Grades 9-12 Earth Science

The Earth's Structure

1. The Earth is a changing planet. As a basis for understanding this concept, students know:
    a. how to use the scientific method to investigate the structure of the earth.
    b. how to explain plate tectonics and how it relates to known structures of the earth's surface, including the formation of mountain ranges, the existence of areas of high earthquake and volcanic activity, and the phenomenon of seafloor spreading, and relating these to plate boundaries.
    c. how to explain the models of the earth's interior, including the relationship between the various layers and the behavior of the tectonic plates, i.e. what causes the plates to move.

2. Forces mold and change the surface of the Earth. As a basis for understanding this concept, students know:
    a. how to explain the forces that cause earthquakes, learn how to locate the epicenter of an earthquake, and be able to differentiate between the properties and effects of the waves that originate from an earthquake's focus.
    b. how to explain the causes of folds in the earth's crust, compare the types of faults and their associated forces, and relate the processes of folding and faulting to plate tectonics and mountain-building.
    c. how to describe the correlation of areas of high volcanic activity to plate boundaries, the relationship between hot spots and volcanic island chains, and distinguish between the various types of volcanoes based on differences in formation and eruption characteristics

3. Various processes erode the surface of the Earth. As a basis for understanding this concept, students know:
    a. how to describe the processes that change the earth's rocks, including factors that affect the rate of weathering, the kinds of chemical and physical weathering and the different types of mass movement.
    b. how to identify the factors involved in soil formation, summarize the characteristics of different types of soils and evaluate various methods of soil conservation.
    c. how to describe the causes of erosion by running water, waves, wind, ice and gravity and the transport of the resulting weathered materials.
    d. how to describe the water cycle, list the factors affecting runoff, and compare and contrast porosity and permeability especially as these relate to ground water.

4. Maps are useful models of the the earth and its various landforms. As a basis for understanding this concept, students know:
    a. how to explore the history of map making; use latitude and longitude to locate places on a map; and explore various types of maps, highlighting their strengths and weaknesses.
    b. how to describe the three kinds of map scales, use a legend and compare and contrast topographical and geological maps.
    c. how to define geomorphology and describe the basic geomorphic provinces of the United States.

The Earth's Resources

5. Minerals are the building blocks of rocks. As a basis for understanding this concept, students know:
    a. how to define and use the major properties of minerals to identify and classify them.

The Earth's Resources (5. continued)

b. how to describe the parts of the atom, explain the relationship between atoms and elements, compounds and molecules; types of chemical bonding and how to create compounds using the Periodic Table.
c. how to explain why different metals and minerals are classified as strategic and what qualities make a gemstone.

6. There are three major kinds of rocks and they each have a specific relationship to the rock cycle. As a basis for understanding this concept, students know:

a. how to describe some of the uses of rocks, the criteria used to classify rocks and correlate the three rock groups with the rock cycle.
b. how to describe the formation, classification and uses of igneous rocks.
c. how to describe the three types of sedimentary rocks, their classification and some uses.
d. how to describe the formation, classification and uses of metamorphic rock.

7. The Earth's resources are finite and consequently there is a need for conservation. As a basis for understanding this concept, students know:

a. how to describe what is meant by a natural resource, distinguish between renewable and nonrenewable resources, and discuss the importance of conservation.
b. how to describe the origin and importance of fossil fuels, as well as the advantages and disadvantages of our reliance on them.
c. how to identify alternatives to fossil fuels, comparing and contrasting their usefulness and limitations.

The Earth's Geologic History

8. The rock record reveals the history of the Earth. As a basis for understanding this concept, students know:

a. how to explain what is meant by and the importance of the ideas of uniformitarianism and superposition.
b. how to explain the difference between absolute and relative dating and describe the process by which fossils are formed.

9. The calendar model is useful in understanding the Earth's history. As a basis for understanding this concept, students know:

a. how to discuss the leading theories on the formation of the planets and the beginning of life during the Cryptozoic time.
b. how to discuss the evolution of life during the three divisions of Phanerozoic time, including the major life forms and changes of each era.

Meteorology

10. Heating of the 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, students know:

a. how to name and describe the layers of the earth's atmosphere and explain the relationship between atmospheric pressure and altitude.
b. how to explain how the earth's surface and atmosphere are heated by radiant energy from the sun and define radiation balance and its effect on the atmosphere.
c. how to explain the Coriolis effect and the motions of planetary winds, as well as the forces that cause land and sea breezes.

Meteorology (continued)

11. The water cycle plays a key role in understanding the weather. As a basis for understanding this concept, students know:
    a. how to describe the processes of evaporation and condensation, distinguish between absolute and relative humidity, and the effect of temperature on relative humidity.
    b. how to describe the classification of clouds and the major types of precipitation, as well as the steps of the water cycle.

12. The interaction of various land and air temperatures, wind patterns, ocean currents, and mountain ranges leads to a great variety of weather systems. As a basis for understanding this concept, students know:
    a. how to identify the types of air masses, the fronts between them and the interactions that cause cyclones and anticyclones.
    b. how to describe the formation and physical characteristics of different kinds of severe weather, such as thunderstorms, tornadoes and hurricanes.
    c. how to describe the steps involved in predicting the weather, as well as the difficulties of doing so, and how to read weather maps.

13. Climate is the long term average of a region's weather and depends on many factors. As a basis for understanding this concept, students know:
    a. how to discuss the conditions that determine the climate of a particular region, focusing on the factors that influence the weather; identify different types of climates.
    b. how to identify causes of climatic changes, including those caused by natural versus human activities; use the fossil record to make inferences about previous climate changes.

Astronomy

14. Earth-based and space-based astronomy reveal the structure, scale, and change over time of stars, galaxies and the universe. As a basis for understanding this concept, students know:
    a. how to describe rotation and revolution of the earth; discuss the tilt of the earth's axis and its relation to the seasons; describe the phases of the moon and both solar and lunar eclipses.
    b. how to name and describe the inner planets, the moon and the asteroid belt.
    c. how to name and describe the outer planets, compare them with the inner planets and describe the structure and composition of comets.
    d. the solar system is located in an outer edge of the disc-shaped Milky Way galaxy which spans 100,000 light years.
    e. galaxies are made of billions of stars and form most of the visible mass of the universe.
    f. all elements larger than helium have been formed by nuclear fusion processes in stars.
    g. stars differ in their life cycles and visual, radio and X-ray telescopes collect data that reveal these differences.
    h. accelerators give subatomic particles energies that simulate conditions in the stars and in early history of the universe before stars formed.
    i. stars are formed and are maintained by a balance between gravitational collapse and nuclear fusion. The mass of a star and the balance between collapse and fusion determine the color, brightness, lifetime, and evolution of a star.
    j. how the red-shift from distant galaxies and the cosmic background radiation provide evidence for the big bang model and that the universe has been expanding for 10 to 20 billion years.

Investigation and Experimentation

15. In the context of investigations designed to develop understanding of the content of the other strands students will:

a. select and use appropriate tools and technology (such as computer linked probes, spread sheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data.
b. identify and communicate the sources of error inherent in experimental design.
c. identify discrepant results and identify possible sources of error or uncontrolled conditions.
d. formulate and revise explanations using logic and evidence.
e. distinguish between a guess, a hypothesis and a theory as these terms are used in science.
f. recognize the use and limitations of models and theories as scientific representations of reality.
g. read and interpret a topographic map, and a geologic map for evidence.
h. identify natural events by sequence and time from natural phenomena (e.g., relative ages of rocks and intrusions).
i. recognize the issues of statistical variability and the need for controlled tests.
j. recognize the cumulative nature of scientific evidence.
k. analyze situations and solve problems that require combining concepts from more than one topic area of science and applying these concepts to real world situations.
l. investigate a science-based societal issue by researching the literature, analyzing data where appropriate and communicating their findings. Examples include irradiation of food, cloning of animals by somatic cell nuclear transfer, choice of energy sources, and land and water use decisions (including California).