NGSS UNIT OVERVIEW

FIELDS AND INTERACTIONS

Performance Expectation MS-PS2-3: Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.

Performance Expectation MS-PS2-4: Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.

Performance Expectation MS-PS2-5: Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.

Performance Expectation MS-PS3-2: Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.

Performance Expectation MS-ETS1-1: Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

Performance Expectation MS-ETS1-2: Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

Performance Expectation MS-ETS1-3: Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

Performance Expectation MS-ETS1-4: Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

Activity Description	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
1. **Problem Solving: Save the Astronaut!** Students are introduced to the process of engineering with a scenario that engages them in solving a simple problem. The activity elicits and builds on students' ideas about how to define a problem and develop a successful solution. The process of solving the problem is compared and contrasted with the work of scientists and engineers. Students then generate questions and define problems in their everyday lives.	MS-ETS1.B	Asking Questions and Defining Problems Analyzing and Interpreting Data	Systems and System Models	ELA/Literacy: SL8.5
2. **Reading: The Apollo Missions** Students continue to investigate the process of engineering with a historical engineering case. While investigating the Apollo missions, students identify important criteria and constraints faced by NASA during the development of the space program. The activity elicits and builds on students' ideas about how to define a problem and develop a successful solution. The reading provides examples of how technologies are driven by individual or societal needs, desires, and values.	MS-ETS1.A MS-ETS1.B MS-ETS1.C	Analyzing and Interpreting Data	Connections to Nature of Science: Influence of Science, Engineering, and Technology on Society and the Natural World	Mathematics: MP.2 ELA/Literacy: SL8.5 RST.6-8.1

FIELDS AND INTERACTIONS (continued)

Activity Description	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
3. **Design: Gravitational Transporter** Students begin to investigate gravitational potential energy in a system of interacting objects. Using a system model, students investigate how the release height and/or mass of a cart will affect the amount of kinetic energy transfer in a collision. Through a process of testing, evaluating, and redesigning, students optimize their solutions by controlling the initial amount of gravitational potential energy of the transporter. They use this model to make conceptual connections between their evidence and explanations of gravitational potential energy.	MS-PS3.A MS-PS2.B MS-ETS1.A MS-ETS1.B	Developing and Using Models Engaging in Argument from Evidence Connections to Nature of Science: Scientific Knowledge Is Based on Empirical Evidence Analyzing and Interpreting Data Asking Questions and Defining Problems	Systems and System Models Connections to Nature of Science: Influence of Science, Engineering, and Technology on Society and the Natural World	Mathematics: MP.2 ELA/Literacy: SL8.5 RST.6-8.1
4. **Investigation: Gravitational Force** Students analyze and interpret data to learn about the relationship between the gravitational force between two objects, the mass of those objects, and the distance between them. Students create and analyze graphs that provide evidence that gravitational force is directly proportional to the mass of the objects interacting and inversely proportional to the distances between the objects.	MS-PS2.B MS-PS3.C	Engaging in Argument from Evidence Connections to Nature of Science: Scientific Knowledge Is Based on Empirical Evidence Analyzing and Interpreting Data Constructing Explanations and Designing Solutions	Systems and System Models Patterns	ELA/Literacy: SL8.5 WHST.6-8.1
5. **Investigation: Mapping Magnetic Fields** Students provide evidence that there are other forces besides gravity that can act at a distance. To do this, students conduct an investigation related to the phenomenon of magnetism. In their exploration, they analyze and interpret data related to the direction of magnetic fields at different locations in those fields. They use the effects seen in one magnetic field map to predict another magnetic field map. By mapping different magnetic fields, students are able to provide evidence that fields exist between objects, exerting forces on each other even though the objects are not in contact.	MS-PS2.B MS-PS3.C	Planning and Carrying Out Investigations Analyzing and Interpreting Data	Cause and Effect	ELA/Literacy: RST.6-8.3

FIELDS AND INTERACTIONS (continued)

Activity Description	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
6. **Design: Magnetic Transporter** Students apply what they have learned on the phenomena of gravity and magnetism to design a magnetic transporter. They define a design problem that can be solved through the development of an object that meets multiple criteria and constraints. They use an iterative testing procedure to optimize the transporter to carry as much weight as possible. This activity provides a formal assessment opportunity for Performance Expectation MS-ETS1-1.	MS-PS3.A MS-PS2.B MS-ETS1.A MS-ETS1.B MS-ETS1.C	Developing and Using Models Analyzing and Interpreting Data Asking Questions and Defining Problems Engaging in Argument from Evidence	Systems and System Models Connections to Nature of Science: Influence of Science, Engineering, and Technology on Society and the Natural World	ELA/Literacy: SL8.5 RST.6-8.7
7. **Reading: Gravitational and Magnetic Fields** Students synthesize their knowledge of gravitational and magnetic fields in a reading that compares and contrasts these two kinds of fields. The reading helps students summarize what influences the magnitude and direction of forces resulting from field interactions. Students also reflect on how energy stored within a system of interacting objects relates to the relative positions of the objects interacting. These relationships are examined through the lens of the crosscutting concept of cause and effect. This activity provides a formal assessment opportunity for Performance Expectation MS-PS2-4.	MS-PS2.B MS-PS3.A MS-PS3.C	Developing and Using Models Asking Questions and Defining Problems Engaging in Argument from Evidence Connections to Nature of Science: Scientific Knowledge Is Based on Empirical Evidence	Cause and Effect Systems and System Models	Mathematics: MP.2 ELA/Literacy: WHST.6-8.1
8. **Investigation: Static Electricity** Students ask questions about and then investigate how static charge can sometimes cause objects to be attracted to, and at other times repelled by, each other. By rubbing certain materials together to generate static electricity, students are able to observe that these interactions provide evidence for forces that act at a distance, which means that they can be explained by fields that extend through space. Students use a simulation to further investigate cause and effect of static phenomena since charged particles occur at scales too small to observe.	MS-PS2.B	Asking Questions and Defining Problems	Cause and Effect	

FIELDS AND INTERACTIONS (continued)

Activity Description	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
9. **Laboratory: Electrostatic Force** Students are introduced to a tool—an electroscope— that can show relative strengths of forces resulting from static electricity. Students then plan and conduct their own investigations using the electroscope to see if there is a relationship between the amount of electric charge, the distance between charged objects, and the amount of force. Students are asked to use the results of their investigations as well as evidence from previous activities to verify that fields exist between objects exerting forces on each other even though the objects are not in contact.	MS-PS2.B	Planning and Carrying Out Investigations	Cause and Effect	ELA/Literacy: WHST.6-8.7 RST.6-8.3
10. **Computer Simulation: Visualizing an Electric Field** Students use a computer simulation to support their understanding of an electrostatic field. The simulation allows students to visualize the interaction between static charges. The model enables students to ask and then investigate questions about what affects the direction and magnitude of forces in an electric field. Students also investigate the potential energy stored in the system of interacting charges.	MS-PS3.A MS-PS2.B	Asking Questions and Defining Problems Constructing Explanations and Designing Solutions	Cause and Effect Systems and System Models	ELA/Literacy: WHST.6-8.7 RST.6-8.3
11. **Modeling: Electric Field Transporter** Students apply what they have learned about electric and gravitational fields to design a hovering transporter cart that depends on electrostatic force to move. They develop a model in a computer simulation where they can manipulate the arrangement of charges to design the system. By testing, analyzing data, and redesigning, students combine the best characteristics of each design to make a new solution that better meets the criteria of the transporter. This activity provides a formal assessment opportunity for Performance Expectation MS-PS3-2. It also provides an opportunity for a formative assessment on Performance Expectation MS-ETS1-4.	MS-PS3.A MS-PS3.C MS-ETS1.B MS-ETS1.C	Developing and Using Models	Systems and System Models Scale, Proportion, and Quantity	Mathematics: MP.2

FIELDS AND INTERACTIONS (continued)

Activity Description	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
12. **Investigation: Electric and Magnetic Fields** Students investigate the induction of electric and magnetic fields through a series of hands-on investigations. Students complete two explorations on the relationship between electricity and magnetism. After observing the effects of electromagnetic induction, students then conduct investigations to determine the factors that affect the strength of magnetic fields from an electromagnetic coil on a test object. Students evaluate the designs of their experiments for the quantity and quality of evidence of what factors affect the strength of electric and magnetic fields. This activity provides a formal assessment opportunity for Performance Expectation MS-PS2-5.	MS-ETS1.B MS-PS2.B	Asking Questions and Defining Problems Developing and Using Models Planning and Carrying Out Investigations	Cause and Effect Patterns	Mathematics: MP.2 ELA/Literacy: RST.6-8.3
13. **Design: Gyrosphere Rescue** In this engineering design challenge, students apply their scientific knowledge about what affects the strength of an electromagnetic field to build a device to move steel bearings from one location to another. They collect data, test and redesign several solutions to optimize their designs, and develop the most successful designs for the criteria. Then they evaluate others' designs and discuss the design trade-offs. Students also consider the scientific investigations they have been conducting and identify what information is needed in order to determine the strength of electric and magnetic forces. This activity provides formal assessment opportunities for Performance Expectations MS-ETS1-4 and MS-PS2-3.	MS-PS2.B MS-ETS1.B MS-ETS1.C	Asking Questions and Defining Problems Analyzing and Interpreting Data Developing and Using Models Engaging in Argument from Evidence Constructing Explanations and Designing Solutions	Cause and Effect	Mathematics: MP.2

FIELDS AND INTERACTIONS (continued)

Activity Description	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
14. **Reading: Electric and Electromagnetic Fields** This reading provides a synthesis of the information in the unit on electric and electromagnetic fields. The factors that determine the strength and direction of these fields is presented. Students are given an opportunity to further explore how electric and electromagnetic fields are distinct from gravitational and magnetic fields. Technology that depends on the phenomena of electric and electromagnetic fields are presented in the context of everyday use. The cause-and-effect relationship between the fields and forces allows students to understand how phenomena are used in these designed systems.	MS-PS2.B	Connections to Nature of Science: Scientific Knowledge Is Based on Empirical Evidence	Cause and Effect	Mathematics: MP.2 ELA/Literacy: RST.6-8.1
15. **Talking It Over: Evaluating Transporter Designs** Students use the scientific knowledge they have accumulated in this unit to systematically evaluate competing design solutions based on scientific validity and design success. After evaluating four proposals, students combine the best aspects of the proposals into their own designs. This activity provides a formal assessment opportunity for Performance Expectations MS-ETS1-2 and MS-ETS1-3.	MS-ETS1.B MS-ETS1.C	Engaging in Argument from Evidence Analyzing and Interpreting Data	Connections to Nature of Science: Influence of Science, Engineering, and Technology on Society and the Natural World	Mathematics: MP.2 ELA/Literacy: WHST.6-8.9 RST.6-8.1