PHYSICAL / INORGANIC CHEMISTRY

DPP

DAILY PRACTICE PROBLEMS

DPP No. 22

Total Marks : 43

Max. Time : 46 min.

Topic : Ionic Equilibrium

Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.6	(3 marks, 3 min.)	[18, 18]
Multiple choice objective ('–1' negative marking) Q.7 to Q.8	(4 marks, 4 min.)	[8, 8]
Subjective Questions ('–1' negative marking) Q.9 to Q.11	(4 marks, 5 min.)	[12, 15]
True or False (no negative marking) Q.12	(2 marks, 2 min.)	[2, 2]
Comprehension ('–1' negative marking) Q.13	(3 marks, 3 min.)	[3, 3]

1. NH_4Cl (aq) is :

(A) acidic due to NH_4^+ (B) acidic due to Cl^-

(C) basic due to NH_4^+ (D) basic due to Cl^-

2. The number of H^+ in 1 cc of a solution of pH = 13 is

(A) 6.023×10^7 (B) 1×10^{-13} (C) 6.023×10^{13} (D) 1×10^{16}

3. The degree of dissociation of water in a 0.1 M aqueous solution of HCl at a certain temperature t°C is 3.6×10^{-15} . The temperature t must be : [density of water at t°C = 1 gm/ml.]

(A) < 25°C (B) = 25°C

(C) > 25°C (D) insufficient data to predict

4. Determine pH of a 0.01 M aqueous solution of $ClC_6H_4NH_3Cl$.

[$K_b(ClC_6H_4NH_2) = 4 \times 10^{-13}$, log 19 = 1.3, log 2 = 0.3, $\sqrt{16.25}$ = 4.02].

(A) 2.1 (B) 2.5 (C) 3.5 (D) 3.1

5. The indicator constant for an acidic indicator, HIn is 5×10^{-6} M. This indicator appears only in the colour of acidic form when $\frac{[In^-]}{[HIn]} \le \frac{1}{20}$ and it appears only in the colour of basic form when $\frac{[HIn]}{[In^-]} \le \frac{1}{40}$. The pH range of indicator is [Given : log 5 = 0.7]

(A) 4.3 – 6.3 (B) 4.0 – 6.6 (C) 4.0 – 6.9 (D) 3.7 – 6.6

(E) 12-14

6. At what minimum concentration OH^- will 10^{-3} mole of $Zn(OH)_2$ go into solution as $Zn(OH)_4^{2-}$ in 1 L solution.

$$Zn(OH)_2\,(s) + 2OH^-\,(aq) \rightleftharpoons Zn(OH)_4^{2-}\,(aq) \quad (K_C = 10^{-2})$$

(A) 0.1 M (B) 0.632 M (C) 0.0316 M (D) 0.316 M

7.* Which of the following statements are correct at 25°C.

(A) pK_a for H_3O^+ is 15.74 (B) pK_b for OH^- is – 1.74

(C) $pK_a(CH_3COOH) + pK_b(NH_4OH) = pK_w(H_2O)$ (D) degree of dissociation of water is 1.8×10^{-7} %

8.* Choose the correct statement(s)

(A) $pH + pOH = pk_W$ is applicable for dilute acid and dilute base aqueous solution as well as for pure water.

(B) In acidic/basic aqueous solution at 25°C degree of dissociation of water is less than 1.8×10^{-9}.

(C) No chemical reaction takes place when 0.1 mol of NaH_2PO_2 and 0.1 mol of NaOH is mixed in enough water to form 1 L solution.

(D) Relative acidic strength of HCl, $HClO_4$, HBr and HI can not be determined in water.

9. At what pH 0.1M Mg^{2+} solution begins to precipitate. Given K_{SP} $[Mg(OH)_2] = 10^{-11}$.

10. K_a for acetic acid in water is 10^{-5} at 25ºC. The pH of a mixture of 25 ml of 0.02 N acetic acid and 2.5 ml of 0.1 N NaOH (neglecting volume change) will be :

11. How many of the following solutions will turn blue litmus red ?

(i) $Al_2(SO_4)_3$	(ii) NaCl	(iii) KCN	(iv) H_3BO_3
(v) H_3PO_3	(vi) HIO_3	(vii) H_2PtCl_6	(viii) NH_4HSO_4
(ix) CH_3CH_2OH			

12. Na_2HPO_3 is not an acid salt.

13. **Comprehension #**

For any polyprotic acid, we always consider successive dissociation. The value of equilibrium consant of successive dissociation decreases due to common ion effect.

For example :

H_2A is a dibasic acid.

$$H_2A \rightleftharpoons H^+ + HA^- \qquad K_1 = \frac{[H^+][HA^-]}{[H_2A]}$$

$$HA^- \rightleftharpoons H^+ + A^{--} \qquad K_2 = \frac{[H^+][A^{--}]}{[HA^-]}$$

K_1 is greater than K_2.

(i) Concentration of H^+ ions in 0.1 M H_2CO_3 is ($K_1 = 4 \times 10^{-7}$, $K_2 = 4 \times 10^{-11}$) :

(A) 2×10^{-4} M (B) 4×10^{-9} M (C) 2×10^{-3} M (D) None of these

(ii) Find the pH of 0.1 M $NaHCO_3$.

Use data ($K_1 = 4 \times 10^{-7}$, $K_2 = 4 \times 10^{-11}$ for H_2CO_3, log 4 = 0.6) :

(A) 3.7 (B) 8.4 (C) 9.6 (D) None of these

(iii) Find the concentration of H^+ ions in an aqueous solution which is saturated with H_2S (0.1 M) as well as H_2CO_3 (0.2 M).

Use data [$K_1 = 10^{-7}$, $K_2 = 10^{-14}$ for H_2S, $K_1 = 4 \times 10^{-7}$, $K_2 = 4 \times 10^{-11}$ for H_2CO_3] :

(A) 3×10^{-4} M (B) 3.83×10^{-4} M (C) 2.83×10^{-4} M (D) None of these

Answer Key

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1.	(A)	**2.**	(A)	**3.**	(C)	**4.**	(A)	**5.**	(C)
6.	(D)	**7.***	(B,D)	**8.***	(A,B,C,D)	**9.**	9	**10.**	5
11.	05	**12.**	True	**13.**	**(i).** (A) **(ii).** (B) **(iii).** (A)				

Hints & Solutions

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2. pH = 13 means $[H^+] = 10^{-13}$ mol L^{-1}
or $10^{-13} \times 6.023 \times 10^{23} / 1000$ H^+ ions/c.c $= 6.023 \times 10^{7}$

3. $K_W = 55.5 \times 3.6 \times 10^{-15} \times 0.1 = 2 \times 10^{-14}$
Hence temperature must be > 25°C.

4. $K_h = \dfrac{10^{-14}}{4 \times 10^{-13}} = 0.025$

	BH^+	+	H_2O	$\rightleftharpoons$	B	+	H_3O^+
t = 0	C						
t_{eq}	$C(1-\alpha)$				$C\alpha$		$C\alpha$

$K_h = \dfrac{C\alpha^2}{(1-\alpha)} = 0.025 \quad \Rightarrow \quad \dfrac{0.01\,\alpha^2}{1-\alpha} = 0.025.$

$\Rightarrow \alpha^2 + 2.5\alpha - 2.5 = 0 \quad \Rightarrow \quad \alpha = 0.76$

$[H^+] = 7.6 \times 10^{-3} \quad \Rightarrow \quad pH = -\log [H^+] = 2.1.$

5. $pH = P_{KIn} + \log_{10}\left[\dfrac{In^-}{HIn}\right]$

$pH = [6 - \log_{10} 5] + \log_{10}\left[\dfrac{1}{20}\right] = 4$

$pH = P_{KIn} + \log_{10}\left[\frac{In^-}{HIn}\right]$

$= P_{KIn} + \log_{10}\left[\frac{40}{1}\right]$

$= 6 - \log_{10} 5 + \log_{10} 40$

$= 6 - 0.7 + 1.6 = 6.9$

6. If 10^{-3} mole $Zn(OH)_2$ go into $Zn(OH)_4^{2-}$.

$Zn(OH)_2\ (s) + 2OH^-\ (aq) \rightleftharpoons Zn(OH)_4^{2-}\ (aq)$

$10^{-2} = \frac{10^{-3}}{[OH^-]^2} \quad \Rightarrow \quad [OH^-] = 0.316\ M$

7.* $pK_a\ (H_3O^+) = -1.74 = pK_b$ of OH^-

$pK_a + pK_b = 14$ only for conjugate acid base pair.

$\alpha = 1.8 \times 10^{-9}$ or 1.8×10^{-7} % for H_2O.

8.* (A) Correct statement

(B) Due to common ion effect on $H_2O \rightleftharpoons H^+ + OH^-$

(D) relative strength of strong acids can not be determined in water due to levelling effect.

9. I.P. $\geq K_{sp}$

$[Mg^{2+}]\ [OH^-] \geq 10^{-11}$

$[OH^-]^2 \geq 10^{-10}$

$[OH^-] \geq 10^{-5}$

$P^{OH} \leq 5$

$P^H \geq 9$

10. 25 ml of 0.02 N acetic acid = $\frac{0.02}{1000} \times 25 = 5 \times 10^{-4}$ g eq.

2.5 ml of 0.1 N NaOH = $\frac{0.1}{1000} \times 25 = 2.5 \times 10^{-4}$ g eq.

After neutralization, CH_3COOH left is $(5 - 2.5) \times 10^{-4}$ g eq. = 2.5×10^{-4} g eq.

$pH = pK_a = -\log(10^{-5})$; $= 5$

11. Blue litmus turns red by acidic solution

(i)	$Al_2(SO_4)_3$	(All five acidic nature)
(iv)	H_3BO_3	
(v)	H_3PO_3	
(vi)	HIO_3	
(vii)	H_2PtCl_{16}	

12. Na_2HPO_3 is the salt of H_3PO_3 which is dibasic in nature (as it contains two OH^- groups)

13. **(i)** $[H^+] = \sqrt{K_1C_0} = \sqrt{4 \times 10^{-7} \times 0.1} = 2 \times 10^{-4}$ M.

(ii) $[H^+] = \sqrt{K_1K_2} = \sqrt{4 \times 10^{-7} \times 4 \times 10^{-11}} = 4 \times 10^{-9}$ M

(iii) $[H^+] = \sqrt{K_1C_1 + K_2C_2} = \sqrt{10^{-7} \times 0.1 + 4 \times 10^{-7} \times 0.2} = 3 \times 10^{-4}$ M