

**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  $2.0 \times 10^{-19}$  J. Photon B has 4 times the frequency of Photon A. What is the energy of Photon B?
- $0.50 \times 10^{-19}$  J
  - $1.0 \times 10^{-19}$  J
  - $8.0 \times 10^{-19}$  J
  - $32 \times 10^{-19}$  J
  - $58 \times 10^{-19}$  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  $5.00 \times 10^{14}$  Hz? ( $h = 6.626 \times 10^{-34}$  J·s)
- $3.31 \times 10^{-19}$  J
  - $3.31 \times 10^{-47}$  J
  - $1.33 \times 10^{-48}$  J
  - $1.33 \times 10^{-24}$  J
  - $1.33 \times 10^{-12}$  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).
- $3.14 \times 10^{-19}$  J
  - $5.40 \times 10^{-19}$  J
  - $7.62 \times 10^{-19}$  J
  - $1.15 \times 10^{-18}$  J
  - $2.53 \times 10^{-17}$  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
  - $45^\circ$
  - $90^\circ$
  - $180^\circ$
  - $135^\circ$
- \_\_\_\_\_ 11. Light from a 560-nm monochromatic source is incident upon the surface of fused quartz ( $n = 1.56$ ) at an angle of  $60^\circ$ . What is the angle of reflection from the surface?
- $15^\circ$
  - $34^\circ$
  - $60^\circ$
  - $75^\circ$
  - $81^\circ$
- \_\_\_\_\_ 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  $30^\circ$  with the normal. Find the angle of the corresponding refracted ray.
- $55.5^\circ$
  - $29.4^\circ$
  - $31.4^\circ$
  - $19.2^\circ$
  - $13.0^\circ$

- \_\_\_\_\_ 14. A beam of light in air is incident at an angle of  $30^\circ$  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?
- $42^\circ$
  - $23^\circ$
  - $30^\circ$
  - $59^\circ$
  - $75^\circ$
- \_\_\_\_\_ 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  $3 \times 10^8$  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  $2.40 \times 10^8$  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  $25^\circ$ ?
- $16^\circ$
  - $25^\circ$
  - $40^\circ$
  - $43^\circ$
  - $57^\circ$
- \_\_\_\_\_ 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)
- $1.56 \times 10^8$  m/s
  - $1.92 \times 10^8$  m/s
  - $2.19 \times 10^8$  m/s
  - $2.88 \times 10^8$  m/s
  - $4.68 \times 10^8$  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  $60^\circ$ , 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  $35.0^\circ$ . 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?
- $23.2^\circ$
  - $32.3^\circ$
  - $38.4^\circ$
  - $46.0^\circ$
  - $53.0^\circ$
- \_\_\_\_\_ 22. A ray of light is incident on a liquid-to-glass interface at an angle of  $35^\circ$ . 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?
- $23^\circ$
  - $30^\circ$
  - $38^\circ$
  - $46^\circ$
  - $54^\circ$
- \_\_\_\_\_ 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,  $n = 1.333$ )
- $18.6^\circ$
  - $37.2^\circ$
  - $48.6^\circ$
  - $54.6^\circ$
  - 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  $45^\circ$  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?
- $33^\circ$
  - $45^\circ$
  - $67^\circ$
  - $58.5^\circ$
  - $71.5^\circ$
- \_\_\_\_\_ 25. A ray of light is incident on the mid-point of a glass prism surface at an angle of  $20^\circ$  with the normal. For the glass,  $n = 1.60$ , and the prism apex angle is  $35^\circ$ . What is the angle of incidence at the glass-to-air surface on the side opposite where the ray exits the prism?
- $38.0^\circ$
  - $35.1^\circ$
  - $22.7^\circ$
  - $12.3^\circ$
  - $10.8^\circ$

- \_\_\_\_\_ 26. A ray of light is incident on the mid-point of a glass prism surface at an angle of  $25.0^\circ$  with the normal. For the glass,  $n = 1.55$ , and the prism apex angle is  $30.0^\circ$ . What is the angle of refraction as the ray enters the air on the far side of the prism?
- $14.1^\circ$
  - $22.3^\circ$
  - $28.4^\circ$
  - $46.0^\circ$
  - $55.2^\circ$
- \_\_\_\_\_ 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  $37.0^\circ$  with the normal, what is the incident angle at the oil-to-water surface?
- $18.1^\circ$
  - $24.2^\circ$
  - $27.3^\circ$
  - $37.0^\circ$
  - $43.0^\circ$
- \_\_\_\_\_ 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  $37.0^\circ$  with the normal, what is the angle of the refracted ray in the water?
- $18.1^\circ$
  - $24.2^\circ$
  - $26.8^\circ$
  - $37.0^\circ$
- \_\_\_\_\_ 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  $48.0^\circ$ . What is the angle of refraction inside the diamond?
- $17.9^\circ$
  - $19.8^\circ$
  - $24.7^\circ$
  - $45.6^\circ$
  - $67.5^\circ$

Name: \_\_\_\_\_

ID: A

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

**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