

A CIGAR BOX SONOMETER.

BY LYNN B. McMULLEN,

Shortridge High School, Indianapolis.

This article is written (1) for those teachers who are without a sonometer of any kind, (2) for those who have not enough to go around and (3) for those who are still using the horizontal form. In presenting this ridiculously simple piece of apparatus I do not wish to be understood as standing for makeshift, home-made apparatus as against well planned, shopmade goods. But I do stand for simple apparatus as against *none* and I do believe that in improving our physics teaching we need to begin with the apparatus. No matter how good the teacher may be he is seriously handicapped in a poorly equipped laboratory. Further, I believe that in starting to equip a laboratory in a community lacking in funds much of the apparatus required for a course of at least forty good experiments can be made by the students themselves.

I would suggest, then, that this article be put into the hands of the students and that the sonometer be made by them.

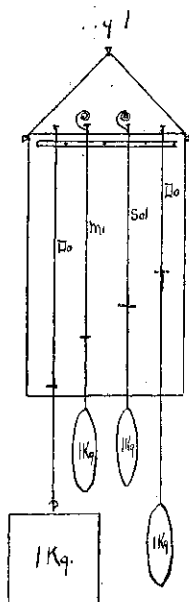
MATERIALS REQUIRED.

The materials required are a large cigar box at least 13x25 cm. (if storing room is plenty a larger box of any thin wood will do better), some strips of tin, some heavy cloth (canvas), 4 E mandolin strings, 1 B guitar string, a string of number-26 spring brass wire and 9 kg. of iron slugs, nails, lead scraps or even sand.

CONSTRUCTION.

Cut a strip of tin 1 cm. wide and almost as long as the box is wide. Draw a line lengthwise of the tin at its center and bend at right angles along the line. Tack the stationary bridge so made at the top of the back of the box as shown in Fig. 1. To make the movable bridges cut four strips of tin 1 cm. wide and 4 cm. long. Bend as shown in Fig. 2. For the weights make 7 bags each 10x12 cm. Fill 6 with iron until each weighs 1 kg. and fill 1 until

it weighs .5 kg. Sew each up tight. Make two bags 10x18 cm. and weight to 1 kg. leaving the



Showing the sonometer arranged for first exercise.

Fig. 2

upper third empty so that weights may be added as required. Put a large hook on the top of each bag and an eye on the bottom. (If sand is used the bags must be much longer.) Drive four brads into the top of the box, as shown, and fasten to each an E mandolin string. Fasten also to one of the center brads the B guitar string and to the other the string of brass. Drive a brad in each side of the top and put on a bail by means of which the sonometer may be hung up. If a finish is desired a coat of dead black Jap-a-lac is easily applied. The ingenious student will be able to improve upon this construction considerably for I have endeavored to use only those materials which may be had for the asking.

DATA.

Using a sonometer made in this way the following data was obtained, which data, it is fair to say, is not as good as my students obtain using a larger box. The first two exercises can well be performed individually by the pupils. The last three are well adapted for class exercises.

THE LAW OF LENGTH.

The four mandolin strings are used each under a tension of 1 kg.

Note	Holes in Siren*	Assumed Vibration Number (N)	Length (L)	$N \times L$
Do	24	256	21.6	553
Mi	30	320	17.3	554
Sol	36	384	14.6	560
Do'	48	512	10.8	553

*If the school has no siren one is easily made by punching the required number of holes in a piece of tin, and from it the vibration ratios of the major chord may be obtained.

THE LAW OF TENSION.

The mandolin strings are used in this exercise also, their lengths being constant.

Note	"N"	Tension "T"	\sqrt{T}	$N \div \sqrt{T}$
Do	256	1000 g.	31.6	8.1
Mi	320	1624	40.3	7.9
Sol	384	2294	47.9	8.0
Do'	Broken string.			

THE LAW OF DIAMETER.

	E Mandolin String	B Guitar String	B Guitar of same Length as E Mandolin
Length,	21.6	16.1	21.6
Diameter,	.0225	.0306	.0306
Tension,	1000	1000	1000
Density,	7.81	7.81	7.81
"N"	384	384	286
$D \times N$	86		87

"N" in the last column is obtained from the preceding column by calculation, using the law of length.

THE LAW OF DENSITY.

	B Guitar	Brass	Brass of Same Length and Diameter
Length,	21.4	14.3	21.4
Diameter,	.0306	.0455	.0306
Tension,	1000	1000	1000
Density,	7.81	8.70	8.70
\sqrt{D}	2.79	2.95	2.95
"N"	290	290	287
$N \cdot \sqrt{D}$	81		84

"N" in the last column is obtained by calculation using the laws of length and diameter.

THE SPEED SOUND IN IRON.

Length of iron pipe,*	143.5
Length of wave in iron,	287
Length of string in unison with pipe,	6.7
Length of string in unison with fork (512)	23.3
Vibration number of pipe,	1780
Speed of sound at temperature of room 510° m. per sec.	

*A piece of gas pipe was clamped in a vise and stroked with a piece of resined leather.