

Seasons

Section and Outcome	Content
I. Adult Content Knowledge	<p>IA.</p> <ul style="list-style-type: none"> • Earth’s one-year revolution around the sun, because of the tilt of the earth’s axis, changes how directly sunlight falls on one part or another of the earth. <ul style="list-style-type: none"> ○ This difference in heating different parts of the earth’s surface produces seasonal variations in climate. • The earth has a variety of climatic patterns, which consist of different conditions of temperature, precipitation, humidity, wind, air, pressure, and other atmospheric phenomena. <ul style="list-style-type: none"> ○ This is caused by solar radiation heating the land, ocean, and air ○ The transfer of heat at the interfaces of the atmosphere with the land and oceans produces layers at different temperatures in both the air and the oceans. <ul style="list-style-type: none"> ▪ The layers rise, sink, or mix which gives rise to winds and ocean currents that carry heat energy between warm and cool regions. ▪ The earth’s rotation and the shape of the land curves the flow of the wind and ocean currents. ○ The cycling of water in and out of the atmosphere plays an important part in determining climatic patterns. <ul style="list-style-type: none"> ▪ Evaporating from the surface, rising and cooling, condensing into clouds and then into snow or rain, and falling again to the surface. ▪ Antarctica has a surface that is covered in thick ice, which interacts with the atmosphere and oceans eventually affecting the climate variation worldwide. <ul style="list-style-type: none"> • The earth’s climates have changed radically and are expected to continue changing. ○ This can include short term changes in climate due to huge volcanic eruptions or long term/permanent changes due to change slight changes in the ocean temperature. <p>IIB.</p> <p>Heat arrives to the earth from the sun. There is an unequal heating of the surfaces of the earth due to direct and indirect sunlight and the type of surface feature. Water retains more heat than land mass. Energy in storms is produced most fiercely when there is a large difference in temperatures. When the sun is completely overhead and the sun’s rays are hitting the earth’s surface directly at the equator (March 21 and September 21) it is called an equinox. When the sun is completely overhead and the sun’s rays are hitting the earth’s surface directly at the Tropics of Capricorn and Cancer (June 21 and December 21) it is called a solstice.</p>
II. Instructional Implications	<p>IIA: <i>Benchmarks for Science Literacy</i></p> <ul style="list-style-type: none"> • Most students are <i>told</i> by teachers what causes the seasons and the phases of the moon, and they read them without understanding • Students have difficulties regarding geometry and solar radiation • Students need direct experience with light and surfaces—shadows, reflection, and warming effects at different angles <p>Grades 3-5</p> <ul style="list-style-type: none"> • Students can begin to learn some of the surface features of the earth and earth’s relation to the sun, moon and other planets • Films and simulations will help, but it is essential that students make physical models and explain what the models show • Students can begin to understand about scale (counting, comparative distances, volumes, etc.)

Grades 6-8

- Students can now consolidate their prior knowledge about the earth (as a planet) by adding more details (especially about climate), getting a firmer grasp of the geometry involved in explaining the seasons
- Gravity can now be thought of as acting toward the center of the earth and reaching indefinitely into space
- The cause of the seasons is a subtle combination of global and orbital geometry and of the effects of radiation at different angles
- Students can learn part of the story at this grade level, but a complete picture cannot be expected until later

Grades 9-12

- Two important strands of understanding can now be pulled together to enrich students' views of the physical setting
- One connects energy, gravitation, conservation and radiation to the picture that students have about the operation of planets
- The other consists of the Copernican Revolution, which illustrates the place of technology, math, experimentation, and theory in scientific breakthroughs

IIB. *NSES*

K-4

- During the first years of school, students should be encouraged to observe closely the objects and materials in their environment, note their properties, distinguish one from another and develop their own explanations of how things become the way they are.
- Should be guided to observe changes such as seasons and their change.
- Emphasis should be on developing observation and description skills and the explanations based on observations.
- Younger children should be encouraged to talk about and draw what they see and think.
- Older students can keep journals, use instruments, and record their observations and measurements.

5-8

- A major goal in middle grades is for students to develop an understanding of earth and the solar system as a set of closely coupled systems.
- Students should have a clear notion about gravity, the shape of the earth, and the relative positions of the earth, sun, and moon.
- The understanding that students gain from their observations in grades K-4 provides the motivation and the basis from which they can begin to construct a model that explains the visual and physical relationships among earth, sun, moon, and the solar system.
- From activities with trajectories and orbits and using the earth-sun-moon system as an example, students can develop the understanding that energy from the sun transferred by light and other radiation is the primary energy source for processes on earth's surface and in its hydrosphere, atmosphere, and biosphere.
- However, more than half of the students will not be able to use these models to explain the seasons.

9-12

- At grades 9-12, students focus on matter, energy, crustal dynamics, cycles, geochemical processes, and the expanded time scales necessary to understand events in the earth system.
- Students will use their backgrounds to examine environmental changes occurring today and make predictions about future temperature fluctuations in the earth system.
- In grades 9-12, the study of the universe becomes more abstract as students expand their ability to comprehend large distances, long time scales, and the nature of

	<p>nuclear reactions.</p> <ul style="list-style-type: none"> • Teachers need to present understandable evidence from sources that range over immense timescales- and from studies of the earth’s interior to observations from outer space. • Since direct experimentation is usually not possible for many concepts associated with earth and space science, it is important to maintain the spirit of inquiry by focusing the teaching on questions that can be answered by using observational data, the knowledge base of science, and processes of reasoning.
<p>III. Concepts and Specific Ideas</p>	<p>Elementary School Learning Goals</p> <ul style="list-style-type: none"> -Some events in nature have a repeating pattern. The weather changes some from day to day, but things such as temperature and rain tend to be high, low, or medium in the same months every year. -Water can be a liquid or a solid and can go back and forth from one form to the other. -Things on or near the earth are pulled toward it by the earth’s gravity. -Like all planets and stars, the earth is approximately spherical in shape. The earth’s rotation on its axis is every 24 hours and produces the night-and-day cycle while the earth’s rotation around the sun is 365 ¼ days. -Different states of matter involved with weather (solid, liquid, gas—evaporation, condensation, clouds, fog) -Air is the substance that surrounds us, takes up space, and whose movement we feel as wind. <p>Middle School Learning Goals</p> <ul style="list-style-type: none"> -The earth is a relatively small planet, the third from the sun in the only system of planets definitely known to exist. -The earth is mostly rock. A relatively thin layer of water covers three-fourths of the earth’s surface and a relatively thin blanket of air surrounds the entire planet. Earth is the only planet that appears to support life. -Sunlight falls more intensely on different parts of the earth during the year due to the earth’s daily axis rotation and the tilt of the planet during the orbit of the sun. The difference in heating of the earth’s surface produces the planet’s seasons and weather patterns. -The moon’s orbit around the earth once in about 28 days changes what part of the moon is lighted by the sun and how much of that part can be seen from the earth—the phases of the moon. -Changes in the earth’s crust, such as volcanoes, have sometimes changed climate in the past and can have effects on the future. -The water cycle and how it determines climate patterns. Water evaporates from the surface of the earth, rises and cools, condenses into rain or snow, and falls again to the surface. The water falling on land collects in rivers and lakes, soil, and porous layers of rock, and much of it flows back into the ocean. -Fresh water is limited and essential for life on earth. Pollution can affect the amount of fresh water left on earth. - Heat energy is carried by ocean currents and has a strong influence on climate around the world. -Some minerals are very rare and some exist in great quantities. Recycling and the development of substitutes can reduce the rate of depletion but may also be costly. <p>High School Learning Goals</p> <ul style="list-style-type: none"> -Life is adapted to conditions on the earth, including the force of gravity that enables the planet to retain an adequate atmosphere, and an intensity of radiation from the sun that allows water to cycle between liquid and vapor. -Weather (in the short run) and climate (in the long run) involve the transfer of energy in and out of the atmosphere. Solar radiation heats the landmasses, oceans, and air. Transfer of heat energy between each atmospheric layer results in different

	<p>temperatures and densities in both the ocean and atmosphere. The action of gravitational force on regions of different densities causes them to rise or fall—and such circulation, influenced by the rotation of the earth, produces wind and ocean currents.</p> <p>IIIB. K-4</p> <ul style="list-style-type: none"> • The sun, moon, stars, clouds, birds, and airplanes all have properties, locations, and movements that can be observed and described. • The sun provides the light and heat necessary to maintain the temperature of the earth. • Weather changes from day to day and over the seasons. Weather can be described by measurable quantities, such as temperature, wind direction and speed, and precipitation. • Objects in the sky have patterns of movement. The sun, for example, appears to move across the sky in the same way every day, but its path changes slowly over the seasons. <p>5-8</p> <ul style="list-style-type: none"> • Most objects in the solar system are in regular and predictable motion. Those motions explain such phenomena as the day, the year, phases of the moon, and eclipses. • The Earth is the third planet from the sun in a system that includes the moon, the sun, seven other planets and their moons, and smaller objects, such as asteroids and comets. • The sun, an average star, is the central and largest body in the solar system. • The sun is the major source of energy for phenomena on the earth’s surface, such as growth of plants, winds, ocean currents, and the water cycle. Seasons result from variations in the amount of the sun’s energy hitting the surface, due to the tilt of the earth’s rotation on its axis and the length of the day. <p>9-12</p> <ul style="list-style-type: none"> • The sun is the major external source of energy. • Heating of earth’s surface and atmosphere by the sun drives convection within the atmosphere and oceans, producing winds and ocean currents. • Global climate is determined by energy transfer from the sun at the near the earth’s surface.
<p>IV. Research on Student Learning</p>	<p>Seasons Misconceptions</p> <p>The earth is closer to the sun during summer and farther away during winter. Seasons happen at the same time everywhere on earth. Seasonal characteristics and change are the same everywhere on earth.</p> <p>As we become adults, we learn more <i>and</i> we develop more "perceptions of the abstract." Furthermore, we differ from each other in what we learn <i>and</i> in what "perceptions" of abstractions we acquire.</p> <p>IVA: <i>Benchmarks for Science Literacy</i></p> <ul style="list-style-type: none"> • Student ideas about the shape of the earth are closely related to their ideas about gravity and the direction of “down” • Students cannot accept that gravity is center-directed if they do not know the earth is spherical • Research suggests teaching the concepts of spherical earth, space, and gravity in close connection to each other • Some research indicates that students can understand basic concepts of the shape of the earth and gravity by 5th grade if the students’ ideas are directly discussed and corrected in the classroom • Explanations of the day-night cycle, the phases of the moon and the seasons are very challenging for students • To understand these phenomena, students should first master the idea of a spherical

	<ul style="list-style-type: none"> earth • Students may not be able to understand explanations of any of these phenomena before they reasonably understand the relative size, motion, and distance of the sun, moon, and earth
<p>V. Coherency and Articulation</p>	<ul style="list-style-type: none"> • SCALE → common theme of the immense size of the solar system <ul style="list-style-type: none"> ○ Earth's relation to the sun • Students need to understand the motion of objects in the sky. • Students in elementary school are not likely to believe or understand the following: <ul style="list-style-type: none"> ○ The sun is a star ○ The Earth orbits the sun • The topic of seasons is very challenging for students. To understand this phenomena students should first master the idea of a spherical earth. • Students may not be able to understand explanations relating to seasons before they understand the relative size, motion, and distance of the sun, moon, and earth.
<p>VI. State Standards</p>	<p>K-4.1 Identify weather changes that occur from day to day.</p> <p>K-4.2 Compare the weather patterns that occur from season to season.</p> <p>K-4.3 Summarize ways that the seasons affect plants and animals.</p> <p>2-3.1 Explain the effects of moving air as it interacts with objects.</p> <p>2-3.2 Recall weather terminology (including temperature, wind direction, wind speed, and precipitation as rain, snow, sleet, and hail).</p> <p>2-3.3 Illustrate the weather conditions of different seasons.</p> <p>2-3.4 Carry out procedures to measure and record daily weather conditions (including temperature, precipitation amounts, wind speed as measured on the Beaufort scale, and wind direction as measured with a windsock or wind vane).</p> <p>2-3.5 Use pictorial weather symbols to record observable sky conditions.</p> <p>2-3.6 Identify safety precautions that one should take during severe weather conditions.</p> <p>4-3.3 Explain how the Sun affects Earth.</p> <p>4-3.4 Explain how the tilt of Earth's axis and the revolution around the Sun results in the seasons of the year.</p> <p>4-3.5 Explain how the rotation of Earth results in day and night.</p> <p>4-3.7 Interpret the change in the length of shadows during the day in relation to the position of the Sun in the sky.</p> <p>8-4.5 Explain how the tilt of Earth's axis affects the length of the day and the amount of heating on Earth's surface, thus causing the seasons of the year.</p>