Let's Do Science

Grade Five

Mechanisms Using Electricity

Science Alberta Programs for Your Classroom

science alberta FOUNDATION

Science-In-A-Crate

From digging for dinosaur bones to balancing a budget or learning about light, each trunk-sized "crate" contains everything you need to bring science and math to life in any learning environment. Science-In-A-Crate uses seven highly visual, hands-on and minds-on activities to illustrate how science is used in everyday situations, all directly linked to Alberta curriculum.

Crates are self-contained—they include everything you need to conduct science learning activities—including an activity guide with detailed, step-by-step instructions for each activity.

Visit www.sciencealberta.org for a complete listing of the crates available or call 403-220-0077 for a program guide.

Wonderville.ca

Step inside the whimsical world of Wonderville.ca, where colourful characters and enchanting environments stimulate learning through exciting online activities.

Wonderville.ca is an award-winning web site that makes science relevant, fun, and accessible to children, youth and families. Wonderville.ca is chockfull of world-class science content in a format that children and youth want to use—exciting digital activities, printable experiments, career videos and hidden science facts. The intriguing and engaging activities directly meet Alberta science curriculum knowledge outcomes from Grades 3 to 7.

Surf to Wonderville.ca to engage in the experience.

Mechanisms Using Electricity

Before You Begin

Students build electrical devices for a variety of purposes, using knowledge gained in the previous topic. Tasks that students are assigned may include such things as making a switch from scrap materials, making a device to control the speed of a motor, making a burglar alarm and lighting three bulbs from one source. Through work on these tasks, students learn the role of various components and control devices that are part of an electrical system. At the same time, they develop skills of problem solving and teamwork.

Topic B: Mechanisms Using Electricity

(Suggested time: 4 weeks)

This unit can be taught at any time of the year but should be done after Electricity and Magnetism so the children have a good working understanding of simple circuits. They will be applying this understanding to the construction and control of motorized devices.

Many of the materials used in the previous unit can be used again. Commercially available construction kits can be used to construct frames for toys and vehicles to which battery-powered electric motors will be attached.

Safety Issues

Short circuit wires can get very hot.

Background Information

Electric current is an extremely useful tool. We use it every day to light and heat our homes, run our appliances, power our toys, communicate, start our cars and to store, manipulate and transport information through computer technology. The operative properties and applications of electric current can be demonstrated simply and engagingly by expanding on the simple circuit introduced in the Electricity and Magnetism unit (see Fig. 1).

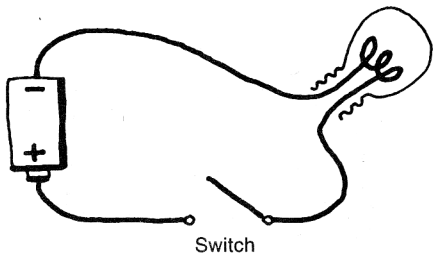

Figure 1.
Simple circuit.

Switches

The cell-bulb-switch circuit illustrated above is handy for experiments with switches. Students quickly discover it doesn't matter which way the bulb is connected to the cell—the bulb still lights. They also find it doesn't matter where the switch is located in the circuit: if either of the wires going from the cell to the bulb is switched open, a gap is created, the electric current doesn't flow and the light doesn't go on. Any method that brings two pieces of conductor together to complete a circuit is called a *switch*. Students can be very creative in coming up with ways to do this.

Series and Parallel Circuits

There are two basic ways that circuits can be set up. These are compared below. Series circuits are good for simple circuits such as flashlights or for circuits where you want all the loads to turn off and on together. Parallel circuits are designed to allow loads to be switched on and off independently. Most circuits in your homes are parallel.

Series Circuit

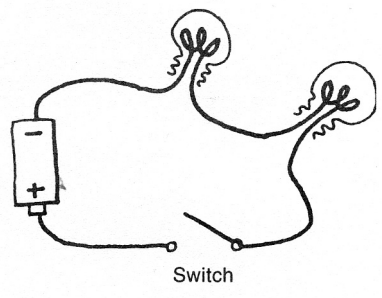

Figure 2.
Lights wired in series.

- Description: All loads are in a single row so electrons follow a single path through each one in turn. (See Fig. 2)
- Adding bulbs: The available power is shared by all loads. For each additional load (light bulbs, motors, buzzers, etc.) there is less power for each individual device so bulbs will dim.
- Removing bulbs: If a bulb is removed, the circuit is broken since the light bulb filament is actually part of the conductive circuit. Therefore, all loads on the circuit stop working.

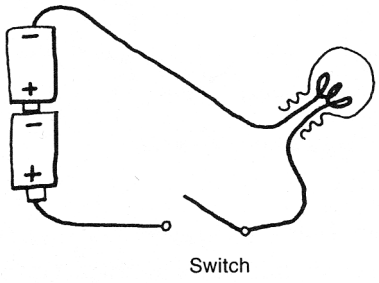

Figure 3.
Batteries wired in series.

- Adding cells: Cells added in series (end to end) will increase the total voltage supplied to the circuit. For example, two 1.5V cells in series create a voltage of 3.0V. (See Fig. 3)

Parallel Circuit

- Description: There is more than one path for current to follow. Any load on a separate path will be able to operate independently. (See Fig. 4)

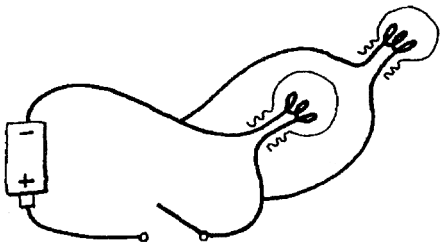

Figure 4.
Lights wired in parallel.

- Adding bulbs: Each separate pathway will have its own power supply that does not have to be shared. Bulbs will not dim, even when more are added as long as they each have their own path to the energy source.
- Removing bulbs: If you remove a light bulb from the circuit, current stops going down the path that's been broken, but there is still another path for the current to travel through. This means the second bulb will stay lit.
- Adding cells: You can add cells in parallel (side by side). This does not change the voltage. However, it does increase the life of the cells since they share the load. (See Fig. 5)

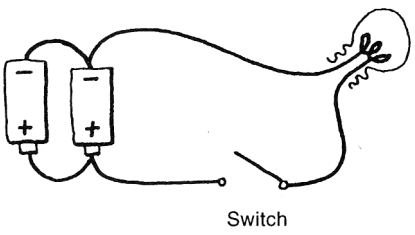

Figure 5.
Batteries wired in parallel.

Note: Students are not required to use the terms series and parallel at this point, but this vocabulary is scientifically accurate and it helps students differentiate types of circuits.

Motors

Motors convert electrical energy into mechanical energy. When experimenting with small, battery-run motors, have your students observe what happens when the cell *leads* (short wires connected to various loads or circuits, according to need) are reversed, connecting the positive (+) side of the cell where the negative (-) was before. The motor will run in reverse! Sometimes, as with the motor, reversing the *polarity* of the power source can be very useful. However, lots of devices won't work if the batteries are the "wrong" way around, and electronic devices can be harmed. Motors can be used in a wide range of devices, including vehicles, hoists or cranes and fans.

Elementary Science Program of Studies

General and Specific Learner Expectations

The following general and specific learner expectations have been taken directly from the 1996 Elementary Science Program of Studies. The specific learner expectations (SLEs) are referred to by number in the second column of the activities table.

General Learner Expectation

Students will be able to:

Construct simple circuits and apply an understanding of circuits to the construction and control of motorized devices.

Specific Learner Expectations

Students will be able to:

1. Identify example applications of electrical devices in the school and home environment and classify the kinds of uses. Categories of electrical use may include: heating, lighting, communication, moving, computing.
2. Design and construct circuits that operate lights and other electrical devices.
3. Recognize the importance of switches and other control mechanisms to the design and operation of electrical devices, and identify purposes of switches in particular applications.
4. Construct and use a variety of switches.
5. Design and construct vehicles or other devices that use a battery-powered electric motor to produce motion; e.g. model cars, hoists, fans.
6. Design and construct a burglar alarm.
7. Demonstrate different ways of lighting two lights from a single power source and compare the results. Students should recognize that wiring two bulbs in series makes both bulbs glow less brightly than if the bulbs are wired in parallel. Students may demonstrate this knowledge operationally and do not need to use the terms series and parallel.
8. Demonstrate different ways of using two batteries to light a bulb and compare the results. Students should recognize that wiring the batteries in series causes the bulb to glow brighter than it would if parallel wiring were used.
9. Given a design task and appropriate materials, invent and construct an electrical device that meets the task requirements.

Cross-curricular Connections

Art

- Appreciate aesthetics in the design process.

Mathematics

- Ratios when discussing gears for motors.

Social Studies

- The role of motorized devices such as the automobile in our changing culture.

Language Arts

- *Explorations in Science, Explore!* student book, Level 5.
- *Innovations in Science, Process and Inquiry*, Level 5.
- Research Canadian inventors with emphasis on electrical devices.

Children's Alternative Frameworks

Because of the belief that electricity involves the flow of atoms, students may wonder why electricity doesn't "leak out" when a switch is opened. In reality, as soon as a direct connection back to the source is severed, electrons immediately settle back into orbit around the nearest nucleus so the "flow" stops instantaneously.

Activities

Classroom teachers have identified the following activities that may be done to address the Specific Learner Expectations (SLEs) in the Program of Studies. The list is not prescriptive and teachers may select activities that are most appropriate for their students.

Activities have been listed under two headings: Key Activities and Extension Activities. Key activities are supported by authorized resources and identify "powerful and practical" means for achieving learner expectations. Extension activities represent alternative ways of achieving or supporting learner expectations.

Key Activities

Key Activity	SLE	Print Resources	Essential Materials	Comments
Introductory activity to assess students' current knowledge	1	*Science and Technology for Children, Magnets and Motors, Teacher's Guide, Lesson 1 (Getting Started—Pre-Unit Assessment)*, p. 7		Review knowledge gained from the Electricity and Magnetism unit. Ask your students the following. 1. What do you know about electricity, magnets and motors? 2. What questions do you have about electricity, magnets and motors? 3. What would you like to know? List or create a picture collage of all the ways they use electricity in their homes.
Identifying examples of electrical energy use	1	*Explorations in Science, Level 5, Energy for the Future (Energy Hunt)*, p. 10 *Electrical Connections (When I Was Ten)*, p. 92 *Electrical Energy: Teacher's Planning Guide* (Atwater et al.) *Introduction*, p. 6-9	Explorations line master 1	Discussion activity.
Exploring with electrical devices	2, 7, 8	*Explorations in Science, Level 5, Zap! It's Electric (Buzz, Zap, Flash)*, p. 23	hand generators, cells, wires, flashlight bulbs, 1.5V hobby motor, low-voltage buzzers, battery-powered toys, bicycle dynamos	This activity can be set up as a centre if materials are limited. Remind students not to attach a source with more voltage than the loads can handle. Otherwise, you will be constantly replacing light bulbs. Lights from Christmas tree strings are a cheap alternative to bulbs and holders.

Key Activity	SLE	Print Resources	Essential Materials	Comments
Designing and assembling series and parallel circuits	2, 7, 9, 8	*Innovations in Science, Level 5, Switched On (Electrical Pathways)*, p. 22 *Electrical Connections (Electric Circuits)*, p. 53 *Science and Technology for Children, Electric Circuits, Teacher's Guide, Lesson 16 (Wiring and Lighting a House)*, p. 85	Watts boxes (wire, alligator clips, type D-cells, cardboard tubes, elastics, three 6-volt light bulbs, bulb sockets, switches, aluminum foil, electrical tape, transparent tape, small box)	Have students represent their circuits using correct circuit symbols.
		Explorations in Science, Level 5, Zap! It's Electric (A Trio of Bright Ideas), p. 30 *Explorations in Science, Level 5, Zap! It's Electric (Parallel Circuits)*, p. 18 *Electrical Energy: Teacher's Planning Guide* (Atwater et al.) *(Different Paths)*, p. 36	bulb holders, battery holders, alligator clips, insulated wire with ends stripped, tape, paper clips, paper fasteners, cells, buzzer, cardboard, string, styrene foam trays, cardboard tubes, wood scraps, hammer, small nails, thumbtacks, clothespins, elastics, screws, screwdrivers, dowel lengths, straws, wire, switches	
Investigating and constructing various types of switches	3, 4, 6	*Innovations in Science, Level 5, Switched On (Walk/Don't Walk)*, p. 28 *Science and Technology for Children, Electric Circuits, Teacher's Guide, Lesson 12 (Learning About Switches)*, p. 69 *Electrical Connections (Make a Switch)*, p. 48	Watts box, materials to make signs (cellophane, translucent paper or overhead transparency acetate), scissors, markers	Remind students to never play with or insert anything into electrical outlets.
		Rainbow Technology (Gibson et al.)	Cell and holder, bulb and holder, 3 wires stripped or 3 wires with alligator clips plus:	These basic materials are used in constructing most of the switches.
		Activity 10: Slide Switches	Activity 10: Popsicle stick, aluminum foil, tacks, pin board, paper clip	Students can keep these switches in mind when designing a burglar alarm.
		Activity 11: Press Switches	Activity 11: materials from 10 plus a dowel	

Key Activity	SLE	Print Resources	Essential Materials	Comments
Investigating and constructing various types of switches (cont'd)		*Activity 12: Reversing Switches*	Activity 12: above materials plus a small electric motor	
		Activity 13: Making Switches from Everyday Items	Activity 13: double-sided sticky tape, narrow strip (3 mm) of thin metal, clothespin	
		Activity 15: Switches that Turn	Activity 15: cardboard disc, 10 cm in diameter, paper clip, cell, bulb and holder, pin board, insulated wire, bare wire	
		Activity 18: A Programmable Switch	Activity 18: card disc, foil, wire, bulbs, buzzers, LEDs	
		Activity 19: A Pressure Pad	Activity 19: 10 cm x 20 cm card, fire retardant foam, paper clip, wire, foil	
		Activity 20: Membrane Switches	Activity 20: cardboard, foil, paper clip, wire	
		Activity 23: Tilt Switches	Activity 23: film canister, paper clips, wire	
Constructing devices that use a battery-powered motor to produce motion	1, 3, 5, 9	*Explorations in Science, Level 5, Zap! It's Electric (Rotors and Motors)*, p. 29	hobby motors, wires with alligator clips, cells and holders, tape, paper, cardboard, stir sticks, corks, spools, string, tacks, scraps of wood, dowels, film canisters, Plasticine, rubber bands, foam trays, screws with eyes, hammer, nails, parts of old mechanical toys	
		Design and Make Activities, Grade 5, Electricity (Technology Teaching Systems), p. 1-25 of all three sections of the book	materials required vary with activity	

Key Activity	SLE	Print Resources	Essential Materials	Comments
Designing and building an alarm that uses a bell or a buzzer	1, 6	*Innovations in Science, Level 5, Switched On (Stop Thief!)*, p. 30	Watts boxes, 6V bell or buzzer, other materials to be chosen by students, such as shoe boxes, aluminum foil, etc.	Integrate into Language Learning with Dear Mr. Henshaw in *Innovations in Science, Level 5, Switched On*, p. 27.
		Technology IDEAS (Reynolds et al.), *It's Your Move*, p. 49	hammer, drill and bits, pliers, white glue, plastic containers, straws, chopsticks, tape, cells, bell or buzzer, aluminum cans, saw, 1-cm-square wood, aluminum foil	
		An Alarming Predicament, p. 43 (see book for a complete list of materials)	funnels, stir sticks, brass fasteners, stop watch, insulated wire, thumb tacks, marbles	
		Design and Make Activities, Grade 5, Electricity (Technology Teaching Systems), Design and Make a Warning System for a Mountainous Area	bulbs, sockets, wood, wire, thumbtacks, cells, cell holder	

Extension Activities

Extension Activity	SLE	Print Resources	Essential Materials	Comments
Building a flashlight out of basic components	2, 9	*Innovations in Science, Level 5, Switched On (May the Light Go with You)*, p. 12 *Science and Technology for Children, Electric Circuits, Lesson 13 (Constructing a Flashlight)*, p. 73	Watts boxes	
Designing a model boat that is powered by a battery-driven electric motor	5, 9	*Technology IDEAS* (Reynolds, Corney and Dale), *Prop It Up (Boat)*, p. 85	saw, sandpaper, chopsticks, foam tray, cells, electric motor, white glue, 3 m length plastic eavestrough, gears, drill, wood scraps, stir sticks, drinking straws	
Using a hand generator to light a flashlight bulb and power small motors or buzzers	1, 5	*Explorations in Science, Level 5, Energy for the Future (Electrical Energy)*, p. 13 *Science and Technology for Children, Magnets and Motors, Teacher's Guide, Lesson 16 (Generating Electricity)*, p. 99	hand generators, cells, wires, flashlight bulbs, 1.5V hobby motor, low-voltage buzzers, battery-powered toys, bicycle dynamo	
Building an electric motor	2, 3, 4, 9	*Science and Technology for Children, Teacher's Guide, Lesson 12 (Making a Motor)*, p. 77 *Science and Technology for Children, Teacher's Guide, Lesson 13 (Building a Spinning Coil Motor)*, p. 83 *Electrical Connections (How to Make an Electric Motor)*, p. 65	two 1.5V D-cells, 2 paper clips, 2 m enabled copper wire (#20), 2 small magnets, 6 thumbtacks, pliers, two 1-m pieces of insulated wire, small wooden base, sandpaper, knife switch	Add switch for control.

Extension Activity	SLE	Print Resources	Essential Materials	Comments
Discovering hidden circuits		*Explorations in Science, Level 5, Zap! It's Electric (Mystery Circuits)*, p. 24 *Science and Technology for Children, Electric Circuits, Lesson 9 (Hidden Circuits)*, p. 53	shoe boxes, metal paper fasteners, wire, alligator clips, bulbs, batteries, holders	
Using the sun to convert light into electricity with solar cells		*Explorations in Science, Level 5, Energy for the Future (Solar Cells)*, p. 18	solar cells, wires, hobby motors, plastic coffee stir sticks, modelling clay, masking tape, light source, cardboard, old plastic toy car, wooden spools, wooden dowelling, buzzers, bulbs, other materials as requested by students	

Assessment

For a broader discussion of science classroom assessment techniques see *Assessing Student Learning* in the introduction of this publication on p. 15. Good places to begin looking for the unit-related ideas are *Explorations in Science* assessment handbooks, *Innovations in Science* teaching notes, Unit tests and Portfolio ideas, Alberta Education sample tests at **www.education.gov.ab.ca** and Alberta Assessment Consortium at **www.aac.ab.ca**

Bibliography

Allen, Maureen et al. Electrical Connections. AIMS Educational Foundation, 1991. ISBN 1-8814-3128-2.

Ardley, Neil. *The Science Book of Electricity*. Toronto: Doubleday, 1991. ISBN 0-385-25343-0.

Atwater, Mary et al. *Electricity and Magnetism*. New York: Macmillan/McGraw-Hill, 1993. ISBN 0-02-274378-6/6.

Atwater, Mary et al. *Electrical Energy: Teacher's Planning Guide*. New York: Macmillan/McGraw-Hill, 1993. ISBN 0-02-274312-X/4.

Atwater, Mary et al. *Electrical Energy: Teacher's Assessment Guide*. New York: Macmillan/McGraw-Hill, 1993.

Campbell, Steve et al. *Explorations in Science, Level 5, Energy for the Future*. Don Mills, Ontario: Addison-Wesley, 1993. ISBN 0-201-88174-8.

Campbell, Steve et al. *Explorations in Science, Level 5, Zap! It's Electric*. Don Mills, Ontario: Addison-Wesley, 1993. ISBN 0-201-88162-4.

Case, Terry. *Click, Flash, Buzz, Whirr*. Toronto: Simon & Schuster, 1991. ISBN 0-7500-0869-5.

Gibson, Chris et al. *Rainbow Technology: Techniques for Primary Design and Technology*. Cheltenham, England: Stanley Thorne, 1993. ISBN 0-7487-1123-6.

Graf, Rudolph F. *Safe and Simple Electrical Experiments*. New York: Dover, 1973. ISBN 0-486-22950-5.

Harrison, Patricia et al. *Folens Science In Action: Teacher's Resource Book 1*. Dunstable, England: Folens, 1994. ISBN 1-85276255-1.

Math, Irwin. *Wires and Watts: Understanding and Using Electricity. New York*: Macmillan/McGraw-Hill, 1981. ISBN 0-02-274954-3.

Moore, Nancy. *Electrically Charged, The Complete Guide to Teaching Elementary Electricity*. Exclusive Educational Products, 1995.

National Science Resources Centre, *Science and Technology for Children, Electric Circuits Teacher's Guide*. Carolina Biological Supply Company, 1992.

National Science Resources Centre. *Science and Technology for Children, Magnets and Motors Teacher's Guide*. Carolina Biological Supply Company, 1992.

Ollershaw, Chris and Pat Triggs. *Toy Box Science: Electricity*. Milwaukee, Wisconsin: Gareth Stevens, 1994. ISBN 0-8368-1119-4.

Peturson, Rod and Neil McAllister. *Innovations in Science, Process and Inquiry, Level 5*. Toronto: Harcourt Brace & Company, Canada, 1996. ISBN 0-7747-0179-X.

Reynolds, Bill, Bob Corney and Norm Dale. *Technology IDEAS (Integrating Design Education Activities for Students)*. Don Mills, Ontario: Maxwell Macmillan, 1993. ISBN 0-02-954154-9.

Technology Teaching Systems. *Design and Make Activities Grade 5, Electricity*. Scarborough, Ontario: Technology Teaching Systems, 1994.

Zubrowski, Bernie. *Blinkers and Buzzers: Building and Experimenting with Electricity and Magnetism*. New York: Beech Tree Books, 1991. ISBN 0-68809-966-1.