JEE–MAIN EXAMINATION – APRIL 2025

(HELD ON WEDNESDAY 2nd APRIL 2025) **TIME : 3:00 PM TO 6:00 PM**

CHEMISTRY

TEST PAPER WITH SOLUTION

SECTION-A

51. When a concentrated solution of sulphanilic acid and 1-naphthylamine is treated with nitrous acid (273 K) and acidified with acetic acid, the mass (g) of 0.1 mole of product formed is :

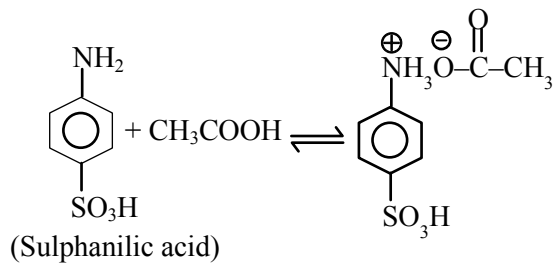
(Given molar mass in g mol^{-1} H : 1, C : 12, N : 14, O : 16, S : 32)

(1) 343 (2) 330

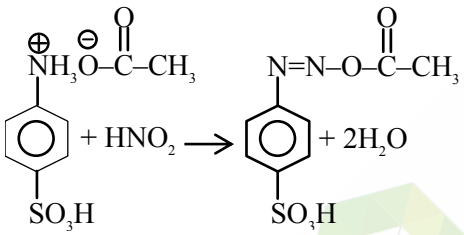
(3) 33 (4) 66

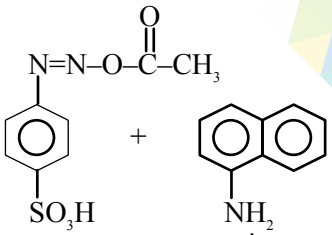
Ans. **(3)**

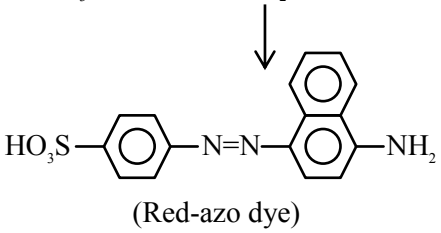
Sol.



(Sulphanilic acid)







(Red-azo dye)

0.1 mole of red-azo dye (Molar Mass = 327 gm/mol) will have 32.7 gm mass. Nearly 33 gm.

52. The d-orbital electronic configuration of the complex among $[Co(en)_3]^{3+}$, $[CoF_6]^{3-}$, $[Mn(H_2O)_6]^{2+}$ and $[Zn(H_2O)_6]^{2+}$ that has the highest CFSE is :

(1) $t_{2g}^6e_g^0$ (2) $t_{2g}^6e_g^4$

(3) $t_{2g}^3e_g^2$ (4) $t_{2g}^4e_g^2$

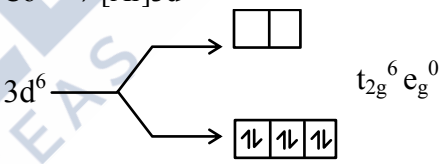
Ans. **(1)**

Sol. In $[Co(en)_3]^{+3}$ S.F.L. is present and hence highest value of CFSE

In rest all complexes WFL is present hence CFSE will be low.

$[Co(en)_3]^{+3} \Rightarrow Co^{+3}$ and en (SFL)

$Co^{+3} \Rightarrow [Ar]3d^6$



53. Given below are two statements :

Statement (I) : Neopentane forms only one monosubstituted derivative.

Statement (II) : Melting point of neopentane is higher than n-pentane

In the light of the above statements, choose the **most appropriate answer** from the options given below :

(1) **Statement I** is correct but **Statement II** is incorrect

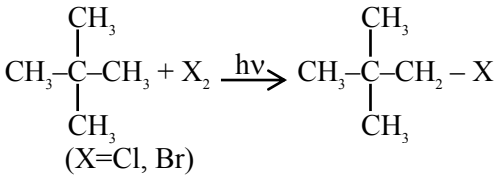
(2) Both **Statement I** and **Statement II** are correct

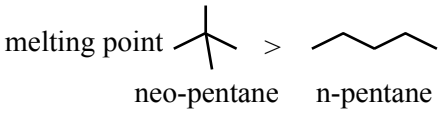
(3) Both **Statement I** and **Statement II** are incorrect

(4) **Statement I** is incorrect but **Statement II** is correct

Ans. **(2)**

Sol. Both Statement-I and Statement-II are correct.





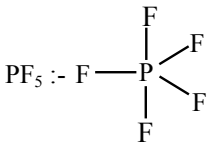
54. Which among the following molecules is (a) involved in sp^3d hybridization, (b) has different bond lengths and (c) has lone pair of electrons on the central atom ?

(1) PF_5 (2) XeF_4

(3) SF_4 (4) XeF_2

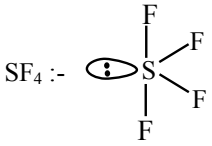
Ans. **(3)**

Sol.

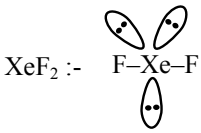


(a) Hybridisation = sp^3d
(b) All bonds are not identical
(c) No lone pair on central atom

XeF_4 :- sp^3d^2 Hybridisation



(a) Hybridisation = sp^3d
(b) All bonds are not identical
(c) 1 lone pair on central atom



(a) Hybridisation = sp^3d
(b) All bonds are identical
(c) 3 lone pair on central atom

55. Formation of $Na_4[Fe(CN)_5NOS]$, a purple coloured complex formed by addition of sodium nitroprusside in sodium carbonate extract of salt indicates the presence of :

(1) Sodium ion (2) Sulphate ion

(3) Sulphide ion (4) Sulphite ion

Ans. **(3)**

Sol. $\underset{\text{Sodium sulphide}}{Na_2S} + \underset{\text{Sodium nitro Prusside}}{Na_2[Fe(CN)_5NO]} \rightarrow \underset{\text{Violet Colour}}{Na_4[Fe(CN)_5NOS]}$

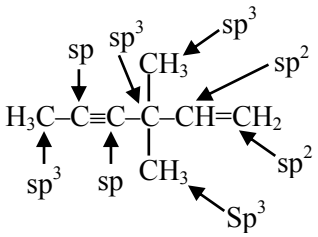
56. In 3, 3-dimethylhex-1-ene-4-yne, there are ____ sp^3, _____ sp^2 and _____ sp hybridised carbon atoms respectively :

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

(3) 2, 4, 2 (4) 2, 2, 4

Ans. **(1)**

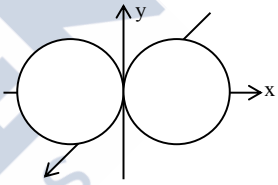
Sol.



4-sp^3, 2-sp^2, 2-sp

57. Which of the following statements are **true** ?

(A) The subsidiary quantum number *l* describes the shape of the orbital occupied by the electron.

(B)  is the boundary surface diagram of the $2p_x$ orbital.

(C) The + and – signs in the wave function of the $2p_x$ orbital refer to charge.

(D) The wave function of $2p_x$ orbital is zero everywhere in the xy plane.

(1) (B) and (D) only

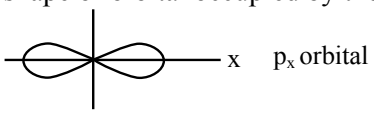
(2) (A), (B) and (C) only

(3) (C) and (D) only

(4) (A) and (B) only

Ans. **(4)**

Sol. (A) Azimuthal quantum number (ℓ) indicates the shape of orbital occupied by the electron

(B) 

(C) The + and – sign in the wave function of $2p_x$ orbital refer to the sign (Phase) of the wave function , not the charge

(D) The wave function of $2p_x$ orbital will be zero in yz plane (Nodal plane).

58. The type of hybridization and the magnetic property of $[MnCl_6]^{3-}$ are :

(1) d^2sp^3, paramagnetic with four unpaired electrons

(2) sp^3d^2, paramagnetic with four unpaired electrons

(3) d^2sp^3, paramagnetic with two unpaired electrons

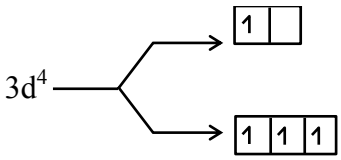
(4) sp^3d^2, paramagnetic with two unpaired electrons

Ans. (2)

Sol. $[MnCl_6]^{3-}$ contains Mn^{+3}

Mn^{+3} :- $[Ar]3d^4$

Ligand $\Rightarrow Cl^-$ (WFL)



Hybridisation = sp^3d^2

4 unpaired electrons

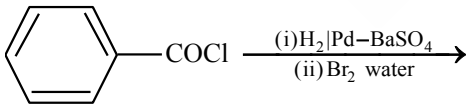
59. Consider the following reactions. From these reactions which reaction will give carboxylic acid as a major product ?

(A) $R-C\equiv N \xrightarrow[\text{mild condition}]{(i)H^+/H_2O}$

(B) $R-MgX \xrightarrow[(ii)H_3O^+]{(i)CO_2}$

(C) $R-C\equiv N \xrightarrow[(ii)H_3O^+]{(i)SnCl_2/HCl}$

(D) $R{\cdot}CH_2{\cdot}OH \xrightarrow{PCC}$

(E) 

Choose the **correct** answer from the options given below :

(1) A and D only

(2) A, B and E only

(3) B, C and E only

(4) B and E only

Ans. (4)

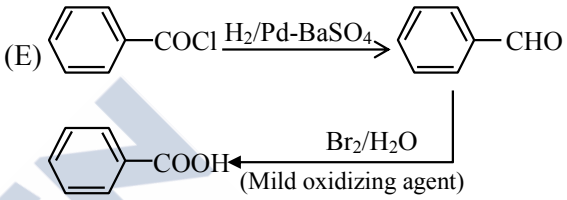
Sol. (A) $R-C\equiv N \xrightarrow[\text{mild condition}]{(i)H^+/H_2O} R-CONH_2$

Under mild condition amide is formed because this reaction is typically slow if further more heat will supplied then it gets convert in to –COOH.

(B) $R-MgX \xrightarrow[(ii)H_3O^+]{(i)CO_2} R-COOH$

(C) $R-C\equiv N \xrightarrow[(ii)H_3O^+]{(i)SnCl_2/HCl} R-CHO$

(D) $R{\cdot}CH_2{\cdot}OH \xrightarrow{PCC} R-CHO$

(E) 

60. Electronic configuration of four elements A, B, C and D are given below :

(A) $1s^22s^22p^3$ (B) $1s^22s^22p^4$

(C) $1s^22s^22p^5$ (D) $1s^22s^22p^2$

Which of the following is the correct order of increasing electronegativity (Pauling's scale) ?

(1) A < D < B < C

(2) A < C < B < D

(3) A < B < C < D

(4) D < A < B < C

Ans. (4)

Sol. N :- $1s^2\ 2s^2\ 2p^3$ (Electronegativity = 3)

O :- $1s^2\ 2s^2\ 2p^4$ (Electronegativity = 3.5)

F :- $1s^2\ 2s^2\ 2p^5$ (Electronegativity = 4)

C :- $1s^2\ 2s^2\ 2p^2$ (Electronegativity = 2.55)

Correct order = C > B > A > D

61. Match **List-I** with **List-II**

List-I (Purification technique)		**List-II (Mixture of organic compounds)**	
(A)	Distillation (simple)	(I)	Diesel + Petrol
(B)	Fractional distillation	(II)	Aniline + Water
(C)	Distillation under reduced pressure	(III)	Chloroform + Aniline
(D)	Steam distillation	(IV)	Glycerol + Spent-lye

Choose the **correct** answer from the options given below :

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

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

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

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

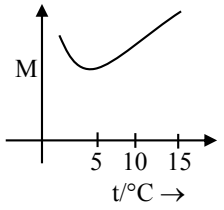
Ans. (4)

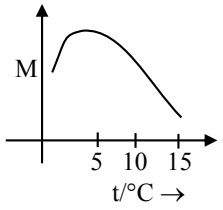
Sol.

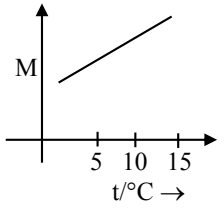
List-I (Purification technique)		**List-II (Mixture of organic compounds)**	
(A)	Distillation (simple)	(III)	Chloroform + Aniline
(B)	Fractional distillation	(I)	Diesel + Petrol
(C)	Distillation under reduced pressure	(IV)	Glycerol + Spent-lye
(D)	Steam distillation	(II)	Aniline + Water

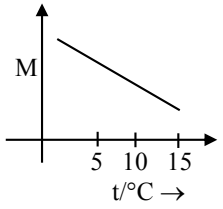
62. 'x' g of NaCl is added to water in a beaker with a lid. The temperature of the system is raised from 1°C to 25°C. Which out of the following plots, is best suited for the change in the molarity (M) of the solution with respect to temperature ?

[Consider the solubility of NaCl remains unchanged over the temperature range]

(1) 

(2) 

(3) 

(4) 

Ans. (2)

Sol. $\underset{1°C}{\text{Water}} \xrightarrow[\text{decreases}]{\text{Volume}} \underset{4°C}{\text{Water}} \xrightarrow[\text{thermal expansion}]{\text{Volume increases}} \underset{25°C}{\text{Water}}$

$$\text{Molarity} = \frac{n_{solute}}{(\text{Volume of solution})_{\ell}}$$

Hence

$$1°C \xrightarrow[\text{increases}]{\text{molarity}} 4°C \xrightarrow[\text{decreases}]{\text{molarity}} 25°C$$

63. Arrange the following in order of magnitude of work done by the system / on the system at constant temperature :

(a) $|w_{reversible}|$ for expansion in infinite stage.

(b) $|w_{irreversible}|$ for expansion in single stage.

(c) $|w_{reversible}|$ for compression in infinite stage.

(d) $|w_{irreversible}|$ for compression in single stage.

Choose the **correct** answer from the options given below :

(1) a > b > c > d

(2) d > c = a > b

(3) c = a > d > b

(4) a > c > b > d

Ans. (2)

Sol. For isothermal process

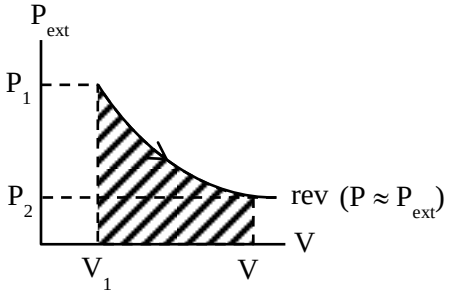
$|W_{reversible}|_{expansion} = |W_{reversible}|_{compression}$

$= -nRT \ln \frac{V_f}{V_i}$

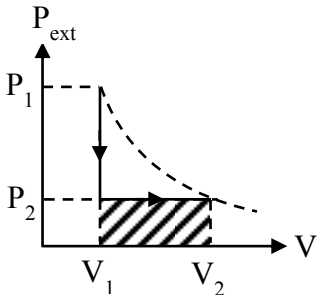
$|W_{irreversible}|_{expansion} < |W_{irreversible}|_{compression}$

d > c = a > b

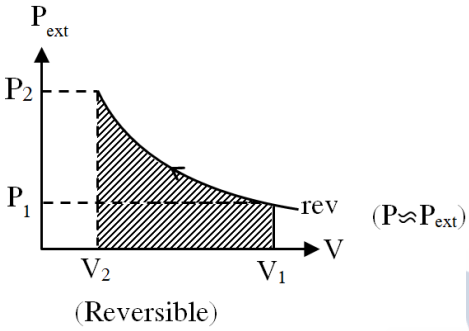
$|W_{irreversible}|_{expansion} = -P_{ext}(V_f - V_i)$



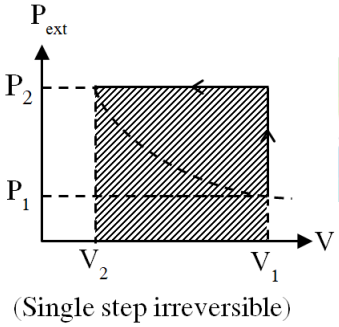
(Reversible expansion)



(Single step irreversible)



(Reversible)



(Single step irreversible)

Graphical representation

We can compare work by area of PV graph.

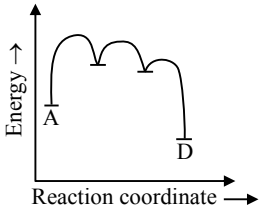
64. Reactant A converts to product D through the given mechanism (with the net evolution of heat) :

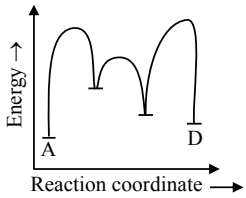
$A \rightarrow B$ slow ; $\Delta H = +ve$

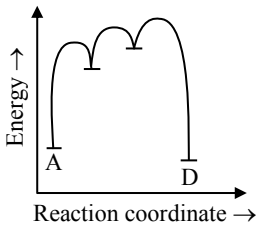
$B \rightarrow C$ fast ; $\Delta H = -ve$

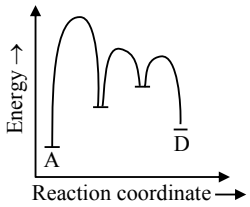
$C \rightarrow D$ fast ; $\Delta H = -ve$

Which of the following represents the above reaction mechanism ?

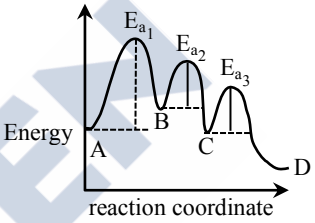
(1) 

(2) 

(3) 

(4) 

Ans. (1)

Sol. 

$A \rightarrow B$ Slow

$\Delta H = +ve$ $E_{a_1} \rightarrow$ High

$B \rightarrow C$ Fast

$\Delta H = -ve$ $E_{a_2} \rightarrow$ Low

$C \rightarrow D$

$\Delta H = -ve$ $E_{a_3} \rightarrow$ Low

65. The nature of oxide (TeO_2) and hydride (TeH_2) formed by Te, respectively are :

(1) Oxidising and acidic

(2) Reducing and basic

(3) Reducing and acidic

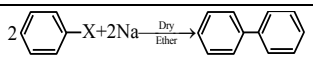
(4) Oxidising and basic

Ans. (1)

Sol. TeO_2 is oxidizing in nature because it can be reduced from +4 oxidation state to lower oxidation state.

TeH_2 due to less bond dissociation energy easily breaks and hence acidic in nature.

66. Match **List-I** with **List-II**

List-I (Reaction)		**List-II (Name of reaction)**	
(A)		(I)	Lucas reaction
(B)	$ArN_2^+X^- \xrightarrow[HCl]{Cu} ArCl + N_2 \uparrow + CuX$	(II)	Finkelstein reaction
(C)	$C_2H_5Br + NaI \xrightarrow[Acetone]{Dry} C_2H_5I + NaBr$	(III)	Fittig reaction
(D)	$CH_3C(OH)(CH_3)CH_3 \xrightarrow[ZnCl_2]{HCl} CH_3C(Cl)(CH_3)CH_3$	(IV)	Gatterman reaction

Choose the correct answer from the options given below :

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

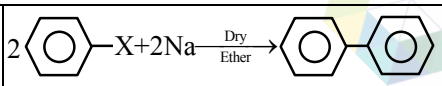
(2) (A)-(III), (B)-(IV), (C)-(II), (D)-(I)

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

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

Ans. (2)

Sol.

List-I (Reaction)		**List-II (Name of reaction)**	
(A)		(III)	Fittig reaction
(B)	$ArN_2^+X^- \xrightarrow[HCl]{Cu} ArCl + N_2 \uparrow + CuX$	(IV)	Gatterman reaction
(C)	$C_2H_5Br + NaI \xrightarrow[Acetone]{Dry} C_2H_5I + NaBr$	(II)	Finkelstein reaction
(D)	$CH_3C(OH)(CH_3)CH_3 \xrightarrow[ZnCl_2]{HCl} CH_3C(Cl)(CH_3)CH_3$	(I)	Lucas reaction

67. Consider the following chemical equilibrium of the gas phase reaction at a constant temperature : $A(g) \rightleftharpoons B(g) + C(g)$

If p being the total pressure, K_p is the pressure equilibrium constant and α is the degree of dissociation, then which of the following is true at equilibrium ?

(1) If p value is extremely high compared to K_p, $\alpha \approx 1$

(2) When p increases α decreases

(3) If k_p value is extremely high compared to p, α becomes much less than unity

(4) When p increases α increases

Ans. (2)

Sol.

$$A(g) \rightleftharpoons B(g) + C(g)$$

$t = 0$	a	0	0
$t = t$	$a(1-\alpha)$	$a\alpha$	$a\alpha$

a moles of A(g) taken initially and at time

Now moles fraction of A(g), B(g) and C(g) are

$$X_A = \frac{a - a\alpha}{a + a\alpha} = \frac{1-\alpha}{1+\alpha}$$

$$X_B = \frac{a\alpha}{a + a\alpha} = \frac{\alpha}{1+\alpha}$$

$$X_C = \frac{a\alpha}{a + a\alpha} = \frac{\alpha}{1+\alpha}$$

Now if P is total pressure then partial pressure of A(g), B(g) and C(g) are

$$P_A = \left(\frac{1-\alpha}{1+\alpha}\right)P$$

$$P_B = \left(\frac{\alpha}{1+\alpha}\right)P$$

$$P_C = \left(\frac{\alpha}{1+\alpha}\right)P$$

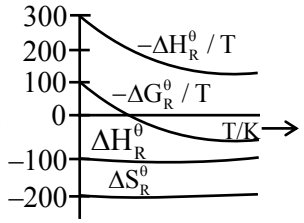
$$K_P = \frac{\left(\frac{\alpha}{1+\alpha}\right)P\left(\frac{\alpha}{1+\alpha}\right)P}{\left(\frac{1-\alpha}{1+\alpha}\right)P}$$

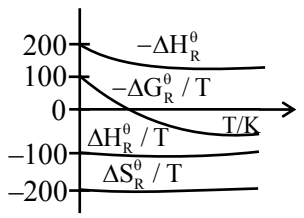
$$K_P = \frac{\alpha^2 P}{1-\alpha^2}$$

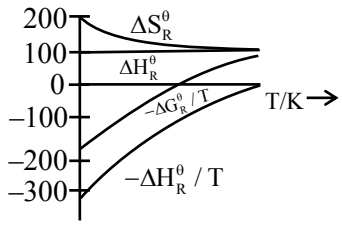
As K_P is only function of temperature.

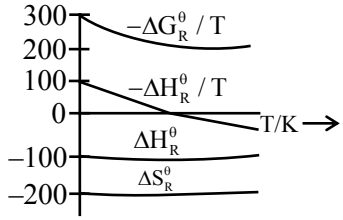
So as P $\uparrow$ $\alpha \downarrow$

68. Which of the following graphs correctly represents the variation of thermodynamic properties of Haber's process ?

(1)


(2)


(3)


(4)


Ans. **(1)**

Sol. $N_2(g) + 3H_2(g) \rightarrow 2NH_3$

$\Delta H° = -ve$

$\Delta S° = -ve$

(As gaseous moles decreases).

(1) As temperature increases $\frac{-\Delta H_R^o}{T}$, decreases

(2) $\Delta G° = -RT \ln K_{eq}$

$R \ln K_{eq} = -\frac{\Delta G^o}{T}$

(on increasing temperature in exothermic reaction K_{eq} decreases)

$\Delta H°$ and $\Delta S°$ are almost constant with temperature.

69. A tetrapeptide "*x*" on complete hydrolysis produced glycine (Gly), alanine (Ala), valine (Val), leucine (Leu) in equimolar proportion each. The number of tetrapeptides (sequences) possible involving each of these amino acids is

(1) 16 (2) 32

(3) 8 (4) 24

Ans. **(24)**

Sol. The number of tetrapeptides (sequences) possible involving each of these amino acids (glycine, alanine, valine, leucine) ; It has three (3) peptides linkage the number of permutations in which they can be arranged

$= 4 \times 3 \times 2 \times 1$

$= 24$

70. In Dumas' method for estimation of nitrogen, 0.5 gram of an organic compound gave 60 mL of nitrogen collected at 300 K temperature and 715 mm Hg pressure. The percentage composition of nitrogen in the compound (Aqueous tension at 300 K = 15 mm Hg) is

(1) 1.257 (2) 20.87

(3) 18.67 (4) 12.57

Ans. **(4)**

Sol. Pressure of N_2 gas = (715 – 15)

= 700 mmHg

$n_{N_2} = \frac{PV}{RT}$

$n_{N_2} = \frac{700 \times 60 \times 10^{-3}}{760 \times 0.0821 \times 300}$

$= 2.24 \times 10^{-3}$ mol

Mass of $N_2 = 2.24 \times 10^{-3} \times 28g$

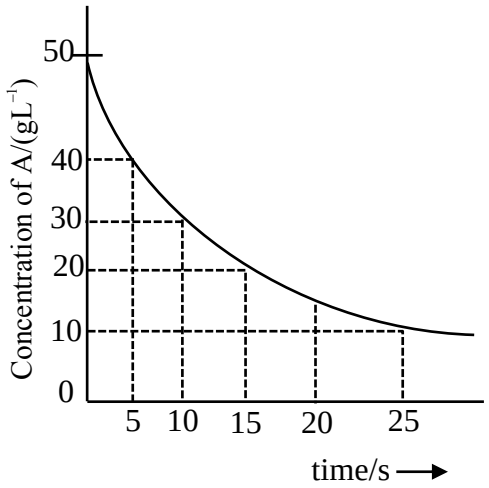
$= 0.06272$ g

$\%N_2 = \frac{0.06272}{0.5} \times 100 \simeq 12.57$

SECTION-B

71. For the reaction A → B the following graph was obtained. The time required (in seconds) for the concentration of A to reduce to 2.5 g L^{-1} (if the initial concentration of A was 50 g L^{-1}) is _____. (Nearest integer)

Given : log 2 = 0.3010



Allen Ans. (BONUS)

NTA Ans. (43)

Sol. As it is difficult to predict order using data provided in graph.

For specific time interval 0 - 5 sec, 5 – 10 sec and 10 – 15 sec. order comes to be zero, but graph is not a straight line.

Assuming 1st order kinetics

$$K = \frac{1}{t}\ln\frac{A_0}{A_t}$$

$$K = \frac{1}{10}\ln\frac{40}{20}$$

Time required to reduce to 2.5 g/L

$$K = \frac{1}{t}\ln\frac{50}{2.5}$$

$$\frac{1}{10}\ln 2 = \frac{1}{t}\ln 20$$

$$t = \frac{1.3010\times 10}{0.3010} = 43.3 \text{ sec.}$$

72. 0.2 % (w/v) solution of NaOH is measured to have resistivity 870.0 mΩ m. The molar conductivity of the solution will be _____$\times 10^2$ mS dm^2 mol^{-1}. (Nearest integer)

Ans. (23)

Sol. Given : Concentration of NaOH = 0.2% (w/v)

∴ 0.2 g of NaOH in 100 ml of solution.

Molarity of NaOH solution

$$= \frac{\text{moles of solute}}{V_{ml}} \times 1000$$

$$= \frac{0.2/40}{100}\times 1000 = = \frac{0.2}{40\times 100}\times 1000 = \frac{2}{40} \text{ M}$$

Given resistivity of solution = 870 m ohm m

$= 870 \times 10^{-3}$ ohm m

$= 870 \times 10^{-3} \times 10$ ohm dm

$= 870 \times 10^{-2}$ ohm dm

= 8.7 ohm dm

Now conductivity

$$K = \frac{1}{\rho} = \frac{1}{8.7} \text{ ohm}^{-1} \text{ dm}^{-1}$$

Now molar conductivity of solution is

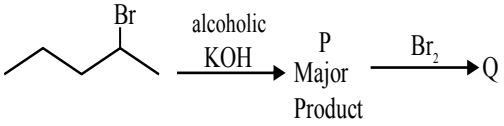
$$\lambda_m = \frac{K}{M} = \frac{\frac{1}{8.7}}{\frac{2}{40}} = \frac{40}{2\times 8.7} = 2.29 \text{ S dm}^2 \text{ mol}^{-1}$$

2.29×10^3 m S dm^2 mol^{-1}

$= 22.9 \times 10^2$ m S dm^2 mol^{-1}

$= 23 \times 10^2$ m S dm^2 mol^{-1}

73.



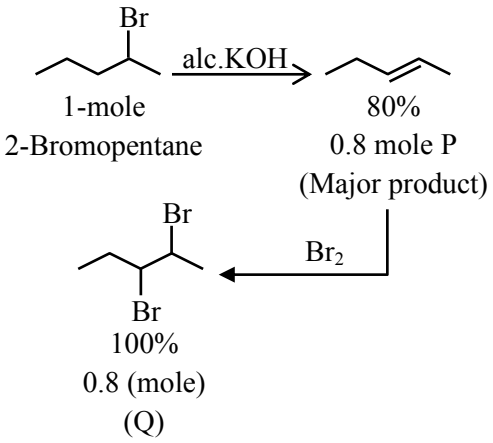
Consider the above sequence of reactions. 151 g of 2-bromopentane is made to react. Yield of major product P is 80% whereas Q is 100%.

Mass of product Q obtained is _____g.

(Given molar mass in g mol^{-1} H: 1, C : 12, O : 16, Br : 80)

Ans. (184)

Sol.



Molecular mass of Q = 230g mol^{-1}

Mass of Q = 0.8 × 230

= 184 g

74. When 1 g each of compounds AB and AB_2 are dissolved in 15 g of water separately, they increased the boiling point of water by 2.7 K and 1.5 K respectively. The atomic mass of A (in amu) is_____$\times 10^{-1}$(Nearest integer)

(Given : Molal boiling point elevation constant is 0.5 K kg mol^{-1})

Ans. (25)

Sol. For AB

$\Delta T_b = 2.7$ K

$2.7 = 1 \times 0.5 \times m$

$\mathbf{m = \frac{27}{5}}$

Let molar mass of AB = x.

So $\frac{1/x}{15} \times 1000 = \frac{27}{5}$

x = 12.34

For AB_2

$\Delta T_b = 1.5$ K

$1.5 = 1 \times 0.5 \times m$

m = 3

Let molar mass of AB_2 = y

So $\frac{1/y}{15} \times 1000 = 3$

$y = \frac{1000}{45}$

y = 22.22

Now let a and b be atomic masses of A and B respectively, then

A + b = 12.34 …. (i)

A + 2b = 22.22 …. (ii)

B = 22.22 – 12.34 = 9.88

Now a = 12.34 – 9.88 = 2.46

$= 24.6 \times 10^{-1} = 25 \times 10^{-1}$

75. The spin-only magnetic moment value of M^{n+} ion formed among Ni, Zn Mn and Cu that has the least enthalpy of atomisation is_____. (in nearest integer)

Here n is equal to the number of diamagnetic complexes among $K_2[NiCl_4]$, $[Zn(H_2O)_6]Cl_2$, $K_3[Mn(CN)_6]$ and $[Cu(PPh_3)_3I]$

Ans. (0)

Sol. $K_2[NiCl_4] \Rightarrow sp^3$, Paramagnetic

$[Zn(H_2O)_6]Cl_2 \Rightarrow sp^3d^2$, Diamagnetic

$K_3[Mn(CN)_6] \Rightarrow d^2sp^3$, Paramagnetic

$[Cu(PPh_3)_3I] \Rightarrow sp^3$, Diamagnetic

Hence the value of n is 2

Least value of enthalpy of atomisation among Ni, Zn, Mn and Cu is of Zn

Zn^{+2} :- $[Ar]3d^{10}$

$\mu = 0$