Self Practice Paper (SPP)

1. Which of the following correctly explains the nature of boric acid in aqueous medium:

(1) $H_3BO_3 \xrightarrow{H_2O} H_3O^+ + H_2BO_3^-$ (2) $H_3BO_3 \xrightarrow{2H_2O} 2H_3O^+ + HBO_3^{2-}$

(3) $H_3BO_3 \xrightarrow{3H_2O} 3H_3O^+ + BO_3^{3-}$ (4) $H_3BO_3 \xrightarrow{H_2O} B(OH)_4^- + H^+$

2. Which of the following is correct ?

(1) $[H^+] = [OH^-] = \sqrt{K_w}$ in all aqueous solutions (2) $[H^+][OH^-] = \sqrt{K_w}$ in all aqueous solutions

(3) $[H^+][OH^-] = K_w$ in all aqueous solutions (4) Dissociation constant of water is $K_w = [H^+][OH^-]$

3. The pH when 10^{-2} M CH_3COOH solution is prepared in 10^{-3} M NaCl solutionis :
(pK_a (CH_3COOH) = 4.7) :

(1) 2.35 (2) 3.35 (3) 5.35 (4) 7

4. For a binary weak electrolyte, the degree of dissociation is proportional to the :

(1) Dilution (2) Square root of dilution

(3) Concentration (4) Square root of concentration

5. A 100 ml solution of a strong acid of pH =1 is mixed with a 100 ml solution of another strong acid of pH = 2. The pH will be nearly : (log 5.5 = 0.74)

(1) 1.74 (2) 2.26 (3) 1.26 (4) 2.74

6. Two weak acids HA and HB with K_{a_1} and K_{a_2} as their dissociation constants are mixed. Which of the following is incorrect, if $K_{a_1} > K_{a_2}$?

(1) $[H^+]$ from HA > $[H^+]$ from HB (2) α of HA > α of HB

(3) $[A^-] > [B^-]$ (4) [HA] > [HB]

7. The pH of the solution obtanied by mixing 10 mL of 10^{-1} M HCI and 10 mL of 10^{-1} M NaOH is:

(1) 8 (2) 2 (3) 7 (4) None of these

8. V_1 ml of 0.1 M HNO_3 is mixed with V_2 ml of 0.1M $Ca(OH)_2$. The final solution :

(1)is neutral if $V_1 = V_2$ (2) is acidic if $V_1 > V_2$

(3) is basic if $V_1 = 2V_2$ (4) is neutral $V_1 = 2V_2$

9. The dissociation constant of two weak acids are K_{a_1} and K_{a_2} respectively. Their relative strength is :

(1) $\frac{K_{a_2}}{K_{a_1}}$ (2) $\left(\frac{K_{a_1}}{K_{a_2}}\right)^{1/2}$ (3) $\frac{K_{a_1}}{K_{a_2}}$ (4) $\left(\frac{K_{a_2}}{K_{a_1}}\right)^{1/2}$

10. Expression $pK_h = pK_w - pK_a - pK_b$ is not applicable to :

(1) Ammonium acetate (2) Ammonium cyanide (3) Aniline acetate (4) Ammonium chloride

11. The salt NaA of weak acid HA is dissolved to form its 0.01 M solution. If the degree of hydrolysis is 0.01, the K_a of HA at 25ºC is :

(1) 10^{-6} (2) 10^{-4} (3) 10^{-8} (4) 10^{-10}

12. The pK_a of acetic acid is 4.74, which implies that :

(1) pH of 1 M acetic acid is 4.74

(2) at pH 4.74, the dissociation of acetic acid is maximum

(3) at pH 4.74, half of the acetic acid molecules are dissociated in the solution

(4) at pH 4.74, the dissociation of acetic acid is minimum.

13. In a titration experiment, 50.0 mL of 0.1 M HCI is being titrated against 0.1 M NaOH. The pH of the solution on addition of 49.9 mL of NaOH is approximately :

(1) 7.0 (2) 6.0 (3) 4.0 (4) 3.0

14. Consider various species generated when H_3PO_4 dissolved in water. Among these, the conjugate acid of HPO_4^{2-} is
(1) H_3PO_4 (2) $H_2PO_4^-$ (3) PO_4^{3-} (4) H_3O^+

15. What volume of 2M weak base should be added to 10ml of 5M solution of its salt with strong acid, so that pOH = pK_b ?
(1) 10ml (2) 50 ml
(3) 25ml (4) The information provided is insufficient to answer

16. The pOH of a basic buffer (e.g. NH_4OH/NH_4Cl is 5. If the concentration of the salt is tripled whereas that of base remains same, what is the new value of pOH ? (Given log 3 $\approx$ 0.48)
(1) 4.52 (2) 5.48 (3) 6.48 (4) 3.52

17. What fraction of indicator is in acidic form at pH of 5 if the pK_a of the indicator is 4.7 ?
(1) $\frac{2}{3}$ (2) $\frac{1}{3}$ (3) $\frac{1}{2}$ (4) $\frac{1}{11}$

18. To a 200 ml of 0.1 M weak acid HA solution 90 ml of 0.1 M solution of NaOH be added. Now, what volume of 0.1 M NaOH be added into above solution so that pH of resulting solution be 5 ? [(K_a(HA) = 10^{-5}]
(1) 2 ml (2) 20 ml (3) 10 ml (4) 15 ml

19. In a saturated solution of $Mg(OH)_2$, the concentration of OH^- is 6×10^{-4} M. The K_{sp} of $Mg(OH)_2$ is :
(1) 1.08×10^{-12} (2) 1.08×10^{-10} (3) 8.64×10^{-10} (4) 9.6×10^{-8}

20. Let the solubilities of AgCl in pure water, 0.01 M $CaCl_2$, 0.01 M NaCl & 0.05 M $AgNO_3$ be S_1, S_2, S_3 & S_4 respectively. What is the correct order of these quantities. Neglect any complexation.
(1) $S_1 > S_2 > S_3 > S_4$ (2) $S_1 > S_2 = S_3 > S_4$ (3) $S_1 > S_3 > S_2 > S_4$ (4) $S_4 > S_2 > S_3 > S_1$

21. Which indicator will be most suitable for the titration of acetic acid vs NaOH?
(1) methyl orange [pK_{in} = 3.7] (2) bromocresol green [pK_{In} = 4.7]
(3) chlorophenol red [pK_{In} = 6.1] (4) phenolphthalein [pK_{In} = 9.6]

22. $SrCO_3$ ($K_{sp} = 10^{-10}$) and $ZnCO_3$ ($K_{sp} = 1.5 \times 10^{-11}$) are dissolved together in a solution. The ratio of $[Sr^{2+}]/[Zn^{2+}]$ in the solution is :
(1) $\frac{10}{3}$ (2) $\frac{3}{10}$ (3) $\frac{20}{3}$ (4) $\frac{3}{20}$

23. Which of the following is most soluble in water :
(1) MnS ($K_{SP} = 8 \times 10^{-37}$) (2) ZnS ($K_{SP} = 7 \times 10^{-16}$)
(3) Bi_2S_3 ($K_{SP} = 1.0 \times 10^{-70}$) (4) Ag_2S ($K_{SP} = 6 \times 10^{-51}$)

24. The pH a 0.01 M solution of ammonium acetate can be changed by changing :
(1) the temperature (2) the volume of solution
(3) the concentration (4) the pressure on solution

25. Which of these mixtures constitute buffer solution ?
Mixture 1 : 25 mL of 0.10 M HNO_3 and 25 mL of 0.10 M $NaNO_3$
Mixture 2 : 25 mL of 0.10 M $HC_2H_3O_2$ and 25 mL of 0.10 M NaOH
(1)1 only (2) 2 only (3) both 1 and 2 (4) neither 1 nor 2

26. A solution of 0.10 M NaZ has pH = 8.90. The K_a of HZ is :
(1) 1.6×10^{-4} (2) 1.6×10^{-5} (3) 6.3×10^{-10} (4) 6.3×10^{-11}

27. Which one is a Lewis acid ?
(1) ClF_3 (2) H_2O (3) NH_3 (4) None of these

28. pK_a values of two acids A and B are 4 and 5. The strengths of these two acids are related as :

(1) Acid A is $\sqrt{10}$ times stronger than acid B

(2) Strength of acid A : strengtha of acid B = 4 : 5

(3) The strengths of the two acids cannot be compared

(4) Acid B is 10 times stronger than acid A

29. Which equilibrium can be described as an acid-base reaction using the Lewis acid-base definition but not using the Bronsted-Lowry definition?

(1) $2NH_3 + H_2SO_4 \rightleftharpoons 2NH_4^+ + SO_4^{2-}$

(2) $NH_3 + CH_3COOH \rightleftharpoons NH_4^+ + CH_3COO^-$

(3) $H_2O + CH_3COOH \rightleftharpoons H_3O^+ + CH_3COO^-$

(4) $[Cu(H_2O)_4]^{2+} + 4NH_3 \rightleftharpoons [Cu(NH_3)_4]^{2+} + 4H_2O$

30. The hydride ion H^- is stronger base than its hydroxide ion OH^- . Which of the following reaction will occur if sodium hydride (NaH) is dissolved in water?

(1) $H^-(aq) + H_2O \rightarrow H_3O^-$ (2) $H^-(aq) + H_2O(l) \rightarrow OH^- + H_2$

(3) $H^- + H_2O \rightarrow$ No reaction (4) None of these

31. A precipitate of CaF_2 ($K_{sp} = 1.7 \times 10^{-10}$) will be obtained when equal volume of the following are mixed

(1) 10^{-4} M Ca^{2+} and 10^{-4} M F^- (2) 10^{-2} M Ca^{2+} and 10^{-3} M F^-

(3) 10^{-5} M Ca^{2+} and 10^{-3} M F^- (4) 10^{-3} M Ca^{2+} and 10^{-5} M F^-

32. The degree of hydrolysis of a salt of weak acid and weak base in its 0.1 M solution is found to be 50%. If the molarity of the solution is 0.2 M, the percentage hydrolysis of the salt should be :

(1) 50% (2) 35% (3) 75% (4) 100%

33. pK_a of acetic acid is 4.74 . The concentration of CH_3COOH solution is 0.01 M. The pH of the soltuion is:

(1) 3.37 (2) 4.37 (3) 4.74 (4) 0.474

34. If the solubility products of AgCl and AgBr are 1.2×10^{-10} and 3.5×10^{-13} respectively, then the relation between the solubilities (denoted by the symbol 'S') of these salts can correctly be represented as :

(1) S of AgBr is less than that of AgCl (2) S of AgBr is greater than that of AgCl

(3) S of AgBr is equal to that of AgCl (4) S of AgBr is 10^6 times greater than that of AgCl

35. For a weak acid HX, $K_a = 10^{-4}$. The degree of dissociation of 10^{-4} M HX is : $\left(\sqrt{5} = 2.24\right)$

(1) 1 (2) 0.62 (3) 0.91 (4) 0

36. If each of the following salts has solubility product Ksp = 1×10^{-9}, which of them is least soluble in water ?

(1) XY (2) X_2Y (3) XY_2 (4) X_3Y

37. Which solution has the highest pH ?

(1) 0.01 M $CaCl_2$ (2) 0.01 M KNO_2 (3) 0.01 M CH_3COOH (4) 0.01 M CH_3COCH_3

38. The concentration of $[H^+]$ and concentration of $[OH^-]$ in a 0.1 aqueous solution of 2% ionised weak acid is : [Ionic product of water = 1×10^{-14}]

(1) 2×10^{-3}M and 5×10^{-12}M (2) 1×10^3 M and 3×10^{-11} M

(3) 0.02×10^{-3} M and 5×10^{-11} M (4) 3×10^{-2} M and 4×10^{-13} M

39. The pH of pure water or neutral solution at 50°C is ….(pK_w = 13.26 at 50°C)
(1) 7.0 (2) 7.13 (3) 6.0 (4) 6.63

40. The Bronsted acids in the reversible reaction are are $HCO_3^-(aq.) + OH^-(aq.) \rightleftharpoons CO_3^{2-}(aq.) + H_2O$
(1) OH^- and CO_3^{2-} (2) OH^- and H_2O (3) HCO_3^- and H_2O (4) HCO_3^- and CO_3^{2-}

41. Increasing order of acidic character would be:
(1) $CH_3COOH < H_2SO_4 < H_2CO_3$ (2) $CH_3COOH < H_2CO_3 < H_2SO_4$
(3) $H_2CO_3 < CH_3COOH < H_2SO_4$ (4) $H_2SO_4 < H_2CO_3 < CH_3COOH$

42. Which of the following salt/s of H_3PO_3 exists ?
(I) NaH_2PO_3 (II) Na_2HPO_3 (III) Na_3PO_3
(1) I and II only (2) I, II and IIII (3) II and III only (4) III only

43. The solubility product of Ag_2CrO_4 is 1.9×10^{-12}. The minimum volume of water in mL from below options that can dissolve 4 mg of Ag_2CrO_4 is about :
(1) 150 mL (2) 1000 mL (3) 250 mL (4) 500 mL

44. The salt that when added to water will not change its pH is:
(1) Na_2CO_3 (2) NaCl (3) KCN (4) NH_4Cl.

45. Carbonic acid, H_2CO_3, is a diprotic acid for which $K_{a_1} = 4.2 \times 10^{-7}$, and $K_{a_2} = 4.7 \times 10^{-11}$. The solution which will have a pH closest to 9 is –
(1) 0.1 M H_2CO_3 (2) 0.1 M Na_2CO_3
(3) 0.1 M $NaHCO_3$ (4) 0.1 M $NaHCO_3$ + 0.1 M Na_2CO_3

SPP Answers

1.	(4)	**2.**	(3)	**3.**	(2)	**4.**	(2)	**5.**	(3)	**6.**	(4)	**7.**	(3)
8.	(4)	**9.**	(2)	**10.**	(4)	**11.**	(3)	**12.**	(3)	**13.**	(3)	**14.**	(2)
15.	(3)	**16.**	(2)	**17.**	(2)	**18.**	(3)	**19.**	(2)	**20.**	(3)	**21.**	(4)
22.	(3)	**23.**	(2)	**24.**	(1)	**25.**	(4)	**26.**	(2)	**27.**	(1)	**28.**	(1)
29.	(4)	**30.**	(2)	**31.**	(2)	**32.**	(1)	**33.**	(1)	**34.**	(1)	**35.**	(2)
36.	(1)	**37.**	(2)	**38.**	(1)	**39.**	(4)	**40.**	(3)	**41.**	(3)	**42.**	(1)
43.	(3)	**44.**	(2)	**45.**	(3)								

SPP Solutions

1. H_3BO_3 is weak, Lewis monobasic acid and shows the given equilibrium.

$H_3BO_3 + H_2O \rightleftharpoons B(OH)_4^- + H^+$

3. Solution will behave as an aqueous solution of weak monobasic acid.

$pH = \frac{1}{2}(pK_a - \log C) = \frac{1}{2}(4.7 + 2) = 3.35$

4. $\alpha \propto \sqrt{\frac{1}{C}}$

$\alpha \propto \sqrt{\frac{V}{n}}$ where n = number of moles of solute ; V = volume.

$\alpha \propto \sqrt{V}$

5. $H^+ = \frac{0.1\times100 + 0.01\times100}{200} = \frac{11}{200}$

$pH = 2 - 0.74 = 1.26$

6. Weak acid will greater K_a will dissociate more.

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

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

Thus both are neutralised and 1 Meq. of NaCl (a salt of strong acid and strong base) which does not hydrolyse and thus pH = 7.

8. Millimole of $H^+ = V_1 \times 0.1 \times 1$

Millimole of $OH^- = V_2 \times 0.1 \times 2$,

If we put $V_1 = 2V_2$

The final solution will be neutral i.e.

Millimole of $H^+ = 2V_2 \times 0.1$ = Millimole of OH^-

9.

	HA	$\rightleftharpoons$	H^+	+	A^-
	C				
	$C(1-\alpha)$		$C\alpha$		$C\alpha$

$\alpha = \sqrt{\frac{K_a}{C}}$

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

Strength of acid $\propto [H^+] \propto \sqrt{K_a}$.

10. $pK_h = pK_w - pK_a - pK_b$ is valid for salt of weak acid and weak base.

11. $h = \sqrt{\frac{K_h}{C}} = \sqrt{\frac{K_W}{K_a.C}} = \sqrt{\frac{10^{-14}}{K_a \times (0.01)}}$

$\Rightarrow \quad 0.01 = \sqrt{\frac{10^{-14}}{K_a \times (0.01)}} \quad \Rightarrow \quad 10^{-14} = \frac{10^{-14}}{K_a \times 10^{-2}} \quad \Rightarrow \quad K_a = 10^{-8}.$

12. At pH = pK_a , $[CH_3COOH] = [CH_3COO^-]$

13. $[H^+] = \frac{50 \times 0.1 - 49.9 \times 0.1}{99.9} = 10^{-9}$ M

$\therefore$ pH = 4

15. $pOH = pK_b + \log \frac{[salt]}{[base]}$

$[salt] = [base]$

$\Rightarrow \quad \frac{2 \times V}{V + 10} = \frac{10 \times 5}{V + 10}$

$\Rightarrow \quad V = 25$ ml.

16. $pOH = pK_b + \log \frac{[salt]}{[base]} = 5$

$pOH = pK_b + \log\left[\frac{3\ [salt]}{[base]}\right] = pK_b + \log \frac{[salt]}{[base]} + \log 3 = 5 + \log 3 = 5 + 0.48 = 5.48.$

17. $pH = pKIn + \log \frac{[In^-]}{[HIn]} \quad \Rightarrow \quad 5 = 4.7 + \log \frac{[In^-]}{[HIn]}$

$\Rightarrow \quad 0.3 = \log \frac{[In^-]}{[HIn]} \quad \Rightarrow \quad \log 2 = \log \frac{[In^-]}{[HIn]}$

$\Rightarrow \quad 2 = \frac{[In^-]}{[HIn]} \quad \Rightarrow \quad HIn \rightleftharpoons H^+ + In^-$

$\text{Fraction} = \frac{HIn}{In^- + HIn} = \frac{1}{3}$

18.

	HA + NAOH	⟶ NaA +	H_2O
t = 0	20 9	0	0
t = t	11 0	9	0
t = 50%	10	10	

10 ml NaOH is required.

19. $Mg(OH)_2 \rightleftharpoons Mg^{2+} + 2OH^-$

S 2S

$2S = 6 \times 10^{-4}$

$\Rightarrow \quad S = 3 \times 10^{-4}$

$K_{sp} = 4S^3 = 4 \times (3 \times 10^{-4})^3 = 4 \times 27 \times 10^{-12} = 1.08 \times 10^{-10}.$

20. (1) in pure water $S = (K_{sp})^{\frac{1}{2}}$

(2) in 0.01 M $CaCl_2$

$CaCl_2 \longrightarrow Ca^{+2} + 2Cl^-$

$0.01 \quad 2 \times 0.01$

$AgCl \longrightarrow Ag^+ + Cl^-$

$x \quad (x + 0.02) = 0.02$

$x = \left(\frac{K_{sp}}{0.02}\right)$

(3) $Y = \left(\frac{K_{sp}}{0.01}\right)$

(4) $Z = \left(\frac{K_{sp}}{0.05}\right)$

So $S_1 > S_3 > S_2 > S_4$

22. $SrCO_3 \rightleftharpoons Sr^{2} + CO_3^{2-}$

$S_1 \quad S_1+S_2$

$ZnCO_3 \rightleftharpoons Zn^{2+} + CO_3^{2-}$

$S_2 \quad S_1+S_2$

$S_1 \times (S_1 + S_2) = 10^{-10}$

$S_2 \times (S_1 + S_2) = 1.5 \times 10^{-11}$

$$\Rightarrow \quad \frac{S_1}{S_2} = \frac{[Sr^{2+}]}{[Zn^{2+}]} = \frac{10^{-10}}{1.5\times10^{-11}} = \frac{10}{1.5} = \frac{100}{15} = \frac{20}{3}$$

23. Find solubility for each separately by $S^2 = K_{SP}$ for MnS and ZnS, $108S^5 = K_{SP}$ for Bi_2S_3 and $4S^3 = K_{SP}$ for Ag_2S.

24. pH of salt solution of weak acid & weak base dipends only upon K_w , K_a & K_b values, which are only dependent upon temperature.

25. 1st solution will behave as solution of strong acid & 2nd solution will behave as salt of WA & SB.

26. NaZ is a salt of weak acid & strong base.

$pH = 7 + \frac{1}{2} pK_a + \frac{1}{2} \log C$

$8.9 = 7 + \frac{1}{2} pK_a + \frac{1}{2} \log(0.1)$

$8.9 - 7 + 0.5 = \frac{1}{2} pK_a.$

$pK_a = 4.8$

$-\log K_a = 4.8$

$\log K_a = -4.8 = \bar{5}.2$

$K_a = 1.6 \times 10^{-5}$

27. Because it has vacant d-orbital on central atom.

28. pK_a of acid A = 4 ; pK_a of acid B = 5

We know that $pK_a = -\log K_a$

$\therefore$ Acid A $K_a = 10^{-4}$

Acid B $K_a = 10^{-5}$

relative strength = $\sqrt{\frac{Ka_1}{Ka_2}} = \sqrt{10}$

Hence A is $\sqrt{10}$ times stronger than B.

29. It involves gain and loss of electron pair (Lewis concept).

30. $H^-_{(aq.)} + H_2O_{(l)} \rightarrow OH^- + H_2$.

31. $[Ca^{2+}][F^-]^2 = \left[\frac{10^{-2}\times V}{2V}\right] \times \left[\frac{10^{-3}\times V}{2V}\right]^2 = 1.25 \times 10^{-9} (>K_{sp})$

32. The degree of hydrolysis of a salt of weak acid and weak base is independent of concentration of salt.

38. Given that

Concentration of solution =.1

Degree of ionisation = 2% = $\frac{2}{100}$ = 0.2

Ionic product of water = 1×10^{-14}

Concentration of $[H^+]$ = Concentration of solution × degree of ionisation = $.1\times .02 = 2\times10^{-3}$ M

Concentration of $[OH^-]$ = $\frac{\text{Ionic Product of water}}{[H^+]}$

= $\frac{1\times10^{-14}}{2\times10^{-3}}$ = $0.5\times10^{-11} = 5\times10^{-12}$ M.

39. $[H^+][OH^-]=10^{-13.26}$

$\therefore [H^+]=[OH^-], \therefore [H^+]^2=10^{-13.26}$

$[H^+]=10^{\frac{-13.26}{2}}$

pH = 6.63.

40. HCO_3^- and H_2O

41. Decreasing order of acidic character is $H_2SO_4 > CH_3COOH > H_2CO_3$

42. H_3PO_3 is dibasic so NaH_2PO_3 & Na_2HPO_3 both exist.

43. $Ag_2CrO_4 \rightleftharpoons 2Ag^+ + CrO_4^{2-}$

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

$S = 7.8\times10^{-5}$ mol/L = $7.8\times10^{-5}\times332$ = 0.026 g/L= 26 mg/L

So, miniumum volume that can dissolve 4mg salt = $\frac{4}{26}$L = 154 mL

45. pH = $\frac{pK_{a_1}+pK_{a_2}}{2} \approx 8.5$ (closest to 9) (amphoteric species HCO_3^-)