BLUE VALLEY DISTRICT CURRICULUM

Science | Earth and Space

ORGANIZING THEME/TOPIC	FOCUS STANDARDS & SKILLS
UNIT 1: EARTH MATERIALS AND RESOURCES • Elements • Minerals • Rocks • Rock Cycle • Alternative Energy • Positive & Negative Feedback System	**HS-ESS3-2. Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.** Science & Engineering Practice(s): • **Engaging in Argument from Evidence:** Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations). Disciplinary Core Idea(s): • **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. Crosscutting Concept(s): • **Influence of Engineering, Technology, and Science on Society and the Natural World:** Analysis of costs and benefits is a critical aspect of decisions about technology. **HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.** Science & Engineering Practice(s): • **Constructing Explanations and Designing Solutions:** Design or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. Disciplinary Core Idea(s): • **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. Crosscutting Concept(s): • **Stability and Change:** Feedback (negative or positive) can stabilize or destabilize a system.

ORGANIZING THEME/TOPIC	FOCUS STANDARDS & SKILLS
UNIT 2: WEATHERING AND EROSION • Mechanical & Chemical Weathering • Soil • Mass Wasting • Water Cycle • Surface Water • Groundwater • Glaciers • Wind	**HS-ESS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.** Science & Engineering Practice(s): • **Planning and Carrying Out Investigations:** Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. Disciplinary Core Idea(s): • **ESS2.C: The Role 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. Crosscutting Concept(s): • **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. **HS-ESS3-3. Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.** Science & Engineering Practice(s): • **Using Mathematics and Computational Thinking:** Create a computational model or simulation of a phenomenon, designed device, process, or system. Disciplinary Core Idea(s): • **ESS3.C: Human Impacts on Earth Systems:** The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. Crosscutting Concept(s): • **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.

ORGANIZING THEME/TOPIC	FOCUS STANDARDS & SKILLS
UNIT 2: WEATHERING AND EROSION (continued)	**HS-ESS2-6. Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.** Science & Engineering Practice(s): • **Developing and Using Models:** Develop a model based on evidence to illustrate the relationships between systems or between components of a system. Disciplinary Core Idea(s): • **ESS2.D: Weather and Climate:** Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. Crosscutting Concept(s): • **Energy and Matter:** The total amount of energy and matter in closed systems is conserved. .

ORGANIZING THEME/TOPIC	FOCUS STANDARDS & SKILLS
UNIT 3: PLATE TECTONICS AND EARTHQUAKES • Continental Drift • Actions & Features at Plate Boundaries • Wave properties • Faults • Measurement & Distribution	**HS-ESS1-5. 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.** Science & Engineering Practice(s): • **Engaging in Argument from Evidence:** Evaluate evidence behind currently accepted explanations or solutions to determine the merits of arguments. Disciplinary Core Idea(s): • **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. • **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. Crosscutting Concept(s): • **Patterns:** Empirical evidence is needed to identify patterns. **HS-ESS2-3. Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.** Science & Engineering Practice(s): • **Developing and Using Models:** Develop a model based on evidence to illustrate the relationships between systems or between components of a system. Disciplinary Core Idea(s): • **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 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. Crosscutting Concept(s): • **Energy and Matter:** Energy drives the cycling of matter within and between systems.

ORGANIZING THEME/TOPIC	FOCUS STANDARDS & SKILLS
UNIT 4: VOLCANOES AND MOUNTAIN BUILDING • Types of Volcanoes • Intrusive/Extrusive Igneous Activity	**HS-ESS2-1. 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.** Science & Engineering Practice(s): • **Developing and Using Models:** Develop a model based on evidence to illustrate the relationships between systems or between components of a system. Disciplinary Core Idea(s): • **ESS2.A: Earth Materials and Systems:** Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. A deep knowledge of how feedbacks work within and among Earth's systems is still lacking, thus limiting scientists' ability to predict some changes and their impacts. • **ESS2.B: Plate Tectonics and Large-Scale System Interaction:** 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. (Plate movements are responsible for most continental and ocean-floor features and for the distribution of most rocks and minerals within Earth's crust. • **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. • Crosscutting Concept(s): • **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. **HS-ESS3-1. 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.** Science & Engineering Practice(s): • **Constructing Explanations and Designing Solutions:** Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. Disciplinary Core Idea(s): • **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. Crosscutting Concept(s): • **Cause and Effect:** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

ORGANIZING THEME/TOPIC	FOCUS STANDARDS & SKILLS
UNIT 5: GEOLOGIC TIME • Radiometric Dating • Relative Rock Dating • Geologic Time Scale	**HS-ESS1-6. Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history.** Science & Engineering Practice(s): • **Constructing Explanations and Designing Solutions:** Apply scientific reasoning to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion. Disciplinary Core Idea(s): • **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 record on Earth, 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. Crosscutting Concept(s): • **Stability and Change:** Much of science deals with constructing explanations of how things change and how they remain stable. **HS-ESS2-7. Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.** . Science & Engineering Practice(s): • **Engaging in Argument from Evidence:** Construct an oral and written argument or counter-arguments based on data and evidence. Disciplinary Core Idea(s): • **ESS2.E: Biogeology:** The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co- evolution of Earth's surface and the life that exists on it. Crosscutting Concept(s): • **Stability and Change:** Much of science deals with constructing explanations of how things change and how they remain stable.

ORGANIZING THEME/TOPIC	FOCUS STANDARDS & SKILLS
UNIT 6: ATMOSPHERIC STRUCTURE AND ATMOSPHERIC MOISTURE • Composition • Structure • Characteristics & Function • Changes of State • Water in the Atmosphere	**HS-ESS2-4. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.** Science & Engineering Practice(s): • **Developing and Using Models:** Use a model to provide mechanistic accounts of phenomena. (HS-ESS2-4) Disciplinary Core Idea(s): • **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. • **ESS2.D: Weather and Climate:** Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. Crosscutting Concept(s): • **Cause and Effect:** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

ORGANIZING THEME/TOPIC	FOCUS STANDARDS & SKILLS
UNIT 7: AIR PRESSURE, FRONTS, AND WEATHER MAPS • Highs and Lows • Air Masses & Fronts • Analyzing weather data	**HS-ESS2-4. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.** Science & Engineering Practice(s): • **Developing and Using Models:** Use a model to provide mechanistic accounts of phenomena. Disciplinary Core Idea(s): • **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. • **ESS2.D: Weather and Climate:** Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. Crosscutting Concept(s): • **Cause and Effect:** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

ORGANIZING THEME/TOPIC	FOCUS STANDARDS & SKILLS
UNIT 8: SEVERE WEATHER AND CLIMATE • Thunderstorms • Tornadoes • Hurricanes • Climate Changes	**HS-ESS3-5. 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.** Science & Engineering Practice(s): • **Analyzing and Interpreting Data:** Analyze data using computational models in order to make valid and reliable scientific claims. Disciplinary Core Idea(s): • **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. • **ESS3.D: Global Climate Change:** 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. Crosscutting Concept(s): • **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. **HS-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.*** Science & Engineering Practice(s): • **Using Mathematics and Computational Thinking:** Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations. Disciplinary Core Idea(s): • **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. • **ESS2.D: Weather and Climate:** Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and biosphere. Crosscutting Concept(s): • **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.

ORGANIZING THEME/TOPIC	FOCUS STANDARDS & SKILLS
UNIT 8: SEVERE WEATHER AND CLIMATE (continued)	**HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.** Science & Engineering Practice(s): • **Analyzing and Interpreting Data:** Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. Disciplinary Core Idea(s): • **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. Crosscutting Concept(s): • **Stability and Change:** Feedback (negative or positive) can stabilize or destabilize a system.

ORGANIZING THEME/TOPIC	FOCUS STANDARDS & SKILLS
UNIT 9: PLANETARY MOTION • Earth/Moon/Sun System **Suggested Time Frame: 3 weeks**	**HS-ESS1-2. 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.** Science & Engineering Practice(s): • **Constructing Explanations and Designing Solutions:** Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. Disciplinary Core Idea(s): • **ESS1.A: The Universe and Its Stars:** The Big Bang theory is supported by observations of distant galaxies receding from our own, of the measured composition of stars and non-stellar gases, and of the maps of spectra of the primordial radiation (cosmic microwave background) that still fills the universe. • **ESS1.A: The Universe and Its Stars:** Other than the 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. • **PS4.B: Electromagnetic Radiation:** 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. Crosscutting Concept(s): • **Energy and Matter:** Energy cannot be created or destroyed–only moved between one place and another place, between objects and/or fields, or between systems. **HS-ESS1-4. Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.** Science & Engineering Practice(s): • **Using Mathematical and Computational Thinking:** Use mathematical or computational representations of phenomena to describe explanations. Disciplinary Core Idea(s): • **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. Crosscutting Concept(s): • **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).

ORGANIZING THEME/TOPIC	FOCUS STANDARDS & SKILLS
UNIT 10: SOLAR SYSTEM • Solar Nebular Hypothesis • Planets & Natural Satellites • Minor Members (Comets/Asteroids/Dwarf Planets)	**HS-ESS1-1. Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy that eventually reaches Earth in the form of radiation.** Science & Engineering Practice(s): • **Developing and Using Models:** Develop a model based on evidence to illustrate the relationships between systems or between components of a system. Disciplinary Core Idea(s): • **ESS1.A: The Universe and Its Stars:** The star called the sun is changing and will burn out over a lifespan of approximately 10 billion years. Crosscutting Concept(s): • **Scale, Proportion, and Quantity:** The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.

ORGANIZING THEME/TOPIC	FOCUS STANDARDS & SKILLS
UNIT 11: THE UNIVERSE • Stellar Evolution • Galaxies • Origin of the Universe	**HS-ESS1-3. Communicate scientific ideas about the way stars, over their life cycle, produce elements.** Science & Engineering Practice(s): • **Obtaining, Evaluating, and Communicating Information:** Communicate scientific ideas (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). Disciplinary Core Idea(s): • **ESS1.A: The Universe and Its Stars:** The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth. Crosscutting Concept(s): • **Energy and Matter:** In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.

ORGANIZING THEME/TOPIC	FOCUS STANDARDS & SKILLS
UNIT 11: THE UNIVERSE (continued)	**HS-ESS1-2. 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.** Science & Engineering Practice(s): • **Constructing Explanations and Designing Solutions:** Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. Disciplinary Core Idea(s): • **ESS1.A: The Universe and Its Stars:** The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth. (HS-ESS1-2),(HS-ESS1-3) • **ESS1.A: The Universe and Its Stars**: The Big Bang theory is supported by observations of distant galaxies receding from our own, of the measured composition of stars and non-stellar gases, and of the maps of spectra of the primordial radiation (cosmic microwave background) that still fills the universe. • **ESS1.A: The Universe and Its Stars**: Other than the 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. • **PS3.D: Energy in Chemical Processes and Everyday Life:** Nuclear Fusion processes in the center of the sun release the energy that ultimately reaches Earth as radiation. • **PS4.B: Electromagnetic Radiation:** 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. Crosscutting Concept(s): • **Energy and Matter:** Energy cannot be created or destroyed–only moved between one place and another place, between objects and/or fields, or between systems.