School District of Marshfield Course Syllabus

Course Name: Earth and Space Science Honors
Length of Course: Year
Credit: 1 Credit

Program Goal:

The School District of Marshfield K-12 Science Program will prepare and motivate learners to explore, problem solve and collaborate with their classmates to interpret science and explain the world around them. Learners will acquire knowledge and evidence that promotes creative solutions through the evaluation and understanding of scientific theories and evidence. Learners will collect, analyze and reason with scientific data through investigations that ultimately allow for the generation of scientific explanations. Critical thinking skills will elevate natural curiosity, make sense of scientific data and promote scientific literate citizens.

Course Description:

Earth and Space Science is a laboratory science course in which students study geology, meteorology, and astronomy. The study of geology includes the composition and dynamics of the earth, earth history, shaping of the earth's surface and energy in earth events. The study of meteorology includes the composition and dynamics of earth's atmosphere, weather related processes and phenomena. The study of astronomy includes the structure and composition of our solar system and the universe with emphasis placed on technology and instruments used to advance our understanding of the universe. Students will demonstrate application of the District Content Standards through hands-on laboratory exercises.

Wisconsin Standards for Science (SCI)	
Crosscutting Concepts (CC)	
CC1: Students use science and engineering practices, disciplinary core ideas, and ***patterns*** to make sense of phenomena and solve problems.	
Patterns	CC1.h: Students observe patterns in systems at different scales and cite patterns as empirical evidence for causality in supporting their explanations of phenomena. They recognize classifications or explanations used at one scale may not be useful or need revision using a different scale, thus requiring improved investigations and experiments. They use mathematical representations to identify and analyze patterns of performance in order to reengineer a designed system.
CC2: Students use science and engineering practices, disciplinary core ideas, and ***cause and effect*** relationships to make sense of phenomena and solve problems.	
Cause and Effect	CC2.h: Students understand empirical evidence is required to differentiate between cause and correlation and to make claims about specific causes and effects. They suggest cause and effect relationships to explain and predict behaviors in complex natural and designed systems. They also propose causal relationships by examining what is known about smaller scale mechanisms within the system. They recognize changes in systems may have various causes that may not have equal effects.
CC3: Students use science and engineering practices, disciplinary core ideas, and an understanding of ***scale, proportion and quantity*** to make sense of phenomena and solve problems.	
Scale, Proportion, and Quantity	CC3.h: Students understand the significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. They recognize patterns observable at one scale may not be observable or exist at other scales, and some systems can only be studied indirectly as they are too small, too large, too fast, or too slow to observe directly. They use orders of magnitude to understand how a model at one scale relates to a model at another scale. They use algebraic thinking to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).
CC4: Students use science and engineering practices, disciplinary core ideas, and an understanding of ***systems and models*** to make sense of phenomena and solve problems.	

Systems and System Models	CC4.h: Students investigate or analyze a system by defining its boundaries and initial conditions, as well as its inputs and outputs. They use models (e.g., physical, mathematical, computer models) to simulate the flow of energy, matter, and interactions within and between systems at different scales. They also use models and simulations to predict the behavior of a system, and recognize that these predictions have limited precision and reliability due to the assumptions and approximations inherent in the models. They also design systems to do specific tasks.
CC5: Students use science and engineering practices, disciplinary core ideas, and an understanding of ***energy and matter*** to make sense of phenomena and solve problems.	
Energy and Matter	CC5.h: Students understand that the total amount of energy and matter in closed systems is conserved. They describe changes of energy and matter in a system in terms of energy and matter flows into, out of, and within that system. They also learn that energy cannot be created or destroyed. It only moves between one place and another place, between objects and/or fields, or between systems. Energy drives the cycling of matter within and between systems. In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.
CC7: Students use science and engineering practices, disciplinary core ideas, and an understanding of ***stability and change*** to make sense of phenomena and solve problems.	
Stability and Change	CC7.h: Students understand much of science deals with constructing explanations of how things change and how they remain stable. They quantify and model changes in systems over very short or very long periods of time. They see some changes are irreversible, and negative feedback can stabilize a system, while positive feedback can destabilize it. They recognize systems can be designed for greater or lesser stability.
Science and Engineering Practices (SEP)	
SEP1: Students ***ask questions and define problems***, in conjunction with using crosscutting concepts and disciplinary core ideas, to make sense of phenomena and solve problems.	
Asking Questions SEP1.A	SEP1.A.h: Students ask questions to formulate, refine, and evaluate empirically testable questions. This includes the following: Ask questions that arise from careful observation of phenomena, or unexpected results, to clarify and seek additional information. Ask questions that arise from examining models or theories to clarify and seek additional information and relationships.

	Ask questions to determine relationships, including quantitative relationships, between independent and dependent variables. Ask questions to clarify and refine a model or an explanation. Evaluate a question to determine if it is testable and relevant. Ask questions that can be investigated within the scope of the school laboratory, research facilities, or field (e.g., outdoor environment) with available resources and, when appropriate, frame a hypothesis based on a model or theory. Ask and evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of the design.
SEP3: Students ***plan and carry out investigations***, in conjunction with using crosscutting concepts and disciplinary core ideas, to make sense of phenomena and solve problems.	
Planning and Conducting Investigations SEP3.A	SEP3.A.h: Students plan and carry out investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models: This includes the following: Individually and collaboratively plan an investigation or test a design to produce data that can serve as evidence to build and revise models, support explanations for phenomena, and refine solutions to problems. Consider possible variables or effects and evaluate the investigation's design to ensure variables are controlled. Individually and collaboratively plan and conduct an investigation to produce data to serve as the basis for evidence. In the design: decide on types, how much, and accuracy of data needed to produce reliable measurements. Consider limitations on the precision of the data (e.g., number of trials, cost, risk, time) and refine the design accordingly. Plan and conduct an investigation or test a design solution in a safe and ethical manner including considerations of environmental, social, and personal impacts. Select appropriate tools to collect, record, analyze, and evaluate data.

	Make directional hypotheses that specify what happens to a dependent variable when an independent variable is manipulated. Manipulate variables and collect data about a complex model of a proposed process or system to identify failure points, or to improve performance relative to criteria for success.
SEP6: Students ***construct explanations and design solutions***, in conjunction with using crosscutting concepts and disciplinary core ideas, to make sense of phenomena and solve problems.	
Construct an Explanation SEP6.A	SEP6.A.h: Students create explanations that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. This includes the following: Make quantitative and qualitative claims regarding the relationship between dependent and independent variables. Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources, including students' own investigations, models, theories, simulations, and peer review. Explanations should reflect 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. Apply scientific ideas, principles, and evidence to provide an explanation of phenomena taking into account possible, unanticipated effects.
Physical Science (PS)	
PS1: Students use science and engineering practices, crosscutting concepts, and an understanding of ***matter and its interactions*** to make sense of phenomena and solve problems.	
Nuclear Processes PS1.C	PS1.C.h: Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption of energy.
Earth and Space Science (ESS)	
ESS1: Students use science and engineering practices, crosscutting concepts, and an understanding of ***Earth's place in the universe*** to make sense of phenomena and solve problems.	
The Universe and Its Stars ESS1.A	ESS1.A.h: Light spectra from stars are used to determine their characteristics, processes, and lifecycles. Solar activity creates the elements through nuclear fusion. The development of technologies has provided the astronomical data that provide the empirical evidence for the Big Bang theory.

Earth and the Solar System ESS1.B	ESS1.B.h: Kepler's laws describe common features of the motions of orbiting objects. Observations from astronomy and space probes provide evidence for explanations of solar system formation. Cyclical changes in Earth's tilt and orbit, occurring over tens to hundreds of thousands of years, cause cycles of ice ages and other gradual climate changes.
The History of Planet Earth ESS1.C	ESS1.C.h: The rock record resulting from tectonic and other geoscience processes as well as objects from the solar system can provide evidence of Earth's early history and the relative ages of major geologic formations.
Example Three-Dimensional Performance Indicators ESS1	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. 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. HS-ESS1-3: Communicate scientific ideas about the way stars, over their life cycle, produce elements. HS-ESS1-4: Use mathematical or computational representations to predict the motion of orbiting objects in the solar system. 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. 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.
ESS2: Students use science and engineering practices, crosscutting concepts, and an understanding of ***Earth's systems*** to make sense of phenomena and solve problems.	
Earth Materials and Systems ESS2.A	ESS2.A.h: Feedback effects exist within and among Earth's systems.
Plate Tectonics and Large-Scale System Interactions ESS2.B	ESS2.B.h: Radioactive decay within Earth's interior contributes to thermal convection in the mantle.
The Roles of Water in Earth's Surface Processes ESS2.C	ESS2.C.h: The planet's dynamics are greatly influenced by water's unique chemical and physical properties.
Weather and Climate ESS2.D	ESS2.D.h: The role of radiation from the sun and its interactions with the atmosphere, ocean, and land are the foundation for the global climate system. Global climate models are used to predict future changes, including changes influenced by human behavior and natural factors.

Example Three-Dimensional Performance Indicators ESS2	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. 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. HS-ESS2-3: Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection. 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. HS-ESS2-5: Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. HS-ESS2-6: Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.
ESS3: Students use science and engineering practices, crosscutting concepts, and an understanding of the ***Earth and human activity*** to make sense of phenomena and solve problems.	
Natural Resources ESS3.A	ESS3.A.h: Resource availability has guided the development of human society and use of natural resources has associated costs, risks, and benefits.
Natural Hazards ESS3.B	ESS3.B.h: Natural hazards and other geological events have shaped the course of human history at local, regional, and global scales.
Human Impacts on Earth Systems ESS3.C	ESS3.C.h: Sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources, including the development of technologies.
Global Climate Change ESS3.D	ESS3.D.h: Global climate models used to predict changes continue to be improved, although discoveries about the global climate system are ongoing and continually needed.
Example Three-Dimensional Performance Indicators ESS3	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. HS-ESS3-2: Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios. HS-ESS3-3: Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity. HS-ESS3-4: Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

	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. 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.

Key Vocabulary:

Big Bang theory cosmic	Bowen's reaction series	nonrenewable resource	background radiation
granitic rock	Pangaea	photosphere	texture
Plate Tectonics	chromosphere corona	sediment	Seafloor Spreading
solar wind sunspot	lithification	tectonic plate	basaltic rock
cementation	divergent boundary	fusion	bedding
rift valley	constellation binary	clastic	convergent boundary
stars parsec parallax	evaporite	subduction	apparent magnitude
foliated	transform boundary	absolute magnitude	nonfoliated
Paleogeography	luminosity	metamorphic rock	Geologic Timescale
main sequence	natural resource	Weathering	mineral
renewable resource	Erosion	crystal	sustainable yield
Deposition	luster	continental drift	troposphere
hardness	fuel	stratosphere	cleavage
lava	mesosphere	fracture streak	partial melting
thermosphere	solar flare prominence	silicates	exosphere radiation
igneous rock	intrusive rock	conduction	extrusive rock
convention	greenhouse effect		

Topics/Content Outline- Units and Themes:

Quarter 1:

- Introduction to Earth Science
- Beyond Earth

Quarter 2:

- Composition of Earth
- Resources and the Environment

Quarter 3:

- Dynamic Earth
- Surface Processes

Quarter 4:

- Geologic Time
- Atmosphere

Primary Resource(s):
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