6. ACIDS AND BASES

PREVIOUS EAMCET BITS

1. pH of a buffer solution decreases by 0.02 untis when 0.12g of acetic acid is added to 250ml of a buffer solution of acetic acid and Potassium acetate at 27^0C. The buffer capacity of the solution is **(2009 E)**

1) 0.1 2) 10 3) 1 4) 0.4

Ans : 4

Sol: To 250 ml. Of buffer solution 0.12g of acetic acid is added

To 1000ml of buffer solution $4\times.12 = 0.48$ g of acid is added

$\therefore$ NO. of moles of acetic acid added

$$= \frac{0.48}{60} = 8\times10^{-3} \text{ moles}$$

Buffer capacity = $\dfrac{No.\ of\ moles\ of\ acid\ added\ to 1lit.solution}{change\ in\ PH}$

$$= \frac{8\times10^{-3}}{0.02} = 0.4$$

2. Assertion (A) : the aqueous solution of CH_3COONa is alkaline in nature.

Reason (R) : Acetate ion undergoes anionic hydrolysis

The correct answer is **(2009 M)**

1) both A and R are true and R is the correct explanation of A

2) both A and R are true and R is not the correct explanation of A

3) A is true and R is not true 4) A is not true but R is true

Ans : 1

Sol: $CH_3COO^- + H_2O \rightleftarrows CH_3COOH + OH^-_{(aq)}$

Anion Weak acid

CH_3COO^- undergoes anionic hydrolysis

$\therefore$ Aq. Solution of CH_3COONa is Alkaline

3. When 0.1moles of an acid is added to 2 litres of a buffer solution, the pH of the buffer decreases by 0.5. The buffer capacity of the solution is **(2008 E)**

1) 0.6 2) 0.4 3) 0.2 4) 0.1

Ans : 4

Sol: Buffer capacity $\phi = \dfrac{No.of\ moles\ of\ acid\ or\ base\ added\ to 1lit.of\ the\ solution}{Change\ in\ pH}$

$$= \frac{0.05}{0.5} = 0.1$$

4. Identify Bronsted –Lowry acids in the reaction given

$$\underset{(A)}{\left[Al(H_2O)_6\right]^{3+}} + \underset{(B)}{HCO^-_3} \rightleftarrows \underset{(C)}{\left[Al(H_2O)_5(OH)\right]^{2+}} + \underset{(D)}{H_2CO_3}$$

[2008 M]

The correct answer is

1. (A), (C) 2. (B), (D) 3. (A), (D) 4. (B), (C)

Ans : 3

Sol: $\left[Al(H_2O)_6\right]^{3+} \xrightarrow{-H^+} \left[Al(H_2O)_5(OH)\right]^{2+}$

Acid

$$H_2CO_3 \xrightarrow{-H^+} HCO_3^-$$

Acid

5. Which of the following is not a conjugate acid-base pair? **(2007 E)**

1) HPO_3^{2-}, PO_3^{3-} 2) $H_2PO_4^-, HPO_4^{2-}$

3) $H_2PO_4^-, H_3PO_4$ 4) $H_2PO_4^-, PO_3^{3-}$

Ans:4

Sol: Conjugate acid and its base must differ by one proton

$H_2PO_4^-, PO_3^{3-}$ not a conjugate acid base pair.

6. 100mL of 0.1 M H_2SO_4 is added to 200 mL of 0.1M NaOH. What is the pH of the resulting mixture? **(2007 M)**

1) 2 2) 7 3) 10 4) 12

Ans : 2

Sol : 0.1 M H_2SO_4 means 0.2N H_2SO_4

0.1 M NaOH means 0.1N NaOH

100ml 0.2N H_2SO_4 exactly neutralizes 200ml 0.1 N NaOH

Resulting solution is neutral

$\therefore pH = 7$

7. The concentration of oxalic acid is 'x' mol lit^{-1}. 40 ml of this solution reacts with 16ml of 0.05 M acidified $KMnO_4$. What is the pH of 'x' M oxalic acid solution? (Assume that oxalic acid dissociates completely) **(2006 E)**

1) 1.3 2) 1.699 3) 1 4) 2

Ans : 3

Sol: Reaction

$$2MnO_4^- + 5C_2O_4^{2-} + 16^+ \rightarrow 10CO_2 + 2Mn^{2+} + 8H_2O$$

2 moles 5 moles

Number of moles of MnO_4^- = $16 \times 0.05 \times 10^{-3} = 0.8 \times 10^{-3}$

Number of moles of oxalic acid = $\frac{0.8 \times 10^{-3} \times 5}{2} = 2 \times 10^{-3}$

Oxalic acid conc. = $\frac{2 \times 10^{-3} \times 1000}{40}$

$\therefore \left[H^+\right] = 2 \times 0.05 = 0.1M$

pH = 1

8. What is the conjugate base of HSO_4^- ? **(2006 M)**

1) H_2SO_4 2) HSO_4^{2-} 3) SO_4^{2-} 4) H^+

Ans : 3

Sol: $HSO_4^- \xrightarrow{-H^+} SO_4^{2-}$

Acid Conjugate base

9. Assertion (A): The P_H of a buffer solution containing equal moles of acetic acid and sodium acetate is 4.8 (P_{Ka} of acetic acid is 4.8).

Reason (R): The ionic product of water at 25^0C is 10^{-14} $mol^2.lit^{-2}$. **(2005 E)**

The correct answer is

1.Both (A) and (R) are true and (R) is the correct explanation of (A).

2. Both (A) and (R) are true and (R) is not the correct explanation of (A).

3. (A) is true but (R) is not true.

4. (A) is not true but (R) is true. **(2006 E)**

Ans : 2

Sol: p^H of Buffer Solution = $pKa + \log \frac{\{salt\}}{\{Acid\}}$

$= 4.8 \log \frac{1}{1} = 4.8 + 0 = 4.8$

$Kw = \left[H^+\right]\left[OH^-\right]$

$= 1 \times 10^{-4}$ $mol^2\ lit^{-2}$ at 25^0C

10. Which of the following is correct? **(2005 M)**

1. The P_H of one litre solution containing 0.49g of H_2SO_4 is 2.0

2. The conjugate base of H_2S is S^{-2}

3. BF_3 is a Lewis Base.

4. Phenolphthalein is colorless in basic medium.

Ans : 1

Sol: Molarity of $H_2SO_4 = \frac{0.49}{98 \times 1}$ = 0.005 M

$H_2SO_4 \rightarrow 2H^+ + SO_4^{2-}$

$\therefore \left[H^+\right] = 2 \times 0.005 = 0.01M$

PH = -log (0.01) = +2

11. Study the following table

Buffer solution	Volume (in ml) of 0.1M weak acid	Volume (in ml) of 0.1M sodium salt of weak acid
I	4.0	4.0
II	4.0	40.0
III	40.0	4.0
IV	0.1	10.0

Which of the two sets of buffer solutions have the least P_H **(2004 E)**

1. I and II 2. I and III 3. II and III 4. II and IV

Ans : 2

Sol: pH of an acid buffer is least when the concentration of an acid is buffer is highest. The buffer I and III have highest acid concentration and least pH.

12. 100ml of 0.015M HCl is mixed with 100 ml of 0.005M HCl, what is the PH of the resulting solution. **(2004 M)**

1.2.5 2. 1.5 3. 2 4. 1

Ans : 3

Sol: $\left[H^+\right] = \frac{(100 \times 0.015) + (100 \times 0.005)}{200}$

$\left[H^+\right] = \frac{1.5 + 0.5}{200} = \frac{2}{200} = 0.01$

pH = 2

13. If the ionic product of water is (K_w) 1.96x10-14 at350C. What is its value at 100C ? **(2003 E)**

1.1.96x10-14 2.3.92x10-14 3.2.95x10-15 4. 1.96x10-13

Ans : 3

Sol: With decrease in temp. the value of (K_w) decreases 10^0C $K_w = 2.95\times10^{-15}$

14. Which one of the following statements is correct? **(2002 E)**

1. Bronsted Lowry theory could not explain the acidic nature of BCl_3
2. The pH of 0.01 M NaOH solution is 2
3. The ionic product of water at 25_0C is 10_{-10} $mole_2/lit_2$
4. The pH of a solution can be calculated using the equation pH=log. (H_+)

Ans : 1

Sol: Bronsted Theory : An acid is a proton donor. But BCl_3 is not a proton donor. BCl_3 is an acid as per Lewis Theory.

15. What is the hybridization state of the central atom in the conjugate base of NH^+_4 ion ? **(2002 E)**

1) sp 2) sp^3 3) sp^2 4) dsp^2

Ans : 2

Sol: $NH^+_4 \rightarrow NH_3 + H^+$

NH_3 has sp^3 hybridisation

16. Which one of the following statements is not correct ? **(2002 M)**

1) Cl^- is a Lewis acid 2) The pH of 10^{-8} M HCl solution is less than 7

3) The ionic product of water at 25^0C is 10^{-14} mol^2. lit^{-2}

4) Bronsted – Lowry theory could not explain the acidic character of $AlCl_3$

Ans : 1

Sol: Cl^- is a Lewis base not Lewis acid.

This is wrong statement

All others correct

17. The P^{Ka} of weak acid is 4.8. What should be the ratio of (acid/salt) if buffer of pH = 5.8 is required **(2001 E)**

1) 0.1 M 2) 10 3) 1 4) 2

Ans : 1

Sol: Henderson equation

$$\text{pH of Buffer} = P^{ka} + \log\frac{[Salt]}{[Acid]}$$

$$5.8 = \left[4.8 + \log\frac{[Salt]}{[Acid]}\right]$$

$$\therefore \log\frac{[Salt]}{[Acid]} = 5.8 - 4.8 = 1$$

We know log 10 = 1

$$\therefore \frac{[Salt]}{[Acid]} = 10$$

$$\therefore \frac{[Acid]}{[Salt]} = \frac{1}{10} = 0.1$$

18. Which of the following would produce a buffer solution when mixed in equal volumes **(2001 E)**

1) 1 M $CH_3COOH \,\&\, 0.5M\ NaOH$

2) $1M\ CH_3COOH \& 0.5M\ HCl$

3) $1M\ NH_4OH \& 0.5M\ NaOH$

4) $1M\ NH_4Cl \& 0.5M\ HCl$

Ans : 1

Sol: A buffer should be an aqueous solution containing a weak acid and its conjugate base in the form of salt.

When mixed in equal volumes,

$1M\ CH_3COOH + 0.5M\ NaOH \rightarrow$

$0.25M\ CH_3COOH + 0.25M\ CH_3COONa \rightarrow$

$\downarrow$

Buffer solution

All others are not buffers

19. The pH of a 0.1M aqueous solution of a weak acid (HA) is 3. What is its degree of dissociation **(2001 M)**

1) 1% 2) 10% 3) 50% 4) 25%

Ans : 1

Sol: pH = 3

$\therefore \left[H^+\right] = 1\times10^{-3}M$

$\left[H^+\right]$ = degree of dissociation $\times$ Concentration of solution

$$\text{degree of dissociation, } \alpha = \frac{\left[H^+\right]}{\text{conc. of solution}}$$

$$= \frac{1\times10^{-3}}{0.1} = 1\times10^{-2} = 1\%$$

20. Which of the following is correct for acid buffer? (salt = S, acid = A) **(2000 E)**

1. $pKa = PH + \log\frac{[S]}{[A]}$

2. $pH = pKa + \log\frac{[S]}{[A]}$

3. $pKa = pH - \log\frac{[A]}{[S]}$

4. $pH = pKa + \log\frac{[A]}{[S]}$

Ans : 2

21. The pH of an aqueous solution of a salt is 10. The salt is **(2000 E)**

1. NaCl 2.NH4Cl 3. CH3COONa 4.(NH4)2 SO4

Ans : 3

Sol : Salt whose pH value "10"

Is Basic Salt i.e., CH_3COONa

22. The P^{ka} of a weak acid is 4.8. What is the ratio of [salt] to [acid], if a buffer of pH = 5.8 is to be prepared **(2000 M)**

1. 1:1 2. 10:1 3.2:1 4. 1:10

Ans: 2

Sol: $pH = Pka + \log \frac{[Salt]}{[Acid]}$

$$5.8 = 4.8 + \log \frac{[Salt]}{[Acid]}$$

$$5.8 - 4.8 + \log \frac{[Salt]}{[Acid]}$$

$$1 = \log \frac{[Salt]}{[Acid]}$$

$$\log_{10} = \log \frac{[Salt]}{[Acid]}$$

$$\frac{[Salt]}{[Acid]} = 10 = \frac{10}{1}$$

$$\therefore \frac{[Salt]}{[Acid]} = 10:1$$

23. Which of the following is a Lewis Acid? **(2000 M)**

1. $HCOO^-$ 2. H_2SO_4 3. SiF_4 4. H_2S

Ans: 3

Sol: In Si atom due to presence vacant d-orbitals, it can accept a pair of electrons.

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