Electromagnetism

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About **Electromagnetism**

DeltaScienceModules, THIRD EDITION

Students explore one of the fundamental physical forces in nature: electromagnetism. Students first investigate the properties of magnetism: magnetic interaction, magnetic fields, polarity, attraction and repulsion of like and unlike poles, and the cumulative strength of multiple magnets. Compass needle deflections indicate to students that, like a magnet, an electric current creates a magnetic field, and the connection is made between electricity and magnetic force. Students construct an electromagnet and two useful electromagnetic devices: a telegraph and a buzzer. Then they make simple and complex motors, observing how the fields of electromagnets and permanent magnets interact to produce rotation.

In the Delta Science Reader *Electromagnetism,* students discover what electricity is and read about static electricity, current electricity, and electric circuits. They learn about magnets and magnetism and discover how electric current is used to make electromagnets. They also find out how generators produce electricity and how electric motors work. In a biographical sketch they are introduced to a famous scientist—Samuel Morse—and his invention of both a practical telegraph system and the signaling code that was named after him. Finally, students learn about the many uses of electromagnets.

Overview Chart for Hands-on Activities

Hands-on Activity	Student Objectives
1 **Magnetic Attraction** *page 13*	• observe that magnets attract materials that contain iron • predict magnetic attraction • record and interpret magnetic attraction data
2 **Magnetic Fields** *page 19*	• use iron filings and a magnet to create and explore magnetic field patterns • predict and observe the pattern created by the interaction of two magnetic fields
3 **Multiple Magnets** *page 25*	• observe the interaction between a magnetic field and a compass needle • demonstrate an increase in the strength of a magnetic field by increasing the number of magnets • record evidence of the increase in strength of the magnetic field
4 **Temporary Magnetism** *page 31*	• introduce a ferrous material into a magnet's magnetic field • temporarily magnetize a nail • determine that a temporarily magnetized object has magnetic poles
5 **A Compass in a Circuit** *page 37*	• construct a circuit • observe the interaction between electric current flowing in a circuit and a compass • conclude that the flow of electric current in a circuit creates an electromagnetic field • conclude that a compass can be used to test a circuit for the presence of current
6 **Building an Electromagnet** *page 43*	• construct and use an electromagnet • alter one variable at a time to determine the relative strength of an electromagnet • record and graph data obtained from their experiments with electromagnetism
7 **Talking with a Telegraph** *page 49*	• construct a telegraph • trace the path of electric current through the circuit of a telegraph • observe that a telegraph works based on the principles of electromagnetism
8 **Building a Buzzer** *page 57*	• construct a buzzer • trace the path of electric current through the circuit of a buzzer • observe that a buzzer works based on the principles of electromagnetism
9 **A Simple Motor** *page 63*	• construct a simple motor • describe the relationship between electric current and magnetism in a simple motor • trace the path of electric current in a simple motor
10 **A Motor Model** *page 69*	• construct a motor • infer the relationship between rotating electromagnets and fixed permanent magnets • determine the function of brushes in a motor
11 **Opposing Electromagnetic Fields** *page 77*	• observe the effects of aligning electromagnetic fields • observe the effects of opposing electromagnetic fields
Assessment *page 85*	• See page 85.

Process Skills	Vocabulary	Delta Science Reader
observe; predict; compare; classify; collect, record, display, or interpret data	**attract, magnet**	pages 6–7
predict, observe, infer	**field lines, force, magnetic field, poles, repel**	pages 6–7
predict; hypothesize; experiment; use variables; measure; collect, record, display, or interpret data	**compass**	pages 6–7
observe, define based on observations, infer	**ferrous, temporary magnet**	pages 6–7
observe, compare, infer	**circuit, electric current, electromagnetic field, electron, energy, polarity**	pages 2–5
experiment; use variables; use numbers; collect, record, display, or interpret data	**electromagnet, energy, series circuit**	pages 8–9
make and use models, communicate	**communicate, Morse code, switch, telegraph**	page 14
make and use models, observe, infer	**buzzer**	pages 2–5, 8–9
hypothesize, experiment, use variables, observe, infer	**armature, mechanical energy, motor, permanent magnet**	page 13
make and use models, observe, infer	**brush**	page 13
observe, compare, infer	**aligning, opposing**	pages 8–9

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

Overview Chart for Delta Science Reader
Electromagnetism

Selections	Vocabulary	Related Activity
Think About...		
What Is Electricity? *page 2*	**atom, electric charge, electric energy, electricity, electron, energy, mechanical energy, neutron, nucleus, proton**	Activity 5
• Static Electricity *page 3*	**static electricity**	
• Current Electricity *page 4*	**conductor, current electricity, insulator, resistance**	
• Electric Circuits *page 4*	**electric circuit, parallel circuit, series circuit, switch**	
What Is Magnetism? *page 6*	**domain, field lines, magnet, magnetic field, magnetic poles, magnetism, permanent magnet, temporary magnet**	Activities 1, 2, 3, 4
Using Electric Current to Make Magnets *page 8*	**electromagnet**	Activities 6, 11
Using Magnets to Make Electric Current *page 10*		
• Generators *page 11*	**generator**	
How Do Electric Motors Work? *page 13*	**electric motor**	Activities 9, 10
People in Science		
• **Samuel F. B. Morse** *page 14*		Activity 7
Did You Know?		
• **About the Uses of Electromagnets** *page 15*		Activity 8

See pages 93–101 for teaching suggestions for the Delta Science Reader.

MATERIALS LIST

Electromagnetism

Quantity	Description
48	batteries, D-cell*
16	battery holders
16	brushes, motor
16	compasses
8	Delta Circuitworks™ bases
64	electrical clips
8	emery cloths, 10 cm × 10 cm*
32	Fahnestock clips
8	foam cylinders
18	hex nuts and screws
1	iron filings, 500 g
32	magnets, bar
128	magnets, rubberized
8	metal strips
16	nails
1	paper clips, large, p/100*
2	paper clips, small, p/100*
1	paper fasteners, p/100*
11	rods, plastic
32	rubber grommet spacers
16	rubber rings
1	tape, masking*
1	thread*
16	vials, shaker, with caps
1	wire cutters
1	wire, enamel-coated, 240 m
1	wire, plastic-insulated, 30 m
1	**Teacher's Guide**
8	**Delta Science Readers**

Quantity	Description
TEACHER-PROVIDED ITEMS	
–	assorted objects to be tested for magnetic attraction
3	board erasers
3	ceramic coffee cups
3	keys, metal
32	paper, white*
3	pencils
16	rulers, metric, plastic and metal
1	scissors
3	soft drink cans, empty
3	soup cans, empty
3	spoons, plastic and metal
–	string*
–	tape, transparent*
3	thumbtacks

* = consumable item

† = in separate box

ACTIVITY SUMMARY

In this Delta Science Module, students are introduced to electromagnetism and the conversion of energy from one form into another by means of electric currents and magnetic fields.

ACTIVITY 1 Students review the properties of magnetism by observing the interaction of magnets with ferrous and nonferrous objects.

ACTIVITY 2 Using magnets and iron filings, students observe the pattern formed by the magnetic lines of force that make up the magnetic field surrounding a magnet. In particular, they note the increased density of the field at a magnet's poles. The relationship between like and unlike poles and attraction and repulsion is also demonstrated by the students.

ACTIVITY 3 Students investigate a compass and observe the interaction of its needle with the magnetic field surrounding a magnet. They then use a compass to measure the cumulative magnetic effect of stacking magnets.

ACTIVITY 4 Students demonstrate how a ferrous object placed within the magnetic fields of two stacks of magnets can become magnetized. Students discover the polarity of the ferrous object when it is in magnetic fields that are aligned and when it is in magnetic fields that are opposed.

ACTIVITY 5 Students discover the phenomenon of electromagnetism by comparing the interaction of a compass needle and a magnet to that of a compass needle and a wire with electric current flowing through it. As both the magnet and the current deflect the compass needle, students are able to infer that the current must be producing a magnetic field around the wire. The students also discover the usefulness of a compass in detecting electric current in a wire.

ACTIVITY 6 Students apply what they have learned about electromagnetism to construct an electromagnet—a ferrous object surrounded by coils of wire through which electric current is flowing. Students observe that the strength of the electromagnet is determined by several variables, including the amount of electric current in the wire.

ACTIVITIES 7 and 8 Students observe some practical applications of electromagnetism when they construct a telegraph and a buzzer. Using the telegraph in conjunction with the Morse code, students experiment with one of the earliest forms of electrical communication.

ACTIVITY 9 Students construct a simple motor to demonstrate the concept that electromagnetic and magnetic fields can interact to produce the motion of rotation. By experimenting with different variables, students reinforce their understanding of the principles responsible for a motor's operation.

ACTIVITY 10 Students construct a more elaborate motor complete with a two-coil armature and brushes. They observe the transfer of energy from the batteries to the coils of wire on the armature via continual, momentary electrical contact between the coils and the brushes.

ACTIVITY 11 Students experiment to determine the effect of two electromagnetic fields on one ferrous object. They observe how, much like magnetic fields, two electromagnetic fields can align or oppose each other, resulting in either increased or decreased strength of the electromagnet.