



மாகாணக் கல்வித் திணைக்களம்  
வடக்கு மாகாணம்  
Provincial Department of Education, Northern Province



**மாதாந்த மதிப்பீடு**

Grade - 13

Chemistry

July - 2022

**Part 1**

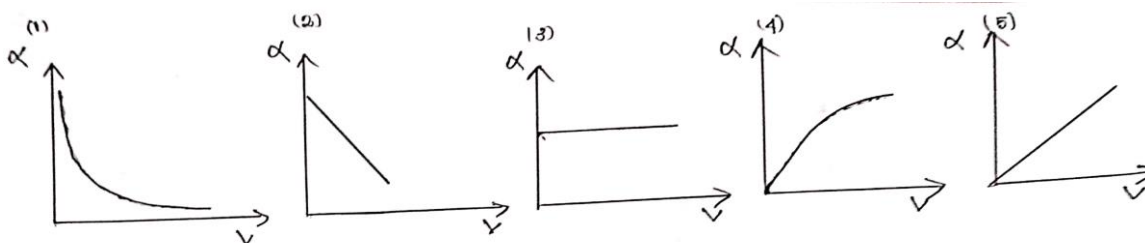
Select the most suitable answer.

- Which of the following aqueous solution shows an ionic equilibrium?  
 (1) NaOH (aq) (2) H<sub>2</sub>SO<sub>4</sub> (aq) (3) CH<sub>3</sub>COOH (aq)  
 (4) Na<sub>2</sub>SO<sub>4</sub> (aq) (5) Ba(OH)<sub>2</sub> (aq)
- 40 ml of 0.1 mol dm<sup>-3</sup> NaOH solution and 10 ml of 0.45 mol dm<sup>-3</sup> HNO<sub>3</sub> solution were mixed together. what would be the pH of the resultant solution?  
 (1) 1 (2) 2 (3) 3 (4) 4 (5) 5
- Which of the following response is true with respect to the ascending order of pH of the given solutions?  
 a. 0.01 mol dm<sup>-3</sup> HCl b. 0.01 mol dm<sup>-3</sup> H<sub>2</sub>SO<sub>4</sub>  
 c. 0.01 mol dm<sup>-3</sup> NaOH d. 0.01 mol dm<sup>-3</sup> CH<sub>3</sub>COOH  
 (1) c < d < b < a (2) d < a < c < b (3) b < a < d < c  
 (4) a < b < c < d (5) d < c < a < b
- At certain temperature, solubility product of; A<sub>2</sub>B<sub>3</sub>(s) is; 108 x 10<sup>-20</sup> mol<sup>5</sup> dm<sup>-15</sup>; solubility of A<sub>2</sub>B<sub>3</sub>(s) in water is ,  
 (1) 1 x 10<sup>-3</sup> mol dm<sup>-3</sup> (2) 1 x 10<sup>-4</sup> mol dm<sup>-4</sup> (3) 2x 10<sup>-4</sup> mol dm<sup>-3</sup>  
 (4) 3 x 10<sup>-4</sup> mol dm<sup>-3</sup> (5) 1.5 x 10<sup>-3</sup> mol dm<sup>-3</sup>
- 1 mol dm<sup>-3</sup> HCOOH solution and; 1 mol dm<sup>-3</sup> CH<sub>3</sub>COOH solution were mixed together .  
 Ka values of HCOOH and H<sub>3</sub>COOH were 1.8 x 10<sup>-4</sup> mol dm<sup>-3</sup> and 1.8 x 10<sup>-5</sup> mol dm<sup>-3</sup> respectively. At equilibrium the value of  $\frac{[HCOO^-(aq)]}{[CH_3COO^-(aq)]}$  is equal to,  
 (1) 1 (2) 1.5 (3) 10 (4) 1.05 (5) 20
- A<sub>2</sub>X, AY are two sparingly soluble salts in water. At room temperature their solubility products are K<sub>sp1</sub> and K<sub>sp2</sub> respectively. Solubility of A<sub>2</sub>X is S<sub>1</sub> and the solubility of AY is S<sub>2</sub>. When each salt is in equilibrium with its saturated solution, if S<sub>2</sub> = 2S<sub>1</sub> , which of the following is correct?  
 (1)  $\frac{K_{sp1}}{K_{sp2}} = S_2$  (2)  $\frac{K_{sp1}}{K_{sp2}} = S_1$  (3) K<sub>sp2</sub> = K<sub>sp1</sub>  
 (4)  $\frac{K_{sp1}}{K_{sp2}} = S_1^2$  (5) K<sub>sp1</sub> = 2K<sub>sp2</sub>
- Which one of the following chlorides in 1 mol dm<sup>-3</sup> aqueous solution shows the highest pH value?  
 (1) AlCl<sub>3</sub> (2) HCl (3) PCl<sub>3</sub> (4) MgCl<sub>2</sub> (5) NH<sub>4</sub>Cl

8. The pH value of the solution obtained by mixing 100 cm<sup>3</sup> of 0.1 mol H<sub>2</sub>SO<sub>4</sub> and 100 cm<sup>3</sup> of 0.4 mol KOH at 25 °C is,  
 (1) 10 (2) 11 (3) 12 (4) 12.5 (5) 13

9. Solution P containing 0.55 mol dm<sup>-3</sup> NH<sub>4</sub>OH and 0.1 mol dm<sup>-3</sup> NH<sub>4</sub>Cl has a pH = 10.0. If 1 cm<sup>3</sup> of 0.1 mol dm<sup>-3</sup> NaOH was added to 1 dm<sup>3</sup> of the solution P, the pH of the resulting solution would be,  
 (1) 9.0 (2) 9.5 (3) 10.0 (4) 10.5 (5) 11.0

10. When 1 mol of Ethanoic acid is diluted at constant temperature to a volume V. Which one of the following graphs represents the variation of degree of dissociation ( $\alpha$ ) of the acid with V?



11. Which one of the following indicator is most suitable for the titration between aqueous Ba(OH)<sub>2</sub> and propanoic acid?

- (1) Methyl orange (2) Methyl Red (3) Litmus paper  
 (4) Bromothymol Blue (5) Phenolphthalein

12. The concentration of aqueous solution of NaOH is 1 x 10<sup>-4</sup> mol dm<sup>-3</sup>. The pH value of this solution at 25 °C is,  
 (1) 4 (2) 10 (3) 5 (4) 13 (5) 11

13. A 1 mol dm<sup>-3</sup> aqueous solution of a mono basic weak acid is 25 % dissociated. The  $K_a$  value of this acid is,  
 (1) 6.25 x 10<sup>-2</sup> mol dm<sup>-3</sup> (2) 6.25 x 10<sup>-2</sup> mol<sup>2</sup> dm<sup>-6</sup> (3) 8.33 x 10<sup>-2</sup> mol dm<sup>-3</sup>  
 (4) 8.33 x 10<sup>-4</sup> mol dm<sup>-3</sup> (5) 62.5 x 10<sup>-2</sup> mol dm<sup>-3</sup>

14. The relationship among  $K_b$  of NH<sub>3</sub>(aq),  $K_a$  of;  $NH_4^+$ (aq) and  $K_w$  at the same temperature is,  
 (1)  $K_a/K_b = K_w$  (2)  $K_b/K_a = K_w$  (3)  $K_a - K_b = K_w$  (4)  $K_a \times K_b = K_w$   
 (5) None of the above

15. The solubility product of M(OH)<sub>2</sub> at room temperature is 5 x 10<sup>-10</sup> mol<sup>3</sup> dm<sup>-3</sup>. The OH<sup>-</sup> ion concentration in mol dm<sup>-3</sup> of a saturated aqueous solution of M(OH)<sub>2</sub> at room temperature is,  
 (1) 5 x 10<sup>-4</sup> (2) 1 x 10<sup>-3</sup> (3) 2.5 x 10<sup>-5</sup> (4) 125 x 10<sup>-30</sup> (5) 5 x 10<sup>-3</sup>

#### Instructions for questions 16 to 20

(1)	(2)	(3)	(4)	(4)
Only (a), (b) are correct	Only (b), (c) are correct	Only (c), (d) are correct	Only (a), (d) are correct	Any other response/responses is/are correct

16. Which of the following statements is / are true?
- Acids and bases are electrolytic solutions
  - Concentration of  $\text{H}_2\text{O}$  is  $55.5 \text{ mol dm}^{-3}$ .
  - Ionic product of water is  $1 \times 10^{-14} \text{ mol}^2 \text{ dm}^{-6}$  at  $25^\circ\text{C}$
  - unit of pH is  $\text{mol dm}^{-3}$
17. In  $298 \text{ K}$  a solution is prepared by mixing  $100 \text{ cm}^3$  of  $1 \text{ mol dm}^{-3}$   $\text{HCl}$  into  $200 \text{ cm}^3$  of  $1 \times 10^{-4} \text{ mol dm}^{-3}$   $\text{CH}_3\text{COONa}$ . Which of the following statements is / are true? ( $K_a = 1.8 \times 10^{-5} \text{ mol dm}^{-3}$ )
- pH of the resultant solution is 7.
  - In the resultant solution ;  $\text{H}^+$  ion concentration is  $0.5 \text{ mol dm}^{-3}$
  - Resultant solution is a buffer solution.
  - pH of the resultant solution is less than 7.
18. Which of the following statements is / are true?
- pH of  $1 \times 10^{-8} \text{ mol dm}^{-3}$   $\text{HCl}$  is 8 at  $25^\circ\text{C}$
  - Conjugate base of  $\text{H}_2\text{PO}_3^-$  is  $\text{HPO}_3^{2-}$
  - With increase of temperature, ionic product of water decreases.
  - Ionization of water is an endothermic reaction.
19. Consider the solution of;  $0.04 \text{ mol dm}^{-3}$   $\text{KOH}$  at  $25^\circ\text{C}$ . Which of the following statements is / are true?
- $\text{OH}^-$  ion concentration is  $0.04 \text{ mol dm}^{-3}$ .
  - $\text{pH} = 12.6$
  - $\text{pOH} = 2.4$
  - Concentration of  $\text{KOH (aq)}$  is greater than  $\text{OH}^-$  ion concentration
20. Solution X has been prepared by mixing  $50 \text{ cm}^3$  of  $0.1 \text{ mol dm}^{-3}$   $\text{CH}_3\text{COOH (aq)}$  and  $50 \text{ cm}^3$  of  $0.1 \text{ mol dm}^{-3}$   $\text{CH}_3\text{COONa (aq)}$ . Which of the following statements is / are true about this solution X?
- It has a  $\text{CH}_3\text{COO}^-$  concentration of  $0.1 \text{ mol dm}^{-3}$ .
  - It has a  $\text{H}_3\text{O}^+$  concentration of  $0.1 \text{ mol dm}^{-3}$ .
  - It's pH is less than 7
  - It has buffer property

#### Instructions for questions 21 to 25

Response	First statement	Second statement
(1)	True	True, and correctly explain in the first statement
(2)	True	True, but not explain in the first statement correctly
(3)	True	False
(4)	False	True
(5)	False	False

	First statement	Second statement
21.	When the pH of an aqueous solution changes, the pOH also changes by the same number of units at same temperature.	When the $\text{H}^+$ concentration of a solution changes, the $\text{OH}^-$ also changes by the same amount at same temperature.

22.	NH <sub>3</sub> solution is classified as a Bronsted base.	NH <sub>3</sub> accepts a proton from water forming forming $NH_4^+$ solution and OH <sup>-</sup> ion solution.
23.	$SO_4^{2-}$ is a conjugate base of H <sub>2</sub> SO <sub>4</sub>	The conjugate bases should have one proton less in each acids.
24.	At 25 °C pH of an aqueous solution of NH <sub>4</sub> Cl is less than 7 .	Cl <sup>-</sup> ion of NH <sub>4</sub> Cl undergoes hydrolysis to give HCl solution.
25.	When H <sub>2</sub> S is passed in acidic medium, Mn <sup>2+</sup> is precipitated as MnS.	Solubility product of MnS is less than that of Group II sulfides in qualitative analysis

### Part 2 - A ( Structured Essay questions )

1) (a) 1. Bicarbonate ion ( $HCO_3^-$ ) can acts as an acid or a base, Give suitable reactions for each?

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2.Mention whether, the following salts in an aqueous solution are acidic, basic, or neutral.

- i. C<sub>6</sub>H<sub>5</sub>COONa - .....
- ii. Ba Cl<sub>2</sub> - .....
- iii. Al Cl<sub>3</sub> - .....
- iv. FeCl<sub>3</sub> - .....

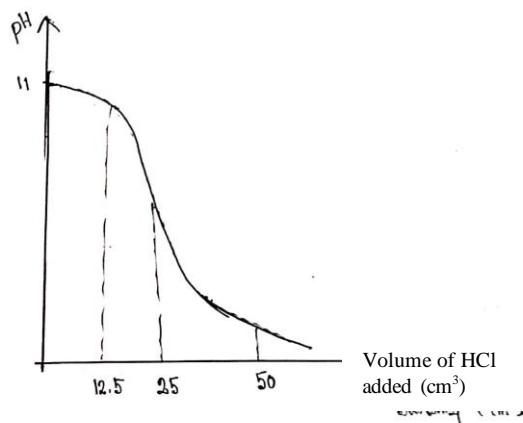
3. Calculate the pH of 0. 025 mol dm<sup>-3</sup> HCl solution?

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4. The pH of a rain water sample collected from Kandy was 4.62. Calculate the H<sub>3</sub>O<sup>+</sup> ion concentration of the sample?

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 .....

(b) Methylamine ( $\text{CH}_3\text{NH}_2$ ) is a weak base. At  $25^\circ\text{C}$   $25.00\text{ cm}^3$  of a given  $\text{CH}_3\text{NH}_2$  was titrated against  $\text{HCl}$  solution of particular concentration. The following graph shows the variation of pH with the volume of  $\text{HCl}$  added into the  $\text{CH}_3\text{NH}_2$  solution.  $K_b$  of Methylamine is  $5 \times 10^{-5}\text{ mol dm}^{-3}$



(1) Write the equilibrium reaction exist in an aqueous solution of  $\text{CH}_3\text{NH}_2$  .

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(2) Write the expression for  $K_b$  of  $\text{CH}_3\text{NH}_2$ ?

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(3) Calculate the initial concentration of  $\text{CH}_3\text{NH}_2$ ?

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(4) Calculate the initial concentration of  $\text{HCl}$  solution?

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(5) Calculate the pH values corresponding three points in of A , B and C .

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(6) Name an indicator that could be used for this titration.

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### Part 2-B (Essay Question)

(1) (a) (i) Derive the relationship between  $K_b$  of  $\text{NH}_3$  and  $K_a$  of  $\text{NH}_4^+$  in aqueous solution?

ii) At  $25^\circ\text{C}$  the concentration of an aqueous solution of a mono- basic weak acid is  $0.1\text{mol dm}^{-3}$ . Calculate the  $\text{OH}^-$  ion concentration in this aqueous solution?

At  $25^\circ\text{C}$   $K_a = 9 \times 10^{-9} \text{ mol dm}^{-3}$  &

$K_w = 1 \times 10^{-14} \text{ mol}^2 \text{ dm}^{-6}$ .

iii) Show that pH of  $C \text{ mol dm}^{-3}$  solution of  $\text{CH}_3\text{COOH}(\text{aq})$  can be given by ,

$$\text{pH} = \frac{1}{2} \text{p}K_a - \frac{1}{2} \log C$$

Here,  $K_a$  is the dissociation constant of weak acid  $\text{CH}_3\text{COOH}$

iv) Find the pH of the solution, where the concentration of  $\text{CH}_3\text{COOH}$  is  $0.1 \text{ mol dm}^{-3}$ .  
 $K_a$  value of  $\text{CH}_3\text{COOH}$  is  $2 \times 10^{-5} \text{ mol dm}^{-3}$

v) Calculate the pH of a solution formed through the reaction of  $0.1 \text{ mol dm}^{-3}$ ,  $40 \text{ cm}^3$  of  $\text{CH}_3\text{COOH}(\text{aq})$  with  $10 \text{ cm}^3$  of  $0.1 \text{ mol dm}^{-3} \text{ KOH}(\text{aq})$  at  $25^\circ\text{C}$ .

$K_a$  of  $\text{CH}_3\text{COOH}$  is  $2 \times 10^{-5} \text{ mol dm}^{-3}$

(b) (i) What is the pH of  $0.05 \text{ mol dm}^{-3}$  solution of a weak base B at  $25^\circ\text{C}$  ?

$K_b$  of B is  $5 \times 10^{-3} \text{ mol dm}^{-3}$ ;  $K_w = 1 \times 10^{-14} \text{ mol}^2 \text{ dm}^{-6}$

(ii) What is the pH of the solution containing the weak base mentioned above and its conjugate acid  $\text{BH}^+$  with equal concentration?

(iii) The above solution was diluted upto  $100 \text{ cm}^3$  with distilled water. Calculate the pH of this solution at  $25^\circ\text{C}$

(C) The solubility product of  $\text{AgCl}(\text{s})$  at  $25^\circ\text{C}$  is  $1 \times 10^{-10} \text{ mol}^2 \text{ dm}^{-6}$ .

(i) Calculate the solubility of  $\text{AgCl}(\text{s})$  in water?

(ii) Calculate the solubility of  $\text{AgCl}(\text{s})$  in a solution of  $0.01 \text{ mol dm}^{-3} \text{ NaCl}(\text{aq})$  ?