Solution

31. **(C)** Correct option is (c) since for strong acids (completely ionised) only concentration is the measure of strength but for weak (incompletely ionised) acids both degree of ionisation (or K_a) and concentration will be required.

32. **(A)** Correct answer is (A) as one can conclude from the increasing values of K_a.

33. **(B)** In the following reaction, NH_3 changes to $NaNH_2$ which contains NH_2^- ion. This means that NH_3 has donated a proton to Na and hence acts as an acid.

34. **(B)** HCl is 100% ionised so

$[H_3O^+] = 1.2 \times 10^{-3}$ M

$pH = -\log(1.2 \times 10^{-3}\text{ M})$

or $pH = 2.92$

35. **(B)** $pH = pK_a - \log \frac{[\text{acid}]}{[\text{salt}]}$

0.1 M NaOH will react with acid to form 0.1 M CH_3COONa and therefore CH_3COOH concentration will be reduced to 0.2 M.

$pH = 4.76 - \log \frac{0.2}{0.1} = 4.45$

36. **(C)** For amphiprotic species

$pH = \frac{pK_1 + pK_2}{2}$

37. **(D)** $[Ba^{2+}][SO_4^{2-}]$

$= 1.5 \times 10^{-9}$ (K_{sp}) and $[Ba^{2+}] = 0.01$ M

so Required $[SO_4^{2-}] = \frac{1.5 \times 10^{-9}}{0.01}$

$= 1.5 \times 10^{-7}$

so $[H_2SO_4] > 1.5 \times 10^{-7}$

for precipitation of $BaSO_4$

38. **(A)** Solubility of $CaCO_3 = \sqrt{K_{sp}} = \sqrt{2.5 \times 10^{-9}}$

solubility of $CaCO_3$ in g $L^{-1} = 5 \times 10^{-5} \times 128$

$= 6.4 \times 10^{-3}$ g L^{-1}

39. **(C)** pH = 12 so $[OH^-] = 10^{-2}$ M

Now $Ba(OH)_{2(s)} \rightleftharpoons Ba^{2+} + 2OH^-$,

5×10^{-3}M $\quad 10^{-2}$ M

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

$= (5 \times 10^{-3})(10^{-2})^2$

$= 5 \times 10^{-7}$

40. **(D)** $pH = pK_a + \log \frac{[Salt]}{[Acid]}$

$5 = 5 + \log\left[\frac{N_2V_2}{N_1V_1 - N_2V_2}\right]$

$1 = \frac{0.1 \times V_2}{0.1 \times 100 - 0.1 \times V_2}$

or $10 - 0.1\,V_2 = 0.1\,V_2$ or $V_2 = 50$ mL

41. **(B)** $[CH_3COOH] = \frac{6.0}{60} \times 1 = 0.1M$

$[CH_3COONa] = \frac{8.2}{82} \times 1 = 0.1M$

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

or $pH = 4.5 + \log\left(\frac{0.1}{0.1}\right) = 4.5$

42. **(D)** $Li_3Na_3(AlF_6)_{2(s)} \rightleftharpoons 3Li^+ + 3Na^+ + 2AlF_6^{6-}$

Let solubility of salt is 's' mol L^{-1}

so $[Li^+] = 3s = [Na^+]$

$[AlF_6^{6-}] = 2s$

so $K_{sp} = [Li^+]^3\,[Na^+]^3\,[AlF_6^{6-}]^2$

$= (3s)^3\,(3s)^3\,(2s)^2$

$= 2916\,s^8$

43. **(B)** $K_h = \frac{K_w}{K_b} = \frac{10^{-14}}{1 \times 10^{-5}} = 10^{-19}$

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

$= 7 + 2 - 3 = 6$

45. **(B)** AgBr forms soluble complex with NH_4OH i.e. $[Ag(NH_3)_2]^+$.

46. **(A)** When NH_4OH is half neutralized

$[NH_4OH] = [NH_4Cl]$

$pOH = pK_b + \log\frac{[salt]}{[Base]} = pK_b = 4.75$

$\therefore pH = 14 - 4.75 = 9.25$

47. **(C)** $CN^- + H_2O \longrightarrow HCN + OH^-$

$pK_b = 4.7$

$\therefore pK_a = 9.3$

$$[OH^-] = Ch = C\sqrt{\frac{K_h}{C}} = \sqrt{K_hC} = \sqrt{\frac{K_wC}{K_a}} = \sqrt{\frac{10^{-14} \times 0.5}{10^{-9.3}}}$$

$$\therefore [OH^-] = \sqrt{10^{4.7} \times 0.5}$$

$$\therefore pOH = 11.4$$

48. **(C)** $[H^+] = C\alpha = 0.1 \times 0.013 = 1.3 \times 10^{-3}$

$$pH = -\log(1.3 \times 10^{-3}) = 3 - 0.11 = 2.89$$

49. **(A)** NH_4OH + HCl for NH_4Cl which gives acidic solution with $pH < 7$

50. **(C)** $pH = pK_a + \log\frac{[salt]}{[acid]}$

$$\Rightarrow 9 = -\log(5 \times 10^{-5}) + \log\frac{[salt]}{[acid]}$$

$$\therefore \frac{[salt]}{[acid]} = 0.5$$

Let volume of KCN to be added is = v

Total volume of HCN + KCN = (10 + v)

$$[KCN] = \frac{5V}{(10+v)}, [HCN] = \frac{10+2}{(10+v)}$$

$$\therefore \frac{[salt]}{[acid]} = \frac{5v/(10+v)}{20/(10+v)} = 0.5$$

$$\therefore \frac{v}{4} = 0.5 \therefore v = 2cc$$

51. **(D)** Mixture of sodium acetate and acetic acid is a buffer of pH value equal to pK_a so its buffer capacity is very high and hence its pH will not change significantly while CH_3COONH_4 is a salt of weak acid CH_3COOH and weak base NH_4OH whose magnitude of K_a and K_b are equal. So its pH does not depend upon concentration. Further more, NaH_2PO_4 is, in fact, a single solute buffer

52. **(C)** pH = pK_a + log $\frac{[Salt]}{[Acid]}$

$$\therefore 4.5 = 4.2 + \log\frac{[Salt]}{[Acid]} = \log\frac{[Salt]}{[Acid]} = 0.3$$

(since log 2 = 0.3)

$$\therefore \frac{[Salt]}{[Acid]} = 2$$

Let V ml 1M C_6H_5 COOH solution and (300 – V) 1M C_6H_5COONa solution be mixed together

$$[Acid] = \frac{V \times 1}{1000} \times \frac{1000}{300}; [Salt] = \frac{(300 - V)}{1000} \times \frac{1000}{300}$$

$[Acid] = \frac{V}{300}$; $[Salt] = \frac{300 - V}{300}$

$\therefore \frac{300 - V/300}{V/300} = 2$

$= 300 - V = 2V \therefore V = 100$ ml

53. **(D)** $Mg(OH)_2 \rightleftharpoons Mg^{2+} + 2OH^-$

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

$\Rightarrow 1.2\times10^{-11} = 0.1\times[OH^-]^2 \Rightarrow [OH^-] = 1.2\times10^{-10}$

$\therefore [OH^-] = 1.1\times10^{-5}$

$\therefore [H^+] = \frac{10^{-14}}{1.1\times10^{-5}} = 9.09\times10^{-9}M$

$\therefore pH = -\log(9.09\times10^{-10}) = 10 - 0.9586 = 9.04$

54. **(A)** $Q_{sp} > K_{sp}$
55. **(D)** at equivalence point solution will be basic in nature
56. (B)
57. (B)
58. (D)
59. (B)
60. (B)