

Shenandoah Community School District

Physical Science

Grade - 9

9.3 (SCSD) Physical Science

9.3.1 (SCSD) Understand and apply knowledge of the structure of atoms (I, D, M)

- Understand the concept of atomic structure (I,D,M)
 - Matter is made of minute particles called atoms (I,D,M)
 - Atoms are composed of even smaller components (I,D,M)
 - ✚ That have measurable properties
 - ❖ Mass (I,D,M)
 - ❖ Electrical charge (I,D,M)
 - Each atom has a positively charged nucleus surrounded by negatively charged electrons (I, D, M)
- Understand the composition and size of atomic nucleus (I,D,M)
 - Is composed of protons and neutrons (I,D,M)
 - More massive than electrons (I,D,M)
 - Each almost two thousand times heavier than an electron (I,D,M)
- Understand Isotopes (related to relative mass)(I,D,M)
 - When an element has atoms that differ in the number of neutrons (I,D,M)
 - These atoms are called different isotopes of the element (I,D,M)
- Understand the concept of nuclear forces (fission, fusion) (I,D,M)
 - Nuclear forces that hold the nucleus of an atom together are usually stronger than the electric forces that would make it fly apart (I,D,M)
 - Nuclear reactions convert a fraction of the mass of interacting particles into energy (I, D, M)
 - They can release much greater amount than atomic interactions (I,D,M)
 - Fission is splitting of a large nucleus into smaller pieces (I,D,M)
 - Fusion is the joining of two nuclei at extremely high
 - Temperature (I,D,M)
 - Pressure (I,D,M)
 - Fusion is the process responsible for the energy of:
 - Sun (I,D,M)
 - Other stars (I,D,M)
- Understand the concept of radioactive isotopes (I,D,M)
 - Radioactive isotopes are:
 - Unstable (I,D,M)
 - Undergo spontaneous nuclear reactions (I,D,M)
 - ✚ Emitting particles (I,D,M)
 - ✚ Emitting wavelike radiation (I,D,M)
- Understand the predictable rates of nucleus decay (I,D,M)
 - The decay of any one nucleus cannot be predictable (I,D,M)
 - A large group of identical nuclei decay at a predictable rate (I,D,M)
 - This can be used to estimate the age of materials that contain radioactive isotopes (I,D,M)

9.3.2 (SCSD) Understand and apply knowledge of the structure and properties of matter (I, D, M)

- Atoms interact with one another by transferring or sharing electrons that are the furthest from the nucleus (I,D,M)
- Understand valence electrons (I,D,M)
 - The outermost electrons of an atom (I,D,M)
 - Determines how the atom reacts chemically with other atoms (I,D,M)

- Complete shell tend to be chemically inert (I,D,M)
 - Closed shell with one or two valance electrons highly reactive (I,D,M)
 - Less than a closed shell with one or two valance electrons highly reactive (I,D,M)
 - The number of valence electrons of an element is determined by its periodic table (I,D,M)
 - Responsible for the electrical conductivity of elements, may be divided into
 - Metals (I,D,M)
 - Nonmetals (I,D,M)
 - Semiconductors (I,D,M)
 - Metalloids (I,D,M)
- Understand chemical bonds (I,D,M)
 - An attraction between atoms brought by:
 - A sharing of electrons between two atoms (I,D,M)
 - A complete transfer of electrons (I,D,M)
 - Three types:
 - Ionic (I,D,M)
 - Covalent (I,D,M)
 - Polar (I,D,M)
 - Some recognize hydrogen bond (I,D,M)
- Understand periodic table and periodic trends (I,D,M)
 - An element is composed of a single type of atom (I,D,M)
 - Elements are listed in order according to the number of protons (atomic number)(I,D,M)
 - Repeating patterns of physical and chemical properties identify families of elements with similar properties (I, D, M)
 - The periodic table is a consequence of the repeating pattern of outermost electrons and their permitted energies (I,D,M)
- Understand molecular and ionic structures (I,D,M)
 - Atoms are bonded together into molecules or crystalline solids (I,D,M)
 - Element (I,D,M)
 - ✚ A substance composed of a single kind of atom (I,D,M)
 - Compound (I,D,M)
 - ✚ Formed when two or more kinds of atoms bind together chemically
 - Bonds (I,D,M)
 - ✚ Created when electrons are paired (shared or transferred)(I,D,M)
- Understand physical properties of chemical compounds (I,D,M)
 - Chemical compound (I,D,M)
 - A pure chemical substance consisting of two or more different chemical elements that can be separated into simpler substances by chemical reactions (I, D, M)
 - Consist of a fixed ratio of atoms (I,D,M)
 - Held together in a defined spatial arrangement by chemical bonds (I,D,M)
 - Elements in a compound cannot be separated by physical methods (I,D,M)
- Understand the states of matter (I,D,M)
 - States of matter differ in the distances and angles between molecules or atoms, therefore, the energy that binds them together (I,D,M)
 - Solids (I,D,M)
 - ✚ The structure is rigid (I,D,M)
 - ✚ Maintains fixed volume (I,D,M)
 - ✚ Maintains fixed shape (I,D,M)
 - Liquids (I,D,M)
 - ✚ Molecules or atoms move around each other but do not move apart (I,D,M)
 - ✚ Maintains a fixed volume (I,D,M)
 - ✚ Adapts to the shape of its container (I,D,M)

- Gases (I,D,M)
 - ✚ Molecules or atoms move almost independently of each other and are mostly far apart (I,D,M)
 - ✚ Matter expands to occupy whatever volume is available (I,D,M)
- Understand the relationships between pressure and volume of gases (I,D,M)
 - Inverse relationship between pressure and volume (I,D,M)
 - When temperature remains constant in a fixed mass of gas (I,D,M)
 - Volume decreases as the pressure increases (I,D,M)
 - ✚ Volume increase when the pressure decreases (I,D,M)
- Understand Hydrocarbon compounds (I,D,M)
 - Carbon atoms can bond to one another in:
 - Chains (I,D,M)
 - Rings (I,D,M)
 - Branching networks (I,D,M)
 - Carbon atoms form a variety of structures, including:
 - Polymers (I,D,M)
 - Oils (I,D,M)
 - Large molecules essential to life (I,D,M)

9.3.3 (SCSD) Understand and apply knowledge of chemical reactions (I, D, M)

- Understand conservation of matter (I,D,M)
 - During an ordinary chemical change, there is no detectable increase or decrease in the quantity of matter (I,D,M)
- Understand common reactions (I,D,M)
 - Chemical reactions occur all around us, for example:
 - Health care (I,D,M)
 - Cooking (I,D,M)
 - Cosmetics (I,D,M)
 - Automobiles (I,D,M)
 - Complex chemical reactions involving carbon-based molecules take place constantly in every cell in our bodies (I,D,M)
 - Chemical reactions in living system are often catalyzed by protein molecules called enzymes (I,D,M)
- Understand thermochemistry (I,D,M)
 - The study of the energy evolved or absorbed in chemical reactions and physical transformations (I,D,M)
 - Chemical reactions may release or consume energy (I,D,M)
 - Some reactions, such as the burning of fossil fuels release large amounts of energy by:
 - Losing heat (I,D,M)
 - Emitting light (I,D,M)
 - Light can initiate many chemical reactions such as:
 - Photosynthesis (I,D,M)
 - ✚ Energy for life is ultimately derived from the Sun and energy flows through ecosystems in one direction, from photosynthetic organisms to herbivores to carnivores and decomposers (I,D,M)
 - Evolution of urban smog (I,D,M)
 - Heat energy consists of random motions and the vibrations of atoms, molecules, and ions (I,D,M)
 - The higher the temperature, the greater the atomic or molecular motion (I,D,M)
 - Energy tends to move spontaneously from hotter to cooler objects by conduction, convection, or radiation (I,D,M)
- Understand acids and bases (I,D,M)
 - Acid is a solution that has an excess of H⁺ ions (I,D,M)
 - Base is a solution that has an excess of OH⁻ ions (I,D,M)

- Understand types of reactions (I,D,M)
 - A large number of important reactions involve the transfer of either electrons or hydrogen ions between:
 - Reacting ions (I,D,M)
 - Molecules (I,D,M)
 - Atoms (I,D,M)
 - In other reactions, chemical bonds are broken by heat or light to form very reactive radicals with electrons ready to form new bonds (I,D,M)
- Understand common reactions in living systems (I,D,M)
 - Radical reactions control many processes such as:
 - Presence of ozone and greenhouse gases in the atmosphere (I,D,M)
 - Burning and processing of fossil fuels (I,D,M)
 - Formation of polymers (I,D,M)
 - Explosions (I,D,M)
- Understand reaction rates and equilibrium (I,D,M)
 - Chemical reactions can take place in time periods (I,D,M)
 - Few femtoseconds (10⁻¹⁵ seconds) required for an atom to move a fraction of a chemical bond distance (I,D,M)
 - Geologic time scales of billions of years (I,D,M)
 - Reaction rates depend on:
 - How often the reacting atoms and molecules encounter one another (I,D,M)
 - The temperature (I,D,M)
 - The properties—including shape—of the reacting elements (I,D,M)
 - Catalysts, such as metal surfaces, accelerate chemical reactions (I,D,M)

9.3.4 (SCSD) Understand and apply knowledge of motions and forces (I,D,M)

- Understand motions, forces and Newton's Laws (I,D,M)
 - Laws of motion are used to calculate precisely the effects of forces on the motion of objects (I,D,M)
 - Newton's laws (I,D,M)
 - Every object in a state of uniform motion tends to remain in the state of motion unless an external force is applied to it (I,D,M)
 - ✚ Objects change their motion only when a net force is applied (I,D,M)
 - ❖ Whenever one object exerts force on another, an equal amount of force is exerted back on the first object (I,D,M)
 - The relationship between an object's mass m , its acceleration a , and the applied force F is $F=ma$ (I,D,M)
 - For every action there is an equal and opposite reaction (I,D,M)
- Understand gravitation (I,D,M)
 - Gravitation is a universal force that each mass exerts on any other mass (I,D,M)
- Understand mass versus weight (I,D,M)
 - The strength of the gravitational attractive force between two masses is proportional to the masses and is inversely proportional to the square of the distance between them (I,D,M)
- Understand electric and magnetic forces (I,D,M)
 - Electric force is a universal force that exists between any two charged objects (I,D,M)
 - Opposite charges attract (I,D,M)
 - Like charges repel (I,D,M)
 - The strength of the force is proportional to the charges (I,D,M)
 - ✚ As with gravitation, inversely proportional to the square of the distance between them (I,D,M)
 - Between any two charged particles:

- Electric force is vastly greater than the gravitational forces (I,D,M)
- Most observable forces such as those exerted by a coiled spring or friction many be traced to electric forces acting between atoms and molecules (I,D,M)
- Electricity and magnetism are two aspects of a single electromagnetic force (I,D,M)
 - Moving electric charges produce magnetic forces (I,D,M)
 - Moving magnets produce electric forces (I,D,M)

9.3.5 (SCSD) Understand and apply knowledge of conservation of energy and increase in disorder (I,D,M)

- Understand types of energy (I,D,M)
 - Kinetic Energy (I,D,M)
 - Energy of motion (I,D,M)
 - Potential Energy (I,D,M)
 - Depends on relative position (I,D,M)
 - Energy contained by a field (I,D,M)
 - ⚡ Electromagnetic waves (I,D,M)
- Understand the law of conservation of energy (I,D,M)
 - The total amount of energy in an isolated system remains constant over time (I,D,M)
 - Energy can neither be created nor destroyed (I,D,M)
 - It can be transformed from one state to another (I,D,M)
- Understand energy transformations (I,D,M)
 - Energy can be transferred by:
 - Collisions in chemical and nuclear reactions (I,D,M)
 - Light waves and other radiations (I,D,M)
 - As transfers occur, the matter becomes steadily less ordered (I,D,M)
- Understand wave phenomena and the concept of energy and matter (I,D,M)
 - Waves have energy and can transfer energy when they interact with matter (I,D,M)
 - Wave include:
 - Sound (I,D,M)
 - Seismic (I,D,M)
 - Waves on water (I,D,M)
 - Light (I,D,M)
 - Apparent changes in wavelength can provide information about changes in motion because the observed wavelength of a wave depends upon the relative motion of the source and the observer (I,D,M)
 - If either the source or observer is:
 - ⚡ moving toward the other, the observed wavelength is shorter (I,D,M)
 - ⚡ moving away, the wavelength is longer (I,D,M)
- Understand electromagnetic waves (I,D,M)
 - Result when a charged object is accelerated or decelerated (I,D,M)
 - Include:
 - Radio waves (the longest wavelength)(I,D,M)
 - Microwaves (I,D,M)
 - Infrared radiation (radiant heat) (I,D,M)
 - Visible light (I,D,M)
 - Ultraviolet radiation (I,D,M)
 - X-rays (I,D,M)
 - Gamma rays (I,D,M)
 - The energy of electromagnetic waves is carried in packets whose magnitude is inversely proportional to the wavelength (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)