

California Science Teachers Association  
In collaboration with the California Department of Education

# **INTEGRATED SCIENCE:**

## **Level 4**

### **A Logic and Sequence for Meaningful Instruction**



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# Forward

In October, 2003, the California State Board of Education established sets of standards for each of four levels of high school integrated science. These standards are identical to the Grade 9-12 content standards in biology, chemistry, earth science, physics, and investigation and experimentation. By “successfully meeting the challenge [of these standards] . . . high school graduates can attain the highest level of science literacy . . .” (2003 Science Framework, Pg.154).

The 2003 Science Framework for California Public Schools states, “that no sequence or emphasis is prescribed” for structuring the high school science program (p.154) but leaves each high school and district the flexibility to design their own course structure. This document, developed collaboratively by the California Science Teachers Association and the California Department of Education, recognizes the autonomy of schools and districts and offers an instructional organization of standards that supports student learning in a four year integrated science program. The instructional models for the four levels of integrated science, as contained in this document, are provided as *examples* of how high school instruction in integrated science might be organized. There are alternative ways in which an integrated science curriculum might be organized and, therefore, this document does not represent a mandate for instruction.

The four models provide for the integration of each of the disciplines of science, as well as the process of science, contained in the investigation and experimentation standards. They include narrative information that describes the overarching concepts for each level. Each level, excluding level IV, is developed into two semesters. Each semester is then developed into possible units. Specific standards are listed for each unit, and narrative is provided to facilitate the reader’s understanding of why specific standards are clustered together. The narrative also gives teachers a design for scaffolding the standards to enhance student understanding of the science concepts contained in the standards. Additionally, flowcharts are presented for one or two concepts in each level to graphically illustrate both the instructional sequence and the “integrated relationships” between the standards clustered in a particular unit of instruction. These visual tools provide teachers with a quick overview of the connections and probable sequences in their curriculum. Teachers are encouraged to review each level and make appropriate modifications to best match their students’ needs and their school context. The reader will also find the investigation and experimentation topics placed at the beginning of each course, as these standards should be embedded and covered throughout the entire course.

It is important to note that the standards sets for the four levels of integrated science are aligned to the blueprints for the California Standards Tests (CSTs). Schools are advised not to rearrange standards from one level to another for this reason. Each high school standard appears once in the four levels of integrated science. However, some standards may be introduced and not tested or may need to be reintroduced to facilitate complete understanding at a particular level.

In January, 2004, the State Board of Education approved a set of blueprints that will be used to design a high school assessment mandated by the No Child Left Behind (NCLB) act. This exam will be administered in 10<sup>th</sup> grade and will be assess the high school biology and middle school

life science standards. Schools/districts that are implementing integrated science in both 9<sup>th</sup> and 10<sup>th</sup> grade should recognize that 57 percent of the standards defined on the blueprint are covered in years one and two of the integrated science blueprints. Districts are encouraged to offer a comprehensive 7<sup>th</sup> grade standards-based science course so that students entering high school will have mastery of the life science standards which form the foundation for the high school biology standards.

This document is designed primary for science teachers who are responsible for implementing the science standards. The document is also useful for designers of science materials and professional development, who will be able to familiarize themselves with what is expected from our California students in the integrated/coordinated sequence. Parents, guardians, and students will find this document useful to see the overall coverage of the Science Content Standards for California Public Schools grade 9-12.

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## INTEGRATED SCIENCE -- LEVEL 4 PROPOSED INSTRUCTIONAL SEQUENCE

**COURSE CONCEPT**— Integrated Science 4 focuses on the collection of evidence that underlies the development of scientific ideas and how science supports the development of various technologies. The sequence emphasizes literature-based research, hands-on investigations, and problem-solving to support student understanding of scientific knowledge and process. Students should discover through reading, research, and problem-solving the underlying concepts supporting technology and how technology can be used to help provide for a sustainable future. Student research should include two essential questions: How is it that scientists know what they know about a particular topic, and how does this knowledge help to develop technology that extends our ability to change the world?

The instructional environment for Integrated Science 4 is intended to be student centered. Students explore each\* of the eleven topics through a series of required investigations and other labs as needed. The investigations are guided by key questions that focus on the science and technological implications of each topic. The explorations allow them to examine key ideas through hands-on activities and to participate in the scientific process by designing their own experiments and building their own equipment. Each topic lends itself to directed instruction so that students become aware of major scientific issues and social implications in each topic. Students are expected to choose a project\*\* based on one or more of the standards, to research the science embedded in the task, and to present their findings to the class at the end of each semester.

### **Semester 1—Human body systems**

The human body is studied from a systems perspective spanning molecular interactions within the cell to the relationships among organs. Students examine the molecular machinery common to living organisms and apply this understanding to improving the quality of life. At the macro level the complexity of the human body is investigated with a particular focus on vision. Internal feedback loops that help our bodies survive stressful and changing environmental conditions are examined at the cellular and organ levels.

Topic	Standards	Key Questions	Required Investigation
Replication	B5a, C2h*, B5b	How can we design a machine to efficiently and accurately make DNA?	Students replicate a short nucleotide sequence and insert it into bacteria and test for its presence.
Immunity	B10a, B10b, B10c, B10d, B10e, B10f*	What is the process of making a vaccine?	Students investigate the process of perfecting an antibiotic.
Human Body Systems	B9c, B9h*	What is the relationship between the nervous, endocrine and muscular systems?	Students will investigate the factors influencing the activity of enzymes such as catalase and diastase.

Topic	Standards	Key Questions	Required Investigation
Vision	B9b, B9d, B9e, C1g*, C1j*, P4c	How do we see in color?	Students investigate the nature of vision and perception.
Homeostasis	B9a, B9f*, B9g*, B9i*, C2d, C5b, C5d	How do our bodies survive extreme conditions? How do our bodies keep us toxin free?	Students explore osmosis as passive transport and the characteristics of cellular equilibrium.

### **Semester 2—Understanding the past to create a sustainable future**

Students and teacher explore the history of the solar system. They examine the evidence that pinpoints the formation of the solar system and its evolution through time. Students and teacher study the Earth’s energy budget and the effects of the sun on the Earth’s surface. They examine the law of conservation of energy and the second law of thermodynamics to better understand how to craft a sustainable future.

Topic	Standards	Key Questions	Required Investigation
Space Exploration	E1b, E1d	How can we use knowledge of the universe and use this information to predict future explorations of the solar system?	Students investigate the nature of parallax and its implications for measuring distances of some astronomical objects.
Origin of the Universe	E1e, E2a, E2b, E2c, E2d, E2e*, E2f*, E2g*, P4c	How do we know the origin of the universe and how can we use this information to predict the future of the universe?	Students study wavelengths of EM waves by measuring microwaves and the Doppler effect.
Earth’s Energy Budget	E4a, E5d, E9a	Can ocean currents be used to generate usable energy?	Students design an instrument to measure the sun’s intensity using a solar cell and multimeter.
Transportation in the Future	C7a, C7d, C7e*, C7f*, C2e, C2f*, C2g*, C1h*, E4c, P5a, P5b, P5c, P5k*, P5l*, P5n*, P5o*, P3g	How do we build a fuel cell car? How can fuel cell technology be used to move people and products in our society?	Students make a fuel cell and use it to do mechanical work.
Nuclear Energy	C11a, C11b, C11c, C11d, C11e, C11f*, C11g*	Is nuclear energy old technology or the wave of the future?	Students use radon gas detectors to monitor presence of radon in designated structures.

Topic	Standards	Key Questions	Required Investigation
Conservation of Energy	P3a, P3b, P3c, P3d, P3e	How do we know that energy cannot be created or destroyed? What does the conservation of energy mean for developing and using energy sources in the future?	Students compete to build the most efficient machine or engine that will raise the temperature of water by a specified number of joules.

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