Calculations Involving pH

1. **What is the pH of a 1.0×10^{-4} M hydrochloric acid solution?**

2. **What is the pH of a 1.0×10^{-3} M sodium hydroxide solution?**

3. **What is the pH of a 3.5×10^{-8} M calcium hydroxide solution?**

4. **What is the pH of a 6.0×10^{-3} M sulfuric acid solution?**

5. **Determine the hydronium ion concentration of an aqueous solution that has a pH of 4.0.**

6. **Determine the hydronium ion concentration of an aqueous solution that has a pH of 8.0.**

7. **Determine the hydroxide ion concentration of an aqueous solution that has a pH of 6.2.**

8. **Determine the hydroxide ion concentration of an aqueous solution that has a pH of 12.5.**

9. **Determine the hydronium ion and hydroxide ion concentrations of an aqueous solution that has a pH of 5.1.**

Calculations Involving pH

1. **What is the pH of a 1.0×10^{-4} M hydrochloric acid solution?**

$= ?\ pH$ $\quad HCl + H_2O \rightarrow H_3O^+ + Cl^-$

$\frac{1.0 \times 10^{-4}\ mol\ HCl}{1\ L\ soln}\left(\frac{1\ mol\ H_3O^+}{1\ mol\ HCl}\right) = 1.0 \times 10^{-4}\ M\ H_3O^+$ $\quad pH = -\log [H_3O^+]$

$= -\log [1.0 \times 10^{-4}\ M]$

$= \boxed{4.00}$

2. **What is the pH of a 1.0×10^{-3} M sodium hydroxide solution?**

$= ?\ pH$ $\quad NaOH \xrightarrow{H_2O} Na^+ + OH^-$

$\frac{1.0 \times 10^{-3}\ mol\ NaOH}{1\ L\ soln}\left(\frac{1\ mol\ OH^-}{1\ mol\ NaOH}\right) = 1.0 \times 10^{-3}\ M\ OH^-$ $\quad pOH = -\log (1.0 \times 10^{-3}\ M\ OH^-)$

$= 3.00$

$pH = 14 - 3.00 = \boxed{11.00}$

3. **What is the pH of a 3.5×10^{-8} M calcium hydroxide solution?**

$= ?\ pH$ $\quad Ca(OH)_2 \xrightarrow{H_2O} Ca^{+2} + 2OH^-$

$\frac{3.5 \times 10^{-8}\ Ca(OH)_2}{1\ L\ soln}\left(\frac{2\ mol\ OH^-}{1\ mol\ Ca(OH)_2}\right) = 7.0 \times 10^{-8}\ M\ OH^-$ $\quad pOH = -\log [7.0 \times 10^{-8}\ M\ OH^-]$

$= 7.15$

$pH = 14 - 7.15 = \boxed{6.85}$

4. **What is the pH of a 6.0×10^{-3} M sulfuric acid solution?**

$= ?\ pH$ $\quad H_2SO_4 + H_2O \rightarrow H_3O^+ + HSO_4^-$

$HSO_4^- + H_2O \rightleftharpoons H_3O^+ + SO_4^{-2}$

$\frac{6.0 \times 10^{-3}\ mol\ H_2SO_4}{1\ L\ soln}\left(\frac{2\ mol\ H_3O^+}{1\ mol\ H_2SO_4}\right) = 1.2 \times 10^{-2}\ M\ H_3O^+$ $\quad pH = -\log (1.2 \times 10^{-2}\ M\ H_3O^+)$

$= \boxed{1.92}$

only ~~1 past~~ 2 places past decimal ∴ [ ] has only 1 SF

5. **Determine the hydronium ion concentration of an aqueous solution that has a pH of 4.0.**

$= ?\ [H_3O^+]$

$pH = -\log [H_3O^+]$

$[H_3O^+] = 2^{nd} \log (-pH)$

$[H_3O^+] = 2^{nd} \log (-4.0)$

$= \boxed{1 \times 10^{-4}\ M}$

6. **Determine the hydronium ion concentration of an aqueous solution that has a pH of 8.0.**

$= ?\ [H_3O^+]$

$[H_3O^+] = 2^{nd} \log (-pH)$ $\quad [H_3O^+] = 2^{nd} \log (-8.0)$

$= \boxed{1 \times 10^{-8}\ M}$

7. **Determine the hydroxide ion concentration of an aqueous solution that has a pH of 6.2.**

$= ?\ [OH^-]$

$pH + pOH = 14$

$pOH = 14 - 6.2 = 7.8$

$[OH^-] = 2^{nd} \log (-pOH)$

$= 2^{nd} \log (-7.8) = \boxed{2 \times 10^{-8}\ M}$

8. **Determine the hydroxide ion concentration of an aqueous solution that has a pH of 12.5.** $= ? \ [OH^-]$

$pH + pOH = 14$

$pOH = 14 - 12.5$

$= 1.5$

$[OH^-] = 2^{nd} \log (-1.5)$

$= 3 \times 10^{-2} M$

9. **Determine the hydronium ion and hydroxide ion concentrations of an aqueous solution that has a pH of 5.1.**

$= ? \ [H_3O^+]$

$= ? \ [OH^-]$

$pH = -\log [H_3O^+]$

$[H_3O^+] = 2^{nd} \log (-pH)$

$= 2^{nd} \log (-5.1)$

$= 8 \times 10^{-6} M \ H_3O^+$

$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14} m^2$

$[OH^-] = \frac{K_w}{[H_3O^+]}$

$= \frac{1 \times 10^{-14} m^2}{8 \times 10^{-6} m}$

$= 1 \times 10^{-9} m \ [OH^-]$