Electricity & Magnetism Planning Chart

Anchor Phenomenon: What causes the Earth's magnetic field?

Lesson #	Lesson Title	# Days	Storyline	Main Activity	Vocabulary	Materials
1	What is Magnetism?	1	The Earth and small magnets both have magnetic fields.	Observe the effect of the Earth's magnetic field on a small compass, compared with that of a nearby bar magnet.	magnet magnetic field	compasses bar magnets strong bar magnet for the teacher
2	Exploring with Magnets	1	A dipole magnetic field has a predictable structure which can be observed through interaction with iron filings.	Demo and exploration activity: iron filings interact with magnetic field lines around a magnet.	dipole attract/attraction repel/repulsion	strong bar magnet iron filings scales
3	Experimenting with Magnets (1-2 days)	2	Experiments, designed methodically, can be used to explore magnetic interactions.	Design, run, revise, and exchange feedback on an experiment that helps answer the investigation question about magnetic interactions they formulated in the previous lesson.	iteration reproducibility	iron filings clear plastic cup with lid (taped closed, with iron filings inside) bar magnets ring magnets paper clips nails or other metallic objects compass, variety of other magnets: round, horseshoe, magnets in plastic casing (optional) metric rulers tray (recommended)
4	Magnetic Force and Potential Energy	1	Magnetic and gravitational fields both extend through space and effect objects at a distance. Potential energy is stored in magnetic systems.	Complete a set of magnetic challenges that explore how magnets interact with one another, analyze in terms of potential energy.	force (review) potential energy (review) system (review)	ring magnets bar magnets compasses metric rulers pencils trays (recommended)
5	Modeling a Magnetic Field	1	Magnetic fields are invisible unless interacting with visible particles, but once they are understood, they can be modeled.	Draw a conceptual model of a magnetic field. Revise the model before submitting for assessment.	scientific model (review)	tape colored pencils or markers for drawing models construction paper poster paper cut into quarters (optional)
6	Static Electricity and Lightning	1	The behavior of static electricity is similar to that of a magnetic field, and connects the phenomena of magnetism and electricity to one another.	Consider the phenomenon of lightning, observe the effects of static electricity when balloons are rubbed. Model what might be happening and consider what charged particles might be responsible for this behavior.	charge discharge static electricity field electric field potential energy	balloons string scissors paper
7	Making a Temporary Magnet	1	Temporary magnetism can be created by exposure to permanent magnets or electrical current. Electricity and magnetism are interrelated.	Observe 2 temporary magnets, 1 created using a permanent magnet and 1 using electromagnetism. Create a new model of Earth's magnetic field that incorporates understanding of electromagnetism.	electromagnet electric current	copper wire 3 m length (22 gauge, lightly coated "magnet wire") battery (1.5V, e.g., AA or AAA) non-galvanized iron or steel nail (2 inch or longer) sandpaper (fine grain) battery holder with red and black lead wires (recommended) strong bar magnets (recommended) iron nails (recommended) paper clips (recommended)

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8	Exploring Simple Circuits	1	Electricity is energy that flows via matter in the form of electrons. An electrical circuit is made of different components that generate, transport or use energy.	Explore and build circuits. Experiment to discover the effect of different numbers and arrangements of batteries and bulbs on the circuit overall.	power source circuit system (review) component (review)	conventional plug-in lamp with 2-prong plug (recommended, for demo) voltmeter/multimeter (optional, for Extension) with instructions simple inexpensive ones work best with these circuits **Per Group**: multiple batteries (at least 2 AA, C, or D batteries), battery holder(s) for whatever types of batteries you have (recommended), 3 wires (recommended: with alligator clips), 2 or 3 small light bulbs (flashlight lamps: 4.8V, or other bulbs with low voltage rating), Mini bulb holders to fit bulbs (optional), OR old string of holiday lights, wirecutter/wirestripper. **Advanced Prep:** make sure to test out circuit components before class to make sure they are functional/safe.
9	Exploring Circuit Components	1	Circuit configuration can vary and produces different function based on numbers of components using power and amounts of power supplied. Motors connect electricity and magnetism.	Analyze the parts of a circuit familiar from the last lesson, and consider a new component: a motor.	power resistor	**Per class:** Variety of batteries (A, AA, AAA, C, D, 9V, watch battery), Paper, scissors, and tape, voltmeters/multimeters with instructions (optional, for the Extension) **Per group:** multiple batteries (at least 2 AA, C, or D; 9 V), battery holders to fit available batteries (recommended, or tape), 3 wires (recommended: with alligator clips, or use tape), 2 small light bulbs (flashlight lamps: 4.8 V or 6.3 V),1 or 2 small motors (1.5 V – 3 V range or similar), small plastic propellers to fit on motor, or paper/cardstock for students to make their own blades **Advanced Preparation:** Before class, set out a variety of batteries where students can see them. If possible, provide enough batteries so students can handle a few during the Opener as well. Label the voltage ratings on the bulbs and motors with permanent marker or small stickers (recommended).
10	Review and INTERIM ASSESSMENT (1-2 days)	2	Review basic concepts of electricity and magnetism.	Create a booklet for younger students about electromagnetism, using written and visual explanations. Complete a short assessment.	none	paper, 1-2 sheets per student (legal: 8.5x14 or ledger: 11x17) for making booklets colored pencils or markers Students' models from Lesson 5 (optional, allows students to build on earlier work)
11	Conductors and Insulators	1	Electrons flow in a closed circuit, and insulating and conducting materials affect their flow.	Explore the conductive and insulating properties of a wide array of materials in the classroom and discuss the importance of each to maintaining electrical current in a circuit.	conductor insulator	Periodic table poster (recommended) electromagnet set up from Lesson 7 bare copper wire (recommended, ~3m) **Per group**: battery (e.g. 1 AA), battery holder, 3 wires (recommended: with alligator clips), 1 small light bulb (e.g. flashlight lamp: 4.8V, 0.5A),different objects or materials to test for conductivity (including rocks, if possible)
12	How to Make an Electric Motor	1	Electricity can be used to generate a magnetic field, which is the basis for the function of an electric motor.	Construct a motor out of wire and magnets that will spin. Explain how the motor works.	none	Electromagnetic nail setup from Lesson 7 (optional) **Per group/pair**: bare copper wire, tape, coated copper wire, wire strippers, sandpaper, batter (C,D or AA), thick marker to wrap wire around (optional), battery holder, 2 copper wires with alligator clips, 2 ring magnets, 'How to Make an Electric Motor' handout

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13	Circuit Project—Design	1	Circuits are used for home electrical systems, and need to be planned to provide needed features and function correctly.	Draft circuit designs and home layouts for their projects in order to prepare for building in the next lesson.	none	**Per pair/group**: shoebox, ruler circuit materials from earlier lessons (to view only, or post a list, so students know what project materials are available) resistors mini solar panels (optional) small hand-crank generators (optional) sliders/dimmers (optional) nails (optional) screwdrivers (optional) stainless steel spoons or butter knives, other available electrical components (optional)
14	Circuit Project—Build	1	Redesign can be necessary to find solutions to the challenges encountered during building.	Build model home electrical systems according to design specifications. Tinker and troubleshoot as part of the building process, engage in the engineering design cycle.	none	**Same as Lesson 13, plus (per group/pair)**: Circuit material: batteries (at least 2 AA, AAA, C, or D; optional: 9V), battery holders, wires (with alligator clips or tape), 2 small light bulbs, 1-2 small motors, small plastic propellers for motors (or cardstock for student to make own), small resistors, small buzzers Other: cardboard, scissors, wire strippers, metal thumbtacks, paper clips, foil
15	Circuit Project—Present and Evaluate (1-2 days)	2	Communicating information to others through presentation and project evaluation is part of engineering.	Present finalized designs and model home electrical system in a classroom gallery walk or video. Share challenges, successful solutions, and any notable innovations achieved during iterations of the engineering design cycle.	none	poster paper index cards and/or sticky notes for displays video recording device(s) to make video presentations (optional)
16	Electricity and Magnetism/Review	1	Compare and contrast electricity and magnetism in this review lesson.	Sort vocabulary terms and defend reasoning using evidence from activities, projects, and phenomena from the unit.	none	electric motor setup from Lesson 12 color pens or pencils (recommended) Small hand-crank generator (recommended, to show that a motor can also run in reverse, generating electricity from a spinning motion)
17	The Mystery of Earth's Magnetic Field	1	Earth's magnetic field is generated by its liquid outer core.	Generate a claim for the field's formation, and then evaluate evidence, some new and some review from earlier lessons.	none	Earth's Magnetic Field cards
	Review	1				
	Assessment	1				
	Total # days	**22**				