Tennessee Science Curriculum Framework

Earth Science

Course Description

Earth Science is a laboratory course that explores the origins and the connections among the physical, chemical, and biological processes of the earth system. Students experience the content through *inquiry-based laboratory and field investigations*. Course topics include: matter, energy, crystal dynamics, cosmic evolution, and structure, cycles, geochemical processes, and the expanded time scales necessary to understand events in the earth system. Earth Science provides the knowledge, skills, and habits of mind needed for problem-solving and ethical decision-making about scientific and technological concerns.

Earth Science students investigate:

- Inquiry
- Technology and Engineering
- The Universe
- Energy in the Earth System
- Cycles in the Earth System
- Geologic History

Embedded Inquiry

Conceptual Strand

Understandings about scientific inquiry and the ability to conduct inquiry are essential for living in the 21st century.

Guiding Question

What tools, skills, and knowledge are needed to conduct scientific inquiry?

Course Level Expectations

CLE 3204.Inq.1 Recognize that science is a progressive endeavor that reevaluates and extends what is already accepted.

CLE 3204.Inq.2 Design and conduct scientific investigations to explore new phenomena, verify previous results, test how well a theory predicts, and compare opposing theories.

CLE 3204.Inq.3 Use appropriate tools and technology to collect precise and accurate data.

CLE 3204.Inq.4 Apply qualitative and quantitative measures to analyze data and draw conclusions that are free of bias.

CLE 3204.Inq.5 Compare experimental evidence and conclusions with those drawn by others about the same testable question.

CLE 3204.Inq.6 Communicate and defend scientific findings.

Checks for Understanding (Formative/Summative Assessment)

- ✓**3204.Inq.1** Trace the historical development of a scientific principle or theory, such as plate tectonics, evolution of the cosmos, and global change.
- ✓**3204.Inq.2** Conduct scientific investigations that include testable questions, verifiable hypotheses, and appropriate variables to explore new phenomena or verify the experimental results of others.
- ✓**3204.Inq.3** Select appropriate tools and technology to collect precise and accurate quantitative and qualitative data.
- ✓**3204.Inq.4** Determine if data supports or contradicts a hypothesis or conclusion.
- ✓**3204.Inq.5** Compare or combine experimental evidence from two or more investigations.
- ✓**3204.Inq.6** Recognize, analyze, and evaluate alternative explanations for the same set of observations.
- ✓**3204.Inq.7** Evaluate the accuracy and precision of data.
- ✓**3204.Inq.8** Analyze experimental results and identify possible sources of bias or experimental error.
- ✓**3204.Inq.9** Formulate and revise scientific explanations and models using logic and evidence.

Embedded Technology and Engineering

Conceptual Strand

Society benefits when engineers apply scientific discoveries to design materials and processes that develop into enabling technologies.

Guiding Question

How do science concepts, engineering skills, and applications of technology improve the quality of life?

Course Level Expectations

CLE 3204.T/E.1 Explore the impact of technology on social, political, and economic systems.

CLE 3204.T/E.2 Differentiate among elements of the engineering design cycle: design constraints, model building, testing, evaluating, modifying, and retesting.

CLE 3204.T/E.3 Explain the relationship between the properties of a material and the use of the material in the application of a technology.

CLE 3204.T/E.4 Describe the dynamic interplay among science, technology, and engineering within living, earth-space, and physical systems.

Checks for Understanding (Formative/Summative Assessment)

- ✓**3204.T/E.1** Distinguish among tools and procedures best suited to conduct a specified scientific inquiry.

✓**3204.T/E.2** Apply the engineering design process to construct a prototype that meets developmentally appropriate specifications.
✓**3204.T/E.3** Evaluate a protocol to determine the degree to which an engineering design process was successfully applied.
✓**3204.T/E.4** Explore how the unintended consequences of new technologies can impact human and non-human communities.
✓**3204.T/E.5** Evaluate the overall benefit to cost ratio of a new technology.
✓**3204.T/E.6** Present research on current bioengineering technologies that advance health and contribute to improvements in our daily lives.
✓**3204.T/E.7** Design a series of multi-view drawings that can be used by other students to construct an adaptive design and test its effectiveness.

Standard 1 – The Universe

Conceptual Strand 1

The cosmos is vast and explored well enough to know its basic structure and operational principles.

Guiding Question 1

What big ideas guide human understanding about the origin and structure of the universe, Earth's place in the cosmos, and observable motions and patterns in the sky?

Course Level Expectations

CLE 3204.1.1 Explore theories for the origin and evolution of the universe.
CLE 3204.1.2 Examine the components of the solar system.
CLE 3204.1.3 Explore the sun, earth, and moon relationships and their gravitational effects.
CLE 3204.1.4 Investigate the history of space exploration.

Checks for Understanding (Formative/Summative Assessment)

✓**3204.1.1** Identify the components of the universe: black holes, galaxies, nebulae, solar systems, stars, planets, meteors, comets, and asteroids.
✓**3204.1.2** Compare explanations for the origin of the universe: Big Bang, nucleosynthesis, galaxy, and star formation**.**
✓**3204.1.3** Construct a solar system model that illustrates ratios and proportions of distance and size of planets.
✓**3204.1.4** Explain the evolution of a star through stages of its development.
✓**3204.1.5** Classify galaxies according to shape.
✓**3204.1.6** Explore the role of astronomical events in the earth's history: asteroid/meteor impacts, solar flares, and comets.
✓**3204.1.7** Compare and contrast the earth with other planets in the solar system.
✓**3204.1.8** Investigate the seasonal relationships between the length of the day and the inclination and relative positions of the sun and earth.
✓**3204.1.9** Describe the position of the sun, earth, and moon during eclipses and different lunar phases.

✓**3204.1.10** Predict tidal conditions based upon the position of the earth, moon, and sun.
✓**3204.1.11** Describe the relationship between the mass of an object and the its gravitational force.
✓**3204.1.12** Construct a historical timeline that depicts man's changing perceptions and understanding of astronomy.
✓**3204.1.13** Understand how telescopes and spectroscopy manipulate light to reveal information about the universe.
✓**3204.1.14** Investigate the history of space exploration.
✓**3204.1.15** Research Tennessee's contribution to earth and space science.

Standard 2 - Energy in the Earth System

Conceptual Strand

Energy cycles drive the earth system.

Guiding Question

What are the scientific explanations for how energy cycles through the earth system?

Course Level Expectations

CLE 3204.2.1 Investigate the principal sources of energy.
CLE 3204.2.2 Explore pathways of energy transfer.
CLE 3204.2.3 Evaluate alternative energy sources.

Checks for Understanding (Formative/Summative Assessment)

✓**3204.2.1** Differentiate among the various forms of energy.
✓**3204.2.2** Illustrate three types of energy transfer: radiation, conduction, and convection.
✓**3204.2.3** Describe different types of energy resources: fossil fuels, solar, geothermal, nuclear, wind, and hydroelectric.
✓**3204.2.4** Distinguish between renewable and nonrenewable resources in terms of resource conservation.
✓**3204.2.5** Investigate how the sun provides the major source of earth's surface energy.
✓**3204.2.6** Explore three primary sources of internal energy: gravitational energy from the earth's original formation, friction, and radioactive decay.
✓**3204.2.7** Diagram and evaluate pathways of energy transfer to demonstrate the law of conservation of energy.
✓**3204.2.8** Describe the energy transfer associated with different geologic events: mantle convection, rock cycle, wind, and ocean currents.
✓**3204.2.9** Describe the human impact of large scale energy transfer events: hurricanes, photosynthesis, earthquakes, volcanoes, and tsunamis.
✓**3204.2.10** Compare and contrast alternative energy sources and their environmental impact.
✓**3204.2.11** Compare energy sources and heat transfer over geologic time to current patterns of global change.

Standard 3 - Cycles in the Earth System

Conceptual Strand

The earth system consists of interrelated subcycles that act over extended periods of geologic time.

Guiding Question

What are the subcycles of the earth system and how do they interact?

Course Level Expectations

CLE 3204.3.1 Explain the components of the tectonic cycle.
CLE 3204.3.2 Investigate the rock cycle.
CLE 3204.3.3 Analyze the hydrologic cycle.
CLE 3204.3.4 Interpret data related to the atmospheric cycle.
CLE 3204.3.5 Differentiate among the geochemical cycles.
CLE 3204.3.6 Evaluate the impact of living organisms on earth system cycles.
CLE 3204.3.7 Investigate how maps can be used to interpret changes in the earth system.
CLE 3204.3.8 Relate earth system cycles to past and current patterns of global change.

Checks for Understanding (Formative/Summative Assessment)

✓**3204.3.1** Use models to explain the theory of plate tectonics.
✓**3204.3.2** Apply mantle convection currents to distinguish between divergent and convergent plate boundaries.
✓**3204.3.3** Explain and map the relationship between plate tectonics and mountain building, volcanoes, and earthquakes.
✓**3204.3.4** Distinguish between minerals and rocks.
✓**3204.3.5** Identify minerals according to their physical properties.
✓**3204.3.6** Distinguish among sedimentary, igneous, and metamorphic rocks.
✓**3204.3.7** Interpret a diagram of the rock cycle.
✓**3204.3.8** Explain a model of the hydrologic cycle.
✓**3204.3.9** Distinguish between mechanical and chemical weathering.
✓**3204.3.10** Describe the impact of water on the evolution of landforms.
✓**3204.3.11** Collect and interpret basic weather data from meteorological instruments: thermometer, rain gauge, and barometer.
✓**3204.3.12** Analyze weather map data to make simple predictions.
✓**3204.3.13** Explain the oxygen/carbon dioxide, nitrogen, and carbon biogeochemical cycles.
✓**3204.3.14** Recognize the connection between geologic processes such as floods, earthquakes, volcanoes, acid rain, global warming and human activities.
✓**3204.3.15** Construct a geological cycle for a physiographic region or geologic time period in Tennessee.
✓**3204.3.16** Interpret topographic maps.
✓**3204.3.17** Relate current global patterns such as sea level change and geographic climate shifts to events that occurred during the earth's distant past.

Standard 4 - Geologic History

Conceptual Strand

The earth has changed over a long period and global change is a continuation of this evolutionary process.

Guiding Question

What is the scientific evidence for the evolution of earth and life on earth?

Course Level Expectations

CLE 3204.4.1 Interpret the nature of geologic time.
CLE 3204.4.2 Investigate the evolution of the earth.
CLE 3204.4.3 Interpret the fossil record for evidence of biological evolution.
CLE 3204.4.4 Demonstrate the impact of environmental change on the origin and extinction of plant and animal species.

Checks for Understanding (Formative/Summative Assessment)

✓**3204.4.1** Explain the law of uniformitarianism.
✓**3204.4.2** Differentiate between absolute and relative time.
✓**3204.4.3** Compare and contrast how relative and absolute dating techniques are used to interpret the advance of geologic history.
✓**3204.4.4** Construct a geologic timetable for the evolution of earth and the history of life.
✓**3204.4.5** Interpret evidence for plate tectonics such as the fossil record, mountain range formation, rock strata, paleomagnetism, paleoclimates, and configuration of the continents.
✓**3204.4.6** Recognize that fossils contained in sedimentary rock provide evidence of past life forms, changes in life forms, and environmental change.
✓**3204.4.7** Determine the relative age of fossils in sedimentary rock.
✓**3204.4.8** Interpret the sequence of rock strata using superposition, cross-cutting relationships, inclusions, the fossil record, and absolute dating techniques.
✓**3204.4.9** Predict how an environmental change might influence the development of new species or cause the extinction of an existing species.