

Electrical Circuits

Mod.3.3

TIME

150 minutes

OVERVIEW

Students improve their electrical circuits and discover what changes make a light bulb brighter. They investigate and invent useful electrical circuits, including switches.

LEARNING OUTCOMES

Through this learning experience (LE), students will achieve specific learning outcomes (SLOs) in various subject areas. Consider the intent of this LE and your choice of instructional and assessment strategies to determine which SLOs students may achieve, in addition to those identified.

English Language Arts

Consider the intent of this LE and your choice of instructional and assessment strategies to determine which SLOs students may achieve, in addition to those identified below:

- 1.2.1 *Develop Understanding* — Reflect on prior knowledge and experiences to arrive at new understanding.
- 1.2.2 *Explain Opinions* — Explain personal viewpoints in clear and meaningful ways and revise previous understanding.
- 1.2.3 *Combine Ideas* — Search for ways to reorganize ideas and information to extend understanding.
- 1.2.4 *Extend Understanding* — Appraise ideas for clarity and ask extending questions; select from others' experiences and ideas to extend ways of knowing the world.
- 5.2.1 *Cooperate with Others* — Assist group members to maintain focus and complete tasks; identify and solve group process issues.

Science

Consider the intent of this LE and your choice of instructional and assessment strategies to determine which SLOs students may achieve, in addition to those identified below:

- SLOs related to Scientific Inquiry or the Design Process in Cluster 0: Overall Skills and Attitudes.
- 6-3-01 Use appropriate vocabulary related to their investigations of electricity.
Include: positive charge, negative charge, current electricity, static electricity, electrical circuit, insulator, conductor, switch, series circuit, parallel circuit, electromagnet, magnetic field, motor, generator, transformation, electrical energy, renewable, non-renewable, energy consumption.
- 6-3-08 Demonstrate and describe the function of switches in electrical circuits.
- 6-3-09 Construct and diagram simple series circuits and simple parallel circuits.
- 6-3-10 Explore to determine factors that affect bulb brightness in simple series and parallel circuits.
Include: number of bulbs, number of batteries, placement of bulbs and batteries.
- 6-3-11 Use the design process to construct an electrical circuit that performs a useful function.
Examples: doorbell, alarm, motorized toy, game...

ICT LITERACY SKILLS AND COMPETENCIES

Consider the intent of this LE and your choice of instructional and assessment strategies to determine which skills and competencies students may achieve, in addition to those identified below:

- basic operating skills
- inquiry using electronic sources
- electronic publishing

SUGGESTED LEARNING RESOURCES**Software**

- web page authoring
- concept mapping
- *Crocodile Clips Elementary*

Note: This software is available on the CD-ROM version of the *Inventions, Innovations, and Discoveries* interdisciplinary unit.

Internet

- IMYM Links Database: <<http://www.edu.gov.mb.ca/ks4/tech/imym/resources/links.html>>

Video

- Manitoba Hydro. *Measuring and Using Electricity*. Videocassette. Winnipeg, MB: Manitoba Hydro, 1991. (VHS, 12 min.)

Print

- Appendix C: Index of Teaching and Learning Strategies and Tools
- Manitoba Education and Training. *Grades 5 to 8 Science: A Foundation for Implementation*. Winnipeg, MB: Manitoba Education and Training, 2000.
- ---. *Success for All Learners: A Handbook on Differentiating Instruction: A Resource for Kindergarten to Senior 4 Schools*. Winnipeg, MB: Manitoba Education and Training, 1996. (See Anticipation Guides, 6.25, 6.98.)

BLMs

- BLM Mod.3.3#1: Factors That Affect Bulb Brightness
- BLM Mod.3.3#2: Insulator or Conductor?
- BLM Mod.3.3#3: Checklist for Creating and Explaining Switches
- BLM Mod.3.3#4: Experiment Report

TBLMs

- TBLM Mod.3.3#1: Constructing a Prototype: Observation Checklist
- TBLM Mod.3.3#2: Experiment Report: Assessment

Materials

- 4.5-volt batteries
- plastic-coated wires
- paperclips or alligator clips
- light bulbs and bulb holders
- common classroom objects (e.g., pencil, key, eraser, utensil, ruler, chalk)
- cardboard
- thumbtacks

- tape
- circuits designed in Mod.3.2: Current Electricity

SUGGESTIONS FOR INSTRUCTION

Preparation and Set-up

- Have available several extra batteries and light bulbs of various voltages for students to use.
- Prepare an Anticipation Guide for the video that students will watch later. (See *Success for All Learners*, Anticipation Guide, 6.98.)

Activating Strategies

- **Note:** Explain and demonstrate proper handling techniques and safety procedures for equipment throughout this LE.
- Students review their light bulb circuits (from Mod.3.2: Current Electricity) posted in the classroom or on the class website.
- Students brainstorm for possible answers to questions such as the following (including processes they think happen with electricity) and explain their thinking:
 - How do you turn a lamp on and off?
 - Do you have to connect any wires when you turn on a lamp?
- Students watch an appropriate video on electricity, such as *Measuring and Using Electricity* (Manitoba Hydro). They begin to fill out the Anticipation Guide before viewing the video, and complete it after the showing.
- Demonstrate a circuit with a switch. Students discuss advantages of putting a switch on a circuit and describe the function it would serve (e.g., it facilitates turning off lamp, radio).
- Students use concept-mapping software to brainstorm and categorize kinds of switches used in electrical appliances (e.g., on-off, dial, push button, thermostat-controlled). Ask students whether there are electrical inventions that do not use a switch (e.g., kettle, clothes iron, popcorn popper, or any other invention that works immediately upon being plugged into an electrical outlet and stops working only when unplugged).

Acquiring Strategies

- Based on their previous experiments with circuits, both online and hands-on in the classroom, collaborative groups of students hypothesize and test what might make a light bulb brighter. (Consider number of batteries, number of bulbs on the same circuit, placement of batteries, length of wire, and so on.) Remind students that an experiment such as this one needs to have variables introduced and tested one at a time. Students note their observations on BLM Mod.3.3#1: Factors That Affect Bulb Brightness.
- In collaborative groups, students review each of their designed circuits from Mod.3.2: Current Electricity. They brainstorm and draw diagrams for possible parallel and series circuits that would improve on their original designs to make the bulb brighter.

Applying Strategies

- Review BLM Mod.3.3#4: Experiment Report with students to help them understand how to record their information.
- Assign points to each section of TBLM Mod.3.3#2: Experiment Report: Assessment. Review the form, explaining how students will assess themselves and how they will be assessed on their experiment.
- Individual students build their redesigned circuit. They note whether their design worked on the first try and hypothesize why or why not. If needed, they experiment until the design works. They record each modification and improvement on their design and note the results of each.

- Students use the same number of batteries and bulbs to build both a series circuit and a parallel circuit. Students experiment to determine which circuit will be brighter. They explain why in their science notebooks or on the class website.
- Students replace the light bulb with an alarm or a bell, and experiment with the circuit to make it ring.

Variations/Extensions

- Students experiment with including a switch in their model, following the design process described in Cluster 0: Overall Skills and Attitudes of the Grade 6 Science curriculum. Suggestions may be found by searching the IMYM Links Database for suitable websites. Students fill out BLM Mod.3.3#3: Checklist for Creating and Explaining Switches when they think they understand how switches work.
- Students write up their experiments, include conclusions and diagrams, and post them on the class website.
- Students experiment with using a variety of materials as switches, observing which materials carry the current (conductors) and which do not (insulators). They record their information and complete BLM Mod.3.3#2: Insulator or Conductor?
- Review the Word Splash started in Mod.3.1: Static Electricity to ensure that it contains all the applicable electricity vocabulary and that students understand and can appropriately use all the terms recorded.
- Students use their knowledge of switches and circuits to make an invention for the school Science Fair.

SUGGESTIONS FOR ASSESSMENT

- Observe the work of students in their groups as they hypothesize and test what makes a bulb brighter, using TBLM Mod.3.3#1: Constructing a Prototype: Observation Checklist.
- Verify students' completed BLM Mod.3.3#1: Factors That Affect Bulb Brightness to check for gaps in understanding. Note concerns and address them individually or with the class.
- Check students' diagrams for accuracy. Confer with collaborative groups as they improve on their designs. Read students' completed BLM Mod.3.3#4: Experiment Report and assess their reports based on TBLM Mod.3.3#2: Experiment Report: Assessment.
- Students fill out TBLM Mod.3.3#2: Experiment Report: Assessment and assign themselves a mark based on the possible points they can achieve. Review each student's self-assessment and assign a mark. Confer with students to discuss any discrepancies between their self-assessment and your assessment.
- Read students' completed self-assessment checklists (see BLM Mod.3.3#3: Checklist for Creating and Explaining Switches). Provide students with feedback.

CONNECTION TO INVENTION CONVENTION

- Students' experimentation with electricity helps them understand electricity as an important force behind major inventions and helps them think about how they can use electricity in developing their own invention.

BLM Mod.3.3#1: Factors That Affect Bulb Brightness

Name _____ Date _____

Carefully note your observations as you change one variable at a time in each electrical circuit.

Change or Variable	Circuit Type	Effect
<i>Example:</i> • Add one light bulb.	Series	The light will be dimmer.
	Parallel	The light will be brighter.
	Series	
	Parallel	
	Series	
	Parallel	
	Series	
	Parallel	
	Series	
	Parallel	

Factors That Affect Bulb Brightness: Adapted from *Grades 5 to 8 Science: A Foundation for Implementation* (Manitoba Education and Training 6.90).

BLM Mod.3.3#2: Insulator or Conductor?

Name _____ Date _____

As you experiment with different materials, note whether they are insulators or conductors.

Material	Insulator	Conductor
Definition of insulator :		
Definition of conductor :		
With which category of materials would you want to cover an electrical wire?		
Name some specific materials from that category that would provide a safe covering for electrical wire.		

BLM Mod.3.3#3: Checklist for Creating and Explaining Switches

Name _____ Date _____

Fill out this checklist when you think you understand how switches work. The teacher will also provide feedback.

Checklist	Student		Teacher	
	Yes	No	Yes	No
• I can connect the materials using a switch to control the electricity flow.				
• I understand that closing the switch (on) allows the electricity to flow.				
• I understand that opening the switch (off) stops the flow of electricity.				
• I provide a clear explanation of how a switch works.				
• I use the correct terminology.				
Teacher Comments				

Checklist for Creating and Explaining Switches: Adapted from *Grades 5 to 8 Science: A Foundation for Implementation* (Manitoba Education and Training 6.85).

BLM Mod.3.3#4: Experiment Report

Name _____ Date _____

Experiment _____

Testable Question:
Independent Variable:
Dependent Variable:
Prediction/Hypothesis: (Identify a cause and effect relationship.)

Planning for a Fair Test
<ul style="list-style-type: none">• Apparatus/Materials: • Variables to Hold Constant: • Method: (Include steps to follow and safety considerations.)

(continued)

Experiment Report: Adapted from *Grades 5 to 8 Science: A Foundation for Implementation* (Manitoba Education and Training BLM 6-H).

Experiment Report (continued)

Observations:

Analysis of Data: (Identify patterns and discrepancies)

Note: Attach graph on a separate page, if required.

(continued)

Experiment Report (continued)

Strengths and Weaknesses of Approach: (State what went well and what needs to be done differently next time.)

Conclusion: (Support or reject prediction/hypothesis; pose new question[s].)

Applications/Implications: (Link to daily life or area of study.)

TBLM Mod.3.3#1: Constructing a Prototype: Observation Checklist

Problem/Challenge _____ Date _____

A group of students can be selected as a focus for observation on a given day, and/or one or more of the observational areas can be selected as a focus. The emphasis should be on gathering cumulative information over a period of time.

Student Names	Has Safe Work Habits (workspace, handling equipment)	Works with Group Members to Carry out Plan	Participates in Analysis and Modification of Prototype	Shows Evidence of Perseverance and/or Confidence	Comments
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					
16.					
17.					
18.					

Constructing a Prototype: Observation Checklist: Reproduced from *Grades 5 to 8 Science: A Foundation for Implementation* (Manitoba Education and Training BLM 6-D).

TBLM Mod.3.3#2: Experiment Report: Assessment

Experiment Title _____ Date _____

Team Members _____

Criteria	Possible Points*	Self-Assessment	Teacher Assessment
Making a Prediction/Hypothesis <ul style="list-style-type: none"> The prediction/hypothesis clearly identifies a cause and effect relationship. 			
Planning for a Fair Test <ul style="list-style-type: none"> Required apparatus/materials are identified. Major variables to hold constant are identified. Steps to follow are included. Safety considerations are addressed. 			
Conducting a Fair Test/ Making and Recording Observations <ul style="list-style-type: none"> Detailed data are recorded and appropriate units are used. Data are recorded in a clear/well-structured/appropriate format. 			
Analyzing and Interpreting <ul style="list-style-type: none"> Graphs are included (where appropriate). Patterns/trends/discrepancies are identified. Strengths and weaknesses of approach are identified. 			
Drawing a Conclusion <ul style="list-style-type: none"> Prediction/hypothesis is supported or rejected. New question(s) is (are) identified. 			
Making Connections <ul style="list-style-type: none"> Potential applications to or implications for daily life are identified and/or links to area of study are made. 			
Total Points			
Comments			

* **Note:** The teacher or the class assigns possible points to reflect the particular emphasis(es) of the experiment.