**pH and Indicators**

**Objectives**

- define pH
- describe the use of the pH scale as a measure of the degree of acidity/alkalinity
- discuss the limitations of the pH scale
- write an expression for Kw
- use universal indicator paper or solution to determine pH
- calculate the pH of dilute aqueous solutions of strong acids and bases
- justify the selection of an indicator for acid base titrations

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*Def*: The **ionic product of water** is \( K_w = [H^+][OH^-] \)

**The pH Scale:**

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**Examples of pH Conditions:**

<table>
<thead>
<tr>
<th>pH</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>gastric juices</td>
</tr>
<tr>
<td>4</td>
<td>tomato juice</td>
</tr>
<tr>
<td>5</td>
<td>human urine</td>
</tr>
<tr>
<td>7</td>
<td>pure water</td>
</tr>
<tr>
<td>7.4</td>
<td>human blood</td>
</tr>
<tr>
<td>10</td>
<td>hand soap</td>
</tr>
<tr>
<td>12</td>
<td>household bleach</td>
</tr>
</tbody>
</table>

**Limitations of the pH scale:**

1. Only has a range of 0-14.
2. Does not work for concentrated solutions.
3. Only works for aqueous solutions.
Calculating pH:

Definition: \( pH = -\log_{10}[H^+] \)

For strong acids:

\( pH = -\log_{10}[H^+] \)

Find the pH of a solution whose \( H^+ \) concentration is \( 7.4 \times 10^{-7} \) mol/L

Find the pH of a 0.11 mol/L solution of HCl

Find the pH of a 0.5 mol/L solution of \( H_2SO_4 \)

Find the \( H^+ \) concentration of a HCl solution whose pH is 1.9
For strong bases:

\[ pOH = -\log_{10}[OH^-] \]

and

\[ pH = 14 - pOH \]

Find the pH of a solution whose OH\(^-\) concentration is \(4.6 \times 10^{-9}\) mol/L

Find the pOH of a 0.35 mol/L solution of NaOH

Find the pH of a 0.75 mol/L solution of Ca(OH)\(_2\)

Find the OH\(^-\) concentration of a KOH solution whose pH is 13.2