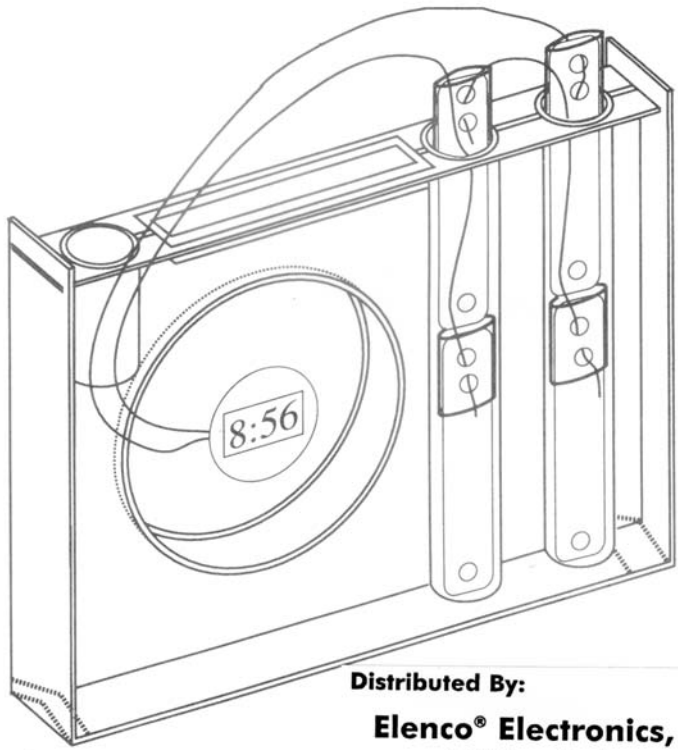
NATURE'S ELECTRICITY



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TREE OF KNOWLEDGE

TREE OF KNOWLEDGE
SCIENTIFIC EXPERIMENT KITS

NATURE'S ELECTRICITY

By Peretz Mahler

- MAKE ELECTRICITY WITH NATURAL MATERIALS
- PRODUCE ELECTRICITY BY SIMPLE CHEMICAL REACTIONS
- DIGITAL CLOCK MODULE INCLUDED

⚠ WARNING:
CHOKING HAZARD-Small parts
Not for children under 3 years

Certain experiments require adult supervision.
Be careful when using parts with sharp points or edges.

PARTS LIST

EXPERIMENT CONSOLE
ELECTRODES- MAGNESIUM STRIP
ELECTRODES- ALUMINUM
ELECTRODES- BRASS
ELECTRODES- COPPER
ELECTRODES- ZINC
ELECTRODES- CARBON
CLOCK MODULE
LED
WIRES
RUBBER (LATEX) TUBE
PLASTIC TUBE
STEEL WOOL
pH PAPER (INDICATOR PAPER)
FUNNEL
INSTRUCTION MANUAL
MEASURING SPOON
PAPER CLIP
POLYSTYRENE SQUARE
ONE AND A HALF VOLT (1 1/2 V) AA BATTERIES REQUIRED (NOT INCLUDED)
CERTAIN HOUSEHOLD SUBSTANCES REQUIRED

WARNING: The Magnesium ribbon included in your kit is highly flammable. Do not use this material in any way other than described in the experiments! Keep it away from any source of heat. If for any reason this material burns, DO NOT INHALE THE FUMES!

INTRODUCTION TO NATURE'S ELECTRICITY

This kit is called "Nature's Electricity" because it shows how electricity can be produced from several materials containing chemicals that react when they come in contact with various metals, just like a battery.

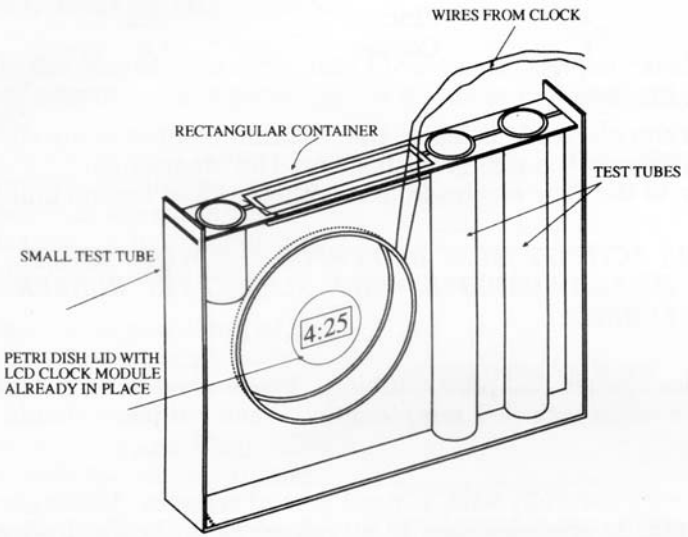
A battery is made of Zinc and a Carbon rod, which are placed between a chemical paste. When you make your own natural battery, the same process occurs as in the ordinary batteries you are familiar with. The electric current flows because a chemical reaction takes place between the metals and the acids in the vegetables, fruits, soaps, etc.

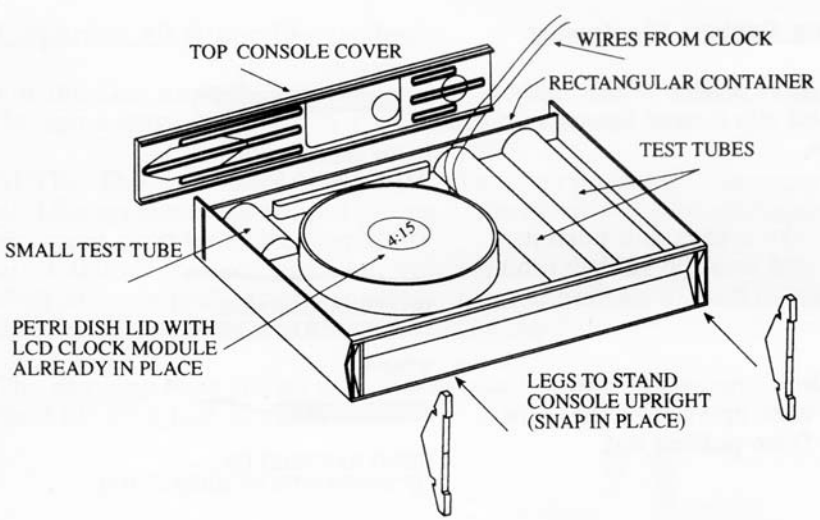
In some experiments, you may find that one piece of fruit, such as a lemon, can produce lots of electricity, enough to light up a LED or the clock module. In other cases, you may have to use 3 or 4 or even more pieces of fruit to get good results. This is very much the same as with batteries. In certain cases, 1 battery will be enough, and in others, you may need 2 or 3 or even 4 batteries.

Explanations are written in italics.

THE EXPERIMENT CONSOLE

Become familiar with the parts of the experiment console. Be very careful when handling the clock module. Keep the petri dish covered so that the clock will not get wet.





Preparing the Electrodes

ABBREVIATIONS

You will use electrodes made from various materials. Chemists use recognised abbreviations for most of these.

Aluminium	Al	Magnesium	Mg
Iron	Fe	Zinc	Zn
Carbon	C	Copper	Cu
Test tube	T.T.		

NOTE: The Carbon electrode is black, the Aluminum one is shiny silver, and the Zinc electrode is a dull greyish silver. The Magnesium ribbon is similar in color to the Zinc electrode, but is thinner and has no holes.

CAUTION: THIS ACTIVITY MUST BE PERFORMED WITH ADULT SUPERVISION. BE VERY CAREFUL WHEN SLICING THE RUBBER AND PLASTIC TUBING!

Your kit includes rubber and plastic tubing. These need to be cut into pieces about 1/4 of an inch (6-7 mm) lengths. Each cut piece should look like this:

Cut the tubing very carefully with a good pair of scissors. These pieces of rubber and plastic are necessary to attach wires to the electrodes.

Preparing Carbon Electrodes

Step 1: Take a slice of the rubber tubing and slip it over the carbon electrode.

STEP 1

CARBON ELECTRODE
WITH RUBBER SLICE

Step 2: Take a wire and push its exposed end into the rubber tubing so that it touches the carbon.

STEP 2

INSERT EXPOSED END
OF WIRE INTO RUBBER SLICE

Step 3: Bend the end of the exposed wire upwards to prevent the wire from pulling out.

STEP 3

BEND EXPOSED END
OF WIRE OVER RUBBER SLICE

Preparing Magnesium Electrodes

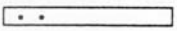
WARNING: ***The Magnesium ribbon included in your kit is highly flammable. Do not use this material in any way other than described in the experiments! Keep it away from any source of heat. If for any reason this material burns, DO NOT INHALE THE FUMES!***

FLAMMABLE

Divide the Magnesium strip into three parts, and cut carefully with a pair of scissors. Each piece should be about one inch (33 mm) long.

On one end of each of the Magnesium electrodes, pierce two holes as shown in the illustration. Use a thumbtack very carefully to do this.

THUMBTACK



PIECE OF MAGNESIUM

Thread the exposed end of one of your wires through both holes as illustrated.

EXPOSED END OF WIRE THREADED THROUGH PIECE OF MAGNESIUM

Cover the wire and Magnesium strips with the rubber tubing. Now your Magnesium electrode is also ready for use.

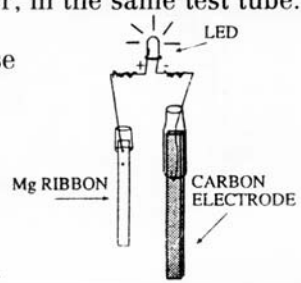
WIRE AND MAGNESIUM COVERED BY RUBBER TUBING

Preparing All Other Electrodes

For the Zinc and all other electrodes, use the plastic tubing. Use it in the same way as explained and illustrated above.

NOTE: The two kinds of tubing serve three important functions:
a) Like an elastic band, the tubing holds the wire to the electrode, ensuring good electrical contact.
b) It shields this contact from unnecessary contamination.
c) It helps to prevent one electrode from touching the other, when both are immersed, one above the other, in the same test tube.

The drawing here shows you how to use the LED attached to electrodes.



Experiment 1 Tasting Electricity

Equipment:
empty, clean glass
table salt
Zinc electrode
Carbon electrode
Magnesium ribbon
pH paper
measuring spoon

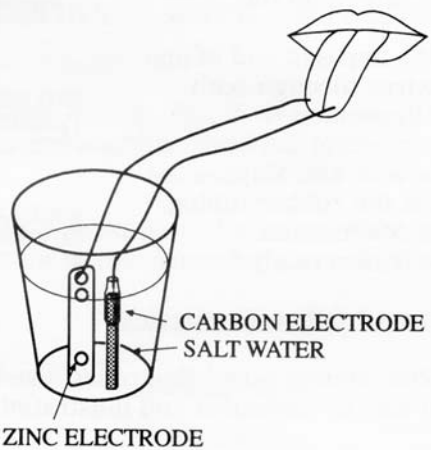
FLAMMABLE

Fill a glass with water, add to it a teaspoon of salt, and dissolve it.

Prepare a Zinc (Zn) and a Carbon (C) electrode as explained in the general instructions at the beginning of this manual. Dip the two electrodes into the salt water, making sure they do not touch one another.

Bring the two exposed ends of the wires from the electrodes to your tongue and taste them. They taste sour. The closer the two wire ends are to each other, the more sour the taste. The sour taste is due to the flow of electricity.

Look at the electrodes in the salt solution. Notice that bubbles form on the Zinc electrode.



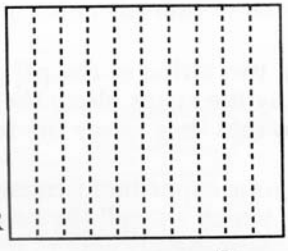
If you like, you could exchange the Zinc electrode for the Magnesium one and note the difference.

Experiment 2 Coloring Indicator Solution

same equipment as previous experiment
experiment console

FLAMMABLE

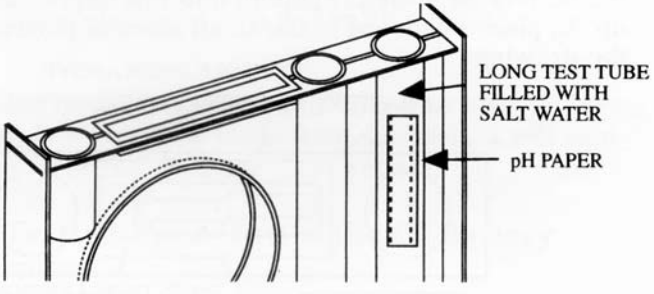
Fill one of the long test tubes from the experiment console with salt water and insert 3 strips of pH paper. The pH paper is the orange paper which looks like this:



pH PAPER

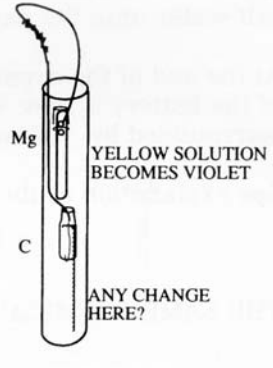
When the salt water becomes colored by these three strips, remove them and repeat Exp. No. 1 in this colored liquid.

Insert the Magnesium and Carbon electrodes into the long T.T. with the yellow liquid and connect the two electrode wires.



After a few minutes, the yellow of the colored salt water solution becomes violet around the Magnesium electrode.

The solution at the bottom of the Carbon also changes color, but much more slowly.



What happens and why?
What would happen if you did not connect the wires of the electrodes?
What would happen if instead of Magnesium, you used Zinc or Aluminum electrodes? What has all this to do with electricity?

The answers are at the back of the book.

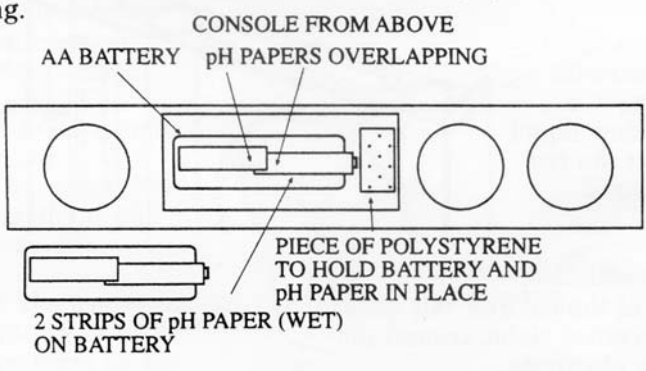
Experiment 3 The Indicator Paper

Equipment:
2 pieces of pH paper
AA size 1 1/2 V battery
small piece of polystyrene
experiment console

Dip two strips of pH paper into salt water solution, just enough to make them wet. Note the color of the wet pH paper.

Overlap the two strips of the pH paper so that they stick together at one end. Lay the strips along the side of an AA battery, and bend the two ends so that they cover the top and the bottom of the battery.

The top of your experiment console has a shallow, rectangular depression, which we call the rectangular compartment (R.C.). Place the battery with the pH papers into this depression and keep this "set-up" in place by means of the small piece of polystyrene, as shown in the drawing.



Wait two to three hours, keeping the paper wet by dripping a drop of salt water onto the paper, as necessary.

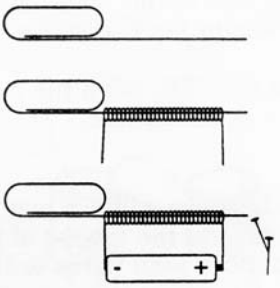
At the end of the experiment, you will see that the paper at the bottom of the battery is now violet (surrounded by blue) and the top, red (surrounded by yellow). Why?

See explanation at the back of the book.

THE SAME CHEMICAL CHANGE TOOK PLACE IN EXPERIMENT 2.

Experiment 4 The Electro Magnet

Equipment:
AA Battery
paper clips



Open the paper clip as shown in the drawing. Wind one of the wires around the straight end of the clip. You should manage between 18 and 20 turns and yet leave about 3 cm (1 inch) of the wire sticking out at each end.

If you touch these two ends of wire to your battery, you produce an electro-magnet. The end of the paper clip will be able to lift one or several pins.

If the paper clip is made of steel, it will remain magnetic even after you remove the battery. If, however, it is made from soft iron, it will stop being magnetic the moment you disconnect the battery.

Experiment 5 Testing Your Own Make Of Battery

Equipment from Experiment 1
Equipment from Experiment 4

Would the results of Experiment 1 produce enough electricity to power your magnet?

Try and see.

Experiment 6 The L.E.D.

Equipment:
LED
AA Battery

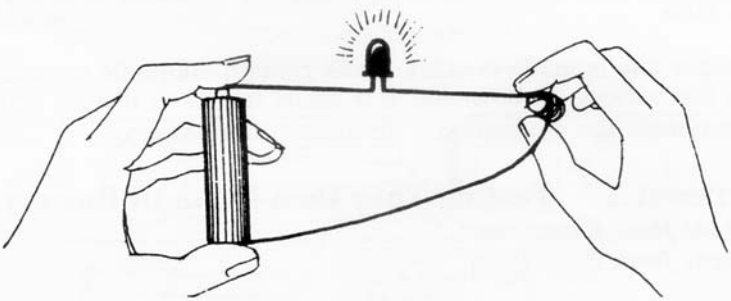
Among the components of your kit, you will find a small red component, something that looks like this:

Perhaps you have wondered what it is. It is a Light Emitting Diode - LED in short.

The LED is very delicate and must be handled with care. Electricity flowing through it does so in one direction only. It will not light up if incorrectly connected to a source of electricity, it might even be spoiled. The LED has two wire leads. Look at the LED closely and you will see that one of the "legs" of the LED is slightly longer than the other. The longer leg is positive.

When using the LED, bend the two wire leads at right angles as illustrated.

To test our LED, we will use one battery . Place one end of the lead wire of the LED to the top (+) of the one and a half volt battery and connect the other lead wires to the bottom (-) of the battery as illustrated. If nothing happens, turn the LED around and try again. **IF THE BATTERY WAS NEW, YOU MAY SEE A SLIGHT FLICKER.**



From this experiment we have learned two important things:
1) We need more than 1 1/2 volts to really light up the LED.
2) The LED lights up in one direction only. Which direction was it in your case?

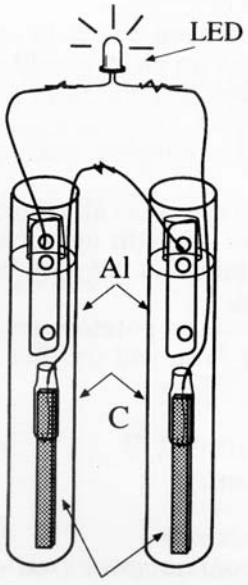
Experiment 7 LED and Alkaline Solution

Equipment:
4 wires
rubber slices
2 Carbon electrodes
2 Aluminum electrodes
LED
household bleach or washing soda solution - not supplied
experiment console

Fill both test tubes with an ***alkaline solution*** such as either household bleach or washing soda (Sodium Carbonate $Na_2 C0_3$) and then set up the experiment as shown in the drawing.

Each test tube contains a Carbon electrode and an Aluminum electrode. One of the Carbon electrodes is connected to the Aluminum electrode in the other test tube. The remaining Carbon electrode is connected to the longer (positive) leg of the LED. The remaining Aluminum electrode is connected to the shorter (negative) leg of the LED. The rubber slices on each end of the electrodes prevent these from touching one another, as well as connecting the wires.

The LED should light up. If it does not, either there is poor contact somewhere along the circuit, or the LED is connected the wrong way round.

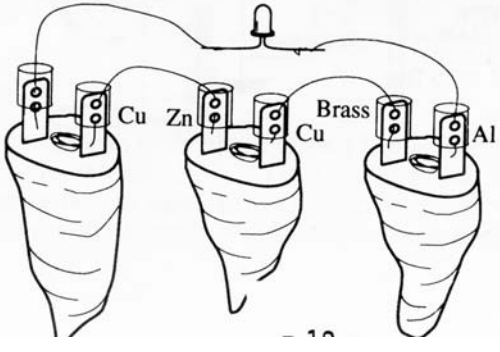


WASHING SODA SOLUTION
OR HOUSEHOLD BLEACH

Experiment 8 Carrot Lamp

Equipment:
3 electrode couples(Copper + Zinc ; + Brass + Aluminum)
LED
carrots

If you do not have household bleach or washing soda, try this experiment. Examine the drawing.



Insert the electrodes vertically into the carrots, making sure that they do not touch each other when inside the carrot. Connect them as shown in the drawing.

Since you need 3 cells (a carrot with electrodes is what scientists would call an electric cell) and have only 2 Copper and 2 Zinc electrodes, you will have to use a Brass electrode instead of a Copper one, and an Aluminum electrode instead of the Zinc. You will later use "mixed couples" such as these, for several other experiments.

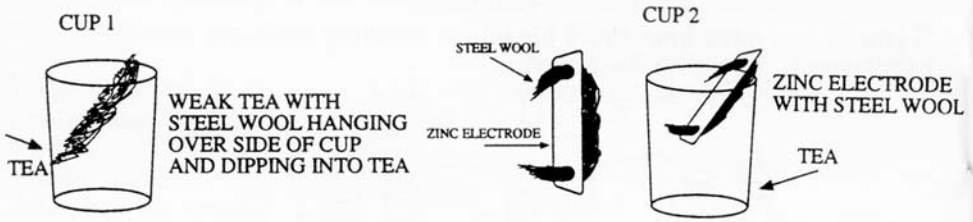
Do not forget that all connections must be clean and perfect! If the LED does not light up, turn it around and now it will give light. The light obtained is not very bright.

Could you use potatoes or other vegetables, or even fruit instead of carrots? You will try this out later.

Experiment 9 Rusting

Equipment:
tea
Zinc electrode
steel wool (serves as Iron -Fe electrode)

Iron and steel tend to rust particularly when the metal becomes wet. We paint metal articles in order to prevent oxidation (rusting) but sometimes that is not practical. Is there something else we can do? Let's find out. Make some weak tea. (No sugar or milk is needed). Fill two tea cups and place some steel wool into one of them.



Thread some steel wool through the holes of a Zinc electrode and place this into the second cup. After about half an hour you will see that the tea in cup one has become dark purple, almost black, while the tea in cup two remains unchanged.

Explanation

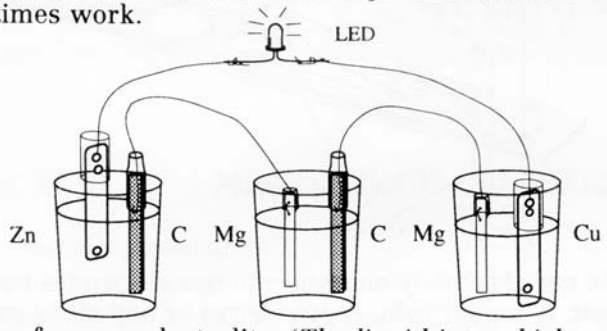
Tea contains an acid called Tannic Acid. This reacts with rust, producing a dark coloration. When steel and iron are in contact with Zinc, the rusting is inhibited. No rust, no dark coloration. This rusting is a chemical reaction involving electricity. It was the electricity produced by the Zinc touching the Iron, which prevented the Iron from rusting . Instead the Zinc oxidised, but you could not see this.

Experiment 10 The Tea Battery


FLAMMABLE

Equipment:
tea
Magnesium ribbons
Carbon electrodes
Zinc electrode
lemon juice
experiment console

You could make yourself a "bedside lamp" by setting up the apparatus as shown in the illustration here. Ideally, you should use three Magnesium /Carbon couples, but you only have two Carbon electrodes..... so instead of the third Magnesium /Carbon couple, you could try a Copper/Zinc couple, or even the three couples shown in the following illustration. We learn from this experiment that even "mixed couples" sometimes work.



Use ordinary tea for your electrolite. (*The liquid into which you dip your electrodes is called ELECTROLITE.*) If you want to make lemon tea, try adding lemon juice to your electrolite. You would find that the LED gives more light but it would shine for a shorter period of time.

Experiment 11 The Fe/Zn Night Light

Equipment:
same as in previous experiment
steel wool (serves as Iron -Fe electrode)

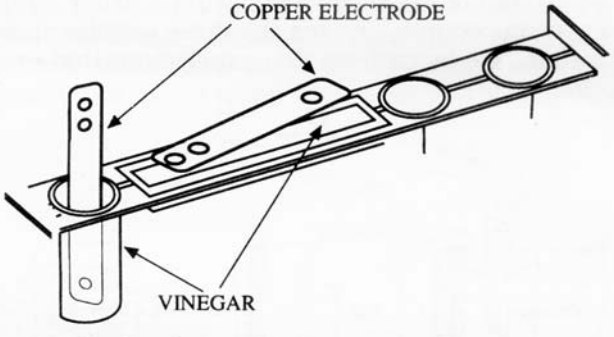
In a previous experiment, you enhanced and inhibited oxidaltion (rusting) by the use of an Iron/Zinc couple. Could you light up your LED by making Iron(Fe)/Zinc couples? Try this by wrapping a small piece of steel wool around the exposed end of a wire.

Experiment 12 Preparing a Copper Solution

Equipment:
experiment console
vinegar
Copper electrodes

Your console has several compartments: two long test tubes (T.T.), 1 short test tube, 1 rectangular compartment (R.C.), and one short test tube. We have already used the two long test tubes and the rectangular compartment. Now we will use the short one.

Fill both the short test tube and the rectangular container almost to the top with vinegar. Stand one of the copper electrodes into the short T.T. and lean the second copper electrode into the R.C. as shown in the drawing.



Note: It is not absolutely necessary to use electrodes for this experiment. A copper coin, copper wires or any other small copper article would do nicely, just as long as you are certain it is made of copper and not, say, copper-plated iron.
Permit this "set-up" to stand undisturbed overnight or even longer. This will be the RAW MATERIAL for several experiments.

Experiment 13 The Reddish Brown Deposit

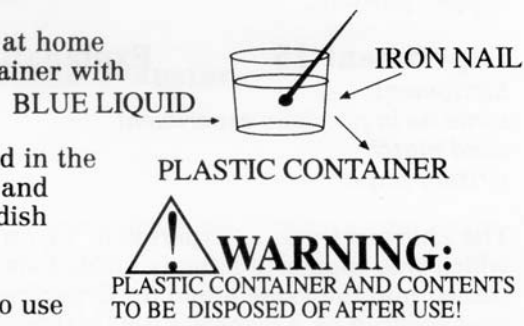
Equipment:
same as in previous experiment
empty plastic container
iron or steel nails - not supplied

About 24 hours after you placed the Copper electrodes into vinegar, you will see that you now have a greenish blue liquid in both the R.C. and the short T.T. Both of the Copper electrodes are covered with a deposit of the same color. This deposit can be added to the greenish-blue liquid.

Remove about half of the liquid from the short T.T. and place it into a small plastic container that can be thrown away after use. (You could use a plastic lid or the empty plastic container of sweetening tablets etc.)

WARNING: The blue liquid is POISONOUS so don't use anything that could come into contact with food!!

Find a few iron or steel nails at home and place them into this container with the blue liquid.



After about an hour, the liquid in the container is almost colorless and the nail is covered with a reddish brown deposit. Why?

We will see later. We will also use the colorless liquid .....

Experiment 14 Making "Gold" Out of Zinc !

Equipment:
same as in previous experiment
Zinc electrode

After removing some of the liquid in the short test tube, it should still be half full of the bluish-green liquid.Take one of the Zinc electrodes, clean it thoroughly and then dip it into the bluish liquid for exactly 10 seconds. Remove it and examine. The Zinc has turned into "gold"!

During the middle ages, there were no chemists. Nobody knew anything about scientific chemistry. There were people who did perform chemical experiments and these people were called ALCHEMISTS. They spent their lives trying to turn ordinary metals into gold.

The Alchemists had Zinc and Copper and they knew how to make vinegar. Perhaps one of them made an experiment like you and thought he had made gold. Unfortunately, neither the alchemist nor you made this precious metal....

The bluish liquid in the short T.T. precipitated Copper onto your Zinc electrode.

*COPPER AND ZINC = **BRASS***

Brass looks like gold.

Place the Zinc electrode into the bluish liquid for a longer time. The electrode becomes covered with a BLACK deposit of finely divided copper powder.

Experiment 15 Explanations and Invisible Ink

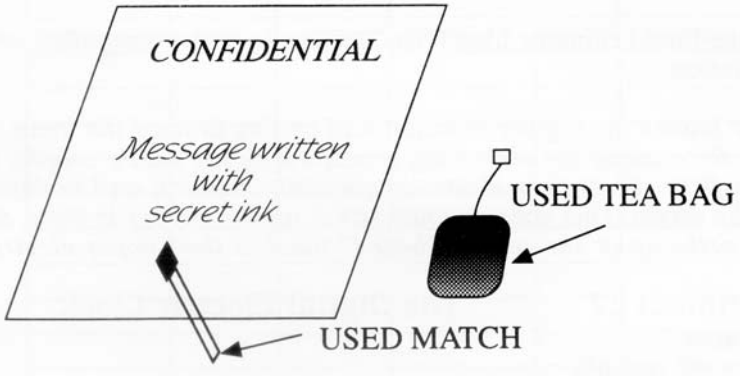
Equipment:
same as in previous experiment
used match
writing paper

The Zinc electrode in Experiment 14 was covered by a black powder which was copper in a thinly divided state. The iron nail which you placed into the same liquid (in Experiment 13) as the Zinc electrode is now covered by a brownish red material which looks like copper and is copper. Here is the explanation.

Originally, the Copper electrode reacted with vinegar and the result of the reaction was a COPPER COMPOUND (POISONOUS). When this copper compound solution touches a metal like IRON OR ZINC, the copper compound breaks up and instead you get a ZINC COMPOUND or IRON COMPOUND as the case may be. In either case, COPPER is left behind.

So, on your nail you have copper powder and the bluish solution is no longer bluish, because it is no longer a COPPER COMPOUND - it is now an IRON COMPOUND.

You can use this iron compound as an invisible, secret ink.
Take a used match, dip it into the colorless liquid (IRON COMPOUND) and scribble or draw something. When dry, it should be invisible. You can make your writing visible by going over it with a used tea bag.



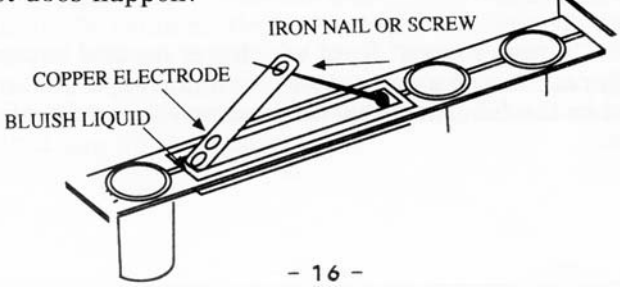
Now you can write secret messages to your friends. Since everyone can get hold of a used tea bag, your friends, if they know the secret, can easily read your message.

Experiment 16 Electric Transfer

Equipment:
equipment from Experiment 11
iron or steel nail or screw

We still have not touched the Copper electrode resting in vinegar in the rectangular compartment. Now is the time!

You already know what will happen if you dip an iron screw into the bluish liquid which now fills the R.C. For this experiment you need an iron nail, or better still, an iron or steel screw. Either nail or screw must be shiny clean. Stand the Copper electrode and Fe (Iron) screw into the bluish liquid-filled R.C. as shown in the drawing. Wait 1/2 an hour, a day, a week, 100 years ... What do you think will happen? What in fact does happen?



The Iron (Fe) screw and the Copper electrode together make up an electric couple. Electricity is produced. A brown "beard" of Copper powder forms at the head of the Iron (Fe) screw. (That was to be expected). More and more of this powder is formed. (Where does it come from?)

The blue liquid remains blue (Why?) Here is a very simplified explanation:

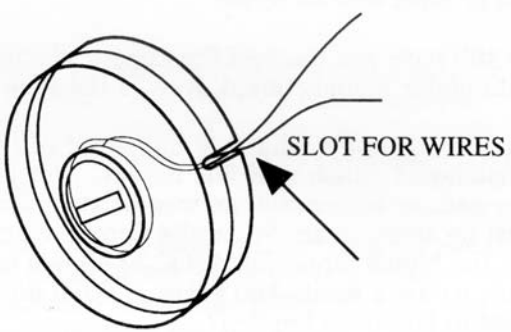
Copper leaves the Copper solution and settles around the head of the screw. Because of the electricity produced by the Cu/Fe couple, more Copper from the Copper electrode goes into solution and is deposited near the screw. This goes on until either all the copper is gone, or the liquid dries up or the copper "beard" touches the Copper electrode.

Experiment 17 The Digital Electric Clock

Equipment:
experiment console
LCD Clock module
solution (salt water, or fruit juice, or vegetable juice)

Begin working with the digital clock mode that has been already inserted to fit securely into the cover of the petri dish. Be very careful when handling the module. If you accidentally pull on the wires, the clock will be disconnected.

Place the wires through the slot and carefully close the petri dish with this cover. After you have done this, you are ready to begin your experiments. It is important that the Petri dish remains closed so that the clock will not get wet.



Prepare your "power source" from whichever natural source you choose. You can choose a salt water solution, vegetable or fruit juices, etc, as listed in the following chart, based on the results of your experiments.

TESTING VARIOUS MATERIALS FOR RUNNING THE CLOCK

Which combinations run the clock for the longest period of time?

	ELECTRODES	MATERIAL	SOLUTION	TIME STARTED	DATE	TIME STOPPED	DATE
Example:	Copper and Zinc	lemon	detergent	8:00 a.m.	Thurs. 12/1	11:46 a.m.	Sun. 15/1

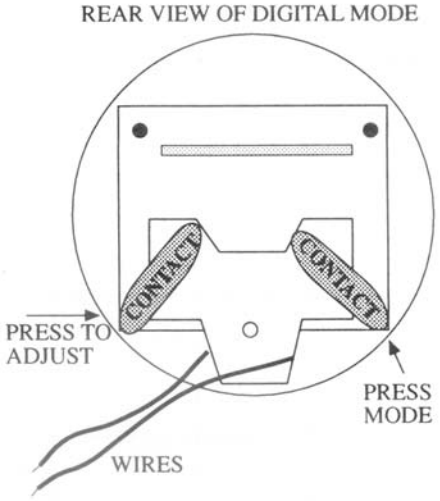
The best way to test if you have enough electricity is to check if the LED lights up. If it does light up, then the clock will work. Remember, the LED only works when it is connected in the correct direction. This same rule also applies to the clock module.

Be very careful once you have the clock working. If you accidentally move the clock, this may disconnect the flow of electricity into the clock.

As soon as you have succeeded in lighting up the clock, open the Petri dish. You will see 2 small metal plates on the back of the LCD clock module. These plates are used for adjusting the time on the clock. This is similar to all LCD clocks and watches.

Look at the LCD module from the back. The contact on the right hand side is the mode contact. Press this and the mode will appear. Press twice and you will get a number 12:A. Now press the left contact to adjust the hour, press the mode contact and then the adjusted contact to set the minutes. The clock also includes a date module, but we suggest that you do not use it.

When you have completed setting the time on the clock, carefully close the cover of the Petri dish.

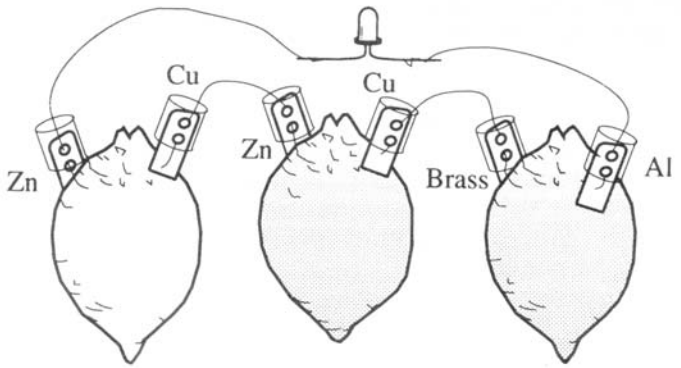


Remember : If there is a break in the flow of electricity to the clock, the clock will stop working and will have to be reset when the electricity flow continues again.

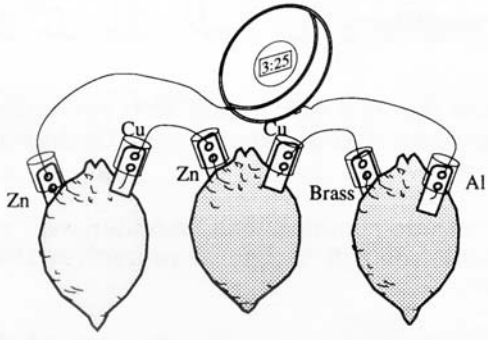
Experiment 18 The Lemon Lamp Or Clock

Equipment:
Aluminum electrode
Brass electrode
Copper electrodes
Zinc electrodes
3 - 4 lemons

Continue to experiment with various kinds of "lamps" and clocks. You could make yourself a lemon lamp as illustrated here.



THE LEMON CLOCK

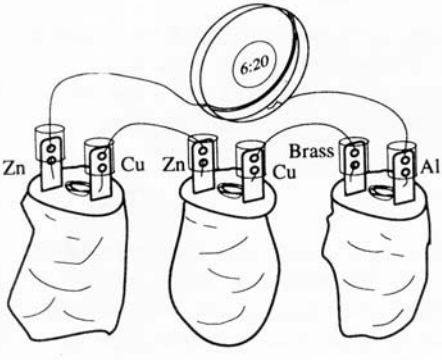


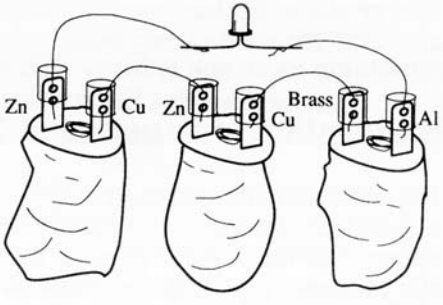
This experiment as well as most of the other ones, will work only if all wires make P-E-R-F-E-C-T contact with all electrodes. If there is just one contact which is not good, the LED will not light up. Make certain that the wires and the electrodes are perfectly clean. If necessary, try adding another lemon and another electrode couple. Make sure that the lemons are juicy. If necessary, add water.

Experiment 19 The Potato Lamp or Clock , etc.

Equipment:
3 sets of electrode couples from your kit
3 potatoes

You could make a potato lamp or clock the same way as you made a lemon lamp, by using potatoes instead of lemons. Try different electrode couple combinations. See which combinations work the best.





Experiment 20 Mixed couples and mixed vegetables !

Equipment:
same as in previous experiment
mixed vegetables

You have already seen that you can, in fact, that you must use mixed electrode couples for some of your experiments. Could you also use mixed vegetables??

By trying various electrode combinations, together with various vegetable combinations, you can design for yourselves 100, even 1000 different experiments.

Perhaps experiments which no scientist has ever tried before! Exciting, isn't it? Many inventions were made that way and even if you do not invent something, remember that with every experiment, you learn something new.

Answer to questions from Experiment 2

The color of the pH paper indicates the presence of an acid or base by changing color. An acid is a substance which is sour. Many fruits contain acids, such as lemons and oranges. A strong acid generally corrodes metals. A base is the opposite of an acid. Substances that are bases are also called alkalis. A base will neutralize an acid and form a salt. The violet color around the Magnesium electrode indicates that you have produced a base near the electrode. Eventually you should also get a red color near the Carbon electrode. The liquid there becomes acid.

If you do not connect the electrode wires, nothing will seem to happen. You produce similar reactions with other electrodes but you will probably get a less basic solution and the color around the Zinc or Aluminum electrode is likely at first to be blue rather than violet.

Explanation to Experiment 3

The electric current passing through the salt water has brought about a chemical change in the salt and this has changed the color on the paper. The violet color is basic and indicates negative; the red is acid and positive. The negative current flowing from the negative side of the battery, and the red color indicates the positive side of the battery.

The direction the current flows is called polarity.