Chapter 11: Light: Shadows and Reflections

Exercises — Let Us Enhance Our Learning

Q1 Which of the following are luminous objects? Mars, Moon, Pole Star, Sun, Venus, Mirror

SOLUTION

A luminous object is one that emits its own light.
Mars: a planet — it does not emit its own light; it reflects sunlight. NOT luminous.
Moon: the textbook states 'The Moon is a non-luminous object. It does not emit its own light. It just reflects the light emitted by the Sun that falls on it.' NOT luminous.
Pole Star: a star — stars emit their own light, just as the Sun does. LUMINOUS.
Sun: the textbook states 'The Sun gives out or emits its own light and is the main source of natural light on the Earth.' LUMINOUS.
Venus: a planet — reflects sunlight, does not emit its own light. NOT luminous.
Mirror: reflects light; does not emit its own light. NOT luminous.

Answer: Luminous objects: Pole Star and Sun. (Mars, Moon, Venus, and Mirror are non-luminous — they only reflect light.)

Q2 Match the items in Column A with those in Column B.
Column A: Pinhole camera, Opaque object, Transparent object, Shadow
Column B: Blocks light completely, The dark region formed behind the object, Forms an inverted image, Light passes almost completely through it

SOLUTION

Pinhole camera — Forms an inverted image. (The textbook states: 'A pinhole camera creates an inverted image of an object on a screen.')
Opaque object — Blocks light completely. (The textbook states: 'Light does not pass through opaque materials.')
Transparent object — Light passes almost completely through it. (The textbook states: 'Light passes almost completely through transparent materials.')
Shadow — The dark region formed behind the object. (The textbook states: 'The dark patch, where light does not reach, is the shadow.')

Answer: Pinhole camera → Forms an inverted image; Opaque object → Blocks light completely; Transparent object → Light passes almost completely through it; Shadow → The dark region formed behind the object.

Q3 Sahil, Rekha, Patrick, and Qasima are trying to observe the candle flame through the pipe as shown in Fig. 11.16. Who can see the flame?

SOLUTION

Principle from the textbook: Light travels in a straight line. A candle flame can be seen through a pipe only if the pipe forms one continuous straight line from the eye to the flame; light cannot travel around a bend.

In Fig. 11.16 the candle is on the right and connects through a horizontal pipe to the central crossing where all the pipes meet. Rekha (on the left) has a horizontal pipe that lies at the same level as the candle's pipe, so her pipe and the candle's pipe together form ONE continuous straight horizontal line through the crossing.

Sahil's pipe reaches the crossing from the upper-left (a steep diagonal), Patrick's from the lower-left (a diagonal), and Qasima's from below (near vertical). None of these is collinear with the candle's horizontal pipe — each has a bend at the crossing, so light from the flame cannot reach those eyes.

Therefore only Rekha, whose pipe is straight and aligned with the candle, can see the flame.

Answer: Only Rekha can see the flame. Her horizontal pipe is collinear (one straight line) with the candle's horizontal pipe, while Sahil's, Patrick's, and Qasima's pipes each bend at the central crossing, so light from the flame cannot reach their eyes.

Q4 Look at the images shown in Fig. 11.17 and select the correct image showing the shadow formation of the boy.

SOLUTION

Rules for judging each picture in Fig. 11.17: (1) the shadow must fall on the side OPPOSITE the Sun — it is cast away from the light; (2) the Sun, the boy's head, and the tip of his shadow must lie on one straight line (light travels straight); (3) the length of the shadow must match how high the Sun is — a low Sun gives a long, slanted shadow, a nearly overhead Sun gives a short shadow.

Option (a): The Sun is high, almost overhead (only slightly to the right), yet the shadow is drawn long. A near-overhead Sun should give a SHORT shadow —

the shadow length does not match the Sun's height. Incorrect.

Option (b): The Sun is at the top-LEFT, but the shadow is a small patch almost directly below the boy instead of a long shadow slanting to the RIGHT (away from a left-side Sun). The shadow is on the wrong side / wrong length. Incorrect.

Option (d): The Sun is clearly to the RIGHT, but the shadow falls almost straight DOWN rather than slanting to the LEFT (away from the Sun). The shadow direction does not line up with the Sun. Incorrect.

Option (c): The Sun is to the right and not overhead, and the shadow is long and slants to the boy's LEFT (opposite the Sun). The Sun, the boy's head, and the shadow tip are collinear, and the long slanted shadow matches the Sun's lower position. All three rules are satisfied.

Therefore option (c) correctly shows the shadow formation.

Answer: Option (c) is correct. The Sun is on the right and the boy's shadow is cast long and slanting to the opposite (left) side; the Sun, the boy's head and the shadow tip lie on one straight line, and the shadow length matches the Sun's lower position. In (a) the shadow is too long for a near-overhead Sun, in (b) it is on the wrong side for a left-side Sun, and in (d) it drops straight down instead of slanting away from the right-side Sun.

Q5 The shadow of a ball is formed on a wall by placing the ball in front of a fixed torch as shown in Fig. 11.18. In scenario (i) the ball is closer to the torch, while in scenario (ii) the ball is closer to the wall. Choose the most accurate representation of the shadows formed in both scenarios from the options provided (a and b).

SOLUTION

Principle: light rays spread out (diverge) from the torch, so where the ball sits between the torch and the wall decides the shadow size.

Scenario (i) — ball closer to the torch: the ball sits in the narrow part of the diverging beam and blocks a wide cone of rays that then spread out further before reaching the far wall. This casts a LARGE shadow on the wall.

Scenario (ii) — ball closer to the wall: the ball is far from the torch and near the screen, so its shadow is only a little larger than the ball itself. This casts a SMALL shadow on the wall.

Matching to the pictured options in Fig. 11.18: option (a) shows the SMALLER shadow and option (b) shows the LARGER shadow on the screen.

Therefore scenario (i) (large shadow) corresponds to option (b), and scenario (ii)

(small shadow) corresponds to option (a).

Answer: Scenario (i) — ball closer to the torch — gives a LARGER shadow, matching option (b). Scenario (ii) — ball closer to the wall — gives a SMALLER shadow, matching option (a). The nearer the ball is to the light source, the bigger its shadow on the wall.

Q6 Based on Fig. 11.18, match the position of the torch in Column A with the characteristics of the ball's shadow in Column B.
Column A: If the torch is close to the ball, If the torch is far away, If the ball is removed from the set-up, If two torches are present in the set-up on the left side of the ball
Column B: The shadow would be smaller, The shadow would be larger, Two shadows would appear on the screen, A bright spot would appear on the screen

SOLUTION

If the torch is close to the ball → The shadow would be larger.
Reason: When the torch (point light source) is very close to the ball, the diverging light rays span a wide angle around the ball. The ball blocks a larger cone of light, casting a larger shadow on the screen.

If the torch is far away → The shadow would be smaller.
Reason: As the torch moves farther away, its light rays become more nearly parallel by the time they reach the ball. The ball blocks a narrower effective cone of light, producing a smaller shadow.

If the ball is removed from the set-up → A bright spot would appear on the screen.
Reason: The ball is the opaque object creating the shadow. With the ball removed, there is no obstruction; light from the torch travels in a straight line directly to the screen, creating a bright lit spot.

If two torches are present on the left side of the ball → Two shadows would appear on the screen.
Reason: Each torch acts as an independent light source. Each casts its own shadow of the ball on the screen (in slightly different positions, since the two torches are at different positions). This results in two shadow regions on the screen.

Answer: Torch close to ball → larger shadow; Torch far away → smaller shadow; Ball removed → bright spot on screen; Two torches → two shadows on screen.

Q7 Suppose you view the tree shown in Fig. 11.19 through a pinhole camera. Sketch the outline of the image of the tree formed in the pinhole camera.

SOLUTION

Principle from the textbook: 'A pinhole camera creates an inverted image of an object on a screen.' The image is upside down.

The tree in Fig. 11.19 has a broad leafy canopy at the TOP narrowing to a thin trunk resting on the ground at the BOTTOM.

How a pinhole inverts it: rays from the top of the tree (the leafy canopy) travel straight through the pinhole and strike the BOTTOM of the screen, while rays from the bottom of the tree (the trunk/ground) strike the TOP of the screen. The image is therefore turned completely upside down (rotated 180°).

To sketch: draw the same tree outline flipped over — the wide leafy canopy now points DOWNWARD at the bottom of the image, and the thin trunk with its patch of ground appears at the TOP.

The image keeps the colours of the object.

Answer: The pinhole-camera image of the tree is inverted (upside down). Sketch the same tree flipped over: the broad leafy canopy now points downward at the bottom and the thin trunk (with its bit of ground) sits at the top — the outline of Fig. 11.19 rotated 180 degrees.

Q8 Write your name on a piece of paper and hold it in front of a plane mirror such that the paper is parallel to the mirror. Sketch the image. What difference do you notice? Explain the reason for the difference.

SOLUTION

Observation: When a name is written on paper and held in front of a plane mirror, the image seen in the mirror appears to have the letters reversed left to right — each letter appears as its mirror image, and the order of letters in the name is also reversed (the last letter appears on the left side of the image, the first letter on the right).

The image appears laterally inverted.

Reason — Lateral Inversion:

The textbook states: 'You find that your left appears right in your image and your right appears left in your image. This type of perceived left-right reversal is called lateral inversion. There is lateral inversion in the images formed by a plane

mirror.'
When light from the left side of the written name reflects off the plane mirror, it appears to come from the right side in the image, and vice versa. This left-right reversal is lateral inversion.

Example: If your name is 'JATIN', the mirror image would show it as 'NITAJ' (letters reversed in order) with each individual letter also appearing as its mirror image.

The image is otherwise the same size as the object (the textbook states: 'The image formed by a plane mirror is of the same size as the object') and is erect (not upside down).

Answer: The image shows the name laterally inverted — left and right are swapped, so the letters appear backwards and in reversed order. This happens because of lateral inversion: in a plane mirror, the left side of an object appears on the right side of the image, and vice versa.

Q9 Measure the length of your shadow at 9 AM, 12 PM, and 4 PM with the help of your friend. Write down your observations: (i) At which of the given times is your shadow the shortest? (ii) Why do you think this happens?

SOLUTION

Expected observation: The shadow is longest at 9 AM and 4 PM, and shortest at 12 PM.

(i) At which time is the shadow shortest?
The shadow is shortest at 12 PM (noon).

(ii) Why does this happen?
The Sun acts as the source of light that creates shadows.
At 9 AM, the Sun is low on the horizon (in the east). Its rays hit you at a shallow angle. Light from a low angle source creates a long shadow, extending far along the ground in the opposite direction.
At 12 PM, the Sun is at its highest point in the sky (nearest to directly overhead). The Sun's rays are most nearly vertical. When the light source is almost directly above, the shadow falls almost directly below you, making it the shortest.
At 4 PM, the Sun is again lower in the sky (in the west). Like at 9 AM, the shallow angle of the Sun's rays makes your shadow long, now extending to the east.

This is consistent with the textbook principle: 'The shape, size, and sharpness of

the shadow depend on the position of the object relative to the light source and the screen.' Here, the 'position of the light source' changes as the Sun moves across the sky during the day.

Answer: (i) The shadow is shortest at 12 PM. (ii) At noon the Sun is at its highest point in the sky, so its rays are most nearly vertical, casting the shortest shadow directly below. At 9 AM and 4 PM the Sun is low, its rays are at a shallow angle, producing long shadows.

Q10 On the basis of following statements, choose the correct option.
Statement A: Image formed by a plane mirror is laterally inverted.
Statement B: Images of alphabets T and O appear identical to themselves in a plane mirror.
(i) Both statements are true
(ii) Both statements are false
(iii) Statement A is true, but statement B is false
(iv) Statement A is false, but statement B is true

SOLUTION

Evaluating Statement A: 'Image formed by a plane mirror is laterally inverted.'
The textbook explicitly states: 'There is lateral inversion in the images formed by a plane mirror.' Statement A is TRUE.

Evaluating Statement B: 'Images of alphabets T and O appear identical to themselves in a plane mirror.'
Lateral inversion means left and right are swapped. For a letter to look identical to itself after lateral inversion, it must be symmetric about a vertical axis (a vertical line through its centre).
Letter T: Draw the letter T — the horizontal bar is at the top, the vertical bar is in the centre. If you reflect T about a vertical axis, the result is still T (the horizontal bar remains on top, the centred vertical bar stays centred). T has vertical-axis symmetry. So the mirror image of T looks the same as T. Statement B holds for T.
Letter O: The letter O (circle or oval shape) is symmetric about both vertical and horizontal axes. Reflecting it about a vertical axis gives the same O. Statement B holds for O.
Both T and O are symmetric about a vertical axis, so their plane mirror images appear identical to the originals. Statement B is TRUE.

Since both Statement A and Statement B are true, the answer is option (i).

Answer: (i) Both statements are true. Statement A is true — plane mirror images are laterally inverted. Statement B is also true — T and O are both symmetric about a vertical axis, so lateral inversion leaves their appearance unchanged.

Q11 Suppose you are given a tube of the shape shown in Fig. 11.20 and two plane mirrors smaller than the diameter of the tube. Can this tube be used to make a periscope? If yes, mark where you will fix the plane mirrors.

SOLUTION

Periscope principle from the textbook: 'We can make a simple periscope by placing two plane mirrors in a Z-shaped box... Reflection from two mirrors enables us to see objects that are not visible directly.'

The tube in Fig. 11.20 is a Z-/step-shaped tube: it has an opening at the top, turns at the top corner, runs down the side, turns again at the bottom corner, and has a second opening at the bottom. It has TWO bends with the two openings offset from each other — exactly the shape a periscope needs.

So YES, this tube can be used to make a periscope.

Fix one plane mirror inside EACH of the two bends (corners) of the tube, each tilted at 45° to the tube walls, with the two mirror faces parallel to each other and facing into the tube. Light entering the top opening strikes the top mirror, is reflected down the tube to the bottom mirror, and is reflected again out of the bottom opening to the eye — letting you see the object at the top even though you look in at the bottom.

Answer: Yes. The tube is Z-shaped with two bends, so it can be made into a periscope. Fix one plane mirror at each bend, each at 45° to the tube walls and parallel to the other, facing into the tube: light entering the top opening reflects off the first mirror, travels down to the second mirror, and reflects out of the bottom opening to the eye.

Q12 We do not see the shadow on the ground of a bird flying high in the sky. However, the shadow is seen on the ground when the bird swoops near the ground. Think and explain why it is so.

SOLUTION

This question is based on the textbook principle: 'Shadows are formed when an object blocks light from falling on a screen' and requires a light source, an opaque object, and a screen.
The bird is an opaque object, the Sun is the light source, and the ground is the screen.

When the bird is flying high in the sky:
The bird does block some sunlight, but the shadow it casts is spread over a very large area of the ground. Light from the Sun reaches the ground from slightly different angles around the small obstacle of the bird high above. This causes the shadow to be extremely spread out and very faint — too faint to be visible.
Additionally, the higher the bird is above the ground, the larger the angle over which light can diffract around the bird's edges, further blurring and diminishing the shadow.
In effect, the bird is so far from the screen (ground) that the shadow becomes very large, very faint, and indistinct — not visible to the eye.

When the bird swoops near the ground:
Now the bird is very close to the screen (ground). It blocks sunlight over a small, well-defined area of ground. The shadow is compact, dark, and sharp — clearly visible.

This is consistent with the textbook statement: 'The shape, size, and sharpness of the shadow depend on the position of the object relative to the light source and the screen.' When the bird is far from the screen, the shadow is large, faint, and diffuse. When it is close, the shadow is small, sharp, and visible.

Answer: When the bird flies high, it is far from the ground (screen), so its shadow is spread over a very large area and becomes too faint and diffuse to see. When it swoops near the ground, it is close to the screen, so the shadow is small, sharp, and clearly visible. The size and sharpness of a shadow depend on the object's distance from the screen.