JEE MAIN 2024 SESSION-2

Paper with Solution

CHEMISTRY | 05th April 2024 _ Shift-2

SECTION – A

61. Given below are two statements:

Statement I: The metallic radius of Na is 1.86 Å and the ionic radius of Na^+ is lesser than 1.86 Å

Statement II: Ions are always smaller in size than the corresponding elements.

In the light of the above statements, choose the correct answer from the options given below :

(1) Both statement I and statement II are true

(2) Statement I is correct but statement II is true

(3) Statement I is correct but statement II is false

(4) Both statement I and statement II are false

Sol. **3**

Cation size always smaller than corresponding elements but anions are always larger than corresponding elements .

62. The number of moles of methane required to produce 11g $CO_2(g)$ after complete combustion is :

(Given moles mass of methane in g mol^{-1} : 16)

(1) 0.35 (2) 0.25 (3) 0.75 (4) 0.5

Sol. **2**

$$CH_4 + 2O_2 \rightarrow \underset{11g}{CO_2} + 2H_2O$$

Moles of $CO_2 = \frac{11}{44} = \frac{1}{4} = 0.25\,\text{mole}$

Moles of CH_4 required = 0.25 mole

63. The metal atom present in the complex MABXL (where A, B, X and L are unidentate ligands and M is metal) involves sp^3 hybridization. The number of geometrical isomers exhibited by the complex is :

(A) 4 (2) 0 (3) 2 (4) 3

Sol. **2**

Tetrahedral Complex does not show geometrical isomerism between all bond angles are identical.

64. Match List-I with List-II :

List-I		List-II	
(A)	ICl	(I)	T-Shape
(B)	ICl_3	(II)	Square pyramidal
(C)	CIF_5	(III)	Pentagonal bipyramidal
(D)	IF_7	(IV)	Linear

Choose the correct answer from the options given below :

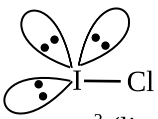
(1) (A)-IV, (B)-III, (C)-II, (D)-I

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

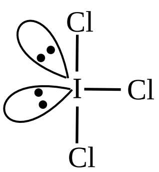
(3) (A)-I, (B)-III, (C)-II, (D)-IV

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

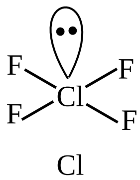
Sol. **4**

(1)


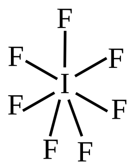
sp^3 (linear)

(2)


sp^3d (T-shape)

(3)


sp^3d^2 (square pyramidal)

(4)


sp^3d^3 (P.B.P)

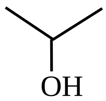
65. Match List-I with List-II :

List-I (Pair of Compounds)		List-II (Isomers)	
(A)	n-propanol and isopropanol	(I)	Metamerism
(B)	Methoxypropane and ethoxyethane	(II)	Chain isomerism
(C)	Propanone and propanal	(III)	Position isomerism
(D)	Neopentane and Isopentane	(IV)	Functional isomerism

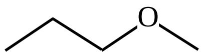
Choose the correct answer from the options given below :

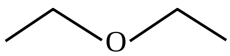
(1) (A)-I, (B)-III, (C)-IV, (D)-II
(2) (A)-II, (B)-I, (C)-IV, (D)-III
(3) (A)-III, (B)-I, (C)-II, (D)-IV
(4) (A)-III, (B)-I, (C)-IV, (D)-II

Sol. **4**

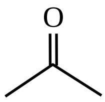
n - Propanol
&


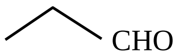
ISo - Propanol
⇒ Position isomers



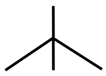
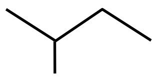
Methoxy Propane
&


ethoxy ethone
⇒ Metamers

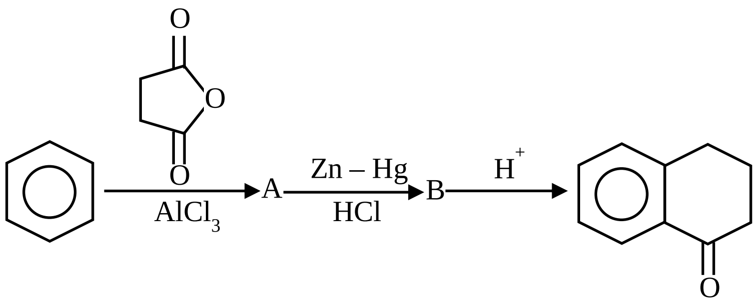


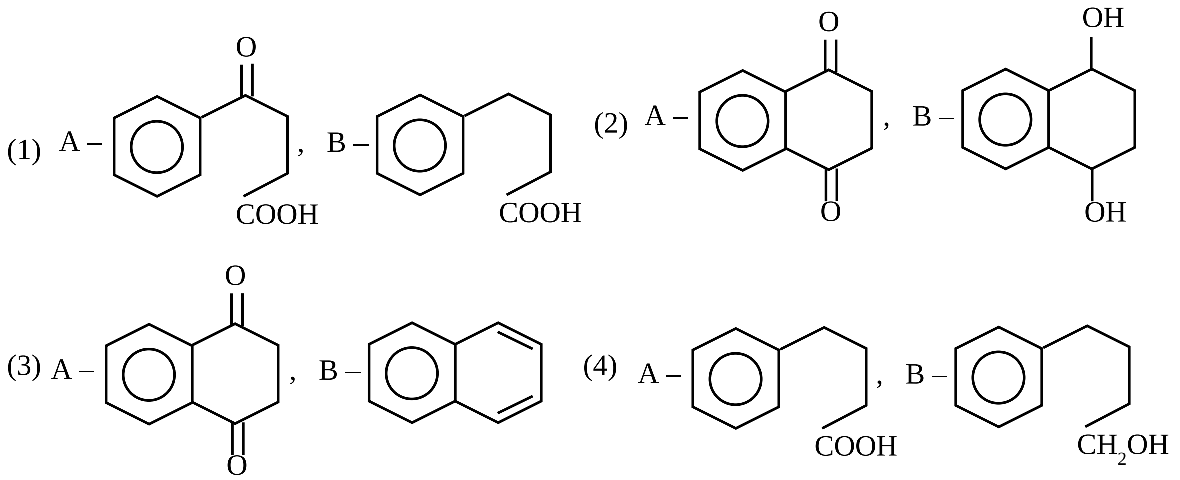
Propanone
&


Propanol
⇒ Functional isomers

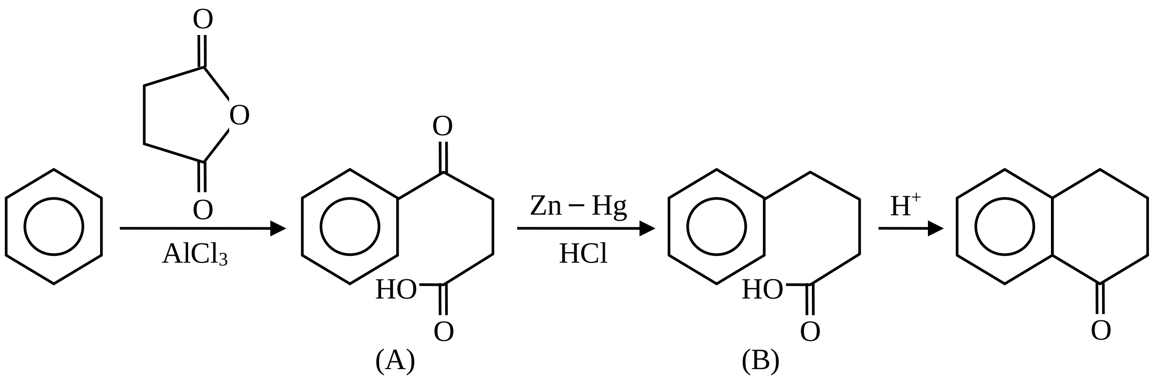

neopentane
&

Iso pentane
⇒ Chain isomers

66. Identify A and B in the given chemical reaction sequence :





Sol. 1



67. The number of ions from the following that have the ability to liberate hydrogen from a dilute acid is ______.
Ti^{2+}, Cr^{2+} and V^{2+}

(1) 3 (2) 0 (3)1 (4) 2

Sol. 1

$E^{o}_{M^{3+}/M^{2+}}$ of Ti^{2+}, V^{2+}, Cr^{2+} are negative there for they liberate H_2 from dil. acid solution

$E^{o}_{Ti^{3+}/Ti^{2+}} = -0.37, E^{o}_{V^{3+}/V^{2+}} = -0.26, E^{o}_{Cr^{3+}/Cr^{2+}} = -0.41$

68. The correct statements from the following are :
(A) The decreasing order of atomic radii of group 13 elements is Tl > ln > Ga > Al > B.
(B) Down the group 13 electronegativity decreasing from top to bottom.
(C) Al dissolves in dil. HCl and liberated H_2 but conc. HNO_3 renders Al passive by forming a protective oxide layer on the surface.
(D) All elements of group 13 exhibits highly stale +1 oxidation state
(E) Hybridisation of Al in $[Al(H_2O)_6]^{3+}$ ion is sp^3d^2.
Choose the correct answer from the options given below :

(1) (A) and (C) only (2) (A), (B), (C) and (E) only
(3) (A), (C) and (E) only (4) (C) and (E) only

Sol. 4

Atomic radii $\rightarrow T\ell > In > A\ell > Ga > B$

EN$\rightarrow B > A\ell < Ga < In < T\ell$

Stability of +1 O.S.$\rightarrow B^{+1} < \ldots\ldots\ldots < T\ell^{+1}$

69. The quantity of silver deposited when one coulomb charge is passed through $AgNO_3$ solution :

(1) 0.1 g atom of silver
(2) 1 electrochemical equivalent of silver
(3) 1g of silver
(4) 1 chemical equivalent of silver

Sol. **2**

On passing 1F charge

= 108g Ag deposited

$\therefore$ On passing 1C $\frac{108}{F} = 1$ electrochemical equivalent

70. Coagulation of egg, on heating is because of :

(1) Breaking of the peptide linkage in the primary structure of protein occurs
(2) Biological property of protein remains unchanged
(3) The secondary structure of protein remains unchanged
(4) Denaturation of protein occurs

Sol. **4**

Denaturation of proteins protein present in egg white has an unique three dimensional structure. When it is subjected to physical change like change in temperature. i.e., on boiling, coagulation of egg white occurs due to denaturation of protein. During denaturation hydrogen bonds are disturbed due to this globules unfold and helix gets uncoiled and protein looses its biological activity.

71. Given below are tow statements : one is labelled as Assertion (A) and the other is labelled as Reason (R).

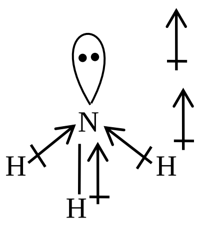
Assertion (A) : NH_3 and NF_3 molecule have pyramidal shape with a lone pair of electron on nitrogen atom. The resultant dipole moment of NH_3 is greater than that of NF_3.

Reason (R) : ln NH_3, the orbital dipole due to line pair is in the same direction as the resultant dipole moment of the N–H bonds. F is the most electronegative element.

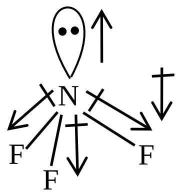
In the light of the above statements, choose the correct answer from the options given below :

(1) Both (A) and (R) are true and (R) is the correct explanations of (A)
(2) (A) is true but (R) is false
(3) Both (A) and (R) are true but (R) is NOT the correct explanation of (A)
(4) (A) is false but (R) is true

Sol. **2**



sp^3(para.)
μ=1.45D



sp^3(para.)
μ=0.23D

72. While preparing crystals of Mohr's salt, dil. H_2SO_4 is added to a mixture of ferrous sulphate and ammonium sulphate, before dissolving this mixture in water, dil. H_2SO_4 is added here to :

(1) Prevent the hydrolysis of ferrous sulphate
(2) Prevent the hydrolysis of ammonium sulphate
(3) Increase the rate of formation of crystals
(4) Make the medium strongly acidic

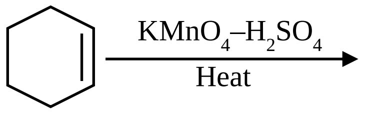
Sol. **1**

Ferrous ions of Mohr's salt undergo hydrolysis in aqueous solution. to prevent the hydrolysis, Conc. H_2SO_4 needs to be added to the Mohr's salt crystals during the preparation of its standard solution. Another reason is also to prevent the oxidation of Fe^{2+} ions Mohr's salt to Fe^{3+} ions.

73. The number of complexes from the following with no electrons in the t_2 orbital is :
$TiCl_4$, $[MnO_4]^-$, $[FeO_4]^{2-}$, $[FeCl_4]^-$, $[CoCl_4]^{2-}$
(1) 2 (2) 3 (3) 4 (4) 1

Sol. **2**
(1) $TiCl_4$, $Ti^{4+}(3d^o)–e^ot_2^o$
(2) $[MnO_4]^-$, $Mn^{4+}(3d^o)=e^ot_2^o$
(3) $(FeO_4)^{2-}$, $Fe^{6+}(3d^6)=e^2t_2^o$
(4) $(FeCl_4)^-$, $Fe^{3+}(3d^5)=e^2t_2^3$
(5) $(CoCl_4)^{2-}$, $Co^{2+}(3d^7)=e^4t_2^3$

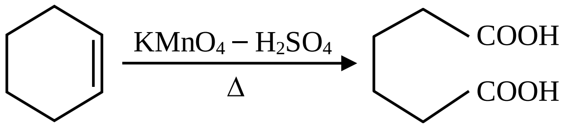
74. Consider the given chemical reaction :



Product "A"

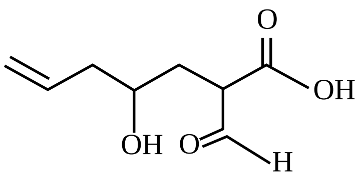
Product "A" is :
(1) Acetic acid (2) Adipic acid (3) Oxalic acid (4) Picric acid

Sol. **2**



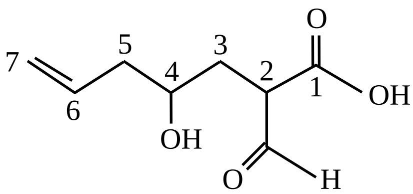
Adipic acid

75. The correct nomenclature for the following compounds is :



(1) 2-formyl-4-hydroxyhept-7-enoic acid
(2) 2-formyl-4-hydroxyhept-6-enoic acid
(3) 2-carboxy-4-hydroxyhept-7-enal
(4) 2-carboxy-4-hydroxyhept-6-enal

Sol. **2**



2 – Formyl – 4 – hydroxy hept – 6 – en oic acid

76. Given below are two statements :
Statement-I : On passing $HCl_{(g)}$ through a saturated solution of $BaCl_2$, at room temperature white turbidity appears.
Statement-II : When HCl gas is passed through a saturated solution of NaCl, sodium chloride is precipitated due to common ion effect.
(1) Both statement I and statement II are correct
(2) Both statement I and statement II are incorrect
(3) Statement I is correct but statement II is incorrect
(4)) Statement I is incorrect but statement II is correct

Sol. **3**
When HCl gas passed through saturated solution of $BaCl_2$ a white ppt is obtained this ios due to precipitation of $BaCl_2$

77. $CH_3CH_2-OH \xrightarrow[\text{(ii) } KMnO_4]{\text{(i) Jone's Reagent}}$

(iii) $NAOH, CaO, \Delta$

Consider the above reaction sequence and identify the major product P.

(1) Methane (2) Methanal (3) Methoxymethane (4) Methanoic acid

Sol. **1**

$$CH_3-CH_2-OH \xrightarrow{\text{Jone's Regent}} CH_3-COOH \xrightarrow[\Delta]{\text{NaOH, CaO}} CH_4$$

78. For the electro chemical cell

$M|M^{2+}||X|X^{2-}$

If $E^0_{(M^{2+}/M)} = 0.46V$ and $E^0_{(X/X^{2-})} = 0.34V$

Which of the following is correct ?

(1) $M + X \rightarrow M^{2+} + X^{2-}$ is a spontaneous reaction

(2) $E_{cell} = -0.80$ V

(3) $M^{2+} + X^{2-} \rightarrow M + X$ is a spontaneous reaction

(4) $E_{cell} = 0.80$ V

Sol. **3**

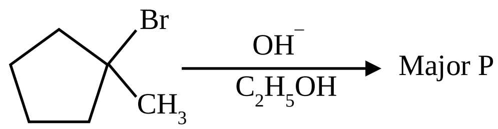
$m \rightarrow m^{2+} + 2e^-$

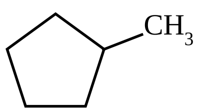
$x + 2e^- \rightarrow x^{2-}$

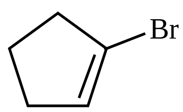
$m + x \rightarrow m^{2+} + x^{2-}$

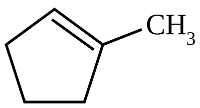
$E^0_{cell} = 0.34 - 0.46 = -0.12$

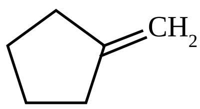
hence, Reverse of above reaction is spontaneous.

79. 

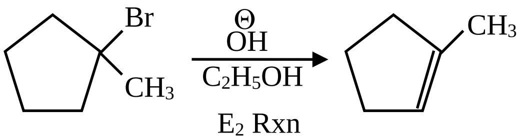
(1) 

(2) 

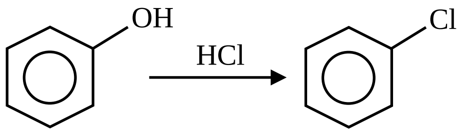
(3) 

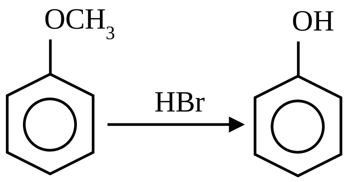
(4) 

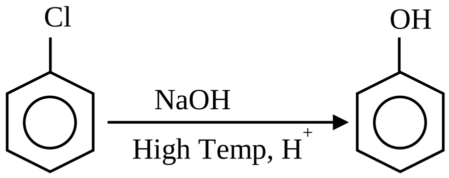
Sol. **3**

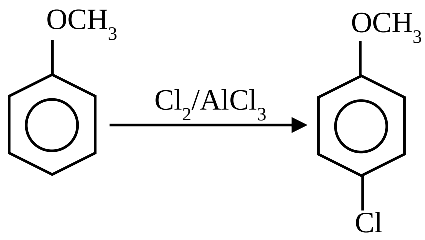


80. Which one of the following reactions is NOT possible ?

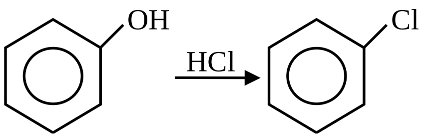
(1) 

(2) 

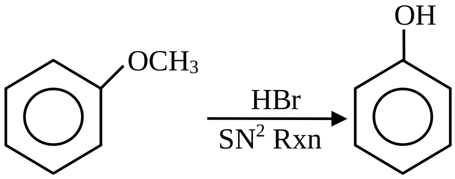
(3) 

(4) 

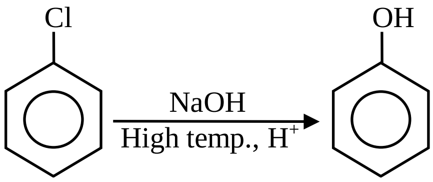
Sol. **1**

1. 

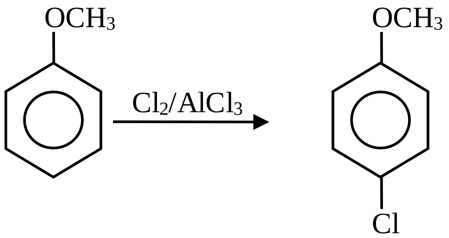
Above rxn is not possible due to double bond character of C – O bond.

2. 

+ CH_3Br

3. 

[Dow's Process]

4. 

It is electrophilic substitution Rxn

SECTION – B

81. Consider the following single step reaction in gas phase at constant temperature.

$2A_{(g)} + B_{(g)} \rightarrow C_{(g)}$

The initial rate of the reaction is recorded as r_1 when the reaction starts with 1.5 atm pressure of A and 0.7 atm pressure of B. After some time, the rate r_2 is recorded when the pressure of C becomes 0.5 atm. The ratio $r_1 : r_2$ is ______ $\times 10^{-1}$. (Nearest integer)

Sol. **315**

Single step (Elementary reaction)

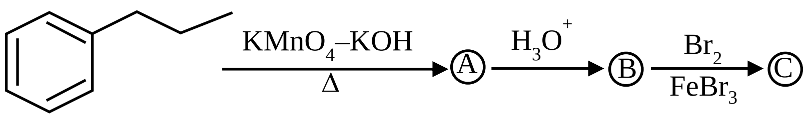
$r_1 = k(1.5)^2(0.7)^1$

	2A	+	B	→	C
t = 0	1.5		0.7		
t = t	0.5		0.2		0.5

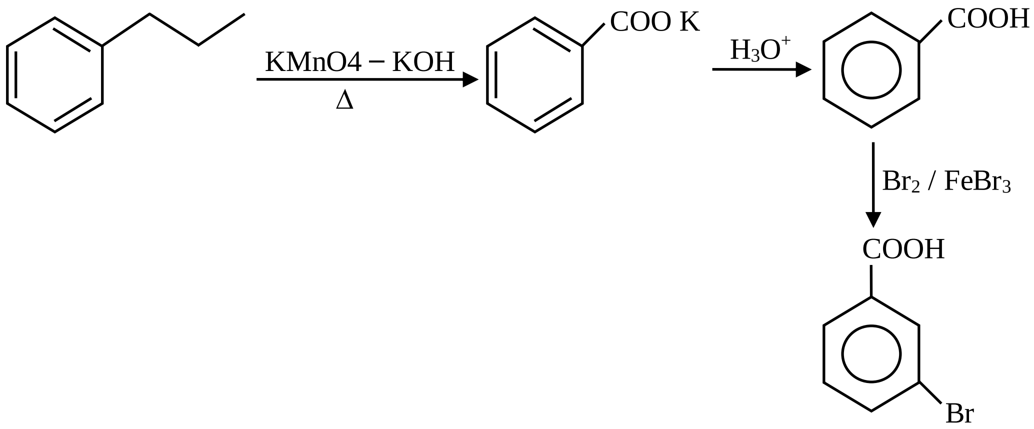
$r_2 = k(0.5)^2(0.2)^1$

$$\frac{r_1}{r_2} = \frac{(1.5)^2(0.7)}{(0.5)^2(0.2)} = \frac{9 \times 7}{2} = 31.5 = 315 \times 10^{-1}$$

82. The product © in the following sequence of reactions has______



Sol. **4**



$4 - \pi$ bonds

83. Number of compounds from the following with zero dipole moment is ________ .

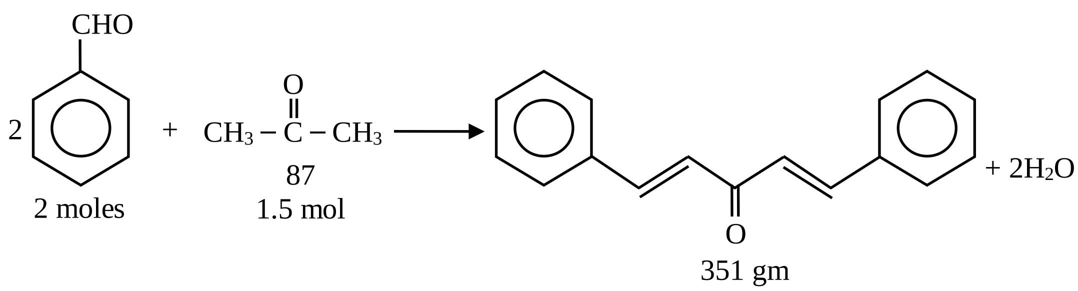
HF, H_2, H_2S, CO_2, NH_3, BF_3, CH_4, $CHCl_3$, SiF_4, H_2O, BeF_2

Sol. **6**

Molecules hav zero D.M. H_2, CO_2, BF_3, CH_4, SiF_4, BeF_2

84. In the Claisen-Schmidt reaction to prepare 351 g of dibenzalacetone using 87 g of acetone, the amount of benzaldehyde required is _________ g. (Nearest integer)

Sol. **318**

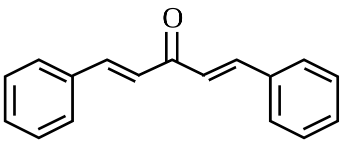


3 moles of benzaldehyde is required.

31 8 gm benzaldehyde is required.

OR

Sol. **318**

$2C_2H_5CHO$ + CH_3COCH_3 $\xrightarrow[C_2H_5OH]{NaOH}$  + $2H_2O$

Benzaldehyde (C_7H_6O)   Acetone (C_3H_6O)   Dibenzylideneacetone ($C_{17}H_{14}O$)

87 g → Mole = $\frac{87}{58}$ = 1.5 Mole

351 g → Mole = $\frac{351}{234}$ = 1.5 Mole

To prepare 1.5 moles of product,

3 moles of benzaldehyde required

Mass of benzaldehyde required

= 3 × 106

= 318 g

85. Combustion of 1 mole of benzene is expressed at

$$C_6H_6(1) + \frac{15}{2}O_2(g) \rightarrow 6CO_2(g) + 3H_2o(I).$$

The standard enthalpy of combustion of 2 mol of benzene is – 'x' kJ.

X = ________ .

Given :

1. standard Enthalpy of formation of 1 mol of C_6H_6(l), for the reaction 6 C (graphite) + $3H_2(g) \rightarrow C_6H_6(l)$ is 48.5 kJ mol^{-1}.
2. Standard Enthalpy of formation of 1 mol of CO_2(g), for the reaction C(graphite) + O_2(g) $\rightarrow$ CO_2(g) is – 393.5 kJ mol^{-1}.
3. Standard and Enthalpy of formation of 1 mol of H_2O(l), for the reaction $H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l)$ is – 286 kJ mol^{-1}.

Sol. **6535**

$$\Delta H^0_{comb} = \sum(\Delta H_f)_{product} - \sum(\Delta H_f)_{Reactant}$$

= 6 × (–393.5) + 3 × (–286) – 48.5

= –2361 – 858 – 48.5

= –3267.5 KJ for 1 mole

Now, for 2 mole = 2 × (–3267.5) = 6535 KJ

86. The fusion of chromite ore with sodium carbonate in the presence of air leads to the formation of products A and B along with the evolution of CO_2. The sum of spin-only magnetic moment values of A and B is _______ B.M. (Nearest integer)

[Give atomic number : C : 6, Na : 11, O : 8, Fe : 26, Cr : 24]

Sol. **6**

$$\underset{\underset{FeO.Cr_2O_3}{or}}{FeCr_2O_4} + Na_2CO_3 \xrightarrow{air} \underset{(A)}{Na_2CrO_4} + Fe_2O_3 + \underset{(B)}{CO_2}$$

$Na_2CrO_4 \rightarrow Cr^{6+}(3d^o) \rightarrow \mu_{(s)}=0$

$Fe_2O_3 \rightarrow Fe^{3+}(3d^5) \rightarrow \mu= \sqrt{35} = 5.92 \simeq 6$

(A+B)=0+6=6

87. Considering acetic acid dissociates in water, its dissociation constant is 6.25×10^{-5}. If 5 mL of acetic acid is dissolved in 1 litre water, the solution will freeze at $-x \times 10^{-2}$ ºC, provided pure water freezes at 0 ºC.

x = __________ . (Nearest integer)

Given :

$(K_f)_{water}$ = 1.86 K kg mol^{-1}.

Density of acetic is 1.2 g mol^{-1}.

Molar mass of water = 1.8 g mol^{-1}.

Molar mass of acetic acid = 60 g mol^{-1}.

Density of water = 1 g cm^{-3}

Acetic acid dissociates as $CH_3COOH \rightleftharpoons CH_3COO^{\ominus} + H^{\oplus}$

Sol. **19**

Mass of acetic acid = 1.2 × 5 = 6 g

Mole of acetic acid = $\frac{6}{60}$ = 0.1 g

Mass of water = 1000 × 1 = 1000 g

Conc^n of Sol^n = $\frac{0.1}{1}$ = 0.1 M

$k_a = c\alpha^2$

$$\alpha = \left(\frac{6.25\times10^{-5}}{10^{-1}}\right)^{1/2}$$

$$= \left(625\times10^{-6}\right)^{1/2} = 25\times10^{-3} = 0.025$$

$\Delta T_f = ik_f m$

= (1 + 0.025) (1.86) × 0.1 = 0.190

0ºC – T_f = 0.190

T_f = – 0.190ºC = –19 × 10^{-2} ºC

x = 19

88. Using the given figure, the ratio of R_f values of sample A and sample C is x × 10^{-2}. Value of x is ________ .

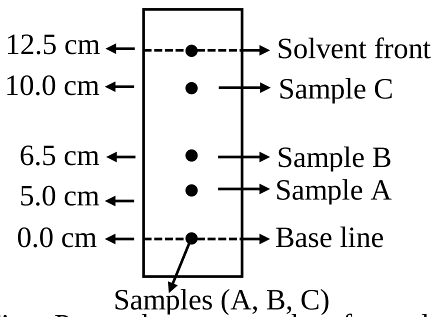


Fig. : Paper chromatography of samples

Sol. 50

$$R_f = \frac{\text{distance travelled by sample}}{\text{distance travelled by solvent}}$$

$$(R_f)_A = \frac{5}{12.5} \qquad (R_f)_C = \frac{10}{12.5}$$

$$\frac{(R_f)_A}{(R_f)_C} = \frac{5}{10} = 0.5 = 50 \times 10^{-2}$$

89. X g of ethanamine was subjected to reaction with $NaNO_2$/HCl followed by hydrolysis to liberate N_2 and HCl. The HCl generated was completely neutralized by 0.2 moles of NaOH. X is _____ g.

Sol. 9

$$C_2H_5NH_2 \xrightarrow[+\ HCl]{NaNO_2} C_2H_5\text{–}\overset{\oplus}{N}{\equiv}N\overset{\ominus}{Cl}$$

Ethyldiazonium chloride

$$\downarrow H_2O$$

$$C_2H_5OH + HCl + N_2$$

0.2 mol of HCl are produced, hence

0.2 mol of $C_2H_5NH_2$ is present

Value of x = 0.2 × 45 = 9gm

90. In an atom, total number of electrons having quantum numbers n = 4, |ml| = 1 and $m_s = -\frac{1}{2}$ is ______ .

Sol. 6

n = 4 $\quad m_l = \pm 1 \Rightarrow 4p,\ 4d,\ 4f$

There are $2e^-$ in each $4p,\ 4d,\ 4f$ having $m_s = \frac{-1}{2}$.

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