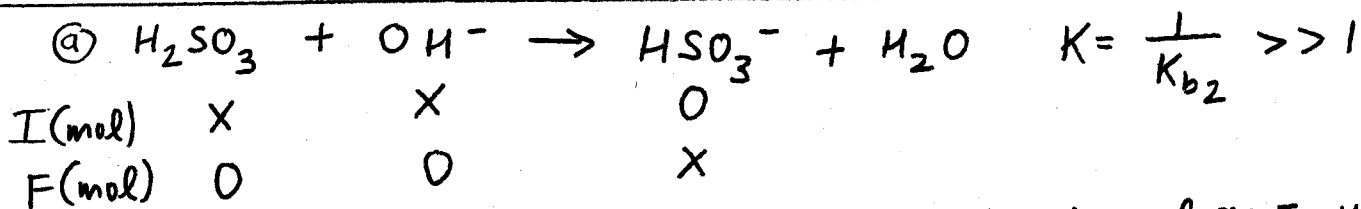


Polyprotic Buffer Example Problem (see Harris Chapter 11)

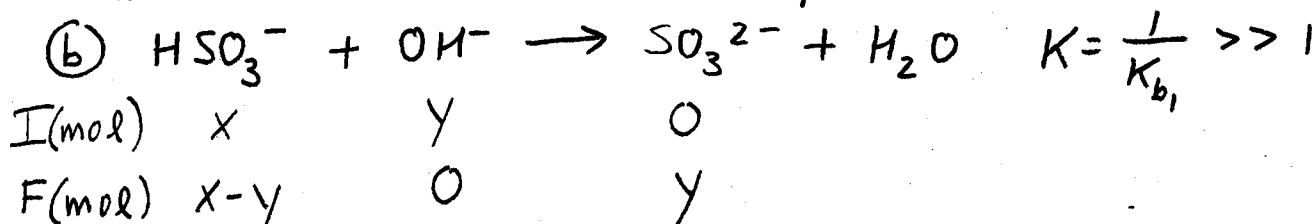
We have solutions of 0.500 M H_2SO_3 and 0.200 M KOH. How many mL of each solution should be mixed together to create 1.00 L of a buffer at pH 6.20?

As in the demo, $\text{pH} = \text{p}K_2 + \log \frac{[\text{SO}_3^{2-}]}{[\text{HSO}_3^-]} \Rightarrow \frac{[\text{SO}_3^{2-}]}{[\text{HSO}_3^-]} = 0.10_{47}$

- Chem: Add enough KOH to convert (a) all $\text{H}_2\text{SO}_3 \rightarrow \text{HSO}_3^-$;
- (b) $\sim 10\%$ of $\text{HSO}_3^- \rightarrow \text{SO}_3^{2-}$ [like a titration!]
- Do stoichiometry in terms of mol, then convert to mL



where $x \equiv \text{mol } \text{H}_2\text{SO}_3$. Now let $y \equiv \text{additional mol } \text{OH}^-$, that is,



so $\frac{[\text{SO}_3^{2-}]}{[\text{HSO}_3^-]} = \frac{y}{x-y} = 0.10_{47} \quad (1)$

and $\text{vol}(\text{H}_2\text{SO}_3) + \text{vol}(\text{KOH}) = 1.00 \text{ L}$ note!

$\Rightarrow x \text{ mol } \text{H}_2\text{SO}_3 \left(\frac{\text{L}}{0.500 \text{ mol/L}} \right) + (x+y) \text{ mol } \text{OH}^- \left(\frac{\text{L}}{0.200 \text{ mol/L}} \right) = 1.00 \text{ L}$

$\Rightarrow 2.00x + 5.00x + 5.00y = 7.00x + 5.00y = 1.00 \quad (2)$

Solve for x , since that will immediately lead to $\text{vol } \text{H}_2\text{SO}_3$.

(1) $\Rightarrow y = 0.10_{47}x - 0.10_{47}y \Rightarrow 1.10_{47}y = 0.10_{47}x$

$\Rightarrow y = 0.094_{78}x \quad (3)$

(over)

$$\textcircled{2} \Rightarrow X = \frac{1}{7.00} (1.00 - 5.00y) = 0.142_{86} - 0.714_{29} y \quad \textcircled{4}$$

$$\textcircled{3} \text{ into } \textcircled{4} \Rightarrow X = 0.142_{86} - 0.714_{29} (0.094_{78} X)$$

$$X = 0.142_{86} - 0.067_{70} X$$

$$1.067_{70} X = 0.142_{86}$$

$$X = 0.133_{80} \text{ mol H}_2\text{SO}_3$$

$$\text{i.e. } 0.133_{80} \text{ mol} \left(\frac{10^3 \text{ mL}}{0.500 \text{ mol}} \right) = \boxed{267.6 \text{ mL H}_2\text{SO}_3}$$

$$\Downarrow$$
$$\boxed{732.4 \text{ mL KOH}}$$