

Simple and Beautiful Experiments V

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 consisting of female staff ranging from primary to university.

Our experiment concepts are, "Simple", "Beautiful" and "Essential". "Simple" experiments are low cost and are easy to perform. "Beautiful" experiments are attractive to children. With these experiments it is also our aim to try to catch female students' eyes and see them from a female point of view. "Essential" experiments help students to learn established scientific ideas and theories.

Furthermore, we believe that these ideas may help resolve gender related problems and would be a great help to non-specialist teachers in primary schools.

Cheap, effective materials for teaching physics will be presented on our hands-on workshop.

For example, Faraday's Motor, the Geiger-Müller Counter, a plastic Bottle Microscope, a "Magnetic chasing", a kaleidoscope, a "voice-copter" and so on.

If you would like to know more about us, please attend our presentation. Let's enjoy physics together!!



Magnetic Chasing

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This is a children's traditional toy. It includes scientific principles of magnetism and moments, or torque.

◆ Materials:

2 x flat magnets 12mm ϕ having a north side and a south side, 1 x button cover 15~18mm ϕ , 1 x 10cm ϕ circle of craft paper of which we will use 1/3, 2 x polystyrene balls 15~18mm ϕ , some double sided tape.

◆ Instructions:

		
<p>1. Stick a magnet to the inside of the button cover.</p>	<p>2. Make a snowman by sticking two polystyrene balls together. Then stick them to the button magnet.</p>	<p>3. Make a cone shaped tree with the craft paper.</p>
		
<p>4. Tape a magnet to the side of the tree, about 7mm from the tree base to the lower edge of the magnet. Ensure that the magnets attract as shown.</p>		<p>5. Finally, bring the tree near to the snowman as indicated by the arrow.</p>

◆ Why does the snowman spin?

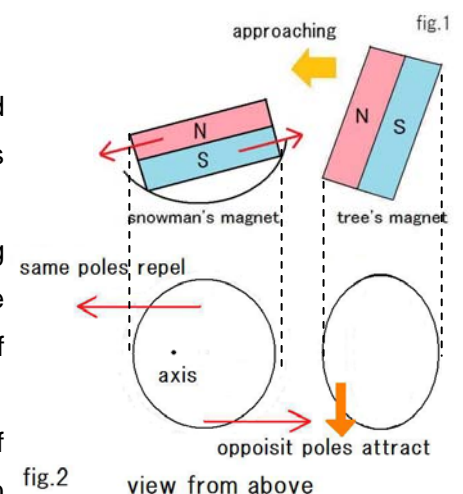
In Magnetism, like poles repel, opposite poles attract.

As the tree magnet approaches, the snowman's magnet lifts and tilts on the rounded base of the button cover, shifting its axis point off centre (fig 1).

Then, the tree magnet is moved sideways, while still moving towards the snowman. This changes the positions of the magnetic fields relative to each other, which creates moments of force in the snowman's magnet (fig 2).

As the magnets are in angled positions, a continuous action of repulsion and attraction takes place, which keeps the snowman spinning.

◆ Let's try! : Make your own original design!



Simple and Beautiful Motors

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I . Educational Aim

The paper clip motor is one of the teaching materials for elementary and junior high schools in Japan. However, there are many students who do not understand the principle of a motor. Instead, I will introduce the Faraday motor, which even elementary school students can easily make. Students can use a soft and colorful aluminum wire instead of a copper wire. These motors are simple and beautiful, so they attract students' interest.

Knowledge of the history of motors helps students comprehend the Principle of the Faraday motor.

II . What is a Faraday motor?

In 1820, Hans Christian Ørsted discovered that passing electric current through a wire produced a magnetic field. Michael Faraday reversed the process and created the first motor. He invented the first device to convert electrical energy into mechanical motion. Fig.1 is an easily built version of his motor. A wire carrying current would rotate around a magnet.



Fig.1

III . How to Make Faraday Motor

1. Form an aluminum wire as in Fig.1.
2. Use sand paper to remove the coating on the wire that touches the battery and the magnet.
3. Put a battery on ferrite magnets covered with aluminum foil. (Neodymium magnets are very strong, so it is dangerous for students.)
4. The wire rotates when it is set as shown in Fig.1.
5. Let's make motors in various forms and shapes.



Fig.2

References

- [1] Dannemann, "Daishizenkagakushi 9" Sanseido(1979), in Japanese.
- [2] M. Taniguchi, et al., "Simple and Beautiful Experiments IV by Lady Cats and Science Teachers' Group" the International Conference on Physics Education 2010



Voice-copter

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1. What is Voice-copter?

This is a paper helicopter with voice.
It spins with your voice.



2. How to make a Voice-copter?

Preparation: Paper Cup, toothpick, paper, tape, scissors

1. Cut a piece of copy paper to make a propeller.
2. Make a hold in the center of the paper.
3. Place a toothpick in the bottom of cup. Be sure to touch the end of toothpick at the center of the bottom of the cup
4. Place tightly a paper propeller to the toothpick.

Procedure

- Hold your cup horizontally as the propeller face up
- speak to the bottom of cup loudly like "Aha-ah-ah"
- check the toothpick is vibrating well, the paper propeller moves well.



3. Physics in a Voice-copter.

Your voice travels through air. When you speak into the cup, the back of the cup vibrates; the vibration extends into the toothpick. The vibration of the toothpick makes the propeller spin.

- Try more: You may make sound with other tools. .
You may make propeller with different paper of size, material
You may experiment with different cup.



The Kaleidoscope

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I. History

The kaleidoscope was investigated by the Scottish physicist, Sir. David Brewster in 1816. His research achievements were wide-ranging, such as studies of polarization, improvement of lightning system of lighthouse and writing of biography of I. Newton. Once he produced the kaleidoscope, it spread among European people and came down to Japan too. Nowadays, they are various types of kaleidoscopes as shown in Fig.1. In each mirror system, we can see a diversity of images.



Fig.1 Various types of kaleidoscopes

II. How to make

◆ Triangular pyramid kaleidoscope

preparation - polycarbonate mirror (cardboard with glued aluminum foil or stainless plate), cardboard, tape

1. Fold mirror to make triangular pyramid.
2. Fold cardboard to make triangular pyramid.
3. Put mirror into triangular pyramid shaped-cardboard.

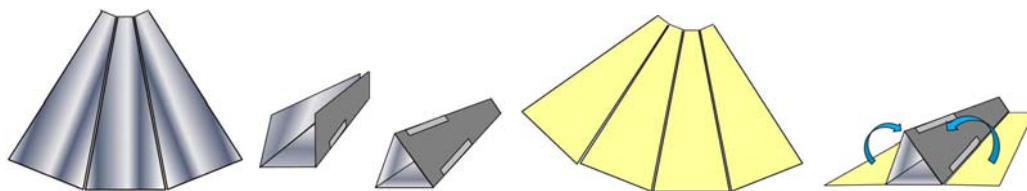


Fig.1 How to make the triangular pyramid kaleidoscope



◆ Two mirror kaleidoscope

preparation - polycarbonate mirror, cardboard, tape, glue

1. Glue mirrors to cardboard. Make diamond shape and taped them as below.

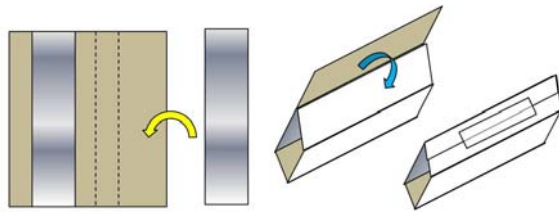


Fig.2 How to make the two mirror kaleidoscope

III. Educational Aim

The kaleidoscope is one of the most popular toys, and contains rich educational aspect of reflection and symmetry. Fig.3 shows various types of mirror system in the cylinder. Each kaleidoscope shows different types of image.

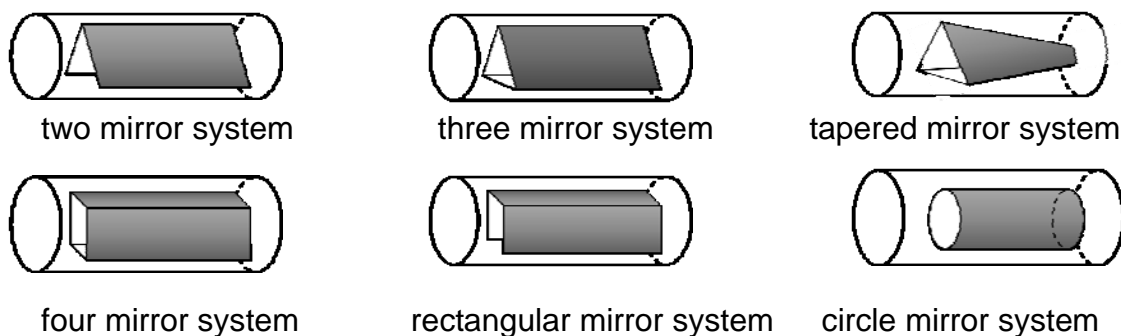


Fig.3 various types of mirror system

I am thankful to Kazue Hashimoto for beautiful illustrations.

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- 1) K.Teruki, "Daredemo Tsukureru Mangekyou", Nitto-shoin, (2011).
- 2) K.Teruki, "Mangekyou", Bunka-shuppan-sha,(2004).



Geiger-Müller Counter Made of a Film Case

Masa-aki Taniguchi

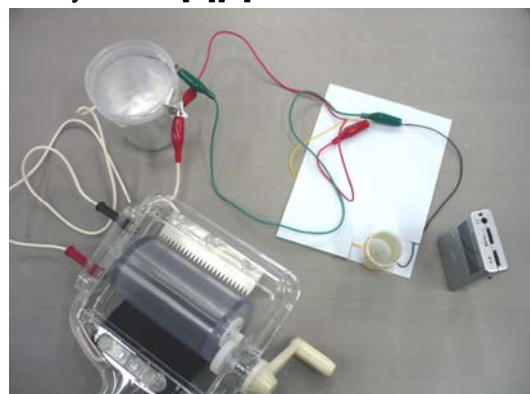
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1. INTRODUCTUON

Geiger-Müller counter (GM counter) is a detector that measures ionizing radiation. We can make this apparatus with daily uses. [1][2]

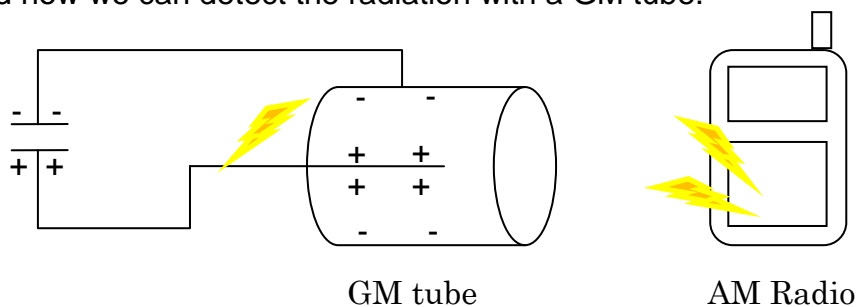
GM tube is made of a film case in which the butane gas is put. The anode is arranged at the center of the film case and the cathode is arranged in its surroundings, and a high voltage is applied between them. A condenser is made of plastic cups and aluminum foil. In this workshop, in order to supply enough electricity, we also use a high voltage generator with hand crank just in case.



2. Physics in this experiment

When an ionizing radiation enters into the GM tube, the butane gas is ionized. The positive and the negative ions move to the cathode and anode, the pulsed current flows, and the electromagnetic radiation is generated. This is picked up on the AM radio.

With this experiment, students can learn that a radiation makes a substance ionize and how we can detect the radiation with a GM tube.



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[1] A. Yano, "Geiger-Muller counter of atmospheric air that can be made by high-school students." Journal of the Physics Education Society of Japan (In Japanese), **38**, p.38-39 (1990).

[2] D. Yonemura, "Geiger-Muller tube that can be made by elementary-school students." Journal of the Physics Education Society of Japan (in Japanese), **41**, p.192-196 (1993).

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Plastic Bottle Microscope

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3. INTRODUCTION

After Leeuwenhoek invented a simple microscope in the middle of 17 century, the technology has been developed, and we, even if children, come to be able to make the microscope with *just* a plastic bottle and a tiny bead (See FIGURE 1). Since the magnification of this microscope is about 200, we can see a crystal of salt, the stomata of plants and so on easily.

4. HOW TO MAKE

We will hand out another sheet to show how to make the plastic bottle microscope. You can make this microscope in 5 minute. Let's try!

5. PHYSICS in this experiment

The principle of this microscope is as same as the usual magnifying glass.

An object can be seen larger than the

real size, because we see the virtual image by the effect of the refraction (See FIGURE 2). In order to bring the object into focus, we need to bring the lens *very* close to the object by screwing the cap of the plastic bottle. This is because the f of this lens is very small and we need to make a small as well to satisfy the equation: $1/a - 1/b = 1/f$. The mechanism of the focus to change the distance between the lens and the object is the same as the one of the squids' eyes, but different from the one of our eyes, which adjust the thickness of the lens.

6. Educational GOAL

The educational goal of this experiment is to understand the principle of the lens and also to understand that the lenses are common as we have it in our eyes.



FIGURE 1. The picture of the plastic bottle microscope.

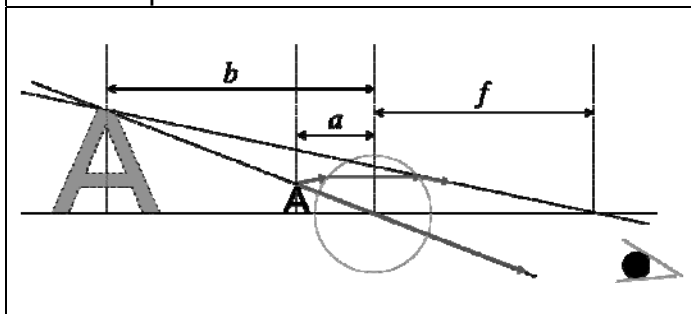


FIGURE 2. The scheme of the microscope. a is the distances from the center of the bead to the object, b is to the virtual image and f is to the focal point.



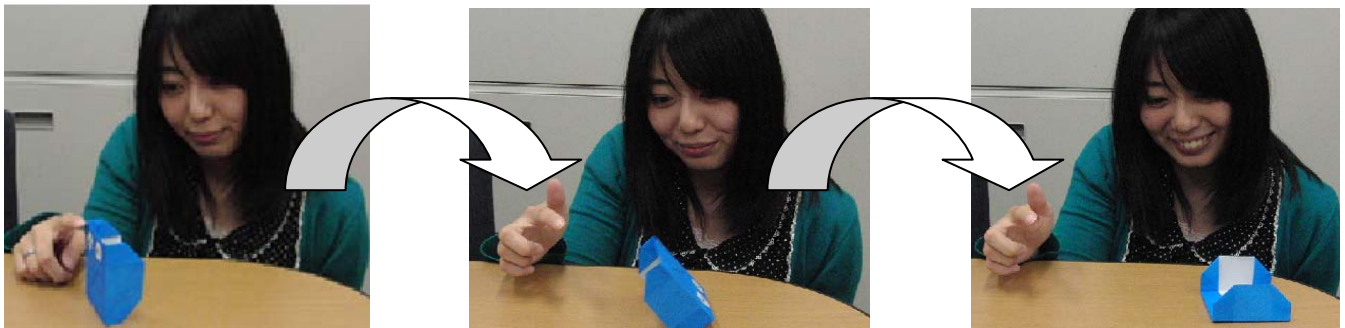
FRONTAL TURN CRAB

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●What is a frontal turn crab?

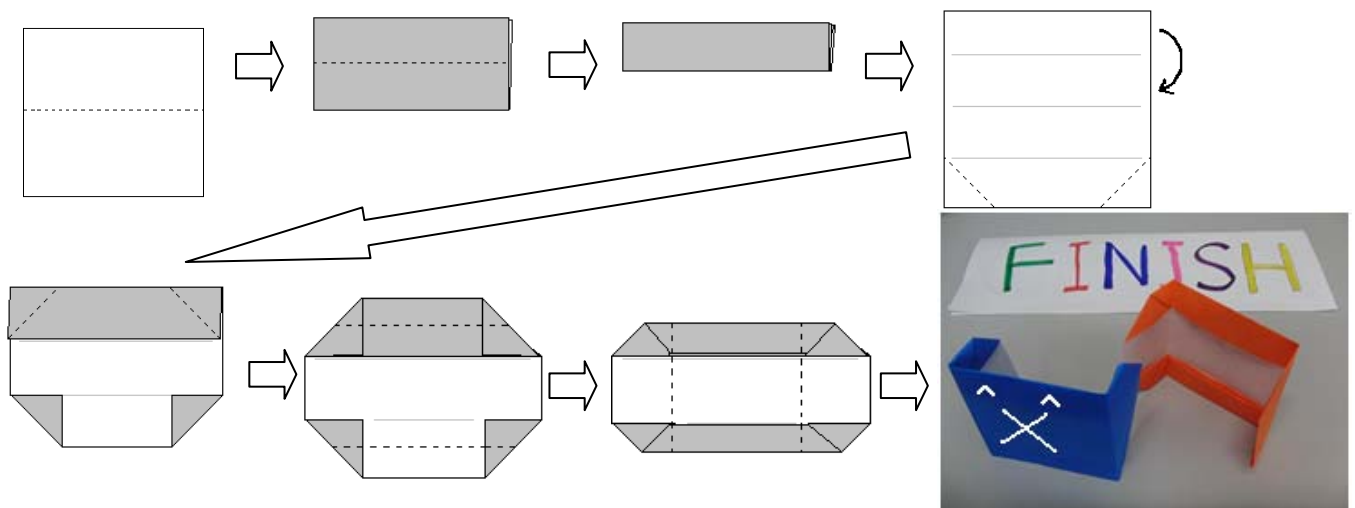
A frontal turn crab is made of one sheet of paper. If it flips with a finger, it will be turned. However, if the crab does a handstand, it will not be turned. It is because then, it has changed the center of gravity. Now, let's make a frontal turn crab.



●Preparation

- Origami sheet (Paper of the square)

●How to make?



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<http://homepage2.nifty.com/pascal/index.html>



The Water Strider of wierwork

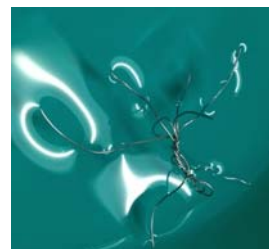
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Although we cannot walk on top of water, a water strider of an insect can walk and move around top of water.

Why can water striders walk on top of water?

It is due to a combination of several factors. First, the high surface tension is known as the phenomenon by the cohesive force among molecules. Second, water striders have waterproof legs which oil soaked. And it is buoyancy. By these three factors, water striders walk on top of water. We make the model of the water strider with wire. It makes you learn through observation on surface of water.



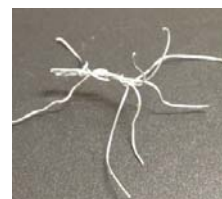
How to make

1. Bend 10cm wire (diameter 0.3mm) twice.
2. Twist it and make it the body.
3. Cut the portion of the point and make it forelimb and an antenna.
4. Cross two 5-cm wires in the middle of the body.
5. Twist wire around the body and make it a leg.
6. Adjust balance so that a model may stand.

A model is completed.



You poured water into a glass, and float a model carefully. When you use the tweezers, it becomes easy to do it. Let's observe the surface on the water. When you cannot float it well, you must contrive the shape of the leg. All the legs of the model need to be attached to the water surface.



Reference

SASAKI Kenichi, K science Lab, "Sasaki Sensei no omoshiro zikken"

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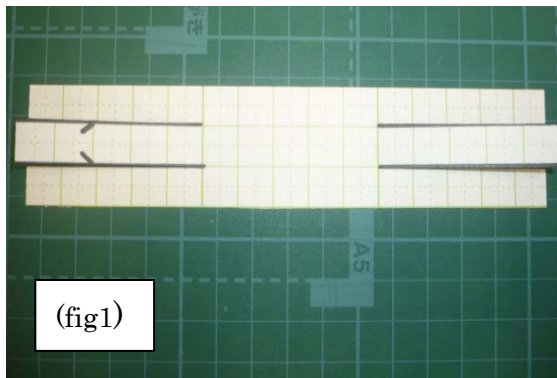


TOKOTOKO HORSE

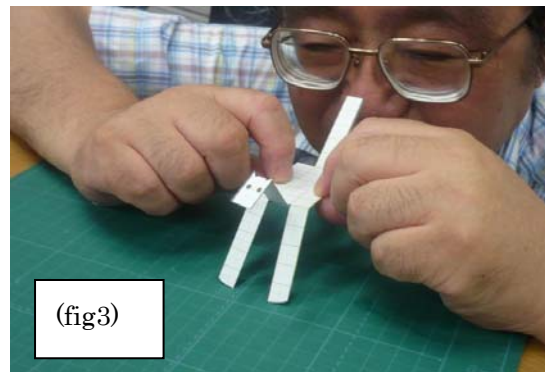
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Let us make pretty horse, swinging his body, running down the slope. Because of paper craft, we can easily change the horse shape into CAT or ELEPHANT or the other child like ANIMALS. So this paper crafts are attractive among the children.



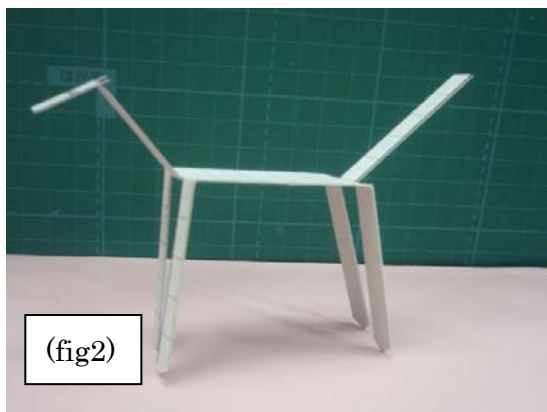
(fig1)



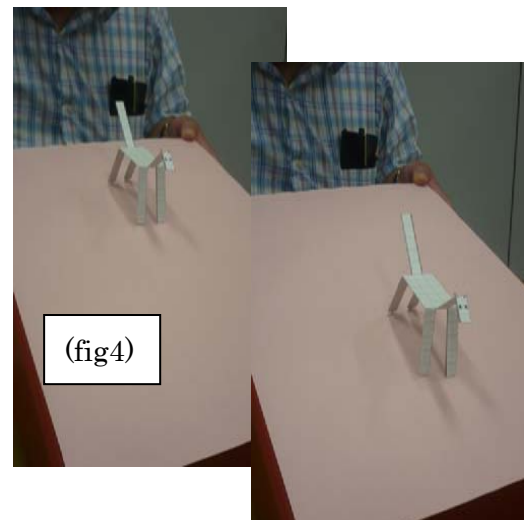
(fig3)

Cut the thick craft paper to $3 \text{ cm} \times 15 \text{ cm}$ (Fig1) And fold into horse. (Fig2)

Finally, cut slantingly the four horse legs. (Fig3) Then the horse will be running down the slope swinging .(Fig4)



(fig2)



(fig4)

References

- [1] "**Wooden Craft**," German Traditional Toy.
- [2] Shigeki Noro, "**Paper Craft**," <http://sky.geocities.jp/noroshigeki3/>
- [3] Room of Pascal, <http://homepage2.nifty.com/pascal/jtool110.htm>

