Simple and Beautiful Experiments IV

by LADY CATS and Science Teachers' Group

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LADY CATS (LADY Creators of Activities for Teaching Science) is an organization of science teachers like STRAY CATS. Our group includes a lot of female teachers, which is rather unusual in the field of physics. We would like to propose and exhibit beautiful and simple science experiments that can demonstrate the principles of physics to fascinate students' interest. These experiments are easily made and low-cost. It is also aimed to catch female and humanities students' eyes on physics from the view point of female teachers. Furthermore, we believe that these ideas help resolve gender problems and support non-specialist teachers in primary school.

Effective teaching materials physics will be presented on our hands-on workshop. Let's enjoy with us!!

Hearing "Voice of Atom"

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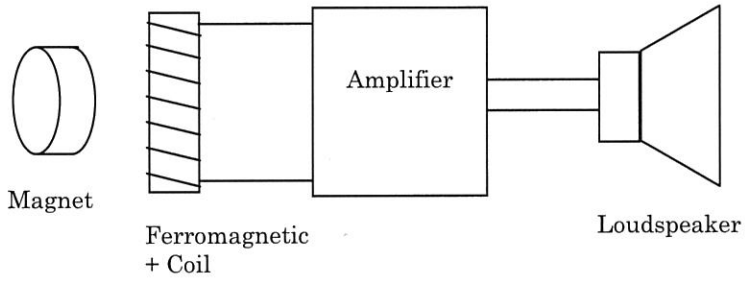
1. How to hear "voice of atom" ?

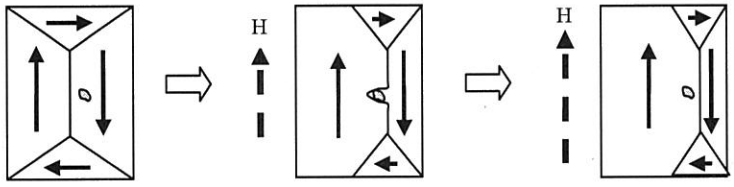
When a ferromagnetic material is magnetized, the magnetic noise is generated because the magnetic wall in the material moves in discontinuity. This phenomenon is called as Barkhausen effect, which is discovered by Barkhausen [1] in 1919.

We easily hear the Barkhausen noise by making the following devices [2]: The coil is rolled in the ferromagnetic such as iron, the edge of the coil tied to the amplifier, and the sound is output from the speaker. If the magnet is brought close to the ferromagnetic, the Barkhausen noise is generated and heard from the loudspeaker.



2. Physics in this experiment

There are lots of magnetic domains where some microscopic spins gather in ferromagnetic. When the external magnetizing field is put on ferromagnetic, the magnetic domain wall moves. When a domain wall moves across impurities, it is temporarily trapped by impurities. The trap is released when the external magnetic field is raised, and the movement of the domain wall continues. Pulsed current flows to the coil by discontinuous movement of such a domain wall.



This experiment is interesting because we can hear the movement of such a microscopic magnetic domain as macroscopic noise. It seems to be educationally worthy.

References

[1] H. Barkhausen, Phys. Zeitschrift, 20 (1919) 201
[2] Lecture demonstration manual, Instructional Research Lab, UCLA physics, http://www.physics.ucla.edu/demoweb/demomanual/electricity_and_magnetism/magnetostatics/barkhausen_effect.html

Curious Cup

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1. What is a Curious Cup (Moral-Cup <教訓茶碗 in Japanese>)

This is a typical folk art in Ishigaki Island, Okinawa.

It looks like a normal cup, and water never runs out from the bottom-pipe even you fill with half-full of it. However, once you fill the cup full with water, water runs out completely through the pipe.

This curious cup reminds you of the following proverbs:

* Feed by measure and defy the physician.
* Kill the goose that lays golden eggs.

2. How to make the curious-cup

Required Materials: paper(plastic) cup, straw, glue, drill

1. Drill a hole in the bottom of the paper cup
2. Insert a straw into the hole.
3. Glue the straw to the cup in order to prevent water leakage.

3. Physics in the curious-cup (Pressure in a fluid)

The pressure is the same at any points at the same level in the fluid.

While you fill the cup halfway with water, it stays since the surface of water does not exceed the top of the straw (Fig.1). However, you fill up the cup with water, the surface of the water in the cup becomes higher than one in the straw. Therefore, water runs through the straw because of the pressure (Fig.2).

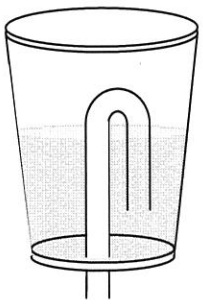

Fig.1

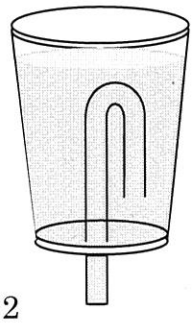

Fig.2

4. Reference [Japanese only]

1) Y. Miyata, (in Japanese) http://www.info-niigata.or.jp/~ymiyata/others/kyoukun.htm

Teaching Materials Based on Science History(Ⅲ)

– Faraday's Motor (Unipolar Motor) –

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Ⅰ. History of Unipolar Motor

The principle of motor was discovered and demonstrated by Michael Faraday in 1821 at the Royal Institution in London.

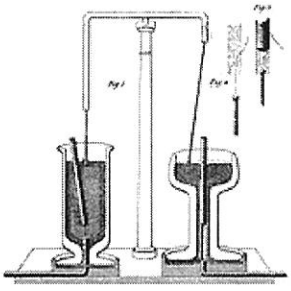

Fig.1 Michael Faraday (1844).
Experimental Researches in Electricity

Ⅱ. Faraday's thinking process

A magnetic needle moves near the lead which current is flowing. In next step, Faraday got an idea that it can keep rotating a magnet. And then he built two devices to produce what he called "electromagnetic rotation" (Fig.1). If supplied with current from a chemical battery;

[A] A magnet rotates in a pool of mercury. (Fig.2)

[B] A wire extending into a pool of mercury with a magnet placed inside that would rotate around the magnet. (Fig.3)

The latter device is known as a unipolar motor. Let's make a unipolar motor.

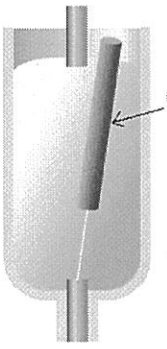

Fig.2

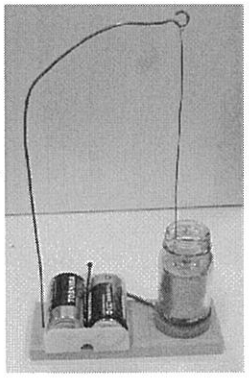

Fig.3

Ⅲ. How to Make a Unipolar Motor

1. Put a battery on ferrite magnets covered with aluminum foil.
2. A wire rotates when it is set as shown in Fig.4.

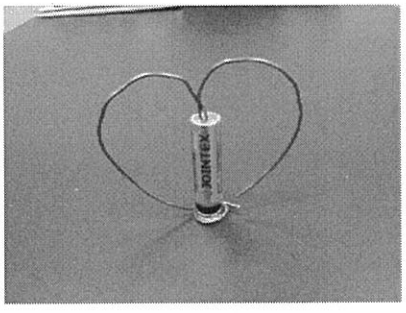

Fig.4

References

[1] M. Faraday, *"Experimental Researches in Electricity (Denki Jikken (jou))"*, Uchida Rokakuho, (1987), in Japanese.

[2]M. Tanemura, *et al.*, "*Simple and Beautiful Experiments III by Lady Cats and Science Teachears' Group*" Proceedings of the International Conference on Physics Education 2009.

Microscope Camera for Plastic Bottle Microscope

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Ⅰ. Plastic Bottle Microscope

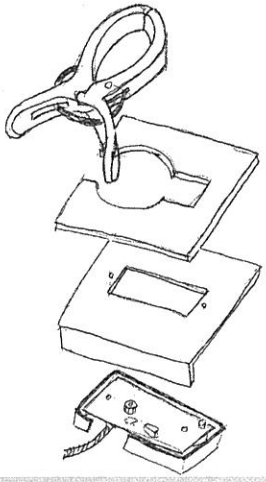
Van Leeuwenhoek[1632-1723] discovered a lot micro-organisms using his handcraft microscope. His microscopes were made of one small grass ball and its frame. Mr. T. Yoshikawa made a portable Leeuwenhoek's Microscope using metal or plastic bottle as its frame[1].

Ⅱ. Making a Microscope camera

◆MATERIALS: USB Camera, clear Plastic case of CD, clothes peg, polystyrene foam plate, double –stick tape, screws.

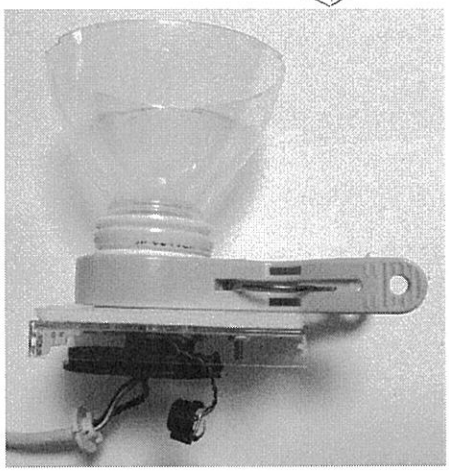
◆PROCESS and ASSEMBLE

1. Remove a panel of USB camera.
2. Cut the clear plastic CD case and make three holes.
3. Cut the polystyrene foam plate.
4. Make a hole in the clothes peg.
5. Combine above parts using the double-stick tape and screws.



Ⅳ. Use the microscope

1. Connect the USB cable of the microscope to a computer and start its viewer software.
2. Set a sample on the plastic bottle microscope.
3. Bind the cap of microscope by clothes peg.
4. Adjust the focus.



Ⅲ. Educational Aim

This microscope camera is portable and easy to show small things on a computer display or screen for many students at the same time.

Reference:[1] T. Yoshikawa;Leeuwenhook's microscope made by plastic bottle;Monotukuri Handbook No.4;Kasetsu Shya(1996)

Rolling Down a Hill

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○ Educational Aim

- Learn the properties which affect the speed of object rolling down a hill.
- Learn the meaning of moment of inertia.

Experiment. I

[Prediction] Which object rolls down a hill faster?

		
Glass Ball (diameter=3cm, 40g)	**Metal Ball (diameter=3cm, 100g)**	**Glass Ball (diameter=2cm, 6g)**

Experiment. II

[Prediction] Which object rolls down a hill faster?

			
Metal cylinder (diameter=5cm, 800g)	**Metal cylindrical shell (diameter=2cm, 20g)**	**Metal Ball (diameter=3cm, 100g)**	**Metal spherical shell (diameter=12cm, 100g)**

✧ **The handout to explain the results of these experiments will be distributed later.**

○ References (Japanese)

[1] T.Shimano, M.Koide, Y.Miyachi, *Kororin: Original Introduction Series3*, Kasetsu-sha, 2003.

[2] M. Mori, Y. Miura, K. Senyo, J. Yasuda, *Handbook of Physics Demonstrations for Students in Nagoya University*, Study Group on Physics Demonstration in Nagoya University, 2010.

Spectrum Kaleidoscope

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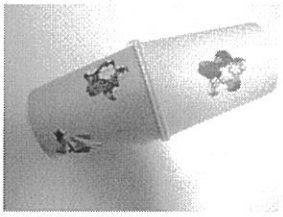
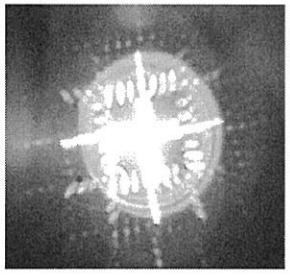


This kaleidoscope does not use amirror. This kaleidoscope uses the diffraction and the interference with light by the diffraction grating.

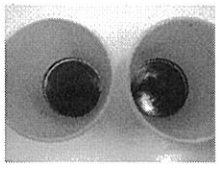
Let's see through light of the fluorescent lamp and the sun. The different world is sure to be seen.



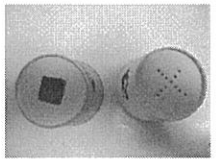
<Preparation thing>

Paper cup (2) spectrum sheet retractable knife scissors thumbtack Scotch tape marker pen (black) drawing paper (black)

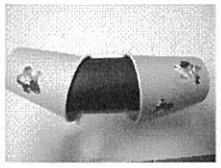
<How to make>



(1) Please paint the bottom in the paper cup black.
(2) Please make a square hole for the bottom in the paper cup.
(3) Please put the spectrum sheet on the hole.



(4) Please puncture the bottom in another paper cup with the thumbtack.(Please devise the pattern)
(5) Please roll the drawing paper, and put it in the paper cup.
(6) Please stick two paper cups together.



(7) It completed! Let's see through the light of the fluorescent lamp and the sun from the spectrum sheet side.

<Attention >

You must not watch the strong light such as light of the sun or the laser beam directly.

<Reference>

DANZYO Shinzi “Fushigitaikan Kagakuzikken”(ISBN-10:4062572672) produced

The Cartesian Diver

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I. The Cartesian Diver

The Cartesian Diver is a traditional toy applying water pressure, which was described first in 17th century [1].

II. Up and Down Experiments

§ How to make the Cartesian Diver

1. We put a weight to one end of a small container.
2. We put water into the container in such that the other end of it floats on the water.
3. We put the container into a plastic bottle filled with the water.

§ Up and Down Experiments

¶ Pre-Experiment

Before we push the bottle, predict the following things:

1. how to move the container,
2. how to change the volume of the air in the container.

¶ Post-Experiment

Was your prediction correct? Why?

III. Educational Aim

When an object exists in the water, it receives buoyancy, which is proportional to the volume of the object. When we push the plastic bottle, the air in the object is compressed by water pressure and the buoyancy of the object decreases, therefore it sinks.

The concept of buoyancy is important in the statics, and whether the object floats or sinks is decided by buoyancy and gravity.

[1] A Philosophical Toy, Richard Frazier, http://www.ed.uiuc.edu/courses/ci241-science-sp95/resources/philotoy/philotoy.html

The PET fiber

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Ⅰ. The PET fiber

The PET fiber is made from a plastic bottle.

A plastic bottle is made from Polyethylene terephthalate (PET). A part of a plastic bottle is recycled to fibers such as the carpets and clothes. Then, to learn recycling the resource, the PET fiber is made from a plastic bottle.

Ⅱ. How to make

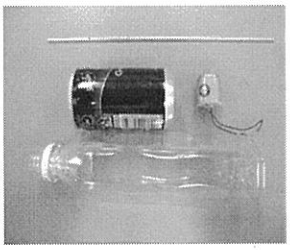

Fig. 1

Plastic bottle, motor, aluminum can, aluminum-pipe (Fig. 1).

1. Make a hole for the center of the upper and the bottom in the can of aluminum (Fig. 2).
2. Make a lot of holes for the side in the aluminum can (Fig.3).
3. Unite a motor and an aluminum-pipe.
4. Be passed the pipe through holes of can (upper and the bottom in the can) (Fig.4).
5. Bend the pipe in the bottom (Fig. 5).
6. Cut the plastic bottle like the pellets (Fig. 6).
7. Put into the can the PET pellets. Turn the can, roast the bottom of can. The PET fiber comes out from holes for the side in the can.

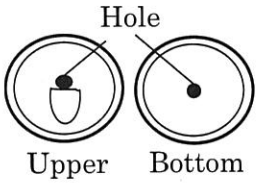

Fig. 2

Fig. 3

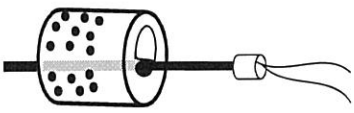

Fig. 4

Fig. 5

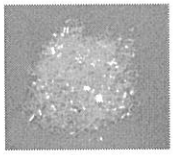

Fig. 6

Ⅲ. Reference

1. Aichi-Gifu Physics circle, "Ikiiki wakuwaku butsuri jikken" Nihonhyouronnsya, p101 (2002), (Japanese).

2. Takeo Samaki, "Rika omosiro jikken・monozukuri kannzen manual" Tokyosyoseki,, p13-17, (1993), (Japanese).

Handmade-Loudspeaker

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If I said that I can make a loudspeaker in five minutes, do you believe me?
I show the loudspeaker that everyone can make low-cost and easily.

1. Preparations

・Paper-cup ・Magnet ・Enameled-wire ・Scotch-tape
・Stereo-mini-plug ・Sand-paper

2. How To Make

First, cut the enameled-wire in 4m. Wrap it around the paper-cup and secure it with scotch-tape.

Next, grind down both ends of the enameled-wire with the sand-paper and pass through it into the stereo-mini-plug's hole.(Figure 1)

Finally, Position the magnets in the bottom of the paper-cup. (Figure 2)

It is completion. (Figure 3)

3. If It Doesn't Sound

Is the enameled-wire neatly ground down?

The volume of the sound source might be too small.

4. Let's Arrange

Let's change the number of rolling of enameled-wires.

Let's change the position in which the enameled-wire is rolled.

Let's try by the one other than the paper-cup.

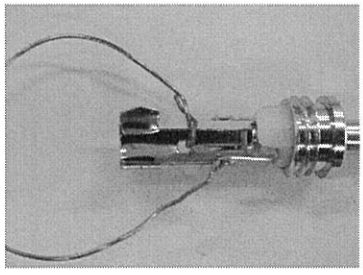

Figure 1

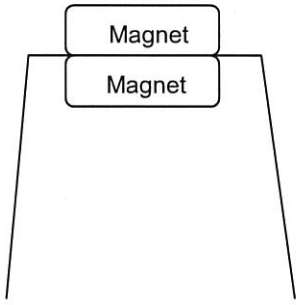

Figure 2

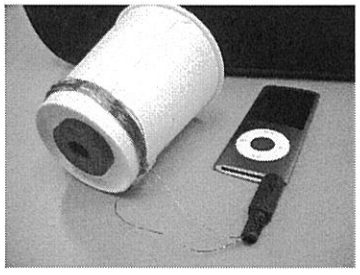

Figure 3

Reference

[1] H.Chikazawa, "Microphone's Speaker", "Ikiiki butsuri Wakuwaku jikken", ISBN4-88011-045-0, Shinsei shuppan, (1988), in Japanese.

SIMPLE CAMERA

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1. INTRODUCTUON

Let's make the camera from a familiar thing. It is possible to make easily and the mechanism is also easy to understand.

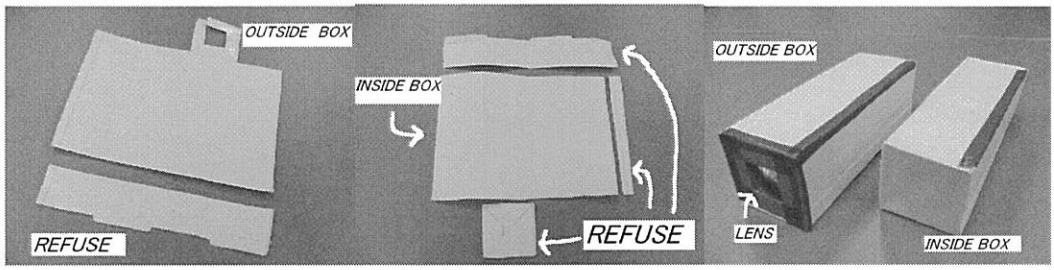
2. PREPARATION

Magnifying glass (convex lens), tracing paper, two paper cartons, black drawing paper, sensitive paper, vinyl tape, cutters, scissors, and irons.

3. HOW TO MAKE

1.Assemble the outside box and the inside box.

2.Put the lens on an outside box.



4. TAKING A PICTURE

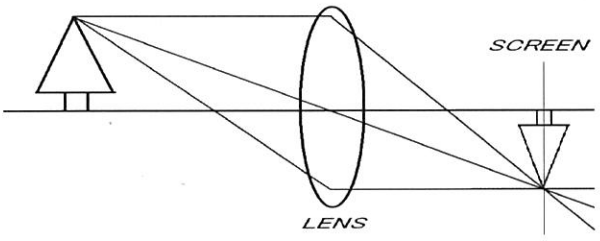
1 Let's peep at an outside box and an inside box, and focus the camera.

2 Sensitive paper is put when the focus is suitable.

3 Leave for 10-20 minutes, and iron sensitive paper afterwards.

5. MECHANISM

Light that goes through the focus and the light that passed center of the lens intersect in the lens back. The image can be done by putting the screen there.



REFERENCE

[1] http://homepage2.nifty.com/pascal/jtool08.html （in Japanese）

A PET bottle Water rocket

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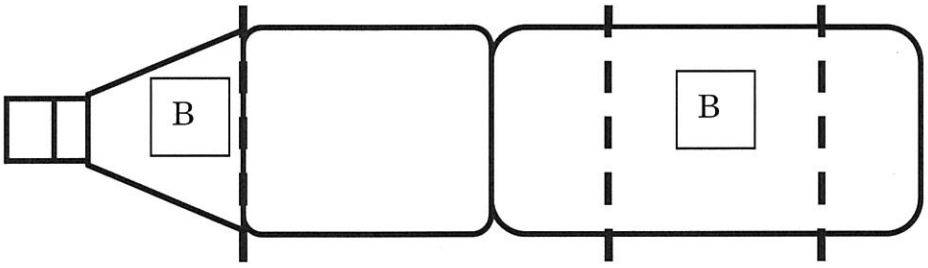
1. Things to prepare

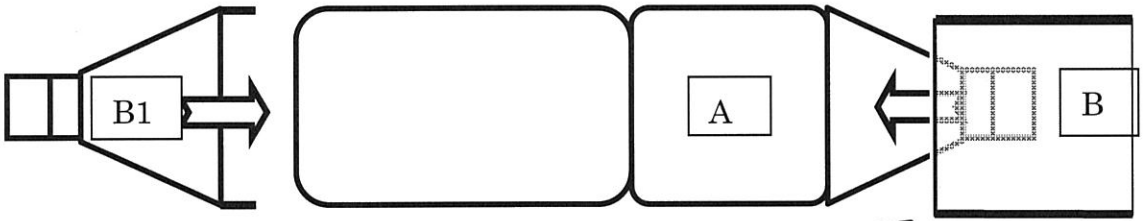
・Two PET bottles ・One is for the carbonated drink (A), another is soft one (B)
・A milk pack or drawing paper ・Plastic tape ・Scissors or a cutter

2. How to make

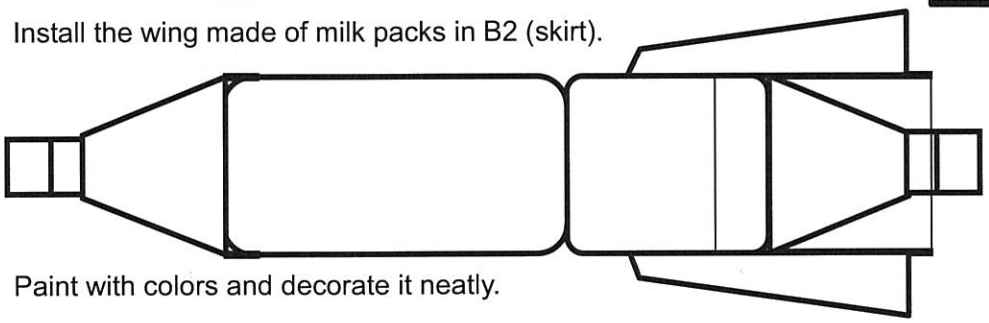
1. Tear off the label of the PET bottle.
2. Cut the top and the part of the soft PET bottle (B) with scissors or cutter.



3. Fix B1 with plastic tape at the bottom of hard PET bottle (A) for carbonated drinks. In addition, I fix B2 (skirt) with plastic tape on a part of, A.



4. Install the wing made of milk packs in B2 (skirt).



5. Paint with colors and decorate it neatly.

3. Physics water rocket

The equation of motion is as follows:

$$m\,dv/dt = F_{ext} - v\,dm/dt \quad (dm<0)$$

The last term is a driving force. It is small in the case of the air, but big in the case of the water.

Reference

1) http://www.wit.pref.chiba.lg.jp/_kikaku/kouza/2009/youshi/HP090822/pet.pdf (in Japanese)