# Grade 9 Electricity/Electronics Technology (10G)

A Course for
Independent Study

Manitoba

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## A Course for Independent Study

2014, 2020
Manitoba Education

Manitoba Education Cataloguing in Publication Data

Grade 9 electricity / electronics technology (10G) :
a course for independent study.

ISBN-13: 978-0-7711-5683-0

1. Electricity—Study and teaching (Secondary).
2. Electronics—Study and teaching (Secondary).
3. Electricity—Programmed instruction.
I. Manitoba. Manitoba Education.
II. Title: Grade 9 electricity / electronics technology (10G) :
a course for independent study
621.30712



Manitoba Education
Winnipeg, Manitoba, Canada



This resource was published in 2014 and updated in 2020.

Available in alternate formats upon request.

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# ACKNOWLEDGEMENTS

Manitoba Education gratefully acknowledges the contributions of the following individuals in the development of *Grade 9 Electricity/Electronics Technology (10G): A Course for Independent Study.*

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# Grade 9 Electricity/ Electronics Technology (10G)

## Introduction

# INTRODUCTION

## Overview

Welcome to Grade 9 Electricity/Electronics Technology!

As a student enrolled in a distance learning course, you have taken on a dual role—that of a student and a teacher. As a student, you are responsible for mastering the lessons and completing the learning activities and assignments. As a teacher, you are responsible for checking your work carefully, noting areas in which you need to improve and motivating yourself to succeed.

In this course, you will study and learn the basics of electricity and electronics, including the following specific topics:

- understand how electricity and electronics affects our lives
- explain the importance of electricity and electronics
- learn important electronic terms
- view and understand various electronics tools
- look at possible career opportunities

### Power Words

DVD player
CD player
amplifier
computer
electronic components
sonar
radar
automatic pilot
repair technician
design technician
electronics engineer
technical designer
draftsperson
assembly technician
machinist
GPS (Global Positioning System)

## What Will You Learn in This Course?

Welcome to the world of electronics, one of the newest, most useful, and fascinating of the applied sciences. In today's high-tech world, electronics can be an educational and entertaining hobby or career. You probably know that electronics has made many high-tech devices possible, such as televisions, DVD players, CD players, amplifiers, and computers.

All of these devices are made up of parts called electronic components. These electronic components can alter and change the movement of electricity in many useful ways. Finding new ways to control electricity is a constant challenge. The vehicles that move us around the world are controlled by electricity. Ships use sonar and radar to keep them on course. Airplanes use electronic components in their radar and automatic pilot systems to help make flights safe. Banks rely on electronics for security and for the accounting of our money. Factories and industry use electronics to control assembly lines, inventory, quality, or precision engineering. Hospitals use many devices with electronic components. These devices are used to find out what is wrong (diagnose) and then treat the patient for the problem. Space shuttles, trains, satellite signals, and even law enforcement use electronic technology.

Electricity has contributed more to modern progress than any other single factor. Of course, it was not always this way. The term *electronics* would not have been included in a dictionary before the 1930s. Most electronic components, measuring processes, and data transmission systems are less than 70 years old. To a person from the early 20th century, the developments in electronics in the past few decades would read like a fairy tale. Today, it is difficult to find a home that is not affected or enhanced by electricity, and it is almost impossible to go through a day without somehow using electronics.

A reason to study electronics may be simply to understand and learn about these devices that have such a major influence on our lives. You may want to repair or build your own electronic stereo equipment, install a car stereo, hook up your own satellite system, repair the family boat trailer wiring, or even build your own computer. There are also many electronics projects that you could build for a fraction of the retail store price. After completing this course, you will have the knowledge to test these projects, and learn how the electronic components in them work.

It may be that you find electronics so fascinating that you would be interested in a career as a repair technician, design technician, electronics engineer, technical designer, draftsperson, assembly technician, machinist, or even an electronics salesperson. All of these professions require an in-depth knowledge of electronics, including background knowledge on the development and production of new electronic equipment.

Any of the activities shown below could make use of the electronic device known as the Global Positioning System or GPS (shown below).

## How Electricity and Electronics Were Discovered

People have always looked for ways to do work easier, faster, and better. They harnessed animal power and reshaped natural objects to make them more useful. They used levers, ramps, wedges, and wheels. These are called **simple machines**.

Before the Industrial Revolution, people built complex machines that were made from more than one type of simple machine. For example, plows were made from levers and wedges, carts were made from levers, wheels, and axles, and machines such as clocks, guns, and spinning wheels were made from even more simple machines. These more complex machines were still relatively simple and were usually powered by muscle and built one at a time by one person. These machines were meant to be used occasionally, not all day, and not every day.

The Industrial Revolution, however, changed that. Machines became more and more complex. Mills and factories made products such as cloth in quantities greater than the population of one village could use. Factories and mills were operated by large numbers of people and were operated all day, every day and powered by steam engines or water wheels, not muscles. This was a truly new way to change, use, and control energy.

However, there were two limitations to these forms of energy (water power and steam):

1. They could not be easily **transported**—a waterwheel stays in one place and steam engines are very heavy.
2. They could not be **changed back** to their original form—the heat of a steam engine could be changed into rotational movement, but could not be changed back into heat.

To overcome these limitations, people looked for a form of energy that could be easily transported and changed. The answer was electricity.

1. Electricity can be **transported** (or transmitted) through wires over long distances.
2. Electricity can be changed or **transformed** into a different kind of energy. The reverse is also true—other types of energy can be transformed into electricity. For example, nuclear power, water power, fossil fuels, wind power, solar power, and geothermal power can all be transformed into electricity.

There are several ways that energy can be made. You can make (**generate**) small amounts of **electronic** power by squeezing crystals. This is called **piezoelectricity**. One example of piezoelectricity is found in running shoes with lights that flash each time the runner hits the ground. Another example is electronic bathroom scales with a crystal inside that determines your weight when someone steps on the scale.

A **thermocouple** is another device that generates power by making small amounts of electronic power directly from heat.

In the previous two paragraphs, you encountered a new word—**electronic**. It is almost "electricity."

Electricity and electronics are close, but not the same. They both operate on the condition that electrons (part of atoms) in some materials can be made to move from one place to another and do work on the way. Does this sound familiar? *Think of water power.*

We often use the words electrical and electronic together, however, because one device can be both electronic and electrical. The following definitions help explain the difference between the two terms:

- When we make (generate), use, or transport large amounts of electrical power, we use the word electric (or electrical or electricity).
- We call it electronic when small amounts of power are involved. It is electronic when **semiconductors** are used. It is also electronic when electricity is used to **communicate** or to **control** something.

This means that a machine can be both electronic and electric—for example, an air conditioner. An air conditioner is electric because it uses large amounts of power to run a fan and compressor. This moves heat from inside a house to the outside. The controls, however, are electronic because they use tiny amounts of electricity to test the temperature inside the house. Tiny electronic **circuits** compare the temperature inside the house to the temperature requested. These circuits turn the fan or compressor on or off. The electronic controls increase and decrease the fan speed and turn the compressor on or off throughout the day, using almost no power to control lots of power. The air compressor is also electronic.

Similarly, the alternator in a car generates electricity to run the spark plugs, radio, headlights, and heater fan—the alternator, however, is electric and is controlled by an electronic regulator. This regulator consists of a semiconductor circuit that turns the alternator on and off—the alternator is also electronic.

As you read this introduction, you may have questions or feel confused by a new term or by the way it is used. Don't worry, these new terms and ideas will be explained and explored in more detail later in the course. As you continue through the course, reread the introduction and see how your understanding of electricity and electronics has improved.

## How Is This Course Organized?

The Grade 9 Electricity/Electronics course consists of the following modules:

Module 1: Electricity: The Shocking Facts on How it is Produced

Module 2: Safety

Module 3: Electronic Components

Module 4: Building a Project: Getting Started with Your Tools and Equipment

Module 5: Series, Parallel, and Combination Circuits

Module 6: Linking Education to Careers

Module 7: Major Project

Each module in this course is made up of several lessons, which are organized as follows:

- **Introduction:** Each lesson begins by outlining what you will be learning.
- **Power Words:** Throughout this course you will be introduced to words that will increase your electronics vocabulary. These words are called "power words." Each power word will be in bold and the definition for each word can be found in the glossary at the end of the course. You should be able to define and/or explain these words when you have completed this course.
- **Lesson:** The main body of the lesson is made up of the content that you need to learn. It contains explanations, diagrams, and fully completed examples.
- **Summary:** Each lesson ends with a brief review of what you just learned.
- **Learning Activities:** Most lessons have a learning activity. These include questions that you should complete in order to help you practise or review what you have just learned. Once you have completed a learning activity, you should check your answers with the answer key provided.
- **Assignments:** Assignments are found at the end of lessons. You will mail or electronically submit all of your completed assignments to the Distance Learning Unit for assessment. The hand-in project from Module 4 must be mailed to the Distance Learning Unit.
- **Major Project:** You will be completing and sending in a major project at the end of Module 7. This will be forwarded to the Distance Learning Unit for review and/or assessment.

In each lesson, you will read a few pages and then complete a learning activity and/or assignment. Some lessons may require you to do some investigative research or observation work in the community.

## What Resources Will You Need for This Course?

You do not need a textbook for this course. All the content is provided directly within the course. You will, however, need access to a variety of resources.

### Grade 9/10 Electronics Video

You will have the opportunity to view the Grade 9/10 Electronics video, which is available in the learning management system (LMS). If you need a copy of the video on DVD, contact the Distance Learning Unit. Watch segments of this video as you work your way through the course.

## Grade 9 Electricity Kit

You will need the Grade 9 Electricity Kit to complete this course. If you have not ordered it, contact the Manitoba Learning Resource Centre at www.manitobalrc.ca or telephone 1-866-771-6822. Please note that there are two options when purchasing the Grade 9 Electricity Kit. If you already have the seven items from the tool kit, whether at home or at school, you would order kit #3308. If you require all the supplies for this course, you would order kit #9993. If necessary, it is also possible to purchase the circuit board found in the Project Kit separately from the Manitoba Learning Resource Centre, stock #3307.

If items are not in working order, contact the Manitoba Learning Resource Centre for replacement parts.

Each student needs to purchase his or her own Grade 9 Electricity Kit, as group submissions for projects and assignments will not be accepted.

## Other Supplies/Requirements

- Safe work area with 120 volt, 15 amp power supply
- Calculator
- 9-volt batteries (kit has one battery, an additional battery may be required)

## Variations in Components and Tools

Components and tools in the Electricity Kit might or might not be identical to those described or shown in the course and on the video. This is common in the electronics industry, where manufacturers often modify components and tools in order to improve them. It is also possible the kit suppliers have had to purchase the components and parts from new manufacturers, which may account for a change from time to time.

People in the electronics industry often face this challenge. It will give you the chance to practise your critical thinking skills to work around it. Troubleshooting skills are an essential part of working in the electronics industry and life in general. If your components or tools are slightly different from the ones shown in the course or on the video, be assured that they work in the same way but just look slightly different.

A list outlining all components found in the Grade 9 Electricity Kit is shown below.

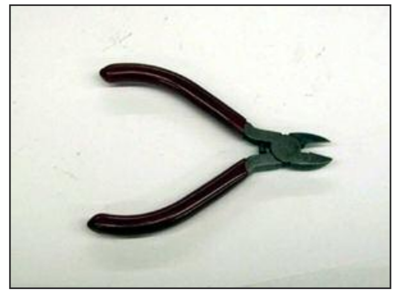
| **MTBB #9993**<br>**Electricity Kit with Tool Kit** | **MTBB #3308**<br>**Electricity Kit without Tool Kit** |
|---|---|
| Tool Kit | |
| digital multimeter (DMM)<br>wire strippers<br>needle-nose pliers<br>diagonal/side cutters<br>soldering iron<br>soldering iron stand w/cleaning sponge<br>safety glasses | Students need access to the Tool Kit items but have access to these items either at home or at school.<br><br>These are the same seven items that are found in the Grade 10 Electricity Kit. |
| Project Kit | Project Kit |
| 1 circuit board (PCB)<br>1 spool of solder<br>1 buzzer<br>1 battery snap and 9-volt battery<br>8 pieces stranded wire<br>1 slide switch<br>1 SCR<br>2 diodes<br>1 capacitor<br>1 fuse<br>2 fuse clips<br>1 pushbutton switch (Normally Closed)<br>3 resistors<br>2 – 1.0 uF electrolytic capacitor<br>1 red LED | 1 circuit board<br>1 spool of solder<br>1 buzzer<br>1 battery snap<br>8 pieces stranded wire<br>1 slide switch<br>1 SCR<br>2 diodes<br>1 capacitor<br>1 fuse<br>2 fuse clips<br>1 pushbutton switch (Normally Closed)<br>3 resistors<br>2 – 1.0 uF electrolytic capacitor<br>1 red LED |
| Experiment Kit | Experiment Kit |
| 1 solderless circuit board<br>1 resistor<br>1 light emitting diode (LED)<br>1 neon bulb<br>2 piece solid wire<br>1 9-volt battery snap<br>1 – 470 uF electrolytic capacitor<br>1 extra LED | 1 solderless circuit board<br>1 resistor<br>1 light emitting diode (LED)<br>1 neon bulb<br>2 piece solid wire<br>1 9-volt battery snap<br>1 – 470 uF electrolytic capacitor<br>1 extra LED |
| Practice Soldering Kit | Practice Soldering Kit |
| solder (use solder from the project kit)<br>4 miscellaneous resistors<br>1 piece of printed circuit board | solder (use solder from the project kit)<br>4 miscellaneous resistors<br>1 piece of printed circuit board |


**Note:** It should be noted that manufacturers periodically change the design of their product and, as a result, the items in your kit may differ in some way from the illustrations in this document. This applies only to appearance and does not affect the use or strength of any of the items.

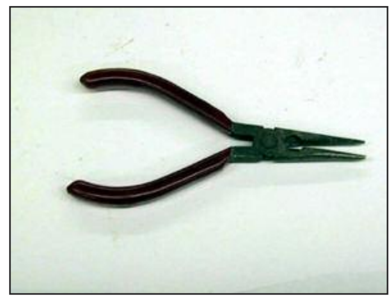
## Inventory Time!

Let's go through your tool kit and make sure you have the following tools and equipment.

Diagonal/Side Cutters

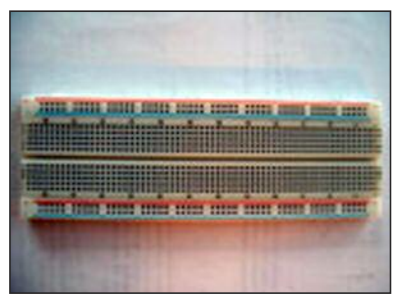


Needle-nose Pliers



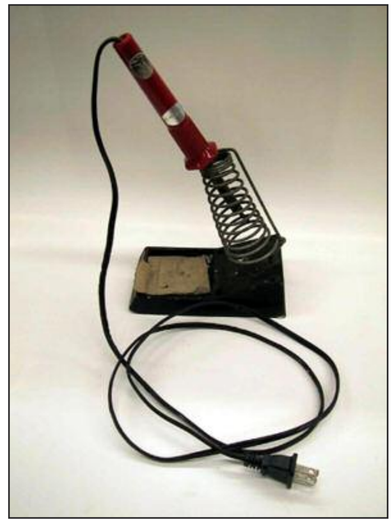
Wire Strippers

Solderless Circuit Board



Parts and tools in the kit may not be identical to those described in the course or on the video.

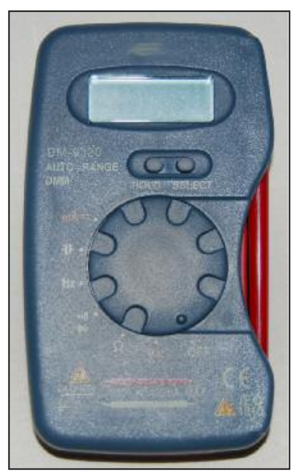
Soldering Iron with
Holder and Cleaning Sponge



Solder (Rosin Core)

Safety Goggles

Digital Multimeter (DMM)



> Parts and tools in the kit may not be identical to those described in the course or on the video.

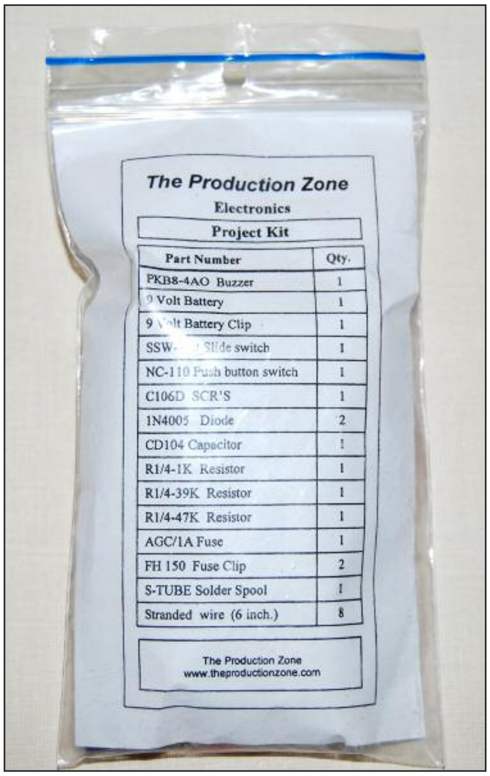
## Tool Kit

**Tool Kit**


**Tool Kit Contents**

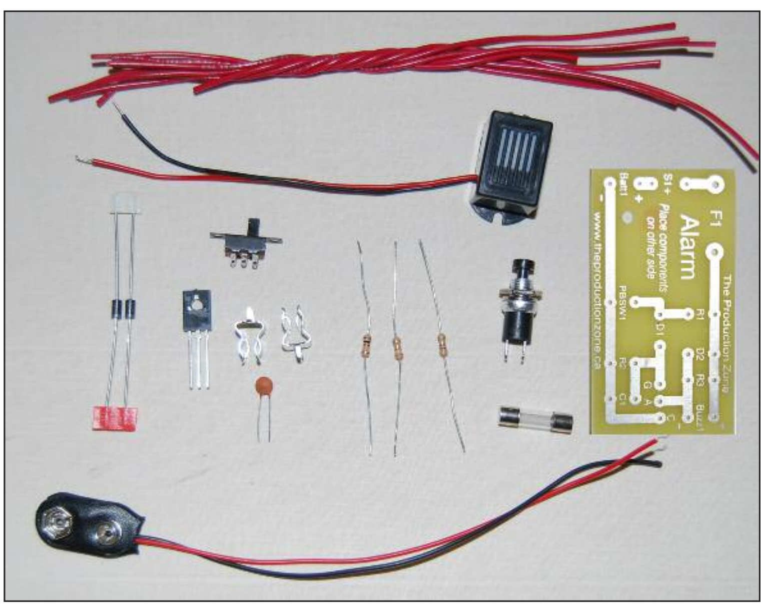
Parts and tools in the kit may not be identical to those described in the course or on the video.

## Project Kit



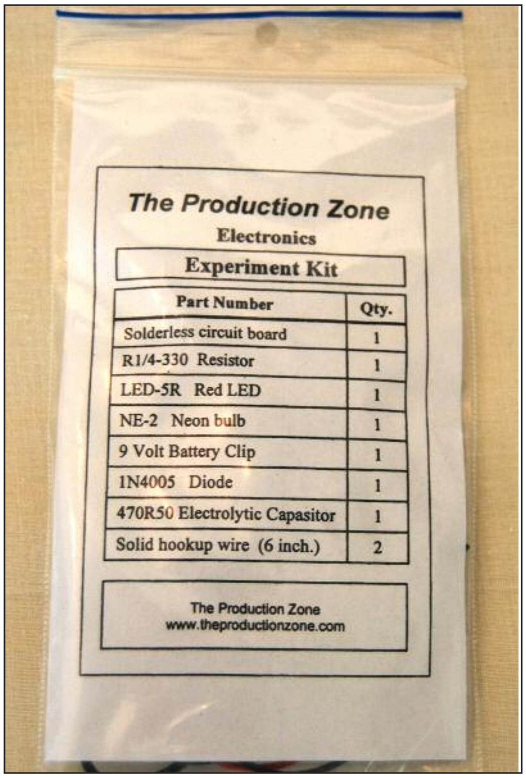

**Project Kit**

Parts and tools in the kit may not be identical to those described in the course or on the video.



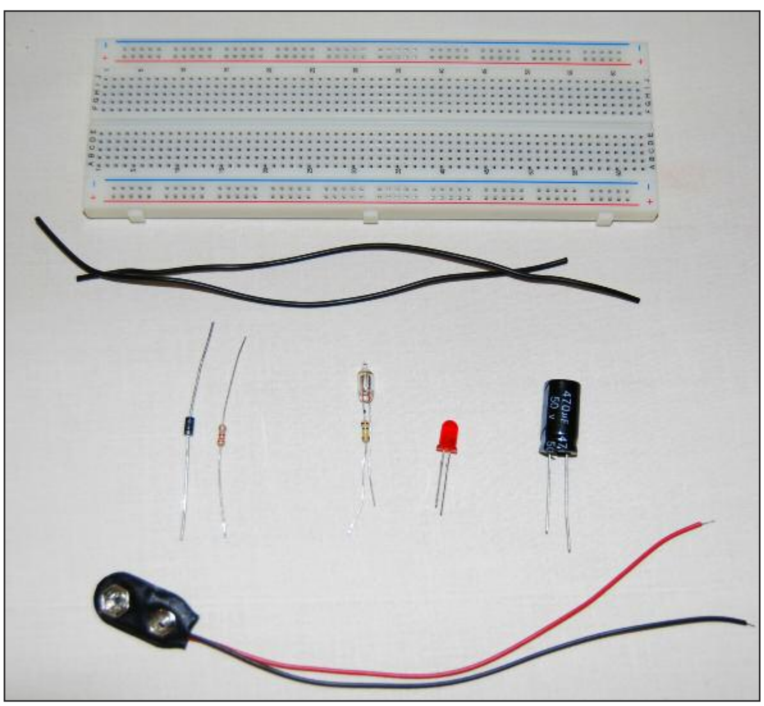

**Project Kit Contents**

## Experiment Kit



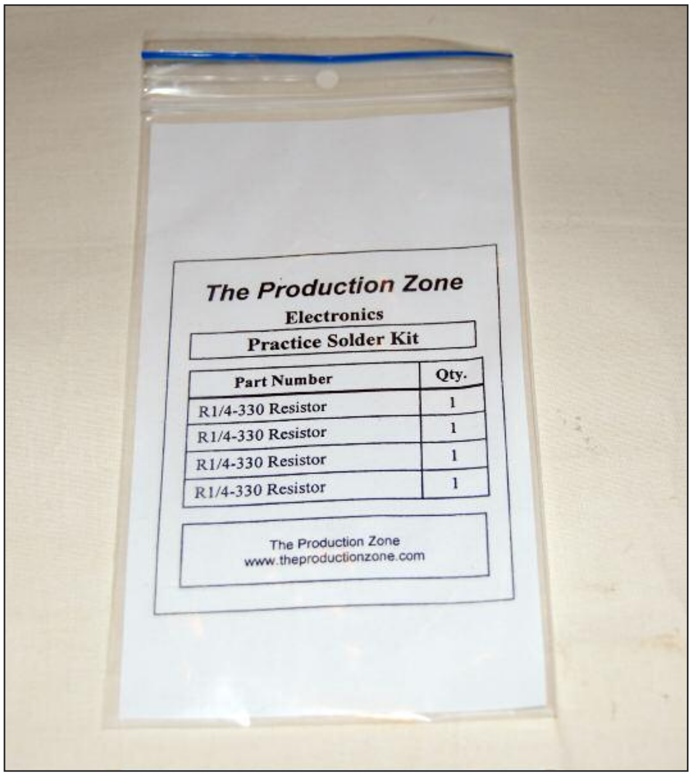

**Experiment Kit**

Parts and tools in the kit may not be identical to those described in the course or on the video.



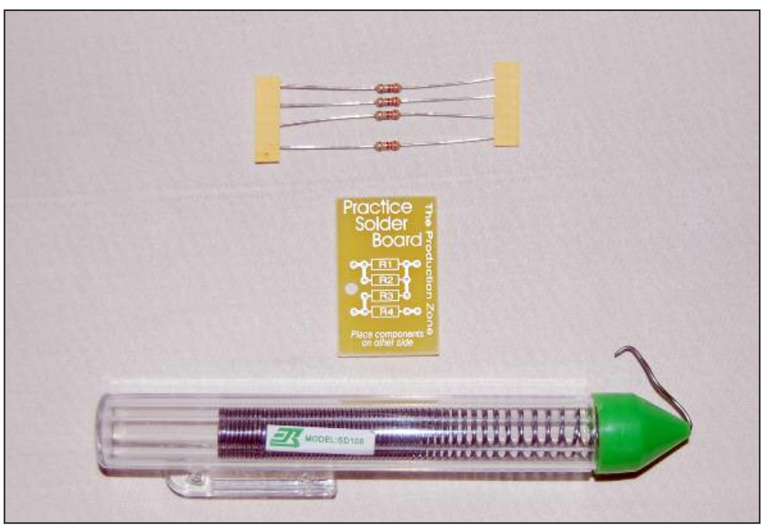
**Experiment Kit Contents**

## Practice Solder Kit




**Practice Solder Kit**

Parts and tools in the kit may not be identical to those described in the course or on the video.




**Practice Solder Kit Contents**

**Note:**
The soldering wire in the Project Kit will be enough wire for the Soldering Practice Project.

## Who Can Help You with This Course?

Taking an independent study course is different from taking a course in a classroom. Instead of relying on the teacher to tell you to complete a learning activity or an assignment, you must tell yourself to be responsible for your learning and for meeting deadlines. There are, however, people who can help you be successful in this course: your tutor/marker, your learning partner, and your supervisor.

### Your Tutor/Marker

Tutor/markers are experienced educators who tutor Independent Study Option (ISO) students and mark assignments and examinations. When you are having difficulty with something in this course, contact your tutor/marker, who is there to help you. Your tutor/marker's name and contact information were sent to you with this course. You can also obtain this information in the learning management system (LMS).

### Your Learning Partner

A learning partner is someone **you choose** who will help you learn. It may be someone who knows something about electricity/electronics, but it doesn't have to be. A learning partner could be someone else who is taking this course, a teacher, a parent or guardian, a sibling, a friend, or anybody else who can help you. Most importantly, a learning partner should be someone with whom you feel comfortable and who will support you as you work through this course.

Your learning partner can help you keep on schedule with your coursework, read the course with you, check your work, look at and respond to your learning activities, or help you make sense of assignments. You may even study for your examination(s) with your learning partner. If you and your learning partner are taking the same course, however, your assignment work should not be identical.

### Your Supervisor

The next person who can help you is your supervisor. Your supervisor could be a teacher in your school or one of your parents. Your supervisor will help you keep on schedule, check your work, help you make sense of the assignments and the Hand-In Project, or look at your work and give you advice. In order to complete this course, your supervisor must sign and initial your Log Sheets before you submit them to the Distance Learning Unit.

## How Will You Know How Well You Are Learning?

You will know how well you are learning in this course by how well you complete the learning activities, assignments, major project, and examination.

### Learning Activities

The learning activities in this course will help you to review and practise what you have learned in the lessons. You will **not** submit the completed learning activities to the Distance Learning Unit. Instead, you will complete the learning activities and compare your responses to those provided in the Learning Activity Answer Key found at the end of each module.

Make sure you complete the learning activities. Doing so will not only help you to practise what you have learned, but will also prepare you to complete your assignments and the examination successfully. Many of the questions on the examination will be similar to the questions in the learning activities. Remember that you **do not submit learning activities to the Distance Learning Unit**.

### Assignments

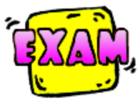
Each module in this course contains assignments, which you will complete and submit to the Distance Learning Unit for assessment. The assignments are worth a total of 70% of your final course mark.

The tutor/marker will mark your assignments and return them to you. Remember to keep all marked assignments until you have finished the course so that you can use them to study for your examination.

### Major Project

You will be completing and submitting in the Major Project at the end of Module 7 by mail. Your project consists of building an Intruder Alarm and is worth **15%** of the final mark for the course.

## Final Examination




The final examination covers the entire course and is worth **15%** of the final mark. The final examination must be written under the supervision of a proctor. When you start Module 6, you need to make arrangements to write the examination.

### Requesting Your Examinations

You are responsible for making arrangements to have the examination sent to your proctor from the Distance Learning Unit. Please make arrangements before you finish Module 7 to write the final examination.

To write your examination, you need to make the following arrangements:

- **If you are attending school,** your examination will be sent to your school as soon as all the applicable assignments have been submitted. You should make arrangements with your school's ISO school facilitator to determine a date, time, and location to write the examination.
- **If you are not attending school,** check the Examination Request Form for options available to you. Examination Request Forms can be found on the Distance Learning Unit's website, or look for information in the learning management system (LMS). Two weeks before you are ready to write the examination, fill in the Examination Request Form and mail, fax, or email it to

    Distance Learning Unit
    500–555 Main Street
    PO Box 2020
    Winkler MB  R6W 4B8
    Fax: 204-325-1719
    Toll-Free Telephone: 1-800-465-9915
    Email: distance.learning@gov.mb.ca

# How Much Time Will You Need to Complete This Course?

Learning through independent study has several advantages over learning in the classroom. You are in charge of how you learn and can choose how quickly you will complete the course. You can read as many lessons as you wish in a single session. You do not have to wait for your teacher or classmates. From the date of your registration, you have a maximum of **12 months** to complete this course, but the pace at which you proceed is up to you. Read the next few pages to get a recommendation on how to pace yourself.

## Chart A: Semester 1

If you want to start this course in September and complete it in January, you can follow the timeline suggested below.

| Module | Completion Date |
|---|---|
| Module 1 | Middle of September |
| Module 2 | Middle of October |
| Module 3 | End of October |
| Module 4 | Middle of November |
| Modules 5 and 6 | End of December |
| Module 7 | Beginning of January |
| Final Examination | Middle of January |

## Chart B: Semester 2

If you want to start the course in February and complete it in May, you can follow the timeline suggested below.

| Module | Completion Date |
|---|---|
| Module 1 | Middle of February |
| Module 2 | End of February |
| Module 3 | Middle of March |
| Module 4 | Beginning of April |
| Modules 5 and 6 | End of April |
| Module 7 | Beginning of May |
| Final Examination | Middle of May |

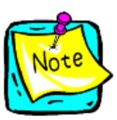
## Chart C: Full School Year (Not Semestered)

If you want to start the course in September and complete it in May, you can follow the timeline suggested below.

| Module | Completion Date |
|---|---|
| Module 1 | End of September |
| Module 2 | End of October |
| Module 3 | End of November |
| Module 4 | Beginning of February |
| Modules 5 and 6 | End of March |
| Module 7 | End of April |
| Final Examination | Middle of May |

## Timelines

Do not wait until the last minute to complete your work, since your tutor/marker may not be available to mark it immediately. It may take a few weeks for your tutor/marker to assess your work and return it to you or your school.




If you need this course to graduate this school year, all coursework must be received by the Distance Learning Unit on or before the first Friday in May, and all examinations must be received by the Distance Learning Unit on or before the last Friday in May. Any coursework or examinations received after these deadlines may not be processed in time for a June graduation. Assignments or examinations submitted after these recommended deadlines will be processed and marked as they are received.

## When and How Will You Submit Completed Assignments?

### When to Submit Assignments

While working on this course, you will submit completed assignments to the Distance Learning Unit six times. The following chart shows you exactly what assignment you will be submitting at the end of each module.

| **Submission of Assignments, Log Sheets, and Project** | |
|---|---|
| **Submission** | **Assignments You Will Submit** |
| 1 | **Module 1: Electricity: The Shocking Facts on How It Is Produced**<br>Module 1 Cover Sheet<br>Module 1 Log Sheet<br>Assignment 1: Electricity |
| 2 | **Module 2: Safety**<br>Module 2 Cover Sheet<br>Module 2 Log Sheet<br>Assignment 2: Electrical Safety |
| 3 | **Module 3: Electronic Components**<br>Module 3 Cover Sheet<br>Module 3 Log Sheet<br>Assignment 3.1: Electronics Components<br>Assignment 3.2: Project Kit Component Testing |
| 4 | **Module 4: Building a Project: Getting Started with Your Tools and Equipment**<br>Module 4 Cover Sheet<br>Module 4 Log Sheet<br>Assignment 4.1: Soldering Practice Project<br>Assignment 4.2:<br>Part 1: Soldering Techniques<br>Part 2: Repairing and Servicing Your PCB |
| 5 | **Module 5: Series, Parallel, and Combination Circuits**<br>**Module 6: Linking Education to Careers**<br>Modules 5 and 6 Cover Sheet<br>Module 5 Log Sheet<br>Assignment 5: Circuits<br>Module 6 Log Sheet<br>Assignment 6: Career Planning |
| 6 | **Module 7: Major Project**<br>Module 7 Cover Sheet<br>Module 7 Log Sheet<br>Major Project: Intruder Alarm |

## How to Submit Assignments

In this course, you have the choice of submitting your assignments either by mail or electronically.

- **Mail:** Each time you **mail** something, you must include the print version of the applicable Cover Sheet (found at the end of this Introduction). Complete the information at the top of each Cover Sheet before submitting it along with your assignments.
- **Electronic submission:** You do not need to include a cover sheet when submitting assignments electronically.

### Submitting Your Assignments by Mail

If you choose to mail your completed assignments, please photocopy/scan all the materials first so that you will have a copy of your work in case your package goes missing. You will need to place the applicable module Cover Sheet and assignment(s) in an envelope, and address it to

Distance Learning Unit
500–555 Main Street
PO Box 2020
Winkler MB  R6W 4B8

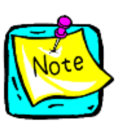
Your tutor/marker will mark your work and return it to you by mail.

### Submitting Your Assignments Electronically

Assignment submission options vary by course. Sometimes assignments can be submitted electronically and sometimes they must be submitted by mail. Specific instructions on how to submit assignments were sent to you with this course. In addition, this information is available in the learning management system (LMS).

If you are submitting assignments electronically, make sure you have saved copies of them before you send them. That way, you can refer to your assignments when you discuss them with your tutor/marker. Also, if the original hand-in assignments are lost, you are able to resubmit them.

Your tutor/marker will mark your work and return it to you electronically.

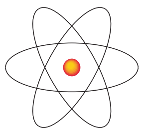



The Distance Learning Unit does not provide technical support for hardware-related issues. If troubleshooting is required, consult a professional computer technician.

## What Are the Guide Graphics For?

Guide graphics are used throughout this course to identify and guide you in specific tasks. Each graphic has a specific purpose, as described below.

**Module Focus/Specific Learning Outcomes (SLOs):** Note that these SLOs are addressed within the lesson.



**Power Words:** This icon indicates key "power" words that you will learn in the module.

**Learning Activity:** Complete a learning activity. This will help you to review or practise what you have learned and to prepare you for an assignment or an examination. You will not submit learning activities to the Distance Learning Unit. Instead, you will compare your responses to those provided in the Learning Activity Answer Key found at the end of the applicable module.

**Check Your Work:** Check your responses against those provided in the Learning Activity Answer Key found at the end of the applicable module.

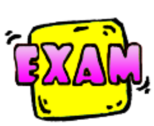
**Video:** View a video.

**Stop/Caution:** Use caution when conducting this learning activity or experiment.

**Assignment:** Complete an assignment. You will submit your completed assignments to the Distance Learning Unit for assessment in accordance with the chart found in the course Introduction.

**Mail or Electronic Submission:** Mail or electronically submit your completed assignments to the Distance Learning Unit for assessment at this time.

**Tech Project:** Complete a project that you must submit to the Distance Learning Unit.




**Examination:** Write your final examination at this time.

# Grade 9 Electricity/Electronics Technology (10G)

## Module 1 Cover Sheet

Please complete this sheet and place it on top of your assignments to assist in proper recording of your work. Submit the package to:

**Drop-off/Courier Address**
Distance Learning Unit
555 Main Street
Winkler MB  R6W 1C4

**Mailing Address**
Distance Learning Unit
500–555 Main Street
PO Box 2020
Winkler MB  R6W 4B8

**Contact Information**

Legal Name: ____________________ Preferred Name: ____________________

Phone: ____________________ Email: ____________________

Mailing Address: ________________________________________

City/Town: ____________________ Postal Code: __________

Attending School: ❑ No ❑ Yes

School Name: ________________________________________

Has your contact information changed since you registered for this course? ❑ No ❑ Yes

**Note:** Please keep a copy of your assignments so that you can refer to them when you discuss them with your tutor/marker.

| For Student Use | For Office Use Only | |
|---|---|---|
| **Module 1 Assignments**<br>Which of the following are completed and enclosed?<br>Please check (✓) all applicable boxes below. | **Attempt 1**<br>__________<br>Date Received | **Attempt 2**<br>__________<br>Date Received |
| ❑ Log Sheet 1 | _______ /5 | _______ /5 |
| ❑ Assignment 1: Electricity | _______ /175 | _______ /175 |
| | **Total: ____ /180** | **Total: ____ /180** |

| For Tutor/Marker Use |
|---|
| **Remarks:** |

| Module 1: The Shocking Facts on How It is Produced<br>Assignment 1 Breakdown of Marks | | |
|---|---|---|
| | Marks Allowed | Marks Received |
| Part 1: Calculating the Distance from Lightning | 3 | |
| Part 2: Testing Your 9-Volt Battery | 4 | |
| Part 3: Schematic Symbols Assignment | 22 | |
| Part 4: Learning about Polarity | 9 | |
| Part 5: Testing for Conductors and Insulators | 27 | |
| Part 6: Check This Out Questions | 7 | |
| Part 7: Measuring the Flow Chart | 6 | |
| Part 8: Ohm’s Law | 6 | |
| Part 9: What Is Electricity? | 27 | |
| Part 10: Static Electricity | 5 | |
| Part 11: Conductors and Insulators | 11 | |
| Part 12: How Does Electricity Move? | 4 | |
| Part 13: Lightning | 9 | |
| Part 14: Ohm’s Law | 24 | |
| Part 15: Electricity | 11 | |
| **Total Marks** | 175 | |

# Grade 9 Electricity/Electronics Technology (10G)

## Module 2 Cover Sheet

Please complete this sheet and place it on top of your assignments to assist in proper recording of your work. Submit the package to:

**Drop-off/Courier Address**
Distance Learning Unit
555 Main Street
Winkler MB  R6W 1C4

**Mailing Address**
Distance Learning Unit
500–555 Main Street
PO Box 2020
Winkler MB  R6W 4B8

**Contact Information**

Legal Name: ____________________ Preferred Name: ____________________

Phone: ____________________ Email: ____________________

Mailing Address: ________________________________________

City/Town: ____________________ Postal Code: __________

Attending School: ❑ No ❑ Yes

School Name: ________________________________________

Has your contact information changed since you registered for this course? ❑ No ❑ Yes

**Note:** Please keep a copy of your assignments so that you can refer to them when you discuss them with your tutor/marker.

| For Student Use | For Office Use Only | |
|---|---|---|
| **Module 2 Assignments** | **Attempt 1** | **Attempt 2** |
| Which of the following are completed and enclosed?<br>Please check (✓) all applicable boxes below. | ________<br>Date Received | ________<br>Date Received |
| ❑ Log Sheet 2 | ______ /5 | ______ /5 |
| ❑ Assignment 2: Electrical Safety | _____ /166 | _____ /166 |
| | **Total:** ___ **/171** | **Total:** ___ **/171** |

| For Tutor/Marker Use |
|---|
| **Remarks:** |

| Module 2: Safety<br>Assignment 2 Breakdown of Marks | | |
|---|---|---|
| | Marks Allowed | Marks Received |
| Part 1: Metrification and Conversion | | |
| Part 1.1: Letter Symbols | 8 | |
| Part 1.2: Conversion | 12 | |
| Part 2: Measuring Body Resistance | 4 | |
| Part 3: Safety in Your Home | 19 | |
| Part 4: Metrification | 7 | |
| Part 5: Conversions | 12 | |
| Part 6: Measuring Body Resistance | 7 | |
| Part 7: Voltage and the Human Body | 4 | |
| Part 8: Current and the Human Body | 5 | |
| Part 9: Hazardous Materials | 37 | |
| Part 10: Tools and Equipment | 51 | |
| **Total Marks** | 166 | |

# Grade 9 Electricity/Electronics Technology (10G)

## Module 3 Cover Sheet

Please complete this sheet and place it on top of your assignments to assist in proper recording of your work. Submit the package to:

**Drop-off/Courier Address**
Distance Learning Unit
555 Main Street
Winkler MB  R6W 1C4

**Mailing Address**
Distance Learning Unit
500–555 Main Street
PO Box 2020
Winkler MB  R6W 4B8

**Contact Information**

Legal Name: ____________________ Preferred Name: ____________________

Phone: ____________________ Email: ____________________

Mailing Address: ________________________________________

City/Town: ____________________ Postal Code: ____________

Attending School: ❑ No ❑ Yes

School Name: ________________________________________

Has your contact information changed since you registered for this course? ❑ No ❑ Yes

**Note:** Please keep a copy of your assignments so that you can refer to them when you discuss them with your tutor/marker.

| For Student Use | For Office Use Only | |
|---|---|---|
| **Module 3 Assignments**<br>Which of the following are completed and enclosed?<br>Please check (✓) all applicable boxes below. | **Attempt 1**<br>__________<br>Date Received | **Attempt 2**<br>__________<br>Date Received |
| ❑ Log Sheet 3 | ______ /5 | ______ /5 |
| ❑ Assignment 3.1: Electronics Components | ______ /196 | ______ /196 |
| ❑ Assignment 3.2 Project Kit Component Testing | ______ /29 | ______ /29 |
| | **Total: ____ /230** | **Total: ____ /230** |

| For Tutor/Marker Use |
|---|
| **Remarks:** |

| Module 3: Electronic Components<br>Assignment 3.1 and Assignment 3.2 Breakdown of Marks | | |
|---|---|---|
| | Marks Allowed | Marks Received |
| Assignment 3.1: Electronic Components | | |
| Part 1: Calculating Resistor Colour Codes | 16 | |
| Part 2: Calculating Resistor Numeric Codes | 64 | |
| Part 3: The Semiconductor Family | 32 | |
| Part 4: Resistance Calculations | 8 | |
| Part 5: Calculating Resistor Numeric Values | 32 | |
| Part 6: Capacitance | 27 | |
| Part 7: Circuit Protection | 11 | |
| Part 8: Indicators | 3 | |
| Part 9: Semiconductors | 3 | |
| Assignment 3.2: Project Kit Component Testing | 29 | |
| **Total Marks** | 225 | |

# Grade 9 Electricity/Electronics Technology (10G)

## Module 4 Cover Sheet

Please complete this sheet and place it on top of your assignments to assist in proper recording of your work. Submit the package to:

**Drop-off/Courier Address**

Distance Learning Unit
555 Main Street
Winkler MB  R6W 1C4

**Mailing Address**

Distance Learning Unit
500–555 Main Street
PO Box 2020
Winkler MB  R6W 4B8

**Contact Information**

Legal Name: ____________________ Preferred Name: ____________________

Phone: ____________________ Email: ____________________

Mailing Address: ________________________________________

City/Town: ____________________ Postal Code: __________

Attending School: ❑ No ❑ Yes

School Name: ________________________________________

Has your contact information changed since you registered for this course? ❑ No ❑ Yes

**Note:** Please keep a copy of your assignments so that you can refer to them when you discuss them with your tutor/marker.

| For Student Use | For Office Use Only | |
|---|---|---|
| **Module 4 Assignments** | **Attempt 1** | **Attempt 2** |
| Which of the following are completed and enclosed?<br>Please check (✓) all applicable boxes below. | __________<br>Date Received | __________<br>Date Received |
| ❑ Log Sheet 4 | ______ /5 | ______ /5 |
| ❑ Assignment 4.1: Soldering Practice Project* | ❑ CO / ❑ INC | ❑ CO / ❑ INC |
| ❑ Assignment 4.2: Soldering and the PCB | | |
| Part 1: Soldering Techniques | ______ /20 | ______ /20 |
| Part 2: Repairing and Servicing Your PCB | ______ /7 | ______ /7 |
| * Refer to the back of this cover sheet for the criteria to receive a "complete" on this project. | **Total:** ____ **/32** | **Total:** ____ **/32** |

| For Tutor/Marker Use |
|---|
| **Remarks:** |

## Practice Soldering Project Criteria

The purpose of the Practice Soldering Project is to demonstrate your soldering skills. In order to receive a complete on this project, your tutor/marker needs a sample of soldering that

- includes three or four components on the proper side of the PCB (use a low heat soldering iron)
- shows solder covering the copper ring that the component leg sticks through
- does not have any adjacent copper surface so that the only path for electrical flow is from one leg of the component to the other, through the component

These points cover the minimum requirements for completing the project.

Soldering that demonstrates a higher level of skill should have the following characteristics:

- nestled close to the board
- contains no burn marks
- does not contain any cold soldered joints
- has the superfluous leg portions trimmed
- has been tested for continuity
- contains a solder joint that is smooth, shiny, and shaped like a Hershey’s Kiss®

# Grade 9 Electricity/Electronics Technology (10G)

## Modules 5 and 6 Cover Sheet

Please complete this sheet and place it on top of your assignments to assist in proper recording of your work. Submit the package to:

**Drop-off/Courier Address**
Distance Learning Unit
555 Main Street
Winkler MB  R6W 1C4

**Mailing Address**
Distance Learning Unit
500–555 Main Street
PO Box 2020
Winkler MB  R6W 4B8

**Contact Information**

Legal Name: ____________________ Preferred Name: ____________________

Phone: ____________________ Email: ____________________

Mailing Address: ________________________________________

City/Town: ____________________ Postal Code: __________

Attending School: ❑ No ❑ Yes

School Name: ________________________________________

Has your contact information changed since you registered for this course? ❑ No ❑ Yes

**Note:** Please keep a copy of your assignments so that you can refer to them when you discuss them with your tutor/marker.

| For Student Use | For Office Use Only | |
|---|---|---|
| **Modules 5 and 6 Assignments** | **Attempt 1** | **Attempt 2** |
| Which of the following are completed and enclosed?<br>Please check (✓) all applicable boxes below. | ________<br>Date Received | ________<br>Date Received |
| ❑ Log Sheet 5 | _____ /5 | _____ /5 |
| ❑ Assignment 5: Circuits | _____ /45 | _____ /45 |
| ❑ Log Sheet 6 | _____ /5 | _____ /5 |
| ❑ Assignment 6: Career Planning | _____ /29 | _____ /29 |
| | **Total: ____ /84** | **Total: ____ /84** |

| For Tutor/Marker Use |
|---|
| **Remarks:** |

# Grade 9 Electricity/Electronics Technology (10G)

## Module 7 Cover Sheet

Please complete this sheet and place it on top of your assignments to assist in proper recording of your work. Submit the package to:

| **Drop-off/Courier Address** | **Mailing Address** |
|---|---|
| Distance Learning Unit<br>555 Main Street<br>Winkler MB  R6W 1C4 | Distance Learning Unit<br>500–555 Main Street<br>PO Box 2020<br>Winkler MB  R6W 4B8 |

**Contact Information**

Legal Name: ____________________________ Preferred Name: ____________________________

Phone: ____________________________ Email: ____________________________

Mailing Address: ________________________________________________________

City/Town: ____________________________ Postal Code: ______________

Attending School: ❑ No ❑ Yes

School Name: ________________________________________________________

Has your contact information changed since you registered for this course? ❑ No ❑ Yes

**Note:** Please keep a copy of your assignments so that you can refer to them when you discuss them with your tutor/marker.

| For Student Use | For Office Use Only | |
|---|---|---|
| **Module 7 Assignments** | **Attempt 1** | **Attempt 2** |
| Which of the following are completed and enclosed?<br>Please check (✓) all applicable boxes below. | ______________<br>Date Received | ______________<br>Date Received |
| ❑ Log Sheet 7 | ❑ CO / ❑ INC | ❑ CO / ❑ INC |
| ❑ Major Project: Intruder Alarm* | | |
| Confirmation | ________ /25 | ________ /25 |
| Design | ________ /25 | ________ /25 |
| Soldering | ________ /25 | ________ /25 |
| Function | ________ /25 | ________ /25 |
| * **Note:** Do not mail your 9-volt battery with your project. | **Total:** ____ **/100** | **Total:** ____ **/100** |

| For Tutor/Marker Use |
|---|
| **Remarks:** |

# Major Project: Intruder Alarm *(100 marks)*
## Marking Rubric

The assembly of parts and completion of this working brain meter are based on the following criteria:

Confirmation: *25 marks*
Construction: *25 marks*
Soldering: *25 marks*
Function: *25 marks*

This project is designed to be the work of one person and group submissions will not be accepted.

**Confirmation: ___________ / 25 marks**

| (20–25 marks) | (11–19 marks) | (less than 10 marks) |
|---|---|---|
| All or most of the components have the following characteristics:<br>❑ They are property placed.<br>❑ They are nestled close to the board within 1 mm.<br>❑ The legs are spread out.<br>❑ The legs are trimmed after soldering.<br><br>**Tutor/marker comments:** | Some of the components have the following characteristics:<br>❑ They are property placed.<br>❑ They are nestled close to the board within 1 mm.<br>❑ The legs are spread out.<br>❑ The legs are trimmed after soldering.<br><br>**Tutor/marker comments:** | Few of the components have the following characteristics:<br>❑ They are property placed.<br>❑ They are nestled close to the board within 1 mm.<br>❑ The legs are spread out.<br>❑ The legs are trimmed after soldering.<br><br>**Tutor/marker comments:** |

# Major Project: Intruder Alarm *(100 marks)*
## Marking Rubric

| Construction: ___________ / 25 marks | | |
|---|---|---|
| **(20–25 marks)** | **(11–19 marks)** | **(less than 10 marks)** |
| All or most of the following have the identified characteristics:<br>❑ The length of wire is correct.<br>❑ The amount of insulation stripped off the wires is correct.<br>❑ There are no avoidable projections.<br>❑ The parts are aligned.<br>❑ The project is smooth.<br>❑ The wires and traces are not broken.<br><br>**Tutor/marker comments:** | Some of the following have the identified characteristics:<br>❑ The length of wire is correct.<br>❑ The amount of insulation stripped off the wires is correct.<br>❑ There are no avoidable projections.<br>❑ The parts are aligned.<br>❑ The project is smooth.<br>❑ The wires and traces are not broken.<br><br>**Tutor/marker comments:** | Few of the following have the identified characteristics:<br>❑ The length of wire is correct.<br>❑ The amount of insulation stripped off the wires is correct.<br>❑ There are no avoidable projections.<br>❑ The parts are aligned.<br>❑ The project is smooth.<br>❑ The wires and traces are not broken.<br><br>**Tutor/marker comments:** |

## Major Project: Intruder Alarm *(100 marks)*
## Marking Rubric

**Function: ___________ / 25 marks**

| (20–25 marks) | (11–19 marks) | (less than 10 marks) |
|---|---|---|
| All or most of the following project functions have the following characteristics:<br>❑ It does not function before the project is armed.<br>❑ It does not function after arming and before input.<br>❑ It has immediate and continuous output after arming and input.<br>❑ The output does not stop by manipulation of the input button.<br>❑ The output can only be stopped by switching off the arming slide switch.<br><br>**Tutor/marker comments:** | Some of the following project functions have the following characteristics:<br>❑ It does not function before the project is armed.<br>❑ It does not function after arming and before input.<br>❑ It has immediate and continuous output after arming and input.<br>❑ The output does not stop by manipulation of the input button.<br>❑ The output can only be stopped by switching off the arming slide switch.<br><br>**Tutor/marker comments:** | Few of the following project functions have the following characteristics:<br>❑ It does not function before the project is armed.<br>❑ It does not function after arming and before input.<br>❑ It has immediate and continuous output after arming and input.<br>❑ The output does not stop by manipulation of the input button.<br>❑ The output can only be stopped by switching off the arming slide switch.<br><br>**Tutor/marker comments:** |

## Module 1: Electricity: The Shocking Facts on How It Is Produced

## Log Sheet 1 *(5 marks)*

Name ________________________________ School ____________________________
(if attending)

Fill in your name and school and send this completed log sheet to the Distance Learning Unit along with Assignment 1.

| Completion (Check) | Lesson | Assignment | Supervisor Initials |
|---|---|---|---|
| | 1 | No assignment | |
| | 2 | Assignment 1, Part 1: Calculating the Distance from Lightning | |
| | 3 | Grade 9/10 Electronics DVD: The Digital Multimeter | |
| | | Assignment 1, Part 2: Testing a 9-Volt Battery | |
| | | Grade 9/10 Electronics DVD: The Wire Stripper and the Solderless Circuit Board | |
| | | Assignment 1, Part 3: Schematic Symbols | |
| | | Activity 1: Building a Continuity Tester | |
| | | Assignment 1, Part 4: Learning about Polarity | |
| | | Activity 2: Testing for Conductors and Insulators | |
| | | Assignment 1, Part 5: Testing for Conductors and Insulators | |
| | | Assignment 1, Part 6: Check This Out Questions | |
| | 4 | Assignment 1, Part 7: Measuring the Flow Chart | |
| | 5 | Assignment 1, Part 8: Ohm's Law | |
| | | Assignment 1, Parts 9 to 15 | |
| | | Log Sheet 1 | |

*(continued)*

## Module 1: Electricity: The Shocking Facts on How It Is Produced

## Log Sheet 1 (page 2)

If you had any difficulties with any of the assignments, explain in the space below.

What have you learned from this module? Was this module too hard or too easy? Explain.

Student's Signature

Date

Supervisor's Signature

# Module 2: Safety
## Log Sheet 2 *(5 marks)*

Name ________________________________ School ____________________________
(if attending)

Fill in your name and school and send this completed log sheet to the Distance Learning Unit along with Assignment 2.

| Completion (Check) | Lesson | Assignment | Supervisor Initials |
|---|---|---|---|
| | 1 | No assignment | |
| | 2 | No assignment | |
| | 3 | Assignment 2, Part 1: Metrification and Conversion | |
| | 4 | Assignment 2, Part 2: Measuring Body Resistance | |
| | 5 | No assignment | |
| | 6 | No assignment | |
| | 7 | No assignment | |
| | | Assignment 2, Parts 3 to 10 | |
| | | Log Sheet 2 | |

*(continued)*

## Module 2: Safety
## Log Sheet 2 (page 2)

If you had any difficulties with any of the assignments, explain in the space below.

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What have you learned from this module? Was this module too hard or too easy? Explain.

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| ______________________ | ______________________ | ______________________ |
| --- | --- | --- |
| Student’s Signature | Date | Supervisor’s Signature |

# Module 3: Electronic Components
## Log Sheet 3 *(5 marks)*

Name ______________________________ School ______________________________
(if attending)

Fill in your name and school and send this completed log sheet to the Distance Learning Unit along with Assignment 3.

| Completion (Check) | Lesson | Assignment | Supervisor Initials |
|---|---|---|---|
| | 1 | Assignment 3.1, Part 1: Calculating Resistor Colour Codes | |
| | | Assignment 3.1, Part 2: Calculating Resistor Numeric Values | |
| | | Grade 9/10 Electronics DVD: Resistance on the DMM | |
| | | Assignment 3.2, Part 1: Component Test Record Sheet—Resistors | |
| | 2 | Assignment 3.2, Part 2: Component Test Record Sheet—Switches | |
| | | Grade 9/10 Electronics DVD: Audible Continuity | |
| | 3 | No assignment | |
| | 4 | Assignment 3.2, Part 3: Component Test Record Sheet—Fuses | |
| | 5 | Assignment 3.2, Part 4: Component Test Record Sheet—Buzzers | |
| | 6 | Assignment 3.2, Part 5: Component Test Record Sheet—Diodes | |
| | | Grade 9/10 Electronics DVD: Testing Diodes | |
| | | Assignment 3.1, Part 3 to Part 9 | |
| | | Log Sheet 3 | |

*(continued)*

# Module 3: Electronic Components
## Log Sheet 3 (page 2)

If you had any difficulties with any of the assignments, explain in the space below.

______________________________________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

What have you learned from this module? Was this module too hard or too easy? Explain.

______________________________________________________________

______________________________________________________________

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______________________________________________________________

______________________________________________________________

______________________________________________________________

| Student's Signature | Date | Supervisor's Signature |
|---|---|---|

# Module 4: Getting Started with Your Tools and Equipment
## Log Sheet 4 *(5 marks)*

Name ________________________________ School ____________________________
(if attending)

Fill in your name and school and send this completed log sheet to the Distance Learning Unit along with Assignment 4.

| Completion (Check) | Lesson | Assignment | Supervisor Initials |
|---|---|---|---|
| | 1 | No assignment | |
| | 2 | Grade 9/10 Electronics DVD: Soldering Techniques | |
| | | Assignment 4.1: Soldering Practice Project | |
| | | Assignment 4.2, Part 1: Soldering Techniques | |
| | | Assignment 4.2, Part 2: Repairing and Servicing Your PCB | |
| | | Log Sheet 4 | |

*(continued)*

## Module 4: Getting Started with Your Tools and Equipment
## Log Sheet 4 (page 2)

If you had any difficulties with any of the assignments, explain in the space below.

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

What have you learned from this module? Was this module too hard or too easy? Explain.

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

| ______________________ | ______________________ | ______________________ |
|---|---|---|
| Student's Signature | Date | Supervisor's Signature |

## Module 5: Series, Parallel, and Combination Circuits
## Log Sheet 5 *(5 marks)*

Name ______________________________ School ______________________________
(if attending)

Fill in your name and school and send this completed log sheet to the Distance Learning Unit along with Assignment 5.

| Completion (Check) | Lesson | Assignment | Supervisor Initials |
|---|---|---|---|
| | 1 | Assignment 5: Circuits | |
| | | Log Sheet 5 | |

If you had any difficulties with any of the assignments, explain in the space below.

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

What have you learned from this module? Was this module too hard or too easy? Explain.

______________________________________________________________________

______________________________________________________________________

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______________________________________________________________________

______________________ ______________________ ______________________
Student's Signature Date Supervisor's Signature

# Module 6: Linking Education to Careers
## Log Sheet 6 *(5 marks)*

Name ________________________________ School ____________________________
(if attending)

Fill in your name and school and send this completed log sheet to the Distance Learning Unit along with Assignment 6.

| Completion (Check) | Lesson | Assignment | Supervisor Initials |
|---|---|---|---|
| | 1 | Assignment 6: Career Planning | |
| | | Log Sheet 6 | |

If you had any difficulties with any of the assignments, explain in the space below.

______________________________________________________________________________

______________________________________________________________________________

______________________________________________________________________________

______________________________________________________________________________

What have you learned from this module? Was this module too hard or too easy? Explain.

______________________________________________________________________________

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________________________ ____________________ ________________________

Student's Signature Date Supervisor's Signature

# Module 7: Major Project
## Log Sheet 7 *(complete)*

Name ________________________________ School ____________________________
(if attending)

Fill in your name and school and send this completed log sheet to the Distance Learning Unit along with your major project.

| Completion (Check) | Lesson | Assignment | Supervisor Initials |
|---|---|---|---|
| | | Grade 9/10 Electronics DVD: Using a Heat Sink | |
| | | Hand-in: Intruder Alarm Project | |
| | | Log Sheet 7 | |

If you had any difficulties with the major project, explain in the space below.

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______________________________________________________________________________

What have you learned from this major project? Was the project too hard or too easy? Explain.

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Student's Signature Date Supervisor's Signature

Released 2020

Printed in Canada
Imprimé au Canada

# Grade 9 Electricity/ Electronics Technology (10G)

## Module 1: Electricity: The Shocking Facts on How It Is Produced

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## Module Focus

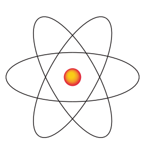
**When you finish this module, you will be able to**

- ❑ explain how electricity functions
- ❑ create a small amount of electrical energy
- ❑ state how electricity can be produced
- ❑ distinguish between a conductor and an insulator
- ❑ read a basic schematic diagram
- ❑ have knowledge of new electronic measurement terms
- ❑ calculate voltage, amperes, and ohms, using "Ohms Law"

## Introduction

Module 1 introduces you to the concept of electricity, explains electrical charges, and then goes on to look at electrical conductors, insulators, and semiconductors, which leads to a discussion of how electricity travels. The module concludes with an explanation of Ohm's Law.

## Power Words



| | | |
|---|---|---|
| atoms | neutral charge | schematic diagrams |
| neon bulb | electrical charge | short circuit |
| humidity | static electricity | filament |
| matter | ferrous metals | amperes |
| elements | permanent magnet | voltage |
| molecule | electrostatic force field | electromotive force (EMF) |
| proton | solderless circuit board | current |
| electron | conductors | ohms |
| neutron | insulators | resistance |
| nucleus | semiconductors | electromagnet |

## Assignments in Module 1

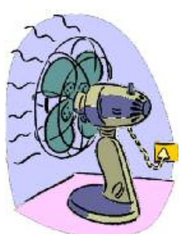
When you have completed the Module 1 assignment, submit your completed assignment, along with the Log Sheet and Module 1 Cover Sheet, to the Distance Learning Unit either by mail or electronically through the learning management system (LMS). The staff will forward your work to your tutor/marker.

## Introduction to Electricity

Electricity and electronics are such an important part of our lives that we may never go a day without using them. Even when camping, we may still use a radio, GPS, flashlight, or boat motor. Guess what they all have in common.

Electricity is a form of energy that is all around us. Electrical energy is transformed into light and heat energy by electric light bulbs. It is changed into mechanical energy by the motor in a washing machine, radio-controlled car, or hair blow dryer. It is changed into sound and light in a television. We are living in a world full of electronic and electrical devices. We are so used to them that we sometimes don't even notice them. This lesson will explore the question of why these devices work. Where does the energy that powers these devices come from? Let us go ahead and learn about what electricity actually is, and how we use it every day.

Examples of how electricity is used on a regular basis are shown below.



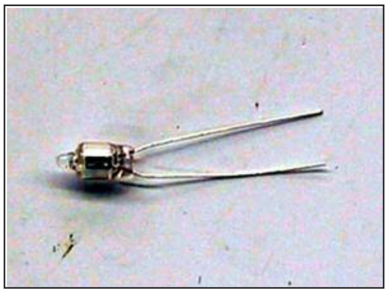


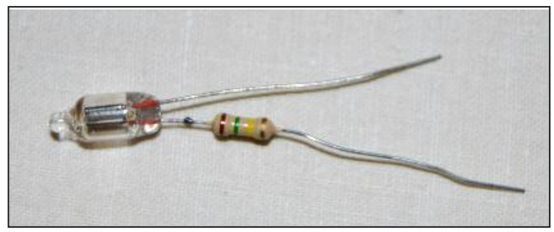

In the Introduction to this course, you will find log sheets that will be used throughout this course to help you monitor the assignments that are in each module, which assignments you have completed, and the assignments to be submitted to the Distance Learning Unit. Use a checkmark in each box to indicate each completed student challenge, lesson experiment, or assignment.

## Student Challenge 1

*Can you make and see electricity without being zapped?*

Yes, of course you can! Here's how. Open the Experiment Kit package and identify the **neon bulb**. Two wires come out of the neon bulb. Grasp one of the two wires with your fingertips. You will need to be in a carpeted area and in your socks. Walk around on the carpet, making sure that you rub your feet against the carpet. Then touch the second wire lead to a metal object such as a doorknob. The neon bulb should flash.





NE2 Bulb

### Troubleshooting

If this experiment doesn't work as described, the reason might be:

1. There is too much humidity in the air.
2. The two leads or legs of the NE2 bulb are touching together.
3. You need to rub your feet on the carpet for a longer time.
4. You need to hold the NE2 bulb by just one leg, not two.

You should understand that you did not see electricity, but rather you saw the effect of electricity on the air and the neon in the small lamp. This effect can be seen in the objects pictured on the following page.

**Exciting Fact**

Excited neon atoms release red light.

Now that you have seen the effect of electricity, the next step is to look at what makes up electricity. To begin, all things in nature are made up of **matter**. Matter is anything that has mass and occupies space. The pages of this book, the parts in your kit, and even your own body is made up of matter. Matter cannot be described by colour, taste, and hardness. These are observable characteristics that truly do not define what the substance is made of.

**What's the Matter?**

There are as many molecules in one teaspoon of water as there are teaspoonfuls of water in the Atlantic Ocean.

To understand this further, matter can be broken down into smaller parts called **molecules**. Molecules are so small that they cannot be seen by the naked eye. Molecules are made up of even smaller particles called **atoms**. These atoms are so small that a piece of copper the size of the head of a pin would contain millions of atoms. Atoms can then be broken down even further into sub-atomic particles. These smaller sub-atomic parts of an atom are known as **protons**, **electrons**, and **neutrons**. It is one of these particles that provides the energy to power electronic and electrical devices.

When all atoms in a substance are alike, the substance is called an **element**. There are just over 100 elements in total. Each of these elements is then broken down into its own physical, chemical, and electrical properties. They all have very unique qualities. Some examples of elements that make electricity and electronics possible are copper, aluminum, carbon, gallium, germanium, neon, oxygen, silicon, gold, and silver.

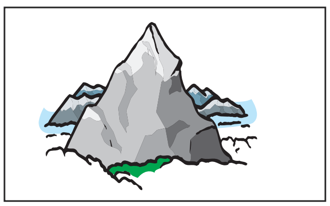
## Learning Activity 1.1

### Components of Electricity

Complete the following. Learning activities are provided to help you practise what you have learned. Remember that you do not send learning activities to the Distance Learning Unit.

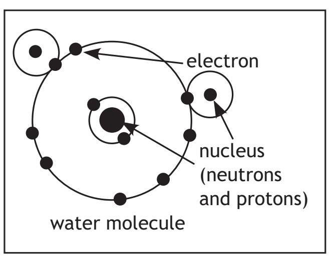
Redraw each of the following four items.

1. **Matter:** It can be defined as anything that occupies space and has mass, being a solid, liquid, or gas.



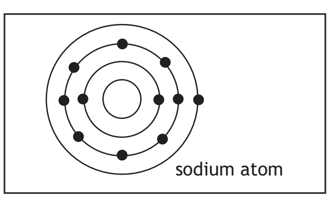
Redraw

2. **Molecules:** Molecules are made up of one or more types of atoms.




Redraw

3. **Single atom:** This is a pure basic substance or element.

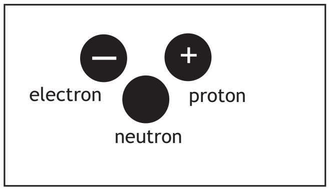



Redraw

*(continued)*

## Learning Activity 1.1: Components of Electricity (continued)

4. **Sub-atomic particles:** These are protons, electrons, and neutrons.




Redraw

Check your answers in the Learning Activity Answer Keys found at the end of this module.

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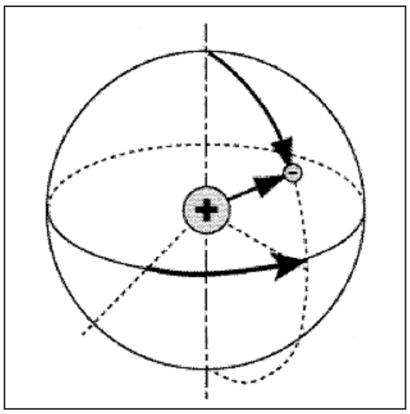
To fully understand electricity, study the research of a brilliant scientist by the name of Niels Bohr.

Bohr presented a structural model of an atom. He suggested that the atom is similar to a miniature solar system, with the nucleus being the centre of the atom. Tiny particles orbit the nucleus like the planets in our solar system rotate around the sun. Although other models exist, Bohr's model is the simplest to understand and will be used to explain electron theory hereafter. To further simplify electron theory, a hydrogen atom will be used.

## Learning Activity 1.2

**Hydrogen Atom**

Below is a graphic image of Bohr's model of the hydrogen atom. Recreate this image in the space provided.



Check your answer in the Learning Activity Answer Keys found at the end of this module.

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There are thousands of different materials in nature called compounds that are made of molecules. A compound is a chemical combination of two or more elements. Everywhere in the compound, atoms of the same element are bonded to each other in the same proportions. For example, carbon dioxide is a gas that is a byproduct of an organism breathing oxygen and then burning that oxygen as fuel in the body. This byproduct is exhaled as carbon dioxide and each molecule of carbon dioxide includes one carbon atom bonded to two oxygen atoms ($CO_2$). Water ($H_2O$) consists of two hydrogen atoms bonded to one oxygen atom. We can break these bonds, but the pure atoms (elements) that we get tend to join other atoms to form different compounds.

Although we rarely find pure elements by themselves in nature, there are instances where it happens such as pure copper (Cu), diamond (pure carbon), and liquid mercury (Hg). Mostly, however, elements combine with other elements to form compounds. This is important because each atom has electrons, the starting point for electricity. Every element has at least one neutron, one proton, and one electron. The only exception is the common form of hydrogen which does not have a neutron, but has one proton and one electron. There are two other more "exotic" forms of hydrogen—both radioactive—called *deuterium* and *tritium* that do have neutrons. We won't be discussing these two forms at this time but go and search out more information if you are interested.

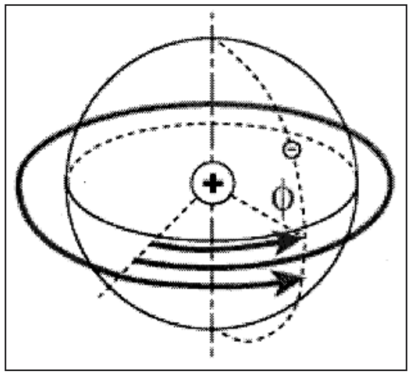
The nucleus is in the centre of the atom and contains the neutrons and protons. For our purposes, each atom of a certain element has the same number of protons as every other atom of that element. If you could change the number of protons, you could then transmute your atom into a different element. This does happen in certain forms of what is referred to as *radioactive decay*.

Most of the time, though, the atom of a particular element has the same number of electrons as protons. If one electron is knocked away, it "opens the door" for that atom to combine with another nearby atom, and its free electron can then be attracted elsewhere. To help understand how electrons operate, think of them as orbiting the nucleus in shells. Atoms different number of shells, each with a different number of electrons.

For example, each atom of copper has 29 protons and 29 electrons. The electrons are contained within four shells or energy levels. The outer shell has only one electron. When an atom has only one, two, or three electrons on its outer shell, those electrons get bumped off easily. The atom has such a loose hold on the outer electrons that these electrons often break free, landing up on the outer shell of another atom. The atom that loses an electron has a positive charge for an instant and attracts another free electron. This flow of free electrons is called *electricity*.

Atoms with two or three electrons in the outer shell are strong **conductors** (such as aluminum and copper). Atoms with six or eight electrons in the outer shell are strong **insulators** (such as carbon). Atoms with four electrons may belong to a special class called **semiconductors** (such as silicon, an important element for electronics technologies).

As previously mentioned, the centre of this atom is the **nucleus**. There is only one particle inside the nucleus of the hydrogen atom. It has a positive charge (+) and is called a **proton**. A particle, known as the **electron**, vibrates or orbits around the nucleus with a negative charge (–). The electron has very high energy and moves at a speed of 112,000 km/second.



In relation to the proton, the electron is very small, but it is the particle that provides us with electrical energy. Since the hydrogen atom has one negative and one positive charge, we could say that it has a **neutral charge**. For electricity to be produced, we need to alter the state of the atom. This leads us to the next lesson on the laws of electrical charges.

The words *electricity*, *electron*, and *electronic* are all related to Greek experiments with electric charges.

**Shocking FACT**

Did you know that the police use electrons to catch speeding cars? The radar gun shoots a wave carrying electrons, which bounces off the automobile and then returns to the radar gun on the returning wave.

*Electrum* is the Greek word for amber. Amber is a semi-precious stone made from petrified tree sap. Many years ago, it was discovered that a charge of static electricity could be generated by rubbing amber with a bit of silk. Electrons from the silk built up in the amber, and when released the result was a sudden shock. The word *electricity* was used for things that acted like amber.

Static electricity is a form of energy that is difficult to use. The word *static* means "not moving." When a static charge is built up, it discharges suddenly and completely as soon as it finds a suitable path for the excess electrons that have been moved about by friction (or rubbing).

An example of static electricity is when you rub your feet on a dry carpet and then touch something metallic such as a doorknob. The electrical charge immediately discharges. It is hard to think of a way that this charge could be made to discharge slowly in order to do useful work.

Much larger quantities of energy are released in a lightning storm. Clouds build up a charge by rubbing against air or other clouds. Sometimes you see lightning discharge from one cloud to another. More often, when a large charge is built up, there is enough charge to jump the gap from the cloud to the earth. This sudden charge is incredibly powerful. You have probably noticed that when lightning hits a tree, that part of the tree where the current hit often explodes from the sudden, intense heat.

# NOTES

# LESSON 2: LAWS OF ELECTRICAL CHARGES

## What Are Electrical Charges?

Have you ever gotten a "shock" by touching a doorknob? When you take off your hat, does your hair stand straight up? Why does this seem to happen only in winter?

Some materials lose or gain electrons when rubbed together. The more rubbing, the more electrons are lost or gained. With less electrons, a material will have a positive charge. With more electrons, the other material will have a negative charge. Each material is carrying a difference in potential or a **charge**. Static electricity is an imbalance of positive and negative charges. Remember that similar charges repel. When electrons move from your hair to your hat, each hair has a positive charge, and is forced to be as far as possible from each other hair. Moisture (a conductor) allows the effect to leak off quickly, so that you only see it when it is very dry (winter). These two types of charge also build up between air and clouds.

Long before anyone knew about electrons and protons, a French chemist named Charles Dufoy discovered that there were two types of **electrical charges**. He discovered that unlike charges attract one another, and like charges repel one another. This discovery became known as the laws of electrical charges. Later, Benjamin Franklin named these two charges positive and negative.

**Shocking FACTS about Lightning**

During a thunderstorm, the static electricity in the clouds puts out massive flashes of static electric energy that light up the sky. This static energy flows from one part of a cloud to another or to the ground below because of a difference in charge. The connection of this electrical energy from the cloud to the ground generates a flash of light. This flash of light produces heat. In turn, this fast-expanding heated air around the lightning bolt (33,315 degrees Celsius) creates the sound of thunder. There are 16 million thunderstorms each year around the world. In Canada and the United States, an average of 143 people die each year from lightning strikes. One bolt of lightning can contain 300,000 amperes of current, enough electrical energy to light 200,000 homes.

**The Laws of Electrical Charges**

1. Protons have a positive charge.
2. Neutrons have no charge.
3. Neutrons have a lot of mass.
4. Electrons have a negative charge.
5. Similar or like charges repel each other.
6. Opposite charges attract each other.
7. Electrons can move away from an atom.

The centre of the atom contains the neutrons and protons (except hydrogen which has no neutron). The nucleus has a positive charge, attracting electrons. Electrons have a negative charge. Like the moons of Earth or Jupiter, these electrons are held in place by attraction and held away by the energy of their orbits.

Unlike moons, electrons gain and lose energy, orbiting closer or farther away. A lot of energy can cause an electron to fly right off, becoming a free electron. The **free electron** often enters the orbit of another atom, giving up its energy to an electron in that atom which may in turn fly off and become a free electron. When a source of energy is connected to a conductor, more and more electrons become free.

We can divide these electrical effects into three types:

1. static electricity
2. direct current
3. alternating current

To prove this theory of charges, Benjamin Franklin flew a kite in a thunderstorm. He wanted to prove lightning was just a powerful form of static electricity.

Benjamin Franklin tied a short piece of dry string to a very thin wire attached to a kite. A nearby bolt of lightning blasted Franklin's kite, and this in turn electrified the key. It is important to note that Franklin was very cautious when he did his kite experiment. He stood on dry ground under an overhanging roof. ***Franklin's experiment should never be attempted as a school or individual project.*** Even with his careful planning, Franklin could have been killed if the lightning would have travelled down the wire to where he was standing. So for those who fly a kite in a thunderstorm, you better say good-bye to your friends and your pet goldfish.

Just in case you are wondering, a nearby bolt of lightning blasted Franklin's kite. This in turn electrified the key.

"Has anyone seen a burnt kite around here?"

Since Dufoy's and Franklin's discoveries we have found that both of these types of charges are surrounded by an **electrostatic force field**. These force fields are equal in strength even though their charges are very different. Depending on the charge, when these force fields come into contact with each other, they repel or attract each other.

## Student Challenge 2

*Can you determine how fast a lightning storm is travelling towards you by using the sound of the thunder?*

Remember that sound travels at 333 metres per second or approximately one kilometre every 3.3 seconds. Because light travels so quickly (300,000 km/sec), we are going to say that we see lightning at the exact second it flashes. This is not exactly true. By the time you see a flash of lightning (or anything else on earth), you are actually seeing it a tiny fraction of a second after it has occurred. To calculate the distance you are from the lightning, count the number of seconds between seeing the lightning flash and hearing the sound. **Divide by increments of 3.3 to get the distance in kilometres from the lightning.**

Take a look at our formula and example in action:

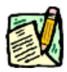
Distance from lightning in kilometres =
time between flash and sound in seconds ÷ 3.3 km

For example, (seconds between flashes and sound):

15 ÷ 3.3 km/s = 4.5 kilometres away

**Now you give it a go . . .**

If you can count nine seconds between seeing the flash of light and hearing the sound of thunder, how far away in kilometres is the lightning from you?



Whenever you see this graphic, you need to go to your Assignment found after the last lesson of the module and complete the section of the Assignment indicated. This Assignment is to be forwarded to the Distance Learning Unit when you have completed the module.

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Go to Assignment 1 found at the end of this module and complete Part 1: Calculating the Distance from Lightning.

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If you ever get caught in a lightning storm, stay low and avoid conductive items such as golf clubs, telephones, indoor appliances, plumbing pipes, fences, and even trees. The best place to be is inside a building or a car with all the windows closed. If you are outside and lightning strikes close to you, crouch down with your feet together and place your hands on your ears to protect your ear drums from the loud crack of thunder.

Speed of light: 300,000 km/hr.

Speed of sound: 1,200 km/hr.

## Static Electricity

Static electricity is a collection of electric charges on an object. These charges do not move. The charge of the particles can be positive or negative. You can create static electricity by walking on carpet, pulling tape from a roll, putting your hand close to a television screen, removing a sweater, or even by separating clothes after they’ve been in a clothes dryer. This isn’t all that different from the lightning we discussed in the previous section, which is a much more powerful form of static electricity. These forms of static electricity will not cause you any problems, unless there are flammable vapours in the room.

## Learning Activity 1.3

### Static Electricity

Student Challenge 3

*Have you ever tried to make static electricity?*

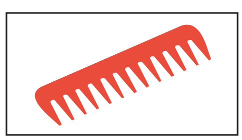
For each part of the experiment, record your findings on the chart that follows.

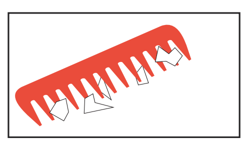
**Part 1: Can you electrify a plastic comb?**

Material list:

- One plastic comb
- Small bits of scrap paper
- Table salt
- Pepper

Tear the paper up into very small 1-cm pieces and then comb your dry hair many times. This will electrify the comb by transferring electrons from your hair to the comb, giving it a negative charge. Now bring the comb closer to the pieces of paper. The pieces of paper will have a positive charge, causing them to stick to the comb. This proves that unlike charges attract each other. Try the same experiment using salt and pepper instead of paper. **Don't forget to record your results on the chart below.**


Before


After

| Part 1: Chart | | |
|---|---|---|
| **Item** | **Effect of Charged Comb** | **Why?** |
| Bring the charged comb near the paper pieces | | |
| Bring the charged comb near the table salt | | |
| Bring the charged comb near the pepper | | |

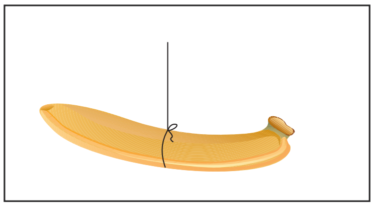
*(continued)*

**Part 2: Can you make a banana dance?**

Material list:

- Piece of string
- One balloon
- One banana

Hang a banana from a string. Make sure to balance the banana as you tie it in the middle. Rub an inflated balloon on your hair or on the carpet in your home. This will put an electric charge on the balloon. Hold the balloon near one end of the banana. The banana should twist and follow the balloon. **Don't forget to record your results on the chart below.**



| **Part 2: Chart** | |
|---|---|
| Effect of Charged Balloon on Banana | Why Did This Happen? |
| | |

*(continued)*

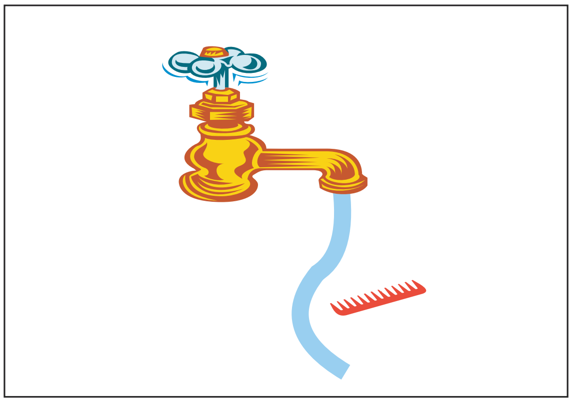
## *Learning Activity 1.3: Static Electricity (continued)*

**Part 3: Can you bend water?**

Material list:

- Plastic comb
- A very slow flow of water

Turn on your water faucet so you have a slow, steady stream of water. Rub the comb through your dry hair several times. Now, slowly put the electrically charged comb near the stream of water but do not touch it. If you do touch the water, dry the comb off well and repeat the procedure from the beginning. **Don't forget to record your results on the chart below.**



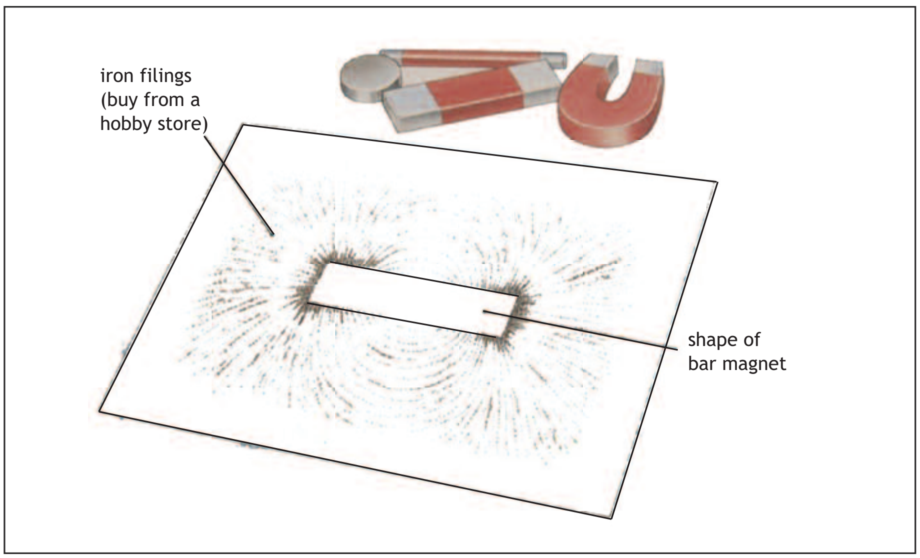
| Part 3: Chart | |
|---|---|
| Effect of Charged Comb against Flow of Water | Why Do You Think This Happened? |
| | |

Check your answers in the Learning Activity Answer Keys found at the end of this module.

From Learning Activity 1.3, you discovered that negatively charged particles (electrons) attract positively charged particles (protons), and vice versa. This attraction or very strong force holds atoms together. In other words, opposite charges attract one another.

## Magnets

Did you know that static cling in your laundry, the movement of your radio speaker, and the magnets on your fridge are very closely related? So is every other magnetic principle that goes on around you every day. Magnets have simplified and made our lives easier, more than you may realize. The magnetic force fields around magnets do many difficult jobs for us. Below is a picture of the magnetic force field around a permanent magnet.




To simplify and understand magnets and magnetism, we have divided them into two categories: **permanent magnets** and **electromagnets**.

### Permanent Magnets

Magnetism has amazed people for centuries. One type of natural magnet is called magnetite or lodestone. The Greeks knew of this natural magnet in ancient times. The Greek translation for loadstone is "leading stone." When the Greeks put the piece of natural loadstone on a free-moving object where the mineral could spin freely, they noticed it would turn so that one end would always point toward the North Star or true north. The Chinese invented the first compass to detect true north without the use of lodestone.

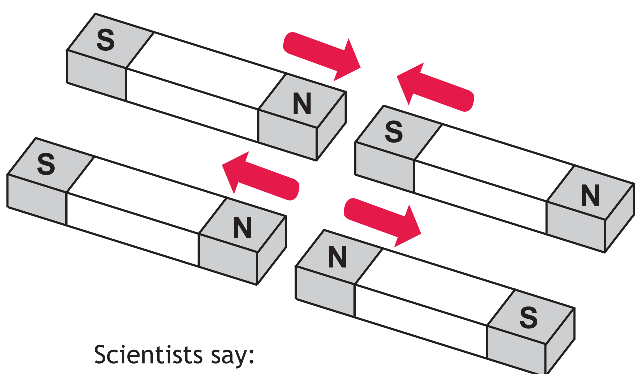
A permanent magnet stays magnetized for an extended period of time. Nuts, bolts, paper clips, tacks, or just about anything made of **ferrous metal** will stick to the magnet.

> Ferrous metals must contain iron. They may have small amounts of other metals or other elements added, to give the required properties.

People have made their own magnets by creating mixtures of metals. These are known as **alloys**. Alnico is an alloy that is a good example of a human-made magnet. It is made of aluminum, nickel, iron, and cobalt. Cobalt, nickel, and iron are the only magnetic elements. All magnets use the basic principle that you proved in Learning Activity 1.3: **like charges repel; unlike charges attract**.

**Magnet Laws**

In the experiment below, you've discovered the laws of magnets. A south pole always repels a south pole and a north pole always repels a north pole. But a north pole always attracts a south pole and a south pole always attracts a north pole.



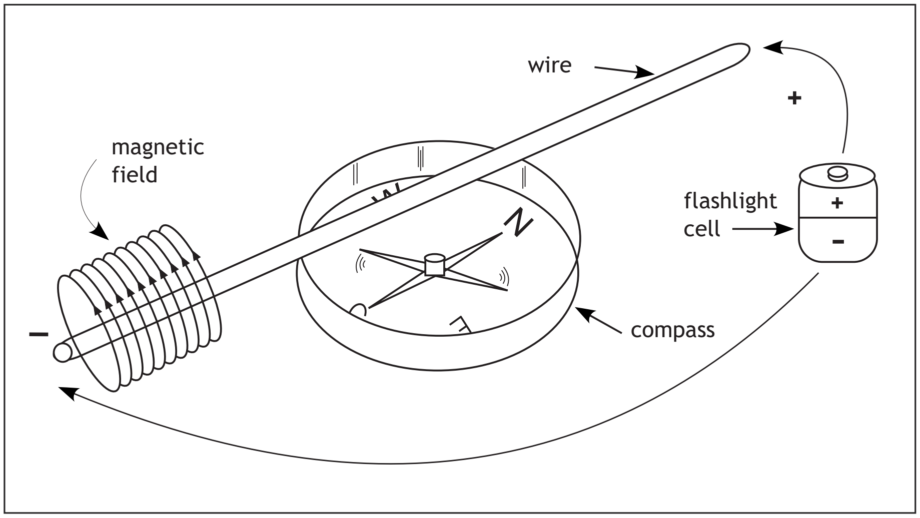

Scientists say:
Like poles repel and unlike poles attract.

There are two poles on a magnet: a south magnetic pole and a north magnetic pole. If a magnet were to swing freely in a circular motion, the north pole of the magnet would settle or stop, pointing towards the earth's geographical North Pole, and the south pole on the magnet would face towards the South Pole of the earth.

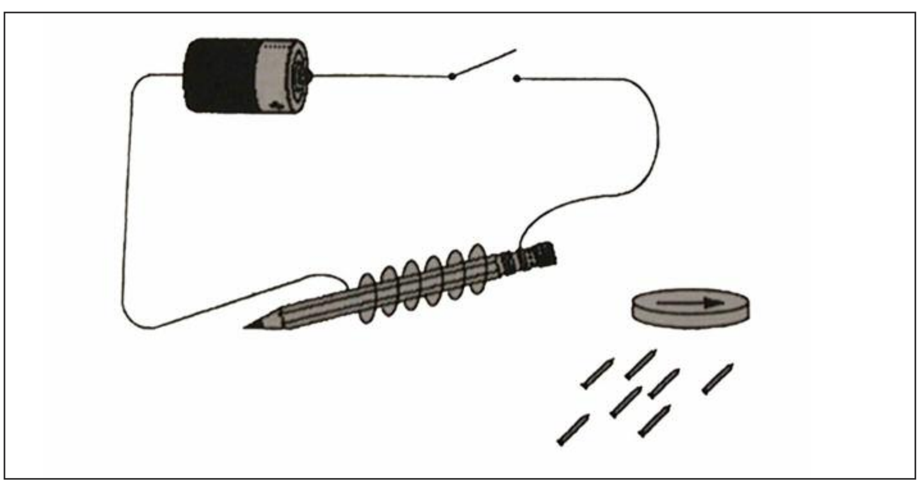
> **Yet Another Shocking FACT**
>
> Did you know that our planet Earth is a huge magnet? That's why a compass works for direction. Scientists believe that the molten red-hot iron in the centre of the earth's core is the cause of this magnetism.

## Electromagnets

The discovery of the principles of electromagnetism was one of the most significant of the 19th century. In 1819, a Danish physicist named Hans Christian Oersted accidentally discovered that when you put a directional compass near a wire carrying electricity, the compass needle moves to one side. He knew the wire made of copper, which is not magnetic, was not causing the needle in the compass to move. Therefore, he concluded that the moving electric current in the wire was the cause of the needle movement.

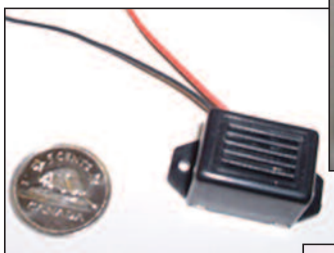



To create an electromagnet, you must wrap a wire several times around an iron core (for example, a conventional carpenter's nail). The ends of the coiled wire must be exposed so that a battery can be attached. Once the power is sent through the wire, the iron core of the electromagnetic set-up becomes controllable or, to use the proper term, an **electromagnet**. Unlike a permanent magnet, once the power source is shut off, the iron core loses all of its magnetic properties.



It was Oersted's accidental discovery of electromagnetism that gave the world electric motors, buzzers, doorbells, television, and electronic measuring tools, just to name a few. These items all have one thing in common: they use electromagnetism to operate.

buzzer



doorbell

electric motor

television

analog multimeter

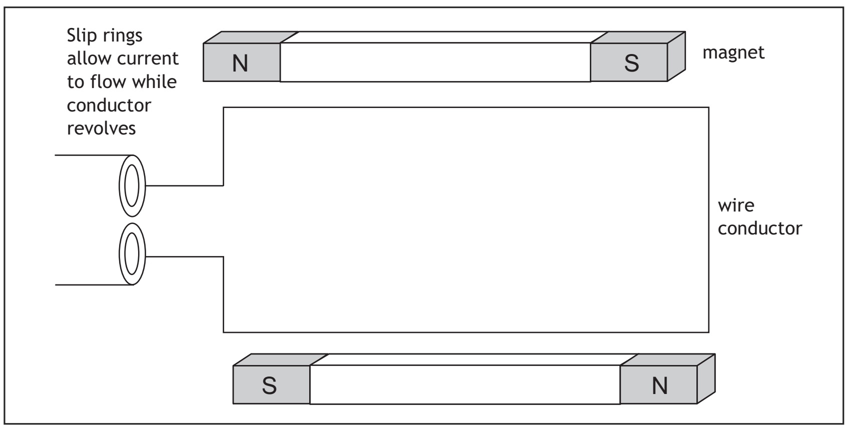
digital multimeter

So now we know how to create a magnetic field. Coil an insulated conductor around an iron core. Apply current and you get a magnetic field. Can we do it the other way around? Say that we want to make (or generate) electricity. If we move a conductor through a magnetic field, we generate an electrical current. If we connect the ends of the wires to a circuit, we can use the power generated. If we keep moving the conductor or the field, we can keep up a constant current.

**Shocking FACT**

Iceland has so much geothermal power that it plans to stop using fossil fuels by 2030!

There are many ways to make (generate) electricity. We have already talked about thermocouples, piezoelectricity, and solar panels. Very little of our power needs is satisfied with these types of electrical "generators." All the other kinds of power we use, though, have something in common. What does nuclear power have in common with wind, coal, tidal, and geothermal power? All these forms of power are used to turn the shaft on a dynamo to make electricity. Have you ever seen a dynamo on a bicycle? The shaft is pressed against the bicycle wheel. It makes electricity when the bicycle moves. When the bicycle stops, the lights go out. This generator is much the same as the generators in a nuclear power plant or a hydroelectric dam.




When a conductor (a wire) moves through a magnetic field, it disturbs the field (like a paddle disturbs the water). As the magnetic field adjusts, it pushes on some of the electrons in the conductor. If the conductor keeps moving in and out of the magnet's field, more and more electrons will be displaced, creating—(yes!)—electrical current. The easiest way to keep current flowing is to wrap many insulated coils of wire around an iron "**armature**." The armature is an axle surrounded by magnets. The ends of the wire coils are attached to conducting slip rings or brushes so that current can flow when the axle turns.

As it turns, current is forced into the wire to go in one direction and then back in the other direction. This is called "alternating current" or AC. The electricity in your house changes direction **sixty times every second**. It flows and does work as it is used in our electrical devices.

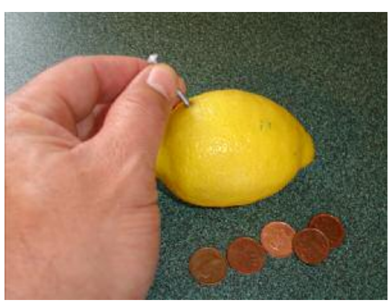
Sometimes alternating current is not what we want or need. We want current with stable polarity (for instance, in a car). We usually start by make alternating current. Then we change the back-and-forth direction of current so that it moves in only one direction. What gets through is called a direct current.

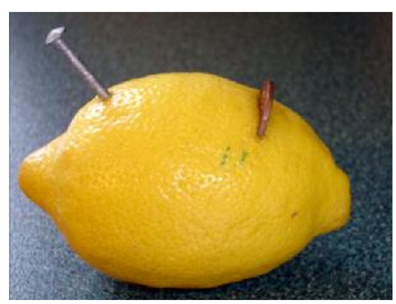
The other major source of direct current electricity is chemical action, such as that found in a battery. Batteries create an electric current by using the stored-up energy in chemicals and changing it to electrical energy. Batteries are made up of one or more electrochemical cells. Car batteries, for example, have 2-volt cells. How many little 2-volt battery cells are in a typical 12-volt car battery? The lead-acid battery was invented in 1859, and the dry cell soon after, both in France.

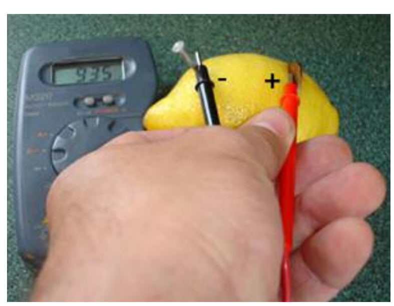
An electrochemical cell has three main parts—two electrodes and an electrolyte. The electrodes are made of metals that are dissimilar (not the same). The acid in which the contacts (or electrodes) are submerged is called an electrolyte. Every battery has a positive part and a negative part. The cathode (negative) and anode (positive) touch the two different kinds of chemicals that are stored in the battery. Close the circuit (connect the circuit so that there is a path for the electrons to flow) with a conductor and resistance from cathode to anode outside the battery. The electricity will flow as long as the circuit is closed and the chemical reaction is not complete.

The best part of the car's lead-acid battery is that it can be recharged. Batteries last for years instead of days. While driving, the electrochemical reactions are reversed by the car's alternator. When the engine is stopped, the circuit is opened (disconnected) so that no power is used.

You can make a 1-volt battery or cell with a lemon (acidic electrolyte), a copper nail or copper penny, and a zinc-coated nail (two dissimilar metal electrodes). Insert the nails into the lemon a couple of inches from each other. Using metallic wire, attach your neon bulb or multimeter to the nails to complete the circuit.





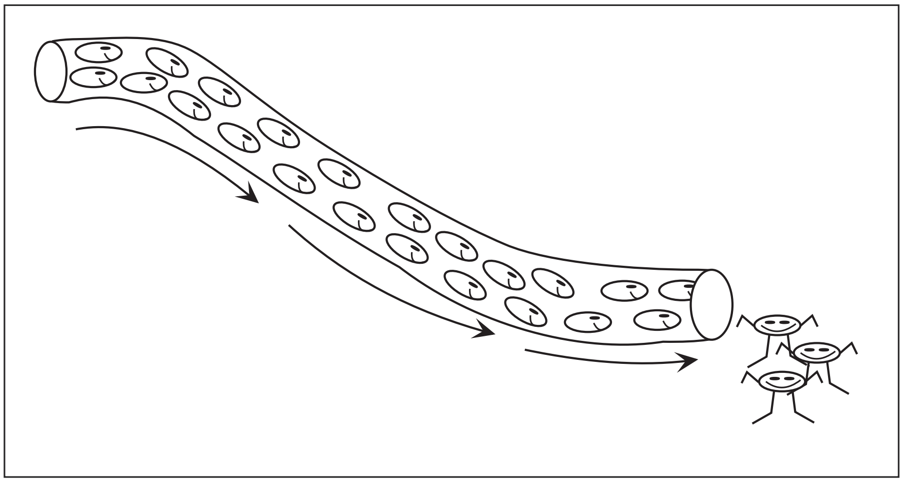


# NOTES

# Lesson 3: Electrical Conductors, Insulators, and Semiconductors

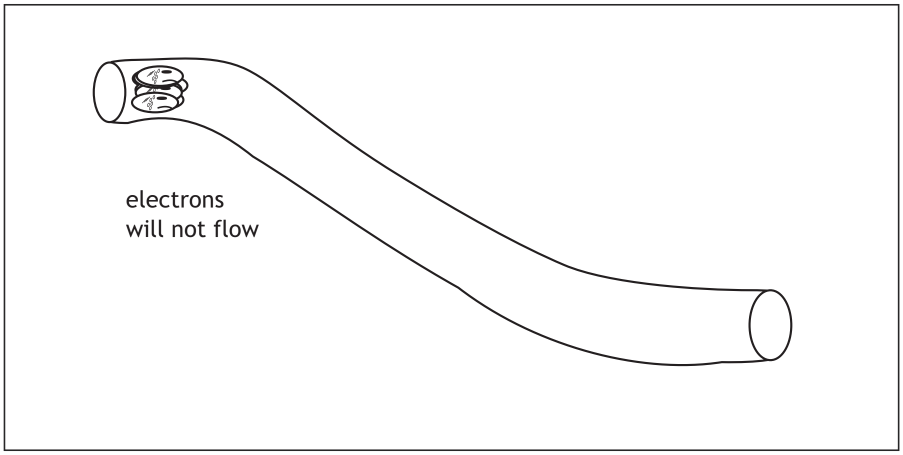
## What Are They?

Different atoms have either a tight or loose hold on their electrons. Atoms with only one, two, or three electrons at their highest shell are likely to lose and gain electrons easily. We call these conductors.



Most metals are good conductors. Because of its low cost and its high conductivity, copper is a good choice for a conductor for electricity and electronics projects. It is often used in the wiring inside the walls of your home. The following is a list of good conductors. They are listed in order of their conductivity: silver, copper, gold, aluminum, tungsten, zinc, brass, platinum, pure iron, tin, and lead.

When there are seven or eight electrons in the orbit of an atom, they are held tightly to the atom. An **insulator** is a material that has very few, if any, free electrons and opposes the flow of electrons.




Some common insulators are air, glass, plastic, rubber, or porcelain. No material has been found to date that acts as a perfect insulator. Electrons can flow through any material if enough external force is applied to make the electrons move from atom to atom. When an insulating material has not been able to stop or slow the flow of electrons, it is considered to be ruptured or broken down.

## *Learning Activity 1.4*

### Conductors and Insulators

Answer the following in your notebook.

List four conductors found in your home. Example: *dinner fork*

List four insulators found in your home. Example: *plastic toothbrush*

Check your answers in the Learning Activity Answer Keys found at the end of this module.

When the upper orbit of an atom has four electrons, it can be made either to conduct or to insulate. A **semiconductor** is a material that has characteristics of both a conductor and an insulator. A pure semiconductor can act as a conductor or an insulator, depending on the temperature and chemical properties of the material. At a low temperature, it is a reasonably good insulator. When operated at a high temperature, it is a reasonably good conductor. Two good examples of semiconductive material are silicon and germanium. It is possible to make a semiconductor more of a conductor or insulator without using temperature by adding other chemical mixtures to silicon and germanium. These special treated semiconductive materials are used to produce our modern lightweight electronic components and gadgets, such as calculators, video games, and laptop computers.

## Building Your First Project

This section involves watching video presentations in between the steps for building your first project. If you have questions during this project, first check that you did not miss or skip any steps.

**Caution**

You will be working with your digital multimeter to test your battery. It is very important that you put the proper multimeter test leads on the proper posts on the battery. The ***red*** probe should be put on the positive battery post marked "+" and the ***black*** test probe put on the "–" side of the battery. Refer to the battery image shown below.

## Using the Multimeter



One of the most commonly used tools in electronics is the **digital multimeter** or DMM. A DMM allows you to easily measure and compare electronic output values. Most DMMs will measure voltage, amperes, continuity, and resistance. These four measurement terms will be discussed in detail later on in this module.

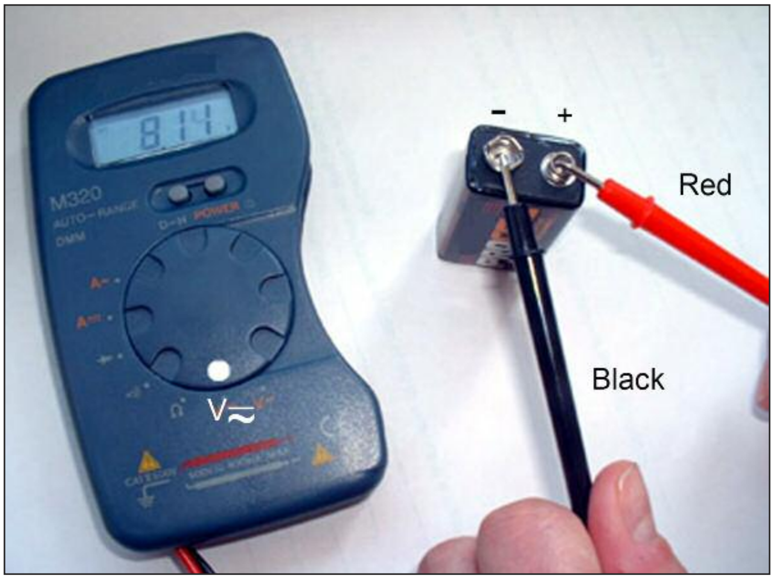
The meter in your tool kit should look similar to the one in the course pictures. From time to time, some of the settings on the meters may change position on the dial. When using your meter, always make sure you find and select the correct function symbol for the task you are performing. The symbols are the same, but their placement on the meter may vary.

To help simplify and understand how to build your project, we will first use just one measuring feature on the DMM. Other features will be used later on in the course. We will set our DMM to the feature or function known as Direct Current Voltage or DCV. It is important to learn about this function because your 9-volt battery needs to be tested to see if it has enough electrical energy to run your projects.

It is now time to view the Grade 9/10 Electronics video found in the learning management system (LMS) or on DVD. Watch the section on the digital multimeter.

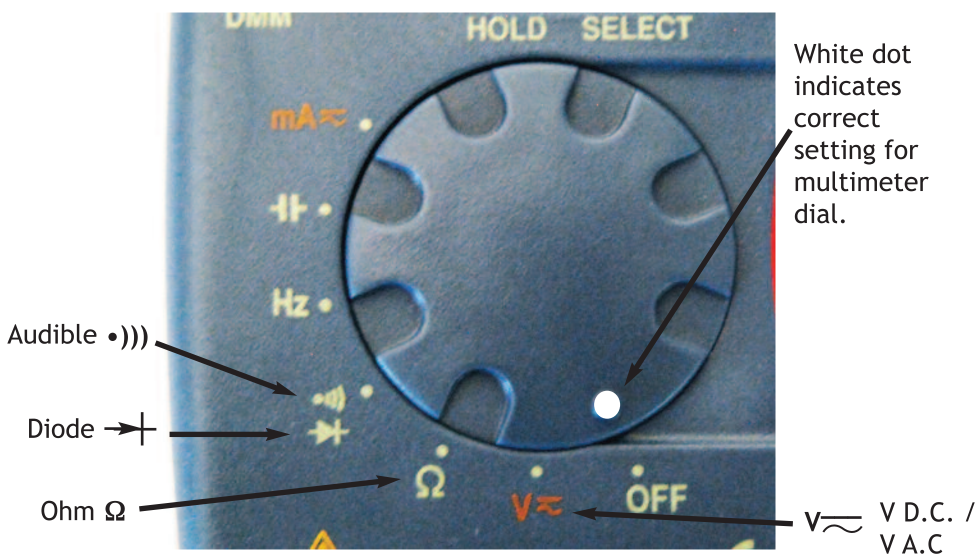
**Digital Multimeter**—The DMM is a special tool used to measure electrical quantities including voltage, amperes, continuity, and ohms. Without this measuring tool, it would be nearly impossible to work in the areas of electricity and electronics.

Your DMM may not be exactly as shown. You may not have audible function or diode check. The basic functions and cautions are the same for every DMM. If in doubt, check the instructions for your DMM. You can severely damage your DMM if you are not careful!



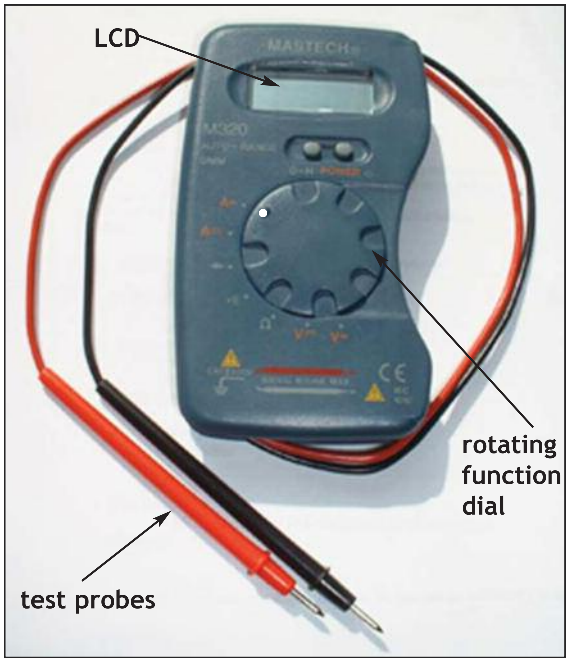

The settings on the multimeter dial are shown below. It is important to know the purpose of each setting. A white dot on a multimeter dial indicates the correct setting. Look for the white dot on multimeter throughout the course.

All meters are different but they have the same symbols. There are five symbols that you will be referring to and they are on all meters regardless of the make and model (see image below).



## Testing Your 9-Volt Battery

With your DMM, you can measure various components or values just by rotating the **function** dial to the proper location. A number of choices are available—DC Volts, AC Volts, DC Amps, capacitance, continuity, and resistance.




By rotating the function dial, you can choose to measure or test almost anything in the world of electronics. Pay close attention to the location and position of the rotating function dial.

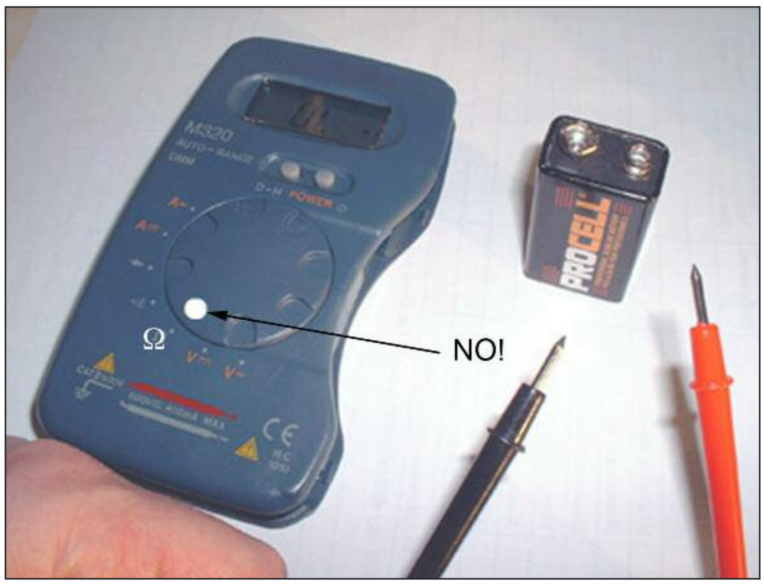
**Caution**

***Use extreme caution*** when using your digital multimeter (DMM) for testing. It is important that the multimeter is on the correct function and that the red and black probes are on the proper test positions. When you are working with batteries, the ***red*** probe should be put on the positive battery post, marked (+), and the ***black*** test probe put on the (–) side of the battery. Refer to the battery images on pages 45 and 46.

If you were to choose the wrong function, you would damage the DMM. Just imagine choosing the wrong function to measure Direct Current Voltage or DCV. (Your 9-volt battery uses DCV to operate.) If you set the Function dial to measure resistance in ohms (shown by the Greek symbol omega Ω) and your battery has nine DCV inside of it, you will burn out the DMM. Once the DMM is burned out, it is useless.

**Caution**

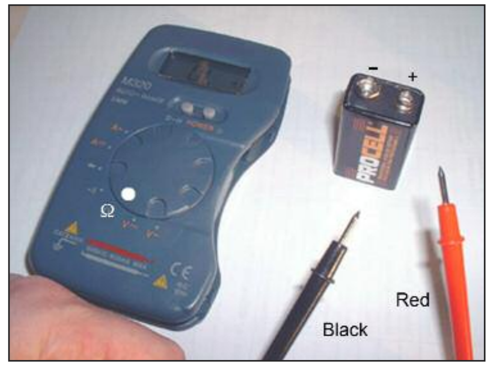
Make sure you are on the proper function! In the picture below, notice that the dial knob is sitting on "Ω," the **wrong** function.




One last thing to consider when measuring DCV from your 9-volt battery is that it is very important that you put the proper test leads on the proper posts on the battery. The ***red*** probe should be put on the positive battery post marked "+" and the ***black*** test probe should be put on the "–" side of the battery. If the probes are in the wrong position when testing your battery for 9 DCV, the screen on the meter will have a negative reading on the display screen. This will not damage the meter. It just reminds you to change the negative and positive probes around because they are backwards.

Refer to battery images below.


**Good Test**




**Bad Test**

## Troubleshooting

Sparkey has some bad news for you if your DMM won't turn on.

The best case scenario is that the battery inside the DMM is dead and this may be why your DMM will not turn on. The worst case is that you misused the meter. Once a DMM is damaged, you only have one option—purchase a new one. It is too expensive to repair a DMM.

Make sure you double and triple check the Function dial before you test anything.

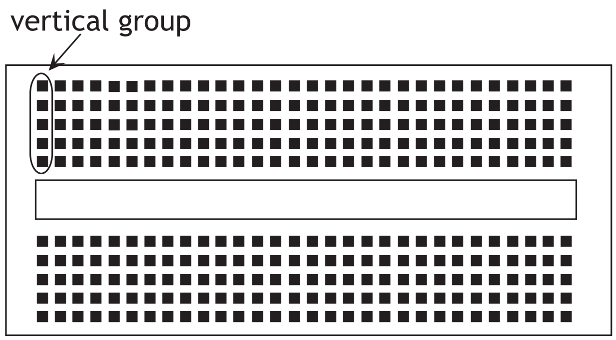
---

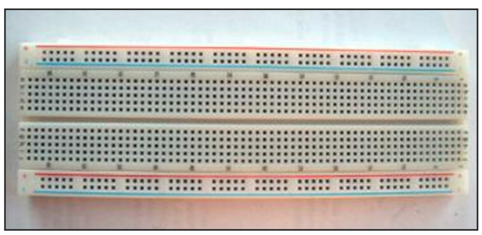
Go to Assignment 1 found at the end of his module and complete Part 2: Testing a 9-Volt Battery.

---

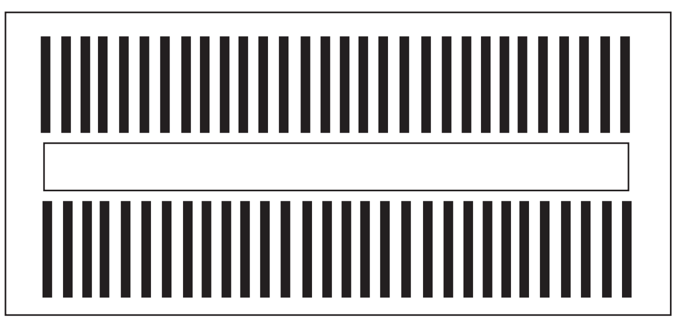
## Using the Solderless Circuit Board

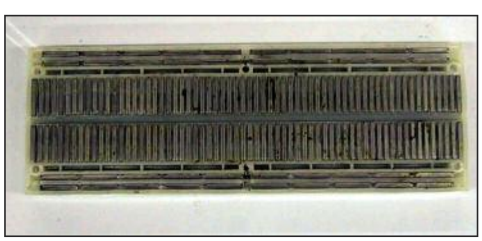
The **solderless circuit board** is a great tool for beginning electronics students. It is a safe, fast, and fun way to construct a project without creating a printed circuit board. The solderless circuit board in your Project Kit is arranged into vertical and horizontal groups.



Notice how each hole is connected to each other in the bottom **x-ray** view.





There are numerous small holes that will accept wires. Each hole is designed for only one component and/or wire.

It is now time to view the Grade 9/10 Electronics video found in the learning management system (LMS) or on DVD. Watch the sections on using the wire stripper and the solderless circuit board.

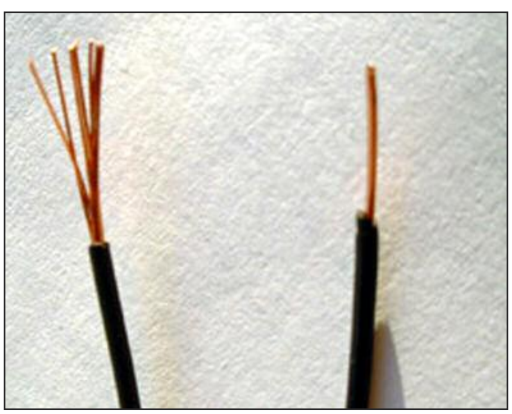
## Variations in Components and Tools

Components and tools in the Electricity Kit might or might not be identical to those described or shown in the course and DVD. This is common in the electronics industry, where manufacturers often modify components and tools in order to improve them. It is also possible the kit suppliers have had to purchase the components and parts from new manufactures which may account for a change from time to time.

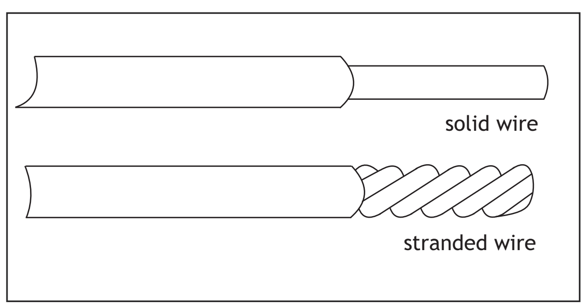
People in the electronics industry often face this challenge. It will give you the chance to practice your critical thinking skills to work around it. Trouble shooting skills are an essential part of working in the electronics industry and of life in general. If your components or tools are slightly different from the ones shown in the course or DVD, be assured that they work in the same way just look slightly different.

**Sparkey's Construction Tip**

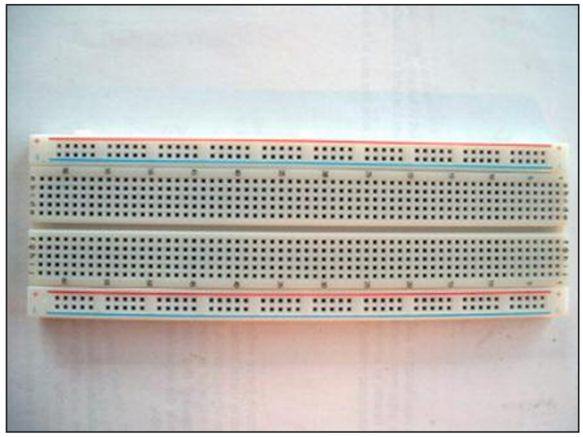
When plugging wires into the holes on the solderless circuit board, solid wire works better than stranded wire. Stranded wire is made up of many strands of wire, whereas solid wire is one large strand. The stranded wire bunches up and doesn't make a good connection on the solderless circuit board.



**Stranded wire** **Solid wire**



Any two wires put in the same group or row will be connected together.



*Look closely; there are 60 sets of five holes per group.*

## Video Review

**Solderless Circuit Board**—The solderless circuit board allows you to assemble electronic circuits without tools or soldering. Quick and easy plug-in connections or conductors inside the plastic body are used to complete the circuits.

Before we can take the next step in building your project, we need to learn a secret language—**schematic symbols**.

---

Go to Assignment 1 found at the end of this module and complete Part 3: Schematic Symbols.

---

## Review of Schematic Symbols

Electronic equipment is made up of many parts called **components**. These components have representative symbols, which can be drawn quickly and easily. These same symbols are used to represent a plan for a completed electronics project. Plans that use symbols to represent a component are called **schematic diagrams**.

**Schematic symbols** are an international language by which electronic technicians anywhere in the world can communicate with each other. You will be learning and manipulating schematic symbols throughout this course.

# Caution!

**While working with your electronics, never connect any parts together unless instructed on how to do so in the course.**

**For example, connecting an LED to a battery is not only unsafe, but will result in your LED not working!**


**Never connect directly together!!**

**Following safe practices and procedures in this course is part of what is expected of an electronics student.**

## Activity 1: Building a Continuity Tester

Now you get to build a **continuity tester** from the Experiment Kit Package!

It is now time to view the Grade 9/10 Electronics video found in the learning management system (LMS) or on DVD. Watch the sections on digital multimeters (DMM) and solderless circuit boards.

**Caution**

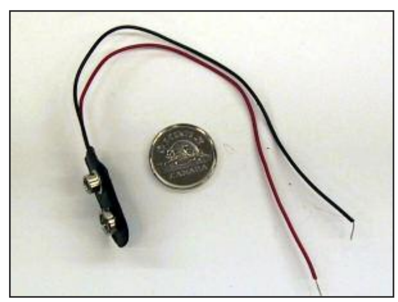
The components you are using in your project or experiment may explode if misused or wired incorrectly! Be sure to review the electrical safety guidelines included in this module.

### Inventory List

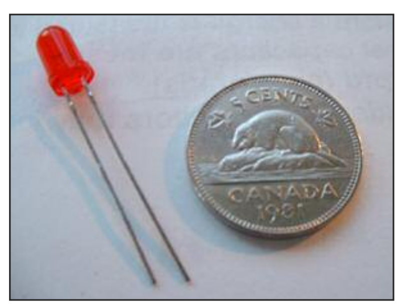
Place a checkmark in each box once you have identified each item.

- ❑ one 9-volt battery


- ❑ 9-volt battery snap



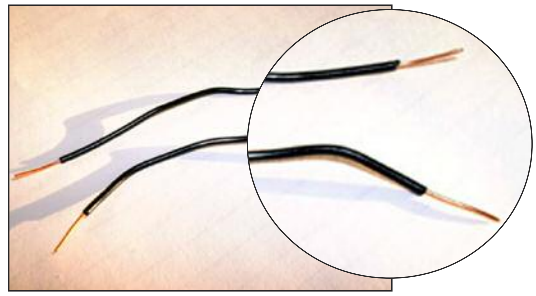
- ❑ light-emitting diode (LED)



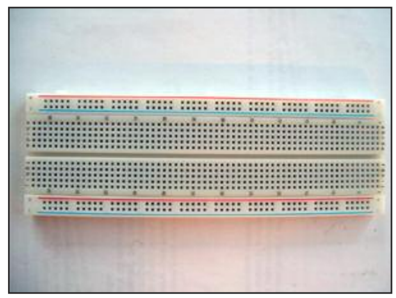

If items are missing or not in working order, contact the Manitoba Text Book Bureau for replacement parts (1-866-771-6822).

- ❑ one 330-ohm resistor


- ❑ solid wires



- ❑ solderless circuit board



- ❑ digital multimeter (DMM)

- ❑ safety goggles

If items are missing or not in working order, contact the Manitoba Text Book Bureau for replacement parts (1-866-771-6822).

Each time you build a circuit, you should first test and record the components. Components include things such as resistors and batteries, not things such as goggles and DMMs. Everything that becomes part of the circuit should be recorded. If it can be tested, it should be tested. If, for instance, you have two resistors, you should test both.

**Component Test Record Sheet Sample**

Pay close attention to the part name, shape/size, special markings, and value.

Student Name: ______________________________

Project Name Title: ______________________________

Note: Write "good" to "bad" for switches.

| Part Name | Part Letter Symbol | Schematic Symbol | Part Value | Tested Value (if any) |
|---|---|---|---|---|
| Resistor | R1 |  | 330 Ohm | 356 Ohm |
| Resistor | R2 |  | 330 Ohm | 321 Ohm |
| Battery Snap | BS1 | | none | none |

The Chart has 5 columns. Here is a description of how you should fill in each of the columns:

1. **Part Name:** In this case, the part is a resistor.
2. **Part Letter Symbol:** The part letter symbol for a resistor is "R." Since there are more than one, we will label them "R1" and "R2."
3. **Schematic Symbol:** The schematic symbol for a resistor is .
4. **Part Value:** These particular resistors have a part value of 330 ohms.
5. **Tested Value (if any):** After testing R1, we find that it has a value of 356 ohms and R2 has a value of 321 ohms.

## Troubleshooting

**Sparkey's "Troubleshooter" Checklist**

The following experiments were designed to work even for the most junior electronics technician. If, for any reason, your project does not work, make sure you go through this checklist before contacting your tutor/marker. It's a good idea to make a small checkmark beside each step as you go through the list.

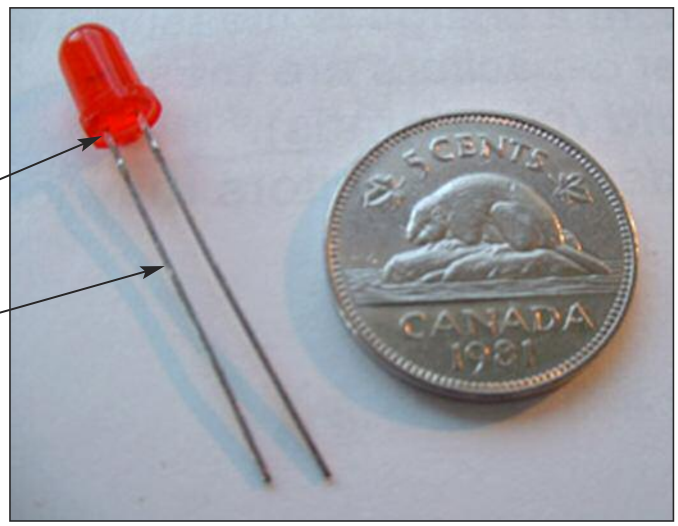
Sometimes junior electrical technicians just hook wires up to see what happens without following the proper procedures. This can be very dangerous and costly. Compare your experiment or project with the following list.

**Checklist**

- ❑ **Check 1—Proper parts?**

  Do you have the proper parts?

- ❑ **Check 2—Is your project wired correctly?**
  - ❑ Yes/No The wires and components are in the wrong holes.
  - ❑ Yes/No The LED is in backwards. (The flat side on the plastic body in the negative. The shorter leg also indicates the negative side.)




  - ❑ Yes/No The wires are not plugged in all the way.

    (**Cool Hint!** Use your needle-nose pliers to plug the wires into the holes. This way the wire will not bend when you apply more pressure.)
  - ❑ The negative and positive of your battery snap (black and red wires) are in the wrong holes.
  - ❑ The resistor is in the wrong holes.

- ❑ **Check 3—Is your battery dead?**

  Another problem could be that your battery is dead. If you think this could be the problem, turn back to the section on “testing your 9-volt battery” earlier in this module. Perform the test and record your value below. If you have less than 4 volts, it’s time to purchase a new battery.

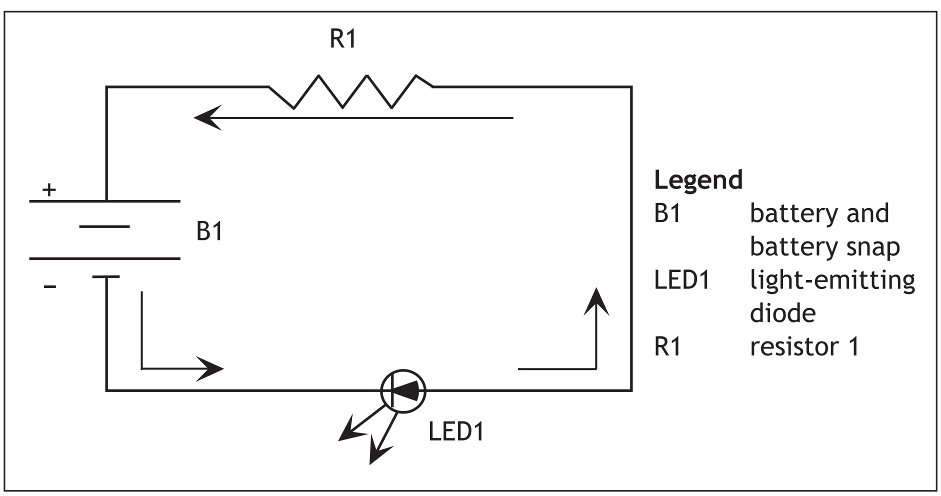
  My 9-volt battery tested value is _______volts.

**Caution**

You will be working with your digital multimeter to test your battery. It is very important that you put the proper multimeter test leads on the proper posts on the battery. The ***red*** probe should be put on the positive battery post marked "+" and the ***black*** test probe put on the "–" side of the battery. Refer to the battery image shown below.


## Experiment

Now that you have tested the battery with the DMM, witnessed how a solderless circuit board is used, and learned a new language called schematic symbols, it is time to do an experiment. You will build a simple circuit to light up a LED (Light-Emitting Diode).



In this simple circuit, the electric current will flow from the negative terminal of the battery to the positive terminal, passing through the LED and the resistor. Notice how the electric current will light the LED as it flows through.

To build this simple circuit on your solderless circuit board, follow the visual instructions shown below.

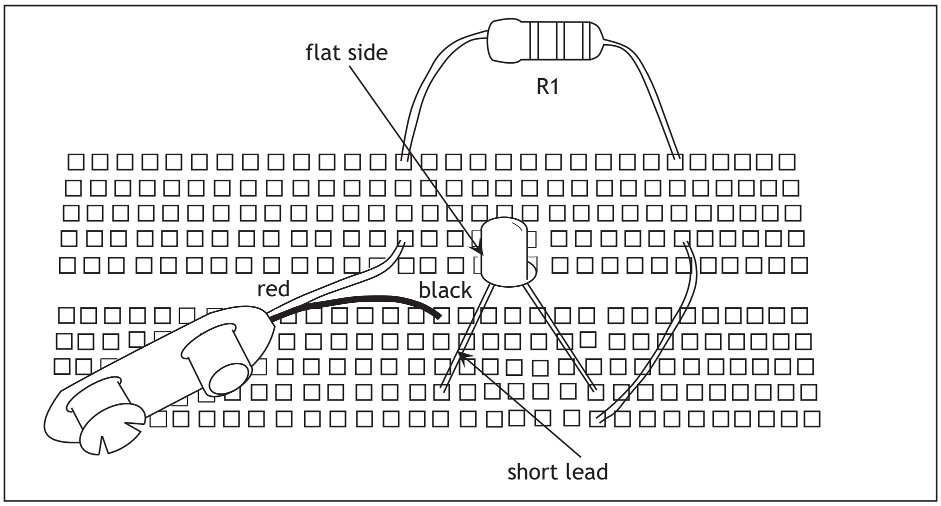



**Figure 1**

Now very carefully plug your components into the same vertical rows as shown below. With your components in place, the metal conductor strips inside the solderless circuit board should have your LED lighting.

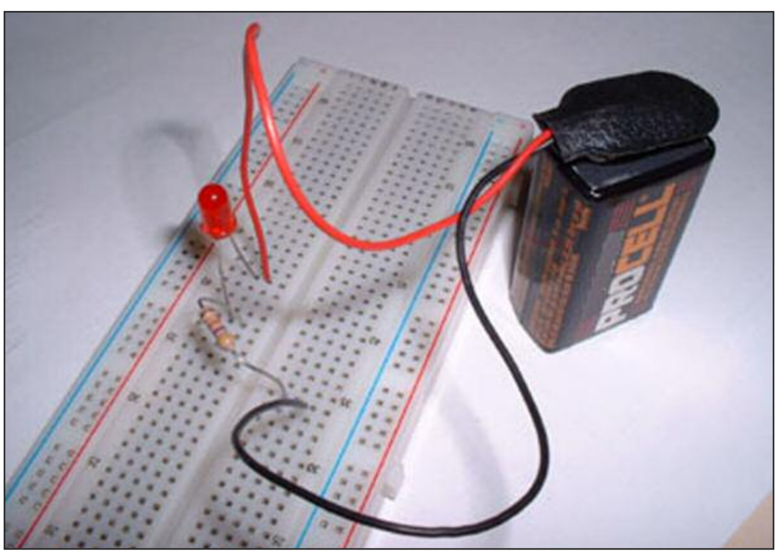



**Figure 2**

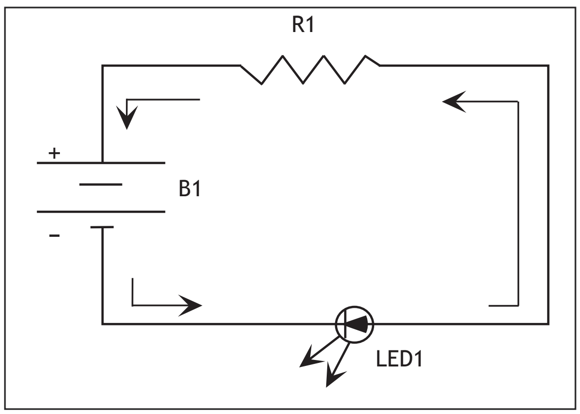
If the light-emitting diode or LED does not turn on, refer to the previous Troubleshooter Checklist. Do not continue if the LED is off.

## Working with Polarity

With this second section of your experiment, you will discover the importance of polarity. Polarity means that a component, such as a LED, can only operate normally in one position or direction once installed.

**Note:** Electrical current flows from the negative terminal to the positive terminal.

For the next few questions, refer to the schematic drawing of your circuit shown below and your working circuit.




Let's make a little change to your circuit. Switch the red and black battery snap wires in your circuit. (The following questions are included in your assignment, Part 4: Learning about Polarity.)

1. What happened to the LED when you made the change?
2. What does the term *polarity* mean?
3. Which components in your solderless circuit board have polarity?
4. Why is it important to place the battery snap and battery in the proper polarity?

   Replace the battery snap back to its original working position. The LED should turn on. Now switch the LED legs around, just like you did for the battery snap.
5. What happened to the LED?
6. Why did this happen?
7. Finally, return the LED to its original position so the circuit LED lights up. Identify the resistor in the circuit in Figure 2. Remove the resistor and switch the component legs around just as you did in the other two experiments. Does the LED remain lit? **No**—then check your connection.
8. Does the resistor have polarity?
9. Explain in detail why you chose your answer for question 8.

Go to Assignment 1 found at the end of this module and complete Part 4: Learning about Polarity.

## Review

Electronic components must be installed with polarity in mind. It's a good idea to look very carefully at the parts or schematics sheet that is included at the beginning of this course to determine whether a component has a positive or a negative polarity. Look for a (+) sign for the positive side and a (–) sign for the negative side. If no positive or negative symbols are visible, then polarity is not an issue. Therefore, the part can be installed in either direction in the circuit. An example of a part that can be installed in either direction would be a resistor.

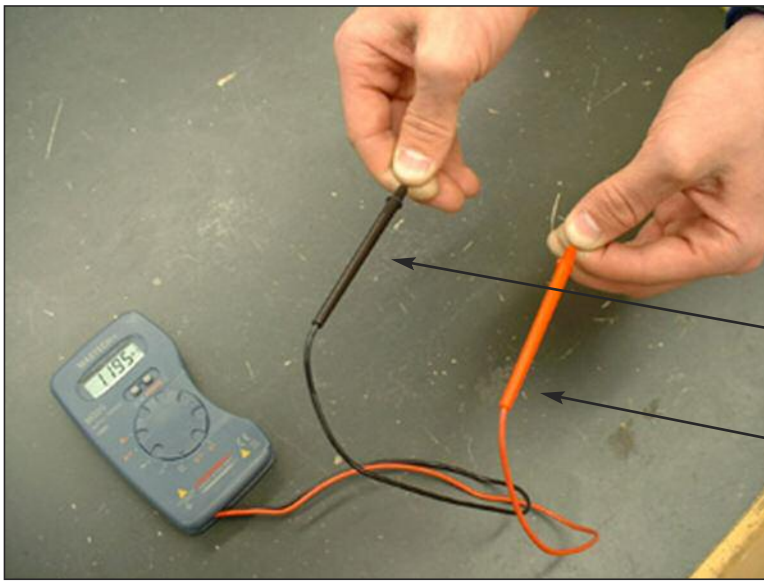

**Note:** The colour code for positive is red and the colour code for negative is black.

**Shocking Direct Current FACT**

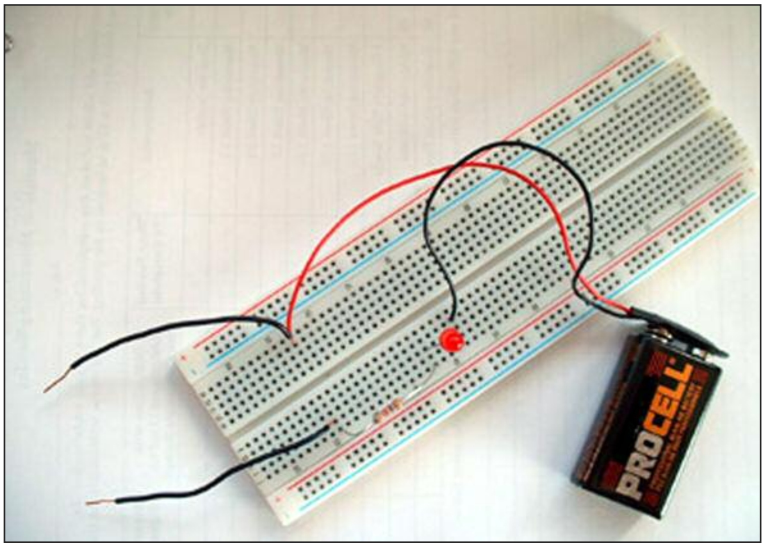
The colour code for positive is red and the colour code for negative is black.

## Activity 2: Testing for Conductors and Insulators

In the previous section, you learned that a **conductor** is a material with many free electrons that allows other electrons to move through it very easily. Insulators, on the other hand, are materials through which electricity cannot travel easily. To determine if the materials in our chart are conductors or insulators, we will need to modify the basic LED circuit to make a continuity tester. Refer to the figure below to modify your LED circuit into a continuity tester.




Split the circuit between the resistor and the LED. Add two wires in the circuit to act as test probes. Refer to the figure below for test probe positioning.




To make sure your simple continuity tester is working, simply touch the two bare wire ends of the test probe together. The LED should turn on. If not, refer back to the Troubleshooter section in this module.

Once your tester is working, walk around your home and find all the items listed in the chart in Question 5, Testing for Conductors and Insulators, at the back of this module. Some items may be substituted for others. You will need to take each item on its own and test to see if electrical current flows through it. If the LED **lights**, the item is a conductor. If the LED **does not light**, the item is an insulator.

Go to Assignment 1 found at the end of this module and complete Part 5: Testing for Conductors and Insulators.

You will need to collect the items listed on the chart. Then, test the items to see if they are conductors or insulators. Record your results on the same chart.

Go to Assignment 1 found at the end of this module and complete Part 6: Check This Out.

# LESSON 4: HOW DOES ELECTRICITY TRAVEL?

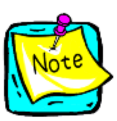
## Alternating Current and Direct Current

We mentioned earlier that lightning is an example of static electricity. Static means stationary. Static electricity stays in one place and is formed by an excess or deficiency of electrons. It discharges when it comes close enough to an opposite charge. It is useful in some technologies such as photocopy machines where each piece of paper is charged, and the toner is attracted to the charged paper. Static electricity cannot, however, travel to complete a circuit.

Before we move on, we need to look at this topic—how electricity travels. In the previous lessons, we discussed how electrons flow in a conductor and how an insulator holds them back. It is important to understand that it is the **Electromotive Force or EMF** that causes the flow of electrons. EMF may be caused by friction (static electricity), a battery cell, heat, electromagnetism, a barbeque lighter spark, or by light for a night light.

EMF is comparable to the force you create when you throw a ball. The size of the ball is the **volume of electricity**, much like the moving electrons you learned about in Lesson 2. How fast the ball is thrown is the rate of flow of electricity in a circuit, called the **current**, which is measured in **amperes**.

Now we will look at how it travels. There are two types of travelling currents: **Direct Current** and **Alternating Current**, also known as AC and DC.




**Note:** In DC or Direct Current circuits, the flow of electrons is in one direction only. It can be said then that DC has **polarity**. An example of this is your 9-volt (9-VDC) battery.

In AC or Alternating Current circuits, the flow of electrons is in two directions. The source frequently alternates or reverses in polarity. Therefore, we can say that AC changes polarity. An example of this is the electricity that travels in the wires inside your walls at home.

**Shocking Alternating Current FACT**

The red and black colour code does not apply to AC.

For safety reasons, DC or Direct Current only will be used for all of the projects in this course. **AC will not be used.**

## Learning Activity 1.5

**Quick Questions**

Answer the following in your notebook.

1. What is the supply for the DC-powered projects we are building in this course?
2. How many DC volts should it have?

Check your answers in the Learning Activity Answer Keys found at the end of this module.

---

## Experiment

**Problem:** How can you measure the flow of electricity?

**Material List**

- Pencil or pen
- Paper or foam cup
- Masking tape
- Timing watch
- 250 mL of table salt
- A bowl (used to catch the salt)
- An assistant

**Directions**

A. Take the pencil and poke a hole in the bottom of the cup. Do not make the hole any larger than the size of the pencil.

B. Cover the hole on the bottom the cup with tape, then pour the salt into the cup.

C. Hold the cup approximately 20 cm away from the bowl.

D. Remove the tape from the bottom of the cup. Ask your assistant to start the timing watch as soon as the salt starts pouring out of the hole.

E. Inform your assistant when the salt stops pouring out of the hole; stop and record how long the salt was flowing from the hole.

F. Then use this simple formula to calculate the flow rate.

$$\text{Rate of Flow} = \frac{\text{volume of salt that poured out (measured in mL)}}{\text{pouring time to empty the cut (measured in seconds)}}$$

The time it took for the salt to flow from the cup can vary depending on the size of the hole in the bottom of the cup. Here is an example you can use to calculate your flow rate.

$$\text{Rate of flow} = \frac{250 \text{ mL}}{37 \text{ seconds}}$$

Rate of flow = 6.75 mL per 1 second

## What's Going On Here?

The rate of flow can be understood by measuring the amount of salt that passes through the hole for a specific measured amount of time. In our example, we had 6.75 mL of salt pass through the hole for each second of time.

This flow rate will help you understand the flow of electric current. Electric current flows down an electric wire in much the same way as the salt flows through the hole in your cup. This quantity of electricity, called a current, is measured in amperes (amps for short).

We can use this image of salt passing through a hole to help understand the relationship of current, energy, and resistance. The amount of **energy** (flow of salt) in a system or circuit can be found by multiplying the amount of **current** (salt) by the amount of **resistance** (size of hole). In electricity and electronics, **energy** is called **voltage** and is measured in **volts**.

In the equation $E = I \times R$:

- **E** represents the amount of voltage. Sometimes the letter 'V' is used as the abbreviation.
- **I** represents the amount of current measured in amperes or amps. Sometimes the letter 'A' is used as the abbreviation.
- **R** represents resistance, measured in ohms. The Greek letter omega (Ω) is the abbreviation for ohms.

The rate of flow of electric current is similar to the flow of water. Just as the flow of salt is measured in mL/second, water can be measured in the same way, although gallons/hour is the more common measurement. Like salt, the larger the hole in a vessel containing water, the greater the rate of flow. Electricity is measured in amps/second. Less resistance equals greater electrical flow. Resistance equals the size of the hole when water pressure (or salt pressure or voltage) remains the same. Smaller wires have more resistance, slowing the flow.


**Hint:** When $6.28 \times 10^{18}$ or 6,280,000,000,000,000,000 electrons pass by a given point in a circuit in one second, it will equal one ampere or one amp of current.

**Lets do some more!**

1. Take the pencil and hollow out the hole twice as large as the first hole. Repeat the steps from the previous experiment and record your values in Assignment 1, Part 7, found at the end of Lesson 5.

2. Finally, use the pencil to make the hole four times as large as the first hole you made. Repeat the steps from the previous experiment and record your values Assignment 1, Part 7, found at the end of Lesson 5.

---

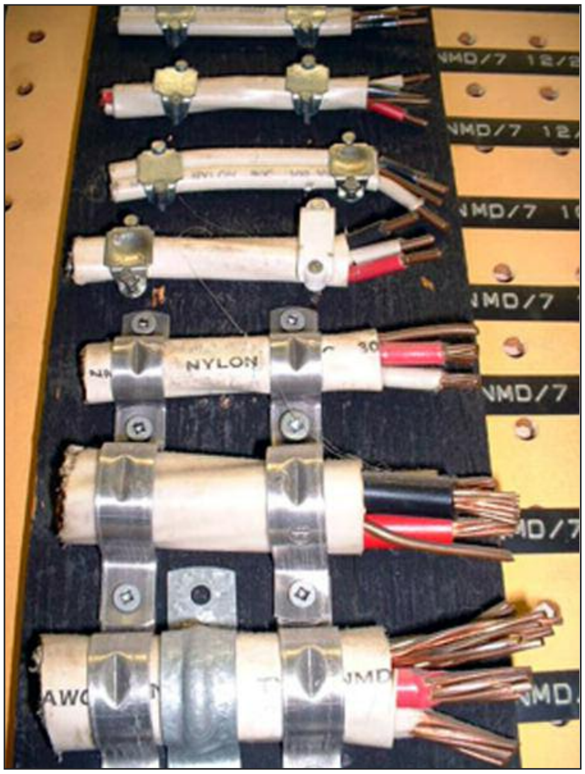
Go to Assignment 1 found at the end of this module and complete Part 7: Measuring the Flow Chart (see above).

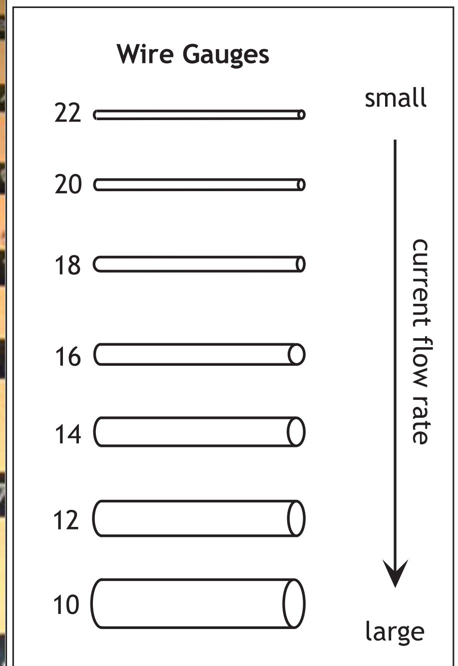
---

**Shocking FACT**

Why are we using salt for an experiment for an electronics course? The answer is simple. You have learned how electricity travels down electrical wires because there is a metal conductor (usually copper) inside. The conductor is covered with an insulator (usually plastic), which will prevent you from being shocked when you plug something into your wall outlet. Each electronic device in your home needs a different amount of current to work. Reading lamps or computers do not need a large flow of current to operate. Stoves, electric heaters, or clothes dryers, however, require a large amount of current to operate. This is why a thin wire is used for a lamp and a thick wire is used for a stove.

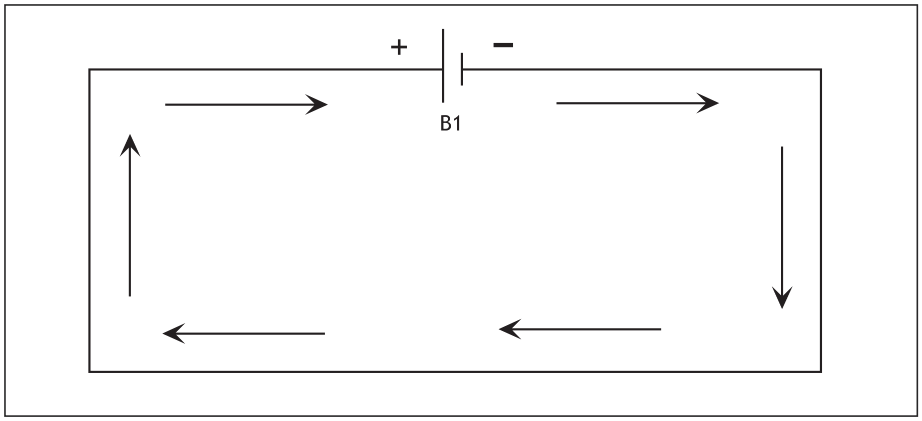
The measurement term we use to measure the thickness of wires is called the "gauge." The larger or thicker the wire, the smaller the number. Look at the wire used in your continuity tester project. The wire you used is 22-gauge wire. Lamps, televisions, stereos, or coffeepots use 14- or 16-gauge wire because they require more current to flow through them to operate.



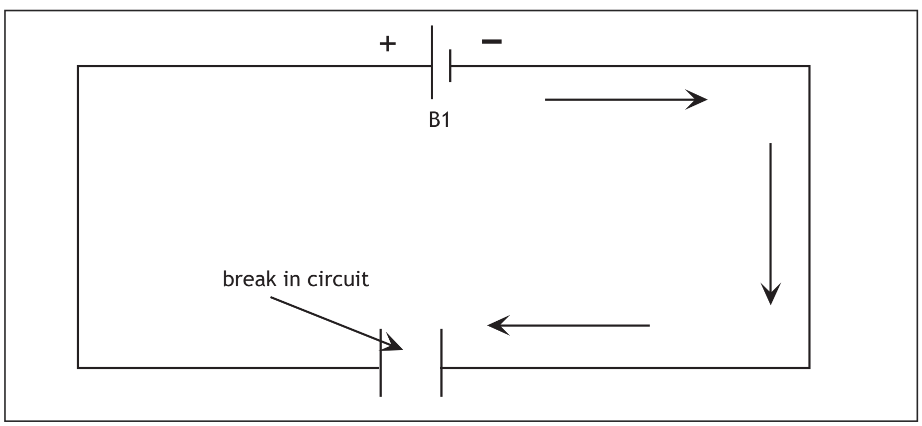

## Why Does Current Flow?

From the previous sections, you should now understand how an electron being knocked out of its original orbit would force other electrons into motion. If a force is placed at one end of a wire to push electrons through the wire and a force is placed at the other end to pull the electrons through, there will be a sudden motion of electrons along the wire conductor. A device that can create this force is a battery. A battery, by means of a chemical reaction inside the battery, will push electrons from one terminal and pull electrons from the other terminal. If a wire is connected between the two battery terminals, the electrons will immediately flow through the wire from one terminal to the other. This is called the flow of electric current.

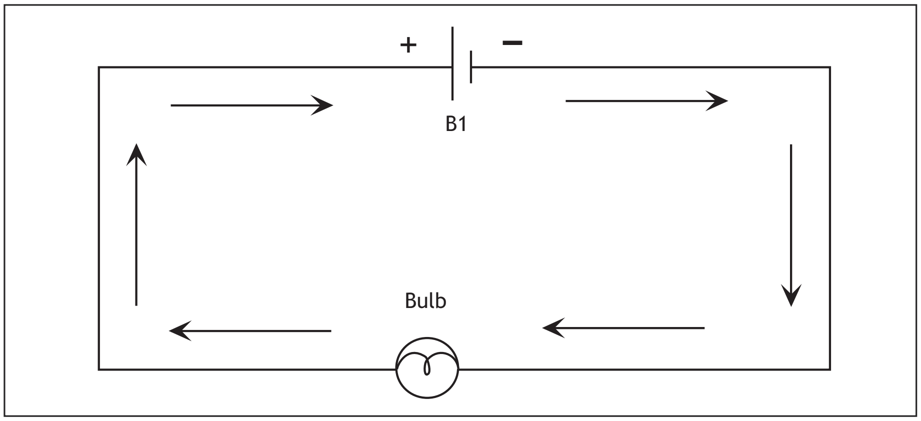



This circuit, though, has a big problem. It has a battery and leads, but no load. It has no switch, light, resistor, or fuse. This is called a **short circuit**. There is a path for electricity to flow but no resistance. The amount of current will increase until the circuit is broken.

Electrons will continue to flow in a circular path until the battery goes dead or until the circuit or path is broken by disconnecting the wire from one of the battery terminals. There must be a complete path for the electricity to flow. Electrons must be able to travel back through the battery to the original terminal they left. If you connect just one terminal to a battery, nothing will happen. There will be no movement of electrons, and therefore no current will flow.

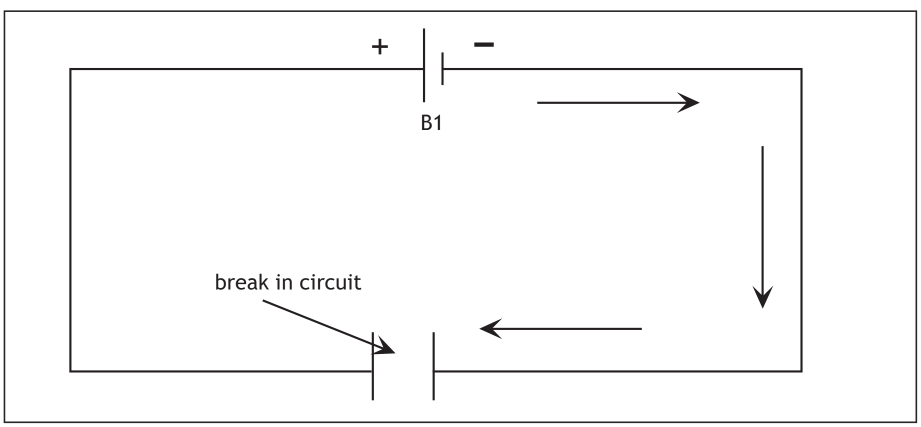



Every battery has a positive terminal. It has a (+) symbol on the side or top of the battery to label it as positive. This side of the battery attracts electrons. The other "post" or side of the battery is labelled as negative, with a (–) symbol to mark it. This side of the battery has many extra electrons that want to leave and flow through an electric circuit.



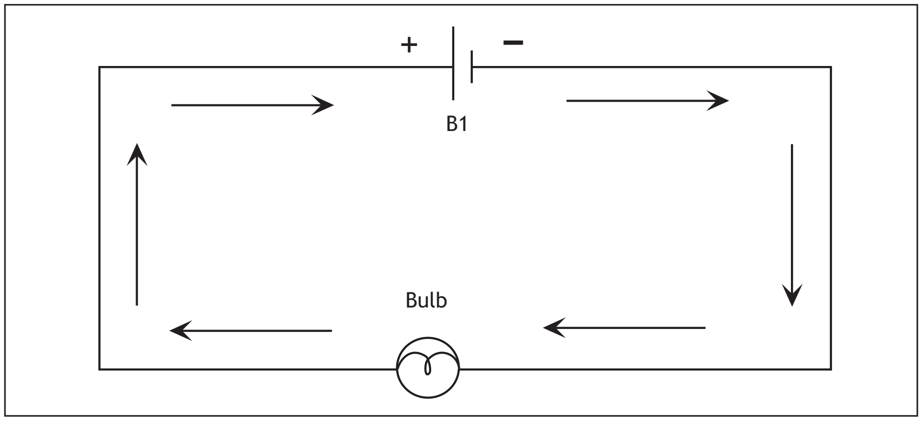

In the previous diagram, instead of using a battery, the positive (+) and negative (–) symbols were used. Notice how a short line is used for the negative and a longer line is used for the positive. Also, a symbol is used to represent the light bulb. Symbols like these are used on all electronic diagrams to identify the various parts/components and connections. It is a lot faster and easier to use symbols to represent parts instead of drawing the part as it appears. There is a different symbol for each electronic part. Diagrams using these symbols are called **schematic diagrams**. Schematic diagrams will be discussed in detail in a later module.

## What's Wrong with This Diagram?




The diagram above illustrates a break in the circuit because the electrons are not doing any useful work. No work is being done because the electrons are flowing from one negative terminal to the positive terminal only.

A useful circuit is one where work is being done. A good example would be a light bulb lighting up as electricity passes through it. The example below is an example of a useful circuit.



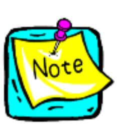

Here the circuit has a light bulb. The electrons are travelling from the negative terminal through the light bulb, and then back to the positive terminal. The light bulb is made by placing a piece of very hard wire (like tungsten) inside a glass body and then removing all the air from the glass enclosure.

The wire inside the glass enclosure is called a **filament**.

When electrons flow through the light bulb in the circuit, the tungsten filament produces a great deal of heat because of the resistance of the filament. In fact, the filament gets so hot it produces **white heat**. This in turn produces **white light**. In this circuit, the electron was put to work to produce light. We could also replace the light bulb with an electric motor, which would produce motion instead of light.

## The Ampere

The movement of electrons through a circuit is referred to as **electric current**. The strength of the current depends on the number of electrons in motion at any given point in the circuit. There needs to be a way to tell how much current is flowing through a circuit. It would be unrealistic to count the number of electrons flowing past a given point in a circuit. Therefore, a unit of measure called the ampere is used. An ampere is the number of electrons passing by a given point in a circuit per second.




**Hint:** When $6.28 \times 10^{18}$ or 6,280,000,000,000,000,000 electrons pass by a given point in a circuit in 1 second, it will equal 1 ampere or 1 amp of current. This can be considered the standard ampere.

This **standard ampere number** has been established, and all current measurements are made in relationship to the standard ampere. If the number of amperes passing by a given point in the circuit were twice the standard ampere, then the circuit would have two amperes of current. If it is 10 times the standard amount, 10 amperes of current will be flowing. The term *amp* or the plural form *amps* are abbreviations of the word *ampere*. To make five amperes plural, it could be simply written as 5 amps or 5 A. The letter symbol for amperes is "A."

**Special Note:** In some formulas the letter "I" is used.

## The Volt

As mentioned in the past lesson, when we look at the ampere, the amount of current that flows is dependent on the amount of force applied to the circuit. There is a way to measure this force. This force is referred to as **electromotive force** or **voltage**. It is thus measured in volts. Quite often electromotive force will be abbreviated as "EMF." There is no need to know how much force is in one volt, but rather the number of volts of force applied to the circuit. The higher the voltage, the more force is applied to the circuit. This would mean two volts have twice as much force of one volt. Ten volts would be ten times the force of one volt. The abbreviation for the term voltage is "V."

**Special Note:** In some formulas, "E" is used to represent voltage.

### Student Challenge 4

Does your flashlight work? If it doesn't, you will probably need to install new batteries or a new light bulb. Let's say you buy two new 1.5-volt batteries for your flashlight. You install them correctly and your light still does not work. So you buy a new light bulb. How many volts would the light bulb have to be? The answer is three volts, because each battery has 1.5 volts and there are two batteries in the flashlight.

**Formula:** 1.5 volts (each battery) multiplied by 2 (number of batteries) = 3 volts or 3 V

**Same Formula:** 1.5 V × 2 = 3 volts

## Learning Activity 1.6

**Measuring Voltage**

Remove the batteries from a flashlight or TV or DVD remote control. Rotate the Function dial on your digital multimeter (DMM) to measure Direct Current volts or DCV.

Measure the voltage in each battery and record your values below.

Battery 1 ______ volts

Battery 2 ______ volts

Battery 3 ______ volts, etc.

Check the DC voltage written on the battery case. If the measured voltage is below half of the written value on the side of the battery case, replace the battery.

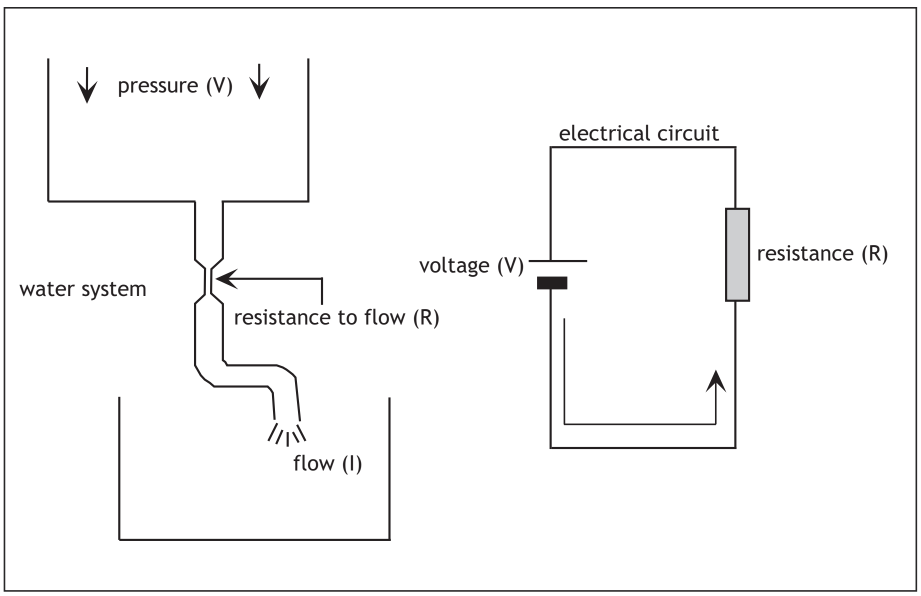
1. What do you notice different on the DMM when you change the measuring probes back and forth from negative to positive?
2. Do the batteries have polarity?
2. How did you determine your answer?

Check your answers in the Learning Activity Answer Keys found at the end of this module.

## The Ohm (Symbol Ω)

The amount of current that flows in a circuit depends upon more than the force applied. It also depends on how readily the material will give up electrons and let them move in the circuit with little or no opposition. However, many materials will not give up electrons very easily, and may create considerable opposition to the flow of current. This opposition is called resistance. The resistance of any material is dependent on how freely electrons can move through it. This resistance is measured in **ohms**. The symbol for ohms is the Greek letter omega, Ω. Once again you do not need to know what an ohm is. All that you need to understand is that resistance is the opposition to current flowing through a circuit and that it is measured in ohms. We will take a closer look at resistance in the next few modules.

How do amps, volts, and ohms work together to create a functioning circuit? Let's have a look at another closely related system to explain the electron flow: a water system. When a battery is connected in a circuit, electrons flow. The rate of flow, the current, is measured in amps, A. Imagine the current as the rate of the water flowing from the tap on the tank.



The voltage can be illustrated as pressure in a tank of standing water, measured in volts. It will want to force the volume of water through a smaller pipe. This smaller pipe will resist and restrict the volume of flow to a second tank. The measurement of this resistance would be in ohms. This picture of a plumbing system will help us visualize the electron flow. The higher the voltage, the more force there is in the circuit to drive the electrons. If the pipe is smaller between the tanks, the flow of water is smaller. Therefore, we can say that the larger the resistance, the smaller the current flow.

The diagram on the previous page is missing one piece. The electrical circuit is like a circle. The electrons keep going around and around. Can you add something to the water system diagram that would make the water go back to the top hopper? That would keep the pressure or voltage stable. The electrical circuit already has something to keep the circuit alive again and again. What part is that?

# NOTES

# LESSON 5: OHM'S LAW

## An Introduction to Ohm's Law

Ohm's Law is one of the most important rules or laws in electronics. Let's take a look at how voltage, current, and resistance are interrelated in an electrical circuit.

Ohm's Law states that the current flowing in the circuit is equal to the voltage divided by the resistance. George Simon Ohm discovered this in 1877. Rather than using words each time to express this law, we use symbols. We use the letter "I" for current, "E" or "V" for voltage, and "R" for resistance. Using the symbols we can express Ohm's Law as:

**George Simon Ohm**

$$E = I \times R$$

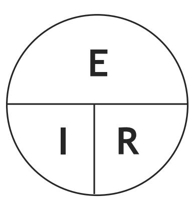
This is often written in the form:

$$\text{Volts} = \text{Amperes} \times \text{Ohms}$$

By arranging the expression, or by re-arranging it mathematically, if we know any two of the three values—resistance, current, or voltage—we can determine the remaining one. The other two formulas would look like this.

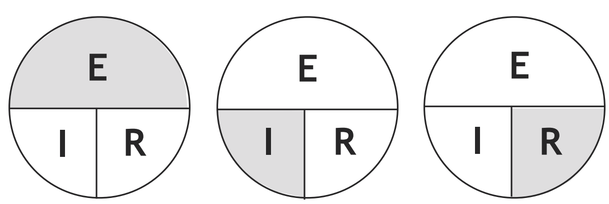
$$R = \frac{E}{I} \qquad \text{and} \qquad I = \frac{E}{R}$$

To prove this law is true, and to give you some practical applications of these formulas, we will do some simple problems using Ohm's Law. **If you find these formulas difficult to remember, you may find the diagram below helpful.**



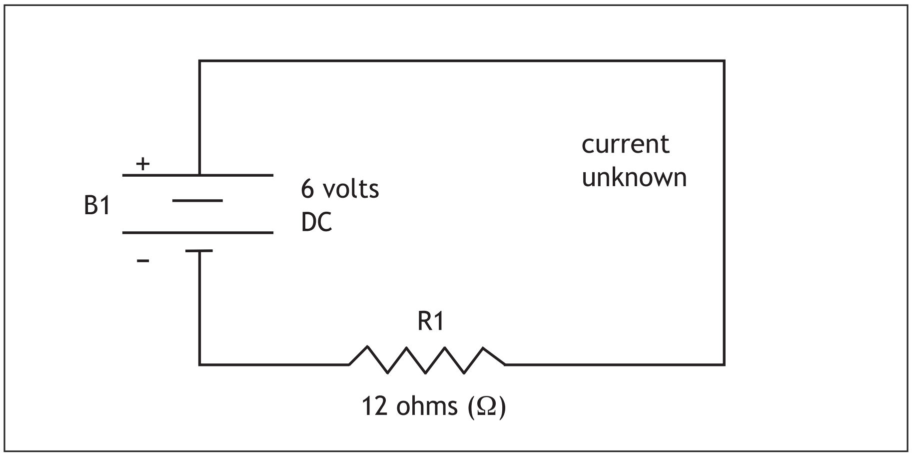

The horizontal line represents "divide;" the vertical line represents "multiply."

Simply cover the value you are looking for with your fingertip, and then the formula you need will be exposed.



### Example

In a circuit consisting of a 6-volt battery and a 12-ohm resistor, find the current passing through the resistor.




We need to find the current so we would cover the "I" with our fingertip on the diagram from the previous page. The formula to find "I" is then shown.

$$I = \frac{E}{R}$$

Substituting the values, we know "E" is six volts and the resistance is 12 ohms. Therefore, to find the current, you would divide 6 by 12 equaling 0.5 amps of current. How we determined this is shown below.

$$I = \frac{E}{R}$$

next $$I = \frac{6}{12}$$

next $I = 0.5$ amps

## Learning Activity 1.7

### Voltage

The purpose of the Learning Activity is to provide an opportunity to practice calculations involving voltage. After filling in the blanks on the chart found on the following page, you should know:

1. how to calculate a missing value, given the other two values.
2. how to keep expressions consistent (current times resistance equals voltage, or E/R = I, not I x ohms = voltage).
3. how to find the rise or fall of a missing value. (If the number of amps stays the same, and the number of ohms rises, will the number of volts go up or down?)

Use the following formula. Below are three different ways of writing it:

1. If you are speaking in terms of **qualities**, the formula is written as:

   **Current x Resistance = Voltage**

2. If you are speaking in terms of **units**, the formula is written as:

   **Amperes (or Amps) x Ohms = Volts**

3. If you are speaking in terms of **letter symbols**, the formula is written as:

   **I x R = E**

*(continued)*

## Learning Activity 1.7 (continued)

Fill in the blanks on the chart below. The first two entries have been done for you.

| 1 x | R = | E |
|---|---|---|
| 7 amps x | 2 ohms = | 14 volts |
| 7 amps x | 0.5 ohms = | 3.5 volts |
| 7 amps x | 12 ohms = | _______ volts |
| 6 amps x | 2 ohms = | _______ volts |
| 14 amps x | 2 ohms = | _______ volts |
| 7 amps x | 2 ohms = | _______ volts |
| 6 amps x | _______ ohms = | 12 volts |
| 6 amps x | _______ ohms = | 120 volts |
| 6 amps x | _______ ohms = | 10 volts |
| 3 amps x | _______ ohms = | 12 volts |
| 16 amps x | _______ ohms = | 12 volts |
| _______ amps x | 1.5 ohms = | 12 volts |
| _______ amps x | 1.5 ohms = | 11 volts |
| _______ amps x | 1.5 ohms = | 15 volts |
| _______ amps x | 0.5 ohms = | 100 volts |
| _______ amps x | 15 ohms = | 12 volts |
| _______ amps x | 12 ohms = | 12 volts |

Check your answers in the Learning Activity Answer Keys found at the end of this module.

## Learning Activity 1.8

**Try This One On Your Own**

You know "I" is calculated as 0.5 amps and that the resistance is 12 ohms. But you are not sure about the battery voltage. How would you work it out to find the voltage value?

Check your answer in the Learning Activity Answer Keys found at the end of this module.

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Go to Assignment 1 found at the end of this module and complete Part 8: Ohm's Law.

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Go to Assignment 1 found at the end of this module and complete Part 9 to Part 15.

# NOTES

# MODULE 1 SUMMARY

Congratulations, you have finished the first module in the course.

Remember

- Electricity is a form of energy.
- Matter is anything that has mass and occupies space.
- Molecules are made up of even smaller particles called atoms.
- Elements are made up of identical atoms. Atoms are made up of smaller particles called electrons, protons, and neutrons.
- The centre of an atom is the nucleus.
- The proton makes up part of the nucleus and it has a positive charge.
- The electron orbits the nucleus and has a negative charge.
- The law of electrical charges states: unlike charges attract and like charges repel.
- A conductor allows electrons to move freely through it.
- An insulator opposes the flow of electrons through it.
- A semiconductor can act as a conductor or an insulator.
- Current is the rate of flow of electrical energy and is measured in amperes (amps), letter symbol "A".
- Electrons flow from negative to positive.
- Electromotive force or voltage is measured in volts, letter symbol "V" and sometimes "E."
- Resistance to current flow is measured in ohms, Greek letter symbol Ω.
- Use Ohm's Law to determine the unknown value of voltage, amperes, or ohms.
- When two of the three units of measure are known, the third can always be calculated.

## Submitting Your Assignments

It is now time for you to submit your work from Module 1 to the Distance Learning Unit so that you can receive some feedback on how you are doing in this course. Remember that you must submit all the assignments in this course before you can receive your credit.

Make sure you have completed all parts of your Module 1 assignment and organize your material in the following order:

- Module 1 Cover Sheet
- Module 1 Log Sheet
- Assignment 1: Electricity

For instructions on submitting your assignments, refer to How to Submit Assignments in the course Introduction.

## Assignment 1

# Electricity

***Total: 175 marks***

### Part 1: Calculating the Distance from Lightning

Record your results in the chart below.

If there are 9 seconds between the flash of light and the sound, how far away is the lightning from you in kilometres? *(3 marks)*

| Time Difference between Flash and Sound (s) | Divide by 3.3 Seconds (Speed of Sound/km) | Equals (Distance in km) |
|---|---|---|
| 16 seconds | 3.3 | |
| 12 seconds | 3.3 | |
| 6 seconds | 3.3 | |

### Part 2: Testing Your 9-Volt Battery

For this question, you need one 9-volt battery and your digital multimeter or DMM.


*(continued)*

## *Assignment 1: Electricity (continued)*

Complete the following chart using your 9-volt battery and multimeter. Copy the symbol from the multimeter switch and the DCV number from the battery. *(4 marks)*

| Function Switch Position (Draw Symbol) | DCV (Record Number) | Tested Value (Correct Polarity) | Tested Value (Reverse Polarity) |
|---|---|---|---|
| | | | |
| | | | |

**Part 3: Schematic Symbols Assignment—"Learning a New Language"**

Electronic equipment is made up of many parts called components. These components have representative symbols, which can be drawn quickly and easily. These same symbols are used to represent a plan for a completed electronics project. Plans that use symbols to represent a component are called schematic diagrams.

Schematic symbols are an international language used by electronics technicians around the world to communicate with each other.

To understand electronics, you must be able to recognize these schematic symbols. Without them, drawing and designing a project would take hours where it takes minutes using schematic symbols.

*(continued)*

## *Assignment 1: Electricity (continued)*

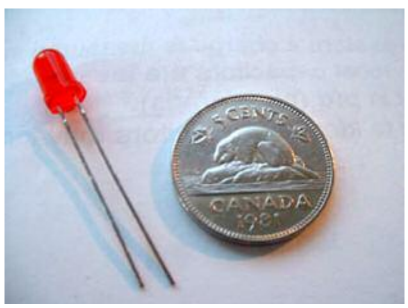
Your assignment is to find and redraw the schematic symbols for each part listed below. Redraw the symbols in the space provided.
*(1 mark each for a total of 22 marks)*

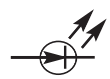
| Component Name and Picture | Schematic Symbol | Your Redrawn Symbol |
|---|---|---|

1. battery



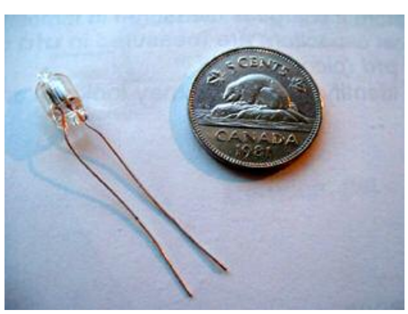
2. light-emitting diode

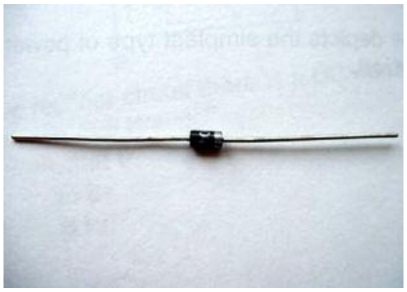
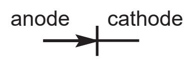
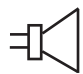
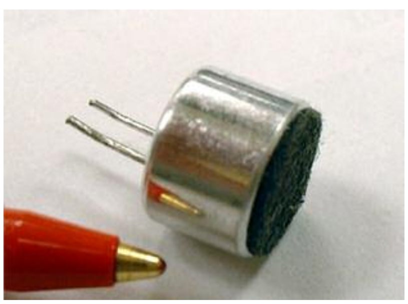
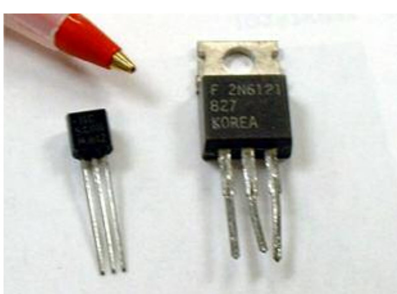
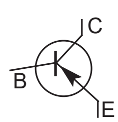
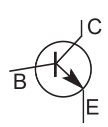


3. resistor

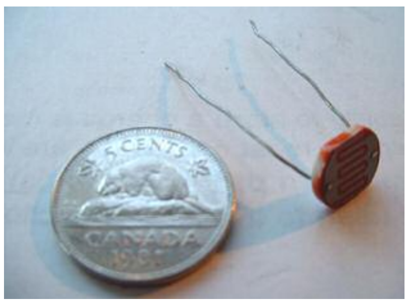
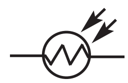
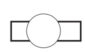

4. neon bulb




| Component Name and Picture | Schematic Symbol | Your Redrawn Symbol |
|---|---|---|
| 5. diode  |   | |
| 6. speaker  |  | |
| 7. microphone  |  | |
| 8. transistor   |   PNP   NPN | |

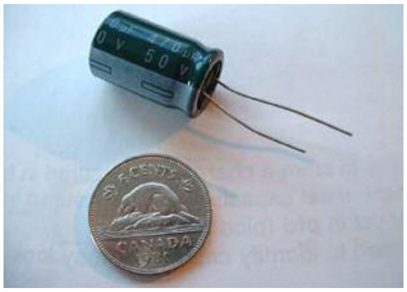
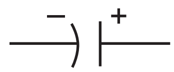
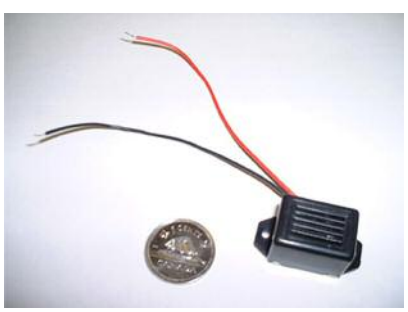
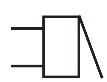
*(continued)*

# *Assignment 1: Electricity (continued)*

| Component Name and Picture | Schematic Symbol | Your Redrawn Symbol |
|---|---|---|
| 9. variable resistors  |  | |
| 10. photocell   |  | |
| 11. light bulb  |  | |
| 12. motor  |  | |

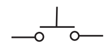
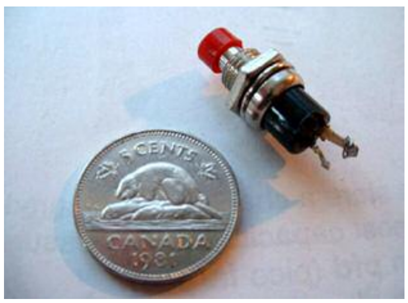
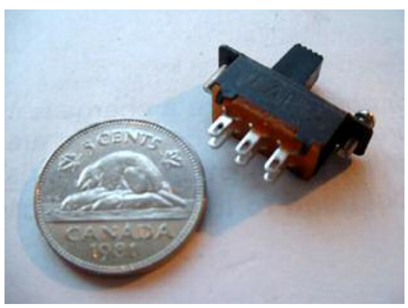
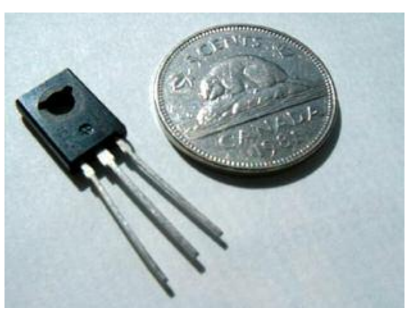
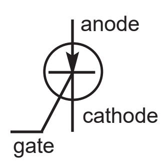
*(continued)*

# Assignment 1: Electricity (continued)

| Component Name and Picture | Schematic Symbol | Your Redrawn Symbol |
|---|---|---|
| 13. electrolytic capacitor  |  | |
| 14. ceramic capacitor  |  | |
| 15. fuse  |  | |
| 16. buzzer  |  | |

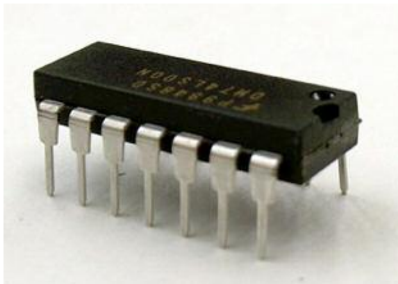
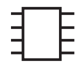
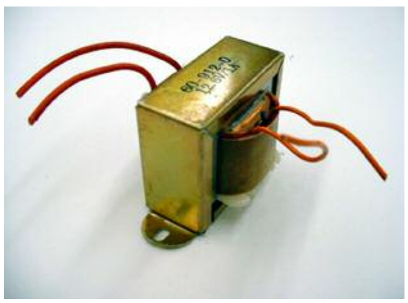
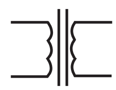
*(continued)*

## Assignment 1: Electricity (continued)

| Component Name and Picture | Schematic Symbol | Your Redrawn Symbol |
|---|---|---|
| 17. pushbutton switch (n.o)  |  normally open (n.o.) | |
| 18. pushbutton switch (n.c.)  |  normally closed (n.c.) | |
| 19. slide switch  |  | |
| 20. silicon controlled rectifier (SCR)  |   | |

*(continued)*

## Assignment 1: Electricity (continued)

| Component Name and Picture | Schematic Symbol | Your Redrawn Symbol |
|---|---|---|
| 21. integrated circuit  |  | |
| 22. transformer  |  | |

*(continued)*

**Part 4: Learning about Polarity**

Complete the following questions. *(1 mark each for a total of 9 marks)*

1. What happened to the LED when you made the change?

 ______________________________________________

2. What does the term *polarity* mean?

 ______________________________________________

 ______________________________________________

3. Which components in your solderless circuit board have polarity?

 ______________________________________________

 ______________________________________________

4. Why is it important to place the battery snap and battery in the proper polarity?

 ______________________________________________

5. What happened to the LED?

 ______________________________________________

6. Why did this happen?

 ______________________________________________

 ______________________________________________

7. Finally, return the LED to its original position so the circuit LED lights up. Identify the resistor in the circuit in Figure 2. Remove the resistor and switch the component legs around just as you did in the other two experiments. Does the LED remain lit?

 ______________________________________________

*(continued)*

8. Does the resistor have polarity?

_______________________________________________

9. Explain in detail why you chose your answer for Question 8.

_______________________________________________

_______________________________________________

**Part 5: Testing for Conductors and Insulators**

Record your results in the chart below. The last four items are your choice. Make sure to write down the names of your four choices. *(27 marks)*

| Item Name | Prediction (Light On / Light Off) | Conductor (Yes / No) | Insulator (Yes / No) |
|---|---|---|---|
| Paper Clip | | | |
| Tape | | | |
| Pencil | | | |
| Dinner Fork | | | |
| Plastic Ruler | | | |
| Drinking Straw | | | |
| Nail | | | |
| String | | | |
| Marble | | | |
| Choice 1 | | | |
| Choice 2 | | | |
| Choice 3 | | | |
| Choice 4 | | | |

*(continued)*

## *Assignment 1: Electricity (continued)*

### Part 6: Check This Out Questions

Answer the following questions. *(total of 7 marks)*

1. List three examples of "things" that use electricity to make your life easier or more fun. *(3 marks)*

   ______________________________________________

   ______________________________________________

   ______________________________________________

2. How do you think electricity travels to your house from the places where it is produced? *(3 marks)*

   ______________________________________________

   ______________________________________________

   ______________________________________________

   ______________________________________________

3. Are hydro power lines insulators or conductors? *(1 mark)*

   ______________________________________________

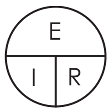
### Part 7: Measuring the Flow Chart

Record your results in the chart below. *(6 marks)*

| Size of Hole | Recorded Time (Measured in Seconds) | Rate of Flow (mL per Second) |
|---|---|---|
| small<br>size of pencil | | |
| medium<br>double pencil-hole size | | |
| large<br>four pencil-hole size | | |

*(continued)*

### Part 8: Ohm's Law




Answer the following questions. *(1 mark each for a total of 6 marks)*

1 In the Ohm's Law equation, which variable or letter symbol represents voltage? *(1 mark)*

a) E
b) I
c) R
d) None of the above

2 In the Ohm's Law equation, which variable or letter symbol represents resistance? *(1 mark)*

a) E
b) I
c) R
d) None of the above

3. In the Ohm's Law equation, which variable or letter symbol represents amperage? *(1 mark)*

a) E
b) I
c) R
d) None of the above

4. In a circuit that has an amperage of 5 amps and a voltage of 35 volts, what must be the resistance value? *(1 mark)*

a) 135 ohms
b) 35 ohms
c) 7 ohms
d) 0.142 ohms

*(continued)*

5. In a circuit that has a resistance of 500 ohms and a voltage of 9 volts, what must be the value in amps? *(1 mark)*
   a) 0.018 amps
   b) 4500 amps
   c) 55.55 amps
   d) 5.55 amps

6 In a circuit that has a resistance of 1200 ohms and an amperage of 0.005 amps, what must be the value in volts? *(1 mark)*
   a) 12 volts
   b) 60 volts
   c) 6 volts
   d) 0.12 volts

**Part 9: What Is Electricity?**

Answer the following questions. *(total of 27 marks)*

1. List the three basic particles that make up an atom, and state charge (negative, positive, or neutral) on each. *(6 marks)*

| Particle Name | Charge |
|---|---|
| ____________________ | ____________________ |
| ____________________ | ____________________ |
| ____________________ | ____________________ |

2. The movement of free electrons is called electric current. It cannot exist where there are no free electrons. What are free electrons? *(3 marks)*

   ________________________________________________

   ________________________________________________

   ________________________________________________

*(continued)*

## *Assignment 1: Electricity (continued)*

3. Draw and label a picture of a basic hydrogen atom including the nucleus, electrons, and protons. *(3 marks)*

4. Indicate the electric charge of the hydrogen atom pictured above: neutral, positive, negative. (Circle one) *(1 mark)*

5. Electrons that have been forced out of orbit are called

   __________________________ . *(1 mark)*

6. Explain the flow of electric current in a copper wire when an electric force is applied to the wire. *(3 marks)*

   ______________________________________________________

   ______________________________________________________

   ______________________________________________________

   ______________________________________________________

   ______________________________________________________

*(continued)*

## *Assignment 1: Electricity (continued)*

7. Two neutrons will neither attract nor repel each other because they have a neutral charge, or no charge. For the following particles, state whether they will attract, repel, or have no effect on each other. *(5 marks)*

   a) Proton and electron ______________________________

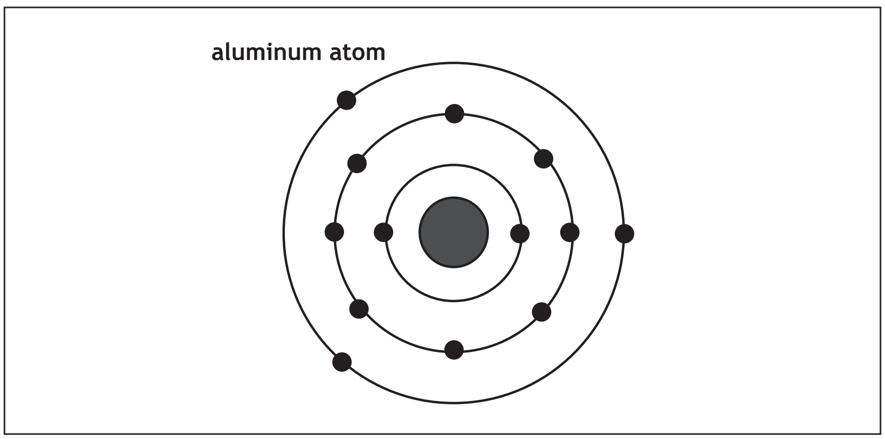
   b) Proton and neutron ______________________________

   c) Electron and neutron ______________________________

   d) Electron and electron ______________________________

   e) Proton and proton ______________________________

8. The aluminum atom shown is electrically neutral. Why? *(3 marks)*




______________________________________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

9. What would the charge of the aluminum atom be if one electron was removed from its outer orbit (negative or positive)? (Circle one) *(1 mark)*

10. Is the atom shown a conductor or an insulator? *(1 mark)*

______________________________________________________________

## *Assignment 1: Electricity (continued)*

### Part 10: Static Electricity

Answer the following questions. *(total of 5 marks)*

1. Blow up the balloon from the experiment kit package. Tie off the end of the balloon so it stays inflated. Rub the balloon on the rug or your hair several times. Take the balloon and place it on a wall surface. Explain what happens. Then explain why you think it happened. *(3 marks)*

 ______________________________________________________________

 ______________________________________________________________

 ______________________________________________________________

 ______________________________________________________________

 ______________________________________________________________

 ______________________________________________________________

2. Which situation involves static electricity? (Circle one) *(1 mark)*
   a) Turning the light on in your home
   b) Making popcorn in your microwave
   c) Combing your dry hair

3. What is the best way to create static electricity? (Circle one) *(1 mark)*
   a) Running around your carpet with socks on
   b) Jumping up and down
   c) Turning on a calculator

*(continued)*

## *Assignment 1: Electricity (continued)*

### Part 11: Conductors and Insulators

Answer the following questions. *(total of 11 marks)*

1. What are the differences between a conductor and an insulator? *(2 marks)*

   __________________________________________________

   __________________________________________________

   __________________________________________________

   __________________________________________________

   __________________________________________________

   __________________________________________________

2. What is a semiconductor? *(1 mark)*

   __________________________________________________

   __________________________________________________

3. Classify each of the following as a conductor or an insulator. Write your answer in the blank provided. You can use your continuity tester from Module 1 to help answer the following questions. *(8 marks)*

   Paper ________________________

   Water ________________________

   Drink Can Tab ________________________

   Copper Penny ________________________

   Plastic Ketchup Bottle ________________________

   Wooden Broom Handle ________________________

   Bicycle Tire ________________________

   Chrome Bicycle Rim ________________________

*(continued)*

*(continued)*

### Part 12: How Does Electricity Move?

Answer the following questions. *(total of 4 marks)*

1. What is the unit of measure for electric current? *(1 mark)*

   ____________________________________________________________

2. What is the unit of measurement that we use to measure electromotive force? *(1 mark)*

   ____________________________________________________________

3. What unit is used to measure the opposition to the flow of current? *(1 mark)*

   ____________________________________________________________

4. If we were to reduce the resistance in a circuit, would the flow of the current increase or decrease? (Circle one) *(1 mark)*

### Part 13: Lightning

Answer the following questions. *(total of 9 marks)*

1. What travels faster, sound or light? _____________ . *(1 mark)*

2. How many kilometres per second does sound travel?

   ___________ km/s *(1 mark)*

3. How many kilometres per second does light travel?

   ___________ km/s *(1 mark)*

4. In a lightning storm, would you see the flash of the lightning bolt before you hear the thunder? _____________ *(1 mark)*

*(continued)*

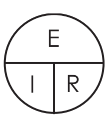
## Assignment 1: Electricity (continued)

5. Explain why. *(2 marks)*

6. Calculate the following distances for lightning. *(3 marks)*

| Time Difference between Flash and Sound (s) | Divide by 3.3 Seconds (Speed of Sound/km) | Equals (Distance in km) |
|---|---|---|
| 16 seconds | 3.3 | |
| 12 seconds | 3.3 | |
| 6 seconds | 3.3 | |

### Part 14: Ohm's Law




Answer the following questions. *(total of 24 marks)*

1. In the Ohm's Law equation, which variable or letter symbol represents voltage? *(1 mark)*
   a) E
   b) I
   c) R
   d) None of the above
2. In the Ohm's Law equation, which variable or letter symbol represents resistance? *(1 mark)*
   a) E
   b) I
   c) R
   d) None of the above

*(continued)*

## *Assignment 1: Electricity (continued)*

3. In the Ohm's Law equation, which variable or letter symbol represents amperage? *(1 mark)*
   a) E
   b) I
   c) R
   d) None of the above

4. In a circuit that has an amperage of 8 amps and a voltage of 32 volts, what must be the resistance value? *(1 mark)*
   a) 44 ohms
   b) 25 ohms
   c) 7 ohms
   d) 4 ohms

5. In a circuit that has a resistance of 990 ohms and a voltage of 12 volts, what must be the value in amps? *(1 mark)*
   a) 0.012 amps
   b) 82.5 amps
   c) 805 amps
   d) 11 880 amps

6. In a circuit that has a resistance of 800 ohms and an amperage of 0.02 amps, what must be the value in volts? *(1 mark)*
   a) 12 volts
   b) 16 volts
   c) 6 volts
   d) 24 volts

*(continued)*

## *Assignment 1: Electricity (continued)*

7. Calculate the resistance of the an automobile's headlight that requires 5 amps and a supply of 12 volts to operate. Make sure to show all formulas and calculations. *(3 marks)*

8. A compact disk player requires 2.5 amperes to operate. The voltage in your home wall outlet is 120 volts. What would be the internal resistance of the compact disk player? Make sure to show all formulas and calculations. *(3 marks)*

9. Your soldering iron requires 120 volts to operate. It also has a resistance of 300 ohms when it heats up. How much current in amps will this soldering iron draw? Make sure to show all formulas and calculations. *(3 marks)*

*(continued)*

## *Assignment 1: Electricity (continued)*

10. When you beep the horn in an automobile, it has a resistance of 0.35 ohms and operates when 12 volts are applied. How much current does the car's electrical system need to supply for the horn to operate? Make sure to show all formulas and calculations. *(3 marks)*

11. A light bulb with a resistance of 25 ohms requires 1.6 amperes before the light is fully lit. How many volts does this light bulb need to light? Make sure to show all formulas and calculations. *(3 marks)*

12. The radio in an automobile has an internal resistance of 300 ohms and operates at 0.04 amperes. What voltage from the electrical system is required to have the radio operate? Make sure to show all formulas and calculations. *(3 marks)*

*(continued)*

## *Assignment 1: Electricity (continued)*

### Part 15: Electricity

Use full sentences to answer the following. *(11 marks)*

1. How can you generate electricity? Make sure that you use some of the vocabulary that you learned as you worked through Module 1. *(5 marks)*

______________________________________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

2. Why would you use the continuity setting on your DMM? *(4 marks)*

______________________________________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

3. We compared a water circuit to an electrical circuit. What electrical component would be like a water-driven wheel on an old mill? *(2 marks)*

______________________________________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

# NOTES

# Grade 9 Electricity/ Electronics Technology (10G)

## Module 1: Electricity: The Shocking Facts on How It Is Produced

Learning Activity Answer Keys

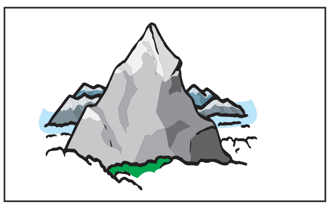
# Module 1: Electricity: The Shocking Facts on How It Is Produced

## Learning Activity 1.1: Components of Electricity

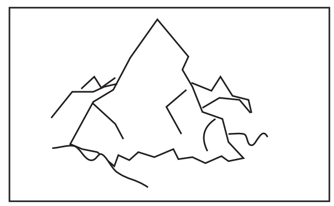
Complete the following. Learning activities are provided to help you practise what you have learned. Remember that you do not send learning activities to the Distance Learning Unit.

Redraw each of the following four items.

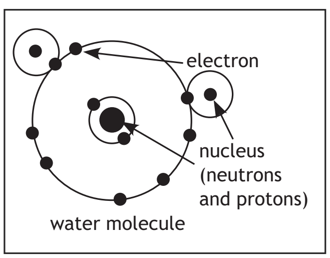
1. **Matter:** It can be defined as anything that occupies space and has mass, being a solid, liquid, or gas.



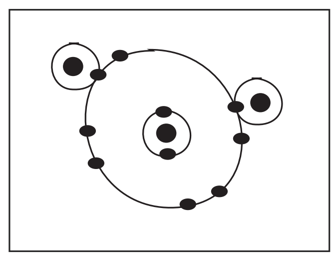
Redraw →



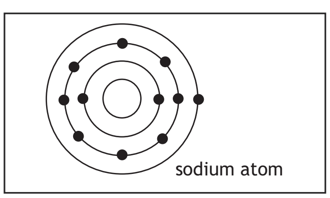
2. **Molecules:** Molecules are made up of one or more types of atoms.




Redraw →



3. **Single atom:** This is a pure basic substance or element.

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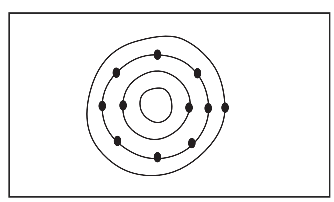
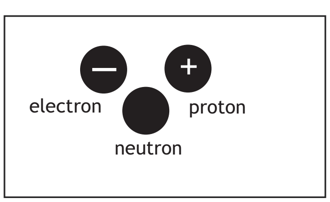


4. **Sub-atomic particles:** These are protons, electrons, and neutrons.

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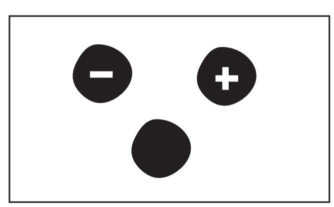
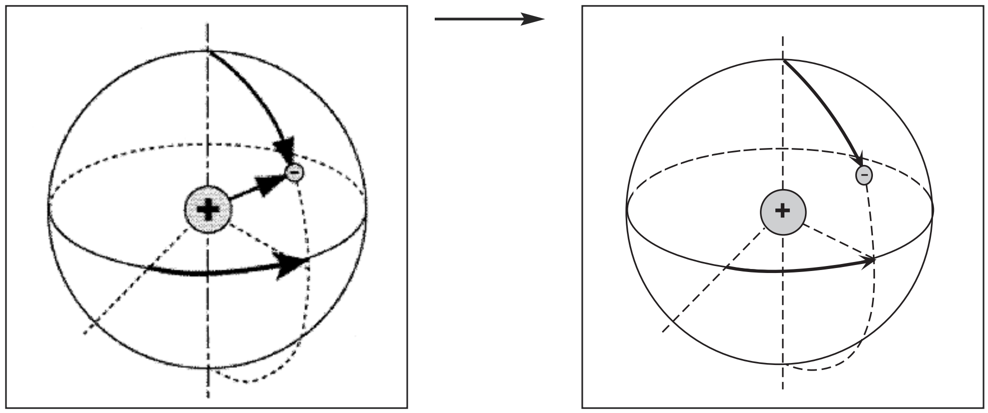


## Learning Activity 1.2: Hydrogen Atom

Below is a graphic image of Bohr's model of the hydrogen atom. Recreate this image in the space provided.



## Learning Activity 1.3: Static Electricity

*Have you ever tried to make static electricity?*

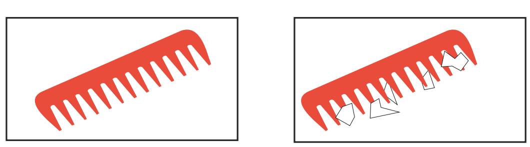
For each part of the experiment, record your findings on the chart that follows.

**Part 1: Can you electrify a plastic comb?**

Material list:

- One plastic comb
- Small bits of scrap paper
- Table salt
- Pepper

Tear the paper up into very small 1-cm pieces and then comb your dry hair many times. This will electrify the comb by transferring electrons from your hair to the comb, giving it a negative charge. Now bring the comb closer to the pieces of paper. The pieces of paper will have a positive charge, causing them to stick to the comb. This proves that unlike charges attract each other. Try the same experiment using salt and pepper instead of paper. **Don't forget to record your results on the chart below.**



Before After

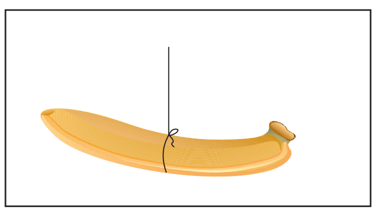
| Part 1: Chart | | |
|---|---|---|
| Item | Effect of Charged Comb | Why? |
| Bring the charged comb near the paper pieces | Paper sticks to comb | Unlike charges attract |
| Bring the charged comb near the table salt | Nothing | No effect on neutral charged object |
| Bring the charged comb near the pepper | Nothing | No effect on neutral charged object |

**Part 2: Can you make a banana dance?**

Material list:

- Piece of string
- One balloon
- One banana

Hang a banana from a string. Make sure to balance the banana as you tie it in the middle. Rub an inflated balloon on your hair or on the carpet in your home. This will put an electric charge on the balloon. Hold the balloon near one end of the banana. The banana should twist and follow the balloon. **Don't forget to record your results on the chart below.**



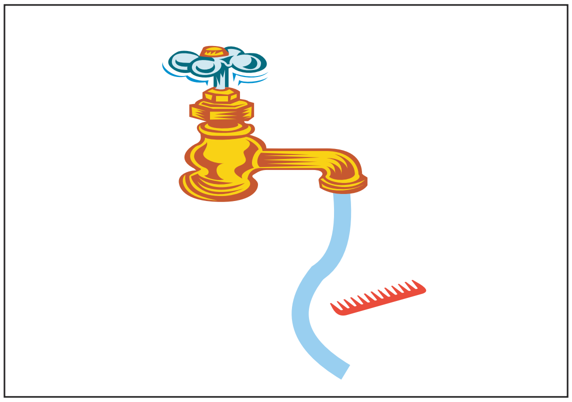
| Part 2: Chart | |
|---|---|
| Effect of Charged Balloon on Banana | Why Did This Happen? |
| The bananas should move away from the balloon. | They were the same charge (i.e., like charges repel). |

**Part 3: Can you bend water?**

Material list:

- Plastic comb
- A very slow flow of water

Turn on your water faucet so you have a slow, steady stream of water. Rub the comb through your dry hair several times. Now, slowly put the electrically charged comb near the stream of water but do not touch it. If you do touch the water, dry the comb off well and repeat the procedure from the beginning. **Don't forget to record your results on the chart below.**



| Part 3: Chart | |
|---|---|
| Effect of Charged Comb against Flow of Water | Why Do You Think This Happened? |
| The water flow bent. | The water moved away from the comb because the comb had a static charge around it. |

## Learning Activity 1.4: Conductors and Insulators

List four conductors found in your home. Example: *dinner fork*

*Possible answers:*

nail clipper

door know

dime

metal bowl

List four insulators found in your home. Example: *plastic toothbrush*

*Possible answers:*

wooden hockey stick

leather belt

glass bowl

pillow

## Learning Activity 1.5: Quick Questions

1. What is the supply for the DC-powered projects we are building in this course?

   *Answer:* battery

2. How many DC volts should it have?

   *Answer:* 9 volts

# Learning Activity 1.6: Measuring Voltage

Remove the batteries from a flashlight or TV or VCR remote control. Rotate the Function dial on your digital multimeter (DMM) to measure Direct Current volts or DCV.

Measure the voltage in each battery and record your values below.

Battery 1 ______ volts

Battery 2 ______ volts

Battery 3 ______ volts, etc.

Check the DC voltage written on the battery case. If the measured voltage is below half of the written value on the side of the battery case, replace the battery.

1. What do you notice different on the DMM when you change the measuring probes back and forth from negative to positive?

   *Answer:*

   The LCD screen will have the negative symbol on it with improper polarity testing.

2. Do the batteries have polarity?

   *Answer:* Yes

3. How did you determine your answer?

   *Answer:*

   When the probes were moved back and forth to each polarized contact, the LCD screen had a negative symbol and then o negative symbol.

## Learning Activity 1.7: Voltage

The purpose of the Learning Activity is to provide an opportunity to practice calculations involving voltage. After filling in the blanks on the chart found on the following page, you should know:

1. how to calculate a missing value, given the other two values.
2. how to keep expressions consistent (current times resistance equals voltage, or E/R = I, not I × ohms = voltage).
2. how to find the rise or fall of a missing value. (If the number of amps stays the same, and the number of ohms rises, will the number of volts go up or down?)

Use the following formula. Below are three different ways of writing it:

1. If you are speaking in terms of **qualities**, the formula is written as:

   **Current × Resistance = Voltage**

2. If you are speaking in terms of **units**, the formula is written as:

   **Amperes (or Amps) × Ohms = Volts**

3. If you are speaking in terms of **letter symbols**, the formula is written as:

   **I × R = E**

Fill in the blanks on the chart below. The first two entries have been done for you.

| 1 x | R = | E |
|---|---|---|
| 7 amps x | 2 ohms = | 14 volts |
| 7 amps x | 0.5 ohms = | 3.5 volts |
| 7 amps x | 12 ohms = | 84 volts |
| 6 amps x | 2 ohms = | 12 volts |
| 14 amps x | 2 ohms = | 28 volts |
| 7 amps x | 2 ohms = | 14 volts |
| 6 amps x | 2 ohms = | 12 volts |
| 6 amps x | 20 ohms = | 120 volts |
| 6 amps x | 1.7 ohms = | 10 volts |
| 3 amps x | 4 ohms = | 12 volts |
| 16 amps x | 0.75 ohms = | 12 volts |
| 8 amps x | 1.5 ohms = | 12 volts |
| 7.3 amps x | 1.5 ohms = | 11 volts |
| 10 amps x | 1.5 ohms = | 15 volts |
| 200 amps x | 0.5 ohms = | 100 volts |
| 0.8 amps x | 15 ohms = | 12 volts |
| 1 amps x | 12 ohms = | 12 volts |

## Learning Activity 1.8: Try This One On Your Own

You know "I" is calculated as 0.5 amps and that the resistance is 12 ohms. But you are not sure about the battery voltage. How would you work it out to find the voltage value?

*Answer:*

$E = I \times R$

$E = 0.5\ A \times 12\ \Omega$

E = 6 volts

NOTES

# MODULE 1 SUMMARY

Congratulations, you have finished the first module in the course.

Remember

- Electricity is a form of energy.
- Matter is anything that has mass and occupies space.
- Molecules are made up of even smaller particles called atoms.
- Elements are made up of identical atoms. Atoms are made up of smaller particles called electrons, protons, and neutrons.
- The centre of an atom is the nucleus.
- The proton makes up part of the nucleus and it has a positive charge.
- The electron orbits the nucleus and has a negative charge.
- The law of electrical charges states: unlike charges attract and like charges repel.
- A conductor allows electrons to move freely through it.
- An insulator opposes the flow of electrons through it.
- A semiconductor can act as a conductor or an insulator.
- Current is the rate of flow of electrical energy and is measured in amperes (amps), letter symbol "A".
- Electrons flow from negative to positive.
- Electromotive force or voltage is measured in volts, letter symbol "V" and sometimes "E."
- Resistance to current flow is measured in ohms, Greek letter symbol Ω.
- Use Ohm's Law to determine the unknown value of voltage, amperes, or ohms.
- When two of the three units of measure are known, the third can always be calculated.

## Submitting Your Assignments

It is now time for you to submit your work from Module 1 to the Distance Learning Unit so that you can receive some feedback on how you are doing in this course. Remember that you must submit all the assignments in this course before you can receive your credit.

Make sure you have completed all parts of your Module 1 assignment and organize your material in the following order:

- Module 1 Cover Sheet
- Module 1 Log Sheet
- Assignment 1: Electricity

For instructions on submitting your assignments, refer to How to Submit Assignments in the course Introduction.

# Grade 9 Electricity/ Electronics Technology (10G)

## Module 1: Electricity: The Shocking Facts on How It Is Produced

Learning Activity Answer Keys

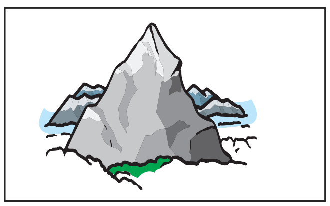
# Module 1: Electricity: The Shocking Facts on How It Is Produced

## Learning Activity 1.1: Components of Electricity

Complete the following. Learning activities are provided to help you practise what you have learned. Remember that you do not send learning activities to the Distance Learning Unit.

Redraw each of the following four items.

1. **Matter:** It can be defined as anything that occupies space and has mass, being a solid, liquid, or gas.



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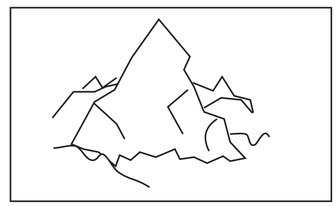
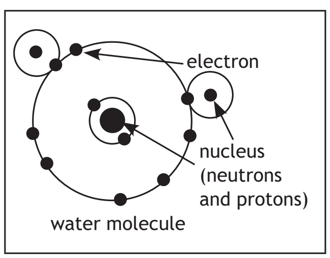


2. **Molecules:** Molecules are made up of one or more types of atoms.

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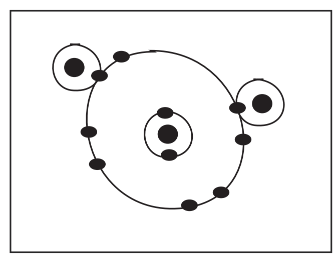
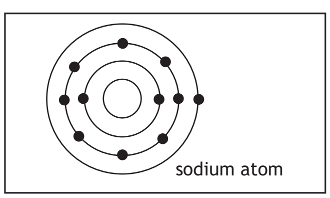


3. **Single atom:** This is a pure basic substance or element.

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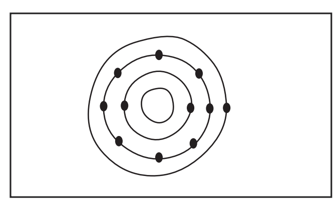
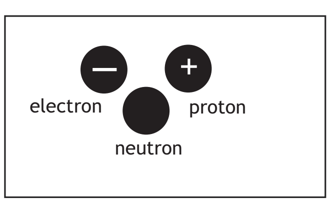


4. **Sub-atomic particles:** These are protons, electrons, and neutrons.

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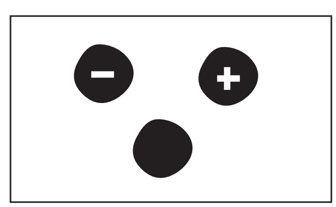
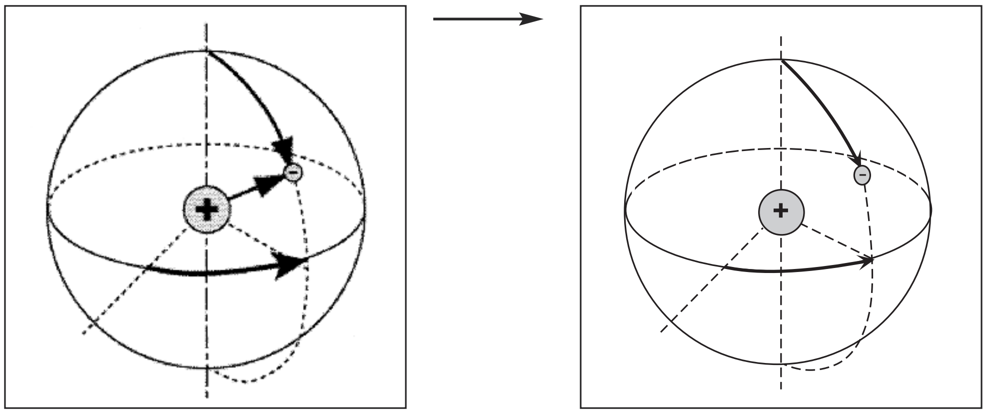


## Learning Activity 1.2: Hydrogen Atom

Below is a graphic image of Bohr's model of the hydrogen atom. Recreate this image in the space provided.



## Learning Activity 1.3: Static Electricity

*Have you ever tried to make static electricity?*

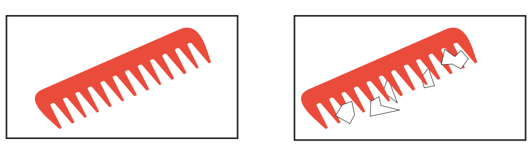
For each part of the experiment, record your findings on the chart that follows.

**Part 1: Can you electrify a plastic comb?**

Material list:

- One plastic comb
- Small bits of scrap paper
- Table salt
- Pepper

Tear the paper up into very small 1-cm pieces and then comb your dry hair many times. This will electrify the comb by transferring electrons from your hair to the comb, giving it a negative charge. Now bring the comb closer to the pieces of paper. The pieces of paper will have a positive charge, causing them to stick to the comb. This proves that unlike charges attract each other. Try the same experiment using salt and pepper instead of paper. **Don't forget to record your results on the chart below.**



Before After

| Part 1: Chart | | |
|---|---|---|
| Item | Effect of Charged Comb | Why? |
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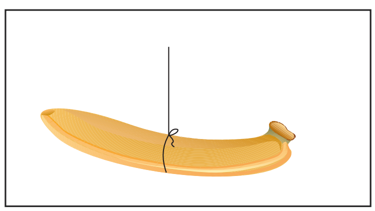
**Part 2: Can you make a banana dance?**

Material list:

- Piece of string
- One balloon
- One banana

Hang a banana from a string. Make sure to balance the banana as you tie it in the middle. Rub an inflated balloon on your hair or on the carpet in your home. This will put an electric charge on the balloon. Hold the balloon near one end of the banana. The banana should twist and follow the balloon. **Don't forget to record your results on the chart below.**



| Part 2: Chart | |
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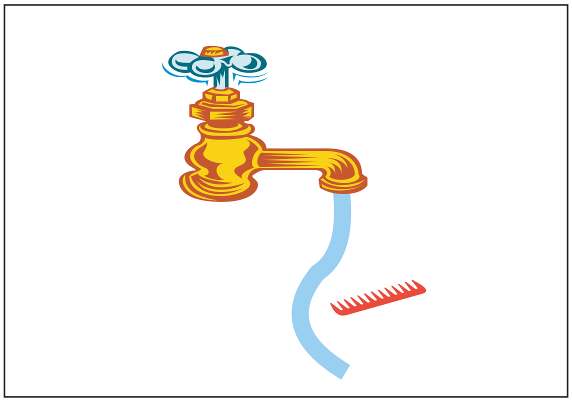
| The bananas should move away from the balloon. | They were the same charge (i.e., like charges repel). |

**Part 3: Can you bend water?**

Material list:

- Plastic comb
- A very slow flow of water

Turn on your water faucet so you have a slow, steady stream of water. Rub the comb through your dry hair several times. Now, slowly put the electrically charged comb near the stream of water but do not touch it. If you do touch the water, dry the comb off well and repeat the procedure from the beginning. **Don't forget to record your results on the chart below.**



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|---|---|
| Effect of Charged Comb against Flow of Water | Why Do You Think This Happened? |
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## Learning Activity 1.4: Conductors and Insulators

List four conductors found in your home. Example: *dinner fork*

*Possible answers:*

nail clipper

door know

dime

metal bowl

List four insulators found in your home. Example: *plastic toothbrush*

*Possible answers:*

wooden hockey stick

leather belt

glass bowl

pillow

## Learning Activity 1.5: Quick Questions

1. What is the supply for the DC-powered projects we are building in this course?

   *Answer:* battery

2. How many DC volts should it have?

   *Answer:* 9 volts

## Learning Activity 1.6: Measuring Voltage

Remove the batteries from a flashlight or TV or VCR remote control. Rotate the Function dial on your digital multimeter (DMM) to measure Direct Current volts or DCV.

Measure the voltage in each battery and record your values below.

Battery 1 ______ volts

Battery 2 ______ volts

Battery 3 ______ volts, etc.

Check the DC voltage written on the battery case. If the measured voltage is below half of the written value on the side of the battery case, replace the battery.

1. What do you notice different on the DMM when you change the measuring probes back and forth from negative to positive?

   *Answer:*

   The LCD screen will have the negative symbol on it with improper polarity testing.

2. Do the batteries have polarity?

   *Answer:* Yes

3. How did you determine your answer?

   *Answer:*

   When the probes were moved back and forth to each polarized contact, the LCD screen had a negative symbol and then o negative symbol.

## Learning Activity 1.7: Voltage

The purpose of the Learning Activity is to provide an opportunity to practice calculations involving voltage. After filling in the blanks on the chart found on the following page, you should know:

1. how to calculate a missing value, given the other two values.
2. how to keep expressions consistent (current times resistance equals voltage, or E/R = I, not I × ohms = voltage).
2. how to find the rise or fall of a missing value. (If the number of amps stays the same, and the number of ohms rises, will the number of volts go up or down?)

Use the following formula. Below are three different ways of writing it:

1. If you are speaking in terms of **qualities**, the formula is written as:

   **Current × Resistance = Voltage**

2. If you are speaking in terms of **units**, the formula is written as:

   **Amperes (or Amps) × Ohms = Volts**

3. If you are speaking in terms of **letter symbols**, the formula is written as:

   **I × R = E**

Fill in the blanks on the chart below. The first two entries have been done for you.

| 1 x | R = | E |
|---|---|---|
| 7 amps x | 2 ohms = | 14 volts |
| 7 amps x | 0.5 ohms = | 3.5 volts |
| 7 amps x | 12 ohms = | __84__ volts |
| 6 amps x | 2 ohms = | __12__ volts |
| 14 amps x | 2 ohms = | __28__ volts |
| 7 amps x | 2 ohms = | __14__ volts |
| 6 amps x | __2__ ohms = | 12 volts |
| 6 amps x | __20__ ohms = | 120 volts |
| 6 amps x | __1.7__ ohms = | 10 volts |
| 3 amps x | __4__ ohms = | 12 volts |
| 16 amps x | __0.75__ ohms = | 12 volts |
| __8__ amps x | 1.5 ohms = | 12 volts |
| __7.3__ amps x | 1.5 ohms = | 11 volts |
| __10__ amps x | 1.5 ohms = | 15 volts |
| __200__ amps x | 0.5 ohms = | 100 volts |
| __0.8__ amps x | 15 ohms = | 12 volts |
| __1__ amps x | 12 ohms = | 12 volts |

## Learning Activity 1.8: Try This One On Your Own

You know "I" is calculated as 0.5 amps and that the resistance is 12 ohms. But you are not sure about the battery voltage. How would you work it out to find the voltage value?

*Answer:*

$E = I \times R$

$E = 0.5\ A \times 12\ \Omega$

E = 6 volts

## NOTES

# Grade 9 Electricity/ Electronics Technology (10G)

## Module 2: Safety

# Module 2: Safety

## Module Focus

**When you finish this module, you will be able to**

- ❑ outline electrical safety rules in your home
- ❑ outline electrical safety rules when working with electronics tools and projects
- ❑ outline factors that determine the severity of electrical shock
- ❑ understand the maximum safe current and voltage values
- ❑ explain how body resistance is related to the severity of electric shock
- ❑ outline the procedures to be followed in case of electrical fire
- ❑ outline some basic first aid procedures in case an accident occurs
- ❑ work safely with electronics
- ❑ identify and state the use of common electronics tools
- ❑ understand how to work safely with electronics tools

## Introduction

Module 2 discusses the safety issues related to the study of electricity/ electronics. Remember: *Take off your rings, not your fingers – the alarming facts about electricity*.

This module also looks at metrification and conversion, milli amps and the dangers associated with electrical current, kilo and mega ohms, issues related to hazardous materials and your right to know, and tools and electrical component safety.

## Power Words

short circuit
grounded
artifical resuscitation
heat sink
torque

## Assignments in Module 2

When you have completed the Module 2 assignment, submit your completed assignment, along with the Log Sheet and Module 2 Cover Sheet, to the Distance Learning Unit either by mail or electronically through the learning management system (LMS). The staff will forward your work to your tutor/marker.

# Lesson 1: Is Your Home a Hazard Zone? Time to THINK!

## Safety at Home

Let's assume you have the proper attitude. Now, we will look at the world's most dangerous place. Your first choice might be the African jungle or a war zone. Actually, it's your home! Next to your automobile, your home is the most likely place for an accident to occur, simply because you spend the majority of your time there. More than one-third of all accident-related emergency visits to the hospital are from accidents in the home.

Look around your home. How many objects do you spot that are unsafe? You may not think about the picture over your bed that could fall on you in the middle of the night, or the empty paint cans that could also fall on you, cause you to trip, or even explode. Maybe your television is top-heavy and just waiting to fall off the shelf. Think about these things as you go through this safety unit.

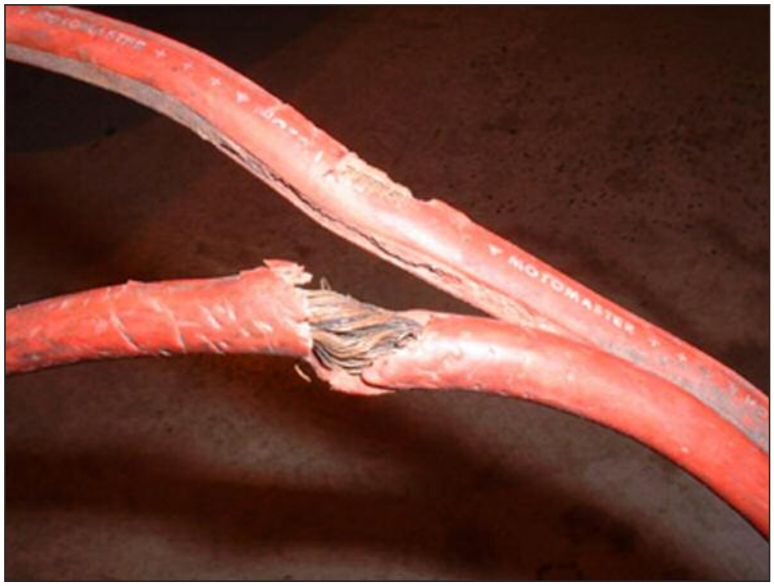
Any job, procedure, or activity should be approached with safety in mind. Throughout this course, you will analyze safety rules, safety labels, and safety procedures. It will be a challenge for you to remember all of the safety procedures hereafter, but one word may help you to go about your day and complete this course without an emergency room visit. That word is **THINK!** Always take a few seconds to ask yourself, "What could happen if I do it this way?" It is a lot easier to take the time to think to prevent an incident than to "learn the hard way" and actually experience one.

As for electricity, strange as it seems, most electrical shocks happen to people who know better. Electrical equipment in the home, when installed and used properly, is safe. It is only dangerous when it is misused or damaged. You will use tools that can cut, burn, shock, blind, and pinch you. The safety you review focuses primarily on electricity, but also includes other general safety tips. What is the key to survival in your home? Take the time to eliminate the many dangerous situations. So let us take a close look at electrical safety and learn how this can be done.

The best way to avoid accidents is to eliminate the potential hazards. Here is a list of potential hazards in your home.

1. Never run extension cords under a rug. They could heat up and start a fire.
2. Never jerk cords from electrical outlets.
3. Never use water to put out an electrical fire.
4. Never use electric heaters, radios, or any other plug-in style appliance near a water source like a bathtub or swimming pool.
5. Never overload a circuit by using several cord splitters or power bars in one wall outlet.

6. Replace damaged electrical cords.



7. Always clean up spills immediately to help eliminate falls or electrical shock.
8. Always plug empty outlet sockets to prevent children from inserting a foreign object into the socket and receiving an electrical shock.
9. Always unplug toasters and clothes irons when not in use.
10. Always turn off the main power switch when modifying or adding to an electrical circuit.

Sparkey Says: Take time to THINK.

## NOTES

# Lesson 2: Let's Raise the Stakes!

## Safety at Work

As mentioned in the previous lesson, the dangers in your home are all around you. As you continue with your projects and complete experiments, the danger factor will be greatly increased. When working with tools and equipment that melt, cut, or bend components, make sure you **THINK** before you do anything. You must learn to protect yourself and others working near you. The following list will help you be safe and will hopefully save you a trip to the doctor.

1. Always wear eye protection when working with any tool. Safety goggles **cannot** be substituted with any type of sunglasses or prescription eyeglasses. Safety goggles are impact resistant and cover your eyes from the top near your eyebrows and to the sides near your temples. Never lay your goggles with the front lens on the table—they scratch.

2. Make sure the equipment that you are going to use is in proper working order.
3. Think!
4. Know the correct and safe ways to use tools.
5. Always keep your work area neat and clean.
6. Always work under good lighting conditions.
7. Think!
8. Never make changes or repairs to a circuit that is plugged in.
9. Do not work on a metal tabletop.

10. Think!
11. Make sure your hands and the work area around you are dry.
12. Remove all watches, rings, or other jewellery when working with tools. The jewellery may get caught in a tool or machine part, creating a potential disaster.
13. Tie back long hair to prevent it from getting entangled in tools or machine parts.
14. If you have a hot soldering iron on your desk, arrange the work surface so you don't have to reach over the extremely hot end.
15. Make sure the soldering iron cord does not get entangled in the holder. The cord could melt and cause a short circuit.
16. Never take a shock on purpose.
17. Make sure all electrical connections are secure before applying power.
18. Do not carry sharp tools in your pocket.
19. **Think!**

# Lesson 3: Metrification and Conversion of SI Units

## Making Sense of Numbers

As you work through electronics labs, projects, and experiments, you will encounter very large or very small numbers. You will find that some of the numbers that you work with may have decimal points or many extra zeros. Those zeros and decimal points mean a world of difference. We are about to learn how to write and understand numbers without having to use too many zeros in our final answers. Adding a prefix to a number will help reduce all the zeros.

### Check This Out!

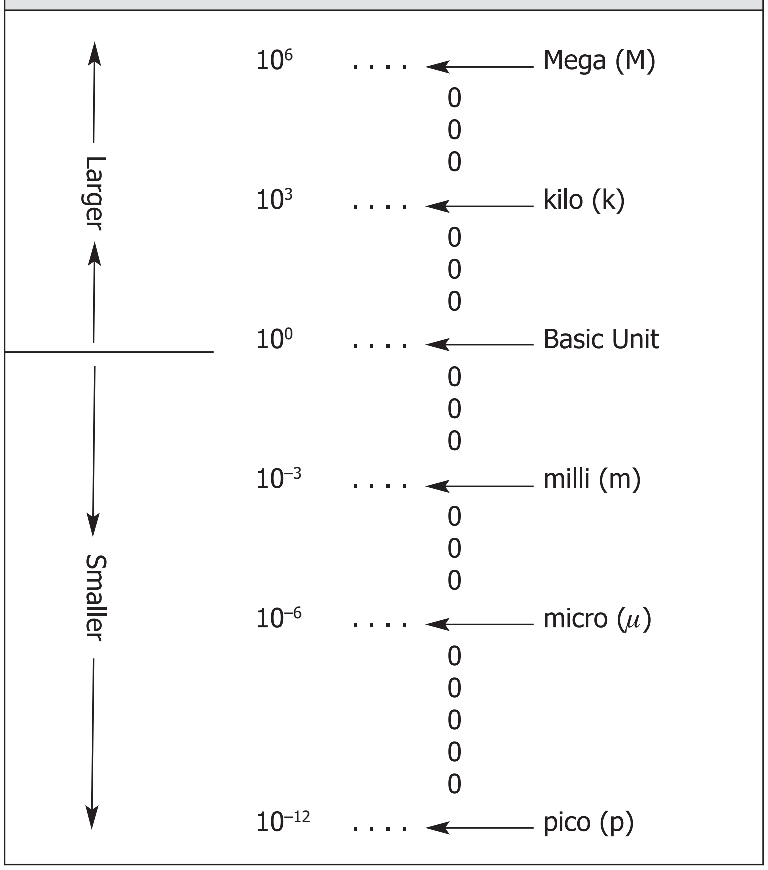
A good comparison to what you will be doing is the system used to express measurement and weight. In measurement, you would always write 1000 metres as 1 kilometre or .001 grams as 1 milligram.


| Common Electrical SI Units and Symbols | | | |
|---|---|---|---|
| **Quantity** | **Abbreviation** | **Basic SI Unit** | **SI Unit Symbol** |
| Electrical Potential Energy Difference | V | volt | V |
| Electric Current | I | ampere | A |
| Resistance | R | ohm | Ω |
| Electric Power | P | watt | W |
| Capacitance | C | farad | F |

All you need to remember is that this system is used to physically shorten or abbreviate the number so that it will not be so long.

| Common SI Prefixes | | | |
|---|---|---|---|
| tera | T | one trillion | ($10^{12}$) |
| giga | G | one billion | ($10^{9}$) |
| mega | M | one million | ($10^{6}$) |
| kilo | k | one thousand | ($10^{3}$) |
| volt, amp, ohm, watt | standard/base unit | | |
| milli | m | one-thousandths | ($10^{-3}$) |
| micro | $\mu$ | one-millionth | ($10^{-6}$) |
| nano | n | one-billionth | ($10^{-9}$) |
| pico | p | one-trillionth | ($10^{-12}$) |

**Conversion Units**



To keep things simple, remember these rules of how to use the chart. Know that all you will be doing is moving the decimal from where you see it to the left or to the right.

When you are moving up in the chart to **L**arger numbers, move the decimal to the **L**eft: **L**arger = **L**eft.

When you are moving down in the chart to smalle**R** numbers, move the decimal place to the **R**ight: **R**ight = smalle**R**.

**Move the decimal place the amount of times from where it starts to where it is going.**

This is how to use the chart on the previous page. Let's say you measured a resistance value that was fairly large, much like the body resistance value you will measure in the next lesson. You will get the relatively long version of the number, 1500 ohms. You could have read this value with a DMM (Digital Multimeter). There is nothing wrong with how this value is written, but it can be shortened to 1.5 kΩ (or 1.5 kilo ohms). Both the values are correct, but the second version did not require so many digits. By using the chart, you moved the decimal three positions to the left. If your number was .001 amps, to reduce the decimal places, go up in the chart to Larger numbers and move the decimal to the Left three places to get the number 1 milli amp. The prefix milli was added to reduce the zeros.

150,000 volts = 1.5 Megavolts: you moved up in the chart from the base standard unit to the **L**arger values of Mega, so you moved the decimal to the **L**eft six times as that is the place difference between these values.

.000000068 watts = 68 Nanowatts: you moved down in the chart from a base standard unit to the smalle**R** unit of nano, so you moved the decimal place to the **R**ight nine times.

In the next example, instead of using ohms as your unit, you will use volts or voltage. Convert 15 M ohms or 15 mega ohms to the basic unit in ohms.

Find the prefix "mega" on the chart. To convert the basic unit, you must convert or move to the right six positions or decimal places.

15 000000

By using the number 15 and doing this, the answer becomes 15,000,000 ohms. Once again, remember that 15,000,000 ohms and 15 mega ohms are exactly the same thing. One is just written a lot shorter.

Use the 15,000,000 ohms value for this question.

## Learning Activity 2.1

### Conversion Question

Question: What would 15,000,000 ohms look like if we converted it into kilo ohms? Don’t forget to use the chart on the previous page.

____________________ k ohms

Check your answers in the Learning Activity Answer Keys found at the end of this module.

---

Remember to always use the prefix **and** the unit when writing values. If the above answer is 15,000 **k ohms**, then just writing 15,000 k is the **wrong** answer.

Remember, it does not matter which unit you use in this conversion process. All you are trying to do is make the value shorter so that, if you have a very small electronics part, the value could be written right on it. Besides, who wants to waste time writing out zeros?

---

Go to Assignment 2 found at the end of this module and complete Part 1: Metrification and Conversion.

---

# Lesson 4: Electricity and the Human Body: Resistance and Electric Shock

## Facts about Shocks

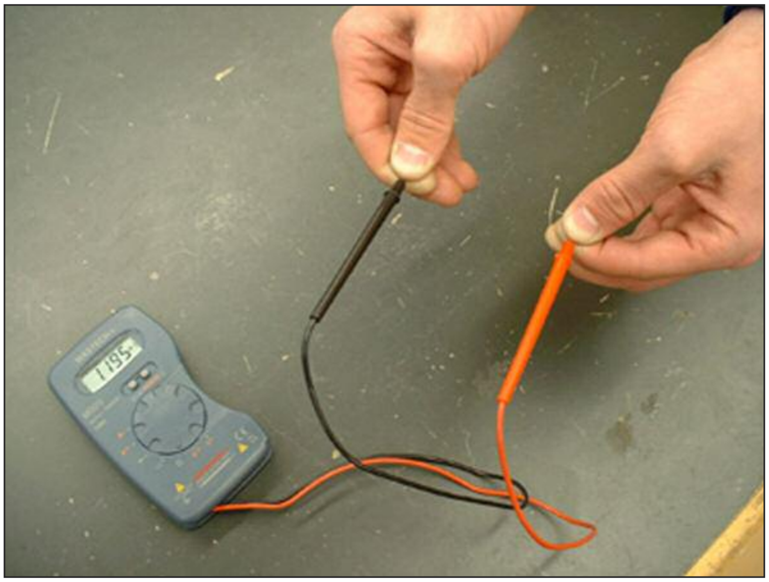
Three factors affect the intensity of an electric shock: resistance, voltage, and current. As mentioned in Module 1, Lesson 4, the resistance letter symbol "R" is the opposition to the flow of electrons and is measured in ohms, "Ω."The lower the body resistance, the greater the chance of severe electric shock. The resistance of the body will vary from different points on the body. The chart below shows typical values measured on a human body.

| Location on Body | Resistance Measurement |
|---|---|
| Damp skin (hand to hand) | 900 Ω |
| Dry skin (hand to hand) | 90,000 Ω to 700,000 Ω |

### Time for an Experiment!

All you need for this simple experiment is your digital multimeter, shown below, and a pencil to record your resistance values in the chart below.

Digital multimeter



**Black** **Red**

Now you are probably thinking, what does resistance have to do with electric shock? Well, it's simple. The higher the resistance, the lesser the chance of you receiving a severe electric shock. When your resistance is fairly low, the severity of electric shock will increase. Besides, who wants to waste time writing out zeros?

---

Go to Assignment 2 found at the end of this module and complete Part 2: Measuring Body Resistance.

---

# Lesson 5: Voltage and Electric Shock

## Voltage and Current

As mentioned earlier, voltage is depicted by the letter symbol "E." It is a measurement of force or pressure that is applied to an electric circuit measured in volts. Review this statement and decide whether it is true or false.

*100,000 volts are more deadly than 100 volts.*

If you answered true, you are wrong. It is not the voltage that makes electricity dangerous; it is the current, which is measured in amperes or amps. You will discover why in the next lesson. One last thing to consider when working with voltage is that there is a safe working voltage value. Generally, any voltage value that is below 30 volts is considered safe. That is why you will be building your project and completing experiments with a 9-volt DC (Direct Current) battery.

### Fatal Currents

The amount of current that is forced through the human body, not the voltage, is the killer.

**Sparkey's Quick Review**

As we discovered in previous lessons, electric current describes the movement of electrons through a circuit past a given point. The strength of the current depends on the number of electrons in motion at any given point in the circuit. There needs to be a way to tell how much current is flowing through a circuit. It would be unrealistic to count the number of electrons flowing past a given point in a circuit. Therefore, a unit of measure called the ampere is used. An ampere measures the number of electrons passing by a given point in a circuit per second.

**Caution**

Any extensive burns, cuts, or chemical injuries should be treated at your local hospital emergency department.

Any device that you plug in a wall outlet in your home has the potential to deliver a fatal current.

**100 mA (.1A)**
At this level of high current, a 100W light bulb in your home could electrocute up to 20 people at once.

**50 mA (.05A)**
Heart will convulse. You will probably die. This level of electric shock is much like a heart attack.

**20 mA (.02A)**
Very painful. You will be unable to let go; muscles contract, hard to breathe.

**5 mA (.005A–.001A)**
Mild sensation; safe current value.

Any amount of current above 0.005 A (amperes) or 5 mA can create severe burns and unconsciousness, and is therefore considered very dangerous. A simple flashlight battery can deliver enough current to kill you. Fortunately, the body resistance from your skin is high enough to prevent this current from flowing through you.

## Learning Activity 2.2

### Time for an Experiment

Look back at your values of body resistance on Assignment Sheet 2 and choose the hand-to-hand measured value. Now, calculate the voltage required to produce a current flow of 100 mA. Hint: Use the Ohm's Law formula at the end of Module 1, Lesson 5. Remember that we know resistance in ohms and the current in amps.

Place formula here:______________________________

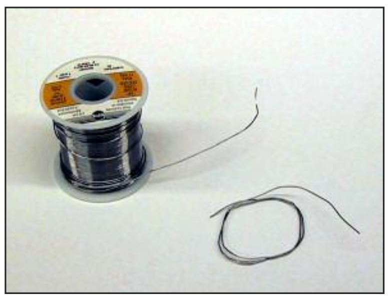
Place answer here:_______________________________volts

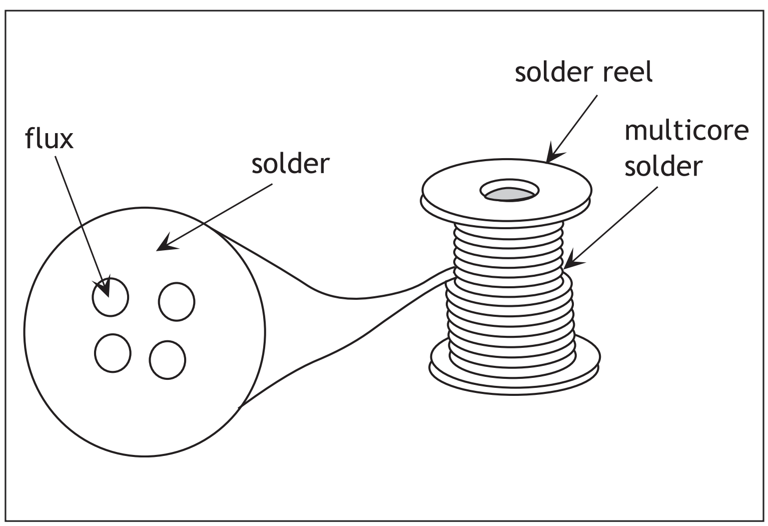
Check your answers in the Learning Activity Answer Keys found at the end of this module.

# Lesson 6: Hazardous Materials

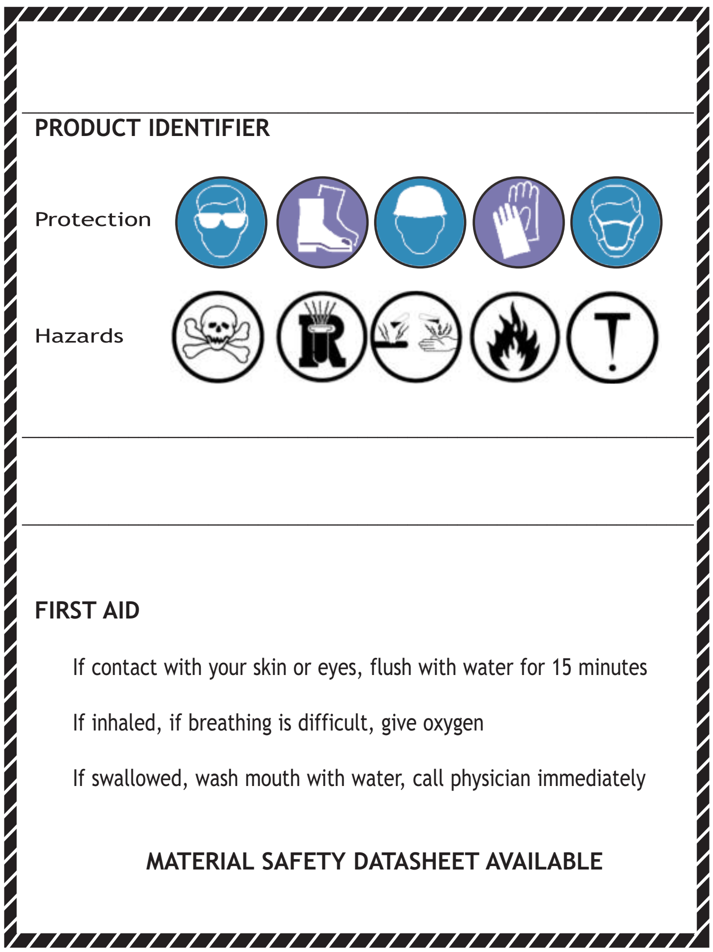
## Know the Symbols

Every day, many new products are produced that are intended to make our world cleaner or to complete a process in industry. Many of these products have been created by combining hazardous materials, possibly to make a better toilet bowl cleaner or a better paint remover. In any case, they are meant to make our lives better, but there is a catch. They can potentially cause you great harm if you get these substances on your skin or in your eyes, mouth, or lungs.





Years ago, many people were getting injured on the job by working with hazardous products. Through interviews, it was found that many of the injured people had no idea of the hazards associated with the products they were using. The Department of Labour created The Workplace Hazardous Material Information System (WHMIS), which each employee is now expected to review and follow. Special emphasis was placed on identifying hazardous goods and materials so that they could be recognized much more readily and proper precautions could be taken towards their safe handling.




Along with the labelling of hazardous materials, a binder is made by the employer or teacher to provide detailed information about all of the hazardous materials within that facility. The binder must be kept up to date and accessible to any employee at any given time. The binder should be clearly marked as Material Safety Data Sheets (MSDS). If you receive a severe injury, make sure to take the binder along with you to the hospital emergency room. If possible, take a sealed, labelled container of the product that caused the injury. This will help the doctor better treat your injury.

Included on the label is a graphic image of what type of personal protective equipment (PPE) should be used to prevent injury. The chart on the following page will give you an idea of what protection one is advised to use.

Make sure to ask your employer where the MSDS binder is located. Don't forget, you have the legal right to know what harmful chemicals you are using.

## Safety When Soldering

Did you know that, if you poured water on an electrical fire caused by your soldering iron, you might not be around to take this course? As mentioned in Module 1, water is a very good conductor. Mixed with electricity, it can kill you.

The type of fire that could occur in your work or play environment is what determines the type of fire extinguisher to use. The fire extinguisher will have one or more letters on the label or tag to inform you of what type of fire it can extinguish. Before a fire starts, take a second to look for the fire extinguisher and see what type of fire it can extinguish. If you don't have a household fire extinguisher, buy one. It could save your life.

# Typical Accident Prevention/Hazardous Materials Signs

# Lesson 7: Tools: Breaking Them Down

## Know Your Tools

In electronics, the work done with tools to fix or create something is almost like doing open-heart surgery at the hospital. Both processes use useful instruments to complete a job or task.

> **Shocking FACT**
>
> Doctors who install pacemakers to keep people's hearts going need to know both medical and electronic principles and procedures.

There is no specific rule that states a tool is capable of only one job; one tool could potentially do many tasks. This will be apparent when you study the explanations of each tool. You may not have all of the tools that are mentioned, but the tool kit that was outlined in the course introduction will be sufficient for the scope of this course.

If you buy other tools, don't buy poor-quality tools. They do not work as well, can potentially be a safety hazard, and may not even last until the end of this course.

For clarity, the tools will be broken into two groups: test instruments and hand tools.

### Test Instruments

**Digital Multimeter (DMM)—In Kit**

A number of test instruments are used in electronics. This whole course could be completed exclusively with electronic test equipment. The next time you are in a garage or an electronics repair shop, ask to see some of the electronic test equipment. You will be amazed by what they have. The shop might have a multimeter like you have in your tool kit. The advantage of your multimeter is that it can be used for many different processes, but is used primarily for measuring AC (Alternating Current) and DC (Direct Current) voltage and amperes. Measurements for continuity (often with a small audible beep). Capacitance and resistance (measured in ohms) are two other very common features found on almost every multimeter.

Your multimeter uses a Liquid Crystal Display (LCD), just like your calculator. Before these digital screens, values were measured with a swinging needle, similar to the way the hands of a clock display the exact time. The older needle-style meter is referred to as an analog multimeter. Both the DMM and analog meters work well, but the DMM is faster, easier, and more accurate. Both the DMM and analog meters are shown below.

**LCD Screen**

**swinging needle**

**digital multimeter**

**analog multimeter**

> **Take Note**
> Remember, the DMM in your kit is very fragile. If you drop the meter on a hard surface (a floor), it is possible that it may not work as well afterwards or may not even turn on. If this happens, it is usually cheaper to buy a new DMM than it is to fix the broken one.

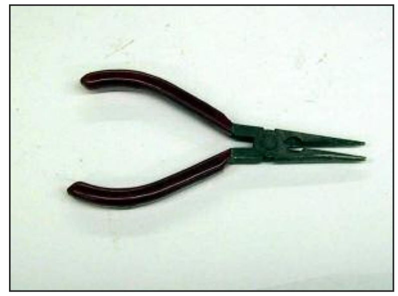
## Line Testers

An inexpensive tester that works great for testing fuses, mini-Christmas lights, and live electrical circuits from electrical cords. It is a must-have tool for testing Christmas tree bulbs.

## Hand Tools

**Needle-nose Pliers—In Kit**

Pointed at the end to grab or twist small items. Can be used for precise bending and looping of component legs of wires. Can also be used for a heat sink.

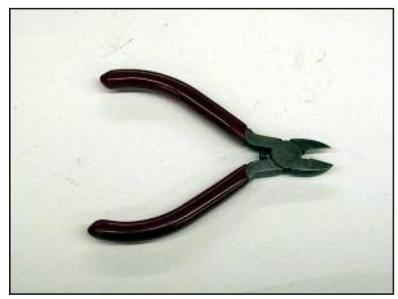


**Wire Strippers—In Kit**

To be used only for stripping the plastic insulation off wire, exposing the bare copper conductor. Can be adjusted to strip various-sized insulation of wires.

**Diagonal Cutters—In Kit**

Designed for specifically cutting or nipping soft electronic wire. The cutting edges are off-centre to make flush surface mount cuts that are close to the bottom of the circuit board. Be careful not to cut hard nails or bolts with these cutters. They can break.



**Soldering Iron with Coil Stand—In Kit**

Has a heating element and a specially designed "tinned" tip to melt solder. Rated in wattage from 25 W to 80 W and can be powered by AC volts, DC volts, or butane gas.

**Note:** Graphics may be different than the items in your kit due to a new product supplier.

**Linesman Pliers**

Used for gripping, twisting, and cutting of wire.

**Curved Jaw or Water Pump Pliers**

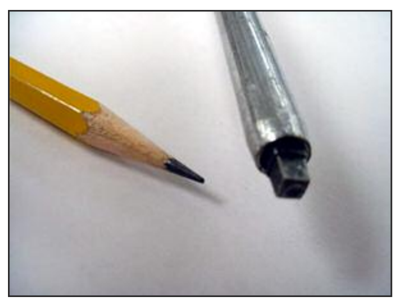
Have an adjustable joint for grabbing items of various sizes.

**Soldering Gun**

Works much like a soldering iron but delivers much more heat. Rated in wattage from 120W to 240W. Works by holding the two-position trigger switch in one of the two positions. This type of soldering gun should never be used on small circuits. It will damage the small heat-sensitive conductors and components.

**Robertson Screwdriver**

Canadian-designed screwdriver that has a square-shaped end. Superior torque quality while twisting in screws. Sized by the colour of the handles and a numbering system.

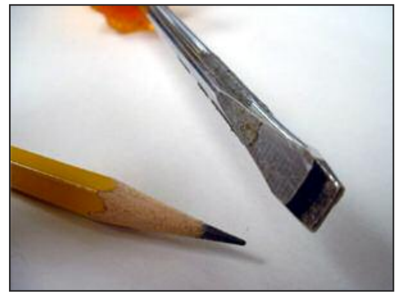


**Phillips Screwdriver**

A star-shaped screwdriver, sized only by numbers and not colours. The smaller the number, the physically smaller the tip.

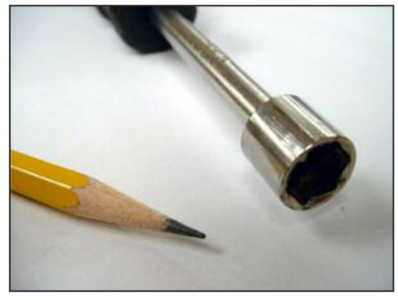
**Standard Screwdriver**

Designed for screws with slotted heads.



**Metric/Imperial Nut Drivers**

Works like a screwdriver but has a hexagonal end that fits both metric and imperial fasteners. Good quality nut drivers have hollow handles used for tightening nuts threaded on long bolts.



**Adjustable Wrench**

Used when odd-sized fasteners are present. Must be set properly or the fastener could strip, ruining the bolt or nut.

**Metric/Imperial Open or Box-End Wrench**

Used to loosen and tighten nuts and bolts. Can have one or both ends boxed or open.

**Socket/Ratchet Set**
**(Can Be Metric or Imperial Sockets)**

A speedier way to loosen and tighten nuts and bolts.

**Locking Pliers**

Designed to grab odd-shaped objects that a conventional wrench will not fit. Can lock in place to hold two pieces together. Regular pliers cannot do this.

**Metric/Imperial Allen Keys**

A hexagonal-type wrench commonly used to tighten knobs and dials or set screws on a machined fitting. Made with a screwdriver-styled handle.

**Torx Wrench Set**

A six pointed style wrench, much like the hex/Allen keys. Common on newly designed electronic components and automobiles. Made with a screwdriver-styled handle.

**Files**

Can be used on metal or wood to remove or create sharp edges. Can also be used to smooth out a surface or edge. **Note:** Some specially designed wood files cannot be used on hard metal.

**File Card**

Used to clean the grooves of a wood or metal file. The wire brush side is dragged through the grooves of the file, removing the debris caught in the grooves.

**Claw Hammer**

A general-purpose hammer used to hit in nails with the face and pull them out with the claw. Note: Cannot be used to hit metal, chisels, or centre punches.

**Ball Peen Hammer**

Used to strike metal materials like chisel punches or sheet metal.

**Centre Punch**

The sharp point is used to mark a specific location for a hole before drilling is attempted. Should be hit with the ball peen hammer.

**Chisels**

There are two types of chisels, wood (top) and metal (bottom). Metal chisels are designed for hard surfaces, whereas wood chisels are made strictly for soft wooden material.

**wood chisel**

**metal chisel**

### Cordless/Plug-in Drills

Used to drill holes in metal, wood, plastics, etc. Can be attached to specially designed screwdriver tips for a speedier method of rotating a screw or bolt.

**cordless drill**

**plug-in drill**

### Twist Drill Bits

A universal type of drill bit that can drill through very hard or very soft material. Tightened in an electric or cordless drill.

### Hacksaw

A specially designed saw for cutting very hard material. Note: If you change the cutting blade on this type of saw, make sure the teeth are angled away from the gripping handle. Put the blade on the material to be cut. Rock back and forth.

### Fish Tape

Fish tape is used to pull wires through hard to access areas, such as electrical conduits. The long, stiff wire (fish tape) is first fed through the hard to access area; you need to wiggle or bend it past any obstructions. Once through the area, tape the wires you want to run through this area onto the fish tape, and pull the fish tape with the wires attached back through the area.

Go to Assignment 2 found at the end of this module and complete Part 3 to Part 10.

## Notes

# Module 2 Summary

Congratulations, you have finished the second module in the course.

Remember

- Don't forget the first safety rule, "THINK!"
- Follow all personal safety rules.
- Tools do not jump at you and try to hurt you; humans who don't think hurt you.
- Look around and check that your work environment is safe.
- Replace dull, broken, or damaged tools.
- Always wear your safety goggles when working with any tool. You could even wear them when you run a grass trimmer or when riding your four-wheeler down a branch-filled trail in the forest.
- Convert the lengthier unit values to shorter values any time it is possible.
- The higher your body resistance, the lower your risk of severe electric shock.
- Your body is a great conductor when damp or wet.
- Voltage is a pressure that makes the electrons want to move.
- Lower voltage is just as dangerous as high voltage.
- It is the high current, measured in amperes, that kills.
- Continue artificial respiration on a non-breathing victim until medical authority has arrived—don't stop.
- Know what the chemicals you use at work could do to you if inhaled, swallowed, or dropped on exposed skin. It is your legal right to know (WHMIS)!
- Choose the right tool to do a job safely and efficiently.
- Choosing the wrong tool for a job can lead to serious injuries.

## Submitting Your Assignments

It is now time for you to submit your work from Module 2 to the Distance Learning Unit so that you can receive some feedback on how you are doing in this course. Remember that you must submit all the assignments in this course before you can receive your credit.

Make sure you have completed all parts of your Module 2 assignment and organize your material in the following order:

- Module 2 Cover Sheet
- Module 2 Log Sheet
- Assignment 2: Electrical Safety

For instructions on submitting your assignments, refer to How to Submit Assignments in the course Introduction.

Assignment 2

# Electrical Safety

***Total: 166 marks***

**Part 1: Metrification and Conversion**

**Part 1.1**

Write the letter symbol for each of the common SI prefixes. Refer back to the Common SI Prefixes chart found in Lesson 3. *(1 mark each for a total of 8 marks)*

1. giga ____________
2. milli ____________
3. tera ____________
4. nano ____________
5. micro ____________
6. mega ____________
7. kilo ____________
8. pico ____________

*(continued)*

### Part 1.2

Convert the following to the unit indicated. Refer back to the conversion chart to do this section. *(1 mark each for a total of 12 marks)*

1. 0.02A = ______________________________ mA
2. 3.42A = ______________________________ uA
3. 0.042V = ______________________________ mV
4. 25 mA = ______________________________ A
5. 3.58 mHy = ______________________________ uHy
6. 13.5 kV = ______________________________ V
7. 0.00045 MΩ = ______________________________ kΩ
8. 165000 Ω = ______________________________ MΩ
9. 470 pFd = ______________________________ nFd
10. 12000 pFd = ______________________________ uFd
11. 6 pFd = ______________________________ nFd
12. 104 MHz = ______________________________ Hz

### Part 2: Measuring Body Resistance

Record your values in the chart below. **Pay close attention to whether your hands should be damp or extremely dry.** *(4 marks)*

| Location on Body | Resistance Measurement in Ohms (Ω) |
|---|---|
| Hand to Hand (pinch with fingers)<br>Damp Skin | |
| Hand to Hand<br>Dry Skin | |

*(continued)*

## *Assignment 2: Electrical Safety (continued)*

### Part 3: Safety in Your Home

Answer the following questions. *(total of 19 marks)*

1. List and describe at least six potential electrical safety hazards that could happen in your home. *(1 mark each for a total of 6 marks)*

   a) ______________________________________________

   ______________________________________________

   b) ______________________________________________

   ______________________________________________

   c) ______________________________________________

   ______________________________________________

   d) ______________________________________________

   ______________________________________________

   e) ______________________________________________

   ______________________________________________

   f) ______________________________________________

   ______________________________________________

2. List and describe at least 12 safety rules that will deal with the care and use of tools and equipment as you work with electricity in this course or in a workshop. *(1 mark each for a total of 12 marks)*

   a) ______________________________________________

   ______________________________________________

   b) ______________________________________________

   ______________________________________________

   c) ______________________________________________

   ______________________________________________

   d) ______________________________________________

   ______________________________________________

*(continued)*

e) ______________________________________________

______________________________________________

f) ______________________________________________

______________________________________________

g) ______________________________________________

______________________________________________

h) ______________________________________________

______________________________________________

i) ______________________________________________

______________________________________________

j) ______________________________________________

______________________________________________

k) ______________________________________________

______________________________________________

l) ______________________________________________

______________________________________________

3. When working with any tool and/or equipment, ____________________ should be worn at all times to protect your eyes. *(1 mark)*

*(continued)*

## *Assignment 2: Electrical Safety (continued)*

### Part 4: Metrification

From the **letter symbol** of each of the common SI prefixes, write the correct full description of what each letter symbol means. An example is done for you. *(1 mark each for a total of 7 marks)*

Example: M Answer: Mega

1. m (lower case) __________________
2. T __________________
3. n __________________
4. $\mu$ __________________
5. G __________________
6. k __________________
7. p __________________

### Part 5: Conversions

Convert the following to the units indicated. *(1 mark each for a total of 12 marks)*

1. 5 mA = ________________________ A
2. 120 V = ________________________ mV
3. 0.067 V = ________________________ mV
4. 49 mA = ________________________ A
5. 8.45 mHy = ________________________ uHy
6. 980 mV = ________________________ V
7. 2.1 MΩ = ________________________ Ω
8. 6.6 kΩ = ________________________ Ω
9. 730 pfd = ________________________ nfd
10. 12000 pfd = ________________________ ufd
11. 6 pfd = ________________________ nfd
12. 20 GHz = ________________________ MHz

*(continued)*

### Part 6: Measuring Body Resistance

Answer the following questions. *(total of 7 marks)*

1. What are the **three** factors that affect the intensity of electric shock? *(3 marks)*

   a) ______________________________________________

   b) ______________________________________________

   c) ______________________________________________

2. What is the term or word used to measure the opposition to the flow of current in an electronic circuit? *(1 mark)*

   ______________________________________________

   Draw the letter symbol for it here. ____________________

   (**Hint:** It is a Greek letter symbol.) *(1 mark)*

3. **Circle one.** The Lower / Higher the body resistance, the greater chance of severe electric shock. *(1 mark)*

4. **Circle one.** Your body resistance would be Low / High when you get out from a hot and wet shower. *(1 mark)*

### Part 7: Voltage and the Human Body

Answer the following questions. *(total of 4 marks)*

1. What is the term or word used to measure the force or pressure that is applied to an electric circuit to generate the flow of current? *(1 mark)*

   ______________________________________________

   Draw the letter symbol for it here. ____________________ *(1 mark)*

2. It is not the voltage that makes electricity dangerous, but rather the high volume of _______________ that would pass through your body. *(1 mark)*

3. Generally voltages below _____ V are considered safe working voltage levels. *(1 mark)*

*(continued)*

## *Assignment 2: Electrical Safety (continued)*

### Part 8: Current and the Human Body

Answer the following questions. *(total of 5 marks)*

1. What is the term or word used to measure the volume of current in an electronic circuit? *(1 mark)*

   ______________________________________________

   Draw the letter symbol for it here. ____________ *(1 mark)*

2. If you were being electrocuted, it is the amount of ____________________ that would go through your body that would determine whether you survive or not, not the voltage. *(1 mark)*

3. Generally, current values below ___________ mA are considered safe. *(1 mark)*

4. An ampere measures the number of __________________ that pass one given point. *(1 mark)*

### Part 9: Hazardous Materials

Answer the following questions. *(total of 37 marks)*

1. Write out the full name for the abbreviation WHMIS. *(5 marks)*

   ______________________________________________

   ______________________________________________

2. Why did the government decide to create the WHMIS system? *(1 mark)*

   ______________________________________________

   ______________________________________________

3. What is meant by the law, "…the right to know?" *(2 marks)*

   ______________________________________________

   ______________________________________________

*(continued)*

## *Assignment 2: Electrical Safety (continued)*

4. Write out the full name for the abbreviation MSDS? *(4 marks)*

   ______________________________________________

5. What is the importance of having a MSDS binder at your workplace? *(3 marks)*

   ______________________________________________

   ______________________________________________

   ______________________________________________

   ______________________________________________

6. Determine which description matches the corresponding hazard sign. *(1 mark each for a total of 8 marks)*

________ a) poison

________ b) dangerously reactive

________ c) corrosive

________ d) biohazardous

________ e) flammable

________ f) compressed gas

________ g) oxidizing material

________ h) toxic effects

*(continued)*

## *Assignment 2: Electrical Safety (continued)*

7. What are four ways a hazardous product can get into your body's system? *(4 marks)*

   a) ____________________

   b) ____________________

   c) ____________________

   d) ____________________

8. List three products in your home that may contain hazardous chemicals. *(3 marks)*

   a) ____________________

   b) ____________________

   c) ____________________

9. List three pieces of safety equipment that should be used when handling dangerous chemicals. *(3 marks)*

   a) ____________________

   b) ____________________

   c) ____________________

10. In your opinion, is the WHMIS a good idea? Explain why or why not in the space below. *(4 marks)*

    ____________________

    ____________________

    ____________________

    ____________________

    ____________________

    ____________________

    ____________________

    ____________________

*(continued)*

### Part 10: Tools and Equipment

Answer the following questions. *(total of 51 marks)*

1. Give the full name for the piece of equipment referred to as DMM. *(3 marks)*

   ______________________________________________

2. In simple terms, what is a DMM used for? *(2 marks)*

   ______________________________________________

   ______________________________________________

   ______________________________________________

3. The DMM in your kit can measure the value of a number of items. Name four quantities the DMM can measure. *(4 marks)*

   a) ____________________________________________

   b) ____________________________________________

   c) ____________________________________________

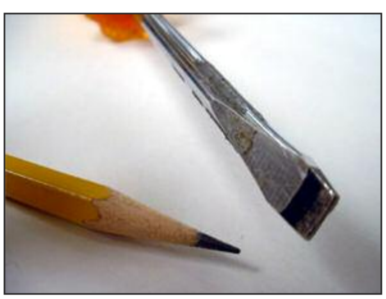
   d) ____________________________________________

4. The DMM in your kit does not use a needle and dial to show the output results. It displays the value or result on a ______________________ display. *(1 mark)*

*(continued)*

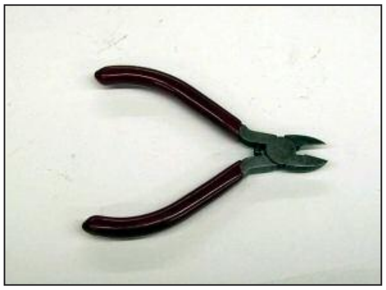
## *Assignment 2: Electrical Safety (continued)*

5. Place the name of the tool next to the picture. *(1 mark each for a total of 21 marks)*



*(continued)*

## *Assignment 2: Electrical Safety (continued)*



______________________________

______________________________

______________________________

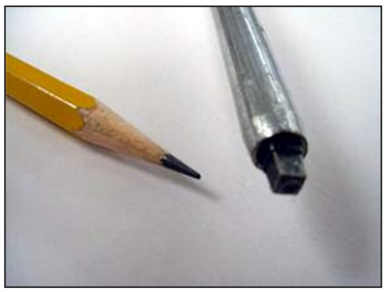
______________________________

______________________________

*(continued)*

## *Assignment 2: Electrical Safety (continued)*

___________________________



___________________________

___________________________

___________________________

___________________________

*(continued)*

## Assignment 2: Electrical Safety (continued)

______________________________

______________________________

______________________________

______________________________

*(continued)*

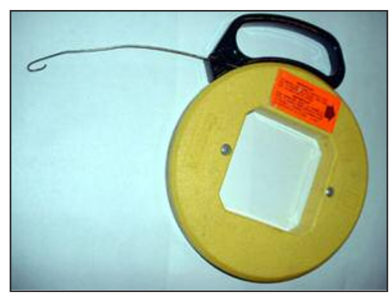
## *Assignment 2: Electrical Safety (continued)*

____________________________

____________________________

6. Describe how and why the following items are used. Make sure that you have described both ***how*** and ***why***. *(2 marks each for a total of 14 marks)*

   a) Fish Tape



_________________________________________________________________

_________________________________________________________________

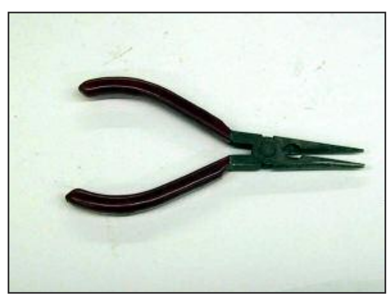
_________________________________________________________________

*(continued)*

b) Centre Punch

c) File Card

d) Needle-nose Pliers



(continued)

## *Assignment 2: Electrical Safety (continued)*

e) Soldering Gun

______________________________________________

______________________________________________

______________________________________________

f) Hacksaw

______________________________________________

______________________________________________

______________________________________________

g) Water Pump Pliers

______________________________________________

______________________________________________

______________________________________________

*(continued)*

## *Assignment 2: Electrical Safety (continued)*

7. Draw the shape of the tips of each of the following screwdrivers in the space provided. *(1 mark each for a total of 5 marks)*

   a) Robertson

   b) Phillips

   c) Torx

   d) Allen Key

*(continued)*

## *Assignment 2: Electrical Safety (continued)*

f) Standard

8. The teeth on a hacksaw should always point ____________________ from the handle. *(1 mark)*

## NOTES

# Grade 9 Electricity/ Electronics Technology (10G)

## Module 2: Safety

Learning Activity Answer Keys

# Module 2: Safety

## Learning Activity 2.1: Conversion Question

Question: What would 15,000,000 ohms look like if we converted it into kilo ohms? Don't forget to use the chart on the previous page.

*Answer:*

15,000 k ohms

## Learning Activity 2.2: Time for an Experiment

Look

*Answer:*

Look back at your values of body resistance on Assignment Sheet 2 and choose the hand-to-hand measured value. Now, calculate the voltage required to produce a current flow of 100 mA. Hint: Use the Ohm's Law formula at the end of Module 1, Lesson 5. Remember that we know resistance in ohms and the current in amps.

| | |
|---|---|
| Place formula here: | $E = I \times R$ |
| Place answer here: | $E = 100{,}000 \times$ (will vary) |
| | $E =$ (will vary) volts |

(The value of R is the reading in Ω that you got when you measured your own body resistance.)

# Notes

# Module 2 Summary

Congratulations, you have finished the second module in the course.

Remember

- Don't forget the first safety rule, "THINK!"
- Follow all personal safety rules.
- Tools do not jump at you and try to hurt you; humans who don't think hurt you.
- Look around and check that your work environment is safe.
- Replace dull, broken, or damaged tools.
- Always wear your safety goggles when working with any tool. You could even wear them when you run a grass trimmer or when riding your four-wheeler down a branch-filled trail in the forest.
- Convert the lengthier unit values to shorter values any time it is possible.
- The higher your body resistance, the lower your risk of severe electric shock.
- Your body is a great conductor when damp or wet.
- Voltage is a pressure that makes the electrons want to move.
- Lower voltage is just as dangerous as high voltage.
- It is the high current, measured in amperes, that kills.
- Continue artificial respiration on a non-breathing victim until medical authority has arrived—don't stop.
- Know what the chemicals you use at work could do to you if inhaled, swallowed, or dropped on exposed skin. It is your legal right to know (WHMIS)!
- Choose the right tool to do a job safely and efficiently.
- Choosing the wrong tool for a job can lead to serious injuries.

## Submitting Your Assignments

It is now time for you to submit your work from Module 2 to the Distance Learning Unit so that you can receive some feedback on how you are doing in this course. Remember that you must submit all the assignments in this course before you can receive your credit.

Make sure you have completed all parts of your Module 2 assignment and organize your material in the following order:

- Module 2 Cover Sheet
- Module 2 Log Sheet
- Assignment 2: Electrical Safety

For instructions on submitting your assignments, refer to How to Submit Assignments in the course Introduction.

# Grade 9 Electricity/ Electronics Technology (10G)

## Module 2: Safety

### Learning Activity Answer Keys

# Module 2: Safety

## Learning Activity 2.1: Conversion Question

Question: What would 15,000,000 ohms look like if we converted it into kilo ohms? Don't forget to use the chart on the previous page.

*Answer:*

15,000 k ohms

## Learning Activity 2.2: Time for an Experiment

Look

*Answer:*

Look back at your values of body resistance on Assignment Sheet 2 and choose the hand-to-hand measured value. Now, calculate the voltage required to produce a current flow of 100 mA. Hint: Use the Ohm's Law formula at the end of Module 1, Lesson 5. Remember that we know resistance in ohms and the current in amps.

Place formula here: $E = I \times R$

Place answer here: $E = 100{,}000 \times$ (will vary)

$E =$ (will vary) volts

(The value of R is the reading in Ω that you got when you measured your own body resistance.)

## NOTES

# Grade 9 Electricity/ Electronics Technology (10G)

## Module 3: Electronic Components

# Module 3: Electronic Components

## Module Focus

**When you finish this module, you will be able to**

- ❑ identify all the parts needed for your project
- ❑ recognize numerous other electronic components found elsewhere in other projects
- ❑ test each specific component
- ❑ distinguish what would be the proper measurement term for each component
- ❑ determine if the component is faulty
- ❑ identify various resistors
- ❑ calculate various resistor values
- ❑ identify various styles of switches and know how to test them
- ❑ identify various styles of capacitors
- ❑ explain the use of fuses and how to use them
- ❑ describe what causes overloads and short circuits
- ❑ explain how various types of output devices are used
- ❑ discuss the characteristics of semiconductor crystals
- ❑ explain the basic operation of a diode
- ❑ describe various practical applications of diodes

## Introduction

It does not matter whether you are just starting out in electronics or are at an advanced level, electronics parts and components will not change. This module will help you to recognize what each component is and to determine if it works or not.

Often, when electronics projects are built too quickly without adequate testing of all the components, they do not work properly or, even worse, explode and cause a safety hazard. Electronics parts and pieces can be very simple or complicated in their size, shape, measurement, and usage, but they are all very easy to understand if we separate them into individual parts.

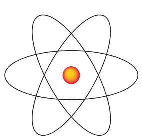
Instead of just sticking the parts onto the circuit board without learning their purpose, let us break down all the project parts to see if they work and to see how they need to be put on the project circuit board. The most common reasons for a project's failure to work are:

1. The project is not wired or assembled correctly.
2. The battery does not work.
3. One of the components is faulty or damaged.
4. The project was assembled without adequate testing.

Once you have completed this section, you will have the confidence and knowledge to recognize familiar parts in your car, TV, stereo, CD player, et cetera. Just don't forget what a fatal current can do. **Never** work on a live circuit.

Many of the following parts are included in your package, but a few are not. They are included for explanation purposes. If such a component is on your project, go to your Component Test Record Form at the end of this module and record your findings for all the parts on your project. A form like this should be used for all of your electronic projects, as it can be very helpful if you need to find out why your project does not work. It will also help to inform your tutor/marker of your knowledge level.

## Power Words



circuit
nichrome wire
watts
working voltage in direct current or WVDC
power
dissipate
resistor

pushbutton switch
slide switch
contacts
tolerance
plates
dielectric
leads
overload

short circuit
epoxy
infrared-emitting diodes
liquid crystal displays
semiconductor
doped
anode
cathode

## Assignments in Module 3

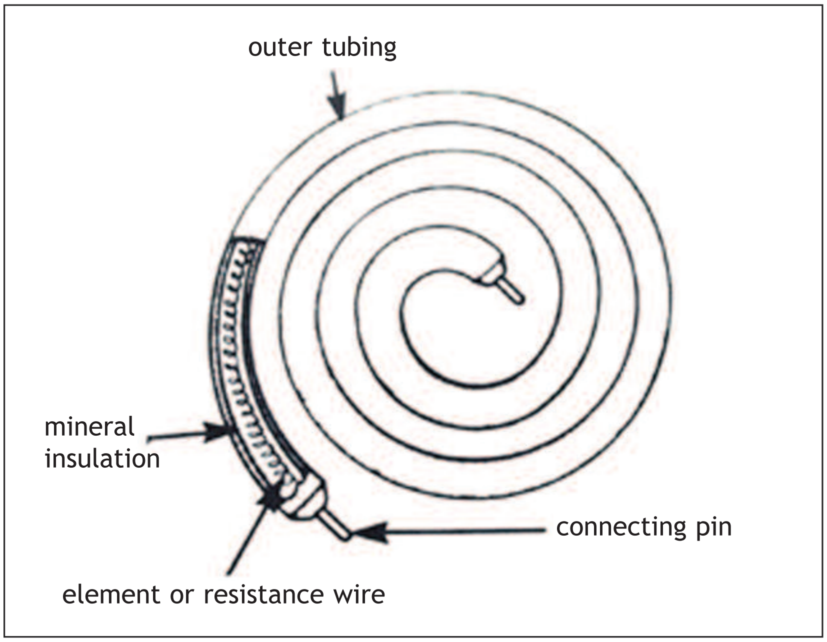
When you have completed the Module 3 assignments, submit your completed assignments, along with the Log Sheet and Module 3 Cover Sheet, to the Distance Learning Unit either by mail or electronically through the learning management system (LMS). The staff will forward your work to your tutor/marker.

# NOTES

# Lesson 1: Resistance

## Resistance Wire

Have you ever wondered how your oven gets hot enough to cook your food? It is done through resistance. A special resistance wire is used to produce the heat. This wire is made from nickel and chromium, and is called a **nichrome wire**. It is also used in clothes dryers and electric heaters. When voltage is applied to the wire, the high resistance of the wire will convert electrical energy into heat energy. The nichrome wire cannot be seen because of the outer insulating cover around it, but when it is hot, you will see that insulating cover glowing bright orange.




Check out the two resistors in your project kit.

## Fixed Resistors

Resistors are one of the most common electronic components and can be found in every electronic gadget made. Without them, we would be unable to control the current. The term *resistance* means to oppose or slow down the flow of current. The function of the resistor is to limit the flow of current. The unit of measure for resistance is called the ohm, symbolized by the Greek letter *omega*, Ω.

## Making a Homemade Resistor!

**Inventory List:** Place a checkmark in each box once you have identified the item.

❑ digital multimeter (DMM)

❑ HB or 2H lead pencil

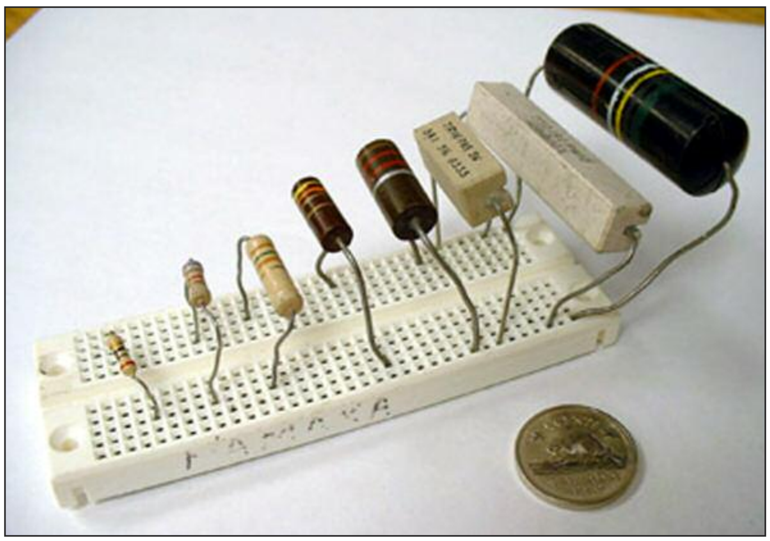
You can make a simple resistor. Draw a line on a piece of paper with a soft lead HB or 2HB pencil. Make sure the line is thick and about 5 cm long. With your multimeter, measure the ohm's value of this line by putting a probe on each side of the line, making sure the probes are touching the carbon from the pencil lead. The value will be around the 700 kΩ to 1.8 MΩ, relative to the thickness of your line and what type of pencil you used. If you double the length of the line, the resistance will increase. If you erase some of the line and make it shorter, the resistance will decrease. Move one of the probes back and forth while keeping the other one stationary. You will see the resistance value increase and decrease.

Resistors are rated in three ways:

1. Measurement in **ohms, Ω**
2. **Tolerance** or accuracy rating

   In the manufacturing process of resistors, it would be virtually impossible to give every small resistor an exact ohmatic rating. That is why a tolerance system, measured by a set percentage, is used for each resistor. The goal is to find a resistor with a very small tolerance rating. We will take a closer look at resistor tolerances later in this section.
3. **Heat dissipation**

   Each resistor can oppose a certain amount of current which produces heat. This heating of the resistor is not good, so the right size of resistor must always be used.



The physically larger the resistor, the larger the **power** rating in **watts**. Or, the physically larger the resistor, the more heat it can **dissipate** safely without exploding.

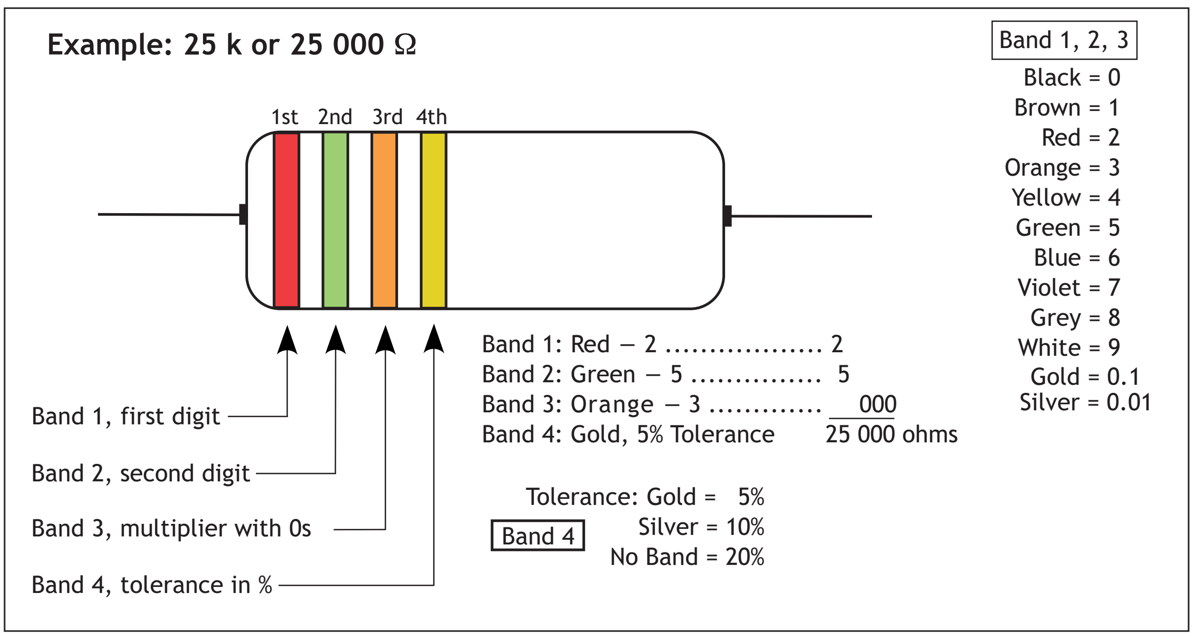
The most common type of resistor used in industry is made of carbon. Just like your project resistors, the carbon resistor uses carbon granules encased inside a ceramic covering. Depending on the composition of the resistor carbon filler, they can range from 0.1 ohm to millions of ohms.

# Calculating the Resistor's Values Using a Resistor Colour Code

To keep electronic components and gadgets small and lightweight, resistors are manufactured to be very small. The small size makes it virtually impossible to write the value in ohms on the body or case. This is why a resistor colour code system is used to identify the resistance and tolerance values. Little coloured bands encircle the whole body of the resistor. Each band colour represents a given number or calculation technique. Observe the diagram below of a common carbon resistor and what each colour means.


**Note:** Always hold the resistor with the gold or silver band to the right when you are looking at it.

The chart below shows how a typical resistor colour code can be used.

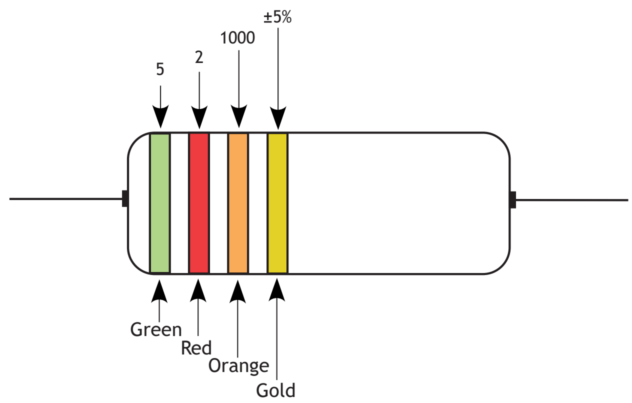


The following chart identifies the numbers and colour combination used for electronic resistor identification.

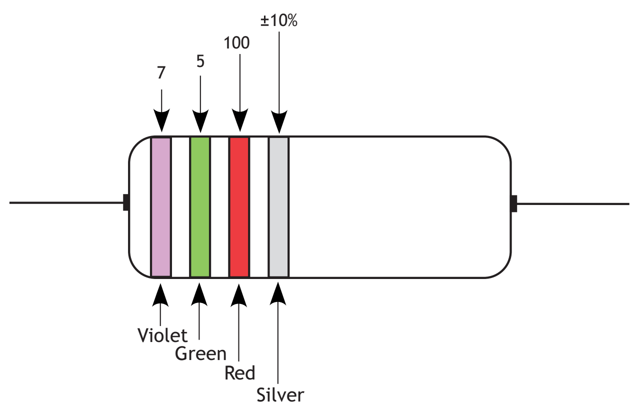
| Resistor Colour Code | | | | |
|---|---|---|---|---|
| **Colour** | **1st Number** | **2nd Number** | **Multiplier** | **Tolerance (Percent)** |
| Black | 0 | 0 | 1 | |
| Brown | 1 | 1 | 10 | |
| Red | 2 | 2 | 100 | |
| Orange | 3 | 3 | 1 000 | |
| Yellow | 4 | 4 | 10 000 | |
| Green | 5 | 5 | 100 000 | |
| Blue | 6 | 6 | 1 000 000 | |
| Violet | 7 | 7 | 10 000 000 | |
| Grey | 8 | 8 | 100 000 000 | |
| White | 9 | 9 | 1 000 000 000 | |
| Gold | | | 0.1 | 5% |
| Silver | | | 0.01 | 10% |
| None | | | | 20% |
| | Band 1 | Band 2 | Band 3 | Band 4 |

The following examples show you how to read the coloured bands on a typical carbon resistor.

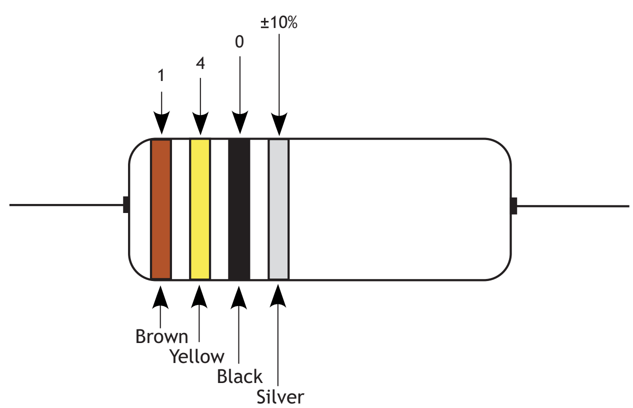
**Example 1:** 52000 Ω ± 5% or 52 kΩ ± 5%




**Example 2:** 7.500 Ω ± 10% or 7.5 kΩ ± 10%



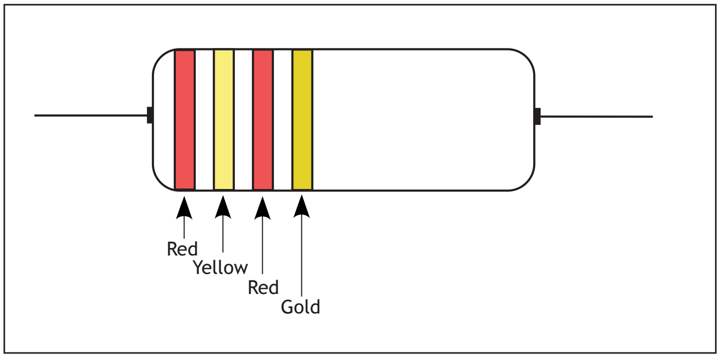

**Example 3:** 14 Ω ± 10%



## Learning Activity 3.1

### Resistance Values

Now you try. Calculate the resistance value for the following two resistors.

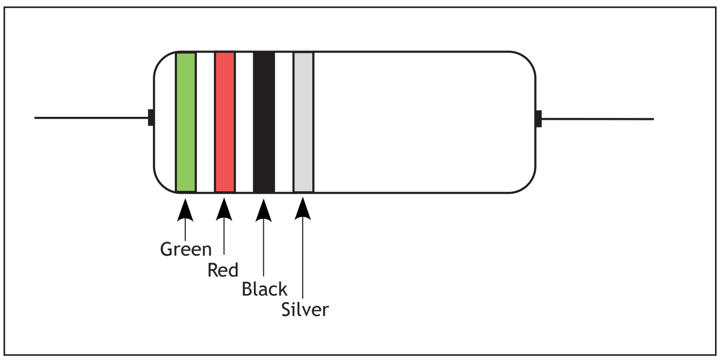



Ohm value:

________________

Tolerance:

________________




Ohm value:

________________

Tolerance:

________________

Check your answers in the Learning Activity Answer Keys found at the end of this module.

Go to Assignment 3.1 found at the end of this module and complete Part 1: Calculating Resistor Colour Codes. Each answer should include the number, the unit, and the tolerance ±.

Now, let's change things around! What if you knew the resistance value in ohms, but you didn't know the colour code. All you would need to do is circle the numbers. To start off, it is a good idea to write out the lengthier version. Here is a great example. What is the colour code for a 15 kΩ resistor?

## Here's How It's Done

Write out 15 15 kΩ 5% on a blank sheet of paper. Use the lengthier version of 15,000 15 Ω 5% until you are comfortable with this value, but remember—they mean the same thing. Now look below and see what is circled.

| | |
|---|---|
| Black | 0 |
| Brown | 1 |
| Red | 2 |
| Orange | 3 |
| Yellow | 4 |
| Green | 5 |
| Blue | 6 |
| Violet | 7 |
| Grey | 8 |
| White | 9 |
| Gold | ±5% |
| Silver | ±10% |
| None | ±20% |

The 1 is circled as the first colour band.

The 5 is circled as the second colour band.

The three zeros are circled as the third colour band.

***To simplify this calculation, the fourth tolerance band will not be calculated at this time.***

Using the colour code chart, try to determine the colours of the 15 kΩ resistor.

The first number, 1, would represent **brown** in colour.

The second number, 5, would represent **green** in colour.

The third circled set of numbers has 3 zeros, representing **orange** in colour

So, the resistor colour code would be: **brown—green—orange—gold**.

***Why the gold?***

Well, **gold** represents 5% tolerance.

---

Go to Assignment 3.1 found at the end of this module and complete Part 2: Calculating Resistor Numeric Values.

---

## Testing the Resistors in the Project Kit

In the previous lesson and assignment, you calculated the value of resistors from colour codes to numbers and numbers to colour codes. Now you need to test the three resistors in the kit. Once you have tested the three resistors, go to Assignment 3.2, Component Test Record Sheet, found at the end of this module and complete the chart for the three resistors. You will be using this record sheet throughout this module. You will need your DMM, a pencil to write with, and an eraser.

It is now time to view the Grade 9/10 Electronics video found in the learning management system (LMS) or on DVD. Watch the section on testing resistance on the DMM.

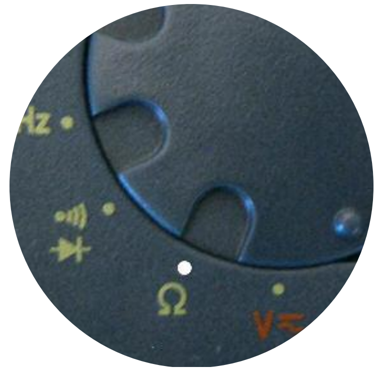
**Inventory List:** Place a checkmark in each box once you have identified the item.

❑ digital multimeter (DMM)


❑ HB or 2H lead pencil

**Procedure:**

1. Set the DMM to the Ohm function (shown below).

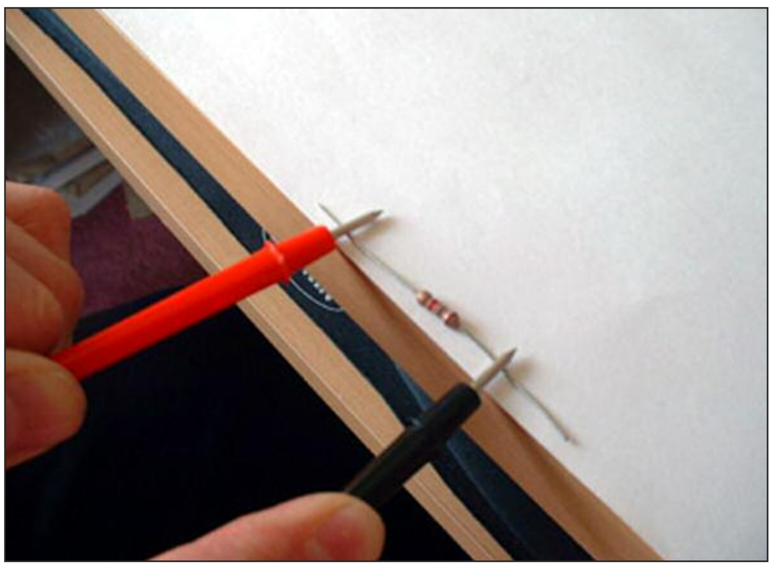

2. Find the three carbon resistors in your project kit package (shown below).

At this time, find Assignment 3.2: Project Kit Component Test Record Sheet. As you follow these instructions, fill in the section on resistors (see the sample that was provided in Module 1). This sheet is to be used for Lessons 1, 2, 4, 5, and 6 in Module 3.

Record R1, R2, and R3 (Part Letter Symbol column). Draw the schematic symbol of the three resistors (Schematic Symbol column). Refer to Module 1 for a review of schematic symbols.

3. Calculate the colour code and record the calculated value on the **part value column**. Part value is for an item rated in ohms, farads, volts, etc.

4. Using the DMM, place a probe on one leg of the resistor and the other probe on the second leg of the resistor just like the pencil lead trick. Do not use your fingers to pinch the probes close to the legs. Use the edge of the table to hold down the legs for a proper reading. Record this value on the Component Test Record Sheet in the **tested value column**. Tested value can be a number value or word value, such as "good," "failed," or "unknown," depending on the part. The three resistors will have a number value.



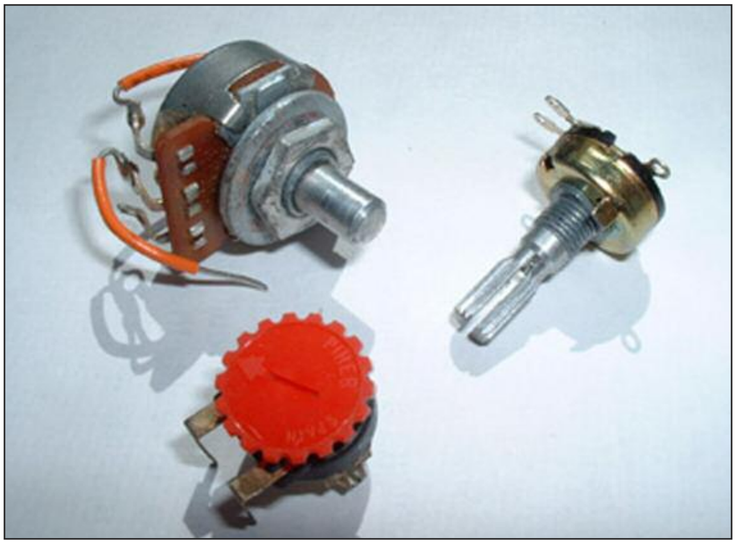
5. Compare the **tested** and **measured** values. They should be very close but they will likely not match perfectly because the tested value can be within 5% tolerance of the measured value. In other words, the tested value must be within 5% higher, or 5% lower of the calculated value. If it is, we say that the resistor is within range. If it is not, check with your tutor/marker. These parts will be used on your project so ensure they are stored back in the zip bag when you are finished with the component parts.
6. Place in the "tested component" bag. These parts will be used on your project.

Once you have covered the steps above, you will have completed Part 1: Component Test Record Sheet—Resistors, of Assignment 3.2.

## Variable Resistors

Variable resistors can be adjusted to provide varying resistance values. Two types are shown below.

**slide resistor**



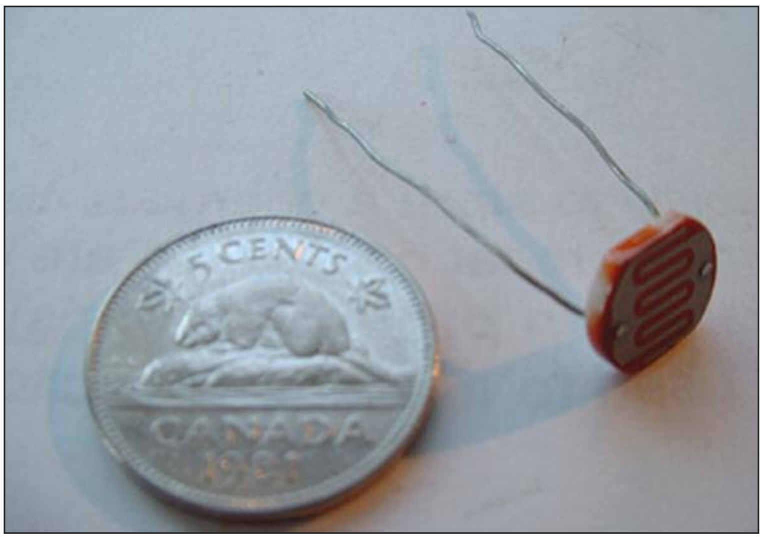
**rotary pots**

These variable or adjustable resistors are most often referred to as Potentiometers, or in short “pots.” These pots are used to turn volume up or down, to dim lights in your home, or to act as a timer controller. Some houses have versions of pots in use, as shown below.


VOLUME
SS
MAX
OUBLE
ORMAL

## Light Dependent Resistors

This type of resistor, also referred to as photocells, use light to change the resistance values. Varying the amount of light that is allowed to fall on the sensitive cadmium sulphide surface brings on change in resistance. The resistance can change in value from 10 W in the dark to 1 kW in light conditions. They are very suitable for detecting light conditions and are very popular for hallway or bedroom night-lights. When the room gets dark, the photocell will turn on the light. A picture of a photocell and a night-light is shown below.

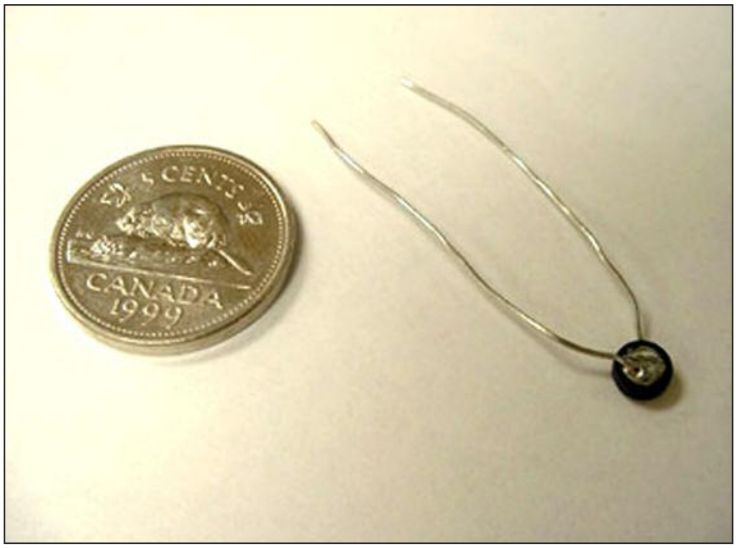



**photocell**

**night light**

## Heat Sensitive Resistors

A thermistor or thermal resistor is a device whose resistance can be changed as its temperature is modified. This makes thermistors suitable for temperature-detecting circuits. A good example is a digital thermometer. A thermistor and a digital thermometer are shown below.




thermistor


digital thermometer

# LESSON 2: CONTROLS

## Switches

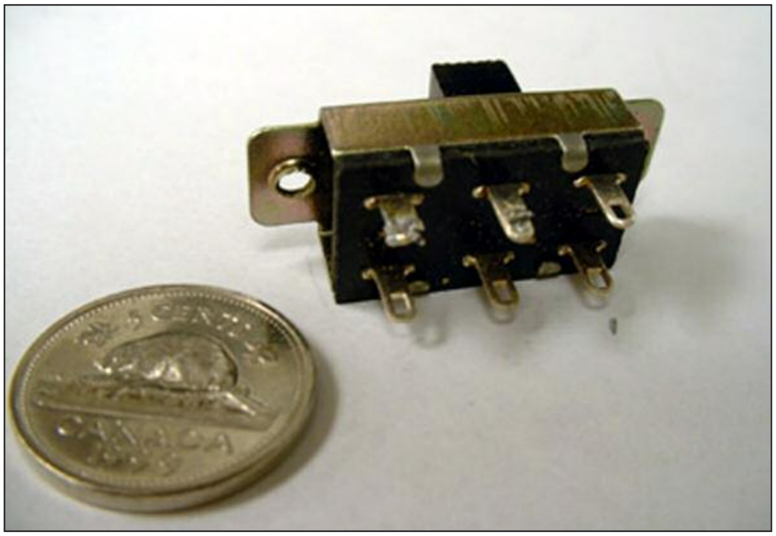
Switches are non-electronic devices that control current flow. They are mechanical devices that can connect or disconnect a circuit. They vary greatly in size, shape, current capacity, and operation. Depending on the application, they can be controlled by a lever, toggle, slider, pressure, or rotary knob like the one on your DMM.

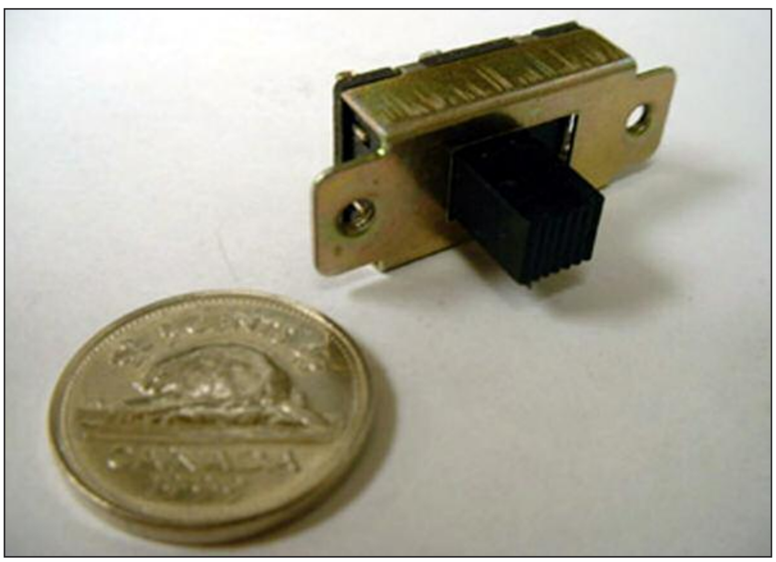
A basic knife switch is the simplest switch to understand.

### Slide or Toggle Switch

The number of contact systems inside the switch will usually determine its application. The term used to describe the contacts inside the switch is called **poles**. The knife switch seen above would be called a SPST (Single Pole, Single Throw) switch. There is one pole to have the lever contact and one single throw switch to make the actual contact.

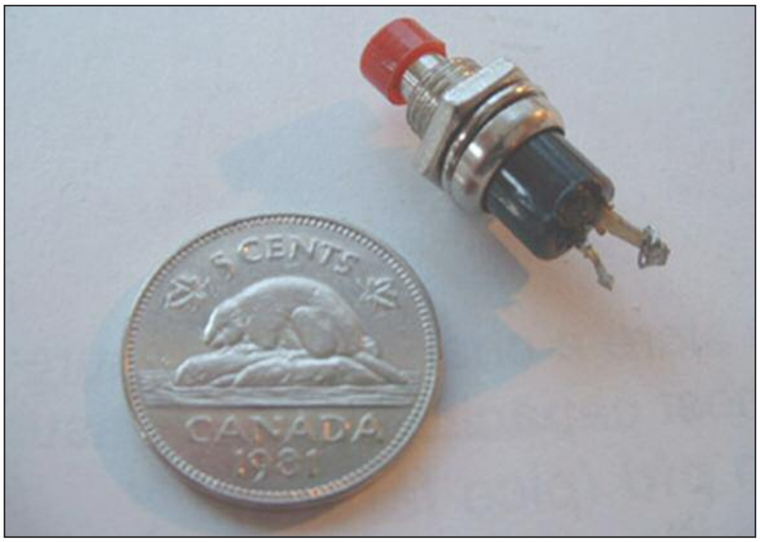
Below you will see a variety of multiple contact switches, DPDT (Double Pole Double Throw), as seen in projects complete with the matching schematic symbol. Look closely at some of the switches with more than one pole and throw.

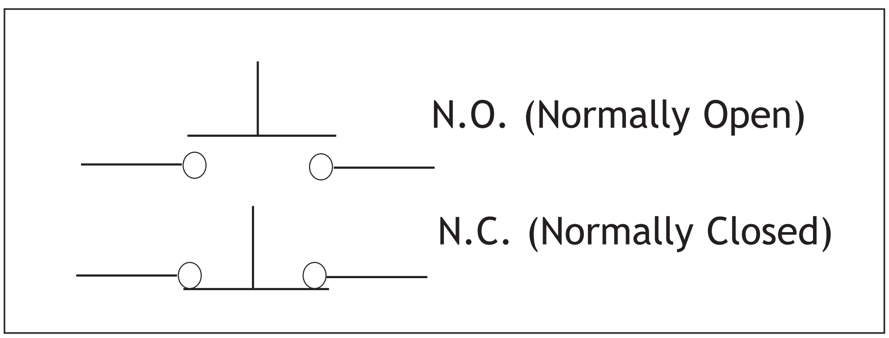




## Pushbutton Switches

Pushbutton switches, like the one in your kit bag, are a very common part used in many electronics projects. They have a return spring inside them so that when they are pushed, the spring will return them to their original position. There are also pushbutton switches that lock in a compressed position. Pushbutton switches are normally opened as "NO" or normally closed as "NC."



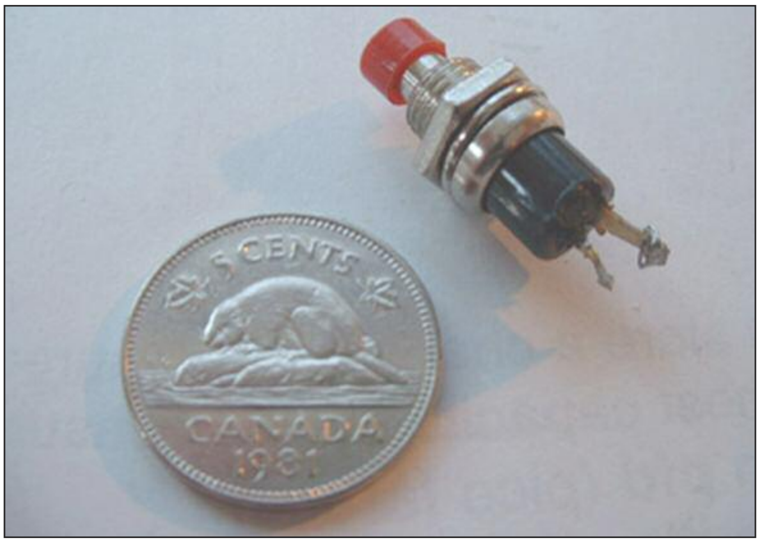



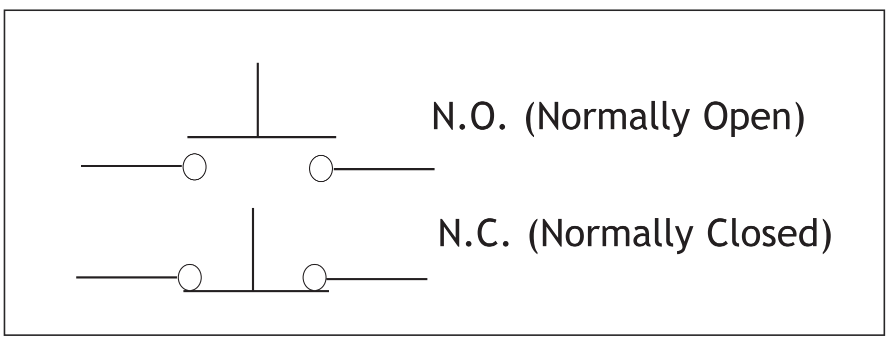
## Another Cool Experiment!

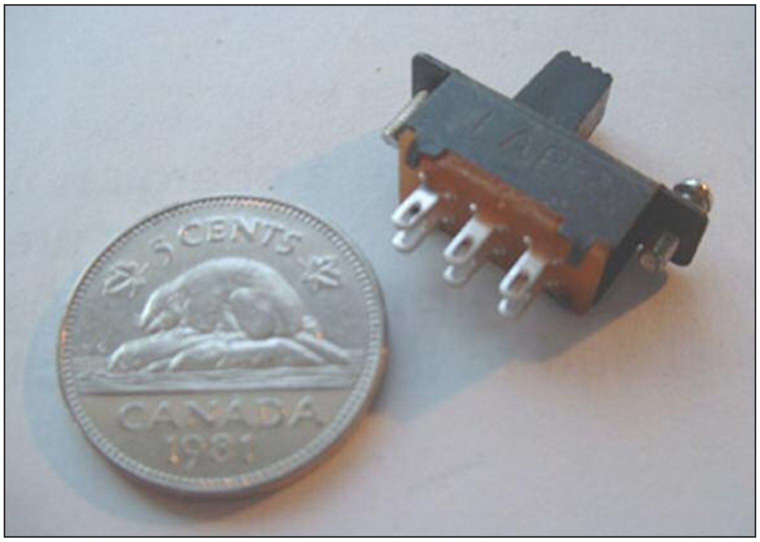
### Student Challenge 5

*Can you determine if the slide switch and pushbutton switch in your project work?*

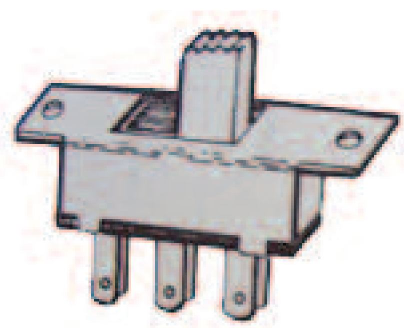
You will need to find the pushbutton switch and the slide switch in your kit bag.





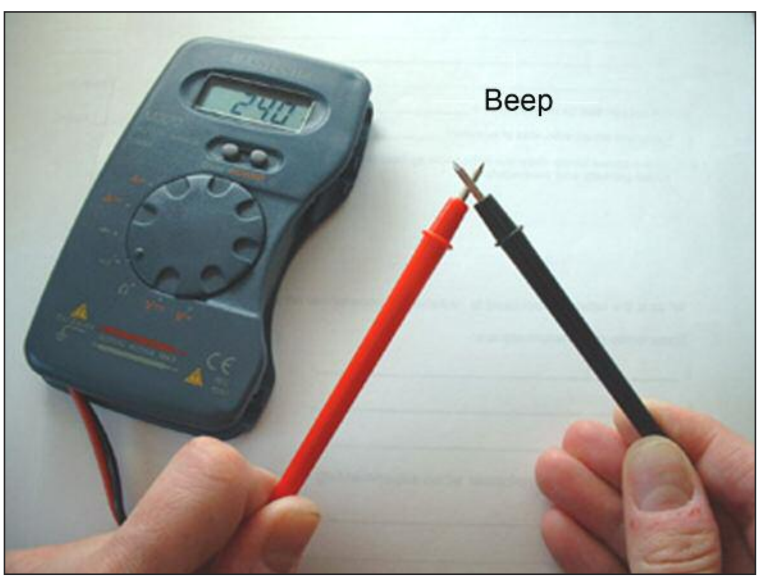

Double Pole Double Throw



It is now time to view the Grade 9/10 Electronics video found in the learning management system (LMS) or on DVD. Watch the section on testing audible continuity with the DMM.

Use your DMM to test the slide switch. Rotate the DMM function dial to the audible continuity option, as shown below.

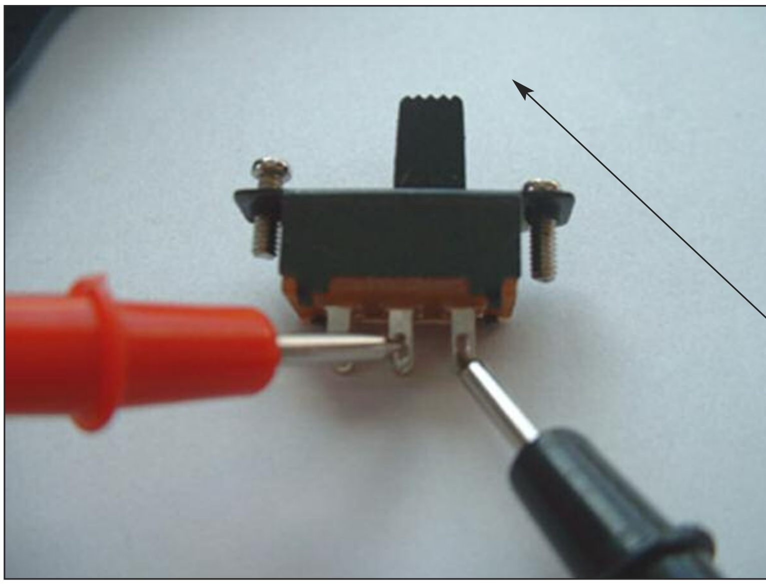
Check to see if your meter works. Once on the audible continuity function, touch the red and black probes together. You should hear a beeping sound. If you don't hear the beeping sound, check to see that you are on the proper function, that your probes are plugged in all the way, and that the battery in the meter is still working.



Find Assignment 3.2: Project Kit Component Test Record Sheet, found at the end of this module, and complete Part 2: Component Test Record Sheet—Switches. You will need to fill in the letter symbol, schematic symbol, and test result.

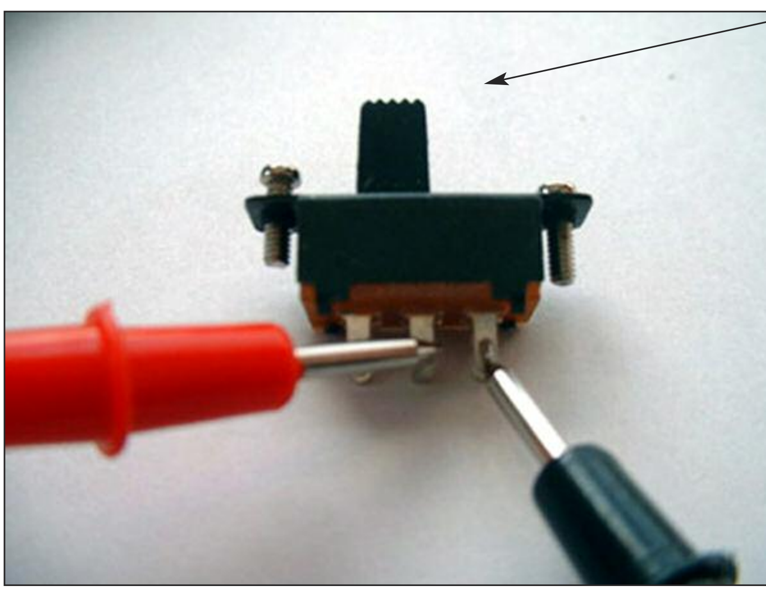
Use your DMM to test the slide switch.

Refer to the picture below to see how the test should be conducted. Be sure to slide one switch back and forth and push the other in and out.



slide switch (beeping)

Slide back and forth to test.



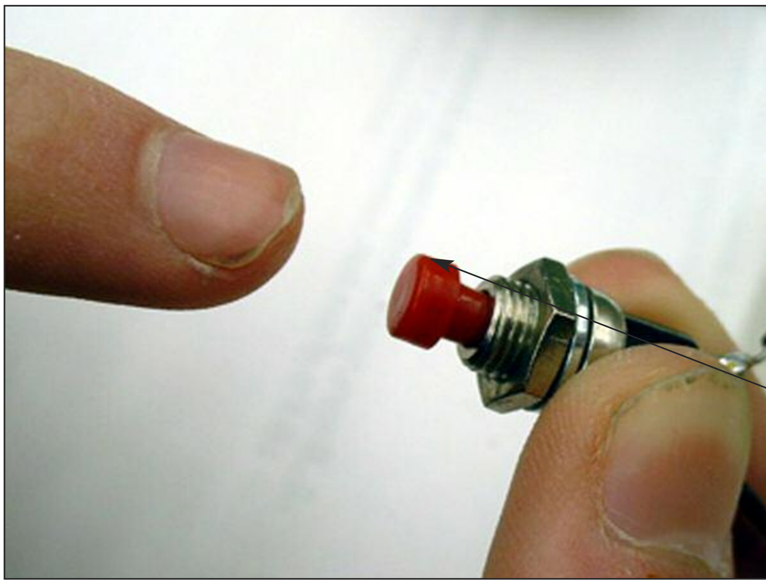
slide switch (no beeping)

**Note:** Graphics may be different than the items in your kit due to a new product supplier.

**Note:** There is no value to look for when testing the slide and pushbutton switches. Just record in the tested column on the Component Test Record Sheet whether the switches are good or bad. It doesn't hurt to get an assistant to help you hold the probes in place as you push the button and slide the switch.

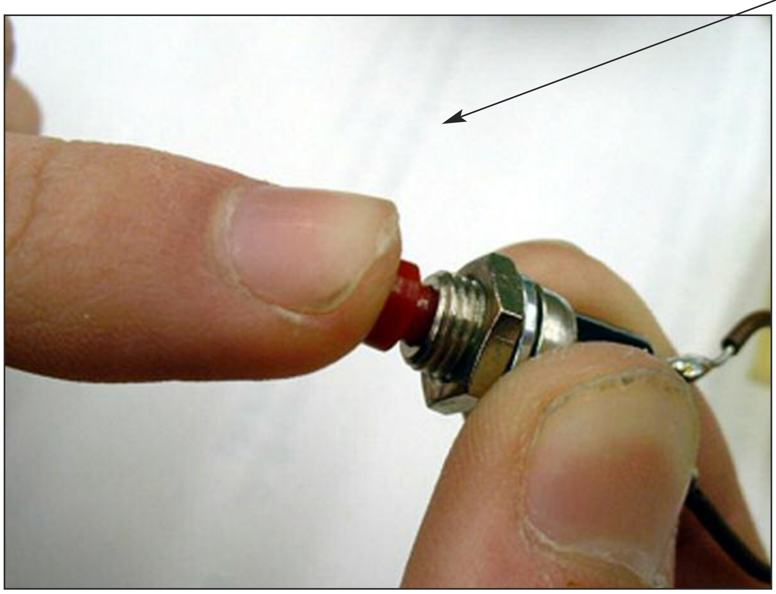
**Note:** The slide switch is the main control to power up your project. The pushbutton switch is the trigger.

Refer to the picture below to see how the test should be conducted to test the pushbutton switch.



**Push down to test.**

**pushbutton switch (beeping)**

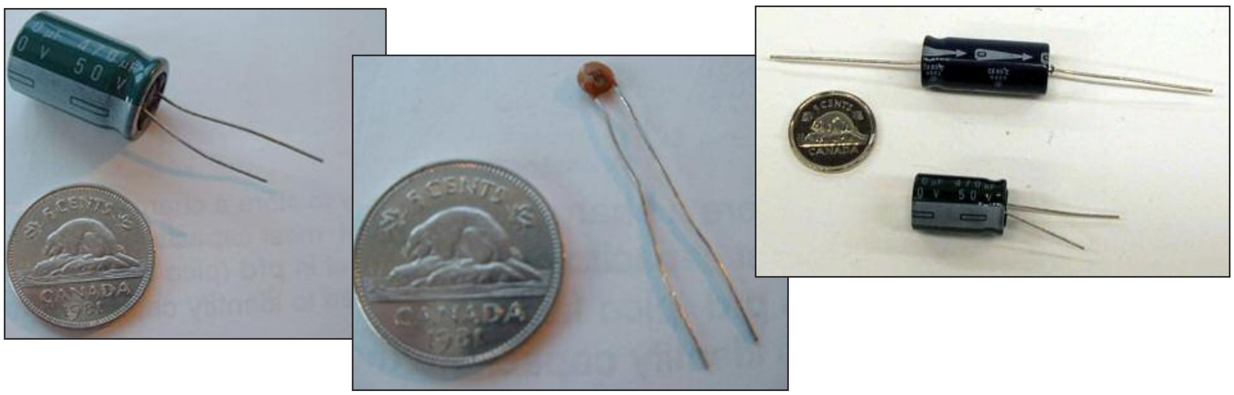


**pushbutton switch (no beeping)**

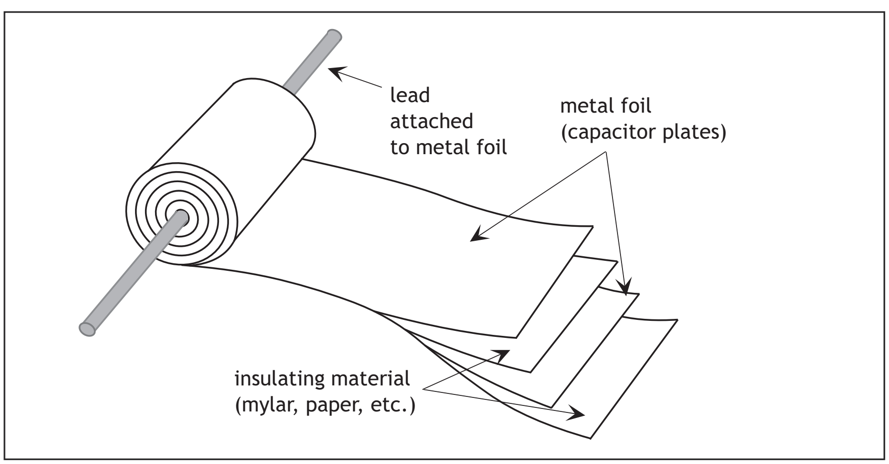
# Lesson 3: Capacitors

## Introduction to Capacitors

The term **capacitance** in electronics refers to the ability of an electrical circuit or device to store electrical energy. The capacitor is a component that can store an electrical charge. Next to the resistor, the capacitor is one of the most common components in electronic projects.




Capacitors consist of two **leads** connected to two metal **plates** separated by an insulating material called a **dielectric**. The **dielectric** can be any non-conducting material, such as paper, mica, ceramic, or air. The plates store the electric charge. The dielectric keeps the two metal plates from touching. If the two metal plates inside the capacitor were to touch, the capacitor would no longer work.



When a capacitor is connected to a voltage supply such as a battery, electrons flow and charge the capacitor. It collects and stores the electric charge like a pail stores water. Like the pail of water, once it is full it cannot store any more.

**Caution**

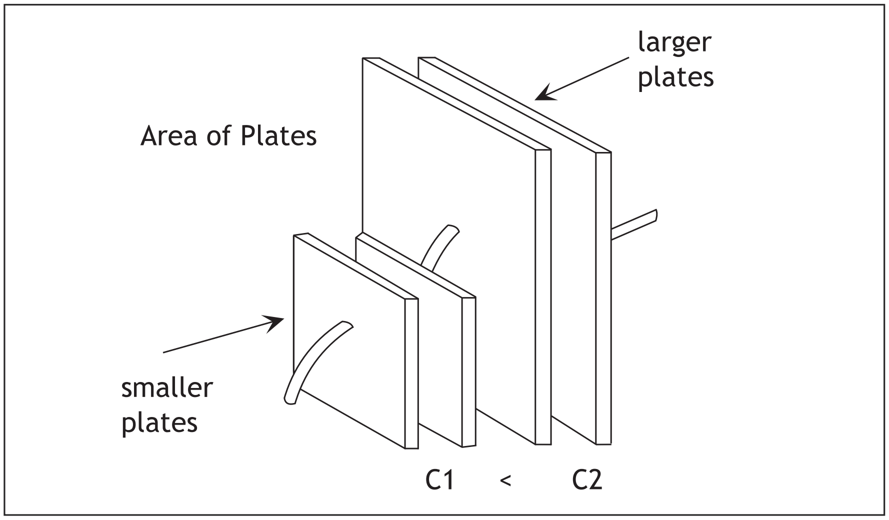
A capacitor, once charged, holds its energy. A charged capacitor can be extremely dangerous. Capacitors should be discharged before handling.

The capacitance of a capacitor is measured in **farads**. Because these are extremely large units of measure, capacitors are usually rated in microfarads ($\mu$F). One microfarad equals one-millionth of a farad. Look at the conversion table below to see how to determine microfarads.

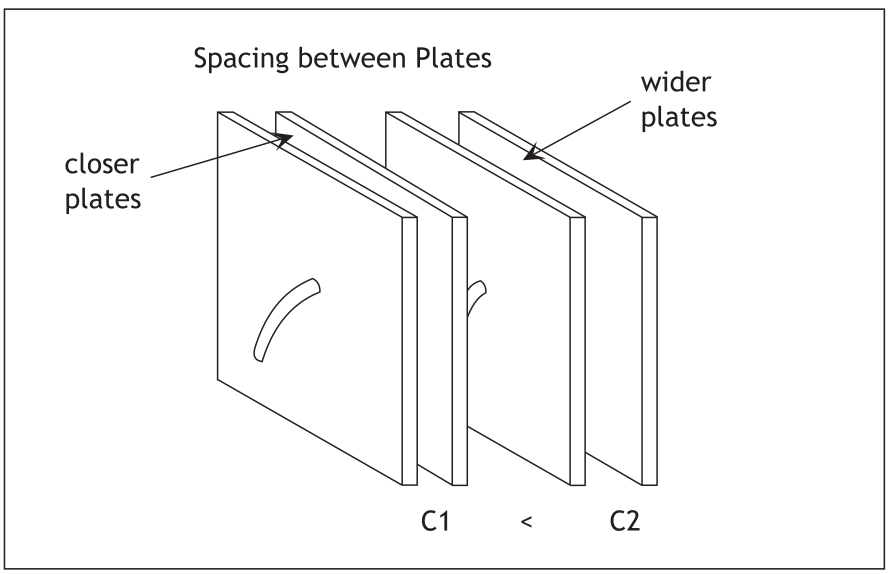
**Table 1: Capacitance Conversion**

| Microfarads ($\mu$F) | Nanofarads (nF) | Picofarads (pF) |
|---|---|---|
| 0.000001 $\mu$F | 0.001 nF | 1 pF |
| 0.00001 $\mu$F | 0.0 nF | 10 pF |
| 0.0001 $\mu$F | 0.1 nF | 100 pF |
| 0.001 $\mu$F | 1 nF | 1000 pF |
| 0.01 $\mu$F | 10 nF | 10,000 pF |
| 0.1 $\mu$F | 100 nF | 100,000 pF |
| 1 $\mu$F | 1000 nF | 1,000,000 pF |
| 10 $\mu$F | 10,000 nF | 10,000,000 pF |
| 100 $\mu$F | 100,000 nF | 100,000,000 pF |

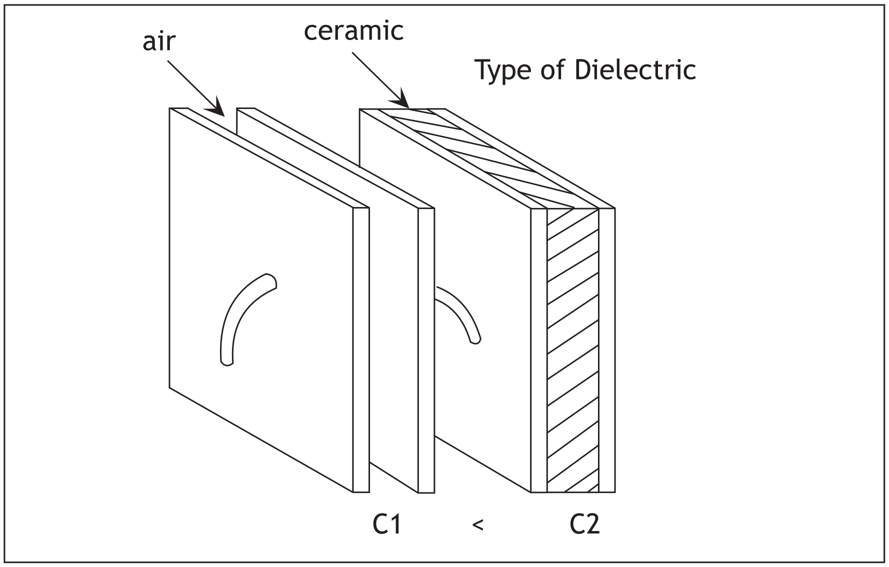
To achieve these various capacitance values, the metal plate on which the charge of electrons is stored can be made larger or smaller. Increasing the plate area will increase the capacitance value of the capacitor.




The distance between the metal plates also affects the capacitance of a capacitor. If we increase the distance or space between the plates, the capacitance is decreased.

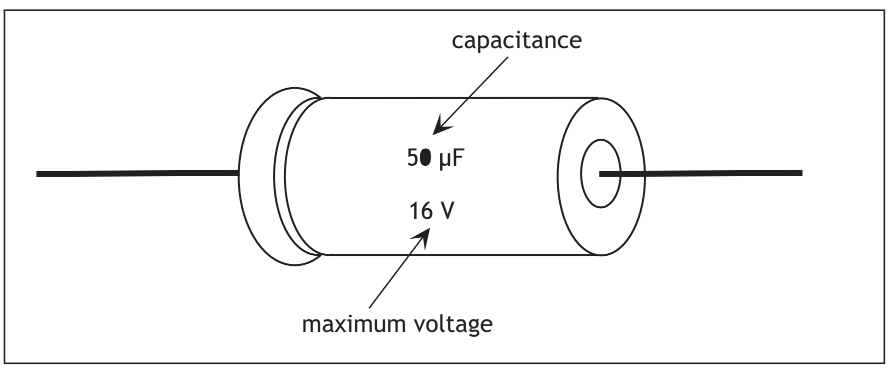


A third factor that affects the capacitance of a capacitor is the type of dielectric or insulating material used to separate the metal plates. Air is one of the simplest dielectrics; however, most capacitors will use other insulators, such as mica, ceramics, or porcelain.

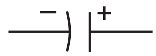



**Sparkey Fact:** Did you know that your toilet is made from porcelain?

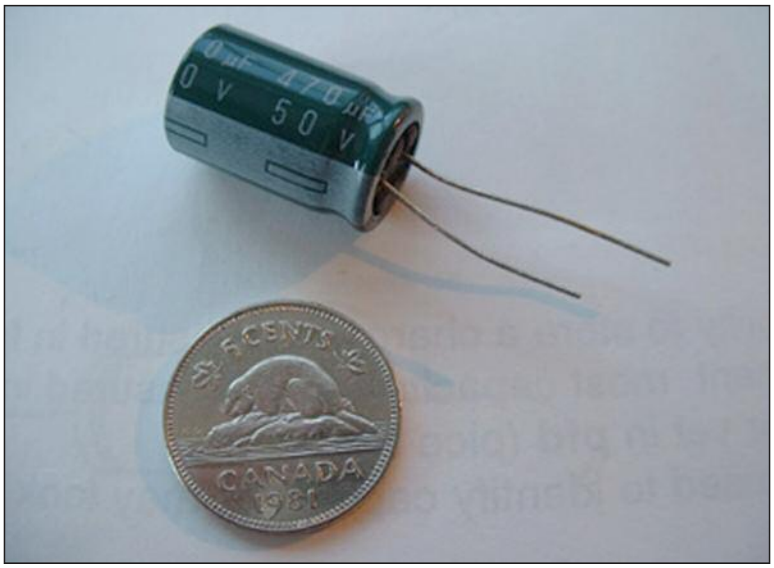
Besides the capacitance value in farads, another thing you must consider when choosing a capacitor is the **working voltage** in Direct Current or WVDC. This is the voltage that a capacitor is designed to work at without breaking down. These two values, capacitance and WVDC, are usually stamped on the side of the capacitors, seen below.



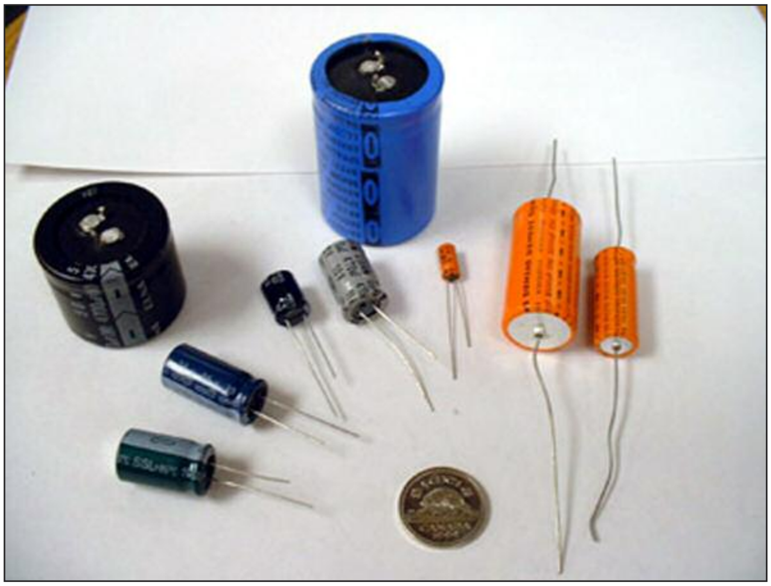

The following is a more detailed explanation of the most commonly used capacitors.

## Electrolytic Capacitors 

Made of electrolyte, this is basically conductive salt in solvent. It uses a thin oxidation membrane with aluminum electrodes. The most common type is a polarized capacitor. These capacitors **will explode** if the rated working voltage or WVDC is exceeded or if the polarity is reversed. **So be careful and watch for the (–) and (+) markings.** The negative can be identified by the shorter lead on the capacitor; the positive can be identified by the longer lead.



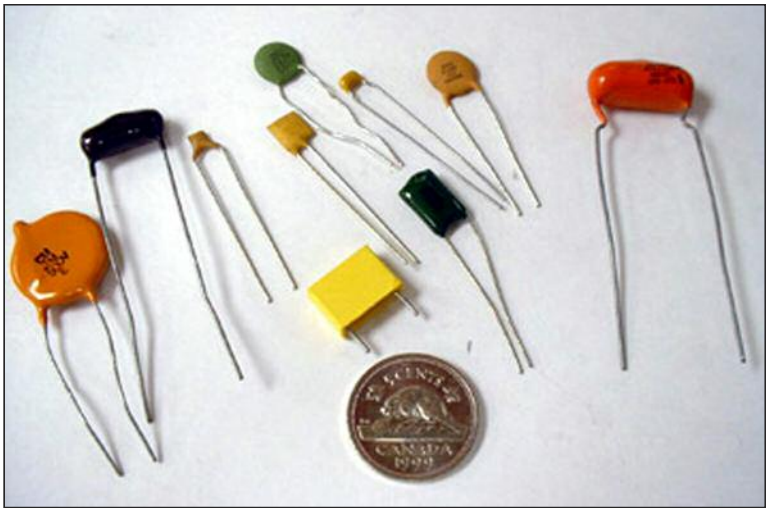

When you use this type of capacitor in one of your projects, the rule of thumb is to choose one that is twice the supply voltage. For example, if your supply power were 12 volts, you would choose a 24-volt (25 V) type. This type has come a long way and its characteristics have constantly improved over the years. It will remain a very popular type unless something better comes along to replace it. Polarized electrolytic capacitors are heavily used in almost every kind of equipment and consumer electronics.



## Ceramic Capacitors

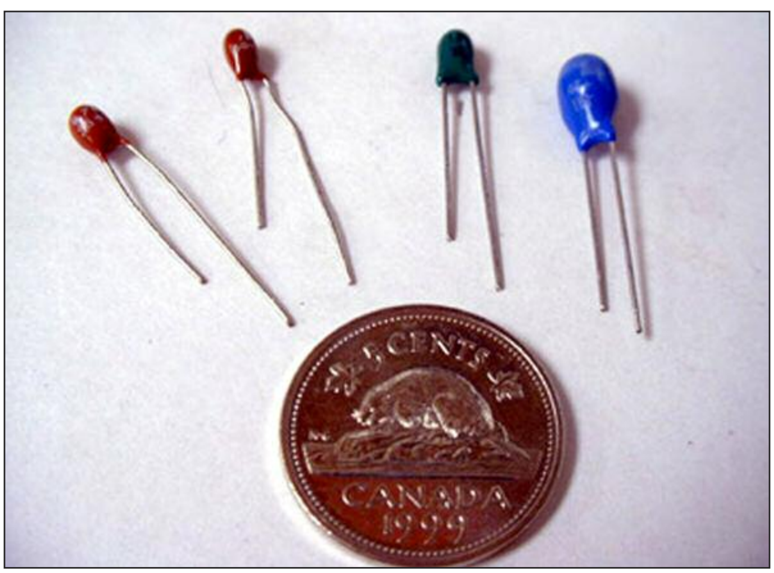
This type of capacitor is constructed with materials such as titanium acid barium for dielectric. Internally these capacitors are not constructed as a coil, so they are well suited for use in high-frequency applications. They are shaped like a disk, and are available in very small capacitance values and very small sizes. Together with the electrolytics, they are the most widely available and used capacitors around. They come in very small sizes and are very cheap and reliable.

**Sparkey Fact:** The name of this type of capacitor, like many others, comes from the type of dielectric it uses.



## Tantalum Capacitors

Tantalum capacitors are made of tantalum pent oxide. They are electrolytic capacitors but are used with a material called tantalum for the electrodes. Superior to electrolytic capacitors, they have excellent temperature and frequency characteristics. When tantalum powder is baked in order to solidify it, a crack forms inside. An electric charge can be stored in this crack. Like electrolytes, tantalums are polarized **so watch the (+) and (–) indicators**. Their small size fits anywhere. They are reliable and one of the most common values readily available. They are, however, expensive and easily damaged by high voltage spikes. Large values exist, but they may be hard to obtain. The negative can be identified by the shorter lead on the capacitor; the positive is the longer one.

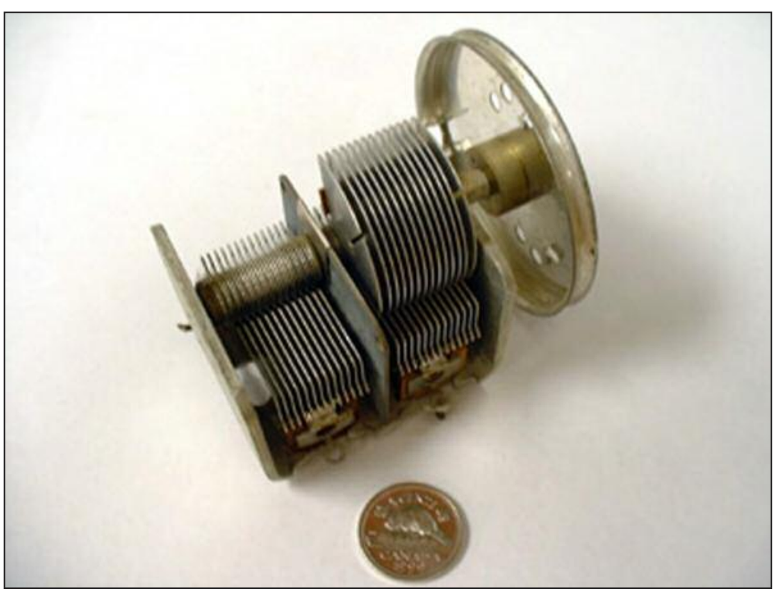


## Variable Capacitors 

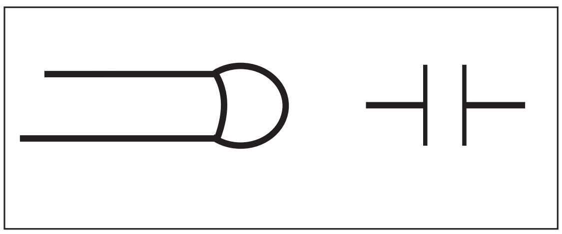
Variable capacitors are also called trimmer capacitors. They use ceramic or plastic as a dielectric. Most of them are colour coded in order to determine their tunable size. The ceramic type has the value printed on them. Colours include: yellow (5 pF), blue (7 pF), white (10 pF), green (30 pF), and brown (60 pF).


**Sparkey Fact:** When you change your radio station, you are using a variable capacitor.

Other styles of variable capacitors use the surrounding air as a dielectric. Variable air-core capacitors must be tuned very slowly and carefully. They are mostly used in radio and radar equipment.



Sparkey says the capacitor you will be using for the actual project will be a very small ceramic capacitor. It will look like this.

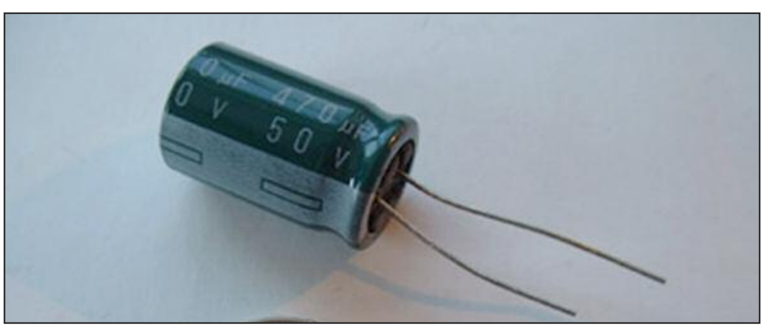
## Check This Out!

Let's use the capacitor to light the LED!

### Student Challenge 6

*Let's have some fun with an electrolytic cap!*

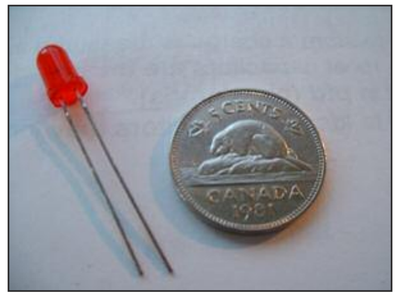
You will need to find the electrolytic capacitor from your kit bag. It will look like the picture below.



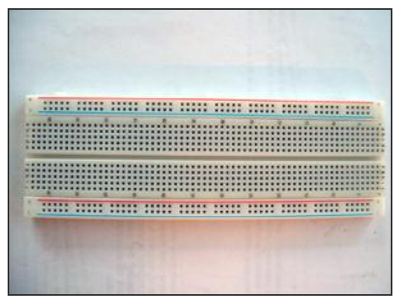
**Inventory List for Student Challenge 6:** Place a checkmark in each box once you have identified the item.

❑ one 9-volt battery


❒ one red light-emitting diode (LED)

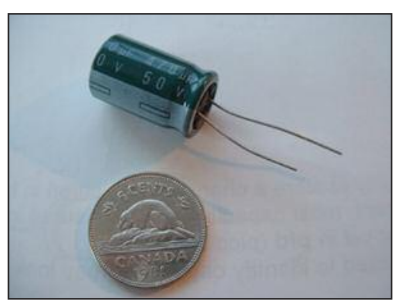


❒ one solderless circuit board



❒ one pair of safety goggles

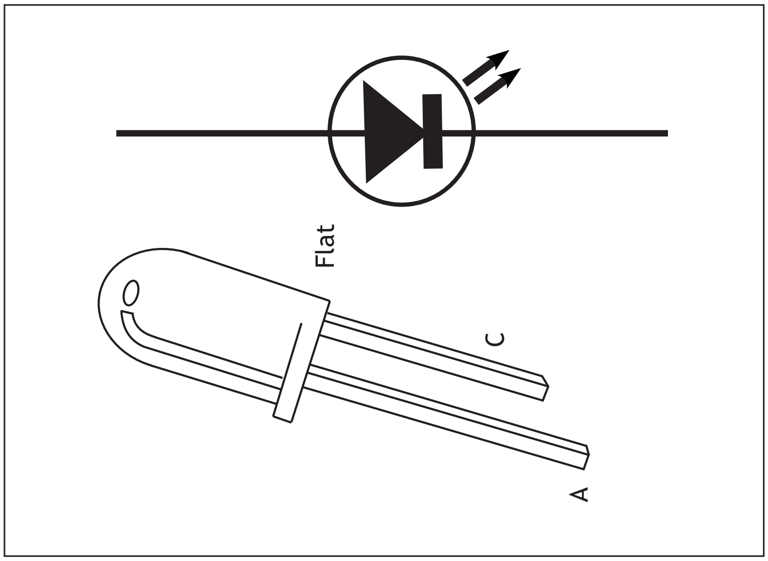
❒ one electrolytic capacitor

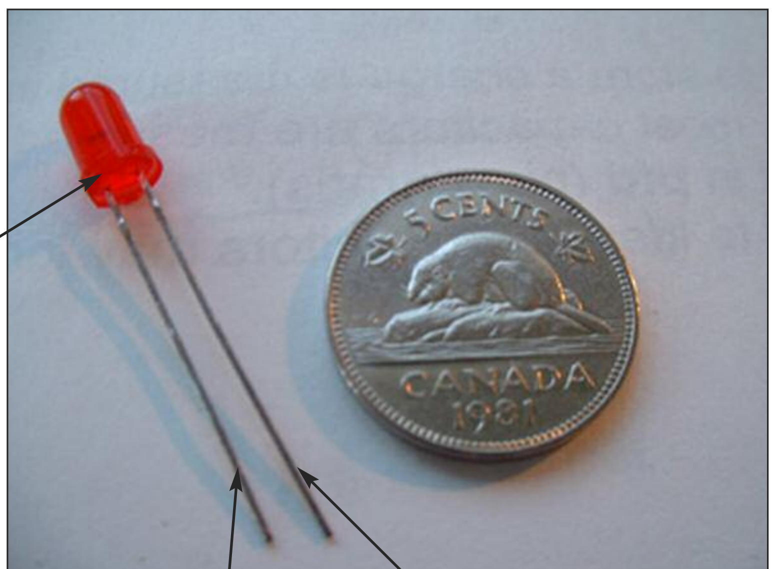


If items are missing or not in working order, contact the Manitoba Text Book Bureau for replacement parts (1-866-771-6822).

**Step 1**

Plug the LED into the solderless circuit board. Make sure the two leads from the LED are in different rows. Pay close attention to the flat side of the LED (also the shorter of the two legs). It is the negative side.

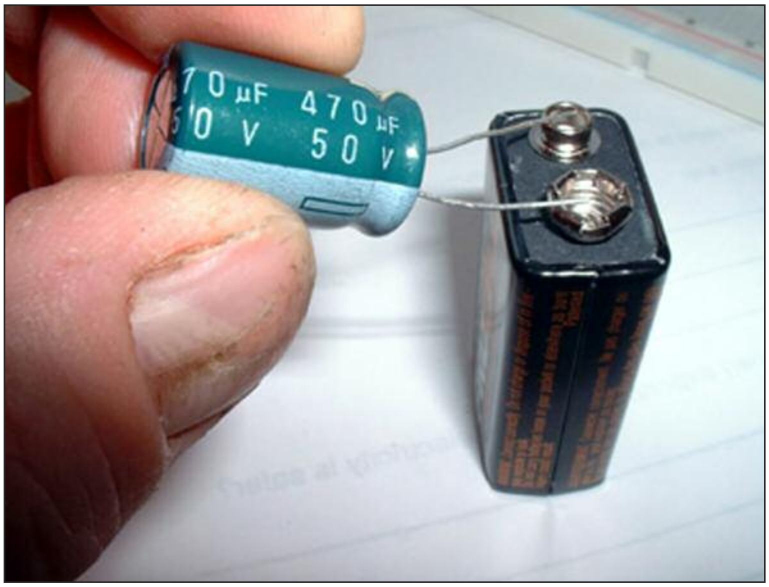



Step 1

**Step 2—Make sure you have your goggles on!!**

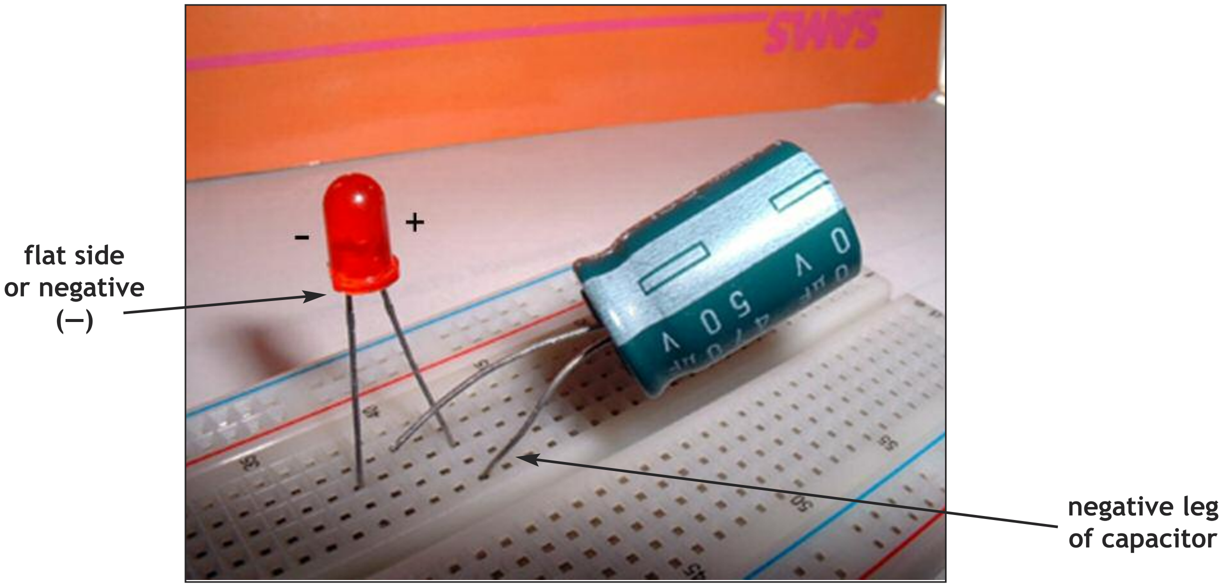
To charge the electrolytic capacitor with the 9-volt battery, place the shorter negative leg of the electrolytic capacitor on the negative of the battery and the longer positive one on the positive of the battery. Hold it on the battery for four seconds. Do not touch the legs together. This will discharge all the electric energy.




**Step 2**

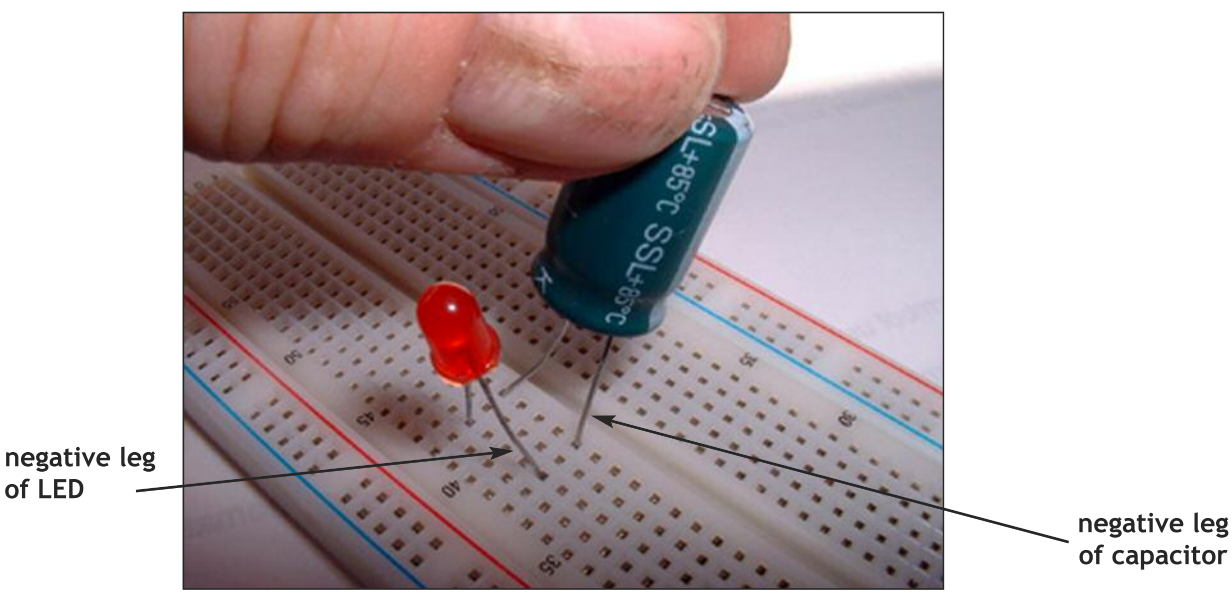
### Step 3

Carefully plug in the electrolytic capacitor with the negative leg of the cap on the flat negative side of the LED, and then plug the longer positive one of the capacitor in the other side.




**Step 3: Picture 1 (incorrect)**

**Note:** In picture 1 above, the electrolytic capacitor is not plugged in on the same row and is connected backwards. This will result in the LED not lighting up! In Picture 2 below, note that the capacitor is plugged in on the same row and the negative and positive sides of the capacitor and LED are correctly connected.




**Step 3: Picture 2 (correct)**

## Learning Activity 3.2

### Capacitors

Answer the questions below.

1. What did the LED do when the capacitor was plugged in?
2. Why did this happen?

Check your answers in the Learning Activity Answer Keys found at the end of this module.

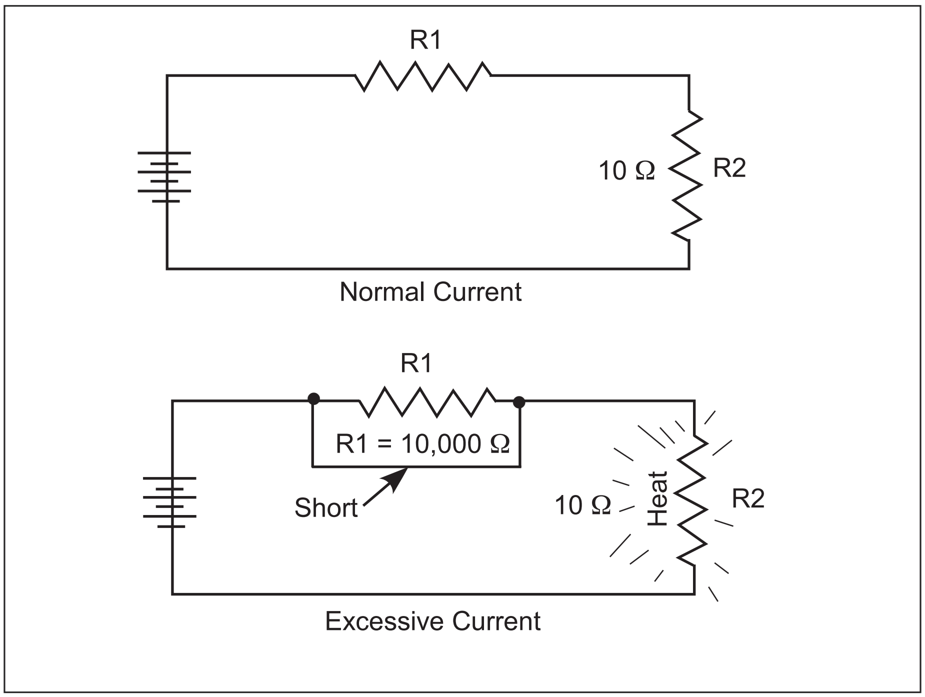
# LESSON 4: CIRCUIT PROTECTION

## Overloads

Every electronic circuit has its limit to how much current it can handle before it fails. A major factor is the gauge or size of wire. A circuit is **overloaded** when it cannot handle the current. An overload can happen in your home when too many items are plugged into a wall outlet. The circuits in your wall and kitchen plugs are rated for 15 amps of current. If the 15-amp capacity is surpassed, the wires attached to the circuit will try to keep up, delivering as much power as possible. When a wire and circuit are stressed, the wire could get hot and cause an electrical fire.

## Short Circuits

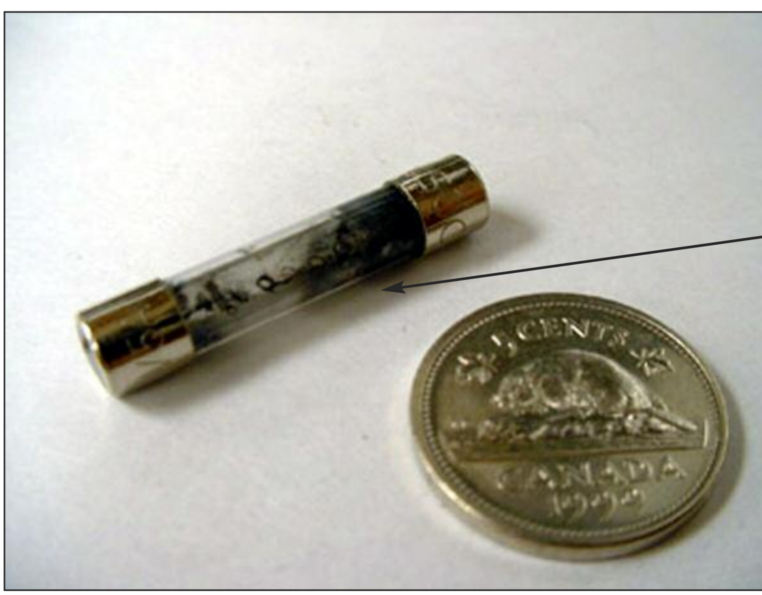
A **short circuit** is an electrical circuit of low resistance established either by accident or intention between two points in the electrical circuit. The current flows through the area of low resistance, bypassing the rest of the circuit. Since the resistor is bypassed, the amount of resistance in the circuit drops to zero. The decreased resistance causes the current flow to increase dramatically and can cause damage to the circuit or even become overheated and start a fire. The diagram below shows a normal current and a short circuit.



## Circuit Breakers and Fuses

Fuses and circuit breakers are over-current protection devices. If there is a problem, they are designed to protect you. They are connected in series with the power supply. When the power supply delivers more energy than the wire and surrounding components can handle, the fuse or circuit breaker will blow or click off. By doing this, it creates a break in the circuit, thereby shutting down all power in the circuit. A picture of a blown and good fuse is shown below.

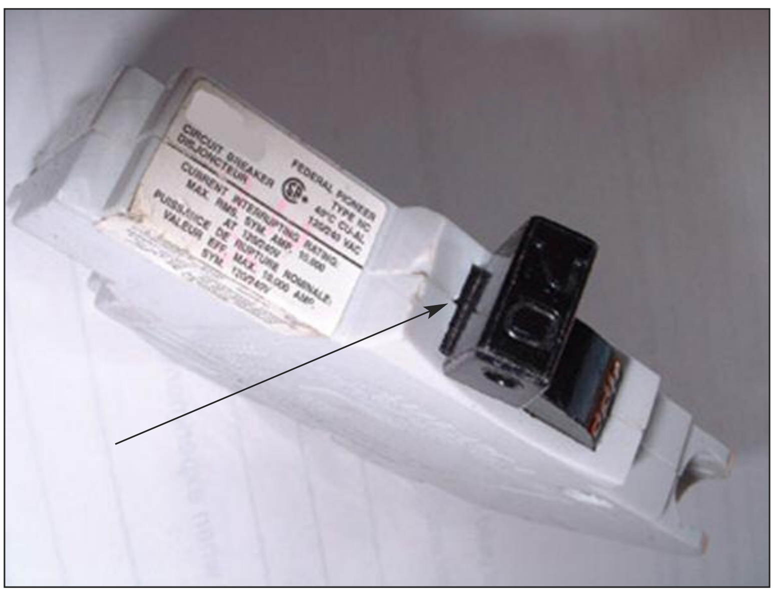
**good fuse (clear wire is connected from each silver cap)**




**blown fuse (black inside)**

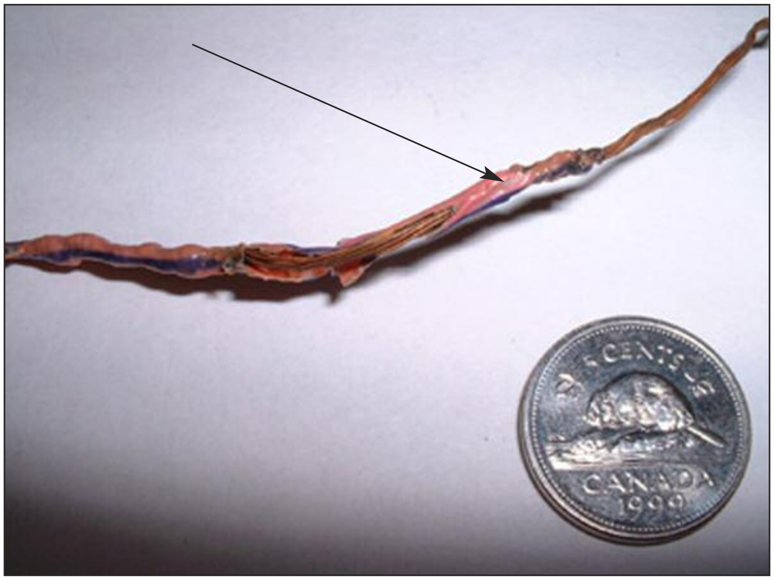
Fuses and circuit breakers are rated in both volts and amps.

fuse amperage and voltage rating stamped here




circuit breaker (20 amp)

All the circuits in your home, car, appliances, et cetera, have fuses or circuit breakers. Without them, there would be a lot of electrical fires from melted-down wires, as shown below.




**melted wire**

## Student Challenge 7

*Can you determine if your project fuse works?*

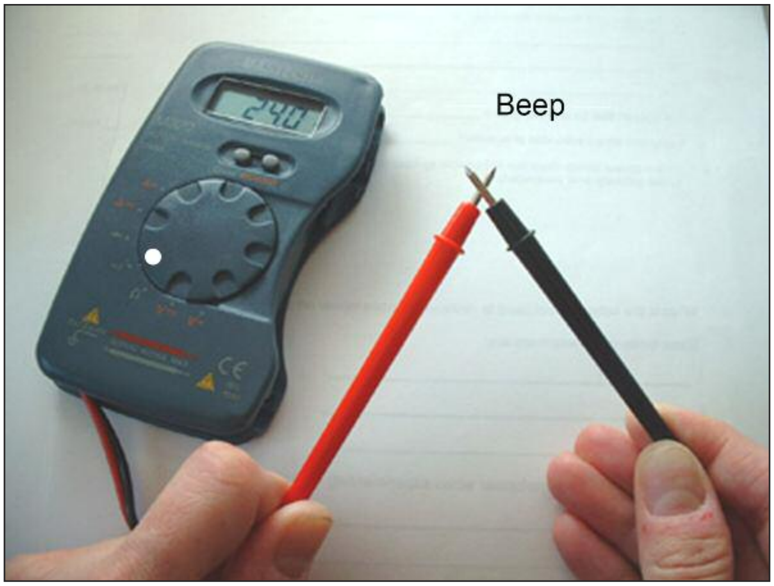
You need to find the fuse in your project kit bag.

Sparkey says the fuse you will use for the actual project should look like this.

Fuses may be tested very easily with a continuity meter. For this activity, we will use the DMM to determine if the fuse is working properly.

**Step 1**

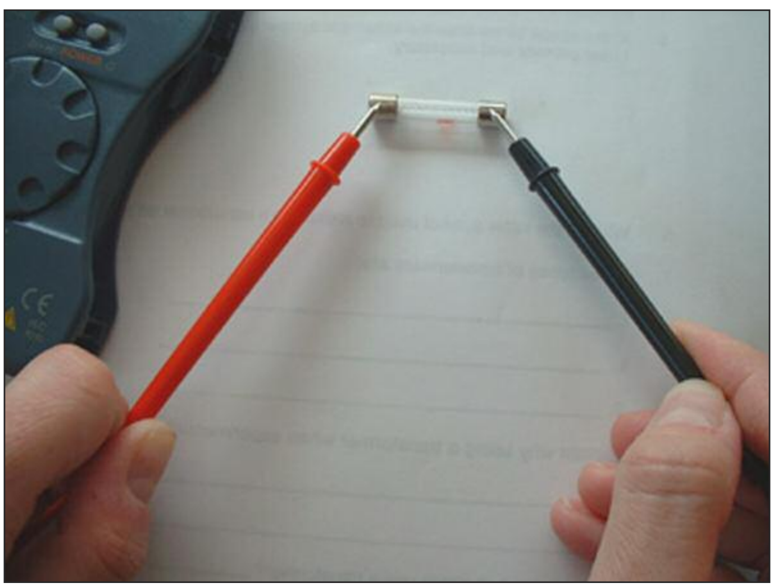
Set the DMM function dial to measure audible continuity. Touch the two probes together to make sure the meter works. You should hear a **beep**!




**Step 2**

**Make sure you have your goggles on!!!**

Place the probes of the meter on opposite ends of the metal-tipped fuse.



## Learning Activity 3.3

**Testing a Fuse**

Answer the questions below.

1. What did the DMM do when the two probes touched the ends of the fuse?
2. Why did this happen?

Check your answers in the Learning Activity Answer Keys found at the end of this module.

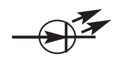
Find Assignment 3.2: Project Kit Component Test Record Sheet, found at the end of this module, and complete Part 3: Component Test Record Sheet—Fuse. You will need to fill in the letter symbol, schematic symbol, and test result. For the fuse, there will be no number or value to record in the test result section of the record sheet. Just record whether it is good or bad. The meter must make a beeping sound to consider the fuse to be in working order.

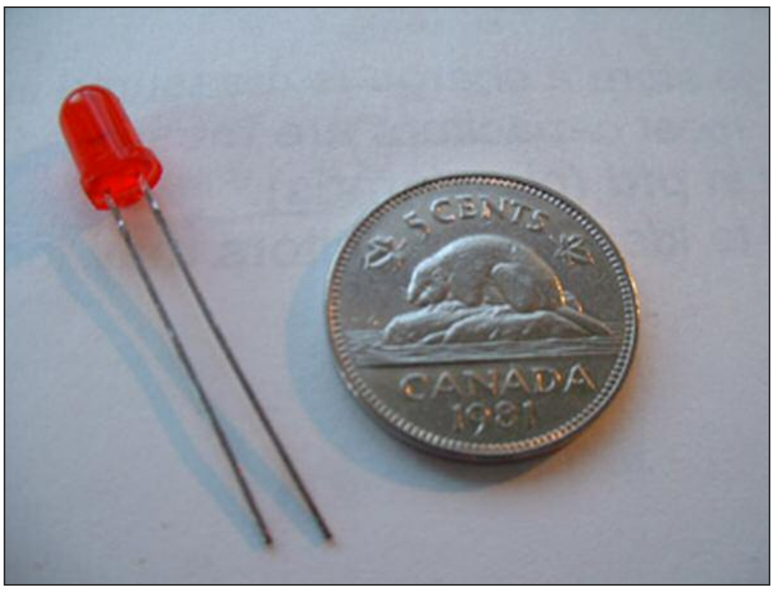
## NOTES

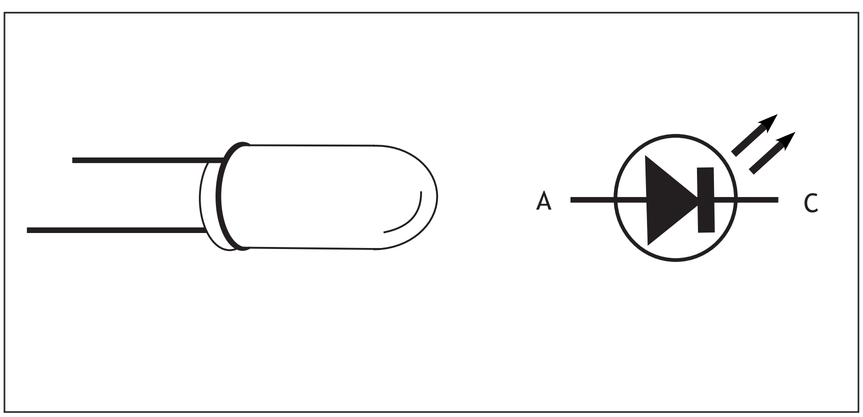
# LESSON 5: OUTPUT DEVICES

## What Are Output Devices?

Output devices are the opposite of sensor devices. They do not detect light, heat, or motion. They are designed to get your attention, just like a streetlight directs drivers to stop or go or an ambulance siren informs your audio sensors (i.e., your ears) that you should move out of the way. Output devices take an electrical signal and give out light, sound, movement, or heat.

## Visible LEDs (Light-Emitting Diodes) 



The circuit that you built used a LED as an output for light. The light bulbs in your house use large amounts of current to heat up the small wire filament inside the bulb, thereby creating light. The problem with this style of light is that it consumes large amounts of current, which is impractical in battery-powered circuits because it shortens the life of the battery. This is why LEDs are used in small battery-powered robots, remote-control toys, stereos, video cameras, et cetera. LEDs are also more rugged, do not create great amounts of heat, and come in numerous colours.

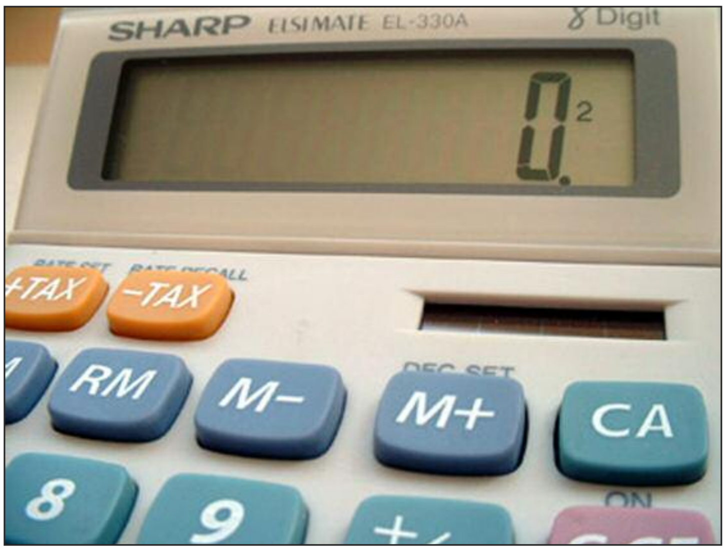
Find your red LED in your project kit package.

Take a close look inside the red **epoxy** case. There is a small chip inside with a reflector around the outside. The reflector helps emit the light produced by the small chip. Light-scattering particles are added to the coloured epoxy case. Yours is red to help make the light brighter from the end of the LED and not the sides.

LEDs can also be packaged in **digital-digit formations**. Digital-digit formations are the visual output from various clocks and timers, just like the timer/clock on your microwave or alarm clock.


Do not confuse digital display with liquid crystal displays that are used in calculators and wrist watches. They are different in both operation and construction.


**digital digit display**




**liquid crystal display (LCD)**


**liquid crystal display (LCD)**

## Invisible LEDs (Infrared-Emitting Diodes)

LEDs are primarily used as visible indicators to tell you something, but can also be used to transmit information invisibly. Infrared-emitting diodes are used in intrusion alarms to detect motion, wireless remote controls, or even diode lasers in police radar guns. The light they emit is not visible to the human eye. That is why you do not see an actual light being emitted from the handheld controller when you change the channel on your television. It is invisible to the human eye.

### Student Challenge 8

*Let's have some fun with a remote control!*

You will use a radio to hear the invisible infrared signal from a remote control.

**Step 1**

You will need a remote control for a television or DVD player.

**Step 2**

Find any AM radio. Tune the radio tuners to one end of the frequency band. There must be no station tuned in for this experiment to work.

**Step 3**

Push and hold one of the function buttons on the remote control. Then hold it close to one side or the back of the radio. What you are trying to do is send the infrared signal to the antenna of the radio. **Note:** Do not crank the volume too high! It gets pretty loud.

## Learning Activity 3.4

### Remote Controls

Record your results.

1. What happened when you put the remote close to the AM radio?
2. Why do you think this happened?
3. What happened to the output sound when you chose a different selection button?

Check your answers in the Learning Activity Answer Keys found at the end of this module.

**Sparkey's History Lesson**

Did you know that the first wireless remote controls did not use batteries? They used tuned metal rods to make different tones so the TV could pick up the sound and make the selection! The remote quit working when the strings connected to the striker broke. One of these remote controls is shown below.

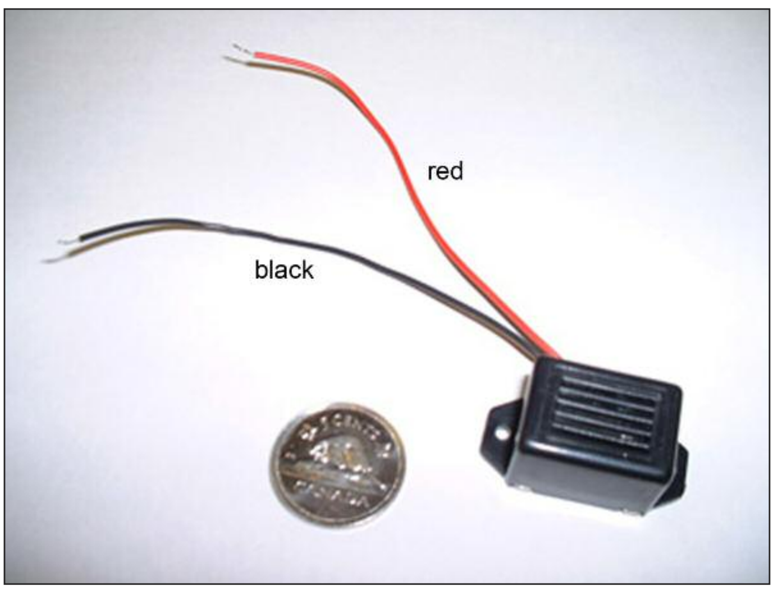
## Sound Output

The door chime is the most common and popular sound output device. It is powered by two 16-volt electromagnetic solenoids. A solenoid is an electromagnet that has a moveable core or plunger. When power is sent to the solenoid, the plunger moves, therefore striking a metal tuned bar. When you hit the front doorbell button, you should hear a "Ding" and then a "Dong" sound. That means that two bars are struck by the solenoid. When the back doorbell button is pushed, only one single "Ding" sound is made.

**Note:** Sounds just like the old style remote controls for television—"Ding."

The indicator on your project works different from the doorbell. With the doorbell, if you hold the button and do not let go, the doorbell will ring and then stop. It will only ring again if the button at the front or back door is released and then pushed again.

The sound indicator on your project works differently. Once power is sent to the two terminals, the buzzer will keep making noise until the power is disconnected or the battery goes dead.

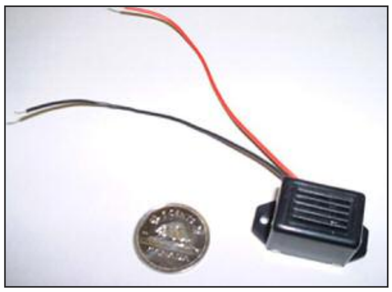


## Student Challenge 9

*Can you determine if your project buzzer works?*

You need the buzzer from your kit bag.

The buzzer you will use for the actual project may be different from this graphic due to a new supplier.



Your buzzer may be tested very easily using the 9-volt battery. Polarity is very important when testing the buzzer. But before you test the buzzer, you must find out if the battery has enough voltage in it to run the buzzer properly.

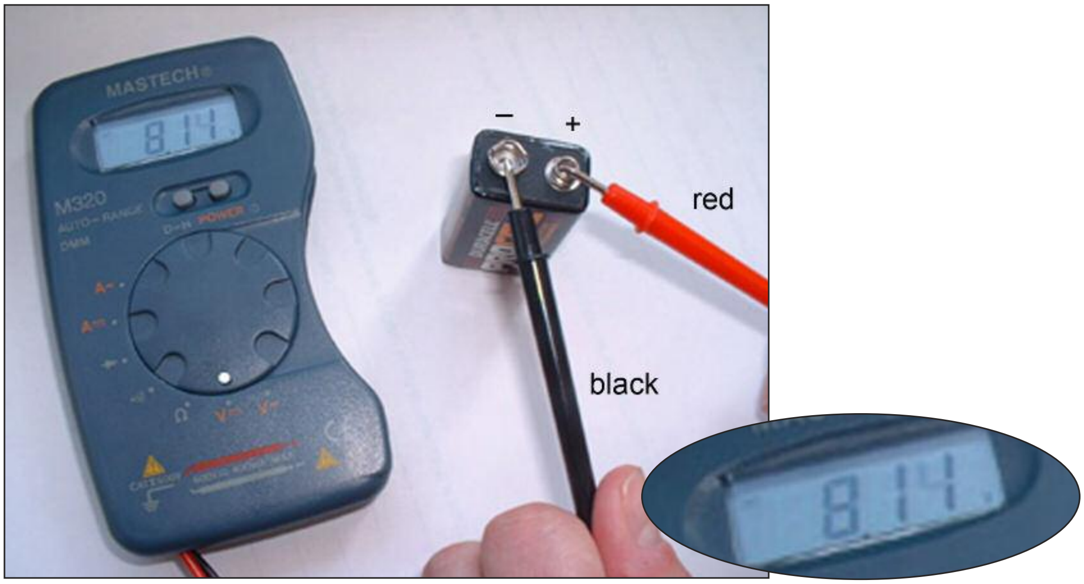
**Step 1**

**Make sure you are wearing your goggles during this experiment!**

**Step 2**

Identify the negative and positive of the battery. Place the probes of the meter on the battery terminals to measure the voltage of the battery. There must be at least six volts left in the 9-volt battery for this experiment to work.

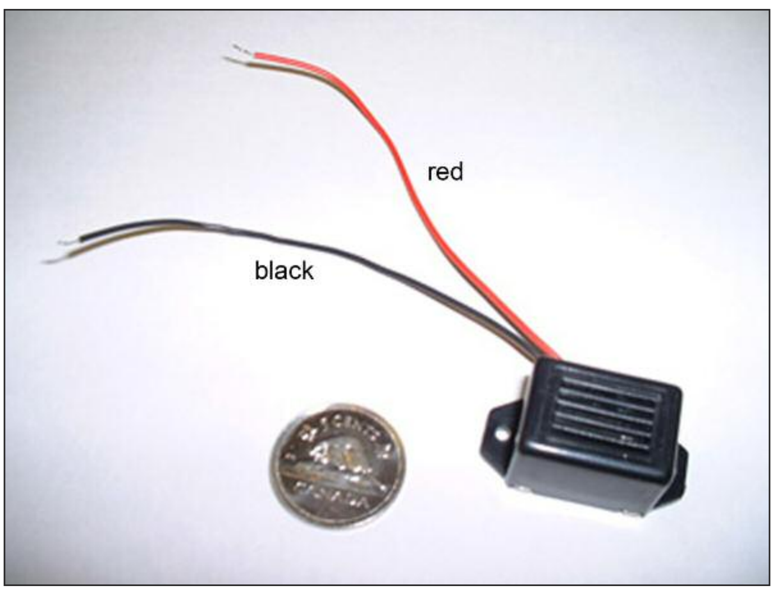
Record value measured from the 9-volt battery: _______________
(If value is below 6 volts, replace it with a new one.)

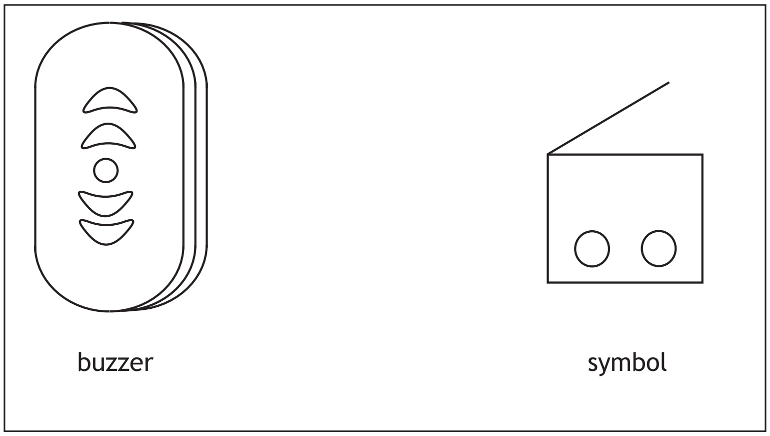



If the battery is good, proceed to Step 3

**Step 3**

Identify the buzzer from your kit package, as shown below.






There is a red and a black wire attached to the buzzer. The red wire is the positive and the black wire is the negative. Make sure some bare wire is exposed to touch the battery on the ends of your buzzer wires.

**Step 4**

Place the black wire on the negative post of the battery and the red wire to the positive post.

**Step 5**

Now do the reverse procedure of Step 4. Place the black wire on the positive post of the battery and touch the red wire to the negative post of the battery.

## Learning Activity 3.5

**Buzzers**

From the results of Student Challenge 9, answer the following questions.

1. What did the buzzer do when the two wires touched the posts of the battery?
2. Why did this happen?
3. What happened when you hooked up the buzzer with the wrong polarity in Step 5?
4. Why did this happen?
5. What will happen if you install the buzzer in your project with the wrong polarity?

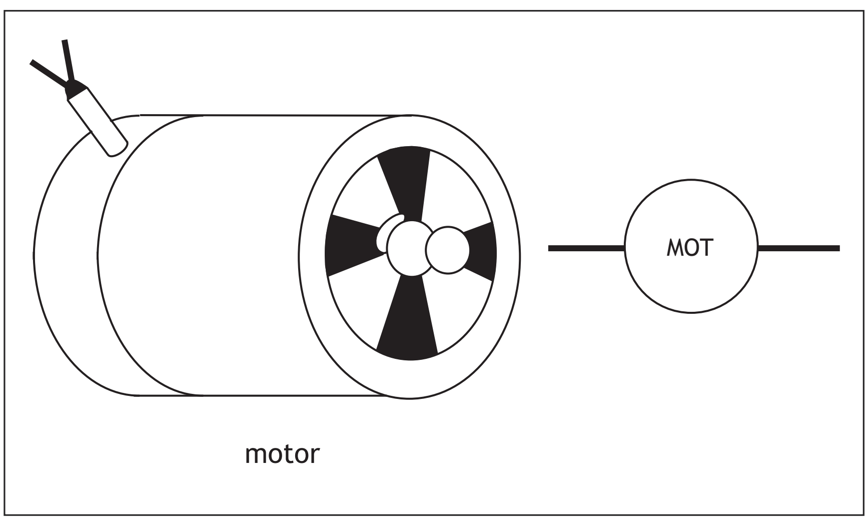
Check your answers in the Learning Activity Answer Keys found at the end of this module.

---

Find Assignment 3.2: Project Kit Component Test Record Sheet, found at the end of this module, and complete Part 4: Component Test Record Sheet—Buzzer. You will need to fill in the letter symbol, schematic symbol, and test result. For the buzzer, there will be no number or value to record on the test result section of the record sheet. Just record whether it is good or bad. It must make a sound to be considered in working order.

## Electric Motors

An electric motor is a device for converting electrical energy into mechanical energy. This is done in the form of rotary motion. Small electric motors run from six to nine volts. They are used in VCRs, blow dryers, and many types of small toys. Larger, more powerful motors, such as car starters, windshield-wiper motors, and power-seat motors, run on 12 volts.



# NOTES

# LESSON 6: SEMICONDUCTORS

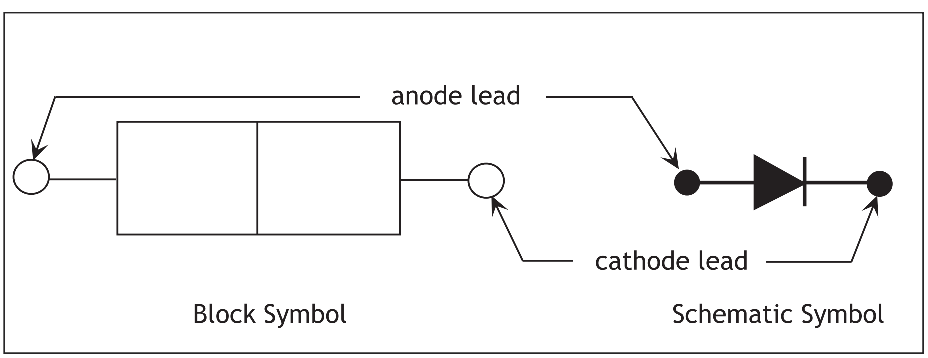
## An Introduction to Semiconductors

As mentioned in earlier lessons, conductors permit current to flow and insulators inhibit the flow of current. What if we could have a material that could do both? Well, there is one, and it is called a **semiconductor**. A semiconductor simply means that it can act as a conductor or as an insulator. Semiconductors are made from several different materials, such as germanium, silicon, and various oxides. The most common type is silicon, a material that comprises 27.7% of the earth's crust. To make the material more of a conductor or more of an insulator, it must be doped. Doping is the process of adding chemicals, such as boron, phosphorous, or arsenic, to the silicon, phosphorous, or oxide in order to make it a usable semiconductor. The amount of doping will determine how good a conductor the material becomes.

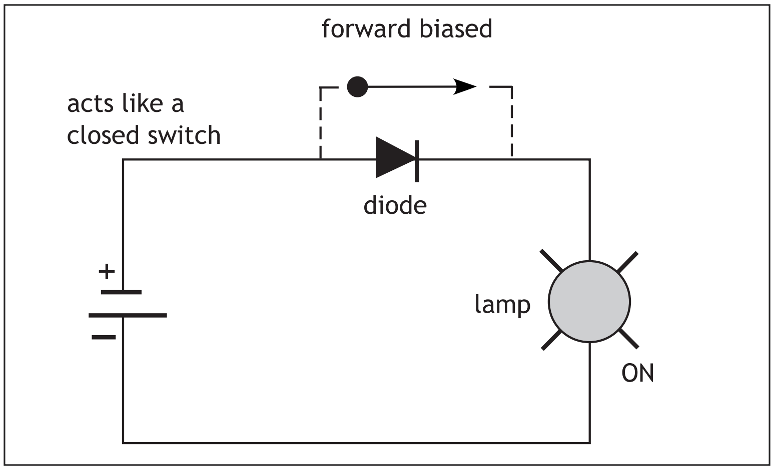
To understand how this all works, the following example will use silicon. When silicon is doped, it forms either an N-type material or a P-type material. N-type material means that it has an excess of electrons, and therefore has a negative charge. These excess electrons are then available to carry electricity. A P-type material, having a positive charge, has a deficiency of electrons or **holes**. The holes are what create a path to carry electricity.

Remember what you learned in Module 1—electricity travels from negative to positive.

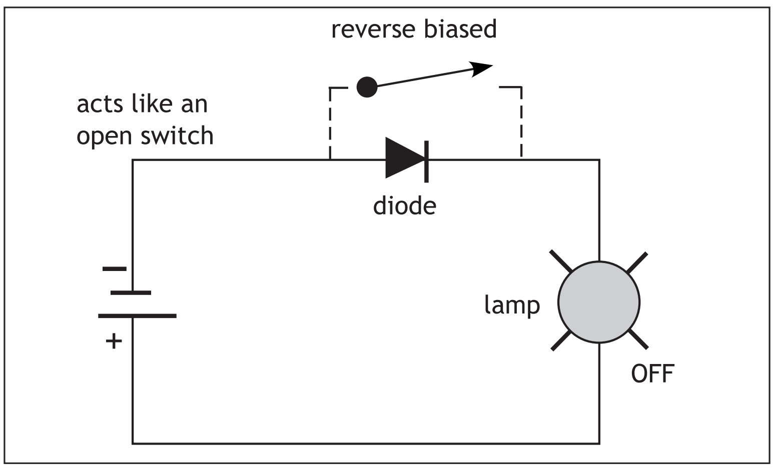
When N- and P-type materials are put close together, the electrons flow in only one direction. The flow will be from the N-type material to the P-type material.




**diode PN junction**




**diode operation forward biased**




**diode operation reverse biased**

Before you go on, you must first realize that the semiconductor family is very large and has many components that can be studied. To study the detailed characteristics and operation of every semiconductor would be a course in itself. This is why just three semiconductor components have been chosen for you to study: diodes, transistors, and silicon-controlled rectifiers (SCRs).

## Diodes

The component that we will use to control the directional flow of electricity is called a diode. The diode is a one-way valve, sort of like a one-way street. The electrical current can only travel in one direction through the diode.

The diode you will use for the actual project will look like this.

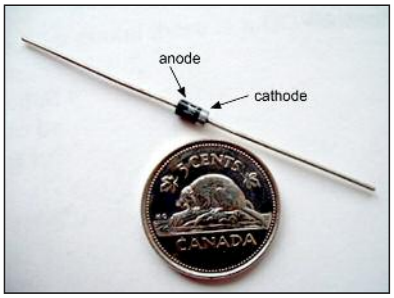



**Figure 1**

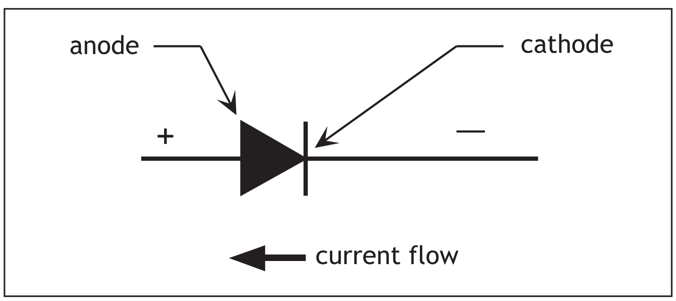
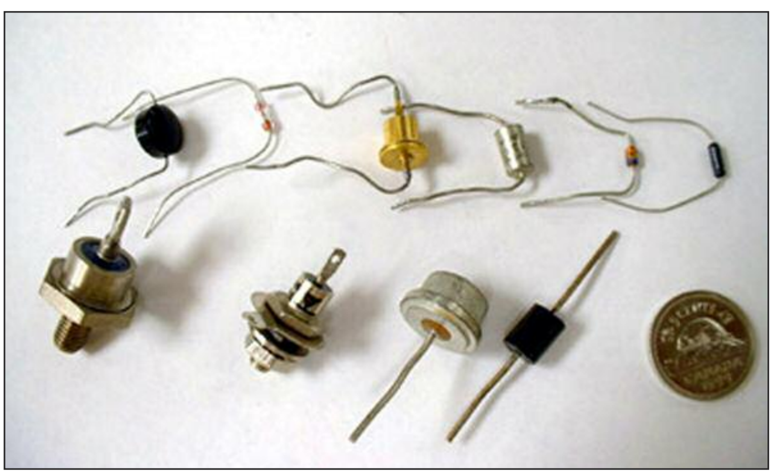
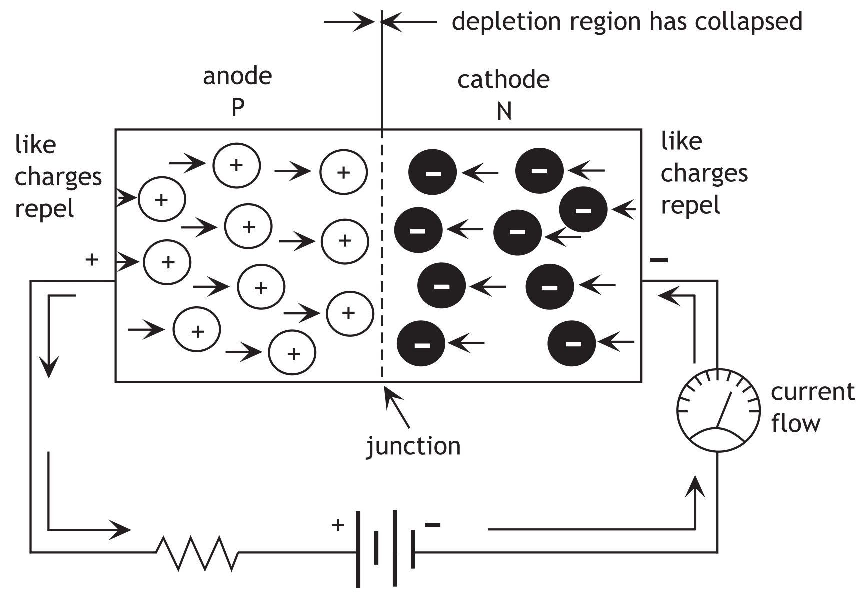



**Figure 2**

Diodes are available in many shapes and sizes, as shown below.

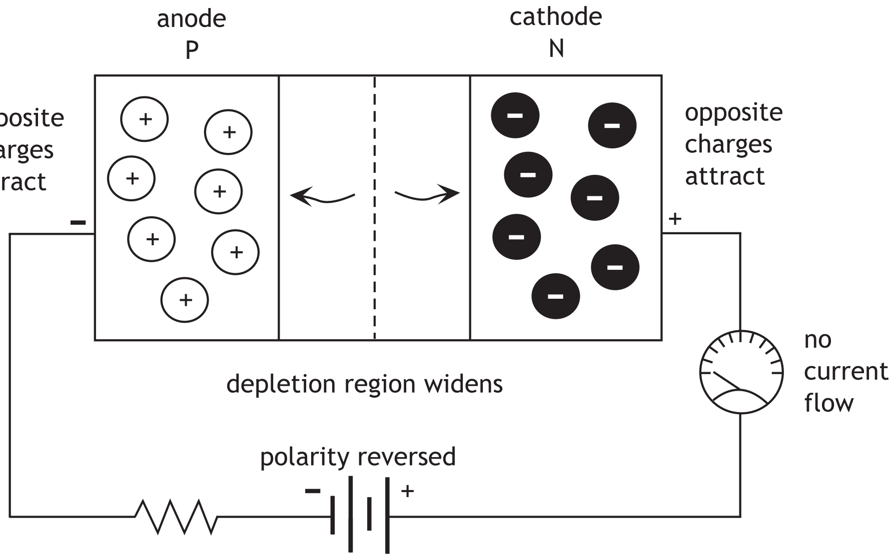


It is also very important to identify the two ends of the diode. As mentioned earlier, the diode is made from N-type and P-type material. To identify the two ends of the diode, one end is given the name **anode** and the other the **cathode**. The cathode is the negative end that is marked on the diode by a strip or band; the other end is the anode, as shown in Figure 1 on the previous page. Some diodes have the schematic symbol on the case to signify the flow of electrons. Look below to see how electrons flow with relation to the diode's anode and cathode markings. If a diode conducts, or is properly connected in the circuit, it is said to be "forward biased."




**Forward-Biased Diode**

If a diode is installed incorrectly or backwards (negative pole closest to positive terminal), current will not flow (see below). This is known as "reverse biased."




**Reverse-Biased Diode**

Diodes are rated according to the maximum current they can safely conduct.

It is now time to view the Grade 9/10 Electronics video found in the learning management system (LMS) or on DVD. Watch the section on testing diodes with the DMM.

---

Find Assignment 3.2: Project Kit Component Test Record Sheet, found at the end of this module, and complete Part 5: Component Test Record Sheet—Diodes. You will need to fill in the letter symbol, schematic symbol, and test result.

---

Go to Assignment 3.1 found at the end of this module and complete Parts 3 to 9.

## Notes

# Module 3 Summary

Congratulations, you have finished the third module in the course.

Remember

- Each component in electronics has a very specific job.
- Each electronic component has a specific "schematic symbol" that represents the component.
- Each electronic component must be tested before it is used.
- Some component values should be calculated, then measured to see if they work.
- Each component can have many different case styles and sizes.
- Make sure to double check the value or number written on the component before it is used.
- Make sure that all circuits are fused for your safety.
- Make sure to connect circuits properly to prevent overloads and short circuits.

## Submitting Your Assignments

It is now time for you to submit your work from Module 3 to the Distance Learning Unit so that you can receive some feedback on how you are doing in this course. Remember that you must submit all the assignments in this course before you can receive your credit.

Make sure you have completed all parts of your Module 3 assignments and organize your material in the following order:

- Module 3 Cover Sheet
- Module 3 Log Sheet
- Assignment 3.1: Electronic Components
- Assignment 3.2: Project Kit Component Testing

For instructions on submitting your assignments, refer to How to Submit Assignments in the course Introduction.

# NOTES

## Assignment 3.1

# Electronic Components

***Total: 196 marks***

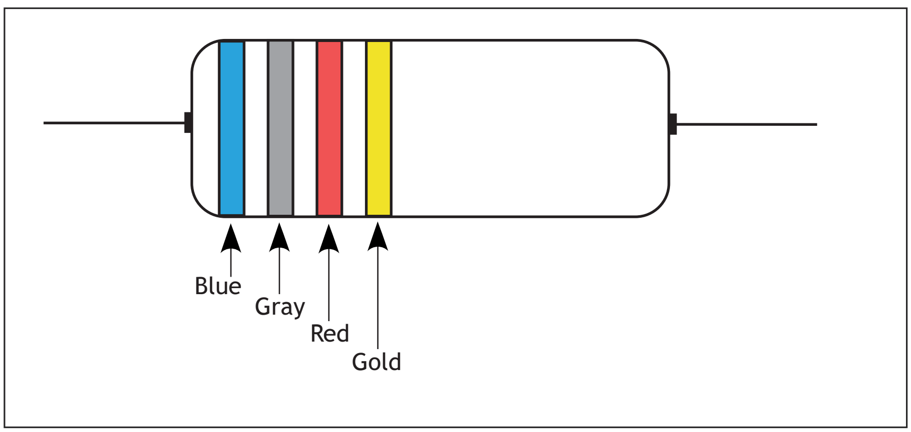
**Note:** All correct answers have a number value, a unit reference, and a tolerance value (+/–).

**Part 1: Calculating Resistor Colour Codes *(2 marks each, for a total of 16 marks)***

Record your results below.

*Example*

| | |
|---|---|
| Black | 0 |
| Brown | 1 |
| Red | 2 |
| Orange | 3 |
| Yellow | 4 |
| Green | 5 |
| Blue | 6 |
| Violet | 7 |
| Grey | 8 |
| White | 9 |
| Gold | ±5% |
| Silver | ±10% |
| None | ±20% |




| 1st Band | 2nd Band | 3rd Band | 4th band |
|---|---|---|---|
| 6 | 8 | 00 | 5% |

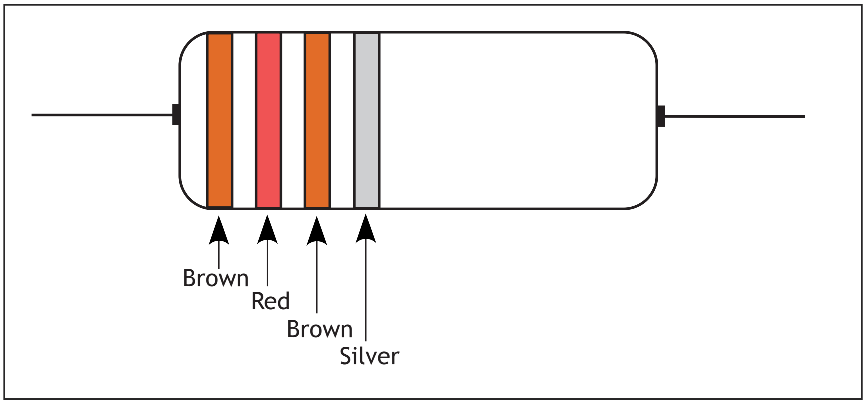
Final Answer: 6,800 Ω or 6.8 kΩ ±5%

*(continued)*

## Assignment 3.1: Electronic Components (continued)

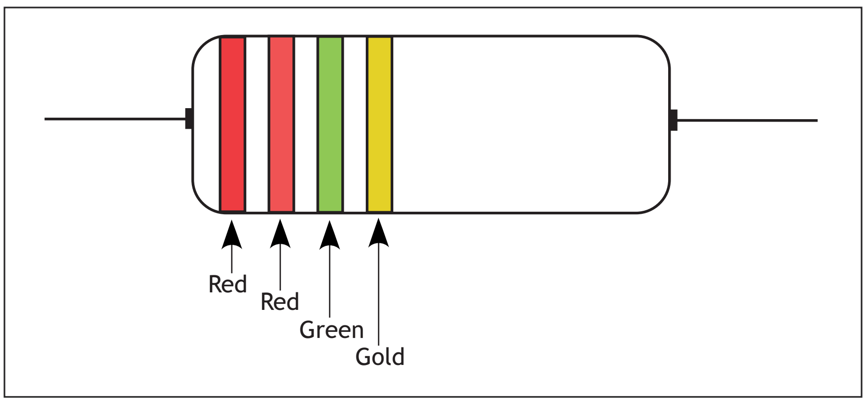
| | |
|---|---|
| Black | 0 |
| Brown | 1 |
| Red | 2 |
| Orange | 3 |
| Yellow | 4 |
| Green | 5 |
| Blue | 6 |
| Violet | 7 |
| Grey | 8 |
| White | 9 |
| Gold | ±5% |
| Silver | ±10% |
| None | ±20% |

1.



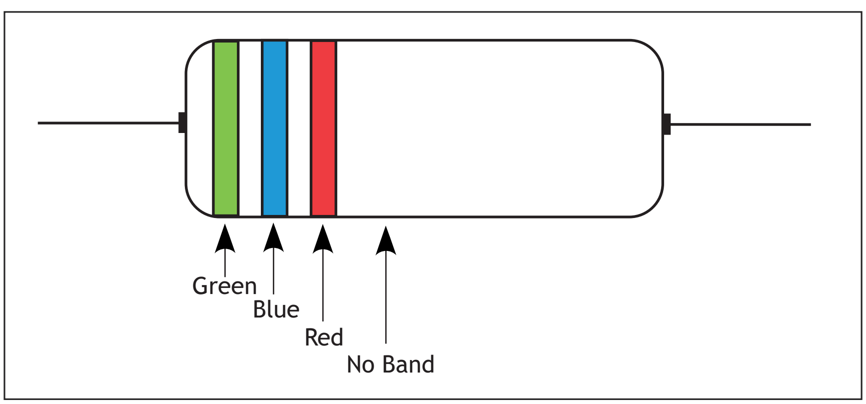

Final Answer: ______________________________ *(2 marks)*

2.




Final Answer: ______________________________ *(2 marks)*

3.



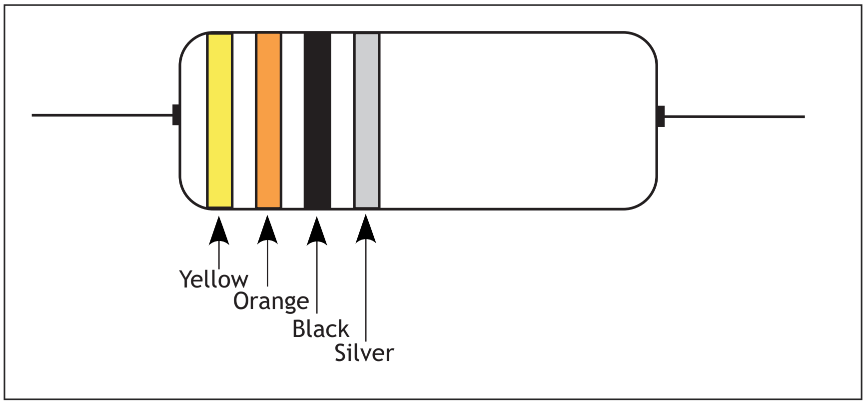

Final Answer: ______________________________ *(2 marks)*

*(continued)*

# *Assignment 3.1: Electronic Components (continued)*

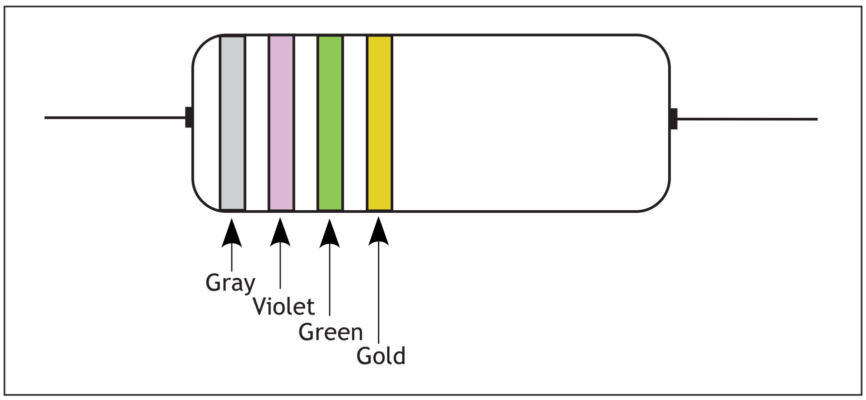
| | |
|---|---|
| Black | 0 |
| Brown | 1 |
| Red | 2 |
| Orange | 3 |
| Yellow | 4 |
| Green | 5 |
| Blue | 6 |
| Violet | 7 |
| Grey | 8 |
| White | 9 |
| Gold | ±5% |
| Silver | ±10% |
| None | ±20% |

4.



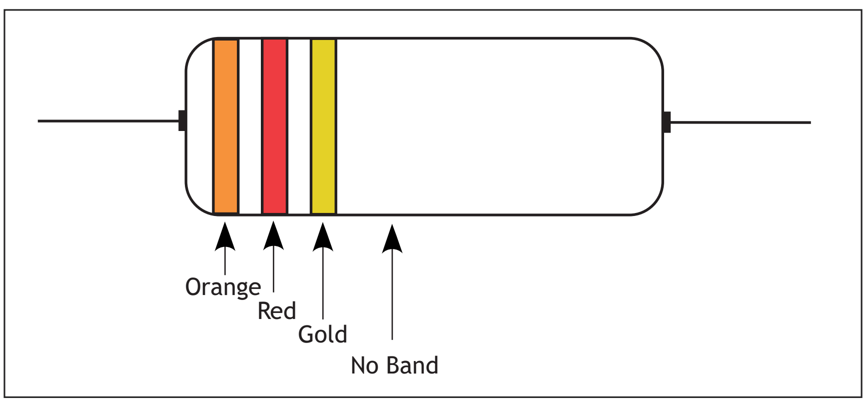

Final Answer: ______________________________ *(2 marks)*

5.




Final Answer: ______________________________ *(2 marks)*

6.



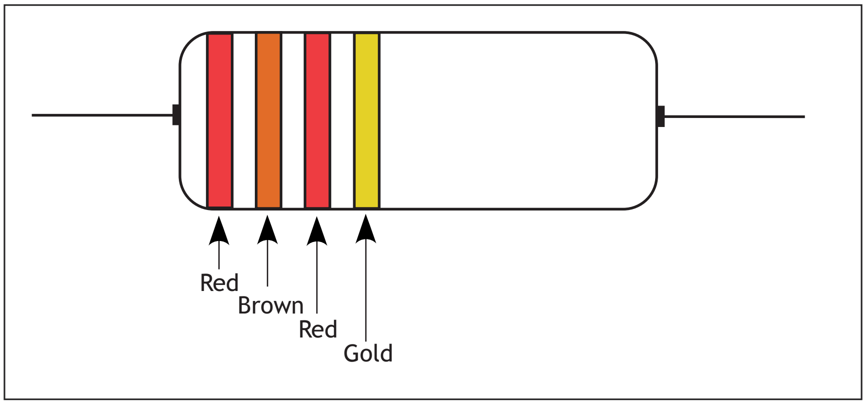

Final Answer: ______________________________ *(2 marks)*

*(continued)*

## Assignment 3.1: Electronic Components (continued)

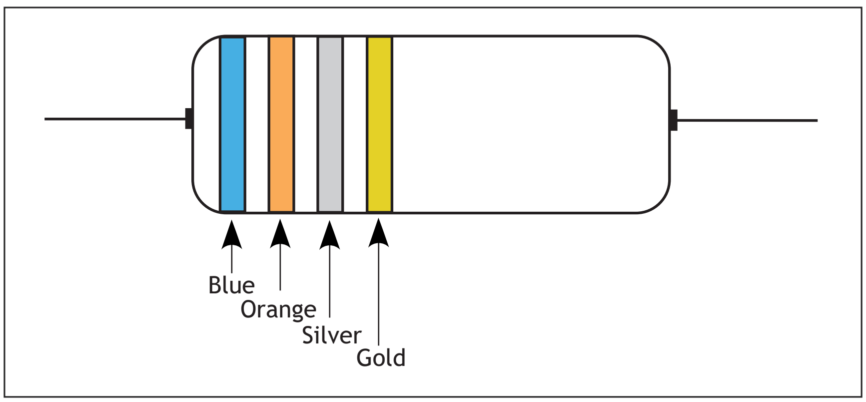
| | |
|---|---|
| Black | 0 |
| Brown | 1 |
| Red | 2 |
| Orange | 3 |
| Yellow | 4 |
| Green | 5 |
| Blue | 6 |
| Violet | 7 |
| Grey | 8 |
| White | 9 |
| Gold | ±5% |
| Silver | ±10% |
| None | ±20% |

7.




Final Answer: ______________________________ *(2 marks)*

8.




Final Answer: ______________________________ *(2 marks)*

*(continued)*

## *Assignment 3.1: Electronic Components (continued)*

### Part 2: Calculating Resistor Numeric Values

Record your results below for this assignment. There are four colours and four numbers for each resistor. *(8 marks each for a total of 64 marks)*

*Example*

| | | | | |
|---|---|---|---|---|
| 220 ohm 5% = | Red | Red | Brown | Gold |
| | 2 | 2 | 0 | 5% |

1. 1,500 ohm 10% =

   ___________ ___________ ___________ ___________

   ___________ ___________ ___________ ___________

2. 2.4 k ohm 5% =

   ___________ ___________ ___________ ___________

   ___________ ___________ ___________ ___________

3. 1 M ohm 5% =

   ___________ ___________ ___________ ___________

   ___________ ___________ ___________ ___________

4. 3,300 ohm 20% =

   ___________ ___________ ___________ ___________

   ___________ ___________ ___________ ___________

5. 12 k ohm 10% =

   ___________ ___________ ___________ ___________

   ___________ ___________ ___________ ___________

6. 270 ohm 20% =

   ___________ ___________ ___________ ___________

   ___________ ___________ ___________ ___________

7. 22 ohm 5% =

   ___________ ___________ ___________ ___________

   ___________ ___________ ___________ ___________

8. 10 M ohm 5% =

   ___________ ___________ ___________ ___________

   ___________ ___________ ___________ ___________

*(continued)*

### Part 3: The Semiconductor Family

Record your results below for this assignment. *(total of 32 marks)*

1. Give a definition of a semiconductor. *(2 marks)*

    ______________________________

    ______________________________

2. Name two of the three semiconductive devices used in this course of study. *(2 marks)*

    a) ______________________________

    b) ______________________________

3. What is the most commonly used semiconductive material? *(1 mark)*

    ______________________________

4. What are two materials used in the doping of semiconductors? *(2 marks)*

    a) ______________________________

    b) ______________________________

5. Describe the characteristics of an "N" type semiconductive material. *(2 marks)*

    ______________________________

6. Describe the characteristics of a "P" type semiconductive material. *(2 marks)*

    ______________________________

7. In very simple terms, with relation to the flow of current, what does it mean when a diode is **forward biased**? *(2 marks)*

    ______________________________

    ______________________________

*(continued)*

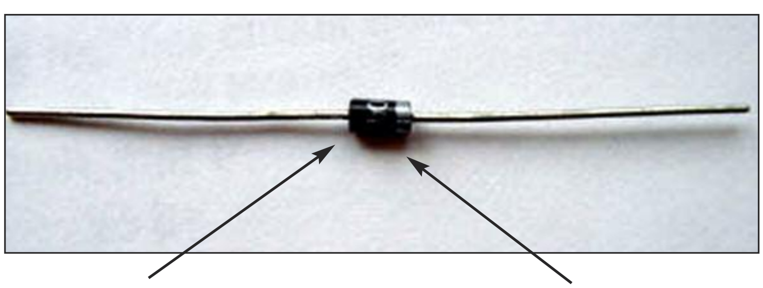
## *Assignment 3.1: Electronic Components (continued)*

8. In very simple terms, with relation to the flow of current, what does it mean when a diode is **reverse biased**? *(2 marks)*

9. Explain why a diode is referred to as a "one-way value" or a "one-way street." *(2 marks)*

10. In the space below, draw the schematic symbol of a diode. Make sure to label the anode, cathode, and direction of current flow. *(3 marks)*

11. Identify the two ends of a diode as shown below. *(2 marks)*



*(continued)*

## *Assignment 3.1: Electronic Components (continued)*

12. Electron flow in a diode is from the ***(circle one)*** cathode / anode to the ***(circle one)*** cathode / anode. *(2 marks)*

13. In the space below, draw and label the *schematic symbol* of a SCR. Remember a SCR has three legs. *(4 marks)*

14. In the space below, draw and label the graphic image of the SCR. *(4 marks)*

*(continued)*

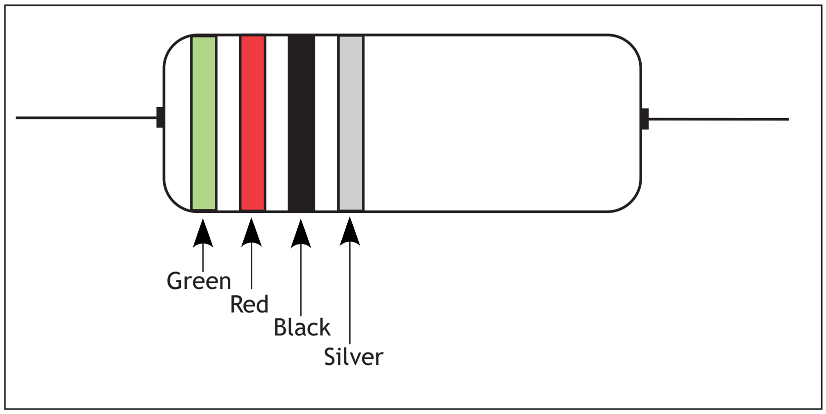
# *Assignment 3.1: Electronic Components (continued)*

## Part 4: Resistance Calculations

Calculate the resistance for the following. *(total of 8 marks)*

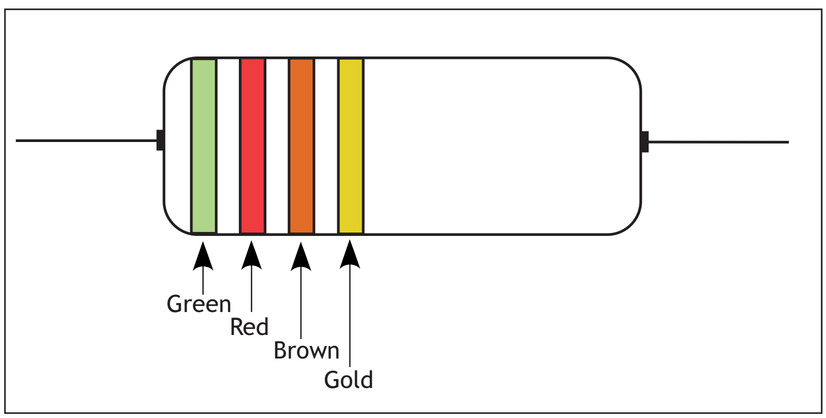
| | |
|---|---|
| Black | 0 |
| Brown | 1 |
| Red | 2 |
| Orange | 3 |
| Yellow | 4 |
| Green | 5 |
| Blue | 6 |
| Violet | 7 |
| Grey | 8 |
| White | 9 |
| Gold | ±5% |
| Silver | ±10% |
| None | ±20% |

1.




Answer: ______________________________ *(2 marks)*

2.



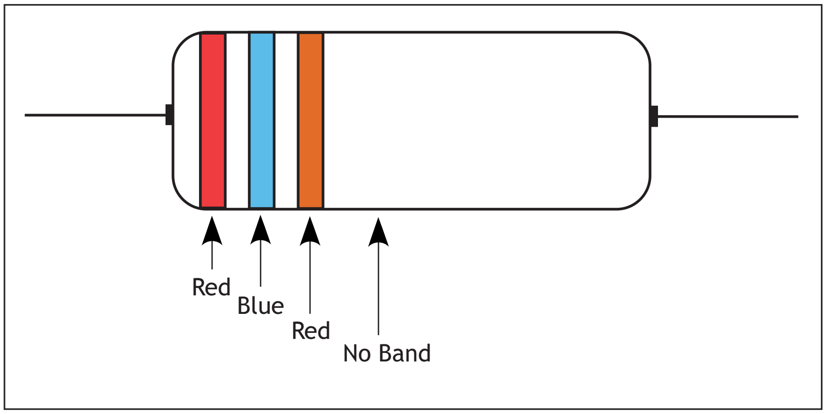

Answer: ______________________________ *(2 marks)*

*(continued)*

## Assignment 3.1: Electronic Components (continued)

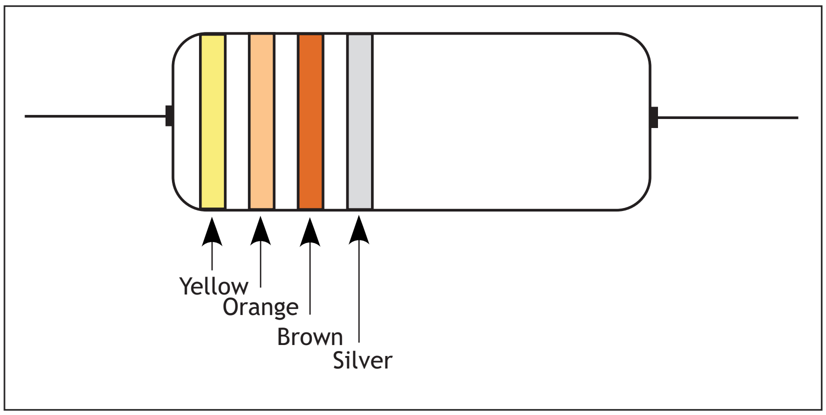
| | |
|---|---|
| Black | 0 |
| Brown | 1 |
| Red | 2 |
| Orange | 3 |
| Yellow | 4 |
| Green | 5 |
| Blue | 6 |
| Violet | 7 |
| Grey | 8 |
| White | 9 |
| Gold | ±5% |
| Silver | ±10% |
| None | ±20% |

3.




Answer: ______________________________ *(2 marks)*

4.




Answer: ______________________________ *(2 marks)*

*(continued)*

## *Assignment 3.1: Electronic Components (continued)*

### Part 5: Calculating Resistor Numeric Values

Calculate the following. Record your results below for this assignment. There are four colours and 4 numbers for each resistor. *(8 marks each for a total of 32 marks)*

*Example*

| | | | | |
|---|---|---|---|---|
| 220 ohm 5% = | Red | Red | Brown | Gold |
| | 2 | 2 | 0 | 5% |

1. 2,400 ohms 10% =

    __________ __________ __________ __________

    __________ __________ __________ __________

2. 6.8 k ohms 10% =

    __________ __________ __________ __________

    __________ __________ __________ __________

3. 2.2 M ohms 5%=

    __________ __________ __________ __________

    __________ __________ __________ __________

4. 7,000 ohms 20% =

    __________ __________ __________ __________

    __________ __________ __________ __________

*(continued)*

## *Assignment 3.1: Electronic Components (continued)*

### Part 6: Capacitance

Answer the following questions. *(total of 27 marks)*

1. Draw schematic symbols for both a fixed and a variable capacitor. *(4 marks)*

2. What three things make up the construction of a capacitor? *(3 marks)*

 ______________________________

 ______________________________

 ______________________________

3. What is a dielectric? *(2 marks)*

 ______________________________

 ______________________________

 ______________________________

4. Capacitance is measured in ____________________ . *(1 mark)*

5. What does pFd stand for? *(1 mark)*

*(continued)*

## *Assignment 3.1: Electronic Components (continued)*

6. What does nFd stand for? *(1 mark)*

7. Where is the charge of electrons stored on a capacitor? *(1 mark)*

8. What are the three factors that affect the capacitance value of a capacitor? *(3 marks)*

9. What is the simplest type of dielectric used in capacitors? *(1 mark)*

10. When you change the station on your analog-tuned radio, what type of capacitor are you adjusting? *(1 mark)*

11. Name two materials used in the construction of capacitors. *(2 marks)*

12. What does WVDC stand for? *(2 marks)*

*(continued)*

## *Assignment 3.1: Electronic Components (continued)*

13. If a capacitor has the positive or negative marked on the body, what two styles of capacitors could it be? *(2 marks)*

    ________________________________________

    ________________________________________

    ________________________________________

14. What type of capacitor mentioned in Module 3 is small in size, has no polarity, and is commonly used? *(1 mark)*

    ________________________________________

15. What are the large capacitors mentioned in Module 3 that have polarity? *(1 mark)*

    ________________________________________

16. What very dangerous thing could happen if you put a capacitor in backwards and power up the project? *(1 mark)*

    ________________________________________

    ________________________________________

*(continued)*

## *Assignment 3.1: Electronic Components (continued)*

### Part 7: Circuit Protection

Answer the following questions. *(total of 11 marks)*

1. What is meant by overloading a circuit? *(2 marks)*

2. What could happen if a circuit does not have a circuit breaker or fuse and it is overloaded? *(2 marks)*

3. What is the definition of a short circuit? *(2 marks)*

4. What happens to a fuse or circuit breaker if the circuit is overloaded? *(2 marks)*

*(continued)*

## *Assignment 3.1: Electronic Components (continued)*

5. What are the two ways that fuses and circuit breakers are rated? *(1 mark)*

______________________________________________

______________________________________________

______________________________________________

6. How do you test a fuse to see if it is working? *(1 mark)*

______________________________________________

______________________________________________

______________________________________________

7. What function would you choose on the DMM to test the fuse? *(1 mark)*

______________________________________________

______________________________________________

______________________________________________

*(continued)*

## *Assignment 3.1: Electronic Components (continued)*

### Part 8: Indicators

List three types of output devices. *(3 marks)*

### Part 9: Semiconductors

List three examples of components that use semiconductor materials. *(3 marks)*

# NOTES

## Assignment 3.2

# Project Kit Component Testing

***Total: 29 marks for the assignment***

The Component Test Record Sheet is found on the following page. Fill in the chart for the following parts of Assignment 3.2.

Part 1: Component Test Record Sheet—Resistors

Part 2: Component Test Record Sheet—Switches

Part 3: Component Test Record Sheet—Fuse

Part 4: Component Test Record Sheet—Buzzer

Part 5: Component Test Record Sheet—Diode

This Component Test Record Sheet is used for Lessons 1, 2, 4, 5, and 6 of Module 3.

*(continued)*

## *Assignment 3.2: Project Kit Component Testing (continued)*

| Project Kit Component Test Record Sheet | | | | |
|---|---|---|---|---|
| **Part Name** | **Part Letter Symbol** | **Schematic Symbol** | **Part Value** | **Tested Value (if any)** |
| **Part 1** Lesson 1: Resistor | | | | |
| Lesson 1: Resistor | | | | |
| Lesson 1: Resistor | | | | |
| **Part 2** Lesson 2: Slide switch | | | N/A | |
| Lesson 2: Pushbutton switch | | | N/A | |
| **Part 3** Lesson 4: Fuse | | | N/A | |
| **Part 4** Lesson 5: Buzzer | | | N/A | |
| **Part 5** Lesson 6: Diode | | | N/A | |

**Note:**

Tested values can be a number value or word value, such as “good,” “bad,” “failed,” or “unknown,” depending on the part.

Part Value is for an item rated in ohms, farads, volts, etc.

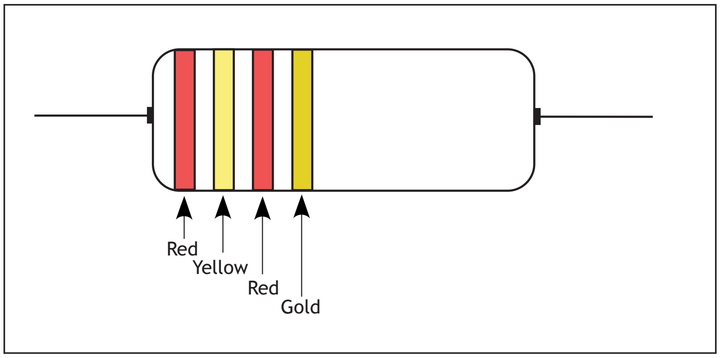
# Grade 9 Electricity/ Electronics Technology (10G)

## Module 3: Electronic Components

Learning Activity Answer Keys

## Learning Activity 3.1: Resistance Values

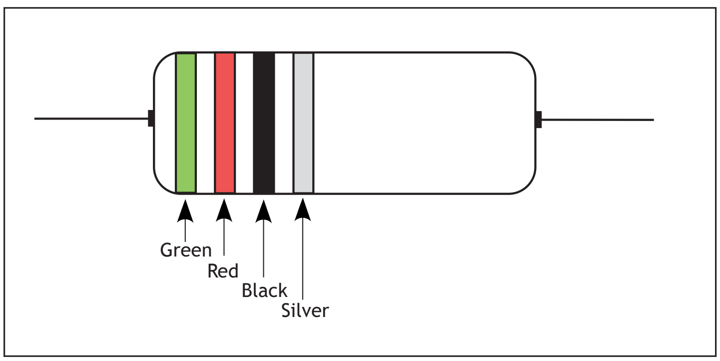
Calculate the resistance value for the following two resistors.




*Answers:*

Ohm value: 2400 Ω or 2.3 kΩ

Tolerance: ±5%




*Answers:*

Ohm value: 52 kΩ

Tolerance: ±10%

## Learning Activity 3.2: Capacitors

1. What did the LED do when the capacitor was plugged in?

   *Answer:*

   The LED lit up.

2. Why did this happen?

   *Answer:*

   The capacitor's electrically stored energy was used to light the LED.

## Learning Activity 3.3: Testing a Fuse

1. What did the DMM do when the two probes touched the ends of the fuse?

   *Answer:*

   The meter made a beeping sound.

2. Why did this happen?

   *Answer:*

   The wire in the glass tube of the fuse is a conductor that is connected from one end to the other.

## Learning Activity 3.4: Remote Controls

1. What happened when you put the remote close to the AM radio?

   *Answer:*

   The AM radio made a clicking or popping sound.

2. Why do you think this happened?

   *Answer:*

   The signal from the remote that was being transferred interfered with the AM radio wave.

3. What happened to the output sound when you chose a different selection button?

   *Answer:*

   The tone from the radio speakers changed.

## Learning Activity 3.5: Buzzers

1. What did the buzzer do when the two wires touched the posts of the battery?

   *Answer:*

   The buzzer made a buzzing sound.

2. Why did this happen?

   *Answer:*

   The power in the battery was used to turn on the buzzer.

3. What happened when you hooked up the buzzer with the wrong polarity in Step 5?

   *Answer:*

   No sound was made by the buzzer.

4. Why did this happen?

   *Answer:*

   The buzzer has polarity and must be hooked up properly.

5. What will happen if you install the buzzer in your project with the wrong polarity?

   *Answer:*

   The buzzer will not make any sound when the alarm is tripped.

# NOTES

# MODULE 3 SUMMARY

Congratulations, you have finished the third module in the course.

Remember

- Each component in electronics has a very specific job.
- Each electronic component has a specific "schematic symbol" that represents the component.
- Each electronic component must be tested before it is used.
- Some component values should be calculated, then measured to see if they work.
- Each component can have many different case styles and sizes.
- Make sure to double check the value or number written on the component before it is used.
- Make sure that all circuits are fused for your safety.
- Make sure to connect circuits properly to prevent overloads and short circuits.

## Submitting Your Assignments

It is now time for you to submit your work from Module 3 to the Distance Learning Unit so that you can receive some feedback on how you are doing in this course. Remember that you must submit all the assignments in this course before you can receive your credit.

Make sure you have completed all parts of your Module 3 assignments and organize your material in the following order:

- Module 3 Cover Sheet
- Module 3 Log Sheet
- Assignment 3.1: Electronic Components
- Assignment 3.2: Project Kit Component Testing

For instructions on submitting your assignments, refer to How to Submit Assignments in the course Introduction.

## NOTES

# Grade 9 Electricity/ Electronics Technology (10G)

## Module 3: Electronic Components

Learning Activity Answer Keys

## Learning Activity 3.1: Resistance Values

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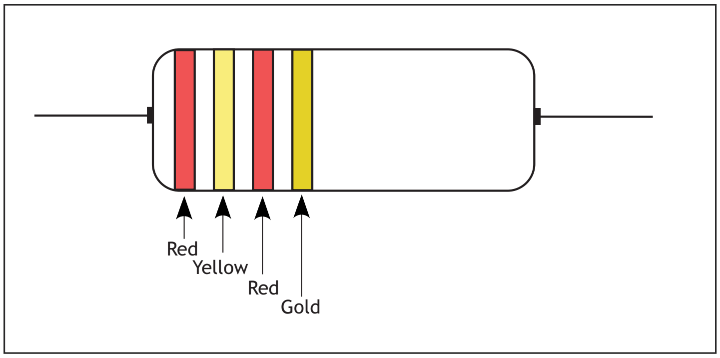
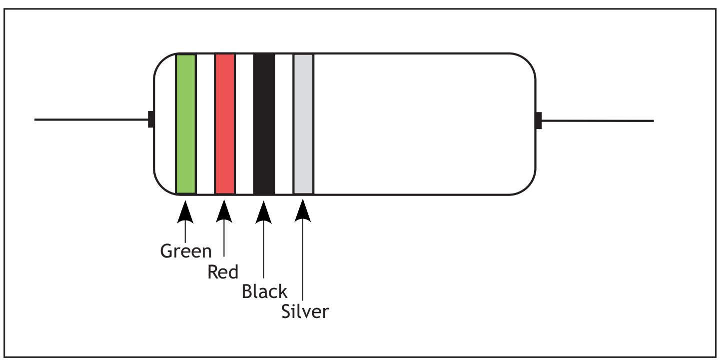



*Answers:*

Ohm value: 2400 Ω or 2.3 kΩ

Tolerance: ±5%




*Answers:*

Ohm value: 52 kΩ

Tolerance: ±10%

## Learning Activity 3.2: Capacitors

1. What did the LED do when the capacitor was plugged in?

   *Answer:*

   The LED lit up.

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5. What will happen if you install the buzzer in your project with the wrong polarity?

   *Answer:*

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## NOTES

# Grade 9 Electricity/ Electronics Technology (10G)

## Module 4: Getting Started with Your Tools and Equipment

# MODULE 4: GETTING STARTED WITH YOUR TOOLS AND EQUIPMENT

## Module Focus

**When you finish this lesson, you will be able to**

- ❑ correctly use tools, equipment, and processes safely
- ❑ practise and use your skills for reading schematic diagrams
- ❑ explain what makes up a printed circuit board
- ❑ prepare the components and the printed circuit board (PCB) for assembly
- ❑ identify and mount components with a PCB
- ❑ understand how to create a proper solder joint
- ❑ create effective and proper solder joints on your project
- ❑ safety de-solder, replace, or change components on a PCB
- ❑ learn how to test and repair a PCB

## Introduction

This module is designed to get you prepared for your major project with your new knowledge of tools, components, and processes. Before you begin, you must realize that each step in the project assembly is crucial. As you learned in the previous units, many of the components in electronics use polarity. Many are also very fragile or heat sensitive. You will be using a soldering iron that will get about as hot as a stove-top element. It is the heat that can damage a component. For this reason, please read every step very closely and **do not skip or modify any steps**. Skipping steps or modifying the project can result in a bag of useless parts that you must purchase again. **It is reckless and dangerous to skip steps.**

Also, the rule is, when you pick up an electronics tool or practise an experiment, always wear your eye protection!

**Shocking Fact**

In 1860, Thomas Edison developed a cockroach electrocution device!

## Power Words

troubleshoot
printed circuit board
fibreglass
laminate
cladding
foil pattern
etching
etchant
heat sinking
soldering
solder
alloy
flux
heat sink
cold solder joint
soldering gun
foil pattern

## Assignments in Module 4

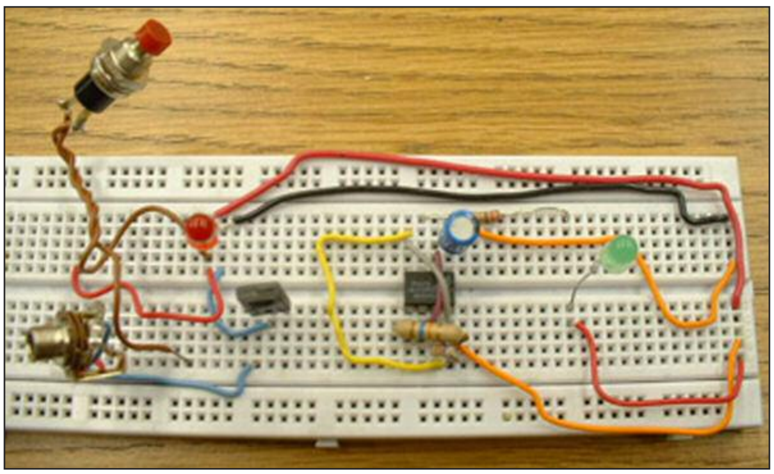
When you have completed the Module 4 assignments, submit your completed assignments, along with the Log Sheet and Module 4 Cover Sheet, to the Distance Learning Unit by mail. The staff will forward your work to your tutor/marker.

**Remember:** Since Assignment 4.1 is a project, it must be mailed to the Distance Learning Unit. Keep all your material together in one mailing and do not electronically submit any material for this module.

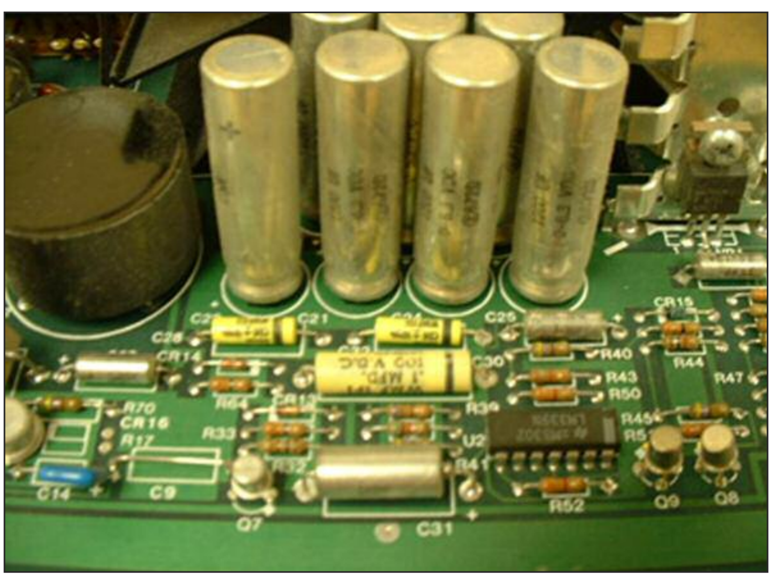
# Lesson 1: Printed Circuits

## An Introduction

In the last few modules, you have built a few small circuits on a solderless circuit board to test or see the operation of various components. The solderless circuit board is great for building a quick circuit or to test a design without having to build something permanent. Just unplug the components and change or move them. The advantage of this is that the circuit looks much like the schematic drawing and it can be completed very quickly.



However, it is not suitable for a compact or rugged design. This is why a **printed circuit board** (PCB) is used to permanently connect a project or electronic device.

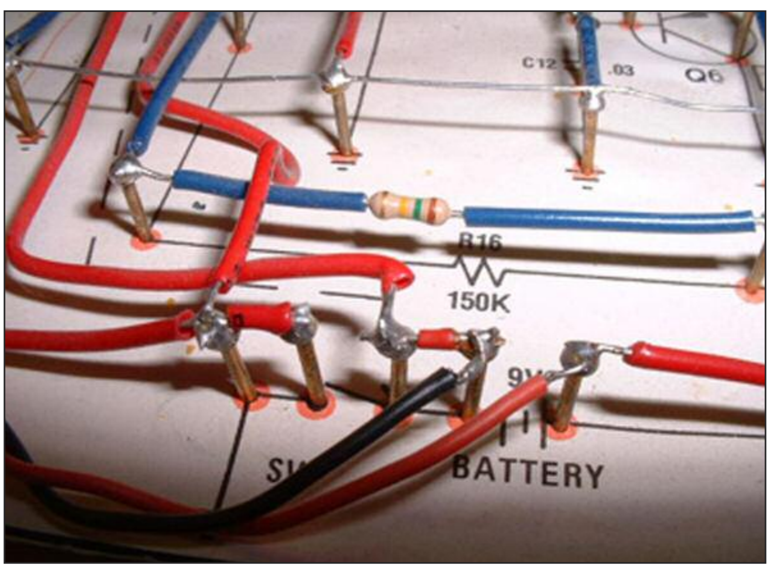



Picture 1

Picture 2

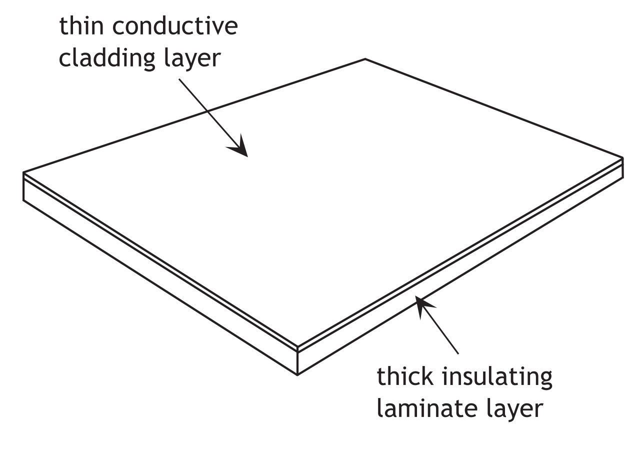
## PCB Construction

PCBs are used in all types of electronics equipment. Before there were PCBs, electronic components were assembled using a hand-wired technique.

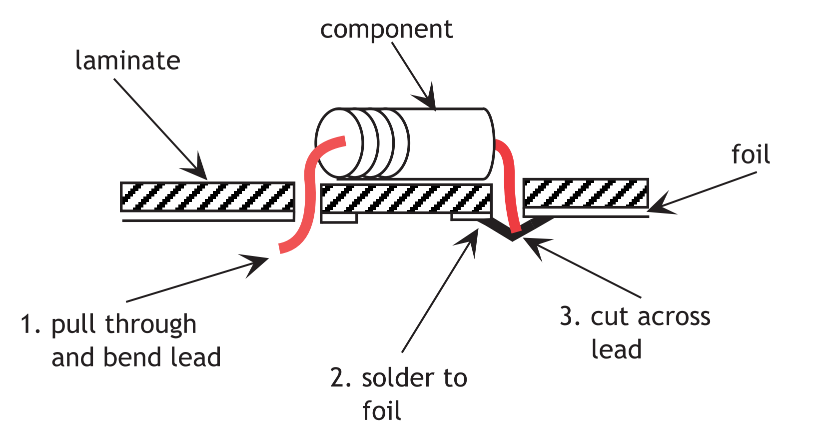



The wires were connected to tabs or posts to make the connections. Today, most of the circuits are not made of rough wire connections, but are instead included on the circuit design.

A basic PCB consists of a very thick layer of insulating material, usually fibreglass or phenolic paper, and a very thin layer of conducting material generally made of copper. The insulating material is called the laminate and the conducting material is called the cladding.

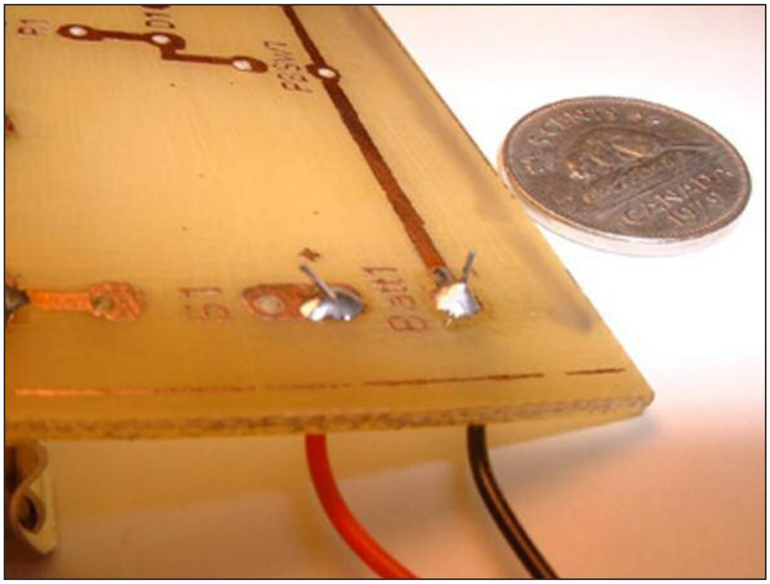



The simplest type of PCB is single sided. It has copper on only one side of the laminate. The components are placed from the laminate side through holes drilled in the PCB.



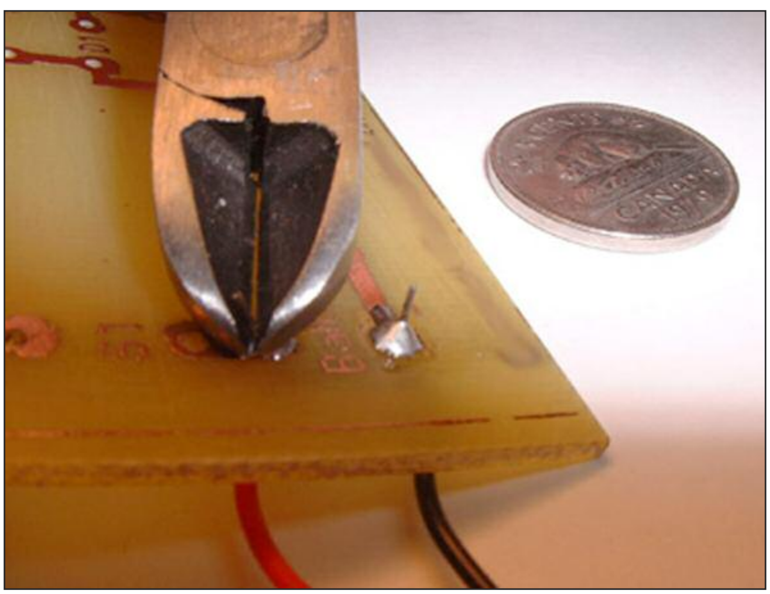

**Installing Components**

The legs of the components are passed through the small drilled holes. The components are then soldered to the copper conductive strips at specific points.

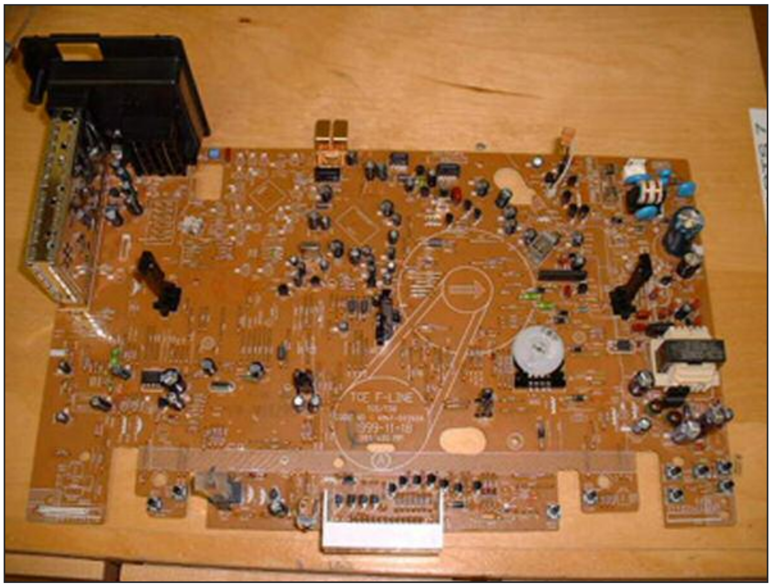


How the conductive strips are created will be discussed later in this module in the Making the PC Board section.

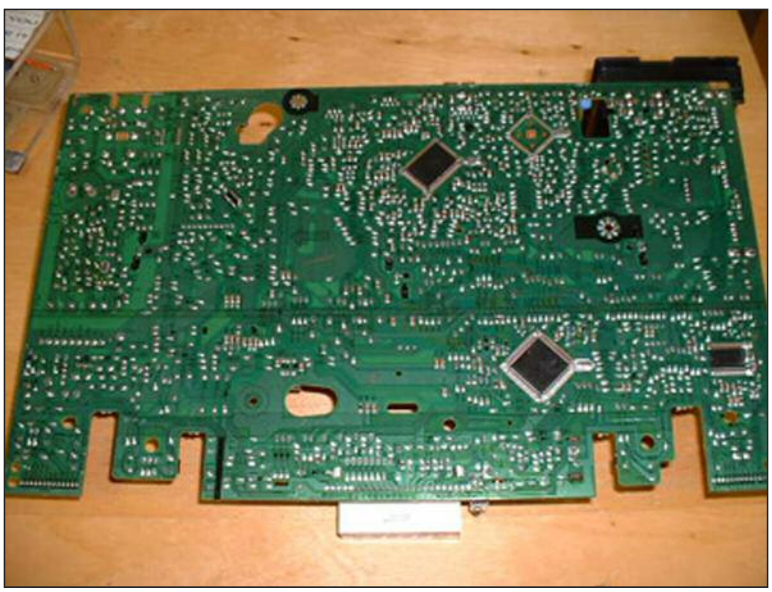
The legs of the components are then trimmed shorter.



There are also doubled-sided cladded boards that are used to save space to create more complex circuits. The double-sided PCBs are not used very often in a beginner electronics course. They are also more difficult to create.



Picture 1

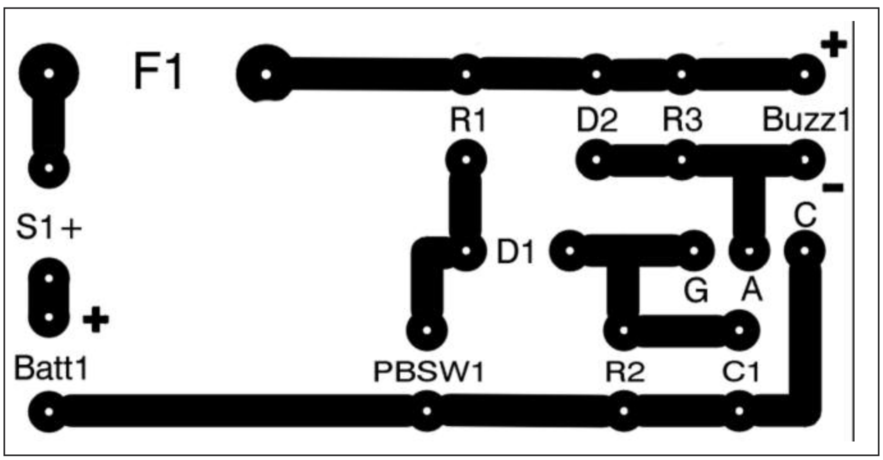


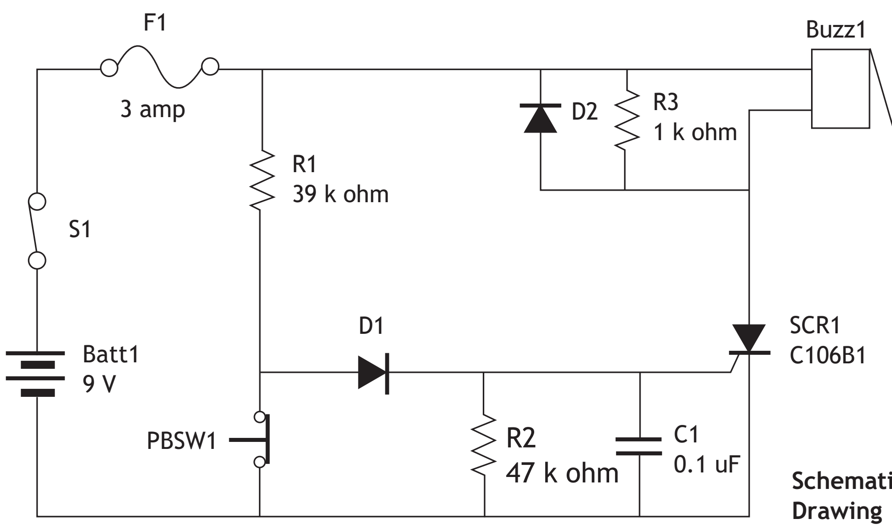
Picture 2

## Laying Out and Planning a PCB

There is no one specific way to lay out a PCB pattern. The only requirement is that the drawing of the conductive lines matches the component configuration and size. Therefore, each designed PCB is considered to be one of a kind. The pattern on the PCB is commonly referred to as the **foil pattern**.

To start drawing the foil pattern, you will need the completed schematic drawing and the actual component's sizes and leg configuration. With this information, a basic top-view sketch is made of the different connected conductive lines and the actual components. The schematic drawing gives a road map of the connections. Be sure that all lines are connected to the proper components.

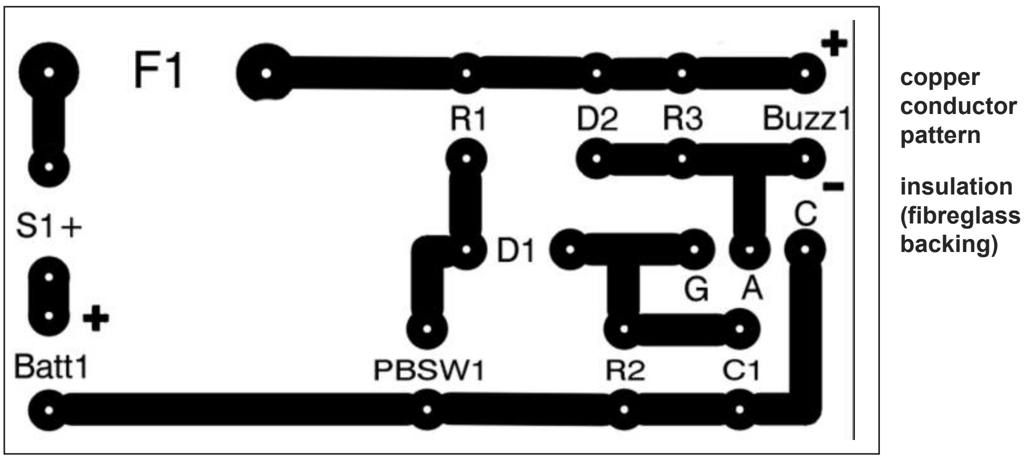



Schematic Drawing

Circuit board traces or patters are like wires. They are conductive pathways that connect your electronic components together in the proper manor for a circuit to perform its designed function.

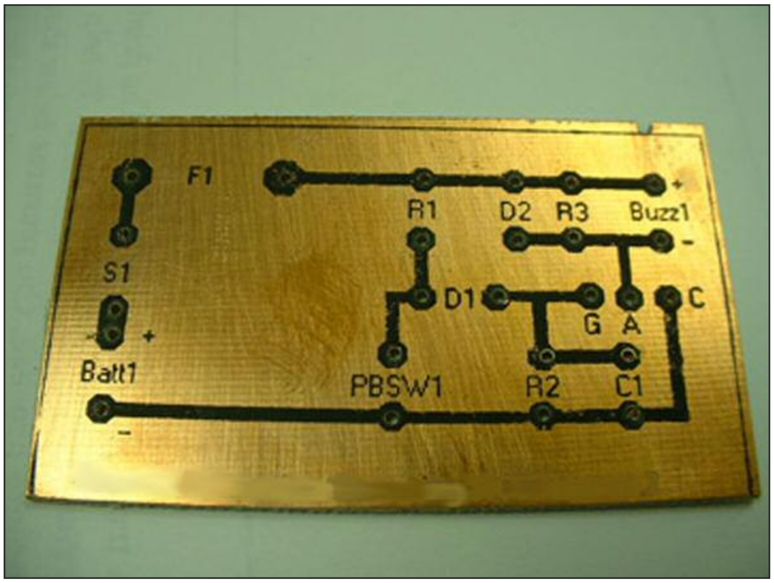
These sketches have to be redrawn several times to accommodate all the connections and components. The pencil drawing is then used to make the actual drawing of the foil pattern. The foil pattern is the exact layout of the project from the bottom side of the cladded copper. It is created by using a resist to cover or protect the copper in the chemical process of removing unwanted copper. A resist can be in the form of a permanent marker, masking tape, or an iron-on transfer sheet from a computer laser printer. Having a computer print the foil resist is a good idea, because the board will look professional and changes can be made very easily before the printout is made.



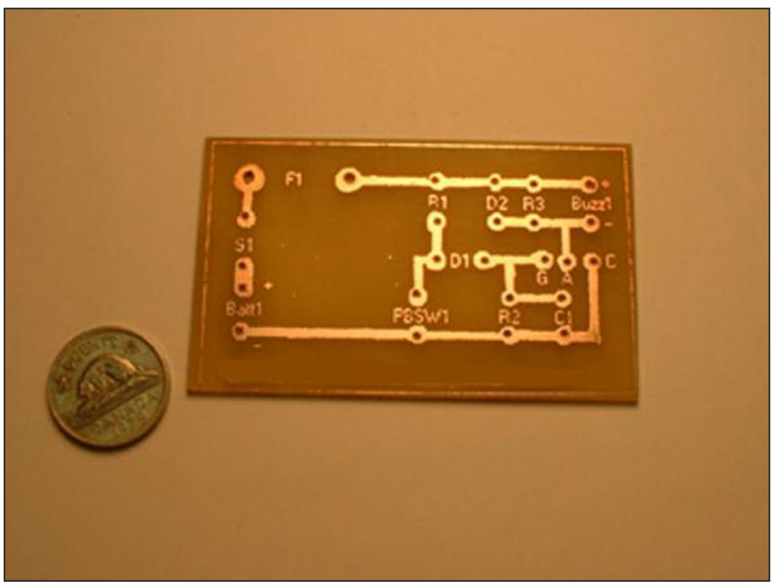

There is one catch when ironing on a PCB pattern. The printout must be printed in a mirror image or wrong reading. To help you understand this complete process, the pictures below show the “wrong reading” printout, the “ironed-on resist” transfer paper printout, and the final product after it has been through the chemical processing procedure.

**x-ray view**

In Picture 1, the pattern (black lines) are on the copper side of the circuit board.




Picture 1



Picture 2

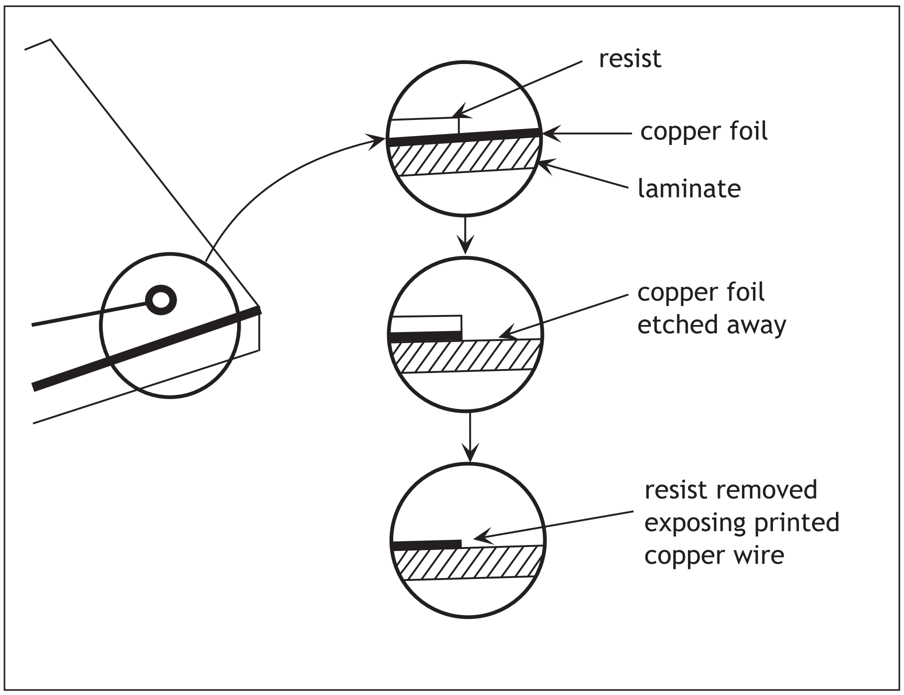
In Picture 2, all the copper has been removed from the board by the chemical solution used to etch the circuit board.

The lines you see now in Picture 2 (made of copper) are the result of the etchant solution not being able to get under the pattern (black lines). In Picture 2, all the copper has been eaten away from the board except for the copper that was beneath the black lines or foil pattern. The solution could not get to it so it did not get eaten away. These are now the wires that will connect all of the electronic components together.

Today, there are special computer programs that will do this foil layout for you. Just draw the schematic layout in the program and then use the computer to generate the foil pattern to match the schematic. The program can draw the foil pattern for you, and tell you where to place each specific component. Unfortunately, the software is too expensive for most general hobbyists.

## Printing the PCB

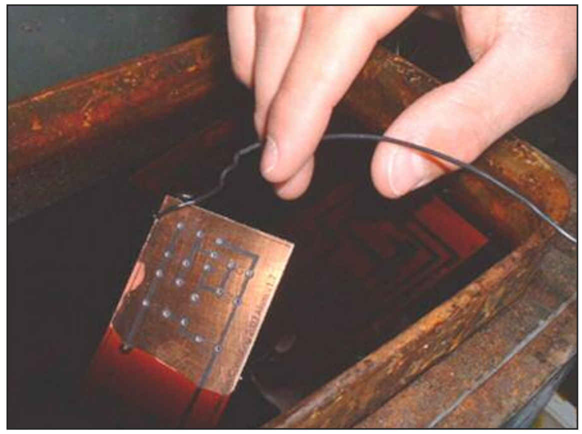
The process of printing the PCB involves removing all unwanted copper from the original blank foil, therefore leaving the conductive lines on the fibreglass backing. It is the resist that protects the copper lines you drew.



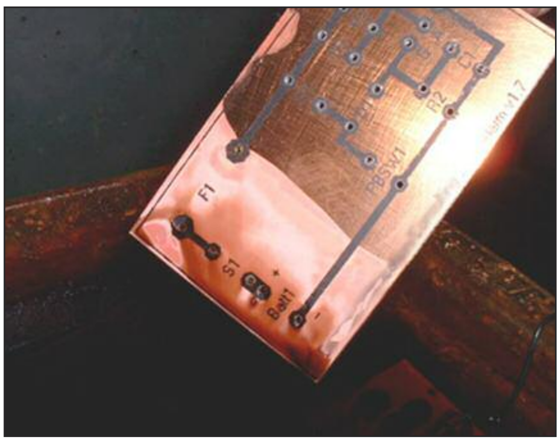

The next step is to use a chemical reaction to remove the unwanted copper. Once the resist has been applied to the copper cladding, a chemical process called **etching** is used to remove the unwanted copper. The chemical that is used to remove the unwanted copper is referred to as the **etchant**. An etchant that can be used is called ferric chloride; another is called ammonium persulphate. The copper clad, with the foil pattern drawn on it, is placed in the etchant for about 10 minutes. Then, the board is removed, rinsed off with water, and dried. Only the metal copper foil under the resist remains, as shown below.

# How a Homemade Circuit Board Is Made

Picture 1: Ferric chloride solution



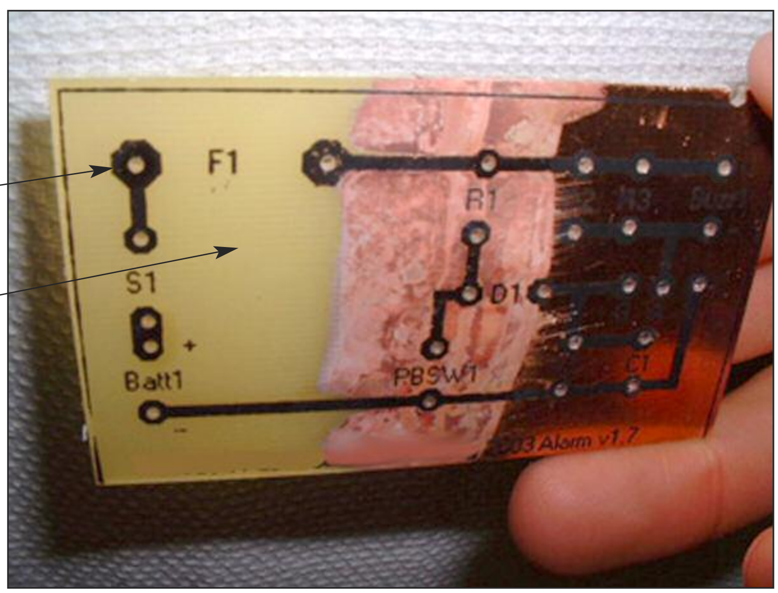
Picture 2: Copper circuit board partially in solution




Picture 3: Copper has been eaten away from being in solution

Copper still exists beneath foil patter

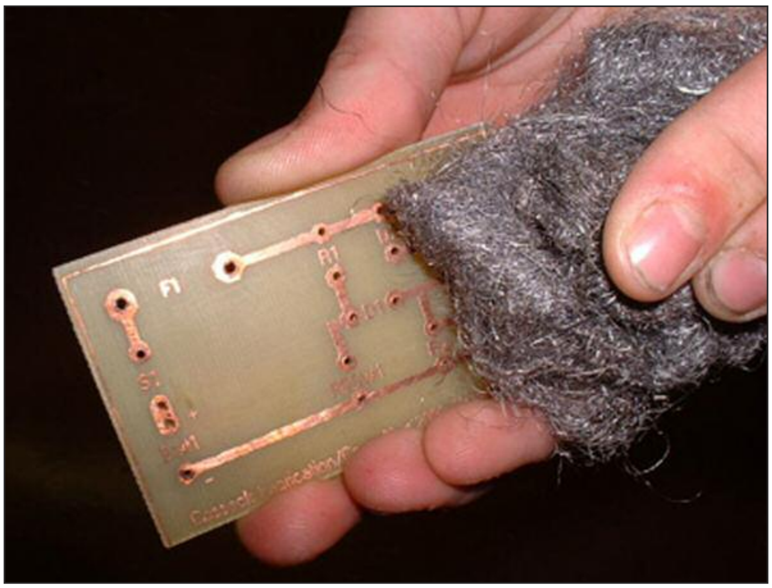
Copper eaten away everywhere else




Picture 4: Reaction of chemical etchant

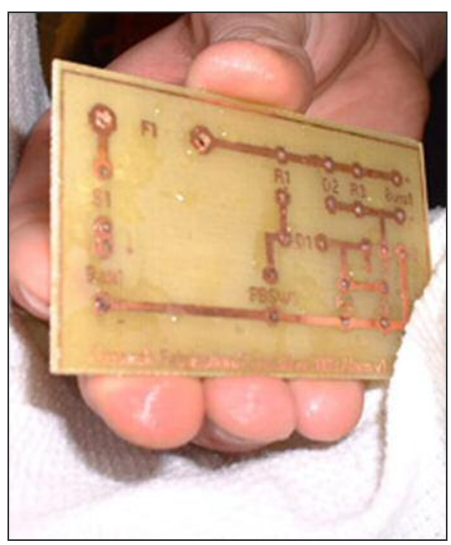
Once the board has dried, the resist that was protecting the copper has done its job and must now be removed with steel wool or a rough scouring pad.

In industry, technicians would bathe the boards in strong chemicals to clean the oxidation and foil pattern. They probably wouldn't use steel wool or a scrubbing pad of any kind. However, using steel wool to clean circuit boards is an acceptable teaching practice in a high school where strong chemicals are not permitted. Issues like this are common where practices in schools are a bit different from that of industry.



Picture 5

The PCB is then rinsed with water and dried completely to complete the fabrication process.



The circuit board supplied in your course is prepared by a professional circuit board manufacture. It is high quality and ready for you to use.

# NOTES

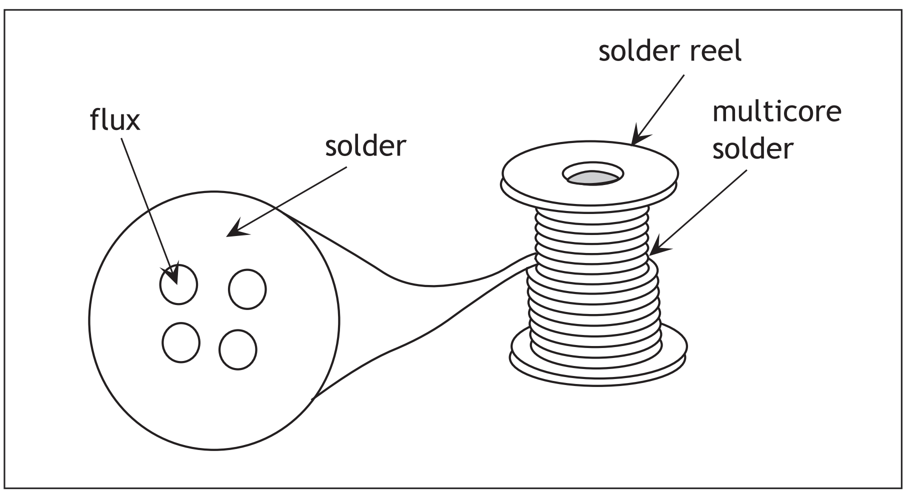
# LESSON 2: SOLDERING

## Let's Get Started

**Soldering** is a permanent method of connecting components in an electrical circuit. The **solder** in your Project Kit looks like this.

Solder is an alloy that is made up of tin and lead. The solder is specifically called 60/40. The first number always represents the amount of tin in the solder. The second number is the lead quantity. The 60 represents 60 percent tin, and the 40 represents 40 percent lead.

The solder will melt around 200º C. The solder is made in a wire-style formation on a roll with a core of **flux**. See picture below.



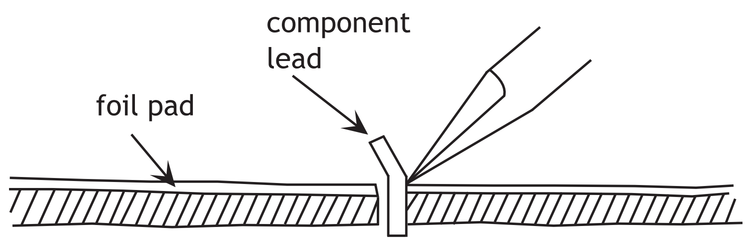

**Flux is not visible to the naked eye.**

For plumbing pipes in your home, 90/10 solder is used. It has a higher quantity of tin in it to make the copper pipe joint a lot stronger.

**The *flux* in the solder is very important.** It melts with the solder when heat is added. The flux in turn cleans the area where the solder is going to stick, it helps the solder flow evenly over the copper foil, and it also helps the solder stick to the copper contact area. The solder is designed to stick to copper foil and **not the fibreglass backing of the PCB**.

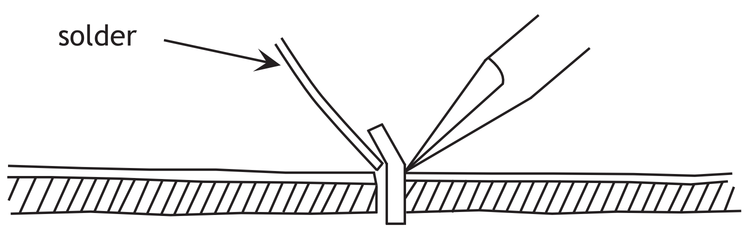
The technique of soldering is not difficult to learn, but there are some rules you have to follow to ensure success.

1. All parts, surfaces, and soldering iron must be clean before you start.
2. Heat both the copper foil and the component lead (also called a component leg) **together**.



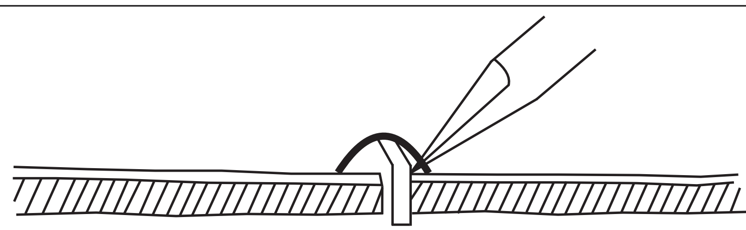

Heat lead and pad for two to three seconds.

3. Once the heat has been applied to both component lead and copper foil, add the solder.



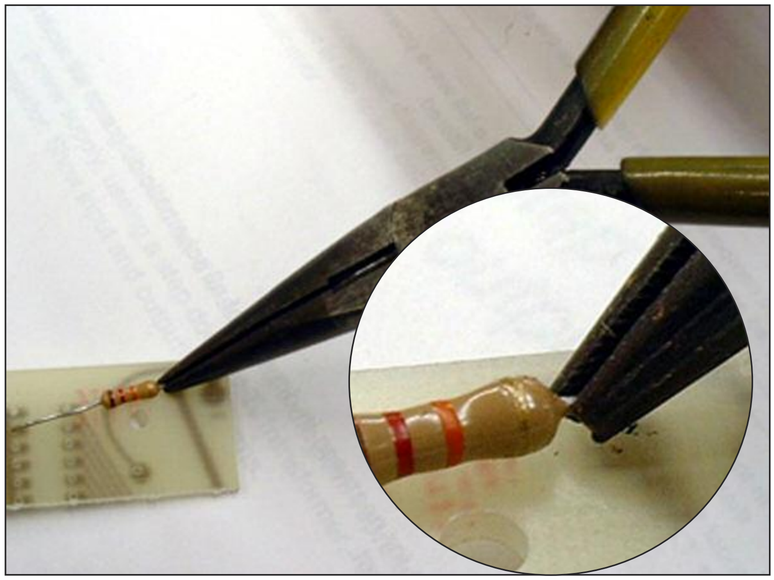

Apply small amount of solder to opposite side of lead.

4. Allow the joint to cool before you move it.

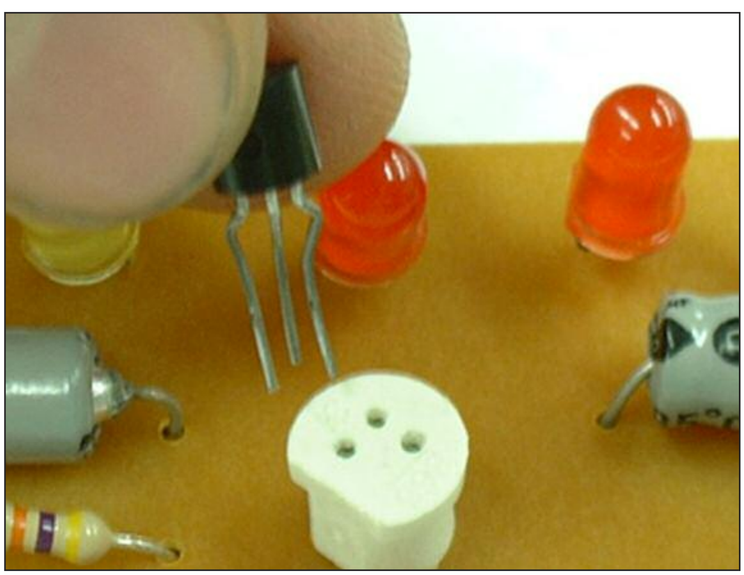


Remove solder first and then the iron.

5. Use a heat sink when soldering in diodes and transistors. **Heat sinking** is a term used to describe the process of drawing the heat from the soldering iron away from the actual component you are soldering. This is usually done by clamping the legs of the component with needle-nose pliers.



6. Use sockets for components when available. Even with heat sinking, many semiconductors are too delicate to be soldered in place. A socket can be soldered in place that can hold a component without solder. The advantages of using a socket is that it avoids overheating problems, allows for easy installation of components with many legs set close together, and makes it easier to replace delicate components.



7. For small electronic circuitry, use a soldering iron and not a soldering gun. The soldering gun will generate too much heat and the copper foil will lift off the fibreglass backing.

**soldering iron**

**soldering gun**

## Assignment 4.1

# Practice Soldering Project

It is now time to view the Grade 9/10 Electronics video found in the learning management system (LMS) or on DVD. Watch the section on soldering techniques.

To ensure you will have proper solder joints, you will need to complete a practice soldering assignment. By doing this, you will have better success at getting your project operating much sooner.

**Often projects that will not work have bad solder joints.** To help you become a master at soldering, watch "proper soldering techniques" on the video. The video will go over how to safely and effectively solder. The video will also cover some bad techniques and poor solder joints.

### Inventory List for Practice Soldering Project

You will need to find the following items from your Practice Soldering Kit.

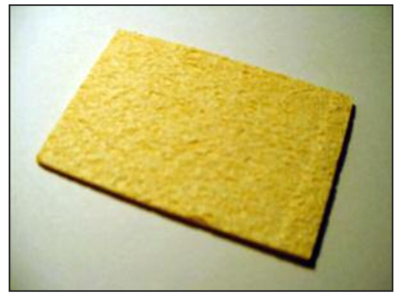
Place a checkmark in each box once you have identified each item.

- ❑ safety glasses

- ❑ soldering iron

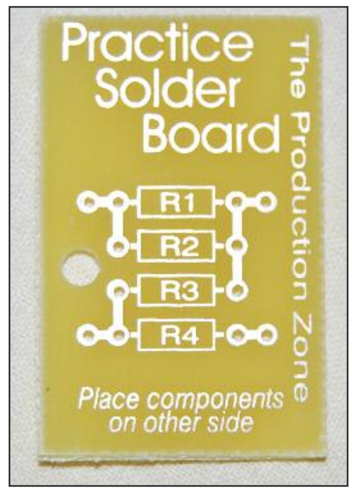
> **Note:** Graphics may be different than the items in your kit due to a new product supplier.

- ❑ wet sponge
  (found with soldering iron stand)

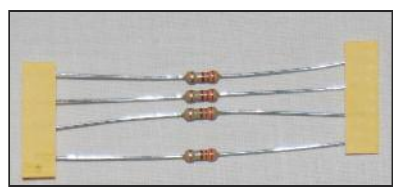


- ❑ solder

- ❑ practice solder board




- ❑ 4 resistors



- ❑ soldering iron stand

- ❑ work table

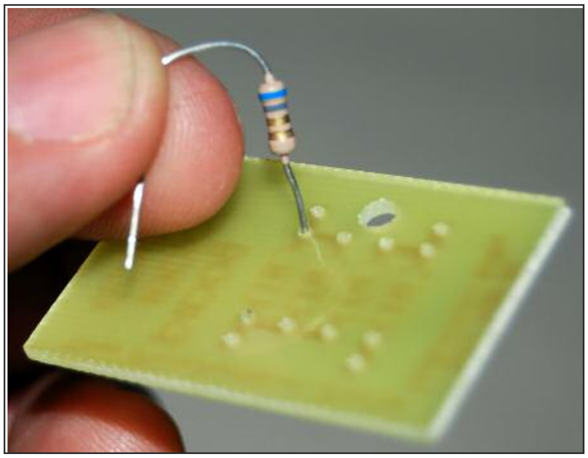
Before you get started, make sure you put on your safety glasses. Once your soldering iron is heated, any moisture in the solder, flux, or joint will immediately start to boil. This could cause flux or solder to spatter. The rule is "Before you grab any tool, put on the **goggles!**"

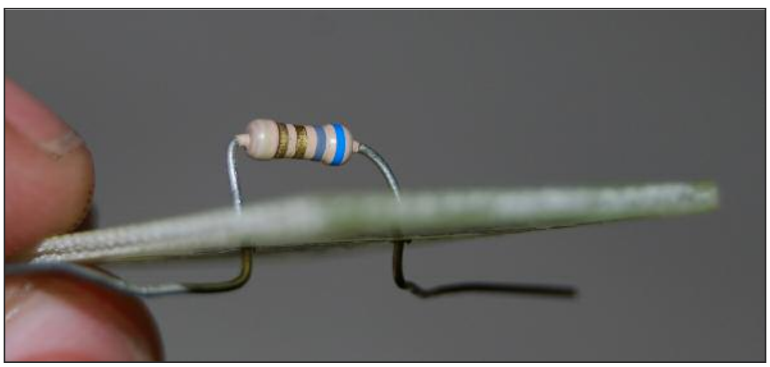
**Step 1**

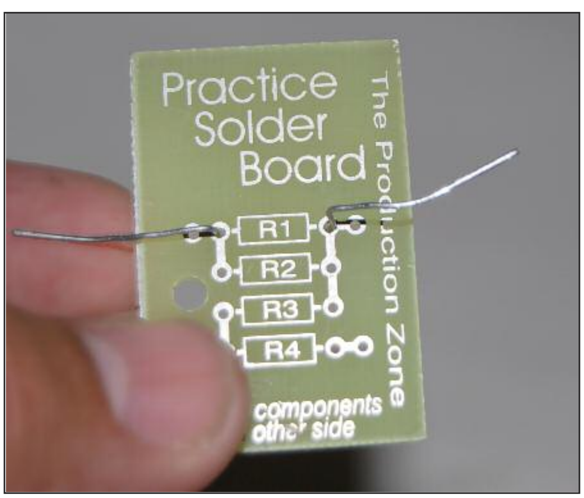
Place the soldering iron on the metal surface. Plug in the soldering iron, making sure the cord is not near the heating element of the iron.

**Step 2**


Find the practice solder kit. Feed the first resistor through the holes on the circuit board labelled R1. Remember to feed the components legs through from the plastic side to the copper side as solder will only stick to the metal foil pattern. It's a good idea to put a slight bend in the leg so that it doesn't fall out of the board.







**Step 3**

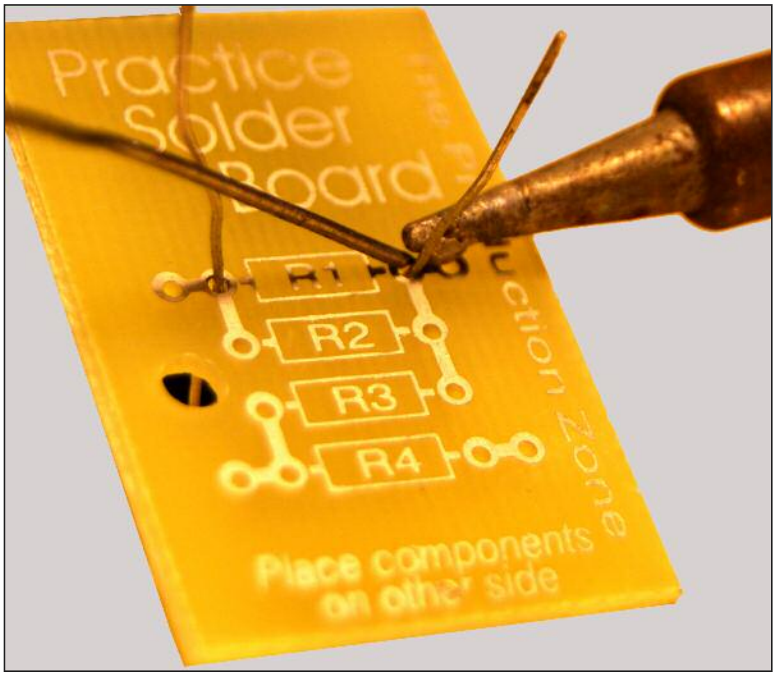
Make sure you have your goggles on. Use the damp paper towel to clean the hot soldering iron tip.


**If you are having trouble soldering, the area may not be heated enough.**

**Step 4**

**Make sure you have your goggles on.** Hold the soldering iron in one hand and the solder in the other. Press firmly against the wire lead and the copper foil pad. Heat both the component legs and the copper foil **together**. If you don’t heat them together the solder joint will be very weak and form a **cold solder joint**.

A cold soldered joint can also form if the leg moves while being soldered. A cold soldered joint may look good and if you tug on the component, you will notice that it is attached. However, there may be just enough air in the joint to block the flow of electrons. The only way to fix a cold soldered joint is to reheat the area, remove the solder, and then resolder the joint. Make sure the leg cannot move and heat it and the solder together.



**proper soldering procedure heating both component legs together**

Use your needle-nose pliers and an elastic band to create a low-cost heat-sinking tool.

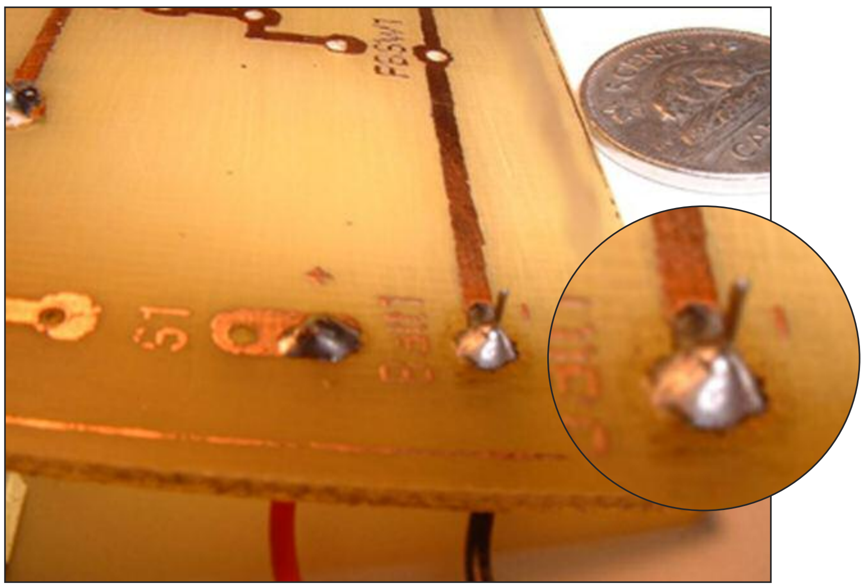
**Sparkey Fact**

When soldering in components such as transistors or diodes, be sure to use a heat sink to protect the heat sensitive components from damage.

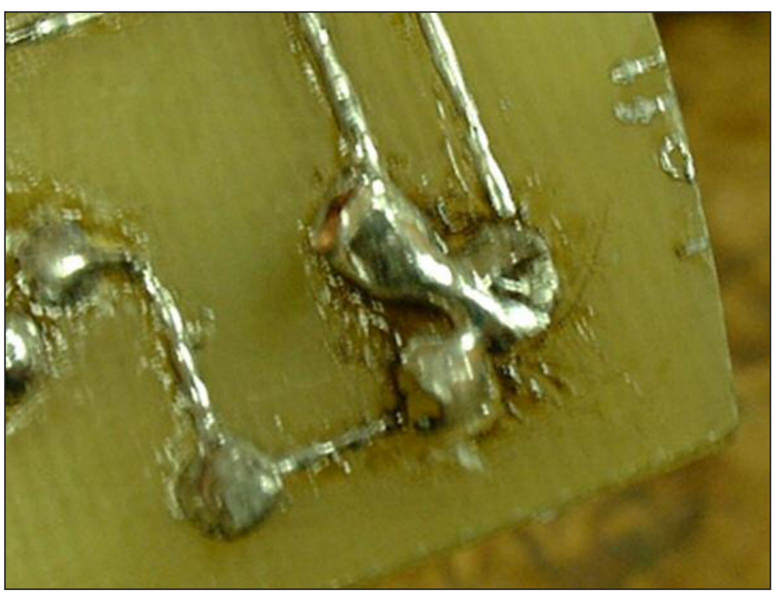
## What Does a Good Solder Joint Look Like?

1. Smooth
2. Shiny
3. Covers the entire copper foil pad

A good solder joint is also shaped like a Hershey's Kiss®.



**picture of a good solder joint**



**picture of a poor solder joint (too much solder)**

When you have completed all the work in this module, send in Assignment 4.1: Soldering Practice Project to the Distance Learning Unit. Make sure you review what makes a good solder joint and compare it with your practice scrap piece. This will enable the tutor/marker to provide feedback on your soldering. Your Practice Soldering Project will be marked complete or incomplete. You will be requested to redo this activity if you receive an incomplete.

The purpose of the Soldering Practice Project is to demonstrate your soldering skills. In order to receive a complete on this project, your tutor/marker needs a sample of soldering that

- includes three or four resistors on the proper side of the PCB (use a low-heat soldering iron)
- shows solder covering the copper ring that the component leg sticks through
- does not have any adjacent copper surface so that the only path for electrical flow is from one leg of the component to the other, through the component

These points cover the minimum requirements for completing the project.

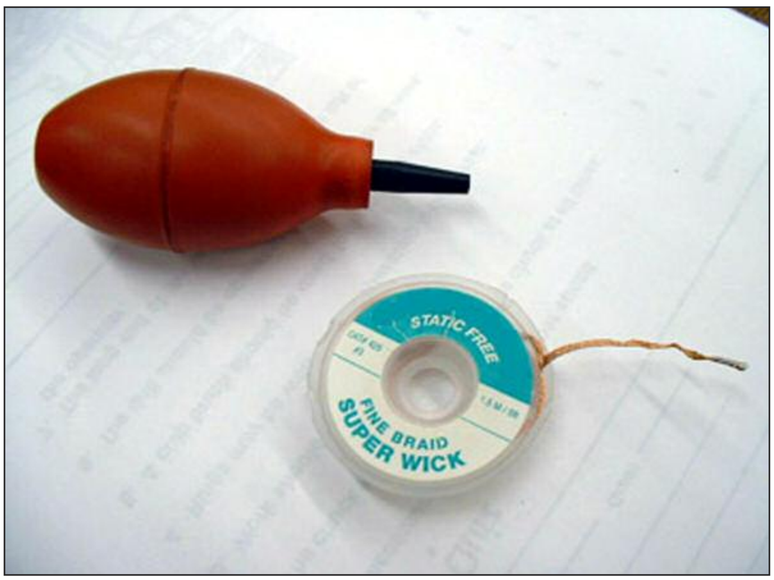
Soldering that demonstrates a higher level of skill should have the following characteristics:

- is nestled close to the board
- contains no burn marks
- does not contain any cold soldered joints
- has the superfluous leg portions trimmed
- has been tested for continuity
- contains a solder join that is smooth, shiny, and shaped like a Hershey's Kiss®

Go to Assignment 4.2 found at the end of this module and complete Part 1: Soldering Techniques.

## Repairing and Servicing Your PCB

Soldering is a permanent method of connecting components in an electrical circuit. It is a semi-permanent method of attaching components to a circuit board. But what happens if you install a component with the wrong polarity or simply in the wrong location? It must be removed! It is possible to remove any style of component from a PCB, but you must be very careful if you plan to reuse the same de-soldered component. The component must be treated with care. There are many ways that the component can be removed, but before you pull on the component legs from the PCB, the solder must first be removed. There are tools such as small hand-held solder vacuums, machine-driven solder vacuums, or solder wick.



## Desoldering

**Option 1:** *If you have solder wick or a de-soldering tool*, the solder can be removed. Heat the component leg and the solder together until solder is liquid. Place the wick or de-soldering vacuum into the puddle while applying heat. Wicking works automatically whereas the de-soldering vacuum needs to be activated. Then the component can be removed quickly.

**Option 2:** *If you do not have any type of de-soldering equipment,* when the solder melts and turns into a liquid, lift up on the one component leg you are heating with your needle-nose pliers. Go back and reheat the other component leg and carefully remove the component. Do not pull too hard because the component may crack and break. If there is any excess solder left on the board, heat up the spot where the hole is filled with solder and then quickly tap the circuit board on its side. The solder will end up as a small spatter on the tabletop. Make sure you do not damage your table. Also don't forget to use a heat sink on diodes and SCRs.

Make sure to re-inspect the component you will reuse. If it is damaged, you may have to buy more. So be very careful!

## Circuit Board Repair

A magnifying glass can be used to find cracks or faults on a PCB. If you think your PCB has a crack or break in the trace, use your DMM to find the fault. A scrap piece of solid wire can very easily repair a broken copper trace on the PCB. The solid piece can be the cut-off leftovers of a previously installed component, or a piece of solid hookup wire with the insulation removed. Then lay the solid piece across the broken trace, and solder it on to act as a bridge to make the connection. Be sure to test your repair job with the DMM. Be sure you don't create a short circuit with another trace with your repair. It is very common for students to use too much solder. Take your time and do it right the first time.

Go to Assignment 4.2 found at the end of this module, and complete Part 2: Repairing and Servicing Your PCB.

# Module 4 Summary

Congratulations, you have finished the fourth module in the course.

Remember

- Wear your goggles when you grab and use any tool.
- Follow the assembly procedures closely to prevent problems later on.
- Test and record everything before you install it in the PCB.
- Good solder joints equal fewer headaches later on.
- Retrace your steps again and again until you find out what went wrong.


## Submitting Your Assignments

It is now time for you to submit your work from Module 4 to the Distance Learning Unit so that you can receive some feedback on how you are doing in this course. Remember that you must submit all the assignments in this course before you can receive your credit.

**Remember:** Since Assignment 4.1 is a project, it must be mailed to the Distance Learning Unit. Keep all your material together in the one mailing and do not electronically submit any material for this module.

Make sure you have completed all parts of your Module 4 assignment and organize your material in the following order:

- Module 4 Cover Sheet
- Module 4 Log Sheet
- Assignment 4.1: Practice Soldering Project
- Assignment 4.2: Soldering and the PCB

For instructions on submitting your assignments, refer to How to Submit Assignments in the course Introduction.

# NOTES

## Assignment 4.2

# Soldering and the PCB

***Total: 27 marks***

**Part 1: Soldering Techniques**

Record your results below for this assignment. *(total of 20 marks)*

1. Solder is an alloy made of ______________________________ and ______________________________. *(2 marks)*

2. The first number written on a roll of solder represents how much ________________________________ is in the solder. *(1 mark)*

3. The second number on a roll of solder represents how much ______________________________ is in the solder. *(1 mark)*

4. The flux inside the solder has three uses. Flux _____________________ the area being soldered, helps the solder _____________________ evenly over the copper foil, and also helps the solder _______________ to the copper contact area. *(3 marks)*

5. Solder will only stick to the (copper foil) / (fibreglass backing) **(Circle one)** *(1 mark)*

6. What must you do to the hot soldering iron tip before you start soldering? *(1 mark)*

    ________________________________________________________________

    ________________________________________________________________

7. When soldering, you must heat the component leg or wire and the copper foil "T _ _ _ _ _ _ R." *(1 mark)*

*(continued)*

## *Assignment 4.2: Soldering and the PCB (continued)*

8. What will happen to a solder joint if you move it before it cools? *(1 mark)*

_______________________________________________

_______________________________________________

_______________________________________________

9. What must you do if you notice one of your soldered connections is a "cold" solder joint? *(1 mark)*

_______________________________________________

_______________________________________________

_______________________________________________

10. Why must a heat sink be used while soldering with heat-sensitive components? *(1 mark)*

_______________________________________________

_______________________________________________

_______________________________________________

11. Why would component sockets be available for such components as transistors or integrated circuits? *(1 mark)*

_______________________________________________

_______________________________________________

_______________________________________________

12. Why is it so important to wear your goggles while soldering? *(1 mark)*

_______________________________________________

_______________________________________________

_______________________________________________

*(continued)*

## *Assignment 4.2: Soldering and the PCB (continued)*

13. How could you make a homemade heat sink clip with the pliers in your kit? *(1 mark)*

    ______________________________

    ______________________________

    ______________________________

14. What are the three visual indicators you must look for in a good solder joint? Do not answer that it looks like a Hershey's Kiss chocolate! *(3 marks)*

    a) ______________________________

    b) ______________________________

    c) ______________________________

15. What would happen to the copper foil pattern on the fibreglass backing if a large soldering gun was used instead of the proper temperature soldering iron? *(1 mark)*

    ______________________________

    ______________________________

    ______________________________

*(continued)*

## *Assignment 4.2 (continued)*

### Part 2: Repairing and Servicing Your PCB

Record your results below for this assignment. *(total of 7 marks)*

1. What tool can be used for a closer inspection of a PCB? *(1 mark)*

   ______________________________________________

2. What two functions could you set your DMM to for testing a possible cracked/broken trace on your PCB? *(2 marks)*

   a) ______________________________________________

   b) ______________________________________________

3. Explain two methods of removing solder from a PCB. *(2 marks)*

   a) ______________________________________________

   ______________________________________________

   ______________________________________________

   b) ______________________________________________

   ______________________________________________

   ______________________________________________

4. Explain how a broken trace on a PCB can be repaired. *(2 marks)*

   ______________________________________________

   ______________________________________________

   ______________________________________________

# MODULE 4 SUMMARY

Congratulations, you have finished the fourth module in the course.

Remember

- Wear your goggles when you grab and use any tool.
- Follow the assembly procedures closely to prevent problems later on.
- Test and record everything before you install it in the PCB.
- Good solder joints equal fewer headaches later on.
- Retrace your steps again and again until you find out what went wrong.


## Submitting Your Assignments

It is now time for you to submit your work from Module 4 to the Distance Learning Unit so that you can receive some feedback on how you are doing in this course. Remember that you must submit all the assignments in this course before you can receive your credit.

**Remember:** Since Assignment 4.1 is a project, it must be mailed to the Distance Learning Unit. Keep all your material together in the one mailing and do not electronically submit any material for this module.

Make sure you have completed all parts of your Module 4 assignment and organize your material in the following order:

- Module 4 Cover Sheet
- Module 4 Log Sheet
- Assignment 4.1: Practice Soldering Project
- Assignment 4.2: Soldering and the PCB

For instructions on submitting your assignments, refer to How to Submit Assignments in the course Introduction.

# NOTES

# Grade 9 Electricity/ Electronics Technology (10G)

## Module 5: Series, Parallel, and Combination Circuits

# Module 5: Series, Parallel, and Combination Circuits

## Module Focus

**When you finish this lesson, you will be able to**

- ❑ explain what makes up a simple circuit
- ❑ explain what constitutes a short circuit
- ❑ state the difference between series, parallel, and combination circuits
- ❑ explain how controls are used in circuits

## Introduction

This module is designed to give you an understanding of the basics of how electricity travels in circuits and why and how we can control it. Before you begin, you must realize that we will be working with low-power circuits. Whenever electricity is travelling in a circuit, you must always respect its power. You will be completing experiments and activities to demonstrate each circuit principle.

## Power Words

polarized
load
short circuit
series circuit
parallel circuit
combination circuits
switch

## Assignments in Module 5

When you have completed the Module 5 assignment, put it in a safe place and wait until you have completed the Module 6 assignment. Once you have completed your Module 6 assignment, submit your completed Module 5 and Module 6 assignments, along with the Log Sheets and Modules 5 and 6 Cover Sheet, to the Distance Learning Unit either by mail or electronically through the learning management system (LMS). The staff will forward your work to your tutor/marker.

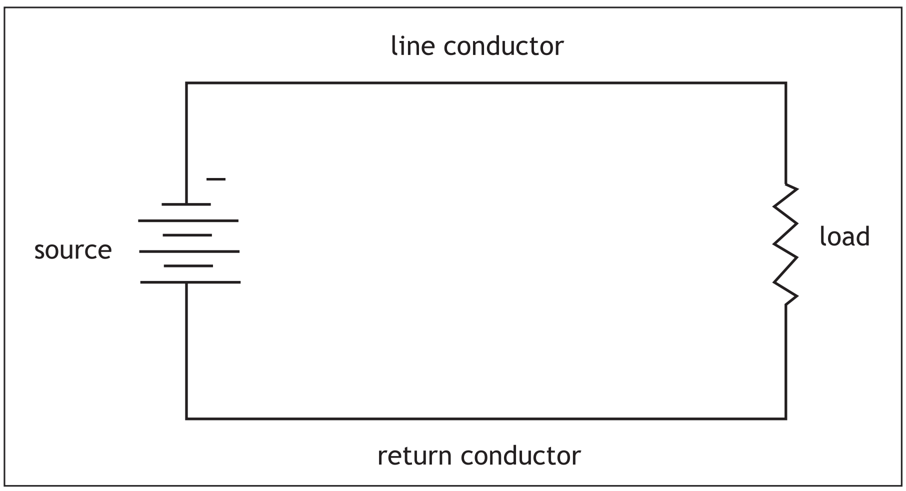
# Lesson 1: Circuit Basics

## Simple Circuits

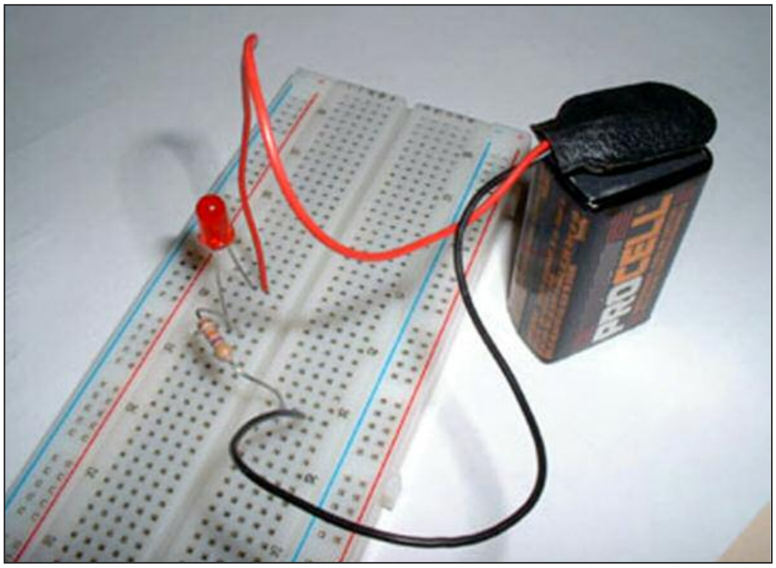
Before current can flow in a circuit, the circuit must be complete. For a circuit to be complete, it must have:

1. a source
2. a negative conductor path
3. a positive conductor path
4. a load

The source must also be **polarized**. That is, it must have a location with a deficiency of electrons and a location of excess electrons. The **load** uses the energy supplied by the moving electrons to perform a function. The function could be to turn a motor, light a light bulb, heat an oven, or run your television.

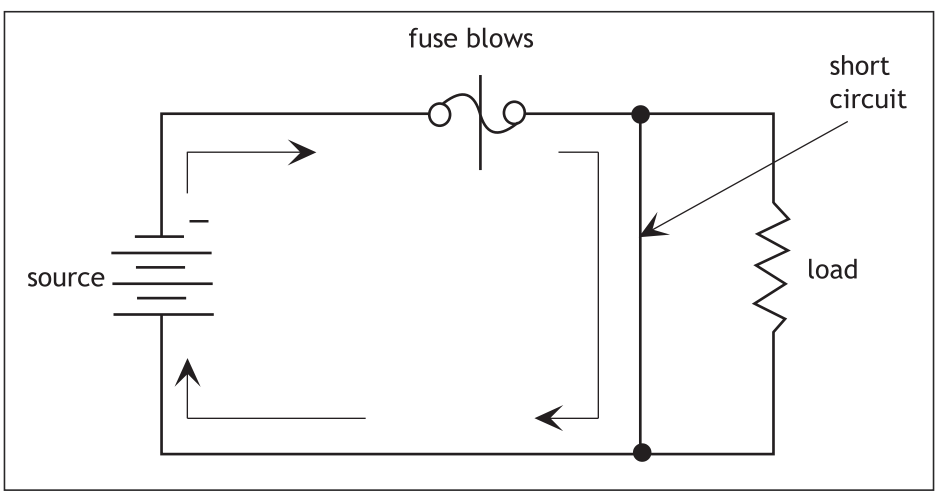


The LED circuit that you built with the solderless circuit board would be considered a simple circuit (see below).



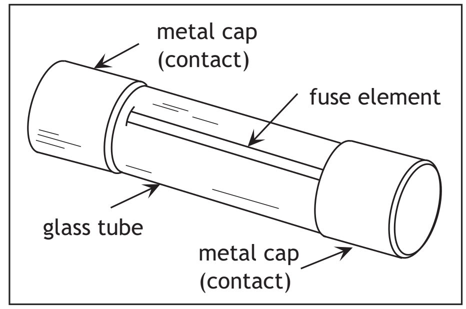

## Short Circuits

In any electrical circuit, it is the resistance that controls the amount of current that can travel in the circuit. Like water flowing downhill, electricity will flow where there is least resistance. If a path for the current is created and there is no load on the circuit, then a **short circuit** is created (see below).



In a short circuit, the uncontrolled flow of energy causes the conductors—usually wires—to overheat and melt or catch fire. To protect circuits from these potential problems, a fuse or circuit breaker is used (see below).

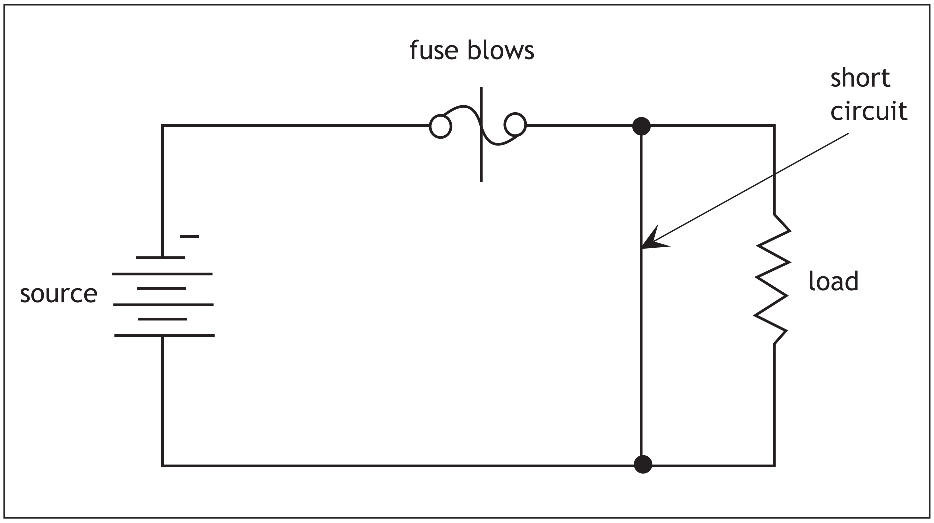
fuse (close up)




inside fuse (graphic)

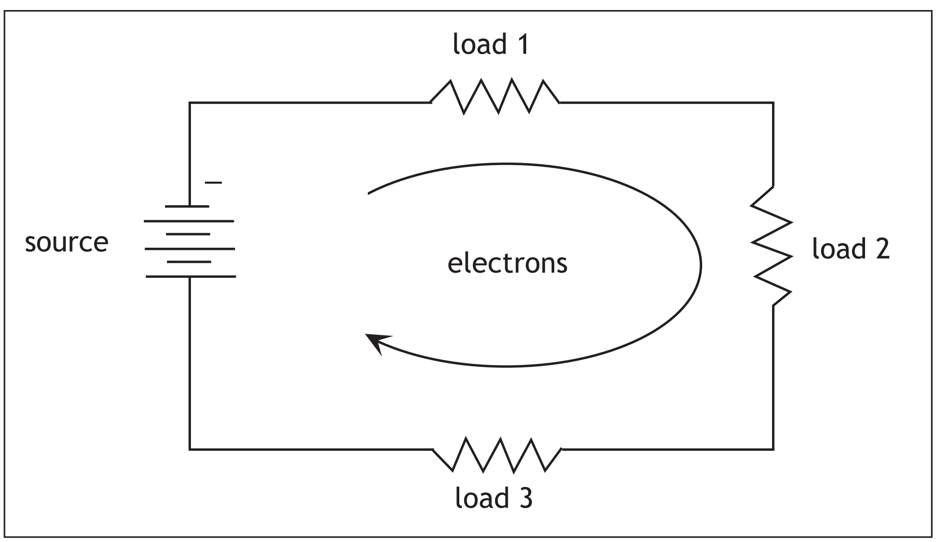
circuit breaker (20 amps)

The conductor in the fuse is made of a metal with a low melting point. When too much current is flowing in the circuit, the metal piece inside the fuse melts, therefore opening up the circuit and preventing any damage from taking place.




## Series Circuits

Sometimes there is more than one load or source in a circuit. Below is a schematic drawing of a series circuit with three resistors. Each resistor would be considered one load (see below).



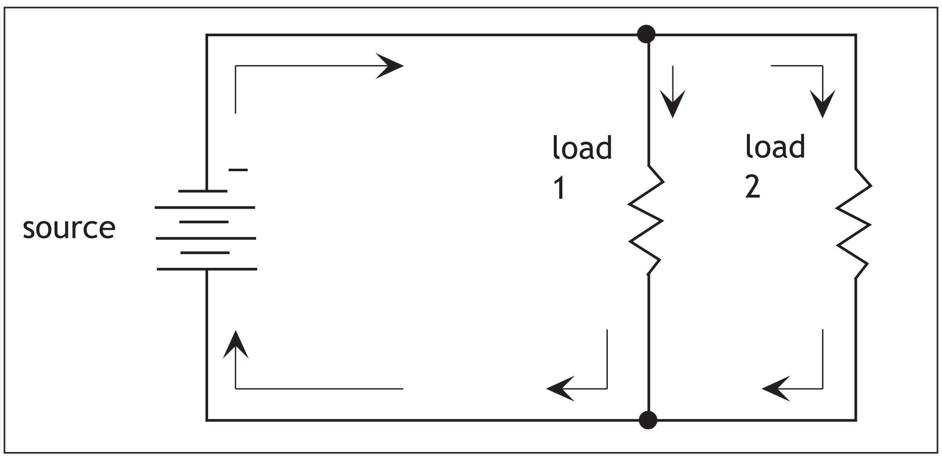
When the path of electrons is from the source through the loads and then returning to the same source, it is obvious that there is only one path for the electricity to flow. This is considered a simple series circuit. Christmas lights that all shut off when one bulb is blown or removed is a good example of a simple series circuit.

**Series Laws**

Electrical current is constant no matter where it is measured in the series circuit. The sum of each voltage drop at each load will equal the total source voltage.

## Parallel Circuits

There is another way that more than one load can be attached to a source. There can be two or more paths for the electrons to flow. This is called a parallel circuit (see below).



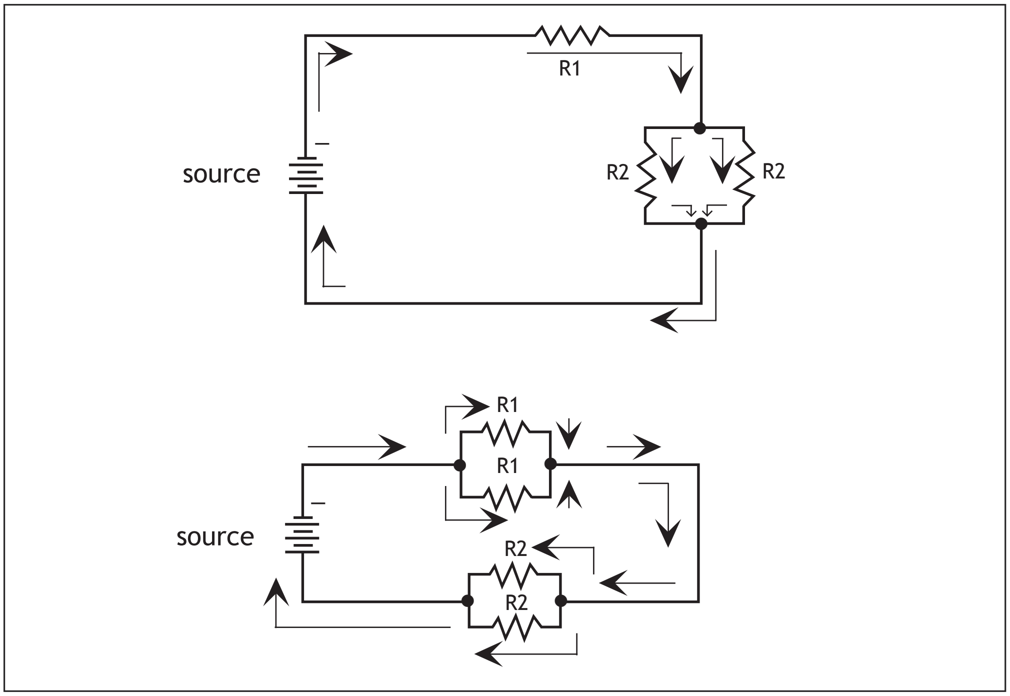

Each of the loads is independent. This means that if one load was disconnected or burned out, the rest of the circuit would keep functioning. An example is automobile headlights. If one headlight on a car burns out or breaks, the rest of the car's lights, inside and outside, will remain on.

**Parallel Laws**

Voltage is constant no matter where it is measured in the parallel circuit. The sum of the current through each load will equal the total source current.

## Combination Circuits

Combination circuits, or series-parallel circuits, are a form of circuit that combines both series and parallel formations (see below).

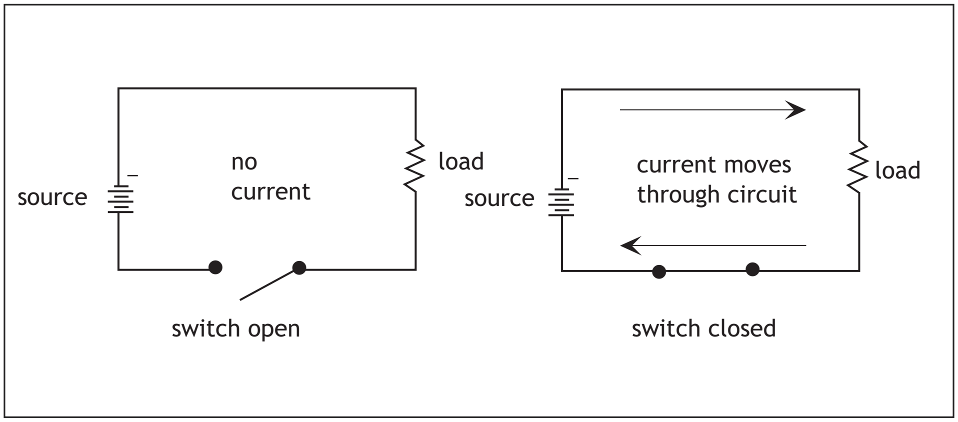



**arrows indicate current flow**

A combination circuit is actually a series circuit with a parallel section added onto it. The series section of the circuit will behave like a basic series circuit. The parallel circuit will behave like a parallel circuit. When calculations are done, the circuits are simply broken down into their type of circuit, and then are calculated. These types of calculations, while important in electronics, are beyond the scope of this course.

## Controlling Circuits

A switch can control circuits. A switch acts like a gate, allowing electrons to flow through only when it is closed. When the switch is open, electrons cannot flow and no current will move in the circuit (see below).




Two or more switches may be used on the same circuit. Both switches must be closed before the circuit will operate. This technique is used on heavy machinery to protect the worker so that when just one switch is turned on, the machine will not start. This ensures that the worker's hands and feet are away from the moving parts.

---

Go to Assignment 5 found at the end of this module and complete the assignment.

---

# NOTES

# MODULE 5 SUMMARY

Congratulations, you have finished the fifth module in the course.

Remember

- A simple circuit needs a load, positive conductor, negative conductor, and a source to operate.
- A load is any device that uses electrical energy to perform work.
- A series circuit has only one path for the electrons to flow.
- In a parallel circuit, each load has an independent path to the source.
- A combination is a complete circuit that has both series and parallel characteristics.

## Submitting Your Assignments

You will not be submitting your Module 5 material to the Distance Learning Unit at this time. Once you have completed Module 6, you will submit both your Module 5 and Module 6 assignments together. Remember that you need to submit all the assignments in this course before you can receive your credit.

## NOTES

## Assignment 5

# Circuits

***Total: 45 marks***

**Basic Circuits**

Record your results below for this assignment.

1. What are the four characteristics of a simple circuit? *(4 marks)*

2. What are the characteristics of a series circuit? *(3 marks)*

3. What are the characteristics of a parallel circuit? *(3 marks)*

*(continued)*

## *Assignment 5: Circuits (continued)*

4. What are the characteristics of a combination circuit? *(2 marks)*

______________________________________________

______________________________________________

______________________________________________

5. Define a short circuit. *(2 marks)*

______________________________________________

______________________________________________

6. What electrical measurement (volts, amps, or ohms) is constant no matter where it is measured in a series circuit? *(1 mark)*

______________________________________________

7. What electrical measurement (volts, amps, or ohms) is constant no matter where it is measured in a parallel circuit? *(1 mark)*

______________________________________________

8. How does a basic switch control the flow of current in a circuit? *(2 marks)*

______________________________________________

______________________________________________

______________________________________________

*(continued)*

## *Assignment 5: Circuits (continued)*

9. Draw a schematic diagram of a basic series circuit. Include a source, switch, and two loads. *(5 marks)*

10. Draw a schematic diagram of a basic parallel circuit. Include a source, switch, and three loads. *(6 marks)*

*(continued)*

## *Assignment 5: Circuits (continued)*

11. Draw a schematic diagram of a basic combination circuit. Include a source, two switches, two loads in series, and three loads in parallel. *(9 marks)*

12. Define what makes up a short circuit. Include all the necessary components. *(2 marks)*

13. What does a fuse in an electrical circuit do? *(2 marks)*

14. How does a fuse work? *(3 marks)*

# Module 5 Summary

Congratulations, you have finished the fifth module in the course.

Remember

- A simple circuit needs a load, positive conductor, negative conductor, and a source to operate.
- A load is any device that uses electrical energy to perform work.
- A series circuit has only one path for the electrons to flow.
- In a parallel circuit, each load has an independent path to the source.
- A combination is a complete circuit that has both series and parallel characteristics.

## Submitting Your Assignments

You will not be submitting your Module 5 material to the Distance Learning Unit at this time. Once you have completed Module 6, you will submit both your Module 5 and Module 6 assignments together. Remember that you need to submit all the assignments in this course before you can receive your credit.

# Notes

# Grade 9 Electricity/ Electronics Technology (10G)

## Module 6: Linking Education to Careers: What Do You Want To Do for the Rest of Your Life?

# Module 6: Linking Education to Careers: What Do You Want To Do for the Rest of Your Life?

**Module Focus**

**When you finish this module, you will be aware of**

- ❑ career opportunities in electronics and electrical professions
- ❑ post-secondary programs in electricity and electronics
- ❑ high-school-based training programs

## Introduction

In today's competitive world, there is little opportunity for the unskilled worker. Unfortunately, there is a high percentage of people who lack the necessary skills to fill a large number of openings in the workforce. A high school diploma has become the bare minimum for workers. If the electrical and electronics fields interest you, start early and enroll in these types of programs in high school. This will give you a better perspective of the types of opportunities available and skills needed to reach them.

What do you want to do for the rest of your life? This is not an easy question to answer at a young age. Let's say, though, that you have chosen a career path and you don't think it includes electronics. Whether you plan on a career as a mechanic, an entrepreneur, a banker, or a plumber, it is a good idea to check with a couple of people in the area you have chosen. You may be surprised to find that in most career fields, people with a background in electronics do better than those without (more options, more doors open). Start your research early, before you graduate from high school.

In this module, we will look at some avenues that you can take in your pursuit of a career in the field of electricity/electronics.

## Assignments in Module 6

When you have completed the Module 6 assignment, submit your completed Module 5 and Module 6 assignments, along with the Log Sheets and Modules 5 and 6 Cover Sheet, to the Distance Learning Unit either by mail or electronically through the learning management system (LMS). The staff will forward your work to your tutor/marker.

## Career Choices

Below is a chart that you can look at to get you thinking about what career you would like to pursue after you graduate from high school.

| Electrical Apprenticeship | Industrial Arts and Technology High School Programs | Community College | University |
|---|---|---|---|
| Electrician | General Technician | Technician | Electronic Engineer |
| Maintenance | Computer Technician | Technologist | Electrical Engineer |
| Telecommunications | Skilled Tradesperson | Consumer Services | Computer Technician |
| Service Technician | Service Technician | Computer Services Technician | Computer Technician |

A great way to get experience in a trade or technical profession before you leave high school is through a work experience program. You will get to enter the real world and deal with true-to-life situations. This will save time and help you make your career decision before you leave high school.

In work experience programs, you are placed, for a period of time, in a situation that will provide a better understanding of that profession. You could be placed with a construction electrician on a job site, or you may be involved with wiring a home or office for power.

## Cooperative Education Programs

Cooperative education programs are similar to work experience programs but differ in the length of time you will be at a job placement. Quite often the student will be partially enrolled in a high school program while working at a job site. An equal amount of time would be spent at the job placement site and in the high school classroom.

## Apprenticeship Programs

This is another method of gaining experience while still enrolled in high school. There is a specific curriculum for this type of schooling. It is very detailed and is not designed to be an interest-based program. The apprenticeship program has a very detailed workload that is geared toward one specific career choice. This saves time while you are still in high school, provided you know what type of trade interests you. A career-orientated education offers credits towards the secondary school graduation diploma.

Go to Assignment 6 found at the end of this module and complete the assignment.

# Module 6 Summary

Congratulations, you have finished the sixth module in the course.

Remember

- Talk to your guidance counsellor about what is the best-tailored educational plan for you.
- Research to find out what you would like to do.
- Talk to people in the industry to see exactly what they do. Then you will know what the job entails.

## Submitting Your Assignments

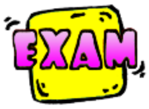
It is now time for you to submit your work from Module 5 and Module 6 to the Distance Learning Unit so that you can receive some feedback on how you are doing in this course. Remember that you must submit all the assignments in this course before you can receive your credit.

Make sure you have completed all parts of your Module 5 and Module 6 assignments and organize your material in the following order:

- Modules 5 and 6 Cover Sheet
- Module 5 Log Sheet
- Assignment 5: Circuits
- Module 6 Log Sheet
- Assignment 6: Career Planning

For instructions on submitting your assignments, refer to How to Submit Assignments in the course Introduction.

## Writing Your Final Examination




You will write the final examination when you have completed Module 7 of this course. The final examination is based on Modules 1 to 7, and is worth 15 percent of your final mark in the course. To do well on the final examination, you should review all the work you complete in Modules 1 to 7, including all the learning activities and assignments. You will write the final examination under supervision.

Assignment 6

# Career Planning

***Total: 29 marks***

**Career Opportunities**

As your last assignment, read the three advertisements attached that are related to electrical/electronics jobs. Complete the Career Opportunities table provided. Note the mark allocation for each answer. This will guide you in how much information is required. *(9 marks for each career, for a total of 27 marks)*

If you prefer an electronic version of this assignment table, one is available for download in the learning management system (LMS).

Based on your current skills and your plans for gaining skills, do you think you might be interested in a career that is related to electronics/electricity? Explain why or why not. *(2 marks)*

*(continued)*

## Sample Advertisement: Senior Electrical Engineer

Company: Smith-Smith & Associates
Location: Central, Ontario
Job Type: Full-Time Employee
Relevant Work Experience: 10+ to 15 Years
Education Level: Bachelor's Degree
Language: Bilingual (French, English)

### Duties

The person who accepts this position will be a member of a team that works to modernize and keep hydroelectric stations operating smoothly by:

- Managing electricity production and transmission equipment upgrade projects.
- Providing technical assistance for power station maintenance work and operations.

### Skills and Abilities

- Ability to deal with all aspects of projects under his/her responsibility, including experience with contracts, budgeting, and quality control.
- Excellent design and support skills for programmable controllers, operations interfaces, communication links, power meters, electrical protections, etc.
- Manage medium and high power electrical equipment installation or replacement projects and do long-term asset maintenance planning.
- Knowledge and the ability to learn quickly to become comfortable with new systems.
- Ability to work in an environment where safety and the environment are priorities.

*(continued)*

## Job Advertisement 1: Service Technician—Wind Turbine Farm

Company: Windy Technology
Location: My Town, Manitoba
Job Type: Full-Time Employee
Relevant Work Experience: 1+ to 2 years
Education Level: High school or equivalent, technical degree preferred
Salary: Salary will depend on experience

### Duties

Perform operational and maintenance work on wind turbine generators that includes preventative maintenance, troubleshooting, repairs, and modifications. Specifics related to the duties are as follows:

1. Troubleshooting and repairing turbine systems.
2. Performing maintenance on turbine equipment.
3. Collecting turbine data for research or analysis.

### Experience

- Minimum of one to two years of hydraulic, electrical, or mechanical work experience

### Skills and Abilities

- Computer and software skills for data collection and reporting.
- Driver's licence.
- Strong written and verbal English communication skills.
- Strong attention to detail and solid problem-solving skills.
- Ability to work on own and with others in a team.
- Ability to climb ladders to heights of 60 to 100 metres several times a day, and to work in confined spaces with diverse environmental conditions.
- Ability to work in a safe manner and follow applicable safety standards and procedures.
- Ability to stand and walk for prolonged periods of time, climb stairs, lift/push/carry up to 75 pounds, pull up to 200 pounds; hearing ability to use close range radios; visual acuity including depth perception, field of vision, and the ability to distinguish between colours; ability to stoop, kneel, crouch, or crawl as needed, as well as possession of hand-eye coordination and manual dexterity.

### What We Offer

As a member of our team, we offer a salary similar to our competitors and one of the most comprehensive benefits plans. Among the many amenities we offer are fully funded healthcare, dental, vision, vacation and sick time, tuition assistance, and much more. Relocation assistance is available. For further information on our company, visit our website.

*(continued)*

### Job Advertisement 2: Building Service Engineer

Company: Right Living
Location: The Big City, MB
Job Type: Full-Time Employee
Relevant Work Experience: 5+ to 7 Years
Education Level: College Diploma (see below for more information)

#### Duties

Under the supervision of the Administrator, the Building Service Engineer ensures that the facility is maintained as outlined in the Building Service Departmental Manual. Specifics related to the primary duty involve:

- Installing, inspecting, repairing, and maintaining mechanical/electrical equipment and systems throughout the facility.
- Keeping all existing equipment in operation with minimal interruption to residents and staff and must meet all safety requirements.
- Organizing and helping with the scheduled maintenance by planning the flow of work.
- Providing feedback to the management team with a variety of reports and statistics to monitor the services provided by the department

#### Experience

- Certification as a fourth class stationary engineer and/or Certificate in Building Environmental Systems or equivalent from a community college.
- Minimum five years, active and progressive, as a journeyman in mechanical/electrical maintenance field, or as a millwright, carpenter, etc.

*This position will require the following knowledge:*

- Building structure, curtain walls, roofs, parapets, floors.
- Boilers, pumps, HVAC, softeners, compressors.
- Plumbing, piping valves, traps, strainers, taps, flush valves, mixing valves.
- Welding, arc brazing, acetylene.
- Electrical, receptacles, switches, MCC, controls.
- Kitchen equipment, gas ranges, kettles.
- Communication equipment, intercoms, buzzers, call bells.
- Fire safety equipment, hoses, fire extinguishers, sprinklers, heat and smoke detectors.
- Drawing to the attention of co-workers any observed, unsafe work practices as they are noted—in that the worker
- Working with the supervisor to learn and grow, which will add to the knowledge and/or skills necessary for the job.

#### Skills/Abilities

- Ability to read and analyze specifications, blueprints, sketches, diagrams, etc.
- Ability to read, write and speak English fluently.
- Courteous and self-organized; a team player.
- Possess manual dexterity to handle tools, equipment, parts

Please forward your resumé by email to John Smith, Environmental Manager at john.smith@email.com

*(continued)*

## Job Advertisement 3: Network Services Manager—Electrical Systems

Company: Network Services Inc.
Location: Southwestern British Columbia
Job Status/Type: Full-Time Employee
Work Experience: 10+ to 15 Years
Education: College Diploma
Salary: Salary is similar to other companies and bonuses
Other: Flexible benefits as well as a generous moving allowance to relocate to British Columbia

### Duties

Duties involve providing electrical service to our client's customers and will be expected to create and maintain an exemplary standard of customer service, to create and develop opportunities for the employees, and to ensure the safe, reliable, and efficient operation of the electric system in the region. The position also includes managing all projects and programs from design/estimation through to completion by the specific area.

### Experience

- Project management experience
- 10 years experience in an electrical utility environment, with a minimum of 5 years of supervisory experience (both union and non-union employees)
- A post-secondary diploma or degree is preferred but not essential
- Trade(s) Certification would be an asset

### Skills and Abilities

- Expertise in electrical system operations, maintenance, and construction.
- Ability to develop and manage a budget.
- Ability to make good decisions and act independently.
- A leadership style that encourages staff, promotes decision making, and rewards ideas and originality.
- Cares about the interests of others and balance multiple tasks that have to be done.
- Ability to engage and motivate staff .
- Communication skills: interact with people, solves problems, and listens to others.
- Customer service dedication.

In order to be considered for this challenging and rewarding career opportunity, please submit your resumé in a *Word* document to: jane.smith@email.ca. If you have any questions or concerns before you apply for this job, please contact Jane Smith, Resource Manager, at 204-123-4567

*(continued)*

## Assignment 6: Career Planning (continued)

| Assignment 6: Career Opportunities | | | | |
|---|---|---|---|---|
| **Categories/ Questions** | **Job Advertisement (Example)** | **Job Advertisement 1** | **Job Advertisement 2** | **Job Advertisement 3** |
| Name of the Position *(1 mark)* | Senior Electrical Engineer | | | |
| Name of the Company *(1 mark)* | Smith-Smith & Associates | | | |
| Job Type *(1 mark)* | Full-Time | | | |
| Educational Requirements *(1 mark)* | Bachelor's Degree | | | |
| Work Experience Required *(1 mark)* | 10+ – 15 years | | | |

*(continued)*

| Assignment 6: Career Opportunities *(continued)* | | | | |
|---|---|---|---|---|
| **Categories/ Questions** | **Job Advertisement (Example)** | **Job Advertisement 1** | **Job Advertisement 2** | **Job Advertisement 3** |
| Duties (General) *(2 marks)* | Modernize and keep hydro-electric stations operating; manage electricity production and transmission equipment. Technical assistance for maintenance work and operations | | | |
| Specialty Skills Required *(2 marks)* | Experience with awarding contract; budgets and quality control. Bilingual (French/ English) | | | |

# Module 6 Summary

Congratulations, you have finished the sixth module in the course.

Remember

- Talk to your guidance counsellor about what is the best-tailored educational plan for you.
- Research to find out what you would like to do.
- Talk to people in the industry to see exactly what they do. Then you will know what the job entails.

## Submitting Your Assignments

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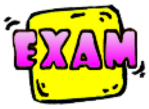


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# Grade 9 Electricity/ Electronics Technology (10G)

## Module 7: Major Project

# Module 7: Major Project

**Module Focus**

**When you finish this lesson, you will be able to**

- ❑ complete a working electronics project

## Introduction

### What Project Will You Be Building?

The project that you will be building has been chosen for you. It covers all the theory and techniques that you will need to gain knowledge and credit at this level of electronics. It has been carefully selected and rated as a beginner-level project.

For your project, you will be building an intruder alarm. It has a triggering system, master power shut-down, and an indicator letting you know someone has tripped the alarm. Later on in this module, we will study the detailed operation of the alarm.

A marking rubric for your major project is found at the end of this module, following the Module Summary.

## Assignment in Module 7

When you have completed the Module 7 assignment, submit your completed assignment, along with the Log Sheet and Module 7 Cover Sheet, to the Distance Learning Unit. The staff will forward your work to your tutor/marker.

**Remember:** Since Assignment 7 is a project, it must be mailed to the Distance Learning Unit. Keep all your material together in one mailing and do not electronically submit any material for this module.

Your intruder alarm is out of 100 marks and is worth 15% of your final mark. There are four components that will be evaluated to determine your final mark on the intruder alarm. A marking rubric for your major project is found at the end of the Module Summary.

- Confirmation: 25 marks
- Construction: 25 marks
- Soldering: 25 marks
- Function: 25 marks

Total: 100 marks

# Major Project

## Preparing to Start Your Major Project

Module 7 is the final module of this course. In this module, you will be assembling an intruder alarm on a PCB. Before starting your project, consider the following:

- Do not start your major project until your tutor/marker has provided feedback and you have received a "complete" on the Soldering Practice Project that you mailed in at the end of Module 4.

## Assembly of the Intruder Alarm on the PCB

### Inventory List

You will need to find the following items from your Project Kit.

Place a checkmark in each box once you have identified each item.

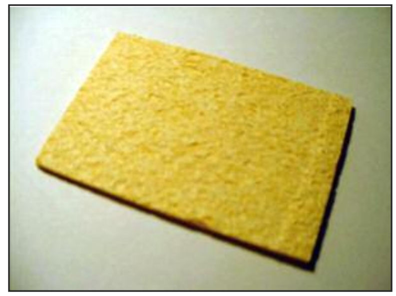
❑ safety glasses

❑ soldering iron

**Note:** Graphics may be different than the items in your kit due to a new product supplier.

If items are missing or not in working order, contact the Manitoba Text Book Bureau for replacement parts (1-866-771-6822).

❑ wet sponge
(found with soldering iron stand)



❑ solder

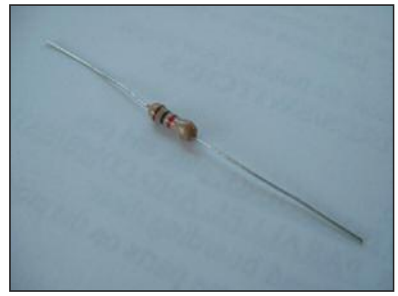
❑ burglar alarm PCB


❑ work table
(Use newspaper to protect the desk or table if it is not to be damaged.)

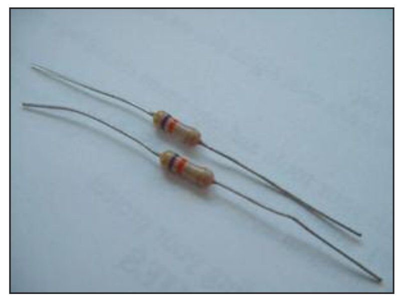
❑ soldering iron stand

- ❑ one 39 kΩ resistor

- ❑ one 1 kΩ resistor



- ❑ one 47 kΩ resistor

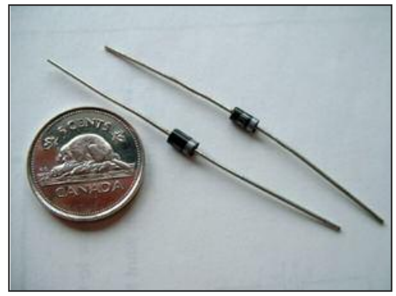


- ❑ one 3-amp fuse

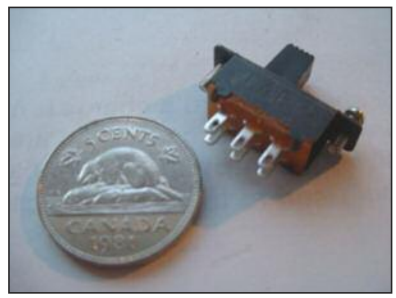
- ❑ two fuse clips
(shown with fuse clipped in)

❑ one 0.1 uF ceramic capacitor

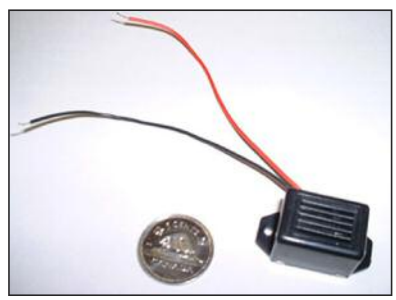
❑ two 1N4005 diodes



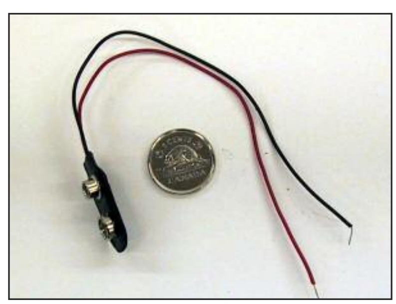
❑ one slide switch



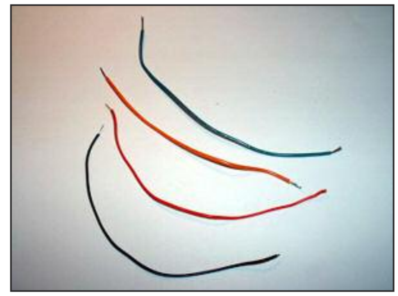
❑ one buzzer



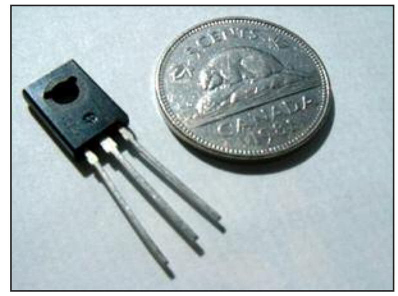
❑ one 9-volt battery snap



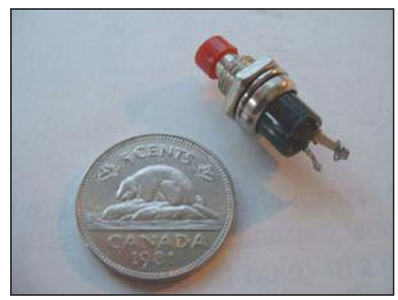
- ❑ four pieces of 22-gauge stranded wire



- ❑ one SCR (C106B)



- ❑ one pushbutton switch

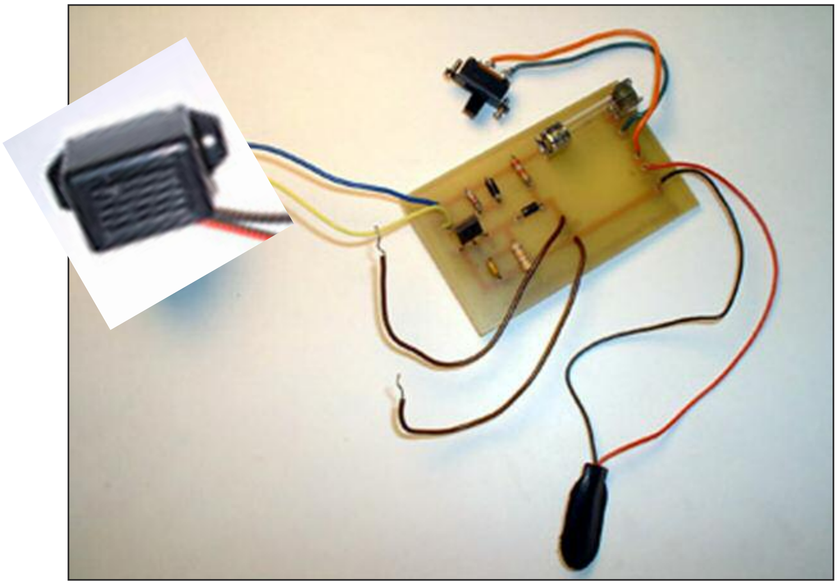


- ❑ 9-volt battery

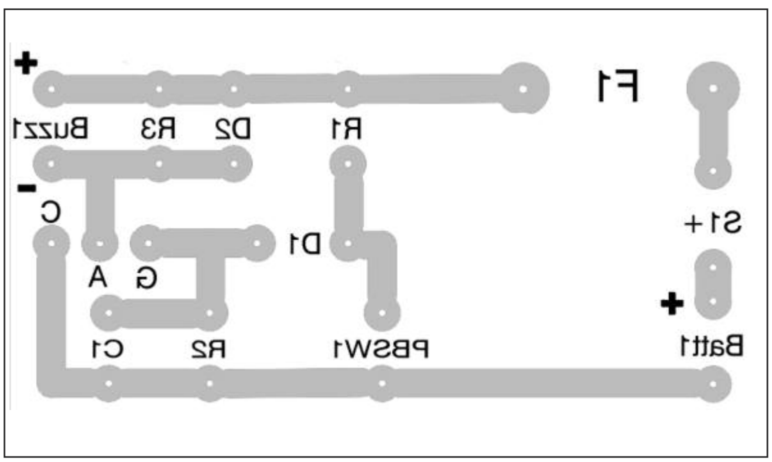

**Construction Tip**

All components will be mounted or inserted from the non-copper trace side and then soldered on the copper side. Do not solder any components into place unless instructed to do so. Bend the component legs slightly to prevent them from falling out until you are ready to solder. Follow all the steps closely. Do not skip any steps.

The two images below are of a finished intruder alarm. The one on the bottom is an x-ray view of the PCB. Pay close attention to the backwards writing. This lets you know the copper foil is on the bottom. The image below is an actual picture of the intruder alarm.



**finished project**




**x-ray**

Notice how each hole position is numbered on the top view and the x-ray view to help with the assembly procedure. Always double-check the item position before you solder it in place.

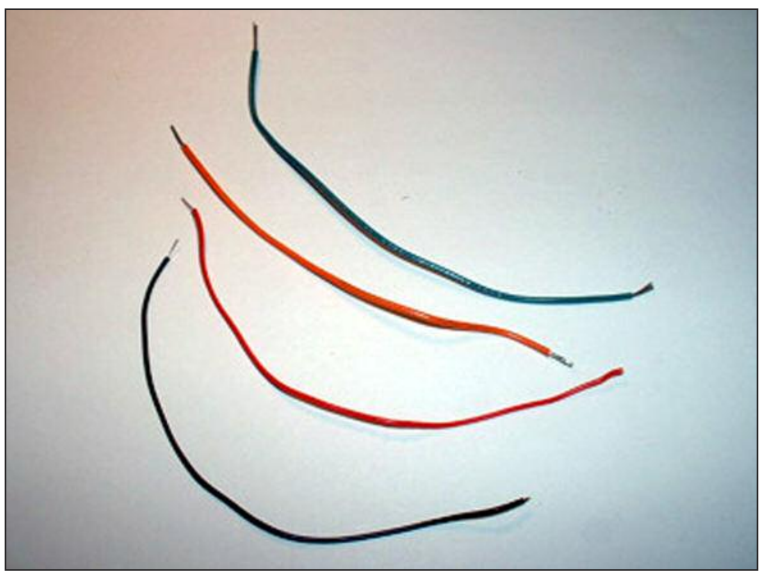
## Assembly Notes

1. For this assembly section, be sure you have tested all of your components and pieces before you solder them in place. A faulty or broken component can give you a big headache if it does not function. That is why you must have your Component Test Record sheet nearby to confirm each part has been tested and that it is ready to be soldered. If you missed a test of a component, be sure to stop and do so now!
2. Be sure to place a checkmark next to each step completed.
3. Be sure to heat sink the diodes and the SCR.
4. Many of the components have plastic parts as part of their construction. They will melt if too much heat is added!

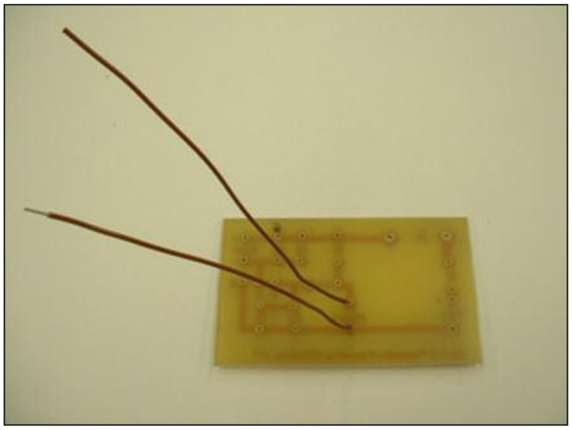
## Assembling the Alarm

Check off each step as it is completed.

❑ 1. Find all four pieces of stranded 22-gauge wire. Strip 5 mm of insulation off each end of the wire (two are done for you).

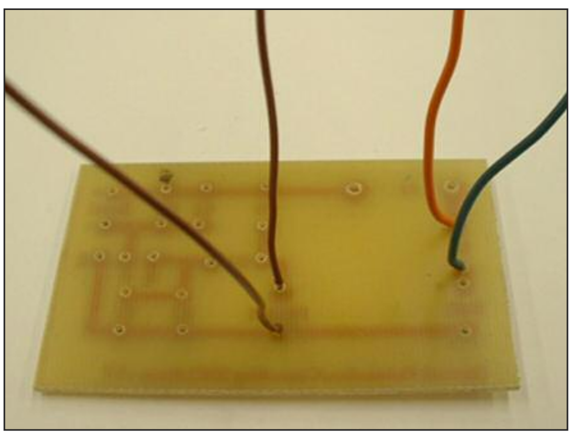


❑ 2. A. Mount the two brown stranded wires in the two holes labelled PBSW1. Solder them in place.

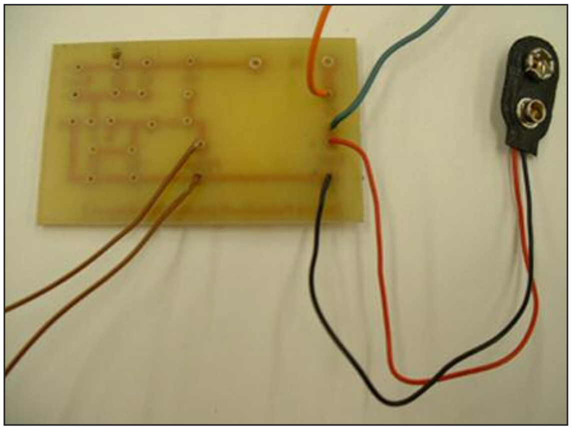



❑ 2. B. Attach black pushbutton switch to wires and solder them on.

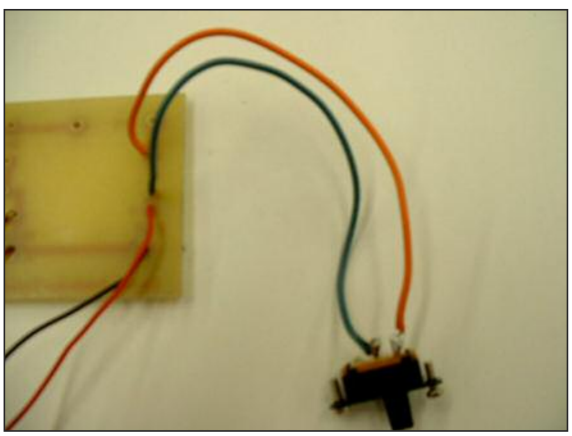
❑ 3. Insert stranded wires in the holes labelled S1. Solder them in place.

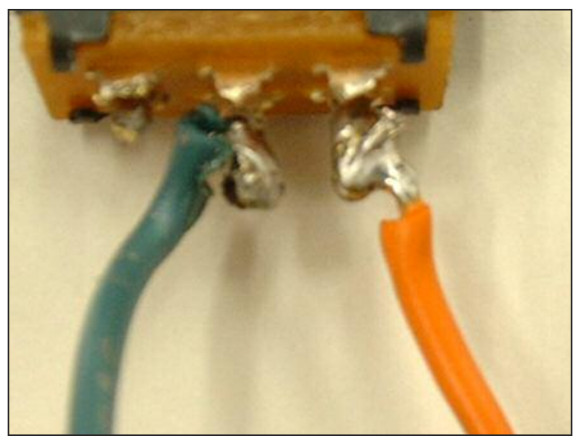


❑ 4. Obtain the battery snap. Mount the positive (red wire) in hole labelled (+) and the negative (black wire) in hole labelled (–).

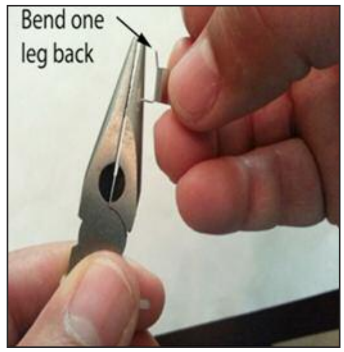


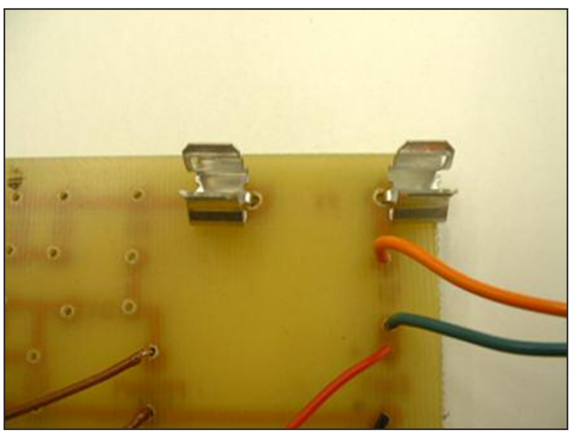

❑ 5. Obtain the slide switch. Find two wires and attach to holes labelled S1. Connect one of the two wires to the centre slide-switch contact and the other wire to one end of the slide-switch contacts. Solder them in place. Be careful not to add too much heat as this will melt the plastic contacts inside.



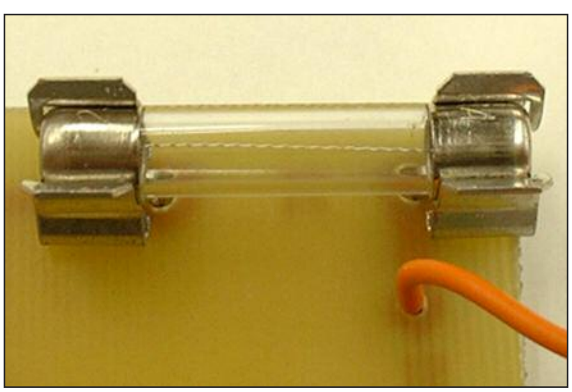


❑ 6. Find the two fuse clips. Solder them in holes marked F1. These clips are made of metal. They may need a little more heat to solder in place because of their size. In order to make the leg of the fuse holders fit into the project, you need to bend one of the legs of the fuse clip holder back to accommodate it fitting into the circuit board. Only one of the two legs will be used and fit into the hole provided on the circuit board. Gently bend it back using your needle-nose pliers.

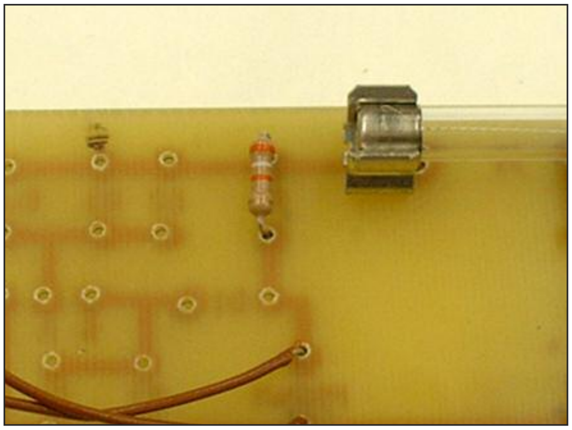



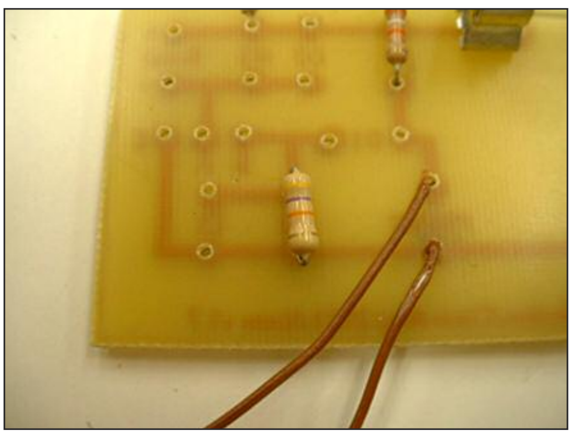

❑ 7. Find the 3-amp fuse and snap it in place. Try not to force the glass in the centre of the tube. Push down on the silver capped ends. It is much safer.

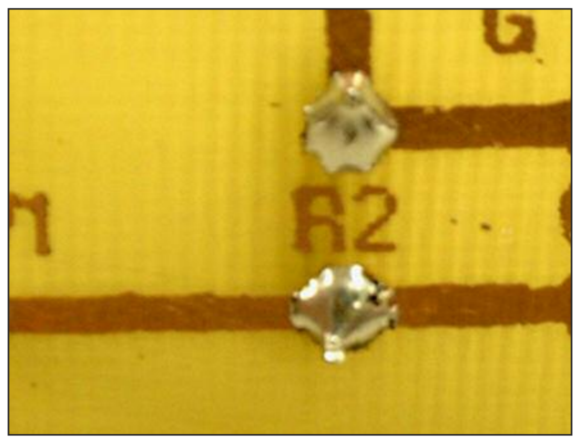


❑ 8. Mount the 39 kΩ resistor (Orange, White, Orange, Gold) in hole positions labelled R1. Solder it in place.

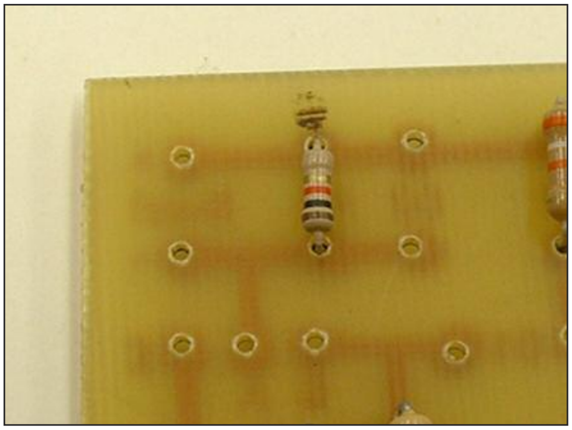



❑ 9. Mount the 47 kΩ resistor (Yellow, Violet, Orange, Gold) in the set of hole positions labelled R2. Solder them in place.

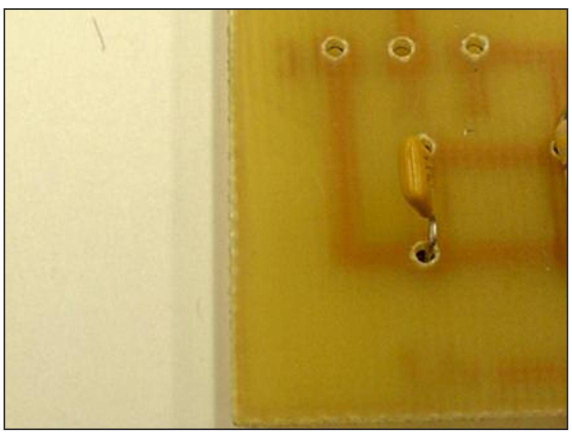


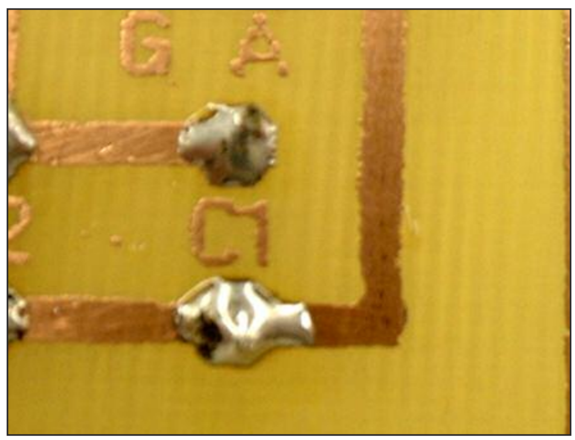


❑ 10. Mount the 1 kΩ resistor (Brown, Black, Red, Gold) in hole position labelled R3. Solder it in place.



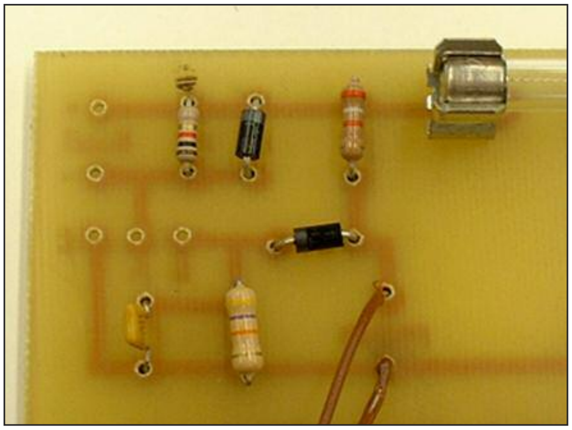

❑ 11. Obtain the one 0.1 uF ceramic capacitor. Pass it through hole position labelled C1. Solder it in place.

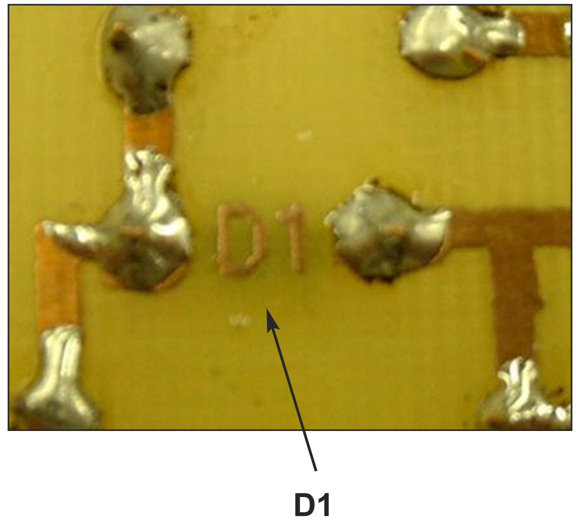


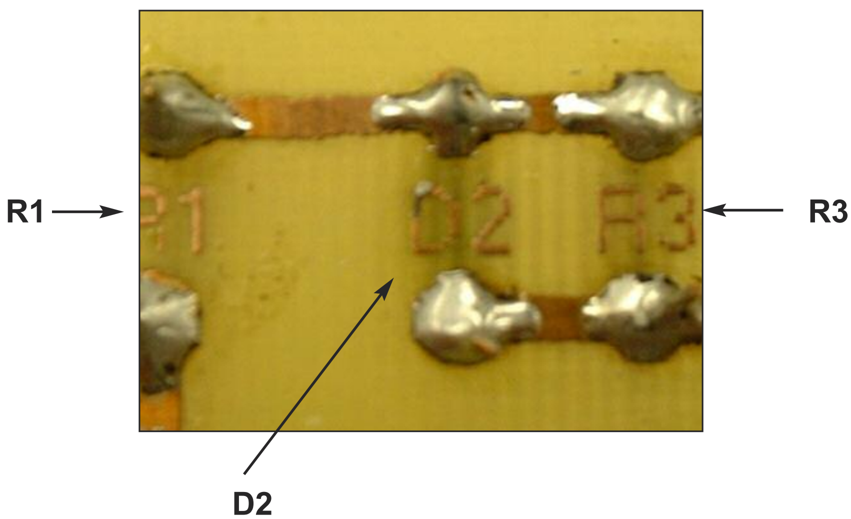



It is now time to view the Grade 9/10 Electronics video found in the learning management system (LMS) or on DVD. Watch the section on using a heat sink to protect components while soldering.

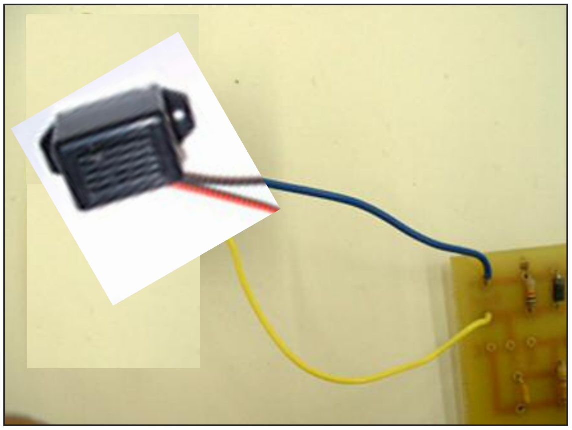
❑ 12. **You will need your home-made heat-sink tool for this step.** Obtain the two **diodes** (part number 1N4005). There are two locations for these diodes: one for each. Take one diode and place it in location labelled D1; then place the other diode in position labelled D2. Look at digital picture to check the polarity or direction of the diode. Use your home-made heat-sink tool and soldering iron to solder in each diode leg separately. Take your time and do this step properly. See picture for proper diode polarity.

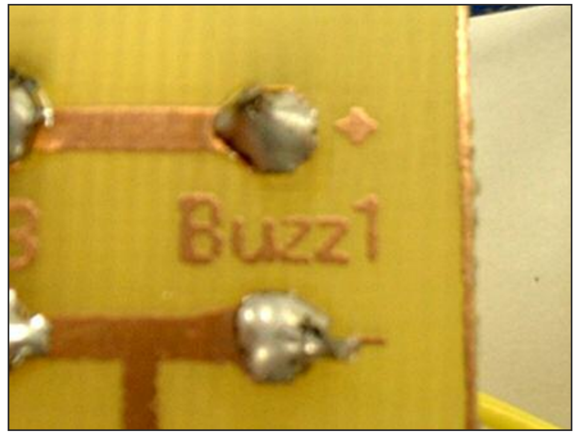




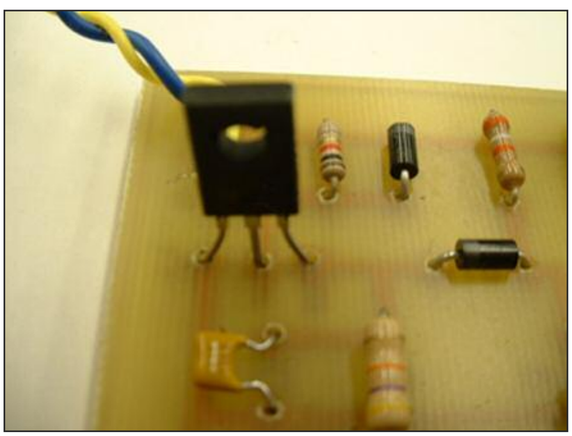



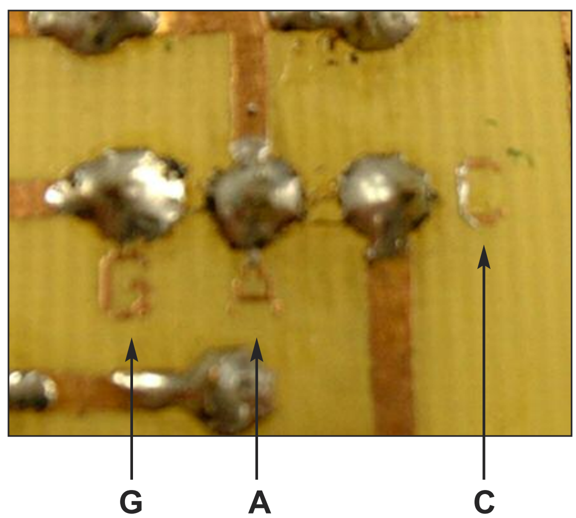
❑ 13. Find your **buzzer**. Insert the black (–) wire in the hole labelled (–) and the red (+) wire in the hole labelled (+). Solder them in place.






❑ 14. Find your **SCR (Silicon Controlled Rectifier)**, part number C106B. Have a look at the digital picture below to see how to properly insert the SCR in the PCB. Try not to bend the legs too much. They will break off if you are too rough. Place the cathode in hole labelled "C," the anode in the hole labelled "A," and the gate in the hole labelled "G." See the picture below before you solder it in.





❑ 15. Your intruder alarm is almost complete. What you need to do is triple-check the component values and locations before moving on to Step 16. Go through the list twice and check to make sure the project is assembled correctly.

**Battery Test Time**

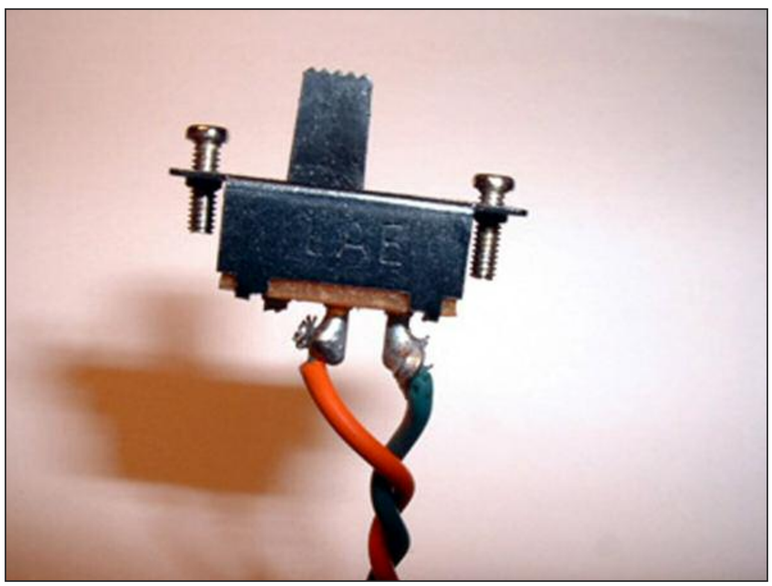
Find your DMM and place the function dial on Direct Current Volts (V⎓). Measure the voltage in the 9-volt battery. If the voltage is below 6 volts, purchase a new battery. Your project will not work well with a weak battery.

**Operating the Alarm**

Follow these steps to test your Intruder Alarm. If at any time you lose your spot or the alarm does not turn on, go back to Step 1 and repeat the procedure. **Read through the complete testing procedure before attempting the test.**

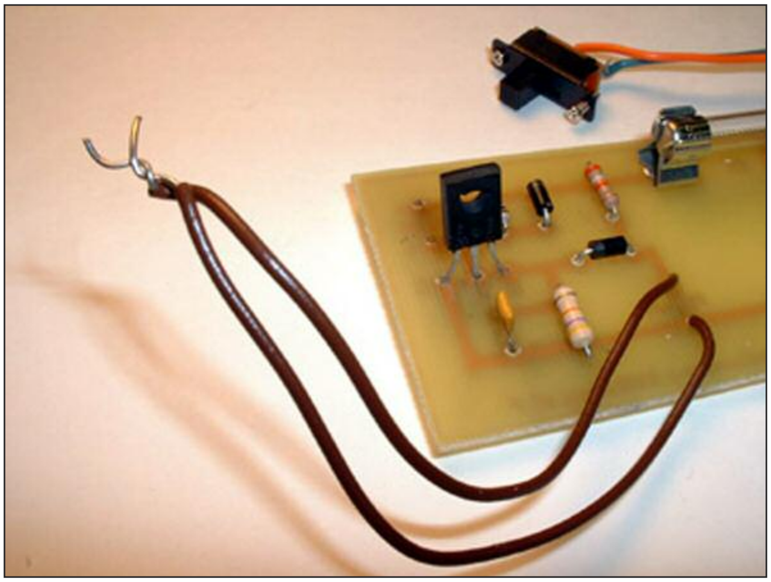
**Step 1**

Place the main power slide switch in the off position.



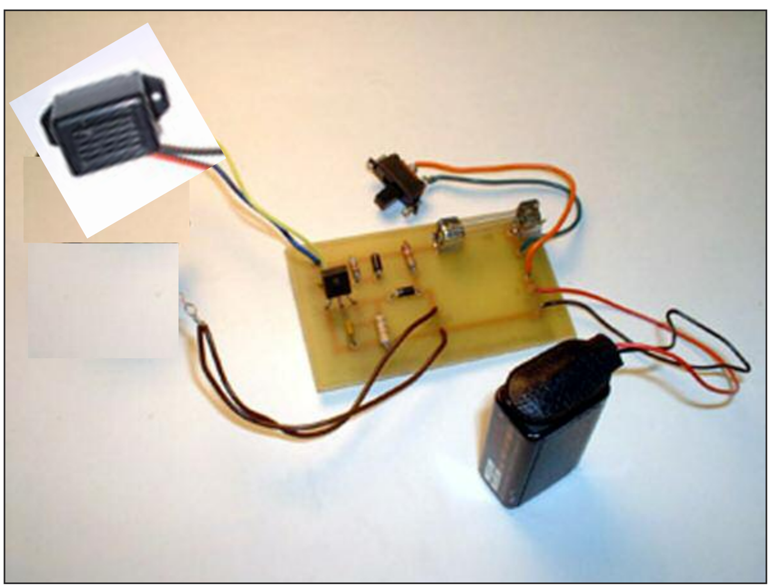
**Step 2**

Make sure the wires coming from position PBS1 are twisted tightly together. We will be using them later on in the test.



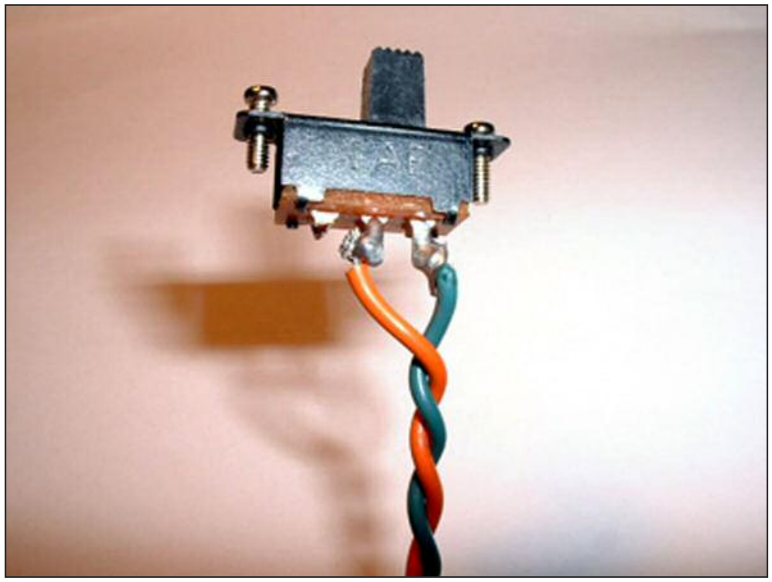
**Step 3**

Connect the 9-volt battery to the battery snap.



**Step 4**

Slide the power switch to the ON position. Nothing should happen at this step. Your alarm is now "armed" and ready to be triggered on.



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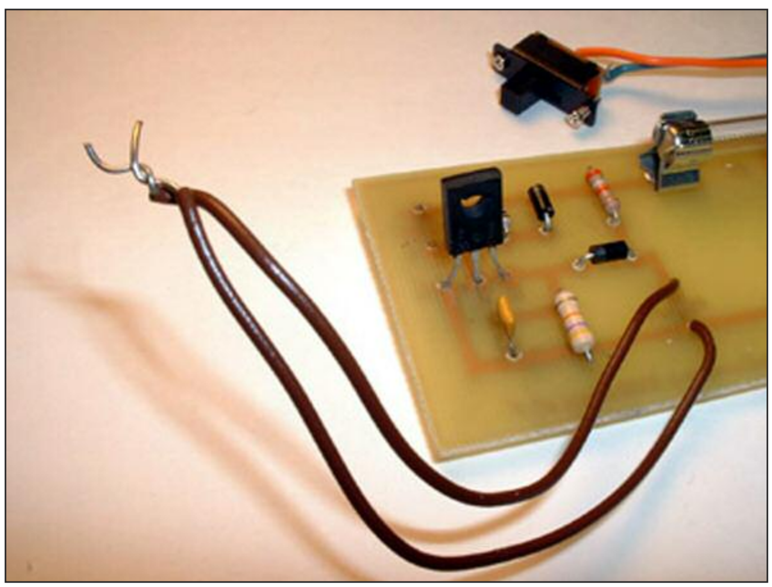
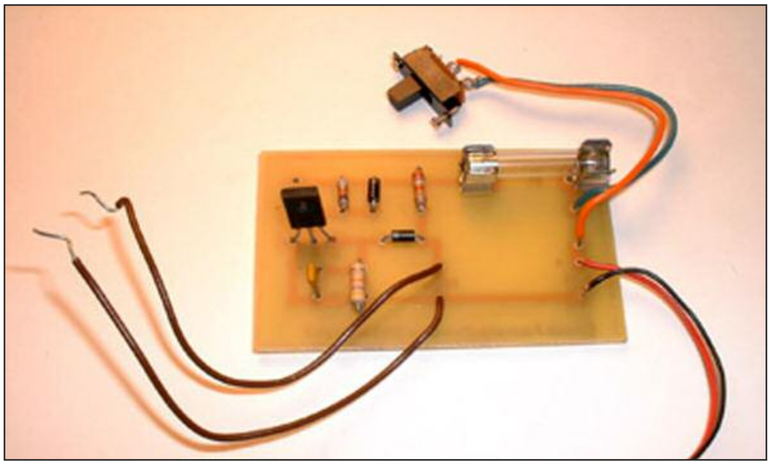
**Step 5**

This is the way to trigger your alarm. Find the two brown wires coming from positions PBSW1. They should still be twisted together.



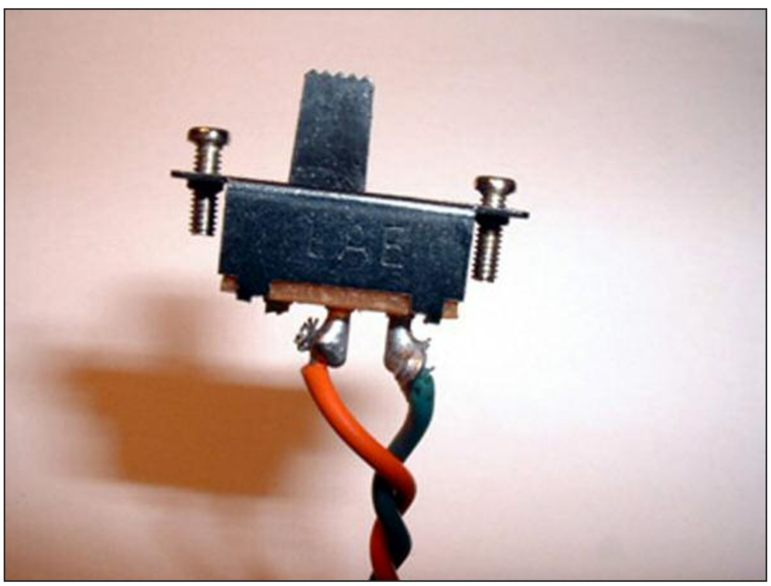
**Step 6**

Separate the two brown twisted wires from positions PBSW1. The alarm should now be sounding.



**Step 7**

To turn the alarm off, slide the main power switch to the **off** position.



**Step 8**

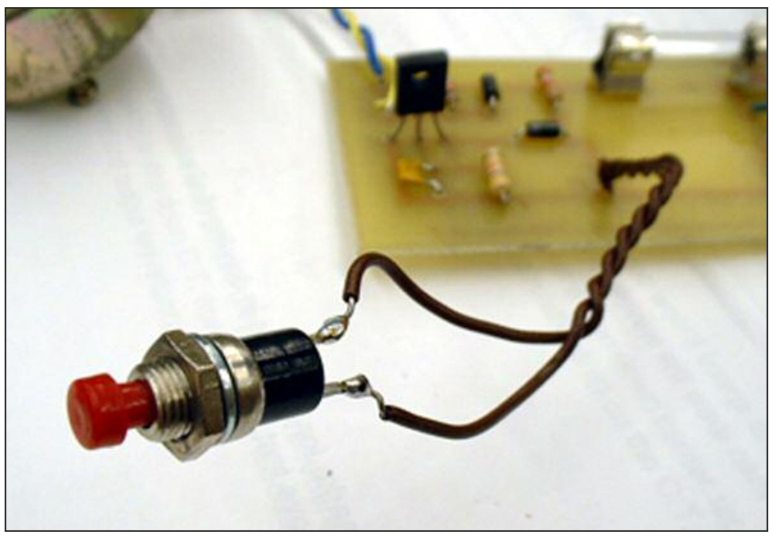
If your alarm still does not work, refer to the troubleshooting procedure below.

**Step 9**

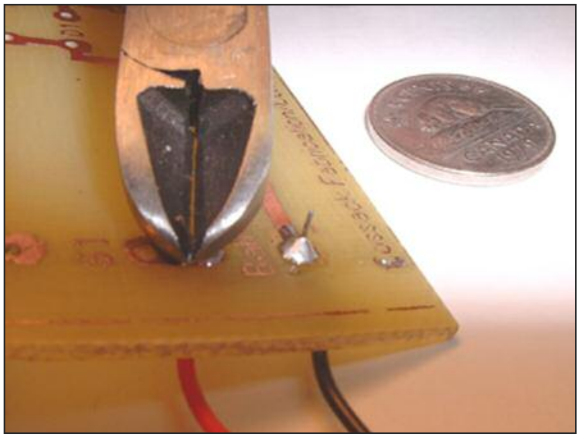
If your alarm sounds and is working well, find the pushbutton switch and solder it to the ends of the two brown wires. Once you have soldered it on, slide the main power switch to "ON," push the button, and see what happens.

One switch arms the alarms, the second switch activates it. The second switch could be replaced with another input to sense disturbance. Some possible detector inputs would include heat sensor, motion sensor, light sensor, sound sensor, or various movement sensitive switches.

The buzzer is the output and could be replaced with other outputs. They might include light, sound, or movement. There could also be remote outputs.

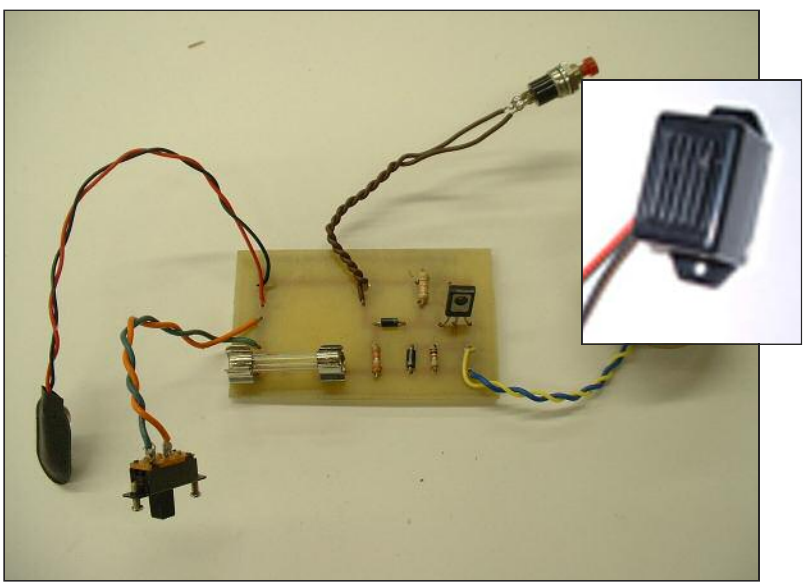


❑ 16. Find your **diagonal pliers** and snip off all the excess component leads.



❑ 17. This completes the assembly of the intruder alarm.
Remember: Do not include the 9-volt battery when you send in your project to the Distance Learning Unit.

## Finished Project



## Troubleshooting: The Intruder Alarm

**Step 1**

Is your battery good? Did you test it?


**Step 2**

Make sure your main power slide switch works and moves freely to the "ON" position.

**Step 3**

Recheck the component locations and values. Are all polarized components installed in the proper orientation or direction?

**Step 4**

Recheck your solder connections. Are they smooth, shiny, and covering the complete copper trace and component leg?

**Step 5**

Check for short circuits between connections.

**Step 6**

Be sure to check that no copper traces are broken or missing.

**Step 7**

Refer back to the Component Test Record to see if the calculated values match your measured values.

**Step 8**

If all else fails, go back to the Assembly Notes section and walk through the **full** procedure again.

It is time to hand in your final Intruder Alarm Project. Your tutor/marker needs to see your final project up close. Carefully package up your **WORKING** final project and send it in for evaluation. **Do not** send the 9-volt battery with your project. Without the completed final project, your tutor/marker will be unable to give you credit for the course. **Remember, your project is worth 15% of your final grade.**

## Final Examination

Congratulations, you have finished Module 7 in the course. The final examination is out of 100 marks and worth 15% of your final mark. In order to do well on this examination, you should review all of your learning activities and assignments from Modules 1 to 7.

You will complete this examination while being supervised by a proctor. You should already have made arrangements to have the examination sent to the proctor from the Distance Learning Unit. If you have not yet made arrangements to write it, then do so now. The instructions for doing so are provided in the Introduction to this module.

A maximum of 2 hours is available to complete your final examination. When you have completed it, the proctor will then forward it for assessment. Good luck!

# Final Examination Review

## Exam Format

The final examination consists of five types of questions, the values of which combine to a total of 100 marks.

### True or False (15 marks)

In this section of the examination, you will decide whether each statement is true or false, and you will indicate your choice by printing either "T" or "F" in the space provided for each statement.

### Fill-in-the-Blank (40 marks)

Fill in the blanks with the best possible answer. Each blank is worth a maximum of 2 marks each for a total of 40 marks. The best answer will be given 2 marks. Answers which are only partially correct will be given 1 mark.

### Multiple Choice (15 marks)

In the multiple choice section of the examination, you will choose the single best answer to each of the questions given.

### Long Answer (30 marks)

You will be asked to answer each question clearly and thoroughly in the space provided.

## Study Strategies

In preparing for this examination, review all learning activities and assignments that you completed in the course.

Reviewing the power words is also an excellent way to review concepts. You could practise defining those terms, perhaps by using index cards—using one side for each term and the other side for its definition.

## Summary

Good luck as you prepare for the final examination. If you have completed all of the learning activities and assignments and have studied using the suggestions above, you have prepared yourself well. The examination will be an opportunity for you to show what you know.

# MODULE 7 SUMMARY

Congratulations, you have finished the major project. Completion of the final examination is the last requirement for this course. Good luck!

## Submitting Your Assignments

It is now time for you to submit your work from Module 7 to the Distance Learning Unit so that you can receive some feedback on how you are doing in this course. Remember that you must submit all the assignments in this course before you can receive your credit.

**Remember:** Since this assignment is a project, it must be mailed to the Distance Learning Unit. Keep all your material together in the one mailing and do not electronically submit any material for this module.

Make sure you have completed all parts of your Module 7 assignment and organize your material in the following order:

- Module 7 Cover Sheet
- Module 7 Log Sheet
- Major Project: Intruder Alarm

For instructions on submitting your assignments, refer to How to Submit Assignments in the course Introduction.

# NOTES

## Major Project: Intruder Alarm *(100 marks)*
## Marking Rubric

In Assignment 3.1, you tested all the Project Kit components required for this project. The assembly of parts and completion of this working intruder alarm are based on the following criteria:

Confirmation: *25 marks*
Construction: *25 marks*
Soldering: *25 marks*
Function: *25 marks*

This project is designed to be the work of one person and group submissions will not be accepted.

**Confirmation: __________ / 25 marks**

| **(20–25 marks)** | **(11–19 marks)** | **(less than 10 marks)** |
|---|---|---|
| All or most of the components have the following characteristics:<br>❑ They are properly placed.<br>❑ They are nestled close to the board within 1 mm.<br>❑ The legs are spread out.<br>❑ The legs are trimmed after soldering.<br>**Tutor/marker comments:** | Some of the components have the following characteristics:<br>❑ They are properly placed.<br>❑ They are nestled close to the board within 1 mm.<br>❑ The legs are spread out.<br>❑ The legs are trimmed after soldering.<br>**Tutor/marker comments:** | Few of the components have the following characteristics:<br>❑ They are properly placed.<br>❑ They are nestled close to the board within 1 mm.<br>❑ The legs are spread out.<br>❑ The legs are trimmed after soldering.<br>**Tutor/marker comments:** |

## Major Project: Intruder Alarm (continued)
## Marking Rubric

**Construction: _________ / 25 marks**

| (20–25 marks) | (11–19 marks) | (less than 10 marks) |
|---|---|---|
| All or most of the following have the identified characteristics:<br>❑ The length of wire is correct.<br>❑ The amount of insulation stripped off the wires is correct.<br>❑ There are no avoidable projections.<br>❑ The parts are aligned.<br>❑ The project is smooth.<br>❑ The wires and traces are not broken.<br>**Tutor/marker comments:** | Some of the following have the identified characteristics:<br>❑ The length of wire is correct.<br>❑ The amount of insulation stripped off the wires is correct.<br>❑ There are no avoidable projections.<br>❑ The parts are aligned.<br>❑ The project is smooth.<br>❑ The wires and traces are not broken.<br>**Tutor/marker comments:** | Few of the following have the identified characteristics:<br>❑ The length of wire is correct.<br>❑ The amount of insulation stripped off the wires is correct.<br>❑ There are no avoidable projections.<br>❑ The parts are aligned.<br>❑ The project is smooth.<br>❑ The wires and traces are not broken.<br>**Tutor/marker comments:** |

## Major Project: Intruder Alarm (continued)
## Marking Rubric

| Soldering: _________ / 25 marks | | |
|---|---|---|
| **(20–25 marks)** | **(11–19 marks)** | **(less than 10 marks)** |
| All or most of the joins have the following characteristics:<br>❑ They are large enough to cover the foil pad.<br>❑ They are small and stay clear of pathways.<br>❑ They are smooth and shiny.<br>❑ They are in full contact between the solder and leg of each component on all sides of the leg.<br>❑ They are not burnt or have no spatter marks on the project.<br>**Tutor/marker comments:** | Some of the joins have the following characteristics:<br>❑ They are large enough to cover the foil pad.<br>❑ They are small and stay clear of pathways.<br>❑ They are smooth and shiny.<br>❑ They are in full contact between the solder and leg of each component on all sides of the leg.<br>❑ They are not burnt or have no spatter marks on the project.<br>**Tutor/marker comments:** | Few of the joins have the following characteristics:<br>❑ They are large enough to cover the foil pad.<br>❑ They are small and stay clear of pathways.<br>❑ They are smooth and shiny.<br>❑ They are in full contact between the solder and leg of each component on all sides of the leg.<br>❑ They are not burnt or have no spatter marks on the project.<br>**Tutor/marker comments:** |

## Major Project: Intruder Alarm (continued)
## Marking Rubric

**Function: _________ / 25 marks**

| (20–25 marks) | (11–19 marks) | (less than 10 marks) |
|---|---|---|
| All or most of the following project functions have the following characteristics:<br>❏ It does not function before the project is armed.<br>❏ It does not function after arming and before input.<br>❏ It has immediate and continuous output after arming and input.<br>❏ The output does not stop by manipulation of the input button.<br>❏ The output can only be stopped by switching off the arming slide switch.<br>**Tutor/marker comments:** | Some of the following project functions have the following characteristics:<br>❏ It does not function before the project is armed.<br>❏ It does not function after arming and before input.<br>❏ It has immediate and continuous output after arming and input.<br>❏ The output does not stop by manipulation of the input button.<br>❏ The output can only be stopped by switching off the arming slide switch.<br>**Tutor/marker comments:** | Few of the following project functions have the following characteristics:<br>❏ It does not function before the project is armed.<br>❏ It does not function after arming and before input.<br>❏ It has immediate and continuous output after arming and input.<br>❏ The output does not stop by manipulation of the input button.<br>❏ The output can only be stopped by switching off the arming slide switch.<br>**Tutor/marker comments:** |

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## NOTES

## Major Project: Intruder Alarm *(100 marks)*
## Marking Rubric

In Assignment 3.1, you tested all the Project Kit components required for this project. The assembly of parts and completion of this working intruder alarm are based on the following criteria:

Confirmation: *25 marks*
Construction: *25 marks*
Soldering: *25 marks*
Function: *25 marks*

This project is designed to be the work of one person and group submissions will not be accepted.

**Confirmation: _________ / 25 marks**

| **(20–25 marks)** | **(11–19 marks)** | **(less than 10 marks)** |
|---|---|---|
| All or most of the components have the following characteristics:<br>❑ They are properly placed.<br>❑ They are nestled close to the board within 1 mm.<br>❑ The legs are spread out.<br>❑ The legs are trimmed after soldering.<br><br>**Tutor/marker comments:** | Some of the components have the following characteristics:<br>❑ They are properly placed.<br>❑ They are nestled close to the board within 1 mm.<br>❑ The legs are spread out.<br>❑ The legs are trimmed after soldering.<br><br>**Tutor/marker comments:** | Few of the components have the following characteristics:<br>❑ They are properly placed.<br>❑ They are nestled close to the board within 1 mm.<br>❑ The legs are spread out.<br>❑ The legs are trimmed after soldering.<br><br>**Tutor/marker comments:** |

## Major Project: Intruder Alarm (continued)
## Marking Rubric

| Construction: _________ / 25 marks | | |
|---|---|---|
| **(20–25 marks)** | **(11–19 marks)** | **(less than 10 marks)** |
| All or most of the following have the identified characteristics:<br>❑ The length of wire is correct.<br>❑ The amount of insulation stripped off the wires is correct.<br>❑ There are no avoidable projections.<br>❑ The parts are aligned.<br>❑ The project is smooth.<br>❑ The wires and traces are not broken.<br>**Tutor/marker comments:** | Some of the following have the identified characteristics:<br>❑ The length of wire is correct.<br>❑ The amount of insulation stripped off the wires is correct.<br>❑ There are no avoidable projections.<br>❑ The parts are aligned.<br>❑ The project is smooth.<br>❑ The wires and traces are not broken.<br>**Tutor/marker comments:** | Few of the following have the identified characteristics:<br>❑ The length of wire is correct.<br>❑ The amount of insulation stripped off the wires is correct.<br>❑ There are no avoidable projections.<br>❑ The parts are aligned.<br>❑ The project is smooth.<br>❑ The wires and traces are not broken.<br>**Tutor/marker comments:** |

## Major Project: Intruder Alarm (continued) Marking Rubric

**Soldering: _________ / 25 marks**

| (20–25 marks) | (11–19 marks) | (less than 10 marks) |
|---|---|---|
| All or most of the joins have the following characteristics:<br>❑ They are large enough to cover the foil pad.<br>❑ They are small and stay clear of pathways.<br>❑ They are smooth and shiny.<br>❑ They are in full contact between the solder and leg of each component on all sides of the leg.<br>❑ They are not burnt or have no spatter marks on the project.<br>**Tutor/marker comments:** | Some of the joins have the following characteristics:<br>❑ They are large enough to cover the foil pad.<br>❑ They are small and stay clear of pathways.<br>❑ They are smooth and shiny.<br>❑ They are in full contact between the solder and leg of each component on all sides of the leg.<br>❑ They are not burnt or have no spatter marks on the project.<br>**Tutor/marker comments:** | Few of the joins have the following characteristics:<br>❑ They are large enough to cover the foil pad.<br>❑ They are small and stay clear of pathways.<br>❑ They are smooth and shiny.<br>❑ They are in full contact between the solder and leg of each component on all sides of the leg.<br>❑ They are not burnt or have no spatter marks on the project.<br>**Tutor/marker comments:** |

## Major Project: Intruder Alarm (continued)
## Marking Rubric

**Function: _________ / 25 marks**

| (20–25 marks) | (11–19 marks) | (less than 10 marks) |
|---|---|---|
| All or most of the following project functions have the following characteristics:<br>❑ It does not function before the project is armed.<br>❑ It does not function after arming and before input.<br>❑ It has immediate and continuous output after arming and input.<br>❑ The output does not stop by manipulation of the input button.<br>❑ The output can only be stopped by switching off the arming slide switch.<br>**Tutor/marker comments:** | Some of the following project functions have the following characteristics:<br>❑ It does not function before the project is armed.<br>❑ It does not function after arming and before input.<br>❑ It has immediate and continuous output after arming and input.<br>❑ The output does not stop by manipulation of the input button.<br>❑ The output can only be stopped by switching off the arming slide switch.<br>**Tutor/marker comments:** | Few of the following project functions have the following characteristics:<br>❑ It does not function before the project is armed.<br>❑ It does not function after arming and before input.<br>❑ It has immediate and continuous output after arming and input.<br>❑ The output does not stop by manipulation of the input button.<br>❑ The output can only be stopped by switching off the arming slide switch.<br>**Tutor/marker comments:** |

# Grade 9 Electricity/ Electronics Technology (10G)

## Glossary

# Glossary

**ampere**
The number of electrons to pass a given point in a given amount of time (the rate of flow)—the measurement is referred to as "amps" and was named after Andre Marie Ampere

**amplifier**
An electrical device used to increase the volume or sound

**amplify**
To boost or increase the current or voltage level in a circuit

**anode**
A positive electrode or lead

**armature**
The rotating coils of a conductor in an alternator—electrical current is induced as the armature passes through a magnetic field

**artificial resuscitation**
The act of helping another to breathe and to keep their blood circulating while they are unconscious

**assembly technician**
An individual who would physically build or assemble electronic items

**atom**
The smallest particle of an element that can exist either alone or in combination

**automatic pilot**
A device used to maintain consistent flight control without the use of a pilot

**cascade**
A waterfall or something that acts like a waterfall—outputs that become inputs are said to "cascade" or rush through a series of operations

**cathode**
A negative electrode or lead

**CD player**
An electrical device that uses a laser beam to scan digitally encoded audio, video, or text material from a disk and transmit the material to a playback system

**charge**
An accumulation of impelling force; an excess or lack of electrons in a place

**circuit**
A path that a source of electrical energy travels

**cladding**
Material made of copper and bonded to fibreglass material—used to make printed copper traces

**cold solder joint**
A connection that is poorly made during the soldering process—will cause electrical devices to fail

**combination circuit**
A circuit that includes parts or components that are connected in both a series and a parallel configuration

**communicate**
To move information from one place or person to another

**compound**
A molecule made of more than one type of atom

**conductor**
A material or element that allows electrons to flow through it easily from one point to another

**contacts**
The location where the physical connection occurs inside a switch

**control**
To direct or to have influence over

**design technician**
An individual who would design or create electronic and electrical devices or circuits

**dielectric**
The insulating material inside a capacitor that separates the two metal plates

**diode**
An electronic component that allows current to flow in just one direction

**dissipate**
The removal of an electric charge from a battery, capacitor, or any other electronic storage device

**doped**
The process of adding arsenic or gallium to a semi-conductive material such as silicon or germanium to make it more of a conductor or insulator

**draftsperson**
An individual who would draw up the technical drawings used in the construction of a project

**electrical charge**
The property of basic partials that causes them to execute a force upon one another—it can be negative like an electron or positive like a proton and, subsequently, they either repel or attract each other

**electricity**
The flow of free electrons through a conductor

**electromotive force or EMF**
The pressure or force that causes current flow in a circuit

**electron**
A tiny negatively charged particle that vibrates or orbits quickly around the nucleus of an atom

**electronic**
Having to do with electricity—in a small quantity, for special purposes, or in semiconductors

**electronic components**
Parts and pieces used in the construction of electronic projects and circuits

**electronics engineer**
An individual who aids in the design, approval, and construction of electronic projects and ideas

**electrostatic force field**
The area of attraction or repulsion that surrounds electrons and protons

**element**
One of over 100 types of matter that has its own unique physical, electrical, and chemical properties

**energy**
The ability to act or to cause activity

**epoxy**
A two-part material that is mixed to form a solid bonding agent

**etchant**
The liquid material used to remove unwanted copper—ferric chloride and ammonium persulfate are two common chemicals used in this process

**etching**
The process of removing unwanted copper with a chemical reaction

**ferrous metals**
Any metal that contains irons or is derived from iron

**fibreglass**
A trade name used to describe material made of glass fibres and resins

**filament**
A metallic wire or ribbon used to produce heat by means of an electron flow—found inside light bulbs

**foil pattern**
The pattern of copper conductors on a printed circuit board

**fossil fuels**
A fuel formed in the earth from plant and animal remains

**free electrons**
Electrons that have been forced out of their orbits, and are therefore readily affected by electric or magnetic fields

**gate**
An electronic switch that prevents or allows the flow of current in a circuit

**generate**
To produce electricity

**grounding**
The process of intentionally attaching part of a circuit to a grounding plate or rod—protects the circuit or individual from an electrical shock

**heat sink**
Any metal clamp or device attached to a component that protects the component from excessive heat—also used while soldering to absorb part of the heat from the soldering iron when melting the solder

**humidity**
Refers to a moderate degree of wetness or dampness in the atmosphere

**infrared emitting diode**
An electronic component used to transmit or receive an electrical signal

**inputs**
Information fed into a data processor

**insulator**
A material or element that does not allow electrons (or very few) to flow through it easily from one point to another

**laminate**
The process of layering two materials together

**leads**
Wires connected to the two metal plates inside a capacitor

**liquid crystal display (LCD)**
A display that uses liquid crystals such as a seven segment numerical display in digital watches or calculators

**load**
An electronic or electrical device or component that makes use of part of the energy of electrons that are forced through it

**machinist**
An individual who uses specialty tools and/or equipment to form material into specific shapes and sizes

**matter**
That which all physical things are composed of, it occupies space and has mass

**molecule**
Smallest unit of matter which can exist by itself and retain all its chemical properties (a group of atoms held together by chemical forces)

**neon bulb**
An electronic component that uses low pressure and electricity to light the gas in a tube

**nuclear power**
Energy from nuclear fission or fusion

**neutral charge**
Having no positive or negative charge

**neutron**
A particle found in the nucleus of an atom that has about the same mass as a proton but lacks an electric charge

**nichrome wire**
Wire made from nickel and chromium—when electricity passes through the wire it gets hot fast and turns a red or orange colour (e.g., nichrome wire is found in toasters)

**nucleus**
The centre of an atom

**ohms**
The measurement of the electrical resistance to the flow of electrons, named after George Simon Ohm

**output**
Information produced by data processing

**overload**
A load on a circuit that exceeds the amount for which the circuit was designed (i.e., too much power)—may cause electric shock or fire

**parallel circuit**
A circuit with more than one path for current to flow

**piezoelectricity**
Electricity created by pressure applied to a crystal

**plates**
The two metal pieces inside a capacitor that store the electrical energy

**polarized**
The term used to indicate when an electronic device has positive and negative poles

**power**
The rate at which work is done

**printed circuit board**
An insulating board with a fibreglass backing that has conductive printed copper traces of copper lines and copper lands on which small components are later mounted

**proton**
A positively charged particle found in the nucleus of an atom

**pushbutton switch**
An electronic component that connects a circuit when a button is pushed

**radar**
A device that uses high frequency microwaves to determine the speed and/or location of an object

**relay**
An electromechanically driven device used to control current flow in a separate circuit

**repair technician**
An individual who services or repairs electronic/electrical devices

**resistance**
Opposition to the flow of electrons within a given circuit

**schematic**
A circuit diagram with symbols that represent actual electronic components

**schematic diagram**
A drawing of a circuit that shows connected components using international standardized symbols

**semi-conductor**
An element that can act as a conductor or an insulator (silicon and germanium are two excellent examples of semi-conductive material)

**series circuit**
A circuit in which the components or contact symbols are connected end to end; it must be closed to allow the current to flow

**short circuit**
An undesirable path of very low resistance in a circuit connecting two points

**silicon controlled rectifier (SCR)**
A semiconductor device used to turn circuits on and off—in some situations they have replaced mechanical relays

**simple machine**
The simplest parts of a complex machine– for example, lever, wedges, and wheel and axle.

**sine wave**
A periodic oscillation that goes from positive high to negative high and back again (alternating current)

**slide switch**
An electronic component that connects a circuit when a small sliding lever is moved

**soldering gun**
A high temperature soldering device used to melt solder to join larger connections

**sonar**
A device that uses high frequency sound waves to locate items—a sound wave bounces back from the object and the device registers the vibrations reflected from the object

**static electricity**
An electrical charge that is usually caused by friction—the charge builds up on the surface of an object

**switch**
An electronic component that connects a circuit when either a small lever is moved or a button is pushed

**technical designer**
An individual who designs circuits and electrical plans for a project

**thermocouple**
The junction of two dissimilar metals—electromotive force is generated if the two ends of the thermocouple are at two different temperatures

**tolerance**
The limiting values within which a device such as a resistor is expected to function

**torque**
The act of twisting or turning

**transform**
To change—in electricity, to use a transformer to change the voltage

**transmit**
To send out a signal, current, or wave

**transport**
To move from one place to another

**troubleshoot**
The process of inspection to find the problem with a faulty electronic item

**video cassette recorder (VCR)**
An electrical device used to record a program that can then be played back at a later time using a television

**voltage**
The amount of pressure applied to a given circuit—usually referred to as "volts"

**water power**
Using the force of moving water to do work

**watt**
The SI unit of power equal to 1 joule per second—letter symbol "W"

**wind power**
Using the force of the moving air to do work

**work**
Transference of energy—in electricity, the energy necessary to free an electron from a metal atom

**working voltage direct current (VDC)**
The voltage at which an electrical or electronic device would normally operate

# Grade 9 and 10 Electricity Electronics Technology Tracks 1-8

https://youtu.be/2dB4Yjs-KX4?list=PLw1g3n2IMV7OwnOdX82gzLjpsoc8cdwH4

https://youtu.be/2dB4Yjs-KX4
https://youtu.be/H1xI4QK9Ipo
https://youtu.be/gZL-38Nm_Ys
https://youtu.be/bw0EtnCUMgI
https://youtu.be/Ik5UEOk2rWo
https://youtu.be/AuoQqxLDaoM
https://youtu.be/ogAmNnr8FXk
https://youtu.be/JdPogk9IAc4

## Grade 9 Electricity/Electronics (10G) - Course Code 7974 10G 002

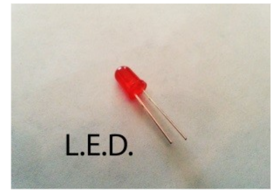
- Please note the options available when purchasing the Kit to use in this course.

| MTTB #9993 Electricity Kit | MTTB #3308 Electricity Kit without Tool Kit |
|---|---|
| **Tool Kit:** | **Project Kit:** |
| **1 multimeter** | 1 circuit board |
| **1 wire stripper** | 1 spool of solder |
| **needle-nose pliers** | 1 buzzer |
| **1 diagonal cutter** | 1 battery snap |
| **1 soldering iron** | 2 pieces stranded wire |
| **1 soldering iron stand w/cleaning sponge** | 2 pieces solid wire |
| **safety glasses** | 1 slide switch |
| **Project Kit:** | 1 SCR |
| 1 circuit board | 2 diodes |
| 1 spool of solder | 1 capacitor |
| 1 buzzer | 1 fuse |
| 1 battery snap | 2 fuse clips |
| 2 pieces stranded wire | 1 pushbutton switch (Normally Closed) |
| 2 pieces solid wire | 3 resistors |
| 1 slide switch | **Experiment Kit:** |
| 1 SCR | 1 solderless circuit board |
| 2 diodes | 1 resistor |
| 1 capacitor | 1 light emitting diode |
| 1 fuse | 1 neon bulb |
| 2 fuse clips | 1 piece solid wire |
| 1 pushbutton switch (Normally Closed) | one 9-volt battery snap |
| 3 resistors | 1 silicon diode |
| **Experiment Kit:** | one 470 uF electrolytic capacitor |
| 1 solderless circuit board | **Practice Soldering Kit:** |
| 1 resistor | 1 spool of solder |
| 1 light emitting diode | 3 miscellaneous components |
| 1 neon bulb | 1 piece of printed circuit board |
| 1 piece solid wire | |
| one 9-volt battery snap | |
| 1 silicon diode | **MTTB # 3307** |
| one 470 uF electrolytic capacitor | 1 circuit board |
| **Practice Soldering Kit:** | |
| 1 spool of solder | |
| 3 miscellaneous components | |
| 1 piece of printed circuit board | |

# What's New in your kit?

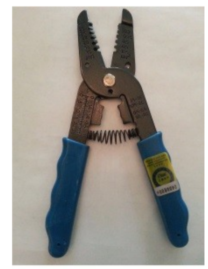
**There have been a few changes to your kit**. (Tool changes only for kits ordered with tools)

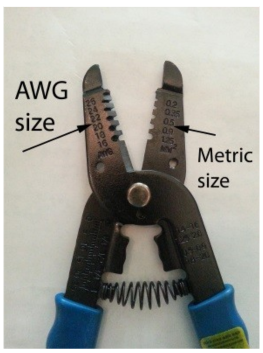
1. An **extra** L.E.D. has been added to your kit in case something happens to the original.
2. New Wire Strippers have been added.
3. An explanation of the Digital Multimeter function dial.
4. Fuse clip holder. (Grade 9 kit only)




1. **Caution! NEVER connect a 9 volt battery directly to the L.E.D.!** (the small lights included in the kits) They will burn out instantly! Only connect or use all the parts in your kit according to the instructions provided.

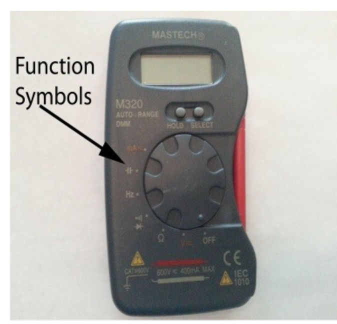
2. The wire strippers in the course are different than the ones in your kit. The new wire strippers are better suited for the work you are doing in the electronics course.


Wire Strippers




On the sides of the cutting edge teeth of the wire strippers are two sets of numbers. On one side is the American Wire Gauge or AWG number. This is a standard measurement for all size or circumferences of wire. Along the adjacent side is the wire size in millimeters.

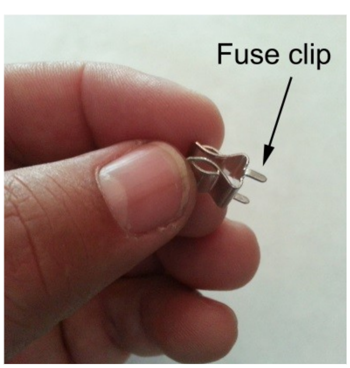
Always find the proper hole size for stripping any wires. If the wire size isn't known, you can always start with the larger hole size on the tool, and try each hole getting progressively smaller until the insulation of the wire is removed successfully.

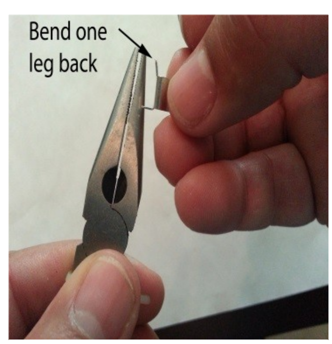



3. The function symbols on the Multimeter may be in a different order than the picture in the curriculum. From time to time, manufactures change the meters slightly. Always find the correct symbol for the operation of the meter for your task.

4. Fuse Clip Holder (grade 9 kit only)

When you are building the project, bend one of the legs of the fuse clip holder back to accommodate the soldering of the clip into the circuit board. Only one of the two legs will be used and fit into the hole provided. Gently bend it back using your needle nose pliers.




If a tool or component is not in working order (or missing) please contact MTBB at 866-771-6822.

If you have questions regarding how to use a tool or component, contact your Tutor/Marker.