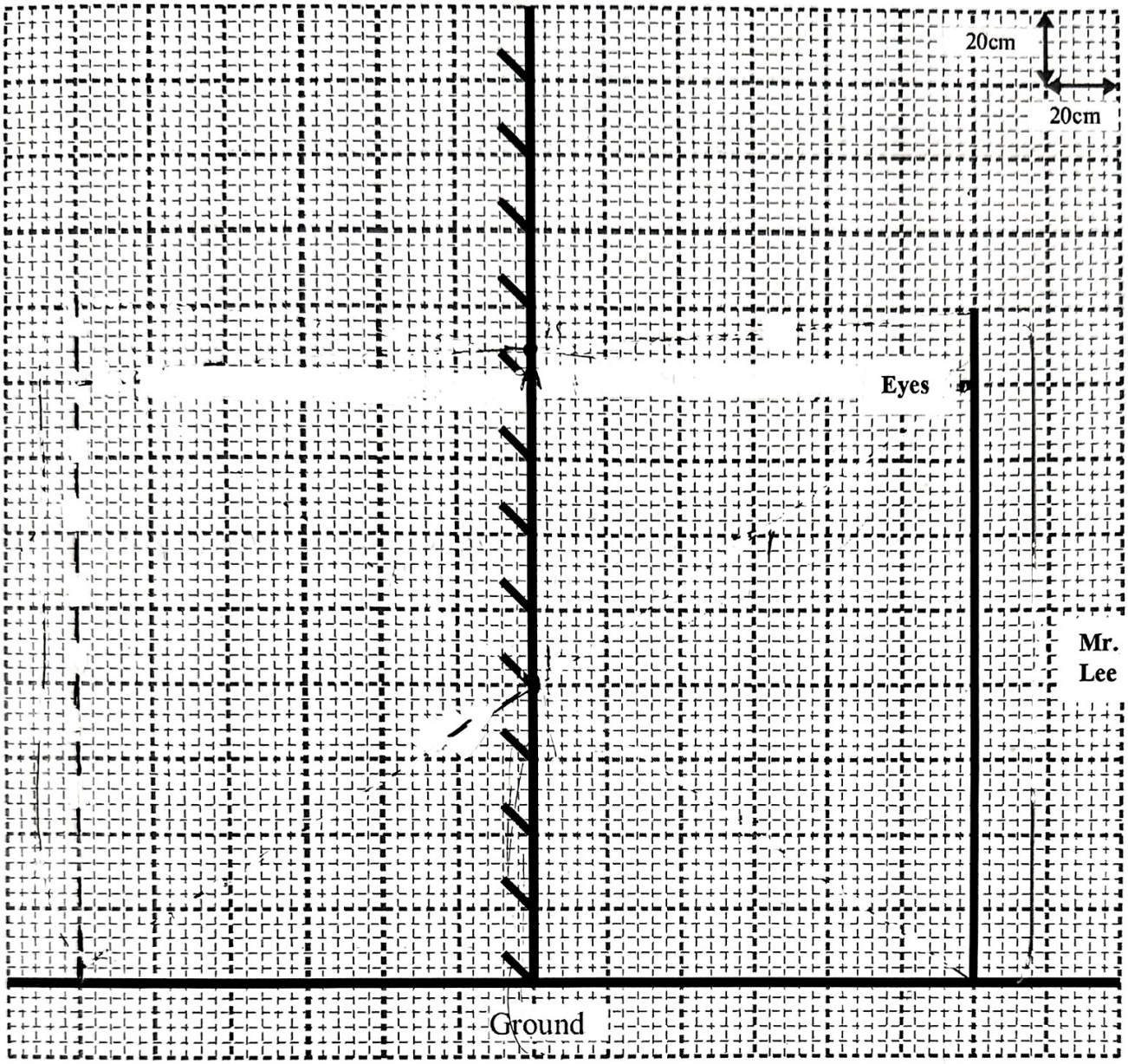
Requirements of this "cheap" mirror:

a. Mr. Lee can just see his _____ (Mr. Lee's image) at the top of the mirror.

b. Mr. Lee can just see his _____ (Mr. Lee's image) at the bottom of the mirror.

Steps:

1. Assume there is a very large mirror.
2. Draw Mr. Lee's image.
3. Draw 2 light rays to represent how he sees his whole body through the mirror.
4. Find out the positions that satisfy the above requirements.
5. Eliminate the unnecessary parts. Then we can know the minimum length and how to place this "cheap" mirror.



Results:

Minimum length of the mirror:

_____

The distance between the bottom of the mirror and the ground:

_____

Test your concept

1. If Mr. Lee walks closer to the mirror (e.g. 1 m in front of the mirror), does he need to change the position of the mirror?

   Answer: _____

2. If Mr. Lee walks farther away from the mirror (e.g. 2 m in front of the mirror), does he need to change the position of the mirror?

   Answer: _____

3. Mr. Lee's sister is shorter than Mr. Lee. She is 165cm tall. Without changing the position of the mirror, can she make use of the mirror to see her whole body?

   Answer: _____

Interactive learning

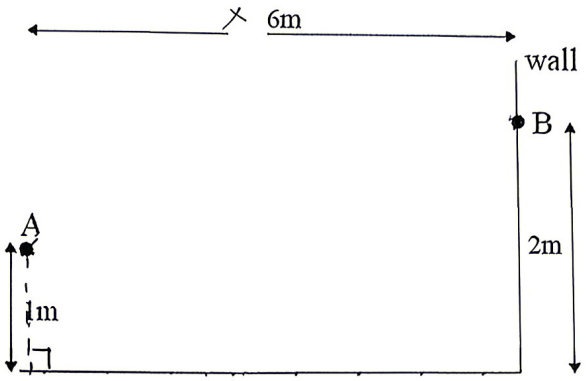
Girl in the Mirror: https://www.geogebra.org/m/jNZ4uqXK

Challenging Questions

John emits a light beam from point *A* to point *X* on the mirror. Then, the light is reflected to point *B* on the wall.

(a) Draw the reflected ray from point A to point *X*, then to point *B*.

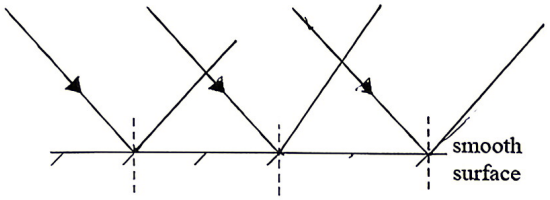
(b) Calculate the horizontal distance between the wall and point *X*.



Distance: _____

Regular reflection & diffuse reflection

Consider there are parallel light rays incident on two different kinds of surfaces.
In both cases, they obey the laws of reflection.

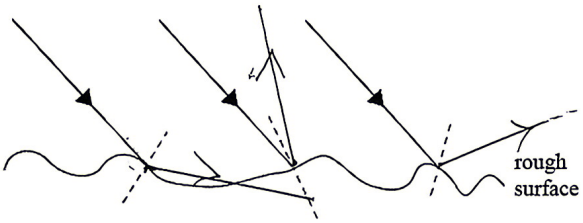


Directions of normals at different points are _____(the same/different).

⇩

Parallel lights in → parallel lights out

_____



Directions of normals at different points are _____(the same/different).

⇩

Parallel lights in → irregular lights out

_____

Refraction

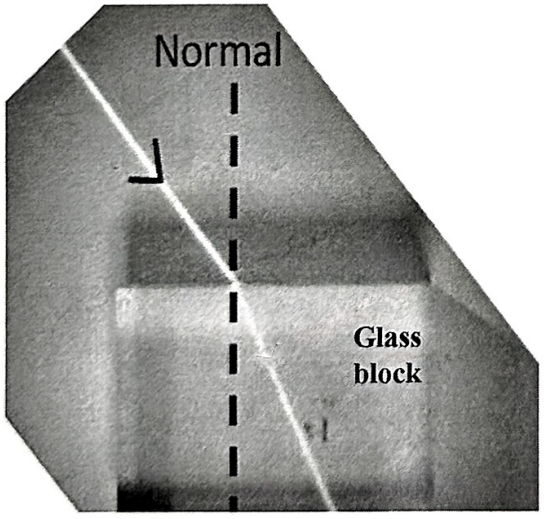
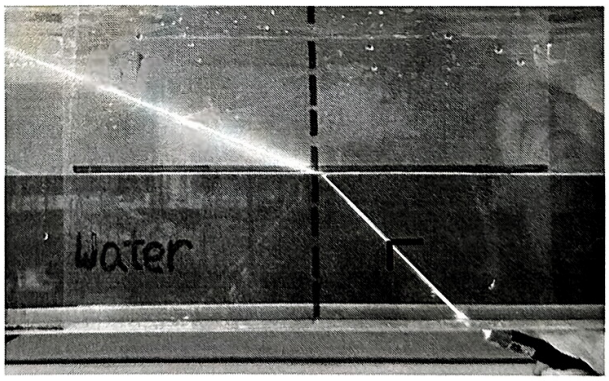
Introduction to Refraction

Speed of light in different media

Medium	Speed of light (ms^{-1})	Speed of light
vacuum / air	3×10^8	**fast** ↓
water	2.25×10^8	
glass	2×10^8	
diamond	1.24×10^8	**slow**

Concept

1. When light goes from one medium to another medium, the speed of light changes.
2. Refraction ONLY happens when the speed of light changes (from one medium to another medium). The light ray **bends** at the boundary between two media.

From air to glass (slow down)	**From water to air (speed up)**
	
Bend towards the normal	**Bend away from the normal**

Summary

From a faster medium to a slower medium, light **bends towards** the normal.

From a slower medium to a faster medium, light **bends away from** the normal.

Refraction of light:

Exercise

If the light goes from medium 1 to medium 2, what happens to the light ray?

Medium 1	Medium 2	Bend towards / away from the normal
air	diamond	
glass	water	
diamond	glass	
water	air	

Refractive index & Speed of Light

As light travels with different speed in different media, we can calculate the ratio between the speed of light in vacuum c and the speed of light in a certain medium v. This ratio is defined as the refractive index of that medium.

$$\text{Refractive index } (n) = \frac{\text{speed of light in vacuum } c}{\text{speed of light in the medium } v} = \frac{3 \times 10^8}{v}$$

Use the table in p. 19 to calculate the refractive index of water: _____

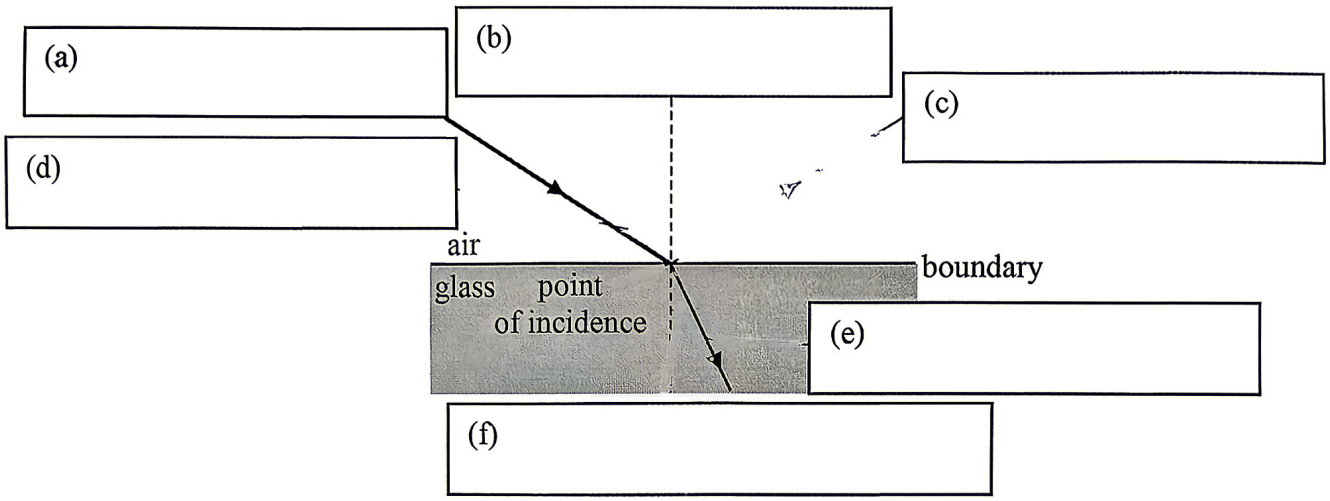
the refractive index of diamond: _____

- Larger the refractive index, higher / lower the speed of light.
- The refractive index of any medium must be _____ (no unit).
- The refractive indices of different media are used to calculate the angle of incidence and angle of refraction (refer to the Snell's law in p.23).

Angle of incidence and angle of refraction

When a beam of light is directed from one transparent medium to another (such as from air to glass) at an angle with the normal,

- it will be partially _____ by the boundary of the two media;
- part of it will pass through the boundary with its direction of _____ changed as shown below.

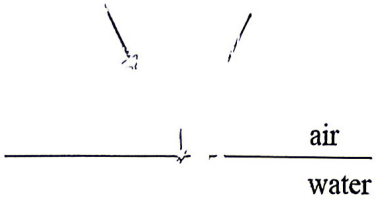


Exercise

In the ray diagrams below,

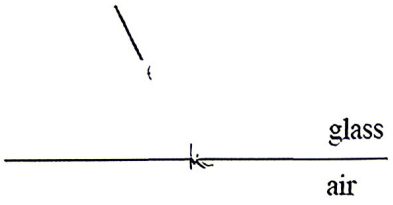
- Draw the normal
- Draw the reflected ray and refracted ray
- Label the angle of incidence as "*i*" and the angle of refraction as "*r*"

1)



bend towards / away from the normal

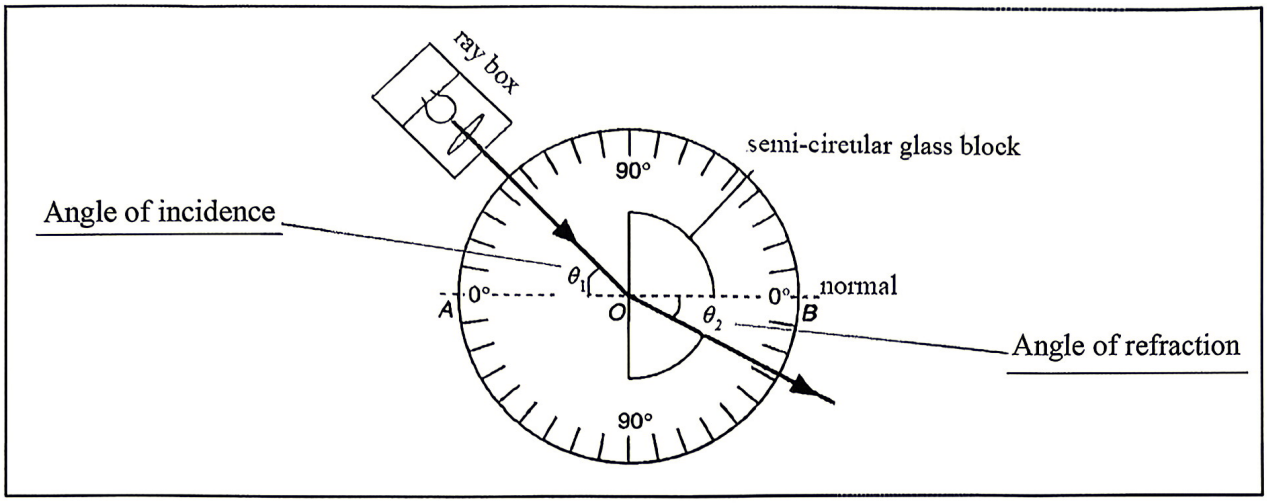
2)



bend towards / away from the normal

Snell's Law

1. Finish the experiment in page 42 to 44.



2. After doing the above experiment,

$$\frac{\sin\theta_1}{\sin\theta_2} = constant$$

$$\Downarrow$$

$$\frac{\sin\theta_1}{\sin\theta_2} = n_g \longleftarrow \_\_\_\_\_ \text{ of glass}$$

Define the refractive index of air n_a as 1. We can rewrite the equation as below.

$$\frac{\sin\theta_1}{\sin\theta_2} = \frac{n_g}{n_a} \longleftarrow \text{refractive index of air}$$

$$\Downarrow$$

$$n_a \sin\theta_1 = n_g \sin\theta_2$$

Medium 1 = air

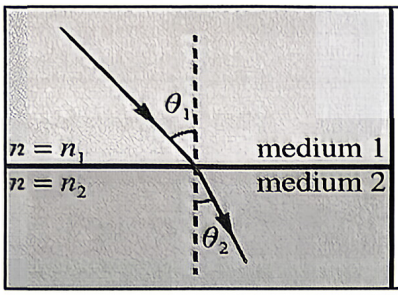
Medium 2 = glass

For general case, we can modify as follow.

$$n_a \rightarrow n_1 \ \& \ n_g \rightarrow n_2$$

$$n_1 \sin\theta_1 = n_2 \sin\theta_2 \quad \text{---------- Snell's Law}$$

Snell's Law



angle of incidence

about refracted medium

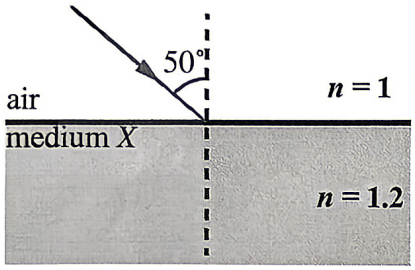
$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$

about incident medium

angle of refraction

Example

A light ray travels from air to medium *X* with refractive index 1.2 as shown below. The angle of incidence is 50°. Find the angle of refraction.



$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$

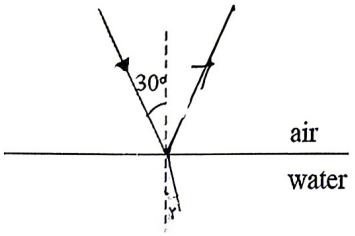
$$1 \times \sin 50^o = 1.2 \times \sin\theta_2$$

Exercise

Please complete the ray diagrams and calculate the angles of refraction (or angles of incidence).

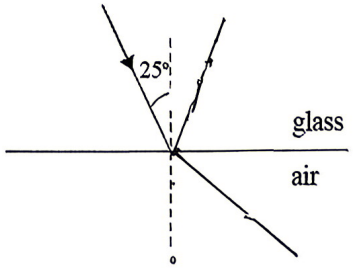
Medium	Vacuum / Air	Water	Glass	Diamond
Refractive index, *n*	1	1.33	1.5	2.42

1)



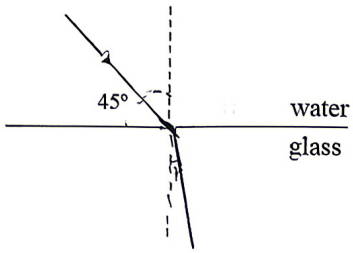
bend towards / away from the normal

2)



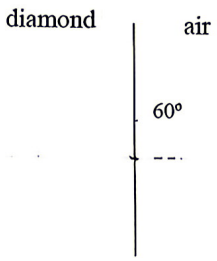
bend towards / away from the normal

3)



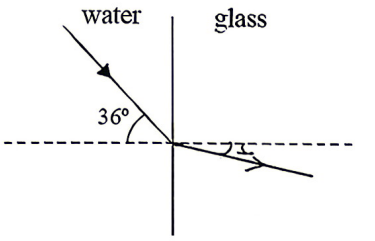
bend towards / away from the normal

4)



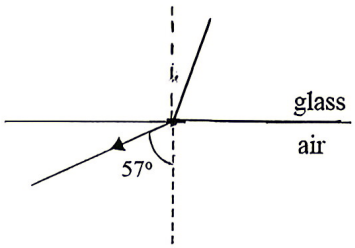
bend towards / away from the normal

5)

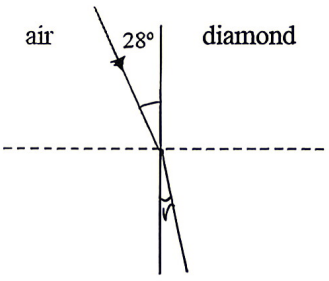


bend towards away from the normal

6)

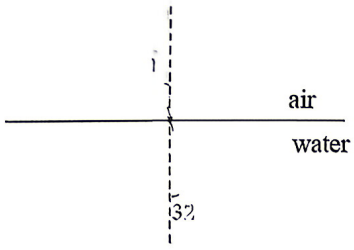


bend towards / away from the normal



bend towards / away from the normal

8)

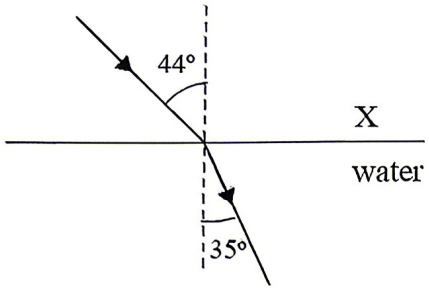


bend towards / away from the normal

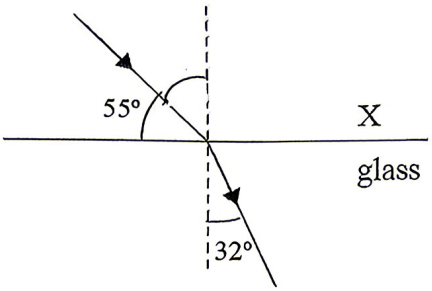
Exercise

Find the refractive index of medium *X*.

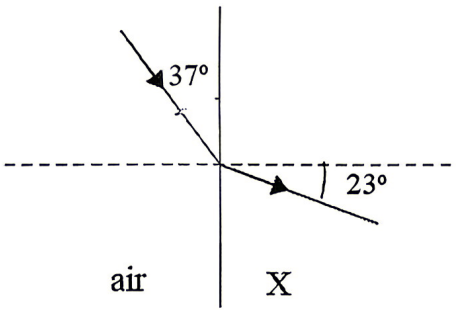
1)



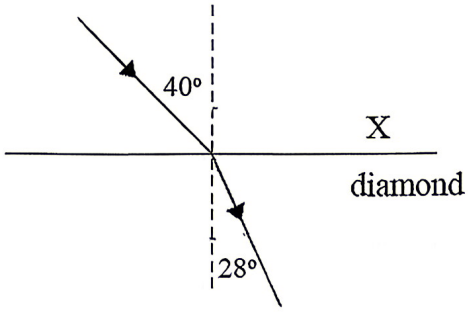
2)



3)

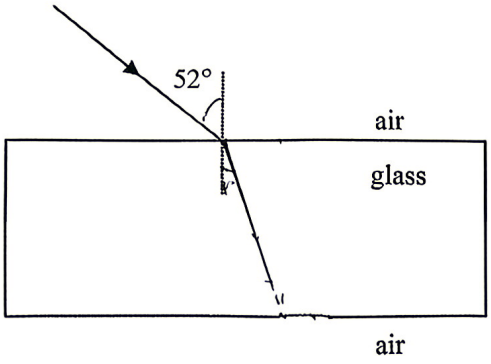


4)



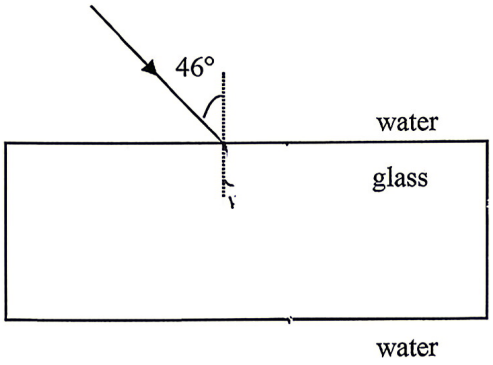
Further Study on Refraction

1. Given that the refractive index of the rectangular glass block is 1.5. Complete the ray diagram below and calculate all angles of incidence and refraction.



Calculations

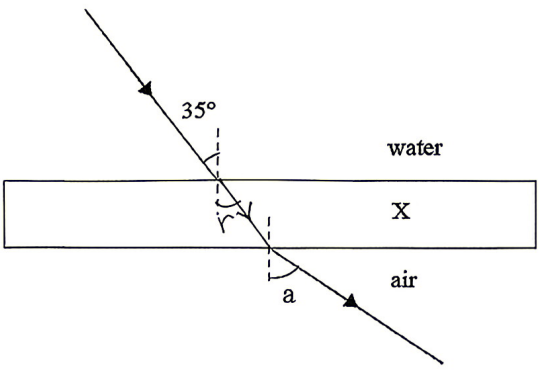
2. Given that the refractive index of the rectangular water and glass block are 1.33 and 1.5 respectively. Complete the ray diagram below and calculate all angles of incidence and refraction.



Calculations

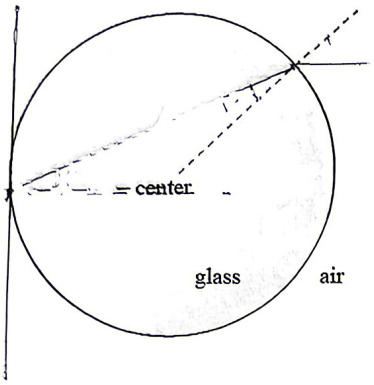
Challenging Questions

There is an unknown medium *X* between water and air. The refractive index of water is 1.33. Find out the angle *a*.



Calculations

3. The refractive index of glass is 1.5. Complete the ray diagram below and calculate all angles of incidence and refraction.



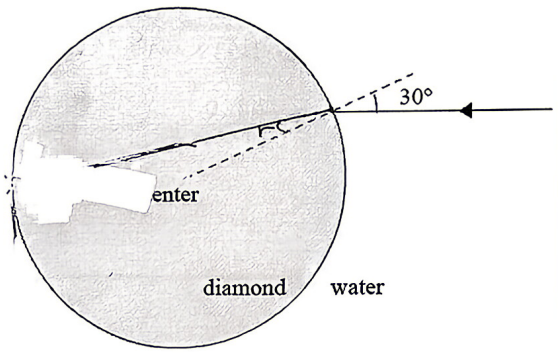
Calculations

Test your concept

According to the question 3, if the cylindrical glass block is placed inside a liquid of the same refractive index of glass. Describe the path of the light ray.

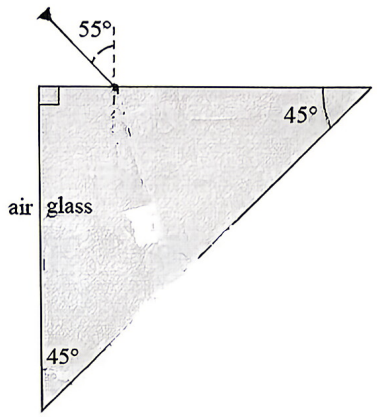
Answer: _____

4. The refractive index of water and diamond are 1.33 and 2.42 respectively. Complete the ray diagram below and calculate all angles of incidence and refraction.



Calculations

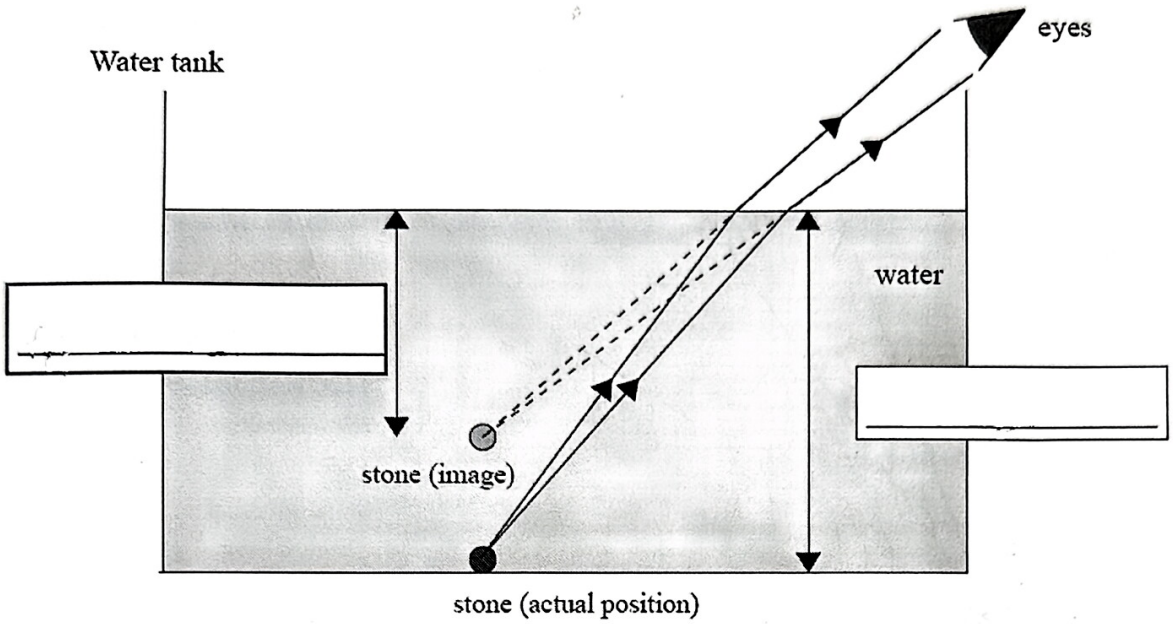
Challenge Questions (The refractive index of glass is 1.5)



Calculations

Examples of Refraction

Real depth & Apparent depth



Summary

- When light rays travel from _____ to _____. They bend _____ normal.
- Elongate the refracted rays backwards to find the _____. This is the position of _____.
- The stone appears to be __above / below__ the actual position.

Test your concept

1. If the water is replaced by another liquid of higher refractive index, how does the apparent position of the stone change?

   Answer: _____

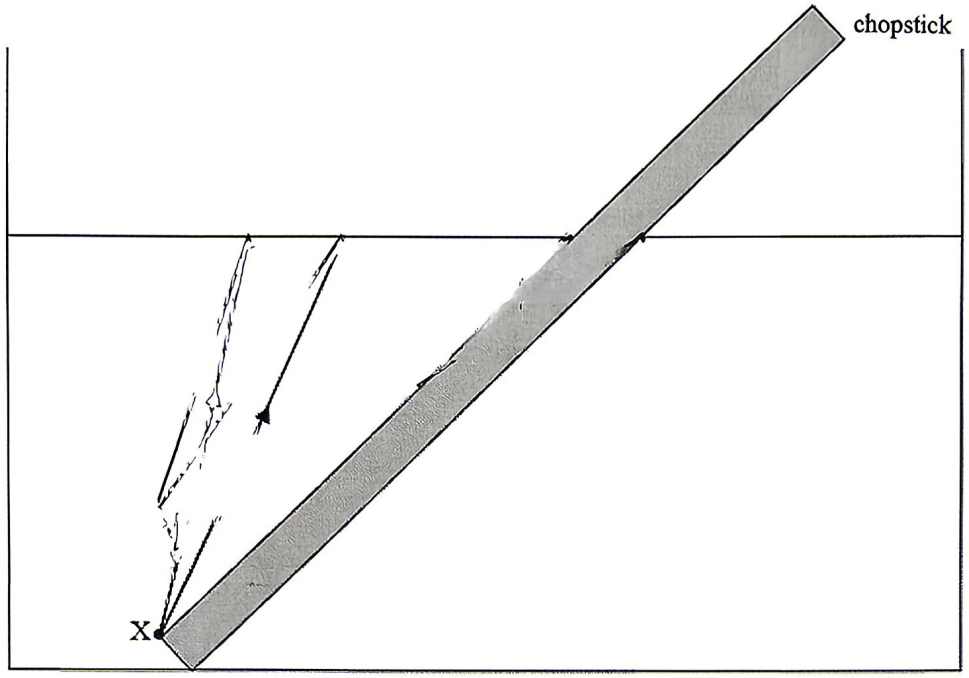
A coin in water - refraction

Bent chopstick

Step 1: Draw two refracted light rays from point *X*.

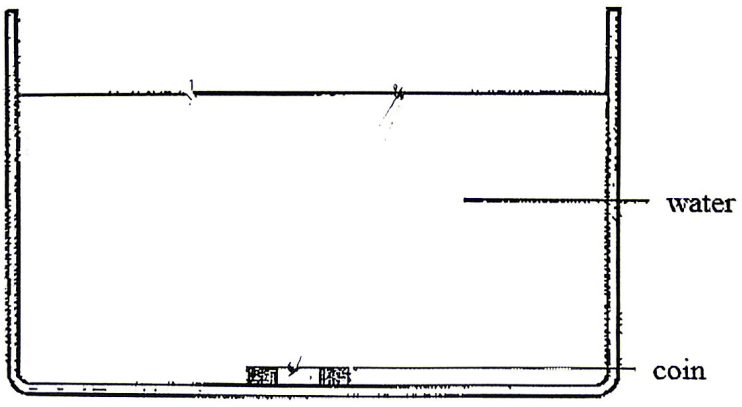
Step 2: Estimate the apparent position of point *X* in the water.

Step 3: Draw the apparent shape of the chopstick in the water.



Draw the ray diagram to explain the image of the coin

Eye

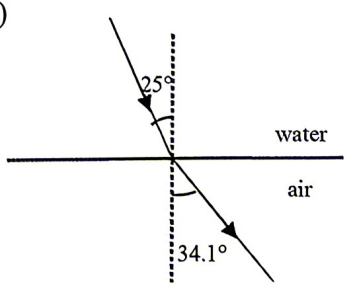


Total Internal Reflection (TIR)

Introduction to Total Internal Reflection

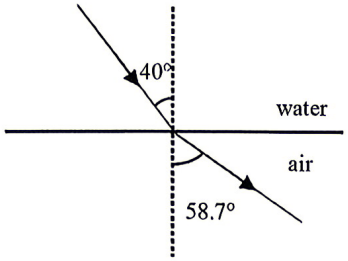
Referring to the result of experiment on p.47, consider light rays traveling from water to air.

a)



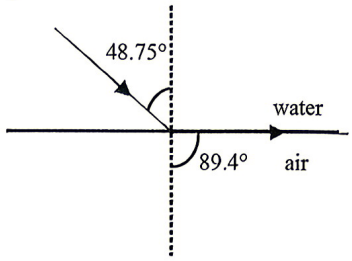
$(1.33)sin25^o = (1)sin34.1^o$

b)



$(1.33)sin40^o = (1)sin58.7^o$

c)



$(1.33)sin48.75^o = (1)sin89.4^o$

As angle of incidence i increases, angle of refraction r (increases / decreases).

$r > i$ ⟹ When $i \uparrow$, r reaches 90° first.

Notes

Light rays travel from slow medium to fast medium — example: water → air

i increases to certain degree, r becomes 90°

This special value of i is called _____ angle (C)

If i > critical angle, there is NO refraction. ONLY reflection occurs.

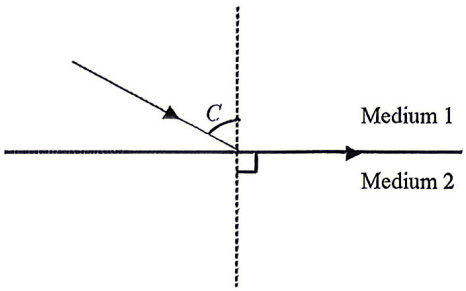
So, we call the situation as _____.

Calculate the critical angel C using Snell's law.

$$n_1 sin\, C = n_2 sin 90^o$$

$$n_1 sin C = n_2$$

$$C = \sin^{-1}\left(\frac{n_2}{n_1}\right)$$



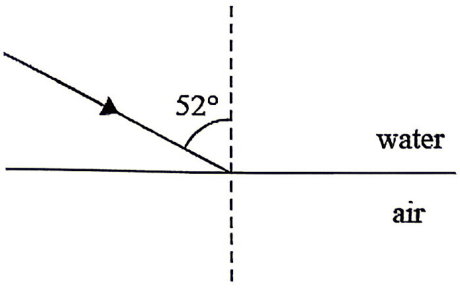
Exercise

Calculate the critical angle C for the following cases.

	Medium 1 (refractive index)	Medium 2 (refractive index)	Critical Angle C
1	Diamond (2.42)	Air	
2	Crystal (2.00)	Air	
3	Glass (1.50)	Air	
4	Glass (1.50)	Water (1.33)	
5	Air	Water (1.33)	
6	Diamond (2.42)	Glass (1.50)	
7	Glass (1.50)	Crystal (2.00)	

The refractive index of water is 1.33. Calculate the critical angle for light rays travelling from water to air. Complete the ray diagram.

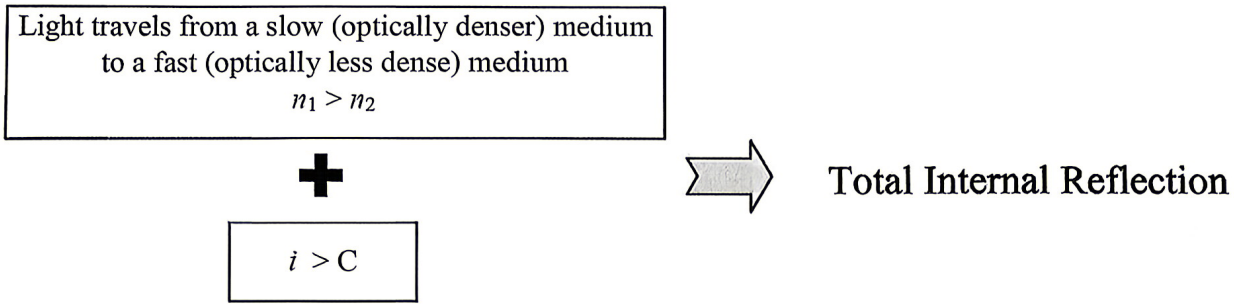
Calculations



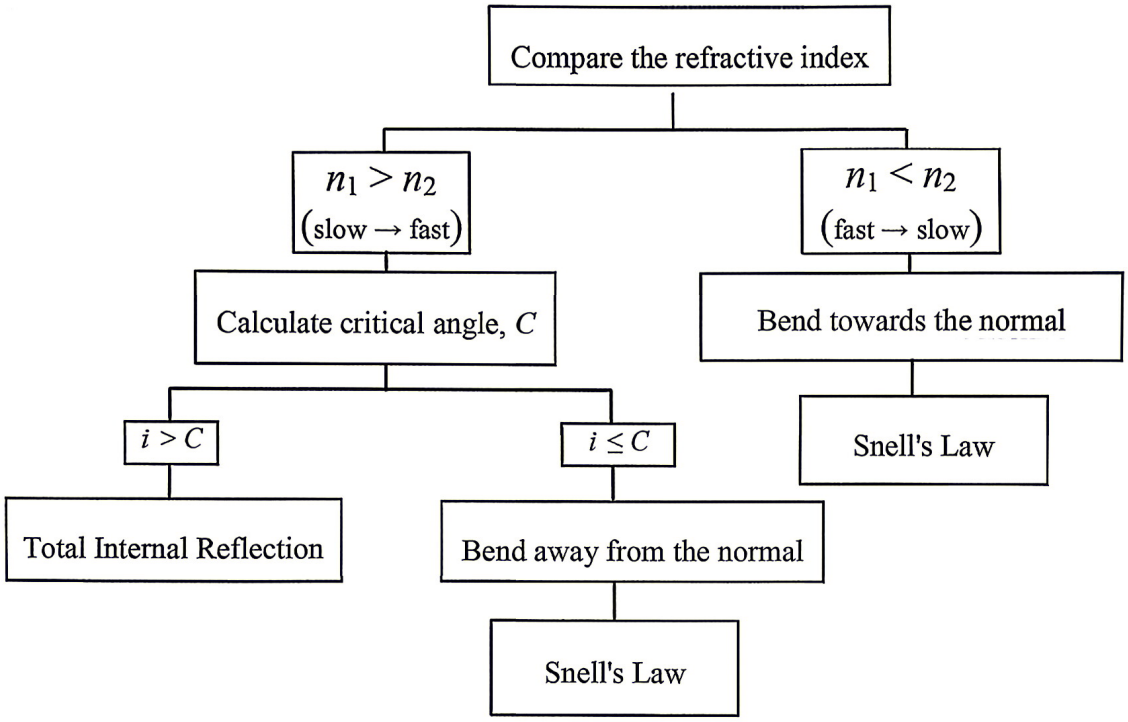
Try to use Snell's law to calculate the angle of refraction if $i = 52°$.

Calculations

Summary



In general, TIR and refraction are strongly related.



Total internal reflection – critical angle:

Exercise

Given:

	water	glass	crystal	diamond
Refractive index	1.33	1.5	2	2.42

Light travels from medium 1 to medium 2. What happens?

A) Bend towards the normal

B) Bend away from the normal

C) Total Internal Reflection

	Medium 1	Medium 2	Incident angle	Result (A / B / C)
1	Air	Water	60°	
2	Diamond	Air	20°	
3	Diamond	Glass	35°	
4	Crystal	Air	53°	
5	Water	Crystal	75°	
6	Glass	Air	40°	

Test your concept

1. If the critical angle is smaller, is it easier or more difficult to have total internal reflection?

   Answer: _____

2. How to increase the critical angle? (Consider the relationship between n_1 and n_2.)

   Answer: _____

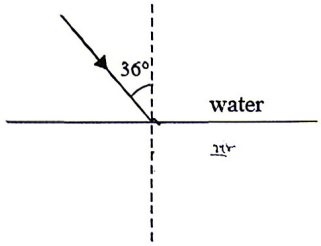
Further Study on Total Internal Reflection

Exercise

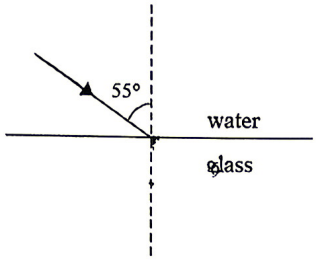
Complete the ray diagrams below and calculate the angles of refraction if necessary.

Refractive index	Water 1.33	Glass 1.5	Diamond 2.42

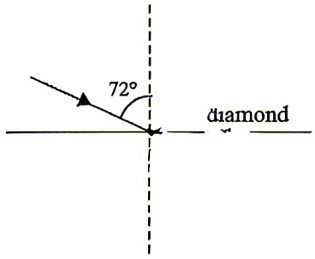
1)



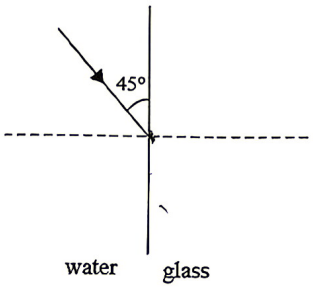
2)



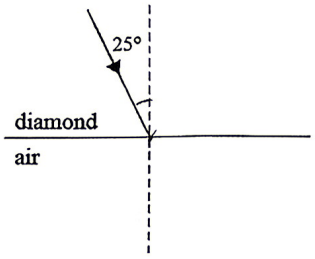
3)



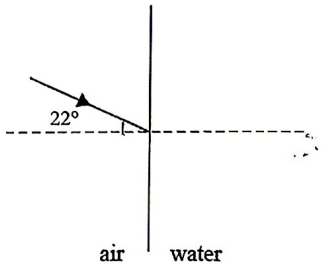
4)

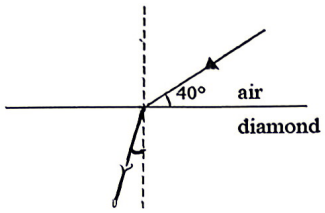


5)

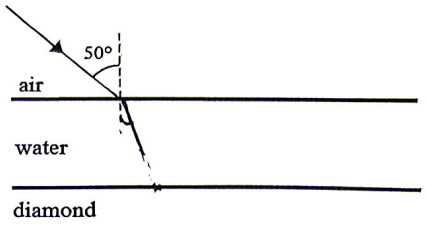


6)

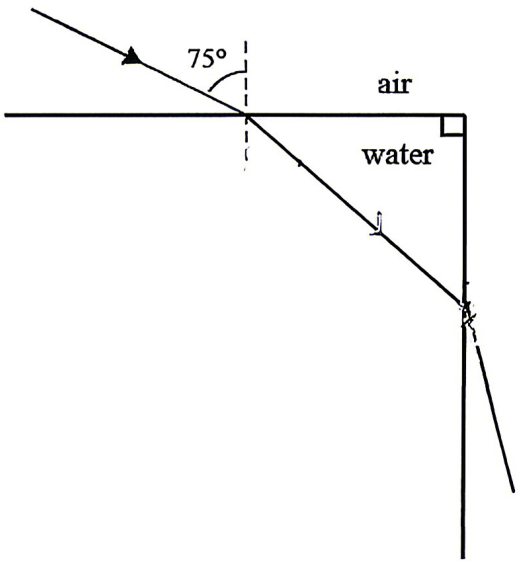




8)

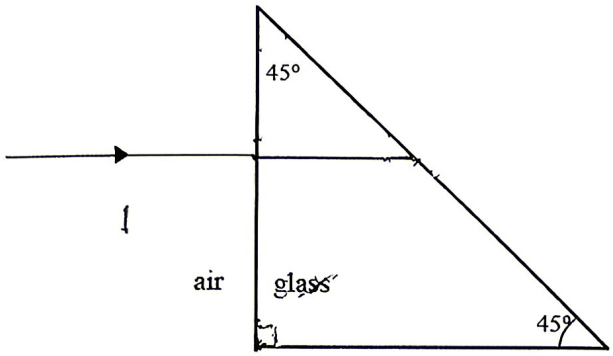


9)



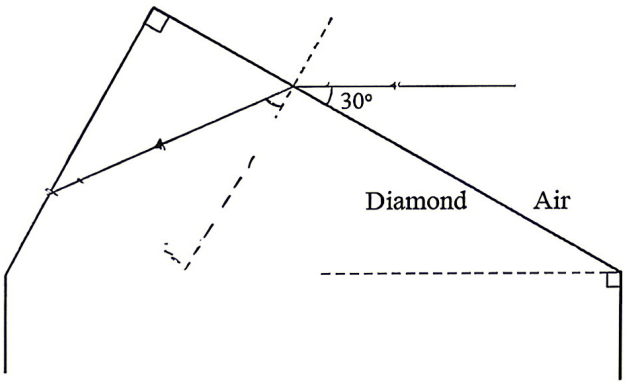
Calculation

10)



Calculation

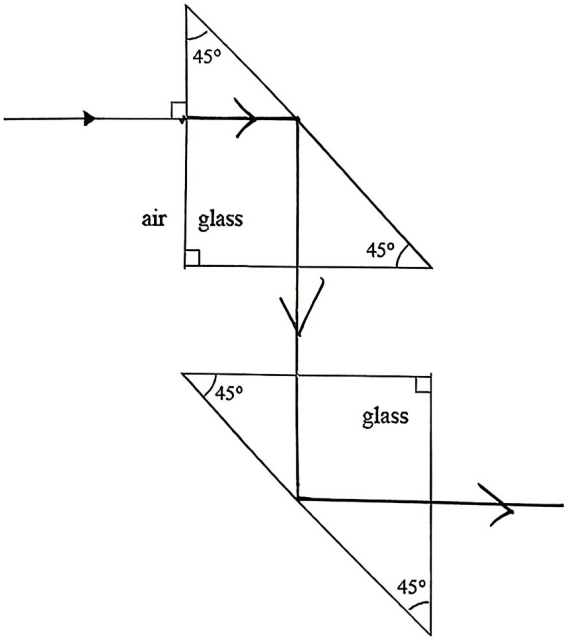
11)



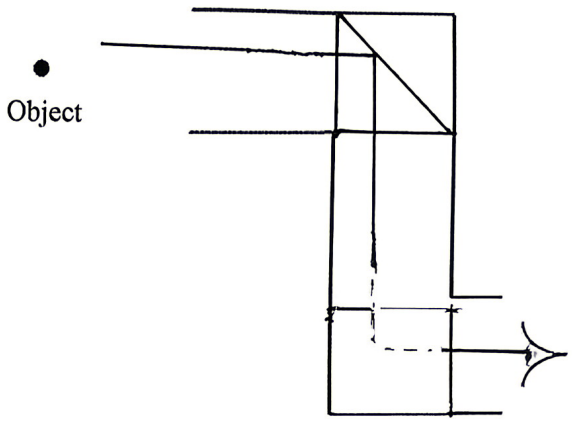
Calculation

Applications of Total Internal Reflection

Periscope using prisms



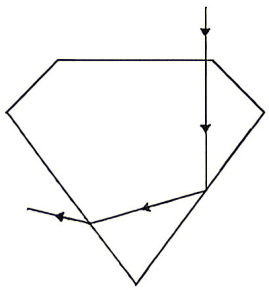
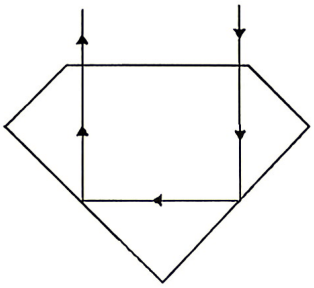
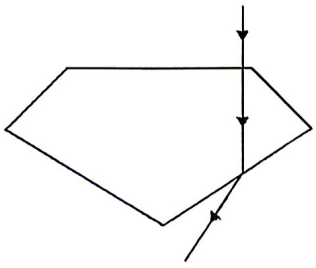
How does a prism periscope work?



Diamond

How to make a diamond become shiny?

It's related to its _____

Too deep	Proper	Too shallow
		

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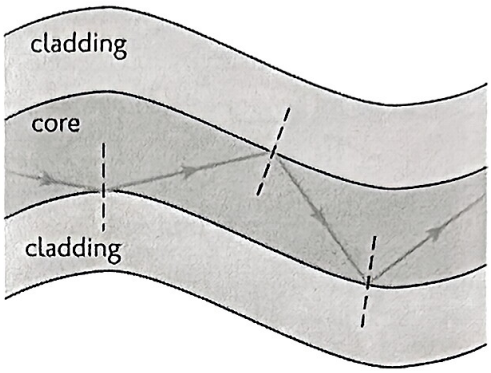
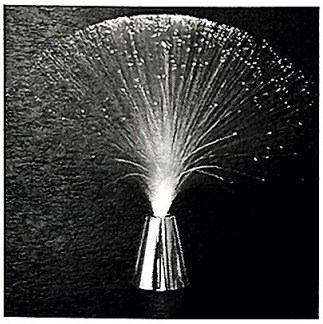
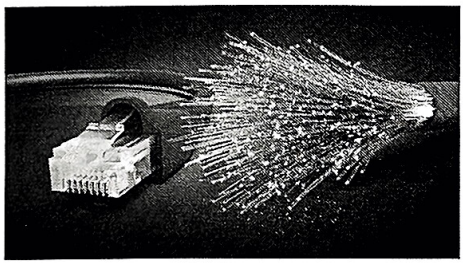
Optical Fiber

An optical fiber is an optical device for guiding light. It consists of a glass core covered in a layer of glass cladding. The glass core has refractive index higher than the cladding. When a light ray enters the core, it is guided from one end to another. The light ray does not escape as long as it is totally reflected on the core-cladding boundary.

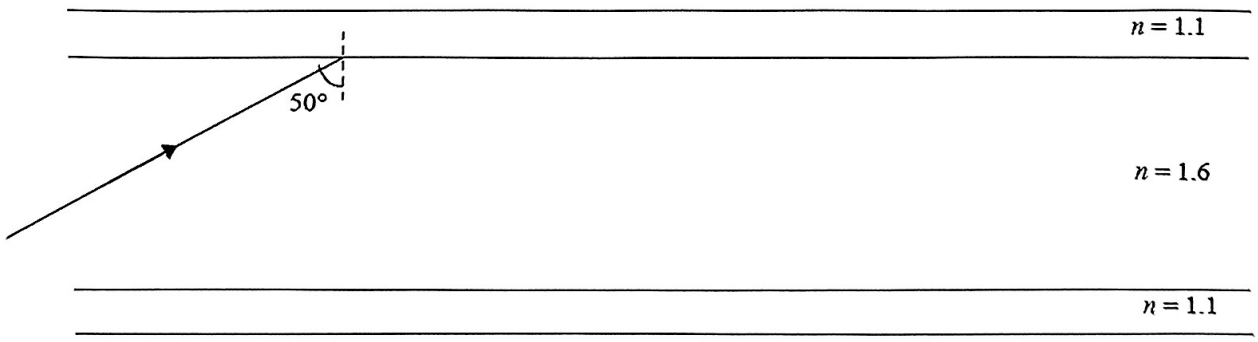


An optical fiber is used to transmit signal or data by light pulses over _____ and with less _____. It can also be used to transmit _____ _____. Typical applications nowadays are telecommunication optical cable and medical endoscopes.





Exercise

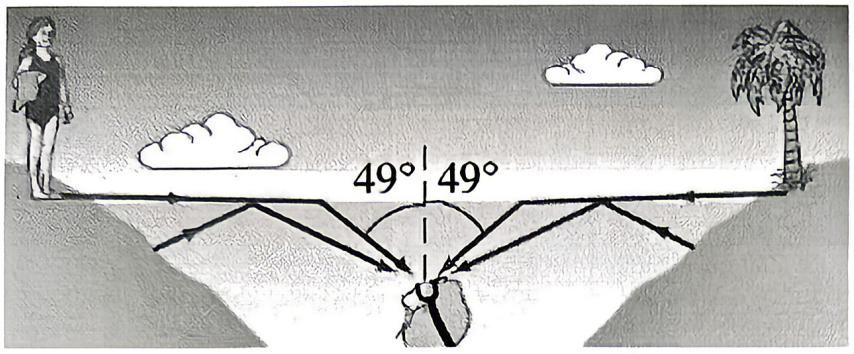


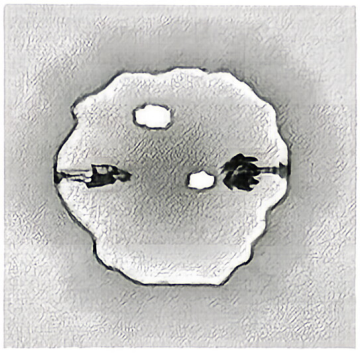
(a) What is the critical angle of the optical fiber above? _____

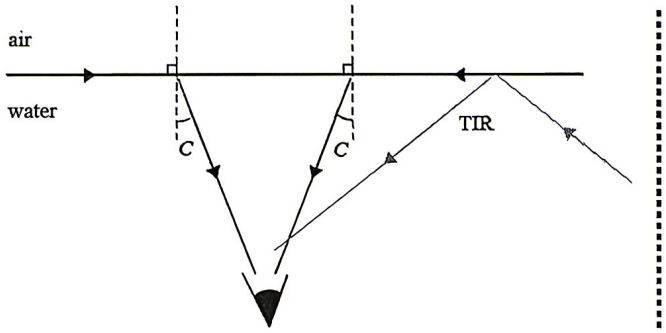
(b) Complete the ray diagram.

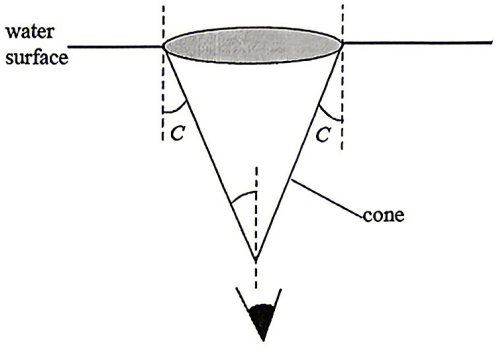
Underwater Scene

- The diver can see **all objects above the water surface** are squeezed into a circular region.
- The water surface outside the circular region acts like a flat mirror, allowing the diver to observe the **underwater environment** through total internal reflection.





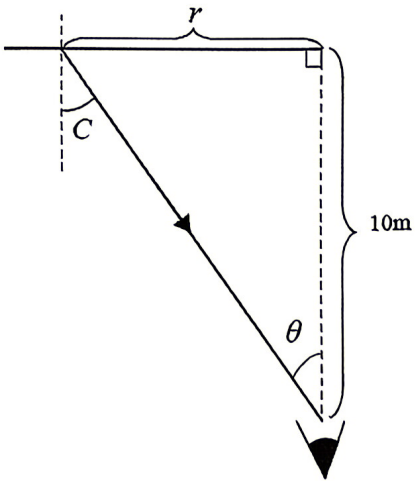




1. What is the value of *C*? _____

2. A man looks up in the water. He sees the things above water. What is the radius of his view if his eyes are 10 m below the water surface?

Calculations



Investigative Study

Periscope

Aim:

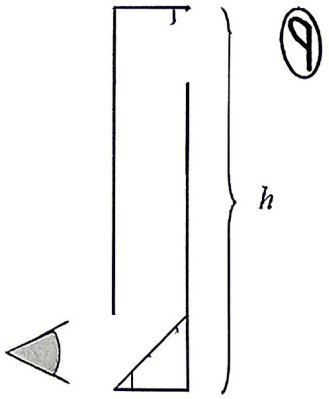
(a) to make a simple periscope
(b) to find out the properties of the image formed by a periscope

Equipment: DIY Periscope kit set x 1

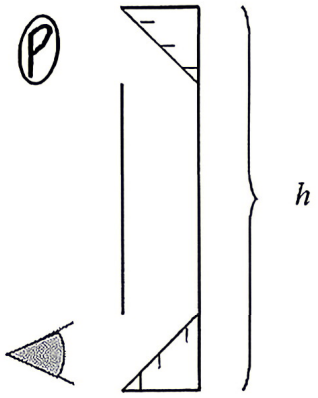
Procedure:

1. Make a simple periscope using DIY Periscope kit set. (blueprint: on kit set)
2. Look at an object using the periscope as below.

Method A



Method B



Results

	Method A	Method B
Image formed by observing 「P」		
Laterally inverted?		
Inverted?		

As *h* increases, the image becomes _____

Analysis

Explain how the images formed using ray diagrams.

Law of Refraction

Aim:

1. Study the refraction of light
2. Study the laws of refraction
3. Using the experimental results to calculate the refractive index of glass block given

Equipment:

1. 1 ray-box with cylindrical lens and slit plate
2. 1 semicircular glass block
3. 1 full-circle protractor (paper)

Procedure:

1. Place a semicircular glass block on the full-circle protractor.
2. Align the mid-point *O* of the straight edge of the glass block at the centre of the full-circle protractor.
3. Direct a ray from the ray box to point *O* as shown in Figure 1.
4. Set the angle of incidence *i* as 0° and record the angle of refraction *r*.
5. Repeat the experiment with larger *i*. Record the angle of refraction *r*.

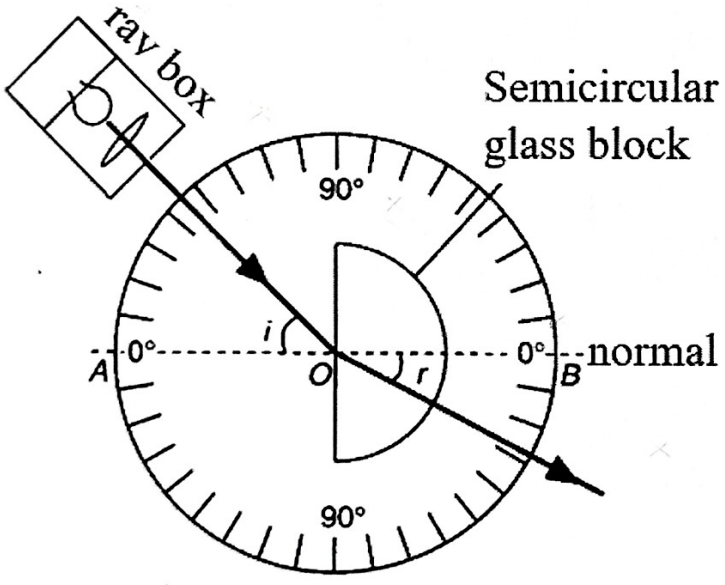


Fig.1

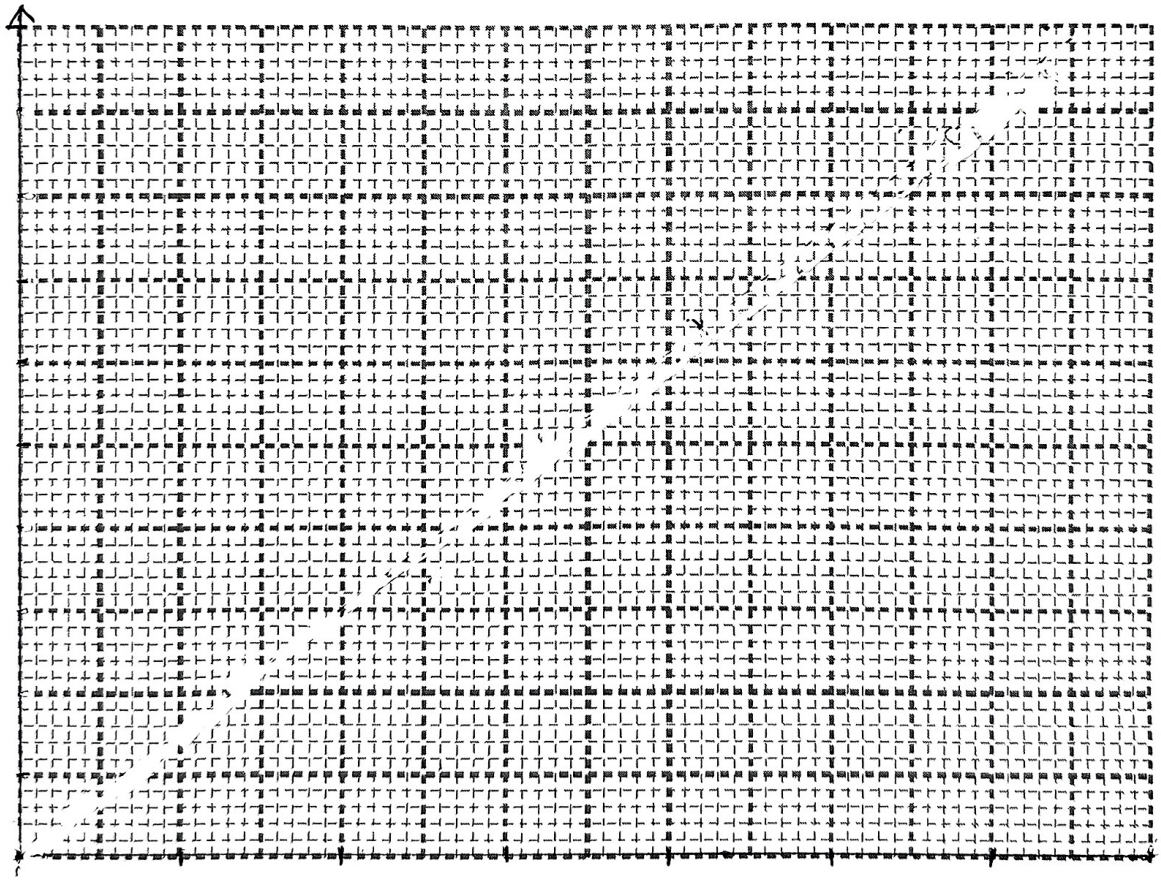
Snell's law of refraction (experiment):

Results & Analysis

1. Calculate sin i and sin r for each value of i and r. keep two decimal places

Angle of incidence i	Angle of refraction r	sin i	sin r
0°			
20°			
30°			
40°			
50°			
60°			
70°			

2. Plot a graph of sin i against sin r. (Note: y-axis:sin i, x-axis:sin r)



Discussion

What is the angle of refraction r when the angle of incidence i is 63°?

(Hint: Read the value from the plotted graph)

_____

_____

_____

Conclusion

- Light _____ when it travels from air to the glass block.
- The plotted graph form a _____ passing through _____. The ratio $\frac{\sin i}{\sin r}$ is constant and is equal to the _____ of the glass block.

Total Internal Reflection

Revision:

1. When light travels from water / glass to air, what happens to the light?

_____

Observation:

2. If the incident angle becomes larger, what do you observe?

_____

Discussion:

3. What is the name of this new phenomenon? _____

4. If light travels from air to water/glass, can you see this phenomenon? _____

5. What are the conditions of having this phenomenon?

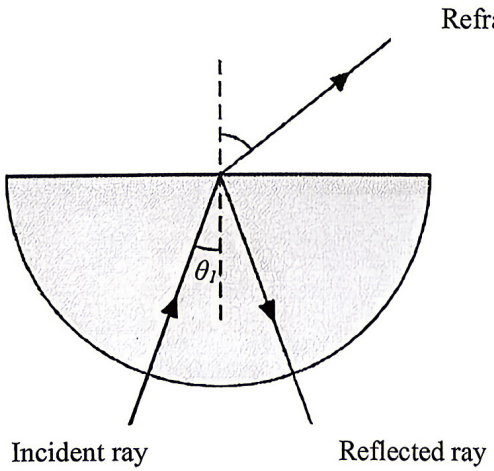
_____

_____

Experiment:

Aim: to find out the conditions of having total internal reflection for glass-air interface.

Set-up:



Steps: 1. Change the incident angle from 0° to 90°.
2. Observe whether there are reflections and refractions.

Results

θ_1	Refraction? (√ / ×)	Reflection? (√ / ×)	θ_1	Refraction? (√ / ×)	Reflection? (√ / ×)
0°			50°		
20°			60°		
30°			70°		
40°			80°		

1. From the experiment, can you find out what is the minimum angle for having total internal reflection?

_____

2. Conditions of having total internal reflection in glass:

_____

3. How does the light travel in a glass tube?

air

air

glass tube

4. One of the applications of the above glass tube is _____.

2024-2025 First Term Uniform Test and Exam Past Paper

S3 First Term Uniform Test (2024-2025)

Physics

(45 minutes)

Date: 29th October 2024

Time: 8:30a.m. – 9:15a.m.

Name: _____

Class: _____ No.: _____

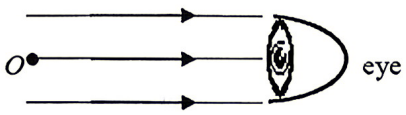
Instructions to students:

1. Write your name, class and class number on both the question paper and the answer sheets.
2. Answer ALL questions.
3. Write down all the answers on the answer sheets.
4. Hand in the question paper and the answer sheets at the end of the examination.
5. The total mark of the paper is 60.
6. The paper consists of two sections: Section A Multiple Choice Questions (20 marks) and Section B Structured Questions (40 marks).
7. The numerical answers should be either exact or correct to 3 significant figures.

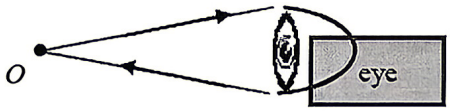
Section A: Multiple Choice Questions (20 marks)

1. Which of the following correctly shows the rays coming from a near point object *O*?

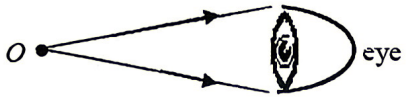
A.



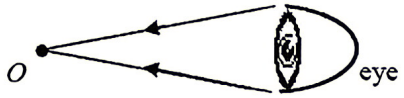
B.



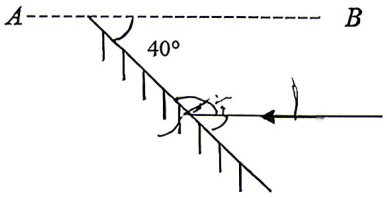
C.



D.

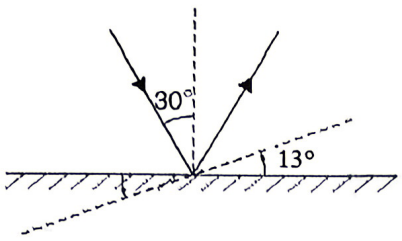


2. As shown in the figure below, the incident ray is parallel to the horizontal plane *AB*. What is the angle of incidence?



A. 20°
B. 40°
C. 50°
D. 60°

3. As shown in the figure below, the angle of incidence of a ray on a plane mirror is 30°.



30 - 13

What is the angle of reflection if the mirror is rotated anti-clockwise through an angle of 13°?

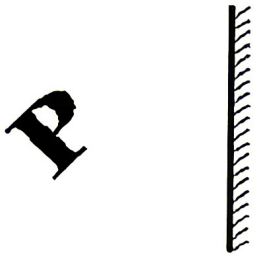
A. 13°
B. 17°
C. 26°
D. 43°

4.

The figure above shows the image of a digital clock face formed by a plane mirror. What is the time shown by the clock?

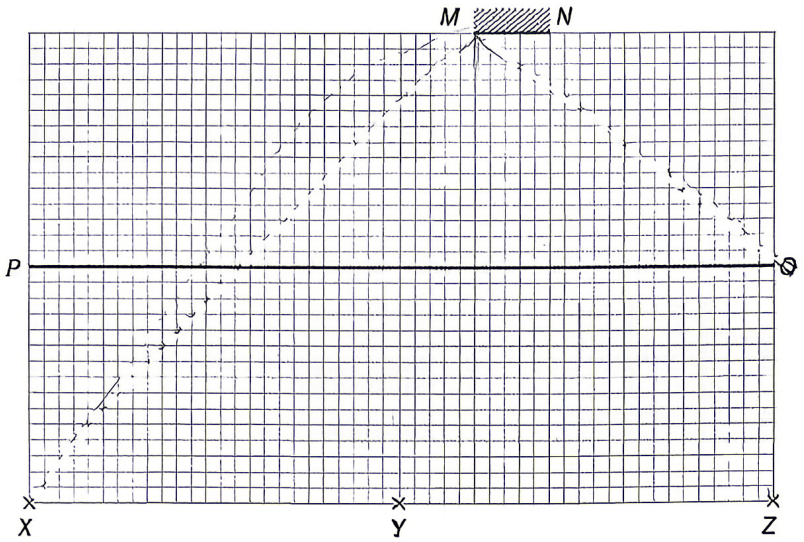
A. 10:51
B. 12:01
C. 12:10
D 15:01

5. Which of the following correctly shows the image of the letter "P" formed by the plane mirror in the figure below.



A. 
B. 
C. 
D. 

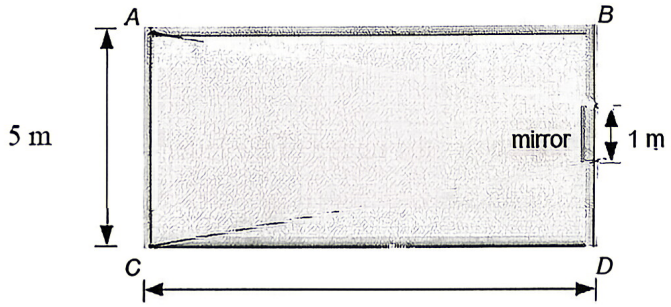
6. Mary is walking along a line PQ in a room. She looks into a plane mirror MN hung on a vertical wall as shown in the figure below. Three pictures are hung at points X, Y and Z respectively on another wall opposite to the mirror.



The image of which point(s) can she see in the plane mirror during the course of walking?

A. X and Y only
B. X and Z only
C. Y and Z only
D. X, Y and Z

7. In a room $ABCD$, a tall plane mirror of width 1 m is placed at the middle of the wall BD. The top view of the room is shown below.



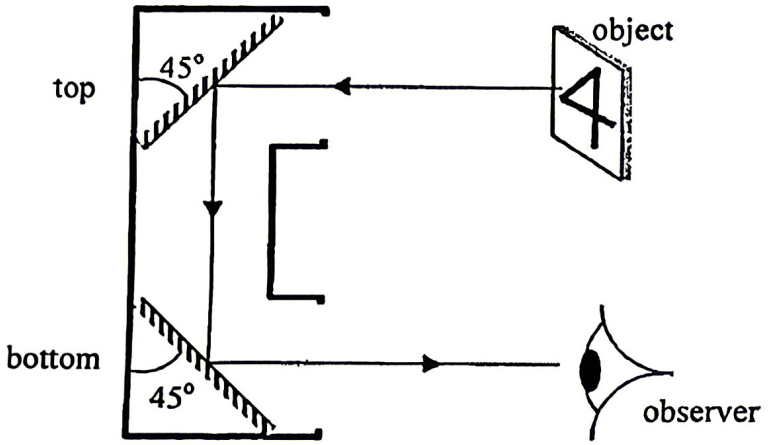
A student facing the mirror wants to see the objects placed at corners A and C at the same time. What is the largest distance at which he stands away from the mirror?

A 2.0 m
B. 2.5 m
C. 3.0 m
D. 3.5 m

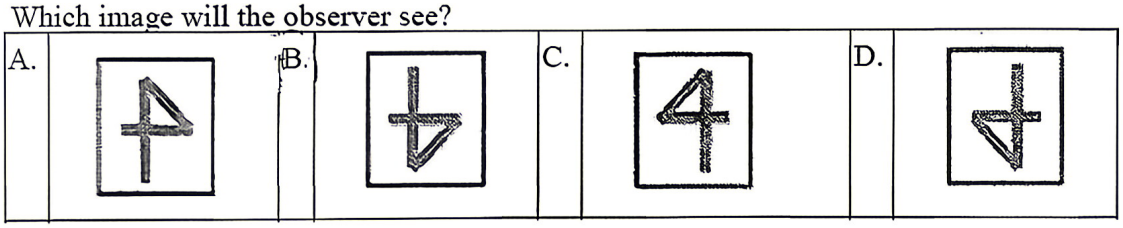
8. A boy stands in front of a plane mirror. If the mirror moves towards him at a speed of 2 m s^{-1}. How does his image move?

	towards the mirror	towards the boy
A.	1 m s^{-1}	2 m s^{-1}
B.	2 m s^{-1}	2 m s^{-1}
C.	2 m s^{-1}	4 m s^{-1}
D.	4 m s^{-1}	4 m s^{-1}

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



Which image will the observer see?



10. Which of the following statements are INCORRECT?

(1) Reflection occurs on smooth surface only.

(2) We can see luminous objects but not non-luminous objects.

(3) A moon is a non-luminous objeet.

A. (1) and (2) only

B. (1) and (3) only

C. (2) and (3) only

D. (1), (2) and (3)

End of Section A

Section B: Structured Questions (40 marks)

1. (a) State THREE properties of light. (3 marks)

   (b) State THREE properties of image formed by a plane mirror. (3 marks)

2. (a) Refer to Figure 2a on the answer sheet, two rays of light from point *O* strike a plane mirror at points *A* and *B* respectively. Draw

   (i) the normals of the mirror at *A* and *B*. (1 mark)

   (ii) the reflected rays. (1 mark)

   (b) Find the angles of incidence for the rays striking the mirror at *A* and *B*. (2 marks)

   (c) State what kind of reflection is on a wavy water surface as shown in Figure 2b. (1 mark)

   (d) Explain briefly why the computer monitor facing to the window in Figure 2c is difficult to see. (2 marks)

Figure 2b

Figure 2c

3. Refer to Figure 3 on the answer sheet, a light ray strikes a plane mirror M_1 at an angle of 36°.

   (a) Complete the ray diagram in Figure 3 on the answer sheet to show the reflected rays on mirror M_1 and M_2. (2 marks)

   (b) What is the angle between the incident ray and the reflected ray on mirror M_1? (2 marks)

   (c) Find the angle of reflection on mirror M_2. Show your calculation. (2 marks)

4. Refer to Figure 4 on the answer sheet, an object is placed in front of a plane mirror.

   (a) Draw the image. (2 marks)

   (b) Draw the reflected rays. (3 marks)

5. Refer to the Figure 5 on the answer sheet, John uses a laser pointer to emit a light ray from point *A* to the plane mirror. The light ray is reflected at point *B* on the screen.

   (a) At which point (*C*, *D*, *E* or *F*) is the image of point *B* formed by the plane mirror? (1 mark)

   (b) Find the image distance of the laser pointer. (1 mark)

   (c) Draw the light ray on Figure 5 to show how the light ray emitted from point *A* and reflected by the mirror to point *B*. (2 marks)

   (d) Find the distance between point *X* and the point where the light ray incidents on the mirror. (1 mark)

6. Figure 6 on the answer sheet shows the top view of Fred's restaurant. There is a picture on the south wall. He sets up a 1 m mirror on the north wall. When he stands at O, he can JUST see the entire picture in the mirror.

   (a) Find the vertical distance from the image of the picture to Fred. (2 marks)

   (b) Complete the light rays on Figure 6 to show how he sees the picture in the mirror when he stands at O. Treat his eyes as a point. (3 marks)

   (c) Calculate the width of the picture. (3 marks)

7. As shown in Figure 7, Michael is viewing a toy soldier O through a periscope whose two plane mirrors are 30 cm apart. His eye E is 8 cm in front of the lower mirror M_2 while the toy soldier is 15 cm in front of the upper mirror M_1.

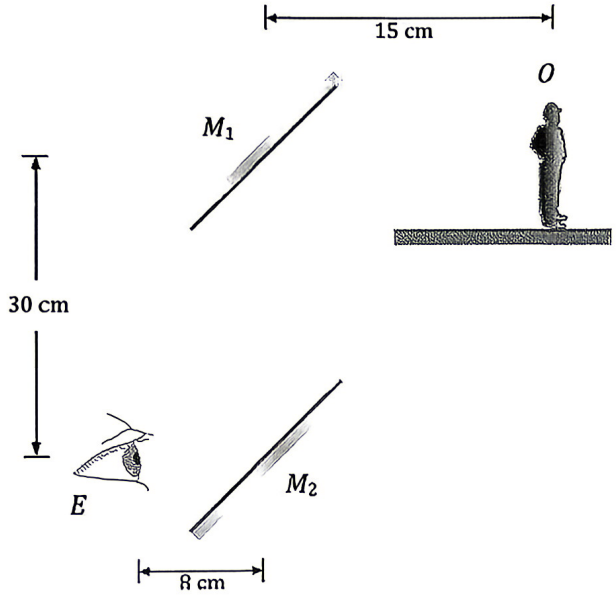


Figure 7

   (a) How far is the image of the toy soldier produced by M_2 from Michael's eye? (2 marks)

   (b) If the distance between the plane mirrors is shortened, how will the answer in (a) change? (1 mark)

End of Section B

S3 First Term Uniform Test (2024–2025)

Physics

Answer Sheet

(45 minutes)

Date: 29th October 2024

Time: 8:30a.m. – 9:15a.m.

Name: _____

Class: _____ No.:_____

Section A: Multiple Choice Questions (20 marks)

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.

Section B: Structured Questions (40 marks)

1. (a) _____

_____

_____

_____

(b) _____

_____

_____

_____

2. (a) (i), (ii)

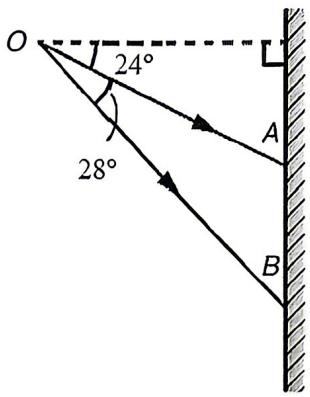


Figure 2a

(b) _____

_____

_____

(c) _____

_____

(d) _____

_____

3. (a)

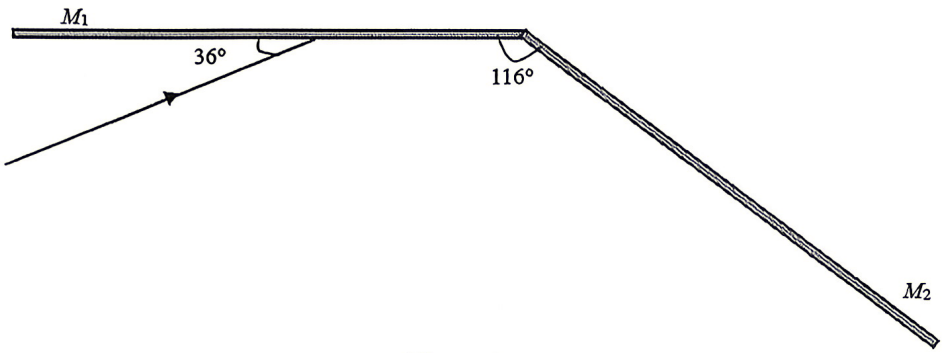


Figure 3

(b) _____

_____

_____

_____

(c) _____

_____

_____

_____

4. (a), (b)

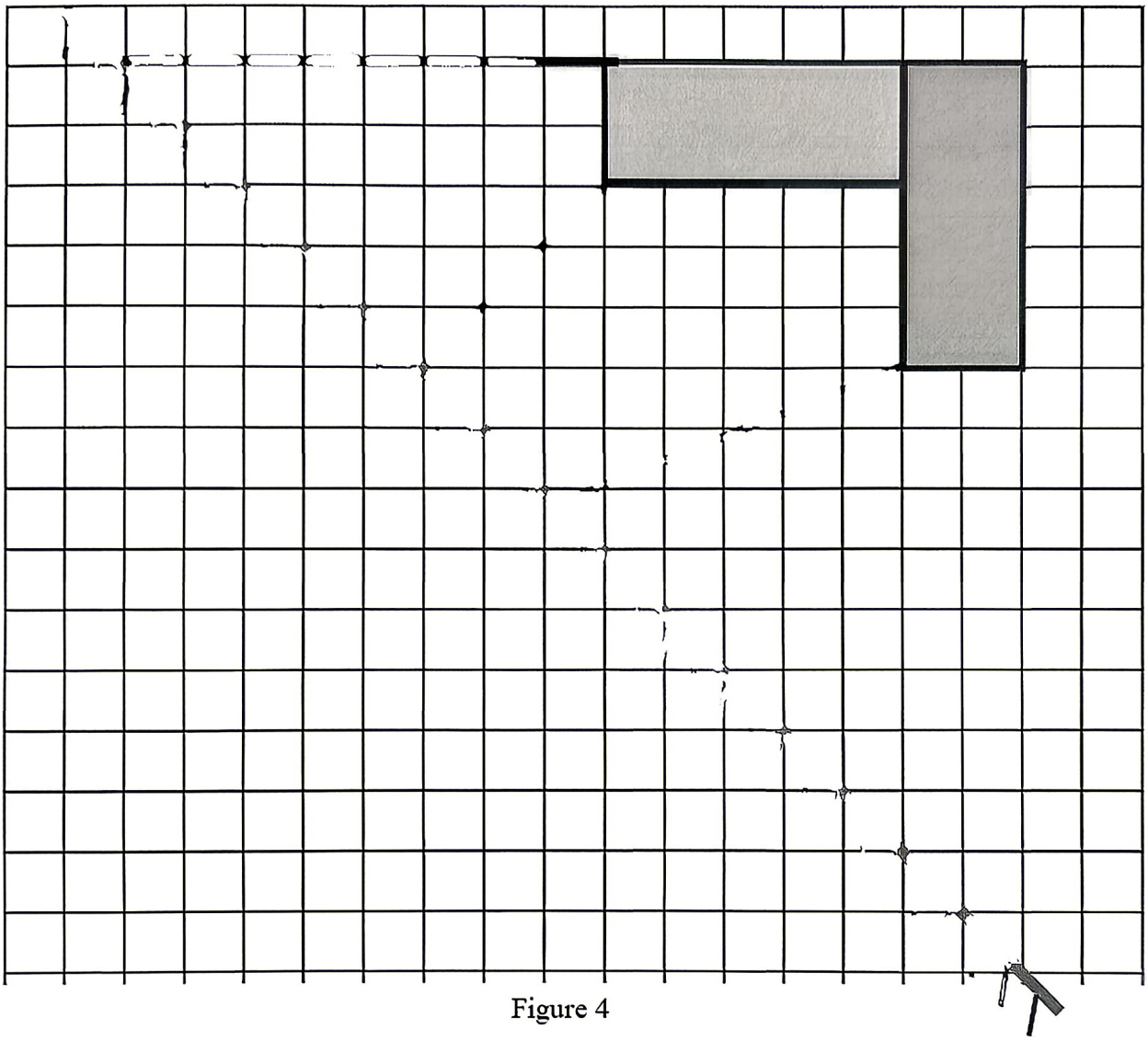


Figure 4

5. (a) _____

(b) _____

(c)

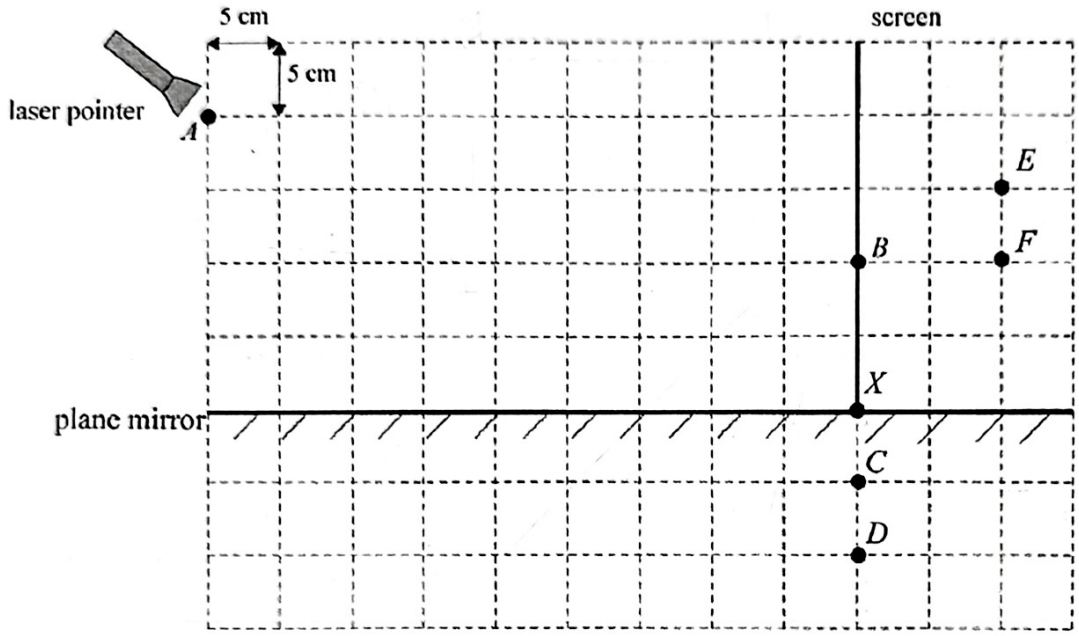


Figure 5

(d) _____

6. (a) _____

(b)

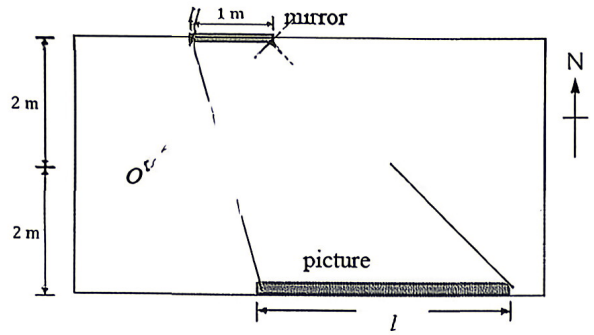


Figure 6

(c) _____

_____

_____

_____

7. (a) _____

_____

_____

(b) _____

_____

_____

END OF ANSWER SHEET

S3 First Term Examination (2024-2025)

Physics

(45 minutes)

Date: 14th January 2025

Time: 10:15 a.m. – 11:00 a.m.

Name: _____

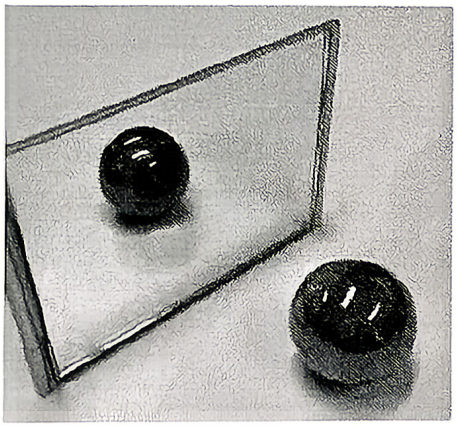
Class: _____ No.:_____

Instructions to students:

1. Write your name, class and class number on both the question paper and the answer sheets.
2. Answer ALL questions.
3. Write down all the answers on the answer sheets.
4. Hand in the question paper and the answer sheets at the end of the examination.
5. The total mark of the paper is 60.
6. The paper consists of two sections: Section A Multiple Choice Questions (20 marks) and Section B Structured Questions (40 marks).

Section A: Multiple Choice Questions (20 marks)

1. An image of a ball is formed by a mirror as shown below. Which of the following statements about the image is/are correct?



(1) It is virtual.

(2) It emits light rays to our eyes so that we can see it.

(3) If the ball is moved further away from mirror, the size of the image becomes smaller.

A. (1) only

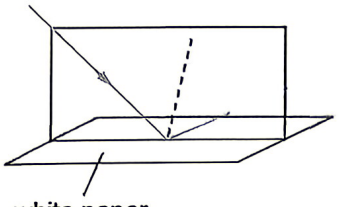
B. (1) and (3) only

C. (2) and (3) only

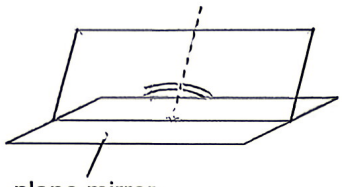
D. (1), (2) and (3)

2. A light ray falls onto different surfaces. Which of the following situations is **impossible**?

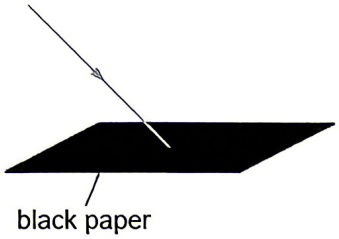
A.



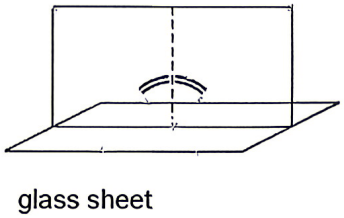
B.



C.

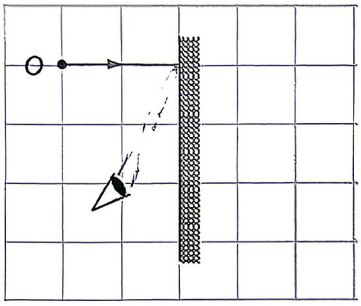


D.

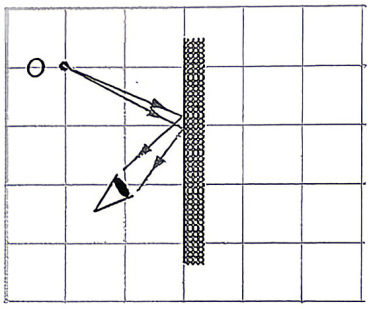


3. Which of the following diagrams correctly shows how the eye sees the image of object *O* in a plane mirror?

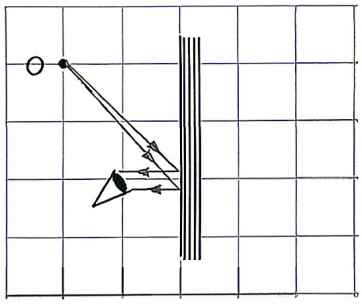
A.



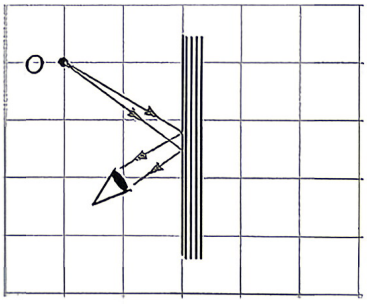
B.



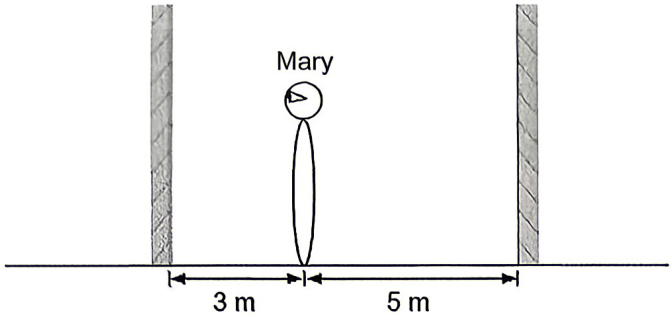
C.



D.

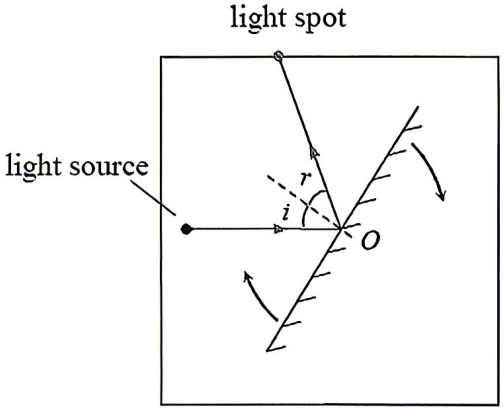


4. Two plane mirrors are placed parallel and opposite to each other. Mary is standing between the two mirrors and is facing the left mirror as shown below. She can see her back in the mirror. Find the distance between Mary and the closest image showing her back that she sees.



A. 8 m
B. 13 m
C. 16 m
D. 19 m

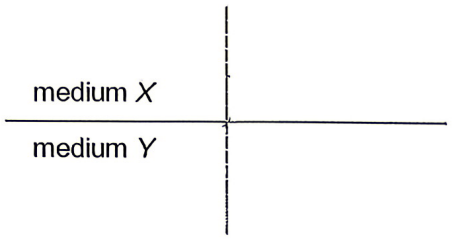
5. In a room, a light ray from a fixed source hits point O at a plane mirror and undergoes reflection. The mirror keeps rotating clockwise at a constant rate. If it takes time T for the mirror to turn 90° about point O, how long does it take for the reflected ray to rotate 90°?



top view

A. $T/4$
B. $T/2$
C. T
D. $2T$

6. A ray of light travels from medium X to medium Y with $i = 36°$ and $r = 42.8°$ as shown below.



The refractive index of X is 1.77. What is the refractive index of Y?

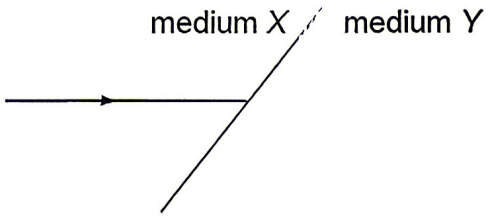
A. 1.16

B. 1.53

C. 1.70

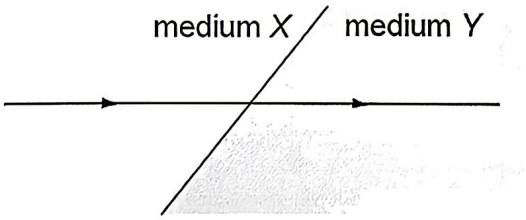
D. 2.05

7. A light ray is directed from medium X to medium Y as shown below. The refractive index of medium Y is greater than that of medium X.

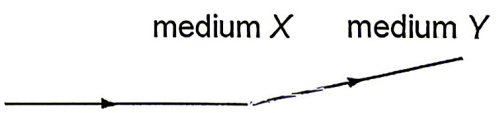


Which of the following figure best shows the path of the light ray?

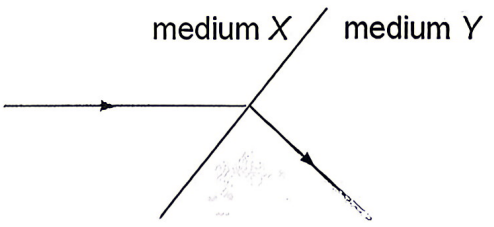
A.



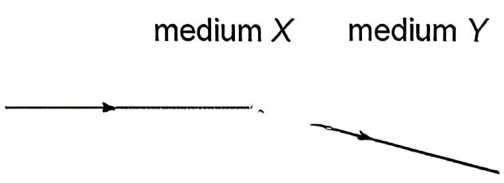
B.



C.



D.



8. Which of the following are examples of refraction?

   (1) A chopstick appears bent when dipped in water.

   (2) A goldfish in a tank appears nearer than it really is.

   (3) A distorted image of a tree is observed on a ruffled water surface.

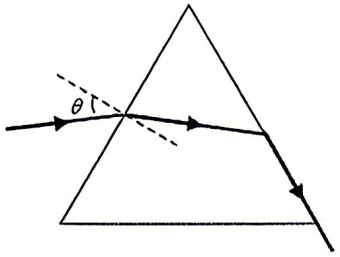
   A. (1) and (2) only

   B. (1) and (3) only

   C. (2) and (3) only

   D. (1), (2) and (3)

9. A ray of light is incident from air to an equilateral triangular glass prism at an angle θ. Its consequent path is shown below. The refractive index of the glass is 1.6.



   What is θ?

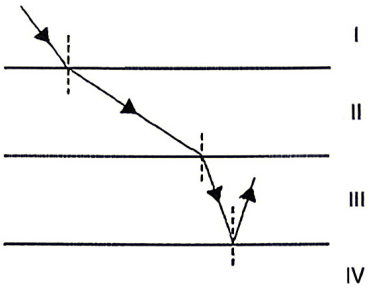
   A. 14.4°

   B. 21.3°

   C. 35.6°

   D. 42.0°

10. A light ray travels from medium I to medium IV as shown below. Arrange the refractive indices of the media in ascending order.



   A. II < I < III < IV

   B. III < IV < II < I

   C. IV < II < I < III

   D. III < I < IV < II

- End of Section A -

Section B: Structured Questions (40 marks)

1. As shown in Figure 1 on the answer sheet, a man wearing a hat stands 100 cm in front of a plane mirror AB hanging on a vertical wall. He can just see the points C and D in the mirror. His eyes E are 5 cm above B and 15 cm below A.

   (a) In Figure 1, draw the paths of two rays, one from C and one from D, to show how he sees the two points in the mirror. (2 marks)

   (b) (i) Find the length of CE. (1 mark)

   (ii) Find the length of CD. (1 mark)

2. Objects X and Y are placed in front of a plane mirror. Figure 2 on the answer sheet shows the positions of X, Y and the image of X. Philip stands at point P and can see the images of X and Y. In Figure 2 on the answer sheet, draw

   (a) the position of the mirror, (2 marks)

   (b) the image of Y, (1 mark)

   (c) two light rays, one from X and one from Y, to show how Philip sees their images. (2 marks)

3. As shown in Figure 3 on the answer sheet, Sally stands behind a bookshelf. Point S is the top of Sally's head and is 160 cm above the floor. Paul stands on the other side of the bookshelf. His eyes are 160 cm above the floor. A plane mirror is installed at the ceiling. The mirror makes an angle of 45° with the ceiling.

   (a) Locate the position of the image of S formed by the mirror. (1 mark)

   (b) Draw a light ray in Figure 3 to show how Paul sees the image of S. (2 marks)

   (c) Find the furthest distance from the bookshelf such that Paul can see the image of S in the mirror. Explain your answer by drawing a light ray in Figure 3. (3 marks)

   (d) Consider a light ray coming from Point P on Paul's body can just pass through the bookshelf and reaches the edge of the mirror. State whether Paul can see the image of P in the mirror. (1 mark)

4. As shown in Figure 4 on the answer sheet, a light ray travels from a liquid to an air bubble with centre O.

   (a) Find the refractive index of the liquid. (2 marks)

   (b) Complete the path of the light ray until it emerges from the air bubble to the liquid. Draw the normal(s) wherever the light ray meets an interface. Label the sizes of all the angles that the light ray makes with the normal(s). (3 marks)

5. (a) A coin is placed at the bottom of a beaker of water as shown in Figure 5 on the answer sheet, two rays of light reflected by the coin reaching the water surface. A student observes the coin from above.

   (i) Sketch a ray diagram to locate the image of the coin as seen by the student. (2 marks)

   (ii) In Figure 5, indicate and label the real depth and apparent depth. (2 marks)

   (b) If the water in the beaker is replaced by a liquid with a lower refractive index. how will the position of the image of the coin change? (1 mark)

6. A ray of light travels from medium X to air as shown in Figure 6a. Figure 6b shows the relation between sin i and sin r.

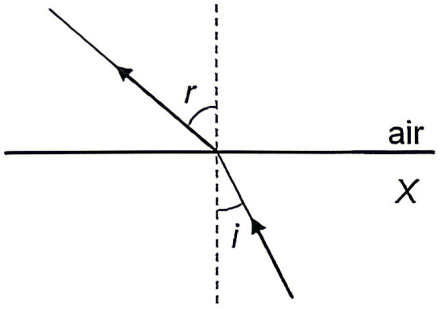


Figure 6a

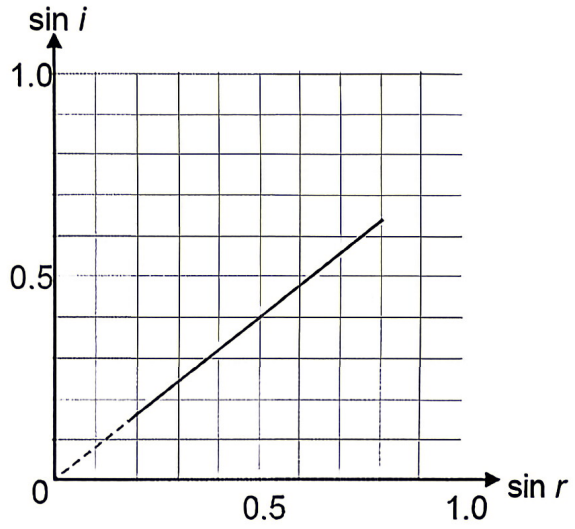


Figure 6b

   (a) Find the refractive index of X. (2 marks)

   (b) Estimate the value of i when sin $r = 1$. State its physical meaning. (2 marks)

   (c) The speed of light in air is 3.00×10^8 m s^{-1}. Find the speed of light in medium X. (2 marks)

7. Figure 7a shows one end of an optical fibre made up of a glass core and a cladding. A ray of light enters the optical fibre from air at one end at an angle of 40.0°. The refractive indices of the glass and the cladding are 1.6 and 1.2 respectively.

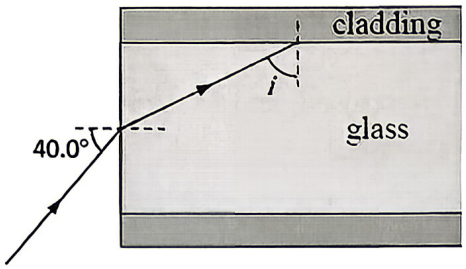


Figure 7a

(a) Find the angle *i*. (3 marks)

(b) Find the critical angle between the core and the cladding. Hence, determine whether total internal reflection occurs when the light ray emerges the interface. (3 marks)

(c) Complete the ray diagram showing the path of the light in the optical fibre in Figure 7b on the answer sheet. (1 mark)

(d) Suggest a practical use of optical fibres. (1 mark)

End of Section B

END OF PAPER

S3 First Term Examination (2024-2025)

Physics Answer Sheet

(45 minutes)

Date: 14th January 2025 Name: _____

Time: 10:15 a.m. – 11:00 a.m. Class: _____ No.:_____

Section A: Multiple Choice Questions (20 marks)

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.

Section B: Structured Questions (40 marks)

1. (a)

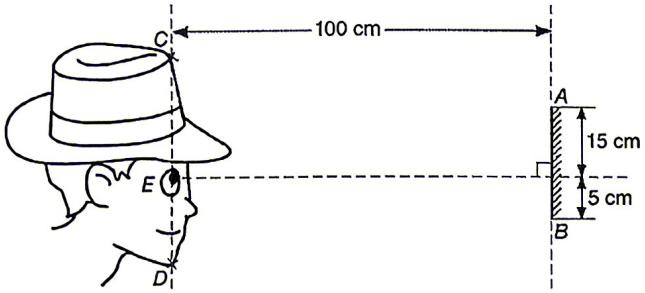


Figure 1

(b) (i) _____

(ii) _____

2. (a). (b), (c)

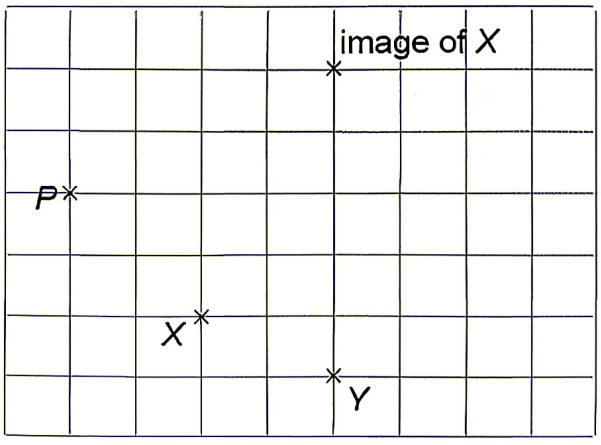


Figure 2

3. (a), (b), (c), (d)

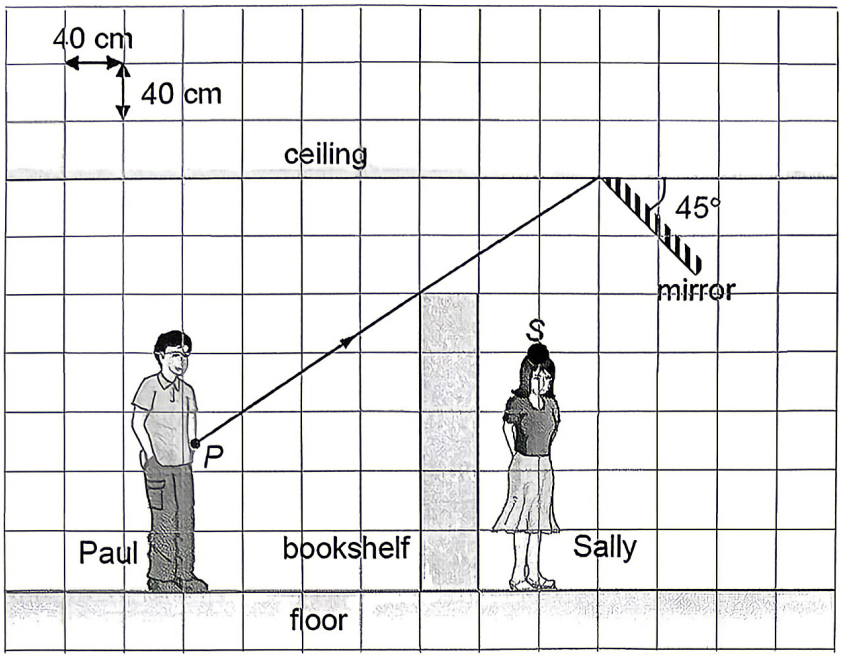


Figure 3

(c) The furthest distance from the bookshelf: _____

(d) Paul _____ (can / cannot) see the image of *P* in the mirror.

4. (b)

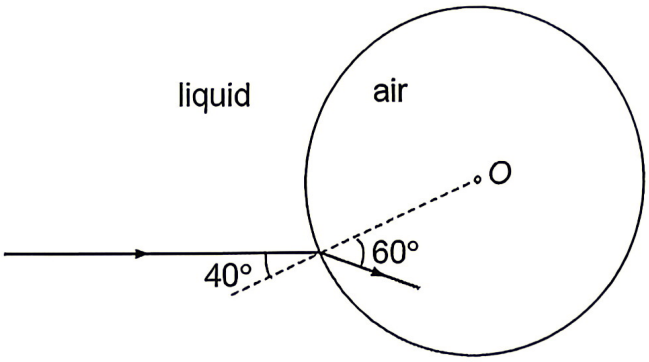


Figure 4

(a) _____

_____

_____

_____

5. (a) (i), (ii)

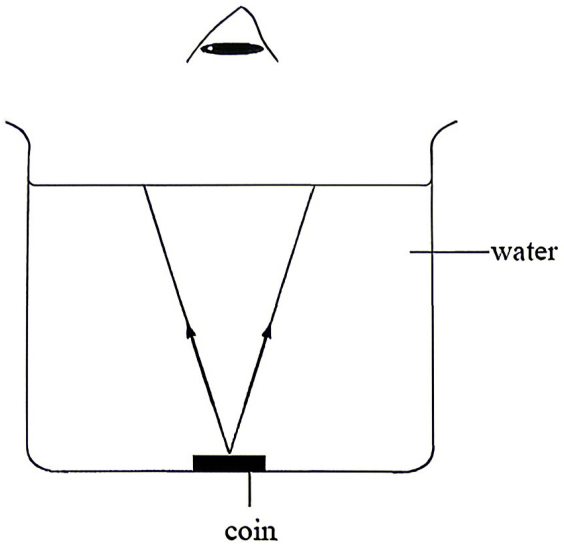


Figure 5

(b) _____

6. (a) _____

_____

_____

(b) _____

_____

_____

_____

(c) _____

_____

_____

_____

7. (a) _____

_____

_____

_____

(b) _____

_____

_____

_____

(c)

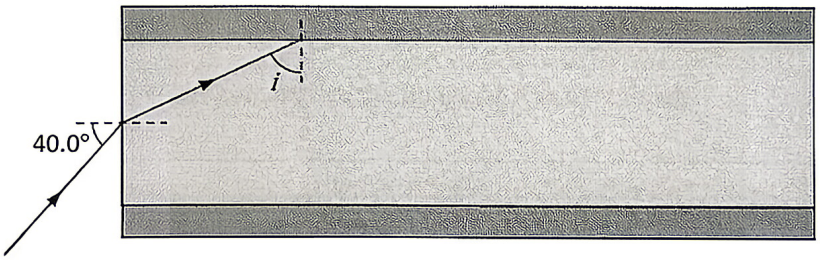


Figure 7b

(d) _____

END OF ANSWER SHEET