# **Earth Science II: Oceanography Content Guidelines**

## I. Science and Engineering Practices

Using the content in the Earth Science II - Geology Content Guidelines, students will demonstrate an understanding of scientific and engineering practices by

a. asking questions and defining problems

* ask questions that arise from observation of phenomena, examination of a model or theory, or unexpected results, and/or to seek additional information
* determine which questions can be investigated within the scope of the school laboratory or field experience
* generate hypotheses based on research and scientific principles
* make hypotheses that specify what happens to a dependent variable when an independent variable is manipulated
* define design problems that involve the development of a process or system with multiple components and criteria

1. planning and carrying out investigations

* individually and collaboratively plan and conduct observational and experimental investigations
* plan and conduct investigations to test design solutions in a safe and ethical manner including considerations of environmental, social, and personal effects
* select and use appropriate tools and technology including seafloor maps and profiles, geologic maps, satellite images, Secchi disks, Seine Net, hydrometer, digital electronic tools, and other scientific instruments to collect, record, analyze, and evaluate data

1. interpreting, analyzing, and evaluating data

* construct and interpret data tables collected from field/classroom investigations and reputable governmental/research facilities showing independent and dependent variables, repeated trials, and means
* construct, analyze, and interpret graphical displays of data and consider limitations of data analysis
* apply mathematical and statistical concepts and processes in building and revising models, supporting explanations of phenomena, or testing solutions to problems
* analyze data using tools, technologies, and/or models in order to make valid and reliable scientific claims or determine an optimal design solution

1. constructing and critiquing conclusions and explanations

* construct and revise explanations based on valid and reliable evidence obtained from a variety of sources including students’ own investigations, models, theories, simulations, and peer review
* apply scientific ideas, principles, and/or evidence to explain phenomena and design solutions
* construct arguments concerning oceanographic theories and models based on evidence and discuss these issues from multiple scientific viewpoints
* compare and evaluate competing arguments or design solutions in light of currently accepted explanations and new scientific evidence
* construct arguments or counter-arguments based on data and evidence

1. developing and using models

* evaluate the merits and limitations of models
* develop, revise, and/or use models based on evidence to illustrate or predict relationships
* construct and/or interpret map scales, satellite imagery, diagrams, classification charts, graphs, tables, models, and oceanographic profiling
* read and interpret oceanographic profiles, geologic maps and globes, including location by latitude and longitude
* develop and/or use models to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems

1. obtaining, evaluating, and communicating information

* compare, integrate, and evaluate sources of information presented in different media or formats to address a scientific question or solve a problem
* gather, read, and evaluate scientific and/or technical information from multiple sources, assessing the evidence and credibility of each source
* communicate scientific and/or technical information about phenomena and/or a design process in multiple formats

## II. Exploring the Ocean

Ocean.2 The student will investigate and understand that the Earth has one big ocean with many features. Key concepts include

* a majority of the Earth’s surface is covered with saltwater that includes a variety of ocean basins, seas, bays, and gulfs; and
* ocean seawater contains a constant proportion of dissolved salts and has unique inter-related physical and chemical properties.

Ocean.3 The student will investigate and understand that the ocean is largely unexplored and exploration is ongoing. Key concepts include

* early ocean explorations were driven by a variety of needs;
* extensive ocean explorations resulted from advances in navigation technologies; and
* recent explorations have greatly expanded our understanding and mapping of ocean depths and its features.

## III. Geological Oceanography

Ocean.4 The student will investigate and understand that seafloor features are the result of geological processes. Key concepts include

* the theory of plate tectonics explains how geologic forces and processes on and between plate boundaries result in seafloor features; and
* data generated from studies of geomagnetic fields, rock dating, sedimentation, seismic are used to understand geological processes of oceanic plate movement.

Ocean.5 The student will investigate and understand that processes in oceanic sedimentation impact seafloor features. Key concepts include

* the processes of sedimentation have identifiable characteristics and predictable rates of sedimentation;
* technology has led to new ways scientists collect data on oceanic sediments; and
* studies of sedimentation are useful in understanding Earth’s geologic history and paleoclimatology.

## IV. Physical Oceanography

Ocean.6 The student will investigate and understand that tides, waves, and currents have characteristics and differing processes by which they are generated. Key concepts include

* tide data reveal a variety of tide types that correlate to Sun-Earth-Moon positioning and geography;
* Earth’s rotation, and temperature differences create surface currents that impact navigation and marine life;
* kinetic energy from moving air is transferred to transverse wave energy that results changes in coastline features; and
* differences in water temperature and density result in thermoclines and deep water currents that create and modify deep seafloor features.

Ocean.7 The student will investigate and understand that the ocean has a role in biogeochemical cycles that affect the atmosphere, seawater, and seafloor features. Key concepts include

* important biogeochemical cycles include the carbon cycle, nitrogen cycle, oxygen cycle, phosphorus cycle, and the water cycle;
* biogeochemical cycles always seek a state of equilibrium; and
* human activities affect biogeochemical cycles and their steady state.

## V. Ocean Effects of Weather and Climate

Ocean.8 The student will investigate and understand that weather and climate are effected by thermal properties of land and water. Key concepts include

* the ocean is a major influence on weather and climate by absorbing, storing, and moving heat; and
* local, regional, and large scale atmospheric winds have specific characteristics and predictable patterns.

Ocean.9 The student will investigate and understand that that ocean is a critical component of climate change. Key concepts include

* global mean sea level fluctuations are caused by natural and human factors;
* the ocean regulates fluctuations of Earth’s average temperature over time, and
* data from a variety of studies reveal interrelationships between ocean properties and rates of climate change.

## VI. Marine Biology, Ecology, and Human Impact

Ocean.10 The student will investigate and understand that populations in ecosystems vary with changes in physical properties and geographic locations of the ocean. Key concepts include

* optical properties of light in water, water temperature, and water pressure affect marine autotrophic populations and their ecosystems; and
* changes in surface water temperatures vary with latitude and ocean currents creating ecological zones.

Ocean.11 The student will investigate and understand how energy flows in an ecosystem through complex food webs. Key concepts include

* interrelationships of biotic and abiotic factors explain the transfer of matter and energy within ecosystems;
* mixing of geothermal fluids with seawater supports a vast microbial ecosystem in deep ocean regions; and
* **most primary producers derive energy from photosynthesis**; and
* models of energy flow in an ecosystem are created to make predictions of the health of ecosystems.

Ocean.12 The student will investigate and understand that marine organisms have unique morphological features that allow them to be successful in specific ecosystems. Key concepts include

the diversity of phyla is greater in the ocean than on land from unicellular microbes to the largest animal on Earth;

the process of natural selection and biological evolution has led to speciation and biodiversity in ocean ecosystems;

morphological adaptations, development, and life cycle allow organisms to survive in specific oceanic ecosystems; and

* organisms that experience drastic changes in their habitat have highly specific adaptations for surviving in extreme ecosystems.

Ocean.13 The student will investigate and understand that the Chesapeake Bay and the ocean are of important social and economic value to Virginia. Key concepts include

* maritime boundaries determine resource ownership and can change due to a variety of factors;
* commercial and recreational fishing in Virginia is impacted by natural and human causal factors;
* state and federal agencies and non-profit organizations advocate and invest in protecting and expanding environmental habitats; and
* Virginia coastal zone management involves protecting and restoring coastal resources.