

**California State Science Curriculum Standards
Grades K-12 – Spiraled**

Content Area: EARTH SCIENCE

The following document lists the standards that should be covered from Kindergarten through 12th grade in this content area.

Kindergarten

3. Earth is composed of land, air, and water. As a basis for understanding this concept:
- Students know* characteristics of mountains, rivers, oceans, valleys, deserts, and local landforms.
 - Students know* changes in weather occur from day to day and across seasons, affecting Earth and its inhabitants.
 - Students know* how to identify resources from Earth that are used in everyday life and understand that many resources can be conserved.

Grade 1

3. Weather can be observed, measured, and described. As a basis for understanding this concept:
- Students know* how to use simple tools (e.g., thermometer, wind vane) to measure weather conditions and record changes from day to day and across the seasons.
 - Students know* that the weather changes from day to day but trends in temperature or of rain (or snow) tend to be predictable during a season.
 - Students know* the sun warms the land, air, and water.

Grade 2

3. Earth is made of materials that have distinct properties and provide resources for human activities. As a basis for understanding this concept:
- Students know* how to compare the physical properties of different kinds of rocks and know that rock is composed of different combinations of minerals.
 - Students know* smaller rocks come from the breakage and weathering of larger rocks.
 - Students know* that soil is made partly from weathered rock and partly from organic materials and that soils differ in their color, texture, capacity to retain water, and ability to support the growth of many kinds of plants.
 - Students know* that fossils provide evidence about the plants and animals that lived long ago and that scientists learn about the past history of Earth by studying fossils.
 - Students know* rock, water, plants, and soil provide many resources, including food, fuel, and building materials, that humans use.

Grade 3

4. Objects in the sky move in regular and predictable patterns. As a basis for understanding this concept:
- Students know* the patterns of stars stay the same, although they appear to move across the sky nightly, and different stars can be seen in different seasons.
 - Students know* the way in which the Moon's appearance changes during the four-week lunar cycle.
 - Students know* telescopes magnify the appearance of some distant objects in the sky, including the Moon and the planets. The number of stars that can be seen through telescopes is dramatically greater than the number that can be seen by the unaided eye.
 - Students know* that Earth is one of several planets that orbit the Sun and that the Moon orbits Earth.
 - Students know* the position of the Sun in the sky changes during the course of the day and from season to season.

Grade 4

4. The properties of rocks and minerals reflect the processes that formed them. As a basis for understanding this concept:
 - a. *Students know* how to differentiate among igneous, sedimentary, and metamorphic rocks by referring to their properties and methods of formation (the rock cycle).
 - b. *Students know* how to identify common rock-forming minerals (including quartz, calcite, feldspar, mica, and hornblende) and ore minerals by using a table of diagnostic properties.
5. Waves, wind, water, and ice shape and reshape Earth's land surface. As a basis for understanding this concept:
 - a. *Students know* some changes in the earth are due to slow processes, such as erosion, and some changes are due to rapid processes, such as landslides, volcanic eruptions, and earthquakes.
 - b. *Students know* natural processes, including freezing and thawing and the growth of roots, cause rocks to break down into smaller pieces.
 - c. *Students know* moving water erodes landforms, reshaping the land by taking it away from some places and depositing it as pebbles, sand, silt, and mud in other places (weathering, transport, and deposition).

Grade 5

3. Water on Earth moves between the oceans and land through the processes of evaporation and condensation. As a basis for understanding this concept:
 - a. *Students know* most of Earth's water is present as salt water in the oceans, which cover most of Earth's surface.
 - b. *Students know* when liquid water evaporates, it turns into water vapor in the air and can reappear as a liquid when cooled or as a solid if cooled below the freezing point of water.
 - c. *Students know* water vapor in the air moves from one place to another and can form fog or clouds, which are tiny droplets of water or ice, and can fall to Earth as rain, hail, sleet, or snow.
 - d. *Students know* that the amount of fresh water located in rivers, lakes, underground sources, and glaciers is limited and that its availability can be extended by recycling and decreasing the use of water.
 - e. *Students know* the origin of the water used by their local communities.
4. Energy from the Sun heats Earth unevenly, causing air movements that result in changing weather patterns. As a basis for understanding this concept:
 - a. *Students know* uneven heating of Earth causes air movements (convection currents).
 - b. *Students know* the influence that the ocean has on the weather and the role that the water cycle plays in weather patterns.
 - c. *Students know* the causes and effects of different types of severe weather.
 - d. *Students know* how to use weather maps and data to predict local weather and know that weather forecasts depend on many variables.
 - e. *Students know* that the Earth's atmosphere exerts a pressure that decreases with distance above Earth's surface and that at any point it exerts this pressure equally in all directions.
5. The solar system consists of planets and other bodies that orbit the Sun in predictable paths. As a basis for understanding this concept:
 - a. *Students know* the Sun, an average star, is the central and largest body in the solar system and is composed primarily of hydrogen and helium.
 - b. *Students know* the solar system includes the planet Earth, the Moon, the Sun, eight other planets and their satellites, and smaller objects, such as asteroids and comets.

c. *Students know* the path of a planet around the Sun is due to the gravitational attraction between the Sun and the planet.

Grade 6

Plate Tectonics and Earth's Structure

1. Plate tectonics accounts for important features of Earth's surface and major geologic events. As a basis for understanding this concept:

- a. *Students know* evidence of plate tectonics is derived from the fit of the continents; the location of earthquakes, volcanoes, and mid-ocean ridges; and the distribution of fossils, rock types, and ancient climatic zones.
- b. *Students know* Earth is composed of several layers: a cold, brittle lithosphere; a hot, convecting mantle; and a dense, metallic core.
- c. *Students know* lithospheric plates the size of continents and oceans move at rates of centimeters per year in response to movements in the mantle.
- d. *Students know* that earthquakes are sudden motions along breaks in the crust called faults and that volcanoes and fissures are locations where magma reaches the surface.
- e. *Students know* major geologic events, such as earthquakes, volcanic eruptions, and mountain building, result from plate motions.
- f. *Students know* how to explain major features of California geology (including mountains, faults, volcanoes) in terms of plate tectonics.
- g. *Students know* how to determine the epicenter of an earthquake and know that the effects of an earthquake on any region vary, depending on the size of the earthquake, the distance of the region from the epicenter, the local geology, and the type of construction in the region.

Shaping Earth's Surface

2. Topography is reshaped by the weathering of rock and soil and by the transportation and deposition of sediment. As a basis for understanding this concept:

- a. *Students know* water running downhill is the dominant process in shaping the landscape, including California's landscape.
- b. *Students know* rivers and streams are dynamic systems that erode, transport sediment, change course, and flood their banks in natural and recurring patterns.
- c. *Students know* beaches are dynamic systems in which the sand is supplied by rivers and moved along the coast by the action of waves.
- d. *Students know* earthquakes, volcanic eruptions, landslides, and floods change human and wildlife habitats.

Energy in the Earth System

4. Many phenomena on Earth's surface are affected by the transfer of energy through radiation and convection currents. As a basis for understanding this concept:

- a. *Students know* the sun is the major source of energy for phenomena on Earth's surface; it powers winds, ocean currents, and the water cycle.
- b. *Students know* solar energy reaches Earth through radiation, mostly in the form of visible light.
- c. *Students know* heat from Earth's interior reaches the surface primarily through convection.
- d. *Students know* convection currents distribute heat in the atmosphere and oceans.
- e. *Students know* differences in pressure, heat, air movement, and humidity result in changes of weather.

Resources

6. Sources of energy and materials differ in amounts, distribution, usefulness, and the time required for their formation. As a basis for understanding this concept:

- a. *Students know* the utility of energy sources is determined by factors that are involved in converting these sources to useful forms and the consequences of the conversion process.
- b. *Students know* different natural energy and material resources, including air, soil, rocks,

minerals, petroleum, fresh water, wildlife, and forests, and know how to classify them as renewable or nonrenewable.

c. *Students know* the natural origin of the materials used to make common objects.

Grade 7

Earth and Life History (Earth Sciences)

4. Evidence from rocks allows us to understand the evolution of life on Earth. As a basis for understanding this concept:

a. *Students know* Earth processes today are similar to those that occurred in the past and slow geologic processes have large cumulative effects over long periods of time.

b. *Students know* the history of life on Earth has been disrupted by major catastrophic events, such as major volcanic eruptions or the impacts of asteroids.

c. *Students know* that the rock cycle includes the formation of new sediment and rocks and that rocks are often found in layers, with the oldest generally on the bottom.

d. *Students know* that evidence from geologic layers and radioactive dating indicates Earth is approximately 4.6 billion years old and that life on this planet has existed for more than 3 billion years.

e. *Students know* fossils provide evidence of how life and environmental conditions have changed.

f. *Students know* how movements of Earth's continental and oceanic plates through time, with associated changes in climate and geographic connections, have affected the past and present distribution of organisms.

g. *Students know* how to explain significant developments and extinctions of plant and animal life on the geologic time scale.

Grade 8

Earth in the Solar System (Earth Sciences)

4. The structure and composition of the universe can be learned from studying stars and galaxies and their evolution. As a basis for understanding this concept:

a. *Students know* galaxies are clusters of billions of stars and may have different shapes.

b. *Students know* that the Sun is one of many stars in the Milky Way galaxy and that stars may differ in size, temperature, and color.

c. *Students know* how to use astronomical units and light years as measures of distances between the Sun, stars, and Earth.

d. *Students know* that stars are the source of light for all bright objects in outer space and that the Moon and planets shine by reflected sunlight, not by their own light.

e. *Students know* the appearance, general composition, relative position and size, and motion of objects in the solar system, including planets, planetary satellites, comets, and asteroids.

Earth Sciences (High School)

Earth's Place in the Universe

1. Astronomy and planetary exploration reveal the solar system's structure, scale, and change over time. As a basis for understanding this concept:

a. *Students know* how the differences and similarities among the sun, the terrestrial planets, and the gas planets may have been established during the formation of the solar system.

b. *Students know* the evidence from Earth and moon rocks indicates that the solar system was formed from a nebular cloud of dust and gas approximately 4.6 billion years ago.

c. *Students know* the evidence from geological studies of Earth and other planets suggest that the early Earth was very different from Earth today.

d. *Students know* the evidence indicating that the planets are much closer to Earth than the stars are.

- e. *Students know* the Sun is a typical star and is powered by nuclear reactions, primarily the fusion of hydrogen to form helium.
- f. *Students know* the evidence for the dramatic effects that asteroid impacts have had in shaping the surface of planets and their moons and in mass extinctions of life on Earth.
- g. * *Students know* the evidence for the existence of planets orbiting other stars.

2. Earth-based and space-based astronomy reveal the structure, scale, and changes in stars, galaxies, and the universe over time. As a basis for understanding this concept:
- a. *Students know* the solar system is located in an outer edge of the disc-shaped Milky Way galaxy, which spans 100,000 light years.
 - b. *Students know* galaxies are made of billions of stars and comprise most of the visible mass of the universe.
 - c. *Students know* the evidence indicating that all elements with an atomic number greater than that of lithium have been formed by nuclear fusion in stars.
 - d. *Students know* that stars differ in their life cycles and that visual, radio, and X-ray telescopes may be used to collect data that reveal those differences.
 - e. * *Students know* accelerators boost subatomic particles to energy levels that simulate conditions in the stars and in the early history of the universe before stars formed.
 - f. * *Students know* the evidence indicating that the color, brightness, and evolution of a star are determined by a balance between gravitational collapse and nuclear fusion.
 - g. * *Students know* how the red-shift from distant galaxies and the cosmic background radiation provide evidence for the “big bang” model that suggests that the universe has been expanding for 10 to 20 billion years.

Dynamic Earth Processes

3. Plate tectonics operating over geologic time has changed the patterns of land, sea, and mountains on Earth’s surface. As the basis for understanding this concept:
- a. *Students know* features of the ocean floor (magnetic patterns, age, and sea-floor topography) provide evidence of plate tectonics.
 - b. *Students know* the principal structures that form at the three different kinds of plate boundaries.
 - c. *Students know* how to explain the properties of rocks based on the physical and chemical conditions in which they formed, including plate tectonic processes.
 - d. *Students know* why and how earthquakes occur and the scales used to measure their intensity and magnitude.
 - e. *Students know* there are two kinds of volcanoes: one kind with violent eruptions producing steep slopes and the other kind with voluminous lava flows producing gentle slopes.
 - f. * *Students know* the explanation for the location and properties of volcanoes that are due to hot spots and the explanation for those that are due to subduction.

Energy in the Earth System

4. Energy enters the Earth system primarily as solar radiation and eventually escapes as heat. As a basis for understanding this concept:
- a. *Students know* the relative amount of incoming solar energy compared with Earth’s internal energy and the energy used by society.
 - b. *Students know* the fate of incoming solar radiation in terms of reflection, absorption, and photosynthesis.
 - c. *Students know* the different atmospheric gases that absorb the Earth’s thermal radiation and the mechanism and significance of the greenhouse effect.
 - d. * *Students know* the differing greenhouse conditions on Earth, Mars, and Venus; the origins of those conditions; and the climatic consequences of each.

5. Heating of Earth’s surface and atmosphere by the sun drives convection within the atmosphere and oceans, producing winds and ocean currents. As a basis for understanding this concept:

- a. *Students know* how differential heating of Earth results in circulation patterns in the atmosphere and oceans that globally distribute the heat.
- b. *Students know* the relationship between the rotation of Earth and the circular motions of ocean currents and air in pressure centers.
- c. *Students know* the origin and effects of temperature inversions.
- d. *Students know* properties of ocean water, such as temperature and salinity, can be used to explain the layered structure of the oceans, the generation of horizontal and vertical ocean currents, and the geographic distribution of marine organisms.
- e. *Students know* rain forests and deserts on Earth are distributed in bands at specific latitudes.
- f. **Students know* the interaction of wind patterns, ocean currents, and mountain ranges results in the global pattern of latitudinal bands of rain forests and deserts.
- g. **Students know* features of the ENSO (El Niño southern oscillation) cycle in terms of sea-surface and air temperature variations across the Pacific and some climatic results of this cycle.

6. Climate is the long-term average of a region's weather and depends on many factors.

As a basis for understanding this concept:

- a. *Students know* weather (in the short run) and climate (in the long run) involve the transfer of energy into and out of the atmosphere.
- b. *Students know* the effects on climate of latitude, elevation, topography, and proximity to large bodies of water and cold or warm ocean currents.
- c. *Students know* how Earth's climate has changed over time, corresponding to changes in Earth's geography, atmospheric composition, and other factors, such as solar radiation and plate movement.
- d. **Students know* how computer models are used to predict the effects of the increase in greenhouse gases on climate for the planet as a whole and for specific regions.

Biogeochemical Cycles

7. Each element on Earth moves among reservoirs, which exist in the solid earth, in oceans, in the atmosphere, and within and among organisms as part of biogeochemical cycles. As a basis for understanding this concept:

- a. *Students know* the carbon cycle of photosynthesis and respiration and the nitrogen cycle.
- b. *Students know* the global carbon cycle: the different physical and chemical forms of carbon in the atmosphere, oceans, biomass, fossil fuels, and the movement of carbon among these reservoirs.
- c. *Students know* the movement of matter among reservoirs is driven by Earth's internal and external sources of energy.
- d. **Students know* the relative residence times and flow characteristics of carbon in and out of its different reservoirs.

Structure and Composition of the Atmosphere

8. Life has changed Earth's atmosphere, and changes in the atmosphere affect conditions for life. As a basis for understanding this concept:

- a. *Students know* the thermal structure and chemical composition of the atmosphere.
- b. *Students know* how the composition of Earth's atmosphere has evolved over geologic time and know the effect of outgassing, the variations of carbon dioxide concentration, and the origin of atmospheric oxygen.
- c. *Students know* the location of the ozone layer in the upper atmosphere, its role in absorbing ultraviolet radiation, and the way in which this layer varies both naturally and in response to human activities.

California Geology

9. The geology of California underlies the state's wealth of natural resources as well as its natural hazards. As a basis for understanding this concept:

- a. *Students know* the resources of major economic importance in California and their relation to California's geology.
- b. *Students know* the principal natural hazards in different California regions and the geologic basis of those hazards.
- c. *Students know* the importance of water to society, the origins of California's fresh water, and the relationship between supply and need.
- d. * *Students know* how to analyze published geologic hazard maps of California and know how to use the map's information to identify evidence of geologic events of the past and predict geologic changes in the future.