Chap 15 Team Problem

Calculate the concentrations of all the species in 0.100M Na_2CO_3

Knowns

H_2CO_3 $K_{a1} = 4.2e^{-7}$

$K_{a2} = 4.8e^{-11}$

$H_2CO_3 \rightleftharpoons H^+ + HCO_3^-$ K_{a1}

$HCO_3^- \rightleftharpoons H^+ + CO_3^{2-}$ K_{a2}

Na_2CO_3 is a strong electrolyte (Alkali metal ionic)

$$Na_2CO_{3(s)} \longrightarrow 2Na^+_{(aq)} + CO_{3(aq)}^{2-}$$

$[Na^+] = 0.200M$ $[CO_3^{2-}] = 0.100M$

↳ conjugate base of a weak acid

$$CO_3^{2-} + H_2O \rightleftharpoons HCO_3^- + OH^-$$

	CO_3^{2-}		HCO_3^-	OH^-
I	0.100		0	0
C	−x		+x	+x
E	0.100 − x		x	x

$$K_b = \frac{[x][x]}{[0.100]} = 2.1e^{-4}$$

$K_w = K_{a2} K_b$ ← for CO_3^{2-}

$1e^{-14} = (4.8e^{-11}) K_b$

$2.1e^{-4} = K_b$

$x = [OH^-] = [HCO_3^-] = 4.6e^{-3}M$

$$HCO_3^- + H_2O \rightleftharpoons H_2CO_3 + OH^-$$

	HCO_3^-		H_2CO_3	OH^-
I	$4.6e^{-3}$		0	$4.6e^{-3}$
C	−x		+x	+x
E	$(4.6e^{-3} - x)$		x	$(4.6e^{-3} + x)$

$$K_b = \frac{[x][4.6e^{-3}]}{[4.6e^{-3}]} = 2.4e^{-8}$$

$[x] = [H_2CO_3] = 2.4e^{-8}$

$K_w = K_{a2} K_b$ ← for HCO_3^-

$1e^{-14} = (4.2e^{-7}) K_b$

$2.4e^{-8} = K_b$

$[H^+][OH^-] = K_w = 1e^{-14} = [H^+][4.6e^{-3}]$

$[H^+] = 2.2e^{-12}$

Because all water solutions have both $[H^+]$ & $[OH^-]$