CALIFORNIA STANDARDS TEST
CHEMISTRY
(Blueprint adopted by the State Board of Education 10/02)

CALIFORNIA CONTENT STANDARDS: CHEMISTRY	# of Items	%
Atomic and Molecular Structure	**6**	**10.0%**
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.	1	
b. *Students know* how to use the periodic table to identify metals, semimetals, non-metals, and halogens.	1	
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.	2	
d. *Students know* how to use the periodic table to determine the number of electrons available for bonding.	1	
e. *Students know* the nucleus of the atom is much smaller than the atom yet contains most of its mass.	1	

ELECTRICAL FORCE

– attraction of oppos chg and repulsion of like chg

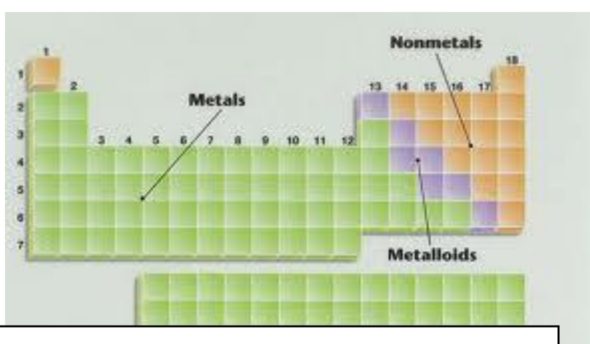
– depends upon chg (↑chg ↑force)

and distance(↑distance↓ ↑force) – this factor squared so bigger impact

IONIZATION ENERGY (IE) – energy required to remove e-

neg e- attracted to pos. protons in nucleus electrical force – so energy is required to break the attraction

ELECTRONEGATIVITY – pull on e- in bond



NONMETALS –
physical properties – dull, brittle,
do not conduct electricity
chemical properties – tend to gain e-
due to high IE and high EN

METALS –
physical properties – shiny, ductile, malleable,
conduct electricity
chemical properties – tend to lose e-
due to low IE and low EN

…ted every two years; 2/5 = rotated every five years)
…epartment of Education

CALIFORNIA STANDARDS TEST
CHEMISTRY
(Blueprint adopted by the State Board of Education 10/02)

Across the table – last e- in same level
– same distance from nucleus
EN increases – more positive protons in nucleus – more pull
IE decreases – more pull in – so more energy to pull off e-
Size decreases – same level but more protons pull in smaller

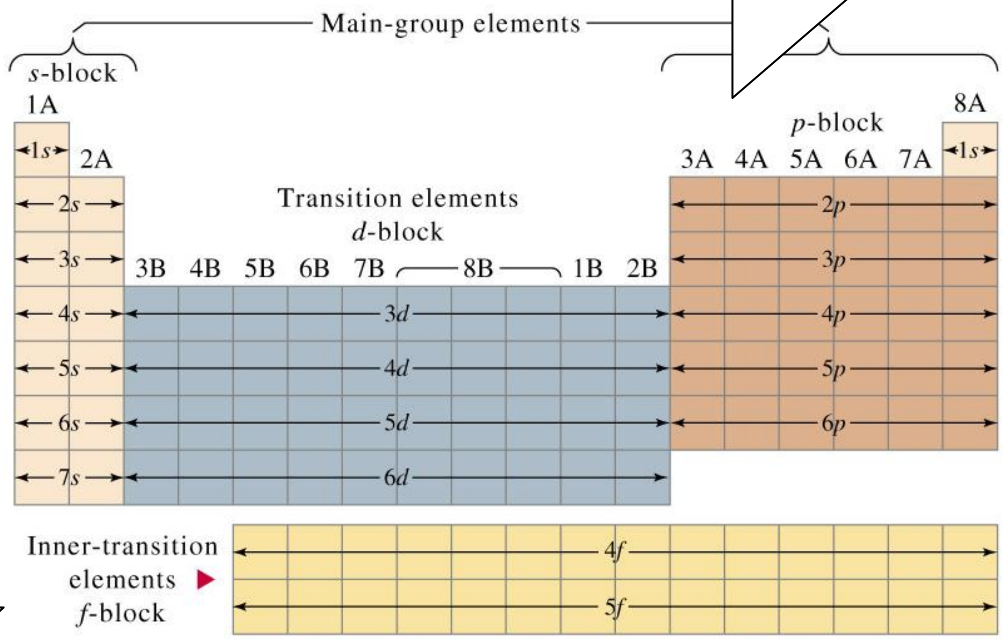
Down the table

Add another energy level

EN decreases – as last e- gets farther from nucleus – less pull

IE decreases – so less energy to pull off e-

Size increases – another layer of e-



Families – columns

Halogens column VIIA – seven valence e-
tend to gain 1 e-

Alkali metals column IA – only one valence e-
tend to lose 1 e-

Alkali Earth metals column IIA – only two valence e-
tend to lose 2 e-

Transition metals –middle of table (B columns)
Lose variable # e- due e- in d orbitals

Column # IA – VIIA
Column # tells the number of valence electrons available for bonding
Atoms gain lose or share electrons to form stable octet.

Alternate years
*** Fractional values indicate rotated standards (e.g., 1/2 = rotated every two years; 2/5 = rotated every five years)

Chemical Bonds	**7**	**11.7%**
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.	2	
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.	1	
c. *Students know* salt crystals, such as NaCl, are repeating patterns of positive and negative ions held together by electrostatic attraction.	1	
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.	1	
e. *Students know* how to draw Lewis dot structures.	2	

Atoms combine and form bonds to become more stable – all about their electrons and electrical force

COVALENT (Nm – Nm) – share electrons → molecules
Unequally – polar OR equally – nonpolar
Determine formula using pre-fixes (mono-, di-, tri-, tetra-)

IONIC (M – Nm) – lose and gain electrons → form ions
Oppositely charged ions attracted
Determine formula using charges on ions – sum of ZERO

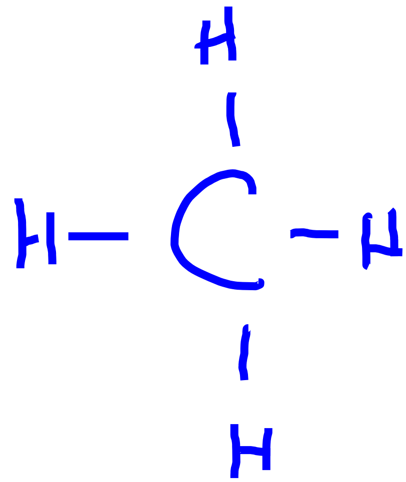
METALLIC (M – M) –
sea of free moving electrons shared between all atoms

Rules for Drawing Lewis Structures:

Count # valence e- for each atom (# e- available)
Draw skeleton structure with first atom as central atom unless H
Give each atom a stable octet except H (only gets two)
Check did you use only the # e- available

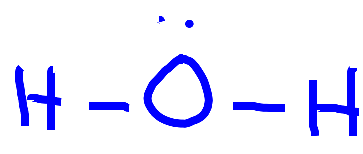
- **If used more than available – add double or triple bonds**
- **If used less than expand octet of central atom**

		valence electrons	single bonds	remaining electrons	final Lewis structure	number of electrons
a.	HF	1 + 7 = 8	H—F	6	H—F̤̈:	H: 2 F: 8
b.	N_2	5 + 5 = 10	N—N	8	:N≡N:	N: 8 N: 8
c.	NH_3	5 + 3(1) = 8	H—N—H | H	2	H—N̈—H | H	H: 2 N: 8
d.	CH_4	4 + 4(1) = 8	H | H—C—H | H	0	H | H—C—H | H	H: 2 C: 8
e.	CF_4	4 + 4(7) = 32	F | F—C—F | F	24	:F̤̈: | :F̤̈—C—F̤̈: | :F̤̈:	F: 8 C: 8
f.	NO^+	5 + 6 − 1 = 10	N—O	8	$[:N\equiv O:]^+$	N: 8 O: 8



H_2O

2 . 1



CALIFORNIA STANDARDS TEST
CHEMISTRY
(Blueprint adopted by the State Board of Education 10/02)

CALIFORNIA CONTENT STANDARDS: CHEMISTRY	# of Items	%
Conservation of Matter and Stoichiometry	**10**	**16.7%**
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.	2	
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.	1	
c. *Students know* one mole equals 6.02×10^{23} particles (atoms or molecules).	1	
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.	3	
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.	3	

Balance equations to show conservation of mass – same number of "atoms" on both sides

Moles – counting the number of particles
One mole is 6.02×10^{23} particles

Molar Mass – mass of one mole in grams calculated using the masses on periodic table

Calculating – What are you looking for? What info are you given? If different stuff – need balanced equation AND moles.

* Not assessed
** Alternate years
*** Fractional values indicate rotated standards (e.g., 1/2 = rotated every two years; 2/5 = rotated every five years)

CALIFORNIA STANDARDS TEST
CHEMISTRY
(Blueprint adopted by the State Board of Education 10/02)

CALIFORNIA CONTENT STANDARDS: CHEMISTRY	# of Items	%
Gases and Their Properties	**6**	**10.0%**
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.	1	
b. *Students know* the random motion of molecules explains the diffusion of gases.	1	
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.	2	
d. *Students know* the values and meanings of standard temperature and pressure (STP).	1	
e. *Students know* how to convert between the Celsius and Kelvin temperature scales.	1/2***	
f. *Students know* there is no temperature lower than 0 Kelvin.	1/2***	

Temperature - AVERAGE KINETIC ENERGY OF THE PARTICLES

Kelvins must be used for all gas laws – an absolute temperature scale

Pressure - COLLISIONS OF THE PARTICLES WITH SQUARE

STP – Standard Temperature and Pressure
0^{O}C or 273 K   1 atm or 760 mmHg
1 moles of gas of any gas at STP is 22.4 Liters

Combined Gas Law – Relating Pressure, Temperature and Volume.

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

Notice – Volume and Temperature directly related
Increase Temp → Increase Volume
Moving with more KE particles collide more and push out the sides of container to expand

Notice – Pressure and Temperature directly related
Increase Temp → Increase Pressure
Moving with more KE particles collide more
If they cannot push out sides pressure increases

Notice – Pressure and Volume inversely related
Decrease Volume → Increase Pressure
With less space to move within particles collide more pressure increases

* Not assessed
** Alternate years
*** Fractional values indicate rotated standards (e.
©

CALIFORNIA STANDARDS TEST
CHEMISTRY
(Blueprint adopted by the State Board of Education 10/02)

Acids and Bases	**5**	**8.3%**
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.	2	
b. *Students know* acids are hydrogen-ion-donating and bases are hydrogen-ion-accepting substances.	1	
c. *Students know* strong acids and bases fully dissociate and weak acids and bases partially dissociate.	1	
d. *Students know* how to use the pH scale to characterize acid and base solutions.	1	

ACIDS - sour, pH below 7 – example lemon juice and vinegar
MORE H+ ions than OH- ions
Donate H+ (protons) ions
Strong Acids – completely split up into H+ ions and anion
Weak Acids – only partially ionize (reversible)

BASES - bitter and slippery, pH above 7 – example soap
MORE OH- ions than H+ ions
Accept H+ (protons) ions

NEUTRAL - pH = 7 neither acid nor base
 # H+ ions = # OH- ions

pH scale based upon the –log of [H+] – an exponential scale where is increment represents a change based upon a power of ten
example pH of 1 is 100 times more concentrated than pH of 3
each jump ten times more or less

* Not assessed
** Alternate years
*** Fractional values indicate rotated standards (e.g., 1/2 = rotated every two years; 2/5 = rotated every five years)

CALIFORNIA STANDARDS TEST
CHEMISTRY
(Blueprint adopted by the State Board of Education 10/02)

CALIFORNIA CONTENT STANDARDS: CHEMISTRY	# of Items	%
Solutions	**3**	**5.0%**
6. Solutions are homogenous mixtures of two or more substances. As a basis for understanding this concept:		
a. *Students know* the definitions of *solute* and *solvent*.	1	
b. *Students know* how to describe the dissolving process at the molecular level by using the concept of random molecular motion.	1	
c. *Students know* temperature, pressure, and surface area affect the dissolving process.	1/2***	
d. *Students know* how to calculate the concentration of a solute in terms of grams per liter, molarity, parts per million, and percent composition.	1/2***	

Salt water solution – example of ionic compound dissolved in water
– salt dissolves in water to form a clear homogenous solution
– water molecules collide with solid salt and break ionic bonds between the ions so that salt is dispersed between water molecules forming ion-dipole attractions to water molecules

Sugar water solution – ex. of covalent compound dissolved in water
water molecules collide with solid sugar and break dipole-dipole attractions between sugar molecules so that sugar is dispersed between water molecules forming dipoel-dipole attractions between polar sugar molecules and polar water molecules

SOLUTE - stuff dissolved example the salt or the sugar

SOLVENT- medium in which it is dissolved example the water

INCREASE TEMP - particles move faster – collide more – dissolves faster

INCREASE SURFACE AREA - more particles on surface – collide more – dissolves faster

MOLARITY - concentration in moles of solute /Liter of solution

* Not assessed
** Alternate years
*** Fractional values indicate rotated standards (e.g., 1/2 = rotated every two years; 2/5 = rotated every five years)

Chemical Thermodynamics	**5**	**8.3%**
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).	1	
b. *Students know* chemical processes can either release (exothermic) or absorb (endothermic) thermal energy.	1	
c. *Students know* energy is released when a material condenses or freezes and is absorbed when a material evaporates or melts.	1	
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.	2	

TEMP - average kinetic energy

HEAT - KE transferred from hot to cold
Calculated using the equation $q = mC\Delta T$
m = mass of water in calorimeter
C = specific heat of water 4.18 J/g^{o}C or 1 calorie/g^{o}C

EXOTHERMIC - Energy transferred OUT of system to surroundings
Ex. Heat packs – as liquid solidified your hand (surroundings) felt HOT
– so hand gained KE (increase temp = increase KE)
That KE came from the phase change as attractions formed

ENDOTHERMIC - Energy transferred INTO system from surroundings
Ex. Ice cubes melts – as solid becomes liquid
your hand (surroundings) felt COLD
– so hand lost KE (decrease temp = decrease KE)
That KE went into the melting of ice to break attractions

As heat is transferred in – particles may gain either
KE --- increase temperature
or
PE --- increase enthalpy – energy went into break attractions

Reaction Rates	**4**	**6.7%**
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.	1	
b. *Students know* how reaction rates depend on such factors as concentration, temperature, and pressure.	1 or 2**	
c. *Students know* the role a catalyst plays in increasing the reaction rate.	1 or 2**	

COLLISION MODEL of reactions

In order to react the particles must collide with enough KE to break attractions (activation energy)

INCREASE TEMP - particles move faster – collide more
– so more collisions are effective (have enough KE to break bonds) and reaction is faster

INCREASE SURFACE AREA - more particles on surface – collide more –
– so more collisions are effective and reaction is faster

INCREASE CONCENTRATION - more particles in same volume – collide more –
– so more collisions are effective and reaction is faster

INCREASE PRESSURE - particles collide more –
– so more collisions are effective and reaction is faster

CATALYST - reduces the activation energy – so less energy is required for a collision to be effective (less KE needed to break bonds)
– so more collisions have enough KE to break bonds and reaction is faster

* Not assessed
** Alternate years
*** Fractional values indicate rotated standards (e.g., 1/2 = rotated every two years; 2/5 = rotated every five years)

CALIFORNIA STANDARDS TEST
CHEMISTRY
(Blueprint adopted by the State Board of Education 10/02)

CALIFORNIA CONTENT STANDARDS: CHEMISTRY	# of Items	%
Chemical Equilibrium	**4**	**6.7%**
9. Chemical equilibrium is a dynamic process at the molecular level. As a basis for understanding this concept:		
a. *Students know* how to use LeChatelier's principle to predict the effect of changes in concentration, temperature, and pressure.	3	
b. *Students know* equilibrium is established when forward and reverse reaction rates are equal.	1	

EQUILIBRIUM – Reactants ⇆ Products

RATE OF FORWARD REACTION

EQUALS

RATE OF REVERSE REACTION

So

Things remain constant

as though the reactions have stopped

but both reactions are still occurring

Le Chatelier's Principle – disruption in equilibrium a change that affects rates

The system will respond to offset any change that disturbs equilibrium.

Reactants ⇆ Products

If the disturbance is adding reactant –

The system will respond to remove reactant

So shift RIGHT (towards products – away reactants)

If the disturbance is removing reactant –

The system will respond to replace reactant

So shift LEFT (towards reactants)

If the disturbance is increasing pressure –

The system will respond to decrease pressure

So shift towards whichever side has less molecules

→ less collisions

CALIFORNIA STANDARDS TEST
CHEMISTRY

(Blueprint adopted by the State Board of Education 10/02)

Organic Chemistry and Biochemistry	**2**	**3.3%**
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.	1	
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.	1/2***	
c. *Students know* amino acids are the building blocks of proteins.	1/2***	

CARBON – with four valence electrons forms four covalent bonds – very versatile

Biochemistry is all based upon carbon molecules

- Glucose – string together a polymer called starch
    - Both a significant PE source for living things
- Amino acids – string together a polymer called protein
    - Enzymes are all proteins – catalysts for biochemical reactions
- DNA is a polymer string of nucleic acids

Plastics are polymers - strings of repeating base units

* Not assessed
** Alternate years
*** Fractional values indicate rotated standards (e.g., 1/2 = rotated every two years; 2/5 = rotated every five years)

Nuclear Processes	**2**	**3.3%**
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.	2/5***	
b. *Students know* the energy release per gram of material is much larger in nuclear fusion (little nuclei combine) or fission (big nuclei split) reactions than in chemical reactions. The change in mass (calculated by $E=mc^2$) is small but significant in nuclear reactions.	2/5***	
c. *Students know* some naturally occurring isotopes of elements are radioactive, as are isotopes formed in nuclear reactions.	2/5***	
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.	2/5***	
e. *Students know* alpha, beta, and gamma radiation produce different amounts and kinds of damage in matter and have different penetrations.	2/5***	

Nucleus – positive protons would repel (electrical force) stronger force must keep protons and neutrons together in nucleus (nuclear force)

Different isotopes of same element – same # protons but different # neutrons

Ex. Stable C-12 isotope has 6 protons and 6 neutrons (mass# of 12 = #p + #n)

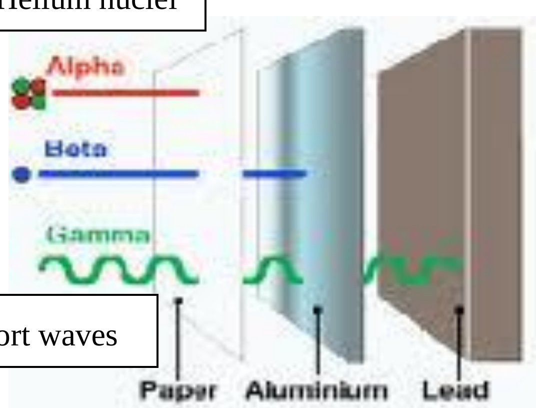
But C-14 isotope has 6 protons and 8 neutrons and is an unstable nucleus that will change to become stable radioactive

$^{14}_{6}C \rightarrow {}^{14}_{7}N + {}^{0}_{-1}e$ an example of beta decay – an electron is emitted

Alpha α Helium nuclei

Beta β electron

Gamma γ short waves



RADIOACTIVE DECAY – unstable nucleus
Balance the top (mass #) and bottom (charge)numbers

ALPHA DECAY – nucleus emits helium nucleus

$$^{242}_{94}Pu \longrightarrow {}^{4}_{2}He + \_\_\_\_\_$$

BETA DECAY – nucleus emits an electron

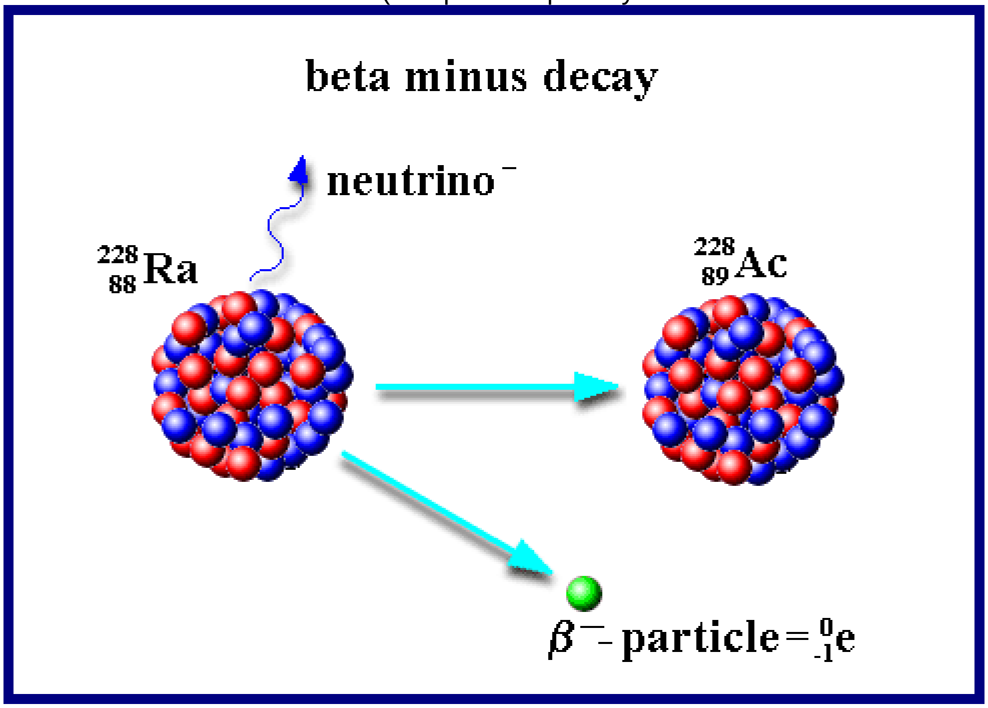
$$^{234}_{90}Th \rightarrow {}^{0}_{-1}e + {}^{234}_{91}\_\_\_$$

* Not assessed
** Alternate years
*** Fractional values indicate rotated standards (e.g., 1/2 = rotated every two years; 2/5 = rotated every five years)

CALIFORNIA STANDARDS TEST
CHEMISTRY
(Blueprint adopted by the State Board of Education 10/02)

CALIFORNIA CONTENT STANDARDS: CHEMISTRY	# of Items	%
Investigation and Experimentation	**6**	**10.0%**
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:		
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	**60**	**100%**

* Not assessed
** Alternate years
*** Fractional values indicate rotated standards (e.g., 1/2 = rotated every two years; 2/5 = rotated every five years)


beta minus decay
neutrino
228 88 Ra
228 89 Ac
β⁻- particle = 0 -1 e