I. Multiple Choice (for those with an asterisk, you must show work)

1. Which one of the following cannot act as an oxidizing agent?
   (A) \( S^{2-} \)  (B) \( SO_3^{2-} \)  (C) \( SO_4^{2-} \)  (D) \( S_2O_8^{2-} \)

2. What is the oxidation number of As in the compound \( K(NH_4)AsO_4 \cdot 6H_2O \)?
   (A) \(-3\)  (B) \(+1\)  (C) \(+3\)  (D) \(+5\)

*3. A sample of 0.040 mol hypochlorite ion is treated with varying amounts of 1.0 M aqueous \( H_2O_2 \). Which graph represents the amount of \( O_2(g) \) that is evolved according to the chemical reaction shown?

\[
OCl^{-}(aq) + H_2O_2(aq) \rightarrow Cl^{-}(aq) + H_2O(l) + O_2(g)
\]

\[\text{(A) } \quad \text{(B) } \quad \text{(C) } \quad \text{(D) } \]

![Graph A](image1.png)  ![Graph B](image2.png)  ![Graph C](image3.png)  ![Graph D](image4.png)

4. What is the oxidation state of nitrogen in magnesium nitride?
   (A) \(-3\)  (B) \(-2\)  (C) \(+3\)  (D) \(+5\)

5. Which solid is most soluble in water at 25 ºC?
   (A) \( AgNO_3 \)  (B) \( CaCO_3 \)  (C) \( PbO \)  (D) \( ZnS \)

6. Potassium carbonate, \( K_2CO_3 \), sodium iodide, \( NaI \), ammonium perchlorate, \( NH_4ClO_4 \), methanol, \( CH_3OH \), and ammonium chloride, \( NH_4Cl \), are soluble in water. Which produces the largest number of dissolved particles per mole of dissolved solute?
   A. \( K_2CO_3 \)  B. \( NaI \)  C. \( NH_4ClO_4 \)  D. \( CH_3OH \)  E. \( NH_4Cl \)

7. Which of the following pairs of aqueous solutions will form a precipitate when mixed?
   A. \( NH_4NO_3 + Li_2CO_3 \)  B. \( Hg_2(NO_3)_2 + LiI \)  C. \( NaCl + Li_3PO_4 \)
   D. \( AgCH_3COO + Cu(NO_3)_2 \)  E. None of the above solution pairs will produce a precipitate.

8. One gram of each of the following compounds is mixed with 100mL of water. List the compounds that will conduct electricity when mixed with water (more than one answer possible).
   A. acetic acid  B. octane  C. calcium acetate
   D. sulfuric acid  E. iron (II) hydroxide  F. sulfur hexafluoride

9. Which one of the following salts is **insoluble** in water?
   A. \( FeCl_2 \)
10. What is the net ionic equation for the following formula unit equation?

\[ \text{Cu(NO}_3\text{)}_2(\text{aq}) + \text{H}_2\text{S(}\text{aq}) \rightarrow \text{CuS(s)} + 2\text{HNO}_3(\text{aq}) \]

A. \[ \text{Cu}^{2+}(\text{aq}) + \text{H}_2\text{S(}\text{aq}) \rightarrow \text{CuS(s)} + 2 \text{H}^{+}(\text{aq}) \]
B. \[ [\text{Cu}^{2+}(\text{aq}) + 2 \text{NO}_3^{-}(\text{aq})] + \text{H}_2\text{S(}\text{aq}) \rightarrow \text{CuS(s)} + 2[\text{H}^{+}(\text{aq}) + 2 \text{NO}_3^{-}(\text{aq})] \]
C. \[ \text{Cu}^{2+}(\text{aq}) + 2 \text{H}^{+}(\text{aq}) + \text{S}^{2-}(\text{aq}) \rightarrow \text{CuS(s)} + 2 \text{H}^{+}(\text{aq}) \]
D. \[ \text{Cu}^{2+}(\text{aq}) + \text{S}^{2-}(\text{aq}) \rightarrow \text{CuS(s)} \]
E. \[ \text{Cu}^{2+}(\text{aq}) + 2 \text{NO}_3^{-}(\text{aq}) + 2 \text{H}^{+}(\text{aq}) + \text{S}^{2-}(\text{aq}) \rightarrow \text{CuS(s)} + 2 \text{H}^{+}(\text{aq}) + 2 \text{NO}_3^{-}(\text{aq}) \]

II. Short Answer (for those with an asterisk, you must show work)

*1. Sulfuric acid dissolves aluminum to produce aluminum sulfate and hydrogen gas.
   A. Write the balanced reaction for this process.
   B. Suppose you wanted to dissolve an aluminum block with a mass of 15.2 g. What mass of sulfuric acid would you need? What mass of aluminum sulfate would you produce? What mass of hydrogen gas would you produce?

2. To be an electrolyte, whether strong, weak, or inert, a substance must ___________________________.

3. Place the following lists of compounds into as many categories (boxes) as appropriate:

   NaNO₃, HNO₃, PbCl₂, CH₃CH₂OH, AgNO₃, CH₃COOH, Fe(CH₃COO)₃, C₆H₁₂O₆, NaOH, Fe(OH)₃, H₂S, CaCO₃, (NH₄)₃PO₄, Li₂PO₄, H₂CO₃, H₂SO₄, HCOOH, CsOH, NH₃

<table>
<thead>
<tr>
<th>Strong acids.</th>
<th>Strong electrolytes.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weak acids.</td>
<td>Weak electrolytes.</td>
</tr>
<tr>
<td>Strong bases.</td>
<td>Nonelectrolytes.</td>
</tr>
<tr>
<td>Insoluble.</td>
<td></td>
</tr>
</tbody>
</table>
4. Write (i) the balanced overall reaction for each of the following reactions. Write (ii) the total ionic equation (TIE), and (iii) the net ionic equation (NIE) for each of the reactions that will occur when the following solutions are mixed. If there is a reaction, it will go to completion. If there is no reaction, write "No Reaction" for the NIE but still complete the balanced overall reaction and the TIE.

   A. aqueous solutions of silver nitrate and potassium chloride

   B. aqueous solutions of acetic acid and potassium hydroxide

   C. H$_2$SO$_4$(aq) and Na$_2$CO$_3$(aq)

   D. aqueous solutions of potassium sulfite and nitric acid
5. A chemist dissolves 0.00491 g of hydrochloric acid in water and dilutes the solution to the mark in a 250.00 mL volumetric flask. A 1.00 mL sample of this solution is then transferred to a 100.00 mL volumetric flask and diluted to the mark.

A. What is the molarity of the hydrochloric acid in the final solution?

B. What is the pH of the final solution

6. Assign oxidation numbers to each of the elements in the following compounds:

A. \( \text{P}_2\text{O}_5 \)  
B. \( \text{N}_2\text{O}_4 \)  
C. \( \text{SO}_2 \)

D. \( \text{Fe(NO}_3\text{)}_2 \)  
E. \( \text{NH}_4\text{Cl} \)  
F. \( \text{CH}_3\text{CH}_2\text{OH} \)

G. \( \text{C}_2\text{H}_5\text{COOH} \)  
H. \( \text{CH}_3\text{COCH}_3 \)  
I. \( \text{CH}_3\text{CH}_2\text{CH}_3 \)

7. Assign an oxidation number to each of the elements in the following reaction. Identify the element oxidized and the element reduced. Also identify the element that is the oxidizing agent and the reducing agent.

\[ \text{NaBr} + \text{Cl}_2 \rightarrow \text{NaCl} + \text{Br}_2 \]

8. List the 7 strong acids.

9. _________ acids are (essentially) 100% ionized.

_______ acids are approximately _________ % ionized.

_______ bases are soluble in water, have the _________ ion in their formulas, and dissociate _________ % into ions.

_______ bases are approximately _________ % ionized. They are called amines and have nitrogen bonded to three other atoms and a lone pair of electrons.
10. Fill in the gaps in the following table:

<table>
<thead>
<tr>
<th>pH</th>
<th>[H⁺] (mol/L)</th>
<th>[OH⁻] (mol/L)</th>
<th>Acid/Base Sol'n?</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.20</td>
<td>1.9 x 10⁻¹³</td>
<td>6.7 x 10⁻⁷</td>
<td></td>
</tr>
<tr>
<td>8.32</td>
<td>5.4 x 10⁻⁴</td>
<td>8.8 x 10⁻⁹</td>
<td></td>
</tr>
</tbody>
</table>

pH: always 2 decimal places
[H⁺], [OH⁻]: always 2 sig figs

*11. A chemical analysis shows that a sample contains 250.0 micrograms of Uranium in 4.00 x 10⁴ grams of water. Convert the measurement to parts per billion (ppb).

12. Determine the type of electrolyte. Also, list or draw all ion(s)/molecule(s) that would be present in each beaker if the substance was dissolved in water in the approximate ratios that they would be present.

A. NaNO₃  
Type of electrolyte: 

B. C₁₂H₂₂O₁₁  
Type of electrolyte: 

C. HCOOH  
Type of electrolyte: