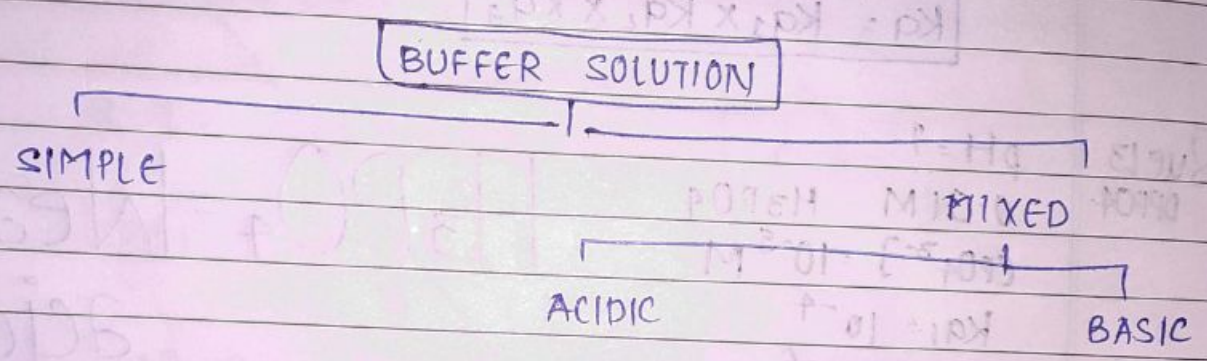


BUFFER SOLUTION

- Solution whose pH does not change significantly on addition of small amount of acid/alkali
- pH of this soln is not affected by dilution
- Based on common ion effect.



SIMPLE BUFFERS:

Salt of WA & WB in water
 Eg: CH3COONH4 ; NH4Cl.

$$pH = \frac{1}{2} (pK_w + pK_a - pK_b)$$

$$pH = 7 + \frac{1}{2} (pK_a - pK_b)$$

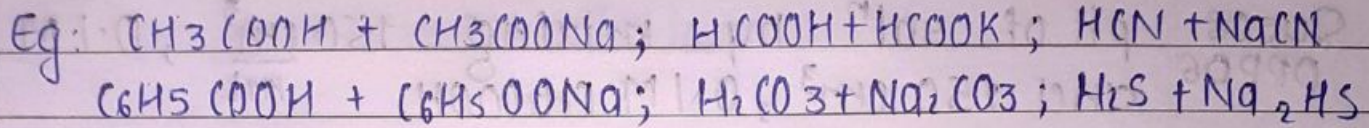
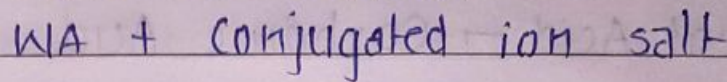
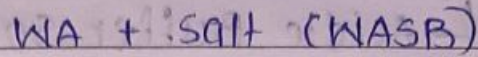
MIXED BUFFERS:

- Aqueous solution of mixture of weak acid and salt of same weak acid with any kind of strong base.

* मातापिता - गुरुजनोना आशीर्वाद्यी सर्वत्र सुभी यवाय. *

OR conjugate

Acidic (Weak Acid with its strong base)



→ pH (By Henderson's equation)

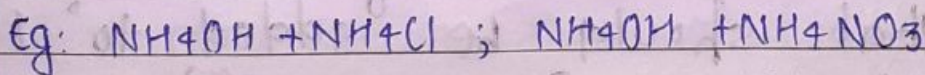
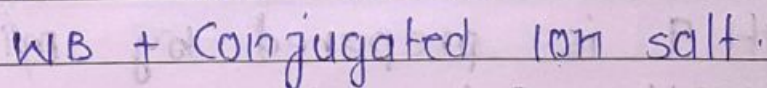
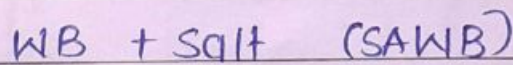
$$\text{pH} = \text{pK}_a + \log \frac{[\text{Salt}]}{[\text{WA}]}$$

$$\text{pH} = \text{pK}_a + \log \frac{[\text{Con. base}]}{[\text{WA}]}$$

$$\text{pH} = -\log K_a + \log \frac{[\text{Salt}]}{[\text{WA}]}$$

BASIC (Weak Base with its strong or conjugate acid)

Aqueous solution of mixture of weak base and salt of same WB with any kind of strong acid.



→ pOH (By Handerson's eqn)

$$\text{pOH} = \text{pK}_b + \log \frac{[\text{Salt}]}{[\text{WB}]}$$

$$\text{pOH} = -\log K_b + \log \frac{[\text{Salt}]}{[\text{WB}]}$$

* कुसंगी मित्र - दुश्मन समान છે. *

Buffer Range / Buffer Index / Buffer Capacity

- Defined as number of moles of SA / Base required for changing its pH value by 1 unit of a one litre solution.

- No. of H^+ / OH^- added = change in number of moles of acid / Base = change in no. of moles of salt.

Buffer range for Buffer Solⁿ of $pK_a \pm 1$

Buffer range for buffer solⁿ = $\frac{[Salt]}{[WA]} = \frac{1}{10}$ to 10

CASE: 01

If concentration ratio of $\frac{[Salt]}{[WA]} = \frac{1}{10}$ to 10 (diffe. of $\pm pH$)

then solution act as B.S.

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

CASE: 02

If concentration ratio of $\frac{[Salt]}{[WA]} > 10$ [Salt], [WA] \therefore SBWA

$$\text{then, } pH = \frac{1}{2} (pK_w + pK_a + \log c)$$

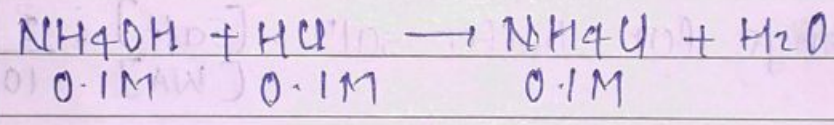
* कुसंगी मित्र - दुश्मन समान છે. *

CASE 03

If conc. ratio $< \frac{1}{10}$ (Salt \downarrow , WA \uparrow)

then, $\boxed{pH = \frac{1}{2} (pKa - \log C)}$

Que 03 In which of the following respective volume ratios should be 0.1 M NH_4OH solⁿ & 0.1 M HCl solⁿ be mixed, so that the resulting solⁿ behaves like a buffer solⁿ?



For preparation of WBSA B.S. required NH_4Cl and NH_4OH so WB (NH_4OH),

Q:1

Que 13 The ionization constant of a certain WA is 10^{-4} . What should be the [Salt] to [Acid] ratio if we have to prepare a buffer with pH=5 using this acid and one of the salts?

$pKa = \log 10^{-4} = 4$

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

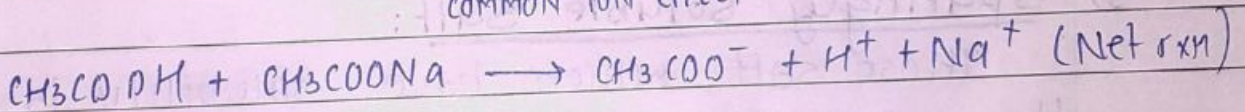
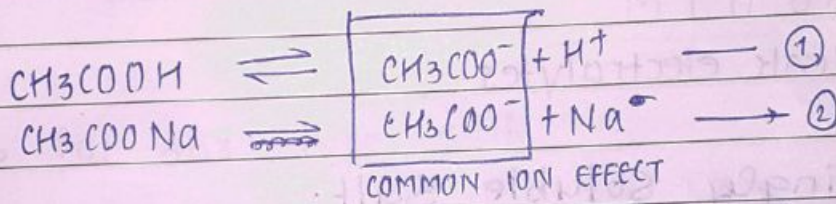
$5 = 4 + \log \frac{[salt]}{[Acid]} \Rightarrow 5 = 4 + \log (100)$

* मातापिता - गुरु ज्ञानां परीक्षां सती सती ध्याता (10)
 $5 = 4 + 1 \Rightarrow [5 = 5]$

Ques 14
PP: 06 In a mixing of acetic acid and sodium acetate, the ratio of conc. of the salts to the acid is increased by ten times. Then the pH of the solution:

☉ Solved in DPP itself

☉ HOW BUFFER SOLUTION WORK [COMMON ION EFFECT]



CASE 01 IF Acid (H^+) ion add then eqn (1) move backward direction according to Le-Chatlier Principle, so pH of Buffer solution not decrease after adding acid in marginal quantity.

IF H^+ add then eq 1 suppressed (\leftarrow)

CASE 02 IF Base (OH^-) ion is added then eqn (1) move forward direction according to Le-Chatlier Principle, so pH of Buffer solution not increase after adding base in marginal quantity.

IF OH^- add then eq. 1 moves forward.

☉ ફુસંગી મિત્ર - દુશ્મન સમાન છે. ☉

☀️ TYPES OF SOLUTION BASED ON SOLUBILITY OF SOLUTE

① Highly Soluble Salt:

Those salt which have solubility more than 0.1 Molar (0.1M)

Eg: NaCl, KCl, Na₂SO₄ etc.

② Partial soluble salt:

Those salt which have solubility is between 0.01 to 0.1 M

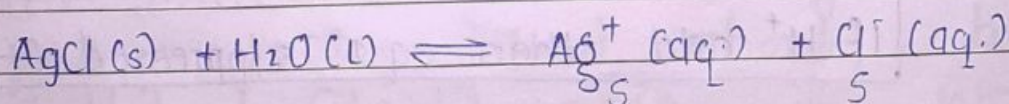
Eg: Weak electrolytes.

③ Sparingly Soluble Salt:

Those salt which have solubility is less than 0.01M. Very low quantity is soluble in salt.

Eg: AgCl, HgCl, FeCOCl₂, HgCl₂, AuCl₃ etc.

☀️ RELATION BETWEEN SOLUBILITY PRODUCT CONSTANT (K_{sp}) AND SOLUBILITY (S):

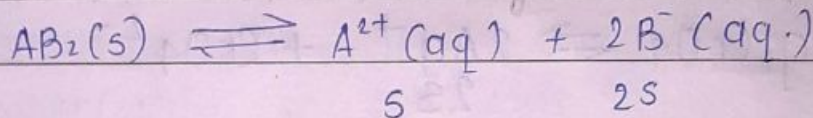


$$K = \frac{[\text{Ag}^+][\text{Cl}^-]}{[\text{AgCl}]}$$

$$\boxed{K_{sp} = [\text{Ag}^+][\text{Cl}^-]} \quad \boxed{K_{sp} = S^2} \Rightarrow \boxed{S = \sqrt{K_{sp}}}$$

$$\boxed{S = (K_{sp})^{1/2}} \quad \text{--- Eq: 01}$$

Case 01 K_{sp} for AB₂ type salt: (HgCl₂)



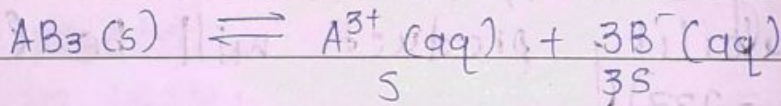
$$K_{sp} = [A^{2+}] [B^-]^2$$

$$K_{sp} = (s) (2s)^2$$

$$\boxed{K_{sp} = 4s^3}$$

$$\boxed{s = \left(\frac{K_{sp}}{4}\right)^{1/3}} \quad \text{--- (2)}$$

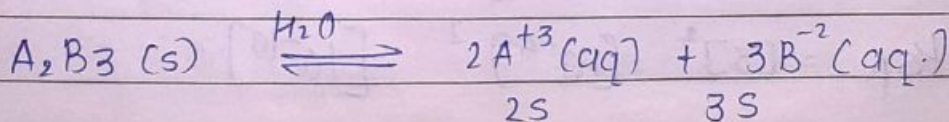
Case:02 K_{sp} for AB₃ type salt



$$K_{sp} = s (3s)^3$$

$$\boxed{K_{sp} = 27s^4} \quad \text{--- (3)}$$

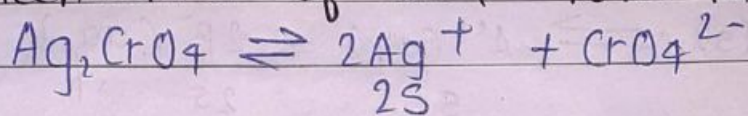
Case 03 A₂B₃ type salt:



$$K_{sp} = (2s)^2 (3s)^3$$

$$\boxed{K_{sp} = 108s^5}$$

Que: 05 Ksp of $\text{Ag}_2\text{CrO}_4 \rightarrow 32 \times 10^{-12}$
 DPP: 07 concentration of CrO_4^{2-} ions in that solution.



$$K_{sp} = 4s^3$$

$$s = \left[\frac{K_{sp}}{4} \right]^{1/3}$$

$$s = (8 \times 10^{-12})^{1/3}$$

$$s = [2^3 \times 10^{-4 \times 3}]^{1/3}$$

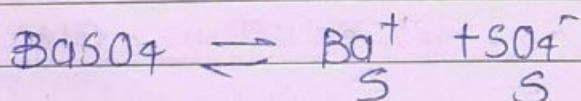
$$s = 2 \times 10^{-4}$$

Que 06 Solubility (BaSO_4) in $\text{H}_2\text{O} \rightarrow 2.33 \times 10^{-3}$ g/litre
 DPP: 07 Its solubility product will be (M.M of $\text{BaSO}_4 = 233$)

It is given that,

$$\text{Solubility}(\text{BaSO}_4) = 2.33 \times 10^{-3} \text{ g/litre}$$

$$s = \frac{2.33 \times 10^{-3}}{233 \times 100} = 10^{-5}$$



$$K_{sp} = [s]^2 = [10^{-5}]^2 = [10^{-10}]$$

Convert into
mol/litre.

Que 07 Ksp of $\text{AgCl} = 1.8 \times 10^{-11}$
 DPP: 07 Max. vol. of water required to dissolve
 1.9 mg of AgCl is approximately: