1) Water is a polar molecule because:
   a) it is composed of 3 atoms.
   b) it is a bent molecule and has polar covalent bonds.
   c) it is a bent molecule and has ionic bonds.
   d) it has a small molecular weight.

2) Predict the products of the following reactions and provide a balanced molecular equation. Be sure to include the phase. If there is no net reaction, indicate as such.
   a) HNO$_3$ (aq) + LiOH (aq) → $\underline{\text{H}_2\text{O} (l)} + \text{LiNO}_3 (aq)$
   b) KNO$_3$ (aq) + CuCl$_2$ (aq) → $\underline{\text{no net reaction OR 2 KCl (aq)} + \text{Cu(NO}_3\text{)_2 (aq)}}$
   c) Li$_2$SO$_4$ (aq) + BaCl$_2$ (aq) → $\underline{\text{BaSO}_4 (s) + 2 LiCl (aq)}$

3) What is the molarity of Na$_2$SO$_4$ in a solution if 0.58 grams of Na$_2$SO$_4$ is in a final volume of 500 mL? 8.17 mM
   What is the molarity of Na$^+$?
   $0.58 \text{ g} \times \text{mol/142.02 g} = 4.08 \times 10^{-3} \text{ mol}$

4) What is the pH of a solution that has a proton concentration of 8.45 x 10$^{-6}$ M?
   $\text{pH} = -\log [\text{H}^+] = -\log 8.45 \times 10^{-6} \text{ M} = 5.07$

5) What is the proton concentration of a solution with a pH of 6.5?
   $[\text{H}^+] = 10^{\text{-pH}} = 10^{6.5} = 3.16 \times 10^{-7}$

6) Provide the oxidation number of the designated atom.
   a) Br in BrO$^-$ $+1$
   b) Cl in Cl$_2$ $0$
   c) H in KH $-1$
   d) C in CH$_3$OH $-2$
   e) Sr in Sr$^{2+}$ $+2$

7) The oxidation number of an element changes from +2 to +5.
   This element has ( gained or lost ) electrons
   This represents ( oxidation or reduction ).

8) A solution of lead(II) nitrate is added to a solution of potassium sulfide. A lead(II) sulfide precipitate forms. Provide the molecular equation, the total ionic equation and the net ionic equation for this reaction
   Molecular: Pb(NO$_3$)$_2$ (aq) + K$_2$S (aq) → 2 KNO$_3$ (aq) + PbS (s)
   Total ionic: Pb$^{2+}$ (aq) + 2 NO$_3$ (aq) + 2 K$^+$ (aq) + S$^{2-}$ (aq) → 2 NO$_3$ (aq) + 2 K$^+$ (aq) + PbS (s)
   Net ionic: Pb$^{2+}$ (aq) + S$^{2-}$ (aq) → PbS (s)
9) A solution of nitrous acid (HNO$_2$) is added to a solution of sodium hydroxide. Provide the molecular equation, the total ionic equation and the net ionic equation for any reaction that occurs.

(Notice, this is a weak acid)

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\begin{align*}
\text{HNO}_2 (aq) + \text{NaOH (aq)} & \rightarrow \text{NaNO}_3 (aq) + \text{H}_2\text{O (l)} \\
\text{HNO}_2 (aq) + \text{Na}^+ (aq) + \text{OH}^- (aq) & \rightarrow \text{Na}^+(aq) + \text{NO}_2^-(aq) + \text{H}_2\text{O (l)} \\
\text{HNO}_2 (aq) + \text{OH}^- (aq) & \rightarrow \text{NO}_2^- (aq) + \text{H}_2\text{O (l)}
\end{align*}
\]

10) Consider the reaction between lead (II) nitrate and potassium sulfide (#8 above)

a) How much lead (II) sulfide would form if 500 mL 0.0500 M lead (II) nitrate was added to 350 mL 0.0600 M potassium sulfide?

\[5.02 \text{ g}\]

b) What is the concentration of nitrate ion after reaction?

\[5.88 \times 10^{-2} \text{ M}\]

c) What is the concentration of lead (II) ion after reaction?

\[4.7 \times 10^{-3} \text{ M}\]

Determine limiting reagent:

0.500 L x 0.0500 mol Pb(NO$_3$)$_2$/L = 2.5 x 10$^{-2}$ mol x 1 mol PbS/1 mol Pb(NO$_3$)$_2$ = 2.5 x 10$^{-2}$ mol PbS

0.350 L x 0.0600 mol K$_2$S/L = 2.1 mol$^{-2}$ mol x 1 mol PbS/1 mol K$_2$S = 2.1 x 10$^{-2}$ mol PbS

Shows that K$_2$S is limiting and 2.1 x 10$^{-2}$ mol PbS would form

This is 2.1 x 10$^{-2}$ mol x 239.2 g/mol = 5.02 g

Amount of nitrate after reaction:

This did not precipitate so calculate new concentration

0.500 L x 0.0500 mol Pb(NO$_3$)$_2$/L = 2.5 x 10$^{-2}$ mol Pb(NO$_3$)$_2$ x 2 mol NO$_3^-$/mol Pb(NO$_3$)$_2$ = 5 x 10$^{-2}$ mol NO$_3^-$

This is present in 0.850 L

5.0 x 10$^{-2}$ mol/0.850 L = 5.88 x 10$^{-2}$ M

Amount of lead (II) after reaction:

Some of this precipitated. How much?

Determine how much lead(II) reacted with sulfide

0.350 L x 0.0600 mol K$_2$S/L = 2.1 mol$^{-2}$ mol K$_2$S x (mol Pb(NO$_3$)$_2$/1 mol K$_2$S) x 1 mol Pb/1 mol Pb(NO$_3$)$_2$

= 2.1 x 10$^{-2}$ mol Pb$^{2+}$

Determine how much lead(II) was there initially

0.500 L x 0.0500 mol Pb(NO$_3$)$_2$/L = 2.5 x 10$^{-2}$ mol Pb(NO$_3$)$_2$ x 1 mol Pb/mol Pb(NO$_3$)$_2$ = 2.5 x 10$^{-2}$ mol Pb

The amount of lead after precipitation is (initial – precipitated) = 2.5 x 10$^{-2}$ - 2.1 x 10$^{-2}$ = 4.0 x 10$^{-3}$ mol

in 0.850 L

4.0 x 10$^{-3}$/0.850 = 4.7 x 10$^{-3}$ M

11) If 0.200 L of 0.20 M Sr(OH)$_2$ is mixed with 0.300 L of 0.25 M HBr, will the resulting solution be acidic or basic?