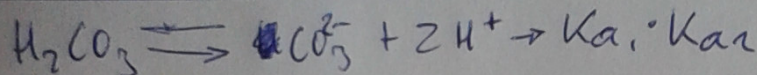
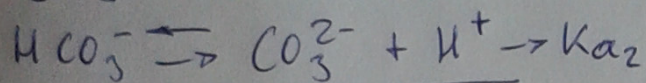
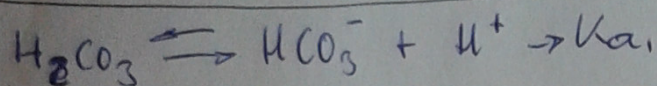


$$\text{p}K_{a1} = 6,4 \quad / \quad \text{p}K_{a2} = 10,3$$



$$K_{a1} \cdot K_{a2} = \frac{[\text{CO}_3^{2-}][\text{H}^+]}{[\text{H}_2\text{CO}_3]} \quad \rightarrow \quad [\text{H}^+] = K_{a1} K_{a2} \frac{[\text{H}_2\text{CO}_3]}{[\text{CO}_3^{2-}]}$$

$$\left| \text{pH} = \frac{1}{2} \left( \text{p}K_{a1} + \text{p}K_{a2} + \log \frac{[\text{CO}_3^{2-}]}{[\text{H}_2\text{CO}_3]} \right) \right| \text{ ① } \text{Ecuación general.}$$

Situación antes de añadir el HCl.

• Balance de masas:

$$C_0 = [\text{Na}^+] = [\text{H}_2\text{CO}_2] + [\text{HCO}_3^-] + [\text{CO}_3^{2-}]$$

• Balance de cargas

$$[\text{Na}^+] + [\text{H}^+] = [\text{HCO}_3^-] + 2[\text{CO}_3^{2-}] + [\text{OH}^-]$$

Donde  $[\text{H}^+]$  y  $[\text{OH}^-]$  son despreciables y  $[\text{Na}^+] = C_0$

$$C_0 = [\text{HCO}_3^-] + 2[\text{CO}_3^{2-}]$$

$$C_0 = [\text{H}_2\text{CO}_2] + [\text{HCO}_3^-] + [\text{CO}_3^{2-}]$$

$$[\text{HCO}_3^-] + 2[\text{CO}_3^{2-}] = [\text{H}_2\text{CO}_2] + [\text{HCO}_3^-] + [\text{CO}_3^{2-}]$$

$$[\text{CO}_3^{2-}] = [\text{H}_2\text{CO}_2] \Rightarrow \log \frac{[\text{CO}_3^{2-}]}{[\text{H}_2\text{CO}_2]} = 0$$

$$\text{pH} = \frac{1}{2} (\text{p}K_{a1} + \text{p}K_{a2}) = \frac{1}{2} (6,4 + 10,3) = \underline{\underline{8,35}}$$



Donde  $[H_2CO_3] = [CO_3^{2-}]$  y  $K_{a1} = \frac{[HCO_3^-][H^+]}{[H_2CO_3]}$

$$[H^+] = (K_{a1} \cdot K_{a2})^{1/2}$$

$$C_0 = [HCO_3^-] + 2[CO_3^{2-}] \rightarrow [HCO_3^-] = C_0 - 2[CO_3^{2-}] = C_0 - 2[H_2CO_3]$$

$$K_{a1} = \frac{(C_0 - 2[H_2CO_3])(K_{a1}K_{a2})^{1/2}}{[H_2CO_3]} \rightarrow \frac{K_{a1}}{(K_{a1} \cdot K_{a2})^{1/2}} [H_2CO_3] = C_0 - 2[H_2CO_3]$$

$$[H_2CO_3] = \frac{C_0}{\frac{K_{a1}}{(K_{a1} \cdot K_{a2})^{1/2}} + 2} = \underline{0,022} \text{ mol/l} = [H_2CO_3]_1 = [CO_3^{2-}]_1$$

Después de añadir el HCl (consideramos  $\Delta V = 0$ )

$$[H_2CO_3] = [H_2CO_3]_1 + \frac{[HCl]}{2} = 0,022 + \frac{0,1 \cdot 2 \cdot 10^{-3}}{0,1} = 0,02242$$

$$[CO_3^{2-}] = [CO_3^{2-}]_1 - \frac{[HCl]}{2} = 0,022 - 4 \cdot 10^{-4} = 0,02148$$

Sustituimos valores en la ecuación general:

$$pH = \frac{1}{2} (6,4 + 10,3 + \log \frac{0,02148}{0,02242}) = \underline{\underline{8,35}} \approx 8,4$$

$$0,0221$$