1. In the following reversible reactions, label the acids and bases on both sides and then identify each conjugate pair.

   a. \( \text{NH}_3 + \text{HCHO} \rightleftharpoons \text{NH}_4^+ + \text{CHO}_2^- \)

   b. \( \text{HCO}_3^- + \text{H}_2\text{O} \rightleftharpoons \text{H}_2\text{CO}_3 + \text{OH}^- \)

2. What is the conjugate base of:

   a. \( \text{HNO}_2 \)

   b. \( \text{H}_2\text{PO}_4^- \)

3. What is the conjugate acid of

   a. \( \text{HS}^- \)

   b. \( \text{H}_2\text{O} \)

4. Match each substance to either a strong acid, weak acid, strong base, weak base, or salt (neutral). You will use each one only once.

   ___KOH  a. strong acid
   ___\text{HC}_6\text{H}_5\text{O}_6  b. weak acid
   ___\text{KCl}  c. strong base
   ___\text{HNO}_3  d. weak base
   ___\text{NH}_3  e. neutral

5. Complete the following table for \([\text{H}_3\text{O}^+]\), \([\text{OH}^-]\), etc.

<table>
<thead>
<tr>
<th>([\text{H}_3\text{O}^+])</th>
<th>([\text{OH}^-])</th>
<th>pH</th>
<th>pOH</th>
<th>Acidic/Basic?</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1.0 \times 10^{-9})</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(4.1 \times 10^{-2})</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.75</td>
<td></td>
<td>5.45</td>
</tr>
</tbody>
</table>
6. Balance each of the following neutralization reactions.
   
a. \( \underline{\text{}}\text{HNO}_3 + \underline{\text{}}\text{Ba(OH)}_2 \rightarrow \underline{\text{}}\text{H}_2\text{O} + \underline{\text{}}\text{Ba(NO}_3)_2 \)

b. \( \underline{\text{}}\text{H}_2\text{SO}_4 + \underline{\text{}}\text{Al(OH)}_3 \rightarrow \underline{\text{}}\text{H}_2\text{O} + \underline{\text{}}\text{Al}_2(\text{SO}_4)_3 \)

7. A 10.0mL sample of ascorbic acid (\( \text{HC}_6\text{H}_7\text{O}_6 \)) solution required 15.3mL of a 0.250M NaOH solution to reach the endpoint. The balanced reaction is:

\[
\text{HC}_6\text{H}_7\text{O}_6 + \text{NaOH} \rightarrow \text{H}_2\text{O} + \text{NaC}_6\text{H}_7\text{O}_6
\]

a. What is the molarity of the ascorbic acid solution?

b. What mass of ascorbic acid is present in the 10.0mL sample?

8. Which of the following pairs of compounds could produce a buffer? (Choose only one) Explain why the others cannot be buffers.

   a. HCl and NaOH

   b. HCHO\(_2\) and KCHO\(_2\)

   c. HNO\(_3\) and NH\(_3\)

9. Consider the \( \text{HC}_3\text{H}_5\text{O}_2 / \text{C}_3\text{H}_5\text{O}_2^- \) buffer system below.

\[
\text{HC}_3\text{H}_5\text{O}_2 \rightleftharpoons H^+ + \text{C}_3\text{H}_5\text{O}_2^-
\]

a. Which species (\( \text{HC}_3\text{H}_5\text{O}_2 / \text{C}_3\text{H}_5\text{O}_2^- \)) reacts with \( H^+ \) when an acid is added to the buffer?

b. Which species (\( \text{HC}_3\text{H}_5\text{O}_2 / \text{C}_3\text{H}_5\text{O}_2^- \)) reacts with \( OH^- \) when a base is added to the buffer?