Q1 - 24 January - Shift 1

At 298 K, a 1 litre solution containing 10 mmol of $Cr_2O_7^{2-}$ and 100 mmol of Cr^{3+} shows a pH of 3.0.

Given : $Cr_2O_7^{2-} \rightarrow Cr^{3+}$; $E^0 = 1.330$ V and

$\frac{2.303\ RT}{F} = 0.059$ V

The potential for the half cell reaction is $x \times 10^{-3}$ V. The value of x is .

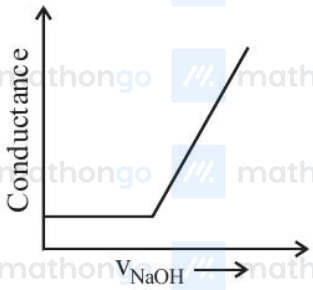
Space for your notes:

Q2 - 24 January - Shift 2

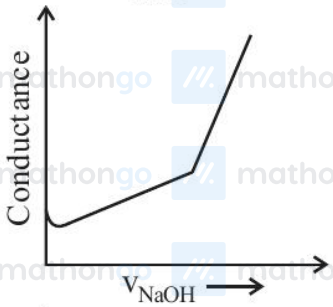
Choose the correct representation of conductometric titration of benzoic acid vs sodium hydroxide.

Space for your notes:

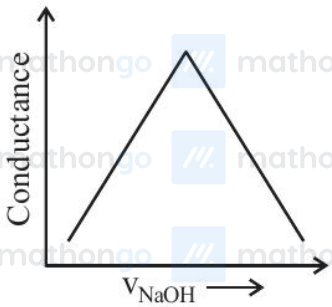
(1)



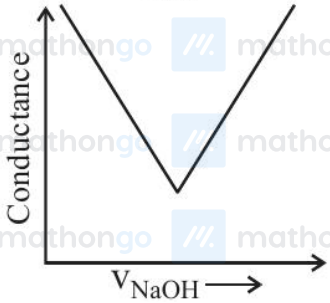
(2)



(3)



(4)



Q3 - 25 January - Shift 1

Consider the cell

$$Pt(s)|H_2(s)(1atm)|H^+(aq,[H^+]=1)||Fe^{3+}(aq),Fe^{2+}(aq)|Pt(s)$$

Given : $E^\circ_{Fe^{3+}/Fe^{2+}} = 0.771V$ and $E^\circ_{H^+/\frac{1}{2}H_2} = 0V, T = 298K$

If the potential of the cell is 0.712 V the ratio of concentration of Fe^{2+} to Fe^{2+} is_____(Nearest integer)

Space for your notes:

Q4 - 25 January - Shift 2

$$Pt(s)H_2(g)(1bar)|H^+(aq)(1M)||M^{3+}(aq),M^+(aq)|Pt(s)$$

The E_{cell} for the given cell is 0.1115 V at 298 K

when $\frac{[M^+(aq)]}{[M^{3+}(aq)]} = 10^a$

The value of a is _____

Given : $E^\theta_{M^{3+}/M^+} = 0.2$ V

$\frac{2.303\ RT}{F} = 0.059$ V

Space for your notes:

Q5 - 29 January - Shift 1

The standard electrode potential (M^{3+}/M^{2+}) for V, Cr, Mn & Co are -0.26 V, - 0.41 V, + 1.57 V and +1.97 V, respectively. The metal ions which can liberate H_2 from a dilute acid are

(1) V^{2+} and Mn^{2+}

(2) Cr^{2+} and CO^{2+}

(3) V^{2+} and Cr^{2+}

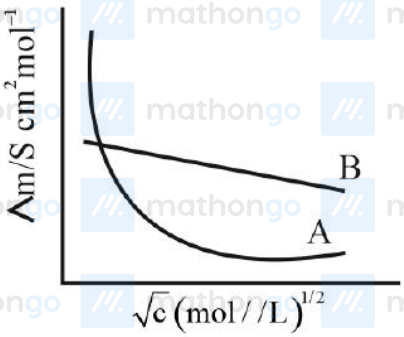
(4) Mn^{2+} and Co^{2+}

Space for your notes:

Q6 - 29 January - Shift 1

Following figure shows dependence of molar conductance of two electrolytes on concentration.

Λ_m^0 is the limiting molar conductivity.



The number of **Incorrect** statement(s) from the following is _____

(A) Λ_m^0 for electrolyte A is obtained by extrapolation

(B) For electrolyte B, vx Λm vs $\sqrt{c}$ graph is a straight line with intercept equal to Λ_m^0

(C) At infinite dilution, the value of degree of dissociation approach zero for electrolyte B.

(D) Λ_m^0 for any electrolyte A or B can be calculated using λ^o for individual ions.

Space for your notes:

Q7 - 29 January - Shift 2

The equilibrium constant for the reaction $Zn(s) + Sn^{2+}(aq) \rightleftharpoons Zn^{2+}(aq) + Sn(s)$ is 1×10^{20} at 298 K. The magnitude of standard electrode potential of Sn/Sn^{2+} if $E^{o}_{Zn^{2+}/Zn} = -0.76$ V is _____ $\times 10^{-2}$ V. (Nearest integer)

Given : $\frac{2.303RT}{F} = 0.059V$

Space for your notes:

Q8 - 30 January - Shift 1

Consider the cell

$$Pt_{(s)} \left| H_2(g, 1atm) \right| H^+(aq, 1M) \left| \right| Fe^{3+}(aq), Fe^{2+}(aq) \left| Pt(s) \right.$$

When the potential of the cell is 0.712 V at 298 K, the ratio $\lfloor Fe^{2+} \rfloor / \lfloor Fe^{3+} \rfloor$ is _____.
(Nearest integer)

Given: $Fe^{3+} + e^- = Fe^{2+}, E^{\circ} Fe^{3+}, Fe^{2+} \left| Pt = 0.771 \right.$

$\frac{2.303\,RT}{F} = 0.06\,V$

Space for your notes:

Q9 - 30 January - Shift 2

The electrode potential of the following half cell at 298 K.

$X \mid X^{2+}(0.001\ M) \parallel Y^{2+}(0.01\ M) \mid Y$

is _____ $\times 10^{-2}$ V (Nearest integer).

Given : $E^0_{x^{2+}|x} = -2.36V$

$E^0_{Y^{2+}|Y} = +0.36V$

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

Space for your notes:

Q10 - 31 January - Shift 1

Which one of the following statements is correct for electrolysis of brine solution?

(1) Cl_2 is formed at cathode
(2) O_2 is formed at cathode
(3) H_2 is formed at anode
(4) OH^- is formed at cathode

Space for your notes:

Q11 - 31 January - Shift 2

The resistivity of a 0.8 M solution of an electrolyte is $5 \times 10^{-3}\ \Omega cm$. Its molar conductivity is _____ $\times 10^4\ \Omega^{-1}\ cm^2\ mol^{-1}$. (Nearest integer)

Space for your notes:

Q12 - 01 February - Shift 1

At what pH, given half cell MnO_4^- (0.1 M) | Mn^{2+} (0.001 M) will have electrode potential of 1.282 V? _____ (Nearest Integer)

Given $E^o_{MnO_4^-/Mn^{2+}} = 1.54$ V, $\frac{2.303RT}{F} = 0.059$V

Space for your notes:

Q13 - 01 February - Shift 2

1×10^{-5} M $AgNO_3$ is added to 1 L of saturated solution of AgBr. The conductivity of this solution at 298 K is _____ $\times10^{-8}$ S m^{-1}.

[Given : $K_{sp}(AgBr) = 4.9\times10^{-13}$ at 298K

$\lambda^0_{Ag^+} = 6\times10^{-3}$ Sm^2 mol^{-1}

$\lambda^0_{Br^-} = 8\times10^{-3}$ Sm^2 mol^{-1}

$\lambda^0_{NO_3^-} = 7\times10^{-3}$ Sm^2 mol^{-1}]

Space for your notes:

Answer Key

(As per Official NTA Key released on 2 Feb)

Q1 (917)	**Q2** (2)	**Q3** (10)	**Q4** (3)
Q5 (3)	**Q6** (2)	**Q7** (17)	**Q8** (10)
Q9 (275)	**Q10** (4)	**Q11** (25)	**Q12** (3)
Q13 (14)			

Q1 (917)

$$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$$

$$E = 1.33 - \frac{0.059}{6}\log\frac{(0.1)^2}{(10^{-2})(10^{-3})^{14}}$$

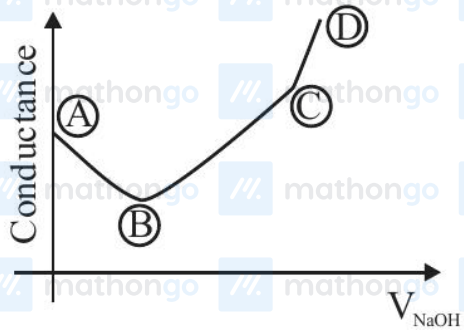
$$E = 1.33 - \frac{0.059}{6} \times 42 = 0.917$$

$$E = 917 \times 10^{-3}$$

$$x = 917$$

Q2 (2)

$$\underset{(WA)}{C_6H_5COOH} + \underset{(SB)}{NaOH} \longrightarrow \underset{(Salt)}{C_6H_5COONa} + H_2O$$



(A) $\rightarrow$ (B) Free H^+ ions are replaced by $Na^{\oplus}$ which decreases conductance.

(B) $\rightarrow$ (C) Un-dissociated benzoic acid reacts with NaOH and forms salt which increases ions & conductance increases.

(C) $\rightarrow$ (D) After equivalence point at (3), NaOH added further increases $Na^{\oplus}$ & $OH^{\odot}$ ions which further increases the conductance.

Q3 (10)

$$\frac{1}{2}H_2(g)+Fe^{3+}(aq.)\longrightarrow H^+(aq)+Fe^{2+}(aq.)$$

$$E=E^o-\frac{0.059}{1}\log\frac{[Fe^{2+}]}{[Fe^{3+}]}$$

$$\Rightarrow \quad 0.712=(0.771-0)-\frac{0.059}{1}\log\frac{[Fe^{2+}]}{[Fe^{3+}]}$$

$$\Rightarrow \quad \log\frac{[Fe^{2+}]}{[Fe^{3+}]}=\frac{(0.771-0712)}{0.059}=1$$

$$\Rightarrow \quad \frac{[Fe^{2+}]}{[Fe^{3+}]}=10$$

Q4 (3)

Overall reaction :–

$$H_{2(g)}+M^{3+}_{(aq)}\longrightarrow M^{+}_{(aq)}+2H^{+}_{(aq)}$$

$$E_{Cell}=E^o_{Cathode}-E^o_{anode}-\frac{0.059}{2}\log\frac{[M^+]\times 1^2}{[M^{+3}]\,1}$$

$$0.1115=0.2-\frac{0.059}{2}\log\frac{[M^+]}{[M^{+3}]}$$

$$3=\log\frac{[M^+]}{[M^{+3}]}$$

$$\therefore \quad a=3$$

Q5 (3)

Metal cation with (–) value of reduction potential (M^{+3}/M^{+2})or with (+) value of oxidation potential (M^{+2}/M^{+3}) will liberate H_2
Therefore they will reduce H^+
i.eV^{+2} and Cr^{+2}

Q6 (2)

Statement (A) and Statement (C) are incorrect

Q7 (17)

$$Zn(s) + Sn^{2+}(aq) \rightleftharpoons Zn^{2+}(aq) + Sn(s)$$

$$\Delta G^\circ = -2.303RT \log_{10} Keq$$

$$-nF\left(E^0_{cell}\right) = -2.303RT \log_{10} Keq$$

$$E^0_{Zn/Zn^{2+}} + E^0_{Sn^{2+}/Sn} = \frac{0.059}{2} \log_{10} Keq$$

$$0.76 + E^0_{Sn^{2+}/Sn} = \frac{0.059}{2} \log_{10} 10^{20}$$

$$0.76 + E^0_{Sn^{2+}/Sn} = \frac{0.059 \times 20}{2}$$

$$E^0_{Sn^{2+}/Sn} = 0.59 - 0.76 = -0.17$$

$$E^0_{Sn/Sn^{2+}} = 17 \times 10^{-2} V$$

Ans. = 17

Q8 (10)

$$Pt_{(s)}\left|H_2(g,1atm)\right|$$

$$H^+(aq,1M)\,||\,Fe^{3+}(aq),Fe^{2+}(aq)\,|\,Pt(s)$$

at anode $H_2 \longrightarrow 2H^+ + 2e^-$

At cathode $Fe^{3+}_{aq} + e^- \longrightarrow Fe^{2+}_{aq}$

$$E^\circ = E^\circ_{H_2|H^+} + E^\circ_{Fe^{3+}|Fe^{2+}} = 0\cdot771\,V$$

$$E = E^\circ - \frac{0\cdot06}{1}\log\frac{Fe^{2+}}{Fe^{3+}}$$

$$0\cdot712 = (0+0\cdot771) - \frac{0\cdot06}{1}\log\frac{Fe^{2+}}{Fe^{3+}}$$

$$\log\frac{Fe^{2+}}{Fe^{3+}} = \frac{0\cdot059}{0\cdot06} \approx 1$$

$$\boxed{\frac{Fe^{2+}}{Fe^{3+}} = 10}$$

Q9 (275)

$$X + Y^{2+} \rightarrow Y + X^{2+}$$

$$E^0_{Cell} = 0.36 - (-2.36) = 2.72\ V$$

$$E_{Cell} = 2.72 - \frac{0.06}{2}\log\frac{0.001}{0.01}$$

$$= 2.72 + 0.03 = 2.75\ V$$

$$= 275 \times 10^{-2}\ V$$

Q10 (4)

Electrolysis of brine solution

$$NaCl(aq.) \longrightarrow Na^{+}_{(aq)} + Cl^{+}_{(aq)}$$

At anode : $2Cl^{+}_{(aq.)} \longrightarrow \underset{\text{(Major)}}{Cl_2(g)} + 2e^{-}$

$$2H_2O_{(\ell)} \longrightarrow \underset{\text{Minor}}{O_{2(g)}} + 4H^{+}_{(aq)} + 4e^{-}$$

At Cathode : $2H_2O_{(\ell)} + 2e^{-} \longrightarrow H_{2(g)}\uparrow + 2OH^{-}_{(aq)}$

$$2Na^{+} + 2OH^{-} \longrightarrow 2NaOH$$

Q11 (25)

$$\Lambda_m = \frac{\kappa \times 1000}{M}$$

$$\Lambda_m = \frac{1}{\rho} \times \frac{1000}{M}$$

$$\frac{1}{5\times10^{-3}} \times \frac{1000}{0.8}$$

Ans. $25\times10^{4}\ \Omega^{-1}\ cm^{-2}\ mol^{-1}$

Q12 (3)

$$MnO_4^- + 8H^+ + 5e^- \rightleftharpoons Mn^{2+} + 4H_2O$$

$$E = E^\circ - \frac{0.059}{5}\log\frac{[Mn^{2+}]}{[MnO_4^-][H^+]^8}$$

$$1.282 = 1.54 - \frac{0.059}{5}\log\frac{10^{-3}}{10^{-1}\times[H^+]^8}$$

$$\frac{0.258\times 5}{0.059} = \log\frac{10^{-2}}{[H^+]^8}$$

$$\Rightarrow \quad 21.86 = -2 + 8pH$$

$$\therefore \quad pH = 2.98$$

$$\simeq 3$$

Q13 (14)

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

$$\left[NO_3^-\right] = 10^{-5}$$

$$\left[Br^-\right] = \frac{Ksp}{\left[Ag^+\right]} = 4.9 \times 10^{-8}$$

$$\Lambda_m = \frac{k}{1000 \times M}$$

For Ag^+

$$6 \times 10^{-3} = \frac{K_{Ag^+}}{1000 \times 10^{-5}}$$

$$K_{Ag+} = 6 \times 10^{-5}$$

$$\Rightarrow 6000 \times 10^{-8}$$

for Br^-

$$8 \times 10^{-3} = \frac{K_{Br^-}}{1000 \times 4.9 \times 10^{-8}}$$

$$K_{Br-} = 39.2 \times 10^{-8}$$

for NO_3^-

$$7 \times 10^{-3} = \frac{K_{NO_3^-}}{1000 \times 10^{-5}}$$

$$K_{NO_3^-} = 7 \times 10^{-5}$$

$= 7000 \times 10^{-8}$

Conductivity of solution

$\Rightarrow (6000 + 7000 + 39.2) \times 10^{-8}$

$\Rightarrow 13039.2 \times 10^{-8}\ \text{S m}^{-1}$