Practice 6-1

Name the following acids:

H$_2$SO$_3$  HBr  HClO$_4$

H$_2$S  HClO  H$_2$SO$_4$

Answer

H$_2$SO$_3$  sulfurous acid  HBr  hydrobromic acid

HClO$_4$  perchloric acid  H$_2$S  hydrosulfuric acid

HClO  hypochlorous acid  H$_2$SO$_4$  sulfuric acid

Practice 6-2

Calculate the pH of each of the following solutions and classify the solution as acidic or basic:

Lemon juice: [H$^+$] = 1.1 x 10$^{-2}$ M  Soft drink: [H$^+$] = 2.5 x 10$^{-4}$ M

Urine: [H$^+$] = 1.2 x 10$^{-6}$ M  Blood: [H$^+$] = 3.9 x 10$^{-8}$ M

Antiseptic: [H$^+$] = 1.2 x 10$^{-10}$ M  Beer: [H$^+$] = 5.0 x 10$^{-3}$ M

Coffee: [H$^+$] = 7.9 x 10$^{-6}$ M  Detergent: [H$^+$] = 3.2 x 10$^{-11}$ M

Answer

<table>
<thead>
<tr>
<th>material</th>
<th>[H$^+$]</th>
<th>pH</th>
<th>acidic or basic?</th>
</tr>
</thead>
<tbody>
<tr>
<td>lemon juice</td>
<td>1.1 x 10$^{-2}$ M</td>
<td>1.96</td>
<td>acidic</td>
</tr>
<tr>
<td>soft drink</td>
<td>2.5 x 10$^{-4}$ M</td>
<td>3.60</td>
<td>acidic</td>
</tr>
<tr>
<td>urine</td>
<td>1.2 x 10$^{-6}$ M</td>
<td>5.92</td>
<td>acidic</td>
</tr>
<tr>
<td>blood</td>
<td>3.9 x 10$^{-8}$ M</td>
<td>7.41</td>
<td>basic</td>
</tr>
<tr>
<td>antiseptic</td>
<td>1.2 x 10$^{-10}$ M</td>
<td>9.92</td>
<td>basic</td>
</tr>
<tr>
<td>beer</td>
<td>5.0 x 10$^{-3}$ M</td>
<td>2.30</td>
<td>acidic</td>
</tr>
<tr>
<td>coffee</td>
<td>7.9 x 10$^{-6}$ M</td>
<td>5.10</td>
<td>acidic</td>
</tr>
<tr>
<td>detergent</td>
<td>3.2 x 10$^{-11}$ M</td>
<td>10.49</td>
<td>basic</td>
</tr>
</tbody>
</table>
Practice 6-3

For the following reaction label each substance as an acid or a base and show the conjugate acid-base pairs.

\[ \text{H}_2\text{CO}_3 + \text{H}_2\text{O} \ce{<=>} \text{H}_3\text{O}^+ + \text{HCO}_3^- \]

Answer

\[ \begin{array}{llll}
\text{H}_2\text{CO}_3 & \text{H}_2\text{O} & \text{H}_3\text{O}^+ & \text{HCO}_3^- \\
\text{Acid} & \text{Base} & \text{Acid} & \text{Base} \\
\text{Conjugate pair} & \text{Conjugate pair} \\
\end{array} \]

Practice 6-4

A) Calculate the \([\text{H}^+]\) given the \([\text{OH}^-]\) in each of the following aqueous solutions and classify each solution as acidic or basic.

\[ [\text{OH}^-] = 6.2 \times 10^{-3} \text{ M} \quad [\text{OH}^-] = 1.3 \times 10^{-11} \text{ M} \]

B) Calculate the \([\text{OH}^-]\) given the \([\text{H}^+]\) in each of the following aqueous solutions and classify each solution as acidic or basic.

\[ [\text{H}^+] = 7.4 \times 10^{-5} \text{ M} \quad [\text{H}^+] = 2.3 \times 10^{-9} \text{ M} \]

Answer

A

\[
\begin{array}{lll}
[\text{OH}^-] & [\text{H}^+] & \text{Acidic or basic?} \\
6.2 \times 10^{-3} \text{ M} & 1.6 \times 10^{-12} \text{ M} & \text{acidic} \\
1.3 \times 10^{-11} \text{ M} & 7.7 \times 10^{-4} \text{ M} & \text{basic} \\
\end{array}
\]

B

\[
\begin{array}{lll}
[\text{H}^+] & [\text{OH}^-] & \text{Acidic or basic?} \\
7.4 \times 10^{-5} \text{ M} & 1.4 \times 10^{-10} \text{ M} & \text{acidic} \\
2.3 \times 10^{-9} \text{ M} & 4.3 \times 10^{-9} \text{ M} & \text{basic} \\
\end{array}
\]
Practice 6-5
For a $7.4 \times 10^{-3}$ M HCl solution, determine the following:
  a) $[H^+]$   b) $[OH^-]$,   c) the pH

Answer

a) Because HCl is a strong acid, it completely dissociates:
   
   \[ \text{HCl} \rightarrow \text{H}^+ + \text{Cl}^- \]
   
   So the concentration of hydrogen ion of a $7.4 \times 10^{-3}$ M HCl solution is
   $7.4 \times 10^{-3}$ M.
   
   \[ [H^+] = 7.4 \times 10^{-3} \]

b) Substituting the $[H^+]$ value in $K_w = [H^+] \times [OH^-] = 1.0 \times 10^{-14}$
   yields:
   
   \[ [OH^-] = \frac{1.0 \times 10^{-14}}{7.4 \times 10^{-3}} = 1.4 \times 10^{-12} \text{ M} \]

c) pH = $-\log [H^+]$ \quad pH = $-\log(7.4 \times 10^{-3})$ \quad pH = 2.13

Practice 6-6
Write molecular, ionic, and net ionic equation for the reaction of HCl and KOH.

Answer

Molecular equation:
We write each substance as if it were a molecular substance
   
   \[ \text{HCl(aq)} + \text{KOH(aq)} \rightarrow \text{KCl(aq)} + \text{H}_2\text{O(l)} \]

Ionic equation:
The formula HCl(aq) actually means H\(^+(aq)\) and Cl\(^-(aq)\)
The formula KOH(aq) actually means K\(^+(aq)\) and OH\(^-(aq)\)
The formula KCl(aq) actually means K\(^+(aq)\) and Cl\(^-(aq)\)
We can replace the molecular equation with the following ionic equation:
   
   \[ \text{H}^+(aq) + \text{Cl}^-(aq) + \text{K}^+(aq) + \text{OH}^-(aq) \rightarrow \text{K}^+(aq) + \text{Cl}^-(aq) + \text{H}_2\text{O(l)} \]

Net ionic equation:
Removing spectator ions from the ionic equation gives the following
   
   \[ \text{H}^+(aq) + \text{OH}^-(aq) \rightarrow \text{H}_2\text{O(l)} \]

All strong acid/strong base neutralization reactions have the same
net ionic equation.