Physics 101 Part 2

Pipes:

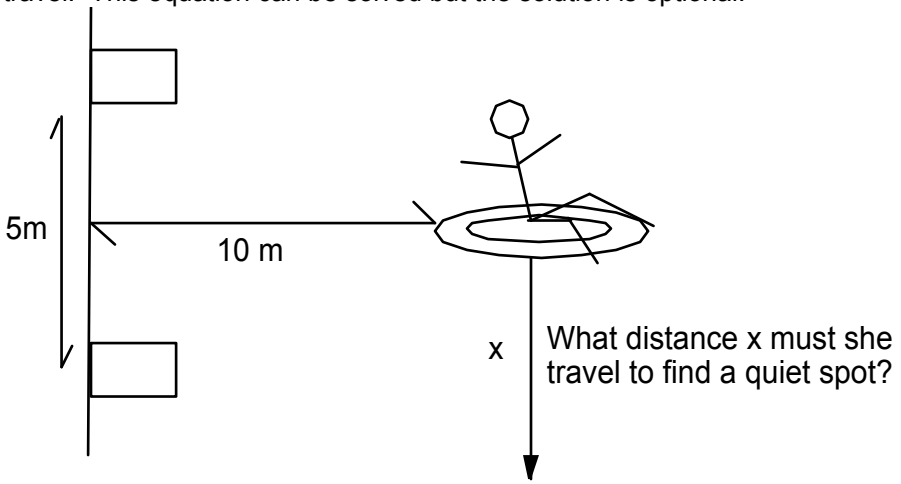
1. A corrugated pipe of length L is open at both ends and whirled around and around. At a particular speed a note is produced which is found to be 220 Hz. When whirled even faster a note of 440 Hz is heard.
a) If the pipe were whirled faster, what are the next three frequencies that would be heard?
b) What is the length of the pipe?

2. Pipe 1 resonates in its second overtone at the same frequency that pipe II resonates in its 1st overtone. Both pipes are closed on one end and pipe II is 50 cm long. How long is pipe I?

Interference of waves:

3. Two loudspeakers are placed on the stage of a theatre. A rat (named "Smoke") is seated 10 metres from one speaker and 13 m from the other. A signal is generated from the two speakers with the same amplitude, the same frequency, and in phase.
a) Write an equation that will tell you the possible frequencies that will make it so that Smoke cannot hear anything.
b) If rat hearing range is 20 Hz to 50000 Hz (which may or may not be true - I dunno. What am I, a vet?), then how many of the frequencies from a) lie in this range?
c) Repeat the whole problem assuming that the sources are completely out of phase.

4. Michelle is sitting on a rubber dingy in the West Edmonton Mall in the wave pool 10 m from the wall; pretend that this wave pool is infinitely large. The wave pool has two wave generators on one end that produce waves of the same amplitude and frequency; these generators are 5 m apart, and produce waves at 2 Hz. For the sake of argument, assume that the waves travel at 5 m/s (although this may not be the real value, it does not affect the solution). The waves generated are also in phase. Michelle, however, would prefer some respite from the waves. Find an equation for the distance that she must travel. This equation can be solved but the solution is optional.



The Doppler Effect:

5. Priscilla just about missed the train but she noticed that the frequency of the train whistle was 600 Hz as she was standing behind the train as it was leaving at 3 m/s. However, by the time she decided to chase the train, it was going 10 m/s and the frequency that she heard was 598 Hz. How fast was she running?

6. Dracula, the form of a bat, is flying after a victim at 13 m/s, because that is his favourite speed. Being that Dracula is in the form of a bat, he can emit high pitched sounds for the purposes of echolocation. Dracula emits chirps at 40 kHz but the sound that he hears returning from his victim has a frequency of 39.53 kHz. How fast is his victim traveling? Will he get any lunch today if things continue as they are? The speed of sound in air is 343 m/s.

7. Krista, a parachuter, jumps from an airplane but quickly realizes that the chute is not opening. At the point where Krista comes to this sad realization, she is 2000 m from the ground and traveling at 10 m/s downward. At this point she lets out a blood curdling scream such that her vocal chords vibrate at 1000 Hz. Assuming that there is no air resistance, what frequency will she hear when the sound is reflected from the ground. Don't forget to take into account the fact that she is moving. Assume the speed of sound to be 343 m/s. In the end she lands on Dracula's back while he's chasing someone else and then jumps happily onto the ground. What are the chances?

Sound Intensity:

8. A pebble of mass 0.20 grams is dropped from a height of 2.0 m. Assume that there is no air friction and that 0.050% of its kinetic energy is converted to sound energy on impact. Also assume that the energy is dissipated over a period of 0.50 s. The noise radiates in all directions and you walk away until you cannot hear it any more when the rock is dropped. The threshold of hearing is 10^{-12} W/m^2.
a) How far are you away at this point?
b) How many pebbles would have to be dropped so that you heard sound at 20 dB?

9. The sound level from a source is measured to be 90dB at 2 m.
a) What is the sound level 4 m from the source?
b) How far away must one be for the dB level to be 45?

Flow and Bernoulli's Equation:

10. A big tank full of water is 10 metres tall and open at the top. A small hole is punched in the side of the side of the tank at the base.
a) What is the speed of the water leaving the tank?
b) If the hole were 2.0 m in radius and the tank itself is 5.0 m in radius, how fast is the water flowing out? How fast is the water level in the tank going down?

11. A tube of radius 10 cm has fluid flowing in it at a speed v_1. The tube then constricts to a radius of 5.0 cm. It is found that the pressure drops by 10 Pa when the fluid enters the constricted region. What is the velocity of the water in the constricted pipe?

12. Water flows according to the diagram below. The density of the liquid is 1000 kg/m^3. The height of the water is h=1m. The areas of the outlet tube are a=1cm^2 and A=2 cm^2.
a) At what speed v does the water finally emerge from the end of the pipe?
b) What is the velocity v' where the cross-sectional area is a?
c) What is the height H of the liquid below the vacuum in the vertical tube?