

Answer on Question #43566, Chemistry, Physical Chemistry

Question:

If the pH of a solution changes from 5.18 to 2.18 what is the effect on the hydronium ion concentration?

- a) increases by a factor of 1000
- b) increases three fold
- c) decreases by a factor of 1000
- d) decreases three fold

Solution:

Mathematically, pH is the negative decimal logarithm of the activity of the (solvated) hydronium ion, more often expressed as the measure of the hydronium ion concentration:

$$\text{pH} = -\log_{10}[\text{H}_3\text{O}^+]$$

Where $[\text{H}_3\text{O}^+]$ - hydronium ion concentration

Using the pH expression we can calculate $[\text{H}_3\text{O}^+]_1$ for pH = 5.18:

$$\begin{aligned}\text{pH} &= -\log_{10}[\text{H}_3\text{O}^+]_1 \\ 5.18 &= -\log_{10}[\text{H}_3\text{O}^+]_1\end{aligned}$$

Multiplying both sides of the equation by -1 , we get

$$-5.18 = \log_{10}[\text{H}_3\text{O}^+]_1$$

Taking the antilogarithm of both sides, we have

$$\text{antilog } -5.18 = [\text{H}_3\text{O}^+]_1$$

The antilog is the exponent of 10; therefore

$$1 \times 10^{-5.18} = [\text{H}_3\text{O}^+]_1$$

The number $1 \times 10^{-5.18}$ written in standard form is 6.6×10^{-6} , therefore

$$[\text{H}_3\text{O}^+]_1 = 6.6 \times 10^{-6}$$

Similarly, We can calculate $[\text{H}_3\text{O}^+]_2$ for pH = 2.18:

$$\begin{aligned}2.18 &= -\log_{10}[\text{H}_3\text{O}^+]_2 \\ -2.18 &= \log_{10}[\text{H}_3\text{O}^+]_2 \\ \text{antilog } -2.18 &= [\text{H}_3\text{O}^+]_2 \\ 1 \times 10^{-2.18} &= [\text{H}_3\text{O}^+]_2\end{aligned}$$

The number $1 \times 10^{-2.18}$ written in standard form is 6.6×10^{-3} , therefore

$$[\text{H}_3\text{O}^+]_2 = 6.6 \times 10^{-3}$$

Now we can compare $[\text{H}_3\text{O}^+]_2$ and $[\text{H}_3\text{O}^+]_1$:

$$[\text{H}_3\text{O}^+]_2 / [\text{H}_3\text{O}^+]_1 = 6.6 \times 10^{-3} / 6.6 \times 10^{-6} = 1000$$

Answer: hydronium ion concentration increases by a factor of 1000.