# Physics 151 Class Exercise: Standing Waves

Your goal in this assignment is to determine the velocity of sound in an unknown metal using a piece of laboratory equipment known as Kundt's Tube. The apparatus consists of a hollow glass tube closed at one end. The tube is mounted on a frame in such a way that it can be moved longitudinally with respect to the frame. A metal rod, m, is clamped to the support frame, exactly at its center. This metal rod carries a disk at one end which is inserted in the glass tube but does not touch the tube. The tube contains cork dust which is distributed along the length of the tube.

KUNDT'S-TUBE APPARATUS
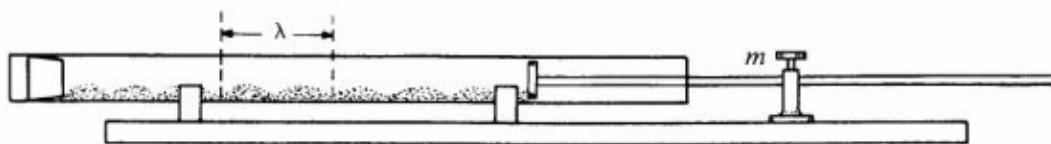
When the right end of the rod is stroked lengthwise with a cloth with rosin applied to it, longitudinal standing waves are set up in the rod with a node at the clamp and an anti-node at each end. The sound waves are produced in the rod as the layers of molecules are successively displaced and released by the cloth. The vibrations are transmitted to the disk, which in turn transmits them into the air column.

As longitudinal waves leave the rod at the end containing the disk, they proceed down the tube which acts as a closed pipe. Hence, if the distance between the disk and the closed end is such as to produce resonance, the cork dust will be agitated at the anti-node positions and remain relatively still at the node positions.

Upon performing the experiment, you note that the distance between the disk and the end of the glass tube is 54.9 cm and that there are exactly 9.5 "hills" of cork dust in the tube. You measure the length of the metal rod to be 88.5 cm and the temperature on this hot July day is 36°C. Use this information to determine the velocity of sound in the metal rod and use this to identify the likely composition of the metal.

Hints: You should spend a fair amount of time discussing the apparatus and making sure you completely understand how it functions before beginning the problem. It would be very useful for you to make a detailed drawing of the cork dust and label the nodes and antinodes. Clearly describe all of your assumptions and show all calculations on the back of this sheet. Remember that the velocity of sound in air is given by:

$$v_{air} = 331 + 0.61 * T \ \frac{m}{s}$$

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Your goal in this assignment is to take 4 empty pop bottles, partially fill them with water, and be able to play "Mary had a Little Lamb". The tables below show the notes that are needed as well as the corresponding frequencies.   The bottles are 25 cm tall. How much water is needed in each bottle?

B	A	G	A	B	B	B
Ma-	ry	had	a	lit-	tle	lamb,
A	A	A	B	D	D	
Lit-	tle	lamb,	lit-	tle	lamb.	
B	A	G	A	B	B	B
Ma-	ry	had	a	lit-	tle	lamb,
B	A	A	B	A	G	
Its	fleece	was	white	as	snow.	
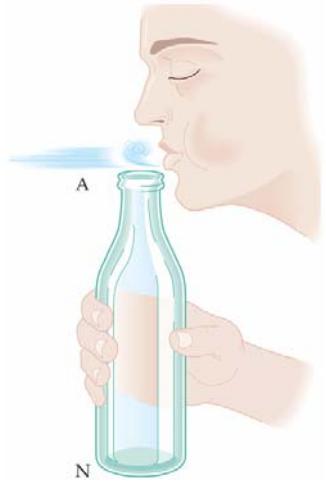
Notes	Frequencies (Hz)
G	392
A	440
B	493.9
D	587.4