Active Physics and the California Science Content Standards

The California Science Content Standards for high school physics address the four major topics of what has become known as "classical" physics: motion and forces, energy and momentum conservation, waves, and electromagnetic phenomena. Except for topics requiring mathematical sophistication not normally expected of entering high school students (such as a facility with vectors), most of these topics are addressed in a variety of ways by the six *Active Physics* modules. The motion and force topics are addressed by the "Sports" module and the last two chapters of "Predictions," with the most complete coverage being provided by the three "Sports" chapters coupled with the third "Predictions" chapter. In dealing with conservation of energy and momentum, the "Sports" chapters once again provide the best coverage, particularly in dealing with potential and kinetic energy. The three "Communication" chapters provide the best coverage of waves, though once again the third "Predictions" chapter helps by bringing in aspects of wave motion as well as the fundamental forces of nature. One of those fundamental forces is magnetism, which is also dealt with in greater detail (particularly its interaction with electricity) in the second Communication" chapter and the third "Home" chapter. Basic electric circuits are the focus of the second "Home" chapter.

Active Physics and "Investigation and Experimentation"

The most unique aspect of *Active Physics* is the way it is taught, and this lends itself especially well to the "Investigation and Experimentation" aspects of the California Standards. Through the use of computer spreadsheets and CBL probes with graphing calculators, students are acquainted with a variety of technologies used to measure and analyze data; and teacher tabulation of data from all the lab groups in a class allows for consideration of inconsistencies and attempts to explain them—as a way to develop models and theories. The Chapter Challenges of *Active Physics* require students to experience phenomena from more than one area of science and to bring these experiences to bear on solving a problem that has relevance to their everyday world.

Correlation between *Active Physics* and the California Physics Standards

	Communication			Home			Predictions			Sports			
Motion and Forces (Number 1.) Newton's laws predict the motion of most objects. Students know:	**Ch 1**	**Ch 2**	**Ch 3**	**Ch 1**	**Ch 2**	**Ch 3**	**Ch 1**	**Ch 2**	**Ch 3**	**Ch 1**	**Ch 2**	**Ch 3**	**Electronic Supplemental Materials**
a. how to solve problems involving constant speed and average speed	*							*		*			*
b. when forces are balanced, no acceleration occurs and an object continues at a constant speed or stays at rest (Newton's First Law)								*			*		*
c. how to apply Newton's Second Law to solve one-dimensional motion problems involving constant forces								*			*		*
d. when on object exerts a force on a second object, the second object always exerts a force of equal magnitude and opposite direction (Newton's Third Law)								*			*		*
e. the relationship between the Universal Law of Gravitation and the effect of gravity at the surface of the Earth									*	*	*	*	*
f. applying a force to an object perpendicular to the direction of motion causes the object to change direction but not speed								*	*		*		*
g. circular motion requires application of a constant force directed toward the center of the circle								*	*		*		*
h. Newton's Laws are not exact but they provide very good approximations unless an object unless an object is moving close to the speed of light									*				*
i. how to solve two-dimensional trajectory problems										*	*	*	*
j. how to resolve two-dimensional vectors into components and calculate magnitude and direction of a vector from its components													*
k. how to solve two-dimension problems involving balanced forces (statics)													*
l. how to solve problems in circular motion using the formula for centripetal acceleration: *a = v^2/r*													*
m. how to solve problems involving forces between two electric charges or two masses at a distance									*				*

Correlation between *Active Physics* and the California Physics Standards

	Communication			Home			Predictions			Sports			
Conservation of Energy and Momentum (Number 2) provide a way to predict and describe the movement of objects. Students know:	**Ch 1**	**Ch 2**	**Ch 3**	**Ch 1**	**Ch 2**	**Ch 3**	**Ch 1**	**Ch 2**	**Ch 3**	**Ch 1**	**Ch 2**	**Ch 3**	**Electronic Supplemental Materials**
a. how to calculate kinetic energy using E = *.5mv^2*										*	*	*	*
b. how to calculate changes in gravitational potential energy near the Earth using the formula *mgh*										*	*	*	*
c. how to solve problems involving conservation of energy in simple systems										*	*	*	*
d. how to calculate momentum as *mv*											*	*	*
e. momentum is a separately conserved quantity											*	*	*
f. an unbalanced force on an object produces a change in its momentum											*	*	*
g. how to solve problems involving elastic and inelastic collisions in one dimension											*	*	*
h. how to solve problems involving conservation of energy in simple systems													*

Correlation between *Active Physics* and the California Physics Standards

	Communication			Home			Predictions			Sports			
Heat and Thermodynamics (Number 3) Energy cannot be created or destroyed, though many processes transfer energy to the environment as heat. Students know:	**Ch 1**	**Ch 2**	**Ch 3**	**Ch 1**	**Ch 2**	**Ch 3**	**Ch 1**	**Ch 2**	**Ch 3**	**Ch 1**	**Ch 2**	**Ch 3**	**Electronic Supplemental Materials**
a. heat flow and work are two forms of energy transfer between systems													*
b. work done by a heat engine is the difference between the heat flow into the engine at high temperature and the heat flow out at a low temperature													*
c. the internal energy of an object includes the energy of random motion of the object's atoms and molecules													*
d. most processes tend to decrease the order of a system													*
e. entropy is a measure of the order or disorder of a system, larger for a disordered system													*
f. that "Entropy tends to increase" is a law of statistical probability governing all closed systems													*
g. hot to solve problems involving heat flow, work, and efficiency in a heat engine													*

Correlation between *Active Physics* and the California Physics Standards

	Communication			Home			Predictions			Sports			
Waves (Number 4) have characteristic properties that do not depend on the type of wave. Students know:	**Ch 1**	**Ch 2**	**Ch 3**	**Ch 1**	**Ch 2**	**Ch 3**	**Ch 1**	**Ch 2**	**Ch 3**	**Ch 1**	**Ch 2**	**Ch 3**	**Electronic Supplemental Materials**
a. waves carry energy from one place to another	*	*	*						*				*
b. how to identify transverse and longitudinal waves	*		*										*
c. how to solve problems involving wavelength, frequency, and wave speed	*		*										*
d. sound is a longitudinal wave whose speed depends on the properties of the medium in which it propagates	*												*
e. radio waves, light, and X-rays are different parts of the electromagnetic wave spectrum, whose speed in vacuum is 3x10^8 m/s			*										*
f. how to identify properties of waves: interference, diffraction, refraction, Doppler effect, and polarization	*		*						*				*

Correlation between *Active Physics* and the California Physics Standards

	Communication			Home			Predictions			Sports			
Electric and Magnetic Phenomena (Number 5) are related and have many practical applications. Students know:	**Ch 1**	**Ch 2**	**Ch 3**	**Ch 1**	**Ch 2**	**Ch 3**	**Ch 1**	**Ch 2**	**Ch 3**	**Ch 1**	**Ch 2**	**Ch 3**	**Electronic Supplemental Materials**
a. how to predict the voltage or current in simple direct current electric circuits					*								*
b. how to solve problems involving Ohm's law					*								*
c. any resistive element in a DC circuit dissipates energy which heats the resistor, can calculate the power in any resisistive circuit element					*								*
d. the properties of transistors and their role in electric circuits													*
e. charged particles are sources of electric fields and experience forces due to the electric fields from other charges						*							*
f. magnetic materials and electric currents are sources of magnetic fields and experience forces due to magnetic fields from other sources		*				*							*
g. how to determine the direction of a magnetic field produced by a current flowing in a wire		*				*							*
h. changing magnetic fields produce electric fields, thereby inducing currents in nearby conductors													*
i. plasmas contain ions and/or free electrons and conduct electricity													*
j. electric and magnetic fields contain energy and act as vector force fields													*
k. the force on a charged particle *q* is *qE*, where *E* is the electric field at the position of the particle													*
l. how to calculate the electric field resulting from a point charge													*
m. static electric fields have as their source some arrangement of electric charges													*
n. the force on a moving particle (with charge *q*) with speed *v* in a magnetic field *B* is *qvB sin(a)*, where *a* is the angle between *B* and *v*, with the force direction determined by the right hand rule													*
o. how to apply the concepts of electrical and gravitational potential energy to solve problems involving energy conservation													*

Correlation between *Active Physics* and the California Physics Standards

	Communication			Home			Predictions			Sports			
Investigation and Experimentation. Students will:	**Ch 1**	**Ch 2**	**Ch 3**	**Ch 1**	**Ch 2**	**Ch 3**	**Ch 1**	**Ch 2**	**Ch 3**	**Ch 1**	**Ch 2**	**Ch 3**	**Electronic Supplemental Materials**
a. select and use appropriate tools and technology to perform tests, collect data, analyze relationships, and display data	*	*	*	*	*	*	*	*	*	*	*	*	*
b. identify and communicate sources of unavoidable experimental error	*	*	*	*	*			*	*	*	*	*	*
c. identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions	*	*	*	*	*			*	*	*	*	*	*
d. formulate explanations by using logic and evidence	*	*	*	*	*	*	*	*	*	*	*	*	*
e. solve scientific problems by using quadratic equations and simple functions													*
f. distinguish between hypothesis and theory as scientific terms								*	*				*
g. recognize the usefulness and limitations of models and theories as scientific representations of reality							*	*	*		*		*
h. read and interpret topographic and geologic maps													*
i. analyze locations, sequences, or time intervals that are characteristic of natural phenomena		*	*						*			*	*
j. recognize the issues of statistical variability and the need for controlled tests	*		*	*			*	*	*	*	*	*	*
k. recognize the cumulative nature of scientific evidence	*	*	*	*	*	*	*	*	*	*	*	*	*
l. analyze situations and solve problems that require combining and applying concepts from more than one area of science			*										*
m. investigate a science-based societal issue		*	*	*	*	*	*		*	*	*	*	*
n. know that when an observation does not agree with an accepted scientific theory, the observation is sometimes mistaken or fraudulent							*		*				*