Ionic Equilibrium

SET Self Evaluation Test - 9

1. The most important buffer in the blood consists of **[BHU 1981]**

(a) HCl and $Cl^{\oplus}$ (b) H_2CO_3 and $HCO_3^{\ominus}$

(c) H_2CO_3 and $Cl^{\ominus}$ (d) HCl and $HCO_3^{\ominus}$

2. The solubility product of AgI at $25°C$ is $1.0\times10^{-16}\,mol^2L^{-2}$. The solubility if AgI in $10^{-4}\,N$ solution of KI at $25°C$ is approximately (in mol l^{-1}) **[CBSE PMT 2003]**

(a) 1.0×10^{-8} (b) 1.0×10^{-16}

(c) 1.0×10^{-12} (d) 1.0×10^{-10}

3. The pH of the solution: $5\,mL$ of $\frac{M}{5}$, $HCl+10\,mL$ of $\frac{M}{10}\,NaOH$ is **[MH CET 2004]**

(a) 5 (b) 3

(c) 7 (d) 8

4. Given that the dissociation constant for H_2O is $K_w=1\times10^{-14}\,mole^2/litre^2$. What is the pH of a 0.001 *molar KOH* solution **[UPSEAT 2000; MP PET 2001]**

(a) 10^{-11} (b) 10^{-3}

(c) 3 (d) 11

5. The pH of 0.1 M solution of the following salts increases in the order **[Pb. CET 2004]**

(a) $NaCl<NH_4Cl<NaCN<HCl$

(b) $HCl<NH_4Cl<NaCl<NaCN$

(c) $NaCN<NH_4Cl<NaCl<HCl$

(d) $HCl<NaCl<NaCN<NH_4Cl$

6. The degree of hydrolysis in hydrolytic equilibrum

$A^-+H_2O \rightleftharpoons HA+OH^-$ at salt concentration of 0.001 M is

$(K_a=1\times10^{-5})$ **[UPSEAT 2004]**

(a) 1×10^{-3} (b) 1×10^{-4}

(c) 5×10^{-4} (d) 1×10^{-6}

7. If pK_b for fluoride ion at 25^oC is 10.83, the ionisation constant of hydrofluoric acid in water at this temperature is **[IIT 1997]**

(a) 1.74×10^{-3} (b) 3.52×10^{-3}

(c) 6.75×10^{-4} (d) 5.38×10^{-2}

8. If the hydrogen ion concentration of a given solution is $5.5\times10^{-3}\,mol\ litre^{-1}$, the pH of the solution will be **[AMU 1985]**

(a) 2.26 (b) 3.40

(c) 3.75 (d) 2.76

9. Henderson's equation is $pH=pK_a+\log\frac{[\text{salt}]}{[\text{acid}]}$. If the acid gets half neutralized the value of pH will be : $[pK_a=4.30]$ **[RPMT 2000]**

(a) 4.3 (b) 2.15

(c) 8.60 (d) 7

10. The pH of a $0.01M$ solution of acetic acid having degree of dissociation 12.5% is **[JIPMER 2000]**

(a) 5.623 (b) 2.903

(c) 3.723 (d) 4.509

11. Which of the following solutions will have pH close to 1.0 **[IIT 1992; MP PET 1993; AMU 1999]**

(a) $100\ ml$ of $\frac{M}{10}HCl+100\ ml$ of $\frac{M}{10}NaOH$

(b) $55\ ml$ of $\frac{M}{10}HCl+45\ ml$ of $\frac{M}{10}NaOH$

(c) $10\ ml$ of $\frac{M}{10}HCl+90\ ml$ of $\frac{M}{10}NaOH$

(d) $75\ ml$ of $\frac{M}{5}HCl+25\ ml$ of $\frac{M}{5}NaOH$

12. In which of the following solvents will $AgBr$ have the highest solubility **[CBSE PMT 1992]**

(a) $10^{-3}\,M\ NaBr$ (b) $10^{-3}\,M\ NH_4OH$

(c) Pure water (d) $10^{-3}\,M\ HBr$

13. How many grams of CaC_2O_4 will dissolve in distilled water to make one litre of saturated solution ? (Solubility product of CaC_2O_4 is $2.5\times10^{-9}\,mole^2litre^{-2}$ and its molecular weight is 128) **[MP PET 1993; MP PMT 2000]**

(a) 0.0064 *gm* (b) 0.0128 *gm*

(c) 0.0032 *gm* (d) 0.0640 *gm*

14. The solubility product of CuS, Ag_2S, HgS are 10^{-31}, 10^{-44}, 10^{-54} respectively. The solubilities of these sulphides are in the order **[CBSE PMT 1997]**

(a) $Ag_2S>CuS>HgS$ (b) $Ag_2S>HgS>Cus$

(c) $HgS>Ag_2S>Cus$ (d) $CuS>Ag_2S>HgS$

15. The solubility product constant K_{sp} of $Mg(OH)_2$ is 9.0×10^{-12}. If a solution is $0.010\ M$ with respect to Mg^{2+} ion, what is the maximum hydroxide ion concentration which could be present without causing the precipitation of $Mg(OH)_2$

(a) $1.5\times10^{-7}\,M$ (b) $3.0\times10^{-7}\,M$

(c) $1.5 \times 10^{-5}\ M$ (d) $3.0 \times 10^{-5}\ M$

16. If the K_b value in the hydrolysis reaction $B^+ + H_2O \rightleftarrows BOH + H^+$ is 1.0×10^{-6}, then the hydrolysis constant of the salt would be **[Roorkee Qualifying 1998]**

(a) 1.0×10^{-6} (b) 1.0×10^{-7}

(c) 1.0×10^{-8} (d) 1.0×10^{-9}

17. For a sparingly soluble salt A_pB_q, the relationship of its solubility product (L_S) with its solubility (S) is

[IIT Screening 2001]

(a) $L_s = S^{p+q}.p^p.q^q$ (b) $L_s = S^{p+q}.p^q.q^p$

(c) $L_s = S^{pq}.p^p.q^q$ (d) $L_s = S^{pq}.(p.q)^{p+q}$

18. Arrange NH_4^+, H_2O, H_3O^+, HF and OH^- in increasing order of acidic nature **[BVP 2003]**

(a) $H_3O^+ < NH_4^+ < HF < OH^- < H_2O$

(b) $NH_4^+ < HF < H_3O^+ < H_2O < OH^-$

(c) $OH^- < H_2O < NH_4^+ < HF < H_3O^+$

(d) $H_3O^+ > HF > H_2O > NH_4^+ > OH^-$

19. How many grams of CaC_2O_4 (molecular weight = 128) on dissolving in distilled water will give a saturated solution $[K_{sp}(CaC_2O_4) = 2.5 \times 10^{-9}\ mol^2 l^{-2}]$ **[KCET 2003]**

(a) 0.0064 *g* (b) 0.1280 *g*

(c) 0.0128 *g* (d) 1.2800 *g*

20. If the concentration of CrO_4^- ions in a saturated solution of silver chromate is 2×10^{-4}. Solubility product of silver chromate will be

(a) 4×10^{-8} (b) 8×10^{-12}

(c) 12×10^{-12} (d) 32×10^{-12}

21. According to Bronsted-Lowry concept, the correct order of relative strength of bases follows the order

[Pb. PMT 2001]

(a) $CH_3COO^- > Cl^- > OH^-$

(b) $CH_3COO^- > OH^- > Cl^-$

(c) $OH^- > CH_3COO^- > Cl^-$

(d) $OH^- > Cl^- > CH_3COO^-$

22. $H_2SO_4^- + OH^- \rightarrow SO_4^{2-} + H_2O$ Which is correct about conjugate acid base pair **[JEE Orissa 2004]**

(a) HSO_4^{2-} is conjugate acid of base SO_4^{2-}

(b) HSO_4^- is conjugate base of acid SO_4^{2-}

(c) SO_4^- is conjugate acid of base HSO_4^-

(d) None of these

23. Which may be added to one litre of water to act as a buffer

[JIPMER 2000]

(a) One mole of $HC_2H_3O_2$ and 0.5 mole of $NaOH$

(b) One mole of NH_4Cl and one mole of HCl

(c) One mole of NH_4OH and one mole of $NaOH$

(d) One mole of $HC_2H_3O_2$ and one mole of HCl

24. Which of the following base is weakest **[DCE 2003]**

(a) $NH_4OH : K_b = 1.6 \times 10^{-6}$

(b) $C_6H_5NH_2 : K_b = 3.8 \times 10^{-10}$

(c) $C_2H_5NH_2 : K_b = 5.6 \times 10^{-4}$

(d) $C_6H_7N : K_b = 6.3 \times 10^{-10}$

25. $HClO$ is a weak acid. The concentration of H^+ ions in $0.1\,M$ solution of $HClO(K_a = 5 \times 10^{-8})$ will be equal to

[CPMT 1993]

(a) $7.07 \times 10^{-5}\ m$ (b) $5 \times 10^{-9}\ m$

(c) $5 \times 10^{-7}\ m$ (d) $7 \times 10^{-4}\ m$

26. Upto what *pH* must a solution containing a precipitate of $Cr(OH)_3$ be adjusted so that all of precipitate dissolves

(When $Cr^{3+} = 0.1\,mol/l, K_{sp} = 6 \times 10^{-31}$) **[MP PET 2003]**

(a) Upto 4.4 (b) Upto 4.1

(c) Upto 4.2 (d) Upto 4.0

27. NH_4Cl is acidic, because **[JEE Orissa 2004]**

(a) On hydrolysis NH_4Cl gives weak base NH_4OH and strong acid HCl

[MP PET 1992; CPMT 1993]

(b) Nitrogen donates a pair of electron

(c) It is a salt of weak acid and strong base

(d) On hydrolysis NH_4Cl gives strong base and weak acid

28. A solution of weak acid *HA* containing 0.01 *moles* of acid *per litre* of solutions has $pH = 4$. The percentage degree of ionisation of the acid and the ionisation constant of acid are respectively **[UPSEAT 2001]**

(a) $1\%, 10^{-6}$ (b) $0.01\%, 10^{-4}$

(c) $1\%, 10^{-4}$ (d) $0.01\%, 10^{-6}$

29. The pH of a buffer solution containg 0.2 *mole per litre* CH_3COONa and 1.5 *mole per litre* CH_3COOH is (*Ka* for acetic acid is 1.8×10^{-5}) **[CPMT 2001]**

(a) 4.87 (b) 5.8

(c) 2.4 (d) 9.2

30. 100 *mL* of $0.04\ N\ HCl$ aqueous solution is mixsed with 100 *mL* of 0.02 *N NaOH* solution. The *p*H of the resulting solution is **[UPSEAT 2004]**

(a) 1.0 (b) 1.7

(c) 2.0 (d) 2.3

31. An alcoholic drink substance $pH = 4.7$ then OH ion concentration of this solution is $(K_w = 10^{-14} mol^2/l^2)$

[RPMT 2002]

(a) 3×10^{-10} (b) 5×10^{-10}
(c) 1×10^{-10} (d) 5×10^{-8}

32. In its 0.2 M solution, an acid ionises to an extent of 60%. Its hydrogen ion concentration is

(a) 0.6 M (b) 0.2 M
(c) 0.12 M (d) None of these

33. pH of 0.1 M NH_3 aqueous solution is

$(K_b = 1.8\times10^{-5})$ [UPSEAT 2004]

(a) 11.13 (b) 12.5
(c) 13.42 (d) 11.55

34. 40 mg of pure sodium hydroxide is dissolved in 10 litres of distilled water. The pH of the solution is

[Kerala PMT 2004]

(a) 9.0 (b) 10
(c) 11 (d) 12
(e) 8

35. Solubility of PbI_2 is 0.005 M. Then, the solubility product of PbI_2 is [BVP 2004]

(a) 6.8×10^{-6}
(b) 6.8×10^{6}
(c) 2.2×10^{-9}
(d) None of these

36. A monoprotic acid in a $0.1\ M$ solution ionizes to 0.001%. Its ionisation constant is

[MP PET 1985,88,99; MP PMT1988; CPMT 2003]

(a) 1.0×10^{-3} (b) 1.0×10^{-6}
(c) 1.0×10^{-8} (d) 1.0×10^{-11}

37. Select the pK_a value of the strongest acid from the following

[KCET 2004]

(a) 1.0 (b) 3.0
(c) 2.0 (d) 4.5

38. At 90°C, pure water has H_3O^+ ion concentration of $10^{-6}\,mol/L^{-1}$. The K_w at 90°C is [DCE 2004]

(a) 10^{-6} (b) 10^{-14}
(c) 10^{-12} (d) 10^{-8}

39. By adding 20 ml $0.1\ N\ HCl$ to $20\ ml\ 0.1\ N\ KOH$, the pH of the obtained solution will be [CPMT 1975, 86, 93]

(a) 0 (b) 7
(c) 2 (d) 9

AS Answers and Solutions

(SET -9)

1. (b) Blood consists of $H_2CO_3 + HCO_3^-$ buffer solution.

2. (c) $AgI \rightleftharpoons \underset{(s)}{Ag^+} + \underset{(s)}{I^-}$; $K_{sp} = S^2 = 10^{-4}\times S$

$$S = \frac{1.0\times10^{-16}}{10^{-4}} = 1\times10^{-12}\,\frac{mol^2}{l^2}$$

3. (c) Milliequivalents of $HCl = 5\times\frac{1}{5} = 1$

Milliequivalents of $NaOH = 10 \times \frac{1}{10} = 1$

$\therefore\ 5ml \frac{M}{5} HCl = 10\,ml \frac{M}{5} HCl$

Hence the solution will be neutral *i.e.,* $pH = 7$.

4. (d) $pH = 14 - pOH = 14 - 3 = 11$

5. (b) *HCl* is strong acid. In its .1*M* solution, $[H^+] = 0.1M$ and hence, $pH = 1$

$NH_4Cl_{(aq)}$ hydrolyses in solution and give acidic solution which is less acidic than .1*M HCl* . *NaCl* is not hydrolysed in aqueous solutions. Its $pH = 7$ *NaCN* undergoes hydrolysis in solution to give alkaline solution. So that pH increases in the order, $HCl < NH_4Cl < NaCl < NaCN$

6. (a) $K_h = \frac{K_w}{K_a} = \frac{10^{-14}}{1 \times 10^{-5}} = 10^{-9}$

$K_h = \alpha^2 C$; $\alpha = \sqrt{\frac{K_h}{C}} = \sqrt{\frac{1 \times 10^{-9}}{.001}} = 1 \times 10^{-3}$

7. (c) $K_a \times K_b = K_w$

$\therefore K_a = \frac{K_w}{K_b} = \frac{10^{-14}}{1.48 \times 10^{-11}} = 6.75 \times 10^{-4}$

8. (a) $[H^+] = 5.5 \times 10^{-3}$ *mole/litre*

$pH = -\log[H^+]$; $pH = -\log[5.5 \times 10^{-3}]$; $pH = 2.26$

9. (a) $pH = pK_a + \log\frac{[\text{Salt}]}{[\text{Acid}]}$

$pH = 4.3 + \log\frac{\frac{1}{2}}{\frac{1}{2}} = 4.3 + \log 1$; $pH = 4.3 + 0 = 4.3$

10. (b) $[H^+] = C\alpha = 0.01 \times \frac{1.25}{100}$

$H^+ = 1.25 \times 10^{-3}$; $pH = \text{between } 2 \text{ or } 3 = 2.90$

11. (d) M.eq. of $HCl = \frac{1}{5} \times 75 = 15$

M.eq. of $NaOH = 25 \times \frac{1}{5} = 5$

Total No. of eq. $= 15 - 5 = 10$

Total volume = 100

Normality $= \frac{10}{100} = \frac{1}{10}$, $[H^+] = 10^{-1}$ *M*

12. (b) *AgBr* are not dissolved in *NaBr* and *HBr* due to common ion effect. And pure water is a neutral solvent. They do not have ions.

13. (a) CaC_2O_4 is a binary electrolyte. Then solubility is

$S = \sqrt{K_{sp}} = \sqrt{2.5 \times 10^{-9}}$

$= 5 \times 10^{-5}$ *mole/l.* $= 0.0064$ *gm/l.*

14. (a)

15. (d) $\underset{K_{sp}}{Mg(OH)_2} \underset{=}{\rightleftharpoons} \underset{S}{Mg^{++}} + \underset{(2S)^2}{2OH^-}$

$K_{sp} = S \times 4S^2$

$\frac{K_{sp}}{S \times 4} = S^2 = \frac{9 \times 10^{-12}}{.010 \times 4} = 2.25 \times 10^{-10}$

$S = \sqrt{2.25 \times 10^{-10}} = 1.5 \times 10^{-5}$ *m/l*

16. (c) For hydrolysis of B^+; $K_H = \frac{K_w}{K_b} = \frac{10^{-14}}{10^{-6}} = 10^{-8}$.

17. (a) $A_pB_q \rightleftharpoons pA^{1+} + qB^{p-}$

$L_s = [A^{q+}]^p[B^{p-}]^q = (p \times S)^p (q \times S)^q = S^{p+q}.p^p.q^q$.

18. (c) $H_3O^+ > HF > NH_4^+ > H_2O > OH^-$.

Acidic nature is decreasing order.

19. (a) Solubility of $CaC_2O_4 = \sqrt{K_{sp}} = \sqrt{2.5 \times 10^{-9}}$

$= 5 \times 10^{-5} molL^{-1}$

$= 5 \times 10^{-5} \times 128 = 640 \times 10^{-5} = 0.0064g$

20. (d) K_{sp} of $Ag_2CrO_4 = [Ag^+]^2\,[Cro_4^{--}]$

$CrO_4^{--} = 2 \times 10^{-4}$ then $Ag^+ = 2 \times 2 \times 10^{-4}$

$K_{sp} = (4 \times 10^{-4})^2\,(2 \times 10^{-4}) = 32 \times 10^{-12}$

21. (c) Relative strength of bases can be shown by their conjugated acids.

Conjugate acid of OH^- is H_2O which is a weak acid conjugate acid of CH_3COO^- is CH_3COOH which is stronger than H_2O . while conjugate acid of Cl^- is HCl which is strongest out of there. so the order of relative strength of bases is $OH^- > CH_3COO^- > Cl^-$.

22. (a) $\underset{\text{Conjugate acid}}{HSO_4^- + OH^-} \rightarrow \underset{\text{Conjugate base}}{SO_4^{2-} + H_2O}$

23. (a) One mole oxalic acid & 0.5 mole of $NaOH$ will make.

24. (b) Smallest value of K_b indicates that aniline $(C_2H_5NH_2)$ is the weakest base.

25. (a) $[H^+]^2 = C.\alpha = 0.1 \times 5 \times 10^{-8}$

$H^+ = \sqrt{5 \times 10^{-9}} = 7.07 \times 10^{-5}$ *M.*

26. (d) $K_{sp} = [Cr^{3+}][OH^-]^3$

$[OH]^{-3} = K_{sp\,/\,Cr^{3+}} = \frac{6 \times 10^{31}}{1 \times 10^{-1}} = 6 \times 10^{-30}$

$[OH]^- = 1.8 \times 10^{-10}$

$pOH = (\log 1.8 + \log 10^{10}) = 10 + 0.25 + 1 = 11.25$

$pH = 14 - 11.25 = 2.27$

27. (a) $NH_3Cl + H_2O \rightleftharpoons NH_4OH + HCl$

NH_4Cl is a salt of weak base & strong acid so solution will be acidic.

28. (a) $H^+ = C\alpha$

$$\alpha = \frac{H^+}{C} = \frac{10^{-4}}{10^{-2}} = 10^{-6}$$

29. (a) $pH = -\log K_a + \log\frac{[\text{Salt}]}{[\text{Acid}]}$

$$= -\log[1.8 \times 10^{-5}] + \log\frac{0.2}{0.1} = 4.87$$

30. (c) $N_1V_1 = .04 \times 100 = 4$

$N_2V_2 = .02 \times 100 = 2$

$N_1V_1 - N_2V_2 = N_3V_3$

$4 - 2 = N_3 \times 200, N_3 = 10^{-2}M$

$$pH = \log 10\frac{1}{H^+} = \log 10\frac{1}{10^{-2}} = 2.$$

31. (b) $pH = 4.7$

$pH + pOH = 14$; $pH = 14 - 4.7$; $pOH = 9.3$

$[OH^-] = \text{Antilog }[-pOH] = \text{Antilog }[-9.3]$

$[OH^-] = 5 \times 10^{-10}$

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32. (c) $[H^+] = C.\alpha, \ = 0.2 \times 0.60 = 0.12\,M$

33. (a) $NH_4OH \rightleftharpoons NH_4^+ + OH^-$

$$K_b = C\alpha^2 \ ; \ \frac{1.8 \times 10^{-5}}{.1} = \alpha^2 ; \alpha = 1.34 \times 10^{-3}$$

$[OH^-] = \alpha \,.\, C = 1.34 \times 10^{-3} \times .1$

$$pOH = \log 10\frac{1}{1.34 \times 10^{-4}} \ ; \ pOH = 2.87$$

$pH + pOH = 14$; $pH + 2.87 = 14$

$pH = 14 - 2.87$; $pH = 11.13$

34. (b) $M = \dfrac{\text{Solute in 1 litre solution}}{\text{Molecular weight of solute}}$

$$= \frac{40 \times 10^{-3}}{40} \times \frac{1}{10} = 10^{-4}M$$

$$pOH = \log 10\frac{1}{[OH^-]} = \log 10\frac{1}{10^{-4}} = 4$$

$pH + pOH = 14$; $pH + 4 = 14 \Rightarrow pH = 10$.

35. (d) $PbI_2 \rightarrow \underset{x}{Pb} + \underset{2x}{I_2}$

$$K_{sp} = 4x^3 = 4(.005)^3 = 4 \times .005 \times .005 = .4 \times 10^{-6}.$$

36. (d) $\therefore$ Monoprotic acid HA

$HA \rightleftharpoons H^+ + A^-$

Ionisation constant = ?

$$\alpha = 0.001\% = \frac{0.001}{100} = 10^{-5}$$

$$K = \frac{\alpha^2}{V} = \frac{[10^{-5}]^2}{10} = 10^{-11}.$$

37. (a) $pKa <<$ then strongest acid

$pKa >>$ then weak acid

$$pKa \propto \frac{1}{\text{Acidic strength}}$$

38. (c) $\underset{10^{-6}}{H_3O^+} \rightarrow \underset{10^{-6}}{H_2O} + \underset{10^{-6}}{H^+}$

$K_w = [H_2O][H^+] = [10^{-6}][10^{-6}] = 10^{-12}$

39. (b) Neutralization reaction will takes place and form salt of strong acid and strong base. Which does not hydrolysed and thus $pH = 7$.