

AP B Webreview ch 22 Reflection and Refraction**Multiple Choice**

Identify the choice that best completes the statement or answers the question.

- _____ 1. Photon A has an energy of 2.0×10^{-19} J. Photon B has 4 times the frequency of Photon A. What is the energy of Photon B?
- 0.50×10^{-19} J
 - 1.0×10^{-19} J
 - 8.0×10^{-19} J
 - 32×10^{-19} J
 - 58×10^{-19} J
- _____ 2. The wave-particle duality of light means that, in the same experiment:
- light will act both like a wave and like a particle.
 - light will act either like a wave or like a particle.
 - light will not act like either a wave or a particle.
 - light always exists as two waves or as two particles.
 - light always exists as two particles and two waves moving in opposite directions.
- _____ 3. What is the energy of a photon of frequency 5.00×10^{14} Hz? ($h = 6.626 \times 10^{-34}$ J·s)
- 3.31×10^{-19} J
 - 3.31×10^{-47} J
 - 1.33×10^{-48} J
 - 1.33×10^{-24} J
 - 1.33×10^{-12} J
- _____ 4. One phenomenon that demonstrates the particle nature of light is:
- the photoelectric effect.
 - diffraction effects.
 - interference effects.
 - the prediction by Maxwell's electromagnetic theory.
 - polarization effects
- _____ 5. One phenomenon that demonstrates the wave nature of light is:
- the photoelectric effect.
 - quantization effects.
 - absorption of light by an electron.
 - interference effects.
 - diffraction of electrons.
- _____ 6. Helium-neon laser light has a wavelength in air of 632.8 nm. What is the energy of a single photon in the beam? ($h = 6.626 \times 10^{-34}$ J·s and $c = 3.00 \times 10^8$ m/s).
- 3.14×10^{-19} J
 - 5.40×10^{-19} J
 - 7.62×10^{-19} J
 - 1.15×10^{-18} J
 - 2.53×10^{-17} J

- _____ 7. Newton's theory of light treated light as _____ while Young demonstrated that light behaved as _____ with _____ behavior.
- particles, waves, refractive
 - particles, waves, interference
 - waves, particles, interference
 - waves, particles, refractive
- _____ 8. The photoelectric effect was discovered by:
- Maxwell.
 - Einstein.
 - Hertz.
 - Planck.
 - Millikan.
- _____ 9. Who formulated the theory explaining the photoelectric effect?
- Hertz
 - Maxwell
 - Newton
 - Einstein
 - Fresnel
- _____ 10. As the angle of incidence is increased for a ray incident on a reflecting surface, the angle between the incident and reflected rays ultimately approaches what value?
- zero
 - 45°
 - 90°
 - 180°
 - 135°
- _____ 11. Light from a 560-nm monochromatic source is incident upon the surface of fused quartz ($n = 1.56$) at an angle of 60° . What is the angle of reflection from the surface?
- 15°
 - 34°
 - 60°
 - 75°
 - 81°
- _____ 12. When light of one wavelength from air hits a smooth piece of glass at an angle, which of the following will not occur?
- reflection
 - refraction
 - dispersion
 - diffraction
 - All of the above will occur.
- _____ 13. Dez pours carbon tetrachloride ($n = 1.46$) into a container made of crown glass ($n = 1.52$). The light ray in glass incident on the glass-to-liquid boundary makes an angle of 30° with the normal. Find the angle of the corresponding refracted ray.
- 55.5°
 - 29.4°
 - 31.4°
 - 19.2°
 - 13.0°

- _____ 14. A beam of light in air is incident at an angle of 30° to the surface of a rectangular block of clear plastic ($n = 1.46$). The light beam first passes through the block and re-emerges from the opposite side into air at what angle to the normal to that surface?
- 42°
 - 23°
 - 30°
 - 59°
 - 75°
- _____ 15. Monochromatic light hits a piece of glass. What happens to the wavelength in the glass as the index of refraction increases?
- decreases
 - increases
 - remains constant
 - approaches 3×10^8 m
 - approaches 0 m
- _____ 16. If the wavelength of a monochromatic source is 490 nm in vacuum, what is the wavelength from the same source when it passes through a liquid where the speed of light is 2.40×10^8 m/s? ($c = 3.00 \times 10^8$ m/s)
- 671 nm
 - 612.5 nm
 - 490 nm
 - 392 nm
 - 258 nm
- _____ 17. What is the angle of incidence on an air-to-glass boundary if the angle of refraction in the glass ($n = 1.52$) is 25° ?
- 16°
 - 25°
 - 40°
 - 43°
 - 57°
- _____ 18. A monochromatic light source emits a wavelength of 490 nm in air. When passing through a liquid, the wavelength reduces to 429 nm. What is the liquid's index of refraction?
- 1.26
 - 1.49
 - 1.14
 - 1.33
 - 1.80
- _____ 19. Fused quartz has an index of refraction of 1.56 for light from a 560-nm source. What is the speed of light for this wavelength within the quartz? ($c = 3.00 \times 10^8$ m/s)
- 1.56×10^8 m/s
 - 1.92×10^8 m/s
 - 2.19×10^8 m/s
 - 2.88×10^8 m/s
 - 4.68×10^8 m/s

- _____ 20. If light from a 560-nm monochromatic source in air is incident upon the surface of fused quartz ($n = 1.56$) at an angle of 60° , what is the wavelength of the ray refracted within the quartz?
- 192 nm
 - 359 nm
 - 560 nm
 - 874 nm
 - 960 nm
- _____ 21. A ray of light travels from a glass-to-liquid interface at an angle of 35.0° . Indices of refraction for the glass and liquid are, respectively, 1.52 and 1.63. What is the angle of refraction for the ray moving through the liquid?
- 23.2°
 - 32.3°
 - 38.4°
 - 46.0°
 - 53.0°
- _____ 22. A ray of light is incident on a liquid-to-glass interface at an angle of 35° . Indices of refraction for the liquid and glass are, respectively, 1.63 and 1.52. What is the angle of refraction for the ray moving through the glass?
- 23°
 - 30°
 - 38°
 - 46°
 - 54°
- _____ 23. A fish is 1.2 m beneath the surface of a still pond of water. At what maximum angle can the fish look toward the surface (measured with respect to the normal to the surface) in order to see a fisherman sitting on a distant bank? (for water, $n = 1.333$)
- 18.6°
 - 37.2°
 - 48.6°
 - 54.6°
 - The fish will not see the fisherman at any angle.
- _____ 24. A light ray passes from air through a thin plastic slab ($n = 1.3$) with parallel sides. If the ray in air makes an angle of 45° with the normal after leaving the slab, what is the angle of incidence for the ray in air as it impinges upon the other side of the slab?
- 33°
 - 45°
 - 67°
 - 58.5°
 - 71.5°
- _____ 25. A ray of light is incident on the mid-point of a glass prism surface at an angle of 20° with the normal. For the glass, $n = 1.60$, and the prism apex angle is 35° . What is the angle of incidence at the glass-to-air surface on the side opposite where the ray exits the prism?
- 38.0°
 - 35.1°
 - 22.7°
 - 12.3°
 - 10.8°

- _____ 26. A ray of light is incident on the mid-point of a glass prism surface at an angle of 25.0° with the normal. For the glass, $n = 1.55$, and the prism apex angle is 30.0° . What is the angle of refraction as the ray enters the air on the far side of the prism?
- 14.1°
 - 22.3°
 - 28.4°
 - 46.0°
 - 55.2°
- _____ 27. An oil film floats on a water surface. The indices of refraction for water and oil, respectively, are 1.333 and 1.466. If a ray of light is incident on the air-to-oil surface at an angle of 37.0° with the normal, what is the incident angle at the oil-to-water surface?
- 18.1°
 - 24.2°
 - 27.3°
 - 37.0°
 - 43.0°
- _____ 28. An oil film floats on a water surface. The indices of refraction for water and oil, respectively, are 1.333 and 1.466. If a ray of light is incident on the air-to-oil surface at an angle of 37.0° with the normal, what is the angle of the refracted ray in the water?
- 18.1°
 - 24.2°
 - 26.8°
 - 37.0°
- _____ 29. When light from air hits a smooth piece of glass ($n = 1.5$) with the ray perpendicular to the glass surface, which of the following will occur?
- reflection and transmission with $\theta_2 = 0^\circ$
 - refraction with $\theta_2 = 41.8^\circ$
 - interference
 - dispersion
 - All of the above will occur.
- _____ 30. When light from air hits a smooth piece of glass with the ray perpendicular to the glass surface, the part of the light passing into the glass:
- will not change its speed.
 - will not change its frequency.
 - will not change its wavelength.
 - will not change its intensity.
 - will not change its wave number.
- _____ 31. Light in air enters a diamond ($n = 2.42$) at an angle of incidence of 48.0° . What is the angle of refraction inside the diamond?
- 17.9°
 - 19.8°
 - 24.7°
 - 45.6°
 - 67.5°

Name: _____

ID: A

- _____ 32. An underwater scuba diver sees the sun at an apparent angle of 30.0° from the vertical. How far is the sun above the horizon? ($n_{\text{water}} = 1.333$)
- a. 22.0°
 - b. 41.8°
 - c. 48.2°
 - d. 68.0°
 - e. 77.1°

**AP B Webreview ch 22 Reflection and Refraction
Answer Section**

MULTIPLE CHOICE

1. C
2. B
3. A
4. A
5. D
6. A
7. B
8. C
9. D
10. D
11. C
12. C
13. C
14. C
15. A
16. D
17. C
18. C
19. B
20. B
21. B
22. C
23. C
24. B
25. C
26. B
27. B
28. C
29. A
30. B
31. A
32. C