Adult Basic Education

Science

Science 3103

Electricity

Study Guide

Prerequisite: Science 3102

Credit Value: 1

Text: *Nelson Physics 12: College Preparation*; Hirsch, Alan J.; Nelson Thomson Canada; 2004.

Science Courses [General College Profile]

Science 2100A
Science 2100B
Science 2100C
Science 3101
Science 3102
Science 3103
Science 3104
Science 3105
Science 3106

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To the Student

I. Introduction to Science 3103

Science 3103 is the second of two Science courses in the General College Profile that covers concepts in the area of Physics. While the course is available to all students, it is specifically designed for students who plan to pursue post-secondary education in the area of industrial trades.

Science 3102 is a prerequisite to Science 3103.

In this course, you are introduced to some of the basic concepts of electrical circuits. You learn about the components of circuits and how to draw simple circuit diagrams. You are introduced to electric current, potential difference, resistance, and power. You learn how to analyze series and parallel circuits. You then analyze electrical power usage in common devices. Proper safety procedures to follow when working with electric circuits are discussed and employed in this course.

You will complete one required lab to explore the properties of series and parallel circuits. You will also be required to complete one assignment dealing with circuits and power. Your instructor may require you to complete additional lab activities and/or assignments.

The textbook that you will need for the course is ***Nelson Physics 12: College Preparation****;* Hirsch, Alan J.; Nelson Thomson Canada; 2004.

To the Student

II. Use of Study Guides

Before beginning this course, ensure you have the text and any other resources needed *(see the information in the Introduction to this course for specifics)*.

As you work through the Study Guide, you will see that it is divided according to the Units listed in the Table of Contents. When you open a unit it will have the following components:

Reading for this Unit:
Here you will find the chapters, sections and pages of the text you will use to cover the material for this unit. Skim the sections of the textbook, look at the titles of the sections, scan the figures and read any material in the margins. Once you have this overview of the unit, you are ready to begin. Do not be intimidated by the content. You will work through the text, section by section, gaining knowledge and understanding of the material as you go.

References and Notes	**Work to Submit**
This left hand column guides you through the material to read from the text. Read any highlighted notes that follow the reading instructions. The symbols ▶▶ direct you to the questions that you should complete when finished a reading assignment..	You come across three (3) headings in this right hand column. **Writing:** This section comprises your notes for the unit. Here you will find either written questions or references to specific questions or problems from your text. You may want to write out each question followed by the answer. This material should be checked by your instructor before moving on to the next unit. Mathematical problems should have their solutions checked as you go. **Laboratory:** This section indicates if there is a Core Lab that should be completed for the unit. Let the instructor know in advance that you will be ready for the lab. A lab report should be submitted for each Core Lab. Your instructor will provide guidelines as to how s/he wants the report written. **Assignment:** This section indicates if there is an assignment that should be completed for the Unit. The information in the "References and Notes" column will indicate how you obtain the assignment. These assignments frequently relate the science content to technology, society and the environment.

III. Recommended Evaluation

Written Notes	10%
Labs/Assignments	20%
Test(s)	20%
Final Exam *(entire course)*	50%
	100%

Unit 1 - Introduction to Electricity

To fulfill the objectives of this unit, students should complete the following:

Reading for this unit: *Nelson Physics 12: College Preparation;*
Chapter 7: Sections 7.1 - 7.3: pages 316 - 326
Section 7.4: pages 328 - 329

References and Notes	Work to Submit
Study pages 316 - 318. Then answer questions 1.1 - 1.8 ▶/▶	**Writing:**
Note: *Remember that all matter is made of atoms and that the electron, the negative (-) particle that is outside the nucleus, is the only one that moves.*	1.1 Define **current electricity** and **electrical circuit**. 1.2 a) What are the three main parts of a simple electrical circuit? b) Describe the function of each of these parts and give an example of each. 1.3 a) What is the optional part of a simple electrical circuit? b) Describe its function and give an example.
Note: *You will need to use* ***Table 6****,* ***Appendix C****, on page 576 of your text to help you with the questions on circuit diagrams.*	1.4 Explain the difference between an **open** and **closed circuit.** 1.5 a) What is a **short circuit**? b) What are the dangers of a short circuit? 1.6 Copy the **circuit diagram** in Figure 4 on page 317 into your notebook and identify each part of the diagram.

Unit 1 - Introduction to Electricity

References and Notes	Work to Submit
	Writing:
	1.7 a) Draw a circuit diagram showing a 3-cell battery connected by wires to a fixed resistor with a fuse as part of the circuit. b) Draw a circuit diagram showing an AC generator being used to run a motor.
	1.8 Complete question 3 in *Applying Inquiry Skills* on page 318.
Study pages 319 - 323. Then answer questions 1.9 - 1.14 ▶▶	1.9 Define **electric current**.
	1.10 What is the SI unit of measurement (and the symbol) for electric current?
	1.11 Explain the difference between **direct current (DC)** and **alternating current (AC)**.
	1.12 Complete question 1 in *Understanding Concepts* on page 320.
	1.13 What instrument is used to measure electric current and how is it connected in a circuit?
	1.14 Complete question 6 in *Practice* on page 322 and question 2 and 3 in *Section 7.2 Questions* on page 323.
Study pages 324 - 327. Then answer questions 1.15 - 1.18 ▶▶	1.15 Define: **electric potential rise** **electric potential drop** **electric potential difference**.

Unit 1 - Introduction to Electricity

References and Notes

Note: *The symbol "Δ" means "change in". ΔV refers to an electrical potential rise* ***or*** *drop.*

Note: Refer to ***Table 2****,* ***Metric Prefixes****, on page 572, if you have forgotten some of the prefixes used in the text.*

Study pages 328 - 329. Then answer questions 1.19 - 1.22 ▶▶

Note: *This is the end of Unit 1. You should check with your instructor to see if there is review work or any other additional work for this unit.*

Work to Submit

Writing:

1.16 What is the SI unit of measurement (and the symbol) for electric potential difference?

1.17 What instrument is used to measure electric potential difference and how is it connected in a circuit?

1.18 a) Complete question 2 in *Practice* on page 326.

b) Complete questions 2 and 4 in *Section 7.3 Questions* on page 327.

1.19 Define **electric resistance**.

1.20 What is the SI unit of measurement (and the symbol) for electric resistance?

1.21 Explain the difference between an **electrical conductor** and **insulator** and give 2 examples of each.

1.22 What are **resistors**?

Unit 2 - Electrical Circuits

To fulfill the objectives of this unit, students should complete the following:

Reading for this unit:	*Nelson Physics 12: College Preparation;*		
	Chapter 7:	Section 7.4:	pages 330 - 331
		Section 7.6:	pages 334 - 343 (omit pages 341 - 342)
		Section 7.7:	pages 344 - 345

References and Notes	**Work to Submit**
Study pages 330 - 331. Then answer questions 2.1 - 2.4 ⏯⏯	**Writing:** 2.1 State **Ohm's law**. 2.2 Write the equation for Ohm's law using words and symbols. 2.3 Complete *Practice* questions 5, 6, 7, and 8 on page 331. (Show your working for each question and make sure that you clearly understand how to do these before you move on.) 2.4 Complete questions 2, 3, 4, and 5 in *Section 7.4 Questions* on page 332.
Study pages 334 - 336, paying close attention to the Sample Problems. Then answer questions 2.5 - 2.8 ⏯⏯	2.5 What is the major difference between **series** and **parallel circuits**? 2.6 State **Kirchhoff's Current Rule (KCR)**. 2.7 State **Kirchhoff's Voltage Rule (KVR)**.

References and Notes

Note: *Applying Kirchhoff's rules means that for a* ***series circuit***
- the ***current (I) is always the same*** *throughout, no matter how many resistors are involved,*
$I_T = I_1 = I_2 = I_3 ..... = I_n$

but the ***voltage will vary for each resistor****, and individual voltages are added together to get the total*
$\Delta V_T = \Delta V_1 + \Delta V_2 + \Delta V_3 ..... + \Delta V_n$

The ***opposite*** *is true for a* ***parallel circuit***
- the ***current will vary for each resistor****, depending on the amount of resistance, and individual currents are added together to get the total,*
$I_T = I_1 + I_2 + I_3 ..... + I_n$

but the ***voltage will stay the same*** *throughout,*
$\Delta V_T = \Delta V_1 = \Delta V_2 = \Delta V_3 ..... = \Delta V_n$

Study pages 337 - 338, paying close attention to the Sample Problem 3. Then answer questions 2.9 - 2.11

Work to Submit

2.8 Complete *Practice* questions 1, 2, and 3 on page 337. (Show your workings for each question and make sure that you clearly understand how to do these before you move on.)

Hint: When doing problems where you are solving for current or voltage, the acronyms PIC and SIV might help.

PIC stands for **p**arallel **i**ndividual **c**urrents. In other words, in a **parallel** circuit you need to calculate **individual current** for each resistor, and the voltage doesn't change.

SIV stands for **s**eries **i**ndividual **v**oltages. In other words, in a **series** circuit, you need to calculate **individual voltage** for each resistor, and the current doesn't change.

2.9 a) What is meant by **equivalent resistance**?

b) What symbol is used to represent equivalent resistance?

Unit 2 - Electrical Circuits

References and Notes	Work to Submit
	Writing:
	2.10 What is the equation for equivalent resistance in a series circuit?
	2.11 Complete *Practice* questions 4, 5, and 6 on page 339. (Show your workings for each question and make sure that you clearly understand how to do these before you move on.)
Study pages 339 - 340, paying close attention to the Sample Problem 4. Then answer questions 2.12 - 2.14 ▶▶	2.12 What is the equation for equivalent resistance in a parallel circuit?
	2.13 Complete *Practice* question 7 on page 340. (Show your workings and make sure that you clearly understand how to do this question before you move on.)
	2.14 Complete questions 1, 2, 3, 4, and 6 in *Section 7.6 Questions* on page 343.
	Laboratory:
Follow the instructions on pages 344 - 345 to complete the Lab work ▶▶	2.15 Complete the Investigation, *Resistors in Series and Parallel*, pages 344 - 345 of your text. Pass your Lab Report in to your instructor for marking.
Note: *See your instructor to discuss what is expected from you for your Lab Report.*	
The assignment is found in the Appendix of this Study Guide. Read the questions carefully and show all workings. ▶▶	**Assignment:**
	2.16 Complete Part I, questions 1 - 16 of the Assignment , *Circuits & Power*.

Unit 3 - Electrical Power and Safety

To fulfill the objectives of this unit, students should complete the following:

Reading for this unit: *Nelson Physics 12: College Preparation;*
Chapter 7: Section 7.8: pages 346 - 350
Section 7.9: pages 351 - 353

References and Notes	Work to Submit
Study pages 346 - 347. Then answer questions 3.1 - 3.4 ▶/▶	**Writing:** 3.1 Briefly describe the possible human reactions to electric currents. 3.2 What is an **overloaded circuit**? 3.3 Name two things that could cause a short circuit in your home. (You may need to refer back to your definition of short circuit from Unit 2.) 3.4 Name two devices commonly used in household circuits to protect the circuit from overheating.
Study pages 351 - 353, paying close attention to the Sample Problem 1 . Then answer questions 3.5 - 3.8 ▶/▶ ***Note:*** *A definition for power is introduced in Section 3.1 of the text. Since that section is not covered in this course, you may find the glossary helpful in defining* ***electrical power****.*	3.5 Define **electrical power**. 3.6 a) Give the equation used to find power in electrical systems. b) What unit is used to measure electrical power?

Unit 3 - Electrical Power and Safety

References and Notes	Work to Submit
	3.7 Complete *Practice* questions 1, 2, 3, and 4 on page 353. (Show your workings for each question and make sure that you clearly understand how to do these before you move on.) 3.8 Complete questions 2, 3, and 4 in *Section 7.6 Questions* on page 356.
The assignment is found in the Appendix of this Study Guide. Read the questions carefully and include all workings with your answers. ⏯⏯	**Assignment:** 3.9 Complete Part II, questions 17 - 21 of the Assignment , *Circuits & Power*.
Note: *This is the end of Unit 3. You should check with your instructor to see if there is review work or any other additional work that you need to complete.*	

Appendix

Name: _____ Date: _____

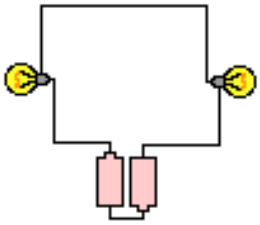
Assignment - Circuits & Power

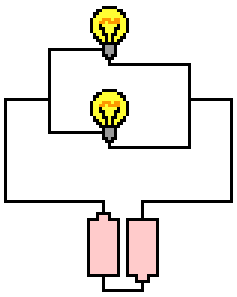
Part I

1. Draw the following electrical circuits:

   a. A single cell, light bulb and switch are placed together in a circuit such that the switch can be opened and closed to turn the light bulb on.

   b. A three-pack of cells is placed in a circuit to power a flashlight bulb.

   c. 

   d. 

2. Calculate the value of the resistance in each case:

   a. V = 12V, I = 0.25A
   b. V = 1.5 V, I = 30 mA
   c. V = 2.4×10^{4} V, I = 6.0×10^{-3} A

3. Find the unknown quantities:

   a. R = 30 Ω, I = 0.45 A, V = ?
   b. R = 2.2 kΩ, I = 1.5 A, V = ?
   c. V = 6.0 V, R = 18 Ω, I = ?
   d. V = 52 mV, R = 26 Ω, I = ?

4. What current is drawn by a vacuum cleaner from a 115 V circuit having a resistance of 28 Ω?

5. Calculate the maximum rating (in volts) of a battery used to operate a toy electric motor which has a resistance of 2.4 Ω, and runs at top speed with a current of 2.5 A.

6. A walkie-talkie receiver operates on a 9.0 V battery. If the receiver draws 300 mA of current, what is its resistance?

7. An electric can opener used in a 120 V circuit has a resistance of 110 Ω. How much current does it draw?

8. An electric razor has a resistance of 20 Ω and draws a current of 250 mA. What is the potential drop across the razor?

9. Find the total resistance when three resistors, having values of 5.0 Ω, 10 Ω, and 30 Ω, are connected

   a. in series; and
   b. in parallel.

10. Find the total resistance when the following resistors are connected in series:

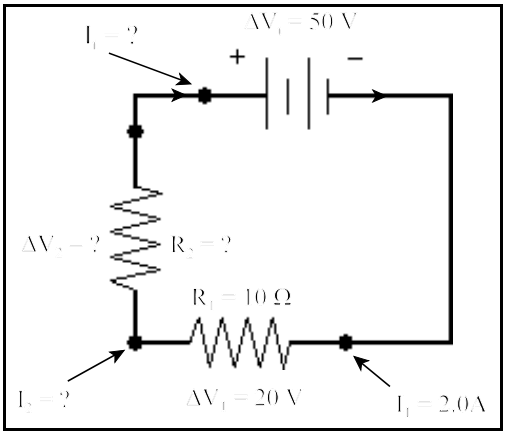
    a. 2.7 Ω, 9.8 Ω
    b. 10 Ω, 10^2 Ω, 10^3 Ω
    c. 1.0 Ω, 10^{-1} Ω, 10^{-2} Ω

11. Find the total resistance when the following resistors are connected in parallel:

    a. 4.0 Ω, 4.0 Ω
    b. 100 Ω, 100 Ω
    c. 300 Ω, 300 Ω, 300 Ω,
    d. 150 Ω, 600 Ω, 600 Ω

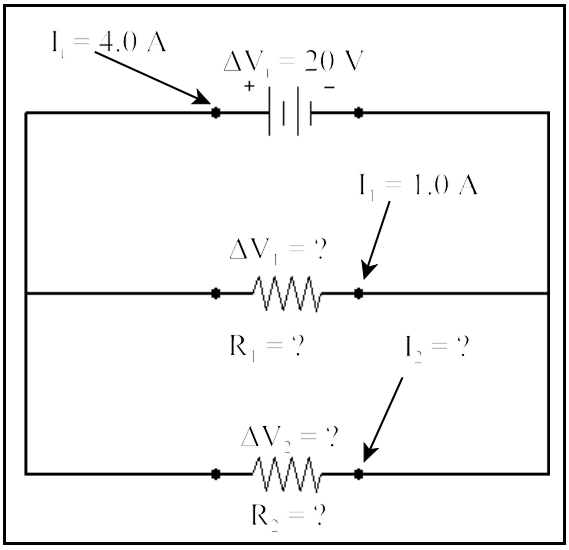
12. In the series circuit shown in the diagram, $\Delta V_1 = 20$ V, $R_1 = 10\ \Omega$, and $I_1 = 2.0$ A. Find values for the following:

a. I_2
b. ΔV_2
c. R_t
d. R_2
e. I_t



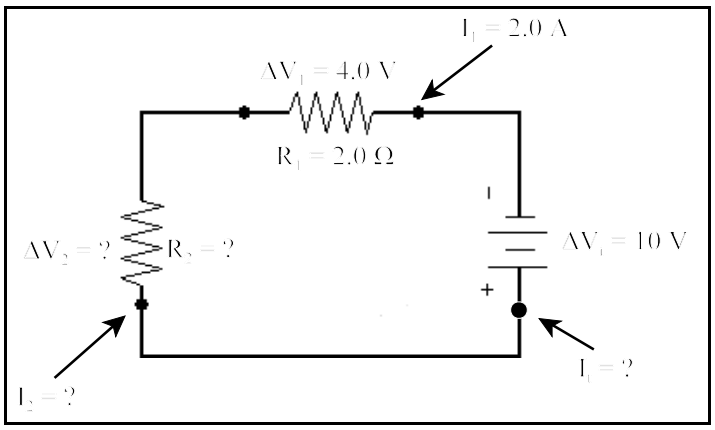
13. In the parallel circuit shown in the diagram, $\Delta V_t = 20$ V, $I_t = 4.0$ A, and $I_1 = 1.0$ A. Calculate values for the following:

a. ΔV_1
b. R_1
c. I_2
d. ΔV_2
e. R_2



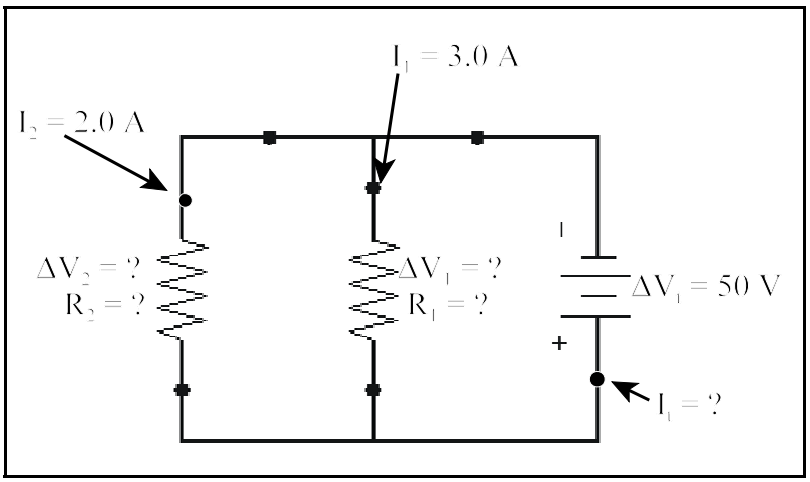
14. In the circuit shown below, find the following values:

a. I_2
b. ΔV_2
c. R_t
d. R_2
e. I_t



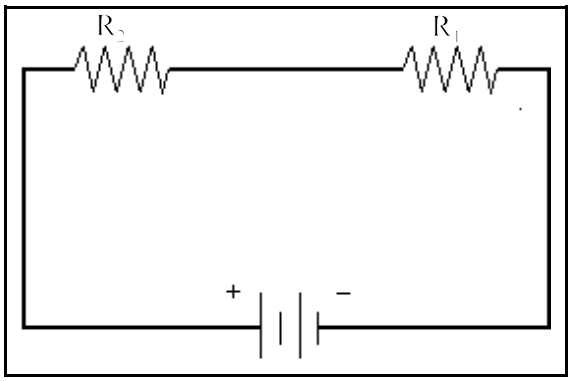
15. In the circuit shown below, calculate the following values:

a. ΔV_1
b. I_1
c. R_t
d. R_1
e. ΔV_2
f. R_2
g. I_t



16. In the circuit shown, $R_1 = 20\ \Omega$. The potential drop across R_1 is 10 V; across R_2, it is 20 V. Determine the following:

    a. The total potential rise of the source
    b. The current through R_1
    c. The current through R_2
    d. The resistance of R_2



Part II

17. Calculate the power of each appliance:

    a. A 120 V electric sander draws 2.9 A of current.
    b. An electric can opener, used in a 120 V circuit, operates at 2.2 A.
    c. A portable radio, using four 1.5 V cells in series, draws a current of 610 mA.

18. Calculate the electric potential drop across a 0.90 W calculator that draws a current of 100 mA.

19. Calculate the electric potential drop across a 34.5 kW welder that draws a current of 150 A.

20. What is the current drawn by a 1.5 kW electric kettle in a 120 V household circuit?

21. What is the current drawn by a 5.06 kW baseboard heater in a 230 V household circuit?