Daily Tutorial Sheet-3	JEE Main (Archive)

31.(D) $HCl \longrightarrow H^+ + Cl^-$

0.2M 0.2 M

$H_2S \rightleftharpoons H^+ + HS^-$ $K_1 = 10^{-7}$

$HS^- \rightleftharpoons H^+ + S^{2-}$ $K_2 = 1.2 \times 10^{-13}$

$H_2S \rightleftharpoons 2H^+ + S^{2-}$ $K = K_1 \cdot K_2 = 1.2 \times 10^{-20}$

$K = \frac{[H^+]^2[S^{2-}]}{[H_2S]}$ $[H^+] = 0.2M$, $[H_2S] = 0.1M$

$1.2 \times 10^{-20} = \frac{(0.2)^2[S^{2-}]}{0.1} \Rightarrow [S^{2-}] = 3 \times 10^{-20} M$

32.(A) $BaSO_4(s) \rightleftharpoons Ba^{2+}(aq) + SO_4^{2-}(aq)$ $K_{sp} = 10^{-10}$

$Na_2SO_4 \to 2Na^+ + SO_4^{2-}$

Conc. of SO_4^{2-} in final solution $= \frac{50 \times 1}{500} = 0.1M$

For final solution

$\Rightarrow [Ba^{2+}][SO_4^{2-}] = 10^{-10} \Rightarrow [Ba^{2+}] = 10^{-9} M$

$M_i V_i = M_f V_f$

$C \times 450 = 10^{-9} \times 500 \Rightarrow C = 1.1 \times 10^{-9} M$

33.(B)

	HCl	+ NaOH	$\longrightarrow$ NaCl + H_2O
	75 ml,	M/5	25 ml, M/5
Initially	15 mmoles	5 mmoles	
After reaction	10 mmoles	5 mmoles	

$\therefore [H^+] = \frac{10}{75 + 25} = 0.1M \Rightarrow pH = 1$

34.(C) $Ca(OH)_2 + Na_2SO_4 \longrightarrow CaSO_4 + 2NaOH$

$Ca(OH)_2$	Na_2SO_4	$CaSO_4$	$2NaOH$
100 mmol	14 mmol		
-	-	14 mmol	28 mmol

Mass of $CaSO_4 = 14 \times 10^{-3} \times 136 = 1.9 g$

$[OH^-] = \frac{28}{100} = 0.28 M$

35.(B) $H_2SO_4 + 2NH_4OH \longrightarrow (NH_4)_2SO_4 + 2H_2O$

	H_2SO_4	$2NH_4OH$	$(NH_4)_2SO_4$
Initial	2m mol	6m mol	–
Initial	–	2m mol	2m mol

Total volume 20 + 30ml = 50mL

$[NH_4OH] = \frac{2}{50} M$

$[NH_4^+] = 2 \times \frac{2}{50} = \frac{4}{50} M$

$pOH = pK_b + \log \frac{[NH_4^+]}{[NH_4OH]} = 4.7 + \log \frac{\frac{4}{50}}{2/50} = 4.7 + \log 2 \approx 5$

$\therefore \quad pH = 14 - 5 = 9$

36.(A) $\underset{}{Ag_2CO_3} \rightleftharpoons \underset{2s+0.1}{2Ag^+} + \underset{s}{CO_3^-}$

$(2s + 0.1)^2 (s) = 8 \times 10^{-12}$

$2s << 0.1$

$10^{-2} \times s = 8 \times 10^{-12}$

$s = 8 \times 10^{-10}$ mole / L

37.(B) For the equilibrium $2H_2O \rightleftharpoons H_3O^+ + \bar{O}H$

$\Delta G^0 = -RT \ln K_{eq}. \qquad K_{eq} = 1 \times 10^{-14}$

$= -2.303 \times 298 \times 8.314 \times \log 10^{-14} = 80\,kJ/mol$

38.(B) **I.** $\underset{\substack{40\ m\,mol \\ (excess)}}{H_2SO_4} + \underset{\substack{40\ m\,mol \\ (Limiting\ reagent)}}{2NaOH} \longrightarrow Na_2SO_4 + 2H_2O$

After reaction	20 mmol	0	20 mmol	40 mmol

Total volume $= 400 + 400 = 800$ mmol

Number of moles of $H_2SO_4 = 20$ mmol

Number of moles of H^+ ion $= 2 \times 20$ mmol $= 40$ mmol

$[H^+] = \frac{40}{800} = 0.05 M$

$pH = -\log[H^+] = -\log(0.05) = 2 - \log 5 = 2 - 0.7 = 1.3$

$pH = 1.3$

II. $K_\omega = [H^+][OH^-]$

As T increases, K_ω also increases

III. $pH = 5$ and $K_a = 10^{-5}$

$\Rightarrow \quad -\log[H^+] = 5$

$[H^+] = 10^{-5}$

Weak monobasic acid 'HA' having concentration 'C'

$HA(aq) \rightleftharpoons H^+(aq) + A^{-1}(aq)$

At $t = 0$	C	0	0
At eqlibrium	$C - C\alpha$	$C\alpha$	$C\alpha$

$K_a = \frac{[H^+][A^{-1}]}{[HA]} = \frac{C\alpha}{C(1-\alpha)}$

$\alpha \rightarrow$ degree of dissociation

$\therefore \quad K_a = \dfrac{C\alpha^2}{1-\alpha} = 10^{-5}$ ... (1) (given)

$[H^+] = C\alpha = 10^{-5}$ ... (2)

From equation (1) & (2)

$\dfrac{\alpha}{1-\alpha} = 1 \Rightarrow \alpha = 1-\alpha \Rightarrow \alpha = \dfrac{1}{2}$

$\%\alpha = \dfrac{1}{2} \times 100 = 50\%$

IV. It is applicable

39.(A) $\underset{a-s}{Zr_3(PO_4)_4} \rightleftharpoons \underset{3s}{3Zr^{4+}} + \underset{4s}{4PO_4^{3-}}$

$K_{sp} = [Zr^{4+}]^3[PO_4^{3-}]^4 = [3s]^3[4s]^4 = 27s^3 \times 256s^4 = 6912s^7$

$S = \left(\dfrac{K_{sp}}{6912}\right)^{1/7}$

40.(A) $K_{sp} = [s][0.2]^3$

$[s] = 24 \times 10^{-24} = 3 \times 10^{-22}/[0.2]^3$

41.(B) $Cd(OH)_2 \rightleftharpoons Cd^{+2} + 2OH^-$

$K_{sp} = [Cd^{+2}][OH^-]^2$

Solubility $s = [Cd^{+2}] = \dfrac{K_{sp}}{[OH^-]^2}$

pH of the buffer $= 12$

pOH = 2, $[OH] = 10^{-2}$

$K_{sp} = 4s^3 = 4(1.84 \times 10^{-5})^3$

$[Cd^{+2}]_f = \dfrac{4[1.84 \times 10^{-5}]^3}{(10^{-4})} = \dfrac{4 \times 6.23 \times 10^{-15}}{10^{-4}} = 2.49 \times 10^{-10} M$

42.(B) pH = ?

$K_b = 10^{-9} \Rightarrow pK_b = 5 \Rightarrow \log = 0.301$

0.02 M NH_4Cl

$\underset{\text{Acidic salt}}{NH_4Cl} + H_2O \rightleftharpoons NH_4OH + HCl$

$pH = 7 - \dfrac{1}{2}(pK_b + \log C) = 7 - \dfrac{1}{2}(5 + \log 2 \times 10^{-2}) = 7 - \dfrac{1}{2}(3.301) = 7 - 1.6505$

pH = 5.3495

43.(B) Initially solution is of NaOH therefore pH is high then it starts decreasing with addition of HCl. After equivalence point pH will become constant and in acidic range due to presence of strong acid.

44.(5.23) mmoles of $CH_3COOH = 50$

mmoles of $HCl = 25$

mmoles of CH_3COOH in $20\,mL = \dfrac{50}{500} \times 20 = 2$

mmoles of HCl in 20mL $= \frac{25}{500} \times 20 = 1$

Now	$NaOH$	+	HCl	$\longrightarrow$	$NaCl$	+	H_2O
t = 0	2.5		1				
t_{end}	1.5		0				

	CH_3COOH	+	$NaOH$	$\longrightarrow$	CH_3COONa	+	H_2O
t = 0	2		1.5		0		
t_{end}	0.5		0		1.5		

In the end we have an acidic buffer

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

pH = 5.23

45.(C) $H_2O \rightleftharpoons H^+ + OH^-$

Dissociation of H_2O is an endothermic reaction.

On increasing temperature, $[H^+]$ ion concentration increases.

$\therefore$ pH decreases

46.(A) $Cr(OH)_3 \longrightarrow \underset{S}{Cr^{3+}} + \underset{3S}{3OH^-}$

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

$6 \times 10^{-31} = 27s^{-4}$; $\quad S = \left(\frac{6}{27} \times 10^{-31}\right)^{1/4}$

$[OH^-] = 3S = 3\left(\frac{6}{27} \times 10^{-31}\right)^{1/4} = (18 \times 10^{-31})^{1/4}$ M

47.(A) Given: $PbCl_2(s) \rightleftharpoons Pb^{2+}(aq) + 2Cl^-(aq)$, $K_{sp} = 1.6 \times 10^{-5}$

And 300 mL of 0.314 M $Pb(NO_3)_2$ with 100 mL of 0.4 M NaCl

On mixing above two solutions, molar concentration changes as volume changes. Hence new molar concentrations are as follow :

For $Pb(NO_3)_2$: $(M_{New})_{Pb(NO_3)_2} = \frac{300 \times 0.134}{400} = 0.1005$

So, $M_{Pb^{2+}} = 0.1005$

For NaCl :

$(M_{New})_{NaCl} = \frac{100 \times 0.4}{400} = 0.1$

So, $M_{Cl^-} = 0.1$

For a reaction,

$Q_{(Reaction\ quotient)} = [Pb^{2+}]_t\,[Cl^-]_t^2$

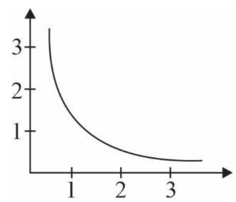
$Q = 0.1005 \times (0.1)^2$

$Q = 1.005 \times 10^{-3} > K_{sp}$

Hence, correct option is (1) $Q > K_{sp}$

Reaction will go in Backward direction i.e. precipitation of $PbCl_2(s)$

48.(4)



The correct answer would be

$XY, K_{sp} = 2\times10^{-6} M^2$

As only this expression of K_{sp} will satisfy all the points on curve.

49.(B) Oxalic acid is a primary standard solution while H_2SO_4 is a secondary standard solution.

50.(10.60) $\underset{(A)}{NaOH} + \underset{(B)}{H_2SO_4}$

Molarity of $NaOH = \dfrac{4}{40\times100} = 10^{-3}$

Molarity of $H_2SO_4 = \dfrac{9.8}{98\times100} = 10^{-3}$

$H_2SO_4 \quad + \quad H_2SO_4 \longrightarrow Na_2SO_4 \quad + \quad H_2O$

$10^{-3}M \qquad 10^{-3}M$

$40\,\ell \qquad 10\,\ell$

Moles $= 40\times10^{-3}$ moles $= 10\times10^{-3}$

Limiting Reagent is H_2SO_4

So, moles of NaOH left $= (40\times10^{-3}) - (10\times10^{-3}\times2) = 20\times10^{-3}$

Molarity of $[OH^-] = \dfrac{20\times10^{-3}}{50} = 4\times10^{-4}$

$pOH = 4 - \log 4 = 3.398 \Rightarrow pH = 14 - 3.398 = 10.602$