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

1. Decreases by one
2. Increases by one-tenth
3. Increases by one
4. Increases ten-fold

Acidic Buffer

$\frac{[Acid]}{[Salt]}$ inc to 10 fold

let $\frac{[Acid]}{[Salt]} = \frac{1}{1} \Rightarrow pH = pKa + \log\frac{[Salt]}{[Acid]}$

$= pKa + \log 1$

$pH = pKa$

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

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

$pH' = pKa + \log\frac{1}{10} = pKa + \log 1 - \log 10 = pKa - 1$

Ans. (1)

Question-

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

1. 0.01
2. 0.05
3. 0.1
4. 0.2

Salt of W.A. — W.A.

$n_{HCOONa} = ?$ $[HCOOH] = 0.1M$

$pH = 3.4$, $K_a = 2 \times 10^{-4}$

$$pH = pK_a + \log \frac{[HCOO^-]}{[HCOOH]}$$

$$3.4 = 3.7 + \log \frac{[HCOO^-]}{[HCOOH]}$$

$$-0.3 = \log \frac{[HCOO^-]}{[10^{-1}]}$$

10^{-1} (−1)

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

$$[HCOO^-] = n_{HCOONa} / V(L)$$

$$pK_a = -\log K_a$$

$$= -\log 2 \times 10^{-4}$$

$$= -[\log 2 + \log 10^{-4}]$$

$$= -[0.3 - 4 \log 10]$$

$$= -[0.3 - 4]$$

$$= 3.7$$

Ans. (2)

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

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

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

$$0.05 = \frac{n_{HCOONa}}{1L}$$

Question-

To 1.0 L solution containing 0.1 mol each of NH_3 and NH_4Cl, 0.05 mol HCl is added. The change in pOH will be (pK_b for NH_3 = 4.74)

1. 0.30
2. –0.30
3. 0.48
4. –0.48

Basic Buffer + 0.05 mol HCl

$$\text{old pOH} = pK_b + \log \frac{[NH_4^+]}{[NH_4OH]}$$

$$= 4.74 + \log \frac{0.1}{0.1}$$

old pOH = 4.74

Change in pOH = $4.74 + \log 3 - 4.74$

$= 0.48$

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

S.A.

$NH_3 + HCl \Rightarrow NH_4Cl$

$0.1 + 0.05 \quad 0.05 \quad 0.05 + 0.1$

$= 0.05 \quad = 0.15$

$$\text{new pOH} = pK_b + \log \frac{[NH_4^+]}{[NH_3]}$$

$$\text{pOH}_{\text{new}} = 4.74 + \log \frac{0.15}{0.05} \quad 3$$

$= 4.74 + \log 3$

Ans. (3)

Question-

w.A. + 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?

acidic oxide →

1. pH will remain same

Acidic buffer

2. pH will be 7

3. pH will increase

4. pH will decrease

Ans. (1)

Question-

The pH of buffer of NH_4OH + NH_4Cl- type is given by

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

1. $pH = pK_b$
2. $pH = 1/2pK_b - 1/2 \log[salt]/[base]$
3. $pH = 14 - pK_b - \log[salt]/[base]$
4. $pH = pOH - pK_b + [salt]/[base]$

$$pOH = pK_b + \log \frac{[Salt]}{[Base]}$$

$$pH = 14 - pOH$$

$$= 14 - pK_b - \log \frac{[Salt]}{[Base]}$$

Ans. (3)

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

CH_3COONa salt of W.A with S.B.

$CH_3COOH \rightarrow$ W.A $\Rightarrow$ Sol^n acidic pH < 7

$CH_3COO^- Na^+$ X

$CH_3COO^- + H_2O \rightarrow CH_3COOH + OH^-$ ↑

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

$\frac{[Salt]}{[acid]} = \frac{1}{1}$

$pH = pKa + \lg \frac{1}{1}$

$pH_{old} = pKa$

pH inc by 1 unit.

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

$pH_{new} = pKa + \lg \frac{10}{1}$

$pH_{new} = pKa + 1$

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 ($K_a = 10^{-5}$)

1. 1 : 10
2. 10 : 1
3. 100 : 1
4. 1 : 100

pH = 6 $CH_3COONa + CH_3COOH$ $\frac{[Salt]}{[Acid]} = ?$

$K_a = 10^{-5} \Rightarrow pK_a = -\log K_a = 5$

$pH = pK_a + \log \frac{[Salt]}{[Acid]}$

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

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

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

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

Ans. (2)

Question-

Which of the following pairs constitutes a buffer?

1. HNO_2 and $NaNO_2$ (W.A. — Salt of W.A. with S.B.)
2. NaOH and NaCl (S.B.)
3. HNO_3 and NH_4NO_3 (S.A.)
4. HCl and KCl (S.A.)

Ans. (1)

Question-

0.1 mol of CH_3NH_2 ($K_b = 5 \times 10^{-4}$) is mixed with 0.08 mol of HCl and the solution diluted to one litre. The H ion concentration in the solution will be

1. 1.6×10^{-11}
2. 8×10^{-11}
3. 5×10^{-3}
4. 8×10^{-2}

w.B. S. Acid

$CH_3NH_2 + HCl \rightarrow CH_3NH_3^+Cl^-$

0.1 0.08 0.08

0.1 − 0.08 0 0.08

= 0.02

$K_b = 5 \times 10^{-4}$

$pK_b = 4 - \log 5$

$= 4 - 0.7 = 3.3$

w.B. + Salt of w.B. with SA

Basic Buffer

$pOH = pK_b + \log \frac{[CH_3NH_3^+]}{[CH_3NH_2]}$

$= 3.3 + \log \frac{0.08}{0.02}$

$= 3.3 + 0.6$

$= 3.9$

$pH = 14 - 3.9$

$= 10.1$

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

L.R. $CH_3NH_2 = \frac{0.1}{1}$

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

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

Ans. (2)

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

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

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

$= \text{antilog } \bar{11}.9$

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

$-10 \quad -0.1 \quad +1 \quad -1$

$-11 + 0.9 = \bar{11}.9$

$pH = 10.1$

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

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

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

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

CH_3COOH CH_3COONa

A B

$x > y$

$pH = x$ $\quad pH' = x - 1$

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

$pH = pKa + \log\frac{x}{y}$ $\quad pH' = x \pm 1 = pKa + \log\frac{y}{x}$

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

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

Ans. (2)

$$1 = \log x - \log y - \log y + \log x$$

$$= 2\log x - 2\log y$$

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

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

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

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

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

Question-

Which of the following mixtures is/are buffer?

1. 10ml 0. 1M NH_4Cl + 10ml 0. 08M NaOH

Salt of W.B. + S.A. — S.B.X → ① W.B. + L.R. is NaOH

$NH_4Cl + NaOH \rightarrow NH_3 + H_2O + NaCl$

milliq.eq. $10 \times 0.1 \times 1 = 1$ | $10 \times 0.08 \times 1 = 0.8$

2. ✗ 20 ml 0. 22M CH_3COOH + 30 ml 0.18M NaOH

NaOH is L.R ✗

3. ✗ 25ml 0. 22M H_2SO_4 + 25ml 0. 15M NaOH

4. 15ml 0. 12M CH_3NH_2 + 10ml 0. 12M HCl

W.A. + S.B. → salt + L.R. is NaOH ✗

$\frac{20}{100} \times 22$

$CH_3COOH + NaOH \rightarrow CH_3COO^-Na^+ + H_2O$

milliq: $20 \times 0.22 \times 1 = 4.4$ | $30 \times 0.18 \times 1 = 5.4$

Salt ✗

Ans. (1, 4)

W.B S.A. → salt + L.R. is HCl

CH_3NH_2 + HCl → $CH_3NH_3^+Cl^-$

millig. eq. $\frac{15 \times 0.12 \times 1}{1.8}$ $\frac{10 \times 0.12 \times 1}{1.2}$

HCl is L.R.

Thank You...