California STAR Coordinated/Integrated Science Blueprint
Earth Science/Chemistry/Physics (ECP)

EARTH SCIENCES	ITEMS	PERCENT
Earth's Place In The Universe		
1. Astronomy and planetary exploration reveal the solar system's structure, scale, and change over time. As a basis for understanding this concept:	10	17%
a. *Students know* how the differences and similarities among the sun, the terrestrial planets, and the gas planets may have been established during the formation of the solar system.		
b. *Students know* the evidence from Earth and moon rocks indicates that the solar system was formed from a nebular cloud of dust and gas approximately 4.6 billion years ago.		
c. *Students know* the evidence from geological studies of Earth and other planets suggest that the early Earth was very different from Earth today.		
d. *Students know* the evidence indicating that the planets are much closer to Earth than the stars are.		
e. *Students know* the Sun is a typical star and is powered by nuclear reactions, primarily the fusion of hydrogen to form helium.		
f. *Students know* the evidence for the dramatic effects that asteroid impacts have had in shaping the surface of planets and their moons and in mass extinctions of life on Earth.		
g.* *Students know* the evidence for the existence of planets orbiting other stars.		
2. Earth-based and space-based astronomy reveal the structure, scale, and changes in stars, galaxies, and the universe over time. As a basis for understanding this concept:	5	8%
a. *Students know* the solar system is located in an outer edge of the disc-shaped Milky Way galaxy, which spans 100,000 light years.		
b. *Students know* galaxies are made of billions of stars and comprise most of the visible mass of the universe.		
c. *Students know* the evidence indicating that all elements with an atomic number greater than that of lithium have been formed by nuclear fusion in stars.		
d. *Students know* that stars differ in their life cycles and that visual, radio, and X-ray telescopes may be used to collect data that reveal those differences.		

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e.* *Students know* accelerators boost subatomic particles to energy levels that simulate conditions in the stars and in the early history of the universe before stars formed.		
f.* *Students know* the evidence indicating that the color, brightness, and evolution of a star are determined by a balance between gravitational collapse and nuclear fusion.		
g.* *Students know* how a red-shift from distant galaxies and the cosmic background radiation provide evidence for the "big bang" model that suggests that the universe has been expanding for 10 to 20 billion years.		
Total Items in **EARTH'S PLACE IN THE UNIVERSE**	**15**	**25%**
Dynamic Earth Processes		
3. Plate tectonics operating over geologic time has changed the patterns of land, sea, and mountains on Earth's surface. As the basis for understanding this concept:	1	2%
a. *Students know* features of the ocean floor (magnetic patterns, age, and sea-floor topography) provide evidence of plate tectonics.		
b. *Students know* the principle structures that form at the three different kinds of plate boundaries.		
c. *Students know* how to explain the properties of rocks based on the physical and chemical conditions in which they formed, including plate tectonic processes.		
d. *Students know* why and how earthquakes occur and the scales used to measure their intensity and magnitude.		
e. *Students know* there are two kinds of volcanoes: one kind with violent eruptions producing steep slopes and the other kind with voluminous lava flows producing gentle slopes.		
f.* *Students know* the explanation for the location and properties of volcanoes that are due to hot spots and the explanation for those that are due to subduction.		
Total Items in **DYNAMIC EARTH PROCESSES**	**1**	**2%**

EARTH SCIENCES	ITEMS	PERCENT
Energy In The Earth System		
4. Energy enters the Earth system primarily as solar radiation and eventually escapes as heat. As a basis for understanding this concept:	1	1.5%
a. *Students know* the relative amount of incoming solar energy compared with Earth's internal energy and the energy used by society.		
b. *Students know* the fate of incoming solar radiation in terms of reflection, absorption, and photosynthesis.		
c. *Students know* the different atmospheric gases that absorb the Earth's thermal radiation and the mechanism and significance of the greenhouse effect.		
d. *Students know* the differing greenhouse conditions on Earth, Mars, and Venus; the origins of those conditions; and the climatic consequences of each.		
5. Heating of Earth's surface and atmosphere by the sun drives convection within the atmosphere and oceans, producing winds and ocean currents. As a basis for understanding this concept:	1	1.5%
a. *Students know* how differential heating of Earth results in circulation patterns in the atmosphere and oceans that globally distribute the heat.		
b. *Students know* the relationship between the rotation of Earth and the circular motions of ocean currents and air in pressure centers.		
c. *Students know* the origin and effects of temperature inversions.		
d. *Students know* properties of ocean water, such as temperature and salinity, can be used to explain the layered structure of the oceans, the generation of horizontal and vertical ocean currents, and the geographic distribution of marine organisms.		
e. *Students know* rain forests and deserts on Earth are distributed in bands at specific latitudes.		
f.* *Students know* the interaction of wind patterns, ocean currents, and mountain ranges results in the global pattern of latitudinal bands of rain forests and deserts.		
g.* *Students know* features of the ENSO (El Niño southern oscillation) cycle in terms of sea-surface and air temperature variations across the Pacific and some climatic results of this cycle.		

EARTH SCIENCES	ITEMS	PERCENT
6. Climate is the long-term average of a region's weather and depends on many factors. As a basis for understanding this concept:		
a. *Students know* weather (in the short run) and climate (in the long run) involve the transfer of energy into and out of the atmosphere.		
b. *Students know* the effects on climate of latitude, elevation, topography, and proximity to large bodies of water and cold or warm ocean currents.		
c. *Students know* how Earth's climate has changed over time, corresponding to changes in Earth's geography, atmospheric composition, and other factors, such as solar radiation and plate movement.		
d.**Students know* how computer models are used to predict the effects of the increase in greenhouse gases on climate for the planet as a whole and for specific regions.		
Total Items in **ENERGY IN THE EARTH SYSTEM**	**2**	**3%**
California Geology		
9. The geology of California underlies the state's wealth of natural resources as well as its natural hazards. As a basis for understanding this concept:	1	2%
a. *Students know* the resources of major economic importance in California and their relation to California's geology.		
b. *Students know* the principal natural hazards in different California regions and the geologic basis of those hazards.		
c. *Students know* the importance of water to society, the origins of California's fresh water, and the relationship between supply and need.		
d.* *Students know* how to analyze published geologic hazard maps of California and know how to use the map's information to identify evidence of geologic events of the past and predict geologic changes in the future.		
Total Items in **CALIFORNIA GEOLOGY**	**1**	**2%**
TOTAL IN EARTH SCIENCES	**19**	**32%**

CHEMISTRY	ITEMS	PERCENT
Atomic And Molecular Structure		
1. The periodic table displays the elements in increasing atomic number and shows how periodicity of the physical and chemical properties of the elements relates to atomic structure. As a basis for understanding this concept:	1	2%
a. *Students know* how to relate the position of an element in the periodic table to its atomic number and atomic mass.		
b. *Students know* how to use the periodic table to identify metals, semimetals, nonmetals, and halogens.		
c. *Students know* how to use the periodic table to identify alkali metals, alkaline earth metals and transition metals, trends in ionization energy, electronegativity, and the relative sizes of ions and atoms.		
d. *Students know* how to use the periodic table to determine the number of electrons available for bonding.		
e. *Students know* the nucleus of the atom is much smaller than the atom yet contains most of its mass.		
f.* *Students know* how to use the periodic table to identify the lanthanide, actinide, and transactinide elements and know that the transuranium elements were synthesized and identified in laboratory experiments through the use of nuclear accelerators.		
g.* *Students know* how to relate the position of an element in the periodic table to its quantum electron configuration and to its reactivity with other elements in the table.		
h.* *Students know* the experimental basis for Thomson's discovery of the electron, Rutherford's nuclear atom, Millikan's oil drop experiment, and Einstein's explanation of the photoelectric effect.		
i.* *Students know* the experimental basis for the development of the quantum theory of atomic structure and the historical importance of the Bohr model of the atom.		
j.* *Students know* that spectral lines are the result of transitions of electrons between energy levels and that these lines correspond to photons with a frequency related to the energy spacing between levels by using Planck's relationship ($E = hv$).		
Total Items in **ATOMIC AND MOLECULAR STRUCTURE**	**1**	**2%**
Chemical Bonds		
2. Biological, chemical, and physical properties of matter result from the ability of atoms to form bonds from electrostatic forces between electrons and protons and between atoms and molecules. As a basis for understanding this concept:	4	7%
a. *Students know* atoms combine to form molecules by sharing electrons to form covalent or metallic bonds or by exchanging electrons to form ionic bonds.		
b. *Students know* chemical bonds between atoms in molecules such as H_2, CH_4, NH_3, H_2CCH_2, N_2, Cl_2, and many large biological molecules are covalent.		

CHEMISTRY	ITEMS	PERCENT
c. *Students know* salt crystals, such as NaCl, are repeating patterns of positive and negative ions held together by electrostatic attraction.		
d. *Students know* the atoms and molecules in liquids move in a random pattern relative to one another because the intermolecular forces are too weak to hold the atoms or molecules in a solid form.		
e. *Students know* how to draw Lewis dot structures.		
f.* *Students know* how to predict the shape of simple molecules and their polarity from Lewis dot structures.		
g.* *Students know* how electronegativity and ionization energy relate to bond formation.		
h.* *Students know* how to identify solids and liquids held together by Van der Waals forces or hydrogen bonding and relate these forces to volatility and boiling/melting point temperatures.		
Total Items in **CHEMICAL BONDS**	**4**	**7%**
Conservation Of Matter And Stoichiometry		
3. The conservation of atoms in chemical reactions leads to the principle of conservation of matter and the ability to calculate the mass of products and reactants. As a basis for understanding this concept:	11	18%
a. *Students know* how to describe chemical reactions by writing balanced equations.		
b. *Students know* the quantity *one mole* is set by defining one mole of carbon 12 atoms to have a mass of exactly 12 grams.		
c. *Students know* one mole equals 6.02×10^{23} particles (atoms or molecules).		
d. *Students know* how to determine the molar mass of a molecule from its chemical formula and a table of atomic masses and how to convert the mass of a molecular substance to moles, number of particles, or volume of gas at standard temperature and pressure.		
e. *Students know* how to calculate the masses of reactants and products in a chemical reaction from the mass of one of the reactants or products and the relevant atomic masses.		
f.* *Students know* how to calculate percent yield in a chemical reaction.		
g.* *Students know* how to identify reactions that involve oxidation and reduction and how to balance oxidation-reduction reactions.		
Total Items in **CONSERVATION OF MATTER AND STOICHIOMETRY**	**11**	**18%**
Chemical Thermodynamics		
7. Energy is exchanged or transformed in all chemical reactions and physical changes of matter. As a basis for understanding this concept:	2	3%
a. *Students know* how to describe temperature and heat flow in terms of the motion of molecules (or atoms).		
b. *Students know* chemical processes can either release (exothermic) or absorb (endothermic) thermal energy.		
c. *Students know* energy is released when a material condenses or freezes and is absorbed when a material evaporates or melts.		

CHEMISTRY	ITEMS	PERCENT
d. *Students know* how to solve problems involving heat flow and temperature changes, using known values of specific heat and latent heat of phase change.		
e.* *Students know* how to apply Hess's law to calculate enthalpy change in a reaction.		
f.* *Students know* how to use the Gibbs free energy equation to determine whether a reaction would be spontaneous.		
Total Items in **CHEMICAL THERMODYNAMICS**	**2**	**3%**
Chemical Equilibrium		
9. Chemical equilibrium is a dynamic process at the molecular level. As a basis for understanding this concept:	1	2%
a. *Students know* how to use LeChatelier's principle to predict the effect of changes in concentration, temperature, and pressure.		
b. *Students know* equilibrium is established when forward and reverse reaction rates are equal.		
c.**Students know* how to write and calculate an equilibrium constant expression for a reaction.		
Total Items in **CHEMICAL EQUILIBRIUM**	**1**	**2%**
TOTAL IN CHEMISTRY	**19**	**32%**

PHYSICS	ITEMS	PERCENT
Motions And Forces		
1. Newton's laws predict the motion of most objects. As a basis for understanding this concept:	12	20%
a. *Students know* how to solve problems that involve constant speed and average speed.		
b. *Students know* that when forces are balanced, no acceleration occurs; thus an object continues to move at a constant speed or stays at rest (Newton's first law).		
c. *Students know* how to apply the law $F = ma$ to solve one-dimensional motion problems that involve constant forces (Newton's second law).		
d. *Students know* that when one object exerts a force on a second object, the second object always exerts a force of equal magnitude and in the opposite direction (Newton's third law).		
e. *Students know* the relationship between the universal law of gravitation and the effect of gravity on an object at the surface of Earth.		
f. *Students know* applying a force to an object perpendicular to the direction of its motion causes the object to change direction but not speed (e.g., Earth's gravitational force causes a satellite in a circular orbit to change direction but not speed).		
g. *Students know* circular motion requires the application of a constant force directed toward the center of the circle.		

Motions And Forces		
h.* *Students know* Newton's laws are not exact but provide very good approximations unless an object is moving close to the speed of light or is small enough that quantum effects are important.		
i.* *Students know* how to solve two-dimensional trajectory problems.		
j.* *Students know* how to resolve two-dimensional vectors into their components and calculate the magnitude and direction of a vector from its components.		
k.* *Students know* how to solve two-dimensional problems involving balanced forces (statics).		
l.* *Students know* how to solve problems in circular motion by using the formula for centripetal acceleration in the following form: $a = v^2/r$.		
m.* *Students know* how to solve problems involving the forces between two electric charges at a distance (Coulomb's law) or the forces between two masses at a distance (universal gravitation).		
Total items in **MOTIONS AND FORCES**	**12**	**20%**
Waves		
4. Waves have characteristic properties that do not depend on the type of wave. As a basis for understanding this concept:	5	8%
a. *Students know* waves carry energy from one place to another.		
b. *Students know* how to identify transverse and longitudinal waves in mechanical media, such as springs and ropes, and on the earth (seismic waves).		
c. *Students know* how to solve problems involving wavelength, frequency, and wave speed.		
d. *Students know* sound is a longitudinal wave whose speed depends on the properties of the medium in which it propagates.		
e. *Students know* radio waves, light, and X-rays are different wavelength bands in the spectrum of electromagnetic waves whose speed in a vacuum is approximately 3×10^8 m/s (186,000 miles/second).		
f. *Students know* how to identify the characteristic properties of waves: interference (beats), diffraction, refraction, Doppler effect, and polarization.		
Total Items in **WAVES**	**5**	**8%**
TOTAL IN PHYSICS	**17**	**28%**

INVESTIGATION AND EXPERIMENTATION	ITEMS	PERCENT
1. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other four strands, students should develop their own questions and perform investigations. Students will:	5	8%
a. Select and use appropriate tools and technology (such as computer-linked probes, spreadsheets, and graphing calculators) 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 trigonometric, exponential, and logarithmic 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 the locations, sequences, or time intervals that are characteristic of natural phenomena (e.g., relative ages of rocks, locations of planets over time, and succession of species in an ecosystem).		
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 by researching the literature, analyzing data, and communicating the findings. Examples of issues include irradiation of food, cloning of animals by somatic cell nuclear transfer, choice of energy sources, and land and water use decisions in California.		
n. Know that when an observation does not agree with an accepted scientific theory, the observation is sometimes mistaken or fraudulent (e.g., the Piltdown Man fossil or unidentified flying objects) and that the theory is sometimes wrong (e.g., the Ptolemaic model of the movement of the Sun, Moon, and planets).		
Total Items in **INVESTIGATION AND EXPERIMENTATION**	**5**	**8%**
TOTAL ITEMS FOR INTEGRATED ECP TEST	**60**	**100%**