Integrated Chemistry & Physics Science Standards

Science and Engineering Process Standards (SEPS)

The Science and Engineering Process Standards are the processes and skills that students are expected to learn and be able to do within the context of the science content. The separation of the Science and Engineering Process Standards from the Content Standards is intentional; the separation of the standards explicitly shows that what students are doing while learning science is extremely important. The Process Standards reflect the way in which students are learning and doing science and are designed to work in tandem with the science content, resulting in robust instructional practice.

Science and Engineering Process Standards	
SEPS.1 Posing questions (for science) and defining problems (for engineering)	A practice of science is posing and refining questions that lead to descriptions and explanations of how the natural and designed world(s) work and these questions can be scientifically tested. Engineering questions clarify problems to determine criteria for possible solutions and identify constraints to solve problems about the designed world.
SEPS.2 Developing and using models and tools	A practice of both science and engineering is to use and construct conceptual models that illustrate ideas and explanations. Models are used to develop questions, predictions and explanations; analyze and identify flaws in systems; build and revise scientific explanations and proposed engineered systems; and communicate ideas. Measurements and observations are used to revise and improve models and designs. Models include, but are not limited to: diagrams, drawings, physical replicas, mathematical representations, analogies, and other technological models. Another practice of both science and engineering is to identify and correctly use tools to construct, obtain, and evaluate questions and problems. Utilize appropriate tools while identifying their limitations. Tools include, but are not limited to: pencil and paper, models, ruler, a protractor, a calculator, laboratory equipment, safety gear, a spreadsheet, experiment data collection software, and other technological tools.
SEPS.3 Constructing and performing investigations	Scientists and engineers are constructing and performing investigations in the field or laboratory, working collaboratively as well as individually. Researching analogous problems in order to gain insight into possible solutions allows them to make conjectures about the form and meaning of the solution. A plan to a solution pathway is developed prior to constructing and performing investigations. Constructing investigations systematically encompasses identified variables and parameters generating quality data. While performing, scientists and engineers monitor and record progress. After performing, they evaluate to make changes to modify and repeat the investigation if necessary.

SEPS.4 Analyzing and interpreting data	Investigations produce data that must be analyzed in order to derive meaning. Because data patterns and trends are not always obvious, scientists and engineers use a range of tools to identify the significant features in the data. They identify sources of error in the investigations and calculate the degree of certainty in the results. Advances in science and engineering makes analysis of proposed solutions more efficient and effective. They analyze their results by continually asking themselves questions; possible questions may be, but are not limited to: "Does this make sense?" "Could my results be duplicated?" and/or "Does the design solve the problem with the given constraints?"
SEPS.5 Using mathematics and computational thinking	In both science and engineering, mathematics and computation are fundamental tools for representing physical variables and their relationships. They are used for a range of tasks such as constructing simulations; solving equations exactly or approximately; and recognizing, expressing, and applying quantitative relationships. Mathematical and computational approaches enable scientists and engineers to predict the behavior of systems and test the validity of such predictions. Scientists and engineers understand how mathematical ideas interconnect and build on one another to produce a coherent whole.
SEPS.6 Constructing explanations (for science) and designing solutions (for engineering)	Scientists and engineers use their results from the investigation in constructing descriptions and explanations, citing the interpretation of data, connecting the investigation to how the natural and designed world(s) work. They construct or design logical coherent explanations or solutions of phenomena that incorporate their understanding of science and/or engineering or a model that represents it, and are consistent with the available evidence.
SEPS.7 Engaging in argument from evidence	Scientists and engineers use reasoning and argument based on evidence to identify the best explanation for a natural phenomenon or the best solution to a design problem. Scientists and engineers use argumentation, the process by which evidence-based conclusions and solutions are reached, to listen to, compare, and evaluate competing ideas and methods based on merits. Scientists and engineers engage in argumentation when investigating a phenomenon, testing a design solution, resolving questions about measurements, building data models, and using evidence to evaluate claims.
SEPS.8 Obtaining, evaluating, and communicating information	Scientists and engineers need to be communicating clearly and articulating the ideas and methods they generate. Critiquing and communicating ideas individually and in groups is a critical professional activity. Communicating information and ideas can be done in multiple ways: using tables, diagrams, graphs, models, and equations, as well as, orally, in writing, and through extended discussions. Scientists and engineers employ multiple sources to obtain information that is used to evaluate the merit and validity of claims, methods, and designs.

Literacy in Science/Technical Subjects: Grades 9-10 (9-10 LST)

The Indiana Academic Standards for Content Area Literacy (Science/Technical Subjects) indicate ways in which educators incorporate literacy skills into science at the 6-12 grade levels.

LEARNING OUTCOMES	**LST.1: LEARNING OUTCOME FOR LITERACY IN SCIENCE/TECHNICAL SUBJECTS** **Read and comprehend science and technical texts independently and proficiently and write effectively for a variety of discipline-specific tasks, purposes, and audiences**
	GRADES 9-10
	9-10.LST.1.1: Read and comprehend science and technical texts within a range of complexity appropriate for grades 9-10 independently and proficiently by the end of grade 10.
	9-10.LST.1.2: Write routinely over a variety of time frames for a range of discipline-specific tasks, purposes, and audiences.

KEY IDEAS AND TEXTUAL SUPPORT	**LST.2: KEY IDEAS AND TEXTUAL SUPPORT (READING)** **Extract and construct meaning from science and technical texts using a variety of comprehension skills**
	GRADES 9-10
	9-10.LST.2.1: Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.
	9-10.LST.2.2: Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate, objective summary of the text.
	9-10.LST.2.3: Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

STRUCTURAL ELEMENTS AND ORGANIZATION	**LST.3: STRUCTURAL ELEMENTS AND ORGANIZATION (READING)** **Build understanding of science and technical texts, using knowledge of structural organization and author's purpose and message**
	GRADES 9-10
	9-10.LST.3.1: Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.
	9-10.LST.3.2: Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., *force, friction, reaction force, energy*).
	9-10.LST.3.3: Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.

SYNTHESIS AND CONNECTION OF IDEAS	**LST.4: SYNTHESIS AND CONNECTION OF IDEAS (READING)** **Build understanding of science and technical texts by synthesizing and connecting ideas and evaluating specific claims**
	GRADES 9-10
	9-10.LST.4.1: 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.
	9-10.LST.4.2: Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.
	9-10.LST.4.3: Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

WRITING GENRES	**LST.5: WRITING GENRES (WRITING)** **Write for different purposes and to specific audiences or people**
	GRADES 9-10
	9-10.LST.5.1: Write arguments focused on discipline-specific content.
	9-10.LST.5.2: Write informative texts, including scientific procedures/experiments or technical processes that include precise descriptions and conclusions drawn from data and research.

THE WRITING PROCESS	**LST.6: THE WRITING PROCESS (WRITING)** **Produce coherent and legible documents by planning, drafting, revising, editing, and collaborating with others**
	GRADES 9-10
	9-10.LST.6.1: Plan and develop; draft; revise using appropriate reference materials; rewrite; try a new approach, focusing on addressing what is most significant for a specific purpose and audience; and edit to produce and strengthen writing that is clear and coherent.
	9-10.LST.6.2: Use technology to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

THE RESEARCH PROCESS	**LST.7: THE RESEARCH PROCESS (WRITING)** **Build knowledge about the research process and the topic under study by conducting short or more sustained research**
	GRADES 9-10
	9-10.LST.7.1: Conduct short as well as more sustained research assignments and tasks to answer a question (including a self-generated question), test a hypothesis, or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
	9-10.LST.7.2: Gather relevant information from multiple authoritative sources, using advanced searches effectively; annotate sources; assess the usefulness of each source in answering the research question; synthesize and integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation (e.g., *APA or CSE*).
	9-10.LST.7.3: Draw evidence from informational texts to support analysis, reflection, and research.

Content Standards
For the high school science courses, the content standards are organized around the core ideas in each particular course. Within each core idea are indicators which serve as the more detailed expectations within each of the content areas.

Indiana Integrated Chemistry and Physics	
Standards 1: Constant Velocity	**ICP.1.1** Develop graphical, mathematical, and pictorial representations (such as a motion map) that describe the relationship between the clock reading (time) and position of an object moving at a constant velocity and apply those representations to qualitatively and quantitatively describe the motion of an object.
	ICP.1.2 Describe the slope of the graphical representation of position vs. clock reading (time) in terms of the velocity of the object moving in one dimension.
	ICP.1.3 Distinguish between the terms "distance" and "displacement," and determine the value of either given a graphical or mathematical representation of position vs. clock reading (time).
	ICP.1.4 Distinguish between the terms "speed," "velocity," "average speed," and "average velocity" and determine the value of any of these measurements given either a graphical or mathematical representation.

Standard 2: Uniform Acceleration	**ICP.2.1** Develop graphical, mathematical, and pictorial representations (such as a motion map) that describe the relationship between the clock reading (time) and velocity of an object moving at a constant acceleration and apply those representations to qualitatively and quantitatively describe the motion of an object in terms of its change in position or velocity.
	ICP.2.2 Describe the differences between average velocity and instantaneous velocity and be able to determine either quantity given a graph of position vs clock reading (time).
	ICP.2.3 For an object thrown vertically, qualitatively describe or quantitatively determine the velocity and acceleration at various positions during its motion.

Standard 3: Newton's Laws of Motion (One Dimension)	**ICP.3.1** Develop pictorial and graphical representations which show that a single external applied force changes the velocity of an object, and that when no force acts, the velocity of an object remains constant.
	ICP.3.2 Construct force diagrams and combine forces to determine the equivalent single net force acting on the object when more than one force is acting on the object.
	ICP.3.3 Distinguish between forces acting on a body and forces exerted by the body. Categorize forces as contact forces, friction, or action at a distance (field) forces.
	ICP.3.4 Develop pictorial and graphical representations which show that a non-zero net force on an object results in an acceleration of the object and that the acceleration of an object of constant mass is proportional to the total force acting on it, and inversely proportional to its mass for a constant applied total force.
	ICP.3.5 Qualitatively describe and quantitatively determine the magnitude and direction of forces from observing the motion of an object of known mass.
	ICP.3.6 Qualitatively describe and quantitatively determine the acceleration of an object of known mass from observing the forces acting on that object.
	ICP.3.7 Develop pictorial and graphical representations which show that when two objects interact, the forces occur in pairs according to Newton's third law and that the change in motion of each object is dependent on the mass of each object.

Standard	
Standard 4: Energy	**ICP.4.1** Define energy as a quantity that can be represented as being within a system that is distinct from the remainder of the universe and is measured in Joules.
	ICP.4.2 Identify forms of energy present in a system (kinetic, gravitational, elastic, etc.), and pictorially represent the distribution of energies, such as using pie or bar charts.
	ICP.4.3 Understand and explain that the total energy in a closed system is conserved.
	ICP.4.4 Qualitatively and quantitatively analyze various scenarios to describe how energy may be transferred into or out of a system by doing work through an external force or adding or removing heat.

Standard	
Standard 5: Particle Theory of Matter	**ICP.5.1** Develop pictorial representations which show that matter is made of particles.
	ICP.5.2 Describe the assumptions used to develop the kinetic theory of gasses.
	ICP.5.3 At the particle level, describe the relationship between temperature and the average kinetic energy of particles in the system and describe how a thermometer measures the temperature of a system.
	ICP.5.4 Distinguish "temperature" from "thermal energy," compare and contrast the Fahrenheit, Celsius, and Kelvin temperature scales, and convert temperatures between them.
	ICP.5.5 Evaluate graphical or pictorial representations that describe the relationship among the volume, temperature, and number of molecules and the pressure exerted by the system to qualitatively and quantitatively describe how changing any of those variables affects the others.
	ICP.5.6 Describe and demonstrate how the kinetic theory can be extended to describe the properties of liquids and solids by introducing attractive forces between the particles.
	ICP.5.7 Analyze a heating / cooling curve to describe how adding or removing thermal energy from a system changes the temperature or state of an object and be able to identify the melting and freezing temperatures of the system.
	ICP.5.8 Collect and use experimental data to determine the number of items in a sample without actually counting them and qualitatively relate this to Avogadro's hypothesis.

Standard 6: Describing Substances	**ICP.6.1** Distinguish between elements, mixtures, and compounds based on their composition and bonds and be able to construct or sketch particle models to represent them.
	ICP.6.2 Develop graphical and mathematical representations to show that mixtures can be made in any proportion and separated based on the properties of the components of the mixture and apply those representations to quantitatively determine the ratio of components.
	ICP.6.3 Cite the evidence that supports the idea that some pure substances are combined of elements in a definite ratio, as for example seen in electrolysis of water.
	ICP.6.4 Given the periodic table, determine the atomic mass, atomic number, and charges for any element.
	ICP.6.5 Given a periodic table, understand and describe the significance of column location for the elements by calculation of molar ratios of known compounds.
	ICP.6.6 Develop graphical and mathematical representations that describe the relationship between volume and mass of an object, describe the slope in terms of the object's density, and apply those representations to qualitatively and quantitatively determine the mass or volume of any object.
	ICP.6.7 Describe how both density and molecular structure are applicable in distinguishing the properties of gases from those of liquids and solids.

Standard 7: Representing Chemical Change	**ICP.7.1** Pictorially or mathematically represent chemical changes using particle diagrams and chemical equations.
	ICP.7.2 Demonstrate the Law of Conservation of Matter in terms of atoms and mass of substances by balancing equations.
	ICP.7.3 Differentiate the basic types of reactions, for example: synthesis, decomposition, combustion, single replacement, and double replacement.
	ICP.7.4 Using balanced equations and stoichiometric calculations, demonstrate the principle of Conservation of Matter in terms of atoms and mass.

Standard 8: Electricity and Magnetism	**ICP.8.1** Describe electrical current in terms of the motion of electrons within a device and relate the rate of motion of the electrons to the amount of current measured.
	ICP.8.2 Describe the relationship among voltage, current, and resistance for an electrical system consisting of a single voltage source and a single device.
	ICP.8.3 Describe on a macroscopic scale how any distribution of magnetic materials (e.g. iron filings, ferrofluid, etc.) aligns with the magnetic field created by a simple magnet.

Standard 9: Waves	**ICP.9.1** Develop qualitative particle models of mechanical waves and explain the relationship of the particles and their interactions in transverse and longitudinal waves, as well as, how waves appear in nature as in water waves and tsunamis, ground waves in earth quakes, and sound waves.
	ICP.9.2 Develop and apply a simple mathematical model regarding the relationship among frequency, wavelength, and speed of waves in a medium as well.
	ICP.9.3 Qualitatively describe the reflection and transmission of a mechanical wave at either a fixed or free boundary or interface.
	ICP.9.4 Describe how interacting waves produce different phenomena than singular waves in a medium (e.g. periodic changes in volume of sound or resonance).
	ICP.9.5 Describe and provide examples of how modern technologies use mechanical or electromagnetic waves and their interactions to transmit information.

Standard 10: Nuclear Energy	**ICP.10.1** Describe and compare/contrast the atomic models suggested by Rutherford and Bohr.
	ICP.10.2 Describe the model of the atomic nucleus and explain how the nucleus stays together in spite of the repulsion between protons.
	ICP.10.3 Develop and apply simple qualitative models or sketches of the atomic nucleus that illustrate nuclear structures before and after undergoing fusion, fission, or radioactive decay.
	ICP.10.4 Distinguish between fusion, fission, and radioactivity and qualitatively compare the amount of energy released in these processes.
	ICP.10.5 Explain the potential applications and possible consequences as the result of nuclear processes such as the generation of energy at nuclear power plants, including the potential damage that radioactivity can cause to biological tissues.