**Week 6 Acids & Bases, Bases, Salts**

**QUESTION 1**
Which of the following substances are spectator ions in aqueous solution?

I. \( \text{NH}_4^+ \)
II. \( \text{Li}^+ \)
III. \( \text{CO}_3^{2-} \)
IV. \( \text{Na}^+ \)
V. \( \text{OH}^- \)
VI. \( \text{Ca}^{2+} \)
VII. \( \text{CN}^- \)

**QUESTION 2**
Write the chemical equation and the equilibrium constant expression \( K_b \) for the following bases in aqueous solution:

a. \( \text{CH}_3\text{CH}_2\text{NH}_2 \)
b. \( \text{HCO}_3^- \)
c. \( \text{N}_3^- \)

**QUESTION 3**
Which of the following bases is the strongest?

<table>
<thead>
<tr>
<th>Base</th>
<th>( K_b )</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Ammonia</td>
<td>( 1.8 \times 10^{-5} )</td>
</tr>
<tr>
<td>B. Methylamine</td>
<td>( 4.4 \times 10^{-4} )</td>
</tr>
<tr>
<td>C. Nicotine</td>
<td>( 7.0 \times 10^{-7} )</td>
</tr>
<tr>
<td>D. Hydroxylamine</td>
<td>( 1.1 \times 10^{-8} )</td>
</tr>
<tr>
<td>E. Trimethylamine</td>
<td>( 6.4 \times 10^{-5} )</td>
</tr>
</tbody>
</table>

**QUESTION 4**
Which of the following is the strongest base: \( \text{NH}_3, \text{SO}_4^{2-}, \text{PO}_4^{3-}, \text{NO}_3^- \) (\( K_b \) for \( \text{NH}_3 \) is \( 1.8 \times 10^{-5} \), \( K_{a2} \) for \( \text{H}_2\text{SO}_4 \) is \( 1.2 \times 10^{-2} \), \( K_{a3} \) for \( \text{H}_3\text{PO}_4 \) is \( 4.8 \times 10^{-13} \))

A. \( \text{NH}_3 \)
B. \( \text{SO}_4^{2-} \)
C. \( \text{PO}_4^{3-} \)
D. \( \text{NO}_3^- \)
E. \( \text{PO}_4^{3-} \) and \( \text{SO}_4^{2-} \) are equally the strongest

**QUESTION 5**
Calculate the pH of a 0.50 M solution of \( \text{NH}_3 \) at 25°C. The \( K_b \) of \( \text{NH}_3 \) is \( 1.8 \times 10^{-5} \).

A. 8.95
B. 11.48
C. 2.52
D. 5.05
E. 9.26

**QUESTION 6**
What is the [OH\(^-\)] in a 0.80 M solution of hydrazine, \( \text{N}_2\text{H}_2 \), at 25°C? \( K_b = 1.7 \times 10^{-6} \)

A. \( 1.2 \times 10^{-3} \) M
B. \( 8.6 \times 10^{-12} \) M
C. \( 2.2 \times 10^{-3} \) M
D. 0.80 M
E. \( 1.4 \times 10^{-6} \) M
QUESTION 7
What is the value of the equilibrium constant for the following reaction? (For HNO₂, K_a = 4.5 × 10^{-4})

\[ \text{NO}_2^- (aq) + \text{H}_2\text{O} (l) \rightarrow \text{HNO}_2 (aq) + \text{OH}^- (aq) \]
A. 4.5 × 10^{-4}  
B. 5.0 × 10^{-4}  
C. 2.0 × 10^{-4}  
D. 5.0 × 10^{-11}  
E. 2.2 × 10^{-11}

QUESTION 8
Which of the following combinations is correct in aqueous solution?

<table>
<thead>
<tr>
<th>Species</th>
<th>Strength</th>
<th>Conjugate</th>
<th>Conjugate Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. F₂⁻</td>
<td>weak base</td>
<td>HF</td>
<td>strong acid</td>
</tr>
<tr>
<td>B. O₂⁻</td>
<td>weak base</td>
<td>OH⁻</td>
<td>strong base</td>
</tr>
<tr>
<td>C. K⁺</td>
<td>negligible acid</td>
<td>KOH</td>
<td>strong base</td>
</tr>
<tr>
<td>D. NO₃⁻</td>
<td>weak base</td>
<td>HNO₂⁻</td>
<td>weak acid</td>
</tr>
<tr>
<td>E. CH₃NH₃⁺</td>
<td>weak base</td>
<td>CH₃NH₂⁺</td>
<td>strong acid</td>
</tr>
</tbody>
</table>

QUESTION 9
Place the following salts in the table below by predicting the pH of their aqueous solutions: NaN₃, KBr, CH₃NH₂Cl, CaF₂, KClO₃, FeBr₃, LiOH, NaNO₃, NH₄Br, AlCl₃, CH₃COOK, SrCl₂.

<table>
<thead>
<tr>
<th>Acidic Salts, pH &lt; 7</th>
<th>Basic Salts, pH &gt; 7</th>
<th>Neutral Salts, pH ~ 7</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

QUESTION 10
Predict the products of the following acid-base reactions, write the net ionic reaction, and predict whether the equilibrium lies to the left or to the right of the equation:

a. CH₃NH₃⁺(aq) + OH⁻(aq) ⇌  
b. CH₃COO⁻(aq) + HCl(aq) ⇌  
c. Ca(OH)₂(aq) + 2 HNO₃(aq) ⇌  

QUESTION 11
A solution is made by mixing 100 mL of 0.100 M HCl with 100 mL of 0.100 M NH₃ at 25°C. What is the pH of the final solution? (K_b for NH₃ = 1.8 × 10^{-5})

QUESTION 12
What is the pH of a 0.05 M solution of CH₃COOK at 25°C? (K_a for CH₃COOH = 1.8 × 10^{-5})

A. 4.8  
B. 7.0  
C. 5.3  
D. 8.7  
E. 9.2
QUESTION 13

Which of the following salts will give the most basic solution when dissolved in water?

A. KBrO₄
B. KBrO₃
C. KBrO₂
D. KBrO
E. KClO₄

QUESTION 14

Which of the following substances will form acidic aqueous solutions: NH₄Cl, Cu(NO₃)₂, K₂CO₃, NaF?

A. NaF only
B. NaF and K₂CO₃ only
C. NH₄Cl and Cu(NO₃)₂ only
D. NH₄Cl and K₂CO₃ only
E. NH₄Cl only

QUESTION 15

Which of these salts will form a basic aqueous solution?

I. KCl
II. CsF
III. KCN
IV. NH₄Cl

A. I only
B. II only
C. III only
D. IV only
E. II and III only