UNIT OVERVIEW

FIELDS AND INTERACTIONS

Unit Issue: How the characteristics of fields can be incorporated into engineering design solutions.

Anchoring Phenomenon: Objects can be observed to interact with other objects even when they are not in contact with one another.

Listed below is a summary of the activities in this unit. Note that the total teaching time is listed as 18–32 periods of approximately 45–50 minutes (approximately 4–6 weeks). If you find you cannot finish in this time frame, consider skipping activities 9 and/or 10.

Activity Description	Topics	Advance Preparation	Assessment	Teaching Periods
1. **Problem Solving: Save the Astronaut!** Students examine the steps involved in problem solving when confronted with a simple physical problem. They learn that there are various approaches to scientific and engineering problem solving. Students will engage in a variety of scientific approaches throughout the activities in this unit.	Model, scientist, engineer, evidence SENSEMAKING	Prepare Student Sheet, prepare paper rectangles, prepare Moon images (optional).		1–2
2. **Reading: The Apollo Missions** Students read a historical account of the Apollo missions that brought a man to the Moon in the 1960s. They are introduced to an engineering design process and apply it to examples provided in the reading. Through this lens, students identify problems, the process used to solve the problems, and the chosen NASA solution to the problems.	Engineering design process, technology, trade-offs, criteria, constraints, optimize SENSEMAKING	Prepare Student Sheet.	E&T A5	1–2
3. **Design: Gravitational Transporter** Students use a model transport system composed of a ramp, track, and cart to investigate what affects the cart's movement down the track. They develop an understanding of gravitational potential energy as they determine which combination of height and mass will fulfill a set of engineering criteria and constraints.	Gravity, mass, gravitational potential energy, engineering design solutions SENSEMAKING	Prepare Student Sheet (optional), gather small and large books.	AID Proc.12 MOD A4	1–2
4. **Investigation: Gravitational Force** Students explore the relationship between gravitational pull, distance, and mass. They graph the gravitational force between the Moon and fictional satellites at varying distances. Students then graph the gravitational force of satellites of varying masses orbiting the Moon. The graphs are analyzed for patterns that describe characteristics of gravity.	Force, force-at-a-distance, gravitational force MATHEMATICS	Gather graph paper.	EXP Proc. 6 ARG A4	1–2

FIELDS AND INTERACTIONS (continued)

Activity Description	Topics	Advance Preparation	Assessment	Teaching Periods
5. **Investigation: Mapping Magnetic Fields** Students conduct a hands-on investigation to explore magnetism. They use magnets and a compass to map field lines of a magnetic field. They compare the magnetic field surrounding a single magnet, two attracting poles, and two repelling poles.	Field, magnetic field, magnetic force, gravitational field, field lines, magnetic SENSEMAKING	Prepare Student Sheet; gather paper clip, transparent tape; practice demonstration; download app for Extension.	COM A2	1–2
6. **Design: Magnetic Transporter** Students investigate the properties of magnetic fields to design a magnetic transporter cart. They follow the engineering design process to design a cart that will, given certain criteria and constraints, maximize the amount of mass it can carry.	Prototype, variable, engineering design solutions SENSEMAKING	Prepare magnetic tracks.	ENG Proc.8 MOD A1 COM A4 (Assessment of PE MS-ETS1-1)	2–3
7. **Reading: Gravitational and Magnetic Fields** Students synthesize the materials on gravitational and magnetic fields in a reading that reviews and synthesizes the content from previous activities in the unit. Gravitational and magnetic fields are compared and contrasted. Students are also introduced to how fields are applied in everyday technology.	Domain, temporary magnet, permanent magnet SENSEMAKING		ARG A1 (Assessment of PE MS-PS2-4)	1–2
8. **Investigation: Static Electricity** Students conduct various hands-on explorations where they generate static electricity and observe its effects. Then they apply what they have experienced to an online simulation that investigates the movement of electrostatic charges.	Electric field, static electricity, discharge SENSEMAKING	Prepare Student Sheet; gather empty aluminum beverage cans, sealable plastic bags, scissors; consider water source.	COM QUICK CHECK: A1	1–2
9. **Laboratory: Electrostatic Force** Students apply what they learned from the last activity to design and carry out experiments with an electroscope. They investigate the relationship between the strength of an electric field, the magnitude of the electric charge, and the distance from the electric charge.	Discharge LITERACY		PCI Proc. 8, 10 COM A2 AID A4	1–2

FIELDS AND INTERACTIONS (continued)

Activity Description	Topics	Advance Preparation	Assessment	Teaching Periods
10. **Computer Simulation: Visualizing an Electric Field** Students use a computer simulation to visualize an electric field around charges. The investigation further refines the relationships between force, charge, and distance discovered in the previous activity. They investigate how potential energy in a field is increased or decreased.	Electric charge, electrostatic force, variables SENSEMAKING	Prepare Student Sheets, secure Internet access.	EXP A5	1
11. **Modeling: Electric Field Transporter** Students use a computer simulation that models the scenario of the Moon transporter. Using the model, they investigate the possibility of an electric field propelling their transporter. By balancing the force of electrostatic repulsion with the force of gravity, students model how the transporter can hover over the track, similar to the magnetic cart in a previous activity.	Electric field, engineering design solutions SENSEMAKING	Secure Internet access.	ENG Proc. 14-16 MOD A4 (Assessment of PE MS-PS3-2)	1–2
12. **Investigation: Electric and Magnetic Fields** Through a hands-on investigation, students induce an electric current using a magnet and a wire, and then induce a magnetic field with a current-carrying wire. Lastly, they investigate what determines the strength of an induced magnetic field in a coiled wire. They consider the effects of the number of turns per length and current in the wire on the electromagnetic coil's strength.	Capacitor, electric current, electromagnetic induction LITERACY	Prepare Student Sheet; gather rulers, masking tape, paper clips (optional), phone app (optional); charge capacitors.	COM A3 (Assessment of PE MS-PS2-5)	2–3
13. **Design: Gyrosphere Rescue** Students apply what they have learned about electromagnetic induction to design a transporter within a set of criteria and constraints that moves steel bearings from one location to the other. By controlling the variables of wire length, the number of turns in a coil, and the strength of the current, students optimize their designs to transport the bearings.	Electromagnetic induction, engineering design solutions LITERACY	Prepare Student Sheet.	AID QUICK CHECK Proc. ENG Proc. 3 (Assessment of PE MS-ETS1-4) COM A3 (Assessment of PE MS-PS2-3)	1–2

FIELDS AND INTERACTIONS (continued)

Activity Description	Topics	Advance Preparation	Assessment	Teaching Periods
14. **Reading: Electric and Electromagnetic Fields** Students synthesize their knowledge about electric and electromagnetic fields through a reading. Similarities and differences between electric and electromagnetic fields are identified. Applications of electric fields are introduced, and technologies that depend on electromagnetism, such as maglev trains, are presented.	Electromagnetic field, maglev LITERACY SENSEMAKING		E&T A4	1–2
15. **Talking It Over: Evaluating Transporter Designs** Students analyze different transporter design proposals for the Moon scenario. Based on their understanding of gravitational, electric, magnetic, and electromagnetic fields, they systematically analyze the proposals for scientific validity, consider how well they meet design criteria and constraints, and identify design trade-offs. After ranking the proposals, they design their own transporters by combining the best features of the ones proposed.	Engineering design solutions LITERACY MATHEMATICS	Prepare Student Sheets.	ENG Proc. 8 (Assessment of PE MS-ETS1-3) ARG A1 (Assessment of PE MS-ETS1-2) E&T A3	2–3