General Chemistry I  Worksheet #4b  Redox. Chemistry, acid/base chemistry, precipitation reactions and titrations

1. Complete and balance each reaction. Classify each of the reactions by reaction type (acid/base, precipitation or redox).

a. \( \underline{1} \text{H}_2\text{C}_2\text{O}_4(\text{aq}) + \underline{1}\text{Na}_2\text{O}(\text{aq}) \rightarrow \underline{1}\text{H}_2\text{O}(\text{l}) + \underline{1}\text{Na}_2\text{C}_2\text{O}_4(\text{aq}) \)
   
   type: ______ acid/base __________________________

b. \( \underline{1}\text{Pb(NO}_3\text{)}_2(\text{aq}) + \underline{1}\text{Na}_2\text{S}(\text{aq}) \rightarrow \underline{1}\text{PbS}(\text{s}) + \underline{2}\text{NaNO}_3(\text{aq}) \)
   
   type: ______ precipitation _________________________

c. \( \underline{1}\text{HCl}(\text{aq}) + \underline{1}\text{NaOH}(\text{aq}) \rightarrow \underline{1}\text{H}_2\text{O}(\text{l}) + \underline{1}\text{NaCl}(\text{aq}) \)
   
   type: ______ acid/base __________________________

d. \( \underline{1}\text{Cu(s)} + \underline{4}\text{H}^+(\text{aq}) + \underline{2}\text{NO}_3^- \rightarrow \underline{1}\text{Cu}^{2+}(\text{aq}) + \underline{2}\text{NO}_2(\text{g}) + \underline{2}\text{H}_2\text{O(ℓ)} \)
   
   type: ______ redox. ______________________________

2. Give the oxidation number of each element in the following balanced reactions.

   metal \downarrow \text{element 'by itself'} \downarrow \text{ionic}

a. \( 4\text{Al(s)} + 3\text{O}_2(\text{g}) \rightarrow \text{2Al}_2\text{O}_3(\text{s}) \)
   
   Al(s) = 0,  O in O\(_2(\text{g}) = 0\),  Al in Al\(_2O_3(s) = +3\),  O in Al\(_2O_3(s) = -2\)

b. \( 2\text{MnO}_4^-(\text{aq}) + 6\text{H}^+(\text{aq}) + 5\text{H}_2\text{C}_2\text{O}_4(\text{aq}) \rightarrow \text{2Mn}^{2+}(\text{aq}) + 10\text{CO}_2(\text{g}) + 8\text{H}_2\text{O(ℓ)} \)

   Mn in MnO\(_4^-(\text{aq}) = +7\),  O in MnO\(_4^-(\text{aq}) = -2\),  H\(^+(\text{aq}) = +1\),  H in H\(_2C_2O_4(\text{aq}) = +1\),  C in H\(_2C_2O_4(\text{aq}) = +3\),  O in H\(_2C_2O_4(\text{aq}) = -2\)

   Mn\(_{2+}(\text{aq}) = +2\),  C in CO\(_2(\text{g}) = +4\),  O in CO\(_2(\text{g}) = -2\),  H in H\(_2O(\text{ℓ}) = +1\),  O in H\(_2O(\text{ℓ}) = -2\)
3. In number 3, **part a** (above), circle the oxidizing agent, and put a square around the reducing agent (on the reactant side).

4. a. Break benzoic acid down into its proton and polyatomic anion (yes, include charges!).

\[
\text{HC}_7\text{O}_2\text{H}_5 \rightarrow \text{H}^+ + \text{C}_7\text{O}_2\text{H}_5^-
\]

b. Break calcium hydroxide down into its ions. \(\text{Ca(OH)}_2 \rightarrow \text{Ca}^{2+} + \text{OH}^{-}\)

c. Write the reaction that occurs between benzoic acid, \(\text{HC}_7\text{O}_2\text{H}_5\), and calcium hydroxide.

\[
\text{HC}_7\text{O}_2\text{H}_5 + \text{Ca(OH)}_2 \rightarrow \text{Ca(C}_7\text{O}_2\text{H}_5)_2 + 2 \text{H}_2\text{O}
\]

5. a. Complete and balance the following reaction. Put a circle around the base (\(\text{Ca(OH)}_2\)) and underline the acid (\(\text{HIO}\)) (not done below; google sites problem).

\[
\underbrace{\text{HIO(aq)}}_{2} + \underbrace{\text{Ca(OH)}_2(aq)}_{1} \rightarrow 2 \text{H}_2\text{O(l)} + \underbrace{\text{Ca(IO)}_2(aq)}_{1}
\]

b. Write the balanced reaction that takes place when acetic acid reacts with lithium hydroxide.

\[
\text{HC}_2\text{H}_3\text{O}_2(aq) + \text{LiOH(aq)} \rightarrow \text{LiC}_2\text{H}_3\text{O}_2(aq) + \text{H}_2\text{O(l)}
\]

6. A 25.00 mL sample of vinegar (a dilute solution of acetic acid, \(\text{HC}_2\text{H}_3\text{O}_2(aq)\)) was titrated with 0.500 M \(\text{NaOH(aq)}\). The stoichiometric point was reached when 38.1 mL of the base had been added.

a. Find the concentration of acetic acid in the vinegar. (Hint: writing a balanced chemical equation of the reaction is a good start).

\[
\begin{align*}
\text{HC}_2\text{H}_3\text{O}_2(aq) + \underbrace{\text{NaOH(aq)}}_{\text{NaC}_2\text{H}_3\text{O}_2(aq) + \text{H}_2\text{O(l)}} \\
(0.500 \text{ mole NaOH})(38.1 \text{ mL})(1 \text{ L})(1 \text{ mole HC}_2\text{H}_3\text{O}_2)(1 \text{ mole NaOH})(25.00 \text{ mL})(1 \text{ L})
\end{align*}
\]

\[
= 0.762 \text{ M HC}_2\text{H}_3\text{O}_2(aq)
\]

b. Circle the strong species in the question above (#7, above part a).