Shenandoah Community School District
Earth and Space
Grade - 9

9.1 (SCSD) Earth and Space

9.1.1 (SCSD) Understand and apply knowledge of energy in the earth system (I, D, M)

- Know that the earth system have internal and external sources of energy, both which create heat (I, D, M)
  - Two primary sources of internal energy are:
    - The decay of radioactive isotopes (I,D,M)
    - The gravitational energy from the earth's original formation (I,D,M)
  - The sun is the major external source of energy (I,D,M)
- Understand plate tectonics (I,D,M)
  - The outward transfer of Earth's internal heat drives convection circulation in the mantle that propels the plates comprising the earth's surface across the face of the globe (I, D, M)
- Know that energy transfers in the atmosphere and ocean (I,D,M)
  - Heating of the earth's surface and atmosphere by the sun drives convection within the atmosphere and oceans, producing winds and ocean currents (I, D, M)
  - Global climate is determined by energy transfer from the sun at and near the earth's surface. This energy transfer is influenced by dynamic processes such as:
    - Cloud cover (I,D,M)
    - Earth's rotation (I,D,M)
    - Static conditions such as the position of
      - Mountain ranges (I,D,M)
      - Oceans (I,D,M)

9.1.2 (SCSD) Understand and apply knowledge of Geochemical cycles (I, D, M)

- Know that elements/atoms are within the Earth reservoirs (I,D,M)
  - The earth is a system containing essentially a fixed amount of each stable chemical atom or element (I,D,M)
  - Each element can exist in several different chemical reservoirs (I,D,M)
  - As part of geochemical cycles, each element on Earth moves among reservoirs:
    - Solid Earth (I,D,M)
    - Oceans (I,D,M)
    - Atmosphere (I,D,M)
    - Organisms (I,D,M)
- Understand the movement of elements/atoms between reservoirs (I,D,M)
  - Movement of matter between reservoirs is driven by the earth's sources of energy (I, D, M)
    - Internal (I,D,M)
    - External (I,D,M)
  - These movements are often accompanied by a change in the physical and chemical properties of the matter (I, D, M)
    - Carbon occurs in:
      - Carbonate rocks such as limestone (I,D,M)
      - In the atmosphere as carbon dioxide gas (I,D,M)
      - In water as dissolved carbon dioxide (I,D,M)
      - In all organisms as complex molecules that control the chemistry of life (I,D,M)

9.1.3 (SCSD) Understand and apply knowledge of the origin and evolution of the earth system (I, D, M)

- Know the formation of the solar system (I,M,D)
  - The sun, the earth, and the rest of the solar system formed from a nebular cloud of dust and gas 10 to 15 billion years ago (I,D,M)
  - The early Earth was very different from the planet on which we live today (I,D,M)
- Understand geologic time (I,D,M)
  - Geologic time can be estimated by:
    - Observing rock sequences (I,D,M)
    - Using fossils to correlate the sequences at various locations (I,D,M)
  - Current methods for measuring geologic time include using the known decay rates of radioactive isotopes present in rocks to measure the time since the rock was formed (I,D,M)
- Understand the interactions among hydrosphere, lithosphere, and atmosphere (I,D,M)
  - Interactions among the solid Earth, the oceans, the atmosphere, and organisms have resulted in the ongoing evolution of the earth system (I,D,M)
  - On a human time scale we can observe some changes such as:
    - Earthquakes (I,D,M)
    - Volcanic eruptions (I,D,M)
  - Many processes take place over hundreds of millions of years such as:
    - Mountain building (I,D,M)
    - Plate movements (I,D,M)
- Understand life: the origin, evolution, and effect on Earth Systems (I,D,M)
  - Evidence for one-celled forms of life—the microbes—extends back more than 3.5 billion years (I,D,M)
  - The evolution of life caused dramatic changes in the composition of the earth's atmosphere, which did not originally contain oxygen (I,D,M)

9.1.4 (SCSD) Understand and apply knowledge of the origin and evolution of the universe.

- Know the age and origin of the universe (I,D,M)
  - Greatest questions in science (I,D,M)
  - The "big bang" theory places the origin between 10 and 20 billion years ago, when the universe began in a hot dense state: According to this theory, the universe has been expanding ever since (I,D,M)
- Know about our universe and galaxies (I,D,M)
  - Early in the history of the universe, matter—primarily the light atoms hydrogen and helium — clumped together through gravitational attraction to form countless trillions of stars (I,D,M)
  - Billions of galaxies, each of which is a gravitationally bound cluster of billions of stars, now form most of the visible mass in the universe (I,D,M)
- Understand the processes in star (I,D,M)
  - Stars produce energy from nuclear reactions, primarily the fusion of hydrogen to form helium (I,D,M)
    - These and other processes in stars have led to the formation of all the other elements (I,D,M)
- Obtain knowledge about stars
  - Stars differ from each other
    - Size (I,D,M)
    - Temperature (I,D,M)
    - Age (I,D,M)
  - Star appear:
    - to be made up of the same elements (I,D,M)
    - to behave according to the same principles (I,D,M)
  - Most stars are in systems of two or more stars orbiting around a common point (I,D,M)

- Understand that the scientific account of the universe comes from studying evidence about its contents and imagining how the contents got to be the way they are today. To help study evidence they used:
  - Mathematical models (I,D,M)
  - Computer simulations (I,D,M)

9.4 (SCSD) Science as Inquiry

9.4.1 (SCSD) Identify questions and concepts that guide scientific investigations (I)

- Understand hypothesis and formulate a testable hypothesis, demonstrating;
  - Logical connections between the scientific concepts guiding:
    - A hypothesis (I)
    - The design of an experiment (I)
- Understand scientific investigations and demonstrate:
  - Appropriate procedures (I)
  - A knowledge base (I)
  - Conceptual understanding (I)

9.4.2 (SCSD) Design and conduct scientific investigations (I)

- Requires:
  - Understanding of the major concepts in the area being investigated (I)
  - Proper equipment (I)
  - Safety precautions (I)
  - Understanding of methodological problems (I)
  - Use of technologies (I)
  - Scientific knowledge obtained from sources other than the actual investigation (I)
  - Clarification of :
    - Ideas that guide the inquiry (I)
    - Question (I)
    - Method (I)
    - Controls (I)
    - Variables (I)
  - Organization and display of data (I)
  - Revision of methods and explanations (I)
  - Public presentation of the results with a critical response from peers (I)
- Must:
    - Use evidence (I)
    - Apply logic (I)
    - Construct an argument for their proposed explanations (I)

9.4.3 (SCSD) Use technology and mathematics to improve investigations and communications (I)

- A variety of technologies are an integral component of scientific investigations (I)
  - Hand tools (I)
  - Measuring instruments (I)
  - Calculators (I)
  - Computers for data (I)
    - Collection (I)
    - Analysis (I)
    - Display (I)
- Mathematics plays an essential role in all aspects of an inquiry investigation (I)
  - Measurement (I)
    - Posing questions (I)
    - Formulas are used for developing explanations (I)
    - Charts and graphs are used for communicating results (I)

9.4.4 (SCSD) Formulate and revise scientific explanations and models using logic and evidence (I)

- Inquiries culminate in formulating an explanation or model (I)
  - Model
    - Physical (I)
    - Conceptual (I)
    - Mathematical (I)
- Process of answering the questions involves:
  - Discussions (I)
  - Arguments (I)
  - Revisions of explanations (I)
  - Based on:
    - Scientific knowledge (I)
    - Use of logic (I)
    - Evidence from investigation (I)

9.4.5 (SCSD) Think critically and logically to make the relationship between evidence and explanations (I)

- Think critically about evidence includes:
  - Deciding what evidence should be used (I)
  - Accounting for anomalous data (I)
- Process
  - Review data from a simple experiment (I)
  - Summarize the data (I)
  - Form a logical argument about the cause-and-effect relationship in the experiment (I)

9.4.6 (SCSD) Recognize and analyze alternative explanations and predictions (I)

- Develop critical abilities of analyzing an argument by reviewing:
  - Current scientific understanding (I)
  - Weighing the evidence (I)
  - Examining the logic (I)
- Develop the ability to decide which explanations and models are best (I)
  - There may be several plausible explanations, they do not all have equal weight (I)
  - Use scientific criteria to find the preferred explanations (I)
- Know that scientific knowledge is based on repeatable standards to ensure accuracy of the information. This knowledge may be constantly updated or corrected as the world tests and makes new advances in science (I)

9.4.7 (SCSD) Communicate and defend scientific procedures and explanations

- Develop the abilities associated with accurate and effective communication these include:
  - Writing and following procedures (I)
  - Expressing concepts (I)
  - Reviewing information (I)
  - Summarizing data (I)
  - Using language appropriately (I)
  - Developing diagrams and charts (I)
  - Explaining statistical analysis (I)
  - Speaking clearly and logically (I)
  - Constructing a reasoned argument (I)
  - Responding appropriately to critical comments (I)

9.4.8 (SCSD) Use mathematics in all aspects of scientific inquiry (I)

- Use mathematics to ask and answer questions about the natural world (I)
- Mathematics is used to:
  - Ask questions (I)

- Gather data (I)
- Organize data (I)
- Present data (I)
- Structure convincing explanations (I)

9.4.9 (SCSD) Know that a code of ethics governing testing, funding, and the disclosure of scientific information bind progress in science and technology (I)

9.4.10 (SCSD) Know that advances in science involve technology and research that are bound by the laws of our society (I)