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

$$NO_2^- + H_3O^+ \Leftrightarrow HNO_2 + H_2O$$

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

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

$$HNO_2 + H_2O \Leftrightarrow NO_2^- + H_3O^+$$

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

Be careful that the given reaction is **NOT** the reaction of K_b for the conjugate base NO_2^-,
Kb reaction: $NO_2^- + H_2O \Leftrightarrow HNO_2 + HO^-$

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

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

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

Answer: It is a strong acid, therefore [acid] = $[H_3O^+]$ = 0.001

pH = -log $[H_3O^+]$ = 3

We know that pH + pOH = 14,

pOH = 14 – pH = 14 – 3 = **11**

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

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

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

	CO_3^{2-}	+	H_20	⇔	HCO_3^-	+	HO^-
Initial (M)	0.25				--		--
Change (M)	-x				x		x
Equilibrium (M)	0.25 – x				x		x

$Kb = [HCO^{3-}]\ [HO^-] / [CO_3^{2-}] = x.x / (0.25 – x)$

Since the initial concentration of carbonate is higher than 100. K_b, we can use the approximation that $[CO_3^{2-}]_0 – [OH^-] \cong [CO_3^{2-}]_0$, where $[CO_3^{2-}]_0$=0.25 M and $[OH^-]$= x,

then

$K_b = x^2 / 0.25$; note: $\sqrt{(x)} = x^{1/2}$

$x = \sqrt{(K_b.0.25)} = \sqrt{(4.3\ 10^{-4}.0.25)} = \sqrt{(0.000107)} =$ **0.010**