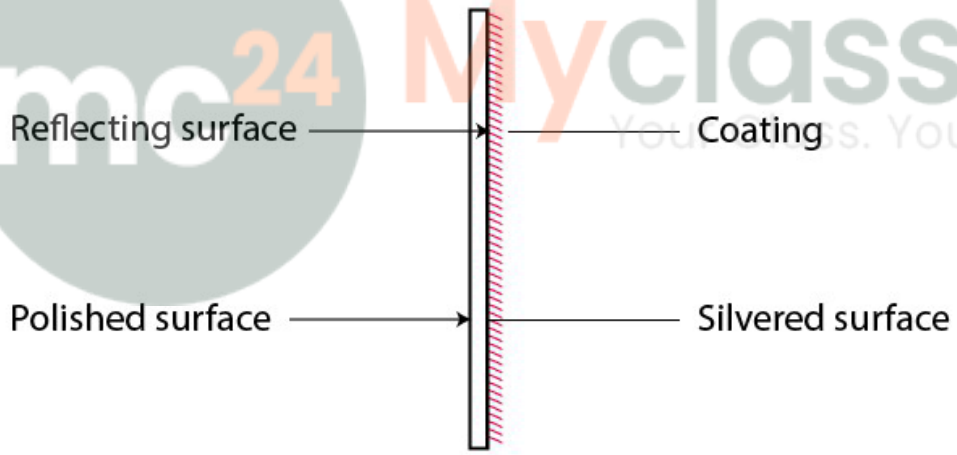
## Exercise-7(A)

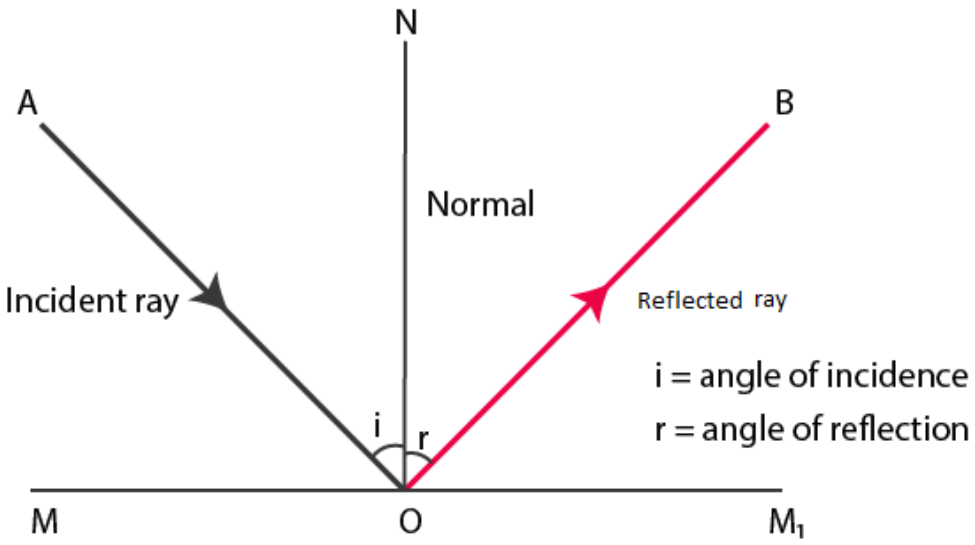
1. **What do you mean by reflection of light?**
   Solution:
   Reflection is when light reverts to the same medium after it strikes a surface.

2. **State which surface of plane mirror reflects most of the light incident on it : the front smooth surface or the back silvered surface.**
   Solution:
   The surface of the plane mirror that reflects most of the light incident on it is the back silvered surface.

3. **Explain the following terms:**
   **(a) Plane mirror**
   **(b) Incident ray**
   **(c) Reflected ray**
   **(d) Angle of incidence and**
   **(e) Angle of reflection**
   Solution:

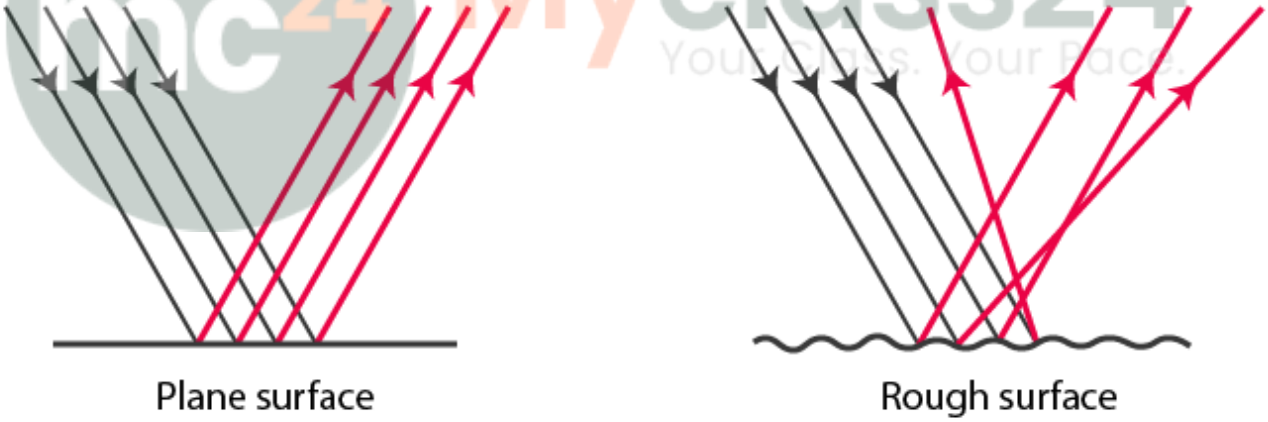



(a) Plane mirror – It is highly polished and a smooth reflecting surface that is prepared from a clear plane glass sheet, which are usually thin and silvered with appropriate reflecting abrasive on one of the sides. After pasting, the glass turns opaque but because of the reflecting property of the abrasive, the plane glass sheet turns into a plane glass mirror or plane glass reflector
(b) Incident ray – it is the light ray that strikes a reflecting surface
(c) Reflected ray – it is the light ray that is obtained after reflection from the surface in the same medium in which the incident ray is travelling
(d) Angle of incidence – it is the angle which the incident ray makes with the normal at the point of incidence. It is denoted by ‘i’
(e) Angle of reflection – it is the angle made by the reflected ray with the normal at the point of incidence. It is denoted by ‘r’




**4. With the help of diagrams, explain the difference between regular and irregular reflection.**

Solution:




When a ray or beam of light falls on a smooth and polished surface an irregular reflection is observed when the light falls on a rough surface. As the surface is uneven, light rays from several points gets reflected in different directions, producing irregular reflections.

**5. Differentiate between reflection of light from a plane mirror and that from a plane sheet of paper.**

Solution:

The differences are as follows:

| Reflection of light from a plane mirror | Reflection of light from s plane sheet of paper |
|---|---|
| It is regular reflection | It is an irregular reflection |

**6. State the two laws of reflection of light.**

Solution:

The two laws of reflection of light are as follows:

- The angle of incidence is equal to the angle of reflection
- The incident ray, the reflected ray and the normal at the point of incidence, all lie in the same plane

**7. State the laws of reflection and describe an experiment to verify them.**

Solution:

The two laws of reflection of light are as follows:

- The angle of incidence is equal to the angle of reflection
- The incident ray, the reflected ray and the normal at the point of incidence, all lie in the same plane

Experiment to verify laws of reflection:

- Fix a sheet of white paper on a drawing board and draw a line $MM_1$ as seen in the figure
- Take a point O at the mid of the line and draw a line OA such that ∠MOA is lesser than 90 °, say 60 °
- Draw a normal ON on $MM_1$ at the point O, placing a small plane mirror vertically with the help of a stand with its silvered surface on the line $MM_1$
- Fix two pins P and Q at some distance vertically on line OA, on the board
- Observe the other side of the normal, on the same side of the mirror, to see the images clearly $P^1$ and $Q^1$ of pins P and Q
- Fix pin R in line with images $P^1$ and $Q^1$ as seen in the mirror
- Fix one more pin S such that S is also in line with pin R as well the images $P^1$ and $Q^1$ of pins P and Q
- Sketch small circles on the paper around the position of pins as observed in the figure
- Remove the pins and draw a line OB joining the point O to the pin points S and R
- AO is the incident ray, OB is the reflected ray, ∠AON = i, is the angle of incidence, ∠BON is the angle of reflection 'r'. ∠AON and ∠BON are measured and recorded in the observation table
- The experiment is repeated for different angles such as 50°, 40°, 30° for ∠MOA
- From the observation it is observed that in each case, angle of incidence is equal to the angle of reflection, verifying the first law of reflection
- Since the experiment is carried out on a plane paper, the lower tips of all the four pins lie on the same plane, hence the incident ray, reflected ray, and the normal at the point of incidence, all lie in the same plane. This verifies the second law of reflection.

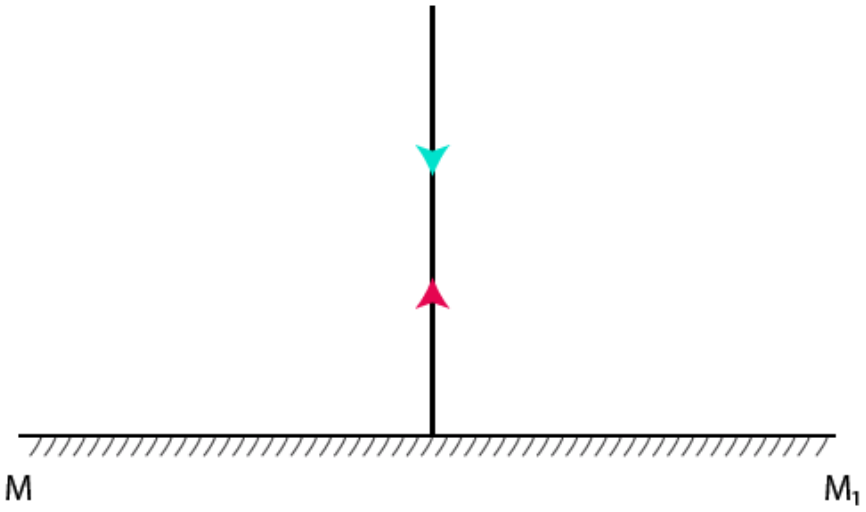
**8. A light ray is incident normally on a plane mirror.**

**(a) What is its angle of incidence?**

**(b) What is the direction of the reflected ray? Show it on a diagram.**

Solution:

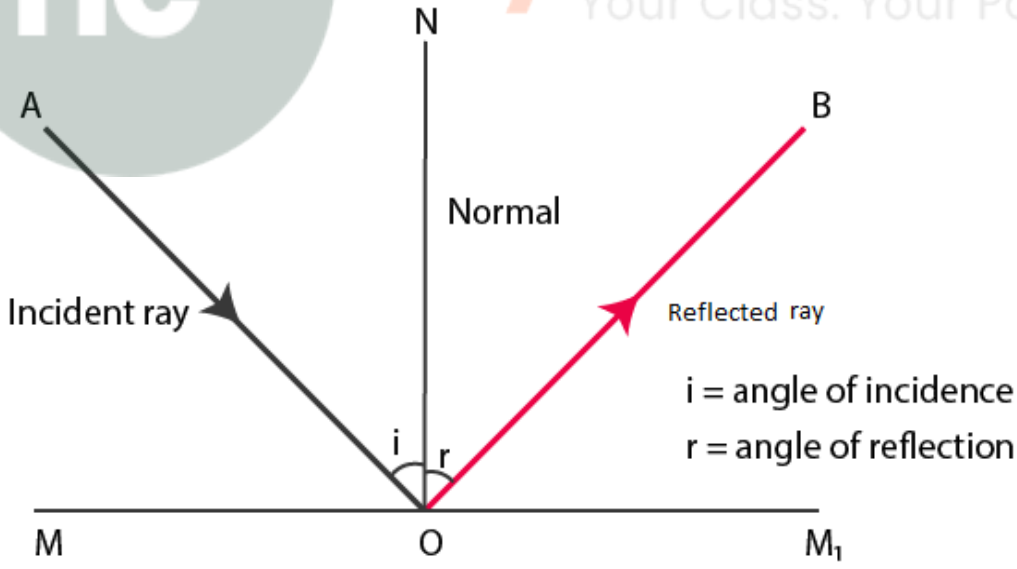
(a) The angle of incidence is 0 °
(b) The direction of the reflected ray is in the same direction as the incident ray.




**9. Draw a diagram to show the reflection of a ray of light by a plane mirror. In the diagram, label the incident ray, the reflected ray, the normal, the angle of incidence and the angle of reflection.**

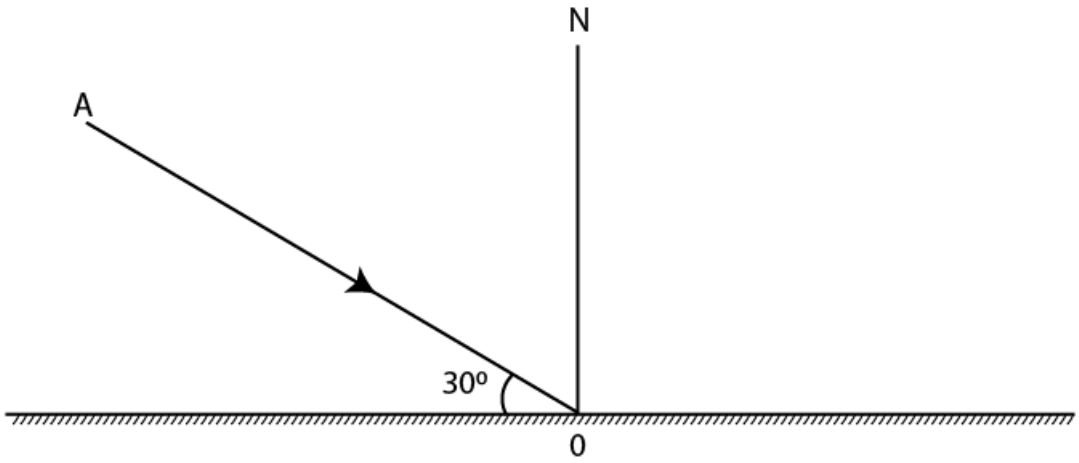
Solution:

The diagram is as follows:




**10. Figure shows an incident ray AO and the normal ON on a plane mirror. The angle which the incident ray AO makes with the mirror is 30°.**

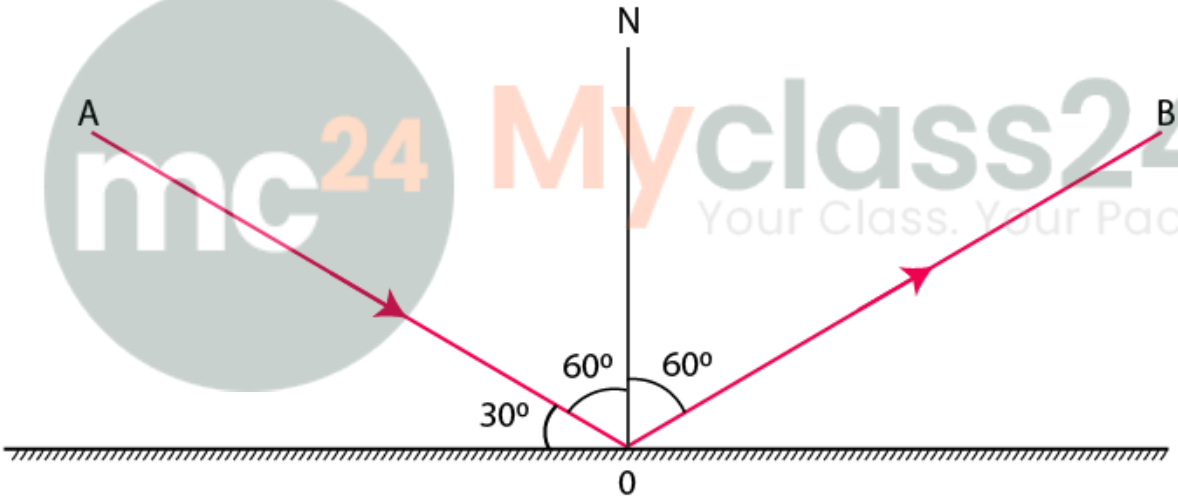
**(a) Find the angle of incidence.**
**(b) Draw the reflected ray and then find the angle between the incident and reflected rays.**




Solution:

(a) The angle of incidence = 90° - 30° = 60°

(b) The angle between the incident and reflected ray= angle of incidence + angle of reflection
Since angle of incidence = angle of reflection
Therefore, angle between the reflected ray and the incident ray = 60° + 60° = 120°

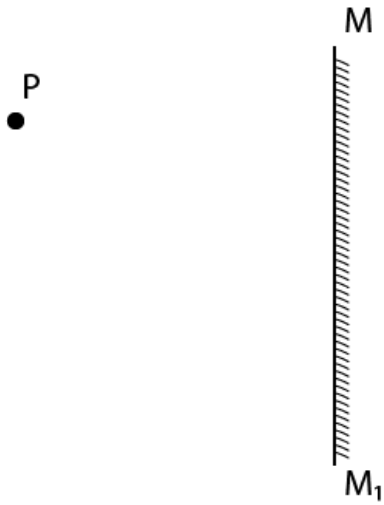



**11. The diagram shows a point object P in front of a plane mirror $MM_1$.**

**(a) Complete the diagram by taking two rays from the point P to show the formation of its image.**

**(b) In the diagram, mark the position of eye to see the image.**

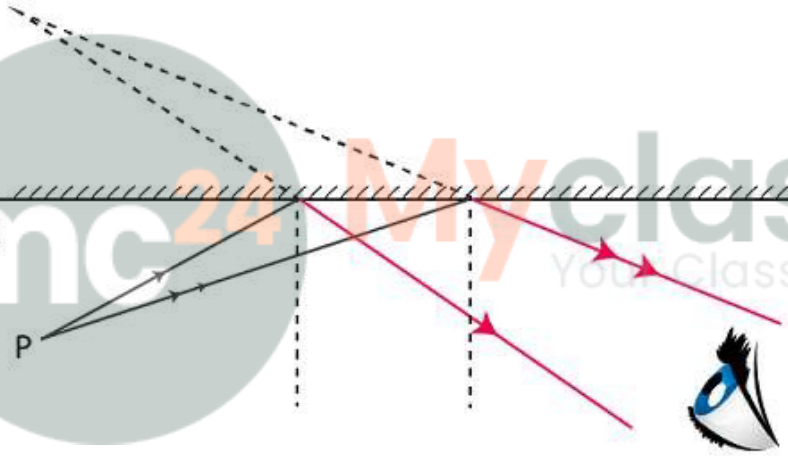
**(c) Is the image formed real or virtual? Explain why.**




Solution:

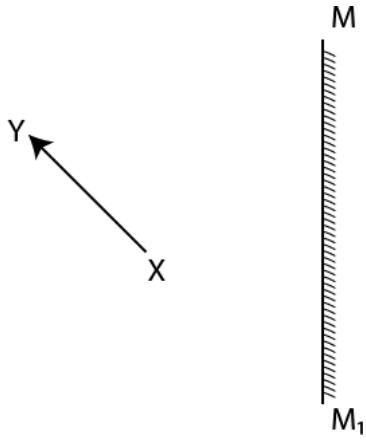
(a) & (b)

The diagram is completed by taking two rays and the position has been marked.



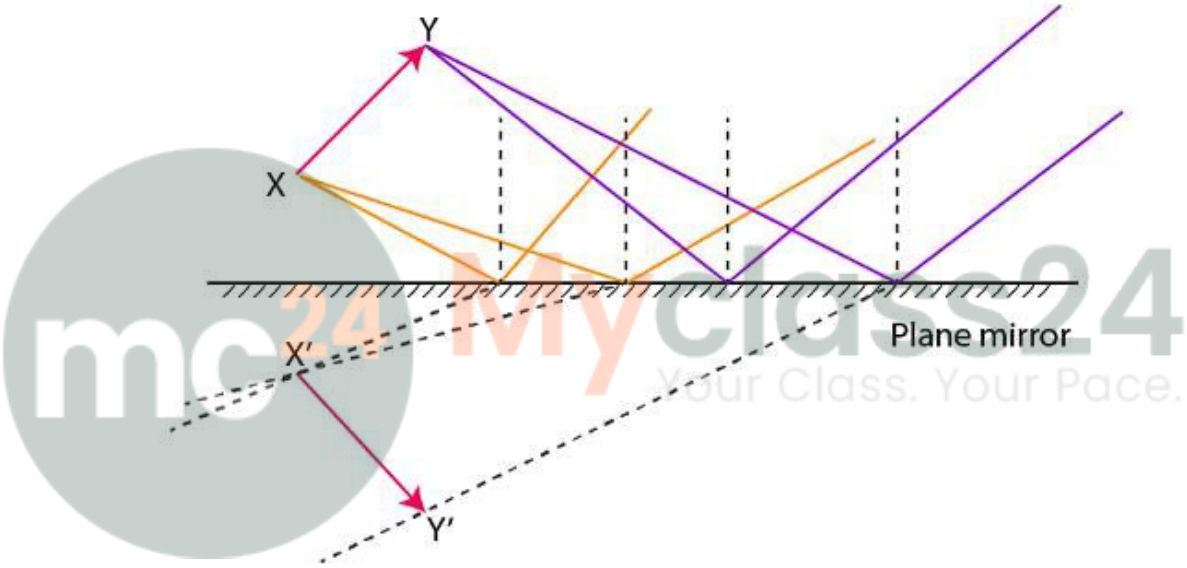

(c) The image formed is virtual because the reflected rays meet only when they are produced backwards.

**12. The diagram below shows an object XY in front of a plane mirror $MM_1$. Draw the diagram, path of two rays from each point X and Y of the object to show the formation of its image.**




Solution:

The required diagram is as shown below:




**13. (a) Write three characteristics of image formed by a plane mirror?**
**(b) How is the position of the image related to the position of the object?**

Solution:

(a) The three characteristics of image formed by a plane mirror:

- Images formed are upright or erect
- Images formed are virtual
- Images formed are of the same size as the object

(b) Both the positions are related such that the image is positioned at the same perpendicular distance behind the mirror as the object in front of it.

**14. Differentiate between a real and a virtual image.**

Solution:

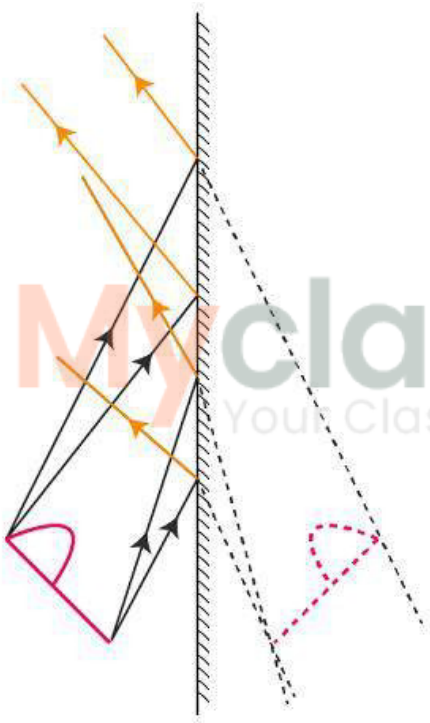
The differences between a real and a virtual image are as follows:

| Real image | Virtual image |
|---|---|
| It is formed due to actual intersection of the reflected rays | It is formed when the reflected rays meet if they are produced backwards |
| It can be obtained on a screen | It cannot be obtained on a screen |
| It is inverted with respect to the object | The image is upright with respect to the object |
| Example- the image formed of a distant object by a concave mirror | Example – the image formed of an object by a plane mirror or by a convex mirror |

**15. What is meant by a lateral inversion of an image in a plane mirror? Explain it with the help of a ray diagram.**

Solution:

Lateral inversion is the interchange of the left and right sides in the image of an object in a plane mirror.



The above diagram indicates the image formation of a letter P in a plane mirror, where the letter appears laterally inversed.

**16. The letters on the front of an ambulance are written laterally inverted like ƎƆИAꓶUꓶAMƎ. Give reason.**

Solution:

It is written inverted because AMBULANCE, if seen through rear mirror in vehicles that are ahead of the driver, appears as AMBULANCE without any inversion, allowing the ambulance to pass.

**17. Why is it difficult to read the image of the text of a page formed due to reflection by a plane mirror?**

Solution:

It is difficult to read the image of the text of a page formed due to reflection by a plane mirror due to lateral inversion.

**Multiple Choice Type:**

1. **According to the law of reflection :**
   **(a) i/r = Constant**
   **(b) sin i/sin r = Constant**
   **(c) i + r = Constant**
   **(d) i = r**
   Solution:
   (d) i=r
   The first law of reflection states that angle of incidence is equal to the angel of reflection

2. **The image formed by a plane mirror is :**
   **(a) Erect and diminished**
   **(b) Erect and enlarged**
   **(c) Inverted and of same size**
   **(d) Erect and of same size**
   Solution:
   (d) Erect and of same size
   Images formed by a plane mirror are erect and laterally inverted.

3. **The image formed by a plane mirror is :**
   **(a) Real**
   **(b) Virtual**
   **(c) Virtual with lateral inversion**
   **(d) Real with lateral inversion**
   Solution:
   (c) Virtual with lateral inversion
   Images formed by a plane mirror are erect, virtual and laterally inversed.

**Numericals:**

1. **A ray is incident on a plane mirror. Its reflected ray is perpendicular to the incident ray. Find the angle of incidence.**
   Solution:
   Given: reflected ray is perpendicular to incident ray
   That is to say, $i + r = 90°$
   We know from the law of reflection that i=r (angle of incidence = angle of reflection)
   $i+i=90° \Rightarrow 2i=90°$
   ⇨ $i=r=45°$

2. **A man standing in front of a plane mirror finds his image at a distance 6 metre from himself. What is the distance of a man from the mirror?**
   Solution:

Given:
Distance between the man and his image is 6m
That is to say,
Distance between the man and mirror and the distance between mirror and image =6m
We know that the object distance = image distance
i.e., distance between the man and the mirror = distance between mirror and image
hence, the distance of the man and the mirror = 6/2 = 3m

3. **An insect is sitting in front of a plane mirror at a distance 1 m from it.**
   **(a)Where is the image of the insect formed?**
   **(b) What is the distance between the insect and its image?**
   Solution:
   (a) The image of the insect is formed 1m behind the mirror
   The image is situated on the normal drawn from the object on the mirror and it is as far behind the mirror as the object is in front of it.
   (b) The distance between the insect and its image, 1 +1 = 2m

4. **An object is kept at 60 cm in front of a plane mirror. If the mirror is now moved by 25 cm away from the object, how does the image shift from its previous position?**
   Solution:
   Given:
   Image formed of the object at the beginning is at a distance 60cm
   We know that, the image is situated on the normal drawn from the object on the mirror and it is as far behind the mirror as the object is in front of it.
   Hence the image is formed behind the mirror at a distance of 60cm
   The distance between the image and the object initially is 60 cm+ 60 cm=120cm
   Now, as per the question, if the mirror is moved 25cm away from the object,
   The new distance of the object from the mirror is given by:
   60cm+25cm=85cm,
   ∴ The new distance is now formed 85cm from the mirror behind it
   Hence, the current distance of the image from the object is 85cm + 85cm=170cm

   Let the reference point be the position of the object,

   ∴ the new distance of the image from the object - the distance of the image from the object initially = distance between the two positions of the image
   That is to say,
   170cm – 120cm = 50cm
   Therefore, the image shifts from its previous position 50cm away.

5. **An optician while testing the eyes of a patient keeps a chart of letters 3 m behind the patient and asks him to see the letters on the image of chart formed in a plane mirror kept at distance 2 m in front of him. At what distance is the chart seen by the patient?**
   Solution:
   Given:
   The distance between the man and the mirror = 2m

The distance between the man and the chart = 3m
∴ the distance between the chart and the mirror = distance between the man and the mirror + distance between the man and the chart = 3m + 2m = 5m
The new image formed on the mirror, 2m apart from the man is 5m + 2m = 7m
∴ the chart seen by the patient is 7m away from him