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.

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

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

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

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 it too dilute, you cannot do that.
Water self-ionizes in such a way that $[H^+][OH^-] = 10^{(-14)}$
The total $[H^+] = [H^+$, from $H_2SO_4] + [H^+$, from self-ionization of $H_2O]$
We were given the first part: $[H+$, from $H_2SO_4] = 2* 10^{(-8)}$ M
The second part is easy enough to compute:
Let us set $[H^+$, from self-ionization of $H_2O] = x$
The $[OH^-] = x$ also because its only source is the self-ionization of water:
H_2O <--> H^+ (aq) + OH^- (aq)
Putting this altogether we get:
$[H^+][OH^-] = 10^{(-14)}$
$(x+ 2*10^{-8})(x) = 10^{(-14)}$
Now we need to solve this quadratic equation:
$x^2 +2*(10^{-8})x - 10^{(-14)} = 0$
$x = 9.05\times10^{-8}$
Note: there is another root, but it is negative and thus has to be discarded since it is impossible to have a negative concentration.
$[H^+$ from self-ioniation of water$] = x = 9.05\times10^{(-8)}$
and, we already know $[H^+$ from $H_2SO_4] = 2*10^{(-8)}$
$[H^+] = 9.05\times10^{(-8)} + 2*10^{(-8)}$
$[H^+] = 1.105 \times 10^{-7}$
pH = 6.96

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