### GENERAL NOTES

While the content focus of this course is consistent with the Physical Science course, students will explore these concepts in greater depth. In general, the academic pace and rigor will be greatly increased for honors level course work. Laboratory investigations that include the use of scientific inquiry, research, measurement, problem solving, laboratory apparatus and technologies, experimental procedures, and safety procedures are an integral part of this course. The National Science Teachers Association (NSTA) recommends that at the high school level, all students should be in the science lab or field, collecting data every week. School laboratory investigations (labs) are defined by the National Research Council (NRC) as an experience in the laboratory, classroom, or the field that provides students with opportunities to interact directly with natural phenomena or with data collected by others using tools, materials, data collection techniques, and models (NRC, 2006, p. 3). Laboratory investigations in the high school classroom should help all students develop a growing understanding of the complexity and ambiguity of empirical work, as well as the skills to calibrate and troubleshoot equipment used to make observations. Learners should understand measurement error; and have the skills to aggregate, interpret, and present the resulting data (National Research Council, 2006, p.77; NSTA, 2007).

### Special Notes:

**Instructional Practices:** Teaching from a range of complex text is optimized when teachers in all subject areas implement the following strategies on a routine basis:

1. Ensuring wide reading from complex text that varies in length.
2. Making close reading and rereading of texts central to lessons.
3. Emphasizing text-specific complex questions, and cognitively complex tasks, reinforce focus on the text and cultivate independence.
4. Emphasizing students supporting answers based upon evidence from the text.
5. Providing extensive research and writing opportunities (claims and evidence).

**Science and Engineering Practices** (NRC Framework for K-12 Science Education, 2010)

- Asking questions (for science) and defining problems (for engineering).
- Developing and using models.
- Planning and carrying out investigations.
- Analyzing and interpreting data.
- Using mathematics, information and computer technology, and computational thinking.
- Constructing explanations (for science) and designing solutions (for engineering).
- Engaging in argument from evidence.
- Obtaining, evaluating, and communicating information.

**Honors and Advanced Level Course Note:** Academic rigor is more than simply assigning to students a greater quantity of work. Through the application, analysis, evaluation, and creation of complex ideas that are often abstract and multi-faceted, students are challenged to think and collaborate critically on the content they are learning.

**English Language Development ELD Standards Special Notes Section:**

Teachers are required to provide listening, speaking, reading and writing instruction that allows English language learners (ELL) to communicate information, ideas and concepts for academic success in the content area of Science. For the given level of English language proficiency and with visual, graphic, or interactive support, students will interact with grade level words, expressions, sentences and discourse to process or produce language necessary for academic success The ELD standard should specify a relevant content area concept or topic of study chosen by curriculum developers and teachers which maximizes an ELL's need for communication and social skills. To access an ELL supporting document which delineates performance definitions and descriptors, please click on the following link:


For additional information on the development and implementation of the ELD standards, please contact the Bureau of Student Achievement through Language Acquisition at sala@fldoe.org.

### Course Standards

Integrate Standards for Mathematical Practice (MP) as applicable.
- MAFS.K12.MP.1.1 Make sense of problems and persevere in solving them.
- MAFS.K12.MP.2.1 Reason abstractly and quantitatively.
- MAFS.K12.MP.3.1 Construct viable arguments and critique the reasoning of others.
- MAFS.K12.MP.4.1 Model with mathematics.
- MAFS.K12.MP.5.1 Use appropriate tools strategically.
- MAFS.K12.MP.6.1 Attend to precision.
- MAFS.K12.MP.7.1 Look for and make use of structure.
- MAFS.K12.MP.8.1 Look for and express regularity in repeated reasoning.

### Florida Standards Connections for Mathematical Practices

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC.912.E.7.3</td>
<td>Analyze the movement of matter and energy through the different biogeochemical cycles, including water and carbon.</td>
</tr>
<tr>
<td>Remarks/Examples:</td>
<td>Describe that the Earth system contains fixed amounts of each stable chemical element and that each element moves among reservoirs in the solid earth, oceans, atmosphere and living organisms as part of biogeochemical cycles (i.e., nitrogen, water, carbon, oxygen and phosphorus), which are driven by energy from within the Earth and from the Sun.</td>
</tr>
<tr>
<td>SC.912.L.18.7</td>
<td>Identify the reactants, products, and basic functions of photosynthesis.</td>
</tr>
<tr>
<td>SC.912.L.18.8</td>
<td>Identify the reactants, products, and basic functions of aerobic and anaerobic respiration.</td>
</tr>
<tr>
<td>SC.912.L.18.12</td>
<td>Discuss the special properties of water that contribute to Earth’s suitability as an environment for life: cohesive behavior, ability to moderate temperature, expansion upon freezing, and versatility as a solvent.</td>
</tr>
</tbody>
</table>
| Remarks/Examples: | Define a problem based on a specific body of knowledge, for example: biology, chemistry, physics, and earth/space science, and do the following:  
1. Pose questions about the natural world, (Articulate the purpose of the investigation and identify the relevant scientific concepts).  
2. Conduct systematic observations, (Write procedures that are clear and replicable. Identify observables and examine relationships between test (independent) variable and outcome (dependent) variable. Employ appropriate methods for accurate and consistent observations; conduct and record measurements at appropriate levels of precision. Follow safety guidelines).  
3. Examine books and other sources of information to see what is already known,  
4. Review what is known in light of empirical evidence, (Examine whether available empirical evidence can be interpreted in terms of existing knowledge and models, and if not, modify or develop new models).  
5. Plan investigations, (Design and evaluate a scientific investigation).  
6. Use tools to gather, analyze, and interpret data (this includes the use of measurement in metric and other systems, and also the generation and interpretation of graphical representations of data, including data tables and graphs), (Collect data or evidence in an organized way. Properly use instruments, equipment, and materials (e.g., scales, probeware, meter sticks, microscopes, computers) including set-up, calibration, technique, maintenance, and storage).  
7. Pose answers, explanations, or descriptions of events,  
8. Generate explanations that explicate or describe natural phenomena (inferences),  
9. Use appropriate evidence and reasoning to justify these explanations to others,  
10. Communicate results of scientific investigations, and  
11. Evaluate the merits of the explanations produced by others. |
| For Students in Grades 9-10 | LAFS.910.RST.1.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.  
LAFS.910.RST.1.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks attending to special measurements or exceptions defined in the text.  
LAFS.910.RST.3.7 Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.  
LAFS.910.WHST.1.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.  
LAFS.910.WHST.3.9 Draw evidence from informational texts to support analysis, reflection, and research.  
For Students in Grades 11-12 | LAFS.1112.RST.1.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.  
LAFS.1112.RST.1.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks analyze the specific results based on explanations in the text.  
LAFS.1112.RST.3.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.  
LAFS.1112.WHST.1.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.  
LAFS.1112.WHST.3.9 Draw evidence from informational texts to support analysis, reflection, and research. |
| For Students in Grades 9-10 | Florida Standards Connections for 6-12 Literacy in Science |
| LAFS.910.RST.1.1 | Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. |
| LAFS.910.RST.1.3 | Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks attending to special measurements or exceptions defined in the text. |
| LAFS.910.RST.3.7 | Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words. |
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| LAFS.1112.RST.3.7 | Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. |
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| LAFS.1112.WHST.3.9 | Draw evidence from informational texts to support analysis, reflection, and research. |

**Remarks/Examples:**

- Florida Standards Connections for 6-12 Literacy in Science
- For Students in Grades 9-10
- LAFS.910.RST.1.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.
- LAFS.910.RST.1.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks attending to special measurements or exceptions defined in the text.
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- LAFS.1112.WHST.3.9 Draw evidence from informational texts to support analysis, reflection, and research.
- Florida Standards Connections for Mathematical Practices
- MAFS.K12.MP.1: Make sense of problems and persevere in solving them.
- MAFS.K12.MP.2: Reason abstractly and quantitatively.
### SC.912.N.1.2:
**Describe and explain what characterizes science and its methods.**

**Remarks/Examples:**
Science is characterized by empirical observations, testable questions, formation of hypotheses, and experimentation that results in stable and replicable results, logical reasoning, and coherent theoretical constructs.

**Florida Standards Connections:** MAFS.K12.MP.3: Construct viable arguments and critique the reasoning of others.

### SC.912.N.1.3:
**Recognize that the strength or usefulness of a scientific claim is evaluated through scientific argumentation, which depends on critical and logical thinking, and the active consideration of alternative scientific explanations to explain the data presented.**

**Florida Standards Connections:** MAFS.K12.MP.2: Reason abstractly and quantitatively MAFS.K12.MP.3: Construct viable arguments and critique the reasoning of others.

### SC.912.N.1.4:
**Identify sources of information and assess their reliability according to the strict standards of scientific investigation.**

**Remarks/Examples:**
Read, interpret, and examine the credibility and validity of scientific claims in different sources of information, such as scientific articles, advertisements, or media stories. Strict standards of science include controlled variables, sufficient sample size, replication of results, empirical and measurable evidence, and the concept of falsification.

**Florida Standards Connections:** LAFS.910.RST.1.1 / LAFS.1112.RST.1.1.

### SC.912.N.1.5:
**Describe and provide examples of how similar investigations conducted in many parts of the world result in the same outcome.**

**Remarks/Examples:**
Identify which questions can be answered through science and which questions are outside the boundaries of scientific investigation, such as questions addressed by other ways of knowing, such as art, philosophy, and religion.

**Florida Standards Connections:** MAFS.K12.MP.1: Make sense of problems and persevere in solving them.

### SC.912.N.1.6:
**Recognize the role of creativity in constructing scientific questions, methods and explanations.**

**Remarks/Examples:**
Work through difficult problems using creativity, and critical and analytical thinking in problem solving (e.g. convergent versus divergent thinking and creativity in problem solving).

**Florida Standards Connections:** MAFS.K12.MP.1: Make sense of problems and persevere in solving them and MAFS.K12.MP.2: Reason abstractly and quantitatively.

### SC.912.N.1.7:
**Identify what is science, what clearly is not science, and what superficially resembles science (but fails to meet the criteria for science).**

**Remarks/Examples:**
Science is the systematic and organized inquiry that is derived from observations and experimentation that can be verified or tested by further investigation to explain natural phenomena (e.g. Science is testable, pseudo-science is not science seeks falsifications, pseudo-science seeks confirmations.)

**Florida Standards Connections:** MAFS.K12.MP.3: Construct viable arguments and critique the reasoning of others.

### SC.912.N.2.1:
**Identify which questions can be answered through science and which questions are outside the boundaries of scientific investigation, such as questions addressed by other ways of knowing, such as art, philosophy, and religion.**

**Remarks/Examples:**
Identify scientific questions that can be disproved by experimentation/testing. Recognize that pseudoscience is a claim, belief, or practice which is presented as scientific, but does not adhere to strict standards of science (e.g. controlled variables, sample size, replicability, empirical and measurable evidence, and the concept of falsification).

**Florida Standards Connections:** MAFS.K12.MP.3: Construct viable arguments and critique the reasoning of others.

### SC.912.N.2.2:
**Identify examples of pseudoscience (such as astrology, phrenology) in society.**

**Remarks/Examples:**
Explain that scientific knowledge is both durable and robust and open to change. Scientific knowledge can change because it is often examined and re-examined by new investigations and scientific argumentation. Because of these frequent examinations, scientific knowledge becomes stronger, leading to its durability.

**Florida Standards Connections:** MAFS.K12.MP.3: Make sense of problems and persevere in solving them MAFS.K12.MP.3: Construct viable arguments and critique the reasoning of others.

### SC.912.N.2.3:
**Recognize that ideas with the most durable explanatory power become established theories, but scientific explanations are continually subjected to change in the face of new evidence.**

**Remarks/Examples:**
Recognize that contributions to science can be made and have been made by people from all over the world.

**Florida Standards Connections:** MAFS.K12.MP.3: Construct viable arguments and critique the reasoning of others.

**Remarks/Examples:**
Explain that scientific knowledge is both durable and robust and open to change. Scientific knowledge can change because it is often examined and re-examined by new investigations and scientific argumentation. Because of these frequent examinations, scientific knowledge becomes stronger, leading to its durability.

**Florida Standards Connections:** MAFS.K12.MP.3: Construct viable arguments and critique the reasoning of others.

### SC.912.N.2.4:
**Describe instances in which scientists’ varied backgrounds, talents, interests, and goals influence the inferences and thus the explanations that they make about observations of natural phenomena and describe that competing interpretations (explanations) of scientists are a strength of science as they are a source of new, testable ideas that have the potential to add new evidence to support one or another of the explanations.**

**Remarks/Examples:**
Identify sources of information and assess their reliability according to the strict standards of scientific investigation.
### SC.912.N.2.5
Remarks/Examples:
Recognize that scientific questions, observations, and conclusions may be influenced by the existing state of scientific knowledge, the social and cultural context of the researcher, and the observer's experiences and expectations. Identify possible bias in qualitative and quantitative data analysis.

### SC.912.N.3.1
Remarks/Examples:
Explain that a scientific theory is the culmination of many scientific investigations drawing together all the current evidence concerning a substantial range of phenomena; thus, a scientific theory represents the most powerful explanation scientists have to offer.

### SC.912.N.3.2
Remarks/Examples:
Florida Standards Connections: MAFS.K12.MP.1: Make sense of problems and persevere in solving them and, MAFS.K12.MP.3: Construct viable arguments and critique the reasoning of others.

### SC.912.N.3.3
Remarks/Examples:
Explain that a scientific theory is a well-tested hypothesis supported by a preponderance of empirical evidence.

### SC.912.N.3.4
Remarks/Examples:
Describe the role consensus plays in the historical development of a theory in any one of the disciplines of science.

### SC.912.N.3.5
Remarks/Examples:
Describe the development and historical importance of atomic theory from Dalton (atomic theory), Thomson (the electron), Rutherford (the nucleus and "gold foil" experiment), and Bohr (planetary model of atom), and understand how each discovery leads to modern atomic theory.

### SC.912.P.8.1
Remarks/Examples:
Differentiate among the four states of matter (solid, liquid, gas and plasma) in terms of energy, particle motion, and phase transitions. (Note: Currently five states of matter have been identified.)

### SC.912.P.8.2
Remarks/Examples:
Discuss volume, compressibility, density, conductivity, malleability, reactivity, molecular composition, freezing, melting and boiling points. Describe simple laboratory techniques that can be used to separate homogeneous and heterogeneous mixtures (e.g. filtration, distillation, chromatography, evaporation).

### SC.912.P.8.3
Remarks/Examples:
Explore the scientific theory of atoms (also known as atomic theory) by describing changes in the atomic model over time and why those changes were necessitated by experimental evidence.

### SC.912.P.8.4
Remarks/Examples:
Explain that electrons, protons and neutrons are parts of the atom and that the nuclei of atoms are composed of protons and neutrons, which experience forces of attraction and repulsion consistent with their charges and masses.
### SC.912.P.8.5
Relate properties of atoms and their position in the periodic table to the arrangement of their electrons.

**Remarks/Examples:**
- Use the periodic table and electron configuration to determine an element’s number of valence electrons and its chemical and physical properties. Explain how chemical properties depend almost entirely on the configuration of the outer electron shell.

### SC.912.P.8.7
Interpret formula representations of molecules and compounds in terms of composition and structure.

**Remarks/Examples:**
- Write chemical formulas for simple covalent (HCl, SO2, CO2, and CH4), ionic (Na+ + Cl- = NaCl) and molecular (O2, H2O) compounds. Predict the formulas of ionic compounds based on the number of valence electrons and the charges on the ions.

### SC.912.P.8.8
Characterize types of chemical reactions, for example: redox, acid-base, synthesis, and single and double replacement reactions.

**Remarks/Examples:**
- Classify chemical reactions as synthesis (combination), decomposition, single displacement (replacement), double displacement, and combusion.

### SC.912.P.8.11
Relate acidity and basicity to hydronium and hydroxyl ion concentration and pH.

**Remarks/Examples:**
- Use experimental data to illustrate and explain the pH scale to characterize acid and base solutions. Compare and contrast the strengths of various common acids and bases.

### SC.912.P.10.1
Differentiate among the various forms of energy and recognize that they can be transformed from one form to others.

**Remarks/Examples:**
- Differentiate between kinetic and potential energy. Recognize that energy cannot be created or destroyed, only transformed. Identify examples of transformation of energy: Heat to light in incandescent electric light bulbs, light to heat in laser drills, Electrical to sound in radios, Sound to electrical in microphones, Electrical to chemical in battery chargers, Chemical to electrical in dry cells. Mechanical to electrical in generators (power plants) Nuclear to heat in nuclear reactors. Gravitational potential energy of a falling object is converted to kinetic energy then to heat and sound energy when the object hits the ground.

### SC.912.P.10.2
Explore the Law of Conservation of Energy by differentiating among open, closed, and isolated systems and explain that the total energy in an isolated system is a conserved quantity.

**Remarks/Examples:**
- Use calorimetry to illustrate conservation of energy. Differentiate between the different types of systems and solve problems involving conservation of energy in simple systems. Explain how conservation of energy is important in chemical reactions with bond formation and bond breaking (Chemistry).

### SC.912.P.10.3
Compare and contrast work and power qualitatively and quantitatively.

**Remarks/Examples:**
- Describe both qualitatively and quantitatively how work can be expressed as a change in mechanical energy, and the concept of power as the rate at which work is done per unit time. Recognize that when a net force, F, acts through a distance on an object of mass, m, work is done on the object.

### SC.912.P.10.4
Describe heat as the energy transferred by convection, conduction, and radiation, and explain the connection of heat to change in temperature or states of matter.

**Remarks/Examples:**
- Explain the mechanisms (convection, conduction, and radiation) of heat transfer. Explain how heat is transferred (energy in motion) from a region of higher temperature to a region of lower temperature until equilibrium is established. Solve problems involving heat flow and temperature changes by using known values of specific heat and/or phase change constants (latent heat). Explain the phase transitions and temperature changes demonstrated by a heating or cooling curve.

### SC.912.P.10.5
Relate temperature to the average molecular kinetic energy.

**Remarks/Examples:**
- Recognize that the internal energy of an object includes the energy of random motion of the object’s atoms and molecules, often referred to as thermal energy.

### SC.912.P.10.6
Create and interpret potential energy diagrams, for example: chemical reactions, orbits around a central body, motion of a pendulum.

**Remarks/Examples:**
- Construct and interpret potential energy diagrams for endothermic and exothermic chemical reactions, and for rising or falling objects. Describe the transformation of energy as a pendulum swings.

### SC.912.P.10.7
Distinguish between endothermic and exothermic chemical processes.

**Remarks/Examples:**
- Classify chemical reactions and phase changes as exothermic (release thermal energy) or endothermic (absorb thermal energy).

### SC.912.P.10.8
Compare the magnitude and range of the four fundamental forces (gravitational, electromagnetic, weak nuclear, strong nuclear).

**Remarks/Examples:**
- Recognize and discuss the effect of each force on the structure of matter and the evidence for it.

### SC.912.P.10.10
Explain and compare nuclear reactions (radioactive decay, fission and fusion), the energy changes associated with them and their associated safety issues.

**Remarks/Examples:**
- Identify the three main types of radioactive decay (alpha, beta, and gamma) and compare their properties (composition, mass, charge, and penetrating power). Explain the concept of half-life for an isotope (e.g. C-14 is used to determine the age of objects) and calculate the amount of a radioactive substance remaining after an integral number of half-lives have passed. Recognize that the energy release per gram of material is much larger in nuclear fusion or fission reactions than in chemical reactions due to the large amount of energy related to small amounts of mass by equation E=mc^2.
### SC.912.P.10.12: Differentiate between chemical and nuclear reactions.

**Remarks/Examples:**
- Describe how chemical reactions involve the rearranging of atoms to form new substances, while nuclear reactions involve the change of atomic nuclei into entirely new atoms. Identify real-world examples where chemical and nuclear reactions occur every day.

### SC.912.P.10.14: Differentiate among conductors, semiconductors, and insulators.

**Remarks/Examples:**
- Describe band structure, valence electrons, and how the charges flow or rearrange themselves between conductors and insulators.

### SC.912.P.10.15: Investigate and explain the relationships among current, voltage, resistance, and power.

**Remarks/Examples:**
- Use Ohm’s and Kirchhoff’s laws to explain the relationships among current, voltage, resistance, and power.

### SC.912.P.10.18: Explore the theory of electromagnetism by comparing and contrasting the different parts of the electromagnetic spectrum in terms of wavelength, frequency, and energy, and relate them to phenomena and applications.

**Remarks/Examples:**
- Describe the electromagnetic spectrum (i.e., radio waves, microwaves, infrared, visible light, ultraviolet, X-rays, and gamma rays) in terms of frequency, wavelength, and energy. Solve problems involving wavelength, frequency, and energy.

### SC.912.P.10.21: Qualitatively apply the concept of angular momentum.

**Remarks/Examples:**
- Describe Newton’s law of universal gravitation in terms of the attraction between two objects, their masses, and the inverse square of the distance between them.

### SC.912.P.12.2: Analyze the motion of an object in terms of its position, velocity, and acceleration (with respect to a frame of reference) as functions of time.

**Remarks/Examples:**
- Solve problems involving distance, velocity, speed, and acceleration. Create and interpret graphs of 1-dimensional motion, such as position versus time, distance versus time, speed versus time, velocity versus time, and acceleration versus time where acceleration is constant.

### SC.912.P.12.3: Describe the apparent change in frequency of waves due to the relative motion of a source or a receiver (the Doppler effect).

**Remarks/Examples:**
- Describe phase transitions in terms of kinetic molecular theory.

### SC.912.P.12.4: Distinguish between scalar and vector quantities and assess which should be used to describe an event.

**Remarks/Examples:**
- Distinguish between vector quantities (e.g., displacement, velocity, acceleration, force, and linear momentum) and scalar quantities (e.g., distance, speed, energy, mass, work).

### SC.912.P.12.5: Interpret and apply Newton’s three laws of motion.

**Remarks/Examples:**
- Explain that when the net force on an object is zero, no acceleration occurs thus, a moving object continues to move at a constant speed in the same direction, or, if at rest, it remains at rest (Newton’s first law). Explain that when a net force is applied to an object its motion will change, or accelerate (according to Newton’s second law, F = ma). Predict and explain how when one object exerts a force on a second object, the second object always exerts a force of equal magnitude but of opposite direction and force back on the first: F1 on 2 = -F1 on 1 (Newton’s third law).

### SC.912.P.12.6: Describe how the gravitational force between two objects depends on their masses and the distance between them.

**Remarks/Examples:**
- Describe the motion of an object in terms of its position, velocity, and acceleration (with respect to a frame of reference) as functions of time.

### SC.912.P.12.7: Qualitatively apply the concept of angular momentum.

**Remarks/Examples:**
- Explain that angular momentum is rotational analogy to linear momentum (e.g. Because angular momentum is conserved, a change in the distribution of mass about the axis of rotation will cause a change in the rotational speed [ice skater spinning]).

### SC.912.P.12.8: Recognize that nothing travels faster than the speed of light in vacuum which is the same for all observers no matter how they or the light source are moving.

**Remarks/Examples:**
- Recognize that regardless of the speed of an observer or source, in a vacuum the speed of light is always c.

### SC.912.P.12.9: Interpret the behavior of ideal gases in terms of kinetic molecular theory.

**Remarks/Examples:**
- Using the kinetic molecular theory, explain the behavior of gases and the relationship between pressure and volume (Boyle’s law), volume and temperature (Charles’s law), pressure and temperature (Gay-Lussac’s law), and number of particles in a gas sample (Avogadro’s hypothesis).

### SC.912.P.12.10: Describe phase transitions in terms of kinetic molecular theory.

**Remarks/Examples:**
- Explain, at the molecular level, the behavior of matter as it undergoes phase transitions.

### SC.912.P.12.11: Explain how various factors, such as concentration, temperature, and presence of a catalyst affect the rate of a chemical reaction.

**Remarks/Examples:**
- Describe how chemical reactions involve the rearranging of atoms to form new substances, while nuclear reactions involve the change of atomic nuclei into entirely new atoms. Identify real-world examples where chemical and nuclear reactions occur every day.

**Remarks/Examples:**
- Describe band structure, valence electrons, and how the charges flow or rearrange themselves between conductors and insulators.

**Remarks/Examples:**
- Use Ohm’s and Kirchhoff’s laws to explain the relationships among current, voltage, resistance, and power.

**Remarks/Examples:**
- Describe the electromagnetic spectrum (i.e., radio waves, microwaves, infrared, visible light, ultraviolet, X-rays, and gamma rays) in terms of frequency, wavelength, and energy. Solve problems involving wavelength, frequency, and energy.

**Remarks/Examples:**
- Qualitatively apply the concept of angular momentum.

**Remarks/Examples:**
- Describe how the apparent change in frequency of waves due to the relative motion of a source or a receiver (the Doppler effect).

**Remarks/Examples:**
- Describe phase transitions in terms of kinetic molecular theory.

**Remarks/Examples:**
- Explain, at the molecular level, the behavior of matter as it undergoes phase transitions.

**Remarks/Examples:**
- Explain how various factors, such as concentration, temperature, and presence of a catalyst affect the rate of a chemical reaction.
Various factors could include: temperature, pressure, solvent and/or solute concentration, steric, surface area, and catalysts. The rate of reaction is determined by the activation energy, and the pathway of the reaction can be shorter in the presence of enzymes or catalysts. Examples may include: decomposition of hydrogen peroxide using manganese (IV) oxide nitrization of benzene using concentrated sulfuric acid hydrogenation of a C=C double bond using nickel.
Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.

LAFS.910.WHST.3.8: Draw evidence from informational texts to support analysis, reflection, and research.
LAFS.910.WHST.3.9: Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.
LAFS.910.WHST.4.10: Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm’s law $V = IR$ to highlight resistance $R$. ★
LAFS.912.A-CED.1.4: English language learners communicate for social and instructional purposes within the school setting.
LAFS.912.F-IF.2.4: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
LAFS.912.F-IF.3.7: Apply concepts of density based on area and volume in modeling situations (e.g., persons per square mile, BTUs per cubic foot).
LAFS.912.G-MG.1.2: Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. ★
LAFS.912.G-MG.1.3: Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.
LAFS.912.N-Q.1.1: Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.
LAFS.912.N-Q.1.2: For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity. ★
LAFS.912.N-Q.1.3: Students describe center and spread in a data distribution. Here they choose a summary statistic appropriate to the characteristics of the data distribution, such as the shape of the distribution or the existence of extreme data points.
LAFS.912.N-Q.1.4: Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets. ★
LAFS.912.N-Q.1.5: In grades 6 – 8, students describe center and spread in a data distribution. Here they choose a summary statistic appropriate to the characteristics of the data distribution, such as the shape of the distribution or the existence of extreme data points.
LAFS.912.S-ID.1.1: Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers). ★
LAFS.912.S-ID.1.2: Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve. ★
LAFS.912.S-ID.1.3: Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data. ★
LAFS.912.S-ID.1.4: Represent data on two quantitative variables on a scatter plot, and describe how the variables are related. ★
LAFS.912.S-ID.1.5: Students take a more sophisticated look at using a linear function to model the relationship between two numerical variables. In addition to fitting a line to data, students assess how well the model fits by analyzing residuals.
LAFS.912.S-ID.2.4: Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude, and using phase shift.
LAFS.912.S-ID.3.7: Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.
LAFS.912.S-ID.3.8: Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.
LAFS.912.S-ID.3.9: Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior.
LAFS.912.S-ID.3.10: Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude, and using phase shift.

Related Certifications
Science (Secondary Grades 7-12)
Earth/Space Science (Grades 6-12)
Physics (Grades 6-12)
Chemistry (Grades 6-12)
Middle Grades General Science (Middle Grades 5-9)

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