

# Stray Cats – Lively and Exciting Physics Demonstrations – Group 1a - Rub & Toss Pipe Music, Three Primary Colors, and Water Rocket -

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## Abstract

*As the first presentation of Stray Cats demonstrations, the problems found in the course of educating high school students are pointed out, and some interesting experiments on the sound of music instruments by the use of aluminum rods, three primary colors, and simple water rocket for teaching physics to high school students are introduced.*

## 1. Introduction

Civilization of mass production, mass consumption, and mass waste in the 20th century cause environmental problems and began to threaten our survival. The 21st century is the time when we should be asked about the human wisdom and ability in order to solve these problems.

Many Japanese high school students are strongly interested in environmental problems. But they think Physics is difficult, uninteresting and trifling. And they believe in supernatural phenomena.

We think there are two keys to make Physics classes worth learning for every student. One is to reconstructing the classes to form their scientific recognition. The other is to show “Physics is fun”, “Physics exists everywhere” and “Everybody can enjoy Physics.”

I pointed out the following to solve these problems at the GIREP 2002.

1) We are now in the information age. We can be more and more easily deceived by manipulated information. Now is the time when we need scientific and rational judgment (challenging unscientific thinking).

2) There are two main natural laws. One is the law of ‘Materials and Energy Conservation.’ The other is the

law of ‘Materials and Energy Diffusion’. We haven’t taught the latter enough in high school science classes in Japan. To teach the latter will be more and more important in physics education in relation to the environmental problems.

3) The IEA<sup>1)</sup> says that many junior high school students in Japan get high scores in science tests, but that they don’t like science. OECD<sup>2)</sup> says that many adults (citizens) in Japan are less interested in science than those in any other 13 nations in the world. Children should be educated so that they will grow to be good citizens, shouldn’t they? These investigations show that science education in Japan has failed. It is important to show “Physics is fun”, “Physics exists everywhere” and “Everybody can enjoy Physics.”

This time I will show some interesting experiments.

<sup>1)</sup> IEA: The International Association for the Evaluation of Educational Achievement

<sup>2)</sup> OECD: Organization for Economic Cooperation and Development, 1996

## 2. Examples of the experiments

### 2.1. “Rub & toss” pipe music

We can make two vibration modes by knocking or rubbing an aluminum rod: transverse vibration and longitudinal vibration. It is fantastic to make musical instruments by using rods. The pitch of the sound of the rod depends on the length of it. If you cut the rods systematically by the wavelength of the sounds they become a musical instrument. Students are very surprised at the beautiful sounds they make. By listening to the two types of musical instruments, students grasp the differences between the transverse vibration and

longitudinal one.

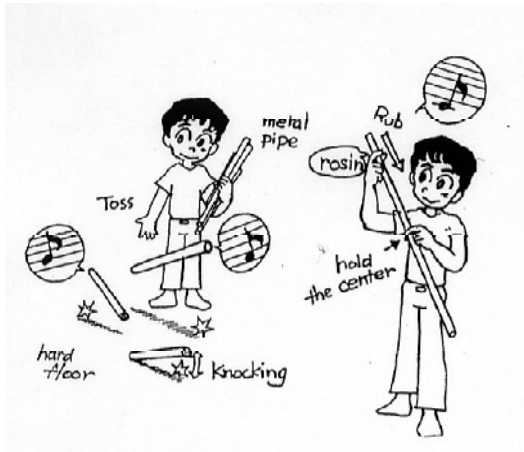


Figure 1. Knocking and rubbing an aluminum rod

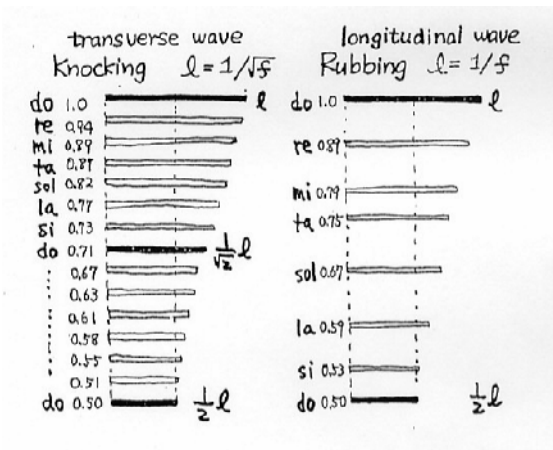


Figure 2. Difference between transverse vibration and longitudinal one

### 2.2. Three primary colors and their shadows

Students wonder how the additive mixture of red, green, and blue lights produces white light.

When they see this experiment, they say “Wow! Beautiful!”

You put a pipe in the white light.

Magenta is the green shadow, which is produced by red and blue beams.

$$(\text{Magenta} = \text{Red} + \text{Blue} + \text{Green})$$

We can think the green shadow is the absorption of green color.

Also Cyan is the red shadow, which is produced by blue and green beams.

$$(\text{Cyan} = \text{Red} + \text{Blue} + \text{Green}),$$

Yellow is the blue shadow, which is produced by red and green beams.

$$(\text{Yellow} = \text{Red} + \text{Blue} + \text{Green})$$

Table 1. Transverse & longitudinal vibration of rod

Ratio of Length

$$f = 2^{(a/12)}$$

f, f': ratio of frequency    l, l': ratio of length

a	transverse vibration $l = (1/f)^{1/2}$			longitudinal vibration $l' = 1/f'$		
	musical scale	f	l	musical scale	f'	l'
0	do	1	1.0000	do	1	1.0000
1						
2	re	$2^{(2/12)}$	0.9439			
3						
4	mi	$2^{(4/12)}$	0.8909	re	$2^{(2/12)}$	0.8909
5	fa	$2^{(5/12)}$	0.8655			
6						
7	sol	$2^{(7/12)}$	0.8170			
8				mi	$2^{(4/12)}$	0.7937
9	la	$2^{(9/12)}$	0.7711			
10				fa	$2^{(5/12)}$	0.7492
11	si	$2^{(11/12)}$	0.7278			
12	do	2	0.7071			
13						
14	re	$2^{(14/12)}$	0.6674	sol	$2^{(7/12)}$	0.6674
15						
16	mi	$2^{(16/12)}$	0.6300			
17	fa	$2^{(17/12)}$	0.6120			
18				la	$2^{(9/12)}$	0.5946
19	sol	$2^{(19/12)}$	0.5777			
20						
21	la	$2^{(21/12)}$	0.5453			
22				si	$2^{(11/12)}$	0.5297
23	si	$2^{(23/12)}$	0.5147			
24	do	4	0.5000	do	2	0.5000



Figure 3. Three colors mixing box by using two mirrors

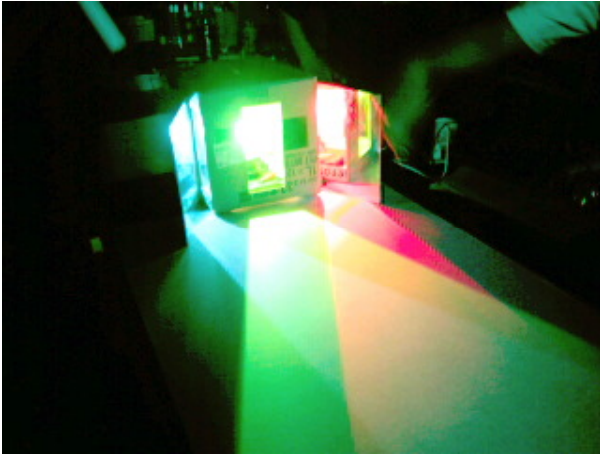


Figure 4. Additive mixture of three colors

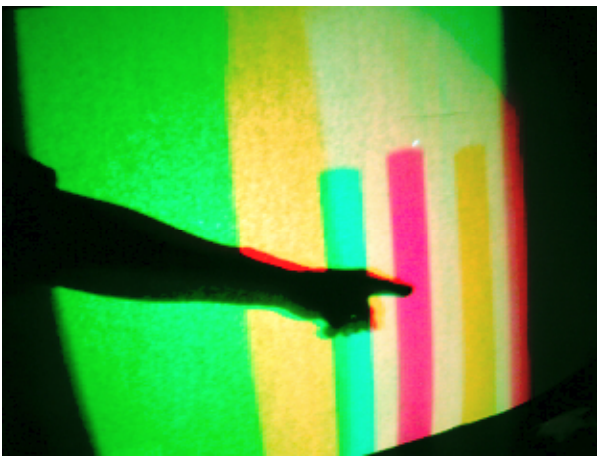


Figure 5. Shadow of red, green and blue light

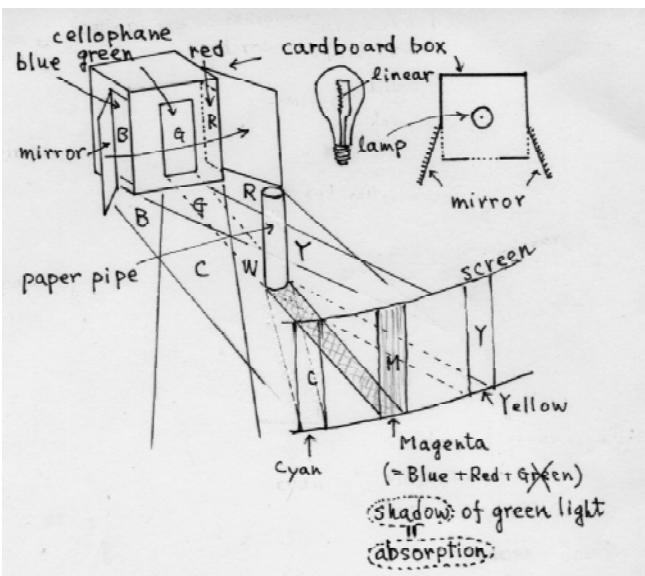


Figure 6. How to make cyan, magenta and yellow

### 2.3. Simple safety water rocket

Students really enjoy physics classes launching their water rockets. These are made of PET-bottles, which are wrapped in a tube of soft plastics. One third of the bottle is filled with water. The bottle is then closed with the help of a garden hose connector and a bicycle valve. Then a bicycle pump is used to fill the bottle with air to create high pressure. When the garden hose connector is released, the rocket takes off.

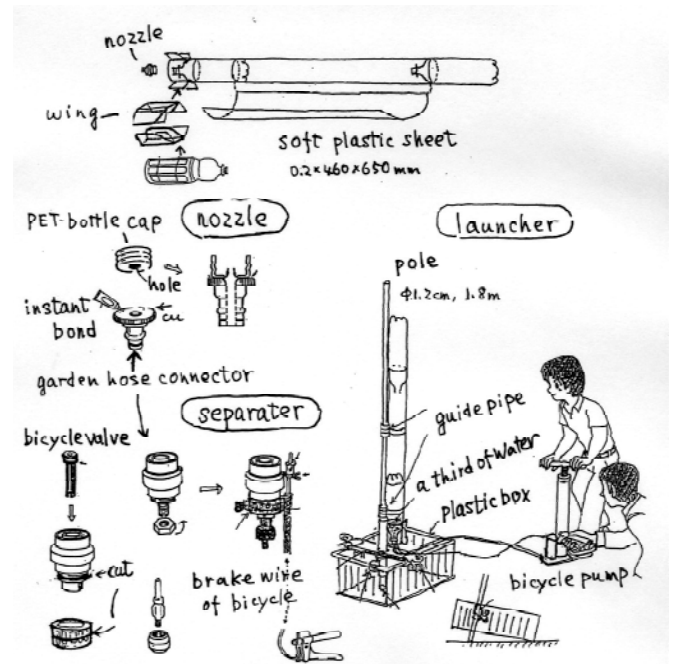


Figure 7. How to make simple safety water rocket