Physical Setting/ Earth Science

Core Curriculum

THE UNIVERSITY OF THE STATE OF NEW YORK THE STATE EDUCATION DEPARTMENT

http://www.nysed.gov

CONTENTS

ACKNOWLEDGMENTS

The State Education Department acknowledges the assistance of teachers and school administrators from across New York State and the Earth Science Mentor Network. In particular, the State Education Department would like to thank:

John Bartsch	Amsterdam High School
James R. Ebert	SUC Oneonta
Kathleen Champney	Colton, NY
Dennis Conklin	Columbia High School
Edward Denecke	Multidisciplinary Resource Center, Whitestone, NY
Dennis DeSain	Averill Park High School
Lois Gundrum	Watervliet Junior-Senior High School
Fran Hess	Cooperstown High School
Susan Hoffmire	Victor High School
Andrea Hyatt	Rush-Henrietta High School
Thomas McGuire	Briarcliff Middle/High School
David Mills	Holland Central High School
Glenn Olf	Columbia High School
Len Sharp	Liverpool High School
Bernadette Tomaselli	Lancaster High School
Brian Vorwald	Sayville High School
Marion Gaita Zachowski	Office of Superintendent of Manhattan High Schools

The *Physical Setting/Earth Science Core Curriculum* was reviewed by many teachers and administrators across the State including Earth Science Mentors. The State Education Department thanks those individuals who provided feedback both formally and informally.

In addition, the following individuals responded to a joint request by the Science Teachers Association of New York State and the State Education Department to review the document from their perspectives as scientists, science professors, and/or science education professors. Thanks to Brian Vorwald for organizing this effort.

Nancy Allen	University of Texas, Austin, TX
Lloyd Barrow	University of Missouri, Columbia, MO
Eugene Chiappetta	University of Houston, Houston, TX
Gerald Krockover	Purdue University, W. Lafayette, IN
Don Lindsey	State University of New York, Stony Brook, NY
Victor Mayer	Ohio State University, Columbus, OH
Barbara Schulz	Bard School, Seattle, WA
Michael J. Smith	American Geological Institute, Alexandria, VA
David Williams	Camden, DE

The project manager for the development of the *Physical Setting/Earth Science Core Curriculum* was Elise Russo, Associate in Science Education, with content and assessment support provided by Sharon Miller, Associate in Educational Testing. Diana K. Harding, Associate in Science Education, provided additional support. Special thanks go to Jan Christman for technical expertise and to John Bartsch, Amsterdam High School, for preliminary drafts of the document.

Physical Setting/
Earth Science

Core Curriculum

PREFACE

This *Physical Setting/Earth Science Core Curriculum* has been written to assist teachers and supervisors as they prepare curriculum, instruction, and assessment for the Earth Science content and process skills of the New York State *Learning Standards for Mathematics, Science, and Technology.* This Core Curriculum should be seen as part of a continuum that elaborates the science content of Standard 4. The learning standards document identifies Key Ideas and Performance Indicators. This document is essential for interpretation by the teacher in implementing the core understandings. Key Ideas are broad, unifying, general statements of what students need to know. The Performance Indicators for each Key Idea are statements of what students should be able to do to provide evidence that they understand the Key Idea. As part of this continuum, this Core Curriculum presents Major Understandings that give more specific detail to the concepts underlying each Performance Indicator.

This Core Curriculum is not a syllabus. It addresses the content and process skills as applied to the rigor and relevancy to be assessed by the Regents examination in Physical Setting/Earth Science. Focus will also be on application skills related to real-world situations. The Core Curriculum has been prepared with the assumption that the content as outlined in the *Learning Standards for Mathematics, Science, and Technology* at the elementary and intermediate levels has been taught previously. This is a guide for the preparation of commencement-level curriculum, instruction, and assessment, the final stage in a K-12 continuum of science education. Teachers should recognize that what is found in this document is the minimum of the content to be taught. Teachers are expected to provide for horizontal and vertical enrichment. Rather, the focus on conceptual understanding in the guide is consistent with the approaches recommended in the *National Science Education Standards* and *Benchmarks of Science Literacy: Project 2061.*

It is essential that instruction focus on student understanding and demonstration of important relationships, processes, mechanisms, and applications of concepts. Students, in attaining scientific literacy, will be able to demonstrate these explanations, in their own words, exhibiting creative problem solving, reasoning, and informed decision making. Future assessments will test students' ability to explain, analyze, and interpret Earth science processes and phenomena, and generate science inquiry. The general nature of these statements will encourage the teaching of science for this understanding, instead of for memorization. The Major Understandings in this guide will also allow teachers more flexibility, making possible richer creativity in instruction and greater variation in assessment.

The order of presentation and numbering of all statements in this guide are not meant to indicate any recommended sequence of instruction. Ideas have not been prioritized, nor have they been organized to indicate teaching time allotments or test weighting. Teachers are encouraged to find and elaborate for students the conceptual cross-linkages that interconnect many of the Key Ideas to each other and to other mathematics, science, and technology learning standards.

Material found on the *Earth Science Reference Tables* should also be considered part of the Core Curriculum.

Laboratory Requirements: Critical to understanding science concepts is the use of scientific inquiry to develop explanations of natural phenomena. Therefore, as a prerequisite for admission to the Regents examination in Physical Setting/Earth Science, students must have successfully completed 1200 minutes of laboratory experience with satisfactory written reports for each laboratory investigation.

It is expected that laboratory experiences will provide the opportunity for students to develop the scientific inquiry techniques in Standard 1, Standard 2, and the interconnectedness of content and skills, and the problem-solving approaches in Standards 6 and 7.

PROCESS SKILLS
BASED ON STANDARDS 1, 2, 6, AND 7

Science process skills should be based on a series of discoveries. Students learn most effectively when they have a central role in the discovery process. To that end, Standards 1, 2, 6, and 7 incorporate in the Physical Setting/Earth Science Core Curriculum *a student-centered, problem-solving approach to Earth Science. The following is a sample of Earth Science process skills. This list is not intended to be an all-inclusive list of the content or skills, but rather a sample of the types of activities that teachers are expected to incorporate into their curriculum. It should be a goal of the instructor to encourage science process skills that will provide students with background and curiosity to investigate important issues in the world around them.*

STANDARD 1—Analysis, Inquiry, and Design

Students will use mathematical analysis, scientific inquiry, and engineering design, as appropriate, to pose questions, seek answers, and develop solutions.

STANDARD 1 Analysis, Inquiry, and Design **MATHEMATICAL ANALYSIS:**	*Key Idea 1:* Abstraction and symbolic representation are used to communicate mathematically. For example: • use eccentricity, rate, gradient, standard error of measurement, and density in context *Key Idea 2:* Deductive and inductive reasoning are used to reach mathematical conclusions. For example: • determine the relationships among: velocity, slope, sediment size, channel shape, and volume of a stream • understand the relationships among: the planets' distance from the Sun, gravitational force, period of revolution, and speed of revolution *Key Idea 3:* Critical thinking skills are used in the solution of mathematical problems. For example: • in a field, use isolines to determine a source of pollution

STANDARD 1 Analysis, Inquiry, and Design **SCIENTIFIC INQUIRY:**	*Key Idea 1:* The central purpose of scientific inquiry is to develop explanations of natural phenomena in a continuing, creative process. For example: • show how our observation of celestial motions supports the idea of stars moving around a stationary Earth (the geocentric model), but further investigation has led scientists to understand that most of these changes are a result of Earth's motion around the Sun (the heliocentric model) *Key Idea 2:* Beyond the use of reasoning and consensus, scientific inquiry involves the testing of proposed explanations involving the use of conventional techniques and procedures and usually requiring considerable ingenuity. For example: • test sediment properties and the rate of deposition *Key Idea 3:* The observations made while testing proposed explanations, when analyzed using conventional and invented methods, provide new insights into phenomena. For example: • determine the changing length of a shadow based on the motion of the Sun

STANDARD 1 **Analysis, Inquiry, and Design** **ENGINEERING DESIGN:**	*Key Idea 1:* Engineering design is an iterative process involving modeling and optimization (finding the best solution within given constraints); this process is used to develop technological solutions to problems within given constraints. For example: • after experimenting with conduction of heat (using calorimeters and aluminum bars), make recommendations to create a more efficient system of heat transfer • determine patterns of topography and drainage around your school and design solutions to effectively deal with runoff

STANDARD 2

Students will access, generate, process, and transfer information, using appropriate technologies.

STANDARD 2 **INFORMATION SYSTEMS:**	*Key Idea 1:* Information technology is used to retrieve, process, and communicate information as a tool to enhance learning. For example: • analyze weather maps to predict future weather events • use library or electronic references to obtain information to support a laboratory conclusion *Key Idea 2:* Knowledge of the impacts and limitations of information systems is essential to its effective and ethical use. For example: • obtain printed or electronic materials which exemplify miscommunication and/or misconceptions of current commonly accepted scientific knowledge *Key Idea 3:* Information technology can have positive and negative impacts on society, depending upon how it is used. For example: • discuss how early warning systems can protect society and the environment from natural disasters such as hurricanes, tornadoes, earthquakes, tsunamis, floods, and volcanoes

STANDARD 6—Interconnectedness: Common Themes

Students will understand the relationships and common themes that connect mathematics, science, and technology and apply the themes to these and other areas of learning.

STANDARD 6 **Interconnectedness: Common Themes** **SYSTEMS THINKING:**	*Key Idea 1:* Through systems thinking, people can recognize the commonalities that exist among all systems and how parts of a system interrelate and combine to perform specific functions. For example: • analyze a depositional-erosional system of a stream

STANDARD 6 Interconnectedness: Common Themes **MODELS:**	*Key Idea 2:* Models are simplified representations of objects, structures, or systems used in analysis, explanation, interpretation, or design. For example: • draw a simple contour map of a model landform • design a 3-D landscape model from a contour map • construct and interpret a profile based on an isoline map • use flowcharts to identify rocks and minerals

STANDARD 6 Interconnectedness: Common Themes **MAGNITUDE AND SCALE:**	*Key Idea 3:* The grouping of magnitudes of size, time, frequency, and pressures or other units of measurement into a series of relative order provides a useful way to deal with the immense range and the changes in scale that affect the behavior and design of systems. For example: • develop a scale model to represent planet size and/or distance • develop a scale model of units of geologic time • use topographical maps to determine distances and elevations

STANDARD 6 Interconnectedness: Common Themes **EQUILIBRIUM AND STABILITY:**	*Key Idea 4:* Equilibrium is a state of stability due either to a lack of change (static equilibrium) or a balance between opposing forces (dynamic equilibrium). For example: • analyze the interrelationship between gravity and inertia and its effects on the orbit of planets or satellites

STANDARD 6 Interconnectedness: Common Themes **PATTERNS OF CHANGE:**	*Key Idea 5:* Identifying patterns of change is necessary for making predictions about future behavior and conditions. For example: • graph and interpret the nature of cyclic change such as sunspots, tides, and atmospheric carbon dioxide • based on present data of plate movement, determine past and future positions of land masses • using given weather data, identify the interface between air masses, such as cold fronts, warm fronts, and stationary fronts

STANDARD 6 Interconnectedness: Common Themes **OPTIMIZATION:**	*Key Idea 6:* In order to arrive at the best solution that meets criteria within constraints, it is often necessary to make trade-offs. For example: • debate the effect of human activities as they relate to quality of life on Earth systems (global warming, land use, preservation of natural resources, pollution)

STANDARD 7—Interdisciplinary Problem Solving

Students will apply the knowledge and thinking skills of mathematics, science, and technology to address real-life problems and make informed decisions.

STANDARD 7 Interdisciplinary Problem Solving CONNECTIONS:	*Key Idea 1:* The knowledge and skills of mathematics, science, and technology are used together to make informed decisions and solve problems, especially those relating to issues of science/technology/society, consumer decision making, design, and inquiry into phenomena. For example: • analyze the issues related to local energy needs and develop a viable energy generation plan for the community • investigate two similar fossils to determine if they represent a developmental change over time • investigate the political, economic, and environmental impact of global distribution and use of mineral resources and fossil fuels • consider environmental and social implications of various solutions to an environmental Earth resources problem

STANDARD 7 Interdisciplinary Problem Solving STRATEGIES:	*Key Idea 2:* Solving interdisciplinary problems involves a variety of skills and strategies, including effective work habits; gathering and processing information; generating and analyzing ideas; realizing ideas; making connections among the common themes of mathematics, science, and technology; and presenting results. For example: • collect, collate, and process data concerning potential natural disasters (tornadoes, thunderstorms, blizzards, earthquakes, tsunamis, floods, volcanic eruptions, asteroid impacts, etc.) in an area and develop an emergency action plan • using a topographic map, determine the safest and most efficient route for rescue purposes

STANDARD 4

Students will understand and apply scientific concepts, principles, and theories pertaining to the physical setting and living environment and recognize the historical development of ideas in science.

Key Idea 1:

The Earth and celestial phenomena can be described by principles of relative motion and perspective.

People have observed the stars for thousands of years, using them to find direction, note the passage of time, and to express their values and traditions. As our technology has progressed, so has understanding of celestial objects and events.

Theories of the universe have developed over many centuries. Although to a casual observer celestial bodies appeared to orbit a stationary Earth, scientific discoveries led us to the understanding that Earth is one planet that orbits the Sun, a typical star in a vast and ancient universe. We now infer an origin and an age and evolution of the universe, as we speculate about its future.

As we look at Earth, we find clues to its origin and how it has changed through nearly five billion years, as well as the evolution of life on Earth.

PERFORMANCE INDICATOR 1.1

Explain complex phenomena, such as tides, variations in day length, solar insolation, apparent motion of the planets, and annual traverse of the constellations.

Major Understandings:

1.1a Most objects in the solar system are in regular and predictable motion.
- These motions explain such phenomena as the day, the year, seasons, phases of the moon, eclipses, and tides.
- Gravity influences the motions of celestial objects. The force of gravity between two objects in the universe depends on their masses and the distance between them.

1.1b Nine planets move around the Sun in nearly circular orbits.
- The orbit of each planet is an ellipse with the Sun located at one of the foci.
- Earth is orbited by one moon and many artificial satellites.

1.1c Earth's coordinate system of latitude and longitude, with the equator and prime meridian as reference lines, is based upon Earth's rotation and our observation of the Sun and stars.

1.1d Earth rotates on an imaginary axis at a rate of 15 degrees per hour. To people on Earth, this turning of the planet makes it seem as though the Sun, the moon, and the stars are moving around Earth once a day. Rotation provides a basis for our system of local time; meridians of longitude are the basis for time zones.

1.1e The Foucault pendulum and the Coriolis effect provide evidence of Earth's rotation.

1.1f Earth's changing position with regard to the Sun and the moon has noticeable effects.
- Earth revolves around the Sun with its rotational axis tilted at 23.5 degrees to a line perpendicular to the plane of its orbit, with the North Pole aligned with Polaris.

PERFORMANCE INDICATOR 1.1

continued

- During Earth's one-year period of revolution, the tilt of its axis results in changes in the angle of incidence of the Sun's rays at a given latitude; these changes cause variation in the heating of the surface. This produces seasonal variation in weather.

1.1g Seasonal changes in the apparent positions of constellations provide evidence of Earth's revolution.

1.1h The Sun's apparent path through the sky varies with latitude and season.

1.1i Approximately 70 percent of Earth's surface is covered by a relatively thin layer of water, which responds to the gravitational attraction of the moon and the Sun with a daily cycle of high and low tides.

PERFORMANCE INDICATOR 1.2

Describe current theories about the origin of the universe and solar system.

Major Understandings:

1.2a The universe is vast and estimated to be over ten billion years old. The current theory is that the universe was created from an explosion called the Big Bang. Evidence for this theory includes:
- cosmic background radiation
- a red-shift (the Doppler effect) in the light from very distant galaxies.

1.2b Stars form when gravity causes clouds of molecules to contract until nuclear fusion of light elements into heavier ones occurs. Fusion releases great amounts of energy over millions of years.
- The stars differ from each other in size, temperature, and age.
- Our Sun is a medium-sized star within a spiral galaxy of stars known as the Milky Way. Our galaxy contains billions of stars, and the universe contains billions of such galaxies.

1.2c Our solar system formed about five billion years ago from a giant cloud of gas and debris. Gravity caused Earth and the other planets to become layered according to density differences in their materials.
- The characteristics of the planets of the solar system are affected by each planet's location in relationship to the Sun.
- The terrestrial planets are small, rocky, and dense. The Jovian planets are large, gaseous, and of low density.

1.2d Asteroids, comets, and meteors are components of our solar system.
- Impact events have been correlated with mass extinction and global climatic change.
- Impact craters can be identified in Earth's crust.

1.2e Earth's early atmosphere formed as a result of the outgassing of water vapor, carbon dioxide, nitrogen, and lesser amounts of other gases from its interior.

1.2f Earth's oceans formed as a result of precipitation over millions of years. The presence of an early ocean is indicated by sedimentary rocks of marine origin, dating back about four billion years.

PERFORMANCE INDICATOR 1.2

continued

1.2g Earth has continuously been recycling water since the outgassing of water early in its history. This constant recirculation of water at and near Earth's surface is described by the hydrologic (water) cycle.

- Water is returned from the atmosphere to Earth's surface by precipitation. Water returns to the atmosphere by evaporation or transpiration from plants. A portion of the precipitation becomes runoff over the land or infiltrates into the ground to become stored in the soil or groundwater below the water table. Soil capillarity influences these processes.
- The amount of precipitation that seeps into the ground or runs off is influenced by climate, slope of the land, soil, rock type, vegetation, land use, and degree of saturation.
- Porosity, permeability, and water retention affect runoff and infiltration.

1.2h The evolution of life caused dramatic changes in the composition of Earth's atmosphere. Free oxygen did not form in the atmosphere until oxygen-producing organisms evolved.

1.2i The pattern of evolution of life-forms on Earth is at least partially preserved in the rock record.

- Fossil evidence indicates that a wide variety of life-forms has existed in the past and that most of these forms have become extinct.
- Human existence has been very brief compared to the expanse of geologic time.

1.2j Geologic history can be reconstructed by observing sequences of rock types and fossils to correlate bedrock at various locations.

- The characteristics of rocks indicate the processes by which they formed and the environments in which these processes took place.
- Fossils preserved in rocks provide information about past environmental conditions.
- Geologists have divided Earth history into time units based upon the fossil record.
- Age relationships among bodies of rocks can be determined using principles of original horizontality, superposition, inclusions, cross-cutting relationships, contact metamorphism, and unconformities. The presence of volcanic ash layers, index fossils, and meteoritic debris can provide additional information.
- The regular rate of nuclear decay (half-life time period) of radioactive isotopes allows geologists to determine the absolute age of materials found in some rocks.

Key Idea 2:

Many of the phenomena that we observe on Earth involve interactions among components of air, water, and land.

Earth may be considered a huge machine driven by two engines, one internal and one external. These heat engines convert heat energy into mechanical energy.

Earth's external heat engine is powered primarily by solar energy and influenced by gravity. Nearly all the energy for circulating the atmosphere and oceans is supplied by the Sun. As insolation strikes the atmosphere, a small percentage is directly absorbed, especially by gases such as ozone, carbon dioxide, and water vapor. Clouds and Earth's surface reflect some energy back to space, and Earth's surface absorbs some energy. Energy is transferred between Earth's surface and the atmosphere by radiation, conduction, evaporation, and convection. Temperature variations within the atmosphere cause differences in density that cause atmospheric circulation, which is affected by Earth's rotation. The interaction of these processes results in the complex atmospheric occurrence known as weather.

Average temperatures on Earth are the result of the total amount of insolation absorbed by Earth's surface and its atmosphere and the amount of long-wave energy radiated back into space. However, throughout geologic time, ice ages occurred in the middle latitudes. In addition, average temperatures may have been significantly warmer at times in the geologic past. This suggests that Earth had climate changes that were most likely associated with long periods of imbalances of its heat budget.

Earth's internal heat engine is powered by heat from the decay of radioactive materials and residual heat from Earth's formation. Differences in density resulting from heat flow within Earth's interior caused the changes explained by the theory of plate tectonics: movement of the lithospheric plates; earthquakes; volcanoes; and the deformation and metamorphism of rocks during the formation of young mountains.

Precipitation resulting from the external heat engine's weather systems supplies moisture to Earth's surface that contributes to the weathering of rocks. Running water erodes mountains that were originally uplifted by Earth's internal heat engine and transports sediments to other locations, where they are deposited and may undergo the processes that transform them into sedimentary rocks.

Global climate is determined by the interaction of solar energy with Earth's surface and atmosphere. This energy transfer is influenced by dynamic processes such as cloud cover and Earth rotation, and the positions of mountain ranges and oceans.

PERFORMANCE INDICATOR 2.1

Use the concepts of density and heat energy to explain observations of weather patterns, seasonal changes, and the movements of Earth's plates.

Major Understandings:

2.1a Earth systems have internal and external sources of energy, both of which create heat.

2.1b The transfer of heat energy within the atmosphere, the hydrosphere, and Earth's interior results in the formation of regions of different densities. These density differences result in motion.

2.1c Weather patterns become evident when weather variables are observed, measured, and recorded. These variables include air temperature, air pressure, moisture (relative humidity and dewpoint), precipitation (rain, snow, hail, sleet, etc.), wind speed and direction, and cloud cover.

2.1d Weather variables are measured using instruments such as thermometers, barometers, psychrometers, precipitation gauges, anemometers, and wind vanes.

PERFORMANCE INDICATOR 2.1

continued

2.1e Weather variables are interrelated.
For example:

- temperature and humidity affect air pressure and probability of precipitation
- air pressure gradient controls wind velocity

2.1f Air temperature, dewpoint, cloud formation, and precipitation are affected by the expansion and contraction of air due to vertical atmospheric movement.

2.1g Weather variables can be represented in a variety of formats including radar and satellite images, weather maps (including station models, isobars, and fronts), atmospheric cross-sections, and computer models.

2.1h Atmospheric moisture, temperature and pressure distributions; jet streams, wind; air masses and frontal boundaries; and the movement of cyclonic systems and associated tornadoes, thunderstorms, and hurricanes occur in observable patterns. Loss of property, personal injury, and loss of life can be reduced by effective emergency preparedness.

2.1i Seasonal changes can be explained using concepts of density and heat energy. These changes include the shifting of global temperature zones, the shifting of planetary wind and ocean current patterns, the occurrence of monsoons, hurricanes, flooding, and severe weather.

2.1j Properties of Earth's internal structure (crust, mantle, inner core, and outer core) can be inferred from the analysis of the behavior of seismic waves (including velocity and refraction).

- Analysis of seismic waves allows the determination of the location of earthquake epicenters, and the measurement of earthquake magnitude; this analysis leads to the inference that Earth's interior is composed of layers that differ in composition and states of matter.

2.1k The outward transfer of Earth's internal heat drives convective circulation in the mantle that moves the lithospheric plates comprising Earth's surface.

2.1l The lithosphere consists of separate plates that ride on the more fluid asthenosphere and move slowly in relationship to one another, creating convergent, divergent, and transform plate boundaries. These motions indicate Earth is a dynamic geologic system.

- These plate boundaries are the sites of most earthquakes, volcanoes, and young mountain ranges.
- Compared to continental crust, ocean crust is thinner and denser. New ocean crust continues to form at mid-ocean ridges.
- Earthquakes and volcanoes present geologic hazards to humans. Loss of property, personal injury, and loss of life can be reduced by effective emergency preparedness.

2.1m Many processes of the rock cycle are consequences of plate dynamics. These include the production of magma (and subsequent igneous rock formation and contact metamorphism) at both subduction and rifting regions, regional metamorphism within subduction zones, and the creation of major depositional basins through down-warping of the crust.

2.1n Many of Earth's surface features such as mid-ocean ridges/rifts, trenches/subduction zones/island arcs, mountain ranges (folded, faulted, and volcanic), hot spots, and the magnetic and age patterns in surface bedrock are a consequence of forces associated with plate motion and interaction.

PERFORMANCE INDICATOR 2.1

continued

2.1o Plate motions have resulted in global changes in geography, climate, and the patterns of organic evolution.

2.1p Landforms are the result of the interaction of tectonic forces and the processes of weathering, erosion, and deposition.

2.1q Topographic maps represent landforms through the use of contour lines that are isolines connecting points of equal elevation. Gradients and profiles can be determined from changes in elevation over a given distance.

2.1r Climate variations, structure, and characteristics of bedrock influence the development of landscape features including mountains, plateaus, plains, valleys, ridges, escarpments, and stream drainage patterns.

2.1s Weathering is the physical and chemical breakdown of rocks at or near Earth's surface. Soils are the result of weathering and biological activity over long periods of time.

2.1t Natural agents of erosion, generally driven by gravity, remove, transport, and deposit weathered rock particles. Each agent of erosion produces distinctive changes in the material that it transports and creates characteristic surface features and landscapes. In certain erosional situations, loss of property, personal injury, and loss of life can be reduced by effective emergency preparedness.

2.1u The natural agents of erosion include:

- *Streams (running water):* Gradient, discharge, and channel shape influence a stream's velocity and the erosion and deposition of sediments. Sediments transported by streams tend to become rounded as a result of abrasion. Stream features include V-shaped valleys, deltas, flood plains, and meanders. A watershed is the area drained by a stream and its tributaries.
- *Glaciers (moving ice):* Glacial erosional processes include the formation of U-shaped valleys, parallel scratches, and grooves in bedrock. Glacial features include moraines, drumlins, kettle lakes, finger lakes, and outwash plains.
- *Wave Action:* Erosion and deposition cause changes in shoreline features, including beaches, sandbars, and barrier islands. Wave action rounds sediments as a result of abrasion. Waves approaching a shoreline move sand parallel to the shore within the zone of breaking waves.
- *Wind:* Erosion of sediments by wind is most common in arid climates and along shorelines. Wind-generated features include dunes and sand-blasted bedrock.
- *Mass Movement:* Earth materials move downslope under the influence of gravity.

2.1v Patterns of deposition result from a loss of energy within the transporting system and are influenced by the size, shape, and density of the transported particles. Sediment deposits may be sorted or unsorted.

2.1w Sediments of inorganic and organic origin often accumulate in depositional environments. Sedimentary rocks form when sediments are compacted and/or cemented after burial or as the result of chemical precipitation from seawater.

PERFORMANCE INDICATOR 2.2

Explain how incoming solar radiation, ocean currents, and land masses affect weather and climate.

Major Understandings:

2.2a Insolation (solar radiation) heats Earth's surface and atmosphere unequally due to variations in:

- the intensity caused by differences in atmospheric transparency and angle of incidence which vary with time of day, latitude, and season
- characteristics of the materials absorbing the energy such as color, texture, transparency, state of matter, and specific heat
- duration, which varies with seasons and latitude.

2.2b The transfer of heat energy within the atmosphere, the hydrosphere, and Earth's surface occurs as the result of radiation, convection, and conduction.

- Heating of Earth's surface and atmosphere by the Sun drives convection within the atmosphere and oceans, producing winds and ocean currents.

2.2c A location's climate is influenced by latitude, proximity to large bodies of water, ocean currents, prevailing winds, vegetative cover, elevation, and mountain ranges.

2.2d Temperature and precipitation patterns are altered by:

- natural events such as El Niño and volcanic eruptions
- human influences including deforestation, urbanization, and the production of greenhouse gases such as carbon dioxide and methane.

Key Idea 3:

Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity.

Observation and classification have helped us understand the great variety and complexity of Earth materials. Minerals are the naturally occurring inorganic solid elements, compounds, and mixtures from which rocks are made. We classify minerals on the basis of their chemical composition and observable properties. Rocks are generally classified by their origin (igneous, metamorphic, and sedimentary), texture, and mineral content.

Rocks and minerals help us understand Earth's historical development and its dynamics. They are important to us because of their availability and properties. The use and distribution of mineral resources and fossil fuels have important economic and environmental impacts. As limited resources, they must be used wisely.

PERFORMANCE INDICATOR 3.1

Explain the properties of materials in terms of the arrangement and properties of the atoms that compose them.

Major Understandings:

3.1a Minerals have physical properties determined by their chemical composition and crystal structure.

- Minerals can be identified by well-defined physical and chemical properties, such as cleavage, fracture, color, density, hardness, streak, luster, crystal shape, and reaction with acid.
- Chemical composition and physical properties determine how minerals are used by humans.

PERFORMANCE INDICATOR 3.1

continued

3.1b Minerals are formed inorganically by the process of crystallization as a result of specific environmental conditions. These include:

- cooling and solidification of magma
- precipitation from water caused by such processes as evaporation, chemical reactions, and temperature changes
- rearrangement of atoms in existing minerals subjected to conditions of high temperature and pressure.

3.1c Rocks are usually composed of one or more minerals.

- Rocks are classified by their origin, mineral content, and texture.
- Conditions that existed when a rock formed can be inferred from the rock's mineral content and texture.
- The properties of rocks determine how they are used and also influence land usage by humans.

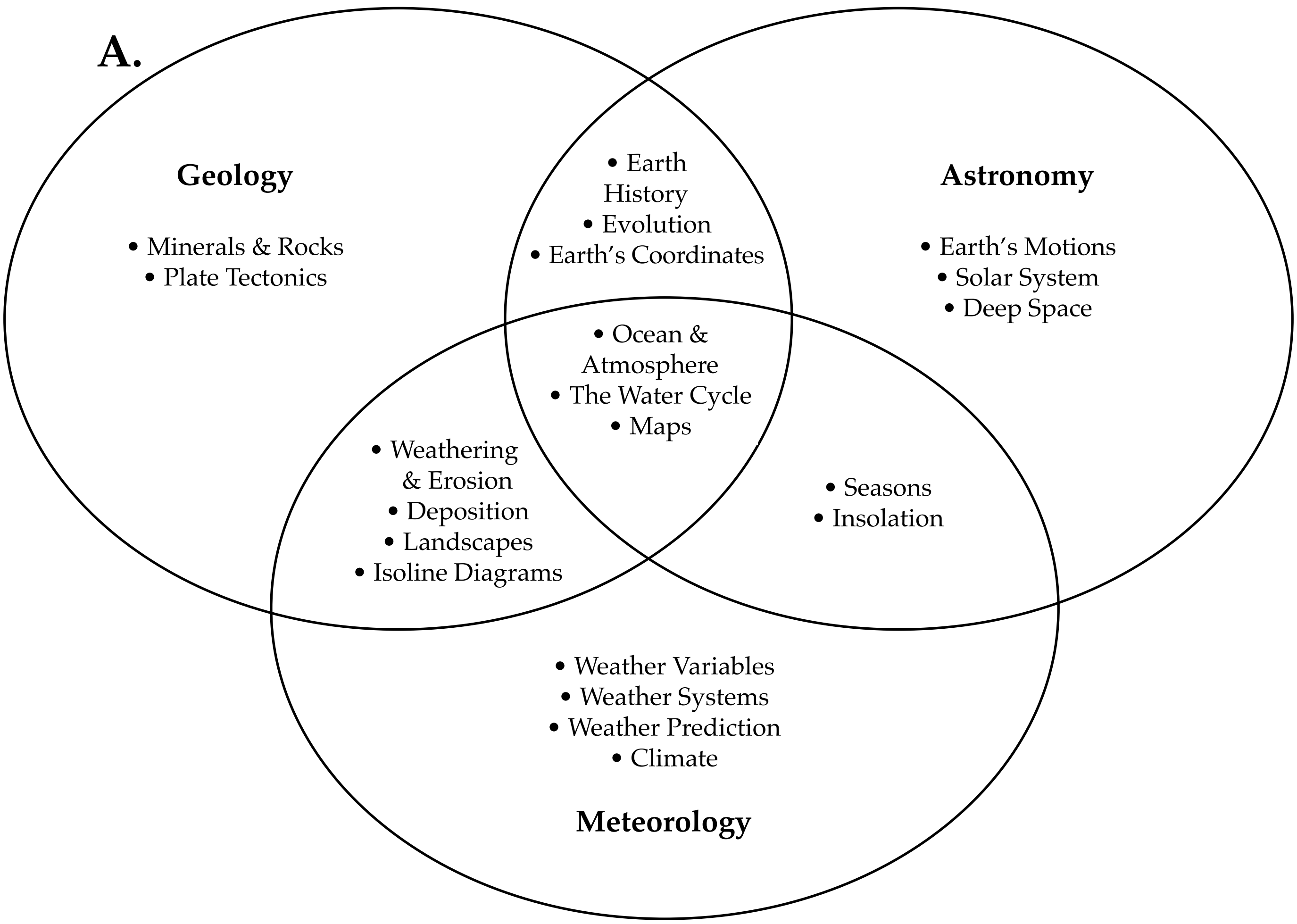
Please note: Key Idea 3, Performance Indicators 3.2 - 3.4, are not included because they will be addressed in the *Chemistry Core Curriculum*.

APPENDIX A
SUGGESTED SEQUENCES OF INSTRUCTION

The *Physical Setting/Earth Science Core Curriculum* follows the sequence of Key Ideas and Performance Indicators listed in *Learning Standards for Mathematics, Science, and Technology*. The instructional methods, time allotments, and sequencing of lessons are all decisions that can and should be made at the local level. Local curriculum decisions should be made based on the resources available and with the best interests of the students in mind.

The overriding goal should be to cover the material outlined in this Core Curriculum. Some teachers may choose to follow the sequence of topics in the 1970 *New York State Earth Science Syllabus* or the sequence of units in the 1991 *New York State Earth Science Program Modifications*. Many textbooks also present this material in a logical sequence.

The diagrams below give two examples of how the material in the Core Curriculum may be organized for curricular and instructional purposes:



B.

Astronomy

- Terrestrial Coordinates (Latitude/Longitude)
- Earth's Motions (Rotation/Revolution)
- Seasons (Insolation)
- Solar System
- Deep Space

Meteorology and Weather

- Weather Variables (Temperature, Moisture, Pressure, Wind)
- The Atmosphere (Measurements & Structure)
- Weather Systems (Air Masses, Fronts, and Cyclones)
- Weather Forecasting
- Weather Hazards

Climate

- Insolation
- Geographic Factors
- The Water Cycle
- Human Influence (Global Warming, Heat Island, etc.)

Geology

- Weathering, Erosion, & Deposition
- Landscapes/Topo Maps
- Minerals & Rocks
- Plate Tectonics
- Earth History

- Minerals & Rocks
- Plate Tectonics
- Weathering, Erosion, & Deposition
- Landscapes/Topo Maps
- Earth History

- Plate Tectonics
- Minerals & Rocks
- Weathering, Erosion, & Deposition
- Landscapes/Topo Maps
- Earth History

Alternative sequences may begin with topics in Geology or Meteorology.