

Lively Physics and Exciting Experiments

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Abstract

To make Physics classes worth learning for every student you need to reconstruct the Physics classes from the viewpoint of the learners (students). There are two keys there. One is to find out how students form their scientific recognition and to reconstruct the classes along the students' recognition process. The other is to use simple, essential and pleasant teaching materials in the classes. For this purpose experiments need not to be the complicated and special ones like commercial equipments but they may be such things as made from the materials around us. Such experiments can draw Physics from the textbook to the real world we live in and stir students' curiosity and creativity

1. Introduction

A lot of students think Physics is difficult and uninteresting. This is one of the reasons why the number of the students who study Physics in the high school has been decreasing. We thought it is most important to make Physics classes worth learning for every student to improve the situation above and have been studying how to make such classes.¹⁾ We found that we need to reconstruct the Physics classes from the viewpoint of the learners (students). We think there are two keys there. One is to find out how students form their scientific recognition and to reconstruct the classes along the students' recognition process. The other is to use simple, essential and pleasant teaching materials in

the classes to show "Physics is fun.", "Physics exists everywhere" and "Everybody can enjoy Physics".

We show the some examples of the experiments on acoustics that we have investigated for the purpose written above. The experiments we show are not the complicated and special ones like commercial equipments but they are made from the materials around us including junks or materials from trash box. But we think such experiments can draw Physics from the limited world only in the textbook to the real world we live in and stir students' curiosity and creativity.

2. Examples of the experiments

2.1. Talking Cup

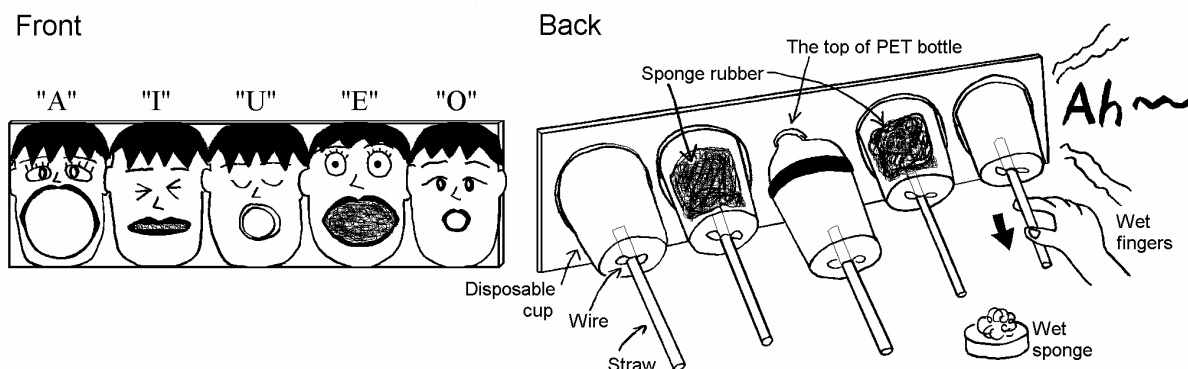
These cups are model for mouth talking Japanese vowel "A" "I" "U" "E" "O". Straw is stuck into bottom of the cup and the cups for "I" and "E" are filled with sponge rubber. (Fig.1) When you rub the straw by wet fingers, the cups will talk "A" "I" "U" "E" "O". (Invented by Mr. Kenji DOHI, Hiroshima technical high school)

2.2. Vibration of the aluminum rod and Sound grating

2.2.1. Vibration of the aluminum rod

We can make two vibration modes by hitting the aluminum rod: longitudinal wave and transverse wave.

Figure 1: Talking Cup



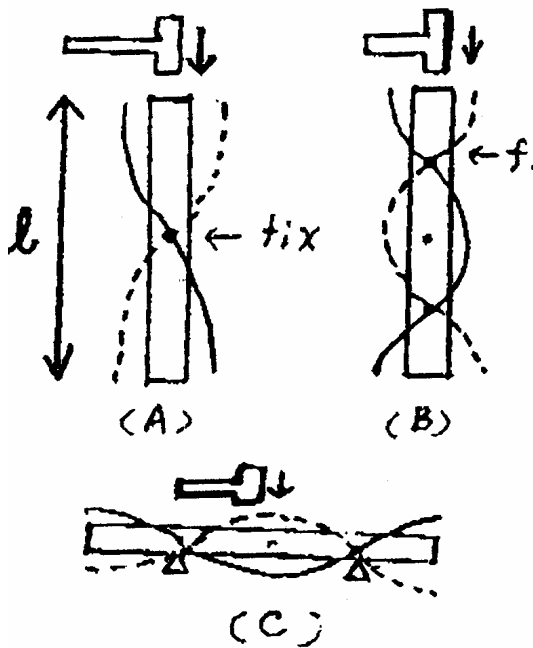


Figure2: Vibration modes of the Aluminum rod

In Fig.2 (A) and (B) are longitudinal wave and (C) is transverse wave. In the class, after the demonstration let the students think why I can make different sounds. Students understand there exists modes in the rod and they cause the difference of the sound. It is also interesting that the height of the sound depends drastically on the mode.

2.2.2. Sound grating

Make five holes in the big pipe at intervals of $d=20\text{cm}$ and attach a speaker to the one end of the pipe.(Fig.2)

Sound of wavelength $\lambda=10\text{cm}$ are sent by oscillator. If you move slowly, you can hear the diffraction of the sound.

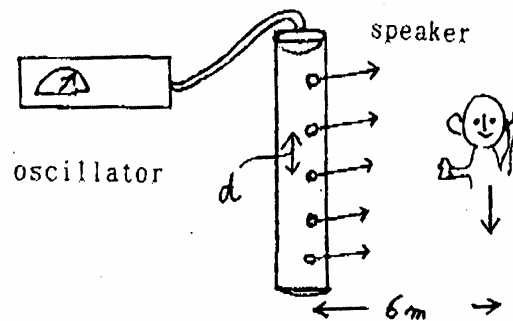


Figure3: Sound grating

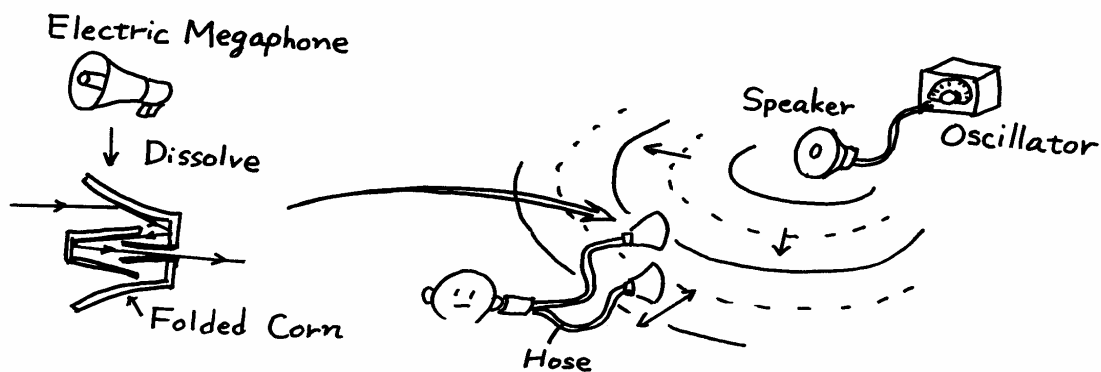
2.3. Gather the sound and hear the interference of the sounds

Corn is good shape to gather the sound. Students are surprised to hear such a simple equipment gather so much sound. You can get good shaped corn from the electric megaphone by dissolving it. You can use the corn to various experiments. One of the experiments is interference of the sounds from one source. Connect a speaker to the oscillator and generate 1000Hz sound. Pick up the sounds with two corns at two different places and mixing them. When the vertical distance of the two places are $n \times \lambda$ or $(n+1/2) \times \lambda$, you hear enforced sound or weakened sound respectively.

2.4. Stereo recorder (handmade ocarina)

It is known that the characteristic frequency of the air in the container changes according to the total area of the container's surface in contact with the outside air. Mouthpieces of a whistle and a recorder were added to solid containers of various shapes.(Fig.4) Then several holes were put in these containers to allow for air flow

Figure4: Interference of the sounds



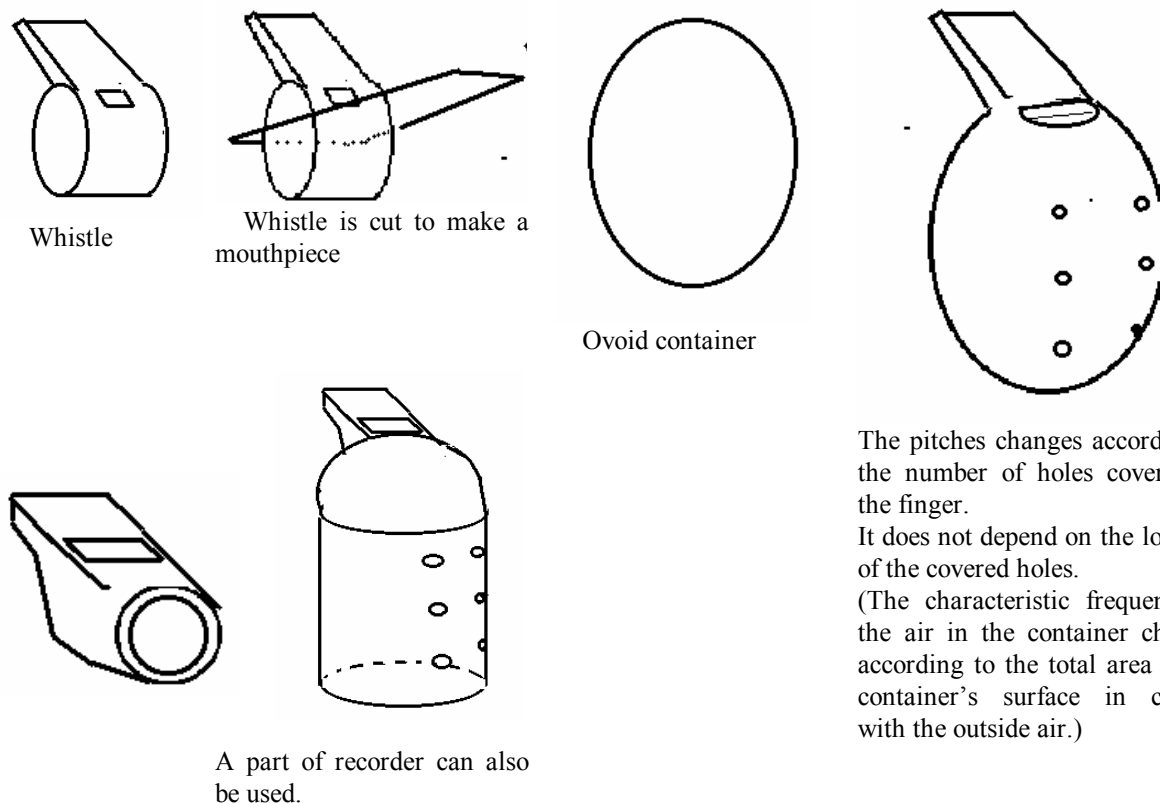


Figure5: Stereo recorder

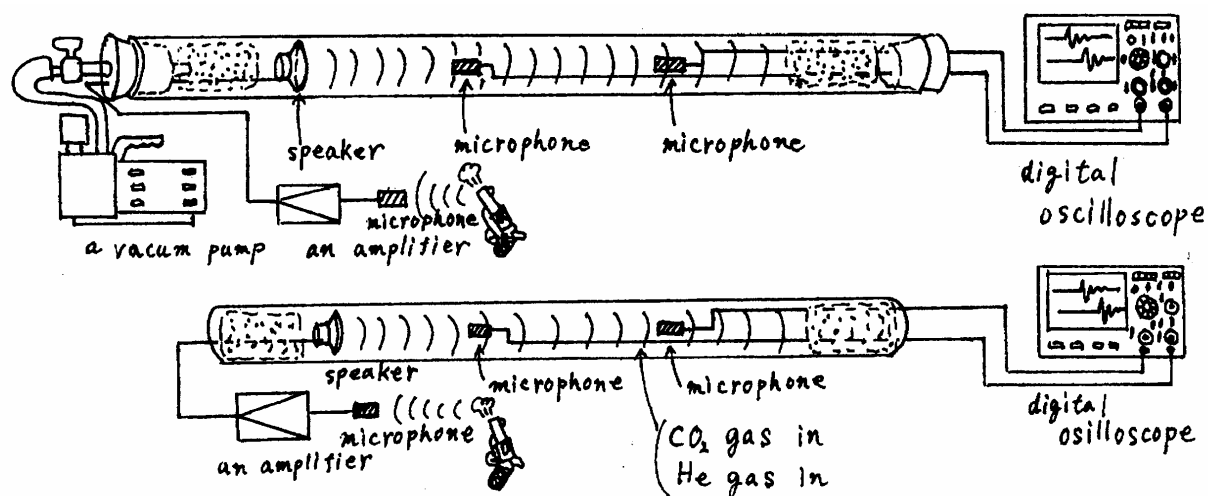
The pitches changes according to the total area of the holes put in the container. The positioning of the holes does not change the pitches. The hand-made containers were able to produce about 1 octave of sound when many small holes were put on them.

velocity in various gases. (Fig.6) Two microphones catch pulse from the speaker. By monitoring the signals from the two microphones, we can know the time sound takes to transmit between them and calculate the sound velocity in the gas. By measuring the sound velocity in the air (1 atm), in the air (1/3atm), in the CO₂ gas and in the He gas, students find that the sound velocity does not relate to the density of the gas but relate to mass of the molecular consisting the gas.

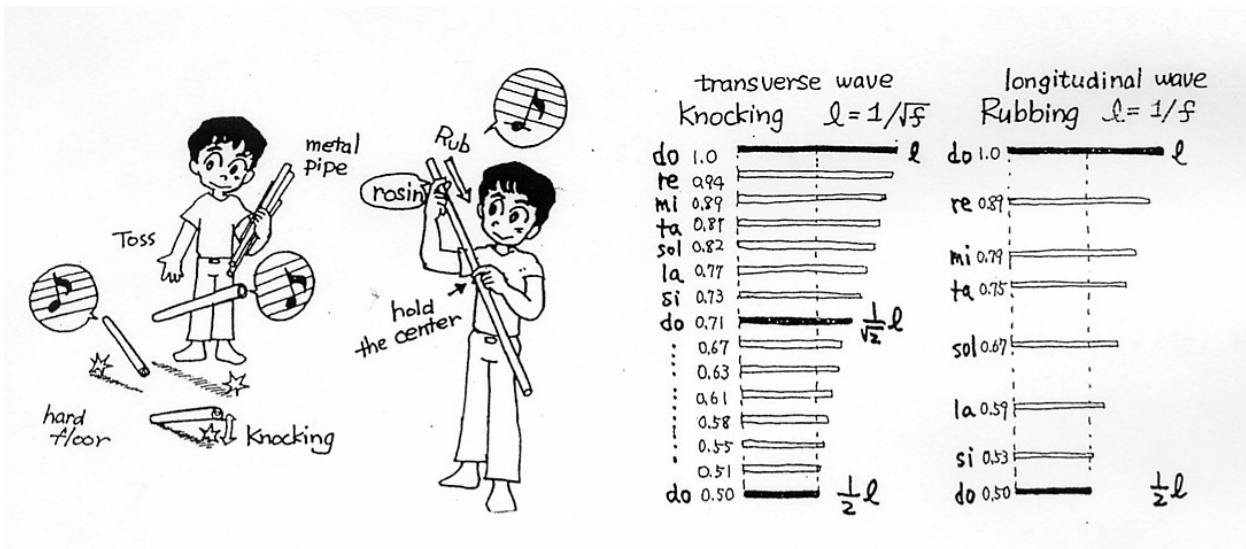
2.5. Measurement of the sound velocity in the gas

We investigated the simple way to measure the sound

Figure6: Measurement of the velocity in the gas



beautiful like the wave from a tuning fork.



2.6. "Rub & Toss" Pipe Music

In 2.2 we show the experiments of the difference between transverse vibration and longitudinal vibration. It is fantastic to make musical instruments by using them. The pitch of the sound of the rod depends on the length of it. If you cut the rod systematically by the wavelength of the sounds they become a musical instrument. Students are very surprised at the beautiful sounds they make. By hearing the two types of musical instruments, students grasp the difference between the transverse vibration and longitudinal one.

2.7. PET bottle musical instruments

It is shown that the Coke PET bottle makes good sound and you can change the frequency by changing the pressure in the bottle. We made musical instruments by putting the valve of the tire tube to the cap of the bottles to adjust the frequency easily. Students are fascinated by the unique sounds from the bottles.

The reason of the good sound is it vibrates stable in the fundamental mode. We observed the shape of it by oscilloscope and found the shape of the sound is very

Figure7: "Rub & Toss" Pipe Music

3. Acknowledgements

We would like to thank Dr.Thomas Rossing for recommending us to participate the Congress. We believe we can contribute to the congress because we are teaching in the school and know what make students enjoy Physics and what change the students' recognition about the Physics concept. We hope many teachers enjoy our experiments and exchange ideas with us.

References

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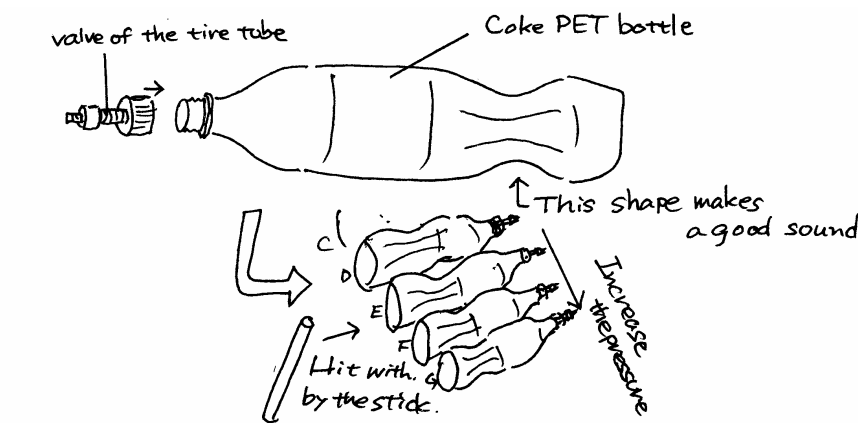


Figure8:PET bottle instruments