OCTOBER 30, 2011

ADDENDUM

TO THE

ELECTRONICS MERIT BADGE

WORKBOOK

FROM GSS TECH ED

WWW.GSSTECHED.COM

1-800-422-1100

Section **A** WORKSHEET 2

TECHNOLOGY YOU CAN BUILD ON

Tronix ELECTRONICS MERIT BADGE WORKBOOK

Electronics Merit Badge Worksheet – (Page 2 of 6)

Study Lessons 2, 5, 8 and 15 and then do the following:

2(b) Tell the purpose of each part.

❑ **What is the purpose of a Resistor?** _____

_____

❑ **What is the purpose of a Capacitor?** _____

_____

❑ **What is the purpose of the 555 Integrated Circuit:** _____

_____

❑ **What is the purpose of the L.E.D. in this circuit?** _____

_____

Counselor's Initials _____ **Date** _____

Requirement #3. Complete Lesson 31 in the workbook with Electronic Kit #9999 and then do the following:

❑ **3(a) Show the right way to solder and desolder. (See pages 110 and 111)**

Counselor's Initials _____ **Date** _____

❑ **3(b) Show how to avoid heat damage to electronic components. (See page 109, paragragh #2)**

Counselor's Initials _____**Date** _____

❑ **3(c) Tell about the function of a printed circuit board. (See page 108)** _____

_____

_____

_____

_____ **Counselor's Initials** _____ **Date** _____

Electronics Merit Badge Worksheet – (Page 3 of 6)

Complete Lesson 31 in the workbook with Electronic Kit #9999 and then do the following:

❑ **3(d) Tell what precautions should be observed when soldering printed circuit boards. (See page 112)**

_____

_____

_____ **Counselor's Initials** _____ **Date** _____

Requirement #4. Discuss each of the following with your merit badge counselor, and then choose ONE of the following, 4a, 4b or 4c and build a circuit to show the techniques used. Then do 4d.

(Hint: electronics kits may be used. Consider one of the kits from www.GSSTechEd.com*.)*

❑ **4(a) Tell how you can use electronics for a control purpose, and then build a control device circuit.**

Do Lessons 16 and 17 in this workbook and tell how they work. _____

_____

_____ **Counselor's Initials** _____ **Date** _____

❑ **4(b) Do Lessons 20 through 25 in this workbook and then tell about the basic principles of digital techniques and then build a digital circuit. Show how to change three decimal numbers into binary numbers and three binary numbers into decimal numbers. (See pages 75 and 81) (Note: You will need parts kit #TP202-CB to complete these lessons. You can use the Order Form in the back of this workbook to order the parts kit.)** _____

_____

_____ **Counselor's Initials** _____ **Date** _____

❑ **4(c) Do Lessons 18 and 19 in this workbook. Three audio applications of electronics are (1) Music Reproduction like CD players, (2) Spoken Word reproduction like Public Address Systems, and (3) Electronic musical instruments like keyboards and synthesizers. You can build a Metronome in Lesson 18 or an electronic Organ in Lesson 19.**

_____

_____ **Counselors Initials** _____ **Date** _____

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Section 3- Supplemental Suggestions

To reduce the likelihood of some of these injuries:

- ☐ **-wear safety glasses (and hearing protection if you use a drill or cutting tools)**
- ☐ **-pass the soldering iron by putting it in the holder, then letting the other person take it from the holder.**
- ☐ **-put the cover back on the X-acto blade**
- ☐ **-do not force tools to do what they were not designed to do, for example cutting something too big for the tool.**
- ☐ **-clean the garbage from the previous job off your workstation.**
- ☐ **-clean up chemical spills immediately AND CAREFULLY (follow the MSDS).**
- ☐ **-do not bypass the safety mechanisms of equipment you use or are working on.**
- ☐ **-develop and use common sense.**

There are several substances that can cause permanent harm to you in the labe. That is why you should be familiar with the chemicals you may use. One of these chemicals is lead, which may be in the solder you use, and in the component leads. To mitigate the long-term effects of lead:

- ☐ **-Never put solder or component leads in your mouth.**
- ☐ **-Do not touch your face, eyes, or nose with your hands while you are handling solder or components.**
- ☐ **-DO NOT HANDLE FOOD IN THE LAB!**
- ☐ **-Wash your hands with soap and water when you are done in the labe.**

When the emergency happens, you are ready. You may need to take ALL of the following steps:

- ☐ **REMAIN CALM! Hide your fear, use your first aid training.**
- ☐ **Check the scene:**
  -Determine what caused the accident if your can. (electric shock, chemical spill, etc.)
  -Is it still dangerous to approach the victim? Electric power still on, chemicals on the floor and workstation, etc.
  -Are there more than one victim? You will have to determine who has the worst injuries.
  -Is there anyone who can help you? Some bystanders may have seen the accident and can tell you what happened. They may be able to help you render aid.
- ☐ **CALL FOR HELP**
  -Call 9-1-1 or your community's emergency response number. They can contact the electric and gas companies to turn off utilities if you need help.
  --If are alone, make the call.
  --if you can send someone to call, do it, and tell them to report back to you.

Section **B** "Safety First" Lesson

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-You or your helper will need to tell the dispatcher the following:
--Where you are and what phone number you are calling from.
--Where the victim(s) are.
--What time the injuries happened.
--Any treatment being given, and what the skill level of the people doing First Aid is, if you can.

☐ **Approach safely**
-DO NOT BECOME A VICTIM YOURSELF! That is why you told the dispatcher to get the utilities turned off, or asked for assistance to help with chemicals from the fire department.
-USE BODY SUBSTANCE ISOLATION TECHNIQUES!
--Use gloves, face masks and shields, and other barriers to keep from touching any liquids, such as vomit, blood and saliva, or having them touch you. (KEEP THESE ITEMS IN THE FIRST AID KIT)
--Dispose of the used gloves, masks, shields properly so no one else can contact these substances. Handle you clothing carefully since these may be dirty, too.
--Wash up with soap and water when you are done.
--Clean up the area, or have qualified people clean up when you are through.
-If the victim is conscious, talk to them and assure them. Ask them if you can help. If they say yes, start first aid. If they say no, you cannot physically touch them. This is the LAW.
-If the victim is unconscious, treat them. Move them only if you need to determine the help you need to give. If you can get help to move them, use it.

☐ **Treat the urgent things first**
-Check for airway, breathing and circulation problems, and get the AED (automated external defibrillator). These are the "ABCD"s. LEARN HOW TO DO CPR AND HOW TO USE AND AED BEFORE YOU NEED TO DO IT.
-Handle the simple stuff, such as small burns and cuts and scrapes.

☐ **Protect from further injury**
-Your first responsibility is to keep the victim, bystanders, or other from becoming further injured.
--Move the victim only if you need to and know how to and have help.
--Support head, neck and back properly.
--Remove objects from the area that can hurt someone worse, such as knives, and turn off soldering irons or power equipment.

☐ **Treat every accident victim for shock (may include bystanders and helpers, and for tiny or big injuries)**
-Remove the causes of shock by restoring breathing and circulation, controlling bleeding, relieving severe pain, and treating injuries.
-You should have called emergency services before now, so help is on the way.
-Monitor the victim closely for problems with breathing or circulation, or other problems.
-Have the victim lie down if they are not already lying down.
-Raise the feet 12 inches if there are no head, neck, or back injuries or fractures in the hips or legs.
-Keep the victim warm.

☐ **Do a thorough examination**
-Again, be sure you have the permission of a conscious victim. Go ahead with an unconscious victim.
-Feel for and look for additional bleeding, fractures or other wounds or injuries, and treat these, as well.

☐ **If no help has arrived, put together a plan to continue treatment, scene safety, your health and welfare, and that of the victim, helpers and other bystanders.**

Lesson **19** "Electronic Organ"

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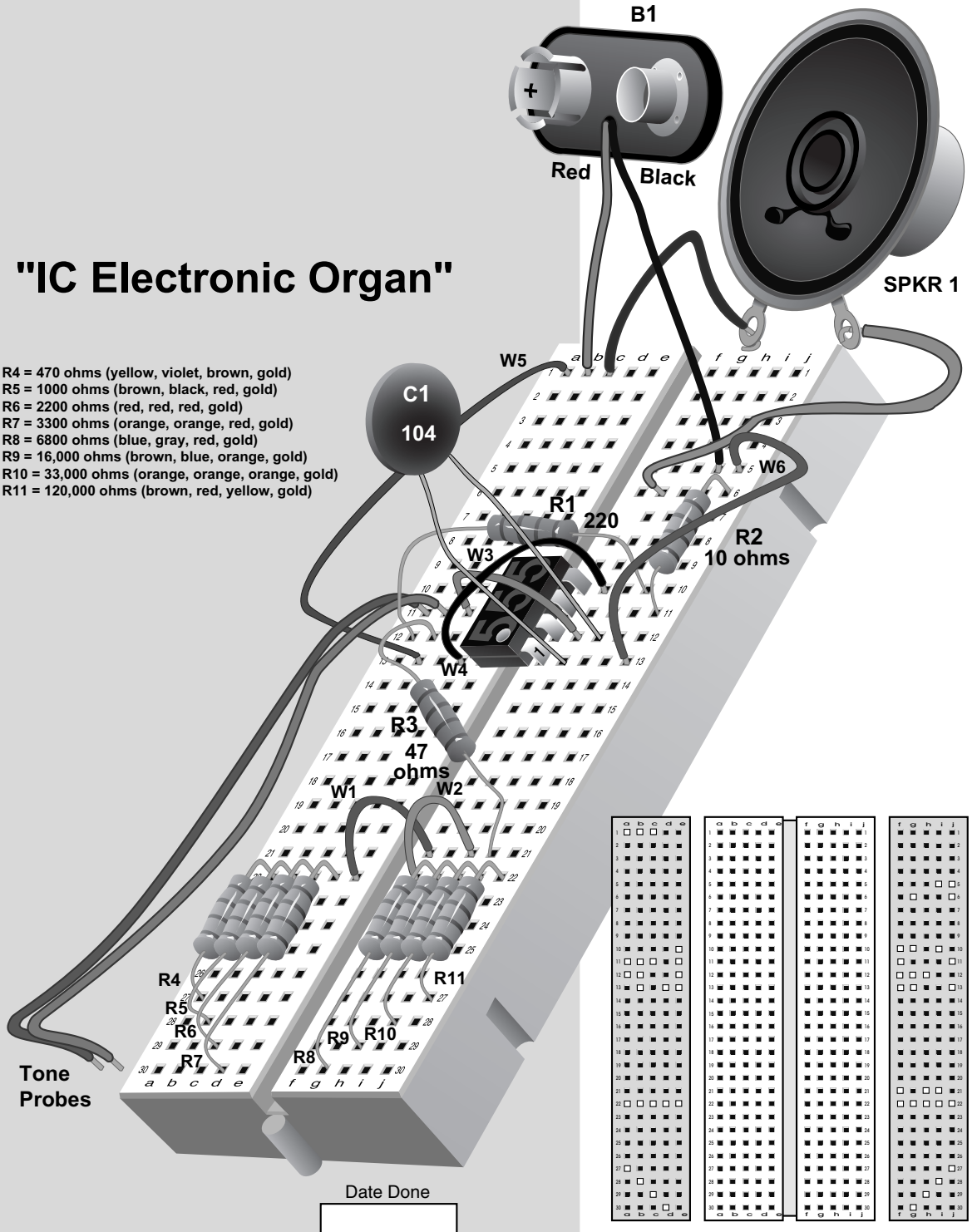
"IC Electronic Organ"



R4 = 470 ohms (yellow, violet, brown, gold)
R5 = 1000 ohms (brown, black, red, gold)
R6 = 2200 ohms (red, red, red, gold)
R7 = 3300 ohms (orange, orange, red, gold)
R8 = 6800 ohms (blue, gray, red, gold)
R9 = 16,000 ohms (brown, blue, orange, gold)
R10 = 33,000 ohms (orange, orange, orange, gold)
R11 = 120,000 ohms (brown, red, yellow, gold)

Date Done

PICTORIAL DIAGRAM

QUICK CHECK BOX

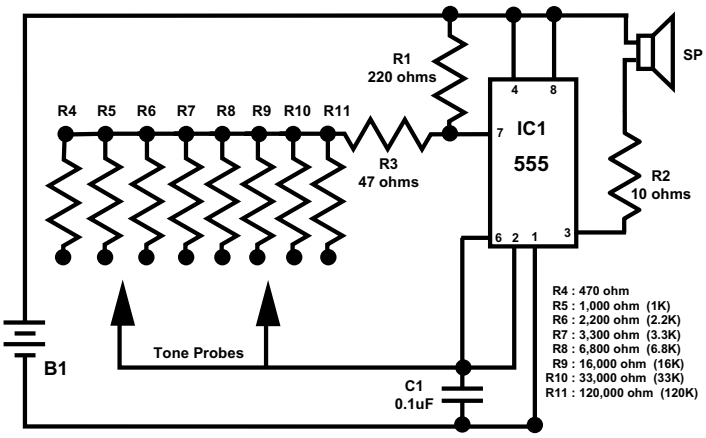
"IC Electronic Organ"

Step 1 - Take Inventory

Using the PARTS INVENTORY (on the right), place each part needed for this project on its corresponding drawing. Observe the schematic symbol for each part. Make sure that you have all the parts ready before you begin Step 2.

Step 2 - Build the circuit.

Using the Schematic Diagram (below) or the Pictorial Diagram (on a separate sheet) build the project with the electronics parts. Use the QUICK CHECK BOX to verify that your wiring is correct, then proceed to Step 3.



Schematic for the IC Electronic Organ

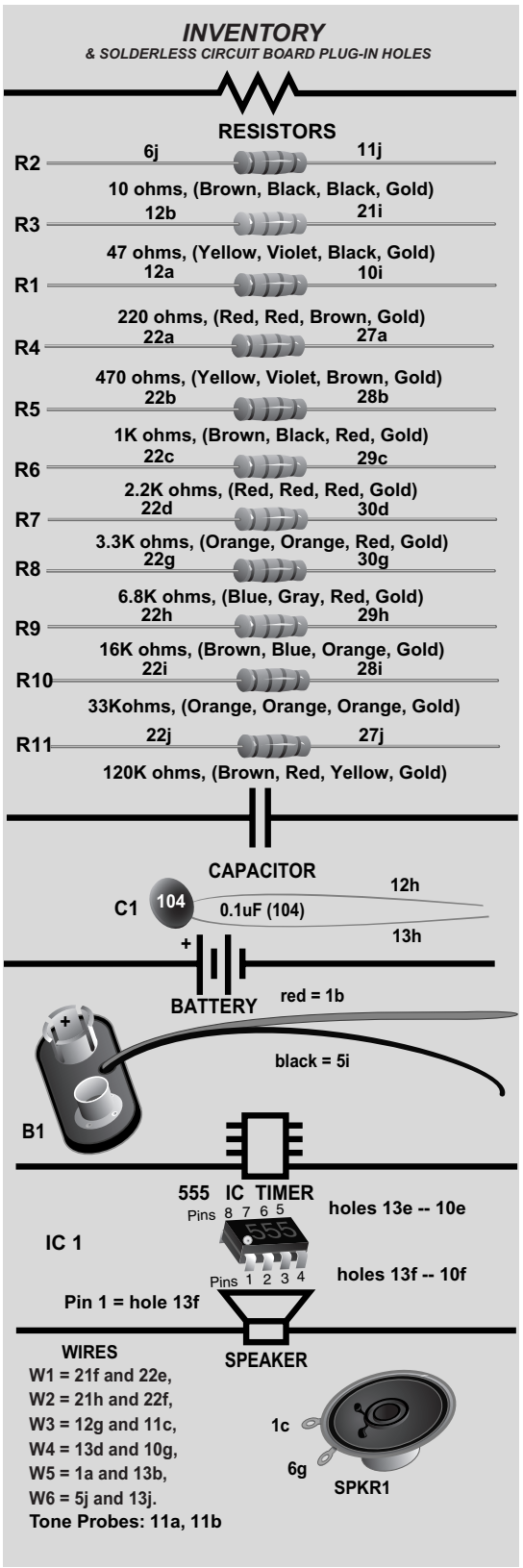
Step 3 - Do Experiment

Theory: Here we are using the 555 Timer IC as an Astable Multivibrator. As we change the voltage across Pins 6 and 7, we change the frequency of the output pulses at Pin 3.

These tones can be made louder by feeding them to a transistor and amplifying them. (Compare this circuit to Project P16 for a sample way to connect the output of Pin 3 to a transistor.)

Procedure: Connect a 9-volt battery to the Battery Snap and touch one of the Tone Probe wires to a resistor lead, from R4 to R11. As you touch each one, you will hear a different tone. Use both hands, one Tone Probe in each one, and you can play your favorite tune. (Note: The 10 ohm resistor will get hot while running this project.)

The pitch or frequency of each tone is different, depending on the value of the resistor.



The Need and Use of Test Equipment in Electronics

Shown below are two Multimeters. The one on the left is called a Digital Multimeter which has number readouts. The one on the right is called an Analog Multimeter which has a needle which moves across multiple scales. A Multimeter has many types of Test Equipment inside of it.

Some of the types of Test Equipment inside of these multimeters are: (1) a Current meter, (2) a DC Voltage meter, (3) an AC Voltage Meter (4) a Resistance Meter also called an Ohmmeter, (5) a Battery Condition meter and also (6) a Transistor Checker to check the condition of certain NPN and PNP transistors.

Digital Multimeter

Analog Multimeter

These pieces of Test Equipment are connected to a circuit with probes, sockets or clips. Each piece of Test Equipment has a way to provide output readings such as numbers, or lights or a needle moving across a scale on the face of the meter.

Remember, the Multimeter usually has at least 5 basic types of Test Equipment inside of it. 1. Continutity Checker 2. Resistance Meter or Ohmmeter 3. DC Voltmeter 4. AC Voltmeter and 5. Current Meter

Lesson **26** "Electronic Test Equipment"

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(1) The **Continuity Checker** is used to check if a circuit is open or closed. A typical use is for testing a light bulb or fuse. It operate by measuring a small current through the device being tested. If no current flows through the device being tested, the device is said to be "open". If a fuse or light bulb is open, it is defective.

(2) The **Resistance Meter or Ohmmeter** is used to check the amount of resistance in an electronic device. To test this, the Resistance Meter applies a small amount of voltage to the electronic component being tested. The more current that flows through the component under test, the lower its resistance.

(3) The **DC Voltage Meter** is used to measure DC voltages in a circuit, The way this works is a small amount of power is taken from the circuit and sent to the meter through the meter probes. The meter displays the voltage reading either by numbers or the needle moving across the scale.

(4) The **AC Voltage Meter** is used to measure AC voltages in a circuit. These are varying voltages used in electronics. Again, the meter takes a small amount of power from the circuit and displays the voltage in numbers or by the needle on a scale on the face of the meter.

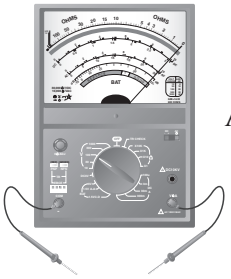
(5) The **Current Meter** is used to measure the amount of current or Amperes flowing in a circuit. The probes on the meter are put in series with the current flow and the reading is given by numbers or by the needle on the scales of the multimeter.

Multimeters are typically hand-held, battery powered devices with positive and negative probes and a dial for selecting the test scale to be tested. A rubber housing, a handle and a stand to enable easier reading of the display are common features.

Continuity checking is the most common basic measurement offered by a multimeter. To test for continuity the meter is set to Ohms, If the circuit is closed, the readout will measure between 0 and .05 ohms. A reading of Infinity would suggest an open circuit or broken connection.

The Multimeter can help locate problems within circuits quickly when used properly. Knowing how to properly use a Multimeter can be very useful around your home, car, or anywhere electrical appliances are used.

Digital 

 Analog

Lesson 31 "How to Solder LED Blinker Kit"

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What is the function of a Printed Circuit Board?

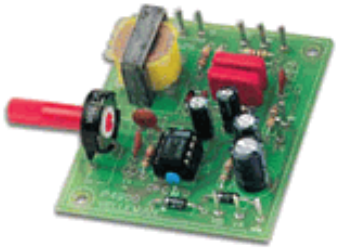
Printed circuit boards are copper traces on a fiberglas with holes drilled in the fiberglas so that the electronic components can be inserted and soldered to the copper traces. The function of a Printed Circuit Board is to take the place of individual wires that were used to connect electronic components.

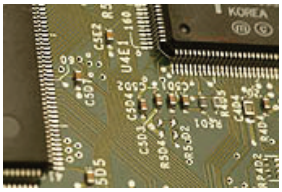
Before **Printed Circuit Boards** were invented, technicians and engineers used a board with holes perforated in it, a perfboard, to solder wires to connect the electronic components. Printed Circuit boards, known as **'PCBs'** were invented by Paul Eisler in the 1930s. He used a method of printing circuit traces on a thin copper sheet that was glued to a fiberglas board. An etching process was then used to remove all the copper that was not part of the circuit. This process left the copper traces on the fiberglas and holes were drilled in the fiberglas so that the electronic components could be inserted and soldered to the copper traces.

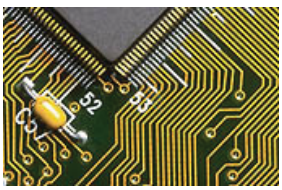
Many of today's **PCBs** use surface-mounted components. Surface-mounted means that you solder the electronic component on the board without the use of holes through the board. The components are designed to solder on the top of the printed circuit board.

As electronic components continue to get smaller and more complex, it will be necessary to create new methods of connecting everything. Little pads on the components get soldered to the boards using a paste solder and a baking process to melt it. These **PCBs** can contain hundreds of parts soldered very close together.

Other technologies are used today as well. **Printed Circuit Boards** with solid copper cores are used in satellites and spacecraft to conduct heat away from sensitive components. **Flexible printed circuit boards** bend and fold enabling them to fit into curved shapes and tight places, like in digital cameras etc.







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A few safety precautions for Soldering

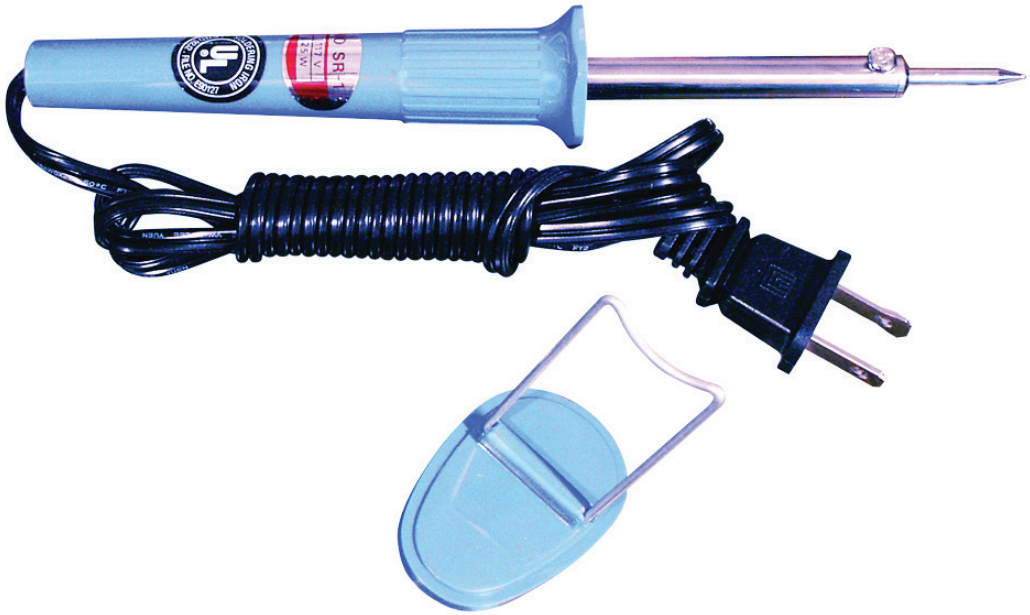
1. **Never touch the heating element or tip of the soldering iron.** They are very hot, generally about 400° C and will cause a sever burn very quickly.

2. **Take care to avoid touching the power cord with the tip of the iron** as it could quickly melt through the protective insulation and short the wires causing serious risk of electric shock.

3. **Always return the hot iron to it's stand** when not in use. Never put it down on your workbench, even for a moment!

4. **Work in a well-ventilated area.** The smoke you see rising off of the solder is mostly flux and very irritating. Avoid breathing it by not working directly over your project, keep your head to the side.

5. **Always wash your hands often** after handling solder because most solder contains lead which is very toxic to the human body.



How to Avoid Heat Damage to heat sensitive components:

Some components can be damaged by the heat of the soldering iron. To protect transistors and ICs from over-heating, you need to remove the extra heat before it gets to the component. This can be done by clamping a special heat-sink or an alligator clip to the components leads to draw away heat.

Heat-Sink Clamp

Lesson 31 "How to Solder LED Blinker Kit"

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The right way to Solder

Steps to follow:

1. **Place the soldering iron in its holding stand and plug it in**. The iron will take some time to reach it's 400° C.

2. **Dampen a sponge with cold tap water under the faucet** (remove the sponge from the stand to do this) squeeze out the extra water, you want it damp not dripping wet. Some stands will have their own sponge, if not get your own.

3. **Wait for the soldering iron to warm up**, if it will melt solder it's ready.

4. **Clean the tip of the iron** with the damp sponge.

5. **Melt just a little solder on the irons tip**, this is called tinning and will help the heat flow from the iron to the connection being soldered. This tinning only needs to be done when the iron is wiped clean on the sponge or first plugged in.

6. **Hold the soldering iron like a pen** by the grip near the base of the handle.

7. **Never touch the hot element** or the tip of the iron.

8. **Touch the tip of the iron to the connection** you plan to solder. Make sure you are touching both the component wire lead and the trace on the PCB until both are hot enough to melt the solder.

9. **Feed a little solder into the connection** (not the iron). It should flow easily onto both parts and look like a little volcano shape.

10. **Remove the solder and then the iron** while holding the joint still until it cools enough to stay on it's own.

11. **Inspect the joint for a shiny volcano shape** when done. If it's not smooth and shiny, you'll need to reheat the connection. Be sure the component lead wire and the circuit traces are both hot before adding the solder.

The right ways to Desolder

When you need to desolder a connection, here are two ways to do it.

1. **Use a solder sucker or desoldering pump to remove solder.**

Here are the steps:

a. Prep the pump by pushing the plunger down till it locks.
b. Apply the soldering iron to the joint to melt the solder and keep it there.
c. While the solder is liquid apply the desoldering pump's tip to the joint and press the trigger to release it.
d. As the plunger pops up, the solder will be sucked into the chamber of the tool.
e. Repeat as needed until all the solder is removed from the connection.
f. You can remove solder from the desoldering tool by unscrewing its nozzle.

2. Use solder wick to remove solder (copper braid). (This copper braid is called "solder wick" because it acts like a wick to suck up the solder when melted solder touches it.)

Here are the steps:

a. Apply the soldering iron to the connection to melt the solder and keep it there.
b. While the solder is liquid, apply the solder wick braid to the connection.
c. The solder melts, it will flow into the wick.
d. Remove the wick first then the iron.
e. Cut off and discard the end of the wick filled with solder.

Note #1: After clearing most of the solder from a connection, you will be able to remove the components leads from the PCB.

Note #2: Always allow the parts to cool a few seconds to avoid getting a burn.

Note #3: Remember to use a heat sink as needed to protect components that are sensitive to heat damage.

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#TEMB-PK1
Parts for the Analog Experiments for the Electronics Merit Badge

Boy Scout Merit Badge Parts Kit 1

Parts ORDER FORM

Send Orders and Make Payments to:
Gibson Sales Systems **31500 Grape St. Suite 3-364, Lake Elsinore, CA 92532**
E-mail: gary@gssteched.org Toll-Free #: 1-800-422-1100 Fax: 1-800-913-8310 www.GSSTechEd.com

TP102 + CB111 + 9VB

Part Number	# of Parts	Part Name	Part Price	Quantity Ordered	Total
GK01017	1	10 ohm	$0.08		
GK01033	2	47 ohm	0.08		
GK01041	2	100 ohm	0.08		
GK01049	3	220 ohm	0.08		
GK01053	3	330 ohm	0.08		
GK01057	1	470 ohm	0.08		
GK01065	5	1k ohm	0.08		
GK01073	1	2.2k ohm	0.08		
GK01077	1	3.3k ohm	0.08		
GK01085	2	6.8k ohm	0.08		
GK01089	3	10k ohm	0.08		
GK01094	1	16k ohm	0.08		
GK01101	2	33k ohm	0.08		
GK01115	1	120k ohm	0.08		
GK01129	1	470k ohm	0.08		
GK02012	2	0.01 mfd disc	0.12		
GK02016	2	0.1 mfd disc	0.22		
GK05003	1	10 mfd electrolytic radial	0.22		
GK05005	2	100 mfd electrolytic radial	0.32		
GK05009	1	1000 mfd electrolytic radial	0.50		
GK33008	1	100k potentiometer	1.20		
GK13001	1	SCR 106B1	0.90		
GK30001	1	Power Diode	0.12		
GK06001	3	LED Red Jumbo	0.15		
GK45028	1	Photocell	0.95		
GK35002	3	9-Volt Battery Snap	0.32		
GK45011	20	4” Solid Insulated Stripped Wire	0.06		
GK14004	1	IC555 Timer	0.39		
GK25006	1	N/O Pushbutton Switch (with wires)	0.95		
GK18001	2	NPN Transistor	0.19		
GK18002	2	PNP Transistor	0.19		
GK27002	1	Speaker (with wires)	1.99		
CB111	-	Solderless Circuit Board	5.95		
9VB	-	9-Volt Battery	0.79		
TEMB-PK1	**-**	**Parts for Analog (set of all above)**	**12.49**		

Make as many copies of this form as you need.

Date: _____ **Ship to:** _____
School: _____ **Address:** _____
City: _____ **State:** _____ **Zip:** _____
Telephone: _____
Purchase Order #: _____ **Check #:** _____
Credit Card #: _____ **Exp. Date:** _____

Total Order	
Shipping (10% or $9 min.)	
Calif. Sales Tax (7.75%)	
TOTAL	

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#TEMB-PK2
Parts for the Digital Experiments for the Electronics Merit Badge

Basic Digital Concepts
REORDER FORM

Send Reorders and Make Payments to:
Gibson Sales Systems 31500 Grape St. Suite 3-364, Lake Elsinore, CA 92532 Gary@GibsonSalesSystems.com
Toll-Free #: 1-800-314-3843 Fax: 1-800-913-8310 www.GSSTechEd.com

Part Number	# of Parts	Part Name	Part Price	Quantity Ordered	Total
GK01059	7	560 ohm	$0.08		
GK01067	7	1.2K ohm	$0.08		
GK01085	1	6.8K ohm	$0.08		
GK01094	1	16K ohm	$0.08		
GK02012	1	0.01 mfd disc Capacitor	$0.12		
GK05003	1	10 mfd Capacitor	$0.22		
GK05004	1	47 mfd Capacitor	$0.25		
GK04029	1	IC 4029B Up Down Div by 10	$0.90		
GK04511	1	IC 4511B 7-Seg Latch/Driver	$0.90		
GK14004	1	IC 555 Timer IC	$0.39		
GK06001	10	LED red jumbo	$0.15		
GK29003	1	7-Segment Display (common cathode)	$2.35		
GK35002	1	9-Volt Battery Snap	$0.32		
GK45008	10	4" solid #24 insulated stripped wire-red	$0.06		
GK45010	10	4" solid #24 insulated stripped wire-black	$0.06		
GK45012	15	2" solid #24 insulated stripped wire-red	$0.05		
GK45013	15	2" solid #24 insulated stripped wire-black	$0.05		
GK25006	1	N/O Pushbutton Switch/w wires	$0.95		
CB222	-	Solderless Circuit Board (Large)	7.85		
TEMB-PK2	**-**	**Parts for Digital Exp. (set of all above)**	**14.95**		

Date: _____ **Ship to:** _____
School: _____ **Address:** _____
City: _____ **State:** _____ **Zip:** _____
Telephone: _____
Purchase Order #: _____ **Check #:** _____
Credit Card #: _____ **Exp. Date:** _____

Total Order	
Shipping (10% or $9 min.)	
Calif. Sales Tax (7.75%)	
TOTAL	

Make as many copies of this form as you need.

ELECTRONICS MERIT BADGE SUPPLIES

ORDER FORM

MARCH 2011

Send Orders and Reorders to: Make checks to Gibson Sales Systems.

Gibson Sales Systems 31500 Grape St. Bldg. 3-364 Lake Elsinore, CA 92532
Tel: 1-800-422-1100 1-951-471-4932 Fax: 1-800-913-8310

TEMB-OrderForm-GSS.QXD

Order Qty	Part Number	Description	Price Each	Total
	TEMB-One-Pak	Single **Electronics Merit Badge Package**	**$25.00**	
		Includes one each of: (TEMB-Book, TEMB-PK1,		
		TEMB-9999 Blinker Kit, 9VB in white box with label)		
	TEMB-10-Pak	**Electronics Merit Badge TEN-PAK (Free Fght)**	**$220.00**	
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	TEMB-Book	**Electronics Merit Badge Workbook only**	**$12.00**	
	TEMB-PK1	**Experiment Parts with board for Lessons 1 - 19**	**$12.49**	
		(Parts as shown on Pages 24 and 25 of Workbook)		
	TEMB-9999	**LED Blinker solder kit for Lesson 31**	**$2.49**	
	9VB	**Nine-Volt Battery for experiments and kit**	**$0.79**	
		***** **Additional Tools and Supplies** *****		
	TEMB-PK2	**Digital Experiment Parts for Lessons 20 - 25**	**$14.95**	
		(TEMB-PK2 is optional for Requirement 4(a))		
	CI-3030S	**Deluxe Analog Multimeter with Stand**	**$42.95**	
	V-DVM850BL	**Deluxe Digital Multimeter with Back light**	**$15.90**	
	E-SR-3B	**Deluxe 25W Soldering Iron with 3-Prong Plug**	**$13.25**	
	GK28001	**1 LB Roll of Lead-Free Solder .031"**	**$39.00**	
	E-ST-1	**Wire Cutters 4 1/2 " good quality**	**$3.25**	
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	E-ST-20	**Safety Goggles (one size fits all)**	**$2.98**	
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