1. (3 points ea.)
   a. Give a balanced equation to prepare \( \text{Mg}_3(\text{PO}_4)_2 \) by acid-base reaction

\[
\text{Mg(OH)}_2 + \text{H}_3\text{PO}_4 \rightarrow \text{Mg}_3(\text{PO}_4)_2 + \text{H}_2\text{O}
\]

b. Give an example of gas forming reaction.

\[
\text{CaCO}_3 + \text{HCl} \rightarrow \text{CaCl}_2 + \text{H}_2\text{O} + \text{CO}_2
\]

c. Give two statements of solubility rules

d. Give a redox reaction identifying oxidation, reduction, oxidizing agent, reducing agent

e. Give an example of a diprotic acid and an amphiprotic compound.

\[
\text{H}_2\text{SO}_4 \quad \text{H}_2\text{O}
\]

2. Complete and give the net ionic equation for the following: (3)

\[
\text{BaCl}_2 + \text{Na}_2\text{SO}_4 \rightarrow \text{BaSO}_4 + \text{H}_2\text{O}
\]

\[
\text{Ba}^{2+} + \text{SO}_4^{2-} \rightarrow \text{BaSO}_4(s)
\]

3. Complete the following reaction and identify acid, base, conjugate acid, conjugate base (3)

\[
\text{NH}_3 + \text{HC}_2\text{H}_3\text{O}_2 \rightarrow \text{NH}_4^+ + \text{C}_2\text{H}_3\text{O}_2^-
\]

4. Balance the following redox reaction in acidic medium. (10)

\[
a. \quad \text{H}_2\text{SO}_3 + \text{VO}_2^{2+} \rightarrow \text{S}_2\text{O}_6^{2-} + \text{VO}^{2+}
\]

\[
b. \quad \text{Mn}^{2+} + \text{CO}_2 \rightarrow \text{MnO}_4^{1-} + \text{H}_2\text{C}_2\text{O}_4
\]

Non Numerical (2 points each)

1. Which oxidation number does not correctly match with the element identified?
   a. \( \text{Na}_2\text{O} \) [+] 1
   b. \( \text{H}_2\text{SeO}_4 \) [+4]
   c. \( \text{NaHCO}_3 \) [+] 4
   d. \( \text{HBrO}_2 \) [+] 3

2. Identify the spectator ion or ions (if any) in the redox reaction of a solution of silver (I) nitrate with Aluminum metal.
   a. \( \text{Ag}^{1+} \)
   b. \( \text{Al}^{3+} \)
   c. \( \text{NO}_3^{1-} \)
   d. \( \text{H}^+ \) and \( \text{Ag}^{1+} \)

3. If the reaction of 1.00 mole \( \text{NH}_3(g) \) and 1.00 mole \( \text{O}_2(g) \) is carried to completion, \( 4 \text{NH}_3(g) + 5 \text{O}_2(g) \rightarrow 4 \text{NO(g)} + 6 \text{H}_2\text{O(g)} \)
   a. all the \( \text{O}_2(g) \) is consumed
   b. 4.0 mole \( \text{NO}(g) \) is produced
   c. 1.5 mole \( \text{H}_2\text{O}(g) \) is produced
   d. all the \( \text{NH}_3(g) \) is consumed

4. The temperature and pressure at which \( \text{CO}_2 \) is most likely to behave like an ideal gas are
   a. 100 °C and 1.0 atm
   b. 0 °C and 0.50 atm
5. Which of the following is a precipitation reaction?
   a. Zn + HCl → ZnCl₂ + H₂
   b. KBrO₃ + CO → KBr + CO₂
   c. AgNO₃ + SrCl₂ → AgCl + Sr(NO₃)₂
   d. LiOH + H₂SO₄ → Li₂SO₄ + H₂O

6. Which is a redox reaction?
   a. Cl₂(g) + NaBr(aq) → NaCl(aq) + Br₂(l)
   b. CuCl₂ + FeBr₂ → CuBr₂ + FeCl₂
   c. H₂O + CO₂ → H₂CO₃
   d. Na₂CO₃ + HNO₃ → NaNO₃ + H₂O + CO₂

7. Which statement is incorrect?
   a. as the pressure increases and temperature decreases, gases tend to deviate from ideal behavior
   b. as the molecular weight increases, the velocity of a gas decreases
   c. as the pressure increases the molecular velocity of a gas increases
   d. as the amount of gas in a given volume increases, to retain the temp. constant pressure must decrease

8. What would be the length of mercury column supported by a pressure of 0.58 atm?
   a. 44 mm
   b. 441 cm
   c. 16.8 inch
   d. 0.44 m

9. Which is the correct arrangement with decreasing oxidation state of Mn?
   a. KMnO₄, MnO₂, MnCl₃, MnSO₄
   b. MnO₂, KMnO₄, MnSO₄, MnCl₃
   c. MnSO₄, MnO₂, MnCl₃, KMnO₄
   d. MnSO₄, MnCl₃, MnO₂, KMnO₄

10. For a fixed amount of gas at fixed pressure, changing the temperature from 100 K to 200 °C causes the gas volume to
    a. to decrease
    b. to double
    c. to increase but not double
    d. not to change

11. When mixed with hydrochloric acid, which of the following salts will produce a gas?
    a. NaNO₃
    b. KCl
    c. K₃PO₄
    d. CaCO₃

12. Which lists contains strong acids and are in order from weak to strong?
   a. HNO₃, H₂SO₄, HI, HF, HCl, HClO₄
   b. HNO₃, H₂SO₄, HCl, HBr, HI, HClO₄
   c. H₃PO₄, HNO₃, HClO₃, HI, H₂SO₄, HCl
   d. HClO₄, HBr, HI, H₂SO₄, HCl, H₂C₂O₄

13. Boyle's law shows direct proportionality between
   a. Volume and Pressure
   b. Volume and 1/Temperature
   c. Volume and moles
   d. Volume and 1/Pressure

14. Select the answer that represents the incorrect statements.
    I. A solution is considered acidic if the substance dissolved in it has produced OH⁻
    II. If you add sulfide to a solution containing any cation, there will be a precipitate.
    III. When there is a decrease in the oxidation state of an atom, it is considered to be oxidized.
    IV. Combustion reactions always produce oxides.
        a. I, III, IV
        b. II, IV
        c. I, II, III
        d. II, III, IV

Numerical (3 points each)
15. If you prepared 3200 mL KMnO₄( 157.04) solution by dissolving 28.14 g KmnO₄, what will be the molarity of the solution?
    a. 5.60 x 10⁻² M
    b. 0.000056 M
    c. 8.79 M
    d. 0.5736 M

16. If 250 mL of propane is reacted with enough oxygen in a 5 L container at 1200°C according to the following equation, how many mL of CO₂ gas can be prepared?
    C₃H₈ (g) + 5SO₂(g) → 3CO₂(g) + 4H₂O (g)
    a. 5250 mL
    b. 750 mL
c. 250 mL  

17. If 35 mL of 0.45 M KOH can completely neutralize 50 mL of a monoprotic acid, what is the molarity of acid?

a. 0.46 M  
b. 0.64 M  
c. 0.32 M  
d. 0.18 M

18. The pressure of 4.0 L of an ideal gas in a flexible container is decreased to one-third of its original pressure and its absolute temperature is decreased to one-half. The volume then is

a. 1.0 L  
b. 4.0 L  
c. 6.0 L  
d. 8.0 L

19. When 2.0 g of Hydrogen gas, 16.0 g of Oxygen gas, 28.0 g of Nitrogen gas, 10 g. Neon gas are placed in a container of 22.4 liter volume at 0 °C, the pressure inside the container would be

a. 1.0 atm  
b. 3.0 atm  
c. 56 atm  
d. 0.28 atm

1. A small bubble rises from the bottom of a pond where the temperature is 12.3°C and the pressure is 5.2 atm to the top where the temperature is 26.4°C and the pressure is 1.0 atm. Assuming that gas from inside of the bubble does not leak out, calculate the final volume of the bubble if its initial volume is 2.6 mL.

\[
P_1 = 5.2 \text{ atm} \quad V_1 = 2.6 \text{ mL} \quad T_1 = 273 + 12.3 = 285.3 \text{ K} \\
P_2 = 1 \text{ atm} \quad V_2 = ??? \text{ mL} \quad T_2 = 273 + 26.4 = 299.4 \text{ K} \\
\]

\[
P_1 V_1 / T_1 = P_2 V_2 / T_2 \\
V_2 = [(5.2 * 2.6 * 299.4) / 285.3 * 1.0] \text{ mL} \\
\]

2. Dumas method of determining the molar mass involves vaporizing a volatile liquid in order to determine its density. The density of this sample of vapor at 90°C and 754 Torr is determined to be 1.585 g/L. What is the molecular weight of vapor?

(5)

3. A 8.78 % solution of CaCl₂ (mw = 110.99) has a density of 1.031 g/mL. Express this concentration in molality and molarity units.

(6)

\[
8.78 \text{ grams of CaCl}_2 + 91.22 \text{ grams of water will give 100 mL Solution} \\
8.78 \text{ grams of CaCl}_2 \times (1\text{ mole} / 110.99 \text{ g}) = 0.07910 \text{ moles} \\
91.22 \text{ grams of water} = 0.09122 \text{ Kg of water} \\
\text{molality} = 0.07910 \text{ moles} / 0.09122 \text{ Kg solvent} = 0.867 \text{ m} \\
100 \text{ g solution (1 mL/1.031 g solution)} = 96.993 \text{ mL solution} = 0.096993 \text{ L solution} \\
\text{So Molarity} = 0.07910 \text{ moles of solute/0.096993 L solution} = 0.8155 \text{ M} \\
\]
4. The pressure of Nitrogen gas in a 2.0-L tank is 1.5 atm at 30°C. If I transfer this to a 5.0-L and raise the temperature to 400 K, what will be the pressure of the gas? How much gas, in grams, do I have? What is the density of the gas in the first container?

(5)

5. You are given a 12.00-M solution of HCl. You are supposed to prepare 15.00 liters of 0.1468-M solution. Determine the amount of stock solution and water needed for the preparation process.

(5)

\[ M_1 V_1 = M_2 V_2 \]
\[ V_1 = \frac{(15.00 \times 0.1468)}{12.00} = 0.1835 \text{ L} \]

You will need 0.1835 L of 12 M solution and \([15 \text{ L} - 0.1835 \text{ L}] = 14.82 \text{ L}\) water to prepare this solution.

6. How many grams of nitrogen gas would occupy the volume of a tennis ball, 150 mL, at a room temperature of 23°C and a playing pressure of 1030 mm Hg? (R = 0.08206 L atm/K mol)

(5)

7. 3.684 grams of Hg(NO₃)₂ (mw = 326.6) is added to a 60.00 mL of 0.248 M solution of MgCl₂. After the reaction, what is the maximum mass of HgCl₂ (mw = 271.5) that can be prepared?

(7)

\[ \text{Hg(NO}_3\text{)₂ + MgCl}_2 \rightarrow \text{HgCl}_2 + \text{Mg(NO}_3\text{)}_2 \]

Limiting reagent

\[ \frac{3.684}{326.6} = 0.01128 \text{ moles of Hg(NO}_3\text{)₂} \]

\[ 0.060 \text{ L} \times 0.248 \text{ M} = 0.01488 \text{ moles of MgCl}_2 \]

<table>
<thead>
<tr>
<th>0.1128 moles of Hg(NO₃)₂</th>
<th>1 mole of HgCl₂</th>
<th>271.5 grams of HgCl₂</th>
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</thead>
<tbody>
<tr>
<td>1 mole of Hg(NO₃)₂</td>
<td>1 mole of HgCl₂</td>
<td>= 3.062 grams</td>
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