LIGHT

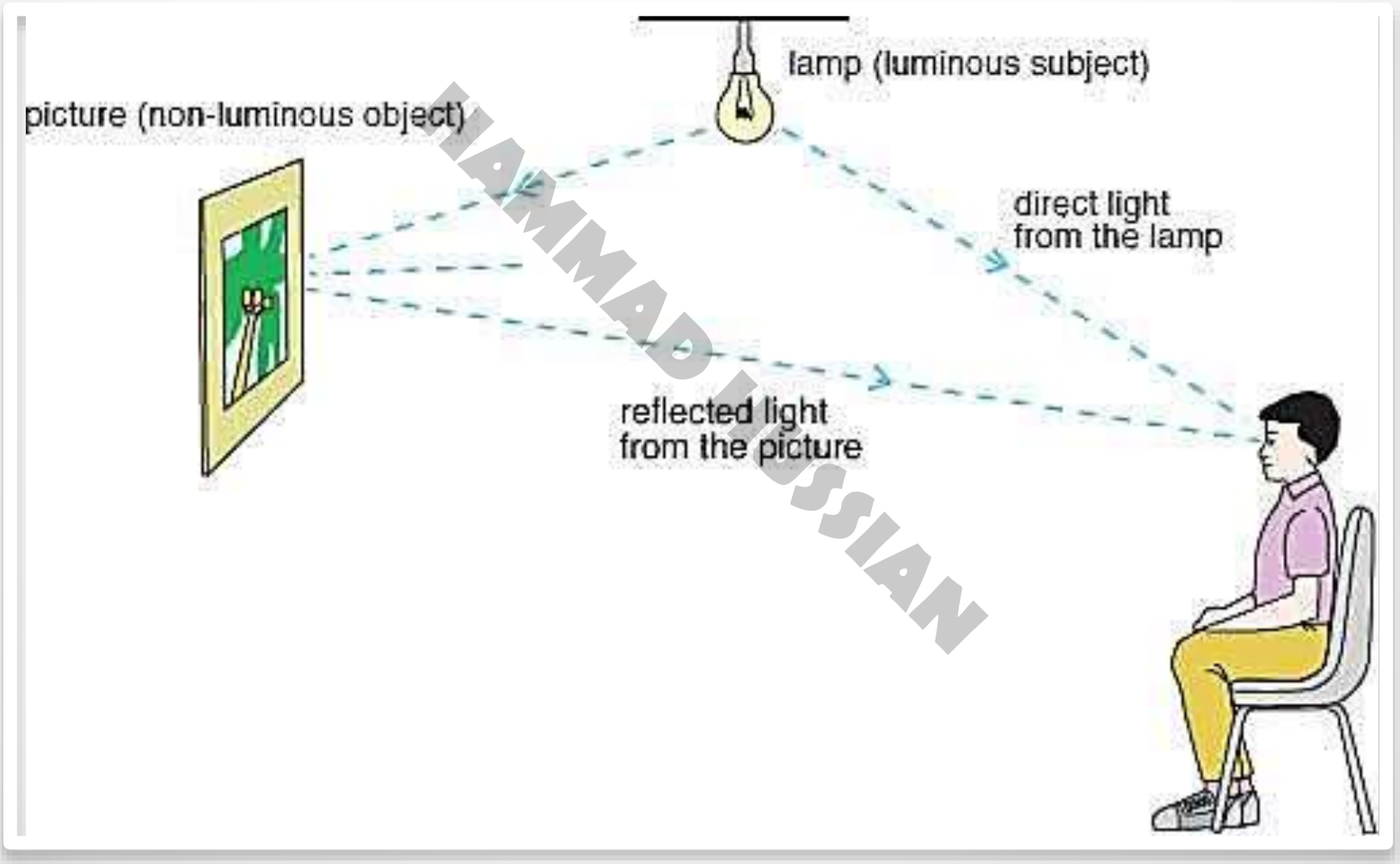
Reflection of Light

Refraction of Light

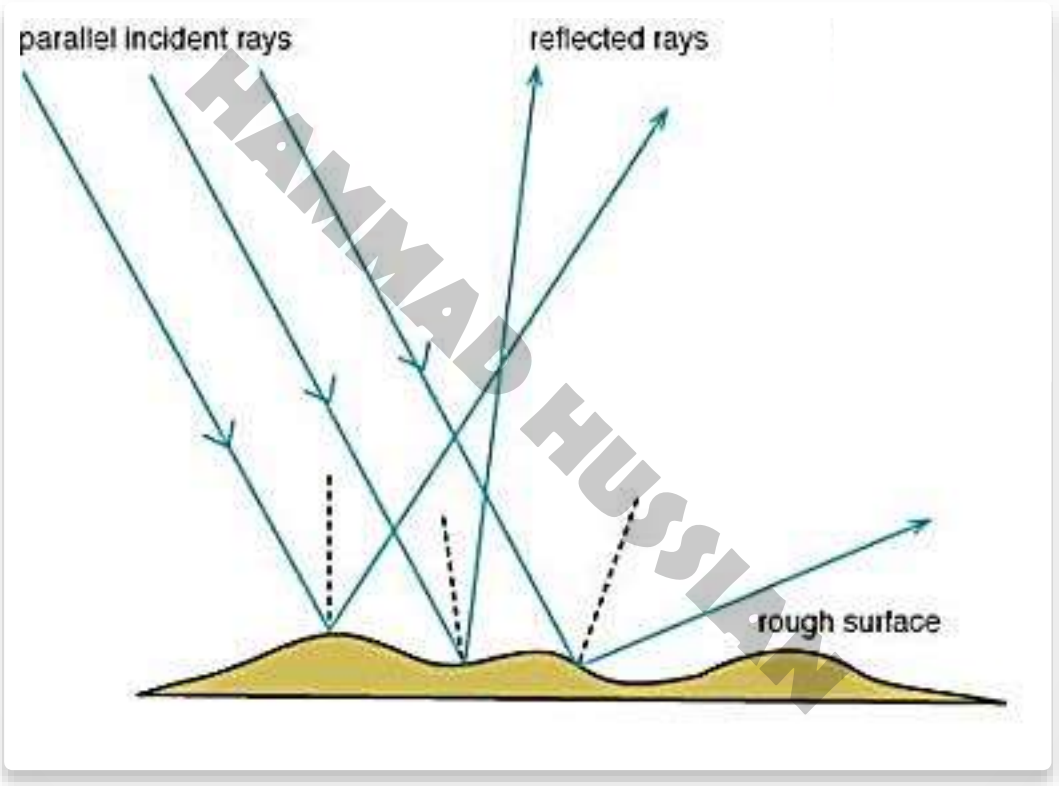
Thin Converging and Diverging Lens

Reflection of Light

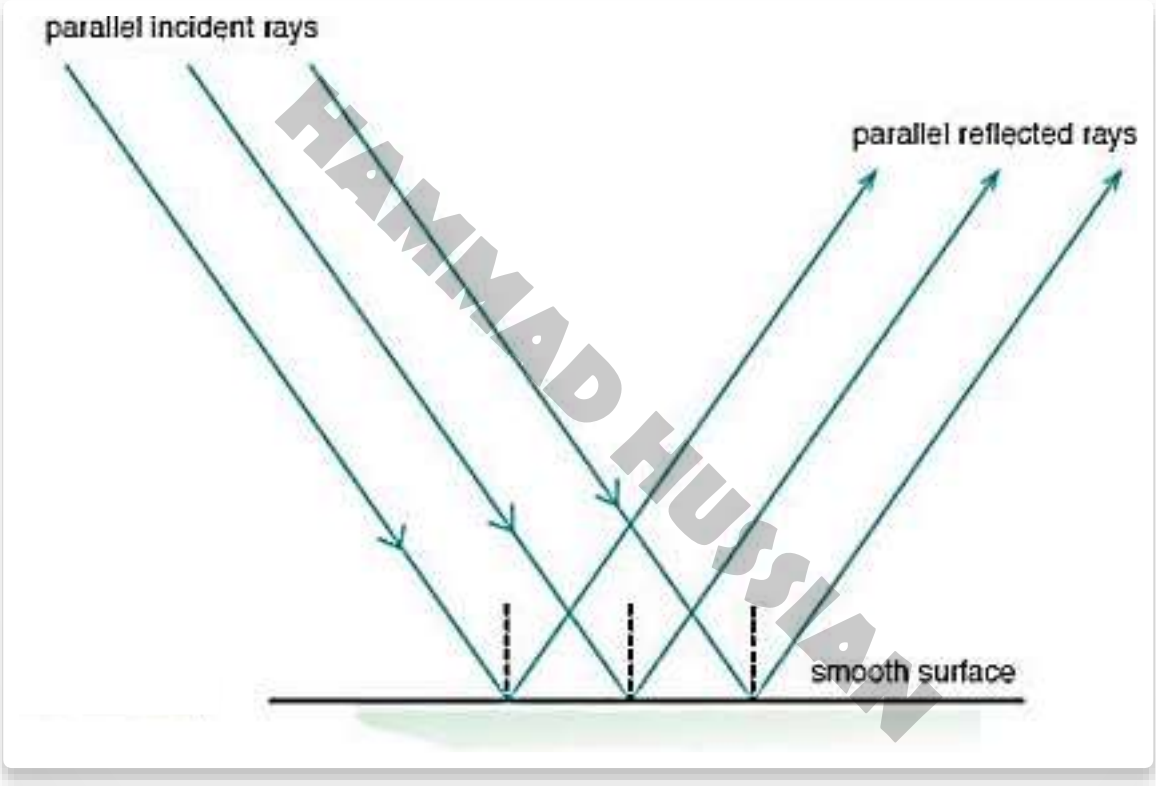
- Object can be seen when the light rays coming from it enter our eyes.
- **Luminous** object like Sun and lamp are seen directly because they give off their own light.
- A **non-luminous** object are only seen when they reflect light from a source like the lamp as they do not give light of their own.



Diffuse Reflection



Regular Reflection

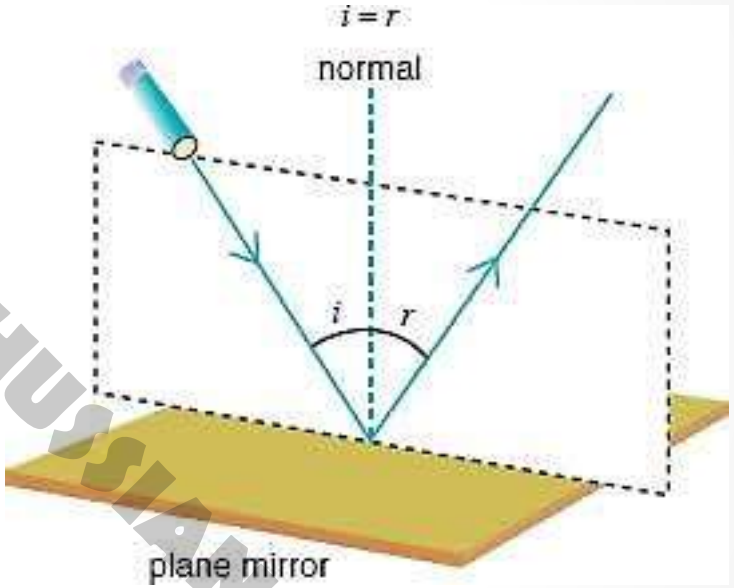


Reflection of light

Define the terms used in reflection including normal, angle of incidence and angle of reflection.

Reflection of Light

- **Normal** is a line drawn perpendicular to the surface of mirror from point the point where incident ray meets the surface of the mirror.
- The **angle of incidence**, i, is the angle between the incident ray and the normal.
- The **angle of reflection**, r, is the angle between the reflected ray and the normal.

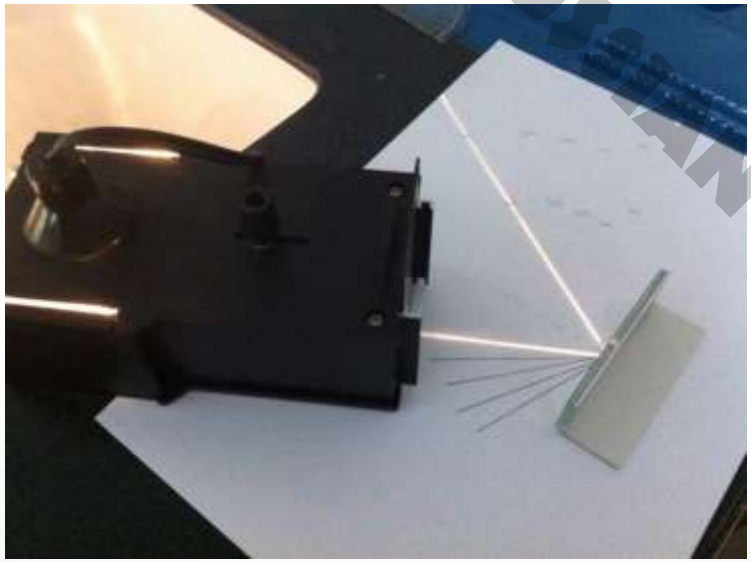


Reflection of Light

Describe an experiment to illustrate the law of reflection.

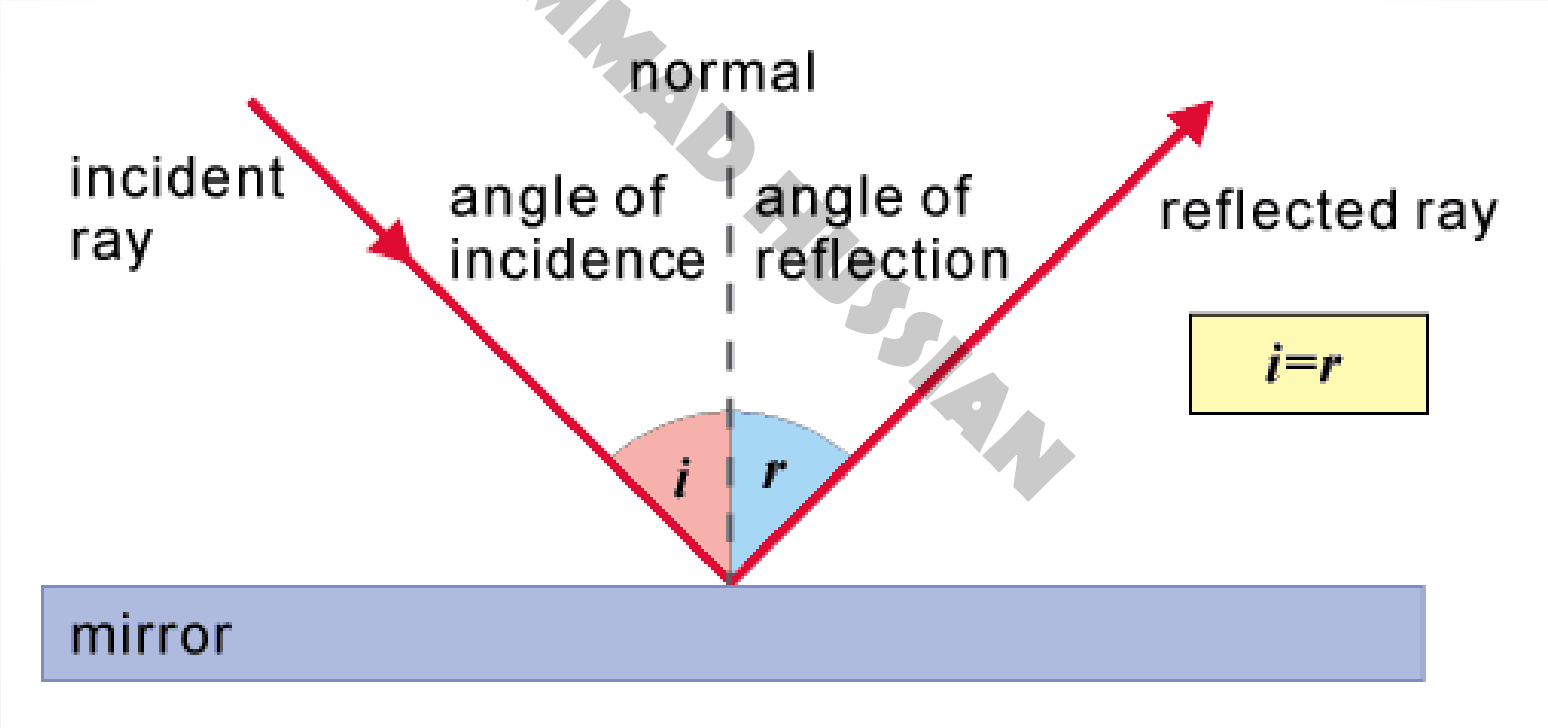
- Aim: To study law of reflection.
- Apparatus:
  - Plane Mirror
  - Ray box
  - Protractor

- Procedure:
  - Place a plane mirror on a sheet of plain paper provided. Use a pencil to trace the outline of the plane mirror. Label the outline of the mirror as AB.
  - Using a ray box, direct a ray of light at an angle, i = 20.0 degrees to P on the side AB of the plane mirror.
  - Use two crosses R and S to mark the ray incident on P and two more crosses T and U to mark the ray reflected from P.



- Remove the plane mirror and the ray box. Draw a line OP normal to the plane. Draw a straight line through RS and TU. Let the line RS representing the incident ray meet the side AB at P. Let the line TU representing the reflected ray meet the side of AB also at P.
- Use a protractor to measure the angles i and r and record in a table.
- Repeat the experiment for different values of i.

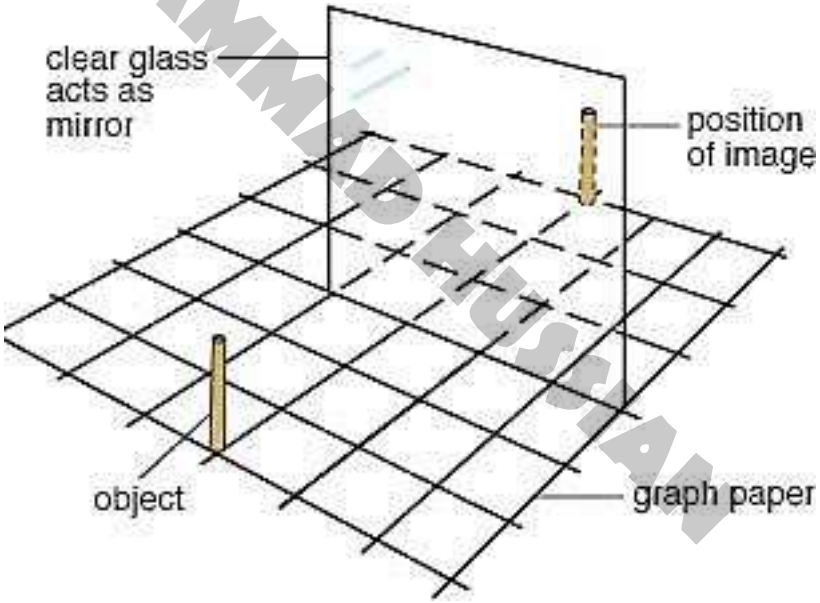
- Result
  - The angle of incident is always equal to the angle of reflection.



Reflection of Light

Describe an experiment to find the position and characteristics of an optical image formed by a plane mirror.

The Image in a Plane Mirror



- Aim: To determine the position of image on a plane mirror.
- Apparatus:
  - Standing object (optical pin)
  - Mirror
  - Graph paper

- Procedure:
  - Place the mirror on the graph paper
  - Place object in front of the mirror
  - Observe the image on the mirror by counting the number of square on the graph paper
- Result
  - Distance of object and mirror is equal distance of image and the mirror

Image formed by Plane Mirror

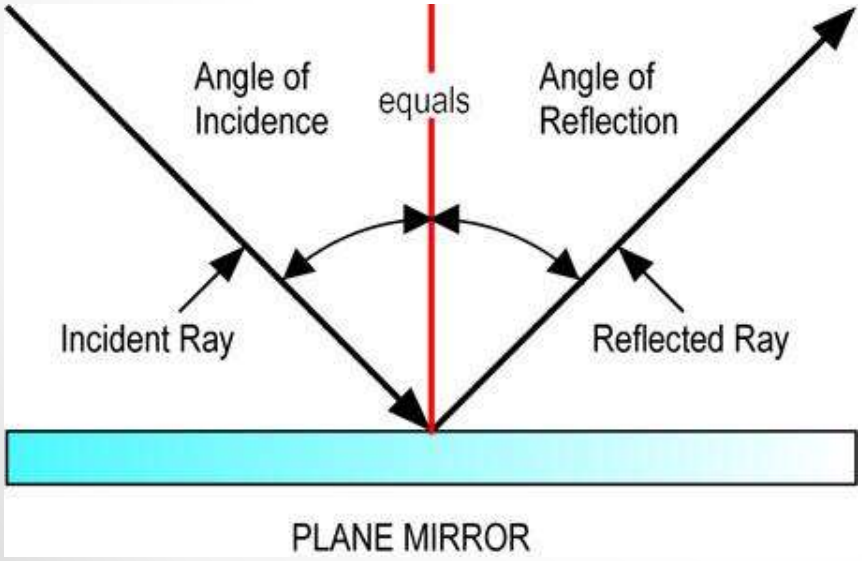
- The image is virtual.
- The image is upright.
- The image formed has the same size as the object.
- The image is as far behind the mirror as the object is in front of the mirror.
- The object and the image is perpendicular to the mirror.
- The image is laterally inverted. (left-to-right inversion)

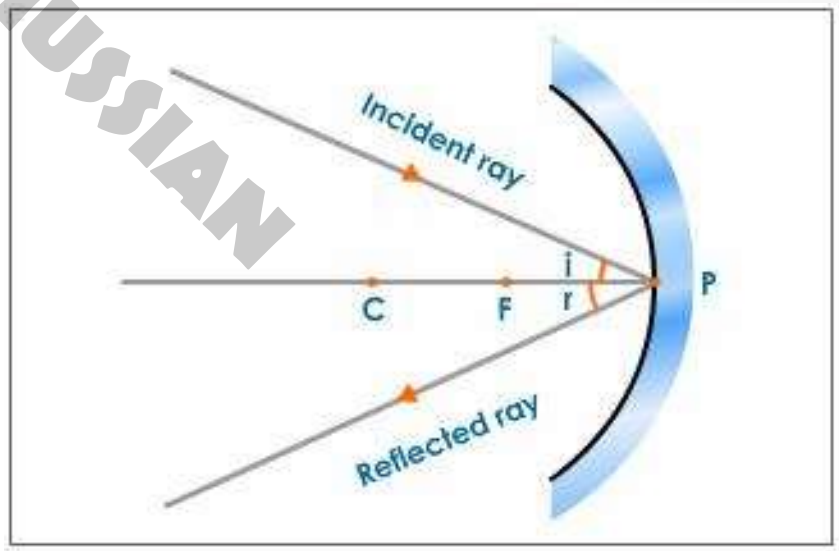
Reflection of Light

- State that for reflection, the angle of incidence is equal to the angle of reflection and use this in constructions, measurements and calculations.

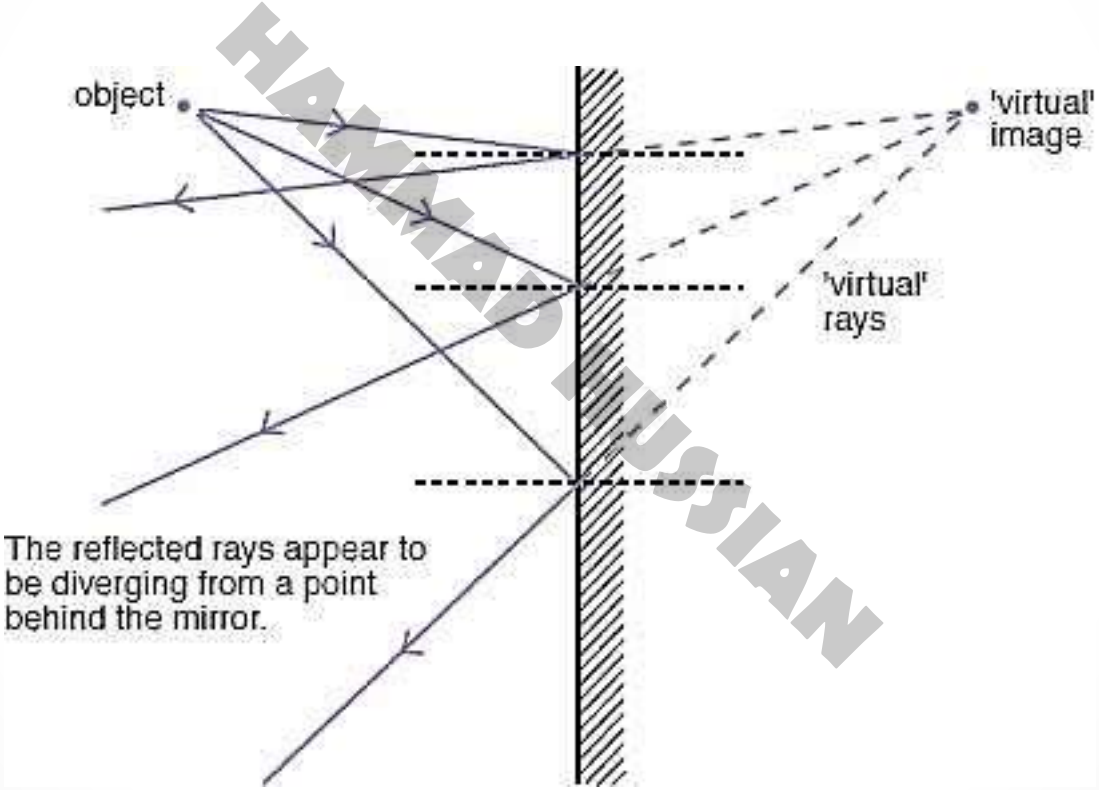
Laws of reflection

- Law of Reflection
  - The angle of incidence, i, is equal to the angles of reflection, r.
  - The incident ray, the reflected ray and the normal all lie on the same plane.
- These laws are true for all reflecting surfaces, for plane mirrors as well as curved mirrors.

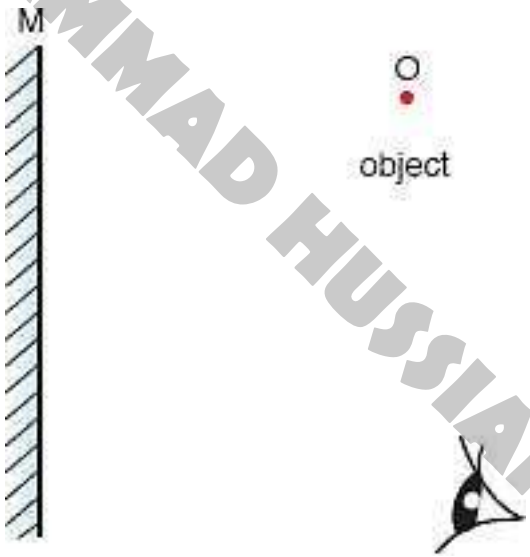




Ray Diagrams & Mirror

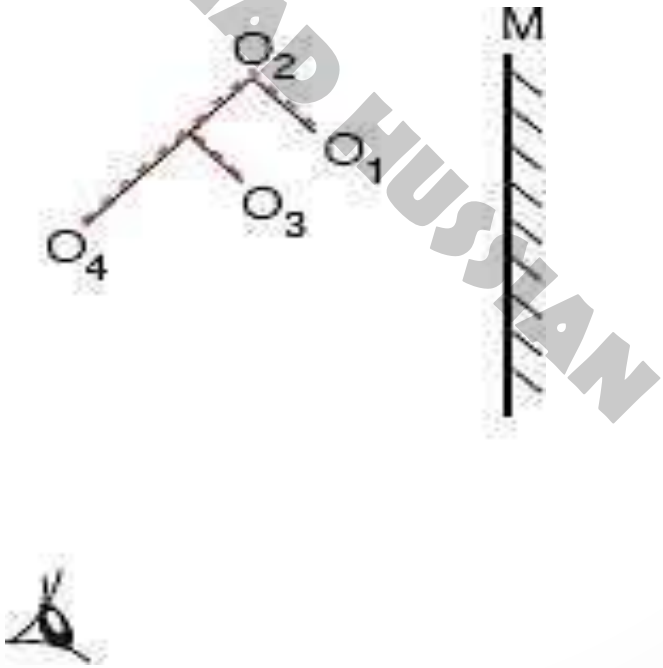


Seeing Images in a Plane Mirror

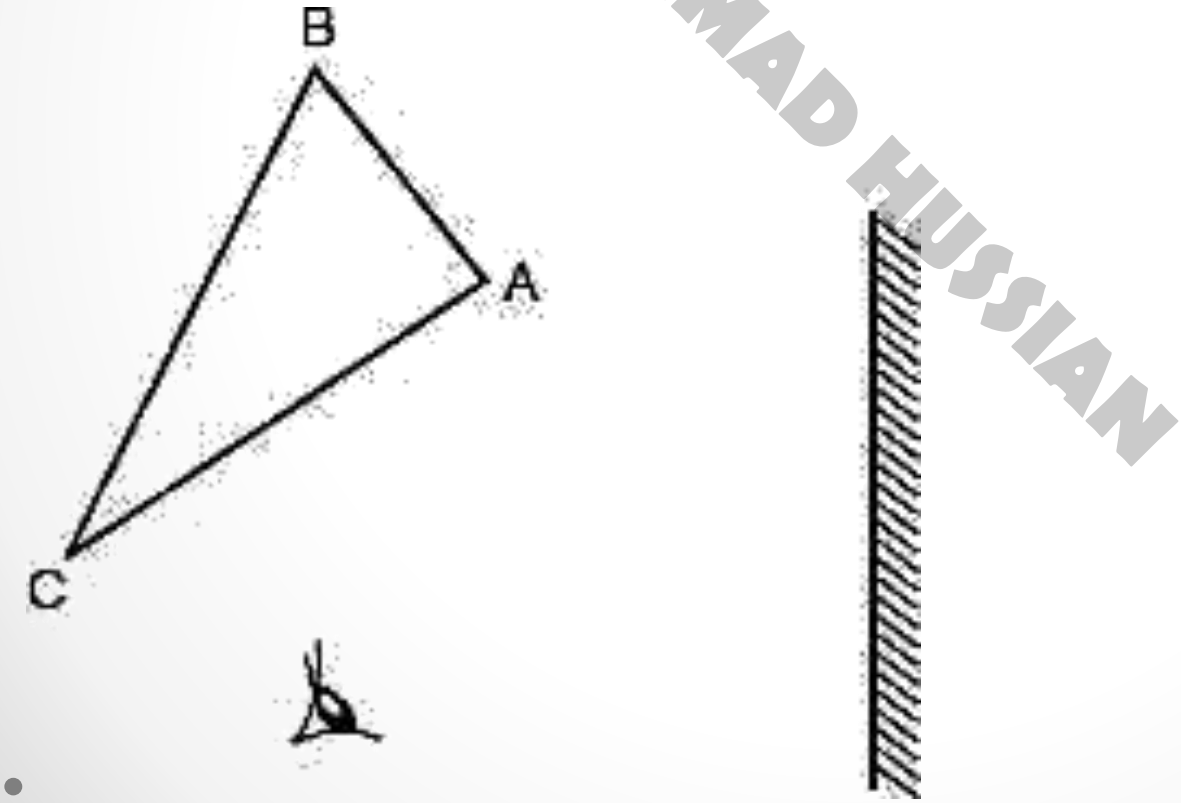


Problem Solving

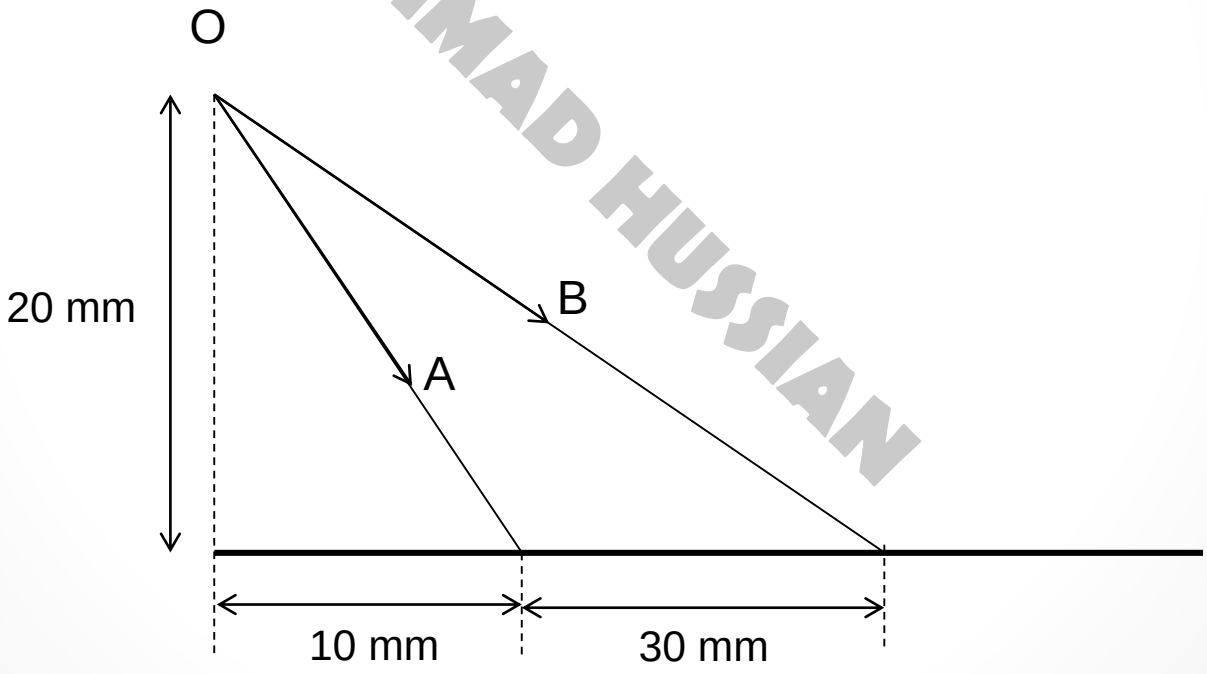
1. Complete the Figure below to show the position of the image. Draw two rays from the point O_4 which reflect from the mirror and enter the observer's eye.



2. Complete the Figure below to show the position of the image. Draw two rays from the point A which reflect from the mirror and enter the observer's eye.



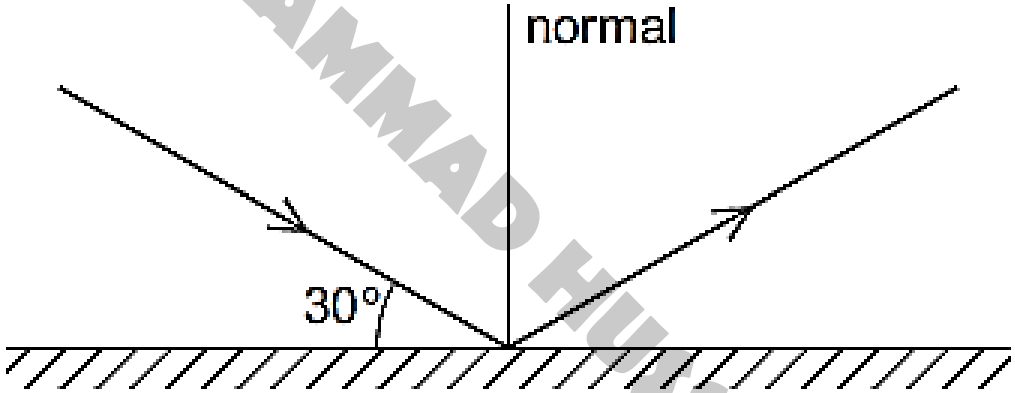
3. In the diagram, two rays leave a point object O and strike a plane mirror.



a. Make an exact copy of the diagram.
b. Measure the angle of incidence of each ray.
c. Draw in the two reflected rays at the correct angles.
d. Find where the image formed and label it.

4. Light strikes a mirror, making an angle of 25° to the surface. What angle will the reflected light make with the surface?
5. Light strikes a mirror, making an angle of 20° to the surface. What is the angle of reflection?
6. Light leaving a mirror makes an angle of 42° with respect to the normal to the surface. What was the angle of incidence?

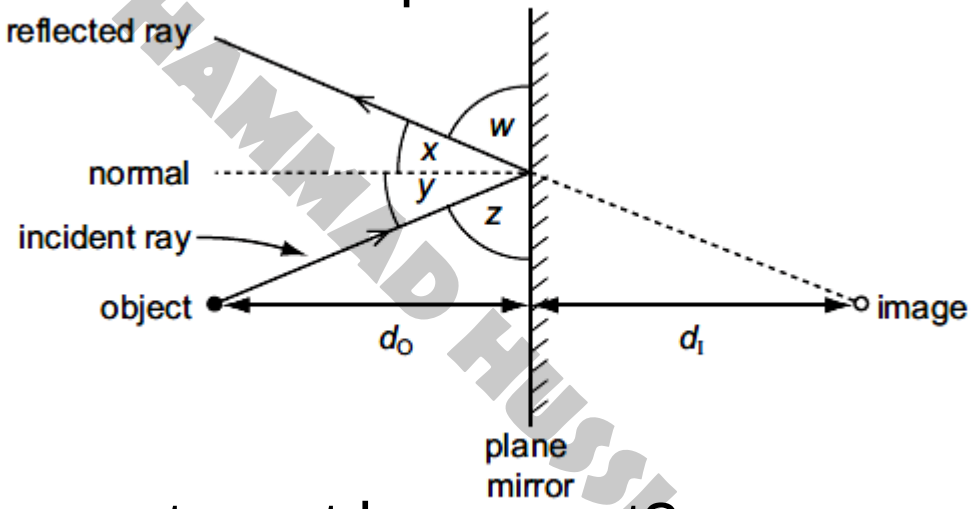
1. The diagram shows a ray of light reflected from a plane mirror.



1. What is the angle of reflection?

A. 30 °
B. 60 °
C. 90 °
D. 120 °

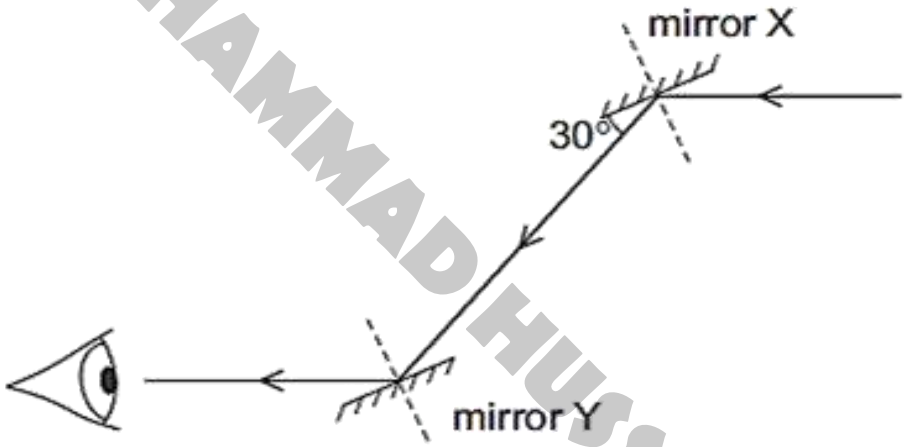
2. An image is formed in a plane mirror.



Which statement must be correct?

C

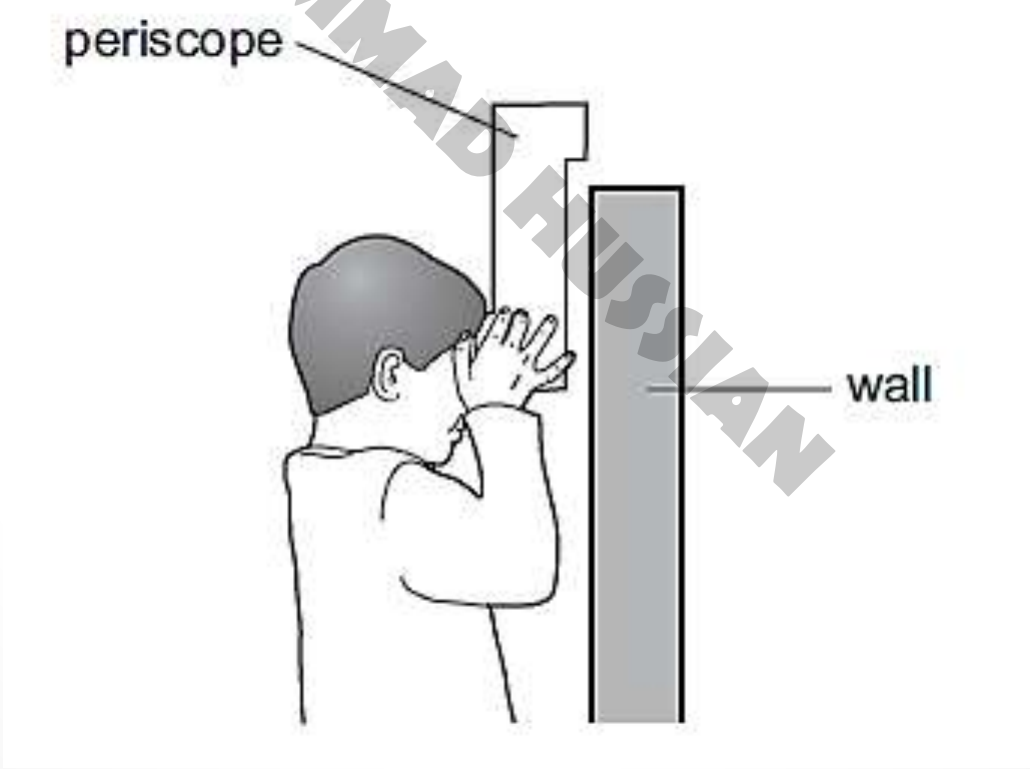
3. A ray of light is reflected by two parallel plane mirrors X and Y.



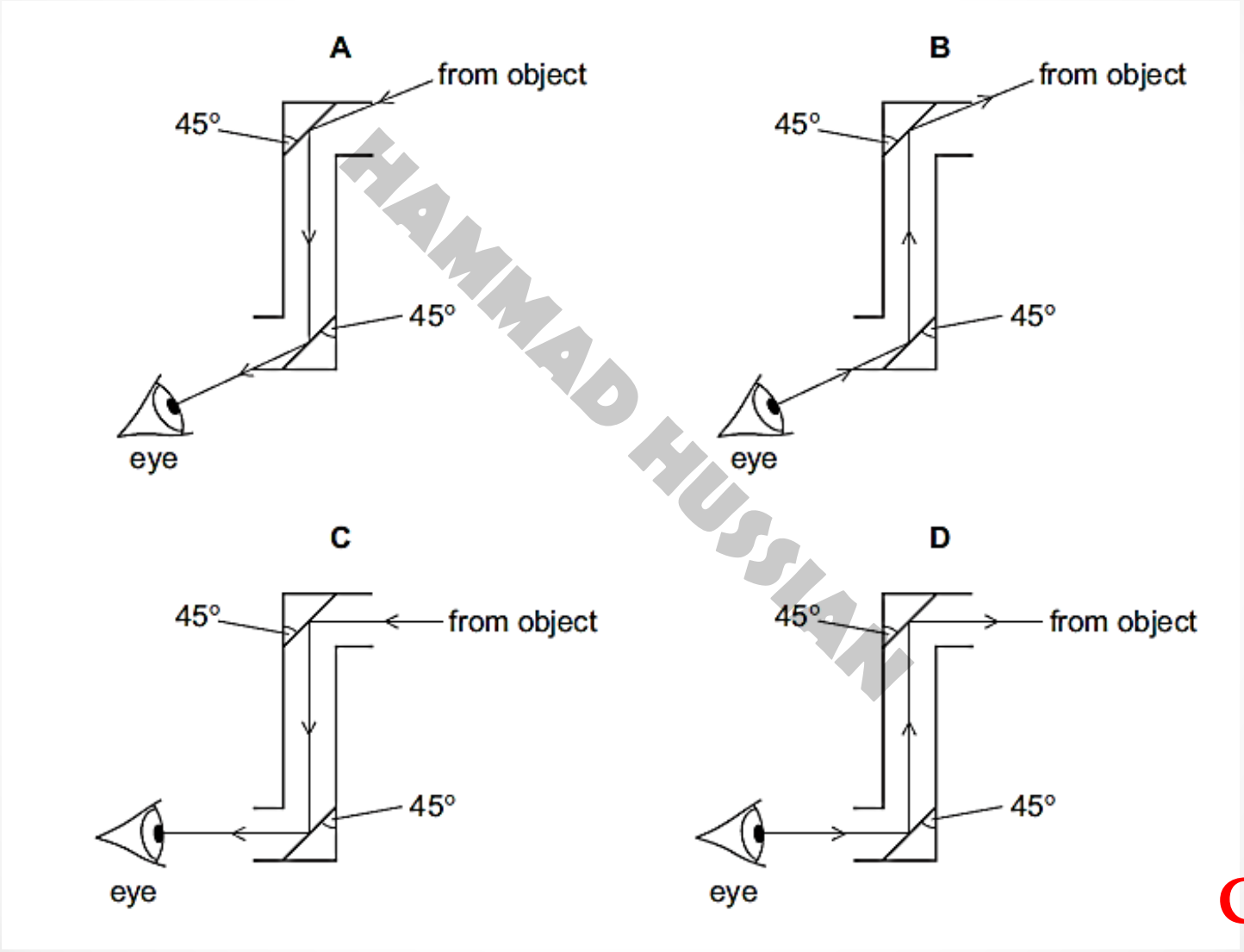
1. Which statement is correct?

A. The angle of incidence at mirror X is 30°.
B. The angle of incidence at mirror Y is 60°.
C. The angle of reflection at mirror X is 120°.
D. The angle of reflection at mirror Y is 0°.

4. The diagram shows a child using a periscope to look at an object on the other side of a wall.



Which diagram shows a correctly drawn ray of light from the object?



C

5. Which characteristics describe an image formed in a plane mirror?

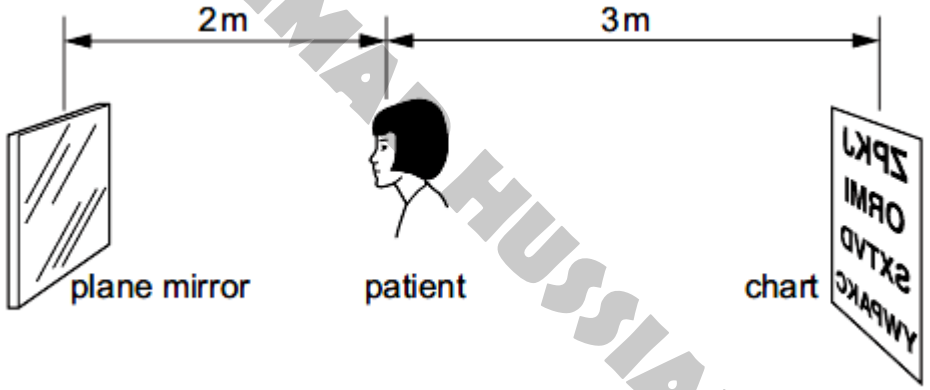
A. real and inverted
B. virtual and upright
C. real and larger than the object
D. virtual and smaller than the object

6. A plane mirror is on a wall.

Which is a correct description of the image formed by the mirror?

A. the right way up and smaller than the object
B. the right way up and the same size as the object
C. upside down and smaller than the object
D. upside down and the same size as the object

7. The diagram shows a patient having her eyes tested. A chart with letters on it is placed behind her and she sees the chart reflected in a plane mirror.

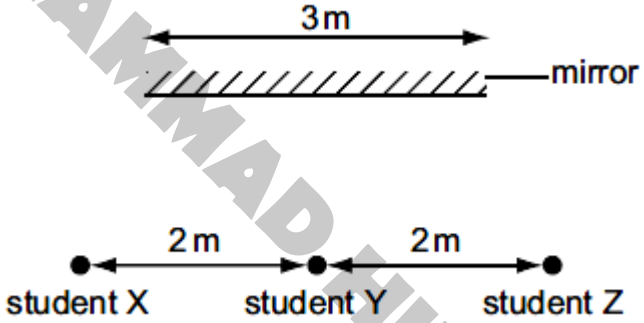


How far away from the patient is the image of the chart?

D

A	2 m	**B**	4 m	**C**	5 m	**D**	7 m

8. Three students stand 2 m apart in front of a plane mirror which is 3 m long.

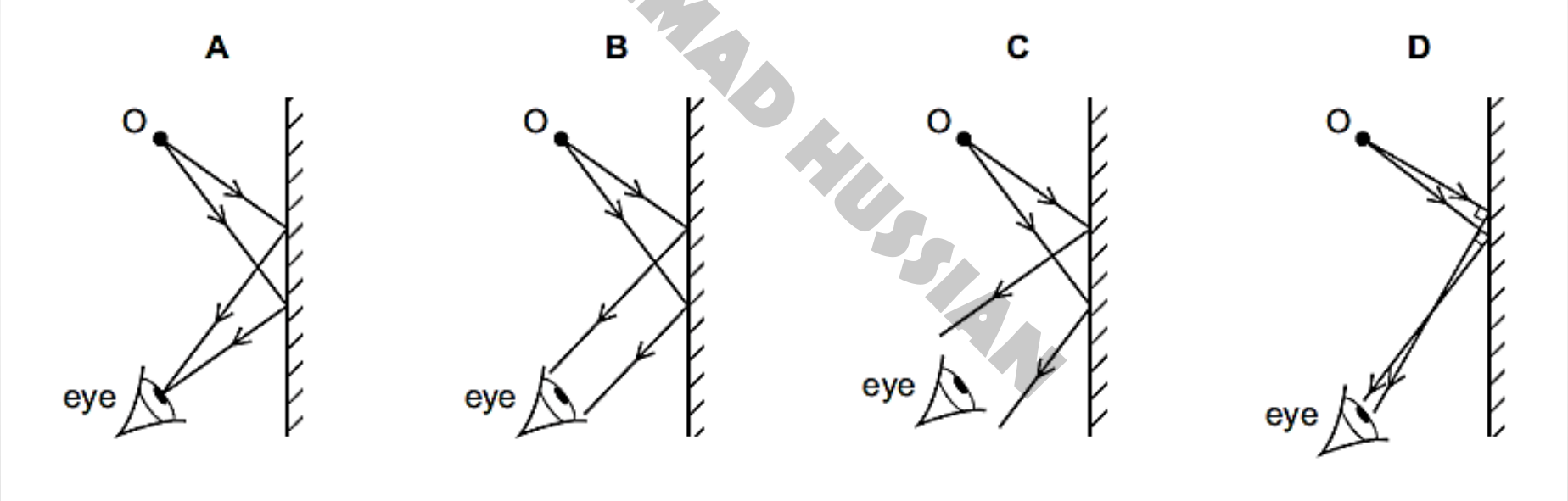


Student Y is standing opposite the mid-point of the mirror.
How many students can see the images of the other two?

A	0	**B**	1	**C**	2	**D**	3

D

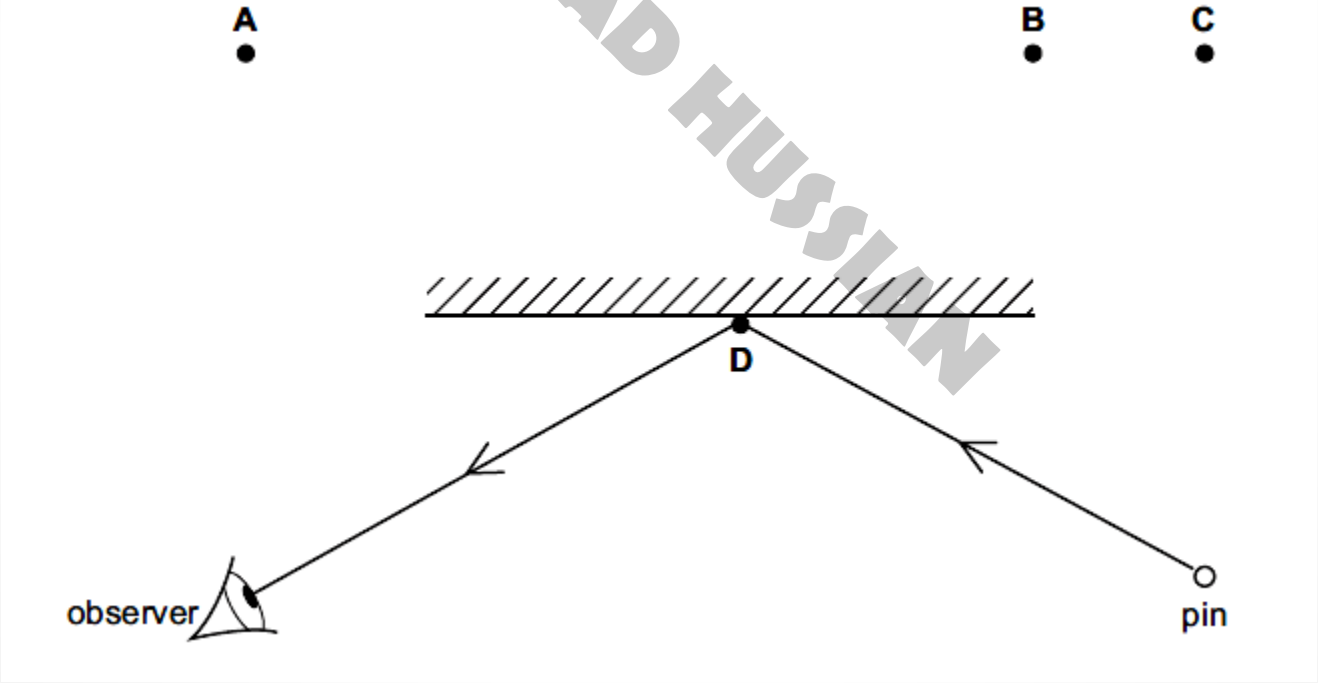
9. An eye views an object O by reflection in a plane mirror.
10. Which is the correct ray diagram?



B

10. A pin is placed in front of, and to the right of, a plane mirror as shown.

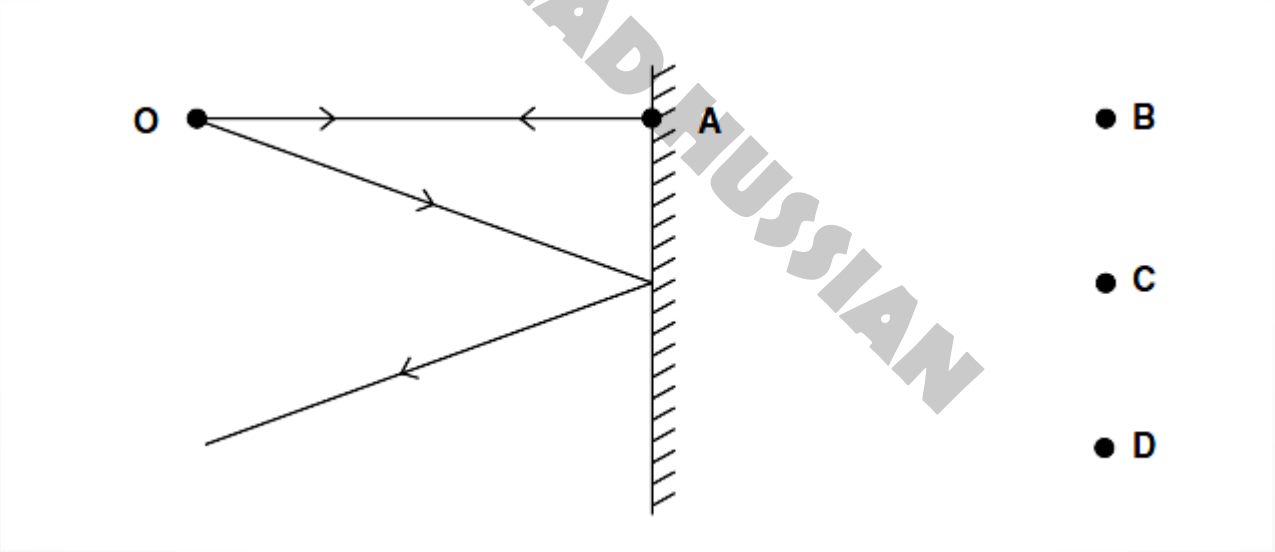
    Where is the image of the pin?



C

11. The diagram shows two divergent rays of light from an object O being reflected from a plane mirror.

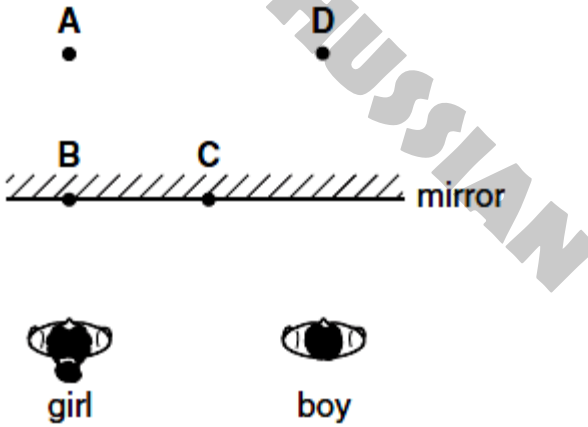
At which position will the image be formed?



B

12. A boy stands beside a girl in front of a large plane mirror. They are both the same distance from the mirror, as shown.

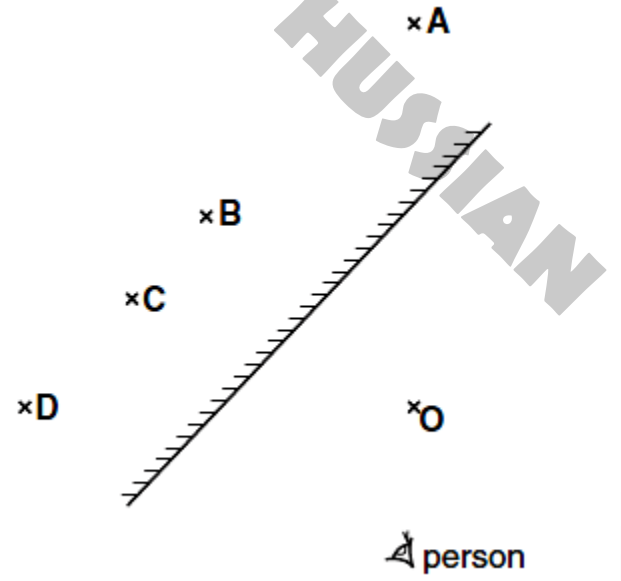
    Where does the boy see the girl's image?



A

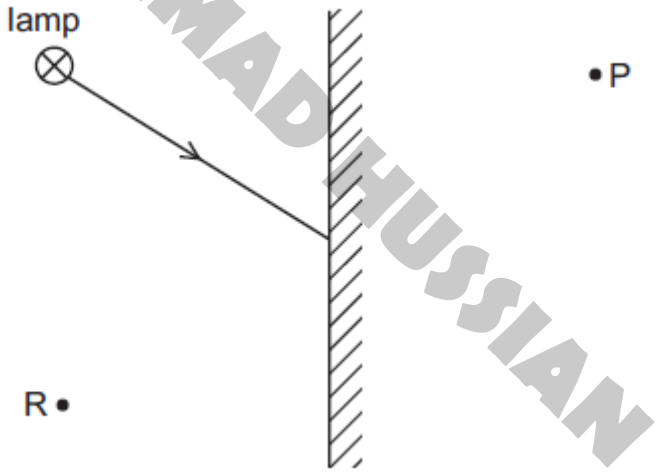
13. An object O is placed in front of a plane mirror. A person looks into the mirror as shown in the diagram.

In which position is the image of O seen?



B

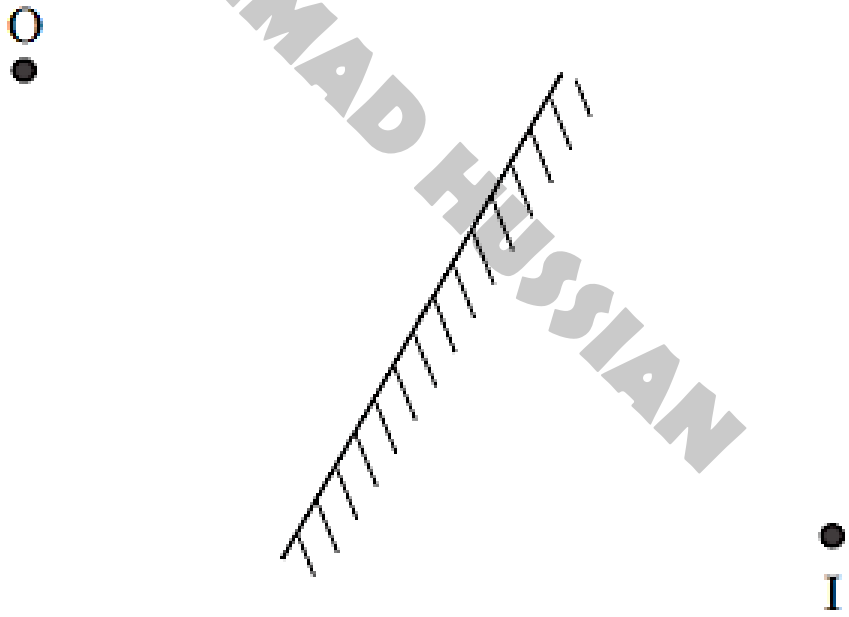
14. The diagram shows a ray of light from one point on a lamp striking a plane mirror.



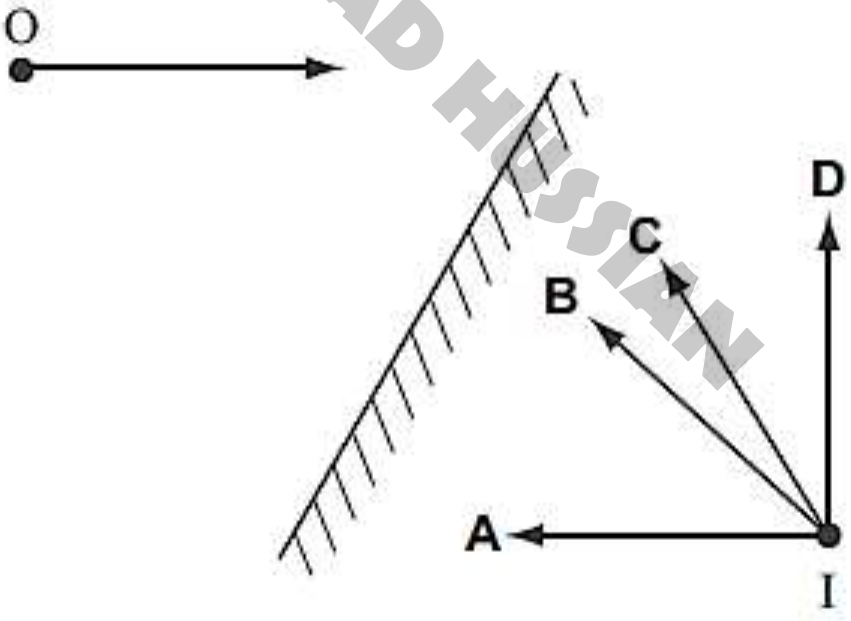
1. The image of the point on the lamp formed by the mirror is

A. at P and is real.
B. at P and is virtual.
C. at R and is real.
D. at R and is virtual.

15. An object placed in front of a plane mirror at O produces an image at I.

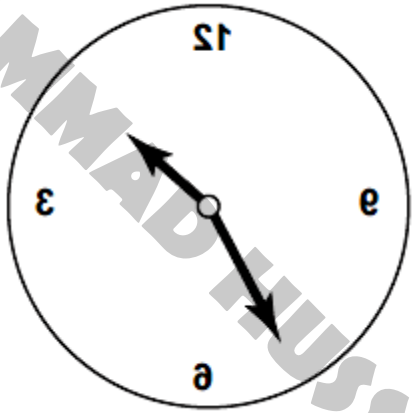


1. If the object moves towards the mirror in the direction shown by the arrow, in which direction does the image move?



C

16. The image of a clock face as seen in a plane mirror is shown.



What is the time on the clock?

A	1.25	**B**	1.35	**C**	10.25	**D**	10.35

B

17. The diagram shows the image of a clockface in a plane mirror.

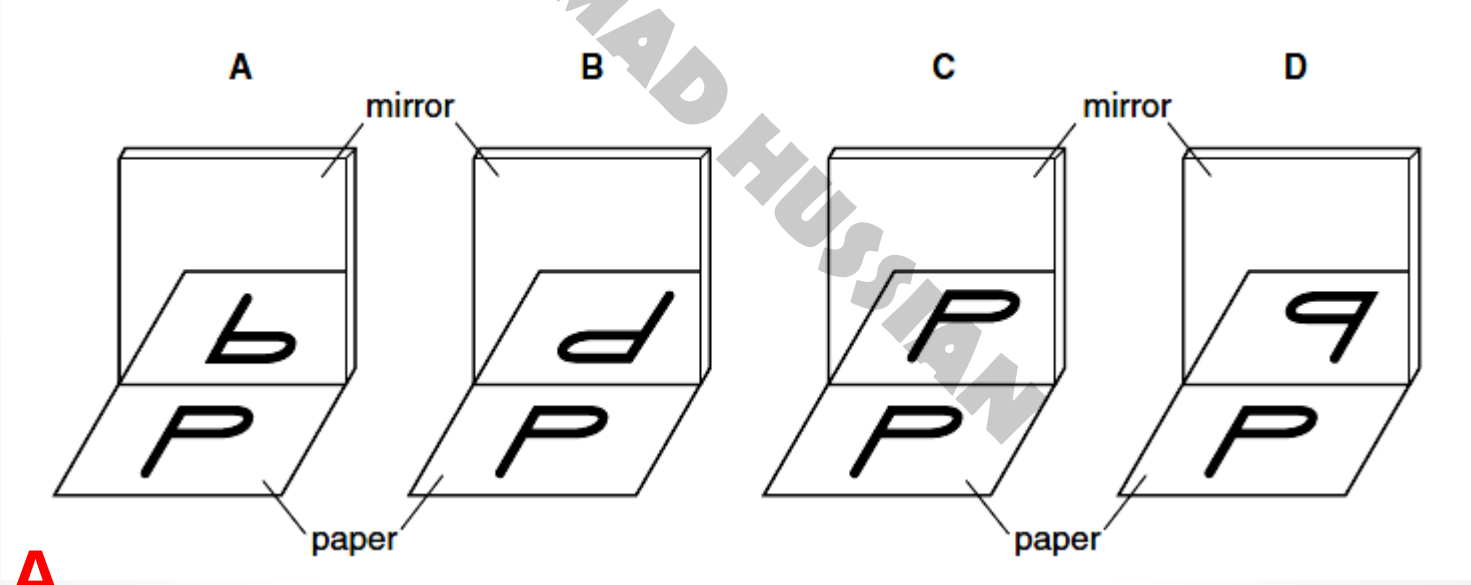
Which of these times is shown?

A	0225	**B**	0235	**C**	0925	**D**	0935

C

18. A student looks at the letter P on a piece of paper, and at its reflection in a mirror.

What does he see?

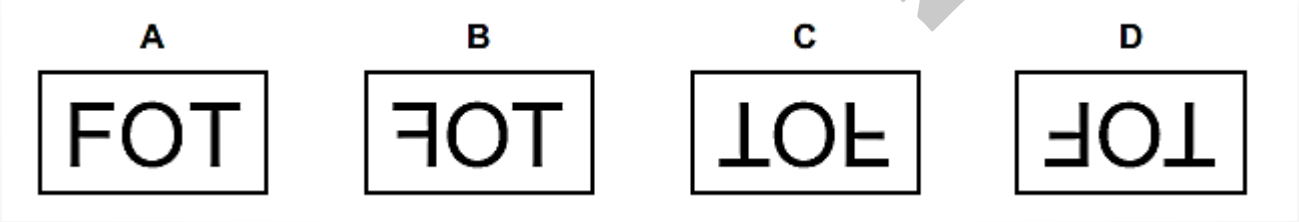


A

19. A student holds a sheet of paper with letters on it facing a plane mirror.

20. The letters on the paper are shown.

21. What does the student see in the mirror?



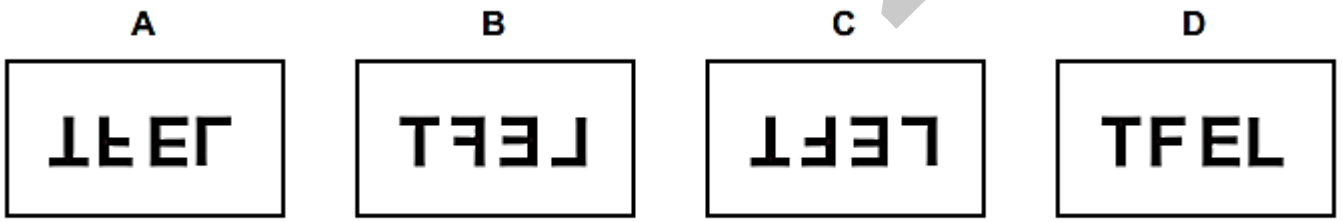
B

20. A girl writes the word LEFT on a piece of card.

21. She looks at the image of this card, made by reflection by a plane mirror.

22. What does she see?

B



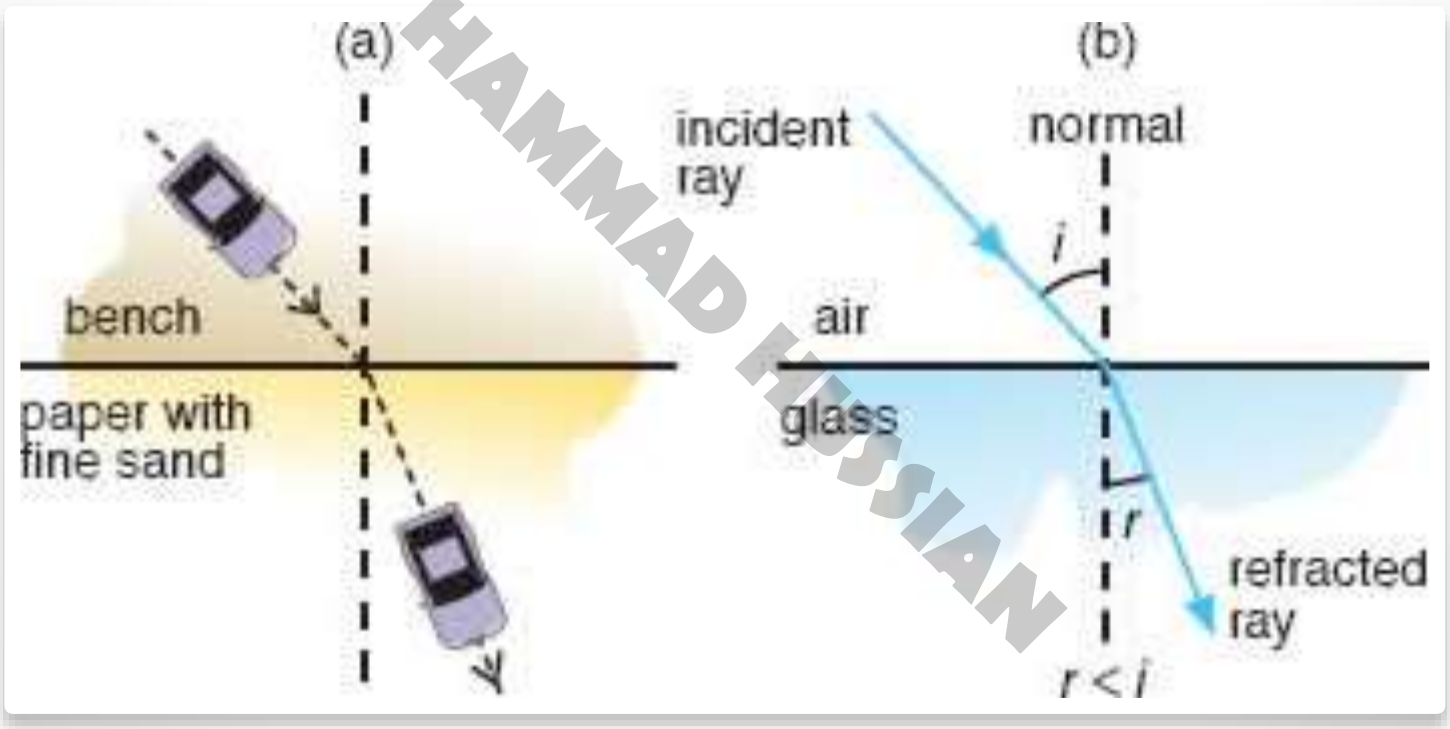
Refraction of light

Define the terms used in refraction including angle of incidence, angle of refraction and refractive index.

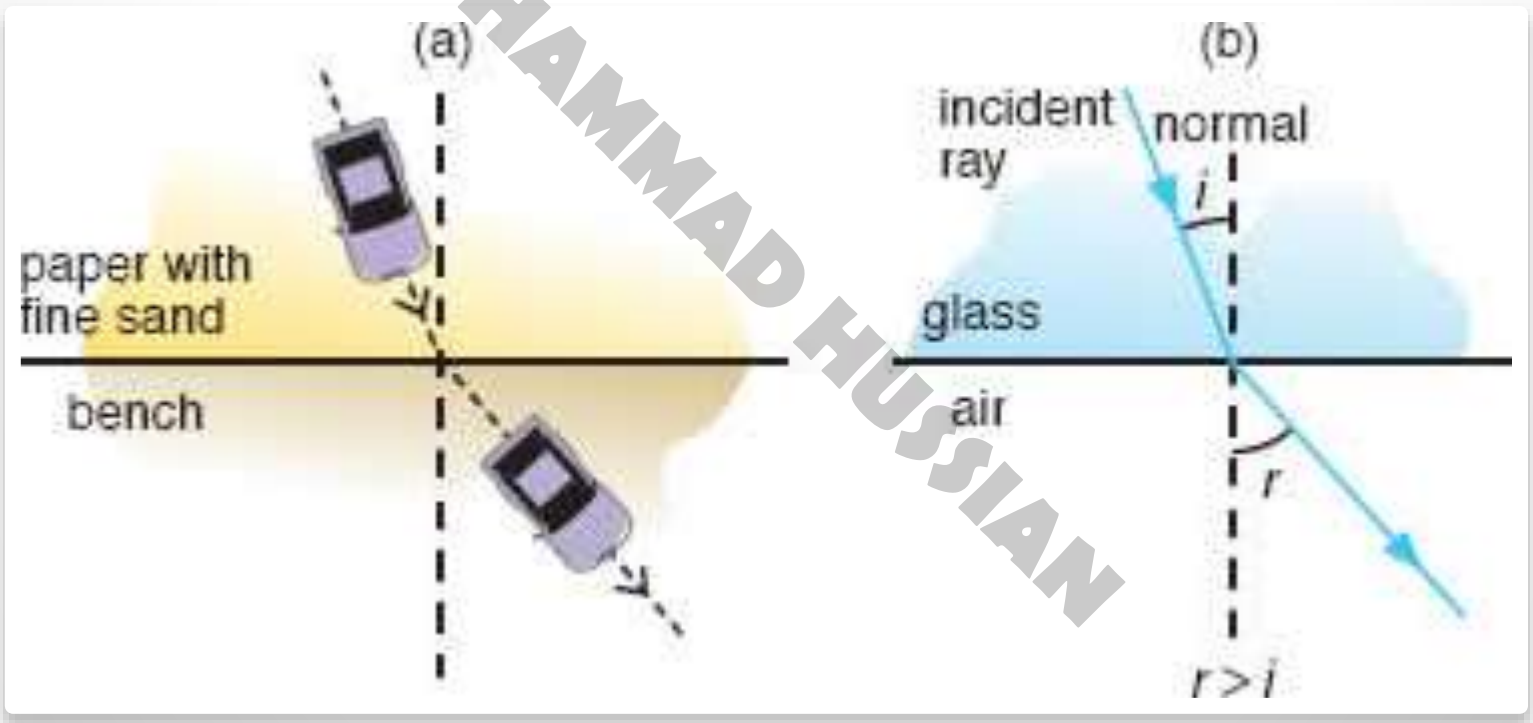
Refraction of Light

- Refraction is a process whereby light changes direction or bend when it passes from one medium to another.
- The angle of incidence, i, is the angle between the incident ray and the normal.
- The angle of refraction, r, is the angle between the refracted ray and the normal.
- Refractive index of a material is a measure of the change in speed of light as it passes from a vacuum (or air as an approximation) into the material.

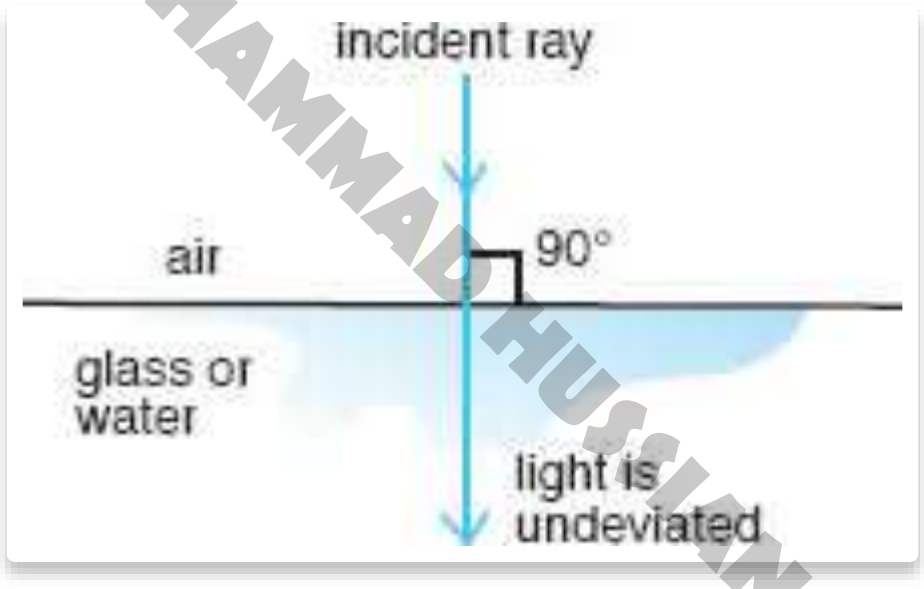
Refraction of light as it passes from air to glass



Refraction of light as it passes from glass to air



Light incident at right angle to a surface of glass

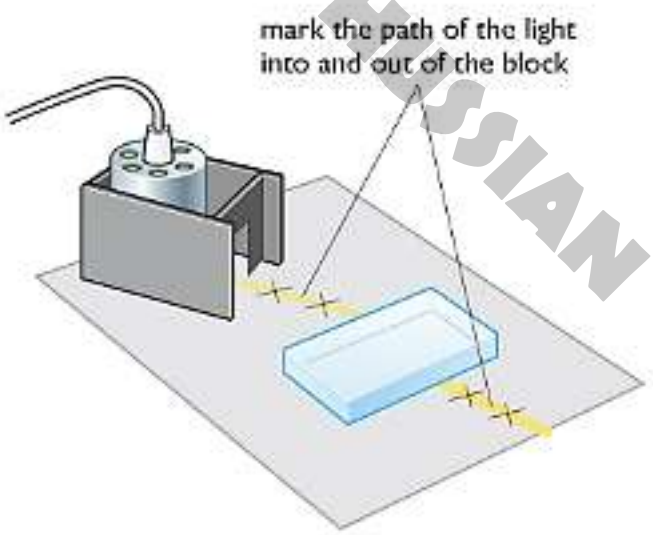


Refraction of light

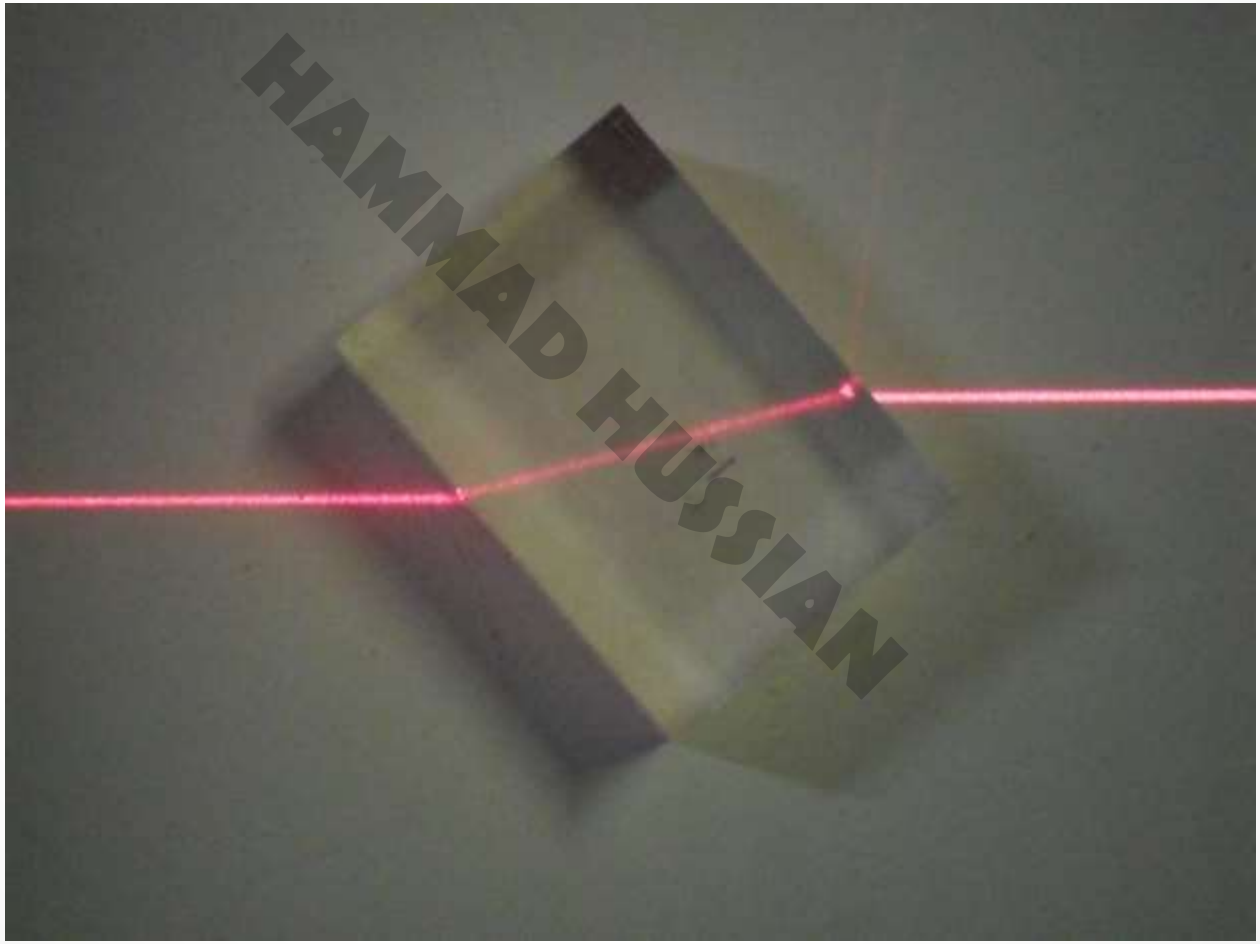
Describe experiments to show refraction of light through glass blocks.

- Aim: To determine the refractive index of glass, using a glass block
- Apparatus:
  - Rectangular glass block
  - Ray box

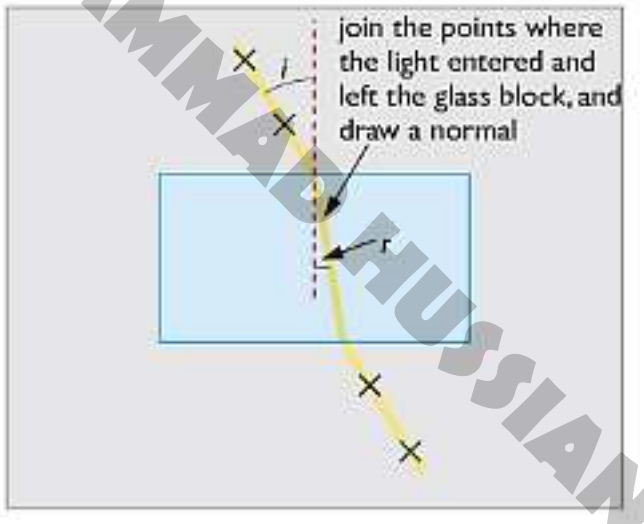
- Procedure:
  - Place the perspex block on the white paper and trace the outline.
  - Shine a single incident ray onto the block, mark its path and draw the incident ray with a ruler.
  - Mark the path of the ray emerging from the block, draw ray with a ruler.



Refraction of Light through Glass Blocks

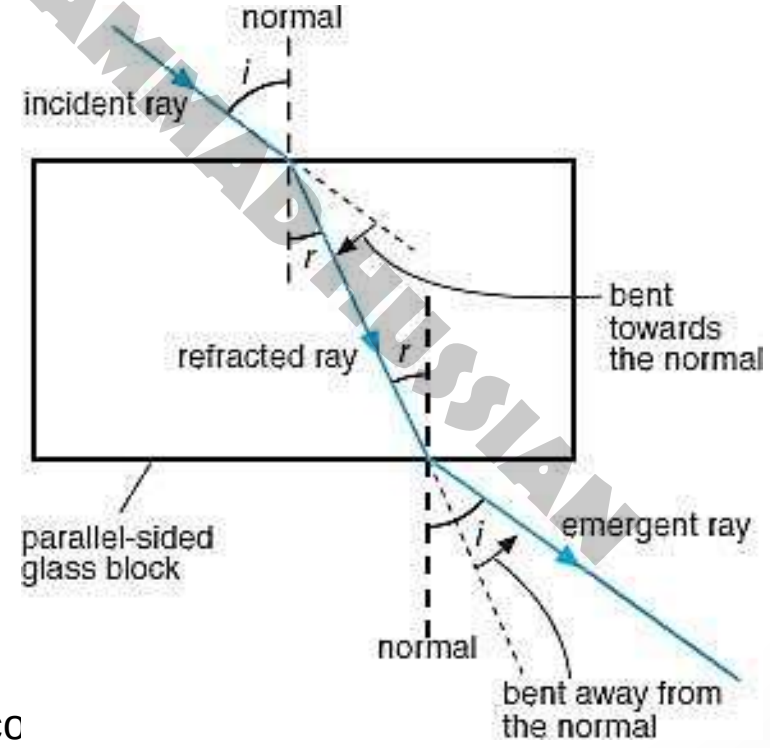


- Remove the block, connect the entry and exit points to show the path of light inside the block.



- Draw a normal at the entry point, measure the angle of incidence (i) and angle of refraction (r) using a protractor.
- Repeat for a range of angles of incidence.

- Result
  - As the angle of incidence (i) is increased the angle of refraction (r) decreased.



  - The ratio of $\frac{\sin i}{\sin r}$ is co

Refraction of light

Do calculations using the equation sin i /sin r = constant.

Refractive Index

- For a light ray passing from vacuum into a given medium, the constant ration sin i/sin r is known as the refractive index, n, for that medium with respect to a vacuum.

$$n = \frac{\sin i}{\sin r}$$

- The greater the value of the refractive index n of a medium, the greater is the bending of light towards the normal when it passes from air into the medium.

Medium	Refractive index, n
vacuum	1.00
air	1.003
water	1.33
ethanol	1.36
glycerine	1.47
crown glass	1.52
Quartz	1.54
flint glass	1.64
diamond	2.42

Refractive Index and Speed of Light

- The refractive index, *n*, of a medium may also be defined as the ratio of the speed of light in a vacuum to the speed of light in that medium.

$$n = \frac{\text{speed of light in vacuum}}{\text{speed of light in medium}}$$

- The higher the refractive index of a medium, the slower will be the speed of light through it.
- A medium's optical density increases as its refractive index increases.

Swimming Pool

- Swimming pool looks shallow compared to its actual depth;
  - At the water-air boundary, light is refracted away from the normal.
  - As a result, the eye sees the light as though it comes from the point higher up.
  - The apparent depth is less than the real depth.

$$\text{refractive index, } n = \frac{\text{real depth}}{\text{apparent depth}}$$

Problem Solving

1. Light (in air) strikes water at an angle of incidence of 45º. If the refractive index of water is 1.33, what is the angle of refraction?
2. The refractive index of water is 1.33. Calculate the angle of refraction if light (in air) strikes water at an angle of incidence of (a) 24º and (b) 53º.
3. If the speed of light in air is 3.0×10^8 m/s, find the speed of light in diamond. (Refractive index of diamond = 2.42)

4. Given the speed of light in vacuum is 3.0×10^8 m/s, calculate the speed of light in crown glass of refractive index 1.52.
5. The speed of light in a block of glass is found to be 1.9×10^8 m/s. Calculate the refractive index of the glass.
6. A solution of sugar in water is found to have a refractive index of 1.38. Calculate the speed of light in the solution.

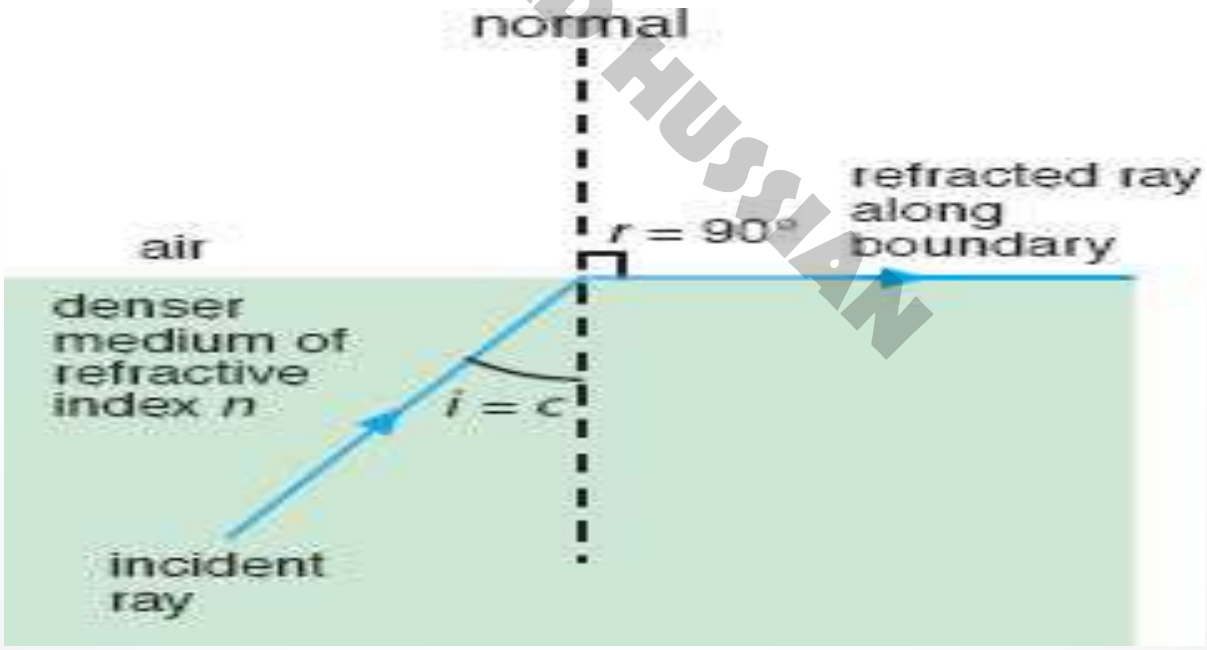
7. Perspex is a form of transparent plastic. It has a refractive index n = 1.5. A ray of light strikes the flat surface of a Perspex block with an angle of incidence of 40º. What will be the angle of refraction?
8. A light ray approaches a block of plastic at an angle of incidence of 60º. When the refractive index of plastic is 1.4. What is the angle of refractions?

Refraction of light

Define the terms critical angle and total internal reflection.

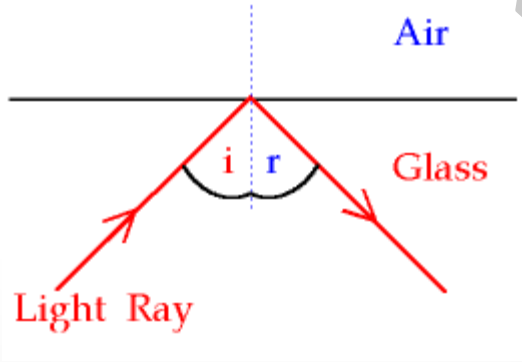
Critical Angle

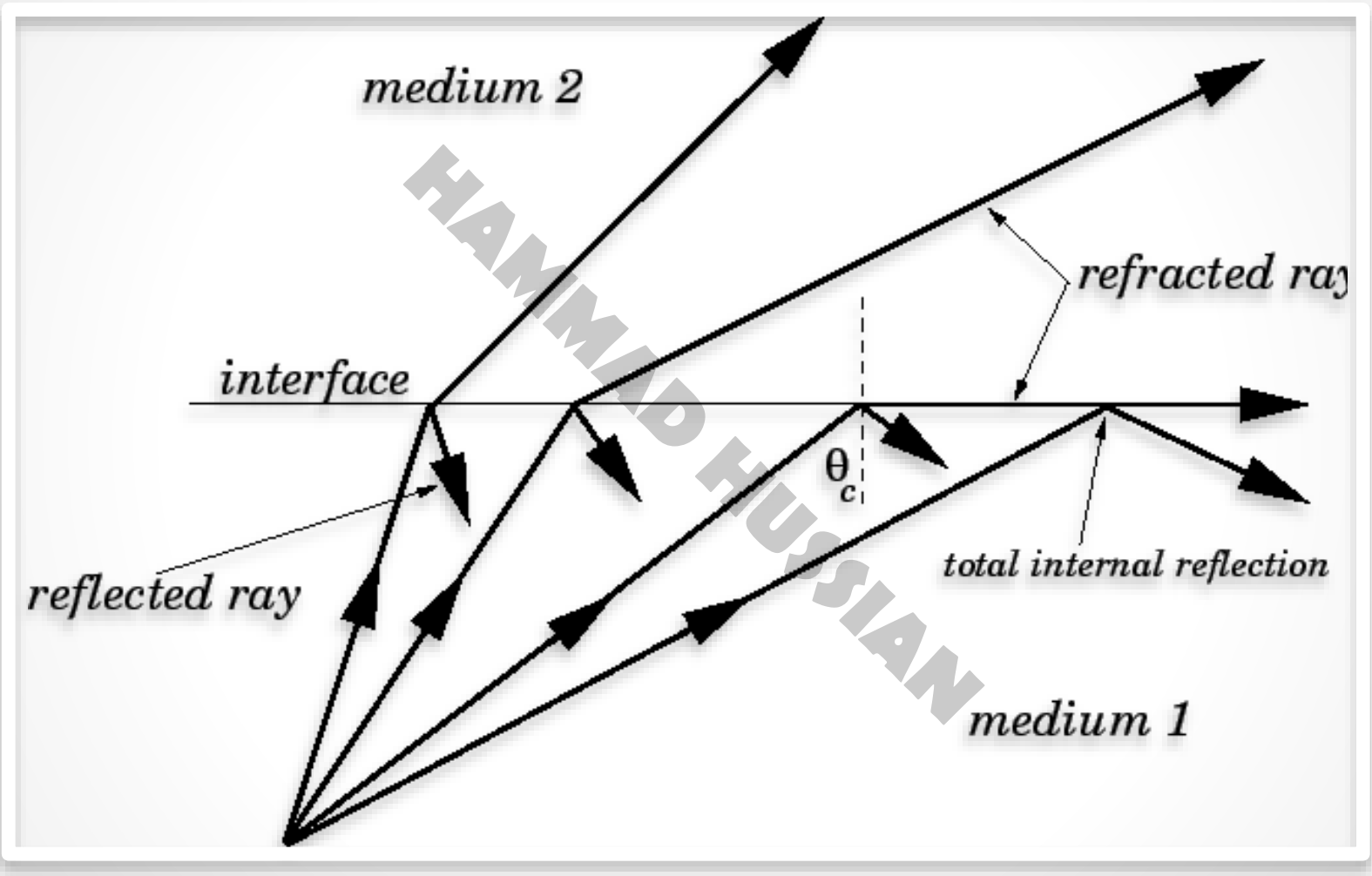
- The **critical angle** is defined as the angle of incidence in the optically denser medium for which the angle of refraction in the optically less dense medium is 90°.



Total Internal Reflection

- Total internal reflection is defined as the complete reflection of a light ray at the boundary of two media, when the ray is in the medium with greater refractive index
- For total internal reflection to occur, the following conditions must be satisfied:
  - The light ray must travel from an optically denser medium towards an optically less dense medium.
  - The angle of incidence must be greater than the critical angle.





Refractive Index and Critical Angle

- There is a relationship between the critical angle *c* and the refractive index *n* for a medium.

$$n = \frac{1}{\sin c}$$

Example

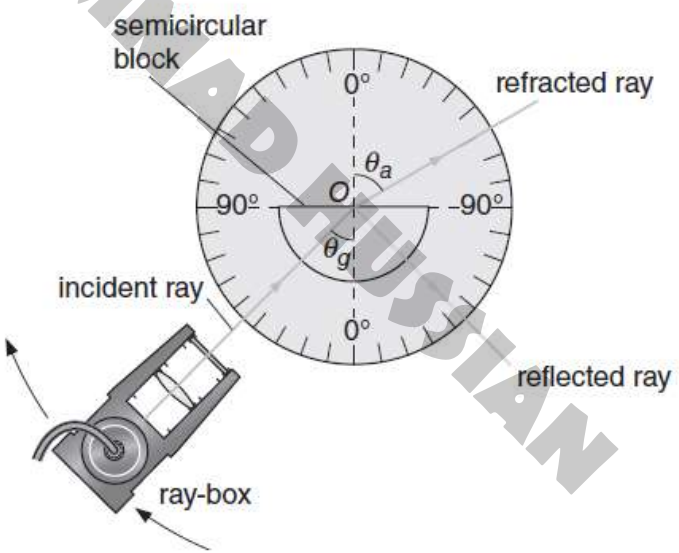
1. Calculate the critical angle for
   a. Glass of refractive index 1.50,
   b. Water of refractive index 1.33,
2. A transparent material has a refractive index of 2.0. calculate the critical angle.
3. Diamond has a refractive index of 2.42. The speed of light in a vacuum (or in air) is 3.0×10^8 m/s. Calculate:
   a. the speed of light in diamond
   b. critical angle for diamond.
4. A glass prism is made of glass or refractive index, n = 1.9. Determine the critical angle of the glass.

Refraction of light

Describe experiments to show total internal reflection.

- Aim: To show total internal reflection
- Apparatus:
  - Semi-circular glass block
  - Ray box
  - Protractor

- Procedure:
  - Set up the apparatus as shown below.

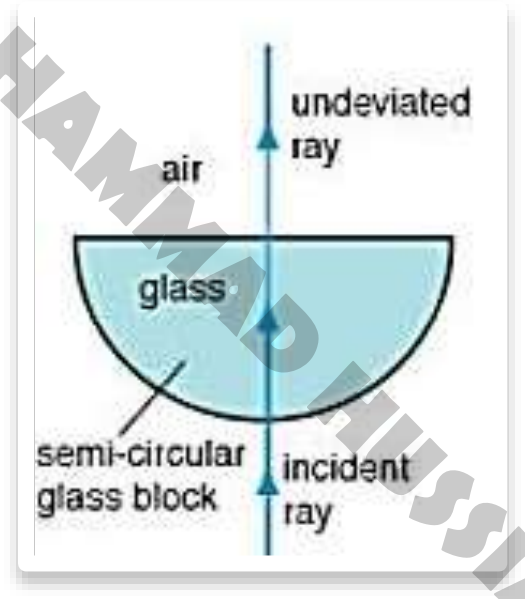


  - Direct the ray of light to enter the semicircular block from its curved edge towards its centre *O*.

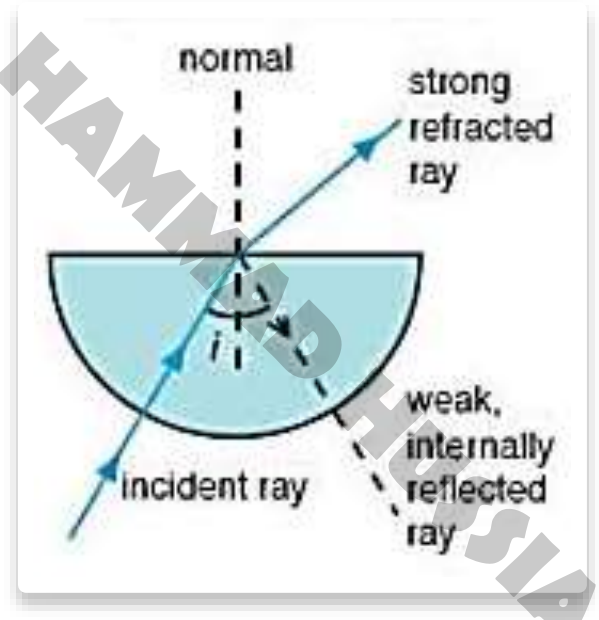
- Set the angle of incidence in the glass block θ_g to 0°. Slowly increase θ_g by moving the raybox.
- Read any pair of θ_g and θ_a. Use them to calculate the refractive index of the semicircular block n_g.
- Read θ_g when the refracted ray becomes almost parallel to the straight edge of the semicircular block, i.e. when θ_g = 90°. This θ_g is called the critical angle C.
- Calculate the refractive index of the block n_g using the value of the critical angle C.
- Further increase θ_g by moving the raybox.

- Calculation
  - $n_g = \frac{\sin \theta_a}{\sin \theta_g}$
  - $n_g = \frac{1}{\sin C}$

- Result
  - When θ_g increases, the refracted ray moves away from the normal.
  - When θ_g is greater than the critical angle C, the ray is totally internally reflected.

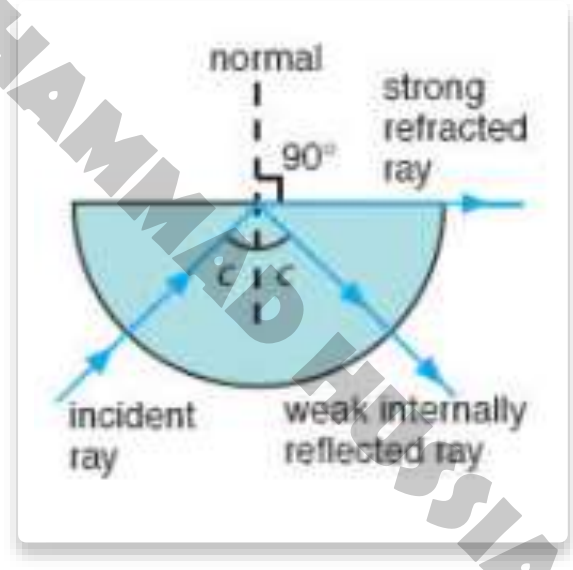


When the angle of incidence is zero at the glass boundary, the ray emerges without deviation



As the angle of incidence increases, the angle of refraction of the emerging ray also increases.

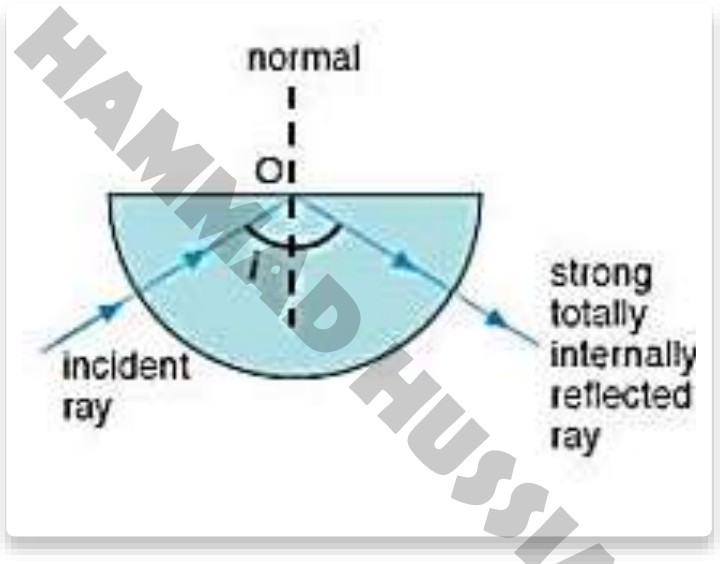
Critical Angle



In addition to the refracted ray, there is also a weak internally reflected ray.

This happens until a certain angle of incidence is reached at which point, the refracted ray passes exactly along the glass-air boundary

Total Internal Reflection



If the angle of incidence is greater than the critical angle, then the ray will not leave the glass at all.

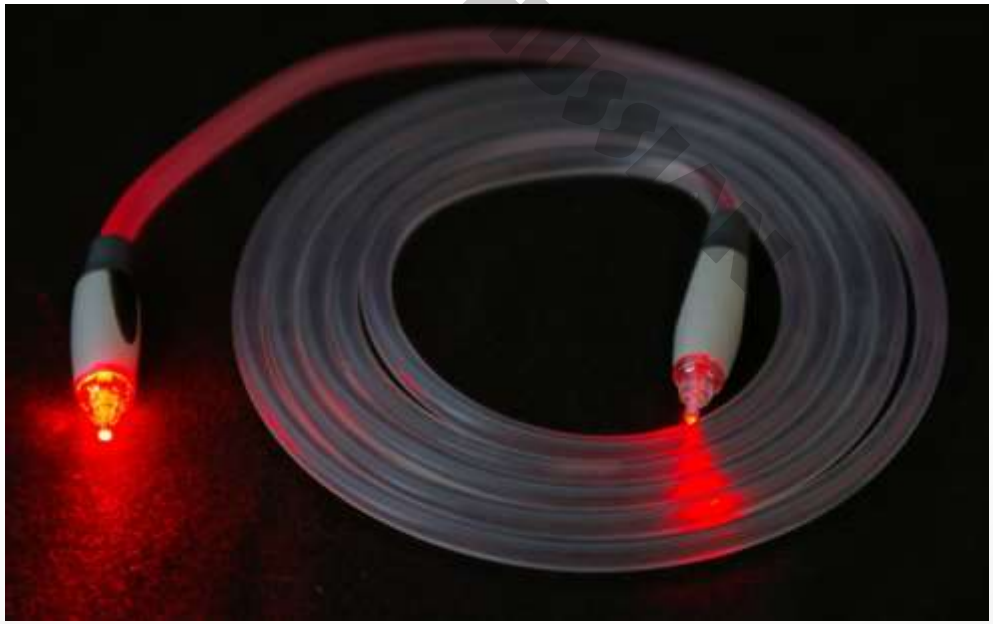
It is reflected internally within the block.

Refraction of light

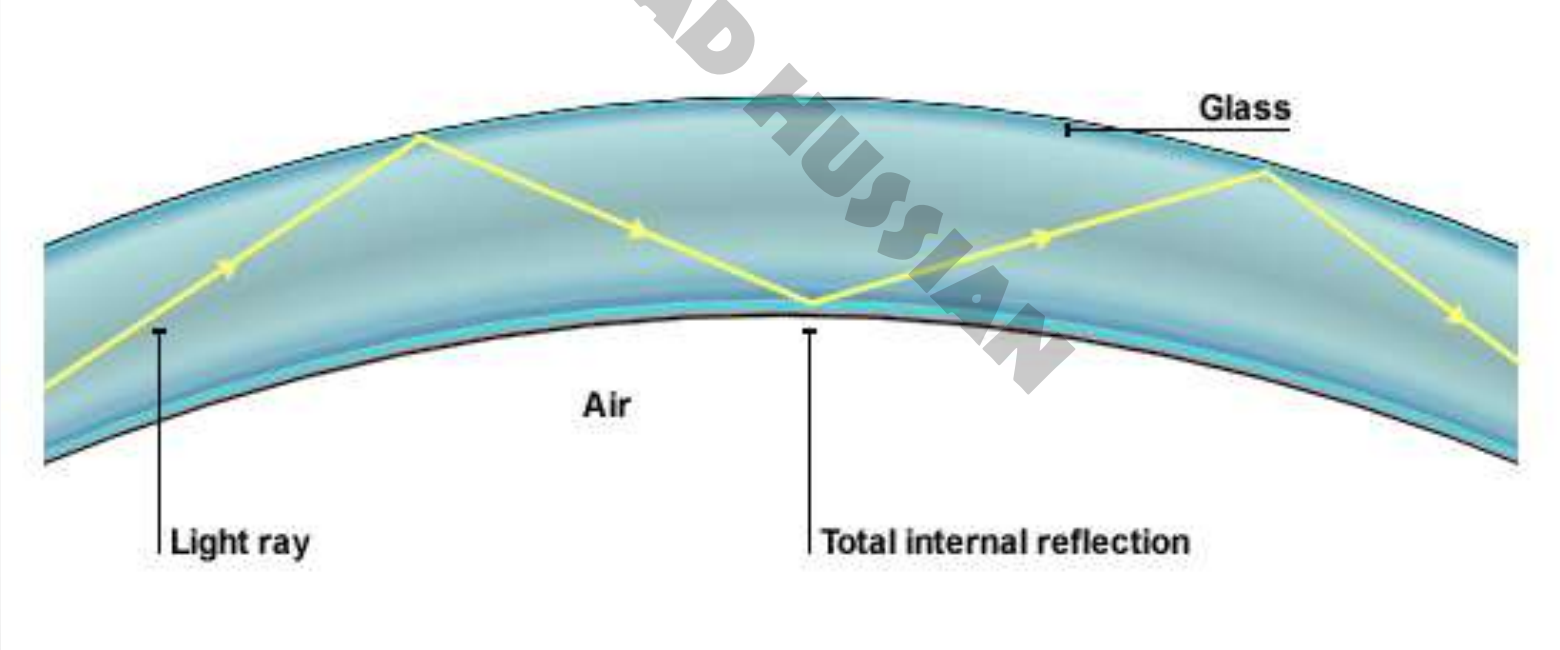
Describe the use of optical fibres in telecommunications and state the advantages of their use.

Optical Fibre

- An optical fibre is **a thin rod of high-quality glass**. Very little light is absorbed by the glass.
- Light getting in at one end undergoes repeated total internal reflection, even when the fibre is bent, and emerges at the other end.



- Information such as **computer data and telephone calls** can be converted into either visible light signals or infrared signals, and transmitted by optical fibres.



Advantage of Fibre Optics

- **Less expensive** - can be made cheaper because of glass are abundant.
- **Thinner** - Optical fibers can be drawn to smaller diameters than copper wire.
- **Higher carrying capacity**- More fibres can be bundled into a given-diameter cable than copper wires.
- **Less signal degradation** - The loss of signal in optical fiber is less.
- **Low interference** - Light signals from one fiber do not interfere with those of other fibers in the same cable.

- **Low power** - Because signals in optical fibres degrade less, lower-power transmitters can be used.
- **Digital signals** - Optical fibers are ideally suited for carrying digital information, which is especially useful in computer networks.
- **Non-flammable** - Because no electricity is passed through optical fibers, there is no fire hazard.
- **Lightweight** - An optical cable weighs less than a comparable copper wire cable.
- **Flexible** - Because fiber optics are so flexible and can transmit and receive light.

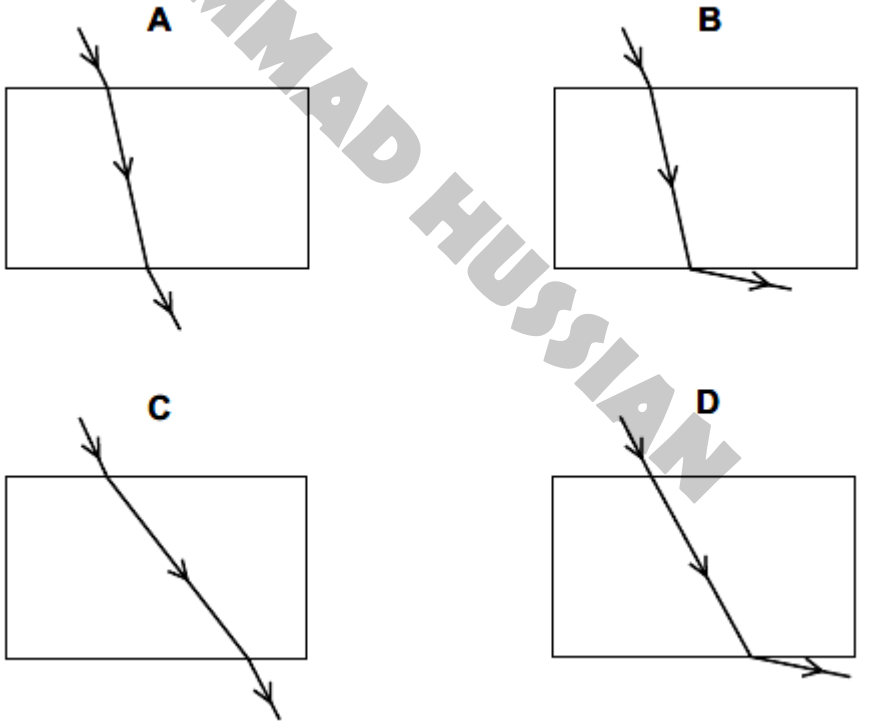
1. What causes refraction when light travels from air into glass?

   A. The amplitude of the light waves changes.
   B. The colour of the light changes.
   C. The frequency of the light waves changes.
   D. The speed of the light changes.

2. What happens to light as it passes from glass into air?

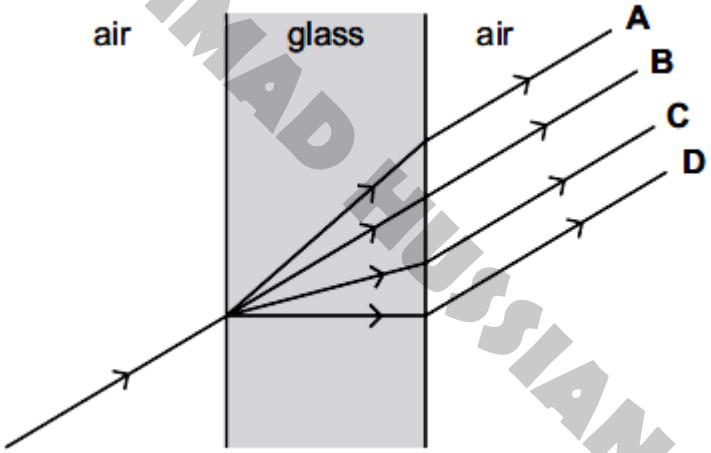
A. Its frequency decreases because its speed decreases.
B. Its frequency increases because its speed increases.
C. Its wavelength decreases because its speed decreases.
D. Its wavelength increases because its speed increases.

3. Which diagram correctly shows a ray of light passing through a rectangular glass block?



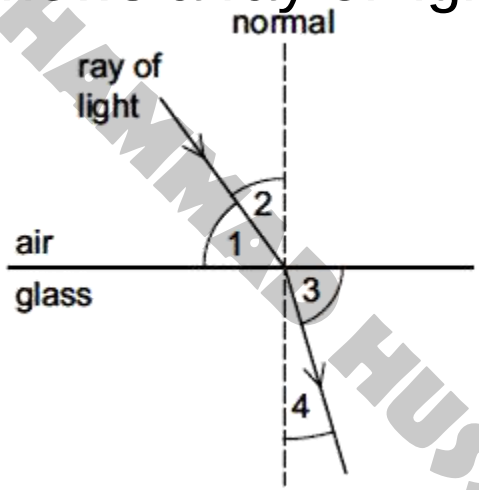
A

4. A ray of light passes through a window. Which path does it take?



C

5. The diagram shows a ray of light entering a block of glass.



Which numbered angles are the angles of incidence and of refraction?

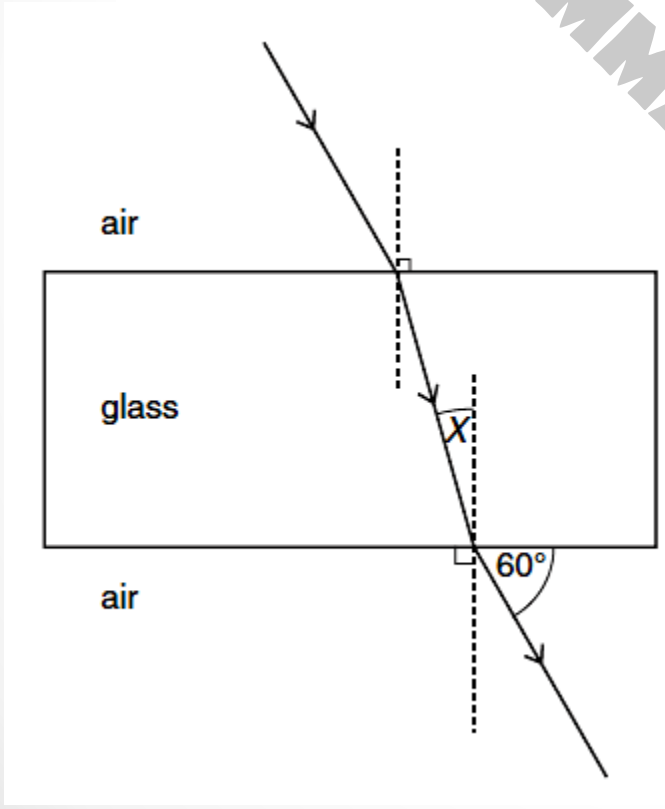
	angle of incidence	angle of refraction
A	1	3
B	1	4
C	2	3
D	2	4

D

6. A ray of light strikes the surface of a glass block at an angle of incidence of 45°.
7. The refractive index of the glass is 1.5.
8. What is the angle of refraction inside the block?

A. 28°
B. 30°
C. 45°
D. 67°

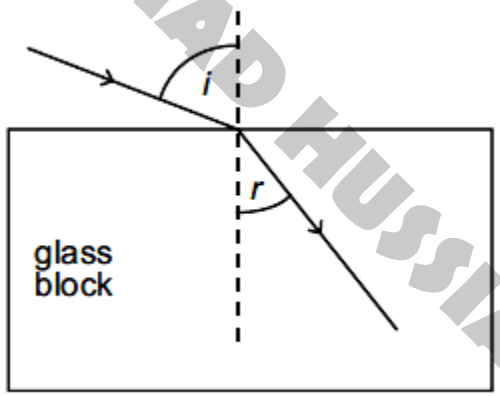
7. For a certain parallel-sided glass block, the value of $\frac{\sin i}{\sin r}$ is 1



A ray of light passes through the block and emerges at an angle of 60° to the surface of the block. What is the value of the angle marked *X* ?

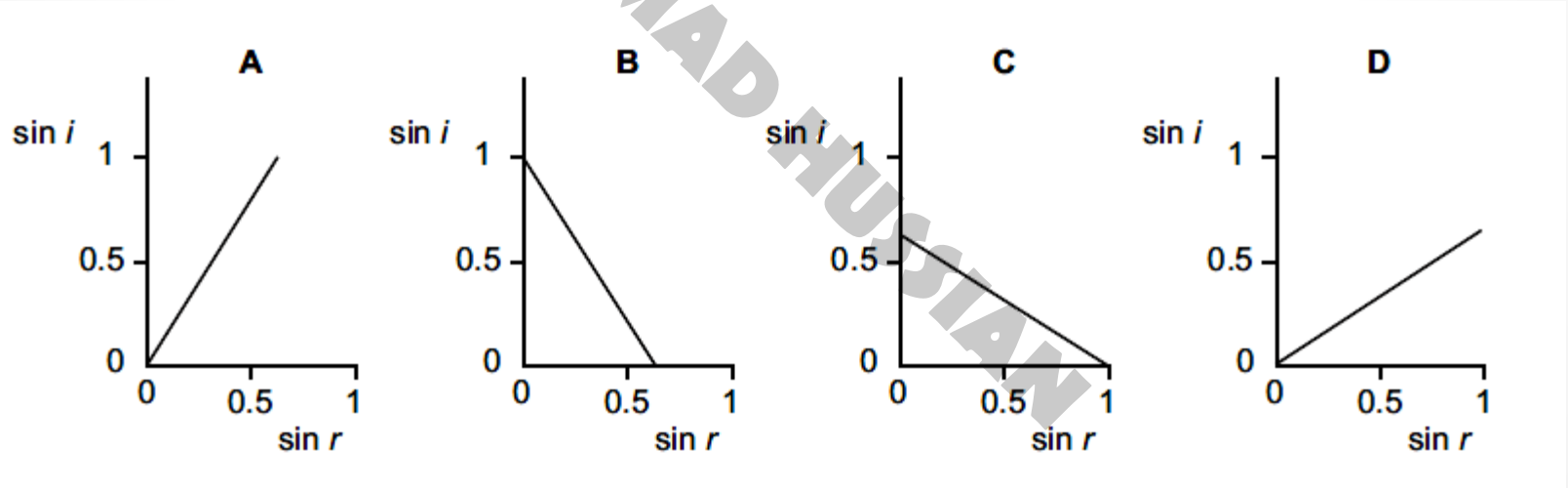
A. 19.5°
B. 35°
C. 40°
D. 48.5°

8. A ray of light enters a glass block at an angle of incidence *i* producing an angle of refraction *r* in the glass.



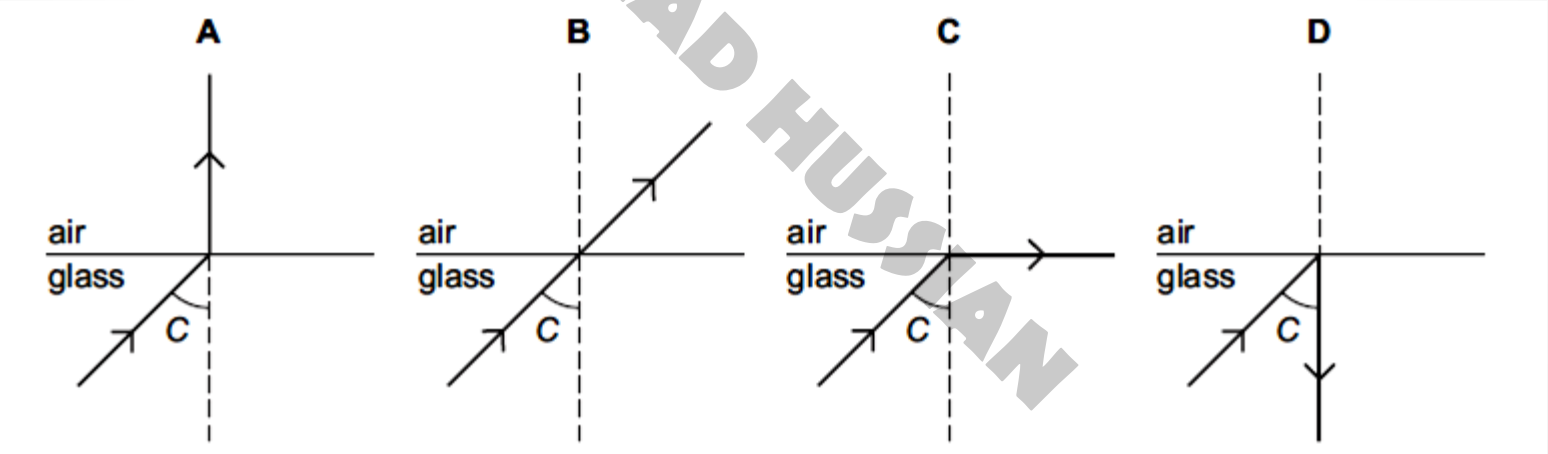
Several different values of i and r are measured, and a graph is drawn of sin i against sin r.

Which graph is correct?



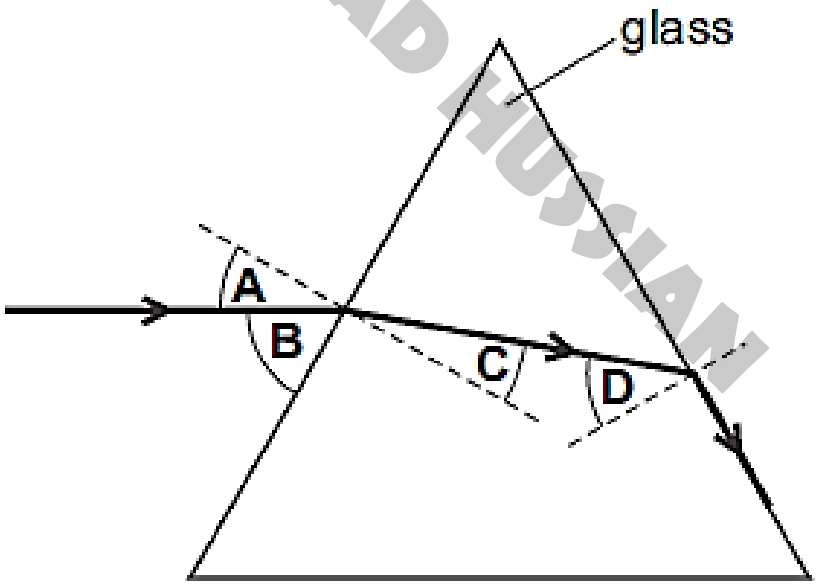
A

9. The critical angle for a glass / air boundary is C.
Which diagram shows the correct path of the light ray?



C

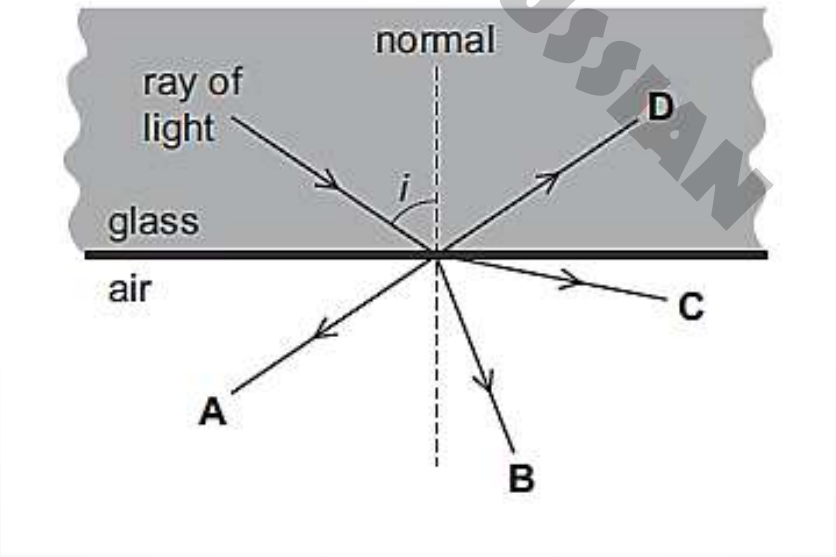
10. The diagram shows the passage of a ray of light through a triangular glass block.
11. What is the critical angle of light in glass?



D

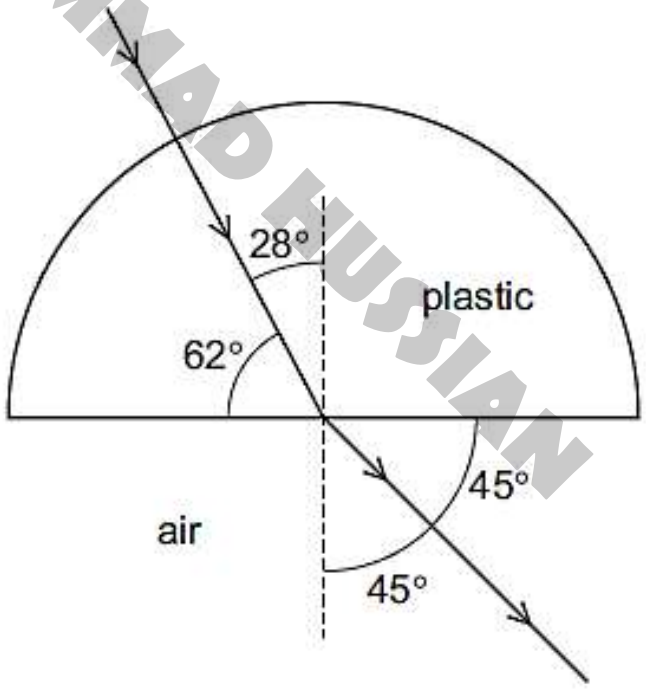
11. The diagram shows a ray of light incident on the edge of a piece of glass. The angle *i* is bigger than the critical angle.

12. Which arrow correctly shows the direction of the ray after it leaves the edge of the glass?



D

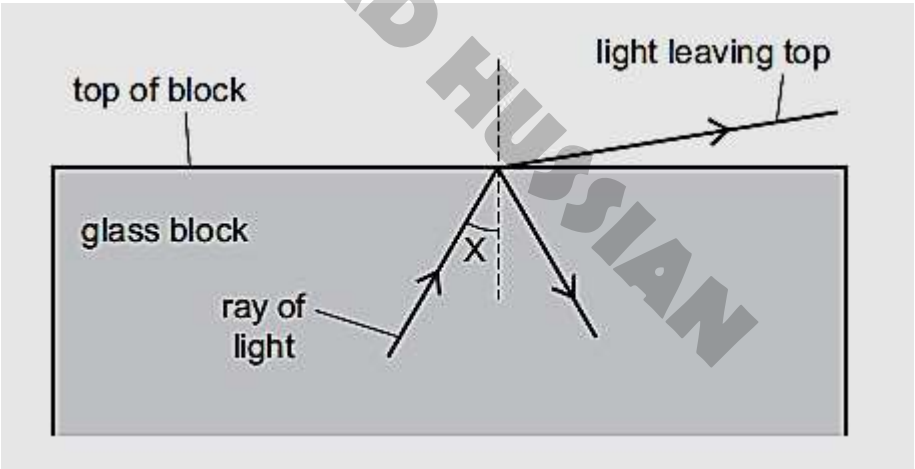
12. A semi-circular block is made from a plastic. A ray of light passes through it at the angles shown.



To two decimal places, what is the refractive index of the plastic?

A. 1.25
B. 1.41
C. 1.51
D. 1.61

13. A scientist is trying to direct a ray of light through a glass block without any light leaving the top of the block. However, some light does leave the top.



The scientist changes angle X and stops the ray of light leaving the top.

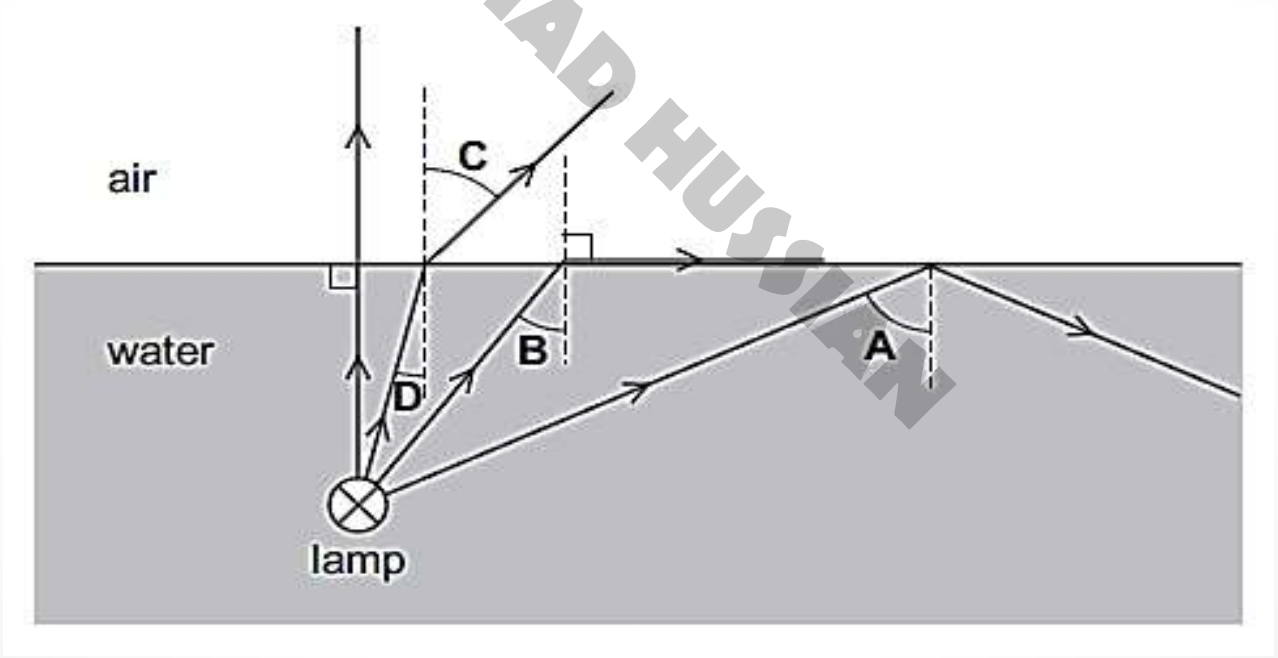
Which row in the table describes the change to angle X and the name of the effect produced?

	change to angle X	name of effect produced
A	decrease	total internal reflection
B	decrease	total internal refraction
C	increase	total internal reflection
D	increase	total internal refraction

C

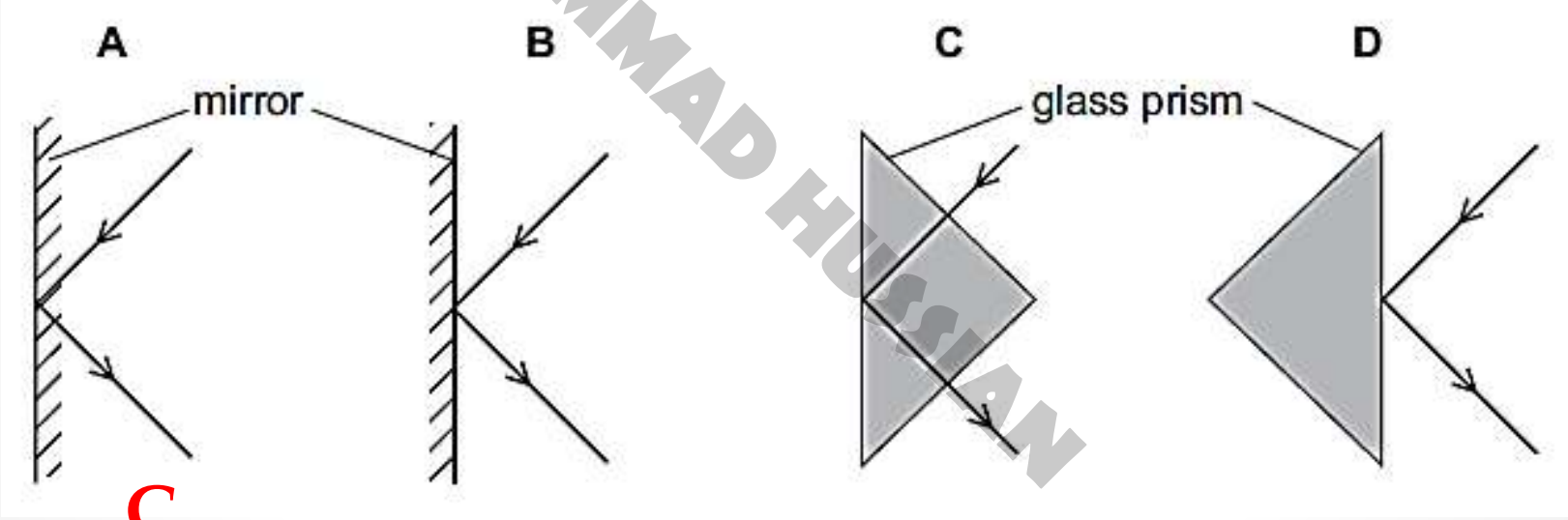
14. The diagram shows four rays of light from a lamp below the surface of some water.

15. What is the critical angle for light in water?



B

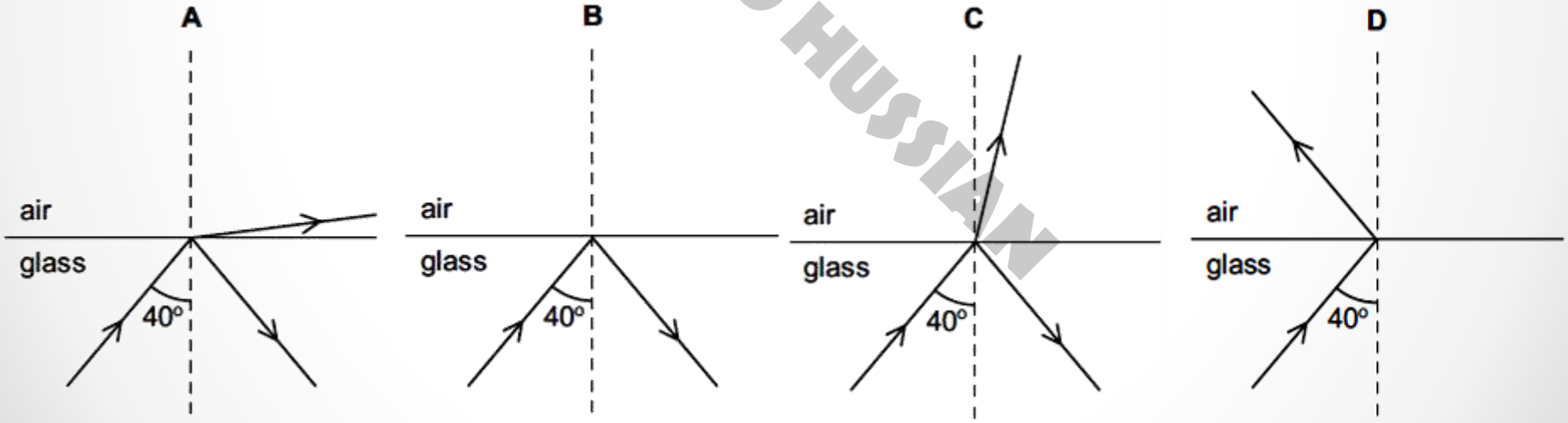
15. Which diagram shows total internal reflection of light?



C

16. A ray of light passes from glass into air at an angle of incidence of 40°. The glass has a critical angle of 42°.

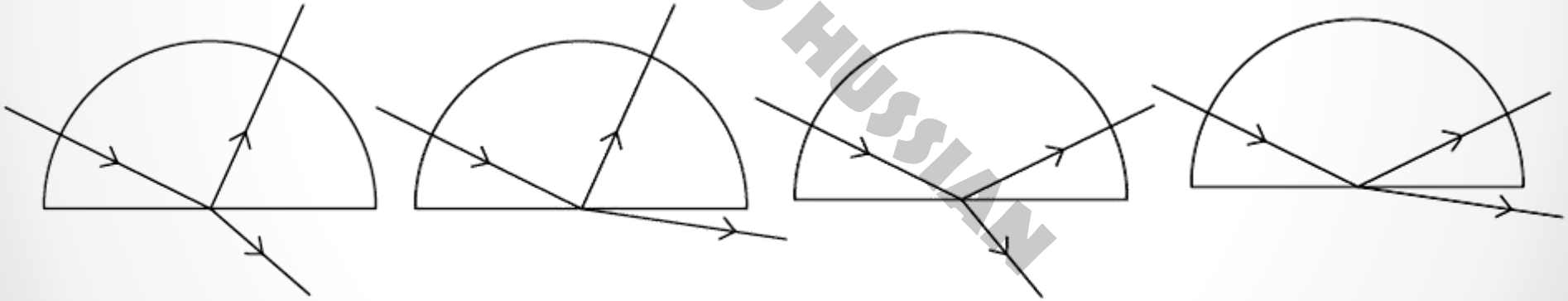
Which diagram shows what happens to the ray?



A

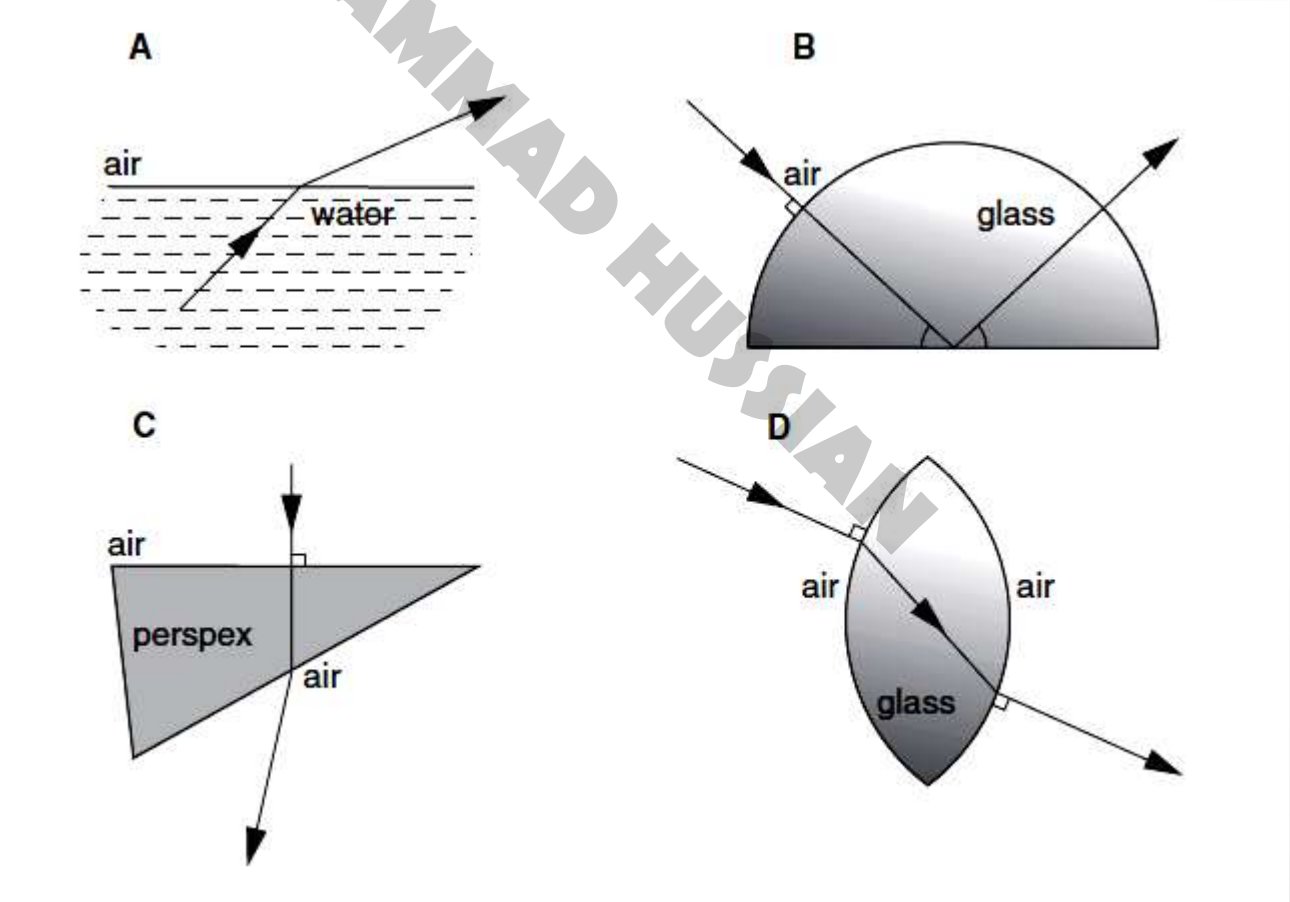
17. A ray of red light enters a semi-circular glass block normal to the curved surface.

Which of the following correctly shows the partial reflection and refraction of the ray?



D

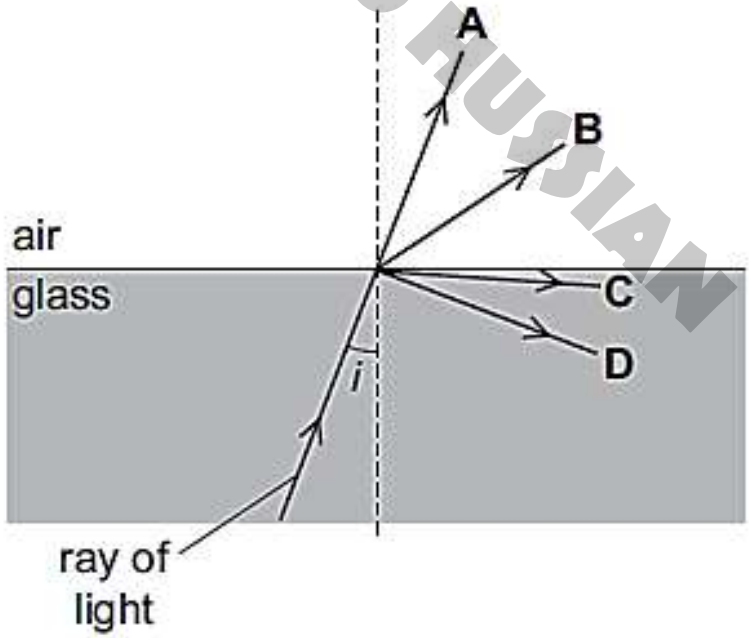
18. In which of the diagrams is the path of the light ray not correct?



D

19. A ray of light in glass is incident on a boundary with air.

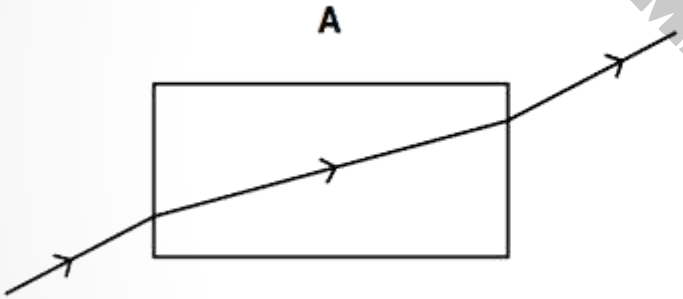
16. Which path does the ray of light take when the angle of incidence i is less than the critical angle?

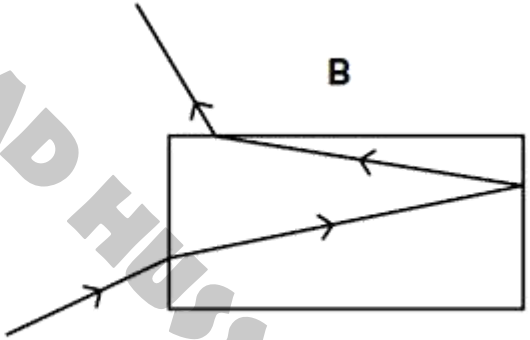


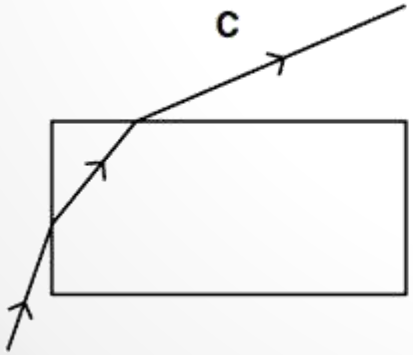
B

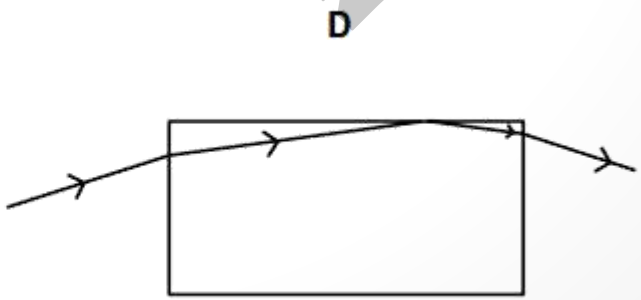
20. A ray of light is incident on one side of a rectangular glass block.

Its path is plotted through the block and out through another side.









Which path is not possible?

B

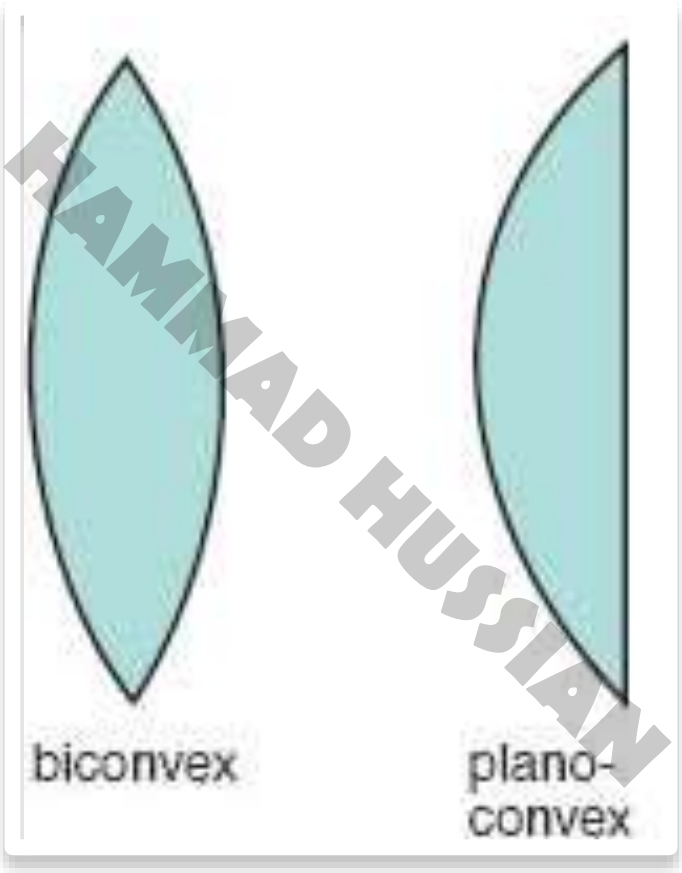
Thin converging and diverging lenses

Describe the action of thin lenses (both converging and diverging) on a beam of light.

Thin Lenses

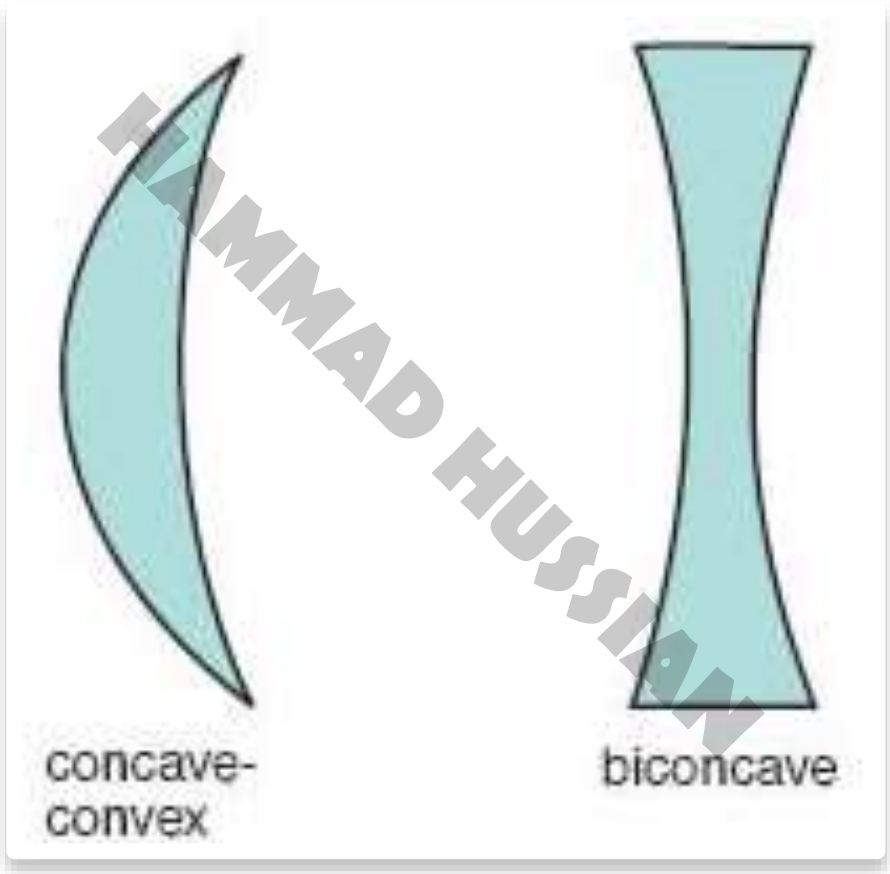
- Lenses are the most important practical application of refraction.
- The human eye, spectacles, cameras, telescopes and microscopes are all contain lenses.
- Most lenses are made from glass of clear plastic.
- In term of structure and function, we can classified lenses into two categories; **converging lenses** and **diverging lenses**.

Converging Lenses



Converging lenses: thicker in the middle

Diverging Lenses

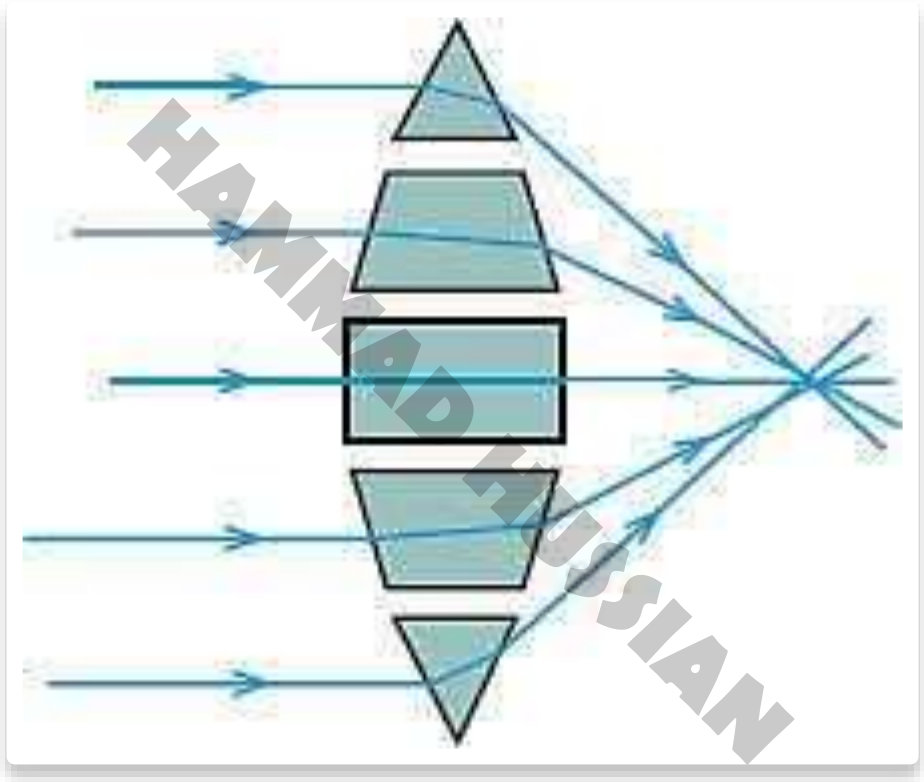


Diverging lenses: thinner in the middle

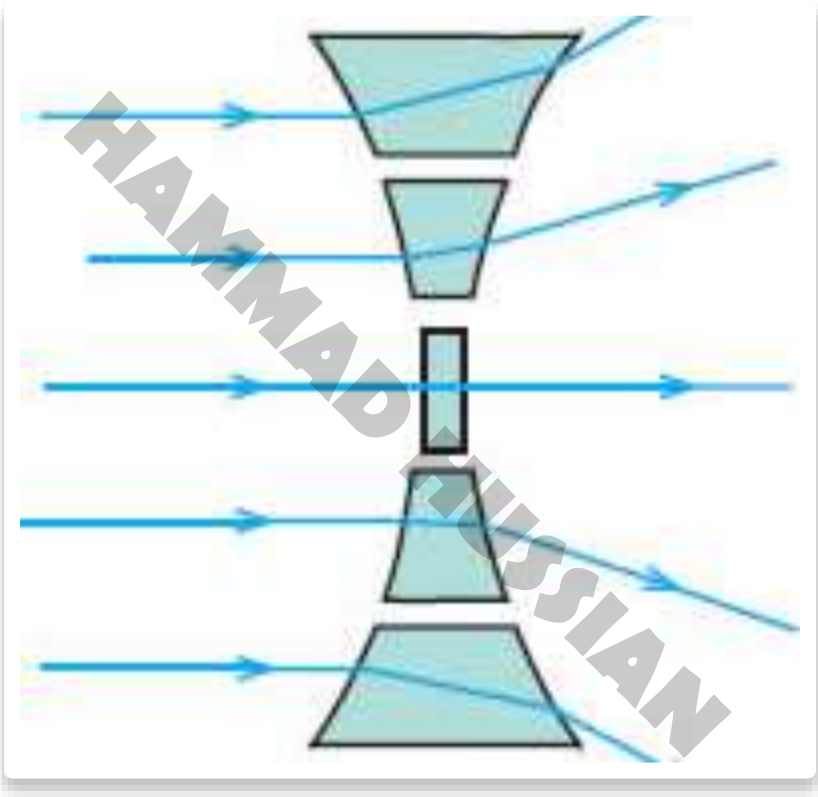
How Do They Work?

- We can illustrate the action of a lens by drawing it as a series of prisms.
- Each ray is refracted towards the normal as it passes into the glass and away from the normal as it leaves it.
- A converging lens converges (brings together) rays of light passing through it while a diverging lens diverges (spreads out) rays of light passing through it.

Action of Converging Lens



Action of Diverging Lens



Thin converging and diverging lenses

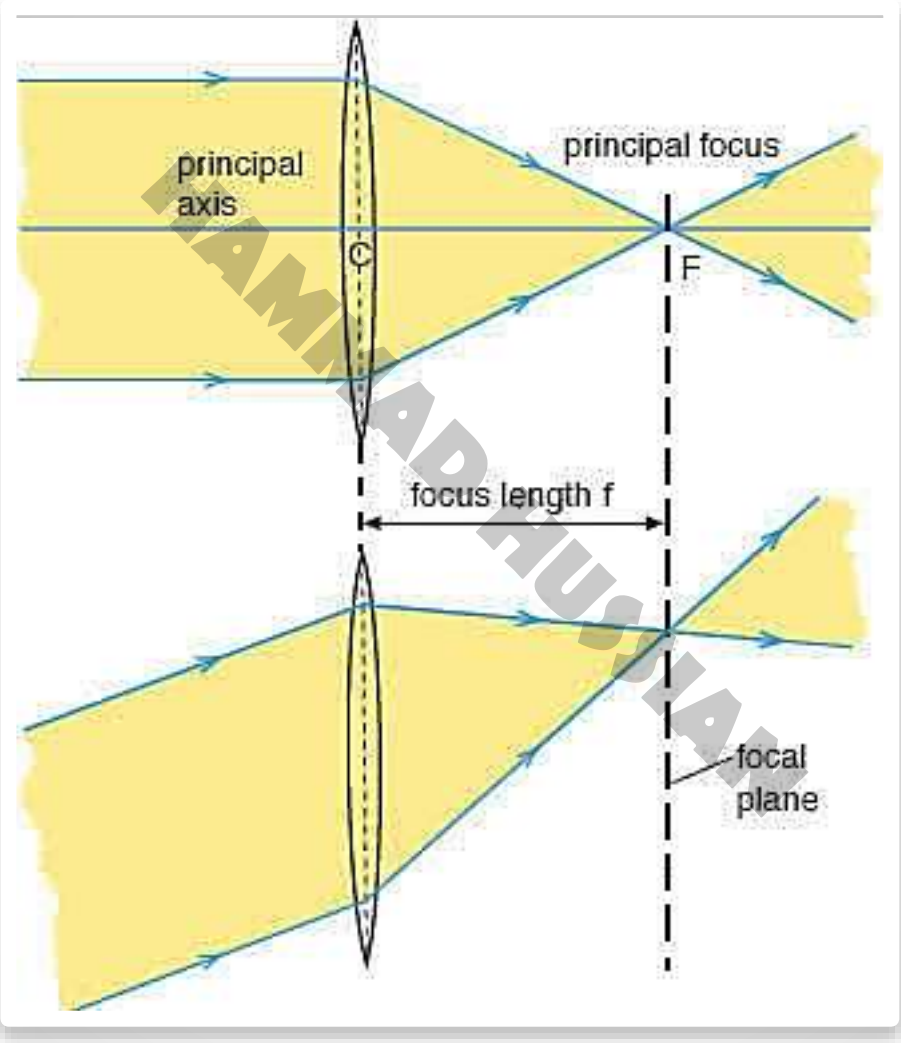
Define the term focal length.

Term Used in Lenses

- The **principal axis** of a lens is a line passing through the optical centre, C, of the lens perpendicular to the plane of the lens.
- The **optical centre**, C, of a lens is the point midway between the lens surface on its principal axis. Rays passing through the optical centre are not deviated.
- The **principal focus**, F of a thin converging lens is the point on the principal axis, to which an incident beam parallel to the principal axis is made to converge.

- The **focal length**, *f*, of a lens is the distance between its optical centre and principal focus.
- The **focal plane** of a lens is the vertical plane which passes through the principal focus and perpendicular to the principal axis.

Term used in Lenses



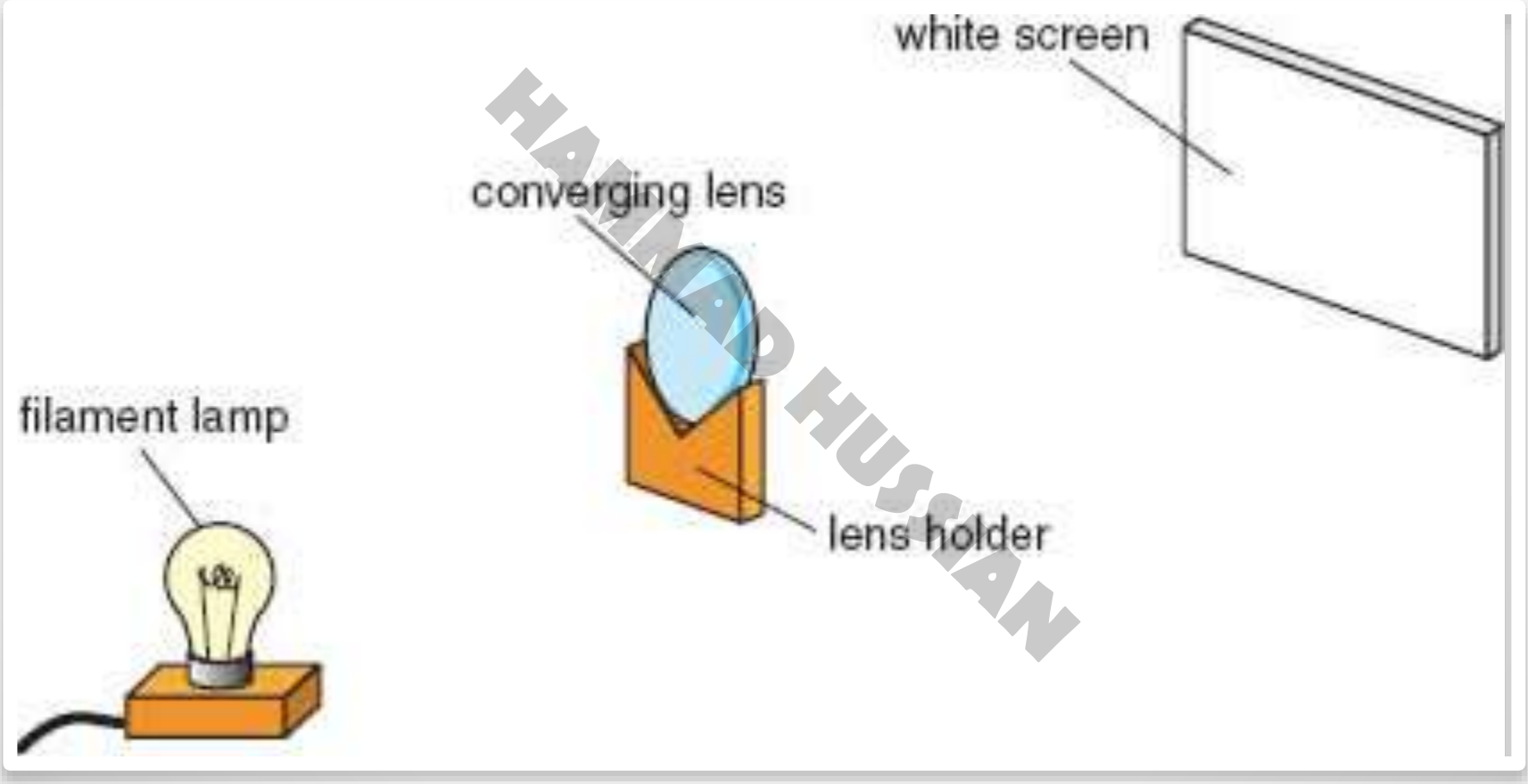
Thin converging and diverging lenses

Draw ray diagrams to illustrate the formation of real and virtual images of an object by a lens.

Thin converging and diverging lenses

Describe the use of a single lens as a magnifying glass and in a camera, projector and photographic enlarger and draw ray diagrams to show how each forms an image.

Investigating: The properties of images obtained through a thin converging lens

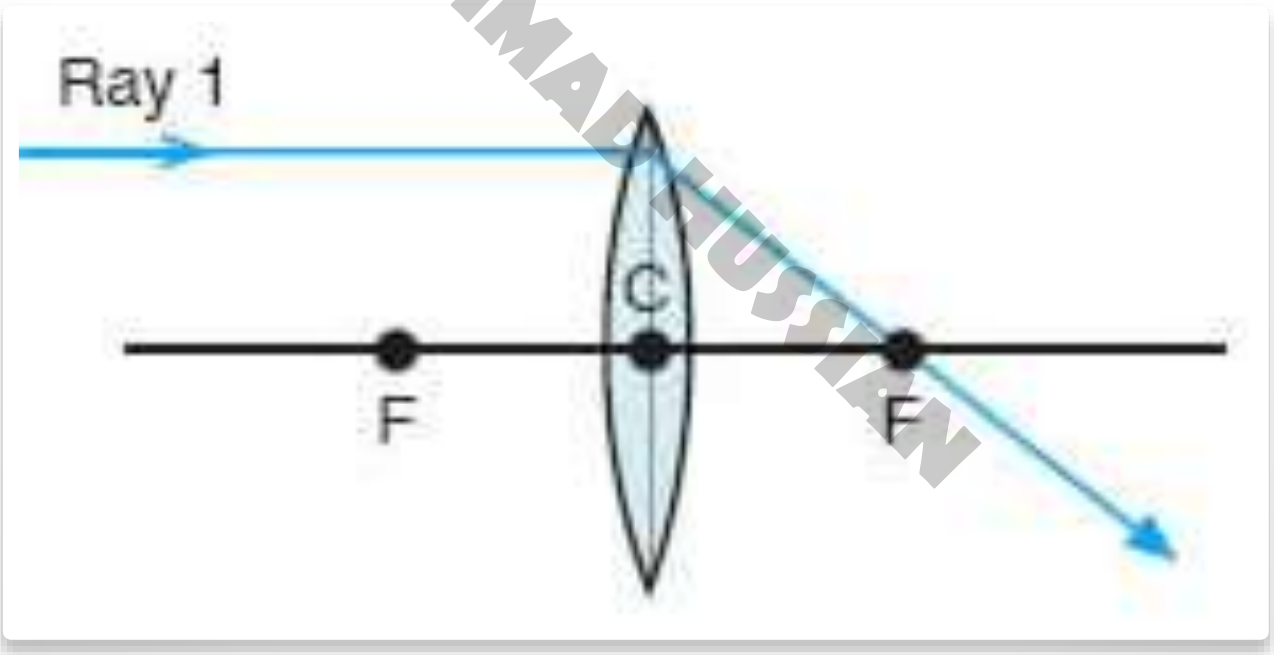


Ray Diagrams for Thin Converging Lenses

- There are three particular rays which can be drawn accurately in a ray diagrams.
- We choose the two most convenient rays to locate the position of the image formed.

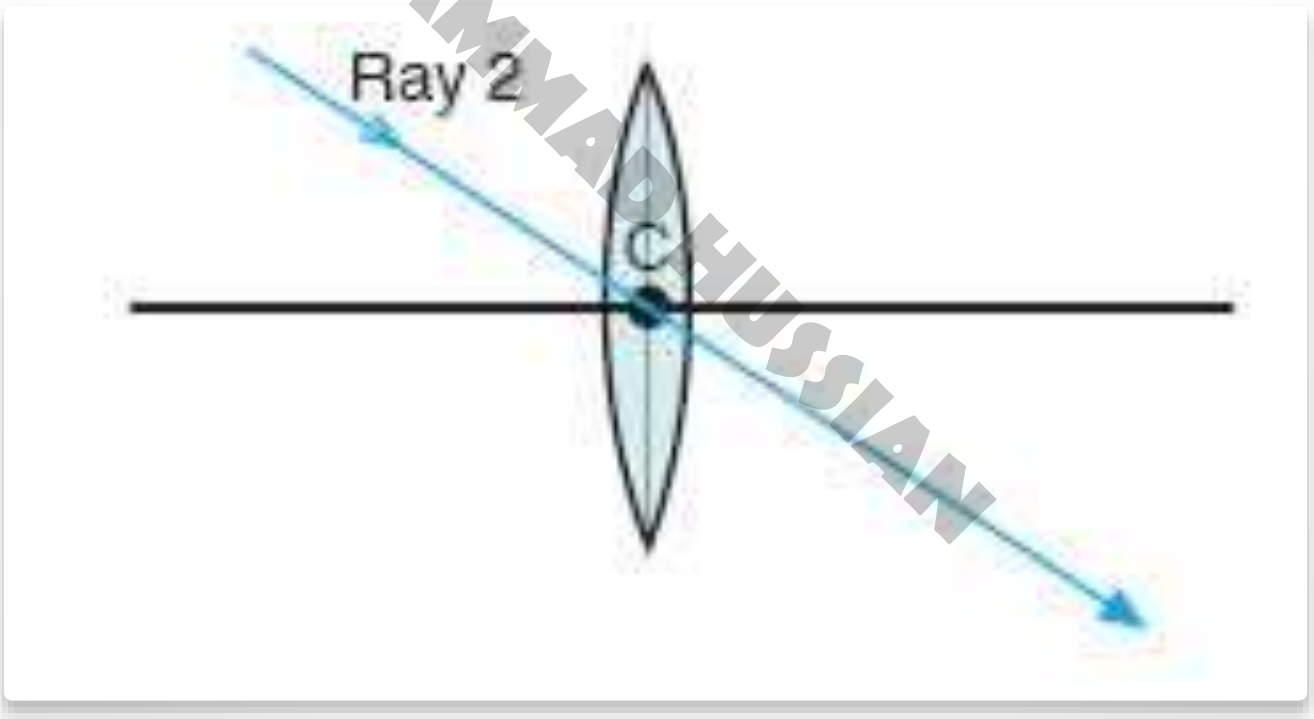
Ray 1

A ray parallel to the principal axis is refracted by the lens to pass through F



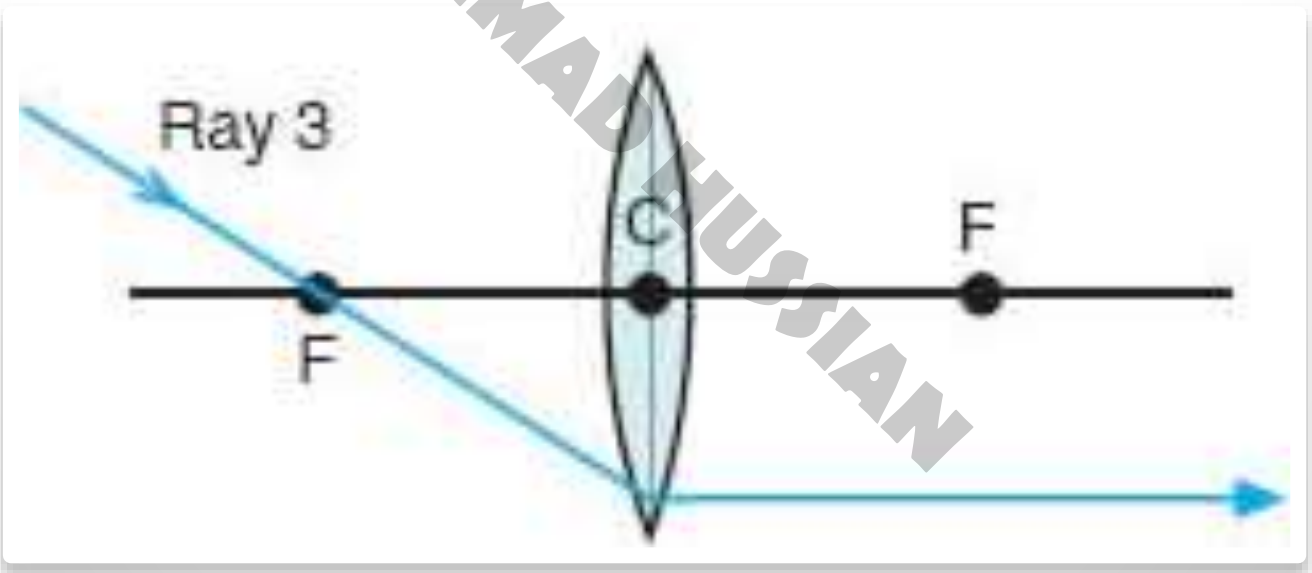
Ray 2

A ray through the optical centre C is not deviated

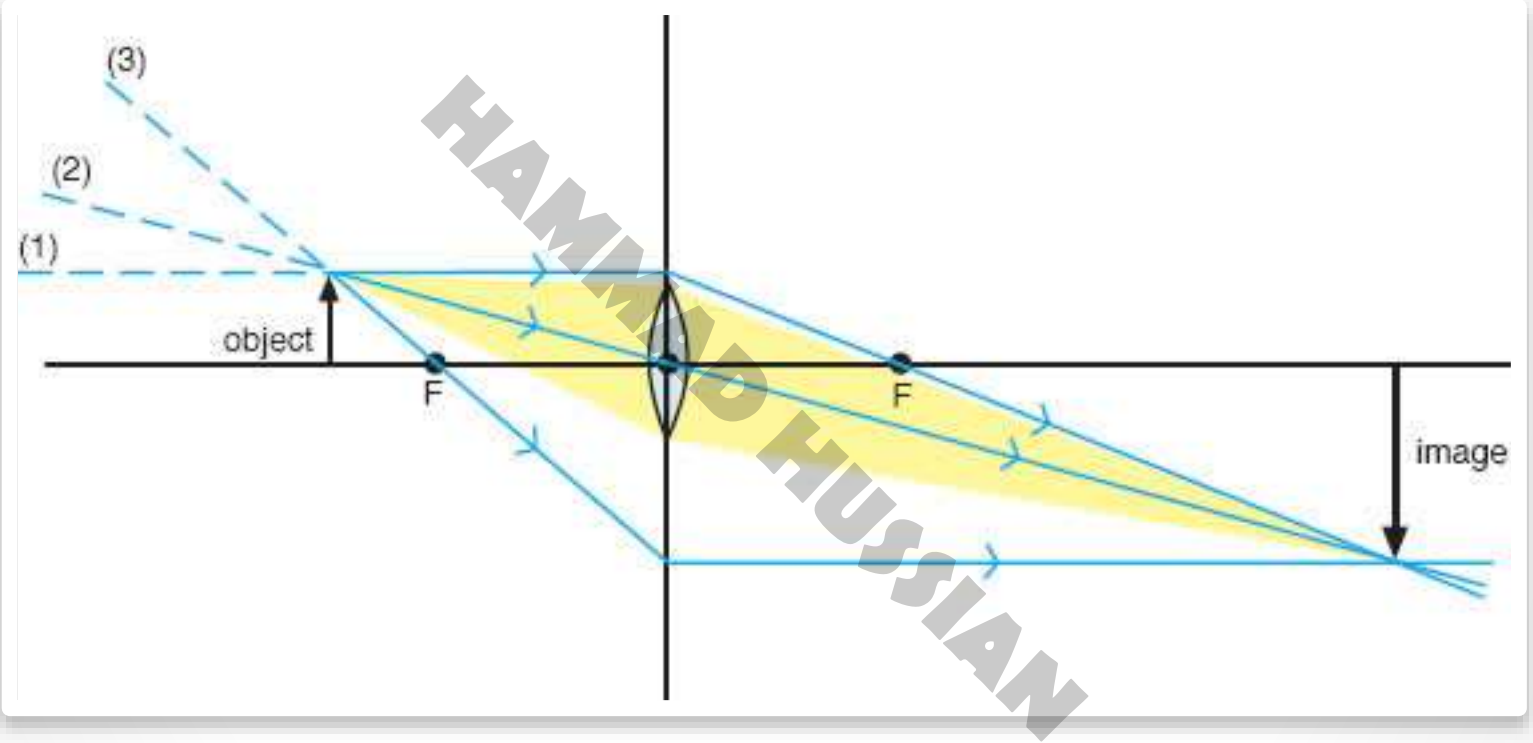


Ray 3

A ray through F is refracted parallel to the principal axis

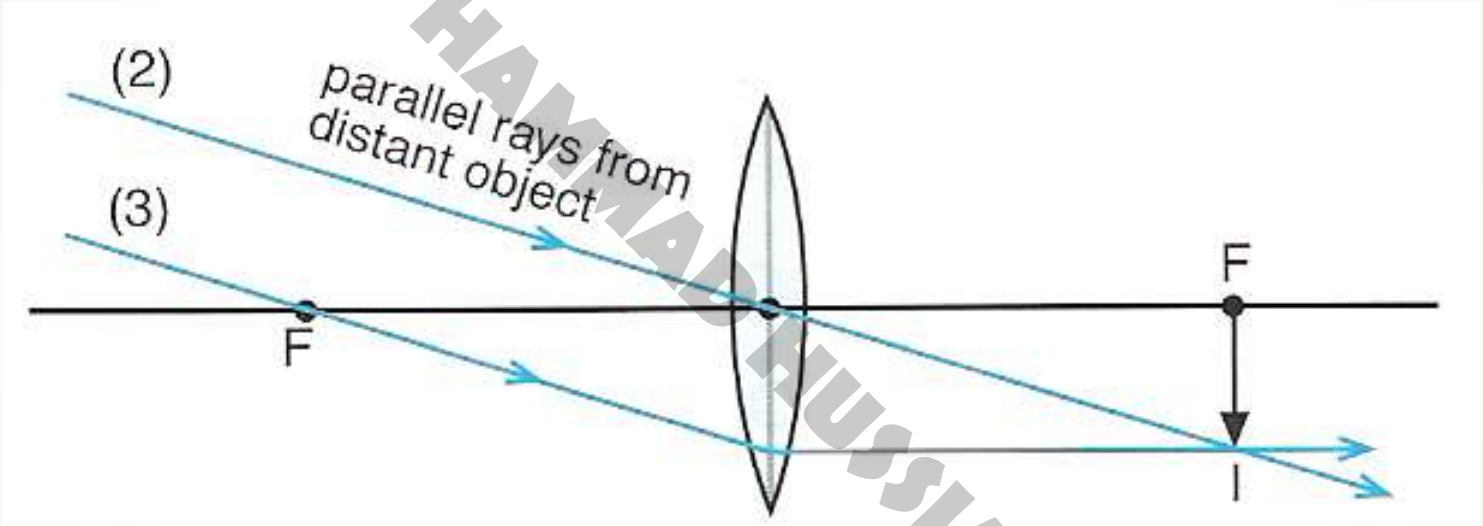


Converging Lens



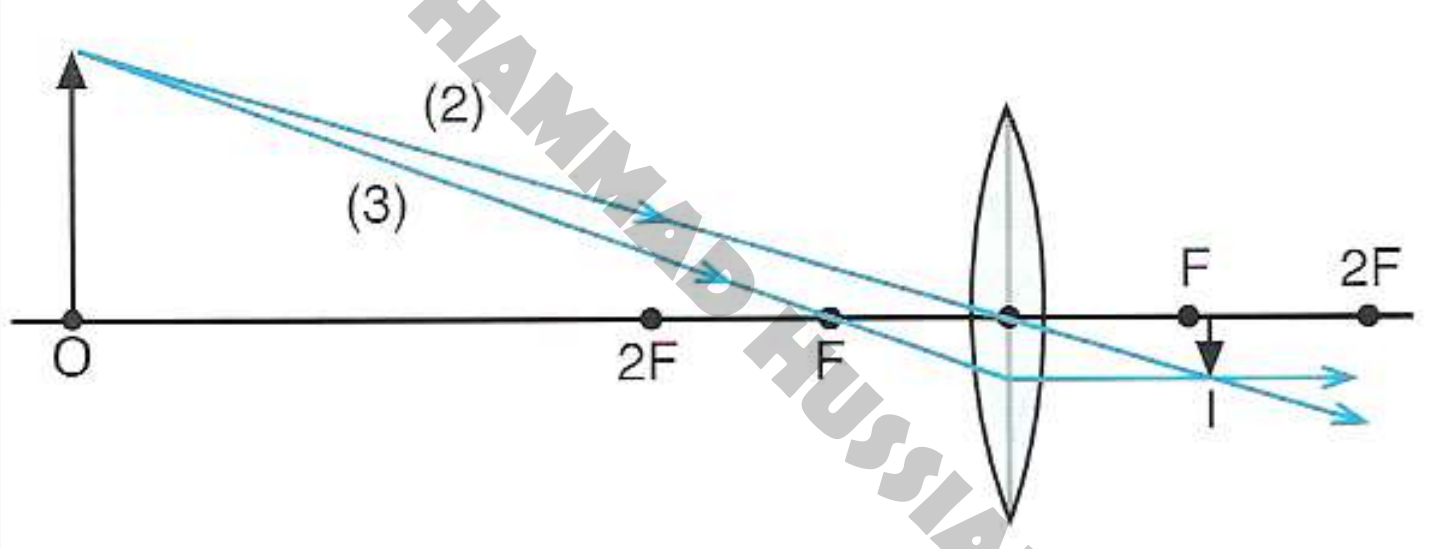
To Locate Images Using Ray Diagrams

Object at Infinity



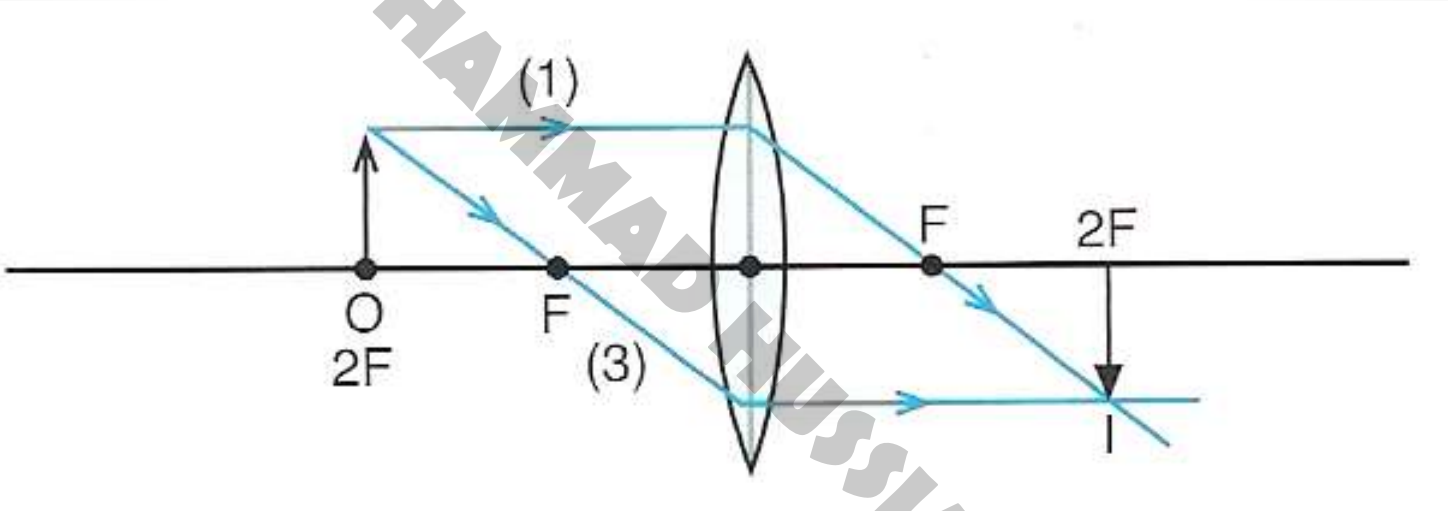
- Real, inverted & diminished
- Image at opposite side of Object, at F
- Objective lens of telescope

Object between 2F and Infinity



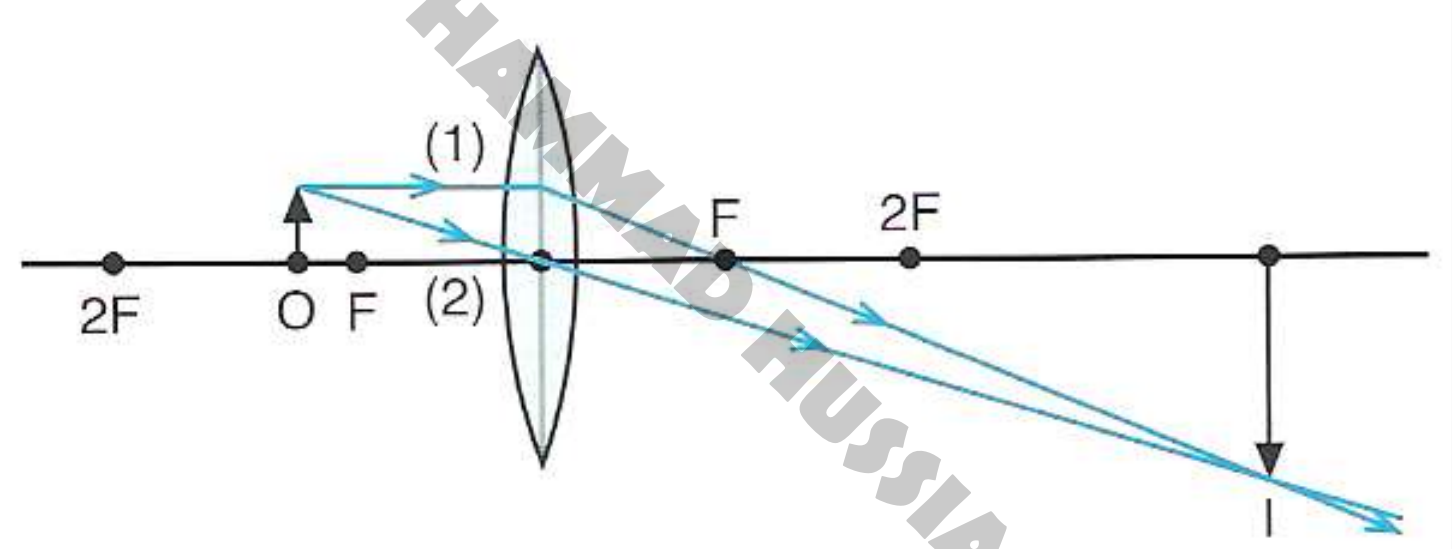
- Real, inverted & diminished.
- Image opposite side of Object, between F & 2F.
- Camera & human eye
-

Object at 2F



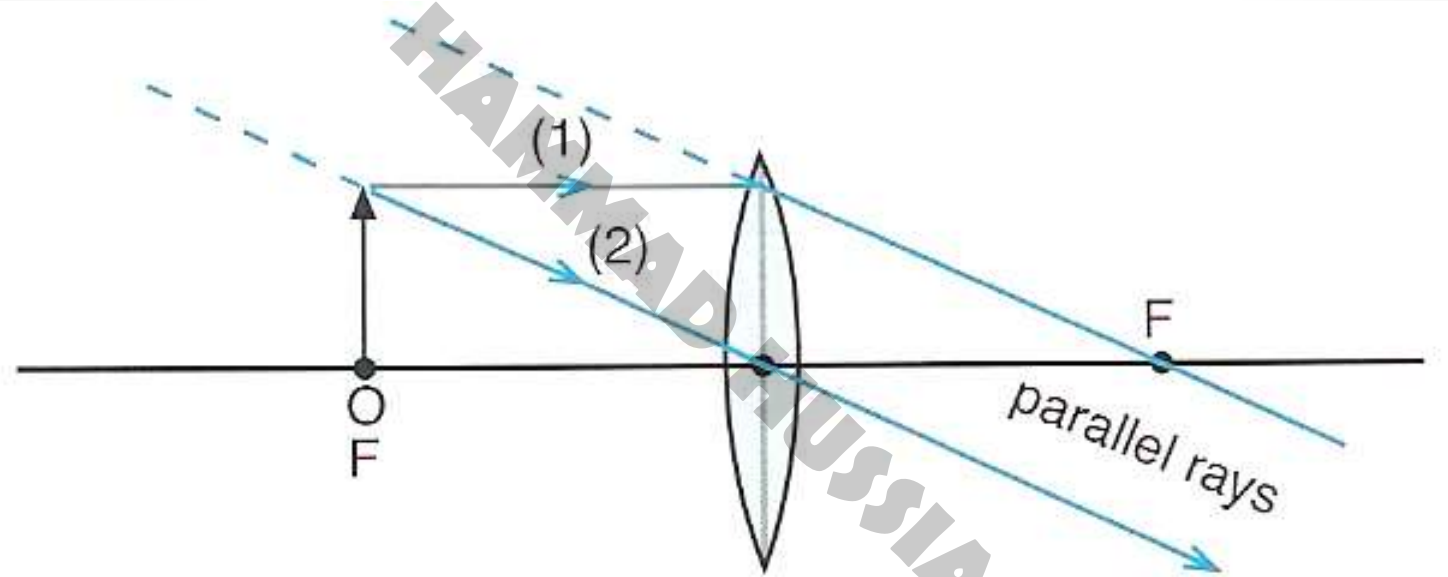
- Real, inverted & same size.
- Image at opposite side of Object, at 2F.
- Photocopier.

Object between F and 2F



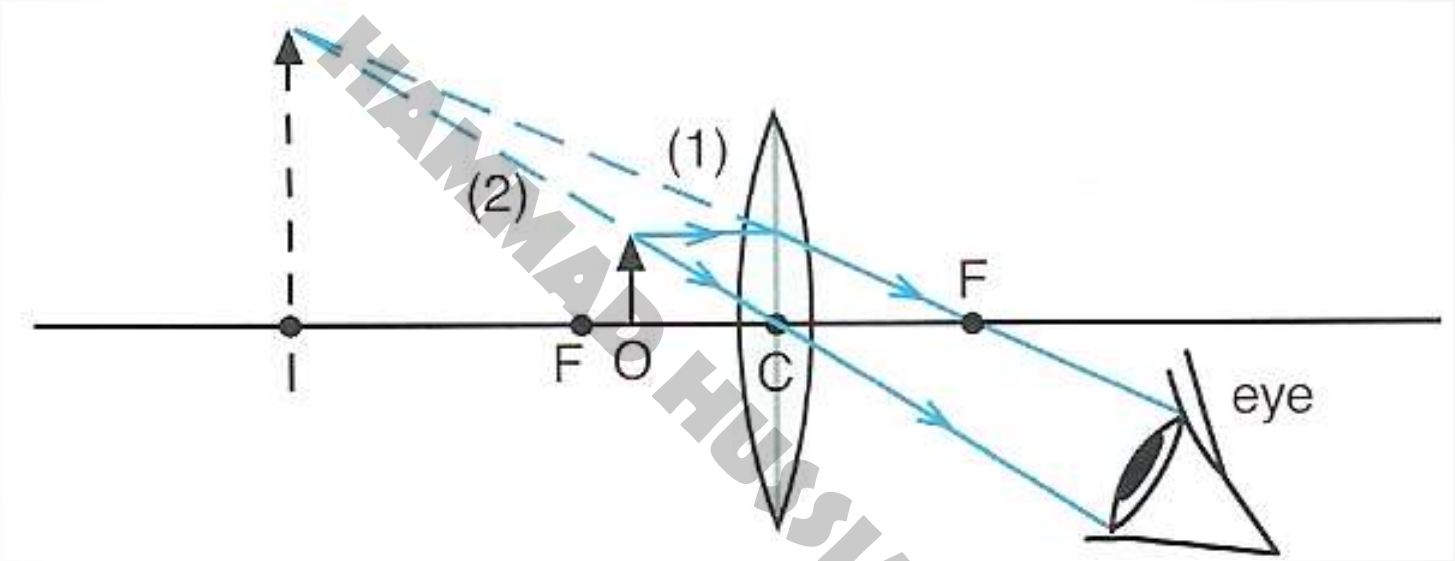
- Real, inverted & magnified.
- Image at opposite side of Object, between 2F & infinity.
- Projector & objective lens of microscope.

Object at F



- Real Image at opposite side of Object, at infinity – used in spotlight.
- Virtual Image on same side of Object, at infinity – used in eyepiece of telescope.

Object between C and F



- Virtual, upright & magnified.
- Image on same side of Object.
- Magnifying glass & spectacles for correction of long-sightedness

Thin converging and diverging lenses

Define the term linear magnification and *draw scale diagrams to determine the focal length needed for particular values of magnification (converging lens only).

Linear Magnification

- A measure of the effectiveness of an optical system in enlarging or reducing an image.

$$\text{Magnification} = \frac{\text{Image Distance}}{\text{Object Distance}} = \frac{\text{Height of Image}}{\text{Height of Object}}$$

- If the magnification is equal to 1, the size of the object is the same as that of the image.
- If the magnification is greater than 1 the image is said to be magnified and if it is less than 1, the image is said to be diminished.

Problem Solving

1. An object 1.5 cm tall is placed 2.5 cm in front of a converging lens of focal length 4.0 cm.
   a) Determine the location of the image.
   b) Completely describe the image.
   c) Calculate the linear magnification.
2. An object 1 cm high is placed 5 cm from a converging lens. The focal length of the lens is 2.5 cm. Find the position of the image. Describe the characteristics of the image. Determine also the linear magnification.

3. A converging lens is used to project an image of a slide onto a screen 10 cm from the lens, which has a focal length of 2 cm. The height of the image is 3 cm. Determine

   a) The distance of the slide from the lens

   b) The height of the slide

   c) The linear magnification

4. An object is placed 5 cm from a converging lens that has a focal length of 10 cm. Make a ray diagram of this situation. From the ray diagram, characterise the image.
5. An object is placed 30 cm from a converging lens that has a focal length of 10 cm. Make a ray diagram of this situation. From the ray diagram, characterize the image.
6. An object is placed 20 cm from a converging lens that has a focal length of 10 cm. Make a ray diagram of this situation. From the ray diagram, characterize the image.

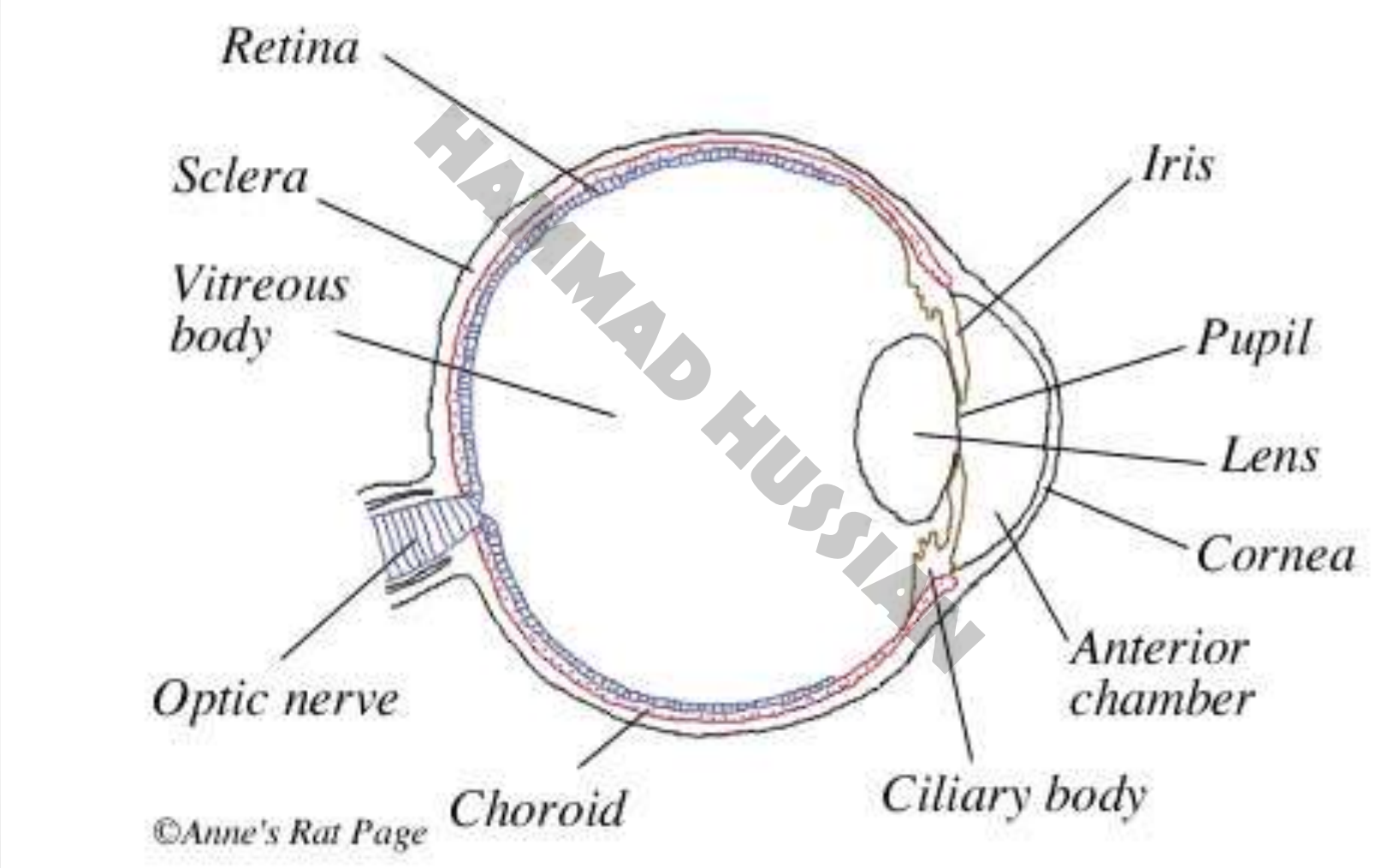
Thin converging and diverging lenses

Draw ray diagrams to show the formation of images in the normal eye, a short-sighted eye and a long-sighted eye.

Thin converging and diverging lenses

Describe the correction of short-sight and long-sight.

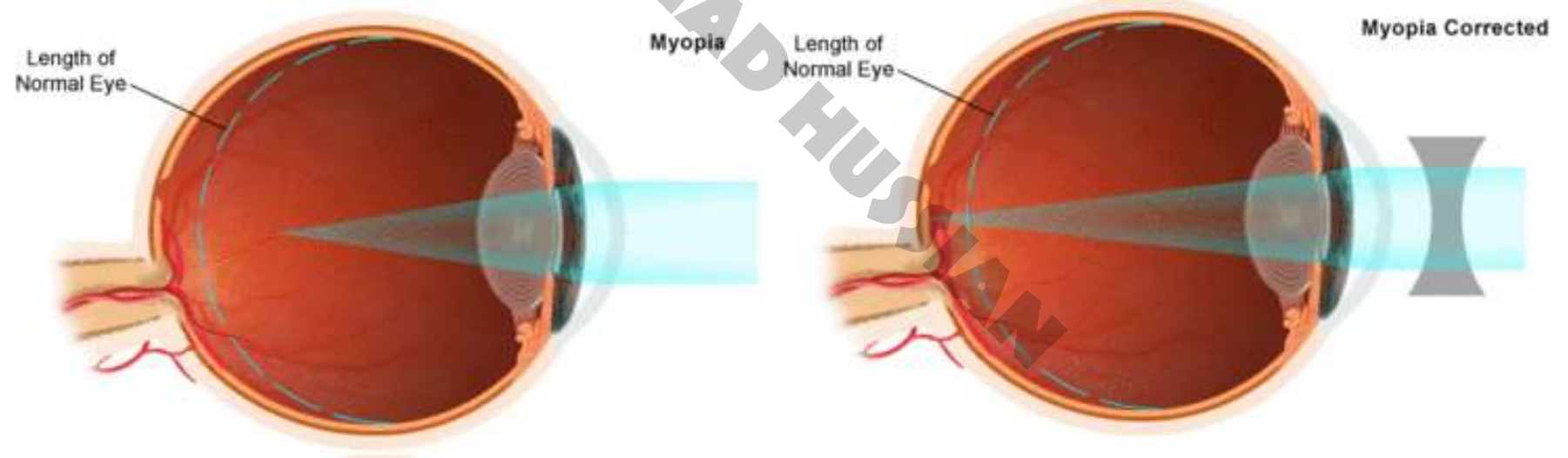
Human Eye


Retina
Sclera
Vitreous body
Optic nerve
Choroid
Iris
Pupil
Lens
Cornea
Anterior chamber
Ciliary body
©Anne's Rat Page
HAMMAD HUSSIAN

Short-Sightedness

1. You have blurry distance vision. 2. You see near objects clearly. 3. Your distance vision seems clearer if you squint your eyes.	1. Eye is too elongated from front to rear, Cornea has too much curvature. Light focuses in front of the retina instead of directly on it.	1. Prescription glasses, or contact lenses 2. Laser refractive surgery to re-shape the cornea to reduce its curvature.

Short-Sighted

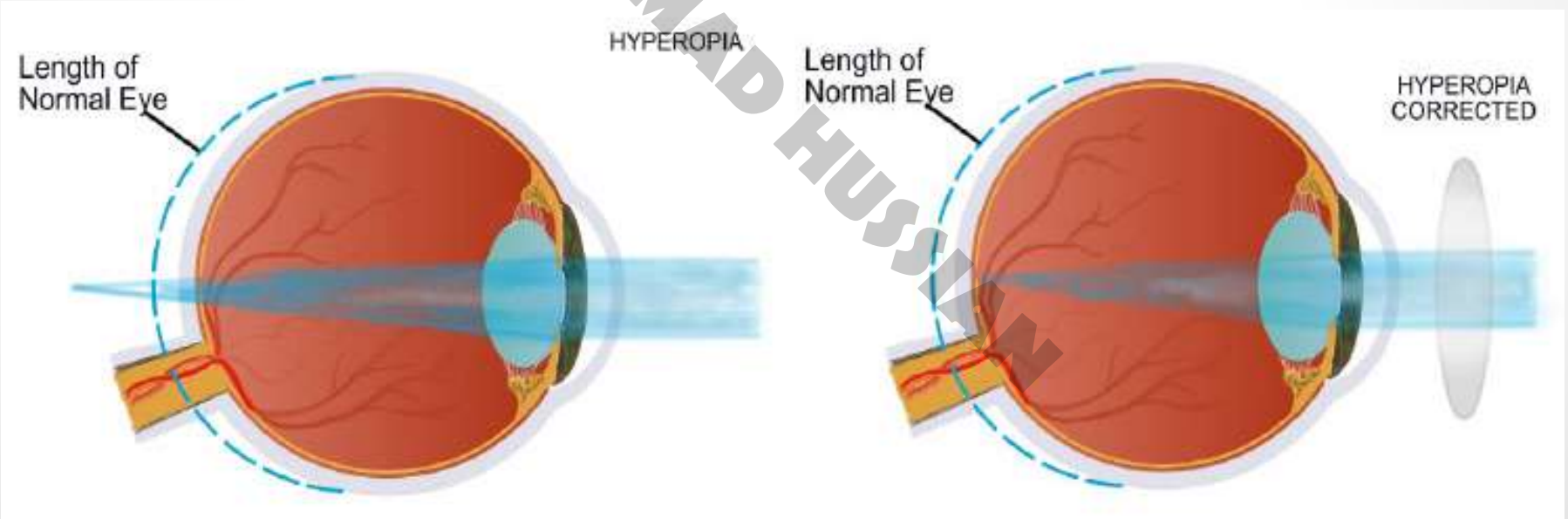


To correct the fault, a *concave* lens is placed in front of the eye.

Long-Sightedness

1. You have trouble seeing near objects. 2. Your distance vision is relatively clear, but it becomes less clear as you get older. 3. You may notice eye fatigue when reading.	1. Eye is too short from front to rear, 2. The cornea has insufficient curvature. 3. Light focuses "behind" the retina, instead of directly on it.	1. Prescription glasses, or contact lenses 2. Laser refractive surgery to re-shape the cornea to increase its curvature.

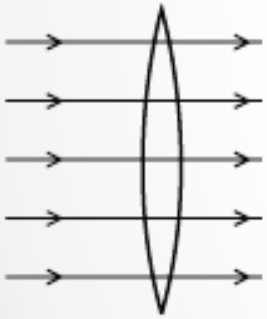
Long-Sighted



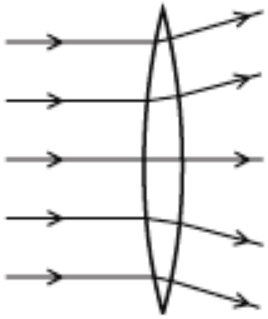
To correct the fault, a *convex* lens is placed in front of the eye.

1. A parallel beam of light falls on a converging lens.
2. Which diagram shows what happens to the beam of light?

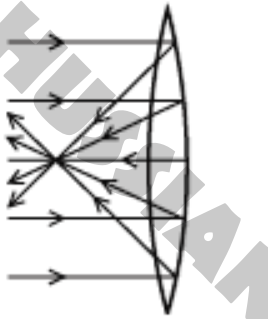
A



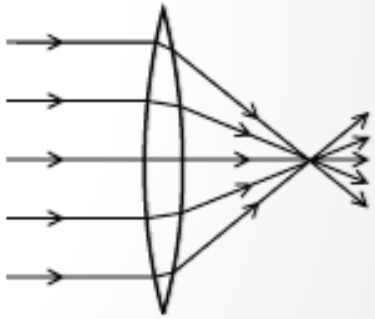
B



C

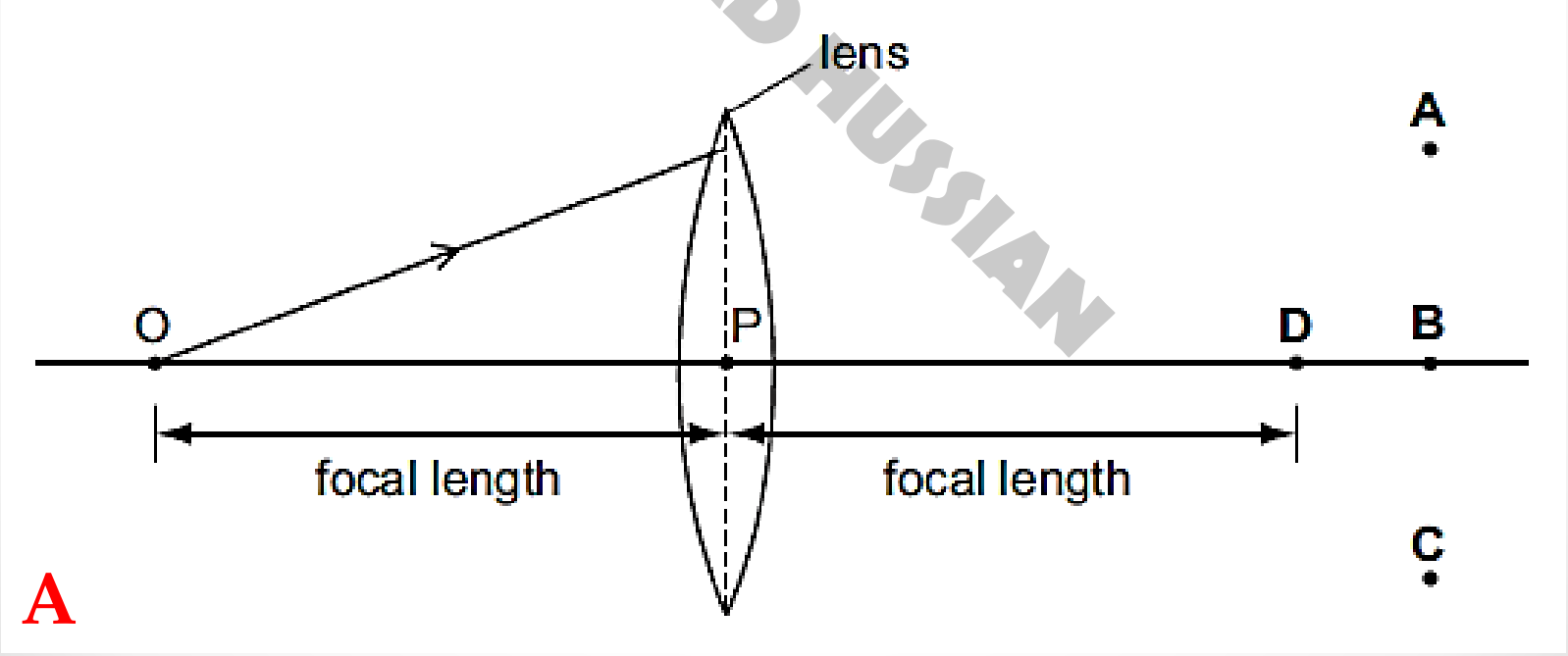


D



D

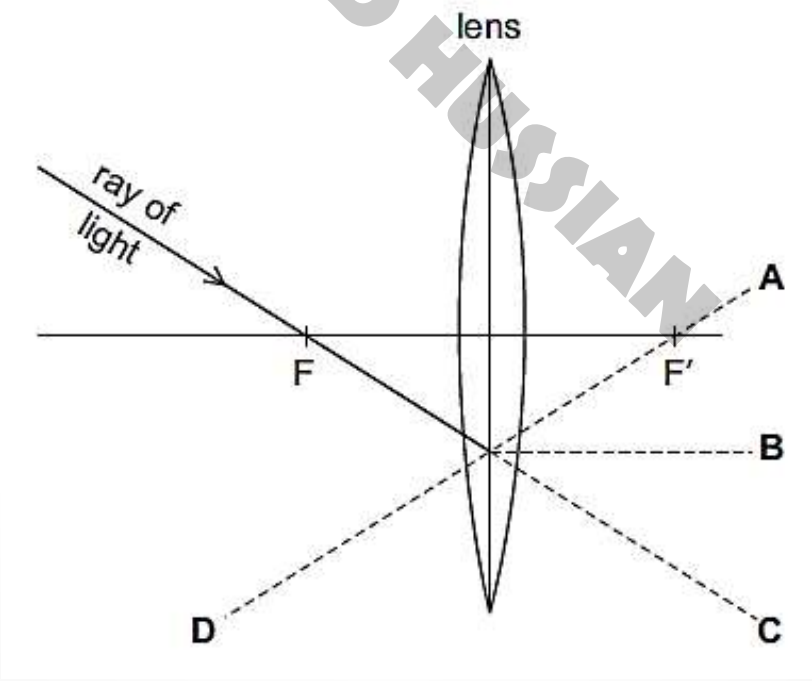
2. In the diagram, the distance OP is the focal length of the lens.
3. Through which point will the ray shown pass, after refraction by the lens?



A

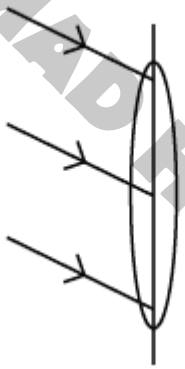
3. The diagram shows the path of a ray of light passing through a principal focus F of a lens.

4. Which broken line shows the direction of the ray after it leaves the lens?



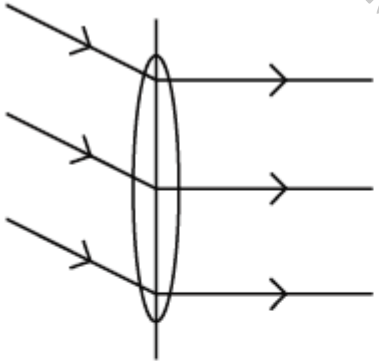
B

4. Three rays of light fall on a converging lens as shown.

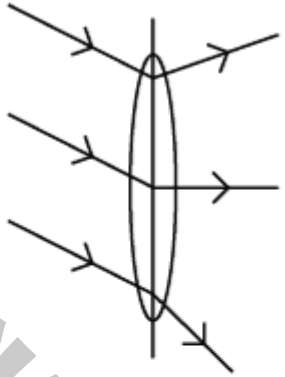


Which diagram shows the path of the rays after passing through the lens?

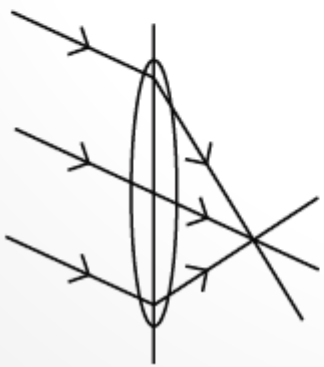
A



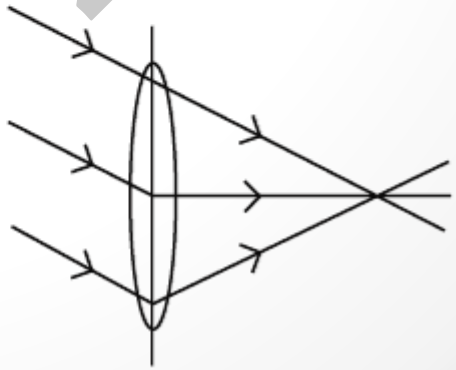
B



C

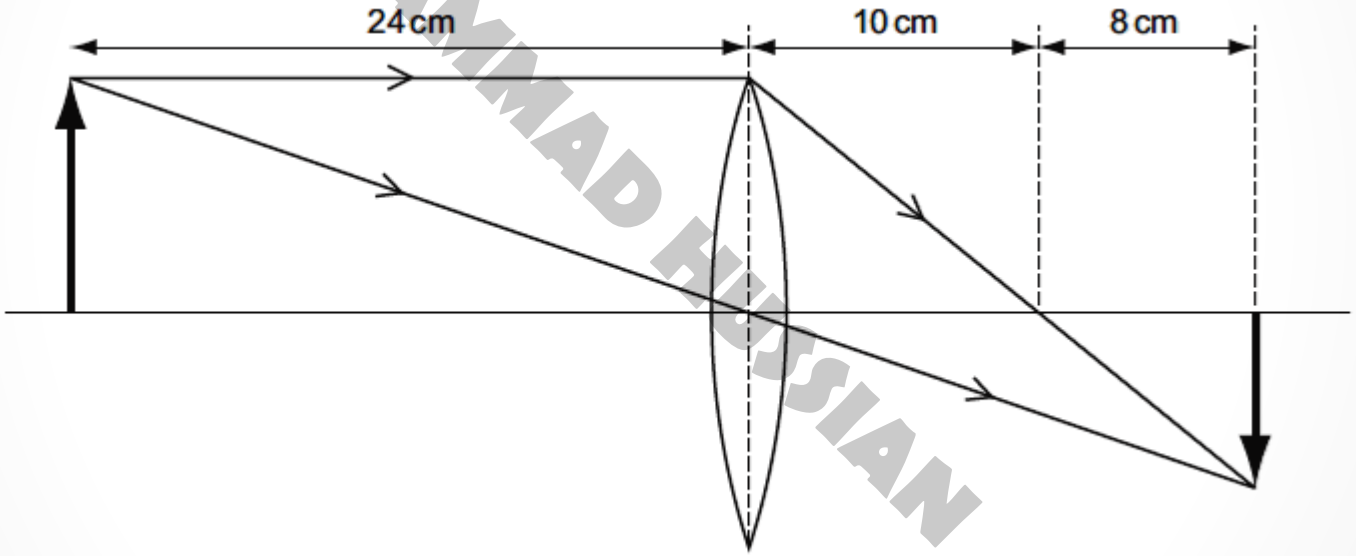


D



C

5. The ray diagram shows how an image is formed by a converging lens.

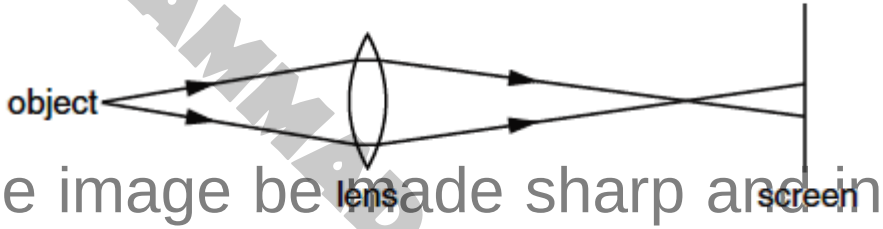


What is the focal length of this lens?

A 8 cm **B** 10 cm **C** 18 cm **D** 24 cm

B

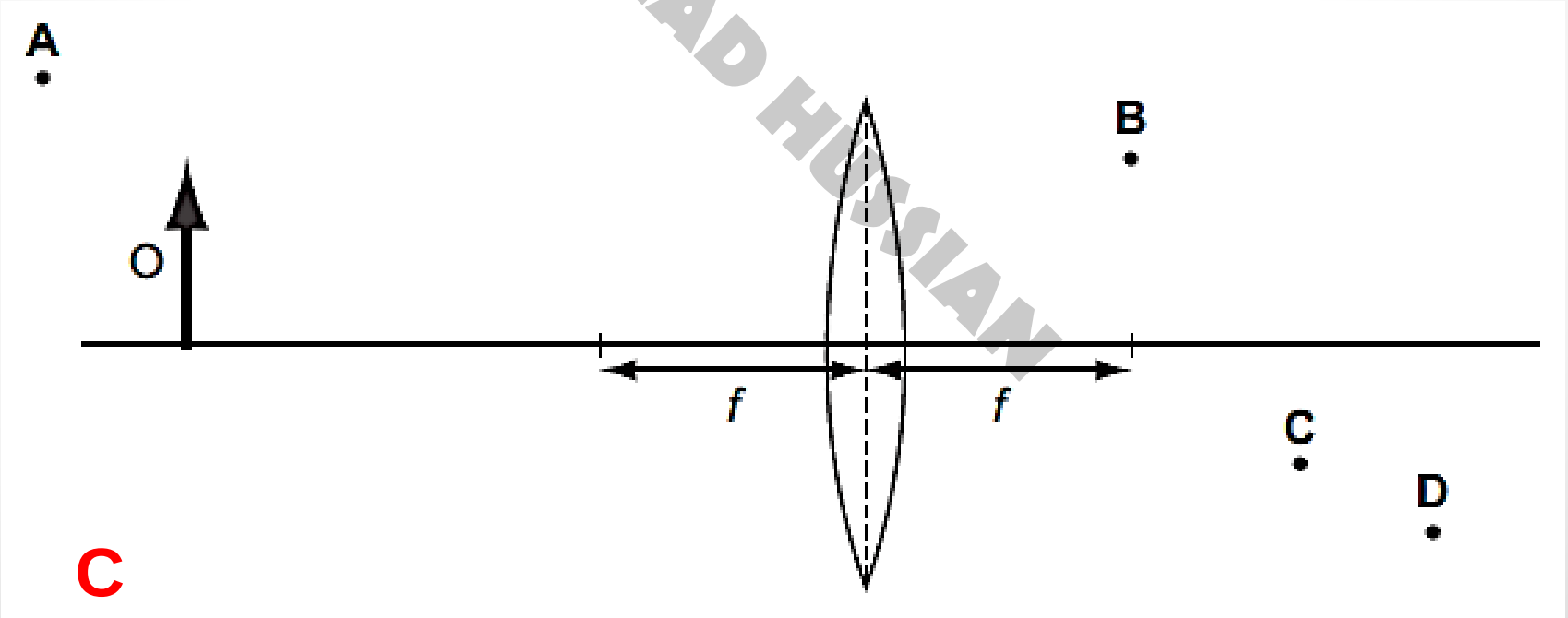
6. A lens forms a blurred image of an object on a screen.



1. How can the image be made sharp and in focus on the screen?

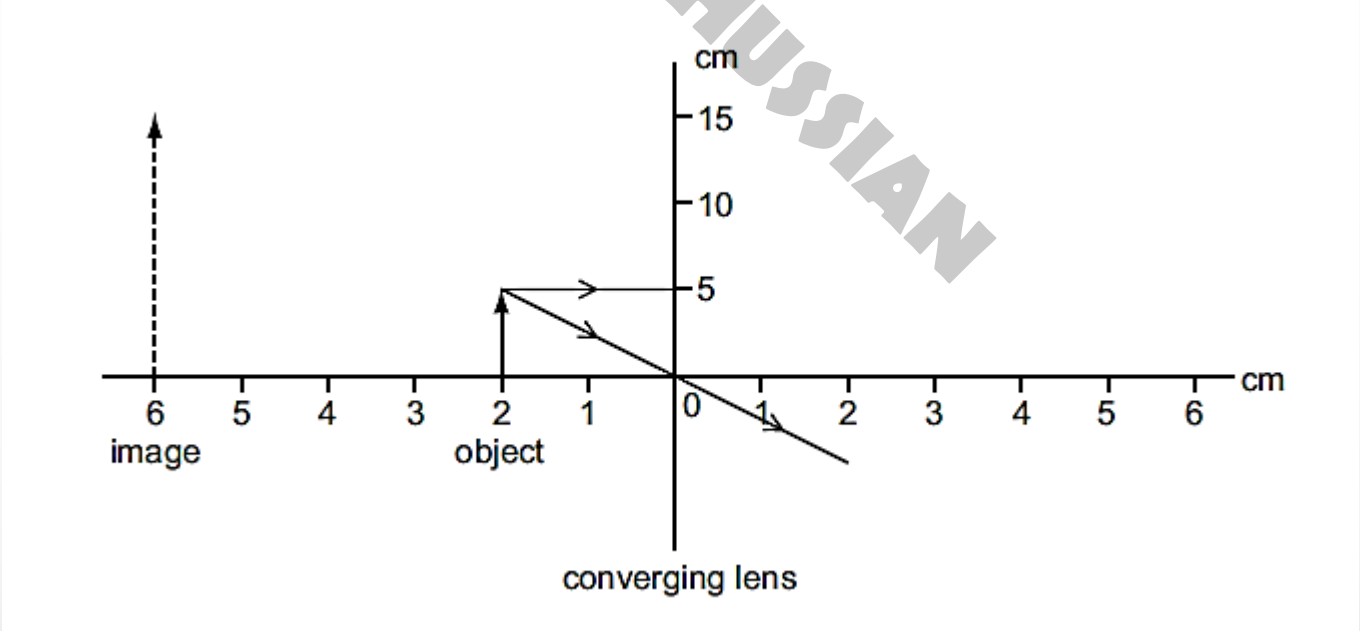
A. by moving the object away from the lens and screen
B. by moving the screen away from the lens and object
C. by using a brighter object at the same position
D. by using a lens of longer focal length at the same position

7. An object O is placed in front of a converging lens of focal length f.
8. At which point will the top of the image be seen?



C

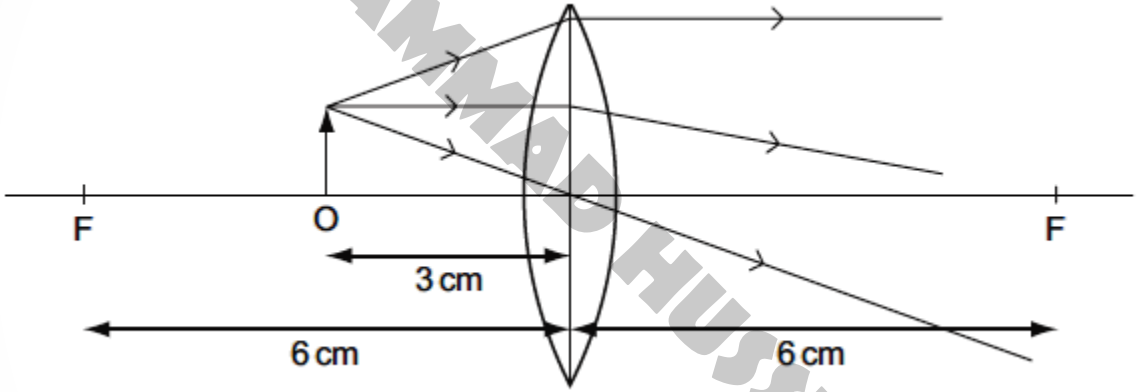
8. An object 5.0 cm high is placed 2.0 cm from a converging (convex) lens which is being used as a magnifying glass.
9. The image produced is 6.0 cm from the lens and is 15 cm high.



1. What is the focal length of the lens?

A. 2.0 cm
B. 3.0 cm
C. 4.0 cm
D. 6.0 cm

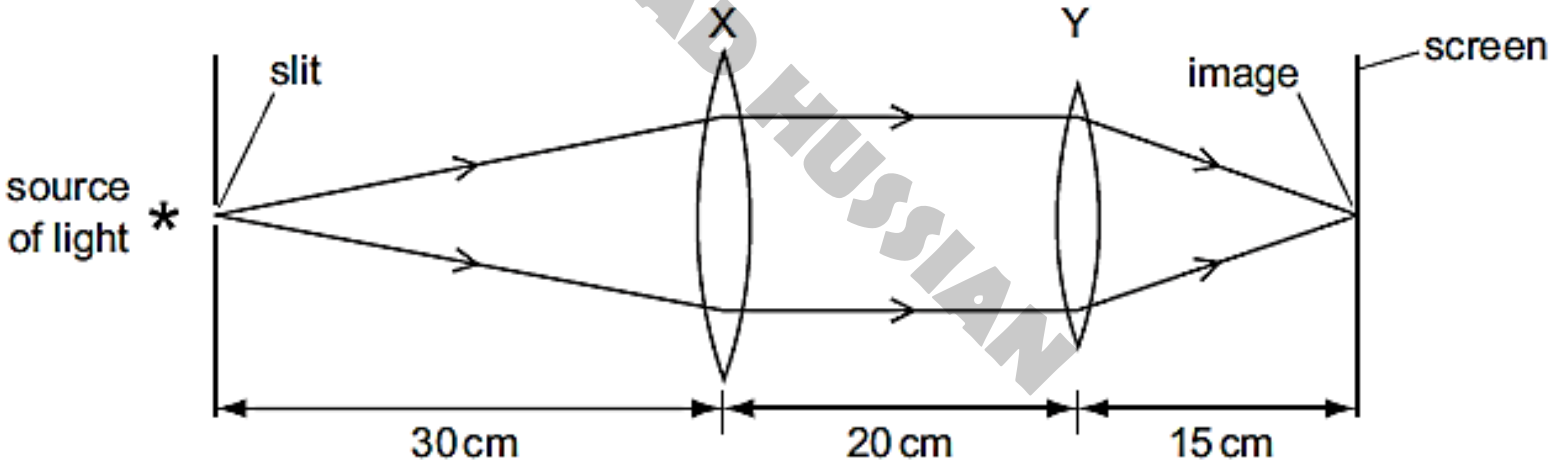
9. The diagram shows an object O placed 3 cm away from a converging lens of focal length 6 cm.



What type of image is produced?

A. real, erect and diminished
B. real, inverted and magnified
C. virtual, erect and magnified
D. virtual, inverted and diminished

10. Two thin converging lenses X and Y are used as shown to give a focused image of an illuminated slit. The rays shown are parallel between X and Y.



1. What are the correct values for the focal lengths of X and of Y?

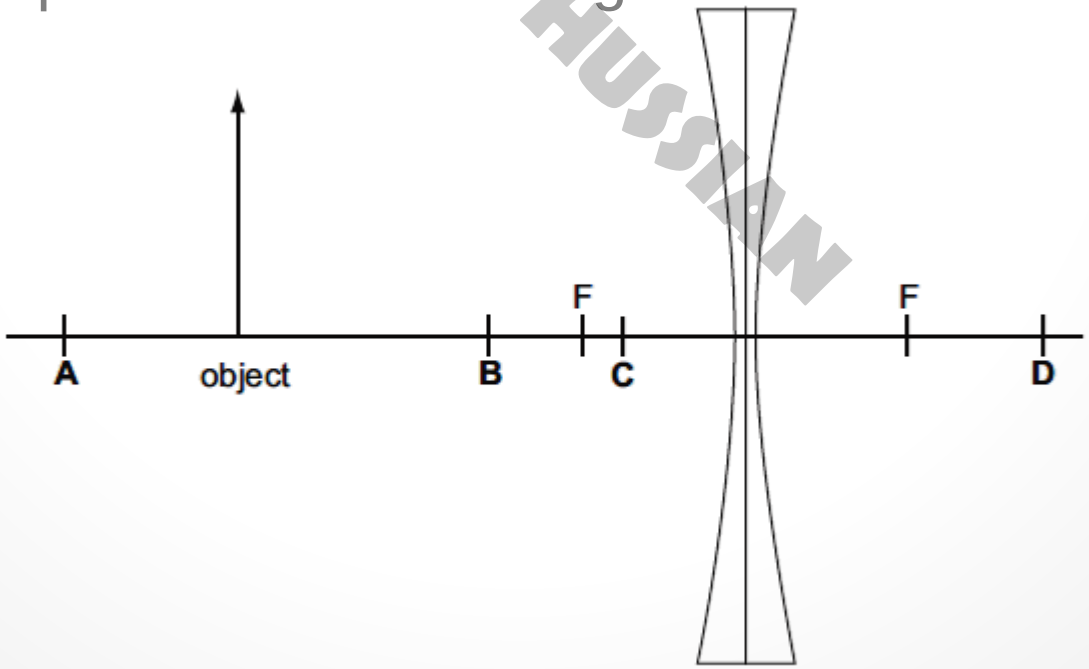
	focal length of X / cm	focal length of Y / cm
A	50	35
B	30	20
C	30	15
D	20	20

C

11. An object is placed in front of a diverging lens as shown on the scale diagram.

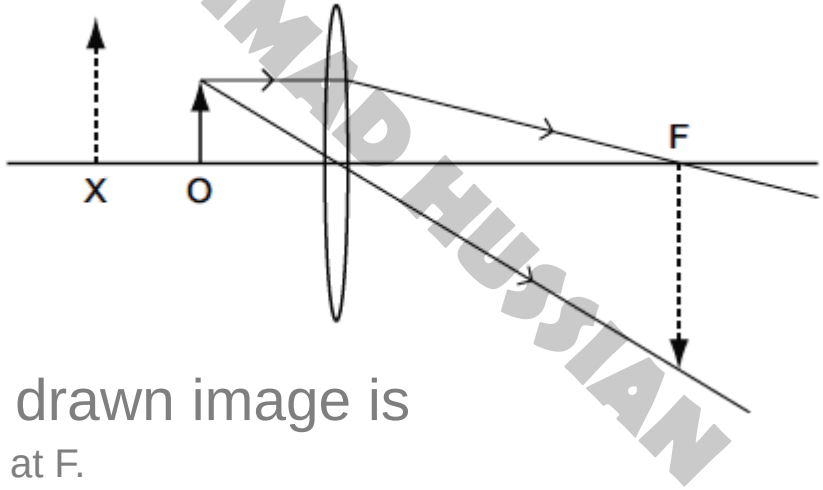
12. The principal focus F is marked on each side of the lens.

    At which position will the image be formed?



C

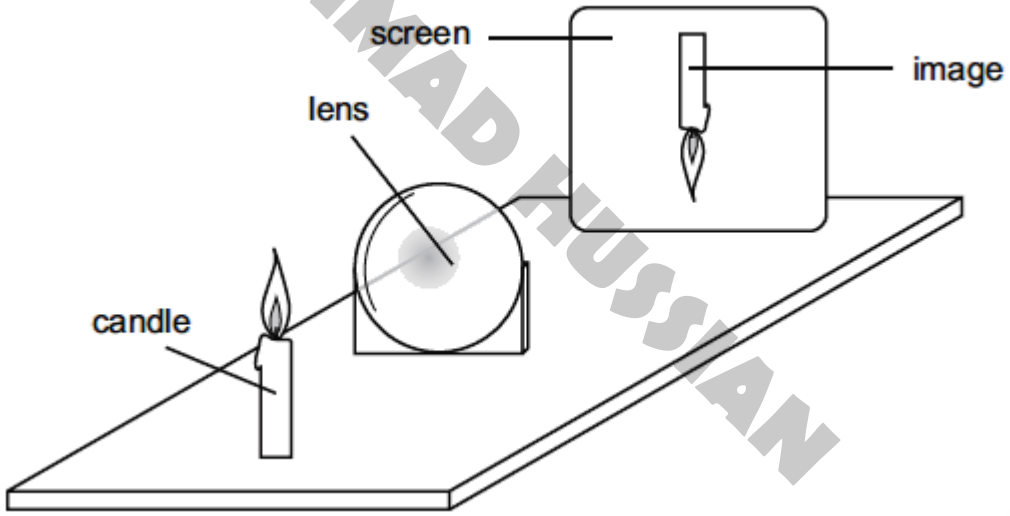
12. A student starts to draw a ray diagram for an object at O, near a thin convex lens, but is not sure whether the image is formed at X or at F.



The correctly drawn image is

A. real and formed at F.
B. real and formed at X.
C. virtual and formed at F.
D. virtual and formed at X.

13. A thin converging lens is used to produce, on a screen, a focused image of a candle.



1. The screen and the lens are moved back and forth and various focused images are produced on the screen.
2. Which statement is always true?

A. The image is at the principal focus (focal point) of the lens.
B. The image is bigger than the object.
C. The image is closer to the lens than the object is.
D. The image is inverted.

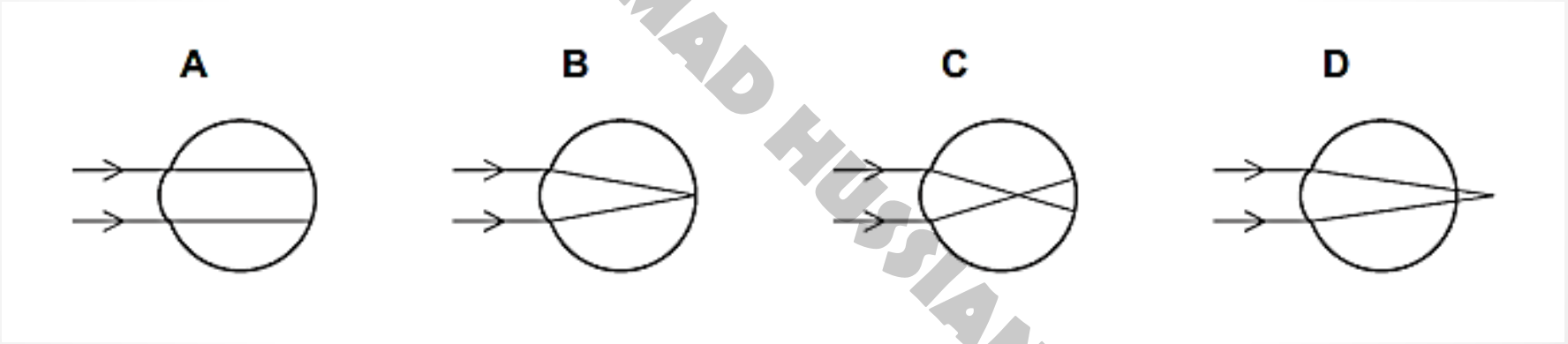
14. What is true for real images formed by a converging lens?

A. They are inverted.
B. They are on the same side of the lens as the object.
C. They can never be shown on a screen.
D. They cannot be seen by the human eye.

15. The human eye has a converging lens system that produces an image at the back of the eye.
16. An eye views a distant object. What type of image is produced?

A. real, erect, same size
B. real, inverted, diminished
C. virtual, erect, diminished
D. virtual, inverted, magnified

16. A man is short-sighted.
17. Which ray diagram shows what happens when he looks at a distant object?



C

17. Convex lenses are used in cameras and as magnifying glasses.

18. Which types of image are formed?

	type of image in camera	type of image in magnifying glass
A	real	real
B	real	virtual
C	virtual	real
D	virtual	virtual

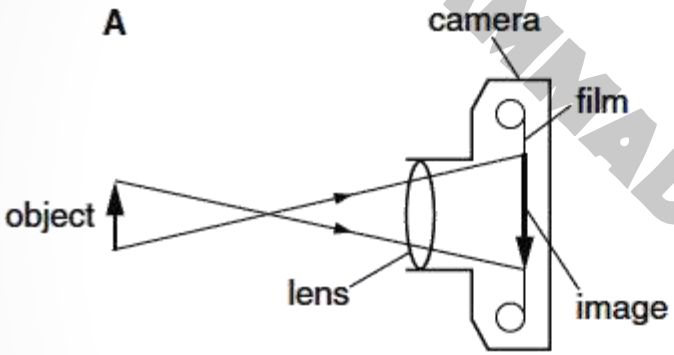
B

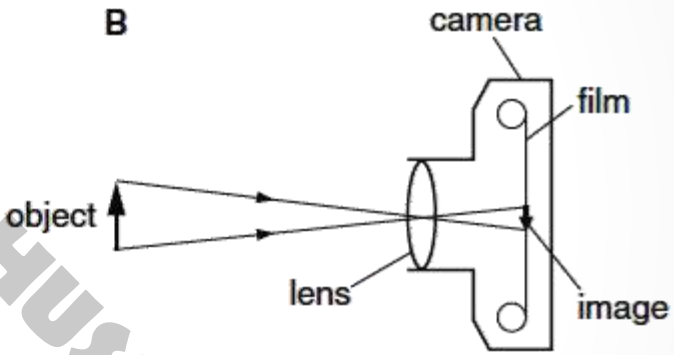
18. In a short-sighted eye, rays from distant objects are not focused on the retina.
19. Where are these rays focused and what type of lens is needed to correct the problem?

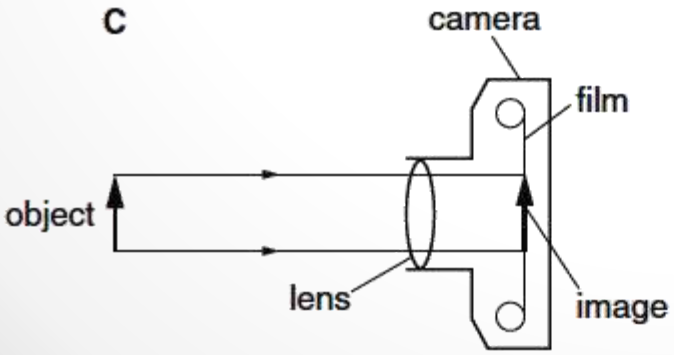
	where focused	lens needed
A	behind the retina	converging lens
B	behind the retina	diverging lens
C	in front of the retina	converging lens
D	in front of the retina	diverging lens

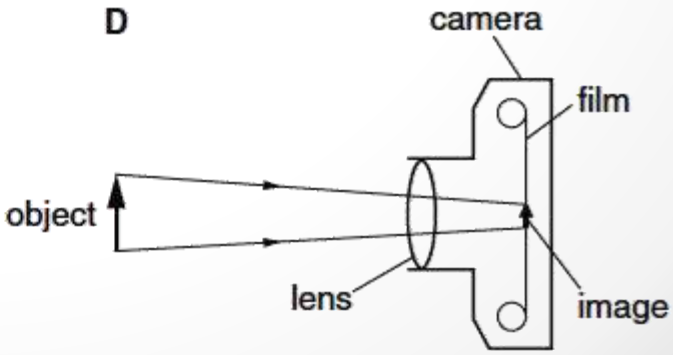
D

19. Which diagram correctly shows rays passing through a camera lens?









B