

Topic :- Equilibrium

1 (a)

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

$$\text{or } 5.24 = 4.74 + \log \frac{[\text{Conjugate base}]}{[\text{Acid}]}$$

$$\therefore \frac{[\text{Conjugate base}]}{[\text{base}]} = 3.$$

2 (a)

$$[\text{H}^+] = C\alpha = \sqrt{K_a C}$$

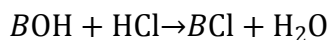
$$\begin{aligned} \text{pH} &= -\log (K_a C)^{1/2} \\ &= \frac{1}{2}[-\log K_a - \log C] \\ &= \frac{1}{2}[4.74 - \log 10^{-2}] \\ &= \frac{1}{2}[4.74 + 2] = 3.37 \end{aligned}$$

3 (a)

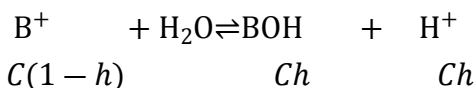
1M solution of CH_3COONa on addition to acid shows a decrease in dissociation of acid due to common ion effect.

4 (d)

Weak monoacidic base *e.g.*, BOH is neutralised as follows



At equivalence point all BOH gets converted into salt and remember! The concentration of H^+ (or pH of solution) is due to hydrolysis of resultant salt (BCl , cationic, hydrolysis here)



Volume of HCl used up

$$V_a = \frac{N_b V_b}{N_a} = \frac{2.5 \times 2 \times 15}{2 \times 5} = 7.5 \text{ mL}$$

Concentration of salt

$$[\text{BCl}] = \frac{\text{conc. of base}}{\text{total volume}} = \frac{2 \times 2.5}{5(7.5 + 2.5)} = \frac{1}{10} = 0.1$$

$$K_h = \frac{Ch^2}{1-h} = \frac{K_w}{K_b}$$

(h should be estimated whether that can be neglected or not)

on calculating $h=0.27$ (significant, not negligible)

$$[H^+] = Ch = 0.1 \times 0.27 = 2.7 \times 10^{-2} M$$

5 **(c)**

A salt is precipitated only when the product of ionic concentration is more than its solubility product.

$$K_{sp} = 1 \times 10^{-8}$$

$$[A^+] = 10^{-3} M$$

$$[B^-] = \frac{1 \times 10^{-8}}{10^{-3}} = 10^{-5} M$$

So, AB will be more precipitated only when the concentration of $[B^-]$ is more than $10^{-5} M$.

6 **(b)**

According to Le-Chatelier's principle exothermic reactions are favourable at low pressure. The reaction in which number of moles decreases are favourable at high pressure or low volume.



∴ The reaction is exothermic and number of moles of reactants are decreasing.

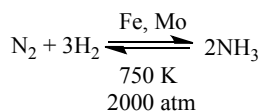
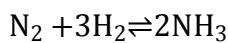
∴ The reaction rate is increased by decreasing temperature and increasing pressure.

7 **(d)**

The reaction does not cease up but goes in both directions with same speed.

8 **(a)**

Haber's process of synthesis of ammonia



Since, the number of molecules of gaseous products are less than the number of molecules of gaseous reactants, thus according to Le-Chatelier's principle, high pressure favours the forward reaction *i.e.*, more ammonia will be obtained.

9 **(d)**

Buffer capacity of an acidic buffer is maximum when the ratio of HA to A^- is unity.

$$\text{Since, pH of acidic buffer} = pK_a + \log \frac{[A^-]}{[HA]}$$

For maximum buffer capacity, $[A^-] = [HA]$

$$\therefore \text{pH} = pK_a$$

10 **(c)**

$$\therefore \text{pH} = 2$$

$$\begin{aligned} \therefore [H^+] &= 10^{-2} \\ [H^+] &= N.\alpha \\ 10^{-2} &= 0.1 \times \alpha \\ \alpha &= \frac{10^{-2}}{0.1} \\ \alpha &= 0.1 \end{aligned}$$

11 **(c)**

Since, catalyst increases the rate of forward reaction as well as the rate of backward reaction, it does not affect the equilibrium constant.

12 **(d)**

Meq. of H_2SO_4 needed for 20 Meq. of NaOH = 20

Thus, volume of H_2SO_4 needed = V_{mL}

$$\text{or } V \times 0.25 \times 2 = 20$$

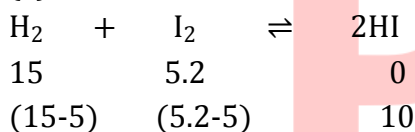
$$\therefore V = 40 \text{ mL}$$

Also, temperature increases during neutralization and then decreases after neutralization on further addition of acid.

13 **(b)**

The dissociation of H_2S decreases in presence of acid (or H^+ a common ion furnished by an acid).

14 **(a)**



Equilibrium constant

$$(K_c) = \frac{[HI]^2}{[H_2][I_2]} = \frac{10 \times 10}{10 \times 0.2} = 50$$

15 **(c)**

New concentration of,

$$HCl = \frac{10^{-6}}{100} = 10^{-8} M$$

$$\begin{aligned} \therefore [H^+] &= 10^{-18} + 10^{-7} \\ &= 1.1 \times 10^{-7} M \end{aligned}$$

$$\therefore \text{pH} \approx 7$$

17 **(a)**

$$\begin{aligned} \text{pH} &= -\log[H^+] \\ &= -\log(3 \times 10^{-3}) \\ &= 3 - \log 3 \\ &= 3 - 0.4771 \\ &= 2.5229 \end{aligned}$$

18 **(d)**

The dissociation of HCN will decrease in presence of NaCN due to common ion effect.

19 **(c)**

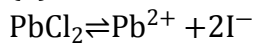
$$\text{Meq. of HCl} = 10 \times 10^{-1} = 1$$

$$\text{Meq. of NaOH} = 10 \times 10^{-1} = 1$$

Thus, both are neutralized and 1 Meq. Of NaCl (a salt of strong acid and strong base) which does not hydrolyse and thus, $\text{pH} = 7$.

20

(d)



$$s \text{ mol/L} \quad s \quad 2s$$

$$\text{Hence, } K_{\text{sp}} = [\text{Pb}^{2+}][\text{I}^-]^2$$

$$= (s)(2s)^2$$

$$= 4s^3$$

$$\therefore s = \sqrt[3]{\frac{K_{\text{sp}}}{4}} = \sqrt[3]{\frac{2.3 \times 10^{-32}}{4}}$$

$$= 1.78 \times 10^{-11} \text{ mol/L}$$

$$= 1.78 \times 10^{-11} \times 278 \text{ g/L}$$

$$= 4.95 \times 10^{-9} \text{ g/L}$$

PE

ANSWER-KEY										
Q.	1	2	3	4	5	6	7	8	9	10
A.	A	A	A	D	C	B	D	A	D	C
Q.	11	12	13	14	15	16	17	18	19	20
A.	C	D	B	A	C	C	A	D	C	D

PE