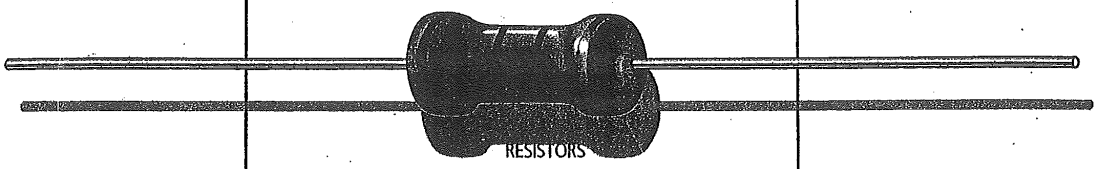
INVENTORY



RESISTORS

10 ohms (Brown,Black,Black,Gold)
47 ohms (Yellow,Violet,Black,Gold)
47 ohms (Yellow,Violet,Black,Gold)
100 ohms (Brown,Black,Brown,Gold)
100 ohms (Brown,Black,Brown,Gold)
220 ohms (Red,Red,Brown,Gold)
220 ohms (Red,Red,Brown,Gold)
1kΩ (Brown,Black,Red,Gold)
1kΩ (Brown,Black,Red,Gold)
2.2kΩ (Red,Red,Red,Gold)
3.3kΩ (Orange,Orange,Red,Gold)
6.8kΩ (Blue,Gray,Red,Gold)
16kΩ (Brown,Blue,Orange,Gold)
33kΩ (Orange,Orange,Orange,Gold)
33kΩ (Orange,Orange,Orange,Gold)
120kΩ (Brown,Red,Yellow,Gold)
470kΩ (Yellow,Violet,Yellow,Gold)

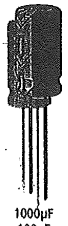
Transistors
2N3906
2N3904

SCR

Photocell

Diode

2 LED's

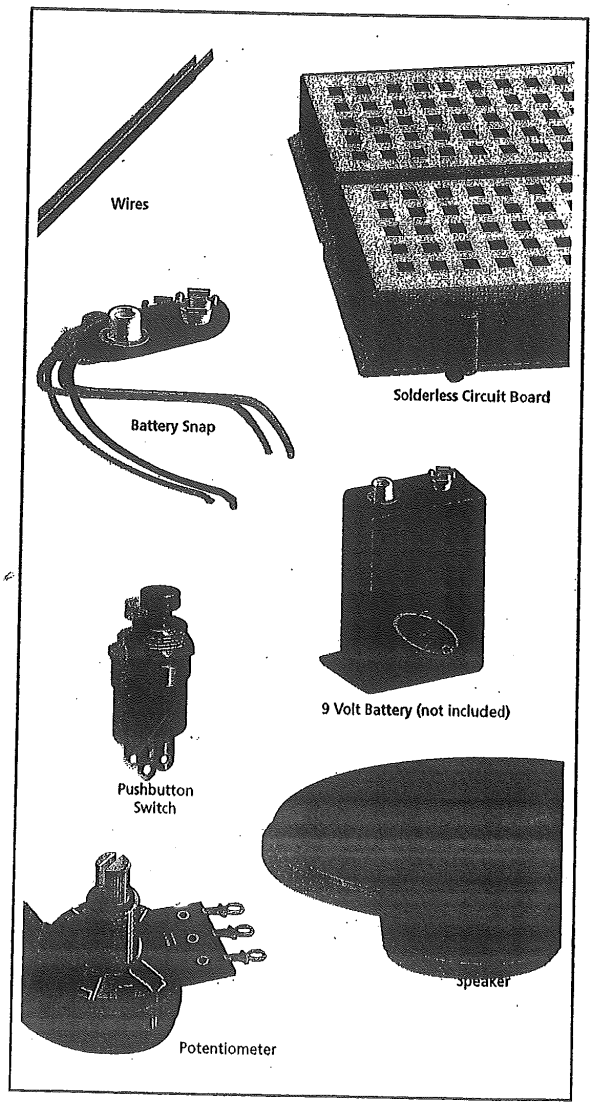


1000µF
100µF
10µF

.1µF
(104)
.01µF
(103)

IC555

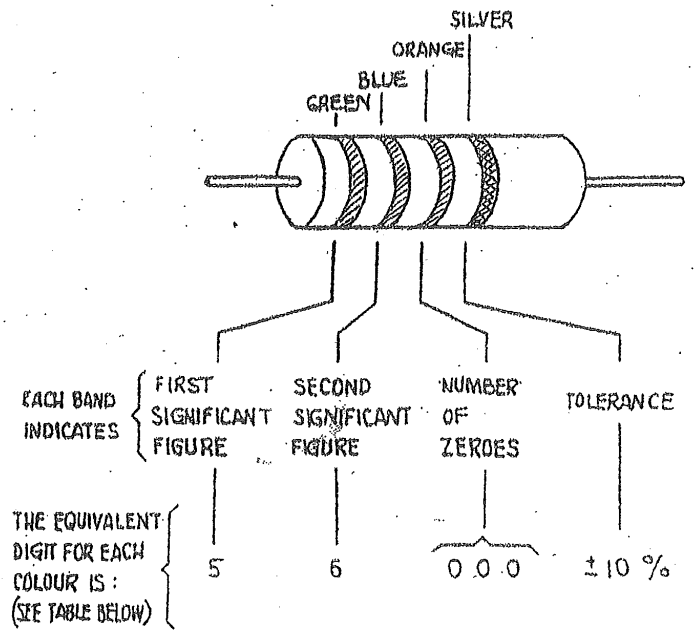
INVENTORY



NOTES :

COLOUR CODE FOR RESISTORS

CONSIDER A RESISTOR WITH COLOUR BANDS AS SHOWN BELOW :



THEREFORE, THE RESISTOR SHOWN ABOVE HAS AN OHMIC RESISTANCE OF : 56 000 Ω ± 10 %.

COLOUR CODE TABLE	
COLOUR	DIGIT
BLACK	0
BROWN	1
RED	2
ORANGE	3
YELLOW	4
GREEN	5
BLUE	6
PURPLE (VIOLET)	7
GRAY	8
WHITE	9

TOLERANCE TABLE	
COLOUR	PERCENT
NONE	± 20 %
SILVER	± 10 %
GOLD	± 5 %
RED	± 2 %

Soldering Safety Rules

1. Always check the condition of the soldering iron cord before you plug it in. Your life may depend upon it. Never plug it in if the cord is cut, broken or damaged.

2. Report all accidents/injuries to the teacher at once.

3. Never touch the tip of the soldering iron even though it may not be plugged in. Always consider the soldering iron as hot. It may just have been unplugged and still be very hot. Do not burn yourself with it.

4. Be careful not to burn the cord of the soldering iron. When it is plugged in, there is about 120 volts of electricity in the cord, enough to give you a fatal electrical shock. If the cord is burned or shorted, the flash of electricity that may occur could scare and injure you. Move the cord away from the area where you are going to solder.

5. Keep the soldering iron in its soldering iron holder when you are not soldering. Never leave it lying on the bench top.

6. The soldering iron holder gets very hot also. Never touch or grab the holder by the top. Handle the soldering iron holder only by its base.

7. Do not leave the soldering iron plugged in if you are not going to use it within the next half hour.

8. Always unplug the soldering iron at the end of the period.

9. Hold the soldering iron firmly when soldering so that you do not drop it.

10. Wear eye protection when there is a chance that molten solder may flick into your eyes.

11. Watch out for any excess molten solder that may be on the soldering iron tip and drop down onto you. Keep the tip clean. Wipe it often.

12. Do not put solder into your mouth. It contains lead which is harmful.

13. Never touch a soldering connection that has just been made. It will still be very hot.

14. Check to make sure the tip of the soldering iron is secure. If it is loose, have the teacher tighten it up.

ssr/90

BASIC ELECTRONIC THEORY

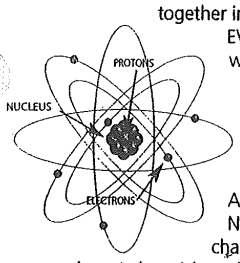
LESSON 1

MATTER

Everything you see around you is made of "matter". The desk, pen, paper, water, etc., even yourself! Matter is something that has mass and takes up space. It can be found in three states: SOLID, LIQUID, and GAS. At this point you might ask, what is matter made of?

Answer: **ELEMENTS**

Matter is made up of elements, which are substances found naturally in the universe, such as carbon, oxygen, silver, gold, etc. There are approximately 104 different known elements in the universe. These elements, when chemically mixed together in specific combinations, make-up.. EVERYTHING. Now, the next question, what are the elements made of?



Answer: ATOMS

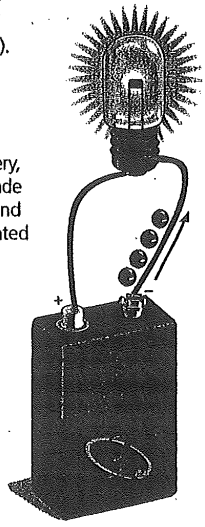
Each element is made up of "atoms", as the one shown in fig 1. Atoms have a central core, called a NUCLEUS, filled with positively (+) charged particles known as PROTONS, and, neutral particles called NEUTRONS. Surrounding the nucleus, in several orbits, are negatively (-) charged particles called ELECTRONS. All atoms are arranged in this way, regardless of whether they constitute an element of hydrogen or gold. The only important difference is the number of protons and electrons each atom has. For example, hydrogen has one electron, while gold has seventy-nine.

PENCIL EXERCISE # 1

Draw an atom and label its parts.

ELECTRONS AND ELECTRIC CURRENT

Now you can say, "Okay, I understand that everything is made up of atoms, and that atoms are made up of protons and neutrons inside a nucleus with electrons running around it, but...what does this have to do with electronics?" By definition, electronics is the part of physics that studies the movement of electrons. Electric current, is the movement of millions of electrons through a conductor (wire).



When you connect a lamp to a battery as shown in fig. 2, the lamp lights up, because electric current circulates through it. Inside the battery, the (+) and (-) terminals are each made of a different element, usually zinc and carbon respectively. These are separated by a chemical that allows electrically charged atoms to move through it. This structure creates a force between the terminals. This force, called VOLTAGE, will cause electrons to flow from the negative (-) terminal to the positive (+) terminal if a path is created that the electrons can follow. Thus, when the bulb is attached to the battery, electrons flow from the (-) terminal through the bulb to the (+) terminal of the battery. This flow of electrons is called "electric current".

PENCIL EXERCISE #2

1) The use of different elements for the anode and cathode of the battery creates a _____.

2) When you connect a lamp or any other conductive material across the terminals of a battery, electrons will flow from the _____ terminal to the _____ terminal of the battery. This flow is called _____ current.

Now that you know that electronics is the part of physics that studies the movement of electrons, and that an electric current is the movement of millions and millions of electrons, from a negative source to a positive source, you are ready to go to Lesson 2, called: The Resistor Color Code.

LESSON 2

RESISTORS, RESISTANCE & OHMS

Resistors are one of the most fundamental electronic components. They are used in nearly every electronic circuit. Each resistor has a specific amount of RESISTANCE, or opposition to current flow. Resistance is measured in ohms (Ω). We can control the flow of current in a circuit by selecting the correct resistance. For example, a resistor of 10,000 ohms would provide much more opposition to current flow than a resistor of 1000 ohms. So the higher the number of ohms, the higher the resistance, and the fewer the electrons that flow through the resistor.

PENCIL EXERCISE 1

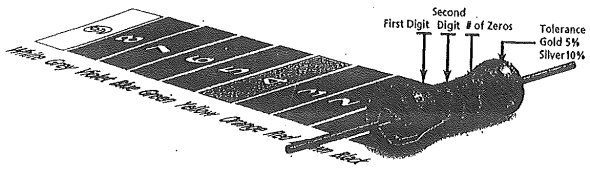
1. Resistance is the _____ to current flow.
2. Each resistor has a certain amount of _____.
3. Resistance is measured in _____.
4. A resistor of 20,000 ohms will provide _____ opposition to the current flow than a resistor of 5,000 ohms.

THE RESISTOR COLOR CODE

The resistor color code is a method of indicating the resistance value in ohms. It is not a secret code designed by sinister cryptographers to confuse and frustrate us. On the contrary, it was made simple and easy to read, so that everyone can learn it in just a few minutes, including you!

WHY THE COLOR CODE

With the color code we use colored bands in order to overcome two basic problems:
ONE: It would be very difficult to print numbers on a small resistor.
TWO: Even if we could print numbers on them, placement of the resistor in the project might make it impossible to see the numbers.
The color coded bands that go entirely around the resistor seem to solve these two problems. When reading the color code, the resistor should be held with the gold (or silver) band on the right, as shown in the next picture.



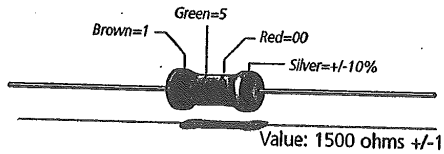
Each color stands for a particular number. For example, red equals two.

When reading the color code remember:
-The FIRST BAND always represents A NUMBER.
-The SECOND BAND always represents A NUMBER.
-The THIRD BAND always represents the NUMBER of ZEROS to be added to the two preceding numbers. (If the third band is black, no zeros are added)
-The FOURTH BAND represents the TOLERANCE value. This band is usually GOLD (5%) or SILVER (10%).

Tolerance means the precision or exactness of the value of the resistor. For example, resistors with a gold band have an actual value plus or minus 5% of what the color code indicates, due to differences in manufacturing.

EXAMPLE

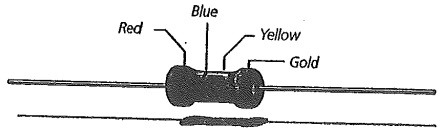
What is the value in ohms, and the tolerance of the following resistor?



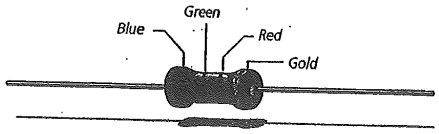
Value: 1500 ohms +/-10%

PENCIL EXERCISE 2

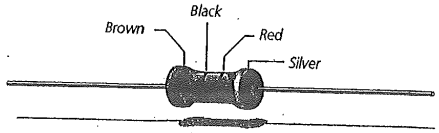
Give the value in ohms and the tolerance, of the following resistors:



Value:_____+/-____%



Value:_____+/-____%



Value:_____+/-____%

ABBREVIATING NUMBERS

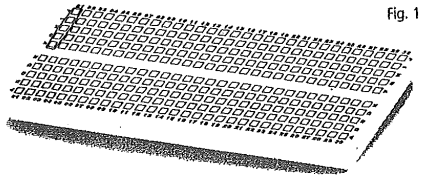
Usually the values of resistors are abbreviated by using the prefix k (kilo) to represent 1000 and the prefix M (Mega) to represent 1,000,000. For example, a 1kΩ resistor is a resistor of 1000 ohms. A 3.3kΩ resistor is a resistor of 3300 ohms. A 2MΩ resistor is a 2,000,000 ohm resistor.

LESSON 3

USING THE SOLDERLESS CIRCUIT BOARD

The Solderless Circuit Board is a device that allows you to assemble electronic circuits without the use of solder. It makes for quick and easy construction and is thus ideal for experimentation. A Solderless Circuit Board comes supplied in this Lab Kit AO. Lay the board in front of you, as shown in Fig 1.

Fig. 1



Notice that there are many tiny holes in each board. Each hole will accept a component lead or wire. ALL FIVE HOLES IN EACH VERTICAL GROUP ARE CONNECTED TOGETHER. Each vertical group is "shorted" together. Two or more wires or leads plugged into anyone of the five holes will be connected together. There are 60 groups of five holes.

Fig. 2

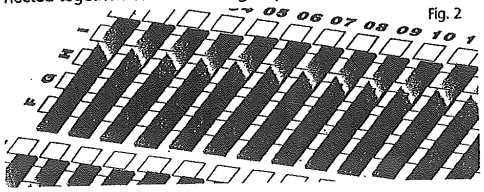
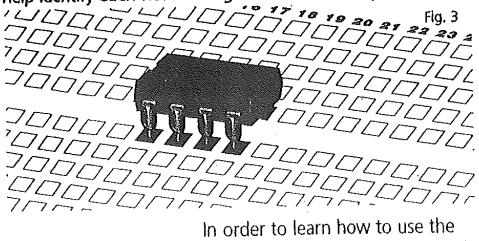


Fig 2 shows the underlying metal strips which connect each group of five holes on the solderless circuit board.

A center channel divides the board in half. Integrated Circuits can be straddled across this channel as shown in Fig. 3. Also note that numbers and letters were printed on the board to help identify each hole during the construction process.

Fig. 3



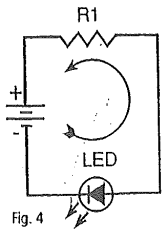


Fig. 4

In order to learn how to use the Solderless Circuit Board do the following experiment. Let us say that we want to build a simple circuit to light up an LED, like the one shown in fig. 4.
In this circuit an electric current flows from the negative terminal of the battery to the positive terminal, passing through the LED and the resistor. As current flows through the LED, it illuminates.
One way to build this circuit is by soldering the leads of the components to one another, as shown in figure 5.

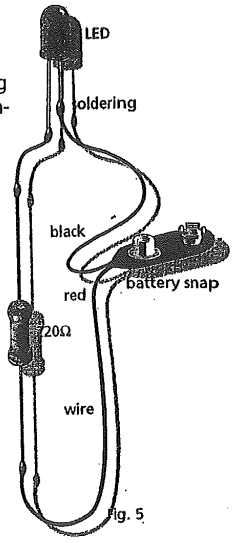
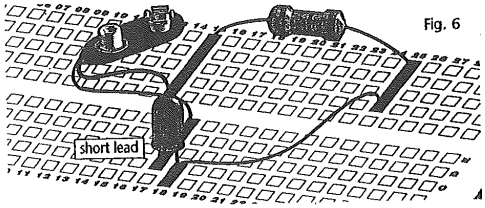


Fig. 5

Or, the same circuit can be constructed, easily and neatly, by using a solderless circuit board, as shown in Fig. 6.
In this case, the leads of the components are connected to one another by the metal strips of the solderless circuit board, as shown in Fig. 6.
REMEMBER, WIRES THAT MUST BE CONNECTED TOGETHER MUST BE INSERTED INTO HOLES OF THE SAME VERTICAL COLUMN.

Now, using the solderless circuit board and the parts, build the circuit of fig. 6.
Take special care while installing the LED to put the short lead in the right direction. Once you have the circuit assembled, connect a battery to the battery snap

Fig. 6



and the LED should light up. Now, make a little change in the circuit. Pull out the red wire of the battery snap from its original position and insert it in the hole shown in Fig 7.

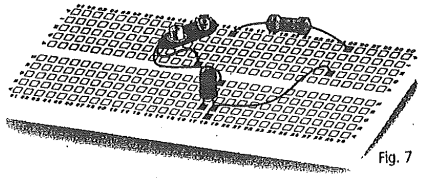


Fig. 7

What happened to the LED when you made that change?

_____

Explain why._____

_____

The LED went out because in the circuit shown in Fig. 7 there is no connection between the red wire of the battery snap and resistor R1. Remember, "WIRES THAT NEED TO BE CONNECTED TOGETHER MUST BE INSERTED INTO THE SAME VERTICAL COLUMN OF HOLES".
Note: Never connect the LED directly to the battery. It will destroy the LED.
Now you are ready to work on more Lab Kits.

HOW A RESISTOR WORKS

LAB KIT A1

PURPOSE OF THIS EXPERIMENT

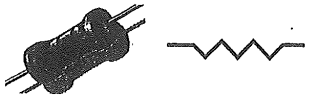
In this experiment you will build a simple device that will allow you to observe the effect of a resistor controlling current flow. You will observe how the value of the resistor in the circuit affects the brightness of the LED.

THEORY OF THIS CIRCUIT

In this experiment we introduce two components, the resistor and the LED.

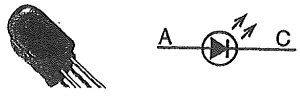
A resistor limits the amount of current flowing through a circuit by presenting opposition or resistance to the current flow. Just like a funnel, where much water can be poured into it, and only a set, small, amount of water comes out, a resistor limits the amount of electrons that can flow through it.

Appearance | Schematic Symbol | Draw Schematic



An LED (light-emitting diode) is a special kind of diode that emits light when current flows through it. It has two terminals called cathode (C) and anode (A). The cathode is indicated by a flat side on the case of the LED and/or by a shorter lead.

Appearance | Schematic Symbol | Draw Schematic



This project is made up of three components; the battery, the LED, and the resistor, which are connected in series, one following the other (see schematic diagram).

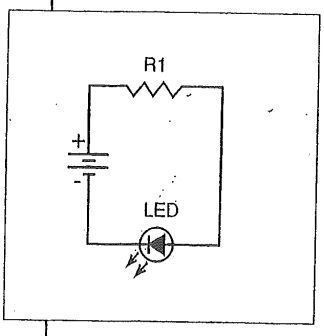
In this circuit the current flows from the negative terminal of the battery to the positive terminal of the battery, passing through the LED and resistor. As current passes through the LED, it lights up. The more current, the more light.

The element that controls the amount of current flowing through the circuit is the resistor. The smaller the resistance value is, the smaller the opposition to the current flow and therefore, the higher the current. The higher the current is, the brighter the LED. On the other hand, the higher the resistance value is, the greater the opposition to the current flow and the lower the current. The lower the current is, the dimmer the LED.

Now you should understand why, as you insert progressively higher values of resistance, the brightness of the LED decreases. The higher the resistance is, the lower the amount of current that flows through the circuit, and therefore, the brightness of the LED decreases.

Now you are ready to assemble this project.

SCHEMATIC DIAGRAM & PARTS LIST

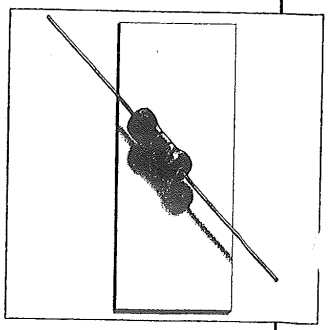


Part #

35001 - Battery snap
06001 - LED (light emitting diode)

Multiple Parts used for R1:

01041 - 100Ω (Brown, Black, Brown, Gold)
01049 - 220Ω (Red, Red, Brown, Gold)
01065 - 1kΩ (Brown, Black, Red, Gold)
01085 - 6.8kΩ (Blue, Grey, Red, Gold)



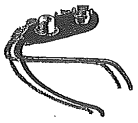
STEP-BY-STEP ASSEMBLY INSTRUCTIONS

HOW A RESISTOR WORKS / LAB KIT A1

USE THE SOLDERLESS CIRCUIT BOARD TO BUILD THE PROJECT. ALWAYS COMPARE YOUR WORK WITH THE SCHEMATIC DIAGRAM.

○ STEP 1

Find the Battery Snap. Insert the red wire into hole 15f and the black wire into hole 17e.



○ STEP 2

Find R1, the 100 ohm resistor (Brown, Black, Brown, Gold). Insert one lead into hole 15j and the other into hole 25j.

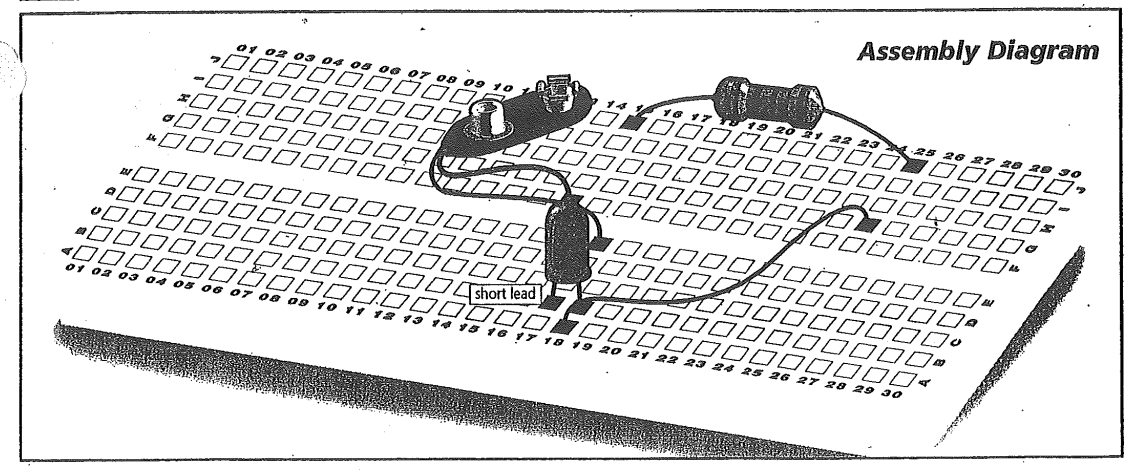
○ STEP 3

Find the red LED (light emitting diode). Insert its short lead into hole 17b and its long lead into hole 18b.

○ STEP 4

Get one wire. Insert one side into hole 25g and the other side into hole 18a.

STOP! BEFORE YOU TEST YOUR PROJECT VERIFY IT AGAINST THE SCHEMATIC DIAGRAM TO BE SURE THAT ALL THE COMPONENTS ARE INSTALLED IN THE RIGHT PLACE. ALSO BE SURE THERE ARE NO SHORT CIRCUITS ON THE BOARD (WIRES OR LEADS TOUCHING EACH OTHER). TO OPERATE THE PROJECT FOLLOW THE DIRECTIONS IN THE SECTION CALLED "OPERATING INSTRUCTIONS."



OPERATING INSTRUCTIONS

1 - Now that you have this project assembled, connect a fresh 9 volt battery to the battery snap. As you do this the LED will turn ON. Notice the brightness of the LED.

2 - Replace resistor R1 (100 ohm) with resistors of larger value and observe how this affects the brightness of the LED. Remove the 100 ohm resistor from the board–The LED will turn OFF. Install, one at a time, the following resistors in the place of R1 (leads to holes 15j and 25j), observe in each case the brightness of the LED.

- 220 ohms (Red, Red, Brown, Gold).
- 1kΩ (Brown, Black, Red, Gold).
- 6.8kΩ (Blue, Gray, Red, Gold).

RESULTS & OBSERVATIONS

By performing this experiment you should have found that the brightness of the LED depends upon the value of the resistor in the circuit. The higher the resistance value, the dimmer the LED.

HOW A POTENTIOMETER WORKS

LAB KIT A2

PURPOSE OF THIS EXPERIMENT

The purpose of this experiment is to observe how a potentiometer works as a variable resistor.

THEORY OF THIS CIRCUIT

In this experiment we introduce the potentiometer, which is a variable resistor. Using the potentiometer you can vary the amount of electrons that flow through a circuit by twisting the control shaft.

Appearance Schematic Symbol Draw Schematic

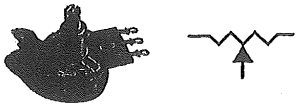


Fig. 1 shows the schematic symbol of a potentiometer. It has three leads labeled A, B and C. C is the cursor that moves between A and B.

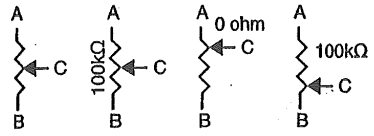


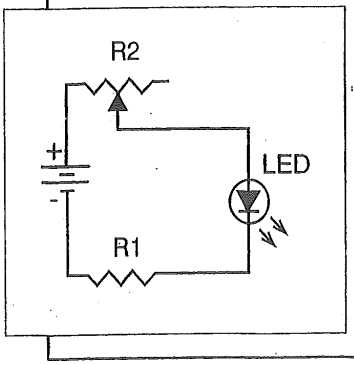
Fig 1 Fig 2 Fig 3 Fig 4

If the value of the potentiometer is, for example, 100kΩ; between A and B there will always be a resistance of 100kΩ (Fig. 2). The resistance between A and C depends upon the position of the cursor. If the cursor is touching the A end, the resistance will be zero (Fig. 3). If the cursor is touching the B end, the resistance between A and C will be 100kΩ (Fig. 4). If the cursor is in any position between A and B, the value of the resistance between A and C will be somewhere between 0 and 100kΩ.

Now, observe the schematic diagram of this project. The current flows from the negative terminal of the battery to the positive terminal of the battery, passing through resistor R1, the LED, and the potentiometer. As you adjust the potentiometer from one end to the other, the resistance changes, causing the brightness of the LED to change.
NOTE: The 100 ohm resistor (R1), is placed in the circuit to limit the current. This is necessary because the LED will burn out if the potentiometer is set to 0 ohms.

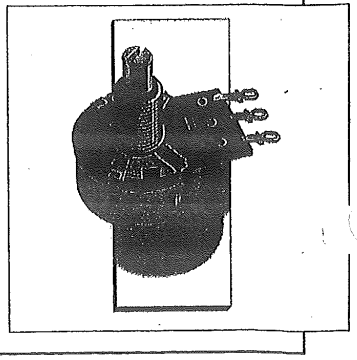
Now you are ready to assemble this project.

SCHEMATIC DIAGRAM & PARTS LIST



Part #

35001 - Battery Snap
06001 - LED (Light Emitting Diode)
01041 - R1: 100Ω (Brown, Black, Brown, Gold)
33008 - R2: 100kΩ Potentiometer



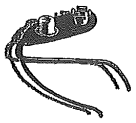
STEP-BY-STEP ASSEMBLY INSTRUCTIONS

HOW A POTENTIOMETER WORKS / LAB KIT A2

USE THE SOLDERLESS CIRCUIT BOARD TO BUILD THE PROJECT. ALWAYS COMPARE YOUR WORK WITH THE SCHEMATIC DIAGRAM.

○ STEP 1

Find the Battery Snap. Insert the red wire into hole 13f and the black wire into hole 13e.

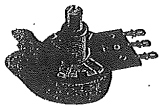


○ STEP 2

Find R1, the 100 ohm resistor (Brown, Black, Brown, Gold). Insert one lead into hole 13a and the other into hole 24a.

○ STEP 3

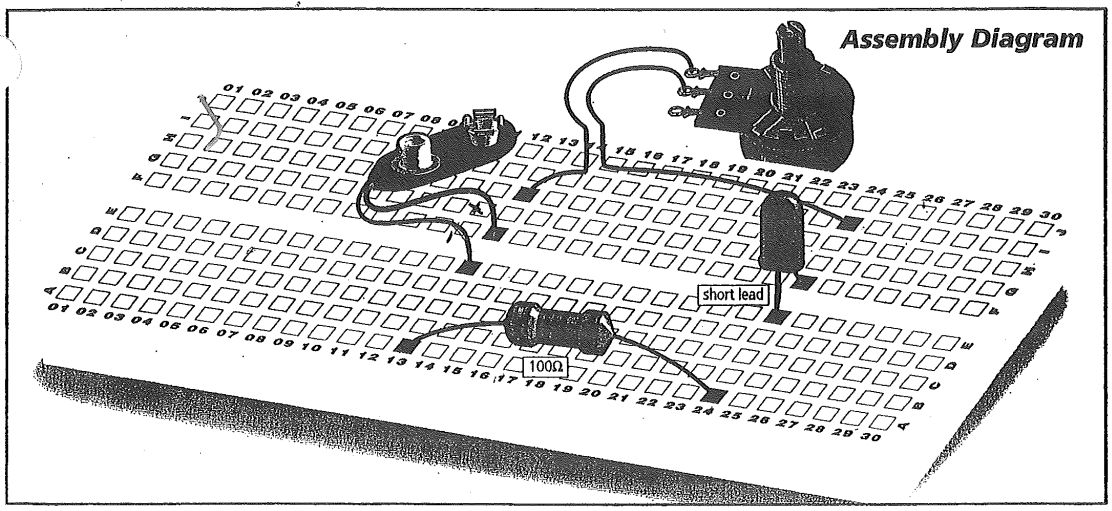
Find the potentiometer. Insert the wire connected to the left lead to hole 13h and the wire connected to the center lead to hole 24i.



○ STEP 4

Find the LED (light emitting diode). Insert its long lead into hole 24f and its short lead into hole 24e.

STOP! BEFORE YOU TEST YOUR PROJECT VERIFY IT AGAINST THE SCHEMATIC DIAGRAM TO BE SURE THAT ALL THE COMPONENTS ARE INSTALLED IN THE RIGHT PLACE. ALSO BE SURE THERE ARE NO SHORT CIRCUITS ON THE BOARD (WIRES OR LEADS TOUCHING EACH OTHER). TO OPERATE THE PROJECT FOLLOW THE DIRECTIONS IN THE SECTION CALLED "OPERATING INSTRUCTIONS."



OPERATING INSTRUCTIONS

1 - Now that you have this project assembled, connect a fresh 9 volt battery to the battery snap.

Twist the shaft of the potentiometer from one end to the other observing the brightness of the LED.
You will notice that by twisting the shaft of the potentiometer from one end to the other you can control the brightness of the LED.

RESULTS & OBSERVATIONS

By performing this experiment you should have found that the brightness of the LED depends upon the position of the shaft of the potentiometer. Also you should have learned that by twisting the shaft of the potentiometer you change its internal resistance. Potentiometers are used for volume control and other knobs on TV's, radios, etc.

HOW A PHOTOCELL WORKS

LAB KIT A3

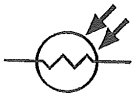
PURPOSE OF THIS EXPERIMENT

The purpose of this experiment is to observe how a photocell works as a light sensitive resistor.

THEORY OF THIS CIRCUIT

In this experiment we introduce the photocell, a special kind of resistor that varies its internal resistance according to the intensity of the light that hits its surface. The more light you shine on a photocell, the lower the resistance it will have, and the more electrons it will allow to pass through it.

Appearance Schematic Symbol Draw Schematic



The circuit of this experiment is made up of three components: the battery, the LED, and the photocell. They are connected in series, one following the other. The current flows from the negative terminal of the battery to the positive terminal of the battery, passing through the LED and the photocell (see the schematic).

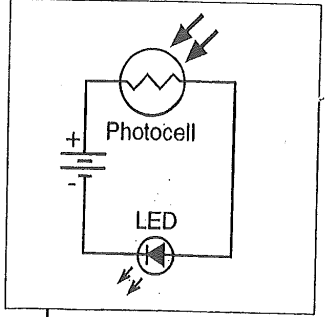
As current passes through the LED it illuminates. The more current that flows, the brighter the LED. The element that controls the amount of current flowing through the circuit is the photocell.

As more light hits its surface, the internal resistance is lowered. When the resistance is lowered the current is increased, causing the LED to be brighter. As less light hits its surface the resistance is increased, and the LED gets dimmer.

Now you understand why, as you shadow the surface of the photocell, the brightness of the LED decreases, and as you illuminate the surface of the photocell the brightness of the LED increases.

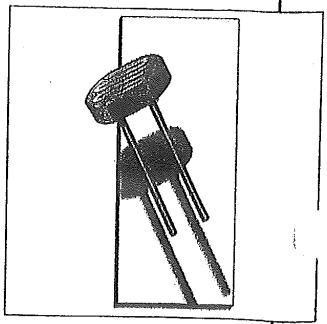
Now you are ready to assemble this project.

SCHEMATIC DIAGRAM & PARTS LIST



Part #

35001 - Battery Snap
06001 - LED (Light Emitting Diode)
45028 - Photocell



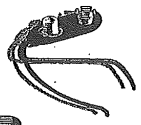
STEP-BY-STEP ASSEMBLY INSTRUCTIONS

HOW A PHOTOCELL WORKS / LAB KIT A3

USE THE SOLDERLESS CIRCUIT BOARD TO BUILD THE PROJECT. ALWAYS COMPARE YOUR WORK WITH THE SCHEMATIC DIAGRAM.

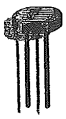
○ STEP 1

Find the Battery Snap. Insert the red wire into hole 15f and the black wire into hole 15e.



○ STEP 2

Find the photocell. Connect its leads to holes 15g and 16g.



○ STEP 3

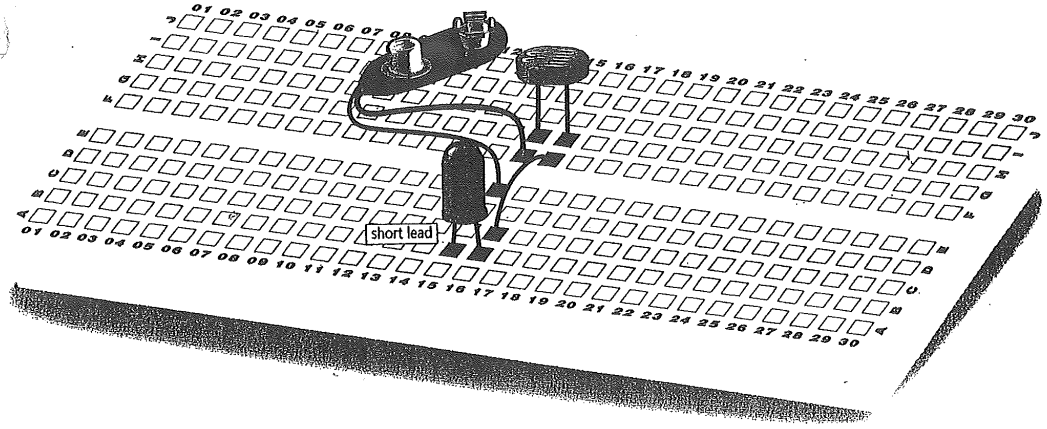
Find one wire. Connect one side of the wire to hole 16f and the other side to hole 16c.

○ STEP 4

Find the LED (light emitting diode). Insert its long lead into hole 16b and its short lead into hole 15b..

STOP! BEFORE YOU TEST YOUR PROJECT VERIFY IT AGAINST THE SCHEMATIC DIAGRAM TO BE SURE THAT ALL THE COMPONENTS ARE INSTALLED IN THE RIGHT PLACE. ALSO BE SURE THERE ARE NO SHORT CIRCUITS ON THE BOARD (WIRES OR LEADS TOUCHING EACH OTHER). TO OPERATE THE PROJECT FOLLOW THE DIRECTIONS IN THE SECTION CALLED "OPERATING INSTRUCTIONS."

Assembly Diagram



OPERATING INSTRUCTIONS

1 - Now that you have this project assembled, connect a fresh 9 volt battery to the battery snap.

Using your hand, partially cover the surface of the photocell to vary the intensity of the light striking the photocell. Observe how this affects the brightness of the LED. When your hand is covering the photocell, the LED is dimmer. When the photocell is not covered the LED is brighter.

RESULTS & OBSERVATIONS

By performing this experiment you should have found that the brightness of the LED depends upon the intensity of light striking the photocell. Because, as you have observed, the value of the internal resistance of the photocell depends upon the intensity of light striking its surface.

HOW A CAPACITOR WORKS

LAB KIT A4

PURPOSE OF THIS EXPERIMENT

The purpose of this experiment is to observe the effect of a capacitor storing electrical energy.

THEORY OF THIS CIRCUIT

A capacitor acts as a temporary battery by storing electricity. In this experiment we use an electrolytic capacitor that can store a relatively large amount of electricity. Electrolytic capacitors have polarity, which means that they have a positive and negative terminal and care must be taken when connecting them to a circuit. They must be installed in the right direction.

Appearance Schematic Symbol Draw Schematic

Figure 1 shows the circuit of this experiment and the flow of current when the battery is connected. The current goes from the negative terminal of the battery to point A, where it divides. A part of the current goes into capacitor C2, which starts to charge. Once C2 is charged, current stops flowing into it. Then, the current path in the circuit is the one shown in Figure 2. The current passing through the LED causes it to illuminate.

When the battery is disconnected, the electrical energy stored in the capacitor flows as shown in Figure 3. It keeps the LED illuminated until the capacitor discharges its stored energy until it can no longer illuminate the LED.

Now you are ready to assemble this project.

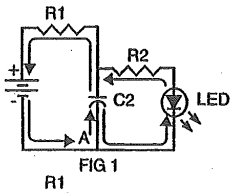


FIG 1

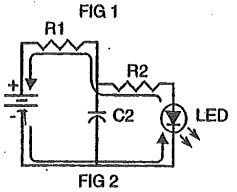


FIG 2

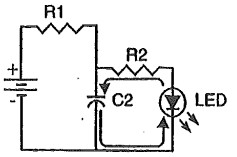
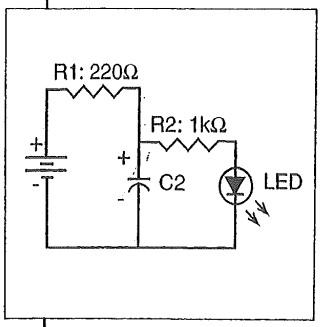


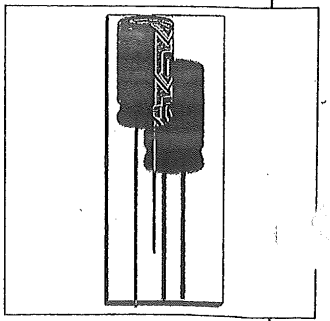
FIG 3

SCHEMATIC DIAGRAM & PARTS LIST



Part #

35001 - Battery Snap
06001 - LED (Light Emitting Diode)
01065 - R1: 220Ω resistor
01049 - R2: 1kΩ resistor
05009 - C1: 1000μF capacitor

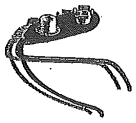


STEP-BY-STEP ASSEMBLY INSTRUCTIONS

HOW A CAPACITOR WORKS / LAB KIT A4

USE THE SOLDERLESS CIRCUIT BOARD TO BUILD THE PROJECT. ALWAYS COMPARE YOUR WORK WITH THE SCHEMATIC DIAGRAM.

○ STEP 1



Find the Battery Snap. Insert the red wire into hole 8g and the black wire into hole 8d.

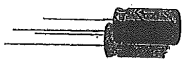
○ STEP 2

Find the 220 ohm resistor (Red, Red, Brown, Gold). Insert one lead into hole 8h and the other into hole 16h.

○ STEP 3

Find the 1kΩ resistor (Brown, Black, Red, Gold). Insert one lead into hole 16g and the other into hole 27g.

○ STEP 4

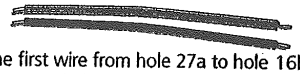


Find the 1000µF capacitor. Insert its positive lead (long lead) into hole 16f and its negative lead (short lead) into hole 16e.

○ STEP 5

Find the LED (light emitting diode). Insert its long lead into hole 27f and its short lead into hole 27e.

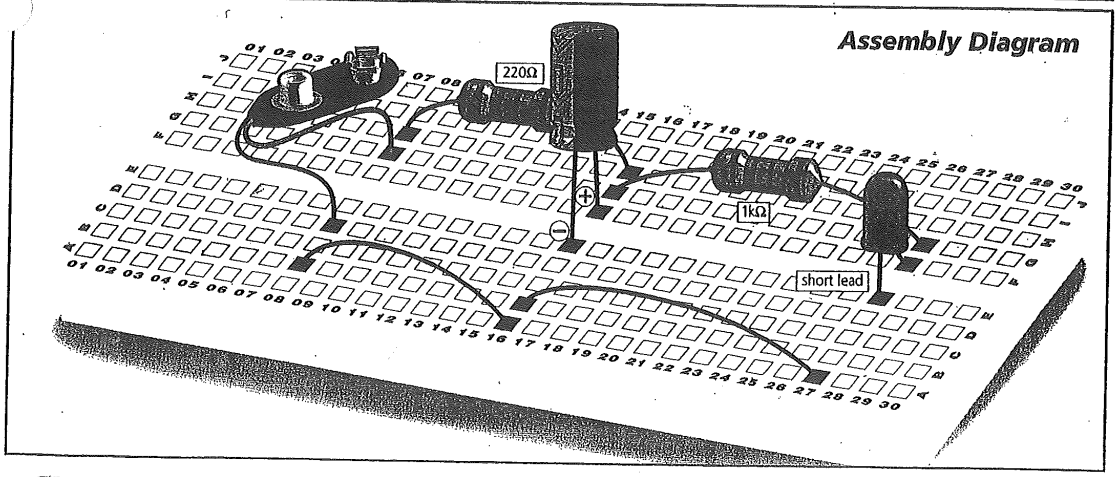
○ STEP 6



Get two wires. Install the first wire from hole 27a to hole 16b. The second wire from hole 16a to hole 8b.

STOP! BEFORE YOU TEST YOUR PROJECT VERIFY IT AGAINST THE SCHEMATIC DIAGRAM TO BE SURE THAT ALL THE COMPONENTS ARE INSTALLED IN THE RIGHT PLACE. ALSO BE SURE THERE ARE NO SHORT CIRCUITS ON THE BOARD (WIRES OR LEADS TOUCHING EACH OTHER). TO OPERATE THE PROJECT FOLLOW THE DIRECTIONS IN THE SECTION CALLED "OPERATING INSTRUCTIONS."

Assembly Diagram



OPERATING INSTRUCTIONS

1 - Now that you have this project built, connect a fresh 9 volt battery to the battery snap. The LED will turn ON.

Disconnect the battery from the battery snap and observe how the LED remains ON for a few seconds after the battery was disconnected. This occurs because the electricity stored in the capacitor maintains the flow of electrons to the LED for a few seconds after the battery is disconnected.

RESULTS & OBSERVATIONS

By performing this experiment you found that after disconnecting the battery from the circuit, the LED continues to be illuminated for a while. The light decreases until it completely turns off. After the battery was disconnected from the circuit, the LED received the electricity from the capacitor.

HOW A SPEAKER WORKS

LAB KIT A5

PURPOSE OF THIS EXPERIMENT

The purpose of this experiment is to observe how a speaker transforms electrical energy (current flowing through it) into sound waves.

THEORY OF THIS CIRCUIT

In this experiment we introduce the speaker. Speakers are devices that produce sound waves from the electric current that flows through them.

Appearance | Schematic Symbol | Draw Schematic

A speaker is an electromechanical device that produces movement of its cone when current is flowing through it. If the current flows in one direction through the speaker, the cone moves in a certain direction. If the current flows in the opposite direction, the cone moves in the opposite direction. See Figure 1a and 1b.

As the cone of the speaker moves, it generates sound waves. The sound waves generated by the speaker are proportional to the variations of the current that flows through it.

Figure 1a shows the current flowing in one direction through the speaker, causing the cone of the speaker to move inward. Figure 1b shows the current flowing through the speaker in the opposite direction, causing the cone to move outward.

When an alternating current, generated by a microphone, oscillator or stereo output, is amplified and then sent to the speaker it will cause the cone to follow the variations of that current producing sound waves (words or music).

Now you are ready to assemble this project.

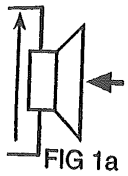


FIG 1a

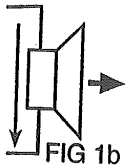
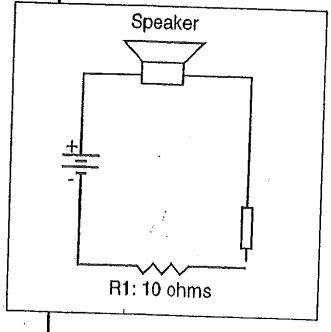


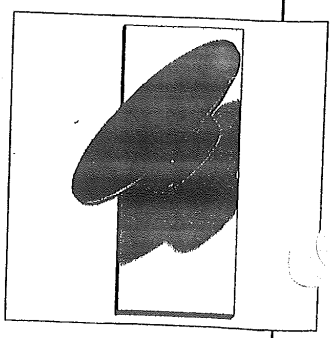
FIG 1b

SCHEMATIC DIAGRAM & PARTS LIST



Part #

35001 - Battery Snap
01017 - R1: 10Ω resistor
27001 - Speaker (8Ω)



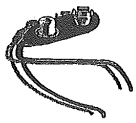
STEP-BY-STEP ASSEMBLY INSTRUCTIONS

HOW A SPEAKER WORKS / LAB KIT A5

USE THE SOLDERLESS CIRCUIT BOARD TO BUILD THE PROJECT. ALWAYS COMPARE YOUR WORK WITH THE SCHEMATIC DIAGRAM.

○ STEP 1

Find the Battery Snap. Insert the red wire into hole 14f and the black wire into hole 14e.



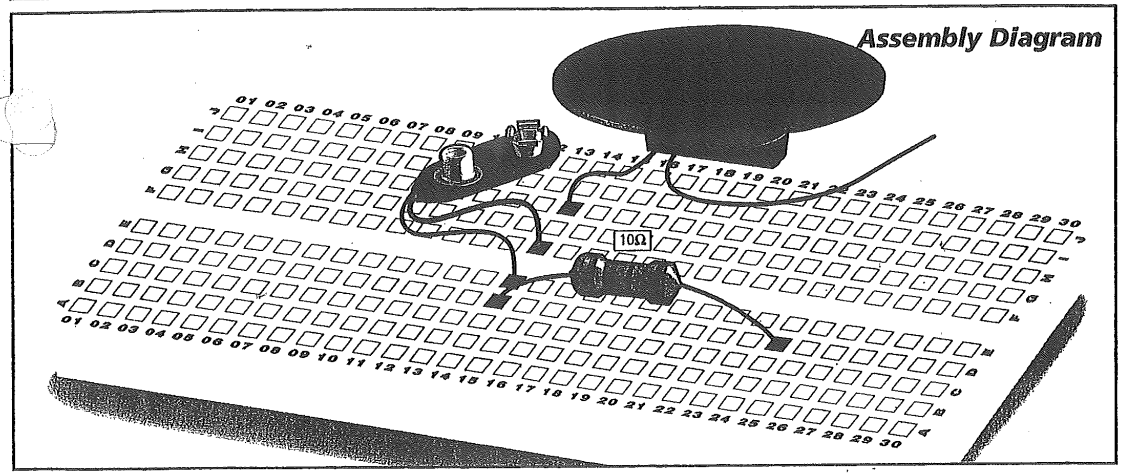
○ STEP 2

Find the 10 ohm resistor (Brown, Black, Black, Gold). Insert one lead into hole 14d and the other into hole 24d.

○ STEP 3

Find the speaker. Connect one of its wires into hole 14h and leave the other wire disconnected.

STOP! BEFORE YOU TEST YOUR PROJECT VERIFY IT AGAINST THE SCHEMATIC DIAGRAM TO BE SURE THAT ALL THE COMPONENTS ARE INSTALLED IN THE RIGHT PLACE. ALSO BE SURE THERE ARE NO SHORT CIRCUITS ON THE BOARD (WIRES OR LEADS TOUCHING EACH OTHER). TO OPERATE THE PROJECT FOLLOW THE DIRECTIONS IN THE SECTION CALLED "OPERATING INSTRUCTIONS."



OPERATING INSTRUCTIONS

1 - Now that you have this project assembled, connect a fresh 9 volt battery to the battery snap.

2 - Touch the unconnected speaker wire to the lead of the resistor connected to hole 24d. As you do this, hear the sound and observe the direction of the movement of the speaker cone. Repeat this step if necessary.

3 - Reverse the polarity of the battery wires connected to the board (connect the red wire in the place of the black wire and the black wire in the place of the red wire). Again, hear the sound and observe the movement of the speaker cone. It should move in the opposite direction from before.

RESULTS & OBSERVATIONS

By performing this experiment you have learned the following:

(A) Every time you touch the speaker wire to the resistor the cone moves and produces a sound.
(B) At Step 2 of the Operating Instructions the cone moves from the normal position away from the magnet.
(C) At Step 3 of the Operating Instructions the cone moves from the normal position toward the magnet. These alternating movements of the speaker cone, when faster pulses of electricity are sent to the speaker, produce sound waves.

HOW A DIODE WORKS

LAB KIT A6

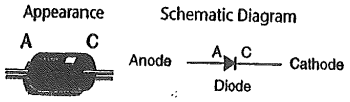
PURPOSE OF THIS EXPERIMENT

The purpose of this experiment is to observe how a diode allows current to flow through it in one direction only.

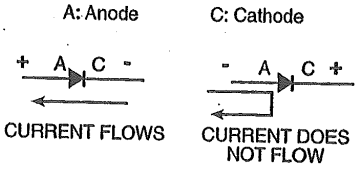
THEORY OF THIS CIRCUIT

A diode is a device that allows current to flow through it in one direction only. You can compare the diode to a "one way street" for electrons.

Diodes have two leads, one is the anode and the other is the cathode. The cathode is indicated by a band around the body of the diode.



A diode is a one-way gate. It allows current to flow through it only when its anode is positive and its cathode is negative, as shown in the next picture.

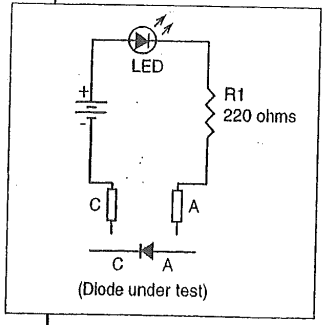


When the diode is connected in the circuit of this experiment with the anode on point A (positive point) and the cathode on point C (negative point), current flows and, therefore, the LED turns on.

On the other hand, when the diode is connected in the circuit of this experiment with the cathode on point A and the anode on point C, current will not flow through the diode and the LED will remain off.

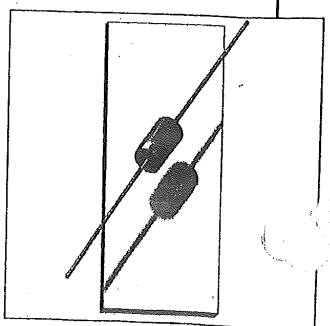
Now you are ready to assemble this project.

SCHEMATIC DIAGRAM & PARTS LIST



Part #

35001 - Battery Snap
01049 - R1: 220Ω resistor
06001 - LED
30001 - Diode

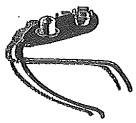


STEP-BY-STEP ASSEMBLY INSTRUCTIONS

HOW A DIODE WORKS / LAB KIT A6

USE THE SOLDERLESS CIRCUIT BOARD TO BUILD THE PROJECT. ALWAYS COMPARE YOUR WORK WITH THE SCHEMATIC DIAGRAM.

○ STEP 1

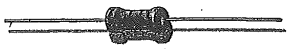


1 - Find the Battery Snap. Insert the red wire into hole 17f and the black wire into hole 15e.

○ STEP 2

2 - Find the LED (light emitting diode). Insert its long lead into hole 17g and its short lead into hole 18g.

○ STEP 3



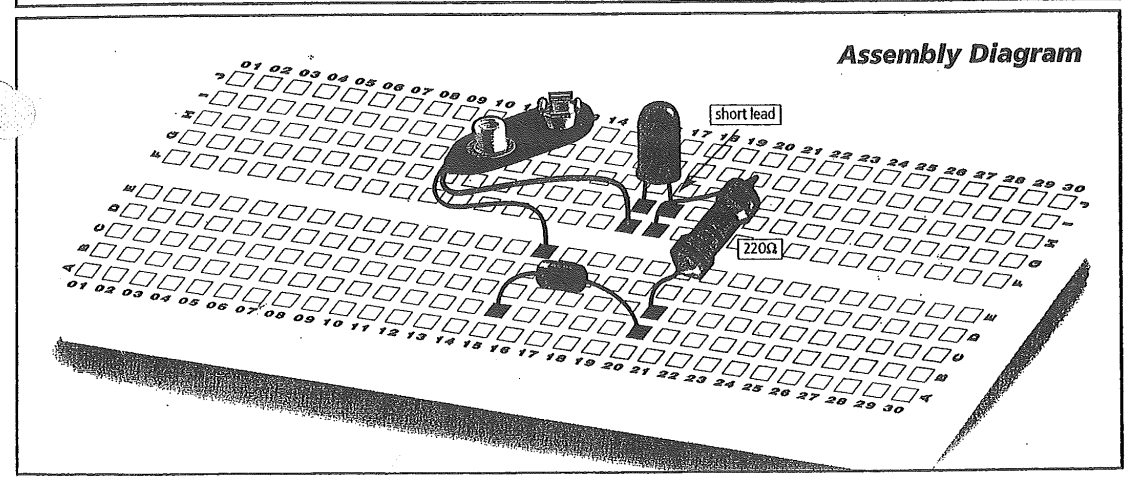
3 - Find the 220 ohm resistor (Red, Red, Brown, Gold). Insert one lead into hole 18f and the other into hole 20c.

○ STEP 4

4 - Find the diode. Notice that it has a band on one side of its body. Insert the lead on the side with the band into hole 15b and the other lead into hole 20b.

STOP! BEFORE YOU TEST YOUR PROJECT VERIFY IT AGAINST THE SCHEMATIC DIAGRAM TO BE SURE THAT ALL THE COMPONENTS ARE INSTALLED IN THE RIGHT PLACE. ALSO BE SURE THERE ARE NO SHORT CIRCUITS ON THE BOARD (WIRES OR LEADS TOUCHING EACH OTHER). TO OPERATE THE PROJECT FOLLOW THE DIRECTIONS IN THE SECTION CALLED "OPERATING INSTRUCTIONS."

Assembly Diagram



OPERATING INSTRUCTIONS

1 - Now that you have this project assembled, connect a fresh 9 volt battery to the battery snap. As you do this the LED will turn ON.

2 - Remove the diode from the circuit, the LED will turn OFF.

3 - Connect the diode in the opposite direction as it was before. This means, the lead on the side with the band to hole 20b and the other lead to hole 15b. The LED will remain OFF even with the diode connected in the circuit.

4 - Remove the diode and install it again in its original position, as shown in the Assembly Diagram. The LED will turn ON.

RESULTS & OBSERVATIONS

By performing this experiment you have found that the diode works as a "one way gate", in that it allows current to flow through it in one direction only. Also, if Steps 1 through 4 of this procedure can be completed successfully, you can conclude that the diode being tested is ok.

HOW AN SCR WORKS

LAB KIT A7

PURPOSE OF THIS EXPERIMENT

The purpose of this experiment is to observe how an SCR (Silicon Controlled Rectifier) works and to build a useful SCR checker.

THEORY OF THIS CIRCUIT

The SCR is a device that allows current to flow through it only after a momentary positive voltage is applied to its gate. SCR's have three leads which are called: anode, cathode and gate.

Appearance Schematic Symbol Draw Schematic

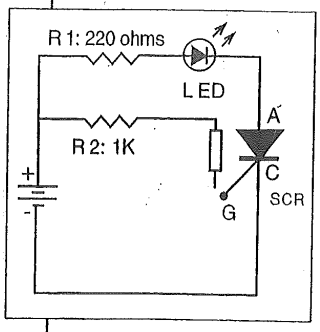
An SCR is a "diode with a difference". Like a diode, it has a cathode and anode, and allows current to flow through it in one direction only. Yet unlike an ordinary diode, it has a gate electrode as well. The gate is used to "trigger" the SCR into conduction.

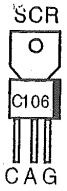
After the gate receives a positive voltage, the SCR conducts. Even if the positive voltage is then remove from the gate, the SCR will continue to conduct. The only way to turn off the SCR is to remove the positive voltage from its anode by, for example, disconnecting the battery.

In this experiment you apply a positive voltage to the SCR by touching the gate of the SCR with a wire. When the battery is disconnected, current stops flowing and the SCR turns off. When the battery is reconnected, the SCR will be off until a positive voltage is applied to its gate again.

Now you are ready to assemble this project.

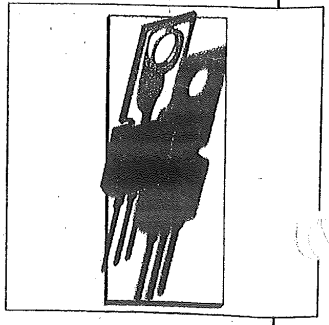
SCHEMATIC DIAGRAM & PARTS LIST





Part #

35001	- Battery Snap
01049	- R1: 220Ω resistor
01065	- R2: 1kΩ
06001	- LED
13001	- SCR



STEP-BY-STEP ASSEMBLY INSTRUCTIONS

HOW AN SCR WORKS / LAB KIT A7

USE THE SOLDERLESS CIRCUIT BOARD TO BUILD THE PROJECT. ALWAYS COMPARE YOUR WORK WITH THE SCHEMATIC DIAGRAM.

○ STEP 1

Find the Battery Snap. Insert the red wire into hole 11f and the black wire into hole 11e.

○ STEP 2

Find the 220 ohm resistor (Red, Red, Brown, Gold). Insert one lead into hole 11j and the other into hole 22j.

○ STEP 3

Find the 1kΩ resistor (Brown, Black, Red, Gold). Insert one lead into hole 11g and the other into hole 20g.

○ STEP 4

Find the LED (light emitting diode). Insert its long lead into hole 22h and its short lead into hole 23h.

○ STEP 5

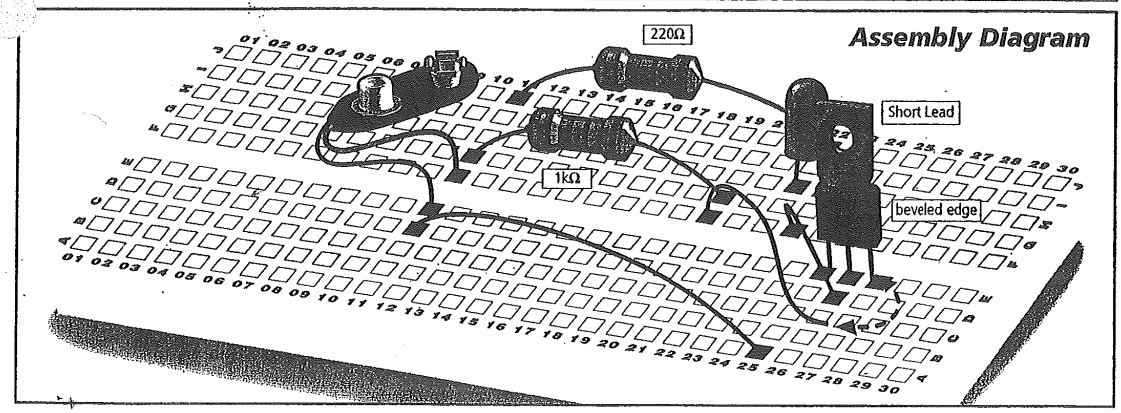
Find the SCR (silicon controlled rectifier). Insert its three leads into holes 25e, 26e and 27e, with the lead on the side of the beveled edge going to hole 27e.

○ STEP 6

Get three wires. Install the first wire from hole 11d to hole 25a, the second wire from hole 23f to hole 26d. Connect only one side of the third wire to hole 20f.

STOP! BEFORE YOU TEST YOUR PROJECT VERIFY IT AGAINST THE SCHEMATIC DIAGRAM TO BE SURE THAT ALL THE COMPONENTS ARE INSTALLED IN THE RIGHT PLACE. ALSO BE SURE THERE ARE NO SHORT CIRCUITS ON THE BOARD (WIRES OR LEADS TOUCHING EACH OTHER). TO OPERATE THE PROJECT FOLLOW THE DIRECTIONS IN THE SECTION CALLED "OPERATING INSTRUCTIONS."

Assembly Diagram



OPERATING INSTRUCTIONS

1 - Now that you have this project assembled; connect a fresh 9 volt battery to the battery snap.
2 - The unconnected end of the wire in 20f is your "test probe". Touch the probe to the lead of the SCR connected to hole 27e (gate of the SCR), as shown in the assembly diagram. As you do this, the LED will turn ON and remain On, indicating that current is flowing through the circuit.
3 - Disconnect the battery briefly and connect it again. The LED will turn OFF when the battery is disconnected and remain OFF after it is reconnected. The only way to turn the LED ON again is by touching the wire to the gate of the SCR (hole 27e).

RESULTS & OBSERVATIONS

By performing this experiment you have found that the SCR conducts current (LED ON) when a positive voltage is applied to its gate. Also, you found that the SCR continues conducting even if the positive voltage has been removed from its gate. You also learned that the only way to turn the SCR OFF is by removing the positive voltage from it by disconnecting the battery. Also, if steps 1 to 3 of this procedure can be completed successfully, you can conclude that the SCR is OK.

HOW AN NPN TRANSISTOR WORKS

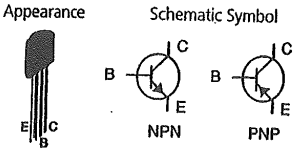
LAB KIT A8

PURPOSE OF THIS EXPERIMENT

To observe how a NPN Transistor works as a current amplifier and to build a useful NPN Transistor Checker.

THEORY OF THIS CIRCUIT

The transistor is a component used to amplify electricity. It has three terminals: Emitter, Base and Collector. Transistors are either NPN or PNP type. Observe the difference in the schematic symbol between these two types.



When the collector of an NPN transistor is positive, the emitter negative, and the base slightly positive, the transistor is correctly biased (polarized) and two currents flow through it: the Collector Current (Ic) (flowing in the Emitter and out the Collector), which is a large current, and the Base Current (Ib) (flowing in the Emitter and out the Base), which is a small current, as shown in Figure 1.

The interesting thing about transistors, is that the small Base Current (Ib) controls the larger Collector Current (Ic). The larger the Base Current, the greater the Collector Current. This important process, of having a small current control a large current, is called AMPLIFICATION.

Figure 2 shows the circuit of this EXPERIMENT. It uses an NPN transistor. Its collector is connected to a positive voltage through resistor R2 and LED2. The emitter is connected directly to the negative terminal of the battery and the base is connected to a positive voltage through resistor R1, the pushbutton, and LED1. The brightness of LED1 is proportional to the Base Current, and the brightness of LED2 is proportional to the Collector Current. Performing the experiment, you will find that LED2 (collector LED) is brighter than LED1 (base LED). This means that the Collector Current is larger than the Base Current.

In this experiment you will also find out that if there is no Base Current (pushbutton open) there is no Collector Current. If there is a Base Current (pushbutton pressed), there is a Collector Current. This means that the small Base Current is controlling the larger Collector Current.

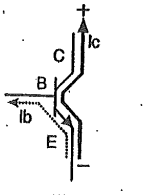


FIG 1

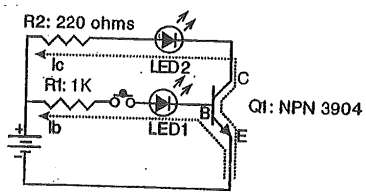
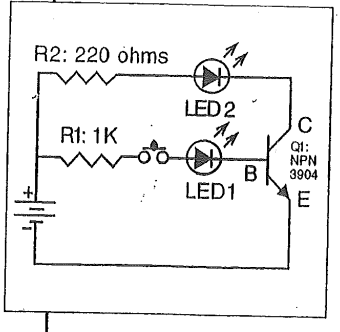


FIG 2

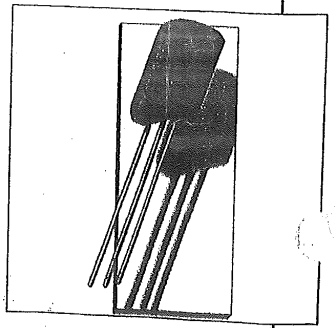
Now you are ready to assemble this project.

SCHEMATIC DIAGRAM & PARTS LIST



Part #

35001	- Battery Snap
01049	- R1: 1kΩ resistor
01065	- R2: 220Ω
06001	- LED1 / LED2
18001	- Q1: 2N3904 (NPN)
25004	- Pushbutton

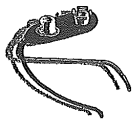


STEP-BY-STEP ASSEMBLY INSTRUCTIONS

HOW AN NPN TRANSISTOR WORKS / LAB KIT A8

USE THE SOLDERLESS CIRCUIT BOARD TO BUILD THE PROJECT. ALWAYS COMPARE YOUR WORK WITH THE SCHEMATIC DIAGRAM.

○ STEP 1



Find the Battery Snap. Insert the red wire into hole 1f and the black wire into hole 1e.

○ STEP 2

Find the 220 ohm resistor (Red, Red, Brown, Gold). Insert one lead into hole 1j and the other into hole 5j.

○ STEP 3

Find the 1kΩ resistor (Brown, Black, Red, Gold). Insert one lead into hole 1g and the other into hole 9g.

○ STEP 4

Find the LED (light emitting diode). Insert its long lead into hole 5i and its short lead into hole 7i.

○ STEP 5

Find another LED. Insert the long lead into hole 14g and the short lead into hole 16g.

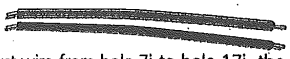
○ STEP 6

Find the pushbutton switch. Insert one lead into hole 9f and the other into hole 10f.

○ STEP 7

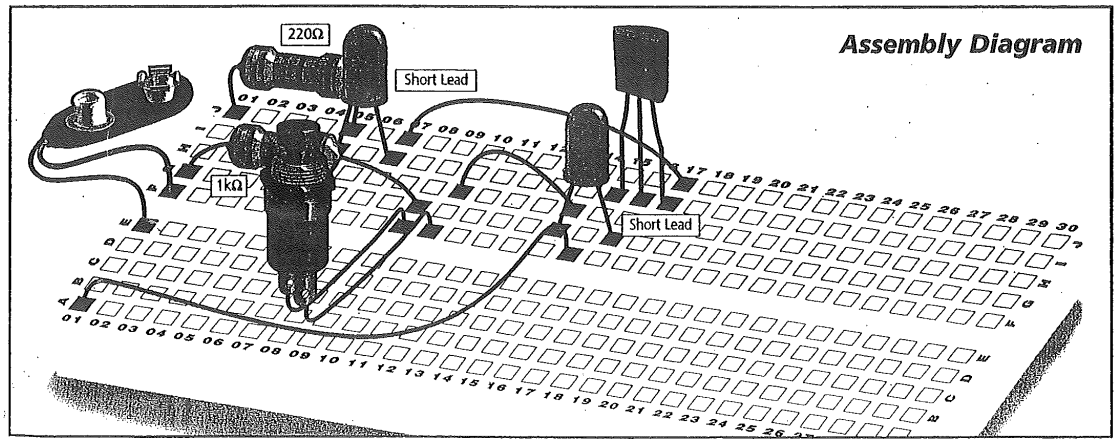
Find the 3904 transistor. Insert the three leads into holes 15i, 16i and 17i. Be sure that the flat side of the transistor is pointing in the direction shown in the assembly diagram.

○ STEP 8



Get three wires. Install the first wire from hole 7j to hole 17j, the second wire from hole 10h to hole 14h. The third wire from 1a to 15f.

STOP! BEFORE YOU TEST YOUR PROJECT VERIFY IT AGAINST THE SCHEMATIC DIAGRAM TO BE SURE THAT ALL THE COMPONENTS ARE INSTALLED IN THE RIGHT PLACE. ALSO BE SURE THERE ARE NO SHORT CIRCUITS ON THE BOARD (WIRES OR LEADS TOUCHING EACH OTHER). TO OPERATE THE PROJECT FOLLOW THE DIRECTIONS IN THE SECTION CALLED "OPERATING INSTRUCTIONS."



OPERATING INSTRUCTIONS

1 - Now that you have your project assembled, connect a fresh 9 volt battery to the battery snap.

2 - Press the pushbutton switch. If both LEDs light-up (one brighter than the other) when the pushbutton is pressed you can assume that the transistor being tested is OK.

RESULTS & OBSERVATIONS

If the transistor is defective, three things might occur:
- Neither of the LEDs light-up when the pushbutton is pressed.
- Only one LED lights-up when the pushbutton is pressed.
- One or both LEDs light-up when the pushbutton is not pressed.

HOW A PNP TRANSISTOR WORKS

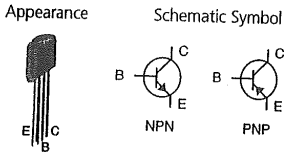
LAB KIT A9

PURPOSE OF THIS EXPERIMENT

To observe how a PNP Transistor works as a current amplifier and to build a useful PNP Transistor Checker.

THEORY OF THIS CIRCUIT

The transistor is a component used to amplify electricity. It has three terminals: Emitter, Base and Collector.
They are two types, NPN and PNP. Observe the difference in the schematic symbols of these two types.



When the collector of an PNP transistor is negative, the emitter positive, and the base slightly negative, the transistor is correctly biased (polarized) and two currents flow through it. First is the Collector Current (Ic) (flowing in the Collector and out the Emitter), which is a large current, and the Base Current (Ib) (flowing in the Base and out the Emitter), which is a small current, as shown in Figure 1.
The interesting thing about transistors, is that the small Base Current (Ib) controls the larger Collector Current (Ic). The larger the Base Current, the greater the Collector Current.

Figure 2 shows the circuit of this experiment. It uses a PNP transistor. Its collector receives a negative voltage through resistor R2 and LED2. The emitter is connected directly to the positive terminal of the battery, and the base is connected to a negative voltage through resistor R1, the pushbutton, and LED1.
The brightness of LED1 is proportional to the Base Current, and the brightness of LED2 is proportional to the Collector Current. Performing the experiment, you will find that LED2 (collector LED) is brighter than LED1 (base LED). This means that the Collector Current is larger than the Base Current. You will also find out that if there is no Base Current (pushbutton open) there is no Collector Current. If there is a Base Current (pushbutton pressed), there is a Collector Current. This means that the small Base Current is controlling the larger Collector Current. We call this AMPLIFICATION.

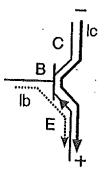


FIG 9.1

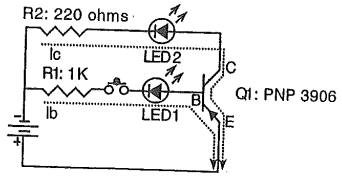
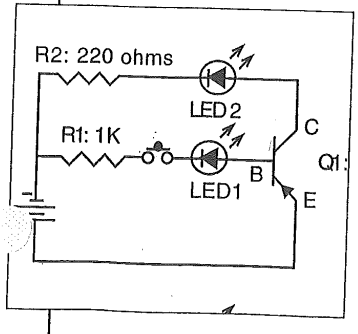


FIG 9.2

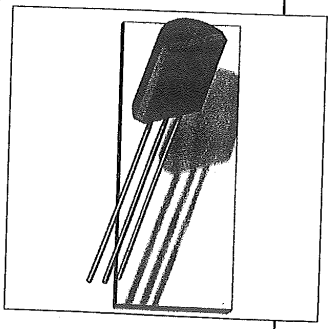
Now you are ready to assemble this project.

SCHEMATIC DIAGRAM & PARTS LIST



Part #

35001	- Battery Snap
01049	- R1: 1kΩ
01065	- R2: 220Ω resistor
06001	- LED1 / LED2
18002	- Q1: 2N3906 (PNP)
25004	- Pushbutton



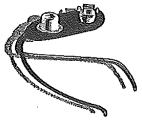
STEP-BY-STEP ASSEMBLY INSTRUCTIONS

HOW A PNP TRANSISTOR WORKS / LAB KIT A9

USE THE SOLDERLESS CIRCUIT BOARD TO BUILD THE PROJECT. ALWAYS COMPARE YOUR WORK WITH THE SCHEMATIC DIAGRAM.

○ STEP 1

Find the Battery Snap. Insert the red wire into hole 1e and the black wire into hole 1f.



○ STEP 2

Find the 220 ohm resistor (Red, Red, Brown, Gold). Insert one lead into hole 1j and the other into hole 5j.

○ STEP 3

Find the 1kΩ resistor (Brown, Black, Red, Gold). Insert one lead into hole 1g and the other into hole 6g.

○ STEP 4

Find the LED (light emitting diode). Insert its long lead into hole 7i and its short lead into hole 5i.

○ STEP 5

Find another LED. Insert the long lead into hole 17f and the short lead into hole 15g.

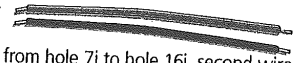
○ STEP 6

Find the pushbutton switch. Insert one lead into hole 6f and the other into hole 8f.

○ STEP 7

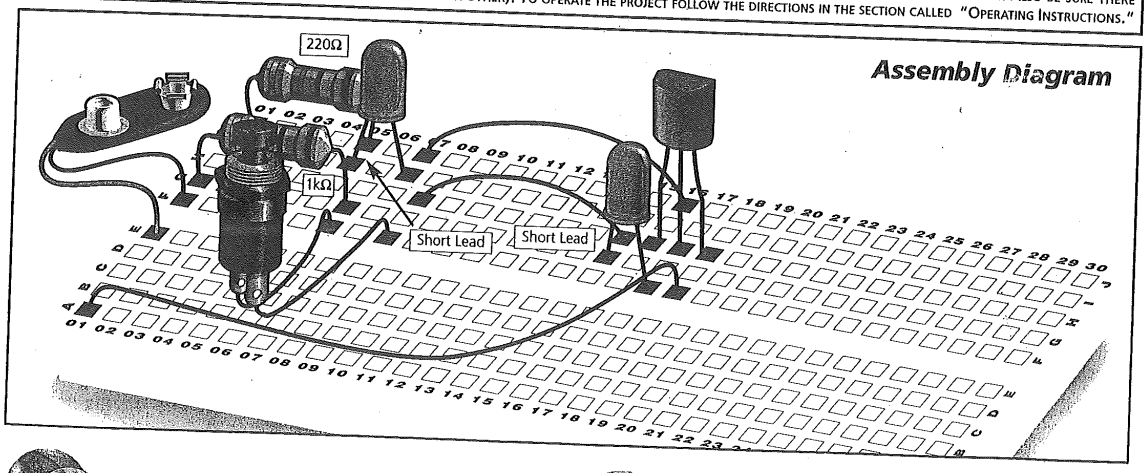
Find the 3906 transistor. Insert the three leads into holes 16h, 17h and 18h. Be sure that the flat side of the transistor is pointing in the direction shown in the assembly diagram.

○ STEP 8



Install three wires: first wire from hole 7j to hole 16j, second wire from hole 8h to hole 15h, and third wire from 1a to 18f.

STOP! BEFORE YOU TEST YOUR PROJECT VERIFY IT AGAINST THE SCHEMATIC DIAGRAM TO BE SURE THAT ALL THE COMPONENTS ARE INSTALLED IN THE RIGHT PLACE. ALSO BE SURE THERE ARE NO SHORT CIRCUITS ON THE BOARD (WIRES OR LEADS TOUCHING EACH OTHER). TO OPERATE THE PROJECT FOLLOW THE DIRECTIONS IN THE SECTION CALLED "OPERATING INSTRUCTIONS."



OPERATING INSTRUCTIONS

1 - Now that you have your project assembled, connect a fresh 9 volt battery to the battery snap.

2 - Press the pushbutton switch. If both LEDs light-up (one brighter than the other) when the pushbutton is pressed you can assume that the transistor being tested is OK.

RESULTS & OBSERVATIONS

If the transistor is defective three things might occur:
- Neither of the LEDs light-up when the pushbutton is pressed
- Only one LED lights-up when the pushbutton is pressed.
- One or both LEDS light-up when the pushbutton is not pressed.

TRANSISTOR OSCILLATOR

LAB KIT A10

PURPOSE OF THIS EXPERIMENT

The purpose of this experiment is to build a simple two transistor oscillator and to learn about transistorized oscillator circuits.

THEORY OF THIS CIRCUIT

A transistor oscillator is an electronic device that generates a constantly increasing and decreasing current.

The frequency of this varying current is how many times per second the current increases and decreases. The unit of measurement for frequency is Hertz (Hz), which represents one complete cycle or pulse per second.

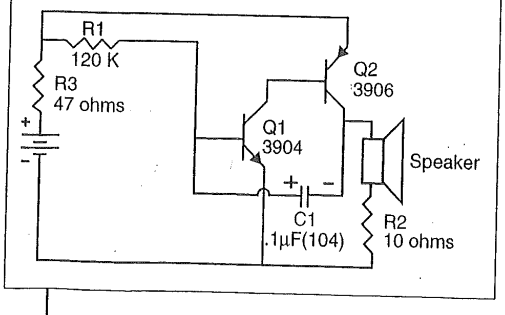
The circuit you will build, shown in the diagram below, oscillates at a frequency of approximately 500Hz (500 cycles or pulses per second). This frequency is called an audio frequency, because when a speaker vibrates at this frequency, it generates a tone that can be heard by the human ear. Audio frequencies range from approximately 10Hz to 16,000 Hz. The oscillator that you will build is a two transistor oscillator. It uses one PNP (3906) and one NPN (3904) transistor.

As the battery is connected, electrons flow from the negative terminal of the battery through R2 and the speaker to charge capacitor C1. This small current flowing through the speaker while C1 is charging, causes the cone to move slightly. As capacitor C1 is charging, Q1 will begin to conduct, which allows Q2 to begin conducting. When Q2 conducts, the electrons travel from the negative of the battery through R2, the speaker, and Q2 back to the positive of the battery. This larger current causes the speaker to move more. When Q2 conducts, it will discharge C1, which causes Q1 to stop conducting, which in turn causes Q2 to stop conducting and the speaker returns to its normal position. Then C1 begins to charge again and the cycle is repeated.

The frequency of oscillation of this circuit, and thus the speaker, is determined by the values of resistor R1 and capacitor C1. The larger the values of R1 and C1, the lower the frequency of oscillation.

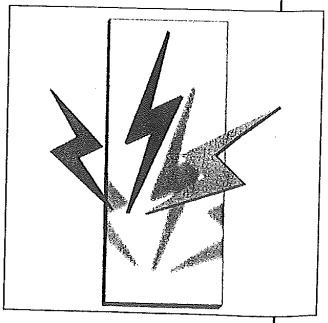
Now you are ready to assemble this project.

SCHEMATIC DIAGRAM & PARTS LIST



Part #

35001	- Battery Snap
01115	- R1: 120kΩ
01017	- R2: 10Ω
01033	- R3: 47Ω
18001	- Q1: 2N3904 (NPN)
18002	- Q2: 2N3906 (PNP)
02016	- C1: .1µF Cap. (104)
27001	- Speaker



STEP-BY-STEP ASSEMBLY INSTRUCTIONS

TRANSISTOR OSCILLATOR / LAB KIT A10

USE THE SOLDERLESS CIRCUIT BOARD TO BUILD THE PROJECT. ALWAYS COMPARE YOUR WORK WITH THE SCHEMATIC DIAGRAM.

❍ STEP 1

Find the Battery Snap. Insert the red wire into hole 2f and the black wire into hole 1e.

❍ STEP 2

Find the 120kΩ resistor (Brown, Red, Yellow, Gold). Insert one lead into hole 1i and the other into hole 10i

❍ STEP 3

Find the 47 ohm resistor (Yellow, Violet, Black, Gold). Insert one lead into hole 2g and the other into hole 6f.

❍ STEP 4

Find the 10 ohm resistor (Brown, Black, Black, Gold). Insert one lead into hole 13b and the other into hole 18b.

❍ STEP 5

Find the 3904 transistor. Insert its three leads into holes 9g, 10g and 11g. Be sure that the flat side is pointing in the direction shown in the assembly diagram.

❍ STEP 6

Find the .1μF ceramic capacitor (104). Insert one lead into hole 10f and the other into hole 15f.

❍ STEP 7

Find the 3906 transistor. Insert the three leads into holes 13g, 14g and 15g. Be sure that the flat side of the transistor is pointing in the direction shown in the assembly diagram.

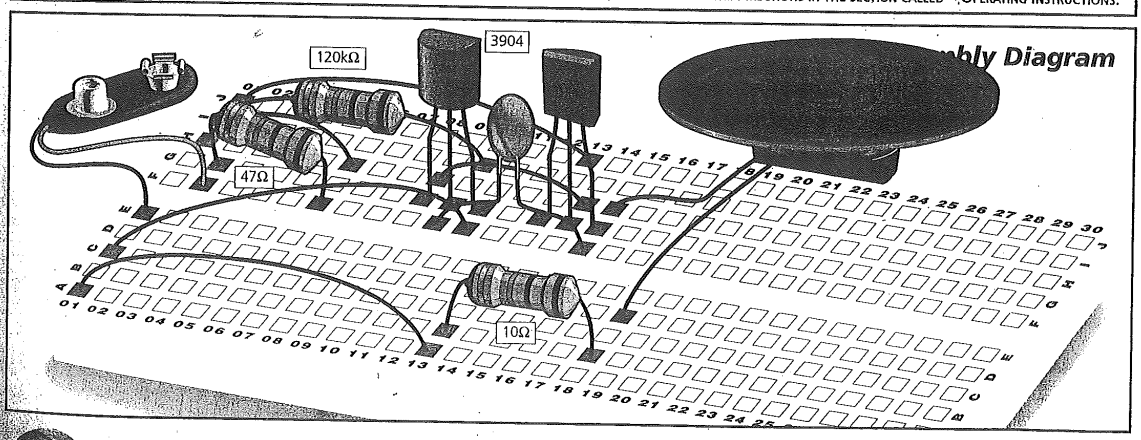
❍ STEP 8

Find the speaker. Insert one lead into hole 15h and the other into hole 18d.

❍ STEP 9

Install five wires: first wire from hole 1j to hole 13j, second wire from hole 9h to hole 14h, third wire from 1h to 6h, fourth from 1c to 11f, and fifth wire from 1a to 13a.

STOP! BEFORE YOU TEST YOUR PROJECT VERIFY IT AGAINST THE SCHEMATIC DIAGRAM TO BE SURE THAT ALL THE COMPONENTS ARE INSTALLED IN THE RIGHT PLACE. ALSO BE SURE THERE ARE NO SHORT CIRCUITS ON THE BOARD (WIRES OR LEADS TOUCHING EACH OTHER). TO OPERATE THE PROJECT FOLLOW THE DIRECTIONS IN THE SECTION CALLED "OPERATING INSTRUCTIONS."



Assembly Diagram

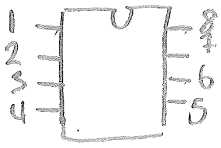
OPERATING INSTRUCTIONS

Now that you have your Transistor Oscillator assembled, connect a fresh 9 volt battery to the battery snap. As you do this an audio tone should be heard from the speaker

RESULTS & OBSERVATIONS

By performing this experiment you have found that the Two Transistor Audio Oscillator generates a constant audio tone.

BLINKING LIGHT



LAB KIT A11

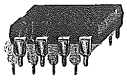
PURPOSE OF THIS EXPERIMENT

The purpose of this experiment is to build a useful LED Blinking Light and to learn about the IC Timer 555.

THEORY OF THIS CIRCUIT

In this experiment we introduce an integrated circuit (IC). Integrated circuits (ICs) have several components (transistors, diodes, resistors, etc.) condensed into a very small package. Each type of IC performs a different function according to the different components it has inside.

Appearance Schematic Symbol Draw Schematic. Symbol



In this experiment the 555 IC Timer is used as a clock. A clock, as the term is used in electronics, does not mean a device to tell time. It refers to a circuit that provides a continuous series of pulses, the frequency of which can range from less than one per second to over a million per second. The Schematic Diagram of this experiment, shows the 555 Timer connected as a clock. This circuit, as you will notice, has no input signal, and in that sense, it operates as an oscillator; a device that generates its own signal.

The pulses produced by the clock are present on pin #3. Thus pin 3 will be alternately positive (HI) and negative (LO). The frequency of the pulses produced by the IC timer depends on the values of resistors R1 and R2, and capacitor C1. The larger the values of the resistors and the capacitor, the lower the frequencies of the pulses.

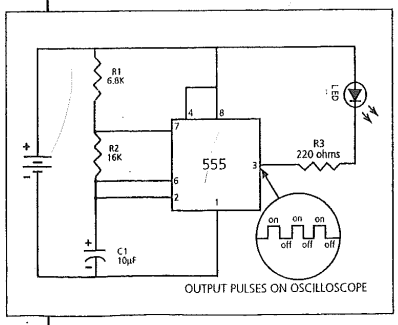
Before C1 begins to charge, the output of the 555 is OFF. When power is applied, C1 charges through R1 and R2. When the voltage across C1 reaches 2/3 of the supply voltage, (6V) the 555 turns ON, the output goes HI, The 555 then begins to discharge C1 through R2 until the voltage on C1 is about 1/3 of the supply voltage (3V). The 555 turns off and the cycle then repeats. Because of the difference between the charge and discharge circuits, R2 is generally much larger than R1 so that the ON and OFF times are about the same.

If an LED (light emitting diode) is connected to the output of the IC Timer (pin #3), when pin 3 is LO, current flows through resistor R3 and the LED, and, therefore, the LED will turn on. When pin 3 is HI, no current flows through the LED and, therefore, it will be off.

You can reduce the frequency by replacing the 10μF capacitor with a 100μF capacitor.

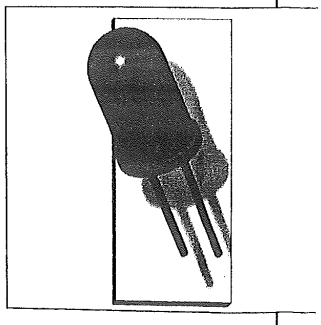
Now you are ready to assemble this project.

SCHEMATIC DIAGRAM & PARTS LIST



Part #

35001 - Battery Snap
01085 - R1: 6.8kΩ
18002 - R2: 16kΩ
01049 - R3: 220Ω
05003 - C1: 10μF Cap.
14004 - 555 IC Timer
06001 - LED: Light Emitting Diode



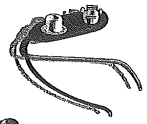
STEP-BY-STEP ASSEMBLY INSTRUCTIONS

BLINKING LIGHT / LAB KIT A11

USE THE SOLDERLESS CIRCUIT BOARD TO BUILD THE PROJECT. ALWAYS COMPARE YOUR WORK WITH THE SCHEMATIC DIAGRAM.

○ STEP 1

Find the Battery Snap. Insert the red wire into hole 1f and the black wire into hole 1e.



○ STEP 2

Find the 6.8kΩ resistor (Blue, Gray, Red, Gold). Insert one lead into hole 17i and the other into hole 18i.

○ STEP 3

Find the 220 ohm resistor (Red, Red, Brown, Gold). Insert one lead into hole 11a and the other into hole 19a.

○ STEP 4

Find the 16kΩ resistor (Brown, Blue, Orange, Gold). Insert one lead into hole 18h and the other into hole 19h.

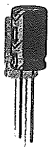
○ STEP 5

Find the red LED (light emitting diode). Insert its long lead into hole 11f and the short lead into hole 11e.

○ STEP 6

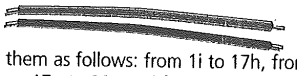
Find the Integrated Circuit 555. Install it in the board with the notch, dot or band at one end in the direction1 shown in the assembly diagram (holes: 17e, 18e, 19e, 20e, 17f, 18f 19f and 20f).

○ STEP 7



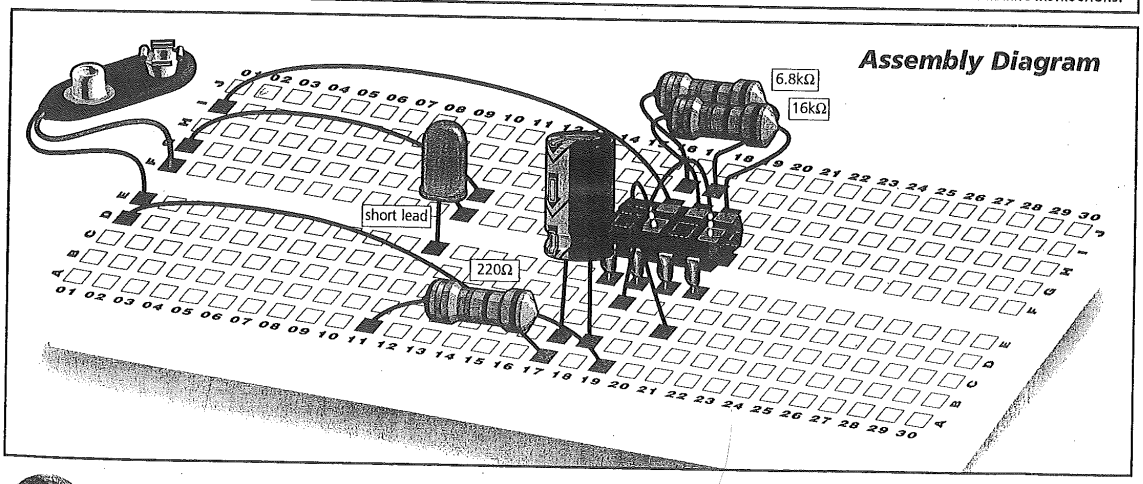
Find the 10µF capacitor. Insert its positive lead (long lead) into hole 18b and its negative lead into hole 17b.

○ STEP 8



Get five wires. Install them as follows: from 1i to 17h, from 1g to 11g, from 1d to 17a, from 17g to 20c and from 19g to 18d.

STOP! BEFORE YOU TEST YOUR PROJECT VERIFY IT AGAINST THE SCHEMATIC DIAGRAM TO BE SURE THAT ALL THE COMPONENTS ARE INSTALLED IN THE RIGHT PLACE. ALSO BE SURE THERE ARE NO SHORT CIRCUITS ON THE BOARD (WIRES OR LEADS TOUCHING EACH OTHER). TO OPERATE THE PROJECT FOLLOW THE DIRECTIONS IN THE SECTION CALLED "OPERATING INSTRUCTIONS."

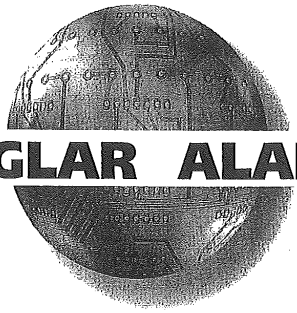


OPERATING INSTRUCTIONS

1 - Now that you have your Blinking Light assembled, connect a fresh 9 volt battery to the battery snap. As you do this the LED will start to blink.

RESULTS & OBSERVATIONS

By performing this experiment you have found that by using the 555 Timer as a clock, you can build a device that is able to turn an LED on and off.



BURGLAR ALARM

LAB KIT A12

PURPOSE OF THIS EXPERIMENT

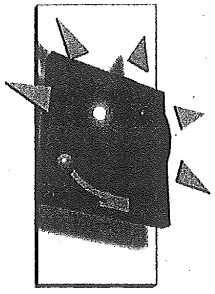
The purpose of this project is to build a useful Burglar Alarm.

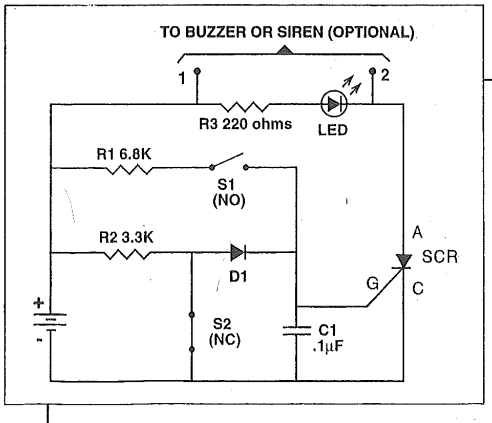
CIRCUIT DESCRIPTION

This burglar alarm is designed to be used with normally open (S1) or normally closed (S2) switches. If after the alarm is armed (battery connected) the normally closed switch (S2) is opened, or the normally open switch (S1) is closed, capacitor C1 will charge and a positive voltage will be applied to the gate of the SCR causing it to conduct.
To learn more about the operation of an SCR refer to Mr. Circuit Lab Kit A7.
When the SCR conducts, the LED turns on, indicating that the alarm was activated.
In order to have an audible signal, an optional 9-volt buzzer can be connected in points 1 and 2 of the circuit (see schematic diagram).
Once the alarm is triggered (LED on) the only way to stop it is by disconnecting the battery from the circuit.

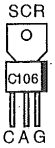
Before connecting the battery, be sure that the two wires labeled S2 are connected together, and the two labeled S1 are not touching one another.

Now you are ready to assemble this project.





SCHEMATIC DIAGRAM & PARTS LIST



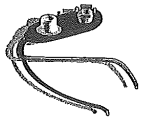
Part #	
35001	- Battery Snap
01085	- R1:6.8kΩ
01077	- R2: 3.3kΩ
01049	- R3: 220Ω
06001	- LED: Light Emitting Diode
13001	- SCR
02016	- C1: .1µF Cap.
30001	- D1: Diode

STEP-BY-STEP ASSEMBLY INSTRUCTIONS

BURGLAR ALARM / LAB KIT A12

USE THE SOLDERLESS CIRCUIT BOARD TO BUILD THE PROJECT. ALWAYS COMPARE YOUR WORK WITH THE SCHEMATIC DIAGRAM.

○ STEP 1



Find the Battery Snap. Insert the red wire into hole 1f and the black wire into hole 1e

○ STEP 2

Find the 3.3kΩ resistor (Orange, Orange, Red, Gold). Insert one lead into hole 1h and the other into hole 5h.

○ STEP 3

Find the 6.8kΩ resistor (Blue, Gray, Red, Gold). Insert one lead into hole 1i and the other into hole 10i.

○ STEP 4

Find the 220 ohm resistor (Red, Red, Brown, Gold). Insert one lead into hole 17h and the other into hole 19h.

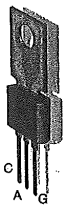
○ STEP 5

Find the red LED (light emitting diode). Insert its long lead into hole 19i and the short lead into hole 21i.

○ STEP 6

Find the diode. Notice that it has a white band on one end of its body. Insert the lead on the end with the band into hole 12g and the other lead into hole 5g.

○ STEP 7



Find the SCR (silicon controlled rectifier). Insert its three leads into holes 20g, 21g and 22g, with the lead on the side of the beveled edge into hole 22g.

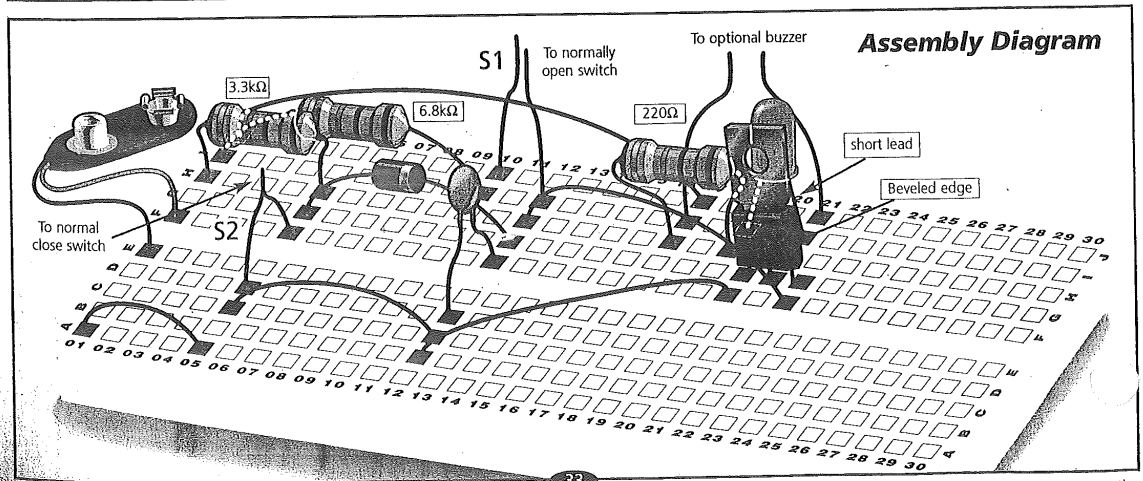
○ STEP 8

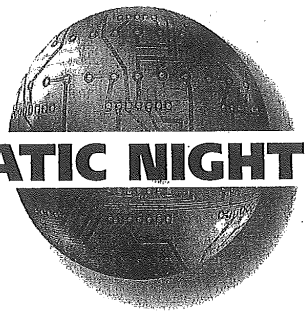
Find the .1μF capacitor (104). Insert one lead into hole 12d and the other into hole 12f.

○ STEP 9

Get nine wires. Install five as follows: from 1j to 17j, from 1a to 5a, from 5c to 12c, from 12b to 20f and from 12h to 22f. Twist the ends of two wires together and connect to 5f and 5d. Connect one wire to hole 10j and another wire to hole 12i Leave the other end of these two wires unconnected.

STOP! BEFORE YOU TEST YOUR PROJECT VERIFY IT AGAINST THE SCHEMATIC DIAGRAM TO BE SURE THAT ALL THE COMPONENTS ARE INSTALLED IN THE RIGHT PLACE. ALSO BE SURE THERE ARE NO SHORT CIRCUITS ON THE BOARD (WIRES OR LEADS TOUCHING EACH OTHER). TO OPERATE THIS PROJECT CONNECT A FRESH 9-VOLT BATTERY TO THE BATTERY SNAP AND OPEN THE NORMALLY CLOSED SWITCH OR CLOSE TO NORMALLY OPEN AND OBSERVE HOW THE LED LIGHTS UP.





AUTOMATIC NIGHT LIGHT

LAB KIT A13

PURPOSE OF THIS PROJECT

The purpose of this project is to build an LED Night Light that turns on at night and goes off during the day.

CIRCUIT DESCRIPTION

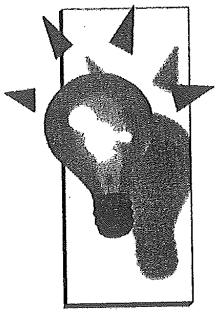
In the Automatic Night Light circuit, the two LEDs turn on at night and go off during the day. The brightness of the two LEDs is inversely proportional to the intensity of light shining on the photocell. The more light received by the photocell, the less the brightness of the LEDs, and vice versa.

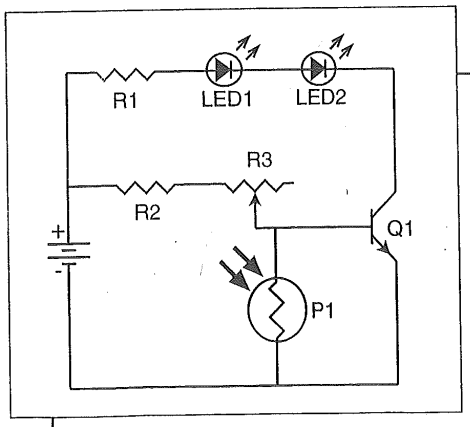
With the potentiometer R3 you can adjust the sensitivity of the device to keep the LEDs off when it is light, and then automatically turn them on when the light disappears.

In order to test this device, first connect the battery and then adjust R3 until the LEDs go off. Then shadow, with your hand, the face of the photocell and the LED should illuminate.

To learn more about the operation of the photocell or the transistor refer to Mr. Circuit Lab Kit A3 and A8 respectively.

Now you are ready to assemble this project.





SCHEMATIC DIAGRAM & PARTS LIST

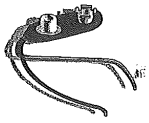
Part #	
35001	- Battery Snap
01033	- R1: 47Ω
01094	- R2: 16kΩ
33008	- R3: 100kΩ Potentiometer
06001	- LED1 / LED2
18001	- Q1: 2N3904 Transistor (NPN)
45028	- P1: Photocell

STEP-BY-STEP ASSEMBLY INSTRUCTIONS

AUTOMATIC NIGHT LIGHT / LAB KIT A 13

USE THE SOLDERLESS CIRCUIT BOARD TO BUILD THE PROJECT. ALWAYS COMPARE YOUR WORK WITH THE SCHEMATIC DIAGRAM.

○ STEP 1



Find the Battery Snap. Insert The red wire into hole 1f and the black wire into hole 1e.

○ STEP 2

Find the 47 ohm resistor (Yellow, Violet, Black, Gold). Insert one lead into hole 1j and the other into hole 5j.

○ STEP 3

Find the 16kΩ resistor (Brown, Blue, Orange, Gold). Insert one lead into hole 1g and the other into hole 6g.

○ STEP 4

Find one red LED (light emitting diode). Insert its long lead into hole 5i and the short lead into hole 7i

○ STEP 5

Find another red LED (light emitting diode). Insert its long lead into hole 7j and the short lead into hole 9j.

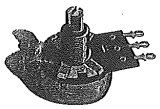
○ STEP 6

Find the photocell. Insert one lead into hole 10b and the other into hole 12b.

○ STEP 7

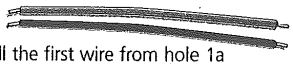
Find the 3904 transistor. Insert its leads into holes 11d, 12d and 13d. Be sure its flat side is pointing in the direction shown in the assembly diagram.

○ STEP 8



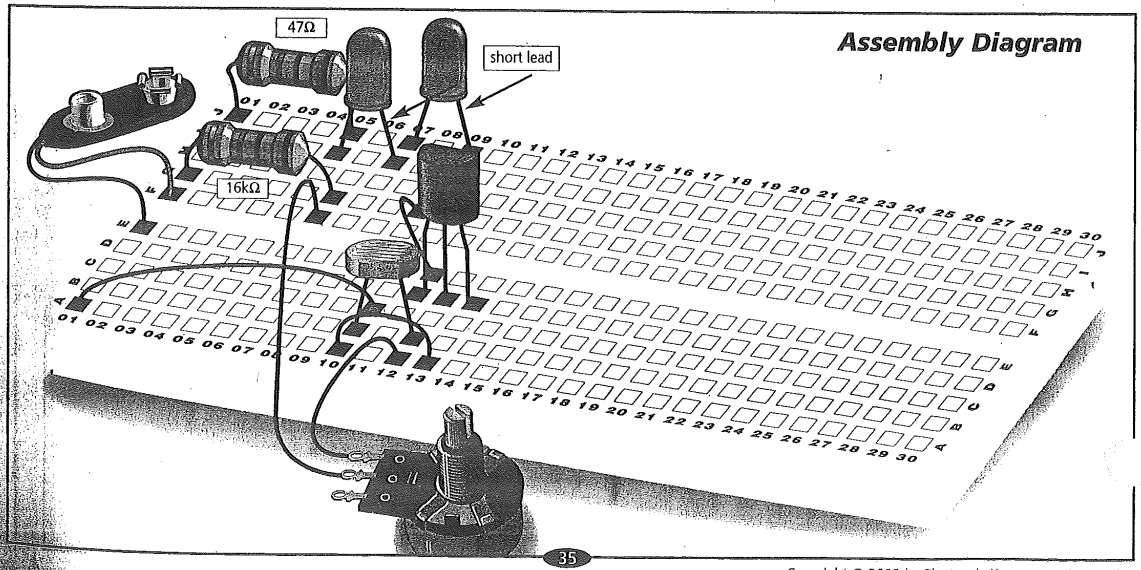
Find the potentiometer. Insert the wire connected to the center lead into hole 6f and the wire connected to the right lead into hole 12a.

○ STEP 9



Get three wires. Install the first wire from hole 1a to 10c, the second wire from hole 10a to 13a and the third wire from hole 9g to hole 11e.

STOP! BEFORE YOU TEST YOUR PROJECT VERIFY IT AGAINST THE SCHEMATIC DIAGRAM TO BE SURE THAT ALL THE COMPONENTS ARE INSTALLED IN THE RIGHT PLACE. ALSO BE SURE THERE ARE NO SHORT CIRCUITS ON THE BOARD (WIRES OR LEADS TOUCHING EACH OTHER). TO OPERATE THIS PROJECT CONNECT A FRESH 9-VOLT BATTERY TO THE BATTERY SNAP AND ADJUST R3 UNTIL THE LEDS GO OFF. THEN SHADOW, WITH YOUR HAND, THE FACE OF THE PHOTOCELL AND THE LEDS SHOULD ILLUMINATE.



DC TO DC POWER SUPPLY

LAB KIT A14

PURPOSE OF THIS PROJECT

In this project you will construct a useful DC to DC adjustable power supply, which, when connected to a 9-volt battery, provides an adjustable output voltage between 0 and 9 volts.

CIRCUIT DESCRIPTION

The DC To DC Power Supply is able to supply an output voltage between 0 to 9 volts and an output current of up to 50 mA, therefore, it is ideal to supply DC to a host of electronic projects from portable radios to burglar alarms.

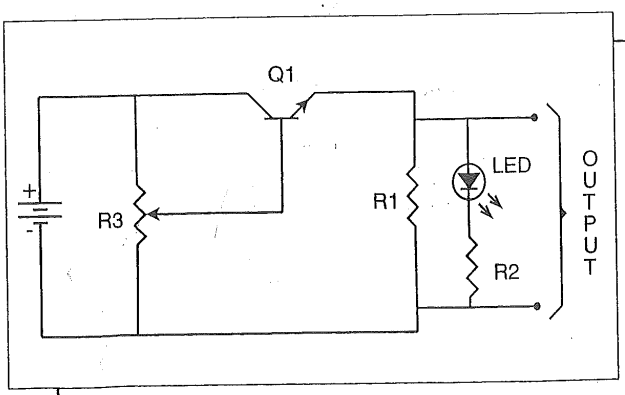
In order to use this power supply, connect a fresh 9-volt battery to the battery snap. Then, using a voltmeter (multimeter), adjust potentiometer P1 until you get the desired output voltage.

We have already seen that changing the position of a potentiometer will change the voltage that can be measured between the center wire and the side connected to either terminal of the battery. (See Lab A2) The problem with using a potentiometer as a variable power supply is the amount of current that may be required in more complex applications. A typical potentiometer is rated at 1/4 watt, which will allow about 225mA at 9V Many circuits and devices require 5A, 10A, or more.

In the DC to DC Power Supply, the circuit is capable of delivering 50mA at any voltage as long as the transistor is conducting. This current limit is imposed by the battery The voltage of the output is the voltage that would be measured from the center wire of the potentiometer to the negative terminal of the battery minus about 0.7V that is used by the transistor. If the voltage on the negative side of the potentiometer is 0.7V or less, the transistor does not conduct. At all other times, the small base current that is allowed to pass through the potentiometer holds the transistor on and allows it to conduct the much larger output supply current.

An LED in series with a 220 ohm resistor (R2) was connected to the output of the power supply. The brightness of this LED is proportional to the output voltage. The maximum brightness corresponds to 9 volts.

To learn more about the operation of the transistor or the potentiometer, refer to Mr. Circuit Lab Kit A2 or A8 respectively. Now you are ready to assemble this project.



SCHEMATIC DIAGRAM & PARTS LIST

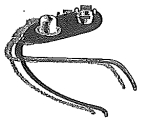
Part #	
35001	- Battery Snap
01085	- R1: 6.8kΩ
01049	- R2: 220Ω
33008	- R3: 100kΩ Potentiometer
18001	- Q1: 2N3904 Transistor (NPN)
06001	- LED

STEP-BY-STEP ASSEMBLY INSTRUCTIONS

DC TO DC POWER SUPPLY / LAB KIT A14

USE THE SOLDERLESS CIRCUIT BOARD TO BUILD THE PROJECT. ALWAYS COMPARE YOUR WORK WITH THE SCHEMATIC DIAGRAM.

○ STEP 1



Find the Battery Snap. Insert the red wire into hole 1f and the black wire into hole 1a.

○ STEP 2

Find the 6.8kΩ resistor (Blue, Gray, Red, Gold). Insert one lead into hole 13f and the other into hole 13d.

○ STEP 3

Find the 220 ohm resistor (Red, Red, Brown, Gold). Insert one lead into hole 13g and the other into hole 25g.

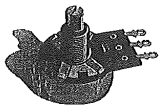
○ STEP 4

Find one red LED (light emitting diode). Insert its long lead into hole 25f and the short lead into hole 25e.

○ STEP 5

Find the 3904 transistor. Insert its leads into holes 11h, 12h and 13h. Be sure its flat side is pointing in the direction shown in the assembly diagram.

○ STEP 6

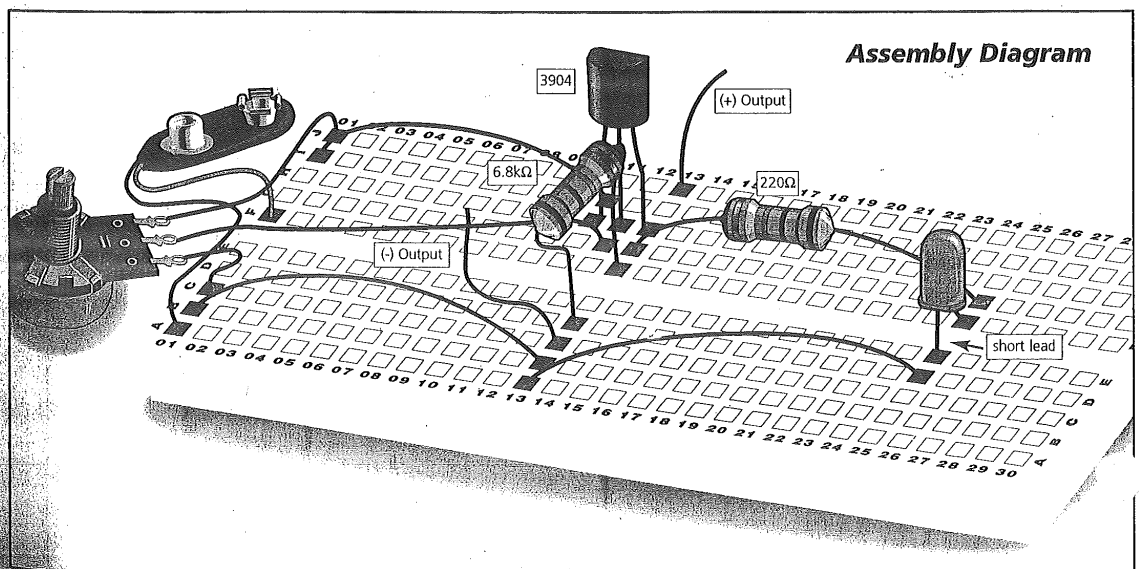


Find the potentiometer. Insert the wire connected to the center lead into hole 12g, the wire connected to the left lead into hole 1j, and the wire connected to the right lead into hole 1c.

○ STEP 7

Get five wires. Install three wires as follows: one from 1i to 11i, one from 1b to 13b, one from 13a to 25d. Connect one wire to hole 13c (Negative output) and another to 13j (Positive Output). Leave the other end of these two wires unconnected.

STOP! BEFORE YOU TEST YOUR PROJECT VERIFY IT AGAINST THE SCHEMATIC DIAGRAM TO BE SURE THAT ALL THE COMPONENTS ARE INSTALLED IN THE RIGHT PLACE. ALSO BE SURE THERE ARE NO SHORT CIRCUITS ON THE BOARD (WIRES OR LEADS TOUCHING EACH OTHER).



ELECTRONIC METRONOME

LAB KIT A15

PURPOSE OF THIS PROJECT

In this project you will construct a useful Electronic Metronome.

CIRCUIT DESCRIPTION

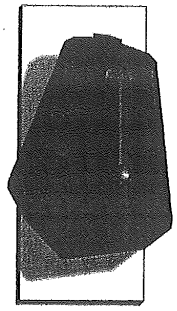
A metronome is a device used to aid in setting and keeping tempo in music.

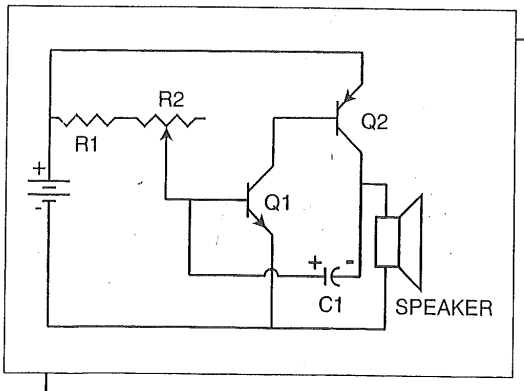
Traditional metronomes are mechanical and employ a swinging arm that causes a clicking sound at the end of each swing. On those metronomes you adjust the tempo by adjusting the speed of the oscillating arm.

In this project you build an electronic metronome which allows you to adjust the tempo by rotating to shaft on the potentiometer.

The circuit of the metronome is made of a low frequency two-transistor oscillator, similar to the one explained in Mr. Circuit Lab A10. The frequency of this oscillator is controlled by potentiometer R2 and by adjusting it, you speed up or slow down the tempo.

Now you are ready to assemble this project.





SCHEMATIC DIAGRAM & PARTS LIST

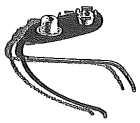
Part #	
35001	- Battery Snap
01077	- R1: 3.3kΩ
33008	- R2: 100kΩ Potentiometer
18001	- Q1: Transistor 2N3904 (NPN)
18002	- Q2: Transistor 2N3906 (PNP)
05005	- C1: 100µF Cap.
27001	- Speaker

STEP-BY-STEP ASSEMBLY INSTRUCTIONS

ELECTRONIC METRONOME / LAB KIT A15

USE THE SOLDERLESS CIRCUIT BOARD TO BUILD THE PROJECT. ALWAYS COMPARE YOUR WORK WITH THE SCHEMATIC DIAGRAM.

○ STEP 1



Find the Battery Snap. Insert the red wire into hole 1f and the black wire into hole 1e.

○ STEP 2

Find the 3.3kΩ resistor (Orange, Orange, Red, Gold). Insert one lead into hole 1h and the other into hole 5h.

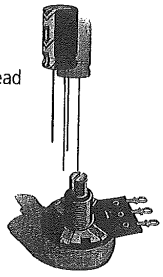
○ STEP 3

Find the 3904 transistor. Insert its leads into holes 11h, 12h, and 13h. Be sure its flat side is pointing in the direction shown in the assembly diagram.

○ STEP 4

Find the 3906 transistor. Insert its leads into holes 15h, 16h and 17h. Be sure its flat side is pointing in the direction shown in the assembly diagram.

○ STEP 5



Find the 100µF capacitor. Insert its positive lead (long lead) into hole 12f, and its negative lead (short lead) into hole 17f.

○ STEP 6

Find the potentiometer. Insert the wire connected to the center lead into hole 5i and the wire connected to the left lead into hole 12j.

○ STEP 7

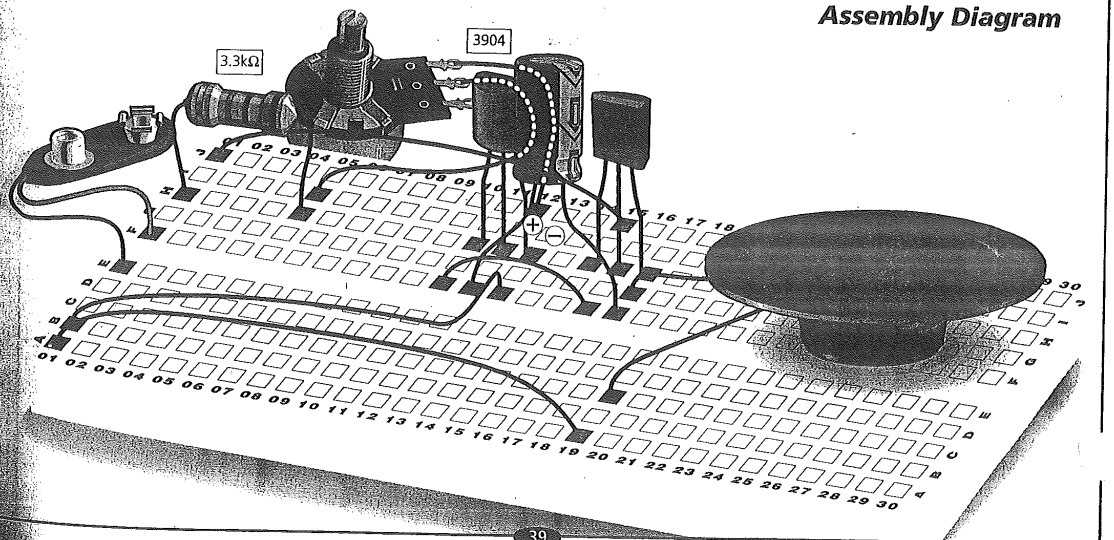
Find the speaker. Insert one of its leads into hole 17g, and the other into hole 19c.

○ STEP 8

Get four wires. Install them as follows: one from 1j to 15j, one from 11f to 16f, one from 1b to 13f and one from 1a to 19a.

STOP! BEFORE YOU TEST YOUR PROJECT VERIFY IT AGAINST THE SCHEMATIC DIAGRAM TO BE SURE THAT ALL THE COMPONENTS ARE INSTALLED IN THE RIGHT PLACE. ALSO BE SURE THERE ARE NO SHORT CIRCUITS ON THE BOARD (WIRES OR LEADS TOUCHING EACH OTHER). TO OPERATE THIS PROJECT JUST CONNECT A FRESH 9-VOLT BATTERY TO THE BATTERY SNAP.

Assembly Diagram



ELECTRONIC MOTORCYCLE

LAB KIT A16

PURPOSE OF THIS PROJECT

To build an electronic project that generates the sound of a motorcycle, starting and speeding up.

CIRCUIT DESCRIPTION

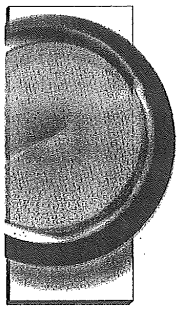
With this project you can generate the sound of a motorcycle starting and speeding up.

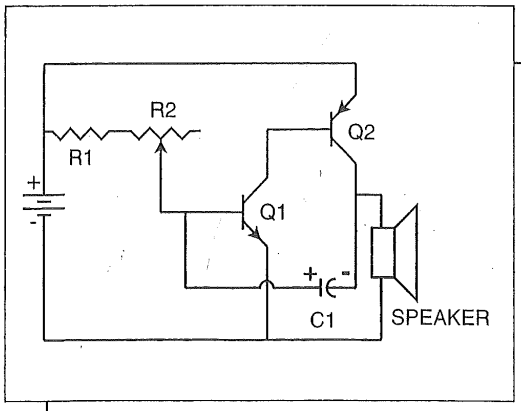
You can accelerate or slow down your electronic motorcycle by rotating potentiometer R2.

The circuit of the Electronic Motorcycle consists of a low frequency two-transistor oscillator, similar to the one explained in Mr. Circuit Lab Kit A10.

The frequency of this oscillator (speed of the motorcycle) is controlled by potentiometer R2.
Adjusting R2 you can accelerate or slow down the motorcycle.

Now you are ready to assemble this project.





SCHEMATIC DIAGRAM & PARTS LIST

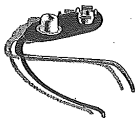
Part #	
35001	- Battery Snap
01077	- R1: 3.3kΩ
33008	- R2: 100kΩ Potentiometer
18001	- Q1: 2N3904 Transistor
18002	- Q2: 2N3906 Transistor
05003	- C1: 10µF Capacitor
27001	- Speaker

STEP-BY-STEP ASSEMBLY INSTRUCTIONS

ELECTRONIC MOTORCYCLE / LAB KIT A16

USE THE SOLDERLESS CIRCUIT BOARD TO BUILD THE PROJECT. ALWAYS COMPARE YOUR WORK WITH THE SCHEMATIC DIAGRAM.

○ STEP 1



Find the Battery Snap. Insert the red wire into hole 1f, and the black wire into hole 1e.

○ STEP 2

Get one wire. Insert one end in hole 1j and the other end in hole 9j, as shown in the pictorial diagram.

○ STEP 3

Find the 3.3kΩ resistor (Orange, Orange, Red, Gold). Insert one lead into hole 1h, and the other into hole 8h.

○ STEP 4

Find the 3904 transistor. Insert its leads into holes 12d, 13d and 14d. Be sure its flat side is pointing in the direction shown in the assembly diagram.

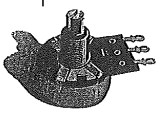
○ STEP 5

Find the 3906 transistor. Insert its leads into hole 18d, 19d and 20d. Be sure its flat side is pointing in the direction shown in the assembly diagram.

○ STEP 6

Find the 10μF capacitor. Install its positive lead (long lead) into hole 13b, and its negative lead (short lead) into hole 20b.

○ STEP 7



Find the potentiometer. Insert the wire connected to the center lead into hole 8j, and the wire connected to the left lead into hole 13e.

○ STEP 8

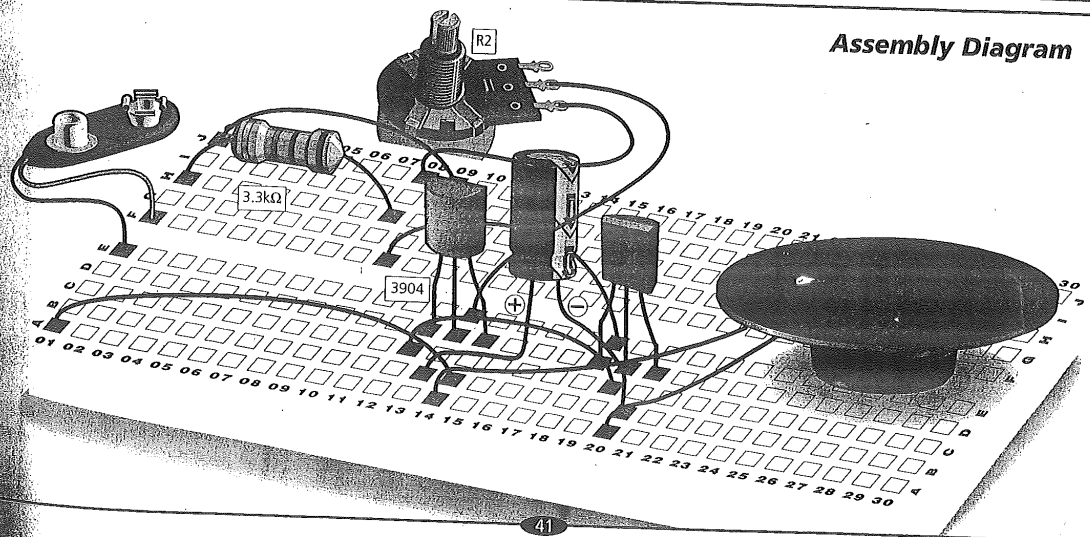
Find the speaker. Insert one of its leads into hole 14a, and the other into hole 20a.

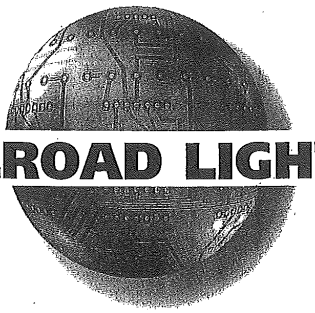
○ STEP 9

Get three wires. Install them as follows: one from 1a to 14b, one from 9f to 18e, and one from 12c to 19c.

STOP! BEFORE YOU TEST YOUR PROJECT VERIFY IT AGAINST THE SCHEMATIC DIAGRAM, TO BE SURE THAT ALL THE COMPONENTS ARE INSTALLED IN THE RIGHT PLACE. ALSO BE SURE THAT THERE ARE NO SHORT CIRCUITS ON THE BOARD (WIRES OR LEADS TOUCHING EACH OTHER).

Assembly Diagram





RAILROAD LIGHTS

LAB KIT A17

PURPOSE OF THIS PROJECT

To build an electronic project that alternately flashes a pair of LEDs.

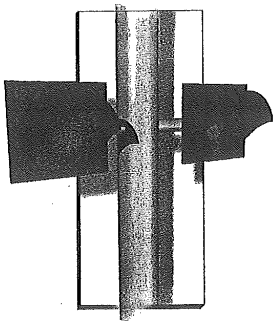
CIRCUIT DESCRIPTION

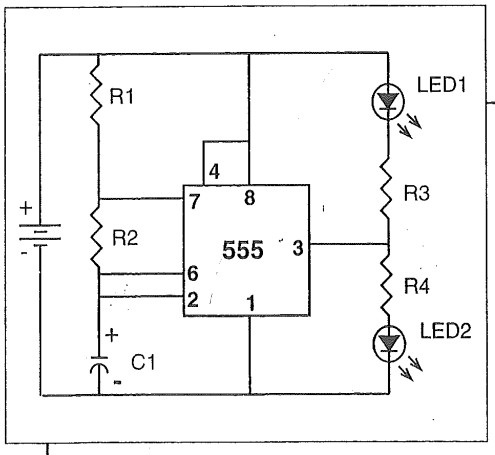
The Railroad Lights project alternately flashes a pair of LEDs at the rate of about two blinks per second, producing the same effect as railroad signals.
To operate this device, connect the battery to the battery snap.

The circuit of the Railroad Lights is made of a 555 Timer working as a clock, similar to the one explained in Mr. Circuit Lab Kit A11. Two LEDs in opposite polarity, are connected to the output of the clock (pin 3 of the 555) through two 220 ohm resistors.

When pin 3 of the 555 is positive (High) LED2 will be forward biased (anode positive, cathode negative) and LED1 reverse biased, therefore, LED2 will light and LED1 will remain off. The opposite situation occurs when pin 3 is negative.

Now you are ready to assemble this project.





SCHEMATIC DIAGRAM & PARTS LIST

Part #

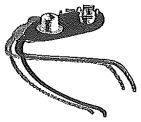
35001 - Battery Snap
01085 - R1: 6.8kΩ
01101 - R2: 33kΩ
01049 - R3: 220Ω
01049 - R4: 220Ω
14004 - 555 IC Timer
05003 - C1: 10µF Capacitor
06001 - LED1 & LED2

STEP-BY-STEP ASSEMBLY INSTRUCTIONS

RAILROAD LIGHTS / LAB KIT A17

USE THE SOLDERLESS CIRCUIT BOARD TO BUILD THE PROJECT. ALWAYS COMPARE YOUR WORK WITH THE SCHEMATIC DIAGRAM.

○ STEP 1



Find the Battery Snap. Insert the red wire into hole 1f, and the black wire into hole 1e.

○ STEP 2

Find the Integrated Circuit 555. Install it in the board with the notch, dot or band at one end in the right direction, as shown in the assembly diagram (holes: 10e, 11e, 12e, 13e, 10f, 11f, 12f, 13f,).

○ STEP 3

Find the 6.8kΩ resistor (Blue, Gray, Red, Gold). Insert one lead into hole 10i, and the other into hole 11i.

○ STEP 4

Find the 33kΩ resistor (Orange, Orange, Orange, Gold). Insert one lead into hole 11h, and the other into hole 12h.

○ STEP 5

Find one 220 ohm resistor (Red, Red, Brown, Gold). Insert one lead into hole 12c, and the other into hole 22f.

○ STEP 6

Find one 220 ohm resistor (Red, Red, Brown, Gold). Insert one lead into hole 12b, and the other into hole 22c.

○ STEP 7

Find the 10μF capacitor. Install its positive lead (long lead) into hole 11c, and its negative lead (short lead) into hole 10c.

○ STEP 8

Find one red LED (light emitting diode). Insert its long lead into hole 21i, and the short lead into hole 22i.

○ STEP 9

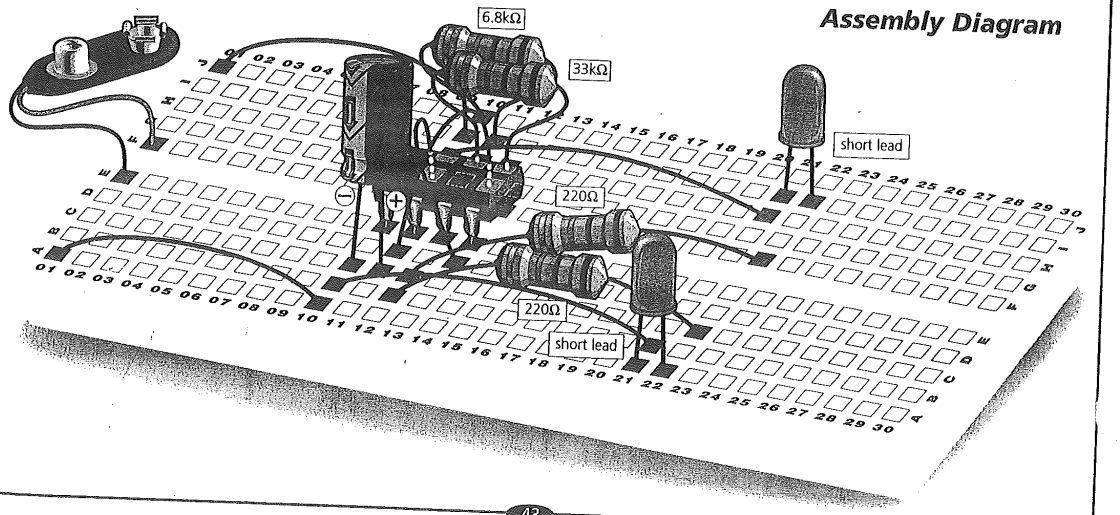
Find one red LED (light emitting diode). Insert its long lead into hole 22a, and the short lead into hole 21a.

○ STEP 10

Get six wires. Install them as follows: one from 1j to 10j, one from 10h to 21h, one from 1a to 10a, one from 10b to 21b, one from 10g to 13d and one from 12g to 11d.

STOP! BEFORE YOU TEST YOUR PROJECT VERIFY IT AGAINST THE SCHEMATIC DIAGRAM, TO BE SURE THAT ALL THE COMPONENTS ARE INSTALLED IN THE RIGHT PLACE. ALSO BE SURE THAT THERE ARE NO SHORT CIRCUITS ON THE BOARD (WIRES OR LEADS TOUCHING EACH OTHER).

Assembly Diagram



VARIABLE SPEED LIGHTS

LAB KIT A18

PURPOSE OF THIS PROJECT

To build an electronic project that alternately flashes a pair of LEDs at an adjustable speed.

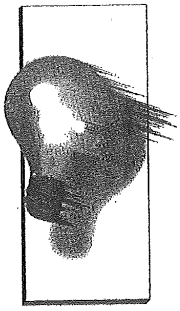
CIRCUIT DESCRIPTION

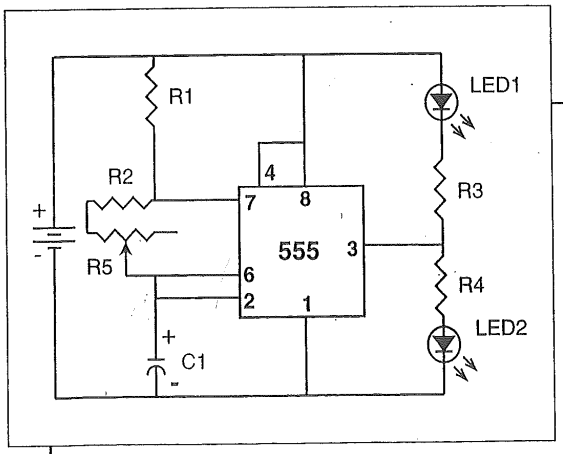
The Variable Speed Lights alternately flashes a pair of LEDs at a rate that can be adjusted through a potentiometer, producing an interesting light display.

To operate this project, connect the battery to the battery snap and adjust the speed of the flashing lights by rotating potentiometer R5.

The circuit of the Variable Speed Lights is made of a 555 IC Timer operating as a clock, similar to the one explained in Mr. Circuit Lab Kit A11. The frequency of the pulses produced by the clock can be adjusted by potentiometer R5. Two LEDs in opposite polarity, which alternately light up, are connected to the output of the clock.

Now you are ready to assemble this project.





SCHEMATIC DIAGRAM & PARTS LIST

Part #	
35001	- Battery Snap
01085	- R1: 6.8kΩ
01065	- R2: 1kΩ
01049	- R3: 220Ω
01049	- R4: 220Ω
33008	- R5: 100kΩ Pot.
14004	- 555 IC Timer
05003	- C1: 10µF Capacitor
06001	- LED1 & LED2

STEP-BY-STEP ASSEMBLY INSTRUCTIONS

VARIABLE SPEED LIGHTS / LAB KIT A18

USE THE SOLDERLESS CIRCUIT BOARD TO BUILD THE PROJECT. ALWAYS COMPARE YOUR WORK WITH THE SCHEMATIC DIAGRAM.

○ STEP 1

Find the battery Snap. Insert the red wire into hole 1f, and the black wire into hole 1e.

○ STEP 2

Find the Integrated Circuit 555. Install it in the board with the notch, dot or band at one end in the right direction, as shown in the assembly diagram (holes: 9e, 10e, 11e, 12e, 9f, 10f, 11f, 12f).

○ STEP 3

Find the 6.8kΩ resistor (Blue, Gray, Red, Gold). Insert one lead into hole 9i, and the other into hole 10j).

○ STEP 4

Find the 1kΩ resistor (Brown, Black, Red, Gold). Insert one lead into hole 4h, and the other into hole 10h.

○ STEP 5

Find two 220 ohm resistors (Red, Red, Brown, Gold). Insert one from hole 11d to 19f, and the other from hole 11c to hole 18c.

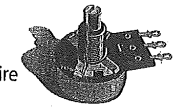
○ STEP 6

Find the 10μF capacitor. Install its positive lead (long lead) into hole 10b, and its negative lead (short lead) into hole 9b.

○ STEP 7

Find two red LED's (light emitting diode). Install one with its long lead into hole 18j, and the short lead into hole 19j. Install the other with its long lead into hole 18b and the short lead into hole 19b.

○ STEP 8

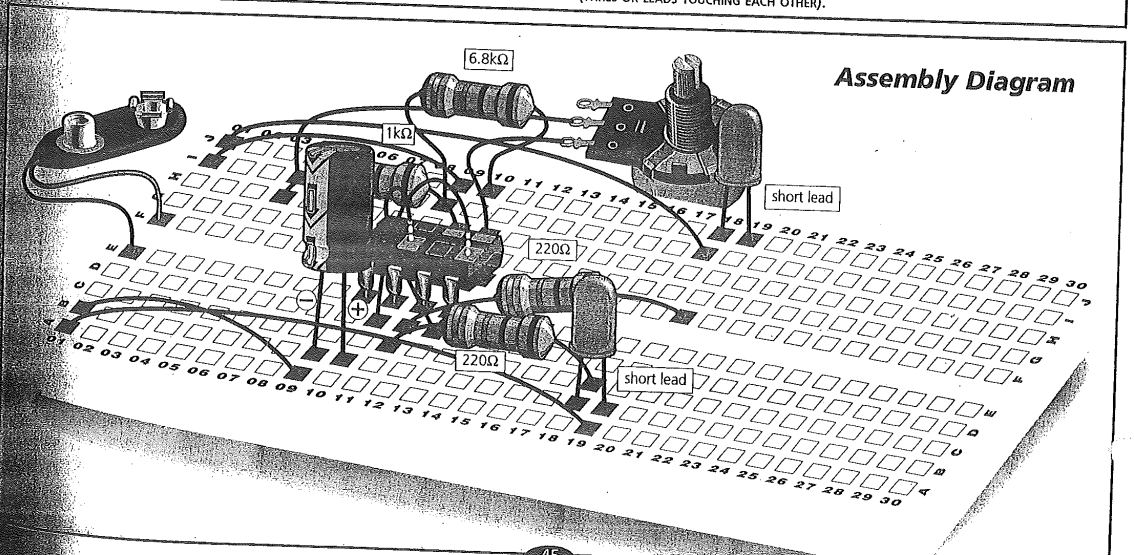


Find the potentiometer. Insert the center wire into hole 4i and the left wire into hole 11h.

○ STEP 9

Get six wires. Install them as follows: one from 1j to 18i, one from 1i to 9j, one from 9g to 12d, one from 11g to 10d, one from 1b to 9a and one from 1a to 19a.

STOP! BEFORE YOU TEST YOUR PROJECT VERIFY IT AGAINST THE SCHEMATIC DIAGRAM, TO BE SURE THAT ALL THE COMPONENTS ARE INSTALLED IN THE RIGHT PLACE. ALSO BE SURE THAT THERE ARE NO SHORT CIRCUITS ON THE BOARD (WIRES OR LEADS TOUCHING EACH OTHER).



CONTINUITY TESTER

LAB KIT A19

PURPOSE OF THIS PROJECT

To build a circuit that can be used to test for open circuits.

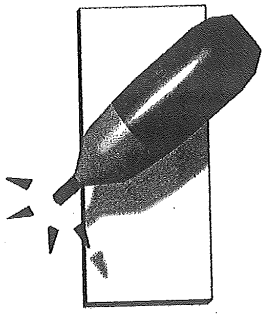
CIRCUIT DESCRIPTION

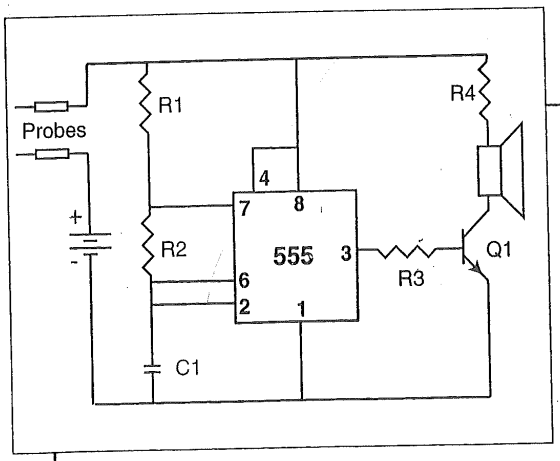
The audible Continuity Tester provides a convenient way to check for open circuits, broken wires, bad connections, or to test light bulbs or fuses.

To operate, connect a fresh 9-volt battery to the battery snap and touch the two probes (wires) of the device to the leads of the circuit under test (fuse, lamp, wire, etc.). If there is electrical continuity in the tested circuit, the Continuity Tester will emit a loud sound. If the circuit is open, no sound will be emitted.

The circuit of the Continuity Tester is made of a 555 timer working as a clock, similar to the one explained in Mr. Circuit Lab Kit A11. When there is electrical continuity between the two probes, the 555 generates an audio signal which is amplified by the transistor Q1 and then reproduced by the speaker.

Now you are ready to assemble the project.





SCHEMATIC DIAGRAM & PARTS LIST

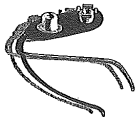
Part #	
35001	- Battery Snap
01065	- R1: 1kΩ
01115	- R2: 120kΩ
01049	- R3: 220Ω
01017	- R4: 10Ω
02012	- C1: .01µF Cap.
14004	- 555 IC Timer
18001	- Q1: 2N3904 Transistor
27001	- Speaker

STEP-BY-STEP ASSEMBLY INSTRUCTIONS

CONTINUITY TESTER / LAB KIT A19

USE THE SOLDERLESS CIRCUIT BOARD TO BUILD THE PROJECT. ALWAYS COMPARE YOUR WORK WITH THE SCHEMATIC DIAGRAM.

○ STEP 1



Find the Battery Snap. Insert the red wire into hole 1f, and the black wire into hole 1e.

○ STEP 2

Find the Integrated Circuit 555. Install it in the board with the notch, dot or band at one end in the right direction, as shown in the assembly diagram (holes: 15e, 16e, 17e, 18e, 15f, 16f, 17f, 18f).

○ STEP 3

Find the 1kΩ resistor (Brown, Black, Red, Gold). Insert one lead into hole 15h, and the other into hole 16i.

○ STEP 4

Find the 120kΩ resistor (Brown, Red, Yellow, Gold). Insert one lead into hole 16j, and the other into hole 17j.

○ STEP 5

Find the 10 ohm resistor (Brown, Black, Black, Gold). Insert one lead into hole 20j, and the other into hole 23j.

○ STEP 6

Find the 220 ohm resistor (Red, Red, Brown, Gold). Insert one lead into hole 17c, and the other into hole 25c.

○ STEP 7

Find the .01µF (103) capacitor. Insert one lead into hole 15c and the other into hole 16b.

○ STEP 8

Find the 3904 transistor. Insert its leads into holes 24d, 25d and 26d. Be sure its flat side is pointing in the direction shown in the assembly diagram.

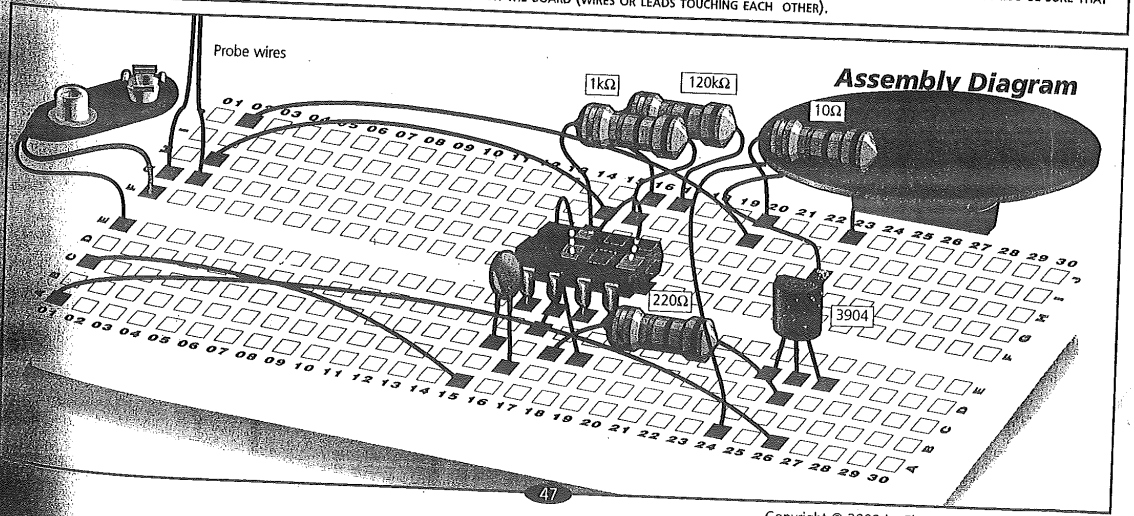
○ STEP 9

Find the speaker. Insert one of its leads into hole 23h and the other into hole 24a.

○ STEP 10

Get eight wires. Install six as follows: one from 2j to 20i, one from 2h to 15i, one from 15g to 18c, one from 16d to 17g, one from 1c to 15a and one from 1a to 26a. Install one wire into hole 1g and another wire into hole 2g. Do not connect the other side of these wires. These two wires are the probes of the continuity tester.

STOP! BEFORE YOU TEST YOUR PROJECT VERIFY IT AGAINST THE SCHEMATIC DIAGRAM, TO BE SURE THAT ALL THE COMPONENTS ARE INSTALLED IN THE RIGHT PLACE. ALSO BE SURE THAT THERE ARE NO SHORT CIRCUITS ON THE BOARD (WIRES OR LEADS TOUCHING EACH OTHER).



AUDIO GENERATOR

LAB KIT A20

PURPOSE OF THIS PROJECT

To build a useful and fun Audio Generator

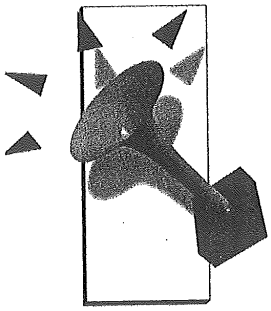
CIRCUIT DESCRIPTION

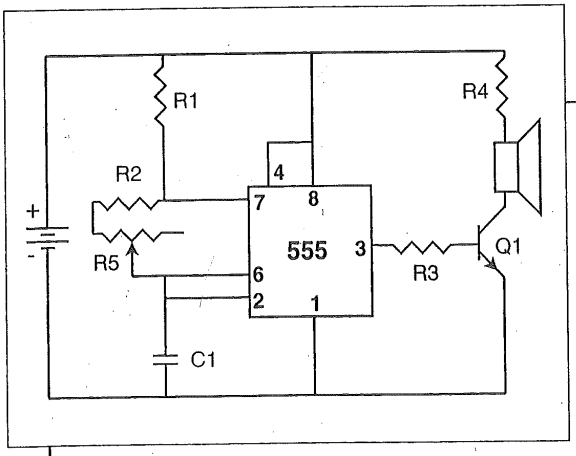
As its name implies, this project generates an audio signal (an electrical signal that is able to be heard through the speaker) of adjustable pitch (tone).

To operate this circuit, connect the battery to the battery snap and then rotate the potentiometer R5 to adjust the pitch of the audio signal.

The circuit of the Audio Generator is made of a 555 timer working as a clock, similar to the one explained in Mr. Circuit Lab Kit A11. Potentiometer R5 controls the frequency of the audio signal generated by the clock. Transistor Q1 amplifies the audio signal which is then reproduced by the speaker.

Now you are ready to assemble the project.





SCHEMATIC DIAGRAM & PARTS LIST

Part #	
35001	- Battery Snap
01085	- R1: 6.8kΩ
01065	- R2:1kΩ
01049	- R3: 220Ω
01017	- R4: 10Ω
33008	- R5: 100kΩ Pot.
02016	- C1: .1μF Cap.
14004	- 555 IC Timer
18001	- Q1: 2N3904 Transistor
27001	- Speaker

STEP-BY-STEP ASSEMBLY INSTRUCTIONS

AUDIO GENERATOR / LAB KIT A20

USE THE SOLDERLESS CIRCUIT BOARD TO BUILD THE PROJECT. ALWAYS COMPARE YOUR WORK WITH THE SCHEMATIC DIAGRAM.

○ STEP 1

Find the Battery Snap. Insert the red wire into hole 2f, and the black wire into hole 2e.

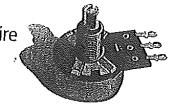
○ STEP 2

Find the Integrated Circuit 555. Install it in the board with the notch, dot or band at one end in the right direction, as shown in the assembly diagram (holes: 15e, 16e, 17e, 18e, 15f, 16f, 17f, 18f.)

○ STEP 3

Find and install the following resistors:
-1kΩ (Brown, Black, Red, Gold) from hole 9f to hole 16g.
-6.8kΩ (Blue, Gray, Red, Gold) from hole 15j to hole 16j.
-10 ohms (Brown, Black, Black, Gold) from hole 21i to hole 24i.
-220 ohms (Red, Red, Brown, Gold) from hole 17d to hole 23c.

○ STEP 4



Find the potentiometer. Insert the center lead wire into hole 9g and the left lead wire into hole 17i.

○ STEP 5

Find the .1μF (104) capacitor. Insert one lead into hole 15c and the other into hole 16b.

○ STEP 6

Find the 3904 transistor. Insert its leads into holes 22d, 23d and 24d. Be sure its flat side is pointing in the direction shown in the assembly diagram.

○ STEP 7

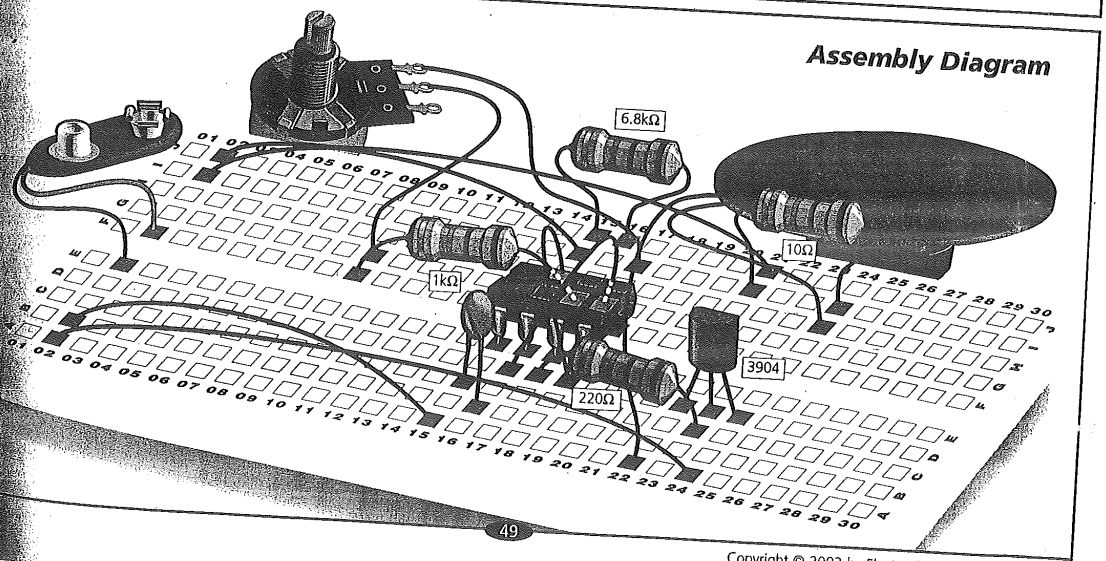
Find the speaker. Insert one of its leads into hole 22a and the other into hole 24h.

○ STEP 8

Get six wires. Install them as follows: one from 2j to 15i, one from 2i to 21j, one from 15h to 18d, one from 16d to 17g, one from 2b to 15a and one from 2a to 24a.

STOP! BEFORE YOU TEST YOUR PROJECT VERIFY IT AGAINST THE SCHEMATIC DIAGRAM, TO BE SURE THAT ALL THE COMPONENTS ARE INSTALLED IN THE RIGHT PLACE. ALSO BE SURE THAT THERE ARE NO SHORT CIRCUITS ON THE BOARD (WIRES OR LEADS TOUCHING EACH OTHER).

Assembly Diagram



ELECTRONIC POLICE SIREN

LAB KIT A21

PURPOSE OF THIS PROJECT

To build a useful and fun electronic project that generates the sound of a police siren.

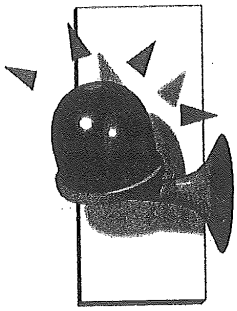
CIRCUIT DESCRIPTION

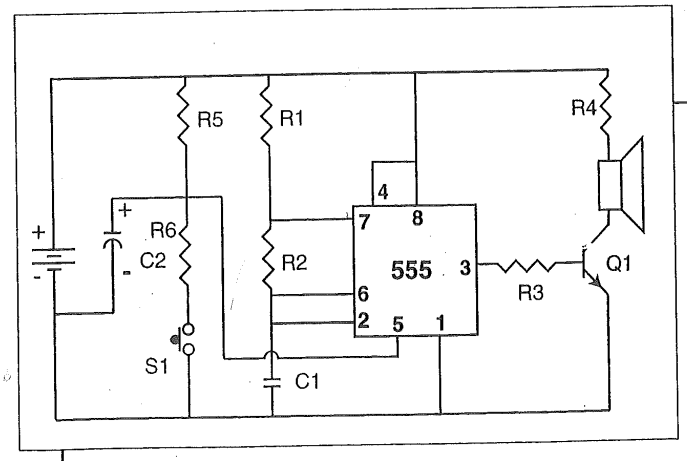
This exciting project will give you and your friends lots of fun. It produces a siren sound of rising and falling pitch.

To operate, connect the battery to the battery snap. Press the pushbutton S1 to produce a steadily rising tone from the speaker. Release the pushbutton and the tone descends in pitch. Thus you control the overall rising and falling pitch of the siren by closing and opening pushbutton S1.

The circuit of the Electronic Police Siren is made of a 555 timer working as a clock, similar to the one explained in Mr. Circuit Lab Kit A11. It has an audio amplifier section consisting of transistor Q1 and the speaker. The frequency of the 555 clock is controlled by the voltage applied on pin 5 which is generated by the charge and discharge of capacitor C2. C2 discharges when the pushbutton switch is pressed and charges when it is open, producing the rising and falling pitch in the siren.

Now you are ready to assemble this project.





SCHEMATIC DIAGRAM & PARTS LIST

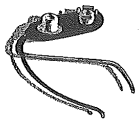
Part #	
35001	- Battery Snap
01065	- R1: 1kΩ
01115	- R2: 120kΩ
01049	- R3: 220Ω
01017	- R4: 10Ω
01085	- R5: 6.8kΩ
01073	- R6: 2.2kΩ
02012	- C1: .01μF Cap.
05005	- C2: 1000μF Cap.
25004	- S1: Pushbutton switch
14004	- 555 IC Timer
18001	- Q1: 2N3904 Transistor
27001	- Speaker

STEP-BY-STEP ASSEMBLY INSTRUCTIONS

ELECTRONIC POLICE SIREN / LAB KIT A21

USE THE SOLDERLESS CIRCUIT BOARD TO BUILD THE PROJECT. ALWAYS COMPARE YOUR WORK WITH THE SCHEMATIC DIAGRAM.

○ STEP 1



Find the Battery Snap. Insert the red wire into hole 2g, and the black wire into hole 1e.

○ STEP 2

Find the Integrated Circuit 555. Install it in the board with the notch, dot or band at one end in the right direction, as shown in the assembly diagram (holes: 17e, 18e, 19e, 20e, 17f, 18f, 19f, 20f).

○ STEP 3

Find and install the following resistors:
-1kΩ (Brown, Black, Red, Gold) from hole 17h to hole 18h.
-6.8kΩ (Blue, Gray, Red, Gold) from hole 2h to hole 11h.
-2.2kΩ (Red, Red, Red, Gold) from hole 2e to hole 11g.)
-220 ohms (Red, Red, Brown, Gold) from hole 19d to hole 25c.
-120kΩ (Brown, Red, Yellow, Gold) from 18j to 19j.
-10 ohms (Brown, Black, Black, Gold) from 24j to 25J.

○ STEP 4

Find the pushbutton switch. Insert one lead into hole 1c and the other into hole 2d.

○ STEP 5

Find the .01μF (103) capacitor. Insert one lead into hole 17c and the other into hole 18c.

○ STEP 6

Find the 1000μF capacitor. Insert its positive lead (long lead) into hole 11f, and its negative lead (short lead) into hole 11c.

○ STEP 7

Find the speaker. Insert one of its leads into hole 25i and the other into hole 24a.

○ STEP 8

Find the 3904 transistor. Insert its leads into hole 24d, 25d, and 26d. Be sure its flat side is pointing in the direction shown in the assembly diagram.

○ STEP 9

Get eight wires. Install them as follows: one from 2j to 17j, one from 11i to 20i, one from 17i to 24h, one from 19h to 18d, one from 17g to 20d and one from 1b to 11b, one from 1a to 17b and one from 17a to 26a.

STOP! BEFORE YOU TEST YOUR PROJECT VERIFY IT AGAINST THE SCHEMATIC DIAGRAM, TO BE SURE THAT ALL THE COMPONENTS ARE INSTALLED IN THE RIGHT PLACE. ALSO BE SURE THAT THERE ARE NO SHORT CIRCUITS ON THE BOARD (WIRES OR LEADS TOUCHING EACH OTHER).