Question 1 8 Points

a. Write a net ionic equation to show that perchloric acid, behaves as an acid in water.

\[
\text{HClO}_4(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{H}_3\text{O}^+ + \text{ClO}_4^- \\
\text{or } (\rightarrow)
\]

b. Write a net ionic equation to show how ammonia behaves as a base in water.

\[
\text{NH}_3(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{NH}_4^+ + \text{OH}^- \\
\text{or } (\rightarrow)
\]

Question 2 8 Points

a. HNO\textsubscript{2} 2 1. Strong Acid
b. C\textsubscript{9}H\textsubscript{7}N 4 2. Weak Acid
c. CH\textsubscript{3}COOH 2 3. Strong Base
d. Ba(OH)\textsubscript{2} 3 4. Weak Base

Question 3 6 Points

Circle the appropriate answers

a. The acid with the smallest [H\textsubscript{3}O\textsuperscript{+}] in a 0.10 M aqueous solution is: A B C

b. The acid with the smallest pKa: A B C
c. The acid with the smallest pOH in a 0.10 M aqueous solution is: A B C

Question 4 4 Points

A student determines that the value of pKa for HCN = 9.29. What is the value of Ka? 5.13x10\textsuperscript{-10}

Question 5 9 Points

The hydroxide concentration in an aqueous solution is 3.5x10\textsuperscript{-2} M.

a. The hydronium ion concentration is: 2.88x10\textsuperscript{-13} M
b. The pH of this solution is: 12.54
c. The pOH is: 1.46

Question 6 10 Points

1. For following net ionic equation:

\[
\text{CN}^- (\text{aq}) + \text{HSO}_3^- (\text{aq}) \rightleftharpoons \text{HCN}(\text{aq}) + \text{SO}_3^{2-} (\text{aq})
\]

- Circle the appropriate answer - B-L = Bronsted Lowry

\[
\text{SO}_3^{2-} \quad \text{B-L Acid} \quad \text{B-L Base}
\]

\[
\text{HSO}_3^- \quad \text{B-L Acid} \quad \text{B-L Base}
\]

2. The formula for the conjugate acid of CN\textsuperscript{-} is: HCN
3. The formula for the conjugate base of HSO\textsubscript{3}^- is: SO\textsubscript{3}^{2-}
Question 7 4 Points
A buffer solution made from $\text{HClO}$ and $\text{KClO}$ has a pH of 7.65. If pKa for $\text{HClO}$ is 7.46, this implies that:

1. $[\text{ClO}^-]/[\text{HClO}] = 1$
2. $[\text{ClO}^-]/[\text{HClO}] \times 1$
3. $[\text{ClO}^-]/[\text{HClO}] < 1$

Circle the appropriate answer

Question 8 4 Points
A buffer solution made from $\text{HF}$ and $\text{NaF}$ has a pH of 2.87. If pKa for $\text{HF}$ is 3.14, what is the $[\text{F}^-]/[\text{HF}]$ in the buffer?

$$\text{pH} = \text{pK}_a + \log_{10} \frac{[\text{F}^-]}{[\text{HF}]}$$

$$2.87 = 3.14 + \log_{10} \frac{[\text{F}^-]}{[\text{HF}]}$$

$$\log_{10} \frac{[\text{F}^-]}{[\text{HF}]} = -0.27$$

$$\frac{[\text{F}^-]}{[\text{HF}]} = 0.54$$

Question 9 8 Points
A small amount of strong base is added to a buffer made from $\text{HCN}$ and $\text{NaCN}$. What changes if any will occur to the solution.

-Circle the appropriate answer

1. pH Increase Decrease Remain the same
2. $[\text{OH}^-]$ Increase Decrease Remain the same
3. $[\text{HCN}]$ Increase Decrease Remain the same
4. $[\text{CN}^-]$ Increase Decrease Remain the same

Question 10 9 Points

<table>
<thead>
<tr>
<th>γ rays</th>
<th>X rays</th>
<th>UV</th>
<th>IR</th>
<th>Microwave</th>
<th>FM Radio waves</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue</td>
<td>Visible</td>
<td>Red</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. Which has the greater frequency, FM or AM Radio Waves? FM
b. Which has the longer wavelength, Red or Blue? Red
c. The region with the shortest wavelengths? γ rays

Question 11 6 Points

a. When the nuclide $^{218}\text{Po}$ decays to $^{214}\text{Pb}$, what kind of decay does $^{218}\text{Po}$ undergo?

$^4_2\text{He}$ (Alpha). The instability of $^{218}\text{Po}$ is probably due to the fact that it has too many protons.

b. What type of radioactive decay would account for the transformation of $^{51}\text{Cr}$ to $^{51}\text{V}$?

$^0_1\text{e}$ (Positron)
Question 12  
3 Points  
$^{131}$I (half-life, 8.04 days) is used as a treatment for thyroid cancer. How many milligrams of a 32 milligram sample of $^{131}$I will remain after 32.16 days?

\[
\frac{32.16}{8.04} = 4
\]

\[32 \times \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} = 2\]

\[2 \text{ Milligrams } ^{131}\text{I}\]

Question 13  
6 Points  
According to the following reaction, how many grams of oxygen gas are required for the complete reaction of 21.3 grams of carbon monoxide?

\[\text{carbon monoxide (g) + oxygen (g) = carbon dioxide (g)}\]

\[2\text{CO} + \text{O}_2 = 2\text{CO}_2\]

\[
\frac{21.3 \text{ g CO}}{28.01 \text{ g}} = 0.76 \text{ mol CO}
\]

\[
\frac{0.76 \text{ mol CO}}{2 \text{ CO}} = 0.38 \text{ mol O}_2
\]

\[
\frac{0.38 \text{ mol O}_2}{1 \text{ mol}} = 12.2 \text{ g}
\]

\[12.2 \text{ Grams of oxygen gas}\]

Question 14  
7 Points  
An aqueous solution of hydrochloric acid is standardized by titration with a 0.453 M solution of barium hydroxide. If 29.4 mL of base are required to neutralize 15.6 mL of the acid, what is the molarity of the hydrochloric acid solution?

\[2\text{HCl} + \text{Ba(OH)}_2 = \text{BaCl}_2 + 2\text{H}_2\text{O}\]

\[0.453 \times 0.0294 = 1.33 \times 10^{-2} \text{ mol Ba(OH)}_2\]

\[\frac{1.33 \times 10^{-2} \text{ mol Ba(OH)}_2}{2 \text{ HCl}} = 2.66 \times 10^{-2}\]

\[\frac{2.66 \times 10^{-2} \text{ mol HCl}}{0.0156 \text{ L}} = 1.71 \text{ M}\]

\[1.71 \text{ M}\]

Question 15  
8 Points  
How many grams of solid calcium hydroxide are needed to exactly neutralize 18.3 mL of a 0.690 M perchloric acid solution? Assume that the volume remains constant.

\[\text{Ca(OH)}_2 + 2\text{HClO}_4 = \text{Ca(ClO)}_4 + 2\text{H}_2\text{O}\]

\[0.690 \times 0.0183 = 0.0126 \text{ mol HClO}_4\]

\[\frac{0.0126 \text{ mol HClO}_4}{2 \text{ HClO}_4} = 6.31 \times 10^{-3} \text{ mol}\]

\[\text{Ca(OH)}_2 \]

\[
\frac{6.31 \times 10^{-3} \text{ mol Ca(OH)}_2}{74.1 \text{ g}} = 0.468 \text{ g}\]

\[0.468 \text{ g}\]