

## Stray Cats – Lively and Exciting Physics Demonstrations – Group 3b - Motion of a Projectile Using Gravity and Inertia, and Visualization of the Concept of Field -

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### Abstract

As the sixth presentation of Stray Cats demonstrations, the following experiments for teaching physics to high school students are introduced. The first is an experiment to understand the motion of a projectile with a fun and surprise. The second is for visual observation of the concept of the field; magnetic field, electric field, electrostatic induction, electromagnetic induction, and electromagnetic wave propagation.

### 1 Introduction

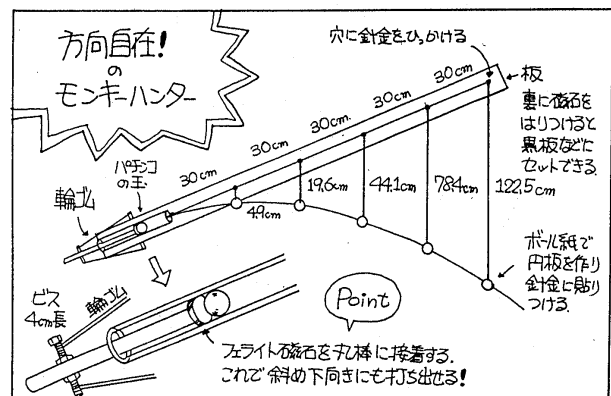
Many Students say, “Physics is difficult to understand, because it is complex. For example, when we learn about projectile, we must memorize many equations.” In order to respond to these opinions, it is effective to simplify the phenomena and to demonstrate them.

### 2 Explanation about motion of a projectile using gravity and inertia

A monkey hunter with which one can shoot in any direction is designed and constructed. By the use of ferrite magnet attached at the end of piston, the iron ball can be ejected even at a downward angle. An illustration of this device is shown in Figure 1. It is hoped that the description in the figure is understandable even though the explanations are written in Japanese. The relation between velocity and acceleration under gravitational field can easily be understood with this experiment. The motion of projectile can be described with a combination of motions governed by the inertia and those by the force.

**Table 1. The velocity and displacement for the motions of constant velocity and constant acceleration**

	Constant velocity	Constant acceleration
Velocity	$v_0$	$\alpha t$
Displacement	$v_0 t$	$(1/2) \alpha t^2$



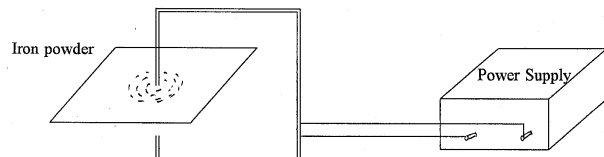
**Figure 1. An experimental device to demonstrate the motion of projectile, “Monkey Hunter” able to shoot in any direction**

### 3 How to teach physics by the concept of field for high school students

It is effective to learn about the field in the first five or six physical classes. Many students feel “Physics is interesting and practical.” Although the concept of the field is hard to understand, visualizations of the field often help for the students to understand the field.

#### 3.1 Observation of magnetic field using iron powder

Although nothing is visible in the space around an electric current, it is a special state called “magnetic field.” One can visualize how this state looks like, by scattering fine iron powders as is shown in Figure 2. The electric current in the magnetic field feels the electromagnetic force from the field.



**Figure 2. A device to show the magnetic field with iron powders**

### 3.2 Observation of electric field using hairs in small size

Just like in the case of magnetic field around an electric current, the space around an electric charge is also a special state, which is called “electric field.” This state of electric field is visible if tiny thin hairs are scattered as is seen in Figure 3.

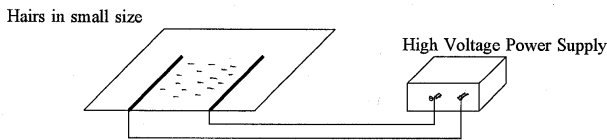


Figure 3. A device to show the electrostatic field with short thin hairs

### 3.3 Confirmation that energy can be taken out from the field

You might think the existence of electric or magnetic field is just an abstract concept. Let’s take out energy from the field. As is shown in Figure 4, a neon lamp will flash when it is connected to two electrodes and placed in high electric field. A light emitting diode (LED) will turn on when it is connected to a small coil and placed in oscillating magnetic field.

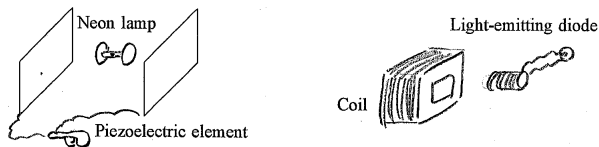


Figure 4. Devices to show the energy can be taken out from the field

### 3.4 Generation of electric field with changing magnetic field

When the magnetic field around a coil is changed in time by moving the coil, an electric current will flow in the coil, and a LED turns on. It is clear from this fact that electric field is induced in the coil. It is called “electromagnetic induction.

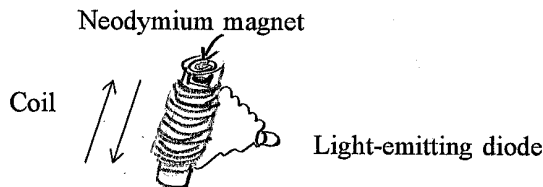


Figure 5. A device to show the electromagnetic induction

### 3.5 PROPAGATION OF ELECTROMAGNETIC WAVE

When electric field is changed rapidly, the magnetic field generated by the electric current caused by this electric field will also change rapidly, and induce electric field varying in time, as is in the case of above-mentioned experiment. This electric field again produces magnetic field varying in time, and the process continues in a cyclic manner, like chains of electric and magnetic fields, intersecting each other. This is the propagation of electromagnetic wave, which is verified experimentally by Hertz.

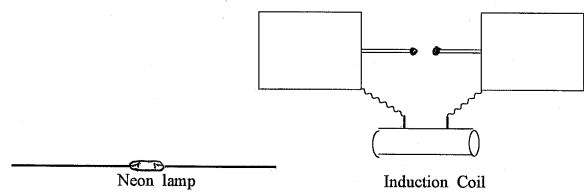


Figure 6. An experiment to show electromagnetic wave propagation

### 4 Conclusion

A monkey hunter to help understanding of the motion of projectile, and experiments for understanding the concept of fields are introduced. The reactions of students are quite favorable to this kind of education.

It has been proved from the students’ response that the education with experiments showing essence of nature and lectures to the point is quite effective to guide students to an attractive world of physics.