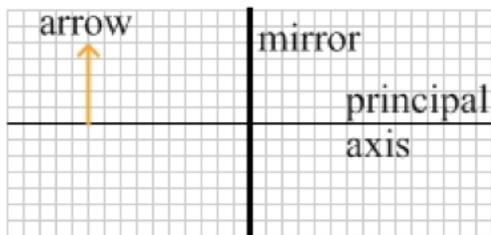


23-1 Reflection

Important Ideas

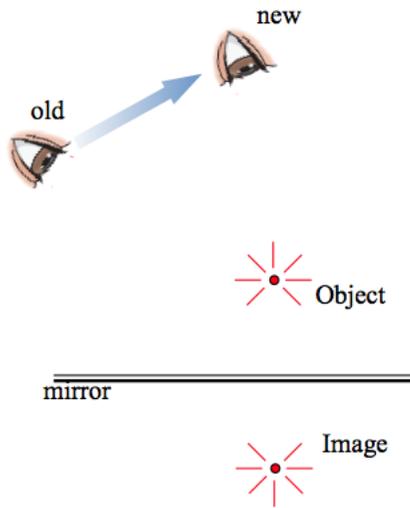
- In the ray model, light is made of rays that travel in straight lines until they encounter an interface between two different materials. Rays are perpendicular to wave fronts (a surface connecting points along the waves that were emitted by the light source at the same time). For a point source, the wave fronts are spheres, and the rays are radial and diverge. For a plane wave (like light emitted by a laser), the wave fronts are parallel lines and the rays are perpendicular to these lines (and parallel to each other). A distributed source is a an object that is made up of many (perhaps infinite) point sources.
- A shadow is caused by an object that blocks light rays. Tracing light rays from the object shows which rays are blocked and thus what the shade looks like.
- When light reflects from an object, then the object can be treated as if it's a source even though it does not produce the light.
- According to the law of reflection, the angle of incidence is equal to the angle of reflection. These angles are generally measured from the normal (i.e. perpendicular) to the surface.
- For a perfect plane mirror, parallel light rays incident on a mirror will reflect and remain parallel to each other. This is called specular reflection. For a surface that is not perfectly smooth, then light reflects in all directions due to the bumps on the surface. This is called diffuse reflection and is sometimes called scattering.
- To find the location of an image in a mirror:
 1. Pick a point on the object, such as the tip of an arrow that represents the object. Sketch two rays of light, which travel in different directions, that leave the tip of the arrow and reflect off the mirror. Trace the rays after they reflect from the mirror.
 2. The reflected rays diverge as they travel away from the mirror. Extend the reflected rays back through the mirror to find a point where they intersect. All incident rays from the tip of the object will reflect from the mirror such that if you extend the reflected rays back through the mirror, they intersect at the same point.
 3. The point where the reflected rays appear to emanate is where the tip of the image is located. Sketch the image of the object (i.e. arrow).
 4. Select another point on the object, sketch two rays coming from this point, trace the reflected rays, and extend the reflected rays backward until they intersect. This is where the image of this point is located.



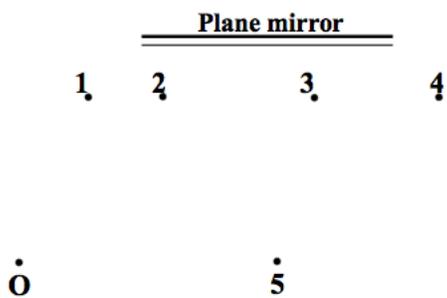
- For a plane mirror, the image is behind the surface of the mirror, along a line perpendicular to the mirror, at the same perpendicular distance from the mirror as the object.
- Because the image is behind the mirror and is formed by reflected rays that are *diverging*, then the image is called a *virtual* image.

Examples

1. If the observing eye is moved to the new position shown, the image it sees will appear _____.

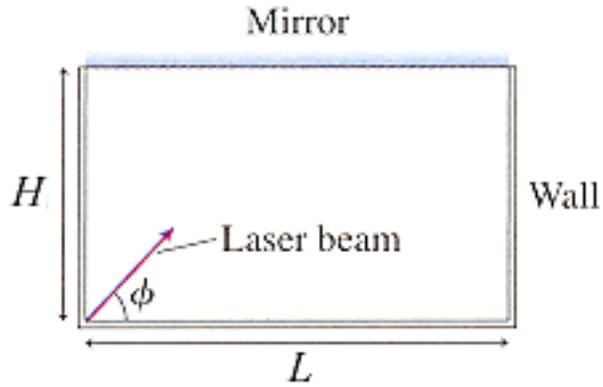


- (a) further from the mirror surface
 (b) further to the left
 (c) further to the right
 (d) in the same place as before
2. For which of the point objects 1, 2, 3, 4, and 5 can an observer at O see an image in the plane mirror?

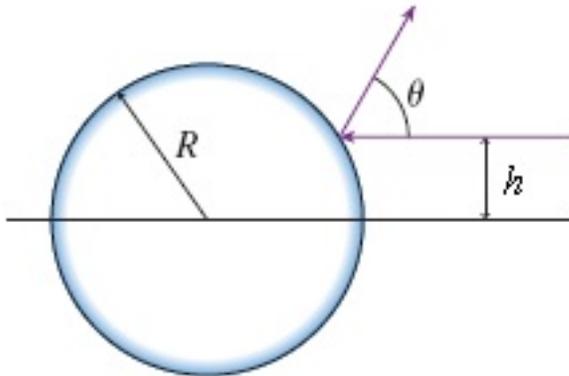


- (a) 2 and 3
 (b) 2, 3, and 5
 (c) 2, 3, 4, and 5
 (d) 1, 2, 3, 4, 5

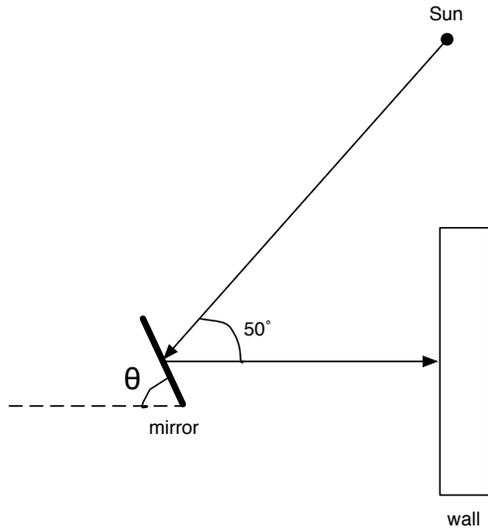
3. Consider the laser beam in The figure below, in which $L = 4$ m and $H = 3$ m. At what angle ϕ should the beam be aimed at the mirrored ceiling in order to hit the midpoint of the far wall?



4. The figure shows a light ray incident on a polished metal cylinder where $h = R/5$. At what angle θ will the ray be reflected?



5. You hold a small mirror such that sunlight reflects from the mirror and makes a spot on the wall that is at the same height as the mirror. One ray from the Sun that reflects from the mirror is shown below.



If the Sun is 50° above the horizontal, what is the angle θ for the tilt of the mirror with respect to the horizontal?

6. The Sun is a distant source. If I sketch other rays (in the previous question) coming from the Sun and reflecting from the mirror, I should draw the rays
- (a) parallel to the ray shown.
 - (b) diverging with respect to the ray shown.
 - (c) converging with respect to the ray shown.