Notes#25/Periodic Trends #3/Chemical Properties/AP Chemistry

I. Periodic Trend 5: <u>METALLIC CHARACTER</u>:

a. Define Metallic character:

1. Metals have ______________ Ionization Energy (Remember: Large atomic radii/weaker Z_{eff})
2. Displaces H2 from acid and water (Single replacement/Hydrogen replacement)
3. Makes BASIC OXIDES (Remember: metallic oxides + H2O = base)
4. Makes ____________ bonds. (Remember: a metal and a non-metal make salts)

b. TREND: *Metallic character* ____ *as you go across P.T.* (From left to right.)

Metallic character ______________________________________ *as you go down P.T.* (From n=1 to n= 1+.)

*** In other words, ________________________________ is the most "metallic" element!

***** THE MORE METALLIC, THE MORE EXTREME EACH OF THESE CHARACTERISTICS. THE MORE METALLIC, THE MORE VIGOROUS THE REACTIVITY, THE MORE BASIC THE OXIDE, THE MORE IONIC THE BOND!**

II. A brief look at the FAMILIES.

a. HYDROGEN ($1s^1$)

1. No suitable place for H on the periodic table. Like alkali metals, H has a single s valence e^-. Like the halogens, H only needs one more e^- to be like it's closest noble gas.
2. As a result, H can form *either* a +1 or -1 ion! +1 ion [$\underset{1s}{\_\_\_\_\_}$ - 1 e^- → $\underset{1s}{\_\_\_\_\_}$] -1 ion [$\underset{1s}{\_\_\_\_\_}$ + 1e^- → $\underset{1s}{\_\_\_\_\_}$]
3. IMPORTANT REACTIVITY:
Ionic Hydrides react with water to produce hydrogen gas and the corresponding metal hydroxide.

- Alkali Metal-like Compd: __________;the hydrogen is _____ charged. H^+ is basically just an ____ or a ____________
- Halogen-like Compd: ___________; the hydrogen is ______ charged. H^- is called a ____________.

EX: 2 NaH (s) + 2 H2O (l) →

CaH2 (s) + H2O (l) →

b. 1A: ALKALI METALS (ns^1)

1. LOW I.E.
2. Alkali metals are LOW DENSITY metals due to their relatively LARGE atomic radii. Li, Na, & K float on water!
3. VERY, VERY, VERY reactive. So reactive that these metals are never found in their pure state in nature (they are always in compounds). Remember: Alkali metals are at the extreme end of the activity series (opposite F2).

Reactivity of the Alkali Metals ____ as you go down the periodic table.

4. ALL alkali metals produce ONLY ionic compounds. (There are some rare organo-metallic molecules with Li.)
5. All Alkali metals react with water to produce hydrogen gas and the corresponding metal hydroxide.

EX: 2 Na (s) + 2 H2O (l) ----->

6. When exposed to air, alkali metals gradually lose their shine as they combine with O2 to form BASIC OXIDES.

The type of oxide made depends on the alkali metal.

- Lithium forms a <u>regular oxide</u> (O^{2-}): Li(s) + O2 (g) ------------->
- Sodium forms a <u>peroxide</u> (O_2^{2-}): Na (s) + O2 (g) ------------>
- Potassium, Rubidium, Cesium form <u>superoxides</u> (O_2^-) M (s) + O2 (g) ------------>
  Superoxides are EXPLOSIVE! (M = K, Rb, Cs)

c. **2A**: ALKALINE EARTH METALS (ns^2)

1. Unusually high Ionization energies (due to the marginal stability of the full s orbital....)

2. Most Be compounds (BeH_2, BeX_2 X=halide) and many Mg compounds are MOLECULAR (covalent bonds) rather than ionic. The remaining metals only produce ionic compounds. (Remember: Metallic character increases as you go down the Periodic Table!)

3. Overall reactivity of alkaline earth metals is LESS than that of Alkali metals but, like the alkali metals, reactivity INCREASES as you go down the family.

4. Be does not react with water, Mg only reacts with steam, the remaining alkaline earth metals react with cold water (Ca, Sr, and Ba). All members of the family react with acid. Large A.E. metals can displace H_2 from H_2O.

EX: $Ba (s) + 2 H_2O (l)$ ------>

5. Alkaline Earth metals also form BASIC OXIDES when exposed to O_2. Basicity increases as you go down!

III. TRENDS WITH OXIDE FORMATION

a. Excluding the noble gases, oxygen will react with every element on the periodic table to form OXIDES. Oxides, like hydroxides, are not appreciably soluble in water.

b. Metals produce BASIC oxides (oxides that dissolve in water to produce OH^-) that are ionic in nature. Non-metals produce ACIDIC oxides (oxides that dissolve in water to produce H^+) that are covalent in nature.

c. Some oxides are AMPHOTERIC meaning they display both acidic and basic properties. Ex: Al_2O_3. ZnO, and BeO.
Elements that can display amphoteric behavior are Be, Al, B, Si, Ga, In, Ge, Sn, Pb, As, Sb, Te, Bi.
Notice their placement on the periodic table! Where do they reside relative to the staircase that defines the metal/nonmetal boundary?

What metal would produce the MOST basic oxide? ____________________

d. Non-metal oxides make acids when dissolved in water.
YOU MUST KNOW HOW TO MAKE THE FOLLOWING COMMON ACIDS FROM NONMETAL OXIDES:

P_4O_{10} (or P_2O_5) (s) + 6 H_2O (l) ------->

SO_3 (g) + H_2O (l) -------->

SO_2 (g) + H_2O (l) -------->

Cl_2O_7 (g) + H_2O (l) ------->

N_2O_5 (g) + H_2O (l) -------->

e. Neutralization Reactions:
1. Basic oxides can react with ACID to make water and a salt.
YOU MUST KNOW HOW TO MAKE THE FOLLOWING COMMON BASES FROM METAL OXIDES:

EX: CuO (s) + H_2SO_4 (aq) ------> ** You did this reaction in the Cu lab!

EX: MgO (s) + HCl (aq) -------> **You did this reaction in the Hess' lab!

2. Acidic oxides react with BASE to make water and a salt.

EX: SO_3 (g) + NaOH (aq) ------->

EX: CO_2(g) + KOH (aq) ------>

f. Amphoteric Oxide Neutralizations: Since amphoteric oxides can act as acids or bases, look at the reagent coupled with the oxide for a clue. If it is a base, treat the oxide as an acid. If it is an acid, treat the oxide as a base.

EX: SiO_2 (s) + 2 NaOH (aq) ------> Na_2SiO_3 (aq) + H_2O (l) (This is why you can't store base in glass for long periods of time.)

EX: Al_2O_3 (s) + 6HCl (aq) ---------> (This is why you should not cook tomato sauces in aluminum cookware.)

Here comes an especially tricky one. No, you will not be tested on this.

EX: Al_2O_3 (s) + 2NaOH (aq) + 3H_2O (l) -----------> 2 $NaAl(OH)_4$ (aq)