A. Short Answer Questions. (1 point each question except as marked.)

1. As the angle of incidence increases, the angle between the incident and reflected ray:
   a) increases  b) decreases  c) stays the same  (Choose one.)

2. A ray of light in air hits the surface of water at an angle of 30° with respect to the normal. When it passes into the water it
   a) bends toward the perpendicular  b) bends away from the perpendicular  c) does not bend at all  (Choose one.)

3. A ray of light in air hits the surface of water head-on. When it passes into the water it
   a) bends toward the perpendicular  b) bends away from the perpendicular  c) does not bend at all  (Choose one.)

4. When looking at a fish in water, it appears ? the surface than it actually is. Choose from:
   a) farther away from;  b) closer to;  c) the same distance from.

5. An example of a direct source of light is ? while an example of an indirect source of light is ?.

6. A light ray strikes glass making an angle of 70 degrees with respect to the normal and 20 degrees with respect to the surface. The angle of incidence of the light ray is ?.

7. REVIEW QUESTION: A person weighing 160 lb here on earth goes to planet Y having a radius six times that of the earth and a mass twelve times as large as the earth. The person will weigh ? on planet Y
   \[ F_Y = \left( \frac{L}{R} \right)^2 \left( \frac{M}{M_e} \right) = 53 \text{ lb}. \]

8. REVIEW QUESTION: A person weighing 160 lb here on the surface of the earth (hav[ing radius 4000 mi]) goes to a distance 8000 mi from the surface of the earth. The new weight of the person will be ?.

9. REVIEW QUESTION: Newton's Second Law can be briefly stated as ?
   \[ F = ma \]

10. REVIEW QUESTION: In Newton's First Law, the Net Force on an object must equal ?.

11. The part of the electromagnetic spectrum that carries the "heat" from the sun is called ?.

12. The part of the electromagnetic spectrum that carries the highest energy that is known to humankind is called ?.

13. (2) LAB QUESTION: In the velocity of sound lab, if the distance between the two nodes is 33.4 cm and the tuning fork frequency is 512 Hz, what would a student calculate for the speed of sound from this data?
   \[ \lambda = \frac{2L}{2} = \frac{33.4 \text{ cm}}{106.8 \text{ cm}} = 0.668 \text{ m/s} \]

14. At a condensation, the density of air is ? what it would normally be for the density of air. Choose from: (a) higher than; (b) lower than; (c) the same as.
15. The alternate increasing and decreasing in the amplitude of the sound produced when two tuning forks of slightly different frequency are struck is called ___. (Hint: Remember the class demonstration when two frequencies of 445 Hz and 447 Hz were struck simultaneously.)

16. A shout is given at t = 0. Five seconds later, an echo is heard. Assuming a speed of sound of 345 m/s, how far away was the reflecting object? ___.

\[ d = v t = (345 \text{ m/s}) \times (5 \text{ s}) = 863 \text{ m} \]

17. If two transverse waves approach each other traveling down a slinky on opposite sides of a slinky and meet each other, ___ interference is said to occur.

18. If two transverse waves, traveling on the same side of a rope coming from opposite directions, meet each other, ___ interference is said to occur.

19. REVIEW QUESTION: If the distance from a condensation of a sound wave to the next successive rarefaction is 2.8 meters, what is the wavelength of the wave?

\[ \lambda = \frac{d}{2} = \frac{5.6}{2} \text{ m} = 2.8 \text{ m} \]

20. (2) BONUS QUESTION: In a closed-ended pipe (such as a soda pop bottle), the distance from the bottom to the open end is 0.5 ft. The wavelength of the fundamental frequency of vibration is ___, and the frequency of that fundamental frequency of vibration is ___. (Include all units and use the speed of sound of 1100 ft/sec.)

\[ V = \frac{\lambda}{T} = \frac{300}{10} = 30 \text{ m/s} \]

21. A pulse travels the length of a 30 m long slinky in 10 s. The speed of the pulse is ___.

\[ V = \frac{d}{t} = \frac{30 \text{ m}}{10 \text{ s}} = 3 \text{ m/s} \]

22. The fundamental frequency of vibration of a closed-ended pipe is 256 Hz. It’s third harmonic frequency is ___, and the frequency of oscillation of its third overtone is ___.

\[ f_3 = 3f_1 = 3(256) = 768 \text{ Hz} \]

23. Two characteristics required for maximum reflection of a surface is that the surface be ___ and ___.

24. The mass of an object per unit volume is a description of a physical quantity called ___.

25. In the Tacoma Narrows Bridge video seen in class, the "initial disturbance" that brought about the resonant behavior of the bridge was ___.

26. What serves as the "initial disturbance" that sets up standing waves in a slinky?

27. A rainbow occurs because of (a) refraction of light (b) dispersion of light (c) total internal reflection of light (d) all of (a) through (c) (e) none of (a) through (c)

28. Refraction of a sound wave refers to ___.

29. If you are relaxing in an inner-tube in a lake, and you count 30 waves hitting you every 10 sec, the frequency of the waves is ___, and the period of the waves is ___. (Include units.)

\[ f = \frac{30 \text{ waves}}{10 \text{ s}} = 3 \text{ waves/s} \]

\[ T = \frac{1}{f} = \frac{1}{3} \text{ s} = 0.33 \text{ s} \]

30. The "threshold of hearing" is ___ dB and the "threshold of pain" is ___ dB.

31. (2) In the playing of a violin, not only does the fundamental frequency resonate, but also there are various ___ that determines the "quality" of the violin sound. Furthermore, if a trumpet plays the same note (pitch) and with the same loudness (amplitude) as the violin, what distinguishes the trumpet sound from a violin sound? (Use the description that we have learned.)

32. A different set of different amplitudes of harmonics are established for trumpet, compared to violin.

33. Find the following area (Don't forget units and precision/sig.fig's!): Area = 5.22 ft x 8.95 ft

\[ 
\frac{46.2}{\text{ft}} \times 3 \text{ ft} \]

\[ = \frac{153.6 \text{ ft}^2}{\text{ft}} \]

\[ = 153.6 \text{ ft}^2 \]
B. Longer Answer Questions:

1. (3) Draw in the positioning of nodes (N) and antinodes (A) for:
   (i) a closed ended pipe playing its third harmonic.

   ![Diagram of closed ended pipe]

   (ii) an open ended pipe playing its third overtone.

   ![Diagram of open ended pipe]

   (iii) a string vibrating in its second overtone.

   ![Diagram of string vibration]

2. (3) Define and give an example of the "Doppler effect".

   Please See Notes

3. (4) Discuss what happens when a plane moves faster than the speed of sound and how its design must be modified and why. Also discuss or use a series of diagrams to show what is heard by a person on the ground when a plane flies overhead that is flying faster than the speed of sound. And finally, what is the "Mach Number?"

4. (5) Define the "electromagnetic spectrum" and list (and briefly discuss) in increasing energy its various components.
5. (5) (a) (3) Discuss those acoustical factors that are important in the design of a music hall—such as the Ordway or Orchestra Hall. Don't forget to include reflection of sound, absorption of sound, and reverberation time. (b) Why is it that there are separate halls for orchestras and theaters? (c) What acoustical problems exist for the St. Paul Cathedral in downtown St. Paul?

Please see notes.

6. (3) Designate portions of the screen which (a) receive no light from the light source due to the obstacle, (b) received partial light from the light source, and (c) are not affected by the presence of the obstacle. (Hint: Draw in appropriate rays.)

Light Source Obstacle

Not affected Screen

PARTIAL LIGHT (PENUMBRA)

NO LIGHT (UMBRA)

PARTIAL LIGHT (PENUMBRA)

Not Affected

7. (3) What is the "Law of Reflection?" Illustrate by drawing in an appropriate surface, rays, and angles.

Please see notes.

8. (3) What is the "Law of Refraction?" Illustrate by drawing in an appropriate surface, rays, and angles. Assume an angle of incidence of 20 degrees for your diagram.
9. (4) Discuss the different images (i) real or virtual, (ii) erect or inverted, and (iii) smaller or larger or the same size) that can be formed with a thin converging ("convex") lens. (a) If the object is located at a distance that exceeds twice the focal length. (b) If the object is located at a distance that equals twice the focal length. (c) If the object is at a distance that is greater than the focal length yet is less distance than twice the focal length. And finally, (d) if the object is at a distance that is less than the focal length. Note: Take your time on this question. Feel free to work through each; also see question #15, page 6.

10. (2) Discuss the different images that can be formed with a diverging ("convex") mirror—are they virtual or are they real? Are they larger or are they smaller? Are they erect or are they inverted?

"Boring" Always virtual, always smaller, & always erect no matter what the object distance is. (You may want to draw a ray diagram to show this.)

11. (3) (a) Define "critical angle". Use a series of diagrams if helpful in your explanation. (b) What is "total internal reflection", and how does it relate to critical angle? (c) List two examples of the use of total internal reflection.

Please See Notes

12. (5) (a) Draw a diagram of the human eye and identify the crystalline lens, the ciliary muscles, the retina, the cornea. (b) Mention or illustrate what happens for (i) a myopic eye, (ii) a hyperopic eye, and (iii) an astigmatic eye and include what is used to correct for each of these conditions.

Please See Notes
14. (4) Find the images cast in the following mirrors by the objects shown. Briefly describe the image: Is it real or virtual? Is it larger or smaller? Is it erect or inverted? Hint: Use the three principle rays.

15. (4) Find the images cast in the following lenses by the objects shown. Briefly describe the image: Is it real or virtual? Is it larger or smaller? Is it erect or inverted? Hint: Use the three principle rays.
16. (4) A poet in performing her pendulum lab took the following data: (i) a 16.0 cm length pendulum took 69.3 seconds for 60 cycles; (ii) a 49.0 cm length pendulum took 121 seconds for 60 cycles.

(a) Find the period for each case.
(b) If she found the period to be proportional to the square root of the length, find the constant of proportionality.

\[ (a) T = \frac{69.3 \text{ s}}{60 \text{ cycles}} = 1.15 \text{ s/cycle} \]

\[ (b) \sqrt{16.0 \text{ cm}} = 4.0 \text{ cm} \]

\[ c = \frac{T}{L} = \frac{1.15}{4.0} \text{ cm} \]

\[ c = 0.29 \text{ cm}^{\frac{1}{2}} \text{ s}^{-1} \]

17. (4) Describe how the acceleration due to gravity can be measured by using two photocells and a timer.

18. (4) Describe how one can use a tuning fork a resonance tube apparatus in order to measure the speed of sound.

19. (4) In the lens lab the following graph was obtained:

(a) Write down the mathematical equation that accompanies this graph.

\[ \frac{1}{u} = -1.33 \frac{1}{x} + 0.08 \frac{1}{cm} \]

(b) What is the focal length of the lens.

\[ f = \frac{1}{b} = 0.08 \frac{1}{cm} = 12.5 \text{ cm} \]

GOOD LUCK TO YOU AND HAVE A GREAT REMAINING SUMMER! J.Artz