Exploring Laws of Reflection of Light

Duration: 90 minutes

Grade: VII, VIII

1. Objective

Students learn the laws of reflection through simple mirror activities.

2. Learning outcomes

In course of transacting this module, children will be able to**:**

1. Arrive at the laws of reflection through exploration
2. Apply laws of reflection to locate the reflected ray
3. Apply laws of reflection to see objects when not in line of sight

3. Prerequisites

Before execution of this module, students should understand

1. Light ray travels in a straight line (rectilinear propagation of light)
2. To see an object, light from the object must reach the eyes

4. Materials Required

Assumed no.of students = 30

Recommended group size = 4 students per group

S.NO	Material	Specification	Quantity	Cost (INR) (approx.)
1	Mirrors	Pocket size	15	25
2	Laser pointer	Red colour	8	50
3	Protractor		8	5
4	Pencil		8	5
5	Double sided tape	1 roll	1	20
6	Cardboards	15 cm x 15 cm	8	Nil
7	Cardboards	30 cm x 2 cm	24	Nil

6. Pre-Activity Discussion

In the pre-activity discussion, the teacher should elicit hypothesis from students and scaffold their responses to help them test it. Children should note down their responses in the worksheet given in Annexure 2.

The questions listed below are pitched at a broader level. The teacher would need to pose intermediary questions, based on children's responses, to help them arrive at the right answer. Care must be taken to not give away the answers to students. Children's doubts/ responses on light, plane mirror and reflection needs to be captured on the blackboard. This discussion can be used to assess children's prior knowledge on light and vision and correct misconceptions that may emerge during the discussion.

1. How do we see objects around us? (Elicit hypothesis)

To see an object, the object should either emit or reflect light. This light reaches our eyes, sends a message to the brain. Our brain processes the signal and we are able to perceive the object.

2. How are we able to see objects from multiple points? (Elicit hypothesis)

Light is reflected in all directions. Therefore, we are able to see the object from different directions.

3. Can we see objects in the dark? What are the objects we can see in the dark?

We can see objects at night only if the objects emit light. We cannot see objects, which do not emit light on their own.

4. How do we see objects in a mirror?

Mirror reflects the light coming from the objects. When that reflected beam reaches our eye, we are able to see the object.

5. Why does a driver adjust his rear view mirror?

We can see objects only when the reflected rays hit our eyes. By adjusting the mirrors, the driver ensures that his/her eyes are in the path of the rays reflected from the mirror.

7. Activity-1: "Spot the Candle"

7.1 Objective:

This activity will enable children to understand the rectilinear propagation of light. i.e. light travels in a straight line.

7.2 Observables:

1. Position of holes relative to each other
2. Candle flame

7.3 Procedure

1. Provide each group with a candle and three cardboards of 15 cm x 15 cm with a hole at the centre
2. Ask students to light up the candle
3. Ask three students to hold the cardboards on one side of the candle as shown in Figure 1.

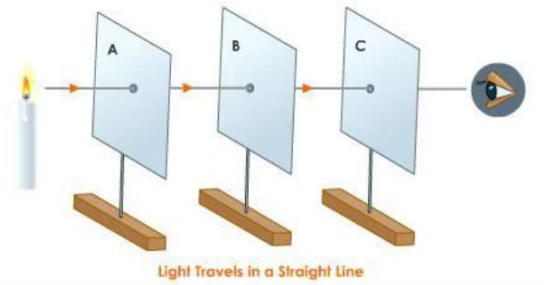


Image source: http://www.just-experimenting.com/light-travels-in-straight-lines.html

Figure 1: Experiment to study that light travels in a straight line

4. Ask the student, holding card C, to look at the candle flame through the hole in his card by coordinating with the other two students to adjust their cards.
5. Once the third student is able to see the candle flame through the hole in his cardboard, ask student holding card B to shift the card.
6. Let students attempt to answer the following questions:
    1. When are you able to see the candle light? Why?
    2. When are you not able to see the candle light? Why?

Student answers may be with respect to the position of holes i.e. when the holes were in one line we were able to see the light from the candle

7. Ask students to move all the cards to a position above the candle flame. Now, ask them to align the holes in a straight line.
8. Engage students in a discussion and enable them to arrive at the conclusion that light travels in a straight line.

8. Activity -2 "Spot the Thumbtack": Understanding the first Law of Reflection (Angle of Incidence = Angle of Reflection)

8.1 Objective

Through this activity, children will find that:

1. Reflection of an object can be seen in a mirror only if the reflected ray reaches the eyes of the observer.
2. When the observer stands at different positions in front of mirror, different reflected rays reach the observer.
3. An incident light ray can be reflected in only one direction such that angle of incidence = angle of reflection

8.2 Observables

1. Image of thumbtack in plane mirror

2. Position of thumbtack

Children stand in front of the mirror and identify the positions at which the image of thumbtack can be seen from the marked observer position, and the positions at which the image of thumbtack cannot be seen from the observer position.

8.3 Procedure

1. Place a pocket size mirror on the desk. Ask the groups to place a thumbtack in front of the mirror on the same line as shown in Fig. 2. Ask students to look at the mirror from the observer position and enquire whether they are able to see the thumbtack in the mirror

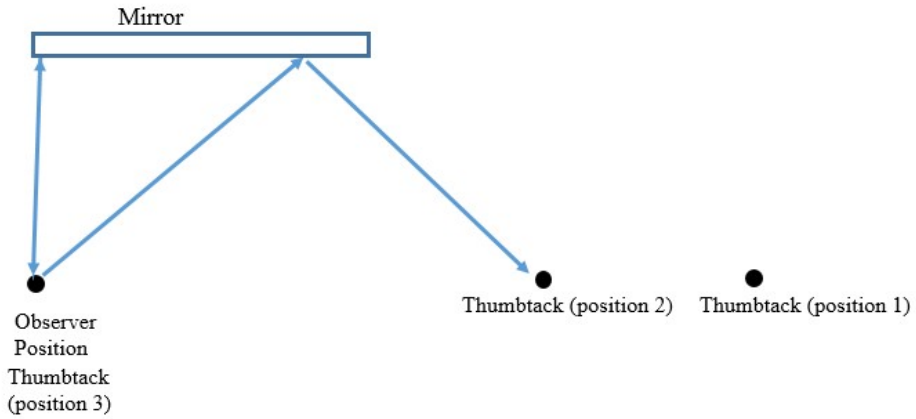


Figure 2 Observe reflection of objects in plane mirrors

2. Now, place the thumbtack at other positions 2 and 3

3. Ask students to trace the path of light.

4. Pose the question: Why was the thumbtack's image not observable at position 1, but can be seen at position 2.

5. Students try to solve the problem - In order to see the image of thumbtack at positions 1 from the observer position, how should light travel.

6. Students observe the pattern of light's path in positions where the image of the thumbtack can be observed and positions where image of thumbtack cannot be observed. Now children may know that light does not travel in certain ways. Ask them to compare two paths (where image is observable and where image is not observable). Elicit a hypothesis to explain their observations.

7. If students struggle to find the difference in patterns, draw normal at all points of incidence and ask them to observe the path of light rays. Instruct them to measure the angles on either side of the normal and arrive at the conclusion. (**Learning Outcome -1**)

8. In addition, the teacher can also shift the observer position so that thumbtack-1 is visible and then trace the path of the light.

9. Introduce the terminologies i) angle of incidence ii) angle of reflection iii) Normal line

9. Activity-3: Catch the Laser beam

9.1 Objective

To understand that the angle of incidence is equal to the angle of reflection through a game of 'catch the laser beam'

9.2 Observables

1. Incident light
2. Reflected light
3. Position of the Laser

These observations help to identify and relate the directions of incident rays and reflected rays

9.3 Procedure

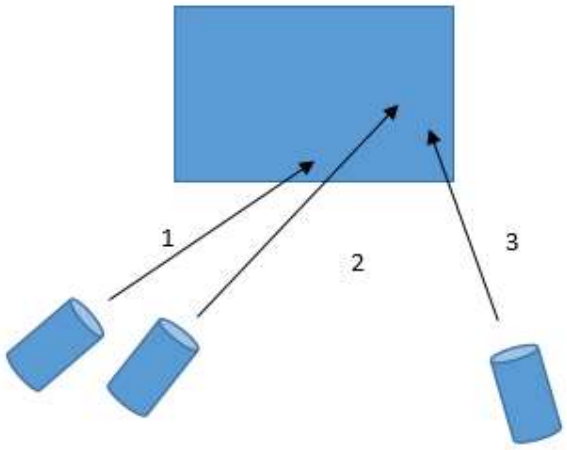


Figure 3 Locate the reflected ray for light rays inclined to different planes

1. Give each group a square piece of paper of 1 square cm. cross sectional area to catch the reflected ray
2. The instructor can start the activity by focussing the laser pointer at different points as shown in Fig. 3. Students have to capture the reflected ray on the 1 square cm paper
3. The following questions needs to be posed at this stage:
    a. Did you know where to hold the paper in order to catch the reflected light?
    b. What is the relationship between where you hold the pointer and where the reflected light goes?
4. Ask children to measure the angle of incidence and angle of reflection in each of the cases and record it. Let children represent the three different planes by placing notebooks in which the incident ray and reflected ray lie together (**Learning Outcome 2**)
5. Use smoke from incense sticks to help children visualise that the incident ray and reflected ray lie on the same plane.

10. Activity-4 "Seeing Around Corners": Position mirrors to see a toy car around the corner

10.1 Objective

To see a toy-car around the corners of a cardboard cut-out using mirrors

10.2 Observables

1. Position of mirror
2. Image of car on mirror-1
3. Image of car on mirror-2

The position of the mirrors affect how the image of a car is obtained on the mirrors.

10.3 Procedure

1. Each group is given two mirrors and a toy car
2. Layout the cardboards on the desk. Place the toy car as shown in Fig. 4.

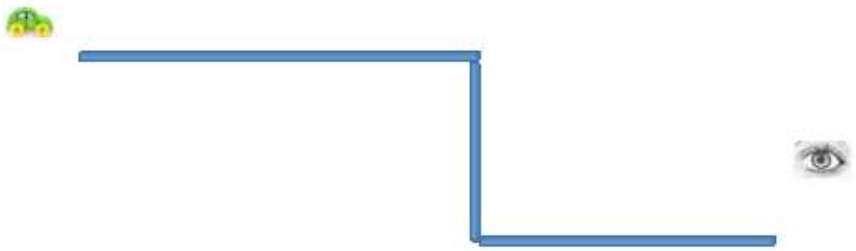
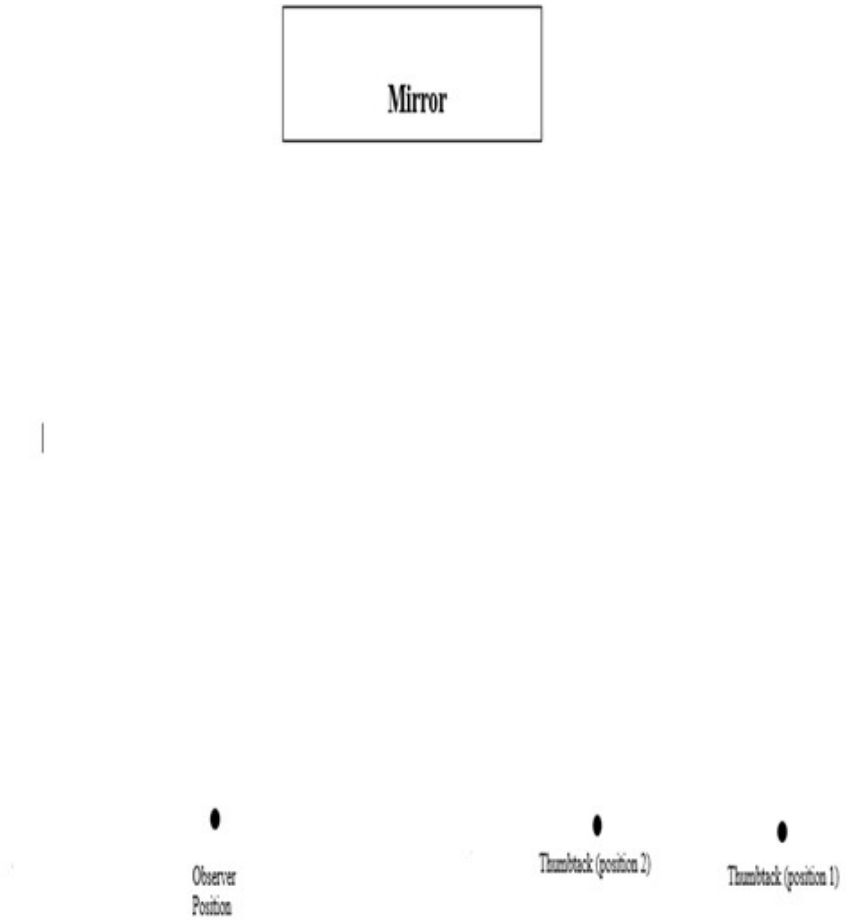


Figure 4: Observing objects when they are not in line of sight (around corners)

3. Ask children to explain how the car can be seen from the observer point using two mirrors
4. Ask children to explain why the car is not visible from the observer position as shown in Fig. 4.
5. Ask about the path light should take to reach the observer's eye.
6. Remind children to apply the laws of reflection. Ask them how the light from thumbtack can reach the observer's eyes using two mirrors
7. Once they are able to place mirrors to obtain the image at the given view point, ask each child to draw the position of mirrors, path of incident and reflected light rays at each mirror, and mark the angle of incidence and reflection at each mirror. [Worksheet - Annexure-2].
8. Discuss the application of this arrangement like in submarines, earthquake rescue teams etc.

Annexure-1: Layout for understanding laws of reflection



Note: Representative layout only. It should be ensured that the image of the thumbtack at position 1 cannot be seen from the observer position.

Annexure-2

Student response sheet: On Light

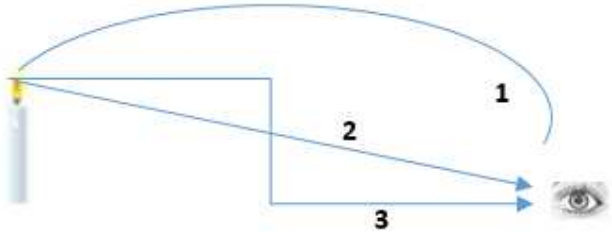
1. You are in the classroom during daytime and the windows are open. How are you able to see objects like chair or bench in the classroom?

a. The light emitted from the object reaches our eyes
b. The light from our eyes hit the object and comes back to our eyes
c. The light in the room hits the object and the reflected light reaches our eyes

2. Why are we not able to see objects in the room when it is dark?

a. Objects do not emit light in the dark
b. There is no light in the room, so object cannot reflect light
c. Eyes do not emit the light in the dark

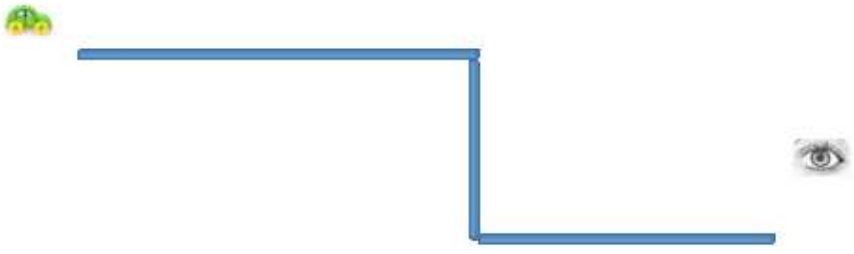
3. How does light travel from candle flame to our eyes?



a. Through path 1
b. Through path 2
c. Through path 3

Worksheet: Guiding the reflected ray using plane mirrors

Draw the two plane mirrors, to see the image of the car at the observer point. Draw the path of light from object to the observer's eyes. Mark and measure the angle of incidence and reflection at both the mirrors.



Observer View Point

Mirror	Angle of Incidence (degree)	Angle of Reflection (degree)
Mirror - 1		
Mirror - 2		

Annexure -3

Rubric for assessing student understanding of laws of reflection of light with reference to activity-3

Criteria	Score
Places the mirrors at 45 degrees to the horizontal and draws the incident and reflected rays at each mirror correctly and marks the angles	5
Places the mirrors at some other angle and draws the incident and reflected rays correctly and marks the angles	4
Places mirrors correctly and draws the incident and reflected ray correctly but does not mark the angles	3
Places one mirror and draws the incident and reflected rays and marks the angles	2
Places one mirror and draws incident rays and reflected rays correctly, but does not mark the angles correctly	1
Does not place mirror and does not draw the path of light	0