Electrical Connections

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About **Electrical Connections**

DeltaScienceModules, THIRD EDITION

Students differentiate between static and current electricity after detecting static charges with electroscopes. The rest of the unit focuses on the transfer of electric energy by electric current. Students build, operate, and analyze circuits, becoming skilled in assembling bulbs, batteries, wires, and switches in parallel and series circuits. They explore the concepts of energy sources, receivers, and converters. Student-built galvanometers detect the presence, direction, and comparative amount of current in circuits. Students also experiment with factors such as resistance that affect current, and they convert electric energy to kinetic energy to operate a motor. In the final current activities, students model three-way and dimmer switches.

In the Delta Science Reader *Electrical Connections,* students read first about electric charge and the detection and discharge of static electricity. They learn about the energy delivered by electric current as it flows through circuits and become familiar with circuit components, types, and diagrams. Then they find out how the relationship between electricity and magnetism is utilized in motors, electromagnets, galvanometers, and generators. Students read about sources of electric energy, kinds of current, and everyday uses of electric power in our homes, schools, and businesses. These concepts are applied to the real world as students find out about safety issues and conservation concerns related to electricity.

Overview Chart for Hands-on Activities

Hands-on Activity	Student Objectives
1 **The Electroscope** *page 13*	• construct an electroscope • detect static charges • infer how objects gain static charges
2 **Simple Circuits** *page 21*	• construct a simple electric circuit • identify the parts of the circuit and their functions
3 **Circuit Symbols** *page 27*	• draw and interpret circuit diagrams • construct circuits from circuit diagrams • recognize series and parallel circuits
4 **The Galvanometer** *page 35*	• observe the interaction between a compass and a current-carrying loop of wire • build a galvanometer to detect current electricity
5 **Comparing Currents** *page 43*	• compare the brightness of light bulbs in different circuits • infer how the currents in the circuits compare • compare galvanometer readings in the above circuits • infer that a galvanometer can be used to compare currents in different circuits
6 **Conservation of Current** *page 51*	• construct a series circuit and a parallel circuit • record galvanometer readings at various locations in each circuit • deduce that current is conserved in a circuit
7 **Resistance** *page 59*	• observe the effect of Nichrome wire on the brightness of a light bulb in a circuit • observe the effect of Nichrome wire on galvanometer readings in a circuit • infer the effect of Nichrome wire on current in a circuit • infer that Nichrome wire is an energy converter
8 **Series Resistors** *page 67*	• observe the effect of resistors in series on the current in a circuit • construct a graph to analyze the effect of resistors in series on current
9 **Batteries in Series** *page 75*	• observe the effect of batteries in series on the brightness of a light bulb • infer the effect of batteries in series on the current in a circuit • construct a graph to analyze the effect of batteries in series on current
10 **Batteries in Parallel** *page 81*	• predict the effect of batteries in parallel on the brightness of a light bulb • construct a circuit containing batteries in parallel • analyze current measurements to determine the effect of batteries in parallel
11 **A Motor Model** *page 89*	• construct a simple motor • infer that a motor is an energy converter
12 **A Three-Way Switch Model** *page 95*	• construct a model of a three-way switch • develop a circuit diagram of a circuit containing two three-way switches
13 **A Control Circuit** *page 101*	• construct a circuit that controls the brightness of a light bulb • interpret a circuit diagram of this circuit • infer the function of a variable resistor in this circuit
Assessment *page 107*	• See page 107.

Process Skills	Vocabulary	Delta Science Reader
communicate, make and use models, infer, analyze	**conductor, electroscope, insulator, static charge**	pages 3–7, 19, 22
predict, make and use models, investigate	**battery, circuit, closed circuit, current electricity, electric current, energy, knife switch, open circuit, switch**	pages 7–11, 13–22
make and use models, communicate, compare	**circuit diagram, parallel circuit, series circuit**	pages 8, 10
observe, make and use models, predict, communicate	**electromagnetic field, galvanometer**	pages 3, 7, 11, 13, 15
make and use models, observe, compare, communicate, conclude		pages 11–13, 15, 17, 21
make and use models, compare, classify, predict, observe, record data, conclude		pages 10, 13
make and use models, observe, infer, conclude	**resistance**	pages 6–7, 9–10, 13, 19, 22
make and use models, record and display data, predict	**fixed resistor, resistor**	pages 7, 10
observe, predict, make and use models, record and display data, conclude	**electromotive force**	page 10
observe, predict, make and use models, communicate, analyze		page 10
communicate, conclude, make and use models, infer	**electric motor**	pages 13–15
make and use models, investigate, communicate	**three-way switch, two-way switch**	page 8
communicate, make and use models, interpret data, compare, infer, conclude	**potentiometer, rheostat, variable resistor**	page 8

See the following page for the Delta Science Reader Overview Chart.

Overview Chart for Delta Science Reader
Electrical Connections

Selections	Vocabulary	Related Activity
Think About...		
What Is Electric Charge? *pages 2–6* • Static Charge • Electric Force • Charging by Friction • Charging by Conduction • Charging by Induction • Detecting Charge • Static Discharge	**atom, charging by conduction, charging by friction, charging by induction, conductor, electric charge, electric energy, electric field, electric force, electron, electroscope, grounding, induced charge, insulator, ion, lightning, lightning rod, neutron, nucleus, proton, separation of charge, static charge, static discharge, static electricity**	Activity 1
What Is Electric Current? *pages 7–10* • Electric Circuits • Voltage, Resistance, and Current • Series and Parallel Circuits	**ampere, battery, circuit diagram, closed circuit, electric circuit, electric current, electric potential, gravitational potential energy, ohm, Ohm's law, open circuit, parallel circuit, potential difference, resistance, resistor, series circuit, switch, volt, voltage**	Activities 2, 3, 6, 7, 8, 9, 10
Electricity and Magnetism *pages 11–14* • Electromagnetic Force • Magnets • Electromagnets • Galvanometers • Electric Motors	**domain, electric motor, electromagnet, ferromagnetic material, galvanometer, magnet, magnetic field, magnetic field lines, magnetic force, magnetic pole, magnetism, permanent magnet, temporary magnet**	Activities 4, 5, 6, 11
Generating Electric Current *pages 15–17* • Energy Sources • Generators • Electrochemical Cells • Two Kinds of Current	**alternating current (AC), direct current (DC), dry cell, electrochemical cell, generator, transformer, wet cell**	
Electricity in Everyday Life *pages 18–20* • What Is Electric Power? • Using Electricity Safely • Conserving Electricity	**circuit breaker, electric power, electrolyte, fuse, kilowatt (kW), kilowatt-hour (kWh), nonrenewable energy source, power, renewable energy source, short circuit, watt**	Activities 12, 13
People in Science		
• **Joseph Henry** *page 21*		
Did You Know?		
• **About Superconductors** *page 22*		

Teaching suggestions for the Delta Science Reader are in a 32-page booklet included with this guide.

MATERIALS LIST

Electrical Connections

Quantity	Description
16	bases, circuit, plastic
36	batteries, D-cell*
5	battery holders, with clips, p/8
32	bulbs, flashlight, #14
32	bulbs, flashlight, #48
1	candles, birthday, p/36*
8	cardboard, sheets, 30 cm × 35 cm
16	cards, scale, galvanometer
2	clay, modeling, 1 lb
38	clips, electrical
80	clips, Fahnestock
4	coils, wire, nyleze #29, p/4
20	compasses, magnetic
16	cups, foam*
1	Delta Circuitworks™ base
1	Delta Science Dictionary
1	Delta Science Dictionary Copymaster Booklet
4	emery cloths*
1	glue, 4 oz*
64	graph paper, sheets*
16	magnets, disk
16	magnets, ferrite
4	measuring tapes, metric
1	nail
1	needle
1	paper clips, p/100
16	pie pans, aluminum foil
1	pins, map, p/100
2	pith balls, graphite-coated, p/8
1	plastic wrap, roll
16	plates, foam
16	pointers, galvanometer
3	posters, resource
2	resistors, 25-ohm, p/8
8	resistors, 50-ohm, p/8
2	rings, rubber
4	screwdrivers
32	sockets, bulb
16	stirrers, plastic
34	switches, knife
2	tape, masking, rolls*
1	thread, spool*
1	wire, copper, enamel-coated, #24, 18 m
1	wire, copper, enamel-coated, #29, 30 m*
1	wire, Nichrome, #32, 30 m*
110	wires, copper, insulated, stripped ends, 25 cm
1	wool, swatch, 30 cm × 60 cm
1	**Teacher's Guide**
8	**Delta Science Readers**

TEACHER-PROVIDED ITEMS

1	knife
4	marking pens
17	scissors

* = consumable item

† = in separate box

ACTIVITY SUMMARY

This Delta Science Module is directed toward increasing students' understanding of static and current electricity, electric circuits, and simple electric energy converters. The activities are designed to give students concrete experiences in building, operating, and analyzing electric circuits and their applications.

ACTIVITY 1 Students construct an electroscope to detect static charges. They see that electric charge can be transferred (by contact) from one object to another. By analyzing how objects gain and lose charges, students determine that materials can be classified as conductors or insulators.

ACTIVITIES 2 and 3 Students are introduced to the concept of electric current as a means of transferring electric energy. They construct simple, and then more complex, electric circuits using batteries, bulbs, wires, and switches. As students manipulate each of these circuit elements, they are introduced to the concepts of electric energy sources, energy receivers, and energy converters. They also learn how to interpret and draw circuit diagrams and differentiate between parallel and series circuits.

ACTIVITY 4 Students observe the interaction between a compass and a current-carrying loop of wire, build a galvanometer, and observe that the galvanometer can detect the presence of an electric current.

ACTIVITY 5 Students compare the brightness of light bulbs in different circuits and then compare the galvanometer readings from these circuits. They learn that the degree of deflection of the needle of a galvanometer can be used to compare the amount of current in different circuits.

ACTIVITY 6 Students construct series and parallel circuits and record the galvanometer readings at various locations in each circuit. They deduce from their observations that current is conserved in a circuit.

ACTIVITY 7 Students are introduced to the concept of resistance and its effect on current. Using Nichrome wire, students observe the effect of a resistor on the brightness of a light bulb and on galvanometer readings in a circuit.

ACTIVITY 8 Students investigate the quantitative effect of resistors in series on electric current in a circuit and analyze their results in a graph.

ACTIVITY 9 Students determine the quantitative effect of batteries in series and analyze their results in a graph.

ACTIVITY 10 Students analyze the effects of resistors and batteries in parallel circuits.

ACTIVITY 11 Students return to the concept of energy converters in circuits as they construct a simple motor, relate the principles of its operation to those of a galvanometer, and determine that electric energy can be converted to kinetic energy.

ACTIVITY 12 Students construct a model of a three-way switch and develop a circuit diagram of a circuit containing two three-way switches.

ACTIVITY 13 Students use Nichrome wire in a circuit to model a dimmer switch for a light bulb.