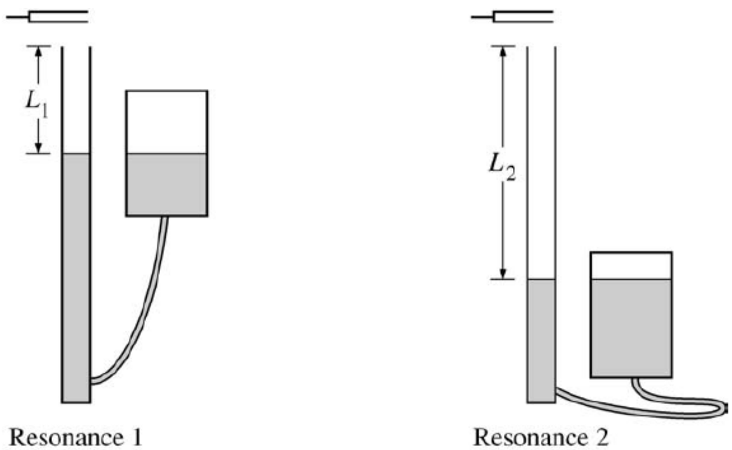
2004B Q3 (15 points)



Note: Figure not drawn to scale.

A vibrating tuning fork is held above a column of air, as shown in the diagrams above. The reservoir is raised and lowered to change the water level, and thus the length of the column of air. The shortest length of air column that produces a resonance is L_1 = 0.25 m, and the next resonance is heard when the air column is L_2 = 0.80 m long. The speed of sound in air at 20°C is 343 m/s and the speed of sound in water is 1490 m/s.

(a) Calculate the wavelength of the standing sound wave produced by this tuning fork.

(b) Calculate the frequency of the tuning fork that produces the standing wave, assuming the air is at 20°C.

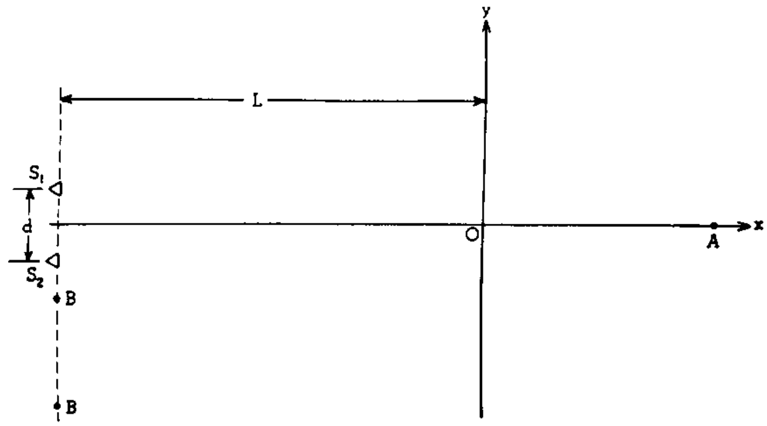
(c) Calculate the wavelength of the sound waves produced by this tuning fork in the water.

(d) The water level is lowered again until a third resonance is heard. Calculate the length L_3 of the air column that produces this third resonance.

(e) The student performing this experiment determines that the temperature of the room is actually slightly higher than 20°C. Is the calculation of the frequency in part (b) too high, too low, or still correct?

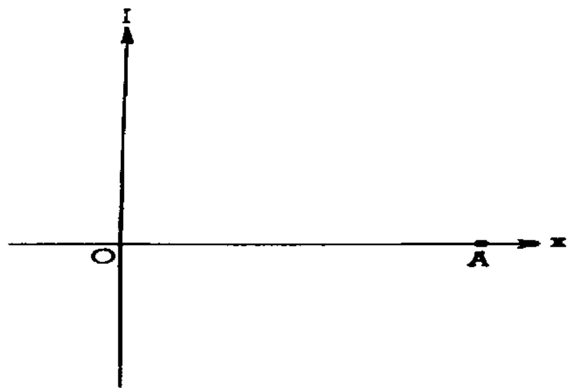
_____ Too high _____ Too low _____ Still correct Justify your answer.

1977 Q5

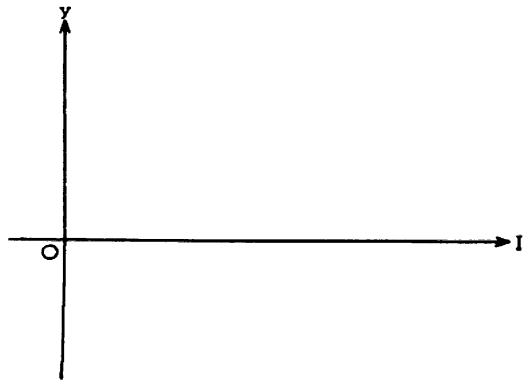


Two loudspeakers, S_1 and S_2, a distance d apart as shown In the diagram above, vibrate in phase and emit sound waves of equal amplitude and wavelength λ. Assume $d \ll L$.

(a) Describe how sound intensity I varies as a function of position x along the line segment OA. Sketch the graph of this function on the axes below.



(b) Assume $\lambda << d$. On the axes provided below, sketch a graph of the sound intensity I as a function of position y along the y-axis.



(c) Assume that d = 2 meters and that the speed of sound is 360 meters per second. Find the lowest speaker frequency, which will yield the minimum sound intensity along the line BB.

2005B Q4 (15 points)

Your teacher gives you two speakers that are in phase and are emitting the same frequency of sound, which is between 5000 and 10,000 Hz. She asks you to determine this frequency more precisely. She does not have a frequency or wavelength meter in the lab, so she asks you to design an interference experiment to determine the frequency. The speed of sound is 340 m/s at the temperature of the lab room.

(a) From the list below, select the additional equipment you will need to do your experiment by checking the line next to each item.

___ Speaker stand ___ Meterstick ___ Ruler ___Tape measure

___ Stopwatch ___ Sound-level meter

(b) Draw a labeled diagram of the experimental setup that you would use. On the diagram, use symbols to identify what measurements you will need to make.

(c) Briefly outline the procedure that you would use to make the needed measurements, including how you would use each piece of equipment you checked in (a).

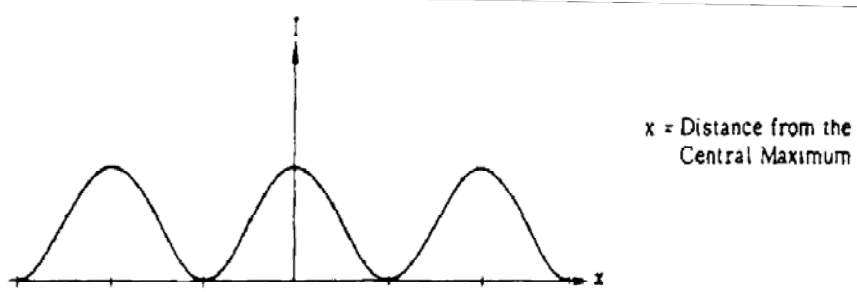
(d) Using equations, show explicitly how you would use your measurements to calculate the frequency of the sound produced by the speakers.

(e) If the frequency is decreased, describe how this would affect your measurements.

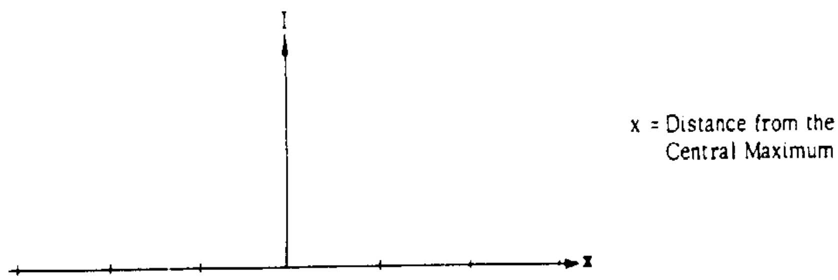
1980 Q4

In the five pairs of graphs that follow, a curve is drawn in the first graph of each pair. For the other graph in each pair, sketch the curve showing the relationship between the quantities labeled on the axes. Your graph should be consistent with the first graph in the pair.

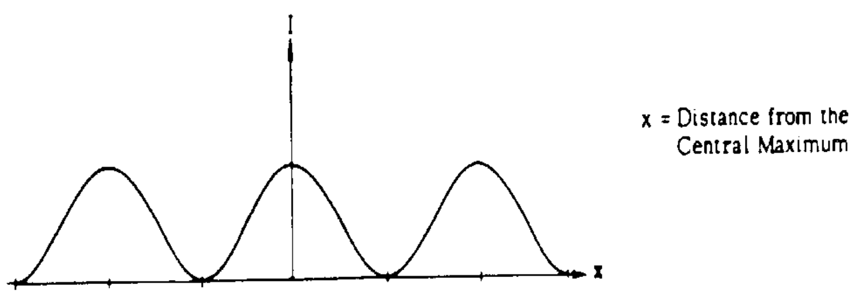
(a) I = Intensity of Light on a Screen 1 meter from 2 Slits a Distance d Apart



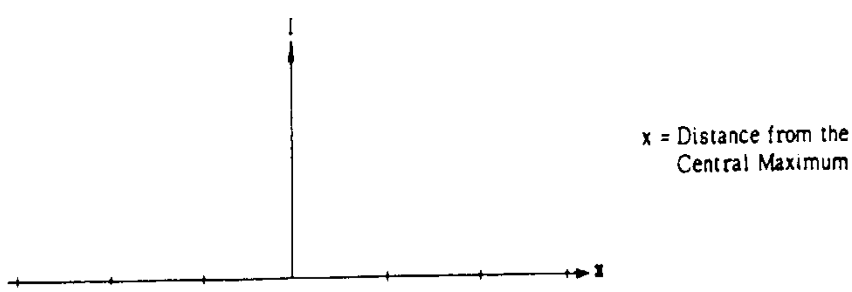
I = Intensity of Light on a Screen 1 meter from a Large Number of Slits Each a Distance d Apart



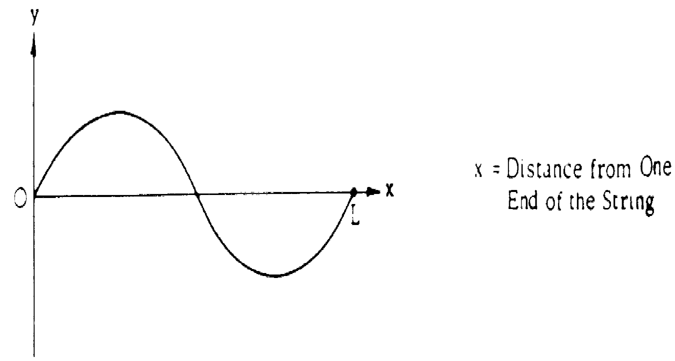
(b) I = Intensity of Light on a Screen I meter from 2 Silts a Distance d apart



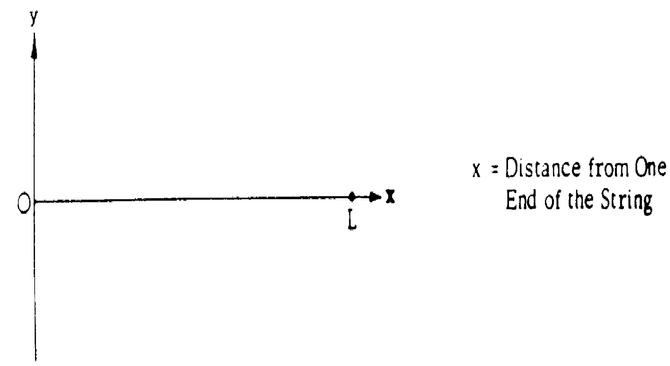
I = Intensity of Light on a Screen 1 meter from 2 Slits a Distance 2d Apart



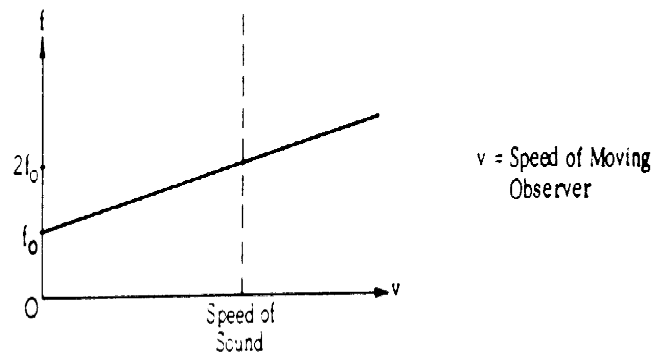
(c) y = Displacement of a String of Length L, Fixed at Both Ends, Vibrating; at a Frequency f = 100 hertz



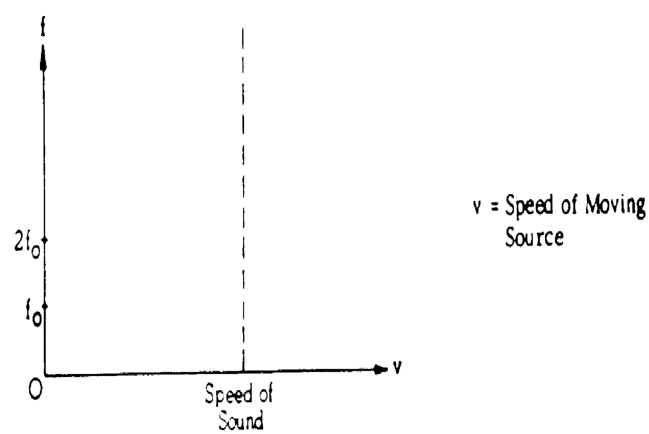
y = Displacement of a String of Length L, Fixed at Both Ends, Vibrating at a Frequency f = 150 hertz



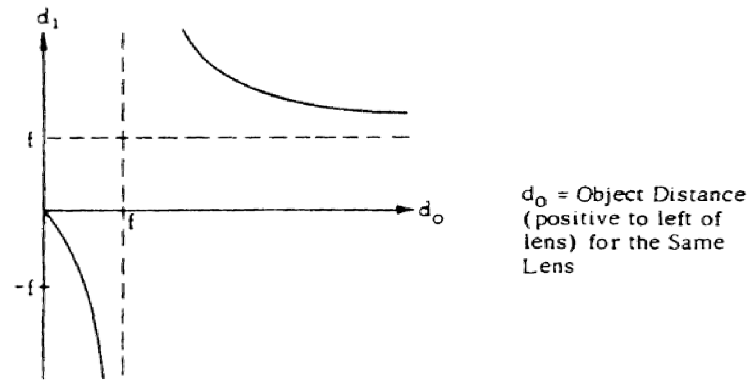
(d) f = Observed Frequency When Observer Moves Toward Stationary Source Emitting Sound of Frequency f_0



f = Observed Frequency When Source Emitting Sound of Frequency f_0 Moves Toward Stationary Observer



(e) d_i = Image Distance (positive to right of lens) for a Thin Convex (converging) Lens of Focal Length f



d_i = Image Distance (positive to right of lens) for a Thin Concave (diverging) Lens of Focal Length $-f$