

ARJUNA

JEE AIR 2024

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Physical Chemistry

Ionic Equilibrium



Lecture No. – 07

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(GC Sir)

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Topics to be Covered

Topic

✓ Buffer Action

Topic

Titration

Topic

Indicator Theory

Topic

Solubility and Solubility Product

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Recap of Previous Lecture

Topic

pH of amphotropic salt

Topic

Buffer Solution

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Buffer Action



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1. Acidic Buffer :

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SA.

H⁺ addition (HCl/HNO₃)



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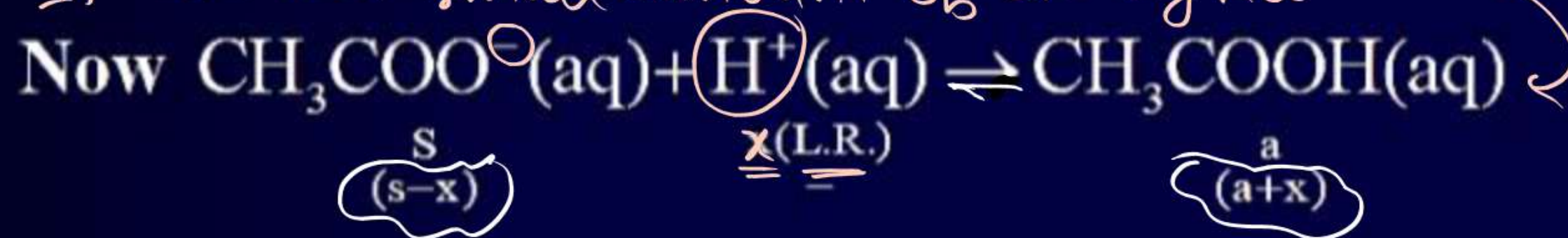
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before addition : $p_1H = pK_a + \log \left(\frac{s}{a} \right)$; $K_{eq} = \frac{1}{K_a}$; $s = [CH_3COO^-]$
 $a = [CH_3COOH]$

If we add small amount of SA. e.g HCl



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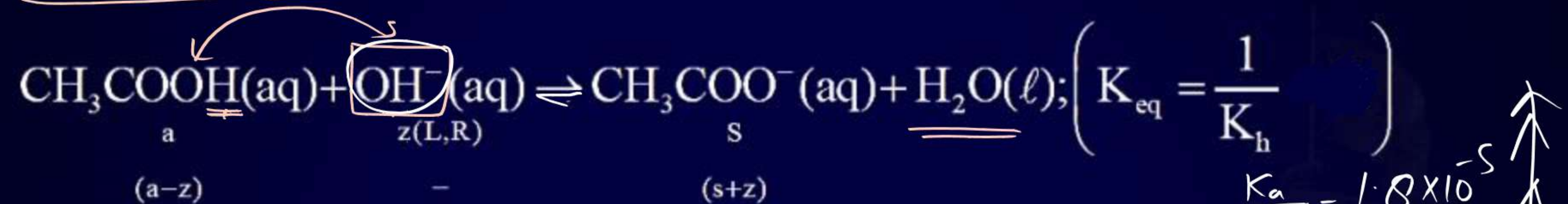
after addition of H^+ $(P^H)_2 = pK_a + \log \left(\frac{(s-x)}{(a+x)} \right)$, P_2^H is slightly lesser than P_1^H

$$K_a = \frac{[H^+][CH_3COO^-]}{[CH_3COOH]} = \frac{[H^+](s-x)}{(a+x)} \quad \text{--- (2)}$$

OH⁻ addition:



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$$(P^H)_2 = pK_a + \log \frac{(s+z)}{(a-z)}$$

P^H_2 is slightly $\uparrow$

$$K_a = \frac{[H^+][CH_3COO^-]}{[CH_3COOH]}$$

$$K_a = \frac{(H^+)(s+z)}{(a-z)}$$

$$= \frac{K_a}{K_w} = \frac{1.8 \times 10^{-5}}{10^{-14}} = 1.8 \times 10^9$$

Handwritten: An upward arrow is drawn next to the calculation.



Addition of Small Amount of Strong Acid

in

Basic
Buffer

(Buffer Action of Basic Buffer)

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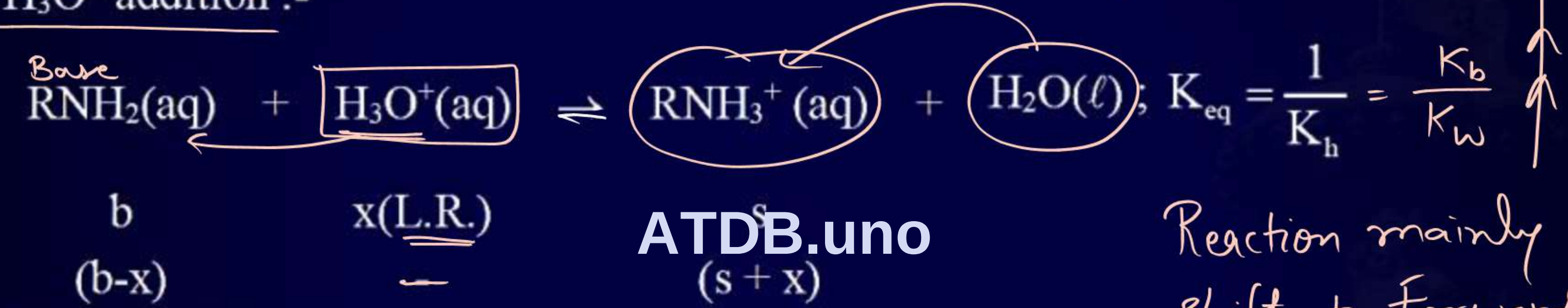
Before addition

$$pOH = pK_b + \log \left(\frac{s}{b} \right)$$

$$s = [RNH_3^+]$$

$$b = [RNH_2(aq)]$$

H₃O⁺ addition :-



$$p_2^OH = pK_b + \log \left(\frac{s+x}{b-x} \right)$$

$$p_2^H \text{ is slightly } \downarrow$$

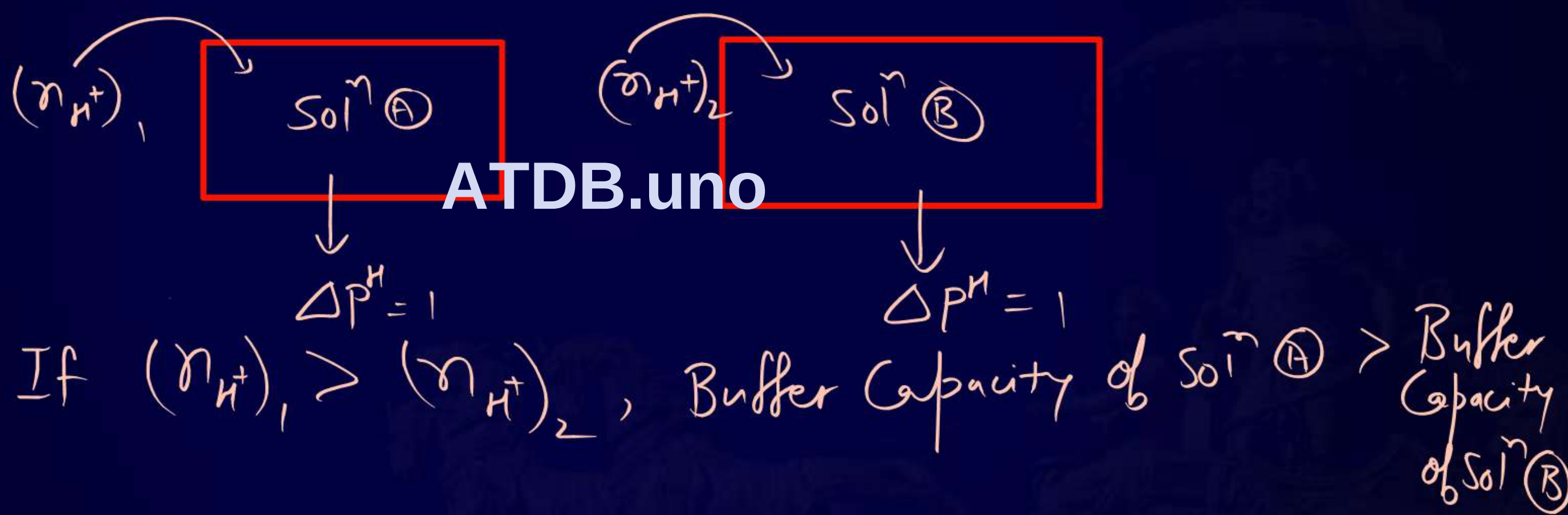
$$p^OH \text{ is slightly } \uparrow$$

$$p^H \text{ is slightly } \uparrow$$

Reaction mainly shift to Forward direction

Buffer Capacity

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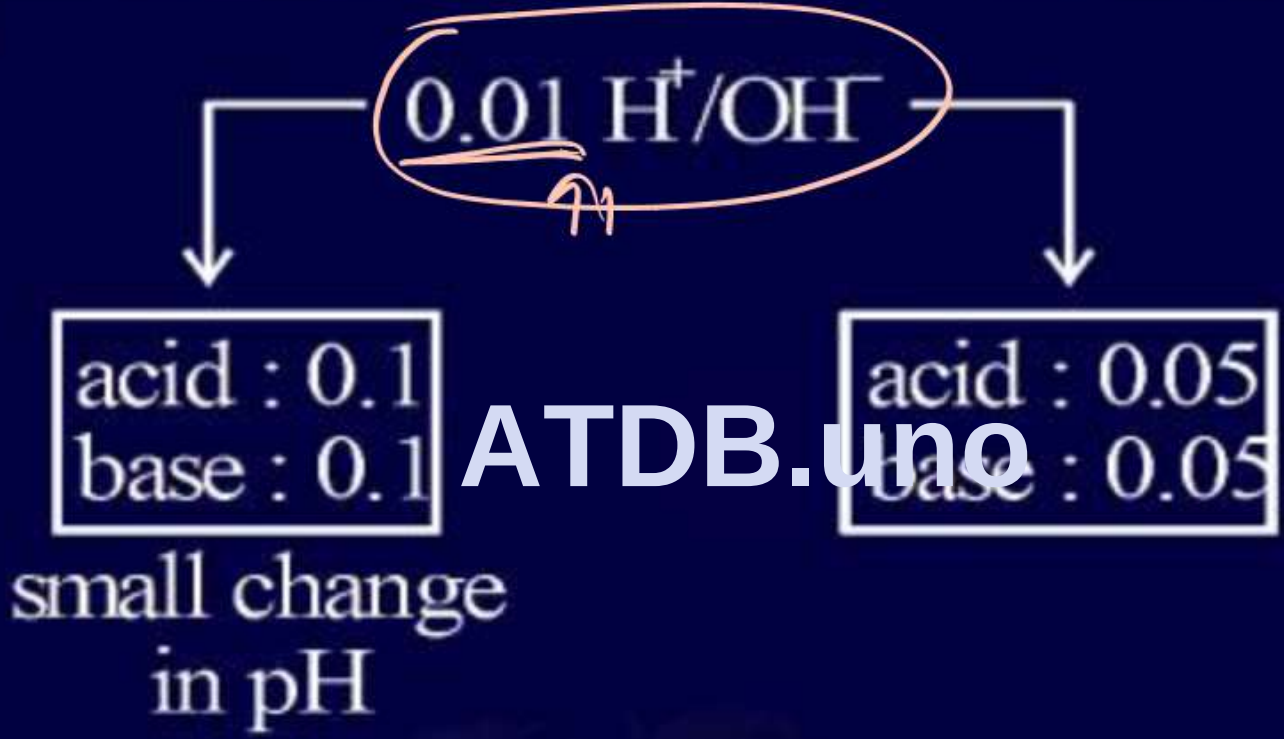




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Buffer capacity = $\frac{\text{no. of moles of } H^+ / OH^- \text{ added per litre of buffer solution}}{\text{Change in pH}}$

* More concentrate buffer solution; more pH resisting power; better buffer solution.





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Maximum Buffer Capacity $[\text{Salt}] = [\text{Acid}] \rightarrow \text{Acidic Buffer}$
 $\text{pH} = \text{pK}_a$

Maximum Buffer Capacity $[\text{Salt}] = [\text{Base}] \rightarrow \text{Basic Buffer}$
 $\text{pOH} = \text{pK}_b$

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Buffer solution at its maximum capacity: $[\text{Salt}] = [\text{Acid}]$



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$$\boxed{\text{pH} = \text{pK}_a}$$

Basic buffer: $\frac{[\text{salt}]}{[\text{base}]} = \frac{1}{10} \text{ to } \frac{10}{1}$

$$\text{pOH} = \text{pK}_b \pm 1$$

Maximum capacity: $[\text{Salt}] = [\text{Base}] ; \boxed{\text{pOH} = \text{pK}_b}$

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$$p_1H = pK_a + \log\left(\frac{s}{a}\right)$$

$$\begin{cases} s = [CH_3COO^-] \\ a = [CH_3COOH] \end{cases} \checkmark$$

b : small amount of strong base

$$p_2H = pK_a + \log\left(\frac{s+b}{a-b}\right)$$

$$[CH_3COO^-] = s + b$$

$$[CH_3COOH] = a - b$$

$$[CH_3COO^-] + [CH_3COOH] = a + s = X$$

↓

Const
-ant.

Change in pH ; $\Delta pH = p_2H - p_1H = \log\left(\frac{(s+b)}{(a-b)} \times \frac{a}{s}\right)$

$$\Delta pH = \log\left(\frac{1 + \left(\frac{b}{s}\right)}{1 - \left(\frac{b}{a}\right)}\right) \checkmark$$



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$$\Delta \text{pH} = \frac{1}{2.303} \ln \left[\frac{1 + \frac{b}{s}}{1 - \frac{b}{a}} \right] = \frac{1}{2.303} \left[\frac{b}{s} + \frac{b}{a} \right] = \frac{b}{2.303} \left[\frac{a+s}{a \cdot s} \right]$$

buffer capacity in terms of buffer index: $\boxed{\frac{b}{\Delta \text{pH}} = 2.303 \left[\frac{a \cdot s}{a+s} \right]}$ ✓

where $\boxed{a+s=x}$ constant $s = (x-a)$ **ATDB.uno**

$$\text{Buffer capacity} = 2.303 \left[\frac{a}{x} (x-a) \right]$$

For maximum buffer capacity

$$\frac{d(\text{BC})}{da} = 0$$

$$x - 2a = 0$$

$$x - a + a(-1) = 0 \quad ; \quad x = 2a, \quad s + a = 2a, \quad \boxed{s = a}$$



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$$x - 2a = 0 \Rightarrow a = \frac{x}{2} \quad \therefore s = \frac{x}{2}$$

where solution at its maximum capacity

$$[\text{Salt}] = [\text{Acid}]$$

$$\text{pH} = \text{pKa}$$

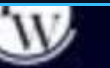
$$\begin{aligned} \text{pH} &= \text{pKa} + \log \left(\frac{s}{a} \right) \\ &= \text{pKa} \end{aligned}$$

↓
①

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Home Work



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H.W

Practice Sheet HW

1,3,7,12,13,14,19,21,22,23,24,37,38,39,40,41,45,53,55,56,
58,59,62,63,65,66,71,72,73,74,75,76,88,89,90,91,92,93,94

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Thank You

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