Academic Integrity Pledge:
In keeping with Creighton University’s ideals and with the Academic Integrity Code adopted by the College of Arts and Sciences, I pledge that this work is my own and that I have neither given nor received inappropriate assistance in preparing it.

Instructions: Show all work whenever a calculation is required! You will receive credit for how you worked each problem as well as for the correct answer. This exam is worth 50 points. BOX YOUR ANSWERS!

1. (4 pts) Circle the two Bronsted-Lowry acids in the following equilibrium. Put a box around the two Bronsted-Lowry bases. Draw lines that connect each acid with its conjugate base.

HF(aq) + NH₃(aq) ⇌ NH₄⁺(aq) + F⁻(aq)

2. (5 pts) Complete the following table that lists conjugate pairs of weak acids and bases.

<table>
<thead>
<tr>
<th>Acid</th>
<th>Base</th>
</tr>
</thead>
<tbody>
<tr>
<td>HC₂H₃O₂</td>
<td>CN⁻</td>
</tr>
<tr>
<td>H₂PO₄⁻</td>
<td></td>
</tr>
<tr>
<td>HClO₂</td>
<td>NH₃</td>
</tr>
</tbody>
</table>

3. (3 pts) What is the pH of a 0.044 M nitric acid solution?

4. (3 pts) What is the pH of a solution prepared by dissolving 0.0473 g KOH in enough water to make 500.0 mL solution? [Given: MM 56.1 g KOH/mol]

5. (3 pts) What is the pH that results from diluting 40.0 mL of a pH = 3.50 solution with enough water to make 250 mL?

6. (2 pts) Which of the following four solutions is most acidic? Circle your answer. Draw a box around the most basic.

   - pH = 3.00
   - pOH = 12
   - [H₃O⁺] = 4 x 10⁻⁵
   - [OH⁻] = 2.2 x 10⁻⁹

   Show work

7. (a) (2 pts) Write the equilibrium expression that shows how formic acid, HCO₂H, behaves in water. Use appropriate long/short arrows.

7. (b) (3 pts) A 0.400 M solution of formic acid has a pH of 2.07. Determine the Kₐ for formic acid.
8. (3 pts) A weak acid, HA, has $K_a = 7.3 \times 10^{-6}$. Determine the pH of a 0.550 M solution of HA.

9. (4 pts) Given $K_a = 6.5 \times 10^{-5}$ for benzoic acid, HCl$_3$H$_2$O$_2$, determine the pH of a 0.25 M solution of sodium benzoate, NaC$_6$H$_5$O$_2$.

10. (7 pts) Identify each of the following substances as strong acid (SA), weak acid (WA), neutral (N), weak base (WB) or strong base (SB) in aqueous solution.

   - HOCl: SA
   - KBr: SA
   - NaOCl: SA
   - NaOH: SA
   - NH$_3$: SA
   - HCl: SA
   - NH$_4$Cl: SA

11. (2 pts) Which of the following solutions would most likely require the use of the quadratic formula in order to correctly calculate the pH for the solution?

   - 0.010 M HBrO: $K_a = 2.06 \times 10^{-6}$
   - 0.100 M HIO$_3$: $K_a = 1.69 \times 10^{-1}$
   - 0.001 M HCN: $K_a = 4.93 \times 10^{-10}$

12. (a) (3 pts) Telluric acid, H$_2$TeO$_4$ is a diprotic acid with $pK_a$ values of 7.68 and 11.29. Write the two equilibrium equations, complete with appropriate arrows and the appropriate $K_a$ expression for each including its numerical value.

   (b) (3 pts) Sodium hydrogen tellurate, NaHTeO$_4$ could behave either as an acid or base in water. Write the two equilibrium equations showing it doing each. Again, use appropriate arrows. Write the $K_a$ or $K_b$ expression as appropriate and include a numerical value for each.

   (c) (3 pts) Is sodium hydrogen tellurate, NaHTeO$_4$ a better weak acid or weak base? Determine the pH of a 0.100 M solution of sodium hydrogen tellurate.

13. (BONUS 1 point) Print your name here:

   (For DocM's use)

   **Your exam score (50 possible):**
   Bonus pts: Max: _____ Earned: _____
   Total Score (50 maximum) _____

   Determine your grade:
   A $\geq$ 46.5; B+ $\geq$ 43.5; B $\geq$ 41.0;
   C+ $\geq$ 37.5; C $\geq$ 34.00; D $\geq$ 30.00
Answers:

1.  
\[ HF(aq) + NH_3(aq) \xrightarrow{\text{H}_2O} NH_4^+(aq) + F^-(aq) \]

2. |
<table>
<thead>
<tr>
<th>酸</th>
<th>基</th>
</tr>
</thead>
<tbody>
<tr>
<td>HCl</td>
<td>Cl (^{-})</td>
</tr>
<tr>
<td>H(_2)PO(_4)(^{-})</td>
<td>HPO(_4)(^{2-})</td>
</tr>
<tr>
<td>HCN</td>
<td>CN(^{-})</td>
</tr>
<tr>
<td>HC(_2)H(_3)O(_2)</td>
<td>C(_2)H(_3)O(_2)^{-}</td>
</tr>
<tr>
<td>NH(_4^+)</td>
<td>NH(_3)</td>
</tr>
</tbody>
</table>

3. 1.36  
4. 11.23  
5. 4.30  
6. 最酸：pOH = 12  
    最碱：[OH\(^{-}\)] = 2.2 \times 10^{-9}  
7. (a):  
    HCO\(_2\)H + H\(_2\)O $\xrightarrow{\text{H}_2O}$ H\(_3\)O\(^+\) + CO\(_2\)H\(^{-}\)  
(b) \(K_a = 1.85 \times 10^{-4}\)
8. 2.70  
9. 8.79  
10.  

    | 酸 | 基 |
    |---|---|
    |HCl | SA |
    |KBr | N |
    |NaOCl | WB |
    |NaOH | SB |
    |NH\(_3\) | WB |
    |H\(_2\)TeO\(_4\) | WA |

11. 0.100 M HIO\(_3\)  
12.  
\[ H_2TeO_4^- + H_2O \xrightarrow{\text{H}_2O} H_3O^+ + HTeO_4^- \]  
\(K_{a1} = [H_3O^+][HTeO_4^-]/[H_2TeO_4^-] = 2.1 \times 10^{-8}\)  
\[ HTeO_4^- + H_2O \xrightarrow{\text{H}_2O} H_3O^+ + TeO_4^{2-} \]  
\(K_{a2} = [H_3O^+][TeO_4^{2-}]/[HTeO_4^-] = 5.1 \times 10^{-12}\)  
12.  
\[ HTeO_4^- + H_2O \xrightarrow{\text{H}_2O} H_3O^+ + TeO_4^{2-} \]  
\(K_{a2} = [H_3O^+][TeO_4^{2-}]/[HTeO_4^-] = 5.1 \times 10^{-12}\)  
\[ HTeO_4^- + H_2O \xrightarrow{\text{H}_2O} OH^- + H_2TeO_4 \]  
\(K_b = [OH^-][TeO_4^{2-}]/[H_2TeO_4^-] = K_w/K_{a1} = 4.8 \times 10^{-7}\)  
12. 更好的基；pH = 10.34