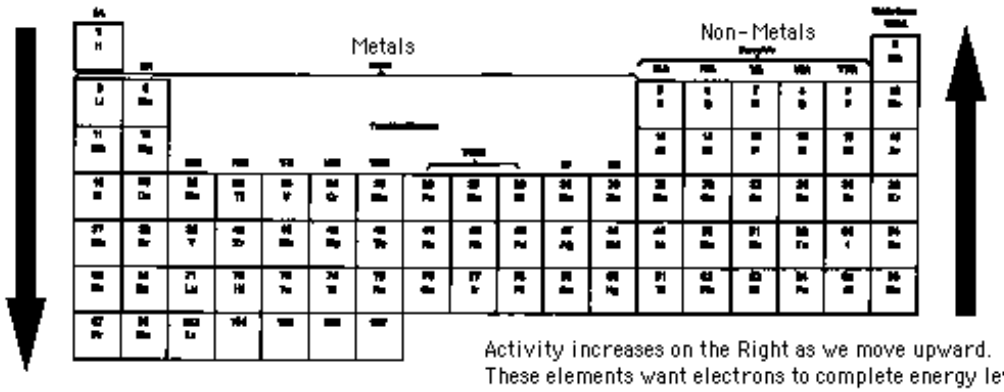
State Standards Chemistry Exam Review

It is essential that you do well on this exam! Your score will be placed on your transcript where it can help you to obtain scholarships and admission to universities. The test is designed to make you think, not just memorize facts. You will have to apply your knowledge to solve the problems.

Expect many questions involving the periodic table. Remember that it is organized into families of elements in columns. Each family has similar properties and oxidation states (valences). The Alkali Metals (first column) lose electrons easily so they are super reactive (blam in water). The Halogens on the left have high electron affinity (want badly to gain an electron). They are super reactive non-metals. The Noble Gases have filled energy levels and are satisfied loafers.



THE PERIODIC TABLE is organized by the regularly repeating pattern of chemical properties of the elements. Each column is a family of elements having similar properties. The properties are a periodic function of the atomic numbers. Atomic number is symbolized "Z".

The first column is the Alkali metals, they react vigorously with water to give hydrogen gas. They are Li, Na, K, Rb, Cs, and Fr. Francium is a man-made radioactive element.

The second column is the Alkaline Earth elements. They are active, but much less so than the previous column. They have outer s orbitals filled. This is more stable than half-filled. Less active than column I.

The transition metals have electrons filling d sub levels. They, used alone or as alloys, are our principal structural metals.

An alloy is a mixture of metals, a solid solution.

The seventh column is the Halogens (salt formers). These are the deadly F, Cl, Br, I, and At.

The eighth column is the noble gases. These loafers are most inactive. Only extreme measures can make them react. They are He, Ne, Ar, Kr, Xe, and Rn.

The Lanthanides and Actinides are the two rows at the bottom of the chart. Each of these two series fit into one spot (Lanthanides in the lanthanum place, and Actinides into the actinium place). The reason for this is because electrons are being added to the 4f sub level instead of to a sub level of the sixth or outer level. Hence they all have the same oxidation state (+3 valence) and similar properties.

Elements from the opposite sides form **IONIC** bonds (electrons transferred, the rip-off). e.g. NaCl.

Elements from the same side share electrons to form COVALENT bonds. e.g. CBr_4..

Terms, Definitions, Etc.

DENSITY is equal to mass/volume. e.g.. D of H_2O = 1.00 g/cm^3.

PHYSICAL PROPERTIES are such things color, density, hardness, ductility, malleability, solubility, heat conduction, electrical properties, melting, boiling point and vapor pressure.

CHEMICAL PROPERTIES are such things as reactivity, oxidation states, flammability, and corrosiveness.

OXIDATION NUMBERS or VALENCES are the number or electrons lost, gained or shared in a chemical reaction. Free elements have zero as an oxidation number.

OXIDATION is a gain in oxidation state (valence) caused by a loss of electrons. Cu ---> Cu^{+2} + 2 e^-

REDUCTION is a reduction in oxidation state caused by a gain of electrons. Al^{+3} + 3e^- ---> Al

EMPIRICAL FORMULA is the simplest whole number ratio of elements in a compound, i.e. CH_2.

MOLECULAR FORMULA shows the actual number of atoms in compound. Ex. C_2H_4.

THE MOLE is the number of atoms in the atomic mass of an element or the number of molecules in the molecular mass of a compound. It = 6.02 X 10^{23} atoms or molecules.

AN ELEMENT is the simplest form of matter.

A COMPOUND is two or more elements chemically combined.

AN ATOM is the smallest particle of a chemical element.

A MOLECULE is the smallest particle of a chemical compound. It contains two or more atoms.

ATOMIC NUMBER is the number of protons in the nucleus of an atom. It is the whole number on the periodic chart. It is also the number of electrons in a neutral atom (where protons = electrons).

ION is a charged atom or group of atoms. Ionization is caused by a gain or loss of electrons. A loss leaves a positive charge, a gain leaves a negative charge.

MASS NUMBER is the relative mass of the isotopes compared to that of Carbon^{12} whose mass is 12.0000 g/mol. It is not shown on the periodic chart. It is also equal to the sum of protons + neutrons inasmuch as protons and neutrons each have an atomic mass of 1 g/mol (amu = atomic mass unit).

ISOTOPES are the same elements with different mass numbers. This is caused by having a different number of neutrons in the nucleus. They are found on the chart of the nuclides.

ATOMIC MASS is the average mass of the isotopes of an element. It is the decimal number on the periodic chart. It depends upon both the isotopes' masses and the amount of each isotope.

MOLECULAR MASS (or Molar Mass) is the sum of the atomic masses of all the atoms in a molecule.

PROTON is a basic particle with a charge of +1 and a mass of 1g/mol (amu).

ELECTRON is a basic particle whose charge is -1 and whose mass is 1/2000 g/mol (amu).

NEUTRON is a basic particle whose charge is 0 and whose mass is 1 g/mol (amu).

NUCLEON refers to the particles in the nucleus-- Protons and Neutrons.

BETA PARTICLES are electrons produced in nuclear reactions. They are Electrons.

ALPHA PARTICLES are helium nuclei (no electrons) produced in nuclear reactions. They are helium ions, He^{+2}.

GAMMA RAYS are electromagnetic radiations beyond the X-rays in frequency. They are usually produced in nuclear reactions.

POSITRONS are electrons with a +1 charge. They are found in cosmic rays and in nuclear reactions. They are antimatter. When they meet an electron there is complete annihilation to give pure energy in the form of gamma rays. This is total matter and energy conversion by $E = mc^2$.

SPECTROSCOPY is the analysis of the lines of light emitted from excited atoms as the electrons drop back through their orbitals. These lines give the energy and distances of the electronic orbitals. From this we learn of the structure of the atom.

ORBITALS are the probability distributions of where electrons may be found in their atoms,

s -orbitals are spherical, p -orbitals are dumbbell shaped at 90^0 to each other.

LIGHT has both wave and particle properties.

ELECTRONS have both wave and particle properties.

De BROGLIE'S HYPOTHESIS states that electrons around atoms are in wave formation.

SCHROEDINGER'S WAVE EQUATION explains the shapes of the orbitals of the electrons around an atom. They are probability distributions. That is, there is a probability of finding an electron's position in a "cloud" around an atomic nucleus. The electron appears to be "spread out" as it orbits, filling its cloud.

QUANTUM NUMBERS describe the distance, shape, and orientation of the electronic orbitals.

THE PRINCIPAL QUANTUM NUMBER, n, gives the energy of the orbital. This is determined by the distance of the electron from the nucleus.

THE SECOND QUANTUM NUMBER, L, describes sub levels. The sub levels are called, s, p, d, f.

s orbitals are spherical in shape.

p orbitals are dumbbell shaped.

for other orbitals, see diagrams in *PowerPoint.*

THE PAULI EXCLUSION PRINCIPLE states that no two electrons may have the same quantum numbers. Only two electrons may occupy an orbital, but they must have opposite spins.

IONIZATION ENERGY is the minimum energy needed to remove an electron from an atom.

FIRST IONIZATION ENERGY takes off the first (outermost) electron.

SECOND AND SUBSEQUENT IONIZATION ENERGIES remove more electrons. The factors that determine the ionization energies are:

... distance from the nucleus (inverse square law)

... whether the orbital is filled or half-filled

... whether there is a noble gas structure

... the shielding effect of electrons in lower orbitals

... the ratio of protons to remaining electrons (guards to prisoners ratio).

METHODS OF IONIZATION include photoionization (using light energy like ultraviolet rays), Thermionic emission (using high temperature to boil off electrons), and electron bombardment (kick 'em out with a stream of electrons from another source, Sparky!).

PHOTOELECTRIC EFFECT is the removal of an electron (ionization) by photons of light. (Spy detector & infra-red spectroscope detector).

THE IONIC BOND is formed by electron transfer (the rip-off). An element whose electrons are loosely held (first and second columns of chart) surrenders its outer electron(s) to an element with high ionization energy (that therefore has a high electron affinity). The latter are the right hand side of the chart (like the halogens). When the transfer is completed, we have ions produced. The unlike charges of the ions holds them together electrically. Hence, the ionic bond. Elements from opposite sides of the chart have very different ionization energies, so that one atom is strong enough to rip-off electrons from the other.

NEGATIVE IONS are those which have gained electrons and therefore have more negative charges than positive charges (protons).

POSITIVE IONS are those which have lost electrons and therefore have fewer negative charges than positive charges (protons).

ONLY ELECTRONS FLOW to produce ions. The protons are deep down in the nucleus and stay there. (Except in nuclear reactions, but that's another story). So electrons are either added or subtracted to make ions.

THE COVALENT BOND is the sharing of electrons. There is no rip-off because the ionization energies of the atoms are not drastically different in magnitude. The result is neither atom is strong enough to remove the electron from the other atom. (Like two kids of equal strength trying to take a ball away from each other. They both can only hold on to it, neither succeeding in taking it and thus they are bonded).

VAN DER WAALS FORCES are weak interactions between **MOLECULES**. (Note: chemical bonds are the forces between **ATOMS** in a molecule, whereas van der waals forces are between MOLECULES). These weak forces are caused by the attraction between protons in one molecule and electrons in an adjacent molecule. Because of the greater distance between the particles in one molecule and another, van der waals forces are only 1/100 as strong as the covalent bond.

MELTING AND BOILING TEMPERATURES are caused by the van der waals interaction. Solids melt and liquids evaporate when the van der waals forces between molecules are broken.

THE HYDROGEN BOND is a special situation that exists between the hydrogen atom in one molecule (like water) and the oxygen atom in another molecule (like another water molecule). This bond is ten times weaker than the covalent bond, and ten times stronger than the van der waals force. The hydrogen bond caused water to have its unusual properties of high boiling point, high melting point, high surface tension, and its formation of the six-sided ring structure in ice. The latter causes water to expand upon freezing, become less dense, and the ice floats in water.

ACTIVATION ENERGY is the minimum energy needed to start a chemical reaction. It overcomes the repulsion of the negative electrons and breaks old bonds so that new bonds can be formed.

EXOTHERMIC REACTION gives out more energy than was put in to start the reaction. It has a negative ΔH. It keeps going after it is started. An example is a fire.

ENDOTHERMIC REACTION takes more energy to start it than it gives back. It has a positive ΔH. It needs energy to keep it going. An example is cooking.

ENTHALPY is the heat of reaction, either exothermic or endothermic. It is measured either in kilocalories/mole or kilojoules/mole. Check out the Activation Energy Curves in your notes.

REGELATION is the process of melting ice by pressure. Inasmuch as water expands upon freezing, pressure will reverse the process, forcing water to melt. Then when the pressure is released, the water re-freezes (re-gells).

SOLUTION is a homogeneous mixture of Solute and Solvent.

MOLAR CONCENTRATION of a Solution is the number of moles of solute in a liter of solution. **M=mol/L**

POLAR MOLECULES are asymmetrical so that the electrons are not equally distributed. There are charged ends (Dipoles), e.g. H_2O (bent), NH_3 (pyramidal). Polar solutes dissolve in polar solvents, e.g. NH_3 in H_2O .

NON-POLAR MOLECULES are symmetrical so that the electrons are balanced with no net charge, e.g. CH_4 (tetrahedral) and CO_2 (linear).

AN ACID is a compound that donates protons ($H^{+1}_{(aq)}$ ions), e.g. HCl, H_2SO4.

A BASE is a compound that accepts protons. It is usually a hydroxide, OH^{-1}, e.g. NaOH, NH_4OH.

ACID - BASE NEUTRALIZATION $H^{+1}_{(aq)} + OH^{-1}_{(aq)} \text{---> } H_2O_{(l)} + 13Kcal/mol.$

EQUILIBRIUM CONSTANT is the ratio of the [products] / [reactants]. In 2A + B ---> 3C + D

$K_{eq} = [C]^3 [D] / [A]^2 [B]$, [ ] is the concentration in M. **M = mol/L**. L = ml/1000ml/L

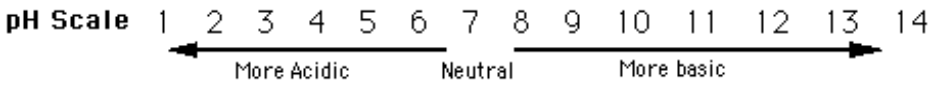
Omit the concentrations of solids and liquid water (they have constant concentrations).

EQUILIBRIUM CONSTANT for Water, $K_w = 1 \text{ X } 10^{-14}$ $H_2O_{(l)} \text{ <---> } H^{+1}_{(aq)} + OH^{-1}_{(aq)}$ so

$1 \text{ X } 10^{-14} = (x)(x)$, and therefore in pure water, $[H^{+1}] \text{ \& } [OH^{-1}] = 1 \text{ X } 10^{-7}$ M

THE pH SCALE is an abbreviation for the exponents of the $[H^{+1}]$ ions for solutions less than 1 M.

Because the pH numbers are exponents, a change of one pH is a **ten-fold** change in concentration!



CHEMICAL CALCULATIONS

PROBLEM SOLVING can best be reviewed by working the examples in your chemistry notebook. Try them first without peeking at the solutions. Then spend your time on those that you failed to solve.

PERCENTAGE COMPOSITION can be found by totaling the atomic masses of the atoms in the formula, dividing each mass by the total, and changing the results to %-age.

WRITING and BALANCING equations should be reviewed in your Big Chem notebook. Try them with the solutions covered, then check your results.

THE GAS LAWS:

Boyle's Law-- the volume of gas varies inversely as the pressure. (Squeeze it smaller).

Charles' Law-- the volume of gas varies directly as the absolute (K) temperature. (Heat it and it expands). **$K = {}^oC + 273^o$.**

PV = nRT where P = pressure, V = volume, n = number of moles, T = temp in K, R= the gas constant.

or **PV/T = P'V'/T'** Standard Temp & Press. = 273 K and 760 mm (or 101.3 kPa).

PARTIAL PRESSURE: When a gas is collected over water, $P_{(gas)} = P_{(atm)} - P_{(water\ vapor)}$

FINDING MOLES: The mole is the number of atoms or molecules in the Atomic or Molecular Mass.

mol = number of particles/6.02 X 10^{23} particles/mol,

- mol = mass/MM,

mol = L/22.4L/mol at STP, for solutions mol = ML (L=ml/1000ml/L),

mol = heat/heat/mol (ΔH).

GENERAL PROBLEMS:

- I. Balanced Equation,
- II. Get moles of given,
- III. Multiply by ratio to get moles of what is wanted,
- IV. change to grams, liters, or heat.

grams = (mol)(MM), liters = (mol)(22.4L/mol) at STP, heat =(mol)(ΔH) ΔH is in cal/mol or Kj/mol

Check you notes for more sample problems!