

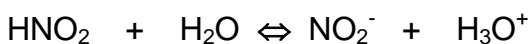
A) For nitrous acid, HNO_2 , $K_a = 4.5 \cdot 10^{-4}$. What is the equilibrium constant for the following reaction?



- 1) $2.2 \cdot 10^{-11}$
- 2) $2.2 \cdot 10^{-3}$
- 3) $2.2 \cdot 10^3$
- 4) $4.5 \cdot 10^{-10}$
- 5) None of the above

Answer:

We have K_a , so we write the equation for K_a .



This is just the inverse of the equation given in the problem, therefore $K=1/K_a$
 $K = \mathbf{2.2 \cdot 10^3}$

Be careful that the given reaction is **NOT** the reaction of K_b for the conjugate base NO_2^- ,



and you CANNOT use here $K_w = K_a \cdot K_b$ in this case.

B) A 0.001 aqueous solution of HClO_4 ($K_a = \text{large}$) has a pOH of _____.

- 1) 13.999
- 2) 11
- 3) -3
- 4) -11
- 5) 3

Answer: It is a strong acid, therefore $[\text{acid}] = [\text{H}_3\text{O}^+] = 0.001$

$$\text{pH} = -\log [\text{H}_3\text{O}^+] = 3$$

We know that $\text{pH} + \text{pOH} = 14$,

$$\text{pOH} = 14 - \text{pH} = 14 - 3 = \mathbf{11}$$

C) Carbonate ion, CO_3^{2-} is a base, with $K_b = 4.3 \cdot 10^{-4}$. Calculate the approximate $[\text{OH}^-]$ (not using the quadratic formula) for a 0.25 M solution of CO_3Na_2 .

- 1) $1.0 \cdot 10^{-12}$
- 2) 0.25
- 3) 0.0001
- 4) $1.0 \cdot 10^{-2}$
- 5) None of the above

Answer: carbonate is a weak base ($K_b < 1$). Therefore the $[\text{OH}^-] < [\text{base}]$. We need to use an ICE table.

	CO_3^{2-}	+	H_2O	\Leftrightarrow	HCO_3^-	+	HO^-
Initial (M)	0.25				--		--
Change (M)	-x				x		x
Equilibrium (M)	$0.25 - x$				x		x

$$K_b = [\text{HCO}_3^-] [\text{OH}^-] / [\text{CO}_3^{2-}] = x \cdot x / (0.25 - x)$$

Since the initial concentration of carbonate is higher than 100. K_b , we can use the approximation that $[\text{CO}_3^{2-}]_0 - [\text{OH}^-] \cong [\text{CO}_3^{2-}]_0$, where $[\text{CO}_3^{2-}]_0 = 0.25 \text{ M}$ and $[\text{OH}^-] = x$,

then

$$K_b = x^2 / 0.25;$$

$$\text{note: } \sqrt{x} = x^{1/2}$$

$$x = \sqrt{K_b \cdot 0.25} = \sqrt{4.3 \cdot 10^{-4} \cdot 0.25} = \sqrt{0.000107} = \mathbf{0.010}$$