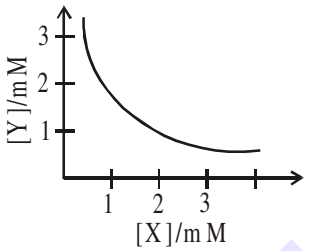
IONIC EQUILIBRIUM

1. Two solutions A and B, each of 100 L was made by dissolving 4g of NaOH and 9.8 g of H_2SO_4 in water, respectively. The pH of the resultant solution obtained from mixing 40 L of solution A and 10 L of solution B is_____.

2. 3g of acetic acid is added to 250 mL of 0.1 M HCl and the solution made up to 500 mL.

To 20 mL of this solution $\frac{1}{2}$ mL of 5 M NaOH is added. The pH of the solution is _____.
[Given : pK_a of acetic acid = 4.75, molar mass of acetic acid = 60 g/mol, log3 = 0.4771]
Neglect any changes in volume

3. The stoichiometry and solubility product of a salt with the solubility curve given below is, respectively :



(1) X_2Y, $2\times10^{-9}M^3$ (2) XY_2, $1\times10^{-9}M^3$

(3) XY_2, $4\times10^{-9}M^3$ (4) XY, $2\times10^{-6}M^3$

4. For the following Assertion and Reason, the correct option is :

Assertion : The pH of water increases with increase in temperature.

Reason : The dissociation of water into H^+ and OH^- is an exothermic reaction.

(1) Both assertion and reason are true, but the reason is not the correct explanation for the assertion.

(2) Both assertion and reason are false.

(3) Assertion is not true, but reason is true.

(4) Both assertion and reason are true, and the reason is the correct explanation for the assertion.

5. The K_{sp} for the following dissociation is 1.6×10^{-5}

$$PbCl_{2(s)} \ell Pb^{2+}_{(aq)} + 2Cl^-_{(aq)}$$

Which of the following choices is correct for a mixture of 300 mL 0.134 M $Pb(NO_3)_2$ and 100 mL 0.4 M NaCl ?

(1) $Q < K_{sp}$

(2) $Q > K_{sp}$

(3) $Q = K_{sp}$

(4) Not enough data provided

6. The solubility product of $Cr(OH)_3$ at 298 K is 6.0×10^{-31}. The concentration of hydroxide ions in a saturated solution of $Cr(OH)_3$ will be :

(1) $(18 \times 10^{-31})^{1/4}$ (2) $(2.22 \times 10^{-31})^{1/4}$

(3) $(4.86 \times 10^{-29})^{1/4}$ (4) $(18 \times 10^{-31})^{1/2}$

7. An acidic buffer is obtained on mixing :

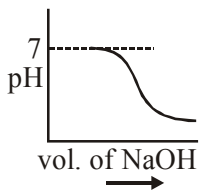
(1) 100 mL of 0.1 M CH_3COOH and 200 mL of 0.1 M NaOH

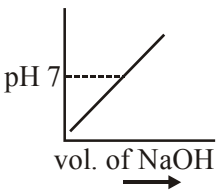
(2) 100 mL of 0.1 M CH_3COOH and 100 mL of 0.1 M NaOH

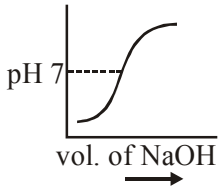
(3) 100 mL of 0.1 M HCl and 200 mL of 0.1 M CH_3COONa

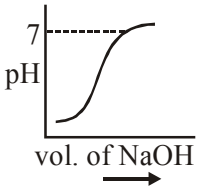
(4) 100 mL of 0.1 M HCl and 200 mL of 0.1 M NaCl

8. 100 mL of 0.1 M HCl is taken in a beaker and to it 100 mL of 0.1 M NaOH is added in steps of 2 mL and the pH is continuously measured. Which of the following graphs correctly depicts the change in pH?

(1) 

(2) 

(3) 

(4) 

9. A soft drink was bottled with a partial pressure of CO_2 of 3 bar over the liquid at room temperature. The partial pressure of CO_2 over the solution approaches a value of 30 bar when 44 g of CO_2 is dissolved in 1 kg of water at room temperature. The approximate pH of the soft drink is _____ $\times 10^{-1}$.

(First dissociation constant of $H_2CO_3 = 4.0 \times 10^{-7}$; log 2 = 0.3; density of the soft drink = 1 g mL^{-1})

10. If the solubility product of AB_2 is 3.20×10^{-11} M^3, then the solubility of AB_2 in pure water is_ _ _ _ _ $\times 10^{-4}$ mol L^{-1}. [Assuming that neither kind of ion reacts with water]

11. Arrange the following solutions is the decreasing order of pOH :

(A) 0.01 M HC1

(B) 0.01 M NaOH

(C) 0.01 M CH_3COONa

(D) 0.01 M NaCl

(1) (B) > (C) > (D) > (A)

(2) (A) > (C) > (D) > (B)

(3) (B) > (D) > (C) > (A)

(4) (A) > (D) > (C) > (B)

SOLUTION

1. NTA Ans. (10.60)

Sol. 4 gm of NaOH in 100 L sol. $\Rightarrow 10^{-3}$ M sol.

9.8 gm of H_2SO_4 in 100 L sol. $\Rightarrow 10^{-3}$ M sol.

Mixture : 40L of 10^{-3} M NaOH and 10 L of 10^{-3} M H_2SO_4 sol.

Final Conc. of OH^-

$$= \frac{10^{-3}(40\times1-10\times1\times2)}{40+10} = 6\times10^{-4}\text{M}$$

$pOH = -\log(6\times10^{-4})$

$= 4 - \log 6 = 4 - 0.60 = 3.40$

$pH = 14 - 3.40 = 10.60$

2. NTA Ans. (5.22 to 5.24)

Sol. 3gm Acetic Acid + 250 ml 0.1 M HCl + Water

$\longrightarrow$ made to 500 ml solution.

$\Rightarrow$ 500 ml solution has 25 meq of HCl

50 meq of CH_3COOH

$\therefore$ 20ml solution has 1 meq of HCl

2 meq of CH_3COOH

We have added 2.5 meq. of NaOH $\left(5\text{M}, \frac{1}{2}\text{ml}\right)$

Finally, NaOH & HCl are completely consumed and we are left with 0.5 meq of CH_3COOH

and 1.5 meq of CH_3COONa

$$pH = pKa + \log\frac{1.5}{0.5}$$

$= 4.75 + \log 3 = 4.75 + 0.4771$

$= 5.2271$

3. NTA Ans. (3)

Sol. From the graph & dimensions salt is : XY_2

$[X] = 1 \times 10^{-3}$M

$[Y] = 2 \times 10^{-3}$M

$$XY_2(s) \rightleftharpoons X^{2+}_{(aq.)} + 2Y^-_{(aq.)}$$

$ksp = [X^{2+}]\,[Y^-]^2$

$= (10^{-3})\,(2\times10^{-3})^2$

$= 4 \times 10^{-9}\ M^3$

4. NTA Ans. (2)

Sol. $H_2O(\ell) \rightleftharpoons H^+_{(aq)} + OH^-_{(aq)}$

For ionization of H_2O : $\Delta H > O$

$\Rightarrow$ ENDOTHERMIC

On temperature increase reaction shifts forward

$\Rightarrow$ both $[H^+]$ and $[OH^-]$ increase

$\Rightarrow$ pH & pOH decreases.

5. NTA Ans. (2)

Sol. $\left[Pb^{2+}\right] = \frac{300\times0.134}{400} = 1.005 \times 10^{-1}$ M

$\left[Cl^-\right] = \frac{100\times0.4}{400} = 10^{-1}$ M

$$PbCl_{2(s)} \rightleftharpoons Pb^{+2}_{(aq.)} + 2Cl^-_{(aq.)}$$

$Q = [Pb^{2+}] \times [Cl^-]^2 = 1.005 \times 10^{-3} > k_{sp}$

6. NTA Ans. (1)

Sol. $Cr(OH)_3(s) \rightleftharpoons Cr^{3+}(aq.) + 3OH^-(aq.)$

(s) (3s)

$k_{sp} = 27(s)^4 = 6 \times 10^{-31}$

$\Rightarrow [3(s)]^4 = 18 \times 10^{-31}$

$[OH^-] = 3(s) = [18 \times 10^{-31}]^{1/4}$

7. Official Ans. by NTA (3)

Sol. $\underset{10\text{ milli mol}}{HCl} + \underset{20\text{ milli mol}}{CH_3COONa} \rightarrow \underset{10\text{ milli mol}}{CH_3COOH} + \underset{10\text{ milli mol}}{NaCl}$

So finally we get mixture of CH_3COOH + CH_3COONa that will work like acidic buffer solution.

8. Official Ans. by NTA (3)

Sol. Steep rise in pH around the equivalence point for titration of strong acid with strong base.

9. Official Ans. by NTA (37)

Sol. $P_{CO_2} = K_H \times CO_2$

$$\frac{3}{30} = \frac{K_H.n_{CO_2}}{K_H 1} \Rightarrow n_{CO_2=0.1}\text{mol}$$

$$pH = \frac{1}{2}\left(pka_1 - \log c\right) = \frac{1}{2}\left(6.4\times1\right) = 3.7$$

$pH = 37 \times 10^{-1}$

10. Official Ans. by NTA (2.00)

Sol. $AB_2(s) \rightleftharpoons \underset{S}{A^{+2}_{(aq.)}} + \underset{2S}{2B^-_{(aq.)}} : K_{sp}$

$K_{SP} = S^1 \times (2s)^2 = 4s^3$

$3.2 \times 10^{-11} = 4 \times S^3$

$S = 2 \times 10^{-4}$ M/L

11. Official Ans. by NTA (4)