Chemistry 192
Problem Set 1
Spring, 2018

1. Calculate the number of carbon atoms in 15.2 g of benzene (C_6H_6).

2. Bismuth oxide reacts with carbon according to the *unbalanced* reaction

$$Bi_2O_{3(s)} + C_{(graphite,s)} \longrightarrow Bi_{(s)} + CO_{(g)}$$

   Calculate the number of grams of carbon monoxide gas that are produced when 100.0 grams of bismuth oxide react with excess graphite.

3. Gas-phase diborane reacts with liquid water to produce boric acid and gas-phase hydrogen according to the *unbalanced* reaction

$$B_2H_{6(g)} + H_2O_{(\ell)} \longrightarrow H_3BO_{3(s)} + H_{2(g)}$$

   Calculate the number of grams of boric acid that form when 10.0 grams of diborane react with 10.0 grams of liquid water.

4. Calculate the final concentration of hydrochloric acid when 25.0 mL of 1.32 M HCl are diluted with water using a 100.00 mL volumetric flask.

5. Calculate the number of grams of solid potassium permanganate ($KMnO_4$) that must be added to a 250.00 mL volumetric flask to form a solution that is 2.54 M.

6. Given that barium sulfate ($BaSO_4$) is highly insoluble in water whereas sodium sulfate (Na_2SO_4) and barium chloride ($BaCl_2$) are highly soluble in water, calculate the number of grams of barium sulfate that form when 10.0 mL of 1.54 M barium chloride are mixed with 15.0 mL of 1.05 M sodium sulfate. Calculate $[SO_4^{2-}]$ that remains after the precipitate forms.

7. Silver chromate $[Ag_2CrO_4]$ is highly insoluble in water whereas silver nitrate $[AgNO_3]$ and sodium chromate $[Na_2CrO_4]$ are highly soluble in water. Calculate the mass of silver chromate that forms in the *unbalanced* reaction

$$Ag^+_{(aq)} + CrO^{2-}_{4(aq)} \longrightarrow Ag_2CrO_{4(s)}$$

when 0.105 L of 2.00 M aqueous silver nitrate are mixed with 0.365 L of 1.75 M aqueous sodium chromate.

8. The salt calcium fluoride (CaF_2) is highly insoluble in water. Calculate the final concentration of calcium ions in a solution formed by mixing 0.0250 L of a solution whose calcium ion concentration is $[Ca^{2+}]$=0.570 M with 0.0750 L of a solution whose fluoride concentration is $[F^-]$=0.360 M.

9. When excess aluminum metal is added to 0.124 L of an aqueous silver nitrate ($AgNO_3$) solution the following *unbalanced* reaction takes place

$$Ag^+_{(aq)} + Al_{(s)} \longrightarrow Ag_{(s)} + Al^{3+}_{(aq)}$$

and 3.68 grams of metal silver is found to have precipitated at completion. Calculate a) the mass of aluminum that has dissolved and b) the concentration of the original silver nitrate solution.

10. Nitric acid (HNO_3) is a strong acid and potassium hydroxide (KOH) is a strong base. Calculate the volume of 1.50 M nitric acid that must be added to 0.569 L of 3.00 M potassium hydroxide to produce a neutral solution.

11. When aluminum metal is added to a solution containing zinc ions, the aluminum dissolves and a precipitate of zinc metal forms. Excess solid aluminum is added to 10.5 mL of a solution of zinc ions having $[Zn^{2+}]$=3.55 M. Calculate the mass of aluminum metal that dissolves.

12. Calculate the mole fractions and partial pressures of Ar and O_2 when 10.0 grams of argon gas and 10.0 grams of oxygen gas are mixed in a 20.0L volume container at 100.00°C.

13. When a sample of aluminum metal is completely dissolved in excess acid according to the *unbalanced* reaction

$$Al_{(s)} + H^+_{(aq)} \longrightarrow H_{2(g)} + Al^{3+}_{(aq)}$$

the volume of produced hydrogen gas is found to be 0.747 L at a temperature of 50.0°C and a pressure of 2.00 bar. Calculate the mass of the aluminum metal that dissolves.

14. A 0.0200 gram sample of solid nickel metal are completely dissolved in 0.0100 L of a 0.100 M hydrochloric acid solution according to the *unbalanced* reaction

$$Ni_{(s)} + H^+_{(aq)} \longrightarrow H_{2(g)} + Ni^{2+}_{(aq)}.$$

Calculate a) the volume of hydrogen gas produced at a pressure of $P = 2.00$ bar and a temperature of T=300.0 K; and b) the final concentration of acid assuming the liquid volume is unchanged after the reaction is complete.

15. A sample of metallic aluminum completely dissolves in 0.750 L of 2.00 molar strong acid forming a $Al^{3+}_{(aq)}$ solution and 2.00 L of hydrogen gas at a temperature of $T = 298$ K and a pressure of $P = 1.125$ bar. Calculate the mass of the original aluminum sample and the acid concentration after the reaction is complete. Assume the volume of acid is unchanged by the reaction.

16. Calculate the number of grams of solid potassium chlorate ($KClO_3$) that decompose according to the *unbalanced* reaction

$$KClO_{3(s)} \longrightarrow KCl_{(s)} + O_{2(g)}$$

if 0.355 L of oxygen gas form at 135.°C and a pressure of 1.07 bar.