

KU Natural History Museum – School Programs

NGSS/Common Core standards information

Gallery Activities

Dinosaur Discovery

Everyone knows what a dinosaur is — or do they? How do you tell a dinosaur from other extinct and living groups of animals? Using the fossil gallery, students will discover important features of this famous group and put their skills to the test.

NGSS Disciplinary Core Ideas: LS1.A, LS4.A, LS4.D

NGSS Disciplinary Core Ideas

LS1.A: Structure and Function

- Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (4-LS1-1)

LS4.A: Evidence of Common Ancestry and Diversity

- Some kinds of plants and animals that once lived on Earth are no longer found anywhere. (3-LS4-1)
- Fossils provide evidence about the types of organisms that lived long ago and also about the nature of their environments. (3-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)

LS4.D: Biodiversity and Humans

- There are many different kinds of living things in any area, and they exist in different places on land and in water. (2-LS4-1)

NGSS Crosscutting concepts

Patterns

- Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.

Scale, Proportion, and Quantity

- In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance.

Structure and Function

- The way an object or living thing is shaped and its substructure determine many of its properties and functions.

NGSS Science and Engineering Practices

Analyzing and interpreting data.

Engaging in argument from evidence.

Obtaining, evaluating, and communicating information.

Walking with Dinosaurs

Students investigate dinosaur footprints — what they can tell us and why — and learn how to calculate the speed of dinosaurs.

NGSS Disciplinary Core Ideas: LS1.A

Common Core Math Domains: NBT, MD, EE, SMP

NGSS Disciplinary Core Ideas

LS4.A: Evidence of Common Ancestry and Diversity

- 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)

NGSS Crosscutting concepts

Patterns

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Structure and Function

- The way an object or living thing is shaped and its substructure determine many of its properties and functions.

NGSS Science and Engineering Practices

Using mathematics and computational thinking.

Obtaining, evaluating, and communicating information.

Common Core Math Standards

Number & Operations in Base Ten

- Add, subtract, multiply, and divide decimals to hundredths, using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; relate the strategy to a written method and explain the reasoning used. (CCSS.Math.Content.5.NBT.B.7)
- Use place value understanding to round decimals to any place. (CCSS.Math.Content.5.NBT.A.4)

Measurement & Data

- Convert like measurement units within a given measurement system. (CCSS.Math.Content.5.MD.A.1)

Expressions and Equations

- Use square root and cube root symbols to represent solutions to equations of the form $x^2 = p$ and $x^3 = p$, where p is a positive rational number. Evaluate square roots of small perfect squares and cube roots of small perfect cubes. Know that $\sqrt{2}$ is irrational. (CCSS.Math.Content.8.EE.A.2)

Mathematical Practices

- Make sense of problems and persevere in solving them. (CCSS.Math.Practice.MP1)
- Reason abstractly and quantitatively. (CCSS.Math.Practice.MP2)
- Model with mathematics. (CCSS.Math.Practice.MP4)
- Attend to precision. (CCSS.Math.Practice.MP6)

Kansas Seas

Kansas was once covered with vast oceans. Discover how we know this and learn about some of the amazing creatures that lived in these seas.

NGSS Disciplinary Core Ideas: LS4.A, ESS1.C, ESS2.A, ESS2.B

NGSS Disciplinary Core Ideas

LS4.A: Evidence of Common Ancestry and Diversity

- Some kinds of plants and animals that once lived on Earth are no longer found anywhere. (3-LS4-1)
- Fossils provide evidence about the types of organisms that lived long ago and also about the nature of their environments. (3-LS4-1)
- 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)

ESS1.C: The History of Planet Earth

- Some events happen very quickly; others occur very slowly, over a time period much longer than one can observe. (2-ESS1-1)
- Local, regional, and global patterns of rock formations reveal changes over time due to earth forces, such as earthquakes. The presence and location of certain fossil types indicate the order in which rock layers were formed. (4-ESS1-1)
- The geologic time scale interpreted from rock strata provides a way to organize Earth's history. Analyses of rock strata and the fossil record provide only relative dates, not an absolute scale. (MS-ESS1-4)

ESS2.A: Earth Materials and Systems

- Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around. (4-ESS2-1)

ESS2.B: Plate Tectonics and Large-Scale System Interactions

- Maps show where things are located. One can map the shapes and kinds of land and water in any area. (2-ESS2-2)
- Maps of ancient land and water patterns, based on investigations of rocks and fossils, make clear how Earth's plates have moved great distances, collided, and spread apart. (MS-ESS2-3)

NGSS Crosscutting concepts

Patterns

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Scale, Proportion, and Quantity

- In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance.

Stability and Change

- For natural and built systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study.

NGSS Science and Engineering Practices

Constructing explanations.

Engaging in argument from evidence.
Obtaining, evaluating, and communicating information.

School Workshops

Fossil Fun

This workshop is designed for younger students and provides an introduction to geological time and fossils. Hands-on activities include digging for and identifying fossils, and developing dinosaurs complete with scientific names.

NGSS Disciplinary Core Ideas: LS1.A, LS4.A, LS4.D, ESS1.C

NGSS Disciplinary Core Ideas

LS1.A: Structure and Function

- All organisms have external parts. Different animals use their body parts in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in food, water and air. (1-LS1-1)
- Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (4-LS1-1)

LS4.A: Evidence of Common Ancestry and Diversity

- Some kinds of plants and animals that once lived on Earth are no longer found anywhere. (3-LS4-1)
- Fossils provide evidence about the types of organisms that lived long ago and also about the nature of their environments. (3-LS4-1)

LS4.D: Biodiversity and Humans

- There are many different kinds of living things in any area, and they exist in different places on land and in water. (2-LS4-1)

ESS1.C: The History of Planet Earth

- Some events happen very quickly; others occur very slowly, over a time period much longer than one can observe. (2-ESS1-1)
- Local, regional, and global patterns of rock formations reveal changes over time due to earth forces, such as earthquakes. The presence and location of certain fossil types indicate the order in which rock layers were formed. (4-ESS1-1)

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NGSS Science and Engineering Practices

Engaging in argument from evidence.

Obtaining, evaluating, and communicating information.

Common Core English Language Arts Standards

Language: Vocabulary Acquisition and Use

- Determine or clarify the meaning of unknown and multiple-meaning words and phrases. (CCSS.ELA-Literacy.L.1.4, 2.4, 3.4, 4.4)

Rock Clocks

This workshop provides an introduction to geological time with activities that investigate relative and absolute dating.

NGSS Disciplinary Core Ideas: LS4.A, ESS1.C, ESS2.B, PS1.A, PS1.C
Common Core Math Domain: MD, SP, SMP

NGSS Disciplinary Core Ideas

LS4.A: Evidence of Common Ancestry and Diversity

- 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)

ESS1.C: The History of Planet Earth

- Local, regional, and global patterns of rock formations reveal changes over time due to earth forces, such as earthquakes. The presence and location of certain fossil types indicate the order in which rock layers were formed. (4-ESS1-1)
- The geologic time scale interpreted from rock strata provides a way to organize Earth's history. Analyses of rock strata and the fossil record provide only relative dates, not an absolute scale. (MS-ESS1-4)

ESS2.B: Plate Tectonics and Large-Scale System Interactions

- Plate tectonics is the unifying theory that explains the past and current movements of the rocks

at Earth's surface and provides a framework for understanding its geologic history. (ESS2.B Grade 8 GBE)

PS1.A: Structure and Properties of Matter

- Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. (HS-PS1-1)

PS1.C: Nuclear Processes

- Spontaneous radioactive decays follow a characteristic exponential decay law. Nuclear lifetimes allow radiometric dating to be used to determine the ages of rocks and other materials. (secondary to HS-ESS1-5)

NGSS Crosscutting Concepts

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Scale, Proportion, and Quantity

- In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance.

Energy and Matter

- Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems' possibilities and limitations.

Stability and Change

- For natural and built systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study.

NGSS Science and Engineering Practices

Analyzing and interpreting data.

Using mathematics and computational thinking.

Common Core Math Standards

Measurement & Data: Represent and interpret data.

- Make a line plot to display a data set of measurements in fractions of a unit ($\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$).
- Solve problems involving addition and subtraction of fractions by using information presented in line plots. (CCSS.Math.Content.4.MD.B.4) (CCSS.Math.Content.5.MD.B.2)

Statistics & Probability: Summarize and describe distributions.

- Display numerical data in plots on a number line, including dot plots, histograms, and box

plots. (CCSS.Math.Content.6.SP.B.4)

Summarize, represent, and interpret data on a single count or measurement variable.

(CCSS.Math.Content.6.SP.B.5)

- Represent data with plots on the real number line (dot plots, histograms, and box plots).

(CCSS.Math.Content.HSS.ID.A.1)

Mathematical Practices

- Make sense of problems and persevere in solving them. (CCSS.Math.Practice.MP1)

- Reason abstractly and quantitatively. (CCSS.Math.Practice.MP2)

- Model with mathematics. (CCSS.Math.Practice.MP4)

- Attend to precision. (CCSS.Math.Practice.MP6)

Hands-on Geology

How can you tell mica from magnetite or granite from gneiss? Students learn identification techniques in this introduction to minerals, rocks and their formation.

NGSS Disciplinary Core Ideas: ESS1.C, ESS2.A

NGSS Disciplinary Core Ideas

ESS1.C: The History of Planet Earth

- Some events happen very quickly; others occur very slowly, over a time period much longer than one can observe. (2-ESS1-1)

- Local, regional, and global patterns of rock formations reveal changes over time due to earth forces, such as earthquakes. The presence and location of certain fossil types indicate the order in which rock layers were formed. (4-ESS1-1)

ESS2.A: Earth Materials and Systems

- Wind and water can change the shape of the land. (2-ESS2-1)

- Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around. (4-ESS2-1)

- All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms. (MS-ESS2-1)

NGSS Crosscutting concepts

Patterns

- Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.

Stability and Change

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NGSS Science and Engineering Practices

Developing and using models.

Explore Animals (coming Spring 2019)

Explore the things that make animals the same and different in an investigation of museum specimens and storytime using focused observation and listening skills.

NGSS Science and Engineering Practices: Analyzing and Interpreting Data; NGSS Crosscutting Concepts: Patterns

NGSS Science and Engineering Practices

Analyzing and Interpreting Data

NGSS Crosscutting concepts

Patterns

- Patterns in the natural and human designed world can be observed and used as evidence.

Common Core English Language Arts Standards

Range of Reading and Level of Text Complexity

- Actively engage in group reading activities with purpose and understanding. (CCSS.ELA-Literacy.RL.K.10)
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Hands-on Mammals

Explore the characteristics of mammals and their adaptations through a series of demonstrations and activities.

NGSS Disciplinary Core Ideas: LS1.A, LS3.B, LS4.A, LS4.D

NGSS Disciplinary Core Ideas

LS1.A: Structure and Function

- Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (4-LS1-1)

LS3.B: Variation of Traits

- Different organisms vary in how they look and function because they have different inherited information. (3-LS3-1)

LS4.A: Evidence of Common Ancestry and Diversity

- 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)

LS4.D: Biodiversity and Humans

- There are many different kinds of living things in any area, and they exist in different places on land and in water. (2-LS4-1)

NGSS Crosscutting concepts

Patterns

- Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.

Structure and Function

- The way an object or living thing is shaped and its substructure determine many of its properties and functions.

NGSS Science and Engineering Practices

Engaging in argument from evidence.

Obtaining, evaluating, and communicating information.

DNA Discovery

This workshop introduces DNA — what it is and how it works. Hands-on activities include DNA extraction and making DNA jewelry.

NGSS Disciplinary Core Ideas: LS1.A, LS1.B, LS3.A, LS3.B, LS4.A

NGSS Disciplinary Core Ideas

LS1.A: Structure and Function

- All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins. (secondary to HS-LS3-1) (HS-LS1-1)

LS1.B: Growth and Development of Organisms

- Reproduction is essential to the continued existence of every kind of organism. Plants and animals have unique and diverse life cycles. (3-LS1-1)

- Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring. (secondary to MS-LS3-2)

LS3.A: Inheritance of Traits

- Many characteristics of organisms are inherited from their parents. (3-LS3-1)
- Other characteristics result from individuals' interactions with the environment, which can range from diet to learning. Many characteristics involve both inheritance and environment. (3-LS3-2)
- Genes are located in the chromosomes of cells, with each chromosome pair containing two variants of each of many distinct genes. Each distinct gene chiefly controls the production of specific proteins, which in turn affects the traits of the individual. Changes (mutations) to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits. (MS-LS3-1)
- Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. The instructions for forming species' characteristics are carried in DNA. All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways. Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural functions, and some have no as-yet known function. (HS-LS3-1)
- Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited. (MS-LS3-2)

LS3.B: Variation of Traits

- Different organisms vary in how they look and function because they have different inherited information. (3-LS3-1)
- The environment also affects the traits that an organism develops. (3-LS3-2)
- In sexually reproducing organisms, each parent contributes half of the genes acquired (at random) by the offspring. Individuals have two of each chromosome and hence two alleles of each gene, one acquired from each parent. These versions may be identical or may differ from each other. (MS-LS3-2)
- In addition to variations that arise from sexual reproduction, genetic information can be altered because of mutations. Though rare, mutations may result in changes to the structure and function of proteins. Some changes are beneficial, others harmful, and some neutral to the organism. (MS-LS3-1)
- In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation. Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. Environmental factors can also cause mutations in genes, and viable mutations are inherited. (HS-LS3-2)
- Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors. (HS-LS3-2),(HS-LS3-3)

LS4.A: Evidence of Common Ancestry and Diversity

- Genetic information, like the fossil record, provides evidence of evolution. DNA sequences vary among species, but there are many overlaps; in fact, the ongoing branching that produces

multiple lines of descent can be inferred by comparing the DNA sequences of different organisms. Such information is also derivable from the similarities and differences in amino acid sequences and from anatomical and embryological evidence. (HS-LS4-1)

NGSS Crosscutting Concepts

Patterns

- Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.

Cause and Effect

- Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.

Structure and Function • The way an object or living thing is shaped and its substructure determine many of its properties and functions.

NGSS Science and Engineering Practices

Developing and using models.

Matter Matters

Students investigate the properties and classification of matter. Topics include the particulate nature of matter, state changes and temperature.

NGSS Disciplinary Core Ideas: PS1.A, PS3.A

NGSS Disciplinary Core Ideas

PS1.A: Structure and Properties of Matter

- Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties. (2-PS1-1)
- Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1)
- The amount (weight) of matter is conserved when it changes form, even in transitions in which it seems to vanish. (5-PS1-2)
- Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. (MS-PS1-4)

- In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations. (MS-PS1-4)
- The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter. (MS-PS1-4)

PS3.A: Definitions of Energy

- The faster a given object is moving, the more energy it possesses. (4-PS3-1)
- 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)

NGSS Crosscutting concepts

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Cause and Effect

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Structure and Function

- The way an object or living thing is shaped and its substructure determine many of its properties and functions.

Energy and Matter

- Energy can be transferred in various ways and between objects.

Scale, Proportion, and Quantity

- In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance.

Systems and System Models

- Defining the system under study—specifying its boundaries and making explicit a model of that system—provides tools for understanding and testing ideas that are applicable throughout science and engineering.

NGSS Science and Engineering Practices

Developing and using models.

Cartoon Guide to Energy

What can falling anvils and exploding TNT tell us about how energy works in the cartoon and real worlds? Using classic cartoon scenarios, students explore how fundamental forces and properties of matter build a framework for thinking about energy across its different contexts.

NGSS Disciplinary Core Ideas: PS1.A, PS1.B, PS2.B, PS3.A, PS3.B, PS3.C, PS3.D

NGSS Disciplinary Core Ideas

PS1.A: Structure and Properties of Matter

- The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. (HS-PS1-3)
- A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart. (HS-PS1-4)

PS1.B: Chemical Reactions

- When two or more different substances are mixed, a new substance with different properties may be formed. (5-PS1-4)
- Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. (MS-PS1-2),(MS-PS1-3),(MS-PS1-5)
- The total number of each type of atom is conserved, and thus the mass does not change. (MS-PS1-5)
- Some chemical reactions release energy, others store energy. (MS-PS1-6)
- Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy. (HS-PS1-4),(HS-PS1-5)

PS2.B: Types of Interactions

- The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center. (5-PS2-1)
- 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, 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)
- Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects.

PS3.A: Definitions of Energy

- Energy can be moved from place to place by moving objects or through sound, light, or electric currents. (4-PS3-2),(4-PS3-3)
- 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)
- 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. (HS-PS3-1),(HS-PS3-2)
- At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. (HS-PS3-2) (HS-PS3-3) • 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. (HS-PS3-2)

PS3.B: Conservation of Energy and Energy Transfer

- Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced. (4-PS3-2),(4-PS3-3)
- Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. (HS-PS3-1)
- Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PS3-1),(HS-PS3-4)
- Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior. (HS-PS3-1)

PS3.C: Relationship Between Energy and Forces

- When two objects interacting through a field change relative position, the energy stored in the field is changed. (HS-PS3-5)

PS3.D: Energy in Chemical Processes and Everyday Life

- The expression “produce energy” typically refers to the conversion of stored energy into a desired form for practical use. (4-PS3-4)
- Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment. (HS-PS3-3),(HS-PS3-4)

NGSS Crosscutting Concepts

Patterns

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Cause and Effect

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Energy and Matter

- Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems' possibilities and limitations.

Scale, Proportion, and Quantity

- In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance.

Systems and System Models

- Defining the system under study—specifying its boundaries and making explicit a model of that system—provides tools for understanding and testing ideas that are applicable throughout science and engineering.

NGSS Science and Engineering Practices

Asking questions and defining problems.

Developing and using models.

How Small is Small?

Discover what the smallest things in the universe are and how small! Explore the concept of scale through giant insects, viruses and chickens.

NGSS Disciplinary Core Ideas: PS1.A, PS2.B

Common Core Math Domains: NBT, MD, SMP

NGSS Disciplinary Core Ideas

PS1.A: Structure and Properties of Matter

- Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties. (2-PS1-1)
- A great variety of objects can be built up from a small set of pieces. (2-PS1-3)

- Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1)

PS2.B: Types of Interactions

- The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center. (5-PS2-1)

NGSS Crosscutting concepts

Patterns

- Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.

Scale, Proportion, and Quantity

- In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance.

NGSS Science and Engineering Practices

Using mathematics and computational thinking.

Common Core Math Standards

Numbers & Operations in Base Ten

- Understand the place value system. (CCSS.Math.Content.5.NBT.A.1 & 2)

Measurement & Data

- Geometric measurement: understand concepts of area and relate area to multiplication and to addition. (CCSS.Math.Content.3.MD.C.5, 5.a, 5b, 6 & 7)
- Solve problems involving measurement and conversion of measurements. (CCSS.Math.Content.4.MD.A.1)
- Convert like measurement units within a given measurement system. (CCSS.Math.Content.5.MD.A.1)
- Geometric measurement: understand concepts of volume. (CCSS.Math.Content.5.MD.C.3, 4 & 5)

Mathematical Practices

- Reason abstractly and quantitatively. (CCSS.Math.Practice.MP2)

Quarks: Ups, Downs and the Universe

Discover what the world is made of. Investigate atoms, states of matter and electrical charge. Be atoms, build atoms and find out what they are made of.

NGSS Disciplinary Core Ideas: PS1.A, PS2.B
Common Core Math Domain: NS, NF, SMP

NGSS Disciplinary Core Ideas

PS1.A: Structure and Properties of Matter

- Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1)
- The amount (weight) of matter is conserved when it changes form, even in transitions in which it seems to vanish. (5-PS1-2)
- Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. (MS-PS1-4)
- In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations. (MS-PS1-4)
- The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter. (MS-PS1-4)
- Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. (HS-PS1-1)
- The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. (HS-PS1-3)
- The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states. (HS-PS1-1),(HS-PS1-2)

PS2.B: Types of Interactions

- Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects.

NGSS Crosscutting Concepts

Patterns

- Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.

Energy and Matter

- Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems' possibilities and limitations.

Scale, Proportion, and Quantity

- In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance.

Systems and System Models

- Defining the system under study—specifying its boundaries and making explicit a model of that system—provides tools for understanding and testing ideas that are applicable throughout science and engineering.

NGSS Science and Engineering Practices

Developing and using models.

Using mathematics and computational thinking.

Common Core Math Standards

Numbers & Operations in Base Ten

- Understand the place value system.

Numbers & Operations – Fractions

- Build fractions from unit fractions.

Mathematical Practices

Reason abstractly and quantitatively. (CCSS.Math.Practice.MP2)