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?
   a. $0.50 \times 10^{-19}$ J
   b. $1.0 \times 10^{-19}$ J
   c. $8.0 \times 10^{-19}$ J
   d. $32 \times 10^{-19}$ J
   e. $58 \times 10^{-19}$ J

2. The wave-particle duality of light means that, in the same experiment:
   a. light will act both like a wave and like a particle.
   b. light will act either like a wave or like a particle.
   c. light will not act like either a wave or a particle.
   d. light always exists as two waves or as two particles.
   e. 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)
   a. $3.31 \times 10^{-19}$ J
   b. $3.31 \times 10^{-47}$ J
   c. $1.33 \times 10^{-48}$ J
   d. $1.33 \times 10^{-24}$ J
   e. $1.33 \times 10^{-12}$ J

4. One phenomenon that demonstrates the particle nature of light is:
   a. the photoelectric effect.
   b. diffraction effects.
   c. interference effects.
   d. the prediction by Maxwell's electromagnetic theory.
   e. polarization effects

5. One phenomenon that demonstrates the wave nature of light is:
   a. the photoelectric effect.
   b. quantization effects.
   c. absorption of light by an electron.
   d. interference effects.
   e. 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).
   a. $3.14 \times 10^{-19}$ J
   b. $5.40 \times 10^{-19}$ J
   c. $7.62 \times 10^{-19}$ J
   d. $1.15 \times 10^{-18}$ J
   e. $2.53 \times 10^{-17}$ J
7. Newton's theory of light treated light as ____ while Young demonstrated that light behaved as ____ with ____ behavior.
   a. particles, waves, refractive
   b. particles, waves, interference
   c. waves, particles, interference
   d. waves, particles, refractive

8. The photoelectric effect was discovered by:
   a. Maxwell.
   b. Einstein.
   c. Hertz.
   d. Planck.
   e. Millikan.

9. Who formulated the theory explaining the photoelectric effect?
   a. Hertz
   b. Maxwell
   c. Newton
   d. Einstein
   e. 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?
    a. zero
    b. 45º
    c. 90º
    d. 180º
    e. 135º

11. Light from a 560-nm monochromatic source is incident upon the surface of fused quartz (n = 1.56) at an angle of 60º. What is the angle of reflection from the surface?
    a. 15º
    b. 34º
    c. 60º
    d. 75º
    e. 81º

12. When light of one wavelength from air hits a smooth piece of glass at an angle, which of the following will not occur?
    a. reflection
    b. refraction
    c. dispersion
    d. diffraction
    e. 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 30º with the normal. Find the angle of the corresponding refracted ray.
    a. 55.5º
    b. 29.4º
    c. 31.4º
    d. 19.2º
    e. 13.0º
14. A beam of light in air is incident at an angle of 30º 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?
   a. 42º
   b. 23º
   c. 30º
   d. 59º
   e. 75º

15. Monochromatic light hits a piece of glass. What happens to the wavelength in the glass as the index of refraction increases?
   a. decreases
   b. increases
   c. remains constant
   d. approaches \(3 \times 10^8\) m
   e. 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)
   a. 671 nm
   b. 612.5 nm
   c. 490 nm
   d. 392 nm
   e. 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 25º?
   a. 16º
   b. 25º
   c. 40º
   d. 43º
   e. 57º

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?
   a. 1.26
   b. 1.49
   c. 1.14
   d. 1.33
   e. 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)
   a. \(1.56 \times 10^8\) m/s
   b. \(1.92 \times 10^8\) m/s
   c. \(2.19 \times 10^8\) m/s
   d. \(2.88 \times 10^8\) m/s
   e. \(4.68 \times 10^8\) 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?
   a. 192 nm
   b. 359 nm
   c. 560 nm
   d. 874 nm
   e. 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?
   a. 23.2°
   b. 32.3°
   c. 38.4°
   d. 46.0°
   e. 53.0°

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?
   a. 23°
   b. 30°
   c. 38°
   d. 46°
   e. 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, $n = 1.333$)
   a. 18.6°
   b. 37.2°
   c. 48.6°
   d. 54.6°
   e. 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?
   a. 33°
   b. 45°
   c. 67°
   d. 58.5°
   e. 71.5°

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?
   a. 38.0°
   b. 35.1°
   c. 22.7°
   d. 12.3°
   e. 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?
   a. 14.1°
   b. 22.3°
   c. 28.4°
   d. 46.0°
   e. 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?
   a. 18.1°
   b. 24.2°
   c. 27.3°
   d. 37.0°
   e. 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?
   a. 18.1°
   b. 24.2°
   c. 26.8°
   d. 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?
   a. reflection and transmission with $\theta_2 = 0°$
   b. refraction with $\theta_2 = 41.8°$
   c. interference
   d. dispersion
   e. 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:
   a. will not change its speed.
   b. will not change its frequency.
   c. will not change its wavelength.
   d. will not change its intensity.
   e. 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?
   a. 17.9°
   b. 19.8°
   c. 24.7°
   d. 45.6°
   e. 67.5°
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°
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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