

Dublin City Schools Science Graded Course of Study

Systems of the Earth

I. Content Standard: Earth and Space Sciences

Students demonstrate an understanding about how Earth systems and processes interact in the geosphere resulting in the habitability of Earth. This includes demonstrating an understanding of the composition of the Universe, the Solar System and Earth. In addition, it includes understanding the properties and the interconnected nature of Earth's systems, processes that shape Earth and Earth's history. Students also demonstrate an understanding of how the concepts and principles of energy, matter, motion and forces explain Earth systems, the Solar System, and the Universe. Finally, they grasp an understanding of the historical perspectives, scientific approaches and emerging scientific issues associated with Earth and space sciences.

Benchmark	Environmental Science Indicator(s)
Benchmark A 11-12 Grade Level Band Explain how technology can be used to gather evidence and increase our understanding of the universe.	Benchmark A Indicator(s) <ul style="list-style-type: none"> Describe how the early Earth was different from the planet we live on today, and explain the formation of the Sun, Earth and the rest of the Solar System from a nebular cloud of dust and gas approximately 4.5 billion years ago. (Ohio Indicator 1, Grade 11)
Benchmark B 11-12 Grade Level Band Describe how Earth is made up of a series of interconnected systems and how a change in one system affects other systems	Benchmark B Indicator(s) <ul style="list-style-type: none"> Analyze how the regular and predictable motions of Earth, Sun and Moon explain phenomena on Earth (e.g., seasons, tides). (Ohio Indicator 2, Grade 11) Explain heat and energy transfers in and out of the atmosphere and its involvement in weather and climate (radiation, conduction, convection and advection; hurricanes, thunderstorms, oceanic and atmospheric currents). (Ohio Indicator 3, Grade 11) Explain the impact of oceanic and atmospheric currents on weather and climate. (Ohio Indicator 4, Grade 11) Use appropriate data to analyze and predict upcoming trends in global weather patterns (e.g., el Niño and la Niña, melting glaciers and icecaps, changes in ocean surface temperatures). (Ohio Indicator 5, Grade 11)



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Benchmark <i>Continued</i>	Environmental Science Indicator(s)
Benchmark B <i>Continued</i>	<ul style="list-style-type: none"> • Explain how interactions among Earth's lithosphere, hydrosphere, atmosphere and biosphere have resulted in the ongoing changes of Earth's system (Ohio Indicator 6, Grade 11) • Describe the effects of particulates and gases in the atmosphere including those originating from volcanic activity. (Ohio Indicator 7, Grade 11) • Describe the normal adjustments of Earth, which may be hazardous for humans. Recognize that humans live at the interface between the atmosphere driven by solar energy and the upper mantle where convection creates changes in Earth's solid crust. Realize that as societies have grown, become stable and come to value aspects of the environment, vulnerability to natural processes of change has increased. (Ohio Indicator 8, Grade 11) • Describe how scientists estimate how much of a given resource is available on Earth (Ohio Indicator 6, Grade 12)



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Benchmark <i>Continued</i>	Environmental Science Indicator(s)
<p>Benchmark C 11-12 Grade Level Band Explain that humans are an integral part of Earth's system and the choices humans make today impact natural systems in the future.</p>	<p>Benchmark C Indicator(s)</p> <ul style="list-style-type: none"> • Explain the effects of biomass and human activity on climate (e.g. climate change and global warming) (Ohio Indicator 9, Grade 11) • Analyze how materials from human societies (e.g. radioactive waste and air pollution) affect both physical and chemical cycles of Earth. (Ohio Indicator 11, Grade 11) • Explain ways in which humans have had a major effect on other species (e.g., the influence of humans on other organisms occurs through land use, which decreases space available to other species and pollution, which changes the chemical composition of air, soil and water). (Ohio Indicator 12, Grade 11) • Explain how human behavior affects the basic processes of natural ecosystems and the quality of the atmosphere, hydrosphere and lithosphere. (Ohio Indicator 13, Grade 11) • Conclude that Earth has finite resources and explain that humans deplete some resources faster than they can be renewed. (Ohio Indicator 14, Grade 11)



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Benchmark <i>Continued</i>	Environmental Science Indicator(s)
<p>Benchmark D 11-12 Grade Level Band Summarize the historical development of scientific theories and ideas and describe emerging issues in the study of Earth and space sciences.</p>	<p>Benchmark D Indicator(s)</p> <ul style="list-style-type: none"> • Use historical examples to show how new ideas are limited by the context in which they are conceived; are often rejected by the social establishment; sometimes spring from unexpected findings; and usually grow slowly through contributions from many different investigators (e.g., global warming, Theory of Continental Drift). (Ohio Indicator 15, Grade 11) • Describe advances in Earth science that have important long-lasting effects on science and society (e.g., global warming, plate tectonics theory). (Ohio Indicator 16, Grade 11)



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II. Content Standard: Life Science

Students demonstrate an understanding of how living systems function and how they interact with the physical environment. This includes an understanding of the cycling of matter and flow of energy in living systems. An understanding of the characteristics, structure and function of cells, organisms and living systems will be developed. Students will also develop a deeper understanding of the principles of heredity, biological evolution, and the diversity and interdependence of life. Students demonstrate an understanding of different historical perspectives, scientific approaches and emerging scientific issues associated with the life sciences.

Benchmark	Environmental Science Indicator(s)
Benchmark B 11-12 Grade Level Band Explain how humans are connected to and impact natural systems.	Benchmark B Indicator(s) <ul style="list-style-type: none"> • Relate how birth rates, fertility rates and death rates are affected by various environmental factors. (Ohio Indicator 3, Grade 11) • Examine the contributing factors of human population growth that impact natural systems such as levels of education, children in the labor force, education and employment of women, infant mortality rates, costs of raising children, birth control methods, and cultural norms. (Ohio Indicator 4, Grade 11) • Investigate the impact on the structure and stability of ecosystems due to changes in their biotic and abiotic components as a result of human activity. (Ohio Indicator 5, Grade 11)
Benchmark D 11-12 Grade Level Band Relate how biotic and abiotic global changes have occurred in the past and will continue to do so in the future.	Benchmark D Indicator(s) <ul style="list-style-type: none"> • Recognize that ecosystems change when significant climate changes occur or when one or more new species appear as a result of immigration or speciation. (Ohio Indicator 12, Grade 11) • Describe how the process of evolution has changed the physical world over geologic time. (Ohio Indicator 13, Grade 11) • Explain additional components of the evolution theory, including genetic drift, immigration, emigration and mutation. (Ohio Indicator 10, Grade 12)



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Benchmark <i>Continued</i>	Environmental Science Indicator(s)
<p>Benchmark E 11-12 Grade Level Band Explain the interconnectedness of the components of a natural system.</p>	<p>Benchmark E Indicators</p> <ul style="list-style-type: none"> • Predict some possible impacts on an ecosystem with the introduction of a non-native species. (Ohio Indicator 6, Grade 11) • Show how populations can increase through linear or exponential growth with corresponding effects on resource use and environmental pollution. (Ohio Indicator 7, Grade 11) • Recognize that populations can reach or temporarily exceed the carrying capacity of a given environment. Show that the limitation is not just the availability of space but the number of organisms in relation to resources and the capacity of earth systems to support life. (Ohio Indicator 8, Grade 11) • Explain how environmental factors can influence heredity or development of organisms. (Ohio Indicator 10, Grade 11) • Relate diversity and adaptation to structures and functions of living organisms at various levels of organization. (Ohio Indicator 7, Grade 12) • Based on the structure and stability of ecosystems and their nonliving components, predict the biotic and abiotic changes in such systems when disturbed (e.g. introduction of non-native species, climatic change, etc.). (Ohio Indicator 8, Grade 12) • Explain why and how living systems require a continuous input of energy to maintain their chemical and physical organization. Explain that with death and the cessation of energy input, living systems rapidly disintegrate toward more disorganized states. (Ohio Indicator 9, Grade 12)



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Benchmark <i>Continued</i>	Environmental Science Indicator(s)
<p>Benchmark G 11-12 Grade Level Band Summarize the historical development of scientific theories and ideas within the study of life sciences.</p>	<p>Benchmark G Indicators</p> <ul style="list-style-type: none"> • Trace the historical development of a biological theory or idea (e.g., genetics, cytology and germ theory). (Ohio Indicator 11, Grade 12) • Describe advances in life sciences that have important, long-lasting effects on science and society (e.g., biotechnology). (Ohio Indicator 12, Grade 12)



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III. Standard: Science and Technology

Students recognize that science and technology are interconnected and that using technology involves assessment of the benefits, risks, and costs. Students should build scientific and technological knowledge, as well as the skill required to design and construct devices. In addition, they should develop the processes to solve problems and to understand that problems may be solved in several ways.

Benchmark	Environmental Science Indicator(s)
Benchmark A 11-12 Grade Level Band Predict how human choices today will determine the quality and quantity of life on Earth.	Benchmark A Indicator(s) <ul style="list-style-type: none"> Identify that science and technology are essential social enterprises but alone they can only indicate what can happen, not what should happen. Realize the latter involves human decisions about the use of knowledge. (Ohio Indicator 1, Grade 11) Predict how decisions regarding the implementation of technologies involve the weighing of trade-offs between predicted positive and negative effects on the environment and/or humans. (Ohio Indicator 2, Grade 11) Explore and explain any given technology that may have a different value for different groups of people and at different points in time (e.g., new varieties of farm plants and animals have been engineered by manipulating their genetic instructions to reproduce new characteristics). (Ohio Indicator 3, Grade 11) Explain why basic concepts and principles of science and technology should be a part of active debate about the economics, policies, politics and ethics of various science-related and technology-related challenges. (Ohio Indicator 4, Grade 11)



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Benchmark <i>Continued</i>	Environmental Science Indicator(s)
Benchmark A <i>Continued</i>	<ul style="list-style-type: none"> Investigate that all fuels (e.g., fossil, solar, nuclear) have advantages and disadvantages; therefore society must consider the trade-offs among them (e.g., economic costs and environmental impact). (Ohio Indicator 5, Grade 11) Research sources of energy beyond traditional fuels and the advantages, disadvantages and trade-offs society must consider when using alternative sources (e.g., biomass, solar, hybrid engines, wind, fuel cells). (Ohio Indicator 6, Grade 11) Explain how science often advances with the introduction of new technologies and how solving technological problems often results in new scientific knowledge. (Ohio Indicator 1, Grade 12) Describe how new technologies often extend the current levels of scientific understanding and introduce new areas of research. (Ohio Indicator 2, Grade 12) Research how scientific inquiry is driven by the desire to understand the natural world and how technological design is driven by the need to meet human needs and solve human problems. (Ohio Indicator 3, Grade 12) Explain why basic concepts and principles of science and technology should be a part of active debate about the economics, policies, politics and ethics of various science-related and technology-related challenges. (Ohio Indicator 4, Grade 12)



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IV. Standard: Scientific Inquiry

Students develop scientific habits of mind as they use the processes of scientific inquiry to ask valid questions and to gather and analyze information. They understand how to develop hypotheses and make predictions. They are able to on scientific practices as they develop plans of action to create and evaluate a variety of conclusions. Students are also able to demonstrate the ability to communicate their findings to others.

Benchmark	Environmental Science Indicator(s)
Benchmark A 11-12 Grade Level Band Make appropriate choices when designing and participating in scientific investigations by using cognitive and manipulative skills when collecting data and formulating conclusions from the data.	Benchmark A Indicator(s) <ul style="list-style-type: none"> • Formulate testable hypotheses. Develop and explain the appropriate procedures, controls and variables (dependent and independent) in scientific experimentation. (Ohio Indicator 1, Grade 11) • Evaluate assumptions that have been used in reaching scientific conclusions. (Ohio Indicator 2, Grade 11) • Design and carry out scientific inquiry (investigation), communicate and critique results through peer review. (Ohio Indicator 3, Grade 11) • Explain why the methods of an investigation are based on the questions being asked. (Ohio Indicator 4, Grade 11) • Summarize data and construct a reasonable argument based on those data and other known information. (Ohio Indicator 5, Grade 11) • Derive simple mathematical relationships that have predictive power from experimental data (e.g., derive an equation from a graph and vice versa, determine whether a linear or exponential relationship exists among the data in a table). (Ohio Indicator 2, Grade 12)



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Benchmark <i>Continued</i>	Environmental Science Indicator(s)
Benchmark A <i>Continued</i>	<ul style="list-style-type: none"> • Research and apply appropriate safety precautions when designing and/or conducting scientific investigations (e.g., OSHA, MSDS, eyewash, goggles, ventilation). (Ohio Indicator 3, Grade 12) • Create and clarify the method, procedures, controls and variables in complex scientific investigations. (Ohio Indicator 4, Grade 12) • Use appropriate summary statistics to analyze and describe data. (Ohio Indicator 5, Grade 12)



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V. Standard: Scientific Ways of Knowing

Students realize that the current body of scientific knowledge must be based on evidence, be predictive, logical, subject to modification, and limited to the natural world. This includes demonstrating an understanding that scientific knowledge grows and advances as new evidence is discovered to support or modify existing theories, as well as to encourage the development of new theories. Students are able to reflect on ethical scientific practices and demonstrate an understanding of how the current body of scientific knowledge reflects the historical and cultural contributions of women and men who provide us with a more reliable and comprehensive understanding of the natural world.

Benchmark	Environmental Science Indicator(s)
Benchmark A 11-12 Grade Level Band Explain how scientific evidence is used to develop and revise scientific predictions, ideas, or theories.	Benchmark A Indicator(s) <ul style="list-style-type: none"> Analyze a set of data to derive a hypothesis and apply that hypothesis to a similar phenomenon (e.g., biome data). (Ohio Indicator 1, Grade 11) Apply scientific inquiry to evaluate results of scientific investigations, observations, theoretical models and the explanations proposed by other scientists. (Ohio Indicator 2, Grade 11) Demonstrate that scientific explanations adhere to established criteria, for example a proposed explanation must be logically consistent, it must abide by the rules of evidence and it must be open to questions and modifications. (Ohio Indicator 3, Grade 11) Explain why scientists can assume that the universe is a vast single system in which the basic rules are the same everywhere. (Ohio Indicator 4, Grade 11) Explain how theories are judged by how well they fit with other theories, the range of included observations, how well they explain observations and how effective they are in predicting new findings. (Ohio Indicator 7, Grade 11) Give examples that show how science is a social endeavor in which scientists share their knowledge with the expectation that it will be challenged continuously by the scientific community and others. (Ohio Indicator 1, Grade 12)



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Benchmark <i>Continued</i>	Environmental Science Indicator(s)
Benchmark A <i>Continued</i>	<ul style="list-style-type: none"> • Evaluate scientific investigations by reviewing current scientific knowledge and the experimental procedures used, examining the evidence, identifying faulty reasoning, pointing out statements that go beyond the evidence and suggesting alternative explanations for the same observations. (Ohio Indicator 2, Grade 12) • Select a scientific model, concept or theory and explain how it has been revised over time based on new knowledge, perceptions or technology. (Ohio Indicator 3, Grade 12) • Analyze a set of data to derive a principle and then apply that principle to a similar phenomenon (e.g., predator-prey relationship, properties of semiconductors). (Ohio Indicator 4, Grade 12) • Describe how individuals and teams contribute to science and engineering at different levels of complexity (e.g., an individual may conduct basic field studies, hundreds of people may work together on major scientific questions or technological problem). (Ohio Indicator 5, Grade 12)



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Benchmark <i>Continued</i>	Indicator(s)
Benchmark B 11-12 Grade Level Band Explain how ethical considerations shape scientific endeavors	Benchmark B Indicators <ul style="list-style-type: none"> • Recognize that bias affect outcomes. People tend to ignore evidence that challenges their beliefs but accept evidence that supports their beliefs. Scientific attempt to avoid bias in their work. (Ohio Indicator 5, Grade 11) • Describe the strongly help tradition of science that serve to keep scientists within the bounds of ethical professional behavior. (Ohio Indicator 6, Grade 11)
Benchmark C 11-12 Grade Level Band Explain how societal issues and considerations affect the progress of science and technology.	Benchmark C Indicator(s) <ul style="list-style-type: none"> • Explain that the decision to develop a new technology is influenced by societal opinions and demands and by cost benefit considerations. (Ohio Indicator 8, Grade 11) • Explain how natural and human-induced hazards present the need or humans to assess potential danger and risk. Many changes in the environment designed by humans bring benefits to society as well as cause risks. (Ohio Indicator 9, Grade 11) • Describe costs and trade-offs of various hazards – ranging from those with minor risk to a few people, to major catastrophes with major risk to many people. The scale of events and the accuracy with which scientist and engineers can (and cannot) predict events are important considerations. (Ohio Indicator 10, Grade 11) • Research the role of science and technology in careers that students plan to pursue. (Ohio Indicator 11, Grade 11) • Explain that scientist may develop and apply ethical tests to evaluate the consequences of their research when appropriate. (Ohio Indicator 6, Grade 12)



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Benchmark <i>Continued</i>	Environmental Science Indicator(s)
Benchmark C <i>Continued</i>	<ul style="list-style-type: none"> • Describe the current and historical contributions of diverse peoples and cultures to science and technology and the scarcity and inaccessibility or information on some of these contributions. (Ohio Indicator 7, Grade 12) • Recognize that individuals and society must decide on proposals involving new research and the introduction of new technologies into society. Decisions involve assessment of alternatives, risks, costs, and benefits and consideration of who benefits and who suffers, who pays and gains, and what the risks are and who bears them. (Ohio Indicator 8, Grade 12) • Recognize the appropriateness and value of basic questions “What can happen?” “What are the odds?” and “How do scientists and engineers know what will happen?” (Ohio Indicator 9, Grade 12) • Recognize that social issues and challenges can affect progress in science and technology (e.g., Funding priorities for specific health problems serve as examples of ways that social issues influence science and technology.) (Ohio Indicator 10, Grade 12) • Research how advances in scientific knowledge have impacted society on a local, national or global level. (Ohio Indicator 11, Grade 12)



Big Idea: Earth systems interact to make life on Earth possible.

Essential Learning:

Atmosphere: Air is a unique characteristic of Earth's atmosphere that allows the movement of matter and energy.

Target 1

Scientific processes allow us to understand atmospheric patterns of Earth.

I can...

characterize the unique composition of air and the layers of the atmosphere.

analyze and interpret atmospheric data to predict weather/climatic events.

Target 2

Energy conversions underlie changes in atmospheric conditions.

I can ...

illustrate the effects of solar radiation, the tilt of the Earth, and the rotation of Earth on atmospheric patterns.

apply the concepts of conduction, convection, radiation, and advection to atmospheric events.

Target 3

The atmosphere is interconnected with other systems.

I can...

discuss the influence of geothermal events on the atmosphere.

describe the interactions between the hydrosphere and the atmosphere.

trace biogeochemical cycles through the atmosphere.

correlate global atmospheric patterns to local weather conditions.

explain the influence of climatic patterns on the biosphere.

Target 4

Human behavior has an affect on the atmosphere.

I can...

evaluate correlations between human influences, atmospheric and climatic changes.

design a plan that addresses the impacts of humans on the atmosphere.



Big Idea: Earth systems interact to make life on Earth possible.

Essential Learning:

Lithosphere: The dynamic nature of the lithospheric plates provides continual change within the earth system.

Target 1

Scientific processes allow us to interpret lithospheric changes of the Earth, over time.

I can...

analyze data from current technology to explain the past, present, and future changes of the Earth's surface.

identify sources of geothermal energy.

identify and describe the formation of different rock types.

apply the theory of plate tectonics to explain geologic events.

Target 2

The transfer of energy causes movement of earth's crust.

I can ...

trace the transfer of energy from the core to the lithosphere.

correlate energy transforms to surface features of the Earth.

Target 3

The lithosphere interacts with the hydrosphere, biosphere, and atmosphere.

I can...

explain how the interactions of spheres cause natural phenomena.

Target 4

The lithosphere impacts humans and the decisions they make.

I can...

assess decisions that impact human vulnerability.



Big Idea: Living systems function and interact with the physical environment.

Essential Learning:

Biosphere: Life on Earth exists because of the interrelationships of the Earth's systems.

Target 1

Scientific processes allow us to understand the interrelationships of life on Earth.

I can...

explain the historical development and current status of biological theories.

use scientific evidence to document the evolution of a species.

explain the importance of biodiversity as an indicator of an ecosystem.

Target 2

Biotic and abiotic factors influence the transfer of energy.

I can ...

trace the pathways of energy through an ecosystem.

Target 3

Life on Earth interacts with the hydrosphere, lithosphere, and atmosphere.

I can...

identify the factors within Earth's spheres that play a role in maintaining a sustainable community.

relate climatic patterns to biome characteristics.

Target 4

Ecosystems are influenced by human behavior.

I can...

predict the effects of human activities on biological diversity.

assess the impact of implementing technologies on the ecosystem.

analyze factors that influence population dynamics of an ecosystem.

evaluate decisions that impact the sustainability of an ecosystem.



Big Idea: Earth systems interact to make life on Earth possible.

Essential Learning:

Hydrosphere: The hydrologic cycle transfers matter and energy through Earth's systems.

Target 1

Scientific processes allow us to understand the flow of water through Earth's systems.

I can...

use technological data to monitor water within Earth's systems.

explain the dynamic nature of the cryosphere.

Target 2

Energy conversions influence the flow of water through Earth's systems.

I can ...

describe the transfer of energy through oceans.

Target 3

The hydrosphere interacts with the atmosphere, lithosphere and biosphere.

I can...

explain the influence of the water cycle on climatic patterns.

correlate the surface features of the Earth to the movement of water.

illustrate the distribution of life due to water availability.

Target 4

Humans influence and rely on the hydrosphere.

I can...

evaluate the impact of humans on water reservoirs.

discuss sustainability of life in relation to the hydrosphere.



Big Idea: Earth systems interact to make life on Earth possible.

Essential Learning:

Beyond Earth: The interaction of matter and energy provide a model of the processes that exist beyond Earth.

Target 1

Scientific processes allow us to study objects and events beyond Earth.

I can...

describe the historical development and the current status of space science.

formulate inferences using the knowledge of forces to explain phenomenon throughout the universe.

categorize objects in space by their physical and chemical characteristics.

Target 2

Evolution of systems in space is shaped by energy transformations.

I can ...

apply the principle of energy conservation to the evolution of objects in space.

Target 3

Matter and energy interconnect the universe.

I can...

use an understanding of forces to explain the interactions of objects throughout space.

Target 4

Exploration of space affects humans in a variety of ways.

I can...

attribute human endeavor to the exploration of space.

identify examples of technological advances that are a result of space exploration.

