DPP-5 [Conjugate Acid–Base and Acidic strength]

Chapter: Ionic Equilibrium

"Success is no accident. It is hard work, perseverance, learning, studying, sacrifice and most of all, love of what you are doing."

GROUP–A: Ka, Kb, Kw & Conjugate Relations

Q1. $HF + H_2O \rightleftharpoons H_3O^+ + F^-$ $[K_1]$

$F^- + H_2O \rightleftharpoons HF + OH^-$ $[K_2]$

For the above two reactions which of the given relation is correct? [NCERT Pg. 223]

(1) $K_2 = K_w$

(2) $K_2 = \dfrac{1}{K_w}$

(3) $K_w = K_1 K_2$

(4) $K_w = \dfrac{K_1}{K_2}$

Q2. **pK_a for an acid HA is 6. The value of K for the reaction $A^- + H_3O^+ \rightleftharpoons HA + H_2O$ is :-**

(a) 1×10^{-6}

(b) 1×10^{8}

(c) 1×10^{-8}

(d) 1×10^{6}

Q3. **If pK_b for fluoride ion at 25°C is 10.83, the ionisation constant of hydrofluoric acid is :-**

(a) 1.74×10^{-5}

(b) 3.52×10^{-3}

(c) 6.75×10^{-4}

(d) 5.38×10^{-2}

Q4. **The dissociation constant of a base MOH is 4×10^{-6}. The dissociation constant of its conjugate acid is :-**

(1) 4.0×10^{-20}

(2) 2.5×10^{-9}

(3) 1.0×10^{-6}

(4) 2.5×10^{-5}

Q5. **The dissociation constant of 0.01 M CH_3COOH is 1.8×10^{-5}. The dissociation constant of its conjugate base CH_3COO^- is :-**

(1) 5.6×10^{-10}

(2) 1.8×10^{-5}

(3) 1.0×10^{-14}

(4) 3.2×10^{-7}

Q6. **What is the ionisation constant of HOCl, if K_b of OCl^- = 4×10^{-10} ?**

(1) 4.6×10^{-2}
(2) 1.0×10^{-10}
(3) 2.5×10^{-5}
(4) 6.0×10^{-7}

Q7. **The percentage of pyridine (C_5H_5N) that forms pyridinium ion ($C_5H_5NH^+$) in a 0.10 M aqueous pyridine solution ($K_b = 1.7 \times 10^{-9}$) is :-**

(1) 0.77%
(2) 1.6%
(3) 0.0060%
(4) 0.013%

Q8. **Which of the following is incorrect?**

(a) K_a (weak acid), K_b (conjugate weak base) = K_w
(b) K_a (strong acid), K_b (conjugate weak base) = K_w
(c) K_a (weak acid), K_b (weak base) = K_w
(d) K_a (weak acid), K_b (conjugate strong base) = K_w

GROUP–B: Conjugate Acid–Base Identification

Q1. **The conjugated acid of O^{2-} ion's is :-**

(1) O_2^+
(2) H^+
(3) H_3O^+
(4) OH^-

Q2. **The conjugated base of $(CH_3)_2NH_2^+$ is :-**

(1) CH_3NH_2
(2) $(CH_3)_2N^+$
(3) $(CH_3)_2N$
(4) $(CH_3)_2NH$

Q3. **Conjugate acid of $Zn(OH)_2$ is :-**

(1) $Zn(OH)^+$
(2) $Zn(OH)_3^-$
(3) Zn^{2+}
(4) None

Q4. **In the reaction $HNO_3 + H_2O \rightleftharpoons H_3O^+ + NO_3^-$, the conjugate base of HNO_3 is :-**

(1) H_2O
(2) H_3O^+
(3) NO_3^-
(4) H_3O^+ and NO_3^-

Q5. **Ammonium ion is :-**

(1) A conjugate acid
(2) A conjugate base
(3) Neither an acid nor a basic
(4) Both an acid and a base

Q6. Which is incorrect?

(1) Conjugate acid of H_2O is H_3O^+
(2) Conjugate base of HCO_3^- is CO_3^{2-}
(3) Conjugate base of NH_3 is NH_2^-
(4) Conjugate base of HOCl is Cl^-

Q7. Which one of the following is not acid–base conjugate pair?

(1) HONO, NO_2^-
(2) $CH_3NH_3^+$, CH_3NH_2
(3) C_6H_5–COOH, $C_6H_5COO^-$
(4) H_3O^+, OH^-

Q8. Conjugate acid of NH_2^- is :-

(1) NH_4OH
(2) NH_4^+
(3) NH_2^-
(4) NH_2

Q9. When HF is dissolved in formic acid, the equilibrium is :-

$HF + HCOOH \leftrightharpoons F^- + HCOOH_2^+$

The true pair of conjugate acid–base is :-

(1) (HF, HCOOH) and ($HCOOH_2^+$, F^-)
(2) (HF, $HCOOH_2^+$) and (HCOOH, F^-)
(3) ($HCOOH_2^+$, HF) and (F^-, HCOOH)
(4) (HF, F^-) and ($HCOOH_2^+$, HCOOH)

Q10. The conjugate base of $H_2PO_4^-$ is :-

(1) PO_4^{3-}
(2) P_2O_5
(3) H_3PO_4
(4) HPO_4^{2-}

Q11. What is the conjugate base of OH^- ?

(1) O_2
(2) H_2O
(3) O^{2-}
(4) O_2^-

Q12. The conjugate base of hydrazoic acid is :-

(1) N_3^-
(2) N_3^{2-}
(3) N_2^-
(4) HN_3^-

Q13. In the reaction $HNO_3 + H_2O \leftrightharpoons H_3O^+ + NO_3^-$, the conjugate base of HNO_3 is :-

(a) H_2O
(b) H_3O^+
(c) NO_3^-
(d) H_3O^+ and NO_3^-

Q14. Out of the following, amphiprotic species in aqueous medium are : I : HPO_4^{2-} II : OH^- III : $H_2PO_4^-$ IV : HCO_3^-

(a) I, III, IV
(b) I and III
(c) III and IV
(d) All

Q15. **The conjugate acid of NH_2^- is :-**
(a) NH_3
(b) NH_2OH
(c) NH_4^+
(d) N_2H_4

Q16. **The following equilibrium is established when $HClO_4$ is dissolved in weak acid HF solvent :**

$HF + HClO_4 \leftrightharpoons ClO_4^- + H_2F^+$

Which of the following is correct set of conjugate acid–base pair ?
(a) HF and $HClO_4$
(b) HF and ClO_4^-
(c) HF and H_2F^+
(d) $HClO_4$ and H_2F^+

Q17. **Select Polyprotic Arrhenius acids from the following : H_3PO_2, H_3PO_3, H_3BO_3, HCOOH, $(COOH)_2$**

(b) Write conjugate acids of SO_4^{2-}, RNH_2, NH_2^-, $C_2H_5OC_2H_5$, F^-

(c) Write conjugate base of HNO_2, OH^-, H_2CO_3, $HClO_4$

(d) Write conjugate acid and conjugate base of following amphoteric species : HS^-, NH_3, C_2H_5OH, H_2O

(e) Classify the following into Lewis acid & Lewis base : H^+, $FeCl_3$, $(CH_3)_3N$, F^-, CH_2

GROUP–C: Acid Strength, pKa, pKb & Relative Strength

Q1. **Which of the following is the weakest acid ?**
(1) Phenol ($K_a = 1.3 \times 10^{-10}$)
(2) Hydrocyanic acid ($K_a = 4.9 \times 10^{-10}$)
(3) Acetic acid ($K_a = 1.8 \times 10^{-5}$)
(4) Benzoic acid ($K_a = 6.5 \times 10^{-5}$)

Q2. **Which of the following is the strongest base ?**
(1) $C_6H_5NH_2$ ($pK_b = 9.42$)
(2) $C_6H_5NHCH_3$ ($pK_b = 9.15$)
(3) $C_6H_5N(CH_3)_2$ ($pK_b = 8.94$)
(4) $C_6H_5NHC_2H_5$ ($pK_b = 8.89$)

Q3. **Value of dissociation constant of acetic acid is 10^{-6}, where as dissociation constant of formic acid is 10^{-5}. Which of the following will be the value of pK_a(acetic acid) – pK_a(formic acid) ?**
(1) 10
(2) +1

(3) 10^{-1}

(4) -1

Q4. For two monobasic acids A and B, $pK_{a1} = 1.2$, $pK_{a2} = 2.8$ respectively in value, then which is true:

(a) A & B both have equal acidic strength

(b) A is stronger than B

(c) B is stronger than A

(d) If both acids have same concentration than A is more acid than B

Q5. Ionization constant of AOH and BOH base are K_{b1} and K_{b2}. Their relation is $pK_{b1} < pK_{b2}$. Conjugate of following base, does not show maximum pH :

(1) AOH

(2) BOH

(3) Both of them

(4) NOT

Q6. K_a for formic acid and acetic acid are 1.8×10^{-4} and 1.8×10^{-5} respectively. The relative strength of acids is :

(a) 10 : 1

(b) 1 : 10

(c) 1 : $\sqrt{10}$

(d) $\sqrt{10}$: 1

Q7. The strongest conjugate base is :-

(1) NO_3^-

(2) Cl^-

(3) SO_4^{2-}

(4) CH_3COO^-

Q8. CH_3COO^- ion is a :-

(1) Weak conjugate base

(2) Strong conjugate base

(3) Weak conjugate acid

(4) Strong conjugate acid

Q9. Which of the following is strongest conjugate base :-

(1) ClO_4^-

(2) HCO_3^-

(3) F^-

(4) HSO_4^-

Q10. The decreasing order of strength of following bases NH_3, CH_3COO^- and Cl^- is :-

(1) Cl^-, CH_3COO^-, NH_3

(2) CH_3COO^-, NH_3, Cl^-

(3) CH_3COO^-, Cl^-, NH_3

(4) NH_3, CH_3COO^-, Cl^-

Q11. Correct basic strength order will be :-

(1) $HSO_4^- < ClO_4^- < NO_3^- < NH_3$

(2) $ClO_4^- < HSO_4^- < NO_3^- < NH_3$

(3) $ClO_4^- > HSO_4^- > NO_3^- > NH_3$

(4) $NO_3^- > ClO_4^- > NH_3 > HSO_4^-$

Q12. **The conjugate base of the weak acid in the reaction $HBr + H_2O \leftrightharpoons H_3O^+ + Br^-$ is :-**

(1) HBr

(2) H_2O

(3) Br^-

(4) H_3O^+

Q13. **The pH of 0.1 M monobasic acid is 4.50. The acidity constant (K_a) of the monobasic acid is–**

(1) 1.0×10^{-7}

(2) 1.0×10^{-5}

(3) 1.0×10^{-4}

(4) 1.0×10^{-8}

Q14. **If an acid–base reaction $HA(aq) + B^-(aq) \leftrightharpoons HB(aq) + A^-(aq)$ has $K_{eq} = 10^{-4}$, how many of the following statements are true ?**

(i) HB is stronger acid than HA

(ii) HA is stronger acid than HB

(iii) HA and HB have the same acidic strength

(iv) B^- is stronger base than A^-

(v) A^- is stronger base than B^-

(vi) B^- and HB are conjugate acid–base pair

(vii) A^- is the conjugate base of acid HA

(viii) HA can be HSO_4^- and HB can be HCOOH

(ix) A^- can be F^- and B^- can be CN^-

(1) 4 (i, v, vi, vii)