Phoenixville Area School District Understanding by Design (UbD) Science Template

Grade Level &/or HS Subject: Physics Unit Name: Circuits and EM

Plain English Summary: This unit is focused on fields and how they generate forces, with special emphasis on the relationship between electric and magnetic fields. There is also a practical circuits component, and it is there that the interaction between fields will first be explored.

<table>
<tr><th colspan="3">Stage 1 Desired Results</th></tr>
<tr><td rowspan="4">Overarching NGSS & PA Standards:

HS-PS2-4

Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.

HS-PS2-5

Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field</td><td colspan="2">Transfer</td></tr>
<tr><td colspan="2">Students will be able to independently use their learning to…

Ask questions and define problems
Develop and use models
Plan and carry out experiments
Analyze and interpret data using computational thinking
Obtain, evaluate, and communicate information (supported by evidence)
Construct explanations and design solutions

(Choose the appropriate content-specific transfer goals)</td></tr>
<tr><td colspan="2">Meaning-Making</td></tr>
<tr><td>Students will understand that…

Mathematical representations of Newton's Law of Gravitation and Coulomb's Law can describe and predict the gravitational and electrostatic forces between objects.

An electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.

Devices that work within given constraints to convert one form of energy into another form of energy can be designed, built and refined.

Scientific experiments provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.

Models of two objects interacting through electric or magnetic fields can be used to illustrate the forces between objects and the changes in energy of the objects due to the interaction.</td><td>ESSENTIAL QUESTIONS
Students will keep considering...

How is energy transferred and conserved?

How are electricity and magnetism related?

How do forces affect objects that are distant from each other?</td></tr>
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and that a changing magnetic field can produce an electric current HS-PS3-2 Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles (objects). HS-PS3-3 Design, build, and refine a device that works within given	***Knowledge and Skills Acquisition***	
	Newton's law of universal gravitation and Coulomb's law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields. "Electrical energy" may mean energy stored in a battery or energy transmitted by electric currents. Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). In some cases, the relative position energy can be thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space. Although energy cannot be destroyed, it can be converted to less useful forms — for example, to thermal energy in the surrounding environment. Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them.	*Students will be skilled at…* Design, evaluate, and/or refine a solution to a complex real-world problem based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. Use mathematical representations of phenomena to describe explanations. Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. Communicate technical information or ideas (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).

constraints to convert one form of energy into another form of energy. HS-PS3-5 Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction. **Which branch(es) of science apply:** **PS**	KEY VOCABULARY Current Voltage Resistance Resistivity Ohm's Law Power Series Parallel Conductor Electric Field Magnetic Field Coloumb's Law Lorentz Force Law	

Stage 2 – Evidence		
Evaluative Criteria	***Assessment Evidence***	
Good process skills (rubric);	PERFORMANCE TASK(S): **Field Investigator**	Differentiation Considerations: Students have choice in what to investigate and the depth of the

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<td>Reasonable conclusions; quality feedback to peers</td>
<td>Goal: Design an experiment that allows the relationship between a changing magnetic or electric field/current on the creation of an electric or magnetic field to be measured, especially the relative maximum field strengths.
Role: A scientist
Audience: The class (peer reviewers)
Situation: Students will work in groups and will try to piece together a complete picture as a class. They will not know the relationships beforehand, so they will be acting as scientists trying to figure out the relationships and find evidence to support their claims. They will then need to report back to the class and face peer review.
Product: They will need to present their results, and also critique the results of others.
Standards: See Left Column</td>
<td>investigation. Report can take several different forms.</td>
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<td>Accuracy of answers and explanations; lab/inquiry process skills</td>
<td>OTHER EVIDENCE:

• HW – these will consist of a range of questioning goals, from basic things like vocab understanding to conceptual understanding to application
• Labs – Series/Parallel Investigation + Circuit Boxes; Pith Ball Lab for determining Coulomb’s Law
• Quizzes – MC or FR where work is required; similar to HW, could be fact recall, conceptual understanding or application being assessed.
• Test – 1 for the unit, will contain a mix of recall and application focused on the understandings and knowledge from Stage 1

(What evidence will be collected to determine whether Stage 1 goals were achieved?)</td>
<td>Differentiation Considerations:

• Notes allowed on some assessments
• Partial credit + test corrections</td>
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