

Answer on Question #41124 – Chemistry – Physical Chemistry

Question:

pH of 10^{-8} M H_2SO_4 is...

Answer:

H_2SO_4 is a strong mineral acid. Strong acid is compound that completely dissociated in water.

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

So for every mol of H_2SO_4 you'll have twice the H^+ .

$$\text{pH} = -\log_{10} [2 \cdot 10^{-8}] = 7.7$$

This is clearly wrong as an acid solution should have a pH of less than 7.

Usually, with a strong acid, you can ignore the contribution of the self-ionization of water.

But, if the acid is too dilute, you cannot do that.

Water self-ionizes in such a way that $[\text{H}^+][\text{OH}^-] = 10^{-14}$

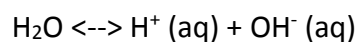
The total $[\text{H}^+] = [\text{H}^+, \text{ from } \text{H}_2\text{SO}_4] + [\text{H}^+, \text{ from self-ionization of } \text{H}_2\text{O}]$

We were given the first part: $[\text{H}^+, \text{ from } \text{H}_2\text{SO}_4] = 2 \cdot 10^{-8}$ M

The second part is easy enough to compute:

Let us set $[\text{H}^+, \text{ from self-ionization of } \text{H}_2\text{O}] = x$

The $[\text{OH}^-] = x$ also because its only source is the self-ionization of water:



Putting this altogether we get:

$$[\text{H}^+][\text{OH}^-] = 10^{-14}$$

$$(x + 2 \cdot 10^{-8})(x) = 10^{-14}$$

Now we need to solve this quadratic equation:

$$x^2 + 2 \cdot (10^{-8})x - 10^{-14} = 0$$

$$x = 9.05 \times 10^{-8}$$

Note: there is another root, but it is negative and thus has to be discarded since it is impossible to have a negative concentration.

$$[\text{H}^+ \text{ from self-ionization of water}] = x = 9.05 \times 10^{-8}$$

and, we already know $[\text{H}^+ \text{ from } \text{H}_2\text{SO}_4] = 2 \cdot 10^{-8}$

$$[\text{H}^+] = 9.05 \times 10^{-8} + 2 \cdot 10^{-8}$$

$$[\text{H}^+] = 1.105 \times 10^{-7}$$

$$\text{pH} = 6.96$$

Answer:

$$\text{pH} = 6.96$$