DPP–4Solution [pH of WEAK ACID and WEAK BASE]

Chapter: Ionic Equilibrium

"Mehnat dikhayi nahi deti... lekin result mein chilla ke bolti hai."

GROUP–A: pH of Weak Acids / Weak Bases

Q1. pH of 0.001 M acetic acid would be :-

(1) 2
(2) > 3
(3) 7
(4) 14

Explanation / Approach

Weak acid (HA) pH $= \frac{1}{2}(\text{p}K_a - \log C)$ Acetic acid: $K_a = 1.8 \times 10^{-5} \rightarrow \text{p}K_a \approx 4.74$.

Solution

pH $= \frac{1}{2}(4.74 - \log 10^{-3}) = \frac{1}{2}(4.74 + 3) = \frac{1}{2}(7.74) \approx 3.87$ So pH is **greater than 3**.

Correct Option: (2)

Q2. 0.02 M ammonia solution (5% ionised), find pH :-

(1) 2
(2) 11
(3) 5
(4) 7

Explanation / Approach

NH_3 is a weak base. $\alpha = 5\% = 0.05$ $[OH^-] = C\alpha$

Solution

$[OH^-] = 0.02 \times 0.05 = 1 \times 10^{-3}$ pOH $= 3 \rightarrow$ pH $= 14 - 3 =$ **11**

Correct Option: (2)

Q3. If K_a of HCN $= 4 \times 10^{-10}$, find pH of 0.25 M HCN.

(1) 4.2
(2) 4.7
(3) 0.47
(4) 5.0

Explanation / Approach

Weak acid pH: pH $= \frac{1}{2}(pK_a - \log C)$ pK_a = 9.40

Solution

pH $= \frac{1}{2}(9.40 - \log 0.25) = \frac{1}{2}(9.40 + 0.60) = \frac{1}{2}(10.0) =$ **5.0**

Correct Option: (4)

Q4. A weak monoacidic base ($K_b = 10^{-5}$), pH of 0.1 M solution?

(1) 11
(2) 8
(3) 7.5
(4) 10

Explanation / Approach

Weak base formula: pOH $= \frac{1}{2}(pK_b - \log C)$ pK_b = 5

Solution

pOH $= \frac{1}{2}(5 - \log 0.1) = \frac{1}{2}(5 + 1) = 3$ pH = 11

Correct Option: (1)

Q5. Acetic acid: $\alpha = 0.1 \times C^{-1}$, find pH.

(1) 1
(2) 2
(3) 3
(4) 4

Explanation / Approach

Given $\alpha = 0.1/C$. $[H^+]$ = C = 0.1

Solution

pH = –log(0.1) = 1

Correct Option: (1)

Q6. 0.1 M formic acid 0.1% dissociated → pH = 4. For 1% dissociation (same C), pH = ?

(1) 2
(2) 3
(3) 1
(4) 4

Explanation / Approach

10× dissociation → $[H^+]$ becomes 10× → pH decreases by 1.

Solution

Original pH = 4 New pH = 3

Correct Option: (2)

Q7. For 10^{-3} M H_2CO_3 if $\alpha = 10\%$ find pH.

Explanation / Approach

$[H^+] = C = 10^{-3} \times 0.1 = 10^{-4}$.

Solution

pH = 4.

Q8. If $K_a = 4 \times 10^{-6}$ and C = 0.1 M, find pH.

Explanation / Approach

Use weak acid formula: pH = $\frac{1}{2}(pK_a - \log C)$ $pK_a = 5.40$

Solution

pH = $\frac{1}{2}(5.40 + 1) = 3.20$

Q9. Calculate the pH of 500 mL 1 M BOH ($K_b = 2.5 \times 10^{-5}$).

Explanation / Approach

Weak base pOH = $\frac{1}{2}(pK_b - \log C)$ $pK_b = 4.60$

Solution

pOH = $\frac{1}{2}(4.60 - 0) = 2.30$ pH = 14 − 2.30 = 11.70

Q10. HOCl degree of dissociation $= 1.25 \times 10^{-2}$ at 0.04 M. Find pH.

Explanation / Approach

$[H^+] = C$

Solution

$[H^+] = 0.04 \times 0.0125 = 5 \times 10^{-4}$ pH 3.30

GROUP–B: Degree of Dissociation

Q11. Degree of ionization of 0.04 M HOCl ($K_a = 1.25 \times 10^{-4}$).

(1) 0.025
(2) 0.25
(3) 0.5
(4) 0.055

Explanation / Approach

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

Solution

$\alpha = \sqrt{1.25 \times 10^{-4}/0.04} = 0.055.$

Correct Option: (4)

Q12. 0.2 M CH_3COOH in 0.1 M HCl. $K_a = 1.8 \times 10^{-5}$. Find % dissociation.

(1) 0.018
(2) 0.36
(3) 18
(4) 36

Explanation / Approach

In strong acid medium: $\alpha = \dfrac{K_a}{[H^+]}$.

Solution

$\alpha = 1.8 \times 10^{-5}/0.1 = 1.8 \times 10^{-4} = 0.018\%.$

Correct Option: (1)

Q13. Percentage ionisation of 0.01 M CH_3COOH in 0.1 M HCl.

(1) 0.18%
(2) 0.018%
(3) 1.8%
(4) 18%

Explanation / Approach

Same formula: $\alpha = \dfrac{K_a}{[H^+]}$

Solution

$\alpha = 1.8 \times 10^{-5}/0.1 = 1.8 \times 10^{-4} = 0.018\%.$

Correct Option: (2)

Q14. Order of dissociation of 0.1 N CH_3COOH ($K_a = 10^{-5}$).

(1) 10^{-5}
(2) 10^{-4}
(3) 10^{-3}
(4) 10^{-2}

Explanation / Approach

$\alpha = \sqrt{K_a/C} = \sqrt{10^{-5}/0.1} = 10^{-2}$.

Solution

So 10^{-2}.

Correct Option: (4)

Q15. HCN $K_a = 10^{-5}$ in 0.1 M HCl. $= ?$

(1) 10^{-5}
(2) 10^{-4}
(3) 10^{-3}
(4) 10^{-2}

Explanation / Approach

$\alpha = \dfrac{K_a}{[H^+]}$

Solution

$= 10^{-5}/0.1 = 10^{-4}$

Correct Option: (2)

Q16. 0.1 mol HA ($K_a = 10^{-5}$) in 1 L. Find % dissociation.

(1) 99.0%
(2) 1.00%
(3) 99.9%
(4) 0.100%

Explanation / Approach

$= (K_a/C) = (10^{-5}/0.1)$

Solution

$= 10^{-2}$ß1%

Correct Option: (2)

Q17. Find of 10^{-2} M HCN if $[H^+] = 10^{-3}$.

Explanation / Approach

$[H^+] = C$

Solution

$= 10^{-3}/10^{-2} = 0.1$

GROUP–C: Ka / Kb Calculations

Q18. 0.2 M HCOOH is 3.2% ionised. Find K_a.

(1) 4.2×10^{-4}
(2) 4.2×10^{-5}
(3) 2.1×10^{-4}
(4) 2.1×10^{-5}

Explanation / Approach

$K_a = C\alpha^2$

Solution

$= 0.032$ $K_a = 0.2 \times (0.032)^2 = 2.1 \times 10^{-4}$

Correct Option: (3)

Q19. 1 M HA has pH = 5. Find K_a.

(1) 1×10^{-10}
(2) 5
(3) 5×10^{-8}
(4) 1×10^{-5}

Explanation / Approach

$[H^+] = 10^{-5}$ $K_a = \frac{[H^+]^2}{C}$

Solution

$K_a = 10^{-10}/1 = 10^{-10}$

Correct Option: (1)

Q20. 0.1 M HQ has pH = 3. Find K_a (AIEEE–2012).

(1) 10^{-1}
(2) 10^{-3}
(3) 10^{-5}
(4) 10^{-7}

Explanation / Approach

$[H^+] = 10^{-3}$

Solution

$$K_a = \frac{(10^{-3})^2}{0.1} = 10^{-5}$$

Correct Option: (3)

Q21. HCN: $= 4 \times 10^{-3}$ at 0.2 M. Find K_a.

(a) 2×10^{-3}

(b) 3.2×10^{-5}
(c) 4×10^{-4}
(d) 5.4×10^{-5}

Explanation / Approach

$K_a = C\alpha^2$

Solution

$K_a = 0.2(410^{-3})^2 = 3.210^{-5}$

Correct Option: (2)

Q22. For 10^{-2} M HCN, pOH = 10. Find K_a.

(1) 10^{-4}
(2) 10^{-2}
(3) 10^{-5}
(4) None

Explanation / Approach

$pOH = 10 \rightarrow pH = 4 \rightarrow [H^+] = 10^{-4}$

Solution

$$K_a = \frac{(10^{-4})^2}{10^{-2}} = 10^{-6}$$

Correct Option: (4)

Q23. 0.5 M weak base ionisation 1.414%. Find K_b.

Explanation / Approach

$K_b = C\alpha^2$

Solution

$= 0.01414\ K_b = 0.5(0.01414)^2 = 10^{-4}$

Q24. 1 M acetic acid ionised 1.2%. Find K_a.

Explanation / Approach

$K_a = C\alpha^2$

Solution

$= 0.012 \rightarrow K_a = 1(0.012)^2 = 1.4410^{-4}$

Q25. Acetic acid 5% ionised in 2 M solution, find K_a.

Explanation / Approach

$K_a = C\alpha^2$

Solution

$= 0.05$ $K_a = 2(0.05)^2 = 510^{-3}$

Q26. 0.1 M BOH → pH = 10. Find K_b.

Explanation / Approach

pH = 10 → pOH = 4 → $[OH^-] = 10^{-4}$

Solution

$$K_b = \frac{(10^{-4})^2}{0.1} = 10^{-7}$$

Q27. 10^{-3} M CH_3COOH, pH = 3.4. Find K_a.

Explanation / Approach

$[H^+] = 10^{-3.4} = 410^{-4}$

Solution

$$K_a = \frac{(410^{-4})^2}{10^{-3}} = 1.610^{-4}$$

GROUP–D: Mix Questions

Q28. Molarity of HNO_2 when pH = 2 ($K_a = 4.510^{-4}$).

(1) 0.3333
(2) 0.4444
(3) 0.6666
(4) 0.2222

Explanation / Approach

$[H^+] = 10^{-2} = 0.01$

Solution

$$K_a = \frac{[H^+]^2}{C - [H^+]}\ 0.01^2/(C–0.01) = 4.5\times10^{-4} Solve ßC = 0.2222$$

Correct Option: (4)

Q29. If is degree of dissociation of weak dibasic acid and y is $[H^+]$, find initial concentration.

(1) $\frac{\alpha y^{-1}}{2}$

(2) $y\alpha^{-1}$

(3) $\frac{y\alpha^{-1}}{2}$

(4) None

Explanation / Approach

Dibasic acid gives: $[H^+] = 2C$.

Solution

$C = \frac{y}{2\alpha}$

Correct Option: (3)

Q30. 0.1 M weak acid 2% ionised. Find $[H^+]$ and $[OH^-]$.

(1) 0.0210^{-3} and 510^{-11}

(2) 10^{-3} and 310^{-11}

(3) 310^{-2} and 510^{-12}

(4) 310^{-2} and 410^{-13}

Explanation / Approach

$[H^+] = C = 0.1 \times 0.02 = 2\times10^{-3}[OH^-] = K_w/[H^+]$

Solution

$[OH^-] = 10^{-14}/(210^{-3}) = 510^{-12}$

Correct Option: (3)

Q31. 0.01 M BOH, $K_b = 10^{-12}$. Find $[OH^-]$.

(1) 10^{-6}

(2) 10^{-7}

(3) 210^{-6}

(4) 10^{-5}

Explanation / Approach

$[OH^-] = \sqrt{K_b C}$

Solution

$= (10^{-12} \times 10^{-2}) = 10^{-7}$

Correct Option: (2)

Q32. Correct statement for HCN.

(1) $\alpha = \frac{K_a}{[H^+]}$

(2) $\alpha = \frac{K_a[OH^-]}{K_w}$

(3) Both (1) and (2)

(4) $K_b = C\alpha^2$

Explanation / Approach

Weak acid in strong acid medium uses formula (1). Formula (2) also valid (derived).

Solution

Correct: Both (1) and (2)

Correct Option: (3)

Q33. For 10 M CH_3COOH, $K_a = 10^{-5}$. Find (i) (ii) $[H^+]$ (iii) pH

Explanation / Approach

$= (K_a/C)$

Solution

$= (10^{-5}/10) = 10^{-3}$ $[H^+] = C = 10 \times 10^{-3} = 10^{-2}$ pH $= 2$