



# The Parent Science Handbook

SCIENCE

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## INTRODUCTION

### A Message to Parents

We are all born with natural curiosity about our world. Science is an extension of this curiosity. When we read about a new discovery, watch a bird fly, or think about how something works, we are doing science. When we pursue knowledge we are doing science.

As enjoyable as it is to marvel at the wonders of our world, science is also useful. 80% of the jobs in California depend on a knowledge of science. Every day we sift through health and safety claims that we receive from the media. We are often asked to make decisions about how to care for our planet, both in the voting booth and in our daily lives. To understand basic science is to be better prepared to deal with these challenges and to live healthy and fulfilling lives.

Student achievement in science can be encouraged by engaging in family interests that promote a love of learning and by supporting students in their study of science in school. The purpose of this booklet is to provide ideas and resources so you can ensure your child's success in learning how the natural world works.

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### The Importance of Parents

Decades of research show that parent involvement in a child's education is the single most important factor for academic success. When parents and schools work together to support learning, children tend to succeed not just in school, but in life. Schooling is a critical part of your child's education, but it is just a part. A supportive home environment that encourages learning is a key factor for success.

Build a strong foundation for science at home by:

- encouraging questions, especially those that have more than one answer.
- asking questions that are open-ended.
- promoting innovative responses.
- encouraging your child to consider creative possibilities when solving problems.
- avoiding using the words "right" and "wrong" when listening to your child's ideas.



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## HOW PARENTS CAN HELP

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- *Have high expectations for your child.* Your child will sense that you expect her to do well if you truly believe that she will. We always give subtle clues that children are very good at sensing. If we genuinely expect our child to do well, she will not disappoint us.

- *Know what your child is studying in science.* Refer to the standards section of this handbook for this information. Be sure to attend “back to school night” each year and look for evidence of appropriate activity-based science in the classroom.

- *Recognize that everyone can succeed in science.* Whether or not you considered yourself “good” in science in school, your child can succeed. He will do well if his natural curiosity is encouraged long before he enters school. He will also experience greater success if his assignments are treated as opportunities to learn, not as drudgery to be completed.

## ACTIVITIES AND STRATEGIES

### Making science part of your family’s life

Scientific literacy for adults starts in childhood. When parents and children wonder together about rocks, trees, flowers, stars, butterflies, weather, machines, or join forces to grow a garden or install a bird feeder, the groundwork is being laid for a better understanding of how the world works. From these pleasurable activities, your child will gain confidence about her ability to learn and to succeed. Consider the following ideas to help your family gain scientific literacy.

- *Display an attitude that encourages learning.* Children sense our feelings and often adopt them for their own. When we feel and act enthusiastic about our child’s opportunities to learn about his world, both in school and out, we are setting a positive tone that will improve his success.

- *Find your own interests in the natural world and pursue them.* When you participate in hobbies, such as bird watching, whale watching, cloud watching, rock collecting, or simply enjoying nature while relaxing at a campsite, you model lifelong learning. Your child will emulate these actions and, in turn, become a lifelong learner herself.

- *Make the natural world an everyday part of your family’s life.* Obtain field guides and look up unfamiliar birds in your yard or identify trees in the neighborhood or rock formations on a driving trip or types of clouds in the sky. Visit museums, zoos, parks, planetariums, science centers, aquariums, and nature preserves.

## ACTIVITIES AND STRATEGIES

• *Encourage your children to ask questions and to pursue their own answers.* Science asks three basic questions, each of which leads to better understanding our world:

*What's there?* What are the rocks in that road-cut? What trees are surrounding our house? What is that bird? What kinds of clouds are in the sky?

*How does it work?* Why does a squirrel dart back and forth on the road? Which trees are preferred by nesting birds? What causes the tides? How do airplanes fly?

*How did it come to be this way?* How did the layers of rock in the road-cut get that way? Why are there more trees on the east slope of the hill than the west side? What is the reason for the magnificent wildflower displays in the desert? Why is the sky blue?

• *Keep in mind that scientific ideas consist of inferences based upon observations.* Observe with your child. Speculate about how things work, using what you see, hear, feel and smell to figure things out: What makes sunsets red? What is the advantage to a plant to have strong-tasting leaves?

Try things: Will tomato plants grow better if we mulch them? What happens when we mix cornstarch with a little water? How can we scare off gophers?

## ACTIVITIES AND STRATEGIES



### The disciplines of science

The simplest definition of science is “knowledge.” Modern science includes observation and experimentation, which lead to explanations of how things work. Since there is so much to observe and explain (from subatomic particles to the entire Universe), science is divided into many areas of study. In order to simplify a very complex subject, we often lump all of natural science into the following disciplines:

- Physical Science includes Physics, which studies the interactions of matter and energy that do not involve chemical changes, and Chemistry, which studies the chemical interactions of atoms and molecules.
- Biology and Life Science are both the study of living things, but Biology is usually considered the more sophisticated term.
- Earth Science, often referred to as Earth/Space Science, is the study of the formation of, and changes in, our planet and the rest of the Universe.

### Inquiry

All professional and amateur science is based on inquiry. That is, people ask questions and try to find answers to those questions. When geologists and paleontologists probe underground to find out what is there, they are using inquiry. Astronomers do the same thing, but look in the opposite direction.

When scientists find out what is there, they attempt to figure out how it works. How do organisms interact? Why do particles behave the way they do and not some other way? Finding out how a system or phenomenon works naturally leads one to ask about its history. How did it get this way? What led to this way of functioning or interacting?

Inquiry is central to what it means to be a learner; a curious and involved person. Students also benefit from, and are motivated by, being able to pursue answers to questions they ask. For this reason, inquiry, referred to as Investigation and Experimentation, is an integral part of the California Science Content Standards.



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## UNDERSTANDING THE SCIENCE CONTENT STANDARDS

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The Science Content Standards reflect the desired content of science curriculum in California public schools. The science standards are written in terms of what students should know. They state explicitly the content that students need to acquire at each grade level, kindergarten through grade eight and in grades nine through twelve.

The standards include grade-level specific content for kindergarten through grade eight. The standards for grades nine through twelve are divided into four content strands. An Investigation and Experimentation strand describes a progressive set of expectations for each grade from kindergarten through grade eight, and one set of Investigation and Experimentation standards is given for grades nine through twelve.

#### Grade level expectations

##### *Kindergarten through Grade Five*

The elementary school science standards provide the foundational skills and knowledge students will need in middle school and high school. Students are introduced to facts, concepts, principles and theories organized under the headings of physical, life and earth sciences. They learn essential investigation and experimentation skills that will continue to be developed through high school.

##### *Kindergarten*

In Kindergarten, the Physical Science standards begin the study of the properties of matter and its transformations. The Life Science standards provide the opportunity to discuss the principles of structure and function at a simple level, and to describe the appearance and behavior of different animals and plants. The Earth Science standards focus on landforms, weather and Earth's resources. The Investigation and Experimentation standards help students develop their own questions, perform investigations, observe through the use of the five senses, describe, compare and sort and communicate observations.

##### *Grade One*

In grade one the Physical Science standards build on the study of the properties of matter through an emphasis on solids, liquids and gases. In Life Science the standards focus on how plants and animals live in different environments and the function of some of their external structures that help them meet their needs. Earth Science standards provide opportunities for students to learn how to use simple weather recording instruments, to discuss daily and seasonal changes in weather and the Sun's influence on weather. The Investigation and Experimentation standards continue to develop students' abilities to make observations and comparisons, to describe relative position of objects and to revisit observations when discrepancies exist.

### ***Grade Two***

In Physical Science grade two students learn about force and motion, pushes and pulls, gravity, magnetism and the ability of vibrating objects to make sounds. The Life Science standards focus on the predictable life cycles of plants and animals, inherited characteristics, variation within a species and environmentally induced changes. The Earth Science standards provide opportunities for students to learn about the composition, processes and materials of Earth's crust, breakage and weathering of rocks to form soil, geologic time, fossils and the evidence they provide about Earth's history. The Investigation and Experimentation standards develop students' ability to make predictions based on observed patterns, measure with appropriate tools, compare and sort objects, describe a sequence of steps or events, use tools to extend their powers of observation, and follow oral directions for an investigation.

### ***Grade Three***

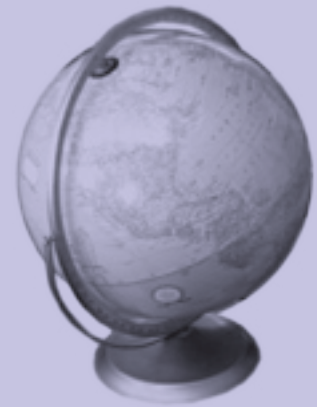
In Physical Science students in grade three discuss sources and forms of energy, forms of matter, atoms, symbols displayed on the periodic table of the elements, the properties of light and how light affects perception of direction, shadow and color. In Life Science students learn about different environments and the types of organisms adapted to live in each, effects of environmental changes on organisms, extinction and organisms in the fossil record. Earth Science standards center on the regular and predictable patterns of objects in the sky, movements of the Sun, Moon and stars, seasonal changes, and the phases of the Moon. The Investigation and Experimentation standards teach students to make predictions based on observations, prior knowledge, and logic, to make repeated observations to improve accuracy, to differentiate evidence from opinion, and that predictions must be verified by data collected.

### ***Grade Four***

In grade four the Physical Science standards provide the opportunity to build series and parallel circuits, build and use a compass, build an electromagnet, observe the behavior of electrically charged objects, and the conversion of electrical energy. In Life Science students expand their knowledge of food chains and food webs, living and non-living components of ecosystems, and ecological relationships. The Earth Science standards focus on the properties of rocks and minerals and the processes of weathering and erosion. Through the Investigation and Experimentation standards, students learn to formulate and justify predictions based on cause-and-effect relationships, differentiate observation from inference, conduct multiple trials to test their predictions, and follow a set of written instructions for a scientific investigation.

### ***Grade Five***

In Physical Science grade five students learn about chemical reactions, special and shared properties of metallic elements, molecules, atoms, chemical compounds, mixtures and the organization of atoms on the periodic table of the elements. The Life Science standards focus on internal structures for blood circulation, respiration, digestion, waste disposal, transport of materials, and photosynthesis in plants. In Earth Science students study the hydrologic cycle, weather, weather maps and weather patterns, the solar system, the composition of the Sun, and the relationship between gravity and planetary orbits. The Investigation and Experimentation standards help students develop testable questions, plan and conduct investigations based upon the questions, select appropriate tools, draw conclusions from scientific evidence, and write a report of an investigation.



## **UNDERSTANDING THE SCIENCE CONTENT STANDARDS**

## Grades Six through Eight

In each grade, kindergarten through grade five, the science content standards cover the areas of physical, life, and earth sciences in approximately equal measures. Investigation and experimentation is embedded within each grade. In each of the middle grades, however, the content standards emphasize an individual area along with the investigation and experimentation standards. This organization permits students to probe each area in greater depth.

### *Grade Six*

In grade six the content standards focus on Earth Science. Students learn the Earth's history and the mechanisms that account for Earth's topography, weather phenomena, and the interactions of living things within the Earth system. The course is based on an understanding of how two sources of energy, the sun and radioactive decay inside the Earth, power convection currents that cause weather, the reshaping of the Earth's surface, and perpetuate ecosystems. Through the Investigation and Experimentation standards students learn to develop hypotheses, use appropriate tools and technology, manipulate data, communicate steps of an investigation, evaluate evidence, interpret maps, interpret events by sequence and time, and identify changes in natural phenomena.

### *Grade Seven*

In grade seven the content standards focus on Life Science. Cells, body systems, and genetics are studied as the results of the history of life on Earth. There is considerable emphasis on understanding the evolution of life in terms of the geologic history learned in grade six. The physical science principles that underlie biological structures and functions (e.g., light, levers, blood pressure) are studied to gain a deeper understanding of living systems. The Investigation and Experimentation standards lead students to learn how to use appropriate tools and technology, use a variety of print and electronic resources, communicate ideas logically, construct scale models and diagrams to communicate knowledge, and to communicate the steps and results from investigations.

### *Grade Eight*

In grade eight the science content standards focus on Physical Science. Topics in Physics, such as motion, forces, and the structure of matter are studied using a mathematical approach and Chemistry is viewed in terms of the behavior of atoms and molecules and the chemistry of living systems. Density and buoyancy are explored as aspects of the behavior of matter. Earth in the solar system is addressed in terms of physical interactions of bodies in space. The Investigation and Experimentation standards allow students to learn how to plan and conduct a scientific investigation, evaluate data, distinguish between variables and controls, understand and construct linear graphs, and manipulate simple mathematical formulas.



## UNDERSTANDING THE SCIENCE CONTENT STANDARDS

## Grades Nine through Twelve

In grades nine through twelve, subject matter is divided by content, not by grade level, as in grades kindergarten through eight. Courses may be presented as Physics, Chemistry, Biology/Life Science, Earth Science, or as an Integrated Science course, which includes all four sciences. High school graduation requirements call for at least two years of laboratory science, but students who take additional years will reap great benefits.

The Investigation and Experimentation standards for all of high school science include selecting and using appropriate tools and technology, identifying sources of error and inconsistent results, formulating explanations by using logic and evidence, solving problems using mathematics, understanding scientific terms such as hypothesis and theory, recognizing the usefulness and limitations of models and theories, interpreting maps, analyzing sequences in natural phenomena, recognizing the need for controlled experiments and the cumulative nature of scientific knowledge, integrating knowledge from more than one area of science, investigating science-based issues, and recognizing that science is a human endeavor, occasionally burdened with mistakes and even fraud.

### **Physics**

Physics is considered the most basic of all sciences. Topics in physics include the study of motion, forces, energy, heat, waves, light, electricity and magnetism. Physics focuses on the development of models deeply rooted in scientific inquiry, in which mathematics is used to describe and predict natural phenomena and to express principles and theories. Topics requiring little or no mathematics are introduced first, then students progress to more sophisticated and quantitative treatments as they learn more mathematics.

### **Chemistry**

In studying chemistry, students discover chemistry's tremendous power to explain the nature of matter and its transformations. The chemistry standards include atomic and molecular structure, the periodic table, chemical bonds, conservation of matter and stoichiometry, gases, acids and bases, solutions, chemical thermodynamics, reaction rates, chemical equilibrium, organic and biochemistry, and nuclear processes. Chemistry requires high-level problem-solving skills, such as designing experiments and solving word problems. An essential prerequisite for chemistry is a firm grounding in algebra.

### **Biology/Life Sciences**

Biology and Life Science approach the study of living things from a number of directions. Living things are studied in terms of cells and cell function, as systems and organisms, the genetics of organisms, as parts of ecosystems, and through the study of the history of life. Biology and Life Science standards include the study of cell biology, genetics, ecology, evolution, and physiology. Both laboratory and field experiences are appropriate to meet the Investigation and Experimentation requirements of these courses.

### **Earth Science**

Earth Science study includes the physical study of our planet and the rest of the Universe. Topics include Earth's place in the Universe, dynamic Earth processes, energy in the Earth system, biogeochemical cycles, structure and composition of the atmosphere, and California geology. Investigations include exploring the physical, chemical and biological interactions that explain phenomena and features of our planet and its surroundings.

### **Integrated Science**

Integrated Science is designed to explore the connections between all the sciences. The purpose of Integrated Science is to gain understanding of how chemical, physical, biological and Earth phenomena interact, to explain how systems work, and how these phenomena and systems came to be. The course offers wide-ranging opportunities to study systems and phenomena first-hand in the field as well as in the laboratory.

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## HELPING WITH SCIENCE HOMEWORK

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The purpose of homework in science is to give students opportunities to apply and share at home what they learned in school. Use these strategies to support your child:

- *Show that you care.* Spend some time each day, perhaps at the dinner table, allowing your child to tell about his day. Ask what he learned in science today. He may want to tell you what he **did**, but be sure to return to the initial question, What did you **learn**?
- *Make sure your child has a special place and the resources to do written homework.* Every student needs basic materials, such as pencils, pencil sharpener, erasers, pens, colored markers, paper, and a safe place to keep things. Most students would also benefit from having a computer with internet access and a printer. Information from the internet, judiciously used and skeptically screened, can be of great help in researching a topic.
- *Be sure that your child has the time and materials to complete projects.* When the project assignment comes along, be prepared to support your child in completing the task. You can help by transporting her to the market, hardware or crafts store, providing funds for materials, and by doing hazardous jobs such as cutting the wood for a backboard. But, the science project should be done by your child. It is in doing the investigation and planning the presentation that learning takes place.
- *Establish a routine time for working on homework.* Make sure the time is productively used and check the completed assignments before the end of the day. Remember, spelling and neatness count in life even if the teacher doesn't specifically mention these criteria in each assignment.



## INTERDISCIPLINARY CONNECTIONS

Reading is an essential skill for all subject areas. Reading allows learners to go beyond their own personal experiences, but for children learning must be experience-based. Hands-on lessons are important at all grade levels but are essential for young children. As children mature, become more skilled at reading, and gain life experiences, they can access more and more information through the printed word.

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Mathematics is the language of science. It is through numbers, formulas, charts, and graphs, along with the written word, that scientists and informed non-scientists communicate. Mathematics allows the precision of measurement, calculation, and communication that makes science an effective enterprise. In the elementary grades, math is used to record information, make measurements, and to do simple calculations. By high school, students need a functional understanding of algebra, and would benefit from knowledge of geometry and trigonometry.



The history of science is inseparable from the history of civilization. As people tried to figure out how their world worked, how to solve problems, how to survive, and to explain how everything came to be, they formed the discipline we now know as science. Learning about the life and work of women and men in science and the culture of their times can be fascinating and can help your child gain perspective on today's world.

A study of history and social interactions, as seen in terms of the development of scientific thinking, is an essential part of a well-rounded education.

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## RESOURCES

If you would like more information about science education or strategies for supporting your child's science learning, you'll find the following lists of books and websites helpful.

### Books

- Eyewitness books
- Junior Eyewitness Books
- California Department of Education's Literature List for Science and Mathematics available at <http://www.cde.ca.gov/ci/sc/ll/index.asp>

### Magazines

- Wild Animal Baby
- Your Big Backyard
- Ranger Rick
- Earth Tomorrow
- National Geographic
- Popular Mechanics
- Scientific American
- Science News

### Places to go

- Museums
- Nature Preserves
- National Parks
- State and Regional Parks
- Aquariums
- Planetariums
- Arboretums

### Websites

- Exploratorium website : <http://www.exploratorium.edu/>
- National Geographic: <http://www.nationalgeographic.com/kids/>



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