School District of Marshfield Course Syllabus

Course Name: Oceanology Honors
Length of Course: Semester
Credit: 1/2 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:

The content includes a rigorous study of the nature of science, origins of the oceans, chemical and physical structure of the marine environment, ecology of the various sea zones, and the interrelationship between humans and the ocean. A variety of teaching/learning strategies will be employed, including lab activities that stress measurement and the use of the scientific method.

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.
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.	

<table>
<tr><td>Construct an Explanation
SEP6.A</td><td>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.</td></tr>
<tr><td colspan="2">Life Science (LS)</td></tr>
<tr><td colspan="2">LS2: Students use science and engineering practices, crosscutting concepts, and an understanding of the interactions, energy, and dynamics within ecosystems to make sense of phenomena and solve problems.</td></tr>
<tr><td>Interdependent Relationships in Ecosystems
LS2.A</td><td>LS2.A.h: Ecosystems have carrying capacities resulting from biotic and abiotic factors. The fundamental tension between resource availability and organism populations affects the abundance of species in any given ecosystem. The combination of the factors that affect an organism's success can be measured as a multidimensional niche.</td></tr>
<tr><td colspan="2">Physical Science (PS)</td></tr>
<tr><td colspan="2">PS4: Students use science and engineering practices, crosscutting concepts, and an understanding of waves and their applications in technologies for information transfer to make sense of phenomena and solve problems.</td></tr>
<tr><td>Wave Properties
PS4.A</td><td>PS4.A.h: The wavelength and frequency of a wave are related to one another by the speed of the wave, which depends on the type of wave and the medium through which it is passing. Waves can be used to transmit information and energy.</td></tr>
<tr><td colspan="2">Earth and Space Science (ESS)</td></tr>
<tr><td colspan="2">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.</td></tr>
<tr><td>Example Three-Dimensional Performance Indicators
ESS1</td><td>HS-ESS1-4: Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.</td></tr>
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	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.
Biogeology ESS2.E	ESS2.E.h: The biosphere and Earth's other systems have many interconnections that cause a continual coevolution of Earth's surface and life on it.
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-ESS2-3: 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.
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.
Engineering, Technology, and the Application of Science (ETS)	
ETS1: Students use science and engineering practices, crosscutting concepts, and an understanding of ***engineering design*** to make sense of phenomena and solve problems.	
Example of Three-Dimensional Performance Indicators ETS1	HS-ETS1-1: Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. HS-ETS1-2: Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
ETS3: Students use science and engineering practices, crosscutting concepts, and an understanding of the ***nature of science and engineering*** to make sense of phenomena and solve problems.	
Science and Engineering Are Unique Ways of Thinking with Different Purposes ETS3.B	ETS3.B.h: Science is both a body of knowledge that represents current understanding of natural systems and the processes used to refine, elaborate, revise and extend this knowledge. These processes differentiate science from other ways of knowing. Science knowledge has a history that includes the refinement of, and changes to, theories, ideas and beliefs over time. Science and engineering innovations may raise ethical issues for which science and engineering, by themselves, do not provide answers and solutions.

Science and Engineering Use Multiple Approaches to Create New Knowledge and Solve Problems ETS3.C	ETS3.C.h: Scientists use a variety of methods, tools and techniques to develop theories. A scientific theory is an explanation of some aspect of the natural word, based on evidence that has been repeatedly confirmed through observation, experimentation (hypothesis-testing), and peer review. The certainty and durability of science findings varies based on the strength of supporting evidence. Theories are usually modified if they are not able to accommodate new evidence. Engineers use a variety of approaches, tools, and techniques to define problems and develop solutions to those problems. Successful engineering solutions meet stakeholder needs and safety requirements, and are economically viable. Trade-offs in design aspects balance competing demands.

Key Vocabulary:			
oceanography	bathymetry	sonar	salinity
thermocline	pycnocline	mixed zone	surface current
gyre	Coriolis effect	upwelling	density current
wave height	wavelength	wave period	fetch
tide	tidal range	El Nino/ La Nina	Bycatch
Cyclone	Tsunami		

Topics/Content Outline- Units and Themes:

Quarter 1:

- Intro to Planet Earth
- Plate Tectonics/ Ocean Floor
- Marine Provinces
- Marine Sediments
- Water & Seawater
- Air-Sea Interaction

Quarter 2:

- Ocean Circulation
- Waves & Wave Dynamics
- Tides
- Beaches, Shorelines, etc.
- Marine Pollution Oceans
- Climate Change

Primary Resource(s):
Essentials of Oceanology, 13th Edition Pearson ISBN: 0-135-25758-1 ©2020