DISCOVERING SCIENCE 9
TEACHER'S RESOURCE

UNIT 3: CHARACTERISTICS OF ELECTRICITY

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McGraw-Hill Ryerson

UNIT 3: OVERVIEW

Unit 3 provides students with an introduction to the study of electricity and its applications in circuits. Students are already familiar with many applications of electricity, both in the static form as well as in current electricity. This unit aims at helping students understand the source of electricity and the laws that describe its behaviour, how to conserve energy, and how generating large amounts of electricity affects the environment.

Chapter 7 begins with our earliest understanding of electricity, static electricity. Students study how an object becomes charged and how this charge can be transferred between objects. Understanding the interaction between charged objects allows students to explain common electrostatic phenomena. Most of students' everyday experiences with electricity are in the form of current electricity. In Chapter 8, students are introduced to the energy transformations that occur in an electric circuit. As students discover that electrical energy in the circuit is transformed into other forms of energy, they learn the relationship between current, voltage, and resistance. Chapter 9 examines the way in which we design circuits to control the transfer of electrical energy. The understanding of the importance of electricity in everyday life is further developed through considering power consumption of electrical devices and the cost of using these devices, ways of conserving energy, and the impact of generating electrical energy on the environment.

Chapter 7: Static charge is produced by electron transfer.

Understanding static charge is a prerequisite for studying current electricity. This chapter describes the origin of charge and how an object can gain a charge. It is important that students understand that only the negatively charged electrons are transferred when an object is charged. The positively charged protons remain fixed in a solid material. Students will learn to model neutral, positive, and negative charge distributions using a diagram.

Students then examine the interaction between charged objects, which are summarized as the laws of static charge. By using these laws, students can explain common phenomena caused by static electricity. Students learn how the amount of force between two charged objects is affected by the amount of charge and also the distance of separation. Charging by conduction and induction can also be explained using the information learned in this chapter.

Chapter 8: Ohm's law describes the relationship of current, voltage, and resistance.

Chapter 8 introduces the concept of current electricity. Students learn that separating charges stores energy, and the amount of energy stored is dependent on both the amount of charge separated and the distance of separation—which can be thought of as the potential difference or voltage. Students will learn that an electrochemical cell or battery is a device that can provide a continuous separation of charge.

Students learn that, to transfer electrical energy, electrons must be able to move. The flow of these electrons is called electric current. To help with students' understanding, a waterslide is used as an analogy to describe voltage, current, and the transfer of energy. Students will use circuit diagram symbols to simplify the drawing of electric circuits. As well, students will be expected to use circuit diagrams to construct electric circuits and to measure voltage and current correctly using voltmeters and ammeters.

Students learn how resistance controls the flow of current and transforms electrical energy into other forms of energy. Using Ohm's law, students are able to solve problems involving voltage, current, and resistance. By placing a resistor in a circuit, students are able to measure the voltage and current for that resistor and therefore calculate its resistance. Activity 8-3D incorporates most of the understanding and skills learned in this chapter.

Chapter 9: Circuits are designed to control the transfer of electrical energy.

Students learn how the concepts of voltage, current, and resistance apply in both series and parallel circuits. Analogies are used to help in the understanding of series and parallel circuits. In this chapter, students have many opportunities to build both types of circuits. For example, in Activities 9-1D and 9-1E, they use various meters to take measurements in order to verify the theories they have learned. Next, students learn how to calculate electrical power and the energy consumption of electrical devices, as well as the cost of using electricity. They discuss ways of conserving energy: by changing habits or by using more energy-efficient devices. Finally, students learn how electrical energy is generated on a large scale, and come to realize that each method has its benefits and risks.

The unit ends with a project that allows students to discover which brand of battery supplies the greatest energy. Students will draw a circuit diagram, construct a circuit, measure voltage and current, and calculate power.

MULTIPLE INTELLIGENCES CORRELATION FOR UNIT 3 ACTIVITIES AND INVESTIGATIONS

The table below shows the multiple intelligences engaged in the activities and investigations for this unit, in order to help you plan for differentiated instruction in your science lessons, as your students require. For more information about differentiated instruction and multiple intelligences, see the Introduction and Implementation section in this Teacher's Resource.

Multiple Intelligences:	VL	VS	BK	MR	LM	N	E	IA	IE
UNIT 3: Characteristics of Electricity									
Find Out Activity: A New Spin on Motors		■	■						
Chapter 7: Static charge is produced by electron transfer.									
Find Out Activity 7-1A: Detecting Static Charge	■	■	■						
Think About It Activity 7-1B: Visualizing Charge Transfer	■				■				■
Find Out Activity 7-1C: Charging Insulators and Conductors		■	■		■				
Find Out Activity 7-2A: What Is the Attraction to Water?	■	■	■		■				
Find Out Activity 7-2B: Static Copier		■	■		■				
Conduct an Investigation 7-2C: Investigating Static Electricity		■	■		■				■
Chapter 8: Ohm's law describes the relationship of current, voltage, and resistance.									
Find Out Activity 8-1A: A Penny for a Battery	■	■	■		■				
Find Out Activity 8-1B: Using the Voltmeter	■	■	■						
Conduct an Investigation 8-1C: Fruit Battery	■	■	■						■
Find Out Activity 8-2A: Lighting It Up		■	■		■				
Think About It Activity 8-2B: Drawing Circuit Diagrams		■			■				
Find Out Activity 8-2C: Pushing Electrons	■	■	■		■				
Find Out Activity 8-2D: Measuring Current	■	■	■		■				■
Conduct an Investigation 8-2E: Make a Model Circuit		■	■		■				■
Find Out Activity 8-3A: Resist Your Thirst	■	■	■		■				■
Think About It Activity 8-3B: Calculating Resistance	■				■				
Think About It Activity 8-3C: Circuit Diagrams with Resistors	■	■			■				■
Core Lab Conduct an Investigation 8-3D: Resistors and Ohm's Law	■	■	■		■				■
Chapter 9: Circuits are designed to control the transfer of electrical energy.									
Find Out Activity 9-1A: Turn Out the Lights		■	■						■
Think About It Activity 9-1B: Is the World Series a Series Circuit?	■				■			■	■
Think About It Activity 9-1C: More Things Are Parallel Than Lines	■				■			■	■
Find Out Activity 9-1D: A Series of Lights and Cells	■	■	■		■				■
Find Out Activity 9-1E: Parallel Lights and Cells	■	■	■		■				■
Core Lab Conduct an Investigation 9-1F: Resistors in Series and Parallel	■	■	■		■				■
Find Out Activity 9-2A: Energy Transformation in Resistors	■	■	■		■				
Think About It Activity 9-2B: The Cost of Electricity	■		■		■			■	
Conduct an Investigation 9-2C: A Current View of Power	■	■	■		■				■
Find Out Activity 9-3A: Putting Energy Conversions to Good Use	■	■			■				
Think About It Activity 9-3B: Conserving Electricity			■				■		■
Find Out Activity 9-4A: Generating an Electric Current		■	■		■				
Think About It Activity 9-4B: Seek the Source	■	■			■				■
Unit 3 Project: Finding the Best Battery	■	■	■		■			■	■
Unit 3 Integrated Research Investigation: Generating Electrical Energy	■	■			■			■	■

Multiple Intelligence codes:
VL = Verbal-Linguistic Intelligence; VS = Visual-Spatial Intelligence; BK = Body-Kinesthetic Intelligence; MR = Musical Rhythmic Intelligence; LM = Logical-Mathematical Intelligence; N = Naturalist Intelligence; E = Existential Intelligence; IA = Intrapersonal Intelligence; IE = Interpersonal Intelligence

Planning Chart for Activities and Investigations for Unit 3: Characteristics of Electricity

ACTIVITY/ INVESTIGATION	ADVANCE PREPARATION	APPARATUS/MATERIALS	TIME REQUIRED
UNIT 3: Characteristics of Electricity			
Find Out Activity: A New Spin on Motors	• 1 day before: – Organize materials.	For each group: – small neodymium disk magnet – C or D cell – 6–8 cm common iron nail – 20 cm length of braided copper wire (stripped at both ends)	• 15 min
Chapter 7: Static charge is produced by electron transfer.			
Find Out Activity 7-1A: Detecting Static Charge	• 1 day before: – Gather materials and apparatus.	For each group: – electroscope – inflated balloon – wool cloth	• 15 min
Think About It Activity 7-1B: Visualizing Charge Transfer	• No advance preparation necessary	For each student: – ruler	• 15 min
Find Out Activity 7-1C: Charging Insulators and Conductors	• 1 day before: – Gather materials. Make sure that your choice of solid materials includes at least one conductor (metal).	For each group: – puffed rice cereal – solid materials such as a plastic straw, a comb, a plastic ruler, an acetate strip, a vinyl strip, a glass rod, an aluminum strip, an iron strip, a brass strip – soft materials such as wool, paper towel, plastic wrap, fur, nylon cloth	• 45 min
Find Out Activity 7-2A: What Is the Attraction to Water?	• 1 day before: – Gather materials.	For each group: – water tap – acetate strip – paper towel – ebonite rod – fur	• 15 min
Find Out Activity 7-2B: Static Copier	• 1 day before: – Gather all materials. • Day of instruction: – Have students read the Putting Static Charge to Work section on page 241 of the student textbook.	For each group: – plastic petri dish with lid – felt marker – dry yeast – acetate strip – paper towels	• 20 min
Conduct an Investigation 7-2C: Investigating Static Electricity	• 1 day before: – Gather materials.	For each group: – watch glass – plastic straws – wool – acetate strips – paper towels – glass rods – plastic bags – ebonite rods – fur	• 60–80 min

ACTIVITY/ INVESTIGATION	ADVANCE PREPARATION	APPARATUS/MATERIALS	TIME REQUIRED
Chapter 8: Ohm's law describes the relationship of current, voltage, and resistance.			
Find Out Activity 8-1A: A Penny for a Battery	• 1 day before: – Gather materials.	For each group: – aluminum foil – paper towel – penny – voltmeter – vinegar	• 20 min
Find Out Activity 8-1B: Using the Voltmeter	• 1 day before: – Gather materials and apparatus.	For each group: – voltmeter – various batteries: AA, AAA, lantern battery, watch battery, 9.0 V battery	• 20 min
Conduct an Investigation 8-1C: Fruit Battery	• 1 day before: – Gather materials and apparatus. – Purchase fresh fruit from the market or have students bring in one piece of fruit each.	For each group: – 1 piece of fruit – aluminum strips – voltmeter – zinc strips – iron strips – copper strips – steel wool – 250 mL beaker – water	• 60 min
Find Out Activity 8-2A: Lighting It Up	• 1 day before: – Gather materials.	For each student/pair/group: – D cell battery – 10 cm of insulated wire with both ends bare – 2.0 V flashlight bulb	• 20 min
Think About It Activity 8-2B: Drawing Circuit Diagrams	• No advance preparation necessary	For each student: – ruler	• 15 min
Find Out Activity 8-2C: Pushing Electrons	• 1 day before: – Gather materials.	For each group: – 6 plastic drinking straws – 3 bar magnets	• 15 min
Find Out Activity 8-2D: Measuring Current	• 1 day before: – Gather materials and apparatus.	For each group: – 1.5 V cell – various flashlight bulbs (1.5 V, 3.0 V, 6.0 V) – connecting wires – knife switch – ammeter	• 40 min
Conduct an Investigation 8-2E: Make a Model Circuit	• 2 days before: – Divide students into groups (4–5 students per group). Have students read the problem and criteria. Students should complete Design and Construct activities 1–3. • 1 day before: – Have students practise their presentation. Students should check that it meets the stated criteria. • Day of instruction: – Groups present their human circuits and complete the Evaluate section of the activity.	For each group: – Students will supply their own materials.	• 90 min

ACTIVITY/ INVESTIGATION	ADVANCE PREPARATION	APPARATUS/MATERIALS	TIME REQUIRED
Find Out Activity 8-3A: Resist Your Thirst	• 1 day before: – Gather materials.	For each group: – water – plastic disposable cup – 4 drinking straws – stopwatch – clear adhesive tape	• 30 min
Think About It Activity 8-3B: Calculating Resistance	• No advance preparation necessary	For each student: – calculator	• 20 min
Think About It Activity 8-3C: Circuit Diagrams with Resistors	• No advance preparation necessary	For each student: – ruler	• 10 min
Core Lab Conduct an Investigation 8-3D: Resistors and Ohm's Law	• 1 day before: – Gather materials and apparatus.	For each group: – 2 different resistors (100 Ω–300 Ω) – ammeter – voltmeter – conducting wires – four 1.5 V cells – switch	• 60 min
Chapter 9: Circuits are designed to control the transfer of electrical energy.			
Find Out Activity 9-1A: Turn Out the Lights	• 1 day before: – Gather materials and apparatus.	For each group: – 1.5 V cell – two 2.0 V light bulbs – switch – connecting wires	• 30 min
Think About It Activity 9-1B: Is the World Series a Series Circuit?	• No advance preparation necessary	None	• 25 min
Think About It Activity 9-1C: More Things Are Parallel Than Lines	• No advance preparation necessary	None	• 25 min
Find Out Activity 9-1D: A Series of Lights and Cells	• 1 day before: – Gather materials and apparatus.	For each group: – two 1.5 V cells – two 1.5 V flashlight bulbs – 2 ammeters – voltmeter – switch – connecting wires	• 60 min
Find Out Activity 9-1E: Parallel Lights and Cells	• 1 day before: – Gather materials and apparatus.	For each group: – two 1.5 V cells – three 1.5 V flashlight bulbs – 3 ammeters – voltmeter – switch – connecting wires	• 60 min
Core Lab Conduct an Investigation 9-1F: Resistors in Series and Parallel	• 1 class before: – Remind students to bring a calculator for the next class. • 1 day before: – Gather materials and apparatus.	For each group: – 6.0 V lantern battery or power supply. – 3 resistors of different sizes (100 Ω –500 Ω) – ammeter – voltmeter – switch – connecting wires – calculator	• 60 min

ACTIVITY/ INVESTIGATION	ADVANCE PREPARATION	APPARATUS/MATERIALS	TIME REQUIRED
Find Out Activity 9-2A: Energy Transformation in Resistors	• 1 day before: – Gather materials.	For demonstration: – 3 power supplies – 3 resistors of different sizes (50 Ω–100 Ω) – 3 glass thermometers – clear adhesive tape – stopwatch – connecting wires	• 30 min
Think About It Activity 9-2B: The Cost of Electricity	• 1 class before: – Remind students to bring a calculator for the next class.	For each student: – calculator	• 20 min
Conduct an Investigation 9-2C: A Current View of Power	• 1 class before: – Remind students to bring a calculator for the next class. • 1 day before: – Gather materials and apparatus.	For each group: – 3 resistors of different sizes (100 Ω–1000 Ω) – 1.5 V cell – ammeter – voltmeter – switch – connecting wires	• 50 min
Find Out Activity 9-3A: Putting Energy Conversions to Good Use	• 1 day before: – Gather materials and apparatus.	For demonstration: – incandescent light bulb (60 W) – compact fluorescent light bulb (13 W) – 2 desktop lamps – 2 thermometers – ruler	• 20 min
Think About It Activity 9-3B: Conserving Electricity	• 1 or 2 days before: – For homework, have students research different ways of conserving electricity at home.	For each student: – Students will supply any materials that they require for research.	• 15–20 min for class discussion
Find Out Activity 9-4A: Generating an Electric Current	• 1 day before – Gather materials and apparatus.	For each group: – 5 m insulated copper wire (about 26 gauge) – cardboard tube – galvanometer or ammeter – powerful bar magnet	• 20 min
Think About It Activity 9-4B: Seek the Source	• 1 day before: – Remind students to bring a calculator to the next class. –If you wish, students can use a computer to make the five bar graphs. Ensure that a computer with graphing software is available.	For each student: – calculator – computer with graphing software (optional) or grid paper	• 30 min (or longer if the bar graphs are drawn on grid paper by hand)
Unit 3 Project: Finding the Best Battery	• 1 week before: – Divide students in groups. Have students decide the size of battery that they are going to test. Students will need to bring 3 different brands of the battery size on the day of the testing. • 1 class before – Assign and have groups complete Procedure steps 1–3. • 1 day before: – Gather materials and apparatus.	For each group: – 3 brands of one battery type, such as C, D, AA, or AAA – identical light bulbs – voltmeters – ammeters – stopwatches – connecting wires – switches	• 90 min
Integrated Research Investigation: Generating Electrical Energy	• 3 days before: – Arrange for access to computers and research materials.	For whole class: – research materials	• 60 min research time • Additional time for presentations

TALKS AND TOURS

Speaker and field trip recommendations for Unit 3:

- Invite a speaker from Newfoundland and Labrador Hydro to talk about the generation and distribution of electricity in the province and your neighbourhood or to talk about electrical safety.
- Invite an electrician to visit the class and demonstrate the various components used to distribute electricity in students' homes. The electrician could discuss the way a house is wired, including topics such as current, the number of loads on a circuit, circuit breakers, switches, and the panel box.
- Invite an electronics repair person to visit the class. This person could bring some of the equipment used for testing circuits and could demonstrate the procedure for troubleshooting.
- Visit a site that generates electricity, such as a hydroelectric or thermal generating station.
- Before booking a field trip or asking a speaker to come in, make sure the topic is interesting and appropriate for students and that the speaker will cover material in a way that the students will find engaging.

UNIT 3 Blackline Masters

CONTENT-RELATED BLACKLINE MASTERS	ASSESSMENT-RELATED BLACKLINE MASTERS
UNIT BLM 3-1, Unit 3 Summary BLM 3-2, Unit 3 Key Terms BLM 3-56, Unit 3 Test BLM 3-57, Unit 3 Review Concept Map BLM 3-58, Unit 3 BLM Answers	• Assessment Checklist 2, Asking Questions • Assessment Checklist 3, Designing an Experiment • Assessment Checklist 4, Laboratory Report • Assessment Checklist 5, Investigating an Issue • Assessment Checklist 6, Developing Models • Assessment Checklist 7, Scientific Drawing • Assessment Checklist 8, Science Fair Display • Assessment Checklist 9, Oral Presentation • Assessment Checklist 10, Computer Slide Show Presentation • Assessment Checklist 11, Poster • Assessment Checklist 17, Science Math Connect • Assessment Checklist 18, Data Table • Assessment Checklist 19, Graph from Data • Assessment Checklist 21, Project Self-Assessment • Process Skills Rubric 3, Controlling Variables • Process Skills Rubric 5, Fair Testing • Process Skills Rubric 6, Designing Experiments • Process Skills Rubric 8, Interpreting Data • Process Skills Rubric 10, Measuring and Reporting • Assessment Rubric 1, Concept Rubric • Assessment Rubric 3, Co-operative Group Work Rubric • Assessment Rubric 4, Scientific Drawing Rubric • Assessment Rubric 5, Conduct an Investigation Rubric • Assessment Rubric 7, Scientific Research Planner Rubric • Assessment Rubric 8, Research Project Rubric • Assessment Rubric 9, Collecting Information Rubric • Assessment Rubric 10, Presentation Rubric • Assessment Rubric 11, Communication Rubric • Assessment Rubric 12, Using Tools, Equipment, and Materials Rubric
CHAPTER 7 BLM 3-3, Chapter 7 Key Terms BLM 3-6, Charge Transfer Diagrams BLM 3-7, Charging Insulators and Conductors BLM 3-8, Obeying the Laws of Static Charge BLM 3-9, Conduction/Induction Venn Diagram BLM 3-10, Conduction/Induction Charge Diagrams BLM 3-11, Forces and Electrical Charges BLM 3-12, Pop Can Race BLM 3-13, Investigating Static Electricity BLM 3-14, Chapter 7 Quiz	• Assessment Checklist 1, Making Observations and Inferences • Assessment Checklist 2, Asking Questions • Assessment Checklist 4, Laboratory Report • Assessment Checklist 6, Developing Models • Assessment Checklist 7, Scientific Drawing • Assessment Checklist 18, Data Table • Assessment Checklist 24, K-W-L Assessment Checklist • Process Skills Rubric 1, Developing Models • Process Skills Rubric 3, Controlling Variables • Process Skills Rubric 5, Fair Testing • Process Skills Rubric 8, Interpreting Data • Process Skills Rubric 9, Questioning • Process Skills Rubric 10, Measuring and Reporting • Assessment Rubric 1, Concept Rubric • Assessment Rubric 4, Scientific Drawing Rubric • Assessment Rubric 5, Conduct an Investigation Rubric • Assessment Rubric 12, Using Tools, Equipment, and Materials Rubric

CONTENT-RELATED BLACKLINE MASTERS	ASSESSMENT-RELATED BLACKLINE MASTERS
CHAPTER 8 BLM 3-4, Chapter 8 Key Terms BLM 3-15, Fruit Battery BLM 3-16, Making Light Bulbs Glow BLM 3-17, Make Your Own Dimmer Switch BLM 3-18, Drawing Circuit Diagrams BLM 3-19, Circuit Symbols BLM 3-20, Calculate the Current BLM 3-21, Calculate the Potential Difference BLM 3-22, Find Out Activity 8-2D, Measuring Current BLM 3-23, Resist Your Thirst BLM 3-24, Ohm's Law BLM 3-25, Resistor Colour Code (optional) BLM 3-26, Practising Calculating Resistance BLM 3-27, Electricity Crossword Puzzle BLM 3-28, Calculating Resistance BLM 3-29, Resistors and Ohm's Law BLM 3-30, Chapter 8 Quiz	• Assessment Checklist 1, Making Observations and Inferences • Assessment Checklist 4, Laboratory Report • Assessment Checklist 6, Developing Models • Assessment Checklist 7, Scientific Drawing • Assessment Checklist 14, Events Chain or Flowchart • Assessment Checklist 17, Science Math Connect • Assessment Checklist 18, Data Table • Process Skills Rubric 1, Developing Models • Process Skills Rubric 3, Controlling Variables • Process Skills Rubric 4, Problem Solving • Process Skills Rubric 5, Fair Testing • Process Skills Rubric 8, Interpreting Data • Process Skills Rubric 10, Measuring and Reporting • Assessment Rubric 3, Co-operative Group Work Rubric • Assessment Rubric 4, Scientific Drawing Rubric • Assessment Rubric 5, Conduct an Investigation Rubric • Assessment Rubric 10, Presentation Rubric • Assessment Rubric 12, Using Tools, Equipment, and Materials Rubric
CHAPTER 9 BLM 3-5, Chapter 9 Key Terms BLM 3-31, Series Circuits BLM 3-32, Parallel Circuits BLM 3-33, Comparing Series Circuits and Parallel Circuits BLM 3-34, Designing Circuits BLM 3-35, Drawing Series and Parallel Circuit Diagrams BLM 3-36, Understanding Circuit Diagrams BLM 3-37, Calculate Voltage and Current BLM 3-3, Compound Circuits BLM 3-39, A Series of Lights and Cells BLM 3-40, Parallel Lights and Cells BLM 3-41, Resistors in Series and Parallel BLM 3-42, Energy Transformations in Resistors BLM 3-43, Calculating Power BLM 3-44, Electrical Power and Energy BLM 3-45, Power Problems BLM 3-46, Calculating Energy Consumption BLM 3-47, The Price of Energy BLM 3-48, The Cost of Electricity BLM 3-49, A Current View of Power BLM 3-50, Putting Energy Conversions to Good Use BLM 3-51, Calculating Energy Efficiency BLM 3-52, Calculating Energy Input or Output BLM 3-53, Generating an Electric Current BLM 3-54, The Efficiency of Producing and Transmitting Electrical Energy BLM 3-55, Chapter 9 Quiz	• Assessment Checklist 1, Making Observations and Inferences • Assessment Checklist 2, Asking Questions • Assessment Checklist 4, Laboratory Report • Assessment Checklist 7, Scientific Drawing • Assessment Checklist 9, Oral Presentation • Assessment Checklist 10, Computer Slide Show Presentation • Assessment Checklist 11, Poster • Assessment Checklist 17, Science Math Connect • Assessment Checklist 18, Data Table • Process Skills Rubric 3, Controlling Variables • Process Skills Rubric 5, Fair Testing • Process Skills Rubric 7, Predicting • Process Skills Rubric 8, Interpreting Data • Process Skills Rubric 10, Measuring and Reporting • Assessment Rubric 1, Concept Rubric • Assessment Rubric 3, Co-operative Group Work Rubric • Assessment Rubric 4, Scientific Drawing Rubric • Assessment Rubric 5, Conduct an Investigation Rubric • Assessment Rubric 10, Presentation Rubric • Assessment Rubric 12, Using Tools, Equipment, and Materials Rubric

Teaching Notes
for
Pages 222 to 345 of the Student Textbook