Worksheet 2 -- Calculating $[H_3O^+]$, [OH-] pH and pOH

ANSWER KEY for 2 pages of worksheet

Key relationships:

- Water very slightly dissociates into ions according to the following equation
  $2\ H_2O \Leftrightarrow H_3O^- + OH^-$
- In water $[H_3O^+] = [OH^-] = 1 \times 10^{-7}$ M at 25°C
- $Kw = [H_3O^+][OH^-] = 1 \times 10^{-14}$ at 25°C --known as the ion product of water
- $pH = -\log [H_3O^+]$
- $pOH = -\log [OH^-]$
- $pH + pOH = 14$

1. A certain solution has $[H_3O^+] = 2 \times 10^{-5}$. Calculate the concentration of $[OH^-]$ and the pH of the solution

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

$pH = \boxed{4.7}$

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

$2 \times 10^{-5}\text{M}\ [OH^-] = 1 \times 10^{-14}$

$[OH^-] = \boxed{5 \times 10^{-10}\text{M}}$

2. A certain solution has $[H_3O^+] = 5 \times 10^{-9}$. Calculate the concentration of $[OH^-]$ and the pH of the solution

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

$pH = \boxed{8.3}$

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

$(5 \times 10^{-9})[OH^-] = 1 \times 10^{-14}$

$[OH^-] = \boxed{2 \times 10^{-6}\text{M}}$

3. A certain solution has $[OH^-] = 4 \times 10^{-3}$. Calculate the concentration of $[H_3O^+]$ and the pH of the solution

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

$[H^+](4 \times 10^{-3}) = 1 \times 10^{-14}$

$[H^+] = \boxed{2.5 \times 10^{-12}\text{M}}$

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

$pH = -\log (2.5 \times 10^{-12})$

$pH = \boxed{11.6}$

11.6

4. A certain solution has $[OH^-] = 3 \times 10^{-11}$. Calculate the concentration of $[H_3O^+]$ and the pH of the solution

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

$[H_3O^+](3 \times 10^{-11}) = 1 \times 10^{-14}$

$[H_3O^+] = \boxed{3.33 \times 10^{-4}}$

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

$= -\log (3.33 \times 10^{-4})$

$pH = \boxed{3.48}$

5. A certain solution has pH = 3.0. Calculate the pOH, the concentration of $[H_3O^+]$ and the $[OH^-]$ of the solution

$[H_3O^+] = \boxed{1 \times 10^{-3}\text{M}}$

$[OH^-] = \boxed{1 \times 10^{-11}\text{M}}$

6. A certain solution has pH = 2.5. Calculate the pOH, the concentration of $[H_3O^+]$ and the $[OH^-]$ of the solution

$pH = 2.5$

$pOH = 14 - 2.5 = \boxed{11.5}$

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

$2.5 = -\log [H_3O^+]$

$[H_3O^+] = \boxed{0.00316\text{M}}$

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

$(0.00316\text{M})[OH^-] = 1 \times 10^{-14}$

$[OH^-] = 3.16 \times 10^{-12}$

7. A certain solution has pOH = 2.0. Calculate the pH, the concentration of $[H_3O^+]$ and the $[OH^-]$ of the solution

$pH + pOH = 14$

$pH + 2 = 14$

$pH = \boxed{12}$

$[H_3O^+] = \boxed{10^{-12}\ M}$

$[OH^-] = \boxed{10^{-2}\ M}$

8. A certain solution has pOH = 9.3. Calculate the pH, the concentration of $[H_3O^+]$ and the $[OH^-]$ of the solution

$pH + pOH = 14$

$pH + 9.3 = 14$

$pH = \boxed{4.7}$

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

$4.7 = -\log [H_3O^+]$

$[H_3O^+] = 10^{-4.7}$

$[H_3O^+] = \boxed{2 \times 10^{-5}\ M}$

$pOH = -\log [OH^-]$

$9.3 = -\log [OH^-]$

$[OH^-] = 10^{-9.3}$

$[OH^-] = \boxed{5.01 \times 10^{-10}}$

9. A certain solution has $[OH^-]$ of 5×10^{-4} Calculate the $[H_3O^+]$, the pH and the pOH, of the solution

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

$[H_3O^+](5 \times 10^{-4}) = 1 \times 10^{-14}$

$[H_3O^+] = \boxed{2 \times 10^{-11}\ M}$

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

$= -\log (2 \times 10^{-11})$

$pH = \boxed{10.7}$

$pH + pOH = 14$

$10.7 + pOH = 14$

$pOH = \boxed{3.3}$

10. A certain solution has $[H_3O^+]$ of 5×10^{-12} Calculate the $[OH^-]$, the pH and the pOH, of the solution

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

$5 \times 10^{-12}\ [OH^-] = 1 \times 10^{-14}$

$[OH^-] = \boxed{0.002\ M}$

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

$= -\log (5 \times 10^{-12})$

$= \boxed{11.3}$

$pOH = -\log [OH^-]$

$= -\log (0.002)$

$pOH = \boxed{2.7}$