CHEM 209 WRAP UP ASSIGNMENT

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CHOSEN SCENARIO : SCENARIO 2

1. A) Where did the student go wrong in their calculations? Why is this considered incorrect?

$$RO_{3\,(aq)}^{-} + H_2O_{(l)} \leftrightarrow HRO_{3\,(aq)} + OH_{(aq)}^{-}$$

Q: 3.0×10^{-2} mols of $RO_3^-{}_{(aq)}$ is added to 1.5L of water and reacts according to the reaction above. The pKb of $RO_3^-{}_{(aq)}$ is 5.9. Calculate the concentration of $OH^-{}_{(aq)}$ in the solution.

$$RO_{3\,(aq)}^{-} + H_2O_{(l)} \leftrightarrow HRO_{3\,(aq)} + OH_{(aq)}^{-}$$

I	3.0×10^{-2}	1.5	0	0
C	-X	-X	+X	+X
E	$3.0 \times 10^{-2} - X$	$1.5 - X$	X	X

$$K = \frac{[P]}{[R]}$$

$$5.9 = \frac{[X][X]}{[3.0x10^{-2} - X][1.5 - X]}$$

$$5.9x^2 - 9.027x + 0.2655 = x^2$$

$$4.9x^2 - 9.027x + 0.2655 = 0$$

X = $3.0x10^{-2}\ mol/L$ and X = $1.8\ mol/L$

∴ X = $3.0x10^{-2}$ Because if it was equal to 1.8, we would have a negative equilibrium concentration on $RO_3^-{}_{(aq)}$

$[OH^-]$ = X = $3.0x10^{-2}$ mol/L

B) Calculate the correct $[OH^-]$ and Kb values in the problem above. Use these corrected values to find the pH and pOH of the solution.

C) Create a Lewis Structure Diagram of each molecule in the reaction (reactants and products) to show how the molecules changed throughout the reaction.

SOLUTIONS:

A) The student made three big errors in their calculations. The student was told that 3.0×10^{-2} mol RO_3^- was added to 1.5L of water for this reaction. The student used this to create an incorrect ICE table. This ICE table is wrong because the student used $H_2O_{(l)}$ in their calculations. Liquid water cannot be used as there is no way of a liquid having a concentration. Another mistake was using the 1.5L of $H_2O_{(l)}$ as a concentration rather than using it to calculate the true concentration of RO_3^-. This was incorrect as 1.5L is not a concentration and not finding the concentration of RO_3^- correctly causes an incorrect "x" value. The final mistake was using the pKb value in their calculation rather than the Kb value. The pKb is used to represent the strength of a base while the Kb value is the dissociation constant used for the calculations. The student needed to make the conversion from pKb to Kb before their calculations.

B) $\frac{3.0\times10^{-2}\ mol}{1.5L} = 2.0\times10^{-2}\ mol/L$ $\quad Kb = 10^{-5.9} = 1.2589\times10^{-6}$

	$RO_3^-{}_{(aq)}$	+ $H_2O_{(l)}$ ⇌	$HRO_{3(aq)}$	+ $OH^-{}_{(aq)}$
I	2.0×10^{-2}		0	0
C	$-x$		$+x$	$+x$
E	$2.0\times10^{-2}-x$		x	x

$1.2589\times10^{-2} = \frac{x^2}{2.0\times10^{-2}-x}$

small x approx: $\frac{2.0\times10^{-2}}{1.2589\times10^{-6}} > 1000$

$\therefore 2.0\times10^{-2}-x = 2.0\times10^{-2}$

$1.2589\times10^{-2} = \frac{x^2}{2.0\times10^{-2}} \longrightarrow 2.5178\times10^{-4} = x^2$ $\quad x = 0.01586$ $\quad x = 0.016$

$[OH^-] = x = \boxed{0.016\ M}$ $\quad pOH = -\log[OH^-] = \boxed{1.80}$

$pH = 14 - pOH = \boxed{12.20}$

C)