Name: _____

Please mark your answer ahere and in the scantron.

1. A light ray is incident on the surface of water (n = 1.33) at an angle of 60° relative to the normal to the surface. The angle of the reflected wave is
a. 80°
b. 40°
c. 20°
d. 60° ANS
e. 30°

2. A light ray whose frequency is 6.00×10^{14} Hz in vacuum is incident on water (n = 1.33). The wavelength of the light after it enters the water is (in nm)
a. 798
b. 500
c. 665
d. 376 ANS
e. 266

3. Light is refracted through a diamond. If the angle of incidence is 30°, and the angle of refraction is 12°, what is the index of refraction?
a. 1.3
b. 2.4 ANS
c. 2.6
d. 1.8
e. 0.4

4. A person in a boat sees a fish in the water (n = 1.33), the light rays making an angle of 40° relative to the water's surface. What is the true angle (in degrees) relative to the water's surface of the same rays when beneath the surface?
a. 40
b. 35
c. 50
d. 55 ANS
e. 61

5. A person looks horizontally at the edge of a swimming pool. If its length is 5 m, and the pool is filled to the surface, to what depth (in m) could the observer see? (n for water is 1.33)
a. 3.2
b. 4.4 ANS
c. 2.1
d. 1.0
e. 0.3

6. Light strikes a diamond (n = 2.42) immersed in glycerin (n = 1.473) at an angle of 60° relative to the normal to the surface. What is the angle of refraction?
a. 20°
b. 60°
c. 32° ANS
d. 64°
e. 15°

7. A monochromatic (single frequency, single wavelength) light ray in air (n = 1) enters a glass prism (n = 1.5). In the glass prism
a. both the frequency and the wavelength are the same as in air
b. the frequency is the same, but the wavelength is greater than in air.
c. the frequency is the same, but the wavelength is smaller than in air. ANS
d. the wavelength is the same, but the frequency is greater than in air.
e. the wavelength is the same, but the frequency is smaller than in air.

8. The angle between two plane mirrors that meet at one edge is 45°. The change in direction of a ray that strikes the first mirror at a 60° angle of incidence when that ray reflects from the second mirror is
a. 0°.
b. 45°
c. 90°
d. 150° ANS
e. 270°

9. When light is either reflected or refracted, the quantity that does not change in either process is its
a. direction of travel.
b. dispersion.
c. frequency. ANS
d. speed.
e. wavelength.

10. A clown 2 m tall looks at himself in a full-length mirror (floor-to-ceiling). Where in the mirror must he look to see his feet?
a. 1 m from the floor ANS
b. 50 cm from the floor
c. 25 cm from the floor
d. at the bottom of the mirror
e. 1.5 m from the floor

11. A concave mirror has a focal length of 20 cm. What is the position (in cm) of the resulting image if the image is inverted and four times smaller than the object?
a. 15
b. 25 ANS
c. 50
d. 100
e. –15

12. A convex mirror has a focal length of –20 cm. What is the position of the resulting image (in cm) if the image is upright and four times smaller than the object?
a. –100
b. –25
c. –50
d. –15 ANS
e. –10

13. An object 15 cm high is placed 15 cm in front of a convex mirror with a focal length of –10 cm. What is the image height (in cm)?
a. 2
b. 4
c. 6 ANS
d. 8
e. 30

14. A dentist uses a concave mirror (focal length 2 cm) to examine some teeth. If the distance from the object to the mirror is 1 cm, what is the magnification of the tooth?
a. 6
b. 1
c. 4
d. 2 ANS
e. 1.5

15. Bottles of perfume sometimes have thick glass (n = 1.5) walls which give the impression the volume is larger than it really is. Assume a cylindrical bottle with an inner radius of 1.0 cm and an outer radius of 2.0 cm. What percentage of the apparent volume is the real volume?
a. 95%
b. 60%
c. 80%
d. 64% ANS
e. 75%

16. A fish is 80 cm below the surface of a pond. What is the apparent depth (in cm) when viewed from a position almost directly above the fish? (For water, n = 1.33.)
a. 50
b. 60 ANS
c. 40
d. 70
e. 110

17. A magnifying glass has a convex lens of focal length 15 cm. At what distance from a postage stamp should you hold this lens to get a magnification of +2.0?

ANS: 7.5 cm

18. A contact lens is made of plastic with an index of refraction of 1.50. The lens has an outer radius of curvature of +2.0 cm and an inner radius of curvature of +2.5 cm. What is the focal length of the lens?

ANS: +20 cm

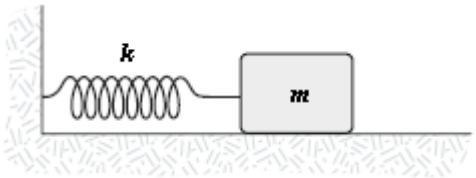
19. An object is placed 25 cm in front of a lens of focal length 20 cm. 60 cm past the first lens is a second lens of focal length 25 cm. How far past the 25 cm lens does the final image form?

a. 20 cm
b. 40 cm
c. 16 cm ANS
d. 25 cm
e. 47 cm

20. A body oscillates with simple harmonic motion along the x axis. Its displacement varies with time according to the equation $x = 5.0 \sin(\pi t + \pi/3)$. The velocity (in m/s) of the body at t = 1.0 s is

a. +7.9
b. –7.9 ANS
c. –14
d. +14
e. –5.0

21. A mass m = 2.0 kg is attached to a spring having a force constant k = 290 N/m as in the figure. The mass is displaced from its equilibrium position and released. Its frequency of oscillation (in Hz) is approximately



a. 12
b. 0.50
c. 0.010
d. 1.9 ANS
e. 0.080

22. The motion of a piston in an auto engine is simple harmonic. If the piston travels back and forth over a distance of 10 cm, and the piston has a mass of 1.5 kg, what is the maximum speed of the piston and the maximum force acting on the piston when the engine is running at 4 200 rpm?

ANS: 22 m/s, 14 500 N