Community Unit School District 303
Dynamic Earth Science

Performance Expectations	Disciplinary Core Ideas	Crosscutting Concepts	Science & Engineering Practices
HS-ESS1-2. Earth's Place in the Universe Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe.	**ESS1.A: The Universe and Its Stars** The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movement, and their distance from Earth. The Big Bang theory is supported by observations of composition of stars and non-stellar gases, and of the maps of spectra of the primordial radiation (cosmic microwave background radiation) that still fills the universe. Other than hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the processes releases electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode. **PS4.B: Electromagnetic Radiation**	**Energy and Matter** Energy cannot be created or destroyed-only moved between one place and another place.	**Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 9-12 builds on K-8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.

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	Atoms of each element emit and absorb characteristic frequencies of light. These characteristics allow identification of the presence of an element, even in microscopic quantities.		
HS-ESS1-3. Earth's Place in the Universe Communicate scientific ideas about the way stars, over their life cycle, produce elements.	**ESS1.A: The Universe and Its Stars** The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movement, and their distance from Earth. Other than hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode.	**Energy and Matter** In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.	**Obtaining, Evaluating, and Communicating Information** Obtaining, evaluating, and communicating information in 9-12 builds on K-8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.

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HS-PS1-8. Matter and Its Interactions Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission and fusion.	**PS1.C: Nuclear Processes** Nuclear processes, including fusion and fission involve release or absorption of energy. The total number of neutrons plus protons does not change in any nuclear process.	**Energy and Matter** In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.	**Developing and Using Models** Modeling in 9-12 builds on K-8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.
HS-ESS1-4. Earth's Place in the Universe Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.	**ESS1.B: Earth and the Solar System** Kepler's laws describe common features of the motions of orbiting objects, including their elliptical paths around the sun. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system.	**Scale, Proportion, and Quantity** Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).	**Using Mathematical and Computational Thinking** Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials, and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.
HS-ESS1-5. Earth's Place in the Universe Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.	**ESS1.C: The History of Planet Earth** Continental rocks, which can be older than 4 billion years, are generally much older than the rocks of the ocean floor, which are less than 200 million years old. **PS1.C: Nuclear Processes**	**Patterns** Empirical evidence is needed to identify patterns.	**Engaging in Argument from Evidence** Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s).

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	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.		Arguments may also come from current scientific or historical episodes in science.
HS-ESS1-6. Earth's Place in the Universe Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct and account of Earth's formation and early history.	**ESS1.C: The History of Planet Earth** Although active geologic processes, such as plate tectonics and erosion, have destroyed or altered most of the very early rock, other objects in the solar system, such as lunar rocks, asteroids and meteorites, have changed little over billions of years. Studying these objects can provide information about Earth's formation and early history. **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.	**Stability and Change** Much of the science deals with construction explanation of how things change and how they remain stable.	**Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 9-12 builds on K-8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.
HS-ESS2-7. Earth's Systems Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.	**ESS2.D: Weather and Climate** Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. **ESS2.E: Biogeology** The many dynamic and delicate feedbacks between the biosphere	**Stability and Change** Much of science deals with constructing explanations of how things change and how they remain stable.	**Engaging in Argument from Evidence** Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and

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	and other Earth systems cause a continual co-evolution of Earth's surface and the life that exists on it.		explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.
HS-ESS2-1. Earth's Systems Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.	**ESS2.A: Earth Materials and Systems** Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes.	**Stability and Change** Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible.	**Developing and Using Models** Modeling in 9-12 builds on K-8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).
HS-ESS1-5. Earth's Place in the Universe Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.	**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.	**Patterns** Empirical evidence is needed to identify patterns.	**Engaging in Argument from Evidence** Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed worlds(s). Arguments may also come from current scientific or historical episodes in science.
HS-ESS2-3. Earth's Systems Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.	**ESS2.A: Earth Materials and Systems** Evidence from deep probes and seismic waves, reconstructions of historical changes in Earth's surface and its magnetic field, and an understanding of physical	**Energy and Matter** Energy drives the cycling of matter within and between systems.	**Developing and Using Models** Modeling in 9-12 builds on K-8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and

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	and chemical processes lead to a model of Earth with a hot but solid inner core, a liquid outer core, a solid mantle and crust. Motions of the mantle and its plates occur primarily through thermal convection, which involves the cycling of matter due to the outward flow of energy from Earth's interior and gravitational movement of denser materials toward the interior. **ESS2.B: Plate Tectonics and Large-Scale System Interactions** The radioactive decay of unstable isotopes continually generates new energy within Earth's crust and mantle, providing the primary source of the heat that drives mantle convection. Plate tectonics can be viewed as the surface expression of mantle convection. **PS4.A: Wave Properties** Geologists use seismic waves and their reflection at interfaces between layers to probe structures deep in the planet.		their components in the natural and designed world(s).

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HS-ESS3-1. Earth and Human Activity Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.	**ESS3.B: Natural Hazards** Natural hazards and other geologic events have shaped the course of human history; (they) have significantly altered the sizes of human populations and have driven human migrations.	**Cause and Effect** Empirical evidence is required to differentiate between cause and correlation and make claim about specific causes and effects.	**Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 9-12 builds on K-8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific knowledge, principles, and theories.
HS-ESS2-4. Earth's Systems Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.	**ESS2.A: Earth Materials and Systems** The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles. **ESS2.D: Weather and Climate** The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land	**Cause and Effect** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.	**Developing and Using Models** Modeling in 9-12 builds on K-8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).

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	systems, and this energy's re-radiation into space.		
HS-ESS2-6. Earth's Systems Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere**.**	**ESS2.D: Weather and Climate** Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen.	**Energy and Matter** The total amount of energy and matter in closed systems is conserved.	**Developing and Using Models** Modeling in 9-12 builds on K-8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).
HS-ESS3-5. Earth and Human Activity Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.	**ESS3.C: Human Impacts on Earth Systems** Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts.	**Stability and Change** Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible.	**Analyzing and Interpreting Data** Analyzing data in 9-12 builds on K-8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.
HS-ESS3-6. Earth and Human Activity Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.	**ESS3.D: Global Climate Change** Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities.	**Systems and System Models** When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models.	**Using Mathematics and Computational Thinking** Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on

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			mathematical models of basic assumptions.
HS-ESS3-1. Earth and Human Activity Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.	**ESS3.B: Natural Hazards** Natural hazards and other geologic events have shaped the course of human history; (they) have significantly altered the sizes of human populations and have driven human migrations.	**Cause and Effect** Empirical evidence is required to differentiate between cause and correlation and make claim about specific causes and effects.	**Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 9-12 builds on K-8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific knowledge, principles, and theories.
HS-ESS2-2. Earth's Systems Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth's systems.	**ESS2.A: Earth Materials and Systems** Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. **ESS2.D: Weather and Climate** The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space.	**Stability and Change** Feedback (negative or positive) can stabilize or destabilize a system.	**Analyzing and Interpreting Data** Analyzing data in 9-12 builds on K-8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.

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HS-ESS2-5. Earth's Systems Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface.	**ESS2.C: The Roles of Water in Earth's Surface Processes** The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks.	**Structure and Function** The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials.	**Planning and Carrying Out Investigations** Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.
HS-ESS3-1. Earth and Human Activity Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.	**ESS3.B: Natural Hazards** Natural hazards and other geologic events have shaped the course of human history; (they) have significantly altered the sizes of human populations and have driven human migrations.	**Cause and Effect** Empirical evidence is required to differentiate between cause and correlation and make claim about specific causes and effects.	**Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 9-12 builds on K-8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence

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			consistent with scientific knowledge, principles, and theories.
HS-ESS3-1. Earth and Human Activity Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.	**ESS3.A: Natural Resources** Resource availability has guided the development of human society.	**Cause and Effect** Empirical evidence is required to differentiate between cause and correlation and make claim about specific causes and effects.	**Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 9-12 builds on K-8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific knowledge, principles, and theories.
HS-ESS3-2. Earth and Human Activity Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources.	**ESS3.A: Natural Resources** All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors. **ETS1.B: Developing Possible Solutions** When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts.		**Engaging in Argument from Evidence** Engaging in argument in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about natural and designed world(s). Argument may also come from current scientific or historical episodes in science.

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HS-ESS3-3. Earth and Human Activity Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.	**ESS3.C: Human Impacts on Earth Systems** The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.	**Stability and Change** Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible.	**Using Mathematical and Computational Thinking** Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.
HS-ESS3-4. Earth and Human Activity Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.	**ESS3.C: Human Impacts on Earth Systems** Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation.	**Stability and Change** Feedback (negative or positive) can stabilize or destabilize a system.	**Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 9-12 builds on K-8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific knowledge, principles, and theories.

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