BOOK EVOLUTION

This book and associated CD evolved from a series of *HANDS-ON* instructional courses originally developed by NOESS LLC as a summer program for kids. In addition to these courses, the *College for Kids* program run by Saddleback College Community Education in Orange County California offers a wide variety of other summer classes for kids of all ages.

Because no hard-copy of this course was provided to the students, many parents asked for CD copies for review at home. Most found that without a knowledgeable instructor to explain them, many of the slides appeared incomplete.

Adding explanatory text to each slide was found to be impractical. Therefore, this book format was created by adding supporting notes to those slides needing more technical detail. These added BOOK NOTES are printed in blue in order to differentiate them from the original material. Because of the young age of most students in this course, the emphasis is on building projects in order to keep them engaged and occupied. Therefore, the level of added technical notation has been deliberately truncated.

INTRODUCTION & ADMINISTRATION

Welcome to *KidsTricity One*. The material in this presentation is intended to be conducted in a classroom which is instructor lead.

This *introductory level* course is specifically designed for kids that are at least 7 years old. Experience has shown that few kids younger than this have the attention span and motor skills to adequately operate the test devices or electronic kit.

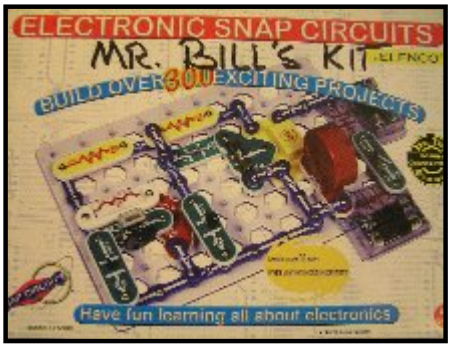
The course covers *basic* electronic processes sufficient for a fundamental understanding of components and process required to construction an AM radio.

For an *intermediate level* course designed for young adults and kids at least 10 years old, see *KidsTricity Two*.

COURSE MATERIALS

The projects as executed in this course are based on Electronic Snap Circuits® SC300 kit with associated book numbers 753102 Rev E, and 753098 Rev E from Elenco® Electronics, Inc.

In addition to the SC300 Kit, two inexpensive multimeters are required in order to adequately complete many of the Projects in the Course.



COURSE DESCRIPTION

Part A: Explore Electronic Concept.

Part B: Build a Circuit.

Part C: Test Concepts Learned.

Part D: Review What You Learned.

Repeat A-B-C-D for next selected section of the course.

Some sections may take these Parts out of order.

LESSON LIST

Lesson 1	Learning how to use the kit to build circuits.
Lesson 2	Learning about VOLTAGE.
Lesson 3	Learning how to measure VOLTAGE.
Lesson 4	Learning about CURRENT.
Lesson 5	Learning how to measure CURRENT.
Lesson 6	Learning about RESISTANCE.
Lesson 7	Learning how to measure RESISTANCE.
Lesson 8	Learning about CAPACITORS, INDUCTORS, OSCILLATORS, AMPLIFIERS, & IC's.
Lesson 9	Building several versions of AM RADIO.

(Lessons based on REV-E of both Instruction Manuals)

LEARNING OBJECTIVES

Build selected SC-300 Projects with the final one being a working AM radio.

Explain the general principals of project operations.

Define what a *radio* signal is.

List components required of a radio receiver.

Define Volts – Amps – Ohms – Henries – Farads.

Safely use a Multimeter to measure circuits and components of selected Projects.

Experiment with these electric/electronic processes.

- Resistance.
- Capacitance.
- Inductance.
- Amplification.
- Oscillation.

LAB SAFETY

All students are encouraged to work in PAIRS.

Each student in the PAIR can check the other's work BEFORE APPLYING POWER TO THE CIRCUIT BOARDS!!!!!!!!!

If there is ANY doubt or confusion … ASK FOR HELP from instructor BEFORE APPLYING POWER TO THE CIRCUIT BOARDS!!!!!!

DO NOT ATTEMPT TO USE MULTIMETERS ON ANY CIRCUITS UNTIL SHOWN HOW TO DO SO BY YOUR INSTRUCTORS.

DO NOT LIFT THE PLASTIC SUBSTRATES OUT OF THE KIT BY THEIR ATTACHED COMPONENT…USE A TOOL (PAPERCLIP).

No propeller flying in classroom.

Do not "experiment" with kit components – you will likely damage them rendering the kit useless for class projects.

Lesson 1

Learning about the KIT and body building CIRCUITS

BOOK NOTES

Please note that a responsible adult should always oversee the use of this material and the associated kit in addition to the optional test equipment. Even after the successful completion of this course, no student will be qualified IN ANY WAY, SHAPE or FORM to work on commercial (120v AC) power circuits or systems.

These BOOK NOTES are written with the expectation that an adult will be reading them. Classroom experience has shown that few students ever read any of the text if not specifically prompted to do so. If you are the supervising adult, we strongly urge that you read all the data in the instruction manual pertaining to a specific Project before having the student built it. NOTES are only intended as adjuncts to the instruction manuals in creating a more linear story line of increasing technical depth.

LEARNING OBJECTIVES

Learn how to correctly use the Kit to build circuits.

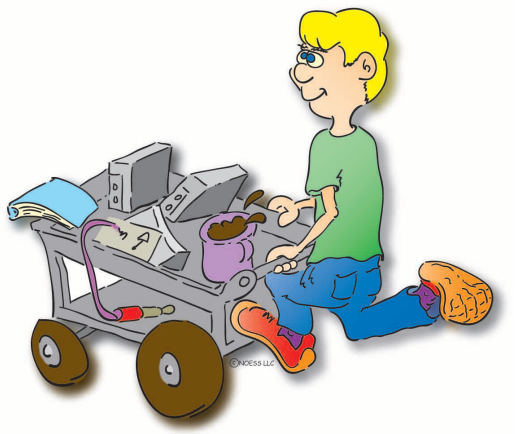
Define the meaning of the term: *electric circuit.*

Begin to define the various meanings of *electricity.*

Name the most common electrical measurements.

Do some simple proofs to verify concepts learned.

PART B: BUILD CIRCUITS



BOOK NOTES

Before building any circuits you should read all of the important information in the first few pages of each Project book. It is very easy to miss-build circuits which can result in damage to the components. In particular, be careful NOT to create short circuits.

Installing components out of sequence will result in having to tear some of them off when building complex circuits. To avoid confusion and wasted time, always follow the sequences listed for each Project.

GET READY - GET SET

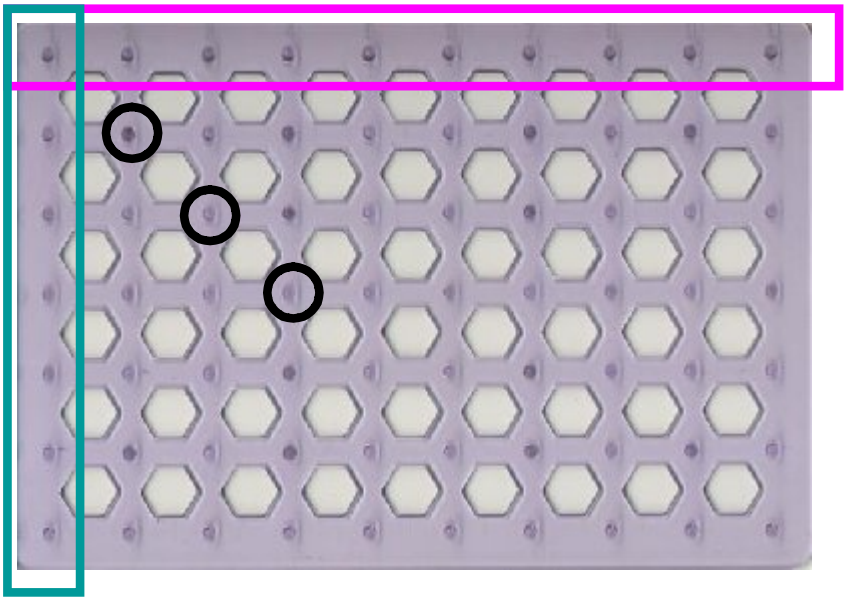
Open your Kit and find the Experiments 1-101 book (Rev E). Turn to Page 5. READ THE "DO'S and DON'Ts of Building Circuits" page (in the front of every book) to insure you do not build something that can damage the KIT parts.

DO NOT BEGIN TO BUILD YET!

Go to page 8 and completely read the info in the directions box for Project #1.

ON THE NEXT SERIES OF SLIDES THE INSTRUCTOR WILL SHOW YOU HOW TO CORRECTLY USE THE SNAP DOWN PARTS.

THE "BREADBOARD"



Notice the numbers embossed along the top.

Notice the letters embossed down the side.

The pins are for snapping down the circuit components.

BOOK NOTES

Because the "breadboard" is made of clear plastic, seeing the embossed numbers and letters can be difficult in low lighting. Using a felt tip pen to highlight them may be of some help.

The breadboard has no electrical or electronic function. It is simply a convenient device for holding the components in place.

FUN-DA-MENTALS

To gain a fundamental understanding of these applications, we need to agree on some simplified concepts of electricity.

We will begin our learning by defining some basic terminology and measurement names.

1) In a metallic (wires) electric circuit, the *flow* of electric current (electrons) = *AMPERES.*
2) The value of circuit *power* = *WATTS*.
3) The electrical *pressure* which causes electron flow = *VOLTS* of EMF (Electro-Motive Force).
4) The *resistance* to electron (current) flow = *OHMS.*
5) The *magnetic field* around a wire with electron (current) flow = *HENRIES.*
6) The *electric field* in a charged circuit = *FARADS.*
7) The *alternations* (cycles) of current flow = *HERTZ.*

GEEZER NAMES

Farad – Michael Faraday (1791-1867)

Henry – Joseph Henry (1797-1878)

Volt – Alessandro Volta (1745-1827)

Ohm – Georg Simon Ohm (1787-1854)

Amp – Andre-Marie Ampere (1775-1836)

Watt – James Watt (1736-1819)

Hertz – Heinrich Rudolph Hertz (1857-1894)

BOOK NOTES

Labeling the men whose names are used for these electrical measurements as "old geezers with beards" helps a lot of the kids to remember their names.

QUANTITY NAMES

Throughout the course we will be discussing electronic numbers which often have a *prefix* to make them easier to work with…these four are the ones we will use the most.

Mega = 1,000,000 = one million.

Kilo = 1,000 = one thousand.

Milli = 1/1,000 = one one thousandth.

Micro = 1/1,000,000 = one one millionth.

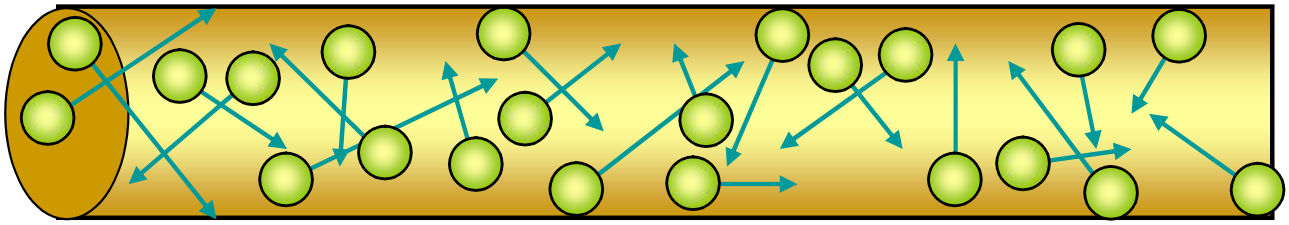
WHAT'S THE HAPPS?

Since no electrons are "used up" by L1, what makes the bulb light up?

The electrical *energy* of the battery is transferred to the load by electromagnet fields produced by electron current flow and it is this which is "used up" by the light bulb in the form of heat.

The actual *physical* mass movement of electrons thru the wire is very slow, something like cold pancake syrup on a plate. You may see this described as *electron drift* caused by applied energy.

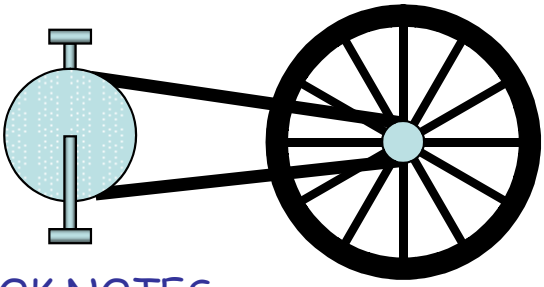
The *energy* transfer via the electromagnetic fields is almost instantaneous, approaching the speed of light.



Individually, each free electron can be moving any direction but when energy is applied across the wire, they all drift in the same direction.

LIKE A BIKE CHAIN

1) Pumping the pedals inserts power into the system. (ENERGY)
2) Crank transfers power to move chain links. (ELECTRONS)
3) Links transfer power to wheel. (LOAD)



NOTE – no chain links (electrons) get "used up" in this energy transfer.

The energy is instantaneously coupled from the source to the load with even the slightest movement of the pedals…minus a little chain slack.

BOOK NOTES

Many times the movement of water thru pipes is used to describe the flow of current in an electrical circuit. While this can be initially useful, it sometimes leaves the impression that it is the physical flow which is doing the work at the circuit's load point.

A more accurate analogy is that of a single link in a bicycle chain representing a single electron. Even the smallest movement (in either direction) will result in energy transfer to the load (wheel). The links don't get used up and don't have to physically get all the way out to the load for energy transfer to take place.

FUNDAMENTAL FORMS

Analog – this type provides a display of measured values using various printed scales. An electromagnetically powered meter movement positions a needle over the scales.

Digital – this type provides a display of measured values using a LCD showing numeric values. Internal circuits convert measured values into discrete numbers for the display.

FIRST RULE OF USING MULTI METERS!!!!!!!!!!!!

ALWAYS ASSUME AND TEST FOR HIGH VOLTAGE FIRST!!

ALWAYS ASSUME AND TEST FOR HIGH VOLTAGE FIRST!

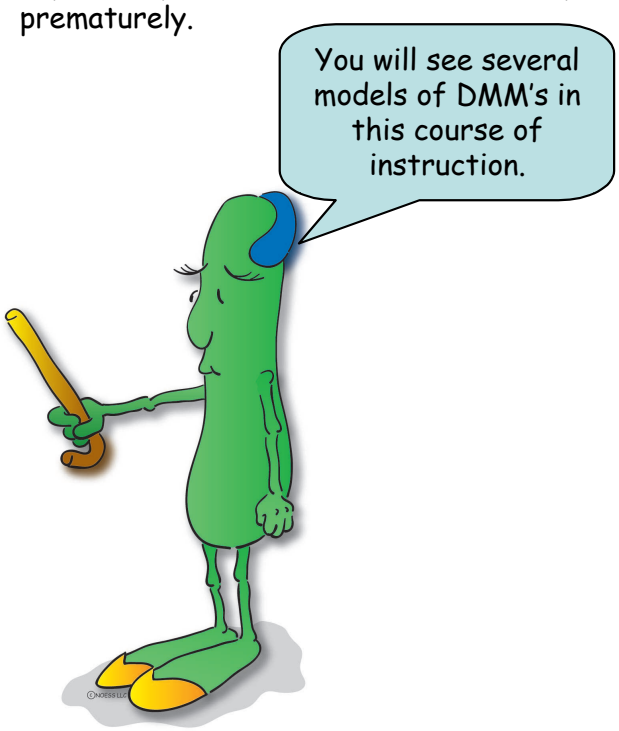
DMM'n MEASUR'IN E's

DMM (E) CHECK - 1 OF 12

IMPORTANT!

Always check the range switch to make sure it is in the *OFF* position any time the meter is not being used.

The internal battery is used to power the LCD display even when no readings are being taken. Leaving the switch set on any other position wears out the battery prematurely.

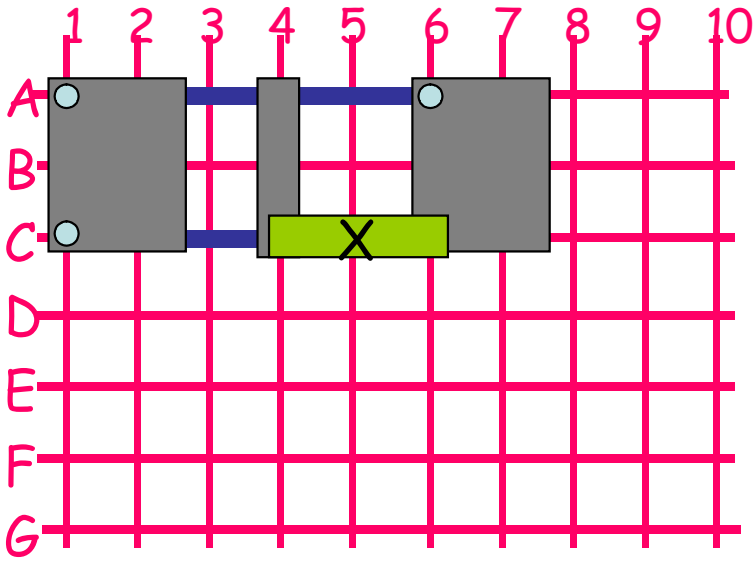


BOOK NOTES

Note this MM2003 meter compared to the DT-830B shown on some other Lesson pages has a larger LCD display, has a range setting for creating a square wave and the designations for AC and DC are symbols instead of letters. Also, the DC amp range does not have a 200µa setting in order to incorporate the square wave selection. Consider this as just a variation on a common basis for digital multimeters.

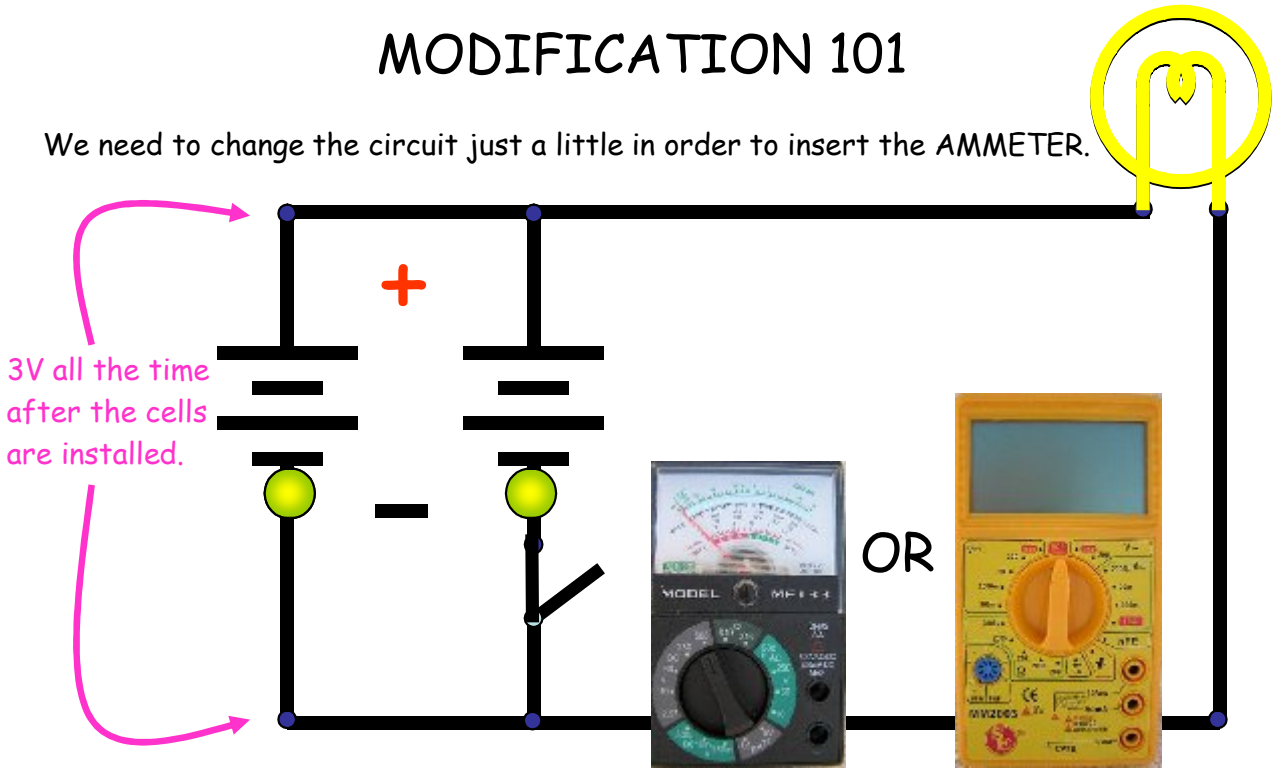
BUILD OR REBUILD

1) Open your kit and find Book 102-305.
2) Go to page 8 and read the OBJECTIVE and instructions for Project #103.
3) Build Project #103.
4) DO NOT OPERATE SWITCH UNTIL PARTNERS CHECK EACH OTHERS CIRCUIT! IF YOU ARE UNSURE…ASK INSTRUCTOR.



MODIFICATION 101

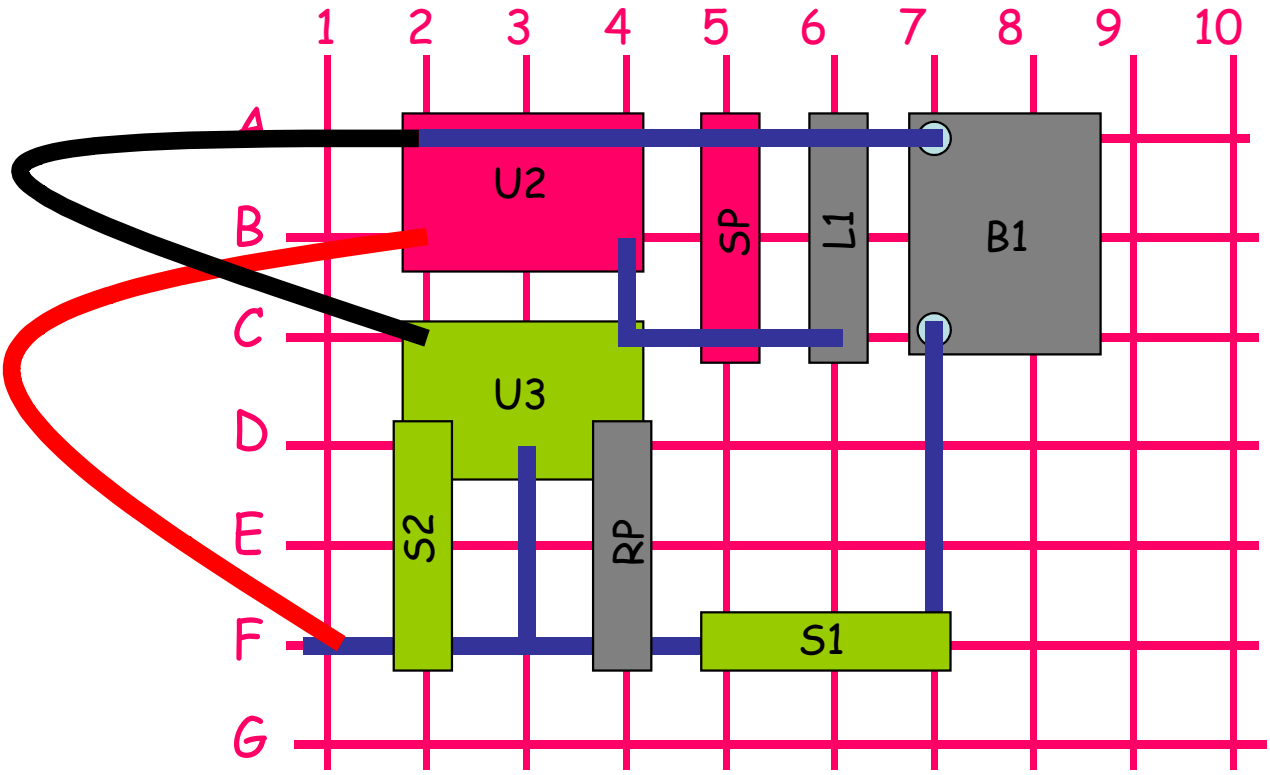
We need to change the circuit just a little in order to insert the AMMETER.



The AMP-METER (AMMETER) must be inserted into the circuit so the current will flow *THRU THE METER*. There is a significant safety issue involved with measuring *I* this way. Additionally, it can damage the meter if done incorrectly.

NOISY WAVES

1) Open your kit and find Book 1-101
2) Go to page 12 and fully read the objective and instructions for Project #10.
3) Build Project #10.
4) Answer this question. Why do the sounds change?



Because light changes makes RP change circuit resistance.

BOOK NOTES

The units U2 and U3 are cases containing a "chip" or IC (integrated circuit) specifically engineered to produce a particular set of electrical oscillations which the speaker converts into audible sound. The details of these devices will be covered in Lesson 8.

MEASURE RESISTANCE AMM (3 of 5)

ANALOG OHM METERS MUST BE "ZEROED" ON EACH SCALE EACH TIME THEY ARE USED!

1) Range switch to 1KΩ range.

2) Touch the ends of the red and black meter leads to each other.

3) Adjust the OHMS ADJ wheel on the side of the AMM to get a zero reading on the top green meter scale.

BOOK NOTES

One of the (many) challenges to younger students using these inexpensive meters shows up here. The accuracy of resistance measuring with an AMM is directly related to getting it properly calibrated. The first step is to get the needle set on the zero mark of the AC/DC scale using the center screw of the meter movement. If this is not set first, the OHMS ADJ to follow will not be accurate.

The AC/DC zero calibration does not require the meter to be "on" any particular range switch setting. It does require the student to eliminate parallax error by sighting with only one eye directly over the needle so its reflection in the mirror strip is covered by the needle.

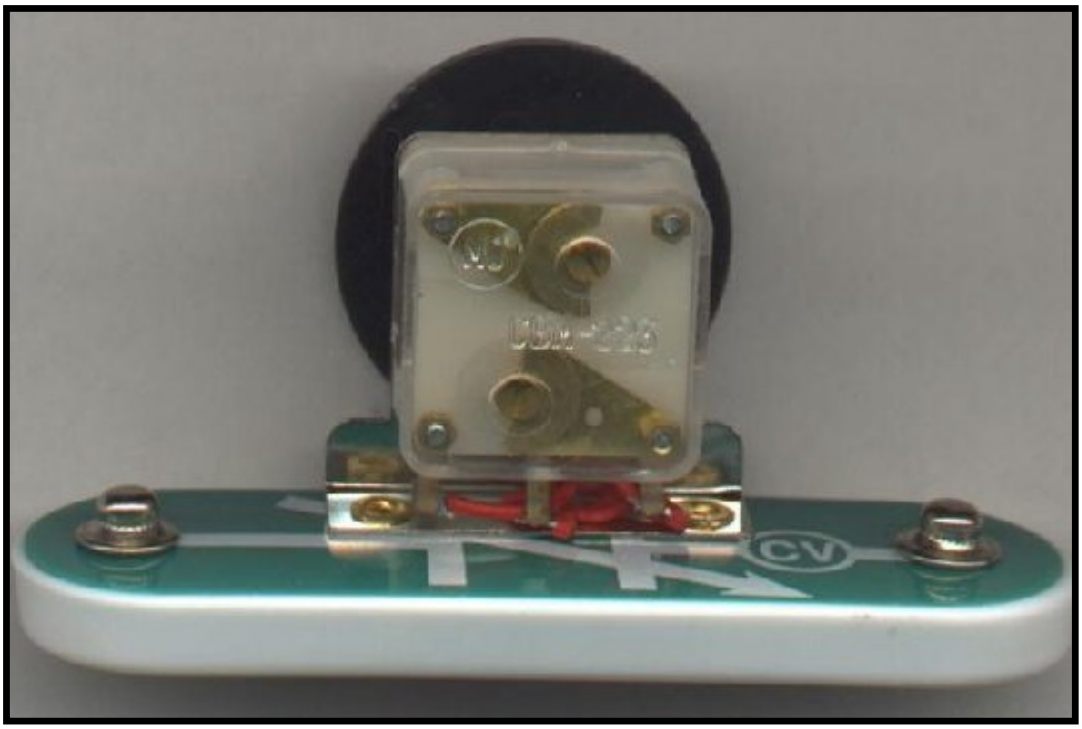
The OHMS calibration (right side green scale 0) is directly dependent on this physical zeroing of the AC/DC in addition to compensation for the condition of the internal battery brought in to play when the range switch is on any Ω setting.

The OHMS ADJ wheel should bring the needle over the green zero but if it does not…the internal battery needs to be replaced. The two Ω range settings of this meter insert different internal loads and can therefore require adjustment each time the switch is moved from one to the other.

Eyeballing the needle is also required for accurate zero calibration of ohms. The younger students frequently need to practice these actions several times in order to understand the requirements and follow the steps in using AMM's for resistance testing.

A VARIABLE *CAPACITOR*

CV in your kit is a variable (adjustable) capacitor which uses air as the insulator between the plates.



HOW DO THEY WORK?

When electrons are packed up together on a metal plate, the plate will exhibit a negative *electrostatic* field thus forcing an equal number of electrons out of an adjacent plate.

- This is the *charging* phase of the capacitor.

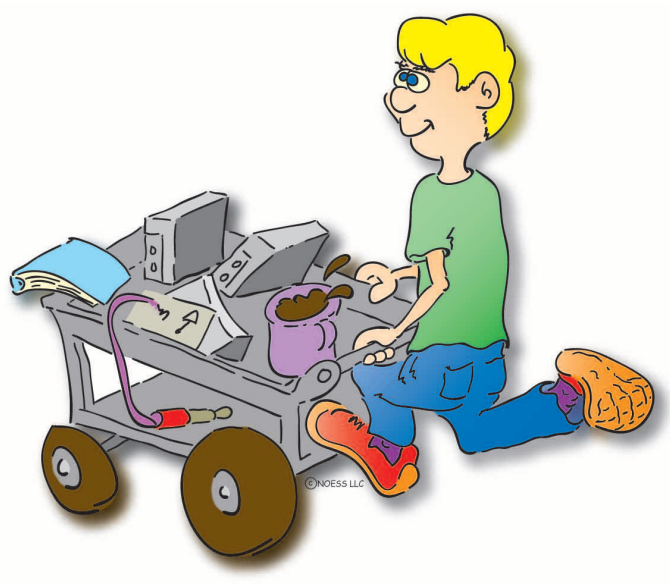
The two plates will act as a "storage" device with lots of electrons on one and fewer on the other (even though the *total* number of electrons within the capacitor remains the same as before the charging phase).

Only when the two plates are connected (thru a circuit) will the difference in plate electrons (field charge) equalize by the flow of energy (current) thru that circuit.

- This is the *discharging* phase of the capacitor.

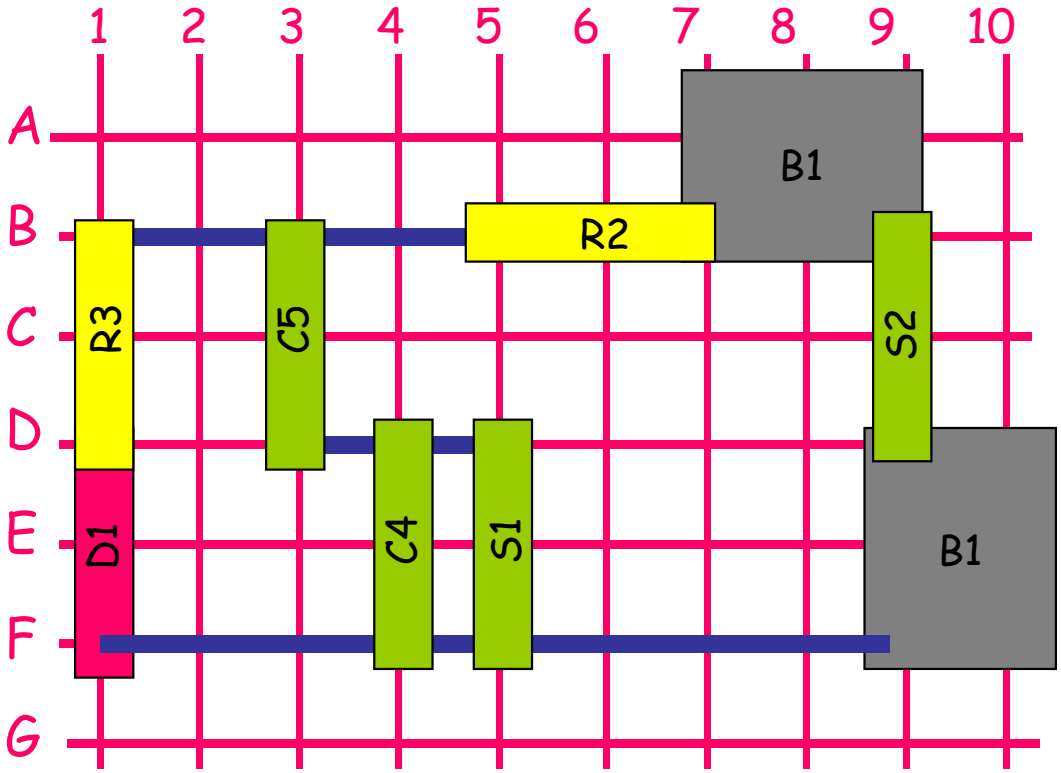
A very common use for capacitors is in circuitry which smoothes out the small fluctuations (known as ripples) in the DC being produced by battery chargers or car alternators. By effectively absorbing the high and discharging into the low points of the ripples the output is flattened into a clean DC.

PART B1: BUILD CIRCUITS



SERIOUS SERIES

1) Open your kit and find Book 102-305.
2) Go to page 25 and fully read the objective
and instructions for Project #164.
3) Build Project and verify it operates per the instruction box.



USING A DMM TO CHECK CONTINUITY

1) Remove the A1 antenna unit from the circuit board.
2) Set up the AMM or DMM to read resistance on the lowest scale.
3) Measure across the A1 snaps.

WHAT HAPPENS?

4) Reverse the AMM or DMM leads.

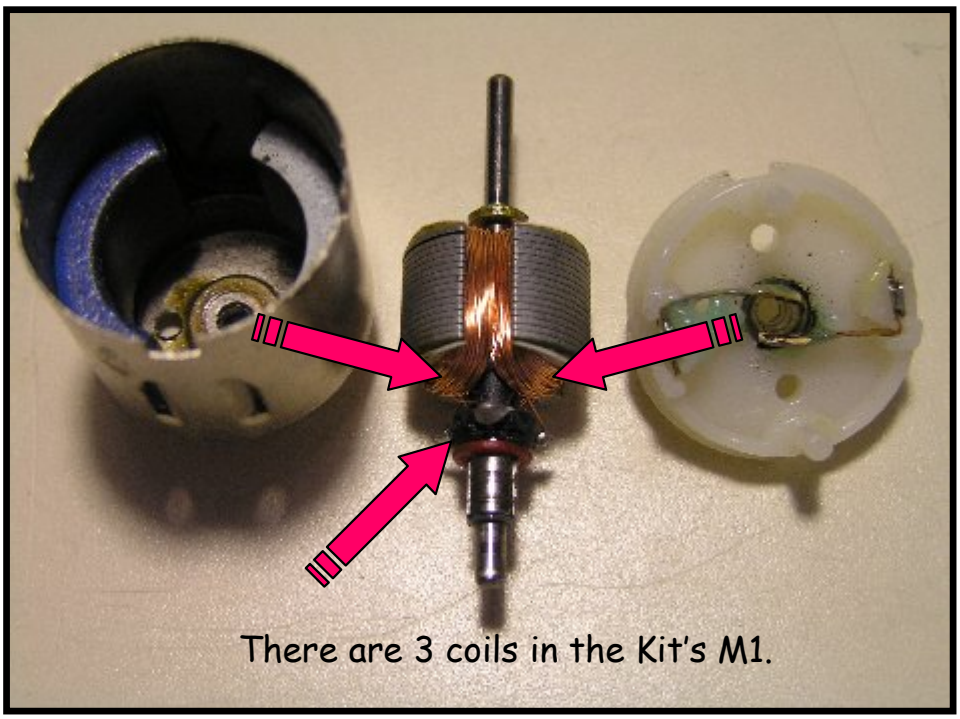
WHAT HAPPENS?

5) See next slide for what you should have seen.

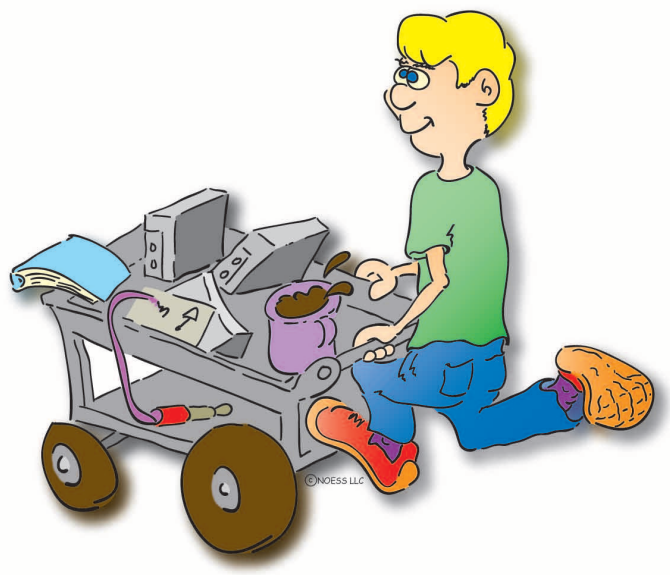
YOU SHOULD HAVE SEEN THIS

A resistance value of A1 somewhere around 2.5 ohms – in either direction – because:
ITS JUST A LONG LENGTH OF WIRE WRAPPED INTO A SMALL SPACE!

If you check the continuity of the Kit's motor you will also be checking a "coil" of wire.



PART B: BUILD CIRCUITS



YO HO HO IT'S A RADIO

1) Open your kit and find Book 102-305.
2) Go to page 68 and fully read the instructions for Project #289.
3) Build Project #289.
4) DO NOT OPERATE SWITCH UNTIL
   PARTNERS CHECK EACH OTHERS CIRCUIT!
   IF YOU ARE UNSURE…ASK INSTRUCTOR.