1) A hydrated compound contains copper(II) sulfate and water. What is the empirical formula of this hydrated compound if it contains 89.858% anhydrous copper(II) sulfate?
2) What is the empirical formula of a hydrated compound of copper(II) sulfate that contains 89.858% anhydrous copper (II) sulfate?
3) What is the empirical formula of a hydrated compound of copper(II) sulfate that contains 10.142% water?
4) A hydrated compound contains copper(II) sulfate and water. What is the empirical formula of 112.6g of hydrated compound if it contains 101.2g anhydrous copper(II) sulfate?
5) What is the empirical formula of a hydrated compound of copper(II) sulfate if 112.6g of the hydrated copper(II) sulfate produces 101.2g of anhydrous copper(II) sulfate?
6) What is the empirical formula of a hydrated compound of copper(II) sulfate if 112.6g of the hydrated copper(II) sulfate produces 11.422g of water when forming the anhydrous compound?
7-12) The expected compound in problems 1-6 would be copper(II) sulfate pentahydrate. Create the data for questions 1-6 that would be consistent with copper(II) sulfate pentahydrate.
13) What is the **empirical formula** of a compound that contains 8.262g N and 9.438g O?
14) What is the **percent sodium** in Na_2CO_3?
15) What is the **percent nitrate ion** in KNO_3?
16) What is the **coefficient of oxygen** in the chemical reaction that is balanced?

$$C_2H_2(g) + O_2(g) \rightarrow CO_2(g) + H_2O(g)$$

17) Write the balanced chemical equation for the reaction of iron metal with chlorine gas to yield **iron(III) chloride**.
18) What reagent could you add to $Pb(NO_3)_2(aq)$ to get a precipitation reaction?
19) Classify the reaction type for $Pb(NO_3)_2(aq)$ reacting with KCl(aq)?
20-21) Write the net ionic equation for the reactions in 18 and 19.
22) Provide reactants for a Bronstead acid-base reaction reaction.
23) Provide the net ionic equation for the reaction 22.
24) Which of the following gives correct reactants for a Bronstead acid-base reaction reaction:
    a) Pb(s) and $Zn(NO_3)_2(aq)$
    b) $Pb(NO_3)_2(aq)$ and Zn(s)
    c) $Pb(NO_3)_2(aq)$ and NaCl
    d) $HNO_3(aq)$ and NaOH(aq)
    e) $KNO_3(aq)$ and NaCl(aq)
25) What is the reaction type when HCl(aq) is mixed with NaOH(aq)?
26) What is the reaction type when $H^+(aq)$ is mixed with $OH^-(aq)$?
27) What could you add to HCl(aq) to cause a Bronstead acid-base reaction?
28) What are the reactants for a gas forming reaction?
29) Which of the following gives correct reactants for a gas forming reaction:
    a) Sn(s) and $Ca(NO_3)_2(aq)$
    b) $Na_2CO_3(aq)$ and NaOH(aq)
    c) $NH_3(aq)$ and HCl(aq)
    d) $HClO_4(aq)$ and $Ca(OH)_2(aq)$
    e) $Na_2CO_3(s)$ and $HNO_3(aq)$

30) Write the net ionic equation for the reaction in question 28.
31) A gas forms when $K_2CO_3(aq)$ is added to what substance?
32) What is the reaction type when $K_2CO_3(aq)$ is added to $HClO_4(aq)$?
33) What is the correct **oxidation number** for Fe in $Fe_2(SO_4)_3$:
34) Which one gives the correct **oxidation number** for Sn in $Sn(Cr_2O_7)_2$:
35) What could be added to $Pb(NO_3)_2(aq)$ to cause a product-favored redox reaction?
36) What could be added to Ni(s) to cause a product-favored redox reaction?
37) Which of the following gives correct reactants for a product-favored redox reaction:
    a) Pb(s) and $Zn(NO_3)_2(aq)$
    b) $Pb(NO_3)_2(aq)$ and Ni(s)
    c) $Pb(NO_3)_2(aq)$ and NaCl
    d) $HNO_3(aq)$ and NaOH(aq)
    e) $NH_4Cl(aq)$ and $Ba(OH)_2(aq)$
38) What is the reaction type when $Pb(NO_3)_2(aq)$ is added to Ni(s)?
39) What is the net ionic equation when $Pb(NO_3)_2(aq)$ is added to Ni(s)?

For 40-50, use this reaction. Note, it is not balanced. $Fe(s) + Au^{+}(aq) \rightarrow Au(s) + Fe^{3+}(aq)$

40) How many **electrons** are transferred in the balanced reaction that occurs in acid solution?
41) How many **electrons** are transferred in the balanced **oxidation half reaction** that occurs in acid solution?
42) How many **electrons** are transferred in the balanced **reduction half reaction** that occurs in acid solution?
43) How many **protons** (hydrogen ions) are needed to balance this reaction in acid solution?
44) How many **hydroxide ions** are needed to balance this reaction in acid solution?
45) How many **water molecules** are needed to balance this reaction in acid solution?
46) How many **protons** (hydrogen ions) are needed to balance this reaction in acid solution?
47) How many **hydroxide ions** are needed to balance this reaction in acid solution?
48) How many **water molecules** are needed to balance this reaction in acid solution?
49) What is the correct balanced reaction in acidic solution?
50) What is the correct balanced reaction in basic solution?
51) How many **protons** (hydrogen ions) are needed to balance this <u>partially balanced half reaction</u> in acid solution: $CrO_4^{2-}(aq) \rightarrow Cr^{3+}(aq)$
52) How many hydroxide ions are needed to balance the reaction in Q51?
53) How many water molecules to balance the reaction in Q51?
54) How many electrons transferred to balance the reaction in Q51?
55) What is the correct balanced half reaction in acidic solution for the reaction in Q51?
56) How many **protons** (hydrogen ions) are needed to balance this <u>partially balanced half reaction</u> in basic (alkaline) solution: $Cr_2O_7^{2-}(aq) \rightarrow Cr^{3+}(aq)$
57) How many hydroxide ions are needed to balance the reaction in Q56?
58) How many water molecules to balance the reaction in Q56?
59) How many electrons transferred to balance the reaction in Q56?
60) What is the correct balanced half reaction in basic solution for the reaction in Q56?
61) What is the reaction type when KCl(aq) is mixed with NaBr(aq)?
62) What is the reaction type when $Pb(C_2H_3O_2)_2(aq)$ is mixed with $HNO_3(aq)$?

63) What is the reaction type when $K_2CO_3(aq)$ is mixed with NaOH(aq)?
64) What is the reaction type when HCl(aq) is mixed with HBr(aq)?
65) What is the reaction type when KOH(aq) is mixed with $Ba(OH)_2(aq)$?
66) What **mass of excess reactant** remains when 15g of C_2H_6 reacts with 45g of O_2 according to the following unbalanced reaction: $C_2H_6(g) + O_2(g) \rightarrow CO_2(g) + H_2O(g)$?
67) What **mass of C_2H_6 is used** when 15g of C_2H_6 reacts with 45g of O according to Q66.
68) What **mass of CO_2 forms** when 15g of C_2H_6 reacts with 45g of O_2 according to Q66.
69) How many **moles of H_2O form** when 15g of C_2H_6 reacts with 45g of O_2 according Q66.
70) How many **grams of $AgNO_3$** are needed to prepare 150.mL of a solution that is 0.100M? The molar mass of silver nitrate is 169.872g/mol.
71) What **molarity of $AgNO_3$** solution can be prepared from 2.55g of $AgNO_3$ diluted to 150.mL? The molar mass of silver nitrate is 169.872g/mol.
72) What **volume** of solution is needed to prepare 0.100M $AgNO_3$ from 2.55g of $AgNO_3$?
73) What **volume of concentrated 6.0M $BaCl_2$** is needed to prepare 1000.mL of 1.2M chloride ion?
74) What **volume of diluted 1.2M $BaCl_2$** can be prepared from 200mL of 6.0M$BaCl_2$ solution?
75) What **is the molarity of 1000mL of diluted $BaCl_2$** that was prepared from 200mL of 6.0M$BaCl_2$ solution?
76) What **molarity of 200mL of concentrated $BaCl_2$** is needed to prepare 1000.mL of 1.2M $BaCl_2$?
76) Did you see the pattern in Q74 to 76 and the relation to the answer to Q73?
77) How many **milliliters** of 0.01535M NaOH are needed to **fully** neutralize 25.0mL of 0.142M H_2SO_4 to Na_2SO_4?
78) A volume of 463mL of what concentration of NaOH is needed to **fully** neutralize 25.0mL of 0.142M H_2SO_4 to Na_2SO_4?
79) A volume of 463mL of 0.01535M NaOH **fully** neutralizes how many milliliters of 0.142M H_2SO_4 to Na_2SO_4?
80) A volume of 463mL of 0.01535M NaOH **fully** neutralizes 25.0 milliliters of what concentration of H_2SO_4? The product of the neutralization is Na_2SO_4.
81) Did you see the pattern in Q77 to Q80?

1-6($CuSO_4 \cdot H_2O$), 7-12(63.924% anhydrous copper(II) sulfate, 36.076% water, 63.924g anhydrous copper(II) sulfate, 30.076g water. Working problems backwards from the answer to the question is an excellent way to study.) 13(NO), 14(43.382%), 15 (61.328%), 16(5, be sure you can balance the reaction), 17($2Fe(s) + 3Cl_2(g) \rightarrow 2FeCl_3(s)$), 18(Unless you have the Ksp values you need from Chem II, use a soluble chloride, bromide, iodide {solubility rule 3}, or sulfate {solubility rule 4}, {hydroxide or oxide, solubility rule 5}, phosphate, carbonate, sulfate, or sulfide {solubility rule 6}, soluble salts of these can be made using alkali metals {solubility rule 1} and the ammonium ion {solubility rule 2}. An example salt solution to cause precipitation would be NaCl(aq), but many others would work.), 19(precipitation, the previous problem in reverse), 20-21($Pb(aq) + 2Cl^-(aq) \rightarrow PbCl_2(s)$ or use the anion from your question 20 if you used something other than chloride. Be sure the reaction is balanced.) 22(The Bronsted

definition has a proton move from the acid to the base, so for example, HCl(aq) + NaOH (aq). Any acid formed by using a common polyatomic ion also works, $H_2Cr_2O_7$. Any of the alkali metal hydroxides works as the base), 23(If you used a strong acid and a strong base like in the example, $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$. If you used a weak acid with a strong base, then for example, $HC_2H_3O_2(aq) + OH^-(aq) \rightarrow C_2H_3O_2^-(aq) + H_2O(l)$. If you used a weak acid and weak base, then for example, $HC_2H_3O_2(aq) + NH_3(aq) \rightarrow C_2H_3O_2^-(aq) + NH_4^+(aq)$. Recall that weak acids and bases do not dissociate in aqueous solution.) 24(d - see Q22. This question uses HNO_3 instead of HCl.) 25-26(acid base, or neutralization), 27(NaOH(aq). Any alkali metal hydroxide works or other basic substance - see Q22.), 28(We learned two in class, ammonium ion and strong base, and carbonate and acid. Many combinations work, for example, $NH_4Cl(aq) + NaOH(aq)$, or $K_2CO_3 + HNO_3$), 29(e), 30($NH_4^+(aq) + OH^-(aq) \rightarrow NH_3(g) + H_2O(l)$ and $CO_3^{2-}(aq) + 2H^+(aq) \rightarrow CO_2(g) + H_2O(l)$), 31(HCl(aq), see question 28), 32(gas forming, see question 28), 33(+3, be sure you can calculate all of the oxidation numbers for all of the bound atoms), 34(The compound has no charge. The dichromate anion has a charge of -2, so 2 of them have a -4 charge. The Sn must have a charge of +4 so that the compound has no charge. Because there is one bound Sn in the compound, the oxidation number of Sn is +4), 35(Sn, Ni, Cd, Fe, Zn, Cr, Al, and Mg. Any metal above lead in the electrochemical series, preferably one that does not react with water.) 36($Pb(NO_3)_2(aq)$ HCl, $CuCl_2(aq)$, $AgNO_3(aq)$, $Hg(NO_3)_2(aq)$, $AuNO_3(aq)$ Any compound below Ni(s), preferably soluble - but it is not required to be soluble, in the electrochemical series), 37(b), 38(redox, reduction oxidation), 39($Pb^{2+}(aq) + Ni(s) \rightarrow Pb(s) + Ni^{2+}(aq)$), 40(3), 41(3), 42(1), 43(0), 44(0), 45(0), 46(0), 47(0), 48(0), 49-50) $Fe(s) + 3Au^+(aq) \rightarrow Fe^{3+}(aq) + 3Au(s)$, no acid, base or water is needed to balance this reaction. 51(8), 52 (0), 53(4), 54(3), 55(The balanced half reaction in acid is $3e^- + 8H^+(aq)\ CrO_4^{2-}(aq) \rightarrow Cr^{3+}(aq) + 4H_2O$), 56(0), 57(14), 58(7), 59(6), 60($6e^- + 7H_2O(l) + Cr_2O_7^{2-}(aq) \rightarrow 2Cr^{3+}(aq) + 14OH^-(l)$), 61(no reaction), 62 (no reaction, reaction is not written in product favored direction), 63(no reaction), 64(no reaction, 2 acids), 65(no reaction, 2 bases), 66(2.9g of C_2H_6 remains. Coefficients of balanced reaction are 2, 7, 4, 6. This is a limiting reagent problem. All calculations are based of the limiting reagent.), 67(12g C_2H_6 used), 68(35g CO_2), 69((1.2mol H_2O), 70(2.55g $AgNO_3$), 71(0.100M), 72(0.150L), 73(100mL - not 200mL because each $BaCl_2$ produces 2 Cl^-. 200mL would be the answer for diluted $BaCl_2$ solution. You need to be proficient with calculations like this for CHEMII), 74(1000mL), 75(1.2M), 76(6.0M), 76(I hope so. This one way you can study and learn. You can do this with any correctly worked molarity problem or example.) 77 (463, be sure to write and balance the acid-base/neutralization reaction), 78(0.01535M NaOH), 79(25.0mL), 80(0.142M H_2SO_4), 81(I hope so. The difference between these questions and the previous set is that you need the coefficients of the balanced chemical reaction - stoichiometry - when a chemical reaction occurs. These stoichiometric coefficients are not needed when making dilutions because no no chemical reaction occurs.)