
TEACHING TASK

JEE MAINS LEVEL QUESTIONS

Multiple choice question type:

1.

1. **Normal:** Draw a line perpendicular to the mirror surface at the point where the light hits. This is the normal.
2. **Angle of Incidence (i):** The angle between the incident ray and the normal.
3. **Angle of Reflection (r):** The angle between the reflected ray and the normal.
4. **Law of Reflection:** $i = r$.
5. **Angle with Mirror (θ):** This is the angle given in your figure, between the ray and the mirror's surface.
6. **Relationship:** $i + \theta = 90^\circ$, so $i = 90^\circ - \theta$.
7. **Angle Between Rays:** The total angle between the incident and reflected rays is $i + r = 2i = 2(90^\circ - \theta)$.

Example: If the ray hits at 20° to the mirror ($\theta = 20^\circ$):

- Angle of Incidence, $i = 90^\circ - 20^\circ = 70^\circ$.
- Angle of Reflection, $r = 70^\circ$.
- Angle between incident and reflected rays = $70^\circ + 70^\circ = 140^\circ$.

2.

The number of images formed when two plane mirrors are facing each other is **D) infinite**.

When two plane mirrors are placed parallel to each other ($\theta = 0^\circ$), light rays reflect back and forth infinitely many times between the surfaces. The general formula used to determine the number of images formed (n) by two plane mirrors inclined at an angle θ is given by $n = \frac{360^\circ}{\theta} - 1$ (for even results of the division, or if the object is on the angle bisector).

In this specific case, the angle between the mirrors is $\theta = 0^\circ$. Substituting this into the formula yields an undefined or infinite result:

$$n = \frac{360^\circ}{0^\circ} = \textbf{infinite}$$

This continuous reflection creates an endless sequence of images extending into the distance.

3.

Step 1: Determine the angle of incidence

The angle given is with the mirror surface, not the normal. The normal is a line perpendicular to the mirror surface at the point of incidence.
The angle of incidence (θ_i) is calculated by subtracting the given angle from 90°:

$$\theta_i = 90^\circ - 30^\circ = 60^\circ$$

Step 2: Determine the angle of reflection

According to the law of reflection, the angle of incidence is equal to the angle of reflection (θ_r).

$$\theta_r = \theta_i = 60^\circ$$

Step 3: Determine the angle between incident and reflected ray

The angle between the incident ray and the reflected ray is the sum of the angle of incidence and the angle of reflection.

$$\text{Angle between rays} = \theta_i + \theta_r = 60^\circ + 60^\circ = 120^\circ$$

4.

The front bulged part of the eyeball is the **cornea** **(A)**, which is the transparent outer layer that covers the iris, pupil, and anterior chamber, responsible for focusing most of the light entering the eye.

- **A) Cornea**: The clear, dome-shaped front surface that bulges out and helps focus light.
- **B) Iris**: The colored, ring-shaped muscle that controls the size of the pupil.
- **C) Retina**: The light-sensitive tissue at the back of the eye that converts light into neural signals.
- **D) Pupil**: The black, circular opening in the center of the iris that lets light in.

5.

The correct option is **C) dispersion of light**.

Explanation

- **Dispersion of light** is the phenomenon where white light splits into its seven constituent colors (VIBGYOR: violet, indigo, blue, green, yellow, orange, and red) when it passes through a transparent medium like a prism.
- This happens because each color of light has a different wavelength and thus travels at a slightly different speed within the medium. This difference in speed causes them to bend (refract) at different angles, leading to their separation.

6.

Step 1: Determine the new object distance

The initial object distance from the plane mirror is $d_{o1} = 15\ \text{cm}$. When the object moves $8\ \text{cm}$ farther away, the new object distance d_{o2} is calculated as:

$$d_{o2} = d_{o1} + 8\ \text{cm} = 15\ \text{cm} + 8\ \text{cm} = 23\ \text{cm}$$

Step 2: Calculate the new object-image distance

For a **plane mirror**, the image distance (d_i) is always equal to the object distance (d_o), i.e., $d_i = d_o$. The distance between the object and the image (D) is therefore $D = d_o + d_i = 2d_o$. The new distance between the object and its image D_2 is:

$$D_2 = 2 \times d_{o2} = 2 \times 23\ \text{cm} = 46\ \text{cm}$$

7.

1. **Initial Position:** A plane mirror forms a virtual image at the same distance behind the mirror as the object is in front of it [1].
   - Initial object distance (d_o) = 8 cm.
   - Initial image distance (d_i) = 8 cm behind the mirror.
   - Initial distance between object and image = $d_o + d_i = 8\text{cm} + 8\text{cm} = 16\text{cm}$.
2. **After Movement:** The object is moved 4 cm *towards* the mirror.
   - New object distance (d_o') = $8\text{cm} - 4\text{cm} = 4\text{cm}$.

3. **New Position of Image:** The new image distance (d_i') is also 4 cm behind the mirror.
4. **New Distance between Object and Image:** The new distance between the object and its image is the sum of the new object and image distances:
   - New distance = $d_o' + d_i' = 4\text{cm} + 4\text{cm} = 8\text{cm}$.

8.

For a plane mirror, the image is formed at the same distance behind the mirror as the object is in front of it, meaning the object distance (d_o) equals the image distance (d_i), so $d_o = d_i$.

The initial object distance is 22cm.
When the object is moved 7cm towards the mirror, the new object distance (d_{new}) is calculated as:

$$d_{\text{new}} = 22\text{cm} - 7\text{cm} = 15\text{cm}$$

Since the image distance must equal the new object distance, the new distance between the mirror and its image is also **15cm**.

9.

Step 1: Understand the principles of a plane mirror

For a **plane mirror**, the image formed is always at the same distance behind the mirror as the object is in front of it. The image distance (v) is equal in magnitude to the object distance (u): $v = u$.

Step 2: Determine the new object distance

The object starts at an initial distance of $15\ \text{cm}$. When it is moved $7\ \text{cm}$ closer to the mirror, the new object distance ($\mathbf{u_{new}}$) is calculated by subtracting the movement from the initial distance:

$$u_{\text{new}} = u_{\text{initial}} - \text{movement} = 15\ \text{cm} - 7\ \text{cm} = 8\ \text{cm}$$

Step 3: Calculate the new image distance

Using the principle from Step 1, the new distance between the mirror and the image ($\mathbf{v_{new}}$) is equal to the new object distance:

$$v_{\text{new}} = u_{\text{new}} = 8 \text{ cm}$$

10.

In a plane mirror, the image distance is always equal to the object distance.

1. Initially, the image is formed at a distance of 14 cm from the mirror. This means the initial object distance was also 14 cm.
2. The object is then moved 6 cm *away* from the mirror.
3. The new object distance becomes $14 \text{ cm} + 6 \text{ cm} = 20 \text{ cm}$.
4. Because the image distance always equals the object distance for a plane mirror, the new image distance from the mirror is also 20 cm.

The new distance between the mirror and its image is 20 cm

JEE ADVANCED LEVEL QUESTIONS

Multi correct answer type:

11.

The image formed by a plane mirror possesses all the listed characteristics:

- **Virtual**: The image cannot be projected onto a screen because the light rays do not actually converge at the image location; they only appear to diverge from a point behind the mirror.
- **Same size**: The size of the image is equal to the size of the object, meaning the magnification is 1.
- **Erect**: The image is upright relative to the object, with no top-bottom reversal.
- **Laterally inverted**: The left and right sides of the image are swapped relative to the object (e.g., the object's right hand appears as the image's left hand).

12.

Regular reflection happens on very smooth, polished surfaces that reflect light rays parallel, like **still water (a)** and **highly polished metals (c)**, creating clear images, while rough surfaces like walls (b) and trees (d) cause diffuse reflection; therefore, **A) a and c** is the correct choice, as these surfaces are smooth enough for uniform reflection.

- **a) still water:** The surface of still water is smooth, acting like a mirror for regular reflection.
- **c) highly polished metals:** Surfaces like mirrors or polished steel are very smooth and produce regular reflection.
- **b) walls & d) trees:** These have rough surfaces, leading to diffuse reflection, scattering light in many directions, which is why you don't see a clear image of yourself.

13.

The correct option for the given Assertion (A: A real image cannot be captured on a screen) and Reason (R: A real image can be captured on a screen) is **(D) 'A' is false and 'R' is true**, because real images *can* be projected onto a screen (like in a movie theater), while virtual images (like those in mirrors) cannot; therefore, the Assertion is false, and the Reason is a true statement.

Here's the breakdown:

- **Assertion (A): A real image can not be captured on a screen** - This statement is **False**. Real images are formed by the actual convergence of light rays and *can* be formed on a screen (e.g., projector, camera).
- **Reason (R): A real image can be captured on a screen** - This statement is **True**. This fact directly contradicts the assertion.

14.

1. **Assertion (A): If the angle between two mirrors is [blank], then the number of images formed are 5.**
   - The number of images (n) formed by two mirrors inclined at an angle θ is generally $n = \frac{360^\circ}{\theta} - 1$ (or $\frac{360^\circ}{\theta}$ if it's an integer and object is not on bisector, etc.).
   - For $n = 5$, we need $\frac{360^\circ}{\theta} - 1 = 5 \implies \frac{360^\circ}{\theta} = 6 \implies \theta = 60^\circ$. So, if $\theta = 60^\circ$, we get 5 images.
   - However, the angle is left blank in the assertion. If we assume it implies *any* angle for 5 images, it's false. If we assume it implies a *specific* angle that yields 5, then it's true *for that specific angle*. Given the context of A/R questions, the assertion is likely intended to be generally false or incomplete. Let's treat it as potentially true if angle is 60°.
2. **Reason (R): Number of images formed n=-1.**
   - The formula for the number of images is $n = \frac{360^\circ}{\theta} - 1$.
   - 'n' represents the *number* of images, which must be a non-negative integer (0, 1, 2, 3...). A negative number of images, like -1, is physically impossible.
   - Therefore, Reason (R) is **False**.

15.

The correct option is **D) a - 2, b - 3, c - 4, d - 1**.

This option matches each item in Column A to its appropriate description or property in Column B. A **house** exhibits **irregular reflection** (a-2) due to its rough surfaces. A **plane mirror** forms a **virtual** image (b-3). The **angle of incidence** is always **equal to the angle of reflection** (c-4), according to the Law of Reflection. **Still water** provides a smooth surface that results in **regular reflection** (d-1).

16.

Step 1: Identify the formula

The number of images (n) formed by two plane mirrors inclined at an angle (θ) is generally calculated using the formula $n = \frac{360^\circ}{\theta} - 1$

Step 2: Substitute the assumed angle

Substitute the assumed angle of $\theta = 90^\circ$ into the formula:

$$n = \frac{360^\circ}{90^\circ}$$

$$n = 4$$

17.

Step 1: State the relevant formula

To determine the angle between the mirrors (θ) when a specific number of images (n) is formed, we use the formula:

$$n = \frac{360^\circ}{\theta} - 1$$

Step 2: Substitute the given number of images

We are given that the number of images formed is $n = 5$. We substitute this value into the equation:

$$5 = \frac{360^\circ}{\theta} - 1$$

Step 3: Solve for the angle of inclination

We rearrange the equation to solve for θ:

$$5 + 1 = \frac{360^\circ}{\theta}$$

$$6 = \frac{360^\circ}{\theta}$$

$$\theta = \frac{360^\circ}{6}$$

$$\theta = 60^\circ$$

18.

Step 1: Understand Plane Mirror Properties

A plane mirror forms a virtual image at the same distance behind the mirror as the object is in front of it. Therefore, the distance between the object and its image (D) is twice the object distance (d_o):

$$D = 2 \times d_o$$

Initially, the object distance d_{o1} is 10 cm. The initial distance between the object and image is $D_1 = 2 \times 10 \text{ cm} = 20 \text{ cm}$.

Step 2: Calculate the New Object Distance

The object is moved 4 cm farther away from the mirror. The new object distance d_{o2} is the initial distance plus the extra distance:

$$d_{o2} = d_{o1} + 4 \text{ cm} = 10 \text{ cm} + 4 \text{ cm} = 14 \text{ cm}$$

Step 3: Calculate the New Object-Image Distance

Using the property from Step 1, the new distance between the object and its image D_2 is twice the new object distance d_{o2}:

$$D_2 = 2 \times d_{o2} = 2 \times 14 \text{ cm} = 28 \text{ cm}$$

19.

1. **Find the Angle of Incidence (i):** The angle given (20°) is with the mirror surface, not the normal. Since the normal is perpendicular (90° to the mirror), the angle of incidence is:
   $i = 90^\circ - 20^\circ = 70^\circ$.
2. **Apply the Law of Reflection:** The angle of incidence equals the angle of reflection ($i = r$). So, the angle of reflection (r) is also 70°.
3. **Calculate the Total Angle:** The angle between the incident ray and the reflected ray is the sum of the angle of incidence and the angle of reflection:
   Total Angle = $i + r = 70^\circ + 70^\circ = 140^\circ$.

LEARNERS TASK

Conceptual understanding questions (CQU'S)

Mutliple Choice Question Type:

1.

- **Rough surfaces** have microscopic irregularities that cause light rays to scatter in many different directions, a phenomenon called diffused or irregular reflection.
- Because the light is scattered and does not reflect uniformly, a clear, sharp image cannot be formed.

2.

A standard Braille character, or cell, is made up of **6** dots arranged in two columns of three dots each. These dots are identified by numbers 1 through 6, and different combinations of raised dots within this cell represent different letters, numbers, punctuation marks, or words.

3.

Glasses are coated with **A) silver, though aluminum is also used**, because these metals offer high reflectivity, with silver being particularly efficient, making them ideal for creating clear mirror surfaces, though silver can tarnish and sometimes gets a protective copper layer behind it.

4.

We are able to see most objects because light from a source (like the sun or a lamp) strikes the object and then bounces off, or **reflects**. This reflected light then enters our eyes, allowing our brain to process the image and color of the object.

5.

The angle of incidence in a plane mirror is **(A) equal to the angle of reflection**, as stated by the fundamental Law of Reflection, which holds true for plane surfaces like mirrors. This means the incoming (incident) ray and the outgoing (reflected) ray make the same angle with the imaginary line perpendicular to the mirror's surface (the normal).

6.

The perpendicular line drawn at any point on a mirror, where a light ray hits, is called the **normal**, which is crucial for measuring the angle of incidence and reflection, making option (C) the correct answer.

7.

The image formed by a plane mirror possesses all the listed characteristics:

- **A) at the same distance behind the mirror as the object is in front of it**: The object distance from the mirror is equal to the image distance behind the mirror.
- **B) laterally inverted**: The image is reversed from left to right.
- **C) of the same size as that of the object**: The image and the object have the same dimensions, which means the magnification is 1.

8.

The correct option is **C) a large number of reflected images** (specifically, an infinite number in theory).

Explanation

- When two plane mirrors are arranged parallel to each other, the light from an object placed between them undergoes **multiple, repeated reflections**.
- Each image formed by one mirror acts as a virtual object for the other mirror, and this process continues indefinitely.
- The number of images formed is theoretically **infinite** because the angle between the mirrors is 0 degrees, and using the formula for the number of images ($n = 360^\circ/\theta - 1$), we get $n = 360^\circ/0^\circ$, which is undefined, or infinite.
- In practice, the images become progressively fainter with each reflection due to some light energy being absorbed by the mirror materials, so only a large, but finite, number of images are actually visible.

9.

A **real image** is formed when light rays actually converge (meet) at a point after reflection from a mirror or refraction through a lens. Because the light rays physically meet, the image has a physical existence at that location and can therefore be projected or **captured on a screen**, such as a cinema screen or camera sensor.

10.

A virtual image is **always erect and uncapturable on a screen**, formed where light rays *appear* to diverge from, unlike real images which are inverted and *can* be projected. The correct option is **D) always uncapturable on a screen**, as virtual images form from apparent light intersections, not actual ones, meaning they can't be focused onto a physical screen like a cinema screen.

JEE MAINS LEVEL QUESTIONS

Multiple choice question type:

1.

Step 1: Identify given values and formula

The given values for the speed of light (v) and time (t) are:

- Speed of light: $v = 3 \times 10^5$ km/s
- Time taken: $t = 500$ s

The formula used to calculate distance (d) from speed and time is:

$$d = v \times t$$

Step 2: Calculate the distance

Substitute the given values into the formula:

$$d = (3 \times 10^5 \text{ km/s}) \times (500 \text{ s})$$

Perform the multiplication:

$$d = 150000000 \text{ km}$$

This value can be expressed in scientific notation or in millions of kilometers:

$$d = 1.5 \times 10^8 \text{ km}$$

$$d = 150 \text{ million km}$$

2.

According to the **Law of Reflection**, the angle of incidence (θ_i) is always equal to the angle of reflection (θ_r), both measured with respect to the normal drawn perpendicular to the reflecting surface at the point of reflection. The relationship is expressed as $\theta_i = \theta_r$. Given an angle of incidence of 80°, the angle of reflection must also be 80°.

3.

Step 1: Determine the initial object distance

For a plane mirror, the distance of the object from the mirror (u) is always equal to the distance of the image from the mirror (v). The problem states the initial image distance is $v_1 = 29\ \text{cm}$. Therefore, the initial object distance u_1 is:

$$u_1 = v_1 = 29\ \text{cm}$$

Step 2: Calculate the new object distance

The car (object) is moved $11\ \text{cm}$ towards the mirror. The new object distance u_2 is calculated by subtracting this movement from the initial distance:

$$u_2 = u_1 - 11\ \text{cm}$$

$$u_2 = 29\ \text{cm} - 11\ \text{cm} = 18\ \text{cm}$$

4.

Step 1: Understand the formula

The number of images (n) formed by two plane mirrors inclined at an angle (θ) is given by the formula $n = \frac{360^\circ}{\theta} - 1$ if the result of $\frac{360^\circ}{\theta}$ is an even integer or an odd integer with the object placed on the angle bisector. If $\frac{360^\circ}{\theta}$ is not an integer, the number of images is the integral part (floor value) of $\frac{360^\circ}{\theta}$.

Step 2: Apply the formula for a common angle

Given the options, an angle of **30°** is the most likely intended value for which 11 images are formed.
We can use the formula:

$$n = \frac{360^\circ}{\theta} - 1$$

Step 3: Calculate the number of images

Substitute $\theta = 30^\circ$ into the equation:

$$n = \frac{360^\circ}{30^\circ} - 1$$

$$n = 12 - 1$$

$$n = 11$$

5.

Explanation

- The **iris** is a dark, muscular diaphragm that adjusts the size of the pupil in response to varying light conditions.
- In **bright light**, muscles in the iris contract, making the pupil smaller to reduce the amount of light entering and protect the sensitive retina.
- In **dim light**, the muscles in the iris relax, making the pupil larger (dilating) to allow more light to enter, enhancing visibility.

6.

Step 1: Determine the initial and final object distances

The initial distance of the object from the plane mirror (u_1) is given as 2 m.
The object is shifted 0.5 m away from the mirror, so the final distance of the object from the mirror (u_2) is calculated as:

$$u_2 = u_1 + 0.5 \text{ m} = 2 \text{ m} + 0.5 \text{ m} = 2.5 \text{ m}$$

Step 2: Calculate the final distance between the object and its image

For a plane mirror, the image distance (v) is equal in magnitude to the object distance (u) (i.e., $|v| = u$), and the image is formed behind the mirror. The total distance (D) between the object and its image is therefore $D = u + |v| = 2u$.

Using the final object distance u_2, the final distance between the object and its image (D_2) is:

$$D_2 = 2 \times u_2 = 2 \times 2.5\ \text{m} = 5\ \text{m}$$

7.

Step 1: Determine initial object-image distance

For a plane mirror, the image distance (d_i) is equal to the object distance (d_o), so $d_i = d_o$ [1]. The initial object distance is $d_{o1} = 10\text{cm}$.

The initial distance between the object and the image is given by $D_1 = d_{o1} + d_{i1} = 2d_{o1}$ [1].

$$D_1 = 2 \times 10\text{cm} = 20\text{cm}$$

Step 2: Calculate new object distance and new object-image distance

The object is moved 4cm farther away from the mirror. The new object distance is $d_{o2} = d_{o1} + 4\text{cm}$.

$$d_{o2} = 10\text{cm} + 4\text{cm} = 14\text{cm}$$

The new image distance is $d_{i2} = d_{o2}$ [1]. The new distance between the object and the image is $D_2 = d_{o2} + d_{i2} = 2d_{o2}$.

$$D_2 = 2 \times 14\text{cm} = 28\text{cm}$$

8.

Explanation

The minimum distance of clear vision for a normal, healthy human eye is approximately **25 cm**, a point also known as the eye's near point. At distances closer than this, the eye's ciliary muscles cannot contract enough to decrease the focal length of the eye lens any further, which prevents the light rays from focusing properly on the retina. As a result, the image appears blurred and causes eye strain.

9.

Step 1: Determine the angle of incidence

The problem states that the angle with the mirror surface is 40°. The **angle of incidence** (θ_i) is the angle between the incident ray and the **normal** (a line perpendicular to the mirror surface at the point of incidence).

$$\theta_i = 90^\circ - \text{angle with mirror} = 90^\circ - 40^\circ = 50^\circ$$

Step 2: Determine the angle of reflection

According to the **Law of Reflection**, the angle of reflection (θ_r) is equal to the angle of incidence (θ_i).

$$\theta_r = \theta_i = 50^\circ$$

Step 3: Determine the angle between the incident and reflected rays

The **angle between the incident ray and the reflected ray** is the sum of the angle of incidence and the angle of reflection.

$$\text{Angle between rays} = \theta_i + \theta_r = 50^\circ + 50^\circ = 100^\circ$$

10.

Step 1: Identify the formula

The number of images (N) formed by two plane mirrors inclined at an angle θ is given by the formula $N = \frac{360^\circ}{\theta} - 1$, especially when $\frac{360^\circ}{\theta}$ is an even number.

Step 2: Substitute the angle and calculate

Given angle $\theta = 45^\circ$, substitute this into the formula to find the value of $\frac{360^\circ}{\theta}$:

$$\frac{360^\circ}{45^\circ} = 8$$

Since 8 is an even number, we subtract 1:

$$N = 8 - 1 = 7$$

JEE ADVANCED LEVEL QUESTIONS

Assertion and Reason Type:

11.

The correct option is **D) Assertion is false, but Reason is true**, because the law of reflection states the angle of incidence *equals* the angle of reflection, making the Assertion (twice) false, while the Reason (equal) is a correct statement of the law.

Analysis:

- **Assertion (A): The angle of incidence is twice the angle of reflection.** This is **False**. The law of reflection states they are equal.
- **Reason (R): The angle of incidence is equal to Angle of reflection.** This is **True**, as it's the fundamental principle of reflection (Law of Reflection).

12.

- **Assertion: We see objects due to diffused reflection.**
  - This is **True**. Unlike shiny surfaces (specular reflection) that send light in one direction, rough surfaces scatter light everywhere, allowing some light to reach our eyes from any angle, making the object visible.
- **Reason: In diffused reflection, different light rays incident with different incident angles.**
  - This is also **True**. A rough surface has many tiny slopes. Parallel light rays hit these slopes at different angles (angle of incidence), and by the law of reflection (angle of incidence = angle of reflection), they reflect at many different angles, causing scattering.

In summary: The rough texture causes varying incident angles, which leads to light scattering in many directions (diffuse reflection), making objects visible from multiple perspectives.

13.

Step 1: Initial Distance Calculation

A plane mirror forms an image at the same distance behind the mirror as the object is in front of it, meaning the image distance (v) equals the object distance (u). The total distance between the object and the image is given by $D = u + v = 2u$.
The initial object distance is $u_1 = 15$ cm.
The initial distance between the object and the image is $D_1 = 2u_1 = 2 \times 15\,\text{cm} = 30$ cm.

Step 2: New Object Distance Calculation

The object is moved 2.5 cm towards the mirror.
The new object distance is $u_2 = u_1 - 2.5\,\text{cm} = 15\,\text{cm} - 2.5\,\text{cm} = 12.5$ cm.

Step 3: New Total Distance Calculation

For the plane mirror, the new image distance v_2 is equal to the new object distance u_2. The new distance between the object and the image is $D_2 = 2u_2 = 2 \times 12.5\,\text{cm} = 25$ cm.

14.

Step 1: Determine the angle of incidence

The angle given (70°) is the angle between the incident ray and the plane of the mirror (the glancing angle). The angle of incidence (θ_{incident}) is defined as the angle between the incident ray and the normal (a line perpendicular to the mirror surface).

We calculate the angle of incidence using the relationship:

$$\theta_{\text{incident}} = 90^\circ - \theta_{\text{mirror}}$$

$$\theta_{\text{incident}} = 90^\circ - 70^\circ$$

$$\theta_{\text{incident}} = 20^\circ$$