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Contents

The New Japanese National Curriculum and Science Education in Junior High Schools – Physics and Chemistry

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I. New national science curriculum

The new national curriculum went into effect both in elementary schools and junior high schools in April 2002 and the syllabuses of all school subjects in every grade have been dramatically changed at once all over Japan. There are two key words in this revision of the course of study: "IKIRU-CHIKARA" and "YUTORI". The evaluation system has also been changed to an absolute criteria.

1. *IKIRU-CHIKARA*. This is the main policy of the new curriculum, whose literal translation means "power for living" It is a very abstract policy. The main objective is that students should learn both how to learn and the way of thinking by themselves rather than just to achieve high grades. Teachers should not only teach the knowledge but also give children some chance to develop the ability to think, experience and do research in their classes.

2. *YUTORI Education*. YUTORI means time to spare or to have something enough and rich to try. This policy is aimed at the development of individual talent rather than learning by memory. It was thought that the required subjects were very difficult to learn due to too much content in the course. In the new curriculum, the amount of basic knowledge has been reduced in the required subjects with the aim that most of the students can understand the subject as a result of learning. However, in the new course of study, the number of class periods for school subjects has been reduced by 10 %. One of the reasons why class hours have been reduced is that we are starting the five-day a week school system. Until recently, students used to go to school every two Saturday mornings per month. The other reason is the introduction of comprehensive education and the expansion of class hours in elective subjects; 2 hours/week are provided for comprehensive study and 3 hours/week are provided for elective study in the third grade of ordinary junior high schools. Teachers are new to this approach and have no experience of teaching with such a number of hours except in the required subjects.

3. The change of the evaluation system to an absolute criteria from a relative criteria. Both fundamental knowledge and skill is still important, but the development of the individual talents is emphasized. So, the Ministry of Education & Science (MOES) requires teachers to use formative evaluation.

II. The new situation in the teaching of science (physics and chemistry) following the revision of the course of study.

The Japanese national curriculum has been very rigid and centralized by MOES for more than 100 years, but, for the first time, it has tried to loosen up the detail-standards in the new curriculum. This is a big change. On one hand, for example, MOES would not make any standards of achievement in comprehensive education and elective subjects. Every school has the chance to use freely a large number of the study hours if it is not too difficult for the children to study in this approach.

On the other hand, MOES made a cut in many study hours of required traditional subjects for the sake of the introduction of the new subjects. As a result, important knowledge and skills that teachers should teach has disappeared from the courses of study. The problem is that there has been no reasonable process or discussion in the making of the courses among researchers, teachers and MOES. Almost all the researchers and teachers had no information. Many science teachers doubt that reasonable arguments were made in the process of making this cut and the selection of the subjects. Today many people worry about the possible lowering of the scholastic ability of students and that this should be addressed immediately. Let me outline some important problems resulting from the changes in the course.

1. The national standard of study hours of science in compulsory education for 9 years (age 6-14) is fewer than in many countries (Table 1). The total for science classes is 640 hours. This means that almost 400 hours has been cut compared with the standard 30-40 years ago.

Table 1. New Standard of study hours of science in compulsory education for one year

	Elementary school						Junior high school		
Grade(age)	1(6)	2(7)	3(8)	4(9)	5(10)	6(11)	1(12)	2(13)	3(14)
Hours	—	—	70	70	95	90	105	105	80

*1 study hour =50 min. **One year is considered the count of 35 weeks

2. Teachers must teach units of science in the order specified by the national curriculum. They must not make their own orders. There has never been such restriction before.

3. Reduced content of science (Physics and Chemistry) in junior high school

   (a) The concept of "The particle" is regarded to be too difficult for students under age 13. Models of atoms and molecules cannot be taught in the first grade of junior high school. As a result of this restriction, it has become difficult for teachers to teach solubility, change of state and molecular motion.

   (b) As some important equations are relatively difficult, they have disappeared from science textbooks. For example, definitions of density, solubility, and electric energy

   (c) The concept of "the ion" was taught in the third grade of junior high school until March 2002 but now this has been cut as it was considered to be too difficult. However, the use of the electric battery remains in the syllabus. Many teachers say, "How do we teach the electric battery without the ion?"

   (d) There are also some other concepts cut from the course of study in junior high school, such as work, free fall, force and spring, addition of force, buoyancy and water pressure, an gaseous discharge, alternating current and so on.

   (e) The periodic table of elements has disappeared from textbooks. It shows the periodic law in elements, and is a very useful teaching aid. Textbooks used to display it on the inside of the cover page.

III. Conclusion

The next revision of the national curriculum may come about exceptionally earlier than usual because there is so much concern about a decline of scholastic ability in junior high schools.

"Current and Energy" A Lesson Plan for Electric Circuits Based on Children's Preconceptions

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Summary
Many studies have reported difficulties with the introductory education of electric circuitry. Also they have pointed out that children 's preconceptions in the domain of electricity often obstructed understanding of the physical concepts. This report gives a brief introduction to a lesson plan which enables children to comprehend the electric circuit as a system of transportation and consumption of electrical energy. The "Wattage Indicator", presented by Hasegawa, was efficient in enabling the understanding of electrical circuits. This lesson plan is suitable for 13 to15 year old pupils.

a. The lesson plan based on children's preconceptions

Our first consideration is that children's preconceptions of electricity are made up of mixed images of energy, power, current and voltage. Secondly, children 's primary image of electricity is that it is the energy in physics, as they have a sense of consuming electrical energy for household devises and paying for it.

Our plan starts from electrical power and energy though many lesson plans start from electric current. Wattage (power) is the only quantity that we can relate to directly in daily life while electric current and voltage (energy) cannot usually be felt or seen. So children could begin with energy and wattage easily in this plan.

b. Separation of the concepts of voltage and current

It is difficult for children to distinguish concepts of voltage and current from a primitive image of so called "electricity". It has been pointed out that the separation of the images of voltage and current is significantly important in introductory education[ii]. This plan has been successful in this subject using the following procedures.

c. Concepts of this lesson plan

1) Our Current and Energy[i] is a lesson plan using a hypotheses and experiment method which was proposed by Itakura in Japan. In this method, children learn a scientific principle through a cycle of expectation, experiment and discussion of a subject where human intuition and scientific principles often conflict.
2) Conception models

- Current (A): the fictitious, positively charged particles which go round the circuit. Amperage is the number of particles passing a certain point in a circuit per second.
- Voltage (V): voltage is a difference in electric potential between two points in a circuit. This means that the charge comes to a point of higher electrical potential energy at a power supply and comes to a point of lower energy at a load. In our plan, we used the following model for voltage at the introductory stage for 13 to 15 year children. Voltage is either an increase of energy per particle transferred at a power supply or a decrease of energy per particle transferred at a load. Each particle receives a bundle of energy

and relieves it at a load (bulbs, resistances). This model enables the images of current and voltage to be separated and is helpful at an introductory stage but is not an exact representation. Children will learn about physical terms such as work, potential energy, electron and charge in the following grades.

- Power (W): quantity of energy consumption at a bulb (or household devises) per second in a circuit.

$$\begin{aligned}\text{Power (W)} &= \text{V [difference of energy/particle]} \times \text{I [number of particles/second]} \\ &= \text{[consumed energy/second]}\end{aligned}$$

In this plan, we used the "Wattage Indicator" as an effective visual description of energy consumption and energy transfer from a power supply.

d. Wattage Indicator

We call the rectangular areas labeled W in Fig. 1, as Wattage Indicators, which shows both the amount of power (energy/second) transfer from the power supply and the amount of power consumption at a load (in series or parallel) in a circuit. The vertical length of the wattage indicator represents the value of the voltage (V) and the width represents the value of the current (A).

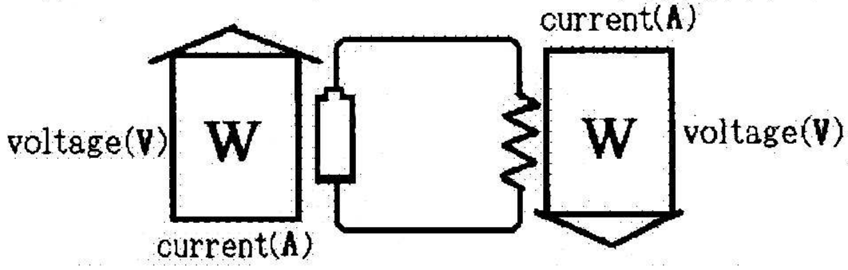

Fig.1

If we put a 4 ohm nichrome wire as a resistance in a circuit, as in Fig.2, power consumption will be 36W. When the nichrome wire is changed to 8 ohm, as in Fig.3, the current will decrease (as is known in Ohm 's Law) and power will be reduced to 18W.

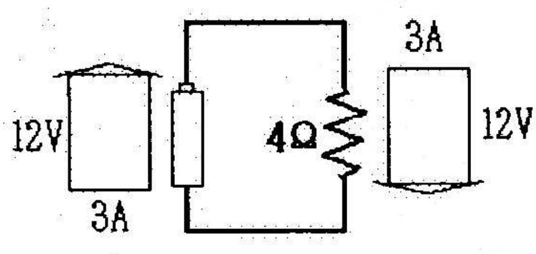

Fig.2

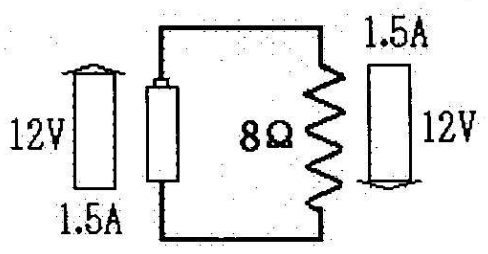

Fig.3

These explain the the difference between red-hot and dark-hot wires. The Wattage Indicator indicates the decrease in power (36W to 18W) and change in current (3Ato1.5A) through its width. The **Wattage Indicator** can connect the change in the heating and the change in physical value with a visible diagram. In our lesson plan, precise questions are prepared to make sure the children understand which value changes and which does not in this experiment.

We consider that understanding the relationship between resistance and power is more effective than that of resistance and current, for, in our daily life, the control of electrical power is more apparent. The brightness of the rooms, loudness of sound devises, productions of heat in kitchenware – most of these devises are consuming electrical energy and being controlled by the regulation of current with resistance. The increase or decrease in power can be described clearly with the **Wattage Indicator**.

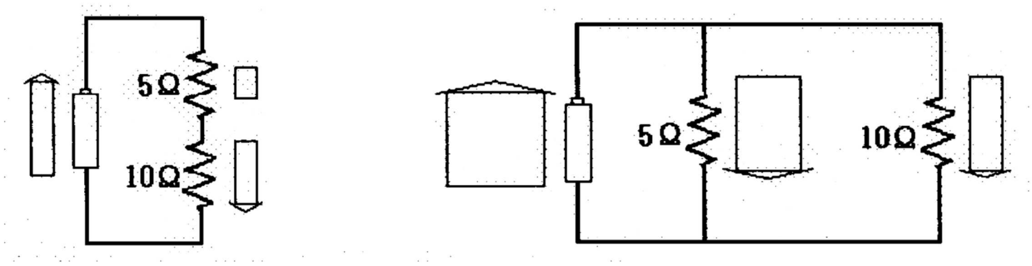

Fig.4

e. Systematic understanding of the circuit

Children often consider the power supply as a constant source of current. When they discuss the above experiments, they don't recognize the change of power (W) from the power supply, although they predict the right value of power for the wire. Moreover, children tend to regard the change in the current occurs only in a local section (for example "after the resistance"). They did not have exact ideas about the current from the power supply. After adequate questions and measurements, they understand the following: a change in the resistance (or increase in the number of bulbs) in a circuit varies the current through every point of the circuit. The two Wattage Indicators together show that no energy consumption occurs without an energy transfer from the power supply. Besides that, they understand the amount of power from the power supply is equal to that of power consumption at a load. The Wattage Indicator supports a systematic understanding of the transportation and consumption of electrical energy in the circuit.

Effects of Current and Energy using the Wattage Indicator
Statistical results

According to our survey, almost 60 to 70% of the children who had learned by this plan have come to identify meanings of current (A) and voltage (V), current and power(W) some 5 months after class lessons. Further results show that 70 to 80% of the children have succeeded in answering questions to distinguish the sections of a circuit where energy is consumed from those where energy is not consumed.

Children's comments after the lesson (1998,1999)

A: I had no idea of the difference between current and energy, but now I can discuss it easily. It's interesting.

B: Now I have confidence in myself. I can understand how electrical energy is consumed.

C: At first I couldn't say which value would change, but now I can predict it with the Wattage Indicator

D: I wasn't interested in electricity at all. But, I realized that it was easy to explain how electricity works with the Wattage Indicator, and I 'm interested in it now.
E: I didn't know the difference between a series circuit and a parallel circuit. I understand the difference easily with the Wattage Indicator.

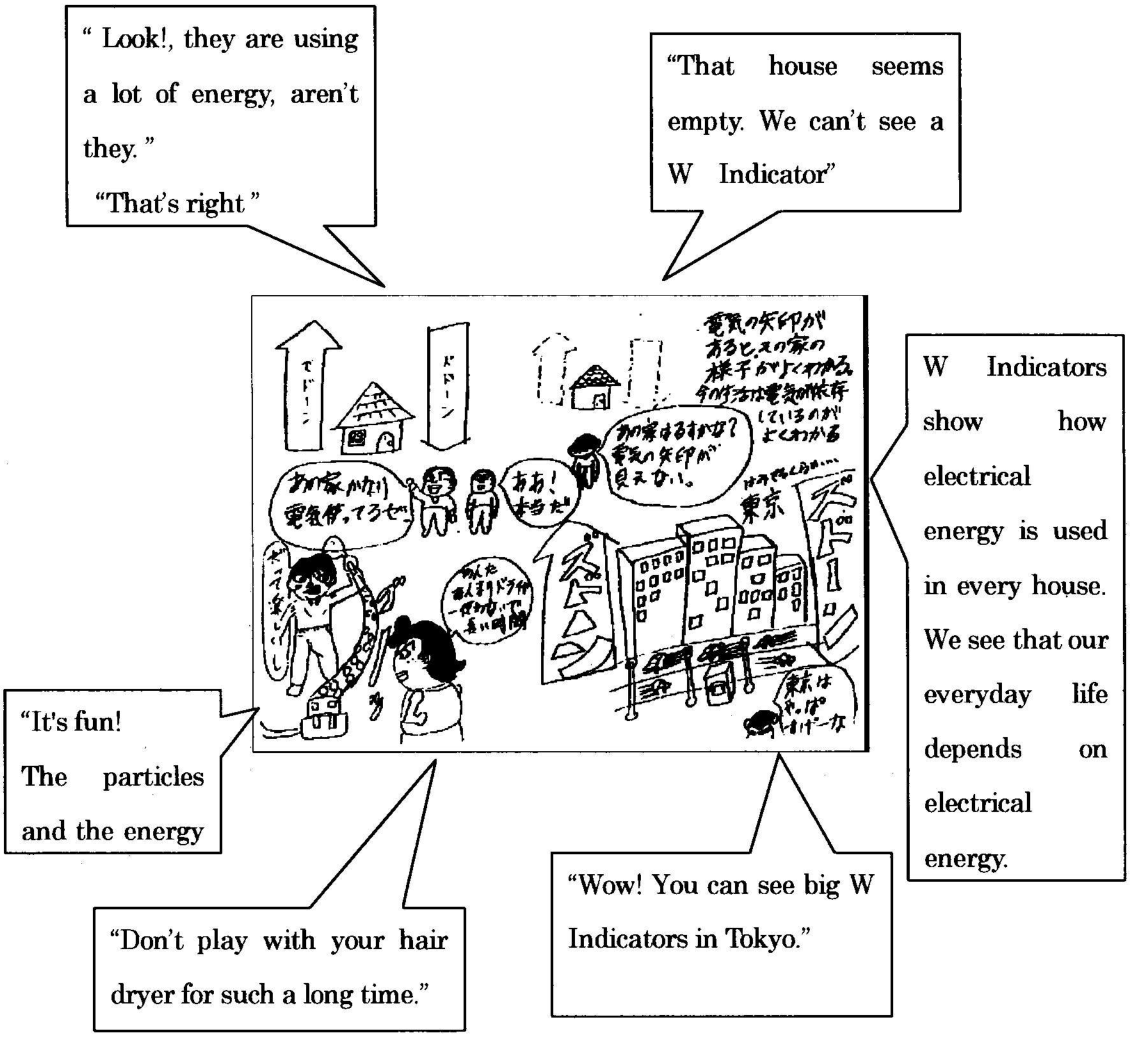

Fig.5 Images inspired by the Current and Energy lesson by a 14 years old boy. The lesson was given by Ms. M.Takimoto, Jyonan junior high school. (1999)

[i]T.Hasegawa, M.Kobayashi. The entire plan is 80 pages (printed on A5 paper) in Japanese. A translation into English is planned.
[ii]R.Duit , C. Rhoneck, Learning and Understanding Key Concepts of Electricity 1998 ICPE book (http://www.physics.ohio-state.edu/~jossem/ICPE/C2.html)

Cellular Phone and LED Detector

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I first came across an LED detector at a stand in the 2001 Summer Science Festival for Youngsters held in Tokyo. It consisted of three parts - a LED, a diode and a coil (Fig.1). It was very simple! At the stand, people had to make a detector by themselves. I took about ten minutes to make one.

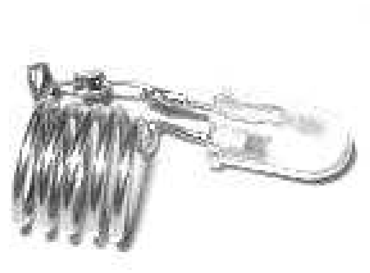

Fig.1

After that in November 2001, the article "Electromagnetism in the Pocket", written by Dr. Katsuyama, showed me another example of a LED detector for the cellular phone (1).

I made my own

In the article, he shows that it is necessary to use 4 diodes to get a voltage high enough to light an LED. I could not understand the necessity for 4 diodes, so I made detectors using only one diode. The detectors work well. The components used were a diode (IN60), a high intensity-type LED and a 6cm length of copper rod. The total cost was about 150 yen (the IN60 was 30 yen, the LED was 80 yen). Fig.2

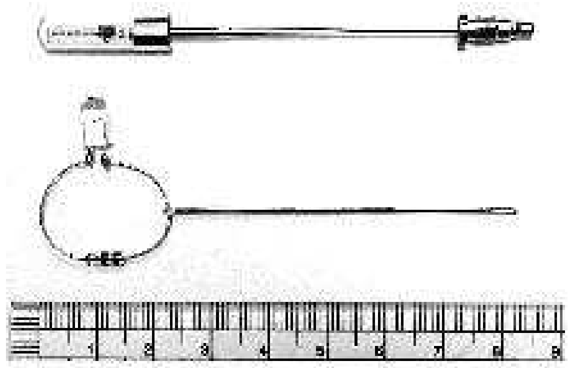

Fig.2

In Fig.2, the above is the LED antenna for a 1.5GHz cellular phone and below is a self-made LED detector.

Length of the copper rod determined by trial and error

The frequency of the cellular phone is 1.5GHz, so I started with a length of copper rod of 10cm (one half of the wavelength). However, this length gave no light on the LED. The total length of lines of diode would have an effect on the efficiency of the detector. Then, shortening the length each time by 5mm, I got a good result at 6cm.

Various experiments

I made telephone calls to nonexistent number. For each call, the phone continues its radiation for about 36 seconds. If you do not mind paying the bill, calling existing numbers, you can do the experiment for a long time.

If the direction of the detector's rod is the same as that of the phone's antenna, it is possible to light the LED detector with up to a distance of 18cm between the two. If the experiment is done in the dark, we can recognize the LED light with up to 21cm away.

Polarization of electromagnetic wave

The electromagnetic waves radiated by the antenna are linearly polarized. So set the diode detector in the vertical direction, and place the cellular phone 20cm away from the detector. Rotating the phone, we can see the change in the light intensity of the LED (Fig.3). In the case where the directions of the detector and the phone are parallel, the intensity becomes a maximum. When the directions are at right angles, the intensity becomes a minimum.

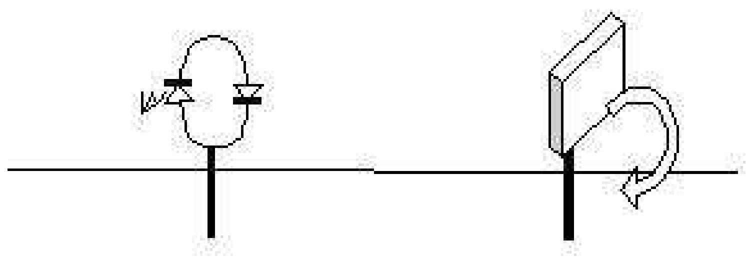

Fig.3

The lattice shows polarization

Prepare the 25cm by 25cm glass and eight 25cm-long steel rods. Fix the steel rods on the glass 3cm apart with adhesive tape. Setting the direction of the detector rod and the phone antenna the same, let the lattice rotate between the detector and the phone. We can see the light intensity of the LED change (Fig.4). When the direction of the lattice rods is parallel to that of the phone antenna, the intensity becomes a maximum.

The stationary wave

Using a metal plate to reflect the electromagnetic wave, the LED detector shows the nodes and anodes of the stationary wave. Fix the positions of the phone and the reflector, then by moving the LED detector back and forth, we can observe that the distance between adjacent nodes is 10cm (Fig.5).

Alternatively, fix the positions of the phone and the LED detector, then move the reflector

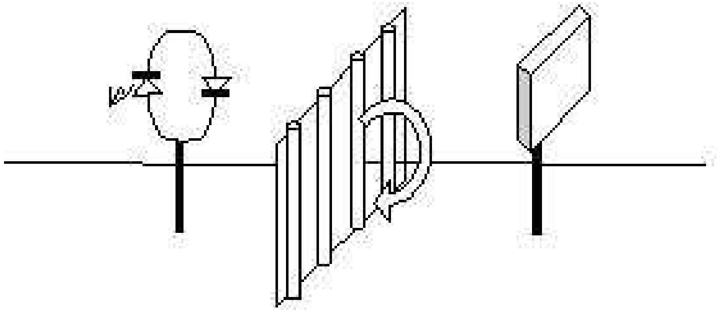

Fig.4

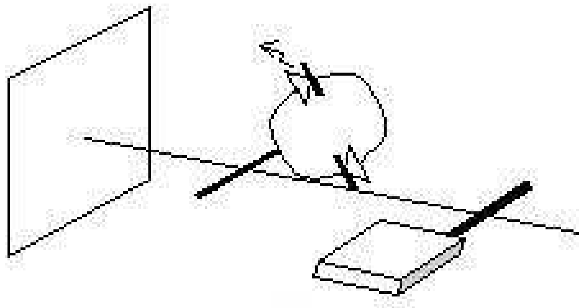

Fig.5

back and forth. This way, we can also observe the superposition of the incident wave and the reflected wave.

LED antenna on the market works well

While I tried making detectors using various LEDs and diodes, I had an idea to use the LED antenna for cellular phones on the market as a detector. The antenna made for installing the cellular phone. One of the LED antennas could Light when 32cm away from the phone.

Reference:
1. Shingo Katsuyama: Parity(Japanese) Nov. 2001 p.66-67, Maruzen Co.

Abstracts of Selected Papers in the Journal of the Physics Education Society of Japan Vol.49, 2001

Selected by AONO Osamu (e-mail:greenfld@jichi.ac.jp)
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No.1 "Report on Energy-Environment Education in Physics Class" by WATAHIKI Takafumi: J. Phys. Ed. Soc. Jpn. 49-1 (2001) 15-20.

The purpose of the teaching of environmental problems is that the students who live in the 21st century acquire a moral and practical understanding of these issues. In a class of the high-school physics IB course, energy and environmental problems were taught. They learned the second law of thermodynamics and the irreversibility principle in physics, and the energy-environmental problem in social science. As a practical exercise, they surveyed energy saving methods in their home, and reduced the consumption of electrical energy. Students' reactions to and impressions of this exercise are also introduced.

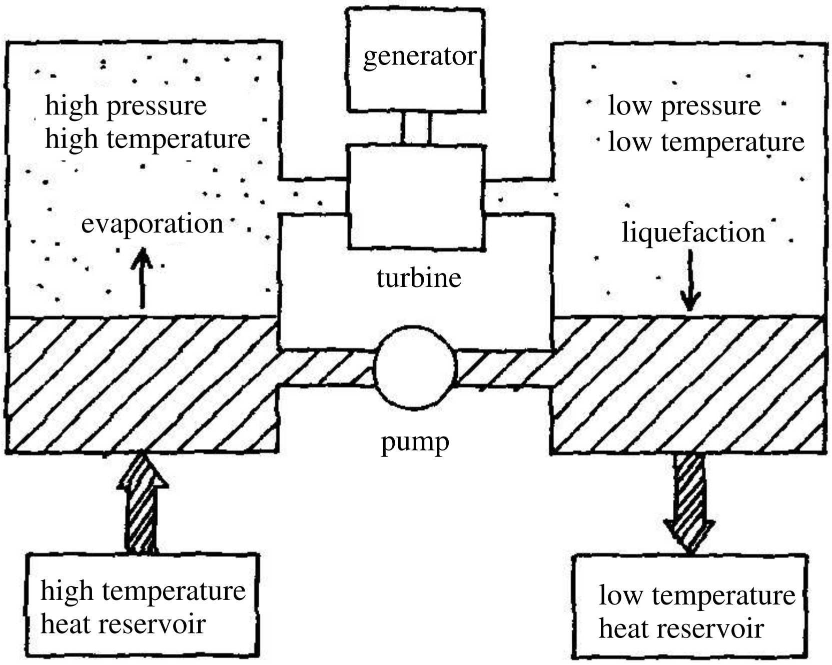

Fig.1 The principle of thermal power generation

No.2 "How Do Coil-Springs Expand" by ENUMA Naoki: J. Phys. Ed. Soc. Jpn. 49-2 (2001) 142-143.

It is well-known that the force acting on a coil-spring is proportional to the elongation of the spring. However, students have no interest in what happens during the process of elongation. By attaching an arrow to the spring, they observed that a rotation of the spring accompanies the elongation as shown in Fig.1. They discovered that the observation of the *whole* process is essential in understanding any natural phenomena.

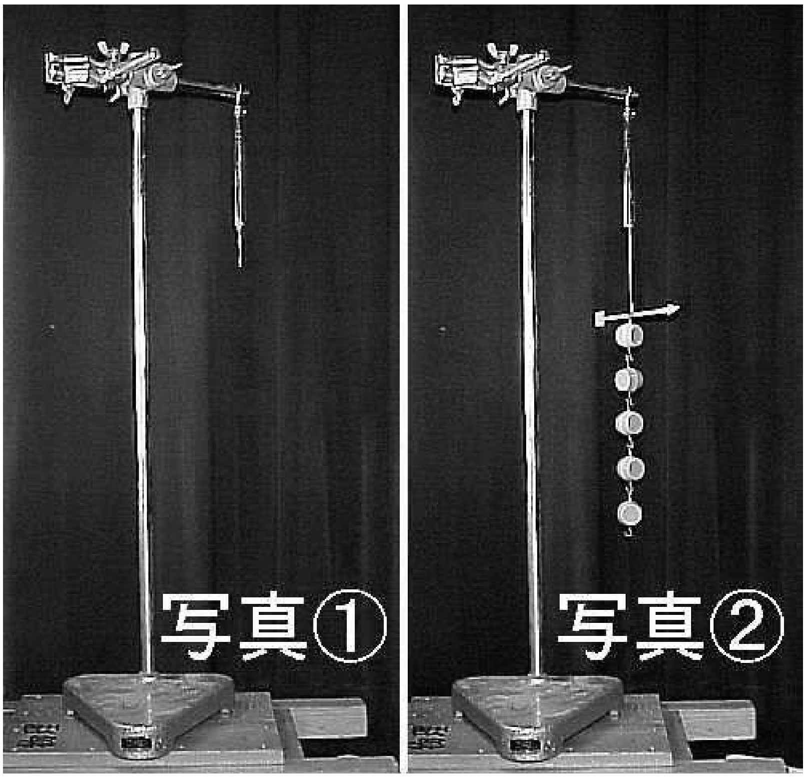

Fig.1 A coil-spring with an arrow

No.3 “Proportion of Success in the National Examination for Physician’s Licence versus Selection of Subjects in Entrance Examinations of Medical Schools” by AONO Osamu: J. Phys. Ed. Soc. Jpn. 49-4 (2001) 339-340.

A newspaper deplored that candidates who did not select biology in the entrance examination can enter medical schools. On the basis of statistics, it is shown that the newspaper made a hasty judgement. Table 1 shows the ratios of the students who get the physician’s licence within the 6 years (the least term for medical students), to the students entered who selected one of the three subjects (physics, chemistry and biology) in the entrance examinations for several medical schools.

subject	x	y	y/x
physics	319	267	84%
chemistry	395	326	83%
biology	96	71	74%

Table 1 x:The number of entrants who selected the subject in the left column in the entrance examination. y:The number of such students as selected the subject in the left column in the entrance examination and got the physician’s licence in 6 years.

No.4 “Estimation of Impulsive Force from the Measurement of Contact Area” by MURAO Yoshiaki: J. Phys. Ed. Soc. Jpn. 49-6 (2001) 548-549.

A simple method was found for estimating the impulsive force on an elastic ball fallen on a flower. When the ball, painted with cinnabar seal-ink, was dropped onto a sheet of white paper, it stamped the paper with the contact area. By pushing the ball against a paper on a balance, the relationship between the contact area and the force was deduced.

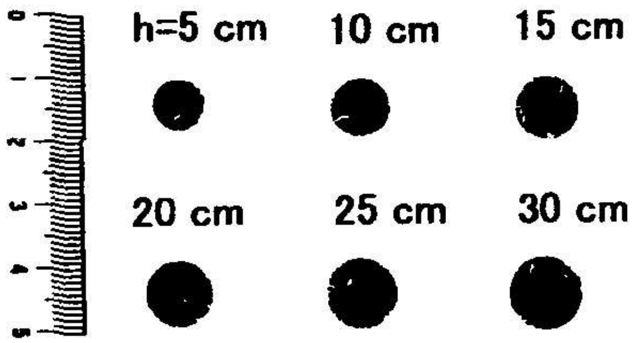

Fig.1 Falling height h with resultant contact area

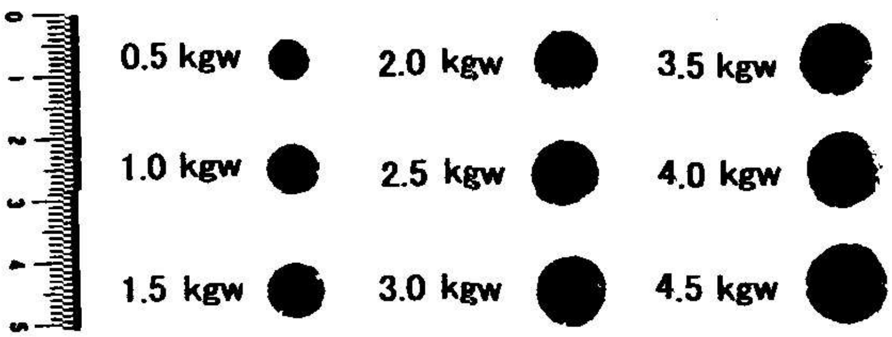

Fig.2 Pushing force with resultant contact area (kgw = kgf)

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