

Reviewing Content

1. b 2. c 3. b
4. b 5. b 6. b
7. c 8. a 9. a
10. a

Understanding Concepts

11. The angle of reflection
12. The image formed by a plane mirror is virtual, upright, and is located the same distance behind the mirror as the object is in front of the mirror.
13. Convex mirrors always cause light rays to diverge, therefore they can form only virtual images.
14. Light bends when it enters a new medium (with a different index of refraction) at an angle.
15. The greater the index of refraction, the slower the speed of light in the medium.
16. Concave lenses always cause light rays to diverge, therefore they are not able to form real images.
17. Total internal reflection
18. The concave lens produces a reduced, virtual image in front of the lens, not a reduced, real image in back of the lens. The rays should diverge as they exit the lens.
19. The diaphragm and the shutter
20. Ciliary muscles inside the eye change the shape of the flexible lens.
21. Rods are more sensitive to low-intensity light, thus they are more effective at seeing objects at night.
22. Each lens adjusts the path of the incoming light rays before they enter the eye, thus compensating for the vision problems caused by the curvature of the cornea, curvature of the lens, or the length of the eyeball.

Critical Thinking

23. A concave mirror
24. No; Student-designed experiments should somehow allow for the determination of the position of a submerged object based upon its apparent position when viewed above the water. This position should then be compared with the actual position of the submerged object.
25. Placing light-sensitive film at the image plane of the pinhole viewer would convert it into a camera.
26. Refracting telescopes use only lenses to form an image, whereas reflecting telescopes use both mirrors and lenses.
27. Student diagrams should show a ray striking the water at a very low angle and being reflected, a ray striking the water at a larger angle and bending toward the normal as it is refracted, and a ray striking the water at a right angle and not being reflected or refracted.
28. The ray bends toward the normal as it is refracted when it enters the water. The ray reflects off of the mirror such that the angle of incidence equals the angle of reflection. The ray then bends away from the normal as it is refracted when exiting the water.
29. Most telescopes produce inverted images.

Concepts in Action

30. Billiard balls often behave the same as light rays that are reflected from flat surfaces, that is, their angle of incidence equals their angle of reflection. Knowing this allows you to plan how a struck billiard ball will travel after it bounces off of a bumper.
31. A convex lens
32. Virtual image; applications will vary but may include use as a magnifying lens.
33. The examples used in student paragraphs will vary but should include the following classifications.
 - Plane mirror: virtual image; same size image
 - Convex mirror: virtual image; reduced size image
 - Concave mirror: virtual or real; reduced, equal, or enlarged size images