PETALUMA CITY SCHOOLS
CONTENT STANDARDS
WITH POWER STANDARDS IN BOLD

Grade Nine
Physical Science

Draft for pilot use in 2007-08.

The 9th grade Physical Science class is designed to expose students to the California State Standards in these areas:

- **Chemistry**
- **Earth Science**
- **Physics**
- **Investigation and Experimentation**

Further depth in Chemistry and Physics is provided in the high school courses with those names.

Some standards in each area are not addressed in this course. Those are marked as ***.

These standards were reviewed by a district committee in 2005-06.
Agreements were reached on which of the California State Content Standards to emphasize.

The bolded standards within this document are being proposed for priority teaching so that all students receive an equitable, aligned curriculum preparing them for success in school, on state tests and in life.

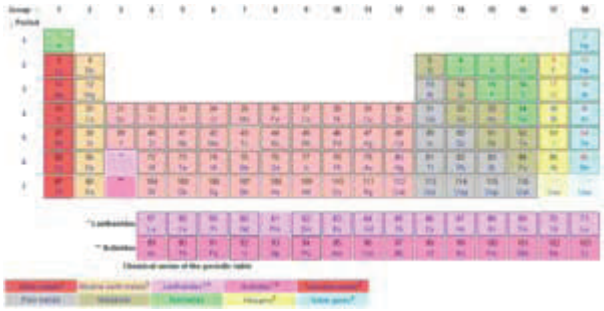
Grade Nine

Physical Science—designed to expose students to the California State Standards n Physics, Chemistry and Earth Science. Extended learning and more depth in Chemistry and Physics is provided by the high school subject-specific course of that name

Chemistry

⇒ 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:
  - **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.**



The periodic table of the chemical elements

⇒ 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:
  - **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.**
  - 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.

⇒ 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:
  - **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.

⇒ Gases and Their Properties

• 4 The kinetic molecular theory describes the motion of atoms and molecules and explains the properties of gases. As a basis for understanding this concept:

a. *Students know* the random motion of molecules and their collisions with a surface create the observable pressure on that surface.

b. *Students know* the random motion of molecules explains the diffusion of gases.

c. *Students know* how to apply the gas laws to relations between the pressure, temperature, and volume of any amount of an ideal gas or any mixture of ideal gases.

d. *Students know* the values and meanings of standard temperature and pressure (STP).

e. *Students know* how to convert between the Celsius and Kelvin temperature scales.

f. *Students know* there is no temperature lower than 0 Kelvin.

⇒ Acids and Bases

• 5 Acids, bases, and salts are three classes of compounds that form ions in water solutions. As a basis for understanding this concept:

a. ***Students know* the observable properties of acids, bases, and salt solutions.

b. **Students know* acids are hydrogen-ion-donating and bases are hydrogen-ion-accepting substances.

c. *Students know* strong acids and bases fully dissociate and weak acids and bases partially dissociate.

d. *Students know* how to use the pH scale to characterize acid and base solutions.

Litmus scale—red acid, blue base

⇒ Solutions

• 6 Solutions are homogeneous mixtures of two or more substances. As a basis for understanding this concept:

a. **Students know* the definitions of solute and solvent.

b. *Students know* how to describe the dissolving process at the molecular level by using the concept of random molecular motion.

c. *Students know* temperature, pressure, and surface area affect the dissolving process.

d. *Students know* how to calculate the concentration of a solute in terms of grams per liter, molarity, parts per million, and percent composition.

⇒ Chemical Thermodynamics

• 7 Energy is exchanged or transformed in all chemical reactions and physical changes of matter. As a basis for understanding this concept:

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.

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.

⇒ Reaction Rates

• 8 Chemical reaction rates depend on factors that influence the frequency of collision of reactant molecules. As a basis for understanding this concept:

a. ●*Students know* the rate of reaction is the decrease in concentration of reactants or the increase in concentration of products with time.

b. *Students know* how reaction rates depend on such factors as concentration, temperature, and pressure.

c. ●*Students know* the role a catalyst plays in increasing the reaction rate.

⇒ Chemical Equilibrium

• 9 Chemical equilibrium is a dynamic process at the molecular level. As a basis for understanding this concept:

a. ●*Students know* how to use Le Chatelier'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.

⇒ Organic Chemistry and Biochemistry

• 10 The bonding characteristics of carbon allow the formation of many different organic molecules of varied sizes, shapes, and chemical properties and provide the biochemical basis of life. As a basis for understanding this concept:

a. *Students know* large molecules (polymers), such as proteins, nucleic acids, and starch, are formed by repetitive combinations of simple subunits.

b. *Students know* the bonding characteristics of carbon that result in the formation of a large variety of structures ranging from simple hydrocarbons to complex polymers and biological molecules.

c. *Students know* amino acids are the building blocks of proteins.

⇒ Nuclear Processes

• 11 Nuclear processes are those in which an atomic nucleus changes, including radioactive decay of naturally occurring and human-made isotopes, nuclear fission, and nuclear fusion. As a basis for understanding this concept:

a. *Students know* protons and neutrons in the nucleus are held together by nuclear forces that overcome the electromagnetic repulsion between the protons.

b. *Students know* the energy release per gram of material is much larger in nuclear fusion or fission reactions than in chemical reactions. The change in mass (calculated by $E = mc^2$) is small but significant in nuclear reactions.

c. *Students know* some naturally occurring isotopes of elements are radioactive, as are isotopes formed in nuclear reactions.

d. *Students know* the three most common forms of radioactive decay (alpha, beta, and gamma) and know how the nucleus changes in each type of decay.

e. *Students know* alpha, beta, and gamma radiation produce different amounts and kinds of damage in matter and have different penetrations.

Radioactive

Earth Science

⇒ Earth's Place in the Universe

• 1 Astronomy and planetary exploration reveal the solar system's structure, scale, and change over time. As a ba-

sis for understanding this concept:

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.**

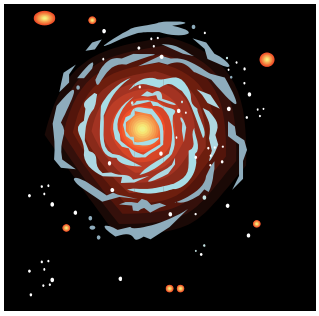
c. ***Students know*** **the evidence from geological studies of Earth and other planets suggest that the early Earth was very different from Earth today.**

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:

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.

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 the 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.

⇒ 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:

a. ***Students know*** **features of the ocean floor (magnetic patterns, age, and sea-floor topography) provide evidence of plate tectonics.**

b. ***Students know*** **the principal 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.

⇒ 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:

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:

  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.

- 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.

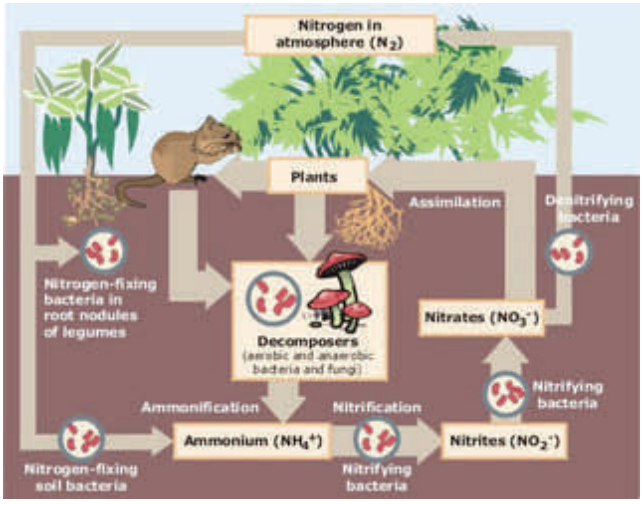
⇒ Biogeochemical Cycles

- 7 Each element on Earth moves among reservoirs, which exist in the solid earth, in oceans, in the atmosphere, and within and among organisms as part of biogeochemical cycles. As a basis for understanding this concept

  a. **Students know the carbon cycle of photosynthesis and respiration and the nitrogen cycle.**

  b. **Students know the global carbon cycle: the different physical and chemical forms of carbon in the atmosphere, oceans, biomass, fossil fuels, and the movement of carbon among these reservoirs.**

  c. Students know the movement of matter among reservoirs is driven by Earth's internal and external sources of energy.



Nitrogen Cycle

d. ***Students know the relative residence times and flow characteristics of carbon in and out of its different reservoirs.

⇒ Structure and Composition of the Atmosphere

- 8 Life has changed Earth's atmosphere, and changes in the atmosphere affect conditions for life. As a basis for understanding this concept:
  - **a. Students know the thermal structure and chemical composition of the atmosphere.**
  - **b. Students know how the composition of Earth's atmosphere has evolved over geologic time and know the effect of outgassing, the variations of carbon dioxide concentration, and the origin of atmospheric oxygen.**
  - **c. Students know the location of the ozone layer in the upper atmosphere, its role in absorbing ultraviolet radiation, and the way in which this layer varies both naturally and in response to human activities.**

⇒ 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:
  - **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.

Physics

⇒ Waves

- 4 Waves have characteristic properties that do not depend on the type of wave. As a basis for understanding this concept:
  - 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.**

⇒ Electric and Magnetic Phenomena

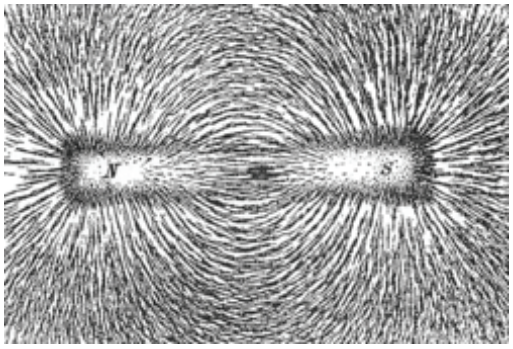
- 5 Electric and magnetic phenomena are related and have many practical applications. As a basis for understanding this concept:
  - **a. *Students know* how to predict the voltage or current in simple direct current (DC) electric circuits constructed from batteries, wires, resistors, and capacitors.**
  - **b. *Students know* how to solve problems involving Ohm's law.**
  - c. *Students know* any resistive element in a DC circuit dissipates energy, which heats the resistor. Students can calculate the power (rate of energy dissipation) in any resistive circuit element by using the formula

Power = IR (potential difference) × I (current) = I^2R.

d. *Students know* the properties of transistors and the role of transistors in electric circuits.

e. *Students know* charged particles are sources of electric fields and are subject to the forces of the electric fields from other charges.

f. *Students know* magnetic materials and electric currents (moving electric charges) are sources of magnetic fields and are subject to forces arising from the magnetic fields of other sources.



Magnetic field lines shown by iron filings

g. *Students know* how to determine the direction of a magnetic field produced by a current flowing in a straight wire or in a coil.

h. *Students know* changing magnetic fields produce electric fields, thereby inducing currents in nearby conductors.

i. *Students know* plasmas, the fourth state of matter, contain ions or free electrons or both and conduct electricity.

Investigation and Experimentation

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:

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 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 and 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, location 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 situation 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).

* = Introduced in 8th Grade ** = Covered in 8th Grade

● = Teacher Discretion *** = Not addressed in 9th grade class