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Topic: pH of sodium bicarbonate solution (Read 4446 times)

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SodiumBicarbonate

Regular Member



Mole Snacks: +0/-1

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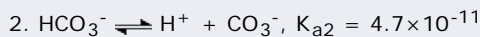
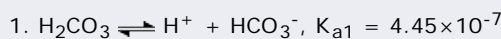
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**pH of sodium bicarbonate solution**

« on: January 06, 2014, 12:32:31 PM »

Hi,

I'm asked to calculate the pH value of a 0.320 M sodium bicarbonate solution, given the following K_a values:



Here's my idea:

I assume sodium bicarbonate dissociates completely in water, so we start with 0.320 M of HCO_3^- , and then the system reaches an equilibrium. In order to use the given data, I look at this equilibrium as if it was the result of a two-step ionization process of the biprotic acid H_2CO_3 . For calculating the pH value purposes, the second step is negligible, so we focus on the first step.

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2.247×10^{-8} . Say x M of sodium bicarbonate have reacted with water, so we have $0.320 - x \approx 0.320$ M sodium bicarbonate, x M H_2CO_3 and x M OH^- .

We get $2.247 \times 10^{-8} = x^2 / 0.320$, so $x = 0.0000848$, $\text{pOH} = -\log(x) = 4.072$ and $\text{pH} = 14 - \text{pOH} = 9.928$.

Am I right? Is this a valid argument? Is there any simpler way to do it (for instance, without calculating the pOH first)? Does it make sense I

didn't use K_{a2} at all?

Thanks in advance!

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Borek
Mr. pH
Administrator
Deity Member



Mole Snacks: +1460/-382

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Posts: 22448



I am known to be occasionally wrong.




Re: pH of sodium bicarbonate solution

< **Reply #1** on:

January 06, 2014, 12:39:41 PM »

<http://www.chembuddy.com/?left=pH-calculation&right=pH-amphiprotic-salt>

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SodiumBicarbonate
Regular Member



Mole Snacks: +0/-1

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Re: pH of sodium bicarbonate solution

< **Reply #2** on:


January 06, 2014, 12:51:14 PM »

Quote from: Borek on January 06, 2014, 12:39:41 PM

<http://www.chembuddy.com/?left=pH-calculation&right=pH-amphiprotic-salt>

Oh, great, thanks! 😊

Now I wonder where exactly my argument fails...

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Borek
Mr. pH
Administrator
Deity Member



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Re: pH of sodium bicarbonate solution

< **Reply #3** on:

January 06, 2014, 09:03:58 PM »

You can't ignore second dissociation step.

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SodiumBicarbonate

Regular Member



Mole Snacks: +0/-1

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**Re: pH of sodium bicarbonate solution**< **Reply #4 on:**

January 07, 2014, 02:31:08 AM »

Quote from: Borek on January 06, 2014, 12:39:41 PM<http://www.chembuddy.com/?left=pH-calculation&right=pH-amphiprotic-salt>

Actually, there's something I don't quite understand. Equation 12.4 says $[H^+] = [A^2] - [H_2A]$, but there's a second source of H^+ , the autoionization of water. How do we know its effect is negligible? I mean, if $K_{a1} = 4.45 \times 10^{-7}$, as in my case, aren't we dealing with H^+ concentration so small that the autoionization of water can no longer be ignored?

Again, thanks in advance. I really appreciate your help.

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BorekMr. pH
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I am known to be occasionally wrong.

**Re: pH of sodium bicarbonate solution**< **Reply #5 on:**

January 07, 2014, 02:43:00 AM »

Please reread the page, it addresses your concerns.

At the very beginning it is stated that we ASSUME water autoionization can be neglected. As every assumption, it doesn't have to be true always.

Then, at the bottom, there are tables that show how the equation behaves depending on the concentration of the amphiprotic salt. The latter shows how the assumption becomes more and more problematic for diluted solutions.

Contrary to what it may look it is not concentration of H^+ that tells us if we can ignore water autoionization, but concentrations of substances involved in the H^+ production and consumption. If they are large enough, water autoionization is not capable of overcoming whatever they do. Your problem asks about pH of the solution that 0.320 M in HCO_3^- , so we are on the safe side. If it were 3.2×10^{-5} situation would be completely different.

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Regular Member



Mole Snacks: +0/-1

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Posts: 9

bicarbonate
solution

« Reply #6 on:

January 07, 2014, 03:20:09
AM »

Quote from: Borek on January 07, 2014, 02:43:00 AM

Please reread the page, it addresses your concerns.

At the very beginning it is stated that we ASSUME water autoionization can be neglected. As every assumption, it doesn't have to be true always.

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You're right, we have 0.320 M of HCO_3^- , but on the other hand, $K_{a1} = 4.45 \times 10^{-7}$, in my case, which is way smaller than NaH_2PO_4 's K_a value of 0.007 from Chembuddy's example. So, if I understand what's going on, in my case, reaction 1 will tend much more toward H_2CO_3 in comparison to Chembuddy's example, which means much lower concentration of H^+ . Am I right? Assuming I am, it's still not completely clear to me why it's legitimate to neglect the water autoionization effect on equation 12.4.

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