MP1-2 Forces and Energy

Content Area: **Science**
Course(s): **Honors Science 8**
Time Period: **MP1-2**
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Essential Questions

- How do you describe the motion of an object?
- How do objects react to force?
- How is energy conserved in a transformation?
- How does heat flow from one object to another?
- How are electricity and magnetism related?
- What are the effects of an asteroid collision and how can we prevent a future one?
- What forces keep the parts of our solar system together and how can we use this knowledge to plot a telescope route through space?

Big Ideas

- A net force causes an object's motion to change.
- Energy can take different forms but is always conserved.

Cross Cutting Concepts

Energy & Forces and Interactions-Physical Science

Cause and Effect

- Cause and effect relationships may be used to predict phenomena in natural or designed systems. (Motion and Stability MS-PS2-3, MS-PS2-5)

Systems and System Models

- Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy and matter flows within systems. (Motion and Stability MS-PS2-1, MS-PS2-4) (Energy MS-PS3-2)

Stability and Change

- Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales. (Motion and Stability MS-PS2-2)

Energy and Matter

- Energy may take different forms (e.g. energy in fields, thermal energy, and energy of motion). (Energy

MS-PS3-5)
- The transfer of energy can be tracked as energy flows through a designed or natural system. (Energy MS- PS3-3)

Colossal Collisions-Physical Science

Patterns

- Macroscopic patterns are related to the nature of microscopic and atomic-level structure. (Matter and Its Interactions MS-PS1-2) (Waves and Their Applications MP-PS4-1)

Cause and Effect

- Cause and effect relationships may be used to predict phenomena in natural or designed systems. (Matter and Its Interactions MS-PS1-4) (Motions and Stability MS-PS2-3, MS-PS2-5)

Scale, Proportion, and Quantity

Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. (Matter and Its Interactions MS-PS1-1) (Energy MS-PS3-1, MS-PS3-4)

Systems and System Models

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Stability and Change

- Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales. (Motion and Stability MS-PS2-2)

Traveling through Space-Earth and Space Sciences

Patterns

- Patterns can be used to identify cause-and-effect relationships. (Earth's Place in the Universe MS-ESS1-1) (Earth's Systems MS-ESS2-3) (Earth and Human Activity MS-ESS3-2)

Cause and Effect

- Cause and effect relationships may be used to predict phenomena in natural or designed systems. (Earth's Systems MS-ESS2-5) (Earth and Human Activity MS-ESS3-1, MS-ESS3-4)
- Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. (Earth and Human Activity MS-ESS3-3)

Scale, Proportion, and Quantity

- Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. (Earth's Place in the Universe MS-ESS1-3, MS- ESS1-4) (Earth's

Systems MS-ESS2-2)

Systems and System Models

- Models can be used to represent systems and their interactions. (Earth's Place in the Universe MS-ESS1-2) (Earth's Systems MS-ESS2-4)

Disciplinary Core Ideas

Energy & Forces and Interactions-Physical Science

PS2.A: Forces and Motion (Motion and Stability)

- For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, but in the opposite direction (Newton's third law). (MS-PS2-1)
- The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion. (MS-PS2-2)
- All positions of objects and the directions of forces and motions must be described in an arbitrarily chosen reference frame and arbitrarily chosen units of size. In order to share information with other people, these choices must also be shared. (MS-PS2-2)

PS2.B: Types of Interactions (Motion and Stability)

- Electric and magnetic (electromagnetic) forces can be attractive or repulsive, and their sizes depend on the magnitudes of the charges, currents, or magnetic strengths involved and on the distances between the interacting objects. (MS-PS2-3)
- Gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass—e.g., Earth and the sun. (MS-PS2-4)
- Forces that act at a distance (electric and magnetic) can be explained by fields that extend through space and can be mapped by their effect on a test object (a ball, a charged object, or a magnet, respectively). (MS-PS2-5)

PS3.A: Definitions of Energy (Energy)

- Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed. (MS-PS3-1)
- A system of objects may also contain stored (potential) energy, depending on their relative positions. (MS-PS3-2)
- Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. (MS-PS3-3),(MS-PS3-4)

PS3.B: Conservation of Energy and Energy Transfer (Science-Energy)

- When the motion energy of an object changes, there is inevitably some other change in energy at the same time. (MS-PS3-5)
- The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the size of the sample, and the environment. (MS-PS3-4)
- Energy is spontaneously transferred out of hotter regions or objects and into colder ones. (MS-PS3-3)

PS3.C: Relationship between Energy and Forces (Energy)

- When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object. (MS-PS3-2)

<u>Colossal Collisions</u>-Physical Science; Life Science; Engineering, Technology and Applications of Science

LS4.A: Evidence of Common Ancestry and Diversity (Biological Evolutions)

- The collection of fossils and their placement in chronological order (e.g., through the location of the sedimentary layers in which they are found or through radioactive dating) is known as the fossil record. It documents the existence, diversity, extinction, and change of many life forms throughout the history of life on Earth. (MS-LS4-1)
- Anatomical similarities and differences between various organisms living today and between them and organisms in the fossil record, enable the reconstruction of evolutionary history and the inference of lines of evolutionary descent. (MS-LS4-2)
- Comparison of the embryological development of different species also reveals similarities that show relationships not evident in the fully-formed anatomy.(MS-LS4-3)

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- Forces that act at a distance (electric, magnetic, and gravitational) can be explained by fields that extend through space and can be mapped by their effect on a test object (a charged object, or a ball,

respectively). (MS-PS2-5)

PS3.A: Definitions of Energy (Matter and its Interactions)

- The term "heat" as used in everyday language refers both to thermal energy (the motion of atoms or molecules within a substance) and the transfer of that thermal energy from one object to another. In science, heat is used only for this second meaning; it refers to the energy transferred due to the temperature difference between two objects. (secondary to MS-PS1-4)
- The temperature of a system is proportional to the average internal kinetic energy and potential energy per atom or molecule (whichever is the appropriate building block for the system's material). The details of that relationship depend on the type of atom or molecule and the interactions among the atoms in the material. Temperature is not a direct measure of a system's total thermal energy. The total thermal energy (sometimes called the total internal energy) of a system depends jointly on the temperature, the total number of atoms in the system, and the state of the material. (secondary to MS-PS1-4)

ETS1.A: Defining and Delimiting an Engineering Problem (Engineering Design)

- The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that is likely to limit possible solutions. (secondary to MS-PS3-3)

ETS1.B: Developing Possible Solutions(Engineering Design)

- A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (secondary to MS-PS1-6)

ETS1.C: Optimizing the Design Solution (Engineering Design)

- Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of the characteristics may be incorporated into the new design. (secondary to MS-PS1-6)
- The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. (secondary to MS-PS1-6)

<u>Traveling Through Space</u>-Physical Science; Life Science

ESS1.A: The Universe and Its Stars (Earth's Place in the Universe)

- Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models. (MS-ESS1-1)
- Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe. (MS-ESS1-2)

ESS1.B: Earth and the Solar System (Earth's Place in the Universe)

- The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them. (MS-ESS1-2), (MS-ESS1-3)

- This model of the solar system can explain eclipses of the sun and the moon. Earth's spin axis is fixed in direction over the short-term but tilted relative to its orbit around the sun. The seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth across the year. (MS-ESS1-1)
- The solar system appears to have formed from a disk of dust and gas, drawn together by gravity. (MS-ESS1-2)

PS2.B: Types of Interactions (Motion and Stability)

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PS3.C: Relationship Between Energy and Forces (Energy)

- When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object. (MS-PS3-2)

Science and Engineering Practices

Energy-Physical Science

Developing and Using Models

- Develop a model to describe unobservable mechanisms. (Energy MS-PS3-2)

Planning and Carrying Out Investigations

- Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim. (Energy MS-PS3-4)

Analyzing and Interpreting Data

- Construct and interpret graphical displays of data to identify linear and nonlinear relationships. (Energy MS-PS3-1)

Constructing Explanations and Designing Solutions

- Apply scientific ideas or principles to design, construct, and test a design of an object, tool, process or system. (Energy MS-PS3-3)

Engaging in Argument from Evidence

- Construct, use, and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon. (Energy MS-PS3-5)

<u>Forces and Interactions</u>-Physical Science

Asking Questions and Defining Problems

- Ask questions that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles. (Motion and Stability MS-PS2-3)

Planning and Carrying Out Investigations

- Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim. (Motion and Stability MS-PS2-2)
- Conduct an investigation and evaluate the experimental design to produce data to serve as the basis for evidence that can meet the goals of the investigation. (Motion and Stability MS-PS2-5)

Constructing Explanations and Designing Solutions

- Apply scientific ideas or principles to design an object, tool, process or system. (Motion and Stability MS-PS2-1)

Engaging in Argument from Evidence

- Construct and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (Motion and Stability MS-PS2-4)

<u>Colossal Collisions</u>-Physical Science

Asking Questions and Defining Problems

- Ask questions that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles. (Motion and Stability MS-PS2-3)

Developing and Using Models

- Develop a model to predict and/or describe phenomena. (Matter and its Interactions MS-PS1-1, MS-PS1-4)
- Develop a model to describe unobservable mechanisms. (Matter and its Interactions MS-PS1-5) (Energy MS-PS3-2)

Planning and Carrying our Investigations

- Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how much data is needed to support a claim. (Energy MS-PS3-4)

Analyzing and Interpreting Data

- Analyze and interpret data to determine similarities and differences in findings. (Matter and its Interactions MS-PS1-2)
- Construct and interpret graphical displays of data to identify linear and nonlinear relationships. (Energy MS-PS3-1)

Constructing Explanations and Designing Solutions

- Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that meets specific design criteria and constraints. (Matter and its Interactions MS-PS1-6)
- Apply scientific ideas or principles to design an object, tool, process or system. (Motion and Stability MS-PS2-1), (Energy MS-PS3-3)

Engaging in Argument from Evidence

- Construct and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (Motion and Stability MS-PS2-4), (Energy MS-PS3-5)

Traveling Through Space-Earth and Space Sciences

Asking Questions and Defining Problems

- Ask questions to identify and clarify evidence of an argument. (Earth and Human Activity MS-ESS3-5)

Developing and Using Models

- Develop and use a model to describe phenomena. (Earth's Place in the Universe MS-ESS1- 1, MS-ESS1-2) (Earth's Systems MS-ESS2-1, MS-ESS2-6)
- Develop a model to describe unobservable mechanisms. (Earth's Systems MS-ESS2-4)

Planning and Carrying out Investigations

- Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions. (Earth's Systems MS-ESS2-5)

Analyzing and Interpreting Data

- Analyze and interpret data to determine similarities and differences in findings. (Earth’s Place in the Universe MS-ESS1-3) (Earth’s Systems MS-ESS2-3) (Earth and Human Activity MS-ESS3-2)

Engaging in Argument from Evidence

- Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (Earth and Human Activity MS-ESS3-4)

Science and Society

Nicolaus Copernicus

A Renaissance-era mathematician and astronomer who formulated a model of the universe that placed the Sun rather than the Earth at the center of the universe

Sir Isaac Newton

An English mathematician, astronomer, theologian, author and physicist Newton formulated the laws of motion and universal gravitation

Daniel Gabriel Fahrenheit

A Dutch-German-Polish physicist, inventor, and scientific instrument maker. A pioneer of exact thermometry, he helped lay the foundations for the era of precision thermometry by inventing the mercury-in-glass thermometer (first practical, accurate thermometer) and Fahrenheit scale

Anders Celsius

A Swedish astronomer who is known for inventing the Celsius temperature scale. Celsius also built the Uppsala Astronomical Observatory in 1740, the oldest astronomical observatory in Sweden.

Michael Faraday

A British scientist who contributed to the study of electromagnetism and electrochemistry. His main discoveries include the principles underlying electromagnetic induction, diamagnetism and electrolysis.

William Thomson

Also known as Lord Kelvin was an eminent physicist, mathematician, engineer and inventor. He is best known for his contributions to physics in the development of the second law of thermodynamics, the electromagnetic theory of light and the absolute temperature scale, which is measured in kelvins in his honor.

Joseph Henry

An American scientist who served as the first Secretary of the Smithsonian Institution. He was the secretary for the National Institute for the Promotion of Science, a precursor of the Smithsonian Institution. He was highly regarded during his lifetime. While building electromagnets, Henry discovered the electromagnetic phenomenon of self-inductance.

James Prescott Joule

A studied the nature of heat and established its relationship to mechanical work. He laid the foundation for the theory of conservation of energy, which later influenced the First Law of Thermodynamics. He also formulated the Joule's law which deals with the transfer of energy.

Samuel Morse

A polymath who studied mathematics and science at college supporting himself selling the works of art he painted. He became a renowned artist and took part in the invention of the telegraph.

Hans Christian Oersted

He discovered that electricity and magnetism are linked. He showed by experiment that an electric current flowing through a wire could move a nearby magnet. The discovery of electromagnetism set the stage for the eventual development of our modern technology-based world. Oersted also discovered the chemical compound piperine and achieved the first isolation of the element aluminum.

Georg Simon Ohm

A German physicist, best known for his "Ohm's Law", which states that the current flow through a conductor is directly proportional to the potential difference (voltage) and inversely proportional to the resistance. The physical unit of electrical resistance, the Ohm (symbol: Ω), was named after him.

James Watt

The father of the industrial revolution; an inventor, engineer and scientist. His crucial role in transforming our world from one based on agriculture to one based on engineering and technology is recognized in the unit of power: the watt.

Alessandro Volta

An Italian physicist, chemist, and a pioneer of electricity and power,[2][3][4] who is credited as the inventor of the electrical battery and the discoverer of methane.

Ada Lovelace

A pioneer of computing science. She took part in writing the first published program and was a computing visionary, recognizing for the first time that computers could do much more than just calculations.

Tasks

Colossal Collisions

Task 1 – An Ancient Collision - students analyze different pieces of evidence that document the existence, diversity, extinction, and change of life forms on Earth due to a major asteroid collision that occurred 65 million years ago.

Task 2 – Contact Forces - students investigate what factors affect the motion of objects and use this knowledge to help prevent a collision.

Task 3 – Gravity in the Galaxies - students explore another, less tangible force that also affects how objects move and collide due to gravity.

Traveling through Space

Task 1 – A Sun-Earth-Moon Model-students will practice modeling with the smaller sub-system of the Sun-Earth-Moon system.

Task 2 – A Solar System Model- students use the modeling skills they practiced in the previous task to develop a model of the entire solar system.

Task 3 - Gravity in the Galaxies- students examine what factors affect the motion of objects within the solar system—specifically gravity.

Task 4 – Invisible Forces- students conduct investigations to prove that magnetic fields do exist and can explain various phenomena that they experience.

Technology Intergration

8.1.8.A.1 Demonstrate knowledge of a real world problem using digital tools.

8.1.8.A.3 Use and/or develop a simulation that provides an environment to solve a real world problem or theory.

Activity:

Students will watch a video on Newton's three laws and how they relate to gravity. The students will complete an activity on the interactions of objects and the forces on them (internet based interactive). The students will then complete free body diagrams to demonstrate knowledge on the interactions.

8.1.8.A.1 Demonstrate knowledge of a real world problem using digital tools.

8.1.8.A.3 Use and/or develop a simulation that provides an environment to solve a real world problem or theory.

8.1.8.A.4 Graph and calculate data within a spreadsheet and present a summary of the results

Activity:

This is a station activity where the students make observations about energy. They have hands on labs where they identify the energy used to make objects move. The students also use a Newton's Cradle to describe energy transfers. They watch videos and take notes on a PowerPoint. They also work on an interactive where they have to maximize the input and output of kinetic and potential energy. During this activity, they have to create a roller coaster that optimizes the energy transfer. Data needs to be collected and put into a spreadsheet. Graphs need to be created to show data. The final stations were interpersonal discussions with the teacher and a conference with another group.

Enduring Understandings

MS. Motion and Stability: Forces and Interactions

MS-PS2-1 Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.

MS-PS2-2 Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.

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

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.

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.

MS. Energy

MS-PS3-1 Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.

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.

MS-PS3-3 Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.

MS-PS3-4 Plan and investigation to determine the relationship among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.

MS-PS3-5 Construct, use and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.

Colossal Collisions

MS. Matter and its Interactions

MS-PS1-1 Develop models to describe the atomic composition of simple molecules and extended structures.

MS-PS1-2 Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.

MS-PS1-4 Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

MS-PS1-5 Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.

MS-PS1-6 Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.

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MS-PS3-5 Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.

Biological Evolution: Unity and Diversity

MS-LS4-1 Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.

MS-LS4-2 Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.

MS-LS4-3 Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals

Traveling Through Space

MS. Motion and Stability: Forces and Interactions

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

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.

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.

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MS. Earth's Place in the Universe

MS-ESS1-1 Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.

MS-ESS1-2 Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.

MS-ESS1-3 Analyze and interpret data to determine scale properties of objects in the solar system.

MS-ESS1-4 Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth’s 4.6-billion-year-old history.

MS. Earth's Systems

MS-ESS2-1 Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process

MS-ESS2-2 Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.

MS-ESS2-3 Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions.

MS-ESS2-4 Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.

MS-ESS2-5 Collect data to provide evidence for how the motions and complex interactions of air masses result in changes in weather conditions.

MS-ESS2-6 Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.

MS. Earth and Human Activity

MS-ESS3-1 Construct a scientific explanation based on evidence for how the uneven distributions of Earth’s mineral, energy, and groundwater resources are the result of past and current geoscience processes.

MS-ESS3-2 Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.

MS-ESS3-3	Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment

MS-ESS3-4	Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

MS-ESS3-5	Ask questions to clarify evidence of the factors that have caused climate change over the past century.

Focus Areas

Motion

- An object is in motion if it changes position relative to a reference point
- To calculate the speed of an object, divide the distance the object travels by the amount of time it takes to travel the distance.
- When you know both the speed and direction of an object's motion you know the velocity of the object.
- You can show the motion of an object on a line graph in which you plot distance versus time.
- In science, acceleration refers to increasing speed, decreasing speed, or changing direction.
- You can use both a speed-versus-time graph and a distance-versus-time graph to analyze the motion of an accelerating object.

Forces

- Like velocity and acceleration, a force is described by its strength and by the direction in which it acts.
- A nonzero net force causes a change in an object's motion.
- Two factors that affect the force of friction are the types of surfaces involved and how hard the surfaces are pushed together.
- Two factors affect the gravitational attraction between objects; their masses and distance.
- Objects at rest will remain at rest and objects moving at a constant velocity will continue moving at a constant velocity unless they are acted upon by non-zero net forces.
- The acceleration of an object depends on its mass and on the net force acting on it.
- If one object exerts a force on another object, then the second object exerts a force of equal strength in the opposite direction on the first object.
- The momentum of a moving object can be determined by multiplying the object's mass by its velocity.
- The total momentum of any group of objects remains the same, or is conserved, unless outside forces act on the objects.
- Free fall is motion where the acceleration is caused by gravity.
- Satellites in orbit around Earth continuously fall toward Earth, but because Earth is curved the travel around it.

Energy

- Since the transfer of energy is work, then power is the rate at which energy is transferred, or the amount of energy transferred in a unit of time.
- The two basic types of energy are kinetic energy and potential energy.
- You can find an object's mechanical energy by adding together the object's kinetic energy and potential energy.
- Forms of energy associated with the particles of objects include nuclear energy, thermal energy,

electrical energy, electromagnetic energy, and chemical energy.
- All forms of energy can be transformed into other forms of energy.
- According to the law of conservation of energy, energy cannot be created or destroyed.

Magnetism and Electromagnetism

- Magnets attract iron and materials that contain iron. Magnets attract or repel other magnets. In addition, one end of a magnet will always point north when allowed to swing freely.
- Magnetic poles that are unlike attract each other, and magnetic poles that are alike repel each other.
- Magnetic field lines spread out from one pole, curve around the magnet and return to the other pole.
- Like a bar magnet, Earth has a magnetic field around it and two magnetic poles.
- An electric current produces a magnetic field.
- The magnetic field produced by a current can be turned on or off, reverse direction or change its strength.
- Both solenoids and electromagnets use electric currents and coiled wired to produce strong magnetic fields.
- By placing a wire with a current in a strong magnetic field, electric energy can be transformed into mechanical energy.
- An electric current turns the pointer of a galvanometer.
- An electric motor transforms electrical energy into mechanical energy.
- An electric current is induced in a conductor when the conductor moves through a magnetic field.
- A generator uses motion in a magnetic field to produce current.
- A transformer is a device that increases or decreases voltage.

*See Appendix E for Cross Content

Resources

Scientific Inquiry

MS-PS2-1 (5.2.8.A.3) *Which Lands First*, p. 58
MS-PS2-2 (5.2.6.E.3) *Sticky Sneakers,* p. 41-45
MS-PS3-1 (5.2.8.E.1) *Mass, Velocity, and Kinetic Energy,* p. 109
MS-PS3-5 (5.2.8.E.2) *Can You Feel the Power?*, p. 100-104