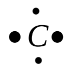
ELEMENTary Knowledge

__________ - indicates the sections that you will need to know for the ELEMENTary knowledge quiz

Polyatomic Ions		Equations	
Hydroxide	OH^-	density	$d = m/V$
Acetate	$C_2H_3O_2^-$	molarity	$M = mol/L$
Nitrate	NO_3^-	Dilution eqn	$M_1V_1=M_2V_2$
Nitrite	NO_2^-	Boyle's Law	$P_1V_1 = P_2V_2$
Carbonate	CO_3^{2-}	Charles' Law	$T_1/V_1 = T_2/V_2$
Chromate	CrO_4^{2-}	Gay-Lussac's Law	$T_1/P_1 = T_2/P_2$
Sulfate	SO_4^{2-}	Combined Gas Law	$P_1V_1/T_1 = P_2V_2/T_2$
Sulfite	SO_3^{2-}	Heat due to temp change	$q = mc\Delta T$
Phosphate	PO_4^{3-}	Heat due to melting	$q = mL_f$
Ammonium	NH_4^+	Heat due to vaporizing	$q = mL_v$
Hydronium	H_3O^+		
Acids			
Acetic acid	$HC_2H_3O_2$		
Carbonic acid	H_2CO_3		
Hydrochloric acid	HCl	Units	
Nitric acid	HNO_3	length	cm, m
Sulfuric acid	H_2SO_4	area	cm^2, m^2
Diatomic Gases		volume	cm^3, m^3, mL, L
Hydrogen	H_2	temperature	°C, K
Oxygen	O_2	mass	g, mg
Fluorine	F_2	density	g/mL
Bromine	Br_2	Amount of substance	Mole, particles (atoms or molecules)
Iodine	I_2	Pressure	atm, psi, mm Hg, torr, Pa, kPa
Nitrogen	N_2	Heat	Calories, joules
Chlorine	Cl_2		
Metric Prefixes		Other pertinent information	
1 km =	1000 m	Copper compounds	bluish in color
100 cm =	1 m	(aq)	aqueous (dissolved in water)
1000 mm =	1 m	(l)	pure liquid
		solute	gets dissolved
		solvent	does the dissolving
		solution	solute + solvent
		NaOH	Sodium hydroxide
		Atomic #	# of protons (whole # on P.T.)
		Mass #	Protons + neutrons
		Isotope	Same # of protons; different # of neutrons (i.e. Li-6 and Li-7)
		Atomic mass	Average mass of all isotopes (decimal # on P.T.)

Group #	# of valence electrons	<u>Bonding Types</u> *Metallic* (Metals only) *Ionic* (Metal/Nonmetal) *Molecular Covalent* (nonmetals; usually liquid or gas or soft solid) *Covalent Network* (nonmetals; hard solids)	 Dissolves, conducts dry Dissolves, conducts only when dissolved Usually dissolves, does not conduct dry nor dissolved Does not dissolve, does not conduct
Period #	# of shells (or energy levels)	<u>Ion Charges</u> Group 1 Group 2 Group 3 Group 4 Group 5 Group 6 Group 7 Group 8	 +1 (loses 1 e^-) +2 (loses 2 e^-) +3 (loses 3 e^-) +4/-4/0 -3 (gains 1 e^-) -2 (gains 2 e^-) -1 (gains 1 e^-) 0 (loses/gains none)
<u>Group names</u> Group 1 Group 2 Group 7 Group 8	 Alkali metals Alkaline earth metals Halogens Noble gases	<u>Naming compounds</u> Ionic Covalent	 End in –ide, -ate, or –ite (do NOT use prefixes!) End in –ide, must USE prefixes (mono, di, tri, etc.)
d-block	Transition metals	<u>Writing Formulas from names</u> Ionic Covalent	 Criss-cross charges (or draw pictures of valence electrons) Use prefixes
Atomic Radius (size)	Trend: Across a period, atoms get bigger Down a group, atoms get bigger (He is smallest; Fr is largest)		
<u>Flame Test</u> Strontium (Sr) Potassium (K) Copper (Cu) Sodium (Na)	 Red Pink Green Yellow/orange	Organic molecule	Contains carbon (organic molecules often contain H and O as well)
Atomic Spectrum	Fingerprint of atom	<u>Name endings</u> -one -ine -ate -ic acid -ol	<u>Smell</u> Minty Fishy Sweet Putrid Camphor
SiO_2	Sand	HONC 1234	Rule to figure out the # of bonds

Lewis dot symbol Ex: 	Group # = # of val. e^- = # of dots (unpaired dots are “open spots” available for bonding—tip: 8-group # = # of bonds)	electronegativity	The ability of an atom to attract bonded electrons to itself Trend: increases to the upper right (F is most; Fr is least)
<u>Functional Group</u> Ester Carboxylic acid Ketone Amine Alcohol Aldehyde		dipole	Contains *partially* positive and *partially* negative ends δ+H—Fδ- ↦
		Nonpolar covalent	Electronegativity difference: 0 to 0.45
		Polar covalent	Electronegativity difference: between 0.45 and 2.0
		Ionic	Electronegativity difference: greater than 2.0
Carboxylic acid + alcohol	→ ester + H_2O	Polar molecule	If molecule contains a dipole moment (assymetrical shape)
catalyst	Speeds up reaction (but not consumed in the reaction)	<u>Intermolecular Forces (IMF’s)</u> *Van der Waals (AKA London Dispersion Forces)* --weakest --result from induced dipoles	Nonpolar molecules ONLY contain these IMF’s (but ALL molecules contain these IMF’s) Ex: CH_4 and hexane
<u>VSEPR Theory</u>	*Geometry* / *Shape*		
4 domains (0 lone pairs)	Tetrahedral / Tetra-hedral		
4 domains (1 lone pair)	Tetrahedral / pyra-midal	*Dipole-Dipole Interactions* --medium strength --result from permanent dipoles	Polar molecules contain these (in addition to London dispersion forces) Ex: HCl
4 domains (2 lone pairs)	Tetrahedral / bent		
4 domains (3 lone pairs)	Tetrahedral / linear	*Hydrogen bonding* --strongest --results from a very, very strong dipole-dipole interaction	Polar molecules containing H bonded to N, O, or F contain these (+ London Dispersion) Ex: H_2O and NH_3
3 domains (0 lone pairs)	Trigonal Planar / trigonal planar		
2 domains (0 lone)	linear / linear		

M I N O H e o o x y t n n y d a s m g r l p e e o s o t n g l a e y l n s	Method to balance equations the quickest	To predict how to get the most product out	Get mol ratio of reactants from balanced eqn⇒mix reactants in that ratio.
		Stoichiometry mass to mass steps	Step 1: P.T. Bridge Step 2: mol ratio (name changes) Step 3: P.T. Bridge
Reaction Types Synthesis Decomposition Single replacement Double replacement Combustion	elem. + elem. → cpd cpd → elem. + elem. A + BC → AC + B AB + CD → BC + AD $C_xH_y + O_2 \rightarrow CO_2 + H_2O$ (Hint: when metal bonds to nonmetal, criss-cross to get formula. Also, when an element is formed, don't forget HOFBrINCl)	General Stoichiometry Steps	Step 1: Convert *to* moles g→mol (P.T.) particles→mol ($6.02x10^{23}$) MxL→mol (triangle) Step 2: Use mol ratio (name changes) Step 3: convert *from* moles mol→g (P.T.) mol→particles ($6.02x10^{23}$) mol→L (mol/M) triangle mol→M (mol/L) triangle
Lethal dose (LD_{50})	Amount of substance required to be lethal to half the population (unit~mg/kg)	% error	((exp – calc)/calc) x 100
		Acid properties (H^+) pH<7	Sour, burns, conducts, reacts with metal (→H_2 gas), litmus paper (b→r), universal indicator ("reds")
		Base properties (OH^-) pH>7	Bitter, slippery, conducts, no rxn with metal, litmus paper (r→b), universal indicator ("blues")
2.2 lb	= 1 kg	Arrhenius Acid	Dissociates → H^+
Molar mass (g/mol)	1 mol = P.T. grams	Arrhenius Base	Dissociates → OH^-
Convenient counting unit for atoms/molecules (Avogadro's #)	1 mol = $6.02x10^{23}$ particles (atoms or molecules)	Bronsted-Lowry Acid (H^+ donor)	Reacts w/$H_2O \rightarrow H_3O^+$
Mole conversions (Mole Island)		Bronsted-Lowry Base (H^+ acceptor)	Reacts w/$H_2O \rightarrow OH^-$
Molarity Triangle		ACIDS	Contain H in front Name ends in "-ic acid"
		BASES	Contain OH (w/metal) or amine (N) Name ends in "hydroxide" or "-ine"
	Tip: To convert from mL to L→move dec. 3 places to the left	Acids become	conjugate bases (by donating protons)
Dilution Equation	$M_1L_1 = M_2L_2$ (Solving for L_1 when trying to figure out how much of the original bottle you need to pour out.)	Bases become	conjugate acids (by accepting protons)
		Phenolphthalein (acid/base indicator)	Clear if acid (or neutral) Pink if base
		Neutralization reaction (a double replacement rxn)	Acid + base → salt + H_2O (criss-cross to get salt)
LeChatlier's Principle	If a disturbance is applied to a system at equilibrium, the system will "undo" the stress (by shifting)	Physical change	Changes form but not identity (i.e. phase changes)

liquid → gas	Evaporation (molecules speed up, V ↑, d↓)	Heating Curve	
gas → liquid	Condensation (molecules slow down, V↓, d↑)		
As temp. ↓	Molecules slown down→attract→ condense		
Absolute Zero (0K or -273°C)	No motion (and V = 0)	Exothermic	Heat is released
Temperature conversions	K = °C + 273 °C = K - 273	Endothermic	Heat is absorbed
Pressure conversions ↓ collisions	1 atm = 760 mm Hg	Melting/boiling/subliming	Endothermic process
Temperature of gas	Related to speed of gas (measure of KE_{avg})	Freezing/condensation/ deposition	Exothermic process
4 variables when dealing with gases	n, P, V, T (n~amount of gas in moles)	Melting point equals	Freezing point (for water: 0°C or 32°F)
P and V	Inversely proportional $P \propto 1/V$	Boiling point equals	Condensation point (for water: 100°C or 212°F)
P and T	Directly proportional $P \propto T$	Sublimation point equals	Deposition point
V and T	Directly proportional $V \propto T$	LeChatlier's Principle (dealing with temperature stresses)	If the temp. of a system at equ. is changed, it will shift to restore equilibrium **Depends on if rxn is endo or exo
Diffusion	Gases collide while moving through a room	Phase changes are	Processes at equilibrium
Directly Proportional	Ratio is constant	Specific Heat Capacity, c	The amount of heat required to increase 1 g of a substance's temp. by 1°C $C_{H2O(s)}$ = 0.5 cal/g°C, $C_{H2O(l)}$ = 1 cal/g°C, $C_{H2O(g)}$ = 0.45 cal/g°C
Inversely Proportional	Product is constant	As c ↓	Heats up quicker
Charles' Law	$\frac{V_1}{T_1} = \frac{V_2}{T_2}$ (T~Kelvin!)	1 calorie	4.184 J
Gay-Lussac's Law	$\frac{P_1}{T_1} = \frac{P_2}{T_2}$ (T~Kelvin!)	Latent Heat of Fusion, L_f	The amount of heat required to melt per gram ($L_{f,H2O}$=80cal/g)
Boyle's Law	$P_1V_1 = P_2V_2$	Latent Heat of Vaporization, L_v	The amount of heat required to vaporize per gram ($L_{v,H2O}$=540cal/g)
Combined Gas Law	$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$ (T~Kelvin)	Heat transfer due to ΔT	q = mcΔT
Dalton's Law of Partial Pressures	$P_T = P_1 + P_2 + P_3 + \ldots\ldots$	Heat transfer due to phase change	$q = mL_f$ $q = mL_v$
LeChatlier's Principle (dealing with pressure stresses)	If P is increased, the system will shift to decrease the pressure (towards less moles of gas) *Note: if placed in a smaller container (V↓), system will shift to decrease pressure (less gas) and vice versa	Standard Temperature and Pressure (STP)	0°C and 1 atm (273 K and 760 mm Hg)

Molar Volume	1 mole = 22.4 L (at STP) = 6.02×10^{23} particles (gases with same volume contain same # of particles, regardless of size of particles)	Food does not "contain" calories; Nutrition Facts tells how much Calories will be given off when the food is burned (we slowly "burn" food when we breathe in O_2)	Fuels are characterized by cal/g because fuel sizes are not all the same size (i.e. cheetos are not all the same size)
Mole Island with Molar Volume		Combustion reaction	Releases heat and light (light can be flame or glow)
Percent Composition (indicates what percentage of each atom makes up the entire compound)	Ex: H_2O %H: (2g/18g)x100=11% %O: (16g/18g)x100=89%	Heat released by system	= heat absorbed by surroundings (and vice versa)
Accuracy vs Precision	Accuracy is how close to the true value a measurement is. Precision is the repeatability of a measurement. (An instrument can be precise but not accurate)	Types of substances that DO COMBUST	(1) Metals (ex: $Na + O_2 \rightarrow Na_2O$) *Tarnishing of metals to produce metal oxides are combustión rxns) (2) Carbon compounds that don't contain too much oxygen already (ex: $C_2H_5OH + O_2 \rightarrow CO_2 + H_2O$)
Significant Figures (indicate precision of a measurement) *Measurements should contain the digits you are certain of plus ONE more estimated digit. *The more markings an instrument has, the higher the precision, the more sig figs the measurement will have	Atlantic-Pacific Rule: (1) If the dec. pt. is Absent, start on the Atlantic side of the number, go to the first NONZERO digit, and count the # of digits all the way through including zeros (ex: 102,000 has 3 sig figs and 10 has 1 sig fig) (2) If the dec. pt. is Present, start on the Pacific side of the number, etc. (ex: 1.020 has 4 sig figs and 0.020 has 2 sig figs)	Types of substances that DO NOT COMBUST (1) Ionic cpds	(2) Compounds that have too much oxygen already (ex: CO_2 and H_2O)
		Alkane	C_xH_y compound
		As size of alkane increases	Amount of reacted oxygen and heat released increases
Significant Figures and Calculations (When using measurements in calculations, your calculation cannot be more precise than your least precise measurement!)	When multiplying/dividing: Your calculation needs to have the least # of sig figs (ex: 0.2g/2.3mL = 0.09 g/mL) When adding/subtracting: Your calculation needs to have the least # of decimal places (ex: 34.50mL – 33.7 mL = 0.8 mL)	Band of Stability (indicates proton to neutron ratio that allows nucleus to be stable)	When isotopes lie on this band, they are stable. When they lie outside of this band, they are unstable and undergo radioactive decay. Below the band (too many protons): alpha decay Above the band (too many neutrons): beta decay
Fire Triangle	Fire requires: O_2, fuel, ignition source	Nuclear Decay	Alpha decay: alpha particle ($^{4}_{2}He$) is emitted Beta decay: beta particle ($^{0}_{-1}e$) is emitted
Calorimetry	Measurement of the amount of heat transferred.		
1 (food) Cal	= 1000 (chemist) cal		

Nuclear Equations	Alpha Decay Example $^{226}_{88}Ra \rightarrow {}^{4}_{2}He + {}^{222}_{86}Rn$ Tip: The daughter isotope is 2 places back on the Per. Table from the parent isotope (see that Rn is 2 places back from Ra on the P.T.) Beta Decay Example $^{47}_{20}Ca \rightarrow {}^{0}_{-1}e + {}^{47}_{21}Sc$ Tip: The daughter isotope is 1 place forward on the Per. Table from the parent isotope (see that Sc is one place in front of Ca on the P.T.)		
Penetration Strength of Nuclear Decay	Alpha Particles: least penetrating (least dangerous) Beta Particles: very penetrating (very dangerous) Gamma rays: (most penetrating (most dangerous)		