1. Define the Doppler Effect. How does the apparent frequency for sound waves shift for an observer based on the motion of the source? How does this differ from the Doppler Effect for light waves?
2. Define and each of the following wave behaviors and provide examples from mechanical waves, sound waves, and EM waves (such as light):
   1. Interference
   2. Transmission
   3. Absorption
   4. Reflection
   5. Refraction
   6. Diffraction
3. What is a beat frequency? Why is the pattern of beats produced?
   1. A tuning fork has a frequency of 465 Hz. When a second tuning fork is struck, beat interference patterns occur with a beat frequency of 5 Hz. What is the lowest and highest frequency of the second fork?
4. What is a standing wave and how is it created? What are nodes and anti-nodes?
   1. Sketch standing waves in a string for the first 4 harmonics. What general equation can be applied to standing waves in a string?
5. Sketch standing waves in an open-end resonator for the first 4 harmonics. What general equation can be applied to standing waves in a string?
   1. A flute acts as an open-end resonator. If the flute has a resonant length of 25 cm, what is the wavelength of the 3rd harmonic frequency?
6. Sketch standing waves in a closed-end resonator for the first 4 harmonics. What general equation can be applied to standing waves in a string?
   1. An organ pipe acts as a closed-end resonator. What is the length of an organ pipe which has a fundamental frequency of 18 Hz?
7. What is an EM Wave? What is the Electromagnetic Spectrum? How is it laid out in terms of frequency, wavelength, and energy?
8. List applications of the following types of EM waves:
   1. Gamma Rays
   2. X-Rays
   3. Ultraviolet Rays
   4. Visible Light
   5. Infrared Radiation
   6. Microwaves
   7. Radio Waves
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17. Explain Snell’s Law and index of refraction.
    1. List the equations for each and explain each of the variables.
    2. A beam of light passes from water into glass. The index of refraction for water (*nwater*) is 1.33 and the angle of incidence is 25°. If the angle of refraction is 22°, what is the index of refraction for glass?
18. Define total internal reflection.
    1. What is the critical angle and how does it relate to total internal reflection?
    2. What are some applications of total internal reflection?
19. What is the range of the visible spectrum?
    1. What colors do we typically say make up the visible spectrum?
    2. Is white a color of light? Why or why not?
    3. Why are sunsets red? Why is the sky blue?
20. How can we use prisms to prove white light is made up of all the visible colors of light? What is dispersion?
21. Draw and label a diagram for both additive and subtractive color mixing.
    1. What are examples of additive color mixing? Subtractive color mixing?
    2. What are the primary, secondary, and complementary colors of light?
    3. What are the primary and secondary colors of ink/pigment?
    4. Is black a color of light? Why or why not?
    5. If you shine a red flashlight and a blue flashlight at a white wall, what color will you see where the flashlight beams overlap?
    6. What color is a yellow ball when viewed under cyan light?
22. You decide to kick off your summer with a relaxing cruise around Lake Sammamish in your friend’s boat. But a storm rolls in to ruin your fun!
    1. If the temperature drops to 15.0°C, what is the speed of sound in air on the lake?
    2. You see a big flash of lightening and count 2.60 seconds before hearing the thunder. How far away is the storm?
    3. How far did the flash of lightening travel in the 2.60 seconds it took for the sound wave from the thunder to reach you?
    4. If the rumble of the thunder had an average frequency of 95 Hz, what was the wavelength of the sound wave?
    5. What is the period of the thunder’s sound wave?
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