Nomenclature Dry Lab

Read all three introductions for Dry Labs 2A, 2B, and 2C prior to lab. No pre-lab is due. The assigned problems are worth 20 points total and are due one week after the lab session. Submit answers to the problems together with your lab group.

Part A Oxidation Numbers

- For uncharged elements in free state, such as O_2 and Al, oxidation number is zero.
- For monatomic ions, such as Na^{+1}, oxidation number is the same as the charge.
- Oxygen almost always has an oxidation number of −2, like in H_2O.
  The exceptions are peroxides, such as H_2O_2, where oxygen is −1, and compounds with oxygen attached to fluorine, where oxygen can be zero or positive.
- Hydrogen almost always has an oxidation number of +1, like in H_2O.
  Exceptions are metal hydrides, where hydrogen has a −1 oxidation number.
- Monatomic cations of main group metals (outer columns of the periodic table, left side), have oxidation numbers that are the same as the column number. That is +1 for column I-A (Na and K), +2 for column II-A (Ca and Mg), and +3 for column III-A (Al and Ga).
- Monatomic anions of main group nonmetals (outer columns of the periodic table, right side) have oxidation numbers that are found by column number minus eight. That is −1 for column VII-A (Cl and Br), and −2 for column VI-A (O and S). Note that the oxidation number in polyatomic ions, such as ClO_4^{-1} and SO_4^{-2}, may be different (see next item).
- Polyatomic ions have a charge equal to sum of oxidation numbers of its atoms.
  For instance, SO_4^{-2} has (1)(S) + (4)(−2) = −2, so S = +6.
- Transition metals and other heavy metals often have more than one possible oxidation number each, and the numbers are difficult to predict.
  (Fe can be +2 or +3, and Cu can be +1 or +2.)
- The combined sum of oxidation numbers for all of the atoms in a neutral compound is zero.

Problems for Part A

1. Use an equation to show how to find the oxidation number of S in SO_3. S = _____
   Note that SO_3 is a neutral compound, not the sulfite anion.

2. Use an equation to show how to find the oxidation number of P in PO_4^{-3}. P = _____

3. Using the periodic table, determine the oxidation number of K in K_2CrO_4. K = _____
   Then, use an equation to show how to find the oxidation number of Cr.
   Cr = _____

4. Determine the formulas for the four compounds formed from Fe^{+2} with P^{-3}, S^{-2}, OH^{-1}, and ClO_4^{-1}.

Part B Binary Compounds

- Binary means the compound possesses two elements.
- The compound can be ionic salt (metal and nonmetal ions) or molecular (two nonmetals).
- For binary ionic compounds, name the element which is the positive ion first.
  Then, follow with stem-ide to name the negative ion's element.
  Formulas are written in the same order. Do not use prefixes in the ionic compound names.
- If more than one oxidation state is possible for the metal, follow the name with the oxidation number as a Roman numeral in parentheses, like copper(I) and copper(II).
- The older Latin system uses metal's Latin stem followed by -ous for lower oxidation number, and -ic for higher oxidation number, such as with ferrous (Fe^{+2}) and ferric (Fe^{+3}).
- Binary molecular compounds are written with a conventional order which names the more positive element first in both the name and the formula. Using the periodic table, the order is generally left-to-right, and then bottom-to-top within a column (more metallic element first).
- For molecular substances, use prefixes (di, tri, tetra, etc.) to denote quantity of each atom in the formula, such as carbon dioxide. Note that some nitrogen oxides, such as nitrous oxide (N_2O) and nitric oxide (NO), have common names as well.
- Hydrates are solids composed of ionic salts combined with water. Name by following the anhydrous (dry) salt's name with prefix-hydrate to denote the number of water molecules. Write the hydrate's formula by following the anhydrous formula unit with a dot, and then the H_2O preceded by the number of water molecules per formula unit. For instance, magnesium chloride hexahydrate is $MgCl_2 \bullet 6H_2O_{(s)}$.
- Binary acids (H combined with a nonmetal) dissolved in water are named using the stem of the other element's name as follows: hydro-[stem]-ic acid. If not dissolved in water, name the molecule as: hydrogen [stem]-ide. $HI_{(aq)}$ is hydroiodic acid, and $HI_{(g)}$ is hydrogen iodide.
- You can use this table, this figure, and this table for the problems below.

Problems for Part B

1. Name the ionic salts $MgBr_2$ and $AlCl_3$.

2. Provide both the systematic (Stock) and older (Latin) names for FeS.

3. Determine the formula for the ionic salts titanium(IV) bromide and titanium(III) oxide.

4. Name the compound in both states for $HF_{(aq)}$ and $HF_{(g)}$. (Prefixes are not needed for the gas.)

5. Name the molecules S_2F_{10} and N_4S_4.

6. Determine formulas for the molecules dichlorine heptaoxide and tetraphosphorus trisulfide.

7. Determine the formulas for the four ionic compounds formed from Mn^{+3} with N^{-3}, S^{-2}, Te^{-2}, and Cl^{-1}.

8. Name the four Mn^{+3} compounds in #7 using the Stock system (include the Roman numeral).

Part C Ternary Ionic Compounds

- Ternary ionic compounds possess three elements, two of which form a polyatomic ion.
- Except for mercury(I), Hg_2^{+2}, and ammonium, NH_4^{+1}, most polyatomic ions are anions.
- Most polyatomic anions are oxoanions, which are negative and contain oxygen.
- To name a compound with a polyatomic ion, name positive ion first, then negative ion.
- If an element has two oxoanions, then the ion with fewer O atoms ends with -ite, and the ion with the more O atoms ends with -ate.
- If an element has four oxoanions, the middle two (number of O atoms) have -ite and -ate. The lowest oxidation number has the prefix hypo- and suffix -ite. The highest oxidation number has the prefix per- and the suffix -ate.
- When dissolved in water, the oxoacids change suffixes, and are then followed by the word acid. The suffix -ite become -ous, and the suffix -ate becomes -ic.
- If an oxoanion salt contains a metal as well as hydrogen, the metal name is first, then hydrogen, then the oxoanion. If there are two hydrogens, it is preceded by di-. An older system for monohydrogen anions precedes the normal anion name with the prefix bi-, such as in bicarbonate and bisulfate.

Problems for Part C

1. Name the ClO_3^{-1} and IO_3^{-1} anions. (Their names are similar.)

2. Name the ionic salts Li_2Se and Li_2CO_3. (Li is in an outer column and is a main group metal.)

3. Provide both the systematic (Stock) and older (Latin) names for the ionic salt $Mn_2(SO_4)_3$.

4. Name the ion $S_2O_3^{-2}{}_{(aq)}$ and the acid $H_2S_2O_{3(aq)}$.
   They are similar to sulfate and sulfuric acid, but an S has replaced one of the O's.

5. The ionic salt $Ca(HCO_3)_2$ has "hydrogen" in its systematic name, but an older system uses "bi" instead. Provide both names.

6. Determine the formula for barium iodide dihydrate: _____
   and for cobalt(II) nitrate hexahydrate: _____

7. Determine the formula for phosphorous acid: _____
   and for phosphoric acid: _____

8. Determine the formulas for the ionic salts sodium chromate and ammonium dichromate.