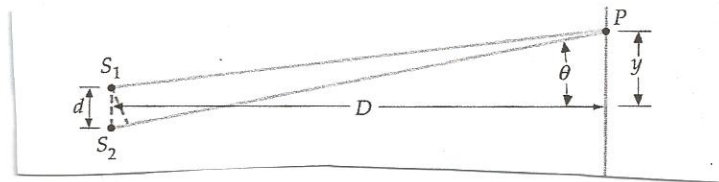


4C Problem Set 6 – Sound Waves

1. While studying physics in her dorm room, a student is listening to a live radio broadcast of a baseball game. She is distance $D = v_s t_1$ due south of the baseball field. Over her radio, the student hears a noise generated by the electromagnetic pulse of a lightning bolt. Time $t_2 = 0.4t_1$ seconds later, she hears over the radio, the thunder picked up by the microphone at the baseball field. Time $t_3 = 0.8t_1$ seconds after she hears the noise of the electromagnetic pulse over the radio, thunder rattles her windows. Taking the origin of the coordinate system to be at the ballpark, find the position vector where the lightning bolt occurred.
2. Two students with vibrating tuning forks of equal frequency f_o walk away from each other with equal speeds. How fast must they walk so that they each hear a beat frequency of frequency of Δf ?
3. A physics student drops a vibrating tuning fork of frequency f_o down the elevator shaft of a tall building. When the student hears a frequency of $f' = 0.9 f_o$, how far has the tuning fork fallen?
4. Three successive resonance frequencies in an organ pipe are 1310, 1834 and 2358 Hz. (a) Is the pipe closed at one end or open at both? (b) What is the fundamental frequency? (c) What is the length of the pipe?
5. Two point sources that are in phase are separated by a distance d . An interference pattern is detected along a line parallel to the line through the sources as shown. (a) Show that the path difference from the two sources to some point on the line at a small angle θ is given by approximately $\Delta S = d \sin \theta$. Hint: Assume that $D \gg d$, so that the lines from the sources to P are approximately parallel. (b) Show that the distance y_m from the central maximum point to the m^{th} interference maximum is given by approximately by $y_m = m(D\lambda/d)$.



6. Hovering over the pit of hell, the devil observes that as a student falls past (with terminal velocity) the frequency of his scream decreases from f' to f'' . (a) Find the speed of descent of the student. (b) The student's scream generates beats when it is mixed with its echo from the bottom of the pit. Find the number of beats per second heard by the student. (c) Find the number of beats per second heard by the devil after the student has passed by.
7. A man drops a stone from a high bridge and hears it strike the water exactly time t later. How high is the bridge? Assume the temperature of the air is 20°C .
8. A whistle of frequency f moves in a circle of radius R at angular velocity ω . What are the maximum and minimum frequencies heard by a listener in the plane of the circle and distance d away from its center?
9. A string is attached to a tuning fork which vibrates with frequency f_o and sets up transverse standing waves of that frequency (and only that frequency) on the string. The other end of the string passes over a pulley, and the tension is varied by attaching weights to that end. The string has approximate nodes at each end, one at the tuning fork and one at the pulley. If the string has mass density μ and length L (from the tuning fork to the pulley), what must the tension be for the string to vibrate in the fundamental mode? In the second, third and fourth harmonics?