



# DPP SOLUTION

- Subject – Physical Chemistry
- Chapter – Ionic Equilibrium

**DPP No.- 05**



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## Question-



In a mixture of a weak acid and its salt, the ratio of concentration of acid to salt is increased tenfold. The pH of the solution

Acidic Buffer

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

increased 10 fold

$$\text{let } \frac{[\text{Acid}]}{[\text{Salt}]} = \frac{1}{1} \rightarrow \text{pH} = \text{pK}_a + \log \frac{[\text{Salt}]}{[\text{Acid}]}$$
$$= \text{pK}_a + \log 1$$

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

$$\frac{[\text{Acid}]}{[\text{Salt}]} = \frac{10}{1}$$

$$\frac{[\text{Salt}]}{[\text{Acid}]} = \frac{1}{10}$$

$$\text{pH}' = \text{pK}_a + \log \frac{1}{10} = \text{pK}_a + \log 1 - \log 10 = \underline{\underline{\text{pK}_a - 1}}$$

1 Decreases by one

2 Increases by one-tenth

3 Increases by one

4 Increases ten-fold

Ans. (1)

## Question-



How many moles of  $\text{HCOONa}$  must be added to 1 L of 0.1M  $\text{HCOOH}$  to prepare a buffer solution with a pH of 3.4? (Given:  $K_a$  for  $\text{HCOOH} = 2 \times 10^{-4}$ )

- ① 0.01  $n_{\text{HCOONa}} = ?$   $[\text{HCOOH}] = 0.1\text{M}$   $[\text{HCOO}^-] = \frac{n_{\text{HCOONa}}}{V(\text{L})}$
- ② 0.05  $\text{pH} = 3.4$ ,  $K_a = 2 \times 10^{-4}$
- ③ 0.1  $\text{pH} = \text{p}K_a + \log \frac{[\text{HCOO}^-]}{[\text{HCOOH}]}$
- ④ 0.2  $3.4 = 3.7 + \log \frac{[\text{HCOO}^-]}{10^{-1}}$
- $-0.3 = \log \frac{[\text{HCOO}^-]}{(10^{-1})}$   $\log 2 = \log \frac{[\text{HCOO}^-]}{10^{-1}}$
- $\text{p}K_a = -\log K_a$   
 $= -\log 2 \times 10^{-4}$   
 $= -[\log 2 + \log 10^{-4}]$   
 $= -[0.3 - 4 \log 10]$   
 $= -[0.3 - 4]$   
 $= 3.7$

Ans. (2)

$$2^{-1} = \frac{[\text{HCOO}^-]}{10^{-1}}$$

$$\frac{1}{2} = 10 [\text{HCOO}^-]$$

$$[\text{HCOO}^-] = \frac{1}{20} = 0.05 = [\text{HCOONa}]$$

$$0.05 = \frac{n_{\text{HCOONa}}}{12}$$

## Question-



To 1.0 L solution containing 0.1 mol each of  $\text{NH}_3$  and  $\text{NH}_4\text{Cl}$ , 0.05 mol  $\text{HCl}$  is added.

The change in pOH will be ( $\text{pK}_b$  for  $\text{NH}_3 = 4.74$ )

① 0.30 Basic Buffer + 0.05 mol  $\text{HCl}$   
 $\text{old pOH} = \text{pK}_b + \log \frac{[\text{NH}_4^+]}{[\text{NH}_3]}$

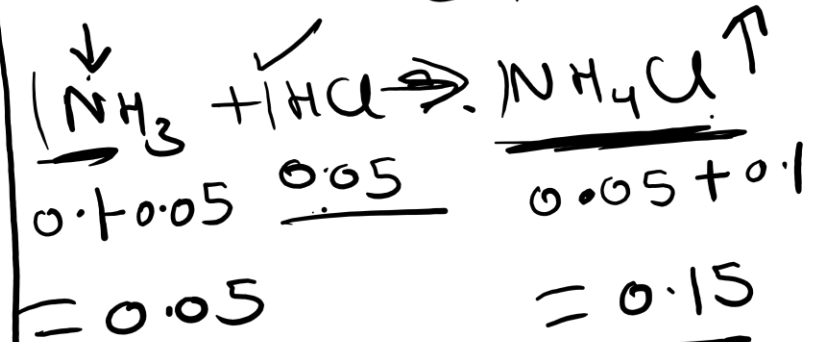
② -0.30

~~③ 0.48~~  
 $= 4.74 + \log \frac{0.1}{0.1}$

④ -0.48 old  $\text{pOH} = 4.74$

Change in  $\text{pOH} = 4.74 + \log 3 - 4.74$   
 $= 0.48$

W.B. Salt of W.B with S.A.



$$\text{new pOH} = \text{pK}_b + \log \frac{[\text{NH}_4^+]}{[\text{NH}_3]}$$

$$\begin{aligned} \text{pOH}_{\text{new}} &= 4.74 + \log \frac{0.15}{0.05} \\ &= 4.74 + \log 3 \end{aligned}$$

Ans. (3)

## Question-



$w.A. + \text{Salt of } w.A.$

The pH of blood is maintained by the balance between  $H_2CO_3$  and  $NaHCO_3$ . If the amount of  $CO_2$  in the blood is increased, how will it effect the pH of blood?

~~1~~ pH will remain same  
*acidic oxide* →

2 pH will be 7

3 pH will increase

4 pH will decrease

Acidic buffer

Ans. (1)

## Question-



The pH of buffer of  $\text{NH}_4\text{OH} + \text{NH}_4\text{Cl}$ - type is given by

$\downarrow$   $\downarrow$   
w.B. + salt of w.B. with S.A.

$$\text{pOH} = \text{p}K_b + \log \frac{[\text{Salt}]}{[\text{Base}]}$$

①  $\text{pH} = \text{p}K_b$

②  $\text{pH} = 1/2\text{p}K_b - 1/2 \log[\text{salt}]/[\text{base}]$   $\text{pH} = 14 - \text{pOH}$

✓ ~~③~~  $\text{pH} = 14 - \text{p}K_b - \log[\text{salt}]/[\text{base}]$   $= 14 - \text{p}K_b - \log \frac{[\text{Salt}]}{[\text{Base}]}$

④  $\text{pH} = \text{pOH} - \text{p}K_b + [\text{salt}]/[\text{base}]$

## Question-



Addition of sodium acetate solution to acetic acid causes the following change

~~1~~ pH increases

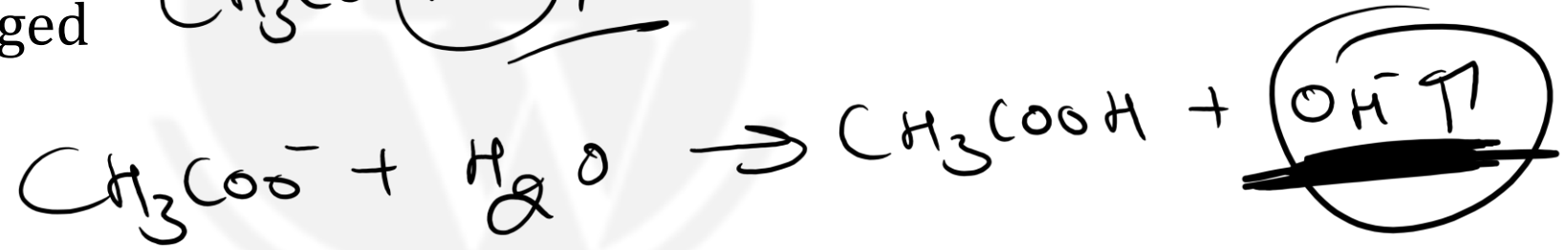
2 pH decreases

3 pH remains unchanged

4 pH becomes 7

$\text{CH}_3\text{COONa}$  salt of w.A. with S.B.

$\text{CH}_3\text{COOH} \rightarrow \text{w.A.} \Rightarrow \text{salt acidic } \text{pH} < 7$



Ans. (1)



## Question-



In a buffer solution of a weak acid and its salt, if the ratio of concentration of salt to acid is raised 10 times then pH of the solution will

- ① Increase ten times
- ② Decrease by one unit
- ③ Decrease ten times
- ~~④ Increase by one unit~~

Acidic buffer

$$\frac{[\text{Salt}]}{[\text{Acid}]} = \frac{1}{1}$$
$$pH = pK_a + \lg \frac{1}{1}$$
$$pH_{\text{old}} = pK_a$$

pH inc by 1 unit.

$$\frac{[\text{Salt}]}{[\text{Acid}]} = \frac{10}{1}$$
$$pH_{\text{new}} = pK_a + \lg \frac{10}{1}$$
$$pH_{\text{new}} = \underline{pK_a + 1}$$

Ans. (4)

## Question-



For preparing a buffer solution of pH 6 by mixing sodium acetate and acetic acid, the ratio of the concentration of salt and acid should be ( $K_a = 10^{-5}$ )

$\text{pH} = 6$        $\text{CH}_3\text{COO Na} + \text{CH}_3\text{COOH}$        $\frac{[\text{Salt}]}{[\text{Acid}]} = ?$

$K_a = 10^{-5} \Rightarrow \text{p}K_a = -\lg K_a = 5$

$\text{pH} = \text{p}K_a + \log \frac{[\text{Salt}]}{[\text{Acid}]}$

$6 = 5 + \log \frac{[\text{Salt}]}{[\text{Acid}]}$

$1 = \log \frac{[\text{Salt}]}{[\text{Acid}]}$

$\log 10 = \log \frac{[\text{Salt}]}{[\text{Acid}]}$

$\frac{[\text{Salt}]}{[\text{Acid}]} = \frac{10}{1}$

Options:

- 1 1 : 10
- 2 10 : 1
- 3 100 : 1
- 4 1 : 100

Ans. (2)

## Question-



Which of the following pairs constitutes a buffer?

~~1~~  $\text{HNO}_2$  and  $\text{NaNO}_2$   
W.A. Salt of w.A. with S.B.

2  $\text{NaOH}$  and  $\text{NaCl}$   
S.B.

3  $\text{HNO}_3$  and  $\text{NH}_4\text{NO}_3$   
S.A.

4  $\text{HCl}$  and  $\text{KCl}$   
S.A.

Ans. (1)

# Question-



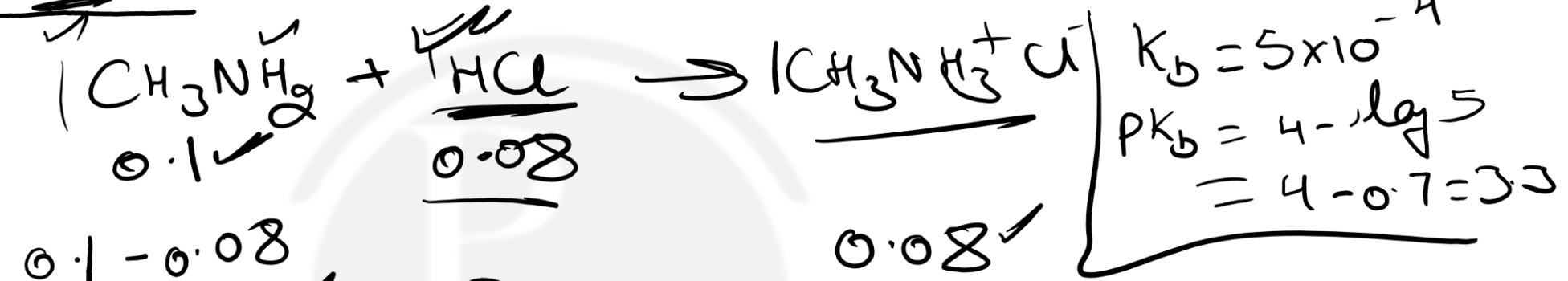
0.1 mol of  $\text{CH}_3\text{NH}_2$  ( $K_b = 5 \times 10^{-4}$ ) is mixed with 0.08 mol of HCl and the solution diluted to one litre. The  $\text{H}^+$  ion concentration in the solution will be

1  $1.6 \times 10^{-11}$

2  $8 \times 10^{-11}$

3  $5 \times 10^{-3}$

4  $8 \times 10^{-2}$



W.B. + Salt of W.B. with S.A.

Basic Buffer  
 $pOH = pK_b + \log \frac{[\text{CH}_3\text{NH}_3^+]}{[\text{CH}_3\text{NH}_2]}$   
 $= 3.3 + \log \frac{0.08}{0.02}$   
 $= 3.3 + \log 4$

$pOH = 3.3 + 0.6$   
 $= 3.9$   
 $pH = 14 - 3.9$   
 $= 10.1$   
 $[\text{H}^+] = 10^{-10.1}$

L.R.  $\text{CH}_3\text{NH}_2 = \frac{0.1}{1}$

L.R.  $\text{HCl} = \frac{0.08}{1} \therefore \text{HCl is L.R.}$

$[\text{H}^+] = 10^{-10} \times 10^{-0.1} = \frac{1}{10^{10.1}}$

Ans. (2)

$$pH = 10.1 = -\log [H^+]$$

$$\log [H^+] = -10.1$$

$$[H^+] = \text{antilog}(-10.1)$$

$$= \text{antilog } \underline{\underline{11.9}}$$

$$= 7.9 \times 10^{-11}$$

$$\begin{array}{ccccccc} \checkmark & & & & & & \checkmark \\ -10 & -0.1 & +1 & -1 \\ \hline & & & & & & \\ -11 & +0.9 & = & \underline{\underline{11.9}} \end{array}$$

$$pH = 10.1$$

$$[H^+] = 10^{-10.1}$$

$$= 10^{-10} \times 10^{-0.1}$$

$$= \frac{10^{-10}}{\underline{\underline{10^{0.1}}}}$$

## Question-



Two buffer solutions, A and B, each made with acetic acid and sodium acetate differ in their pH by one unit, A has salt : acid =  $x : y$ , B has salt : acid =  $y : x$ . If  $x > y$ , then the value of  $x : y$  is

1 10,000

2 3.17

3 6.61

4 2.10

A

$\text{CH}_3\text{COOH}$

$\text{pH} = x$

$\frac{[\text{Salt}]}{[\text{Acid}]} = \frac{x}{y}$

$\text{pH} = \text{pKa} + \log \frac{x}{y}$

B

$\text{CH}_3\text{COONa}$

$\text{pH} = x - 1$

$\frac{[\text{Salt}]}{[\text{Acid}]} = \frac{y}{x}$

$\text{pH} = x - 1 = \text{pKa} + \log \frac{y}{x}$

$$\text{pH} - \text{pH}' = x - (x - 1) = \text{pKa} + \log \frac{x}{y} - \text{pKa} - \log \frac{y}{x}$$

$$1 = \log x - \log y - (\log y - \log x)$$

$$1 = \underline{\log x} - \underline{\log y} - \underline{\log y} + \underline{\log x}$$

$$= 2 \log x - 2 \log y \quad \left| \quad \cancel{\log 3.1} = \cancel{\log \frac{x}{y}} \right.$$

$$1 = 2 \log \frac{x}{y}$$

$$\frac{x}{y} = 3.1$$

$$\frac{1}{2} = \log \frac{x}{y}$$

$$\cancel{0.5} = \log \frac{x}{y}$$

## Question-

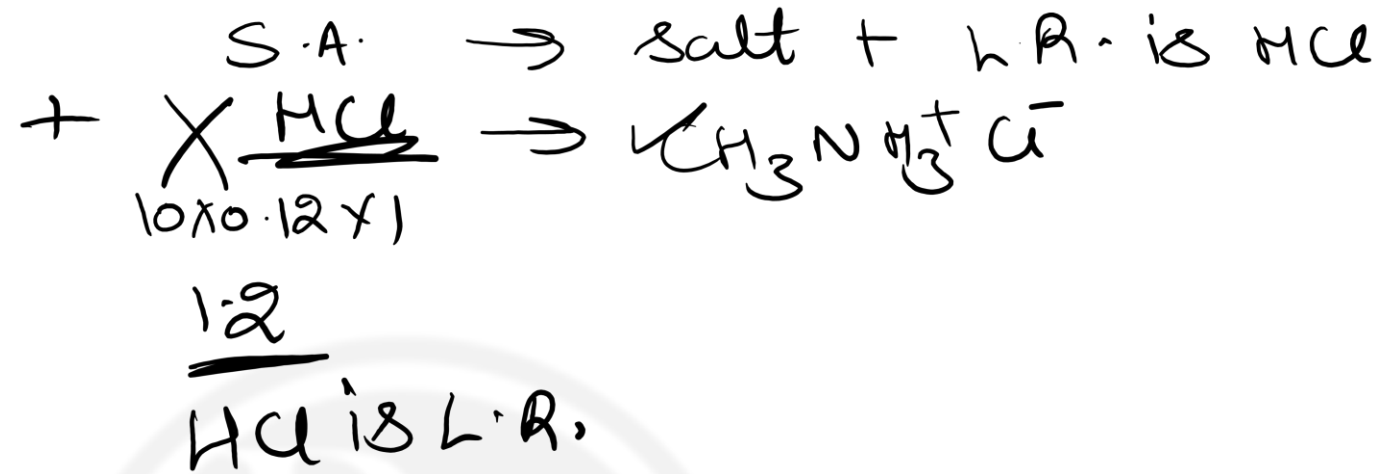
Which of the following mixtures is/are buffer?

- ①  $10\text{ml } 0.1\text{M } \text{NH}_4\text{Cl} + 10\text{ml } 0.08\text{M } \text{NaOH}$   
 $\text{Salt of W.B.} \quad \text{S.B.X} \rightarrow \text{W.B.} + \text{L.R. is NaOH}$   
 $\text{millieq. } 10 \times 0.1 \times 1 = 1 \quad 10 \times 0.08 \times 1 = 0.8$   
 $\text{NH}_4^+ \text{Cl}^- + \text{OH}^- \rightarrow \text{NH}_3 + \text{H}_2\text{O} + \text{NaCl}$
- ②  $20\text{ml } 0.22\text{M } \text{CH}_3\text{COOH} + 30\text{ml } 0.18\text{M } \text{NaOH}$   
 $\text{NaOH is L.R. X}$
- ③  $25\text{ml } 0.22\text{M } \text{H}_2\text{SO}_4 + 25\text{ml } 0.15\text{M } \text{NaOH}$
- ④  $15\text{ml } 0.12\text{M } \text{CH}_3\text{NH}_2 + 10\text{ml } 0.12\text{M } \text{HCl}$   
 $\text{W.A.} \quad \text{CH}_3\text{COOH} + \text{NaOH} \rightarrow \text{salt} + \text{L.R. is NaOH X}$   
 $\text{millieq. } 20 \times 0.22 \times 1 = 4.4 \quad 30 \times 0.18 \times 1 = 5.4$   
 $\text{CH}_3\text{COOH} + \text{NaOH} \rightarrow \text{CH}_3\text{COO}^- \text{Na}^+ + \text{H}_2\text{O}$   
 $\text{S.B. X Salt}$

Ans. (1, 4)



$\checkmark$  w.B  
 $\text{CH}_3\text{NH}_2$   
 millig. eq.  $\frac{15 \times 0.12 \times 1}{1.8}$





**Thank**

*You...*

