Energy Conversion

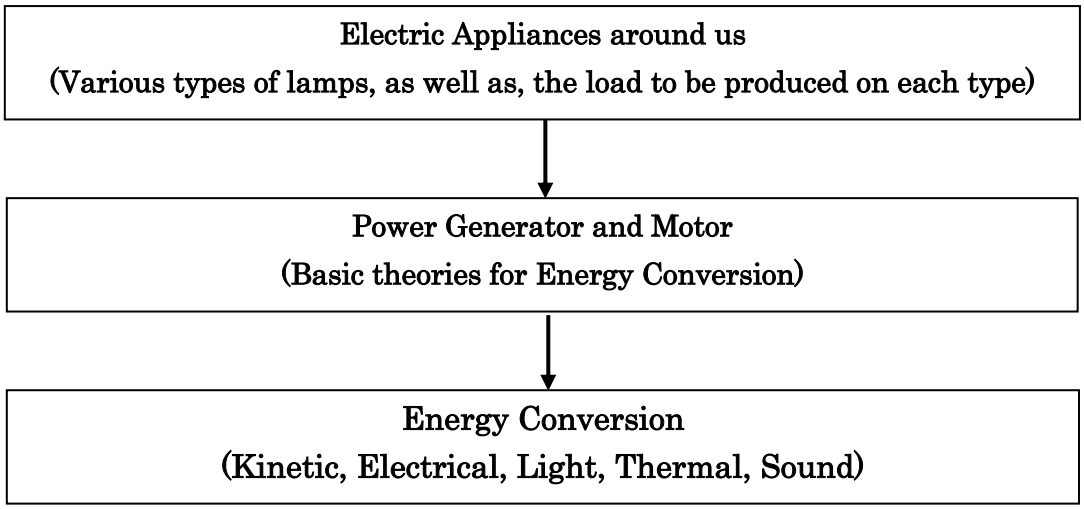
NaRiKa Corporation

1. Learning Outcome

We are living our lives by using various electrical appliances like home lights, refrigerators, TVs, radios, microwaves, cell phones, transceivers, flashlights and more. In this unit, through the experiment of energy conversion, teachers **provide** the learning opportunities for students to understand that kinetic energy can be converted into electric energy, while electric energy can be converted into light, thermal and sound energy.

Furthermore, teachers **demonstrate** the interactions of two **GENECONs** for the correlation between power generators and motors addressed in the previous unit, so that students realize power generator converts kinetic energy into electric energy that would drive motor(s) to produce kinetic energy.

2. Learning Flow



3. Preparation for Experiment

In this unit, use the instrument as follows. Instrument to be used (per each student)

- GENECON DUE (for Teacher's use) 1 B10-2632-W0
- GENECON V3 (for Students' use) 1 B10-2634-W0
- GENECON Light Box 1 B10-2700-W0

1. What's GENECON

Genecon is a user-friendly hand-held DC (Direct Current) generator extremely useful for the power generation to be used for experiments of energy conversion and electrolysis of water.

Genecon DUE produces (up to) approx. 12V DC only by turning the handle. Genecon V3 produces (up to) approx. 3V DC only by turning the handle. Genecon is a power generator specialized for the educational use to self-produce electricity.

Genecon is quite simply designed with the built-in motor inside that works to generate power. Students may realize the structural interaction of embedded motor, gears, shafts and handle through the transparent body. Teachers may easily instruct the students about the identical/interchangeable correlation between “motor” and “generator”.

[Note]
Specifications differ between Genecon V3 and Genecon DUE. In case lighting a miniature bulb 6.3V type, use Genecon DUE instead of Genecon V3. Otherwise, the bulb would be shortly broken.

GENECON V3 (DC3V Type)

GENECON DUE (DC12V Type)

[Specification]

	GENECON V3	GENECON DUE
Available generating voltage	approx. 3V	approx. 12V
Most suitable bulb	2.5V Type	6.3V Type

2. What’s GENECON Light Box Ⅱ

This is an experimental apparatus to light each of three types; incandescent lamp, fluorescent lamp, and LED (light-emitting diode) lamp, by using Genecon DUE, and then, to compare the heaviness of Genecon handle (e.g. to feel how much differently loaded) in either case of lighting the incandescent lamp and fluorescent lamp. Also, by comparing the incandescent lamp and LED lamp, which is being equipped with the latest electronics technology, students would further be interested in issues of the energy consumption

[Specification]

Input: DC 12V

Size: 245 x 175 x 100 mm

Incandescent lamp: 12V 20W

LED lamp: 10~15V 2.5W

[Note]

1) This apps is designed to be used exclusively in combination with Genecon DUE. Hence, Genecon V3 is not adequate for this apps.

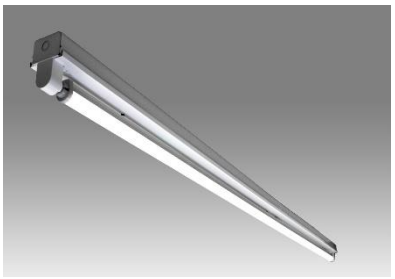
2) Don't plug in the apps directly to wall socket (AC100V～AC240V) as it might catch fire.

4. Background Topics

1. Electric light around us

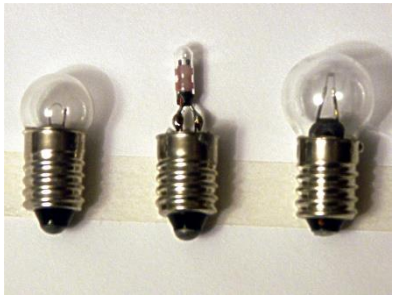
We are using electric light in our daily lives. Let's try to recall what types of lights you know. Let's try to think about differences in the light types. Below are some of the typical types of electric lights.

(1) Normal incandescent lamp



(2) Fluorescent tube lamp

(3) Normal LED lamp



(4) Miniature light bulb

(5) Compact fluorescent lamp (CFL)

(6) Various types of LED lamps

Q1. What types of electric lights do you use at home?

This question is to raise the awareness of the students that they are using a lot of types/number of lamps in their daily lives, because there must be various types of lamps in their houses. It is highly recommended for teachers to denote lamps used in their schools and/or shopping centers.

Q2. Let's try to summarize features of each type of lights written below.

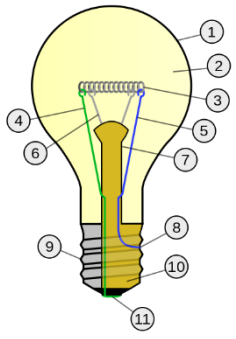
- Incandescent lamp　- Fluorescent lamp　- LED lamp

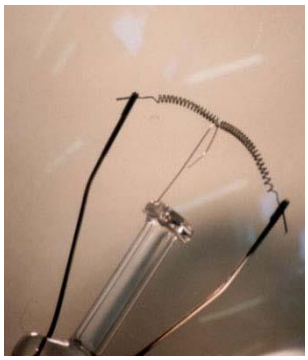
At the beginning of the class, teachers should ask students to describe what they have in mind no matter what they are. Then, at the end of the class, teachers should ask students to describe what they learned correctly. This enables the teachers to evaluate the progress and level of proficiency of the students. For the detail, see the reference information shown below.

[Reference Information 1] Structure and feature of Incandescent lamp

An incandescent light bulb, incandescent lamp or incandescent light globe is an electric light which produces light with a filament wire heated to a high temperature (2200~2700 ℃) by an electric current passing through it, until it glows (See the right-hand figure and photo). The hot filament is protected from oxidation (if being exposed to air) with a glass or quartz bulb that is filled with inert gas (Nitrogen or Argon) or evacuated.

Features of Incandescent Lamp are 1) warm color, 2) evolution of heat and 3) infrared-ray-emitting, etc.

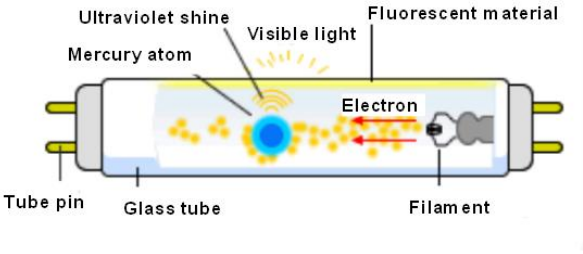




①Bulb、②Inert gas、③Filament、④⑤Lead-in wire、⑥Suspender、⑦Mount、⑧Lead-in wire、⑨Ferrule、⑩Insulant、⑪Center electrode

[Reference Information 2] Structure and feature of Fluorescent lamp

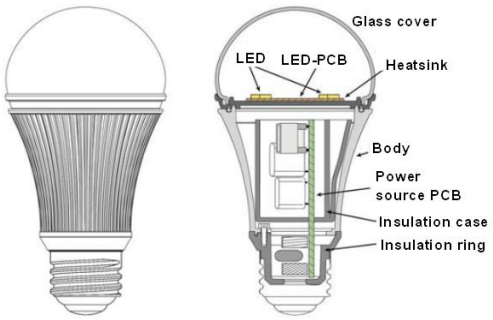
A fluorescent lamp or fluorescent tube is a low pressure mercury-vapor gas-discharge (containing a slight amount of Argon) lamp that uses fluorescence to produce visible light. An electric current (a large amount of electron is discharged from the emitter on the heated filament) in the gas excites mercury vapor which produces short-wave ultraviolet light that then causes a phosphor coating on the inside of the bulb to fluoresce, producing light.



Features of Fluorescent Lamp are 1) white or bluish white light 2) less evolution of heat and 3) ultra-violet-emitting, etc.

[Reference Information 3] Structure and feature of LED lamp

A LED lamp is a light-emitting diode (LED) product that is assembled into a lamp (or light bulb)) for use in lighting fixtures. LEDs emit light in a very small band of wavelengths, emitting light of a color characteristic of the energy bandgap of the semiconductor material used to make the LED. To emit white light from LEDs requires either mixing light from red, green, and blue (RGB) LEDs. As a semiconductor, it is a controlling circuit mounted on a PCB (printed-circuit board).



Features of LED lamp are 1) bluish white light 2) less evolution of heat and 3) expensiveness and 4) long life, etc.

[Reference Information 4] Comparing each type of lamps

Type of lamps	Incandescent	Fluorescent	LED
Consumer price			
Power consumption	60W	12W	9W
Brightness	60W	60W	60W
Product Lifetime	Max 2000 Hr.	6000 Hr.	40,000 Hr.

* Teachers should emphasize to the students about the inverse correlation between "Power consumption" and "Product Lifetime".

* Fill the actual consumer prices at your country in the "Consumer price" field.

5. [Demonstration] Light lamps with GENECON DUE

Now we understand that around us are many types of lights, like incandescent light, fluorescent lamp, LED light and others being used. Here, the teacher lights up incandescent light bulb, fluorescent lamp and LED bulb by using GENECON DUE.

GENECON DUE belongs, same as GENECON V3, to the Genecon family of products. We have used GENECON V3 before. GENECON DUE can generate 4 times electricity i.e. 12V compared to 3V of GENECON V3. It is a hand-held power generator to generate higher voltage compared to GENECON V3.

1. Experiment (Demonstration)

1. Connect red and black colored clips of Genecon DUE to the terminals on the Genecon Light Box.
2. Turn the switch on Genecon Light Box to the position of Incandescent lamp.
3. Start turning the handle of the GENECON DUE.
4. Confirm the light of incandescent lamp. Write down what you saw (intensity, color

and other things) into the Experiment result section.

5. Stop turning the handle of GENECON DUE.

6. Turn the switch on GENECON Light Box to the position of LED Bulb.

7. Start turning the handle of the GENECON DUE.

8. Confirm the light of LED bulb. Write down what you saw (intensity, color and other things) into the Experiment result section.

2. Experiment result

Table 1 (use numbers 1~3, where 1 is the best, 2 is worse, 3 is the worst)

	Incandescent lamp	LED lamp
1. Sort the brightness by order	**2**	**1**
2. Sort the lightness of turning the handle by order	**2**	**1**
3. Sort the speed of turning handle by order	**2**	**1**

3) Discussion about the experiment

Q1. Which lamp was brightest of all? And why do you think was that, write down your thoughts.

The answer should be “LED lamp was lit brightest.”, “LED lamp was bright while the filament of incandescent lamp only turned slightly red.”

Those students who can focus on the different of handle turning speed and/or who well understand the difference of each lamp may mention “LED lamp was lit brightest

because the speed of turning handle was fastest, or, because the energy consumption of LED is lowest."

Q2. Which bulb was the darkest of all? And why do you think was that, write down your thoughts.

Most of the answers would be as simple as something like "Incandescent lamp was darkest."

Those students who can focus on the different of handle turning heaviness and/or who well understand the difference of each lamp may mention "Lighting incandescent lamp was heaviest work because the energy consumption of incandescent lamp is highest."

Q3. Why heaviness of (difficulty in turning) the handle differs? Write down your thoughts.

Tough question for students. Even though some students can describe none, teachers should urge students to feel free to describe no matter what they have come up with.

Heaviness of the handle would differ depending on the different amount of the "current" needed for lighting each type of lamps. The handle becomes heavier when supplying more "current". Also, "operating voltage" can only be obtained by turning handle with a certain speed. This makes us feel the handle even heavier by turning the handle that has already become heavy enough.

Q4. Why speed of turning the handle is different? Write down your thoughts.

Tough question for students. Even though some students can describe none, teachers should urge students to feel free to describe no matter what they have come up with.

Heaviness of the handle would differ depending on the different amount of the "current" needed for lighting each type of lamps. The handle becomes less heavy when turning the handle for lighting LED that needs less "current". Also, high "operating voltage" has to be obtained by turning the light handle with high speed. This makes us feel the handle turning even faster.

Teachers indicate students that electricity can be obtained through the energy conversion mentioned below.

[1] Operate (Turn the handle of) a generator by Kinetic energy (student's physical arm force).
[2] The generator converts the Kinetic energy to Electric energy.

[3] Lamp(s) converts the Electric energy to Light and/or Thermal energy.

Electric energy can be converted to various energy including Light, Thermal or Sound energy, which means lamps, air conditioners, radios and TVs are operated by Electric energy.

Be aware that larger demand for electricity means larger demand for Kinetic energy. Experiment of turning an incandescent lamp for one minute will be a good way of making sense that enormous workload is needed to generate enough power by using GENECON DUE.

6. [Demonstration] Which one is generator, which one is motor?

1. Energy Conversion

In this unit, we would like to have consistency in the wording of "Kinetic energy", while it is sometimes called as "Mechanical energy". Prior to students experiment, be sure to light a miniature bulb by using GENECON V3 in order to remind them about aforementioned energy conversion.

In previous experiment with lighting up electric lights, where we were lighting up incandescent bulb, fluorescent bulb and LED bulb, recall if you felt that the Genecon handle was heavy or if you felt that the GENECON handle was light.

By everyone's work of turning the handle, through the handle, you let the generator (in the GENECON) do its work, therefore electricity was created. And then, generated electricity was transferred through the cables and did work in the form of lighting up each of the electric lights.

Also, during the experiment with GENECON V3 and lighting up bulbs, kinetic energy you created when you were turning the handle was conversed in GENECON V3 to electricity and in the bulb was conversed again into light energy in the light bulb.

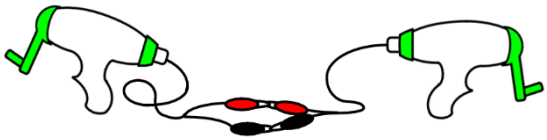
Furthermore, electric energy can be conversed not only into light energy, but as well into heat, sound and other types. It can be said that electric energy is very beneficial because it can be converted into various forms of energy.

2. Generator and Motor

1. Experiment with two pieces of GENECON V3

1) Make pairs of two persons. This experiment is done in pairs.

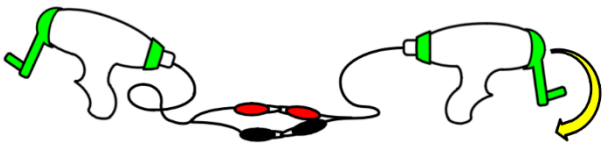
2) Connect two GENECON V3 together, red clip with red clip and black clip with black clip (as shown on the right figure)



Connect red - red, black - black

3) Pair will hold in their hands one GENECON V3 for each.

4) One person starts to turn the handle of GENECON V3. The other one observes what happens with handle of the 2nd GENECON V3 (at the other side).



Rotate one handle

5) Further, change the person who was rotating the handle and the other one again observes what will happen.

Rotate the other handle

2. Experiment result

Depending on the results of experiment, draw arrows (→) bellow.

a) When the handle of the Genecon V3 on the right is turned:

b) When the handle of the Genecon V3 on the left was turning:

Be aware that handle of the "motor" would turn the other way round if the direction of turning handle of "generator" is changed.

Q1. After observing results of this experiment, please explain correlation between generator and motor.

One of the paired GEMECONs, of which handle is turned, would work as a "Generator", while the other Genecon would work as a "Motor". And, the "Motor" and "Generator" are identical to each other.

Some students may not figure out this at first, but make sure they have a good understanding that "Motor" and "Generator" are identical to each other.

Q2. Please write any other comments or things you have noticed.

Students should realize that.

1) The "Motor" GENECON turns less compared to the other one (the "Generator" Genecon).

2) The "Generator" GENECON's handle seems to rotate slower than the other one (the "Motor" Genecon).

In this unit, teachers aim for the recap and facilitating the anchoring of the concept for Energy Conversion.

It would be even more effective and comprehensive if teachers explain the unit to students in connection with the Fleming's Left-Hand Law and/or the Fleming's Right-Hand Law.