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- (vii) For a real image formed by a convex lens, the ratio of I : O = 2 : 5, then the object is: (I is the height of the image and O is the height of the object)
 - (a) between O and F
 - (b) beyond 2F
 - (c) at F
 - (d) between F and 2F

The magnification m produced by a convex lens is given by:

$$m=rac{I}{O}=rac{h_i}{h_o}=rac{v}{u}$$

Where:

- h_i = height of the image
- h_o = height of the object
- v = image distance
- u = object distance

Given $rac{I}{O}=rac{2}{5}$, the magnification $m=rac{2}{5}$

Since this is a real image formed by a convex lens, magnification is positive for erect and virtual images and negative for real and inverted images. So, we take $m=-\frac{2}{5}$.

This means the image is **smaller** than the object, and **real and inverted**.

For a convex lens:

- When the object is beyond 2F, the image is formed between F and 2F, real, inverted, and diminished →
 matches the magnification.
- Correct answer: (b) beyond 2F.



- (viii) A ray of light is incident normally on a face of an equilateral prism. The ray gets totally reflected at the second refracting surface. The total deviation produced in the path of the ray is:
 - (a) 30°
 - (b) 60°
 - (c) 90°
 - (d) 120°

We are given:

- The prism is equilateral, so all angles = 60°.
- The ray is **incident normally** on one face → it enters without deviation.
- It undergoes total internal reflection at the second face.
- We need to find the total deviation in the ray's path.

Step-by-step:

- 1. Since the ray enters normally, it goes straight through into the prism without bending.
- 2. Inside the prism, it hits the second surface at an angle of 60° and gets totally internally reflected.
- 3. It then exits from the third face.

Now, visualize or imagine the ray's path:

- The ray changes direction after internal reflection.
- Since the internal angles of the prism are 60°, and the reflection angle is 60°, the emerging ray deviates from the original path.

Total deviation in this case is 120°.

The ray bends by 60° during internal reflection and then again by 60° when exiting, adding up to:

Total deviation =
$$60^{\circ} + 60^{\circ} = 120^{\circ}$$

Correct answer: (d) 120°.



- (b) Refractive index of a medium is **independent** of ________

 [temperature / angle of incidence / wavelength of light].
- Refractive index does depend on:
 - Wavelength of light due to dispersion, as described by Cauchy's formula:

$$n(\lambda) = A + rac{B}{\lambda^2} + rac{C}{\lambda^4} + \cdots$$

- Temperature changes in temperature affect the medium's density and hence its refractive index.
- Refractive index is independent of:
 - Angle of incidence this only affects the direction the light bends, not the refractive index itself.
- Corrected Answer:

Refractive index of a medium is independent of angle of incidence.

Question 3

(i) A ray of light enters a rectangular glass slab submerged in water at an angle of incidence 55°. Does this ray undergo total internal reflection when it moves from water to glass? Justify your answer. (The critical angle for glass-water interface is 54°.)

To determine if total internal reflection (TIR) occurs, we need to understand the conditions required for it:

Conditions for TIR:

- 1. The ray must travel from denser to rarer medium (e.g., from glass to water).
- 2. The angle of incidence in the denser medium must be greater than the critical angle.

Given:

- The ray enters glass from water at 55°.
- Critical angle for glass-water interface = 54°.
- The question asks if TIR occurs when moving from water to glass.

Analysis:

- When a ray moves from water to glass, it goes from rarer to denser medium.
- Total internal reflection cannot occur in this direction because TIR only happens when light travels from denser to rarer medium.

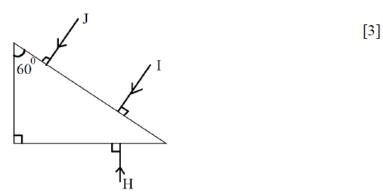
✓ Final Answer:

No, the ray does not undergo total internal reflection when it moves from water to glass, because TIR only occurs when light travels from a denser to a rarer medium, not the other way around.



Question 4

(i)



- (a) Out of the three rays (I, J, H) shown in the diagram, which ray will suffer Total Internal Reflection while inside the prism? (Critical angle of the prism is 42°.)
- (b) Copy the diagram to complete the path of the ray which you have named in (a) till it comes out of the prism.

Given:

- Right-angled triangle prism with angles 90°, 60°, and 30°.
- Critical angle of the prism = 42°.
- Rays I, J, and H are incident on different faces.
- We are to find which ray suffers **Total Internal Reflection (TIR) inside the prism**.

(a) Which ray suffers TIR?

To suffer TIR, two conditions must be satisfied:

- 1. The ray must go from a denser to a rarer medium (inside prism to outside).
- 2. The angle of incidence at the internal face must be greater than the critical angle (42°).



Ray-by-ray analysis:

Ray I:

- Strikes the surface at the right angle (90°).
- So it passes straight through, no TIR.

Ray H:

- Enters the prism from air (rarer to denser), and heads toward the hypotenuse face.
- At the hypotenuse, it hits at 30° (angle of incidence = 30°).
- Since 30° < critical angle (42°) → No TIR, ray gets refracted out.

Ray J:

- Hits the 60° face at 60°.
- Then moves toward the hypotenuse (internal face).
- Since the prism angle at that vertex is 60°, the angle of incidence on the hypotenuse (from inside the prism) will also be 60°.
- 60° > 42° (critical angle) → TIR occurs.

Answer (a):



Ray J will suffer Total Internal Reflection inside the prism.

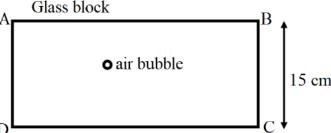
(b) Completing the path of Ray J:

You should:

- Reflect Ray J from the hypotenuse using the law of reflection:
 Angle of incidence = angle of reflection (both = 60°).
- After reflection, the ray will travel toward the base of the prism.
- At the base (glass-air interface), it will emerge refracted out of the prism.

Final path:

- **1.** Ray J enters normally \rightarrow no deviation.
- 2. Reflects off hypotenuse at 60° (TIR).
- 3. Exits the prism at the base, bending away from normal.
- (ii) A rectangular glass block of refractive index 1.5 has an air bubble trapped inside
 it as shown in the diagram. When seen from the surface AB, it appears to be
 4 cm deep.



- (a) Calculate the **actual depth** of the air bubble from the surface **AB**.
- (b) For which colour of light, blue or yellow, the apparent depth will be greater?
- (c) Turning the glass block upside down, **DOES NOT** change the apparent depth of the air bubble. State **True** or **False**.

We are given:

- Apparent depth = 4 cm
- Refractive index of glass, $\mu=1.5$
- Relation:

$$\mu = \frac{\text{real depth}}{\text{apparent depth}}$$

Real depth = $\mu \times \text{apparent depth} = 1.5 \times 4 = \boxed{6 \text{ cm}}$

- (b) For which colour of light, blue or yellow, the apparent depth will be greater?
- Refractive index μ depends on wavelength.
- . Blue light has a shorter wavelength, so it bends more, i.e., has a higher refractive index.
- $\mu = rac{ ext{real depth}}{ ext{apparent depth}} \Rightarrow ext{higher } \mu \Rightarrow ext{smaller apparent depth}.$

So, yellow light (lower μ) will have a greater apparent depth.

Yellow light

- (c) Turning the glass block upside down does NOT change the apparent depth of the air bubble. State True or False.
- Apparent depth depends on the optical path, not orientation.
- · The thickness and refractive index remain the same.

True

- Final Answers:
- (a) 6 cm
- (b) Yellow light
- (c) True
- (iii) (a) An object is placed at 2F position of a convex lens. Draw a ray diagram [4] showing the formation of the image.
 - (b) How will the size of the image change if we, ONLY replace the lens in the above arrangement with another lens of a greater focal length?



(iii)(a) Ray diagram when object is at 2F of a convex lens

Key Features:

- Object at 2F (twice the focal length)
- Image is formed:
 - At 2F on the other side
 - Same size
 - · Real and inverted

Ray Diagram Description:

- 1. Draw a convex lens with its principal axis.
- 2. Mark the two focal points on either side: F and 2F.
- 3. Place the object at 2F on the left side.
- 4. Draw two rays from the top of the object:
 - One ray parallel to the principal axis, refracted through F on the other side.
 - One ray through the optical center, going undeviated.
- 5. The rays intersect at 2F on the right side that's where the image forms.

Let me know if you'd like an image of this ray diagram.

(iii)(b) If the lens is replaced with another lens of greater focal length

Now:

- New lens has greater focal length.
- Object is still at the same distance as before (i.e., the old 2F).
- · But now this position is less than 2F for the new lens.

Result:

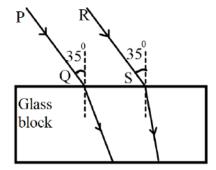
- The image is now formed beyond 2F (on the other side).
- Since the object is closer relative to the new 2F, the image will be:
 - Larger than the object (magnified)
 - Real and inverted

✓ Final Answers:

- (a) Image is at 2F, same size, real and inverted.
- (b) Image size will become larger (magnified) when using a lens of greater focal length.

Question 5

- (i) An object is placed in front of a concave lens at a distance of 45 cm from it. If its image is formed at a distance of 30 cm from the lens, calculate the focal length of the lens.
- (ii) Two rays **PQ** and **RS** are incident on a rectangular glass block as shown in the diagram. Observe the diagram and answer the questions that follow.



Which of these two rays will:

- (a) have **greater** lateral displacement on emerging out of the block?
- (b) travel with **greater** speed in the block?
- (c) scatter more in the atmosphere?



(i) Focal length of concave lens

Given:

- Object distance, $u=-45~\mathrm{cm}$ (object is on the left, so negative)
- Image distance, $v=-30~{
 m cm}$ (virtual image for concave lens, so also negative)
- Lens formula:

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

Substitute values:

$$\frac{1}{f} = \frac{1}{-30} - \frac{1}{-45} = -\frac{1}{30} + \frac{1}{45} = \frac{-3+2}{90} = \frac{-1}{90}$$
$$\boxed{f = -90 \text{ cm}}$$

(ii) Questions on rays PQ and RS

Let's analyze the setup:

- Both rays are incident at 35° but at different positions.
- Ray PQ travels a longer path inside the glass compared to RS.

(a) Greater lateral displacement?

- Lateral displacement increases with the thickness of glass traversed.
- . Since PQ travels more diagonally across the glass, it has greater path length inside the block.

- Answer: PQ
- (b) Greater speed in the block?
- · Speed in a medium depends on wavelength and refractive index.
- . Both rays have the same medium (glass), but nothing in the question suggests a different wavelength.
- Answer: Both travel at the same speed in the glass.
- (c) Scatter more in the atmosphere?
- · Scattering depends on wavelength (Rayleigh scattering).
- · Shorter wavelengths (blue/violet) scatter more than longer ones (red/yellow).
- . If PQ and RS are different colors (implied), blue light (shorter wavelength) will scatter more.
- Answer: The one with shorter wavelength so if PQ is blue, then:
- Answer: PQ
- ✓ Final Answers:
- (i) Focal length = -90 cm
- (ii)
- (a) PQ
- (b) Same speed
- (c) PQ (assuming it is shorter wavelength like blue)

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- (xii) Linear magnification(m) produced by a concave lens is:
 - (a) m < 1
 - (b) m > 1
 - (c) m = 1
 - (d) m = 2



For a concave lens, the image formed is:

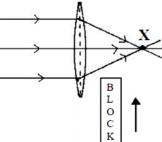
- Virtual,
- Upright,
- · And smaller than the object.

Thus, the linear magnification m is always less than 1.

Correct answer:

$$(a) \quad m<1$$

- (xv) A block of glass is pushed into the path of the light as shown below. Then the converging point X will:
 - (a) Move away from the slab
 - (b) Move towards the slab
 - (c) Not shift
 - (d) Move towards the left side of the lens



When a glass block is placed in the path of light before it reaches a convex lens:

- The light rays slow down inside the glass block because glass has a higher refractive index than air.
- · This causes the rays to refract towards the normal, changing their direction before entering the lens.
- As a result, the rays converge closer to the lens, meaning the focal point X moves towards the lens (or towards the slab).

Correct answer:

(b) Move towards the slab

Question 3

- (i) (a) In a reading glass what is the position of the object with respect to the convex lens used?
 - (b) Why can we **not** use concave lens for the same purpose?

(i)(a) Position of the object in a reading glass with respect to the convex lens:

- The object (the text or reading material) is placed within the focal length (F) of the convex lens.
- This allows the lens to form a virtual, magnified, and upright image for easier reading.

(i)(b) Why can we NOT use a concave lens for the same purpose?

- · A concave lens always forms a diminished (smaller), virtual, and upright image.
- It cannot magnify the object.
- Therefore, it is not suitable as a reading glass, which requires magnification to make the text easier to see.

Summary:

- . (a) Object is placed within the focal length of the convex lens.
- (b) Concave lens cannot magnify; it only produces smaller images, so it is unsuitable for reading glasses.

Question 4

(i) The image of a **candle flame** placed at a distance of 36 cm from a spherical lens, is formed on a screen placed at a distance of 72 cm from the lens. Calculate the focal length of the lens and its power.



Given:

- Object distance, u=-36 cm (object is on the left side, so negative)
- Image distance, v=+72 cm (image is real and on the right side, so positive)

Step 1: Calculate the focal length f

Using the lens formula:

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

Substitute the values:

$$\frac{1}{f} = \frac{1}{72} - \frac{1}{-36} = \frac{1}{72} + \frac{1}{36} = \frac{1}{72} + \frac{2}{72} = \frac{3}{72} = \frac{1}{24}$$

So,

$$f=24~\mathrm{cm}=0.24~\mathrm{m}$$

Power P (in diopters) is given by:

$$P = \frac{100}{f \text{ (cm)}}$$

Or using focal length in meters:

$$P = \frac{100}{24} = 4.17 \text{ diopters}$$

Final answers:

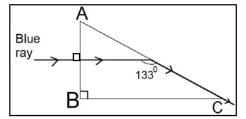
$$f=24~{
m cm}, \quad P=+4.17~{
m diopters}$$



(iii) (a) Why do we use red colour as a danger signal on the top of a skyscraper?

[4]

- (b) The diagram below shows the path of a blue ray through the prism:
 - Calculate the critical angle of the material of the prism for blue colour.



- 2. What is the measure of the angle of this prism (A)?
- 3. Which colour should replace the blue ray, for the ray to undergo Total Internal Reflection?

(iii)(a) Why do we use red colour as a danger signal on the top of a skyscraper?

- Red light has the longest wavelength among visible light and scatters the least in the atmosphere (less Rayleigh scattering).
- · It can be seen from a greater distance, especially in fog or smoke.
- · Thus, red is highly visible and attention-grabbing, making it ideal for warning or danger signals.

(iii)(b) Prism questions

1. Calculate the critical angle of the material of the prism for blue colour.

From the diagram:

- The angle of incidence inside the prism at BC is i = 133° 90° = 43°.
- For Total Internal Reflection (TIR), this angle should be the critical angle C.

So, the critical angle:

$$C=43^{\circ}$$

2. What is the measure of the angle of the prism A?

- The prism ABC is a right angled triangle.
- The angle at $B=90^{\circ}$,
- The angle at C = 133° − 90° = 43°.
- Sum of angles in triangle = 180°.

$$A = 180^{\circ} - 90^{\circ} - 43^{\circ} = 47^{\circ}$$

- 3. Which colour should replace the blue ray for the ray to undergo Total Internal Reflection?
- Total Internal Reflection occurs when the angle of incidence inside the prism is greater than the critical angle.
- . Since blue light has a shorter wavelength, its refractive index is higher, so the critical angle is smaller.
- Red light has a lower refractive index and a larger critical angle.

To undergo TIR with the same prism angle, a colour with a smaller critical angle (i.e., higher refractive index) than blue is needed.

Therefore, the violet or violet-blue light should replace the blue ray, as it has the highest refractive index and smallest critical angle.

Summary of (iii)(b):

- 1. Critical angle = 43°
- 2. $A = 47^{\circ}$
- 3. Replace blue ray with violet ray (or a colour with higher refractive index than blue).

Question 5

- (i) (a) Refractive index of glass with respect to water is $\frac{9}{8}$. [3] Find the refractive index of water with respect to glass.
 - (b) Name the principle used to find the value in part (a).
 - (c) If we change the temperature of water, then will the ratio $\frac{9}{8}$ remain the same? Write **Yes** or **No**.



(a) Find the refractive index of water with respect to glass.

Given:

$$n_{\rm glass/water} = \frac{9}{8}$$

Refractive index of water with respect to glass is the reciprocal:

$$n_{\rm water/glass} = \frac{1}{n_{\rm glass/water}} = \frac{1}{\frac{9}{8}} = \frac{8}{9}$$

(b) Name the principle used to find the value in part (a).

The principle used is:

Reciprocal Principle of Refractive Indices

or simply,

Principle of Inverse Refractive Index

(c) If we change the temperature of water, will the ratio $\frac{9}{8}$ remain the same? Write Yes or No.

- · The refractive indices of both glass and water depend on temperature.
- However, glass's refractive index changes very little with temperature compared to water.
- So the ratio $\frac{9}{8}$ will change when the temperature changes.

Answer: No

- (ii) Light travels a distance of '10x' units in time ' t_1 ' in vacuum and it travels a distance of 'x' units in time ' t_2 ' in a denser medium. Using this information answer the question that follows:
 - (a) 'Light covers a distance of '20x' units in time ' t_1 ' in diamond.' State true or false.
 - (b) Calculate the refractive index of the medium in terms of t_1 and t_2 .



(a) Statement:

"Light covers a distance of 20x units in time t₁ in diamond."

Is this True or False?

Given:

- In vacuum, light travels 10x units in time t_1 .
- In diamond (a denser medium), light travels less distance in the same time because speed is less than in vacuum.

So, light cannot travel more than 10x in time t_1 , especially in a denser medium like diamond.

Answer: False

(b) Refractive Index in terms of t_1 and t_2 :

Speed of light in vacuum:

$$v_1 = \frac{10x}{t_1}$$

Speed of light in denser medium:

$$v_2 = rac{x}{t_2}$$

Refractive index (n) is given by:

$$n = \frac{\text{speed in vacuum}}{\text{speed in medium}} = \frac{v_1}{v_2}$$

Substitute the values:

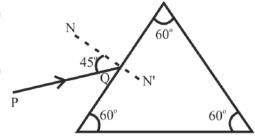
$$n = \frac{10x/t_1}{x/t_2} = \frac{10x}{t_1} \cdot \frac{t_2}{x} = \frac{10t_2}{t_1}$$

Final Answer:

- (a) False
- (b) Refractive index $n=rac{10t_2}{t_1}$



- (iii) A monochromatic ray of light is incident on an equilateral prism placed at **minimum** [4] **deviation position** with an angle of incidence 45° as shown in the diagram.
 - (a) Copy the diagram and complete the path of the ray PQ.
 - (b) State two factors on which the angle of deviation depends.



(a) Copy the diagram and complete the path of the ray PQ.

Since the ray is incident at minimum deviation position:

- · The light ray will pass symmetrically through the prism.
- That means:

Angle of incidence = Angle of emergence, and The internal ray is parallel to the base of the prism.

- So, draw the ray:
- 1. From Q to the opposite face, running parallel to the base.
- 2. Then, draw the emergent ray at the same angle (45°) to the normal on the other side (symmetric to incident ray).
- **Tip: The emergent ray will be parallel to the incident ray but displaced laterally due to refraction.
- (b) State two factors on which the angle of deviation depends.
- The angle of deviation depends on:
- 1. Angle of incidence changing the angle alters the deviation.
- 2. Refractive index of the prism material which depends on the wavelength (or color) of light.

(You can also mention angle of the prism, but since it's fixed at 60° here, it's not a variable in this diagram.)

✓ Final Answers:

- (a) Ray path: symmetric inside the prism, internal ray parallel to base, emergent ray at 45°.
- (b) Two factors:
- Angle of incidence
- Refractive index of prism (depends on wavelength)



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- (v) Speed of blue light in water is:
 - (a) more than green light
 - (b) more than orange light
 - (c) more than violet light
 - (d) more than red light

Refractive Index & Wavelength

· Refractive Index (n) is inversely proportional to wavelength of light.

$$n \propto \frac{1}{\lambda}$$

- This means:
 - Shorter wavelength (violet) → higher refractive index → lower speed
 - Longer wavelength (red) → lower refractive index → higher speed

So for blue light:

- Its wavelength is longer than violet but shorter than green, orange, and red.
- Therefore, its speed in water is:
 - More than violet
 - Less than green, orange, and red X

Correct Answer: (c) more than violet light

Thanks again for your correction — your reasoning is absolutely accurate.

Logic: In correct answer. logic for higher web length RI is less, if RI is less then speed is high correct answer should be speed in blue light should be more than Violet, option C.



(vi)	A concave lens produces only image.			
	((a) real, enlarged		
	((b) virtual, enlarged		
	((c) virtual, diminished		
	((d) real, diminished		
The correct answer is:				
(c) virtual, diminished				
✓ Explanation:				
A concave lens (also called a diverging lens) always produces an image that is:				
Virtual (cannot be projected on a screen)				
• Erect				
 Diminished (smaller than the object) Formed on the same side as the object 				
This is true for all object positions in front of a concave lens.				
(xiv)	When	When a ray of light travels normal to the given surface, then the angle of refraction		
	is:			
	(a)	180°		
	(b)	90°		
	(c)	0°		
	(d)	45°		

The correct answer is:

(c) 0°

Explanation:

When a ray of light travels normal (perpendicular) to the surface (i.e., at an angle of incidence of 0°), it does not bend at the interface between two media. Hence, the angle of refraction is also 0°.

This is a direct result of Snell's Law:

$$n_1 \sin i = n_2 \sin r$$

If $i=0^\circ$, then $\sin i=0$, which means $\sin r=0$, so $r=0^\circ$.

✓ Final Answer:

(c) 0°

- (xv) Small air bubbles rising up a fish tank appear silvery when viewed from some particular angle is due to the:
 - (a) reflection
 - (b) refraction
 - (c) dispersion
 - (d) total internal reflection

The correct answer is:

(d) total internal reflection

Explanation:

Small air bubbles in water appear silvery when viewed from certain angles due to **Total Internal Reflection** (TIR). This happens because:

- Light from inside the water hits the air bubble-water interface at an angle greater than the critical angle.
- Since air has a lower refractive index than water, the light is totally internally reflected at that interface.
- This reflected light gives the silvery appearance.

✓ Final Answer:

(d) total internal reflection

Question 3

- (i) (a) Is it possible for a concave lens to form an image of size two times that of the object? Write Yes or No.
 - (b) What will happen to the focal length of the lens if a part of the lens is covered with an opaque paper?

(i) (a)

Is it possible for a concave lens to form an image of size two times that of the object?

Answer:

No.

Explanation:

A concave lens always forms a virtual, erect, and diminished image. It can never produce an enlarged image of a real object.

(i) (b)

What will happen to the focal length of the lens if a part of the lens is covered with opaque paper?

Answer:

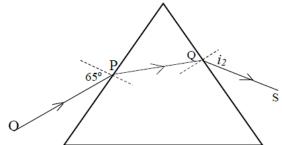
The focal length will remain unchanged.

Explanation:

Covering part of the lens only reduces the amount of light passing through the lens (the image becomes fainter), but does not change the curvature or the refractive properties, so the focal length stays the same.

Question 4

- (i) The diagram below shows the ray **OP** travelling through an *equilateral* prism of a certain material. [3]
 - (a) Calculate the value of i_2 , if the angle of deviation is 43° .
 - (b) What is the ray **QS** called?



(a) Calculate the value of i_2 , if the angle of deviation is 43°.

Given:

- Angle of incidence, $i_1=65^\circ$
- Deviation, $\delta=43^\circ$
- Prism angle $A=60^\circ$ (since it's an equilateral prism)

Formula:

$$\delta = i_1 + i_2 - A$$

Substitute the known values:

$$43 = 65 + i_2 - 60$$

$$43 = 5 + i_2$$

$$i_2=38^\circ$$

 $lap{Normalize}$ Answer: $i_2=38^\circ$

(b) What is the ray QS called?

The ray QS is the emergent ray.

Answer: Emergent ray



Given:

- Light ray PQ is incident normally (at 90°) on face AB.
- The prism is equilateral: all angles are 60°.
- Critical angle of glass = 42°.

Step-by-step:

1. At point Q:

Since PQ is normal to the surface AB, the ray enters without deviation (no bending).

2. Inside the prism:

The ray travels in a straight line from Q towards the opposite face AC.

- 3. At the face AC:
 - The ray will strike AC from inside the prism.
 - The angle of incidence at this surface will be 60° (since internal angle at A = 60° and ray is horizontal).
 - Compare this with the critical angle (42°):

Since 60° > 42°, the ray undergoes Total Internal Reflection (TIR) at surface AC.

4. After reflection:

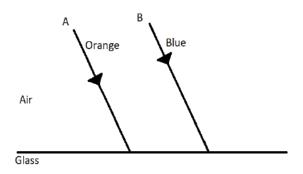
The ray reflects inside the prism, now moving towards face BC.

- 5. At face BC:
 - · The ray hits BC and emerges out of the prism.
 - It will refract away from the normal as it moves from denser (glass) to rarer (air).

Final Answer:

- The ray enters normally at AB, goes straight.
- It hits AC, undergoes TIR.
- Then it emerges out through BC, bending away from the normal.

- (iii) The diagram below shows two parallel rays **A** (Orange) & **B** (Blue) incident from [4] air, on air-glass boundary.
 - (a) Copy and complete the path of the rays A and B.
 - (b) How do the speeds of these rays differ in glass?
 - (c) Are the two refracted rays in glass parallel? Give a reason.



(a) Copy and complete the path of rays A (Orange) and B (Blue):

- · Both rays are incident from air to glass.
- Since glass is denser than air, both rays bend towards the normal on entering the glass.
- The ray with higher refractive index bends more.
- Blue light has a higher refractive index in glass than orange light, so:
 - Blue ray bends more towards the normal than orange ray.

(b) How do the speeds of these rays differ in glass?

- Speed of light in a medium is inversely proportional to the refractive index.
- Since blue light has a higher refractive index in glass, its speed is slower than orange light.
- · So, blue light travels slower in glass than orange light.

(c) Are the two refracted rays in glass parallel? Give a reason.

- No, the two refracted rays are not parallel.
- Reason: Different colors have different refractive indices in glass, so they bend by different amounts
 when entering the glass.
- This causes the rays to diverge or converge, depending on the setup here, they bend at different
 angles.



Question 5

(i) A convex lens of focal length 10 cm is placed at a distance of 60 cm from a screen. [3] How far from the lens should an object be placed so as to obtain a real image on the screen?

Given:

- ullet Focal length of convex lens, $f=+10\,\mathrm{cm}$ (positive for convex lens)
- Distance from lens to screen (image distance), $v=60\,\mathrm{cm}$
- Object distance = u (unknown)

Goal:

Find u, the object distance so that a real image is formed on the screen.

Lens formula:

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

Rearranged to find u:

$$\frac{1}{u} = \frac{1}{v} - \frac{1}{f}$$

Substitute the values:

$$\frac{1}{u} = \frac{1}{60} - \frac{1}{10}$$

Calculate the right side:

$$\frac{1}{u} = \frac{1}{60} - \frac{6}{60} = \frac{-5}{60} = -\frac{1}{12}$$

So,

$$u = -12 \,\mathrm{cm}$$

Interpretation:

The negative sign for u means the object is placed 12 cm in front of the lens (on the same side as the
incoming light).

Answer:

The object should be placed 12 cm from the lens to obtain a real image on the screen 60 cm away.

- (ii) (a) A coin kept inside water $[\mu=4/3]$ when viewed from air in a vertical direction [3] appears to be raised by 3.0 mm. Find the depth of the coin in water.
 - (b) How is the critical angle related to the refractive index of a medium?



Given:

- Refractive index of water with respect to air, $\mu=\frac{4}{3}$
- · Apparent raise of coin (apparent depth real depth) = 3.0 mm
- (a) Find the depth of the coin in water (real depth).

Relation between real depth (d) and apparent depth (d'):

$$\mu = \frac{\text{Real depth (d)}}{\text{Apparent depth (d')}}$$

The coin appears to be raised by 3.0 mm, so:

$$d - d' = 3.0 \,\mathrm{mm}$$

Using the refractive index formula:

$$\mu = \frac{d}{d'}$$

Rearranged:

$$d' = \frac{d}{\mu}$$

Substitute d' in the raise formula:

$$d - \frac{d}{\mu} = 3$$





Multiply through by μ :

$$\mu d - d = 3\mu$$

$$d(\mu-1)=3\mu$$

Solve for d:

$$d = \frac{3\mu}{\mu - 1}$$

Substitute $\mu = \frac{4}{3}$:

$$d = rac{3 imes rac{4}{3}}{rac{4}{3} - 1} = rac{4}{rac{1}{3}} = 4 imes 3 = 12 \, \mathrm{mm}$$

Answer:

The depth of the coin in water is 12 mm.

(b) How is the critical angle related to the refractive index of a medium?

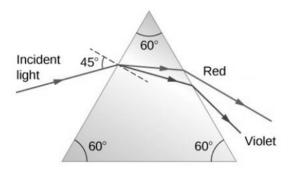
Explanation:

• The critical angle C of a medium is related to its refractive index μ (relative to air) by the formula:

$$\sin C = \frac{1}{\mu}$$

This means the critical angle decreases as the refractive index increases.

- (iii) (a) Infrared radiations are used in warfare. Explain with reason, why.
- [4]
- (b) A ray of light is incident at 45° on an equilateral prism in the diagram below.



- Name the phenomenon exhibited by the ray of light when it enters and emerges out of the prism.
- 2. State the cause of the above phenomenon mentioned by you.

(iii) (a) Why are infrared radiations used in warfare? Explain with reason.

Answer:

- Infrared radiations are used in warfare because they are invisible to the naked eye, so they can be used for stealthy communication and detection.
- Infrared rays can be detected by special sensors and night-vision devices, allowing soldiers to see in the dark or detect enemies without being seen.
- They can also be used for heat-seeking missiles and other targeting systems due to their heat detection capabilities.

(iii) (b)

- 1. Name the phenomenon exhibited by the ray of light when it enters and emerges out of the prism.
- Answer: Dispersion of light.
- 2. State the cause of the above phenomenon.
- Answer:

Dispersion occurs because different colors (wavelengths) of light have different refractive indices in the prism material. This causes them to bend (refract) by different amounts, separating white light into its constituent colors (spectrum). Violet light bends more than red light because it has a shorter wavelength and a higher refractive index in the prism.