Worksheet – Acid-Base Equilibrium

Worksheet goal: Continue using equilibrium concepts and apply them to acid-base reactions.

1. Give the conjugate acid or base of the following bases and acids.
   a. HClO
   b. CH₃COOH
   c. OH⁻
   d. Cl⁻
   e. H₂SO₄

2. Lactic acid (HC₃H₅O₃) is a weak acid. It exists in two forms that have slightly different pKa values. The L-form has a pKa of 3.79 and the D-form has a pKa of 3.83. The D-form is found in molasses, beer, wines, and souring milk. The L-form is produced in muscle cells during anaerobic metabolism. When lactic acid builds up too rapidly in muscle tissue, severe pain results.
   a. Which form of lactic acid (D or L) is the stronger acid?
   b. A solution of D-lactic acid is prepared. Use HL as a general formula for lactic acid and write the equation for the ionization of lactic acid in water.
   c. If 0.1 M solutions of these two acids (D and L) were prepared, what would be the pH of each solution?
   d. Calculate the pH of a solution made by dissolving 4.46 g of D-lactic acid in 500 mL of water.
e. How many mL of a 0.115 M NaOH solution would be required to completely neutralize 4.46 g of pure lactic acid?

3. The pH of 90 mL of a 0.1 M solution of HCl is measured with a digital pH meter and shown to be about 1. Roughly how many mL of water need to be added to reach a pH of about 2?
   a. 10
   b. 100
   c. 1000

4. A solution with pH=5 is 100 times more acidic than a solution with a pH =?
   a. 7
   b. 3
   c. 0.05

5. Make the following interconversions. In each case tell whether the solution is acidic or basic.

<table>
<thead>
<tr>
<th>pH</th>
<th>$[\text{H}_3\text{O}^+]$ (M)</th>
<th>$[\text{OH}^-]$ (M)</th>
<th>Acidic or Basic?</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>10.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c.</td>
<td></td>
<td>$1.8 \times 10^{-4}$</td>
<td></td>
</tr>
<tr>
<td>d.</td>
<td></td>
<td>$5.6 \times 10^{-10}$</td>
<td></td>
</tr>
<tr>
<td>e.</td>
<td></td>
<td></td>
<td>$2.3 \times 10^{-5}$</td>
</tr>
</tbody>
</table>

6. What is the pH of a solution that is 0.025 M in NaOH? What is the pOH of this solution?

7. The pH of a Ba(OH)$_2$ solution is 10.66 at 25°C. What is the hydroxide-ion concentration of this solution? If the solution volume is 250 mL, how many grams of Ba(OH)$_2$ must have been used to make this solution?