Introduction to Indiana's Academic Standards for Science – 2010

Indiana's Academic Standards for Science were last revised in 2000. This new document, Indiana's Academic Standards for Science – 2010, reflects the ever-changing science content and the underlying premise that science education should be an inquiry-based, hands-on experience. These standards were adopted by the Indiana State Board of Education in April, 2010, and will be implemented in the 2011-12 school year.

Indiana's Academic Standards for Science – 2010 reflect a few significant changes that are worth noting. Primarily, there are fewer standards and each grade level focuses on the big ideas for each of these sub-disciplines: physical science; earth science; life science; and science, technology and engineering. The overarching organization of the standards has also changed; they are divided into two sections: Process Standards and Content Standards, which are described in greater detail below.

Process Standards

The 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 Process Standards from the Content Standards is intentional; in doing so we want to make explicit the idea that what students are doing while they are 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.

The Process Standards are organized in the following grade bands: K-2, 3-5, 6-8. Within each grade band, the Process Standards address a particular topic or topics. Kindergarten introduces The Nature of Science, while grades 1 through 5, reflect two parts: The Nature of Science and The Design Process. In grades 6 through 8, Reading for Literacy in Science and Writing for Literacy in Science have been added to emphasize these processes in science. For high school, the Process Standards include Reading and Writing for Literacy in Science as well as The Nature of Science.

As noted in the previous paragraph, grades 6 through 8 and high school content courses will include Reading and Writing for Literacy in Science. It is important to note that these Process Standards emerged with the adoption of the Common Core State Standards in the area of Reading and Writing for Literacy in Science. The Literacy Standards establish that instruction in reading, writing, speaking, listening, and language is a shared responsibility. The Literacy Standards are predicated on teachers in the content areas using their unique disciplinary expertise to help students meet the particular challenges of reading, writing, speaking, listening, and language in their respective fields. It is important to note that the literacy standards are meant to complement rather than supplant content standards in the disciplines.

Part of the motivation behind the disciplinary approach to literacy promulgated by the Literacy Standards is extensive research establishing the need for college- and career-ready students to be proficient in reading complex informational text independently in a variety of content

areas. Most of the required reading in college and workforce training programs is informational in structure and challenging in content. Postsecondary education programs typically provide students with both a higher volume of such reading than is generally required in K-12 schools and comparatively little scaffolding.

The Literacy Standards make clear that significant reading of informational texts should also take place outside ELA classrooms in order for students to be ready for college and careers. Future assessments will apply the sum of all the reading students do in a grade, not just their reading in the ELA context. The Literacy Standards demand that a great deal of reading should occur in all disciplines.

The Literacy Standards also cultivate the development of three mutually reinforcing writing capacities: writing to persuade, to explain, and to convey real or imagined experience. College and career readiness requires that writing focus significantly on writing to argue and to inform or explain.

The Literacy Standards use grade level bands to present the standards. Teachers teaching at the beginning of the grade band may need to provide scaffolding for students to be successful, where teachers teaching at the end of the grade band should expect students to demonstrate the standards independently.

Content Standards

In grades 1 through 8, the Content Standards are organized in four distinct areas: 1) physical science; 2) earth science; 3) life science; and 4) science, technology and engineering. Kindergarten has only the first three areas: physical, earth and life science. In each of these areas there is at least one core standard, which serves as the big idea at that grade level for that content area. For the high school science courses, the content standards are organized around the core ideas in each particular course, which are represented by the core standard. The core standard is not meant to stand alone or be used as an individual standard, but instead is meant to help teachers organize their instruction around the “big ideas” in that content area and for grades K-8, at that particular grade level. Beneath each core standard are indicators which serve as the more detailed expectations within each of the content areas.

Finally, in the development of these revised science standards, careful attention was paid to how ideas are articulated across the grade levels so that content and skills that students will need to succeed in a particular sub-discipline are introduced in an appropriate manner in the early elementary grades and then progressed as students move towards high school.

Earth and Space Science I

Process Standards

The Nature of Science

Scientific knowledge is scientists' best explanations for the data from many investigations. Ideas about objects in the microscopic world that we cannot directly sense are often understood in terms of concepts developed to understand objects in the macroscopic world that we can see and touch. Student work should align with this process of science and should be guided by those principles. Students should also understand that scientific knowledge is gained from observation of natural phenomena and experimentation by designing and conducting investigations guided by theory and by evaluating and communicating the results of those investigations according to accepted procedures. These concepts should be woven throughout daily work.

- Develop explanations based on reproducible data and observations gathered during laboratory investigations.
- Recognize that their explanations must be based both on their data and other known information from investigations of others.
- Clearly communicate their ideas and results of investigations verbally and in written form using tables, graphs, diagrams and photographs.
- Regularly evaluate the work of their peers and in turn have their work evaluated by their peers.
- Apply standard techniques in laboratory investigations to measure physical quantities in appropriate units and convert quantities to other units as necessary.
- Use analogies and models (mathematical and physical) to simplify and represent systems that are difficult to understand or directly experience due to their size, time scale or complexity. Recognize the limitations of analogies and models.
- Focus on the development of explanatory models based on their observations during laboratory investigations.
- Explain that the body of scientific knowledge is organized into major theories, which are derived from and supported by the results of many experiments and allow us to make testable predictions.
- Recognize that new scientific discoveries often lead to a re-evaluation of previously accepted scientific knowledge and of commonly held ideas.
- Describe how scientific discoveries lead to the development of new technologies and conversely how technological advances can lead to scientific discoveries through new experimental methods and equipment.
- Explain how scientific knowledge can be used to guide decisions on environmental and social issues.

Reading Standards for Literacy in Science

The standards below begin at grade 9 and define what students should understand and be able to do by the end of grade 10.

Key Ideas and Details

9-10.RS.1 Cite specific textual evidence to support analysis of science texts, attending to the precise details of explanations or descriptions.

9-10.RS.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 summary of the text.

9-10.RS.3 Follow precisely a complex multistep procedure when carrying out experiments or taking measurements, attending to special cases or exceptions defined in the text.

Craft and Structure

9-10.RS.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific context relevant to *grades 9-10 texts and topics*.

9-10.RS.5 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.RS.6 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.

Integration of Knowledge and Ideas

9-10.RS.7 Translate quantitative 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.RS.8 Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific problem.

9-10.RS.9 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.

Range of Reading and Level of Text Complexity

9-10.RS.10 By the end of grade 10, read and comprehend science texts in the grades 9-10 text complexity band independently and proficiently.

Writing Standards for Literacy in Science

Text Types and Purposes

9-10.WS.1 Write arguments focused on *discipline-specific content*.

a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.
b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline appropriate form and in a manner that anticipates the audience's knowledge level and concerns.
c. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.
d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
e. Provide a concluding statement or section that follows from or supports the argument presented.

9-10.WS.2 Write informative/explanatory texts, including scientific procedures/ experiments.

a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
b. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.
c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.
d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.
e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

9-10.WS.3 *Note: Students' narrative skills continue to grow in these grades. The Standards require that students be able to incorporate narrative elements effectively into arguments and informative/ explanatory texts. In science, students must be able to write precise enough descriptions of the step-by-step procedures they use in their investigations that others can replicate them and (possibly) reach the same results.*

Production and Distribution of Writing

9-10.WS.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

9-10.WS.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

9-10.WS.6 Use technology, including the Internet, 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.

Research to Build and Present Knowledge

9-10.WS.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) 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.WS.8 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 selectivity to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.

9-10.WS.9 Draw evidence from informational texts to support analysis, reflection, and research.

Range of Writing

9-10.WS.10 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.

Content Standards

Standard 1: The Universe

Core Standard
Describe the age, origin and evolution of the universe. (ES.1.1)

Core Standard
Describe the size and organization of stars and galaxies found within the universe. (ES.1.2, ES.1.3, ES.1.4)

ES.1.1 Describe the Big Bang Theory and understand that evidence to support the formation of the universe and its age is found in Hubble's law and the cosmic background microwave radiation. Describe the role of gravitational attraction in formation of stars and galaxies.

ES.1.2 Differentiate between the different types of stars, including our sun, found on the Hertzsprung - Russell diagram. Compare and contrast the evolution of stars of different masses.

ES.1.3 Understand and discuss the basics of the fusion processes, which are the source of energy of stars and the formation of the elements.

ES.1.4 Understand and explain the hierarchical relationship and scales of planetary systems, stars, multiple-star systems, star clusters, galaxies and galactic groups in the universe.

Standard 2: The Solar System

Core Standard
Describe the age, origin and evolution of our solar system and describe the characteristics of objects in the solar system. (ES.2.1, ES.2.2, ES.2.3)

Core Standard
Recognize the role of gravity and other forces in determining the motion of bodies in the solar system. (ES.2.4)

ES.2.1 Understand and discuss the nebular theory concerning the formation of solar systems. Include in the discussion the roles of planetesimals and protoplanets.

ES.2.2 Describe the characteristics of the various kinds of objects in the solar system (e.g., planets, satellites, comets and asteroids). Recognize that planets have been identified orbiting stars other than the sun.

ES 2.3 Recognize that the sun is the main source of external energy for the Earth. Describe the cycles of solar energy and some of their impacts on the Earth.

ES.2.4 Describe the motions of the various kinds of objects in our solar system (e.g., planets, satellites, comets and asteroids). Explain that Kepler's laws determine the orbits of those objects and know that Kepler's laws are a direct consequence of Newton's Law of Universal Gravitation together with his laws of motion.

Standard 3: The Earth

Core Standard

Recognize and describe that earth sciences address planet-wide interacting systems (e.g., the oceans, the air, solid ground, and life on Earth) and interactions with the solar system. (ES.3.1, ES.3.2, ES. 3.3)

Core Standard

Examine the interrelationships between society and the planet-wide interacting systems and understand the basic physical and chemical laws that control these interactions. (ES.3.4)

ES.3.1 Understand 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 cycles), which are driven by energy from within the earth and from the sun.

ES.3.2 Demonstrate the possible effects of atmospheric changes brought about by natural and human-made processes.

ES.3.3 Identify and differentiate between renewable and nonrenewable resources present within Earth's systems. Describe the possible long-term consequences that increased human consumption has placed on natural processes that renew some resources.

ES.3.4 Recognize that fundamental physical and chemical laws control past, present and future dynamic interactions between and within Earth systems.

Standard 4: The Atmosphere and Hydrosphere

Core Standard

Understand the structure and circulation of Earth's atmosphere and hydrosphere and explain how natural and human factors may interact with these processes. (ES.4.1, ES.4.2)

Core Standard

Understand that both weather and climate involve the transfer of matter and energy throughout the atmosphere and hydrosphere, driven by solar energy and gravity. (ES.4.3, ES.4.4, ES.4.5, ES.4.6)

ES.4.1 Examine the origins, structure, composition, and function of Earth's atmosphere. Include the role of living organisms in the production and cycling of atmospheric gases.

ES.4.2 Describe the relationships among evaporation, precipitation, ground water, surface water, and glacial systems in the water cycle. Discuss the effect of human interactions with the water cycle.

ES.4.3 Explain the importance of heat transfer between and within the atmosphere, land masses, and bodies of water.

ES.4.4 Understand and describe the origin, life cycle, and behavior of weather systems and methods of predicting them. Investigate the causes of severe weather and propose appropriate safety measures that can be taken in the event of severe weather.

ES.4.5 Explain the role of Milankovitch cycles (rotation, revolution, and procession of axis) on differential heating of Earth, leading to climate changes such as the cycles of glaciation.

ES.4.6 Understand the origin, effects and uses of tides.

Standard 5: The Solid Earth

Core Standard

Understand the structural and compositional layers of the earth, its magnetic field, and how this knowledge is based on data from direct and indirect observation. (ES.5.1, ES.5.2, ES.5.3, ES.5.4. ES.5.5)

Core Standard

Understand how the processes of rock formation, weathering, sedimentation, and reformation continually shape the surface of the Earth. (ES.5.6, ES.5.7)

ES 5.1 Describe the large-scale, compositional layers of the Earth.

ES.5.2 Understand the origin and effects of Earth's magnetic field.

ES.5.3 Compare and contrast the properties of rocks and minerals. Explain the uses of rocks and minerals, particularly those found in Indiana, in daily life.

ES.5.4 Illustrate the various processes involved in the rock cycle and discuss the conservation of matter during formation, weathering, sedimentation and reformation.

ES 5.5 Understand the concepts of relative and absolute geologic time and their measurement by means of evidence from fossils and radioactive dating.

ES 5.6 Understand the role of changing sea level and climate in the formation of the sedimentary rocks of Indiana.

ES.5.7 Explain how sea level changes over time have exposed continental shelves, created and destroyed inland seas, and shaped the surface of the land.

Standard 6: Earth Processes

Core Standard

Understand the cyclical nature of processes that modify the Earth and how humans interact with these cycles. (ES.6.1, ES.6.2, ES.6.3)

Core Standard

Understand the role of plate tectonics in controlling the large scale structure of Earth's surface. Understand how the dynamic Earth impacts human society. (ES.6.4, ES.6.5)

ES.6.1 Investigate and discuss how humans affect and are affected by geological systems and processes.

ES.6.2 Differentiate among the processes of weathering, erosion, transportation of materials, deposition and soil formation.

ES.6.3 Explain the origin of geologic features and processes that result from plate tectonics (e.g., earthquakes, volcanoes, trenches and mountain ranges).

ES.6.4 Understand and discuss the development of plate tectonic theory, which is derived from the combination of two theories: continental drift and seafloor spreading.

ES.6.5 Explain that the source of Earth's energy, which drives the process of tectonics, is derived from the decay of radioactive isotopes and gravitational energy from Earth's original formation.