Grade 9
Electricity/Electronics Technology (10G)

A Course for
Independent Study
Grade 9
Electricity/Electronics Technology (10G)

A Course for Independent Study
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**Acknowledgements**

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</tr>
</tbody>
</table>
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 to check 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 repair technician
- CD player design technician
- amplifier electronics engineer
- computer technical designer
- electronic components draftsperson
- sonar assembly technician
- radar machinist
- automatic pilot GPS (Global Positioning System)

Introduction to Electronics

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.

**What Will You Learn in This Course?**

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. There are the following seven modules in this course:

- **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
How Is This Course Organized?

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 booklet. 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 email all of your completed assignments to your tutor/marker for assessment. The hand-in project from Module 4 must be mailed to your tutor/marker.
- **Major Project:** You will be completing and sending in a major project at the end of Module 7. This will be forwarded to your tutor/marker for review and/or assessment.

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 on the distance learning unit website at <www.edu.gov.mb.ca/k12/dl/iso/av.html>. If you need a copy of the video on DVD, please contact the ISO Office. 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 Text Book Bureau at <www.mtbb.mb.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 Text Book Bureau, stock #3307.

If items are not in working order, contact the Manitoba Text Book Bureau 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.

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

**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

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

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

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

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

Parts and tools in the kit may not be identical to those described in the course or on the video.
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 Who Is My Tutor/Marker? section of the distance learning website at <www.edu.gov.mb.ca/k12/dl/iso/assistance.html>.

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 with your study 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 mail them in to your tutor/marker.
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 your tutor/marker. 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 mail learning activities to your tutor/marker.

Assignments

Each module in this course contains assignments, which you will complete and submit to your tutor/marker 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 sending 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 exam covers the entire course and is worth 15% of the final mark. The final exam must be written under the supervision of a proctor. When you start Module 6, you need to make arrangements to write the exam. When you reach this point, do one of the following:

Requesting Your Examination

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

- **If you are attending school**, ask your school’s ISO facilitator to request your examination. Do this at least three weeks before you are ready to write your examination. For more information on examination procedures, please contact your ISO school facilitator or visit the Grading and Evaluation section of the distance learning website at <www.edu.gov.mb.ca/k12/dl/iso/assignments.html>.

- **If you are not attending school**, check the Examination Request Form for options available to you. The form was mailed to you with this course. Three weeks before you are ready to write the examination, fill in the Examination Request Form and mail, fax, or email it to

  ISO Office  
  555 Main Street  
  Winkler MB  R6W 1C4  
  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 the course in September and complete it in January, you can follow the timeline suggested below.

<table>
<thead>
<tr>
<th>Module</th>
<th>Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module 1</td>
<td>Middle of September</td>
</tr>
<tr>
<td>Module 2</td>
<td>Middle of October</td>
</tr>
<tr>
<td>Module 3</td>
<td>End of October</td>
</tr>
<tr>
<td>Module 4</td>
<td>Middle of November</td>
</tr>
<tr>
<td>Modules 5 and 6</td>
<td>End of December</td>
</tr>
<tr>
<td>Module 7</td>
<td>Beginning of January</td>
</tr>
<tr>
<td>Final Examination</td>
<td>Middle of January</td>
</tr>
</tbody>
</table>

Chart B: Semester 2

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

<table>
<thead>
<tr>
<th>Module</th>
<th>Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module 1</td>
<td>Middle of January</td>
</tr>
<tr>
<td>Module 2</td>
<td>Middle of February</td>
</tr>
<tr>
<td>Module 3</td>
<td>End of February</td>
</tr>
<tr>
<td>Module 4</td>
<td>Middle of March</td>
</tr>
<tr>
<td>Modules 5 and 6</td>
<td>End of April</td>
</tr>
<tr>
<td>Module 7</td>
<td>Beginning of May</td>
</tr>
<tr>
<td>Final Examination</td>
<td>End of May</td>
</tr>
</tbody>
</table>
Chart C: Full School Year (Not Semestered)

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

<table>
<thead>
<tr>
<th>Module</th>
<th>Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module 1</td>
<td>End of September</td>
</tr>
<tr>
<td>Module 2</td>
<td>Middle of November</td>
</tr>
<tr>
<td>Module 3</td>
<td>End of December</td>
</tr>
<tr>
<td>Module 4</td>
<td>Middle of February</td>
</tr>
<tr>
<td>Modules 5 and 6</td>
<td>End of April</td>
</tr>
<tr>
<td>Module 7</td>
<td>Beginning of May</td>
</tr>
<tr>
<td>Final Examination</td>
<td>End of May</td>
</tr>
</tbody>
</table>

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 to your school.

If you need this course to graduate this school year, remember to schedule and complete your final examination by **May 31**.
When and How Will You Submit Completed Assignments?

When to Submit Assignments

While working on this course, you will submit completed assignments to your tutor/marker six times. The following chart shows you exactly what assignments you will be submitting.

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

In this course, you have the choice of submitting your assignments either by mail or electronically. The Major Project and Assignment 4.1 must be submitted by mail.

- **Mail**: Each time you mail something, you must include the print version of the applicable Cover Sheet (found at the end of this Introduction).

- **Electronic submission**: Each time you submit something electronically, you must include the electronic version of the applicable Cover Sheet (found in the Student Downloads section of the distance learning website at [www.edu.gov.mb.ca/k12/dl/downloads/index.html](http://www.edu.gov.mb.ca/k12/dl/downloads/index.html)) or you can scan the Cover Sheet located at the end of this Introduction.

Complete the information at the top of the Cover Sheet before submitting it along with your assignments.

**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

ISO Tutor/Marker
555 Main Street
Winkler MB R6W 1C4

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. You can also obtain this information in the Grading and Evaluation section of the distance learning website at [www.edu.gov.mb.ca/k12/dl/iso/assignments.html](http://www.edu.gov.mb.ca/k12/dl/iso/assignments.html).

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 assignments are lost, you are able to resubmit them.

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

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The Independent Study Option office 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 your tutor/marker. 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 your tutor/marker for assessment in accordance with the chart found in the course Introduction.

**Mail or Electronic Submission:** Mail or electronically submit your completed assignments to your tutor/marker for assessment at this time.

**Tech Project:** Complete a project that you must send in to your tutor/marker.

**Examination:** Write your final examination at this time.
Module 1: Electricity: The Shocking Facts on How It Is Produced
Module 1: Electricity: The Shocking Facts on How it Is Produced

Module Focus

When you finish this lesson, you will be able to

- identify terms, variables, numerical coefficients, constants, and exponents
- draw pictures of expressions using algebra tiles
- write algebraic expressions from diagrams
- describe a situation using a polynomial expression

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
- neon bulb
- humidity
- matter
- elements
- molecule
- proton
- electron
- neutron
- nucleus
- neutral charge
- electrical charge
- static electricity
- ferrous metals
- permanent magnet
- electrostatic force field
- solderless circuit board
- conductors
- insulators
- semiconductors
- schematic diagrams
- short circuit
- filament
- amperes
- voltage
- electromotive force (EMF)
- current
- ohms
- resistance
- electromagnet
Assignments in Module 1

You will need to complete Assignment 1 at the end of Lesson 5. After you have completed the assignment, fill out the Log Sheet for Module 1 and forward it, along with your completed assignment and module cover sheet, to your tutor/marker.
Lesson 1: What Is Electricity?

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 your tutor-marker. 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](image)

**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.

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.

What’s the Matter?
There are as many molecules in one teaspoon of water as there are teaspoonfuls of water in the Atlantic Ocean.
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 your tutor/marker.

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](Matter_diagram)

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

   ![Redraw](Molecule_diagram)

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

   ![Redraw](Single_atom_diagram)

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

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

   ![Diagram of sub-atomic particles]

   Redraw

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

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.
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.

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 (CO₂). Water (H₂O) 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.

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**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.

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*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.