Q1 - 24 January - Shift 1

The dissociation constant of acetic is x × 10^{-5}. When 25 mL of 0.2 M CH_3COONa solution is mixed with 25 mL of 0.02 M CH_3COOH solution, the pH of the resultant solution is found to be equal to 5. The value of x is _____.

Space for your notes:

Q2 - 24 January - Shift 2

If the pKa of lactic acid is 5, then the pH of 0.005 M calcium lactate solution at 25° C is _____ × 10^{-1} (Nearest integer)

Lactic acid $CH_3 - \underset{\underset{OH}{|}}{\overset{\overset{H}{|}}{C}} - COOH$

Space for your notes:

Q3 - 25 January - Shift 1

A litre of buffer solution contains 0.1 mole of each of NH_3 and NH_4Cl. On the addition of 0.02 mole of HCl by dissolving gaseous HCl, the pH of the solution is found to be _____ × 10^{-3} (Nearest integer)

[**Given** : $pK_b(NH_3) = 4.745$

log 2 = 0.301

log 3 = 0.477

T = 298 K]

Space for your notes:

Q4 - 25 January - Shift 2

When the hydrogen ion concentration $[H^+]$ changes by a factor of 1000, the value of pH of the solution _____.

(1) increases by 1000 units

(2) decreases by 3 units

(3) decreases by 2 units

(4) increases by 2 units

Space for your notes:

Q5 - 25 January - Shift 2

Match List I with List II

	List I (Amines)		List II (pK_b)
A.	Aniline	I.	3.25
B.	Ethanamine	II.	3.00
C.	N-Ethylethanamine	III.	9.38
D.	N, N-Diethylethanamine	IV.	3.29

Choose the correct answer from the options given below :-

(1) A-I, B-IV, C-II, D-III

(2) A-III, B-II, C-I, D-IV

(3) A-III, B-II, C-IV, D-I

(4) A-III, B-IV, C-II, D-I

Space for your notes:

Q6 - 29 January - Shift 1

Millimoles of calcium hydroxyide required to produce 100 mL of the aqueous solution of pH 12 is $x \times 10^{-1}$. The value of x is _____ (Nearest integer). Assume complete dissociation.

Space for your notes:

Q7 - 30 January - Shift 1

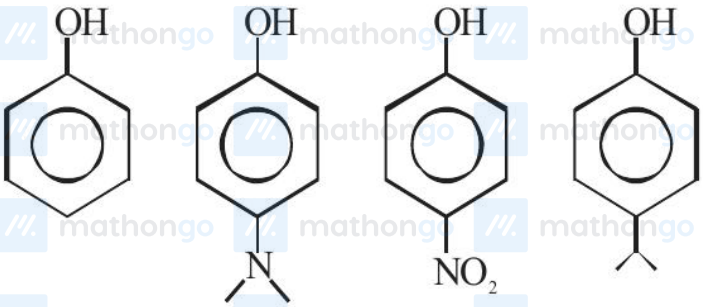
600 mL of 0.01M HCl is mixed with 400 mL of 0.01 M H_2SO_4. The pH of the mixture is _____ $\times 10^{-2}$. (Nearest integer)

[Given $\log 2 = 0.30$, $\log 3 = 0.48$
$\log 5 = 0.69$ $\log 7 = 0.84$
$\log 11 = 1.04$]

Space for your notes:

Q8 - 30 January - Shift 2

The correct order of pK_a values for the following compounds is:



(a) (b) (c) (d)

(1) c > a > d > b (2) b > d > a > c
(3) b > a > d > c (4) a > b > c > d

Space for your notes:

Q9 - 31 January - Shift 1

The logarithm of equilibrium constant for the reaction $Pd^{2+} + 4Cl^- \rightleftharpoons PdCl_4^{2-}$ is _____ (Nearest integer)

Given: $\frac{2.303RT}{F} = 0.06V$

$Pd^{2+}_{(aq)} + 2e^- \rightleftharpoons Pd(s)$ $E^o = 0.83V$

$PdCl_4^{2-}(aq) + 2e^- \rightleftharpoons Pd(s) + 4Cl^-(aq)$

Space for your notes:

Q10 - 31 January - Shift 2

Incorrect statement for the use of indicators in acid-base titration is :

(1) Methyl orange may be used for a weak acid vs weak base titration.

(2) Methyl orange is a suitable indicator for a strong acid vs weak base titration

(3) Phenolphthalein is a suitable indicator for a weak acid vs strong base titration

(4) Phenolphthalein may be used for a strong acid vs strong base titration.

Space for your notes:

Q11 - 31 January - Shift 2

At 298 K, the solubility of silver chloride in water is 1.434×10^{-3} g L^{-1}. The value of $-\log K_{sp}$ for silver chloride is _____.

(Given mass of Ag is 107.9 g mol^{-1} and mass of Cl is 35.5 g mol^{-1})

Space for your notes:

Answer Key

(As per Official NTA Key released on 2 Feb)

Q1 (10)	**Q2** (85)	**Q3** (9079)	**Q4** (4)
Q5 (4)	**Q6** (5)	**Q7** (186)	**Q8** (2)
Q9 (6)	**Q10** (1)	**Q11** (10)	

Q1 (10)

Buffer of HOAc and NaOAc

$$pH = pKa + \log \frac{0.1}{0.01}$$

$$5 = pKa + 1$$

$$pKa = 4$$

$$Ka = 10^{-4}$$

$$x = 10$$

Q2 (85)

Concentration of calcium lactate = 0.005 M,:

concentration of lactate ion = (2 × 0.005) M.

Calcium lactate is a salt of weak acid + strong base

∴ Salt hydrolysis will take place.

$$pH = 7 + \frac{1}{2}(pKa + \log C)$$

$$= 7 + \frac{1}{2}\left(5 + \log\left(2 \times 0.005\right)\right)$$

$$= 7 + \frac{1}{2}[5 - 2\log 10] \; = 7 + \frac{1}{2} \times 3 \; = 8.5 = 85 \times 10^{-1}$$

Q3 (9079)

In resultant solution

$$n_{NH_3} = 0.1 - 0.02 = 0.08$$

$$n_{NH_4Cl} = n_{NH_4^+} = 0.1 + 0.02 = 0.12$$

$$pOH = pK_b + \log\frac{[NH_4^+]}{[NH_3]}$$

$$= 4.745 + \log\frac{0.12}{0.08}$$

$$= 4.745 + \log\frac{3}{2}$$

$$= 4.745 + 0.477 - 0.301$$

$$pOH = 4.921$$

$$pH = 14 - pH$$

$$= 9.079$$

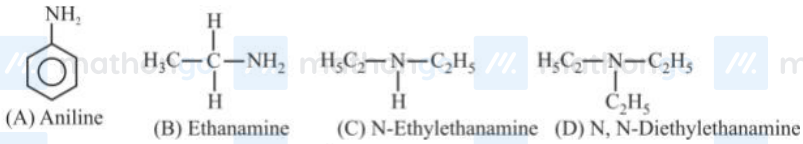
Q4 (4)

$$\Delta[H^+] = 1000$$

$$\Delta pH = -\log \Delta[H^+] = -\log 10^3$$

$$= -3$$

Q5 (4)



(A) Aniline (B) Ethanamine (C) N-Ethylethanamine (D) N, N-Diethylethanamine

$$\text{Basic Strength } \alpha \frac{1}{pK_b}$$

Order for pK_b: A > B > D > C

Q6 (5)

$\because$ pH = 12

$\therefore [H^+] = 10^{-12}$ M

$\therefore [OH^-] = 10^{-2}$ M

$\therefore [Ca(OH)_2] = 5 \times 10^{-3}$ M

$$5 \times 10^{-3} = \frac{\text{milli moles of } Ca(OH)_2}{100\,mL}$$

$$\text{milli moles of } Ca(OH)_2 = 5 \times 10^{-1}$$

Ans. = 5

Q7 (186)

Total milimoles of $H^+ = (600\times0.01) + (400\times0.01\times2)$

$= 14$

$$[H^+] = \frac{14}{1000} = 14\times10^{-3}$$

$pH = 3 - \log 14$

$= 1.86$

$= 186 \times 10^{-2}$

Q8 (2)

Due to $-M$ effect of $-NO_2$ group, it increases acidity

$+M$ effect of $N(CH_3)_2$ decreases acidity.

Hyperconjugation of isopropyl decrease acidity

$\therefore$ order of acidic strength

Q9 (6)

$E^\circ = 0.65V$

$\Delta G^\circ = -RT\ell n K$

$-nFE^\circ_{cell} = -RT\times2.303(\log_{10} K)$

$$\frac{E^\circ_{Cell}}{0.06}\times n = \log K \quad \ldots(1)$$

$Pd^{+2}(aq.) + 2e^- \rightleftharpoons Pd(s)\ ,\ E^\circ_{cat,red^n} = 0.83$

$Pd(s) + 4Cl^-(aq.) \rightleftharpoons PdCl_4^{2-},(aq) + 2e^-, E^\circ_{Anode,Oxid^n} = 0.65$

Net Reaction ->

$$Pd^{2+}(aq.) + 4Cl^-(aq.) \rightleftharpoons PdCl_4^{2-}(aq.)$$

$E^\circ_{cell} = E^\circ_{cat,red^n} - E^\circ_{Anode,Oxid^n}$

$E^\circ_{cell} = 0.83 - 0.65 = 0.18 \quad \ldots(2)$

Also $n = 2 \quad \ldots(3)$

Using equation (1), (2) & (3)

Q10 (1)

Indicator	pH range
Methyl orange	3.2 – 4.5
Phenolpthalein	8.3 – 10.5

Methyl orange may be used for a strong acid vs strong base and strong acid vs weak base titration.

Phenolpthalein may be used for a strong acid vs strong base and weak acid vs strong base titration.

Q11 (10)

$$AgCl(s) \rightarrow \underset{S}{Ag^{+}(aq.)} + \underset{S}{Cl^{-}(aq.)}$$

$$K_{sp} = S^2 = \left(\frac{1.43}{143.4} \times 10^{-3}\right)^2 = 10^{-10}$$

$$-\log K_{sp} = 10$$