Electricity Program of Study Standards and Benchmarks

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ELECTRICITY PROGRAM OF STUDY Standards and Benchmarks

Standard	K-2 Benchmarks	Grades 3-5	Grades 6-8	Grades 9-12
US National Science Standard **Understands energy types, sources, and conversions, and their relationship to heat and temperature.** *Project 2061: Benchmarks for Science Literacy, p. 81 (Implied)*	Knows that electricity in circuits can produce light, heat, sound, and magnetic effects. Benchmark, Declarative • *NRC: National Science Education Standards, p. 127 (Explicitly Stated)* • *CDE: Science Framework for California Public Schools, p. 68 (Explicitly Stated)* • *NAEP: 1996 Science Framework, p. 60 (Implied)* • *New Standards: Elementary School, p. 132(Implied)* • *NAEP: Science Assessment and Exercise Specifications, p. 95 (Implied)*	Knows the organization of a simple electrical circuit (e.g., battery or generator, wire, a complete loop through which the electrical current can pass). Benchmark, Declarative • *NRC: National Science Education Standards, p. 127 (Explicitly Stated)* • *CDE: Science Framework for California Public Schools, p. 68 (Explicitly Stated)* • *New Standards: Elementary School, p. 132 (Implied)* • *NAEP: Science Assessment and Exercise Specifications, p. 93 (Implied)*	Knows that electrical circuits provide a means of transferring electrical energy to produce heat, light, sound, and chemical changes. Benchmark, Declarative • *NRC: National Science Education Standards, p. 155 (Explicitly Stated)* • *International Baccalaureate: Middle Years Science, p. 35, pp. 126-129 (Implied)* • *International Baccalaureate: Physics, pp. 38-39 (Implied)* • *NAEP: Science Assessment and Exercise Specifications, p. 101 (Explicitly Stated)*	
US National Science Standard **Knows the kinds of forces that exist between objects and within atoms.** • *Project 2061: Benchmarks for Science Literacy, p. 93 (Explicitly Stated)*		Knows that electrically charged material pulls on all other materials and can attract or repel other charged materials. Benchmark, Declarative • *Project 2061: Benchmarks for Science Literacy. p. 94 (Explicitly Stated)* • *CDE: Science Framework for California Public Schools, p. 68 (Explicitly Stated)*	Knows that just as electric currents can produce magnetic forces, magnets can cause electric currents Benchmark, Declarative • *Project 2061: Benchmarks for Science Literacy, p. 95 (Implied)* • *CDE: Science Framework for California Public Schools, p. 69 (Explicitly Stated)* • *International Baccalaureate: Physics, pp. 39-40, 55 (Explicitly Stated)* • *NAEP: Science Assessment and Exercise Specifications, p. 100 (Explicitly Stated)* • *Pearsall: NSTA: The Content Core, p. 108 (Explicitly Stated)*	

Michigan Standards, Science Matter and Energy **All students will measure and describe the things around us**.	1. Classify common objects and substances according to observable attributes/properties. *Key concepts*: See PME-IV.1 e.2 (materials that conduct electricity); C-I. 1 e.4 (use measuring devices). 2. Identify properties of materials which make them useful. *Key concepts*: Useful properties—unbreakable, water-proof, light-weight, conducts electricity (see PME-IV. 1 e.4, electric circuits), conducts heat, attracted to a magnet, clear. See EG-V.1 e.4 (uses of earth materials). *Real-world contexts*: Appropriate selection of materials for a particular use, such as waterproof raincoat, cotton or wool for clothing, glass for windows, metal pan to conduct heat, copper wire to conduct electricity.	(Does not include information about electricity)	(Does not include information about electricity)
Michigan Standards, Science Matter and Energy	3. Identify forms of energy associated with common phenomena.		

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All students will identify and describe forms of energy.	*Key concepts*: Heat, light, sound, food energy, energy of motion, electricity (see PCM-IV.2 e.1 about heat, PWV-IV.4 e.1-4 about light and sound, PME-IV.1 e.4 about electricity, LEC-III.5 e.2 about energy from food). *Real-world contexts*: Appropriate selection of energy and phenomena, such as appliances like a toaster or iron that use electricity, sun's heat to melt chocolate, water wheels, wind-up toys, warmth of sun on skin, windmills, music from guitar, simple electrical circuits with batteries, bulbs and bells.		
Michigan Standards, Science Matter and Energy **All students will explain how electricity (and magnetism; see PMO) interact with matter.**	4. Construct simple, useful electrical circuits. (3-5) Key concepts and tools: Complete loop; batteries, bulbs, bells, motors, wires, electrical switches (see PME-IV.1 e.2, materials that conduct electricity). *Real-world contexts*: Flashlights, battery-powered toys. 5. Describe possible electrical hazards to be avoided at home and at school. (K-2) *Key concepts*: Shock, wall outlet, hazards; see PME-IV. 1 e.3 (electrical energy). *Real-world contexts*: Electric outlets, power lines, frayed electric cords, electric appliances, lightning, hair dryers in sinks and tubs.	5. Construct simple circuits and explain how they work in terms of the flow of current. *Key concepts and tools*: Complete circuit, incomplete circuit, short circuit, current, conductors, non-conductors, batteries, household current, bulbs, bells, motors, electrical switches. *Real-world contexts*: Household wiring, electrical conductivity testing, electric appliances. 6. Investigate electrical devices and explain how they work, using instructions and appropriate safety precautions. *Key concepts*: Flow of electricity for energy or information transfer. Safety precautions for using electrical appliances; grounding. Documentation for toys and appliances—wiring diagrams, written instructions. *Real-world contexts*: Situations requiring assembly, use, or repair of electrical toys, radios, or simple appliances, such as replacing batteries and bulbs; connecting electrical appliances, such as stereo systems, TV's and videocassette recorders, computers and computer components.	4. Explain how current is controlled in simple series and parallel circuits. *Key concepts*: Single path, multiple paths, switches, fuses, circuit breakers, power supply, batteries, household current, motors, bulbs, circuit diagrams. *Real-world contexts*: Basic household wiring, automobile wiring, flashlights, tree lights, power lines; electrical conductivity testing. 5. Describe how electric currents can be produced by interacting wires and magnets, and explain applications of this principle. *Key concepts*: Current flow and direction, magnetic fields. See PMO-IV.3 m.4 (magnetism from electricity). *Real-world contexts*: Generators, alternating current, direct current.

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British National Curriculum **Summary of Objectives for Key Stages for:** **Electricity**	Key Stage 1 (ages 5-7) <u>Circuits</u> • everyday appliances that use electricity • about simple series circuits involving batteries, wires, bulbs and other components [for example, buzzers, motors] • how a switch can be used to break a circuit. During key stage 1 pupils observe, explore and ask questions about living things, materials and phenomena. They begin to work together to collect evidence to help them answer questions and to link this to simple scientific ideas. They evaluate evidence and consider whether tests or comparisons are fair. They use reference materials to find out more about scientific ideas. They share their ideas and communicate them using scientific language, drawings, charts and tables.	Key Stage 2 (ages 8-11) <u>Simple circuits</u> • to construct circuits, incorporating a battery or power supply and a range of switches, to make electrical devices work [for example, buzzers, motors] • how changing the number or type of components [for example, batteries, bulbs, wires] in a series circuit can make bulbs brighter or dimmer • how to represent series circuits by drawings and conventional symbols, and how to construct series circuits on the basis of drawings and diagrams using conventional symbols. During key stage 2 pupils learn about a wider range of living things, materials and phenomena. They begin to make links between ideas and to explain things using simple models and theories. They apply their knowledge and understanding of scientific ideas to familiar phenomena, everyday things and their personal health. They begin to think about the positive and negative effects of scientific and technological developments on the environment and in other contexts. They carry out more systematic investigations, working on their own and with others. They use a range of reference sources in their work. They talk about their work and its significance, and communicate ideas using a wide	Key Stage 3 (ages12-14) <u>Circuits</u> • how to design and construct series and parallel circuits, and how to measure current and voltage • that the current in a series circuit depends on the number of cells and the number and nature of other components and that current is not 'used up' by components • that energy is transferred from batteries and other sources to other components in electrical circuits <u>Magnetic fields</u> • about magnetic fields as regions of space where magnetic materials experience forces, and that like magnetic poles repel and unlike poles attract <u>Electromagnets</u> • that a current in a coil produces a magnetic field pattern similar to that of a bar magnet • how electromagnets are constructed and used in devices [for example, relays, lifting magnets]. During key stage 3 pupils build on their scientific knowledge and understanding and make connections between different areas of science. They use scientific ideas and models to explain phenomena and events, and to understand a range of	Key Stage 4 (ages 15-17) <u>Circuits</u> • that resistors are heated when charge flows through them • the qualitative effect of changing resistance on the current in a circuit • the quantitative relationship between resistance, voltage and current • how current varies with voltage in a range of devices [for example, resistors, filament bulbs, diodes, light dependent resistors (LDRs) and thermistors] • that voltage is the energy transferred per unit charge • the quantitative relationship between power, voltage and current <u>Mains electricity</u> • the difference between direct current (dc) and alternating current (ac) • the functions of the live, neutral and earth wires in the domestic mains supply, and the use of insulation, earthing, fuses and circuit breakers to protect users of electrical equipment • how electrical heating is used in a variety of ways in domestic contexts • how measurements of energy transferred are used to calculate the costs of using common domestic appliances

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		range of scientific language, conventional diagrams, charts and graphs. 1a --> ICT opportunity Pupils could use simulation software to extend an investigation of components in a series circuit. Note for 1b Resistance does not need to be taught.	familiar applications of science. They think about the positive and negative effects of scientific and technological developments on the environment and in other contexts. They take account of others' views and understand why opinions may differ. They do more quantitative work, carrying out investigations on their own and with others. They evaluate their work, in particular the strength of the evidence they and others have collected. They select and use a wide range of reference sources. They communicate clearly what they did and its significance. They learn how scientists work together on present-day scientific developments and about the importance of experimental evidence in supporting scientific ideas 1a --> ICT opportunity Pupils could use simulation software to investigate and model circuits.	<u>Electric charge</u> • how an insulating material can be charged by friction • about forces of attraction between positive and negative charges, and forces of repulsion between like charges • about common electrostatic phenomena, in terms of the movement of electrons • the uses and potential dangers of electrostatic charges generated in everyday situations [for example, in photocopiers and inkjet printers] • the quantitative relationship between steady current, charge and time • about electric current as the flow of charge carried by free electrons in metals or ions during electrolysis. They explore how technological advances relate to the scientific ideas underpinning them. They consider the power and limitations of science in addressing industrial, ethical and environmental issues. They do more quantitative work and evaluate critically the evidence collected and conclusions drawn. They see how scientists work together to develop new ideas, how new theories may, at first, give rise to controversy and how social and cultural contexts may affect the extent to which theories are accepted.

