Thanks for your interest in AP Chemistry.

AP Chemistry is a second year chemistry course.

In order to be successful in AP chemistry it is critical that you have a solid foundation of chemistry basics from your general or honors chemistry class, as well as some stuff you will have to learn on your own.

If you need extra help you can go to this website:

http://www.chemteam.info/ChemTeamIndex.html

It has plenty of explanation and practice problems.

Included in this packet:

- A table of metric prefixes
- A list of polyatomic ions that you must memorize (make flash cards!)
- Solubility rules for ionic compounds that you must memorize
- Nomenclature rules for ionic compounds, covalent compounds, acids, and old school nomenclature.
- A practice worksheet that includes problems on
  - Nomenclature
  - Solubility rules and precipitates
  - Balancing equations
  - Stoichiometry and limiting reactants
  - Scientific notation
  - Metric conversions

The packet will be discussed on the first day of class and a test will be given in the first week of class on this information. You can find the answer key to this packet on my website (http://colemanchemistry.weebly.com/ap-chemistry.html)

<table>
<thead>
<tr>
<th>Multiples and Submultiples</th>
<th>Prefixes</th>
<th>Symbols</th>
<th>Meaning</th>
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</thead>
<tbody>
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<td>$1,000,000,000,000 = 10^{12}$</td>
<td>tera</td>
<td>T</td>
<td>trillion</td>
</tr>
<tr>
<td>$1,000,000,000 = 10^{9}$</td>
<td>giga</td>
<td>G</td>
<td>billion</td>
</tr>
<tr>
<td>$1,000,000 = 10^{6}$</td>
<td>mega</td>
<td>M</td>
<td>million</td>
</tr>
<tr>
<td>$1000 = 10^{3}$</td>
<td>kilo</td>
<td>k</td>
<td>thousand</td>
</tr>
<tr>
<td>$100 = 10^{2}$</td>
<td>hecto</td>
<td>h</td>
<td>hundred</td>
</tr>
<tr>
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<td>deka</td>
<td>da</td>
<td>ten</td>
</tr>
<tr>
<td>Unit $1 = 10^{0}$</td>
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<td></td>
<td></td>
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<tr>
<td>$1 = 10^{-1}$</td>
<td>deci</td>
<td>d</td>
<td>tenth</td>
</tr>
<tr>
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<td>centi</td>
<td>c</td>
<td>hundredth</td>
</tr>
<tr>
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<td>milli</td>
<td>m</td>
<td>thousandth</td>
</tr>
<tr>
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<td>micro</td>
<td>µ</td>
<td>millionth</td>
</tr>
<tr>
<td>$.000000001 = 10^{-9}$</td>
<td>nano</td>
<td>n</td>
<td>billionth</td>
</tr>
<tr>
<td>$.000000000001 = 10^{-12}$</td>
<td>pico</td>
<td>p</td>
<td>trillionth</td>
</tr>
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</table>
### Polyatomic Ion List

**Bold = memorize**

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<thead>
<tr>
<th></th>
<th>1+</th>
<th>2+</th>
<th>3+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonium</td>
<td>NH₄⁺</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Hydronium</td>
<td>H₃O⁺</td>
<td>none</td>
<td>none</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>1⁻</th>
<th>2⁻</th>
<th>3⁻</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetate</td>
<td>C₂H₃O₂⁻¹ (an alternate way to write acetate is CH₃COO⁻)</td>
<td>Carbonate CO₃²⁻</td>
<td>Borate BO₃³⁻</td>
</tr>
<tr>
<td>Hydroxide</td>
<td>OH⁻¹</td>
<td>Peroxide O₂²⁻</td>
<td>Arsenate AsO₄³⁻</td>
</tr>
<tr>
<td>Amide</td>
<td>NH₂⁻¹</td>
<td>Tartrate C₄H₄O₄²⁻</td>
<td>Thiosulfate S₂O₃²⁻</td>
</tr>
<tr>
<td>Permanganate</td>
<td>MnO₄⁻²</td>
<td>Thiosulfate S₂O₃²⁻</td>
<td>Oxalate C₂O₄²⁻</td>
</tr>
<tr>
<td>Nitrate</td>
<td>NO₃⁻¹</td>
<td>Selenate SeO₃²⁻</td>
<td>Selenate SeO₃²⁻</td>
</tr>
<tr>
<td>Nitrite</td>
<td>NO₂⁻¹</td>
<td>Silicate SiO₃²⁻</td>
<td>Silicate SiO₃²⁻</td>
</tr>
<tr>
<td>Chlorite</td>
<td>ClO₂⁻¹</td>
<td>Tetraborate B₄O₇²⁻</td>
<td>Tetraborate B₄O₇²⁻</td>
</tr>
<tr>
<td>Hypochlorite</td>
<td>ClO⁻¹</td>
<td>Hydroxide Phosphate HPO₄²⁻</td>
<td>Hydroxide Phosphate HPO₄²⁻</td>
</tr>
<tr>
<td>Chlorate</td>
<td>ClO₃⁻¹</td>
<td>Sulfate SO₄²⁻</td>
<td>Sulfate SO₄²⁻</td>
</tr>
<tr>
<td>Perchlorate</td>
<td>ClO₄⁻¹</td>
<td>Sulfite SO₃²⁻</td>
<td>Sulfite SO₃²⁻</td>
</tr>
<tr>
<td>Hydrogen Carbonate (Bicarbonate)</td>
<td>HCO₃⁻¹</td>
<td>Chromate CrO₄²⁻</td>
<td>Chromate CrO₄²⁻</td>
</tr>
<tr>
<td>Hydrogen Sulfate (Bisulfate)</td>
<td>HSO₄⁻¹</td>
<td>Dichromate Cr₂O₇²⁻</td>
<td>Dichromate Cr₂O₇²⁻</td>
</tr>
<tr>
<td>Hydrogen Sulfitic (Bisulfite)</td>
<td>HSO₃⁻¹</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydrogen oxalate (Binoxalate)</td>
<td>HC₂O₄⁻¹</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dihydrogen Phosphate</td>
<td>H₂PO₄⁻¹</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydrogen Sulfate</td>
<td>H₂O⁻¹</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:** Writing just the plus sign or minus sign for ions with +1 or -1 charges is acceptable.
Solubility Rules

Always Soluble:

- All compounds containing alkali metal cations (Li\(^+\), Na\(^+\), K\(^+\), Rb\(^+\), Cs\(^+\)), and the ammonium ion (NH\(_4^+\)) are soluble.
- All compounds containing NO\(_3^-\), ClO\(_4^-\), ClO\(_3^-\), and C\(_2\)H\(_3\)O\(_2^-\) anions are soluble.

Generally Soluble:

- Bromides, Iodides and Chlorides are soluble except those containing Pb\(^{2+}\), Ag\(^+\), or Hg\(^{2+}\) (remember "brickle peebag hag" aka Br\(^-\)-I\(^-\)-Cl\(^-\)-Pb\(^{2+}\)-Ag\(^+\)-Hg\(^{2+}\)).
- Flourides (F\(^-\)) are soluble except with Ca\(^{2+}\), Ba\(^{2+}\), Sr\(^{2+}\), Pb\(^{2+}\), Mg\(^{2+}\) (Remember: CBS-PM).
- All sulfates (SO\(_4^{2-}\)) are soluble except with containing Ca\(^{2+}\), Ba\(^{2+}\), Sr\(^{2+}\), Pb\(^{2+}\), Hg\(^{2+}\). (Remember: CBS-PH)

Generally Insoluble:

- All hydroxides are insoluble except compounds of the alkali metals (Li\(^+\), Na\(^+\), K\(^+\), Rb\(^+\), Cs\(^+\)), Ca\(^{2+}\), Ba\(^{2+}\), Sr\(^{2+}\) (CBS) and NH\(_4^+\).
- All compounds containing PO\(_4^{3-}\), S\(^2-\), CO\(_3^{2-}\), and SO\(_3^{2-}\) ions are insoluble except those that also contain alkali metals (Li\(^+\), Na\(^+\), K\(^+\), Rb\(^+\), Cs\(^+\)), or NH\(_4^+\).

Ionic Compound Nomenclature

1. Cation is always written first (in name and in formula)
   a. If the cation is not a transition metal (d-block metal), then you just name as is.
   b. If the cation is a transition metal, you must give it a charge. Transition metals have variable charges. To find its charge, look at what it is bonded to.
      Ex: CuO
      Cation: Copper \(\text{II}\)
      (copper is transition. It is bonded to one oxygen that carries a -2 charge. Therefore the copper must have a +2 charge, hence the (II) after the copper)
      Anion: Oxygen ide
      Name: Copper (II) Oxide

2. Anion is written last: change the last syllable of any monatomic anion to -ide
   Ex: MgCl\(_2\)
   Cation: Magnesium
   Anion: Chlorine ide
   Name: Magnesium Chloride

3. Polyatomic ion names remain the same (don’t change the ending.
   Ex: NaNO\(_3\)
   Cation: Sodium
   Anion: Nitrate
   Name: Sodium Nitrate
Covalent compound nomenclature

1. The first element is named first, using the elements name.
2. Second element is named as an Anion (suffix "-ide")
3. Prefixes are used to denote the number of atoms
4. "Mono" is not used to name the first element

**Note:** when the addition of the Greek prefix places two vowels adjacent to one another, the "a" (or the "o") at the end of the Greek prefix is usually dropped; e.g., "nonaoxide" would be written as "nonoxide", and "monooxide" would be written as "monoxide". The "i" at the end of the prefixes "di-" and "tri-" are never dropped.

<table>
<thead>
<tr>
<th>Number</th>
<th>Greek prefix</th>
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<tbody>
<tr>
<td>1</td>
<td>Mono</td>
</tr>
<tr>
<td>2</td>
<td>Di</td>
</tr>
<tr>
<td>3</td>
<td>Tri</td>
</tr>
<tr>
<td>4</td>
<td>Tetra</td>
</tr>
<tr>
<td>5</td>
<td>Penta</td>
</tr>
<tr>
<td>6</td>
<td>Hexa</td>
</tr>
<tr>
<td>7</td>
<td>Hepta</td>
</tr>
<tr>
<td>8</td>
<td>Octa</td>
</tr>
<tr>
<td>9</td>
<td>Nona</td>
</tr>
<tr>
<td>10</td>
<td>Deca</td>
</tr>
<tr>
<td>12</td>
<td>Dodeca</td>
</tr>
</tbody>
</table>

Ex: CO₂ Carbon monoxide  
P₂O₄ diphosphorus tetraoxide  
N₂O dinitrogen monoxide

**Acid Nomenclature**

1. When the name of the anion ends in -ide, the acid name begins with the prefix hydro-, the stem of the anion has the suffix -ic and it is followed by the word acid.  
   -ide becomes hydro ____ic Acid  
   Ex: HCl: Cl⁻ is the Chloride ion so HCl = hydrochloric acid

2. When the anion name ends in -ite, the acid name is the stem of the anion with the suffix -ous, followed by the word acid.  
   -ite becomes ____ous Acid  
   Ex: ClO₂⁻¹ is the Chlorite ion so HClO₂ = Chlorous acid.

3. When the anion name ends in -ate, the acid name is the stem of the anion with the suffix -ic, followed by the word acid.  
   -ate becomes ____ic Acid  
   ClO₃⁻¹ is the Chlorate ion so HClO₃ = Chloric acid.
## Common Transition Metal Variable Charges (for Old School Nomenclature)

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<th>Symbol</th>
<th>Charge</th>
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<td>Cr</td>
<td>+2</td>
<td>Chromium (II)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+3</td>
<td>Chromium (III)</td>
</tr>
<tr>
<td>Manganese</td>
<td>Mn</td>
<td>+2</td>
<td>Manganese (II)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+3</td>
<td>Manganese (III)</td>
</tr>
<tr>
<td>Iron</td>
<td>Fe</td>
<td>+2</td>
<td>Iron (II)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+3</td>
<td>Iron (III)</td>
</tr>
<tr>
<td>Cobalt</td>
<td>Co</td>
<td>+2</td>
<td>Cobalt (II)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+3</td>
<td>Cobalt (III)</td>
</tr>
<tr>
<td>Copper</td>
<td>Cu</td>
<td>+1</td>
<td>Copper (I)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+2</td>
<td>Copper (II)</td>
</tr>
<tr>
<td>Lead</td>
<td>Pb</td>
<td>+2</td>
<td>Lead (II)</td>
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<tr>
<td></td>
<td></td>
<td>+4</td>
<td>Lead (IV)</td>
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<td>Hg</td>
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</tr>
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<td></td>
<td>+2</td>
<td>Mercury (II)</td>
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<tr>
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<td>Sn</td>
<td>+2</td>
<td>Tin (II)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+4</td>
<td>Tin (IV)</td>
</tr>
<tr>
<td>Gold</td>
<td>Au</td>
<td>+1</td>
<td>Gold (I)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+3</td>
<td>Gold (III)</td>
</tr>
<tr>
<td>Silver</td>
<td>Ag</td>
<td>+2</td>
<td>Silver (II)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+2(rarely)</td>
<td>Silver (II)</td>
</tr>
<tr>
<td>Bismuth</td>
<td>Bi</td>
<td>+3</td>
<td>Bismuth (III)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+5</td>
<td>Bismuth (V)</td>
</tr>
<tr>
<td>Antimony</td>
<td>Sb</td>
<td>+3</td>
<td>Antimony (III)</td>
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<td></td>
<td></td>
<td>+5</td>
<td>Antimony (V)</td>
</tr>
<tr>
<td>Cadmium</td>
<td>Cd</td>
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</tr>
<tr>
<td>Zinc</td>
<td>Zn</td>
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<td>Zinc</td>
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# Old School Nomenclature

<table>
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<tr>
<th>Symbol</th>
<th>(Stock system)</th>
<th>name</th>
<th>Symbol</th>
<th>(Stock system)</th>
<th>name</th>
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</thead>
<tbody>
<tr>
<td>Cu⁺</td>
<td>copper(I)</td>
<td>cuprous</td>
<td>Hg₂⁺</td>
<td>mercury(I)</td>
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</tr>
<tr>
<td>Cu²⁺</td>
<td>copper(II)</td>
<td>cupric</td>
<td>Hg²⁺</td>
<td>mercury(II)</td>
<td>mercuric</td>
</tr>
<tr>
<td>Fe²⁺</td>
<td>iron(II)</td>
<td>ferrous</td>
<td>Pb²⁺</td>
<td>lead(II)</td>
<td>plumbous</td>
</tr>
<tr>
<td>Fe³⁺</td>
<td>iron(III)</td>
<td>ferric</td>
<td>Pb⁴⁺</td>
<td>lead(IV)</td>
<td>plumbic</td>
</tr>
<tr>
<td>Sn²⁺</td>
<td>tin(II)</td>
<td>stannous</td>
<td>Co²⁺</td>
<td>cobalt(II)</td>
<td>cobaltous</td>
</tr>
<tr>
<td>Sn⁴⁺</td>
<td>tin(IV)</td>
<td>stannic</td>
<td>Co³⁺</td>
<td>cobalt(III)</td>
<td>cobaltic</td>
</tr>
<tr>
<td>Cr²⁺</td>
<td>chromium(II)</td>
<td>chromous</td>
<td>Au⁺</td>
<td>gold(I)</td>
<td>aurous</td>
</tr>
<tr>
<td>Cr³⁺</td>
<td>chromium(III)</td>
<td>chromic</td>
<td>Au³⁺</td>
<td>gold(III)</td>
<td>auric</td>
</tr>
<tr>
<td>Mn²⁺</td>
<td>manganese(II)</td>
<td>manganous</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mn³⁺</td>
<td>manganese(III)</td>
<td>manganic</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Notice: the lower of the two values for a given cation is assigned the ending "-ous" and the higher uses the ending "-ic."
AP Chemistry Summer Assignment
The following assignment is to be completed and brought on the first day of class.

Nomenclature

1. Name these binary compounds of two nonmetals. (two nonmetals make a covalent compound)
   - IF$_7$ _iodine heptafluoride_
   - N$_2$O$_5$ _dinitrogen pentoxide_
   - XeF$_2$ _xenon difluoride_
   - N$_2$O$_4$ _dinitrogen tetroxide_
   - As$_4$O$_{10}$ _tetrarsenic decoxide_
   - SF$_6$ _sulfur hexafluoride_
   - PCl$_3$ _phosphorus trichloride_
   - S$_2$Cl$_2$ _disulfur dichloride_

2. Name these binary compounds with a fixed charge metal. (metal + nonmetal is always an ionic compound. “Fixed charge metal” just means that the metals are non transition metals.)
   - AlCl$_3$ _aluminum chloride_
   - MgO _Magnesium oxide_
   - BaI$_2$ _barium iodide_
   - KI _potassium iodide_
   - SrBr$_2$ _strontium bromide_
   - Na$_2$S _sodium sulfide_
   - CaF$_2$ _calcium fluoride_
   - Al$_2$O$_3$ _aluminum oxide_

3. Name these binary compounds of cations with variable charge.
   - CuCl$_2$ _Copper (II) chloride_
   - Fe$_2$O$_3$ _Iron (III) oxide_
   - SnO _Tin (II) oxide_
   - PbCl$_4$ _Lead (IV) chloride_
   - Cu$_2$S _copper (I) sulfide_
   - HgS _mercury (II) sulfide_
   - AuI$_3$ _gold (III) iodide_
   - CoP _cobalt (III) phosphide_

4. Name these compounds with polyatomic ions.
   - Fe(NO$_3$)$_3$ _Iron (III) Nitrate_
   - NaOH _sodium hydroxide_
   - Cu$_2$SO$_4$ _copper (I) sulfate_
   - Ca(ClO$_3$)$_2$ _calcium chlorate_
   - KNO$_2$ _potassium nitrite_
   - NaHCO$_3$ _sodium bicarbonate_
   - NH$_4$NO$_2$ _ammonium nitrite_
   - Cu$_2$Cr$_2$O$_7$ _copper (II) dichromate_

5. Name these binary acids
   - HCl _hydrochloric acid_
   - HI _hydroiodic acid_
   - HF _hydrofluoric acid_

6. Name these acids with polyatomic ions.
   - HClO$_4$ _perchloric acid_
   - H$_2$SO$_4$ _sulfuric acid_
   - HC$_2$H$_3$O$_2$ _Acetic acid_
   - H$_3$PO$_4$ _phosphoric acid_
   - HNO$_2$ _nitrous acid_
   - H$_2$CrO$_4$ _chromic acid_
   - H$_2$C$_2$O$_4$ _binoxalic acid (or hydrogen oxalic acid)_
   - H$_2$CO$_3$ _carbonic acid_

7. Name these compounds appropriately.
   - CO _carbon monoxide_
   - NH$_4$CN _ammonium cyanide_
   - HIO$_3$ _iodic acid_
   - Ni$_3$ _nitrogen triiodide_
   - AlP _aluminum phosphide_
   - OF$_2$ _oxygen difluoride_
   - LiMnO$_4$ _lithium permanganate_
   - HClO _hypochlorous acid_
   - HF _hydrofluoric acid_
   - SO$_2$ _sulfur dioxide_
   - CuCr$_2$O$_7$ _copper (II) dichromate_
   - K$_2$O _potassium oxide_
   - FeF$_3$ _iron (III) fluoride_
   - KC$_2$H$_3$O$_2$ _potassium acetate_
   - MnS _Manganese (II) sulfide_
8. Write the formulas for the following compounds.

Tin (IV) phosphide \( \text{Sn}_3\text{P}_4 \)  
Magnesium hydroxide \( \text{Mg(OH)}_2 \)  
Sulfurous acid \( \text{H}_2\text{SO}_3 \)  
Potassium nitride \( \text{K}_3\text{N} \)  
Gallium arsenide \( \text{GaAs} \)  
Zinc fluoride \( \text{cannot answer because zinc is a transition metal and no roman numeral was given to indicate its charge!} \)

Copper (II) cyanide \( \text{Cu(CN)}_2 \)  
Sodium peroxide \( \text{Na}_2\text{O}_2 \)  
Lithium silicate \( \text{Li}_2\text{SiO}_3 \)  
Chromium (III) carbonate \( \text{Cr}_2\text{(CO}_3\text{)}_3 \)  
Cobalt (II) chromate \( \text{CoCrO}_4 \)  
Dichromic acid \( \text{H}_2\text{Cr}_2\text{O}_7 \)

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9. Review solubility rules and identify each of the following compounds as soluble (S) or insoluble (IS) in water.

\( \text{Na}_2\text{CO}_3 \_\_\_\_ \)  \( \text{CoCO}_3 \_\_\_\_\_\_ \)  \( \text{Pb(NO}_3\text{)}_2 \_\_\_\_ \)
\( \text{K}_2\text{S} \_\_\_\_\_\_ \)  \( \text{BaSO}_4 \_\_\_\_\_\_ \)  \( \text{(NH}_4\text{)}_2\text{S} \_\_\_\_\_\_ \)
\( \text{AgI} \_\_\_\_\_\_ \)  \( \text{Ni(NO}_3\text{)}_2 \_\_\_\_\_\_ \)  \( \text{KI} \_\_\_\_\_\_ \)
\( \text{FeS} \_\_\_\_\_\_ \)  \( \text{PbCl}_2 \_\_\_\_\_\_ \)  \( \text{CuSO}_4 \_\_\_\_\_\_ \)
\( \text{Li}_2\text{O} \_\_\_\_\_\_ \)  \( \text{Mn(C}_2\text{H}_3\text{O}_2)_2 \_\_\_\_\_\_ \)  \( \text{Cr(OH)}_3 \_\_\_\_\_\_ \)
\( \text{AgClO}_3 \_\_\_\_\_\_ \)  \( \text{Sn(SO}_3\text{)}_4 \_\_\_\_\_\_ \)  \( \text{FeF}_2 \_\_\_\_\_\_ \)

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10. Predict whether each of these double replacement reactions will give a precipitate or not based on the solubility of the products. If yes, identify the precipitate.

Silver nitrate and potassium chloride \( \_\_\_\_\_\_ \text{yes, AgCl will precipitate} \)
Magnesium nitrate and sodium carbonate \( \_\_\_\_\_\_ \text{yes, MgCO}_3 \text{ will precipitate} \)
Strontium bromide and potassium sulfate \( \_\_\_\_\_\_ \text{yes, SrSO}_4 \text{ will precipitate} \)
Cobalt (III) bromide and potassium sulfide \( \_\_\_\_\_\_ \text{yes, Co}_2\text{S}_3 \text{ will precipitate} \)
Ammonium hydroxide and copper (II) acetate \( \_\_\_\_\_\_ \text{yes, Cu(OH)}_2 \text{ will precipitate} \)
Lithium chlorate and chromium (III) fluoride \( \_\_\_\_\_\_ \text{no precipitate will form, so no reaction} \)

---

11. Balance the following equations with the lowest whole number coefficients.

\( \text{S}_8 + 12\text{O}_2 \rightarrow 8\text{SO}_3 \)
\( \text{C}_{10}\text{H}_{16} + 8\text{Cl}_2 \rightarrow 10\text{C} + 16\text{HCl} \)
\( 4\text{Fe} + 3\text{O}_2 \rightarrow 2\text{Fe}_2\text{O}_3 \)
\( 2\text{C}_2\text{H}_6\text{O}_2 + 15\text{O}_2 \rightarrow 14\text{CO}_2 + 6\text{H}_2\text{O} \)
\( 2\text{KClO}_3 \rightarrow 2\text{KCl} + 3\text{O}_2 \)
\( 2\text{H}_3\text{AsO}_4 \rightarrow \text{As}_2\text{O}_5 + 3\text{H}_2\text{O} \)
\( \text{V}_2\text{O}_5 + 6\text{HCl} \rightarrow 2\text{VOCl}_3 + 3\text{H}_2\text{O} \)
\( 3\text{Hg(OH)}_2 + 2\text{H}_3\text{PO}_4 \rightarrow \text{Hg}_3(\text{PO}_4)_2 + 6\text{H}_2\text{O} \)
Stoichiometry and Limiting Reactants

12. Given the equation below, what mass of water would be needed to react with 10.0g of sodium oxide?
   \[ \text{Na}_2\text{O} + \text{H}_2\text{O} \rightarrow 2\text{NaOH} \]
   
   \[ 2.90 \text{ g H}_2\text{O} \]

13. \[ 2\text{NaClO}_3 \rightarrow 2\text{NaCl} + 3\text{O}_2 \]
    What mass of sodium chloride is formed along with 45.0g of oxygen gas?
    \[ 54.4 \text{ g NaCl} \]

14. \[ 4\text{NH}_3 + 5\text{O}_2 \rightarrow 4\text{NO} + 6\text{H}_2\text{O} \]
    What mass of water will be produced when 100.0g of ammonia is reacted with excess oxygen?
    \[ 158.8 \text{ g H}_2\text{O} \]

15. If the reaction in #14 is done with 25.0g of each reactant, which would be the limiting factor (also called limiting reactant)?
   \[ \text{O}_2 \text{ would be the limiting reactant} \]

16. \[ \text{Na}_2\text{S} + 2\text{AgNO}_3 \rightarrow \text{Ag}_2\text{S} + 2\text{NaNO}_3 \]
    If the above reaction is carried out with 50.0g of sodium sulfide and 35.0g of silver nitrate, which is the limiting factor (also called limiting reactant)?
    \[ \text{AgNO}_3 \text{ is the limiting reactant} \]
    What mass of the excess reactant remains?
    \[ 41.9 \text{ g of Na}_2\text{S remains} \]
    What mass of silver sulfide would precipitate?
    \[ 25.5 \text{ g} \]

17. \[ 6\text{NaOH} + 2\text{Al} \rightarrow 2\text{Na}_3\text{AlO}_3 + 3\text{H}_2 \]
    What volume of hydrogen gas (measured at STP) would result from reacting 75.0g of sodium hydroxide with 50.0g of aluminum?
    \[ 1.88 \text{ g H}_2 \]
Scientific Notation

Write the following numbers in scientific notation.

\[
\begin{align*}
3,400 & \; \; \; _{3.4 \times 10^3}^{\ldots} & 0.00023 & \; \; \; _{2.3 \times 10^{-5}}^{\ldots} \\
101,000 & \; \; \; _{1.01 \times 10^5}^{\ldots} & 0.010 & \; \; \; _{1.0 \times 10^{-2}}^{\ldots} \\
45.01 & \; \; \; _{4.501 \times 10^1}^{\ldots} & 1,000,000 & \; \; \; _{1 \times 10^6}^{\ldots} \\
0.00671 & \; \; \; _{6.71 \times 10^{-3}}^{\ldots} & 4.50 & \; \; \; _{4.50 \times 10^0}^{\ldots}
\end{align*}
\]

Write the following number in standard notation.

\[
\begin{align*}
2.30 \times 10^4 & \; \; \; _{23,000}^{\ldots} & 1.76 \times 10^{-3} & \; \; \; _{0.00176}^{\ldots} \\
1.901 \times 10^{-7} & \; \; \; _{0.0000001901}^{\ldots} & 8.65 \times 10^1 & \; \; \; _{0.865}^{\ldots} \\
9.11 \times 10^3 & \; \; \; _{9,110}^{\ldots} & 5.40 \times 10^1 & \; \; \; _{54.0}^{\ldots} \\
1.76 \times 10^0 & \; \; \; _{1.76}^{\ldots} & 7.4 \times 10^{-5} & \; \; \; _{0.000074}^{\ldots}
\end{align*}
\]

Metric Conversions

Make the following metric conversions.

\[
\begin{align*}
36.52 \text{ mg} & \; \; \; _{0.03652}^{\ldots} \text{ g} & 14.72 \text{ kg} & \; \; \; _{1.472 \times 10^7}^{\ldots} \text{ mg}
\end{align*}
\]

\[
\begin{align*}
0.134 \text{ m} & \; \; \; _{1.34 \times 10^{-4}}^{\ldots} \text{ km} & 25 \text{ mm} & \; \; \; _{2.5}^{\ldots} \text{ cm}
\end{align*}
\]

\[
\begin{align*}
243 \text{ daL} & \; \; \; _{2430}^{\ldots} \text{ L} & 45.23 \text{ L} & \; \; \; _{45,230}^{\ldots} \text{ mL}
\end{align*}
\]

\[
\begin{align*}
27.32 \text{ mm} & \; \; \; _{0.02732}^{\ldots} \text{ m} & 15 \text{ m} & \; \; \; _{150}^{\ldots} \text{ dm}
\end{align*}
\]

\[
\begin{align*}
0.00049 \text{ km} & \; \; \; _{0.490}^{\ldots} \text{ mm} & 0.025 \text{ kg} & \; \; \; _{25}^{\ldots} \text{ g}
\end{align*}
\]

\[
\begin{align*}
0.035 \text{ hm} & \; \; \; _{3.5}^{\ldots} \text{ dm}
\end{align*}
\]

\[
\begin{align*}
2.5 \text{ cm}^3 & \; \; \; _{2.5}^{\ldots} \text{ mL}
\end{align*}
\]

\[
\begin{align*}
0.035 \text{ hL} & \; \; \; _{350}^{\ldots} \text{ cL}
\end{align*}
\]

\[
\begin{align*}
0.023 \text{ cc} & \; \; \; _{2.3 \times 10^{-5}}^{\ldots} \text{ L}
\end{align*}
\]

\[
\begin{align*}
15 \text{ g} & \; \; \; _{0.15}^{\ldots} \text{ hg}
\end{align*}
\]

\[
\begin{align*}
\text{cm}^3 = \text{1 cc} = \text{1 mL}
\end{align*}
\]