FINAL JEE–MAIN EXAMINATION – JANUARY, 2024

(Held On Wednesday 31st January, 2024) **TIME : 3 : 00 PM to 6 : 00 PM**

CHEMISTRY

TEST PAPER WITH SOLUTION

SECTION-A

61. Match List I with List II

	LIST – I (Complex ion)		LIST – II (Electronic Configuration
A.	$\left[Cr(H_2O)_6\right]^{3+}$	I.	$t_{2g}^2 e_g^0$
B.	$\left[Fe(H_2O)_6\right]^{3+}$	II.	$t_{2g}^3 e_g^0$
C.	$\left[Ni(H_2O)_6\right]^{2+}$	III.	$t_{2g}^3 e_g^2$
D.	$\left[V(H_2O)_6\right]^{3+}$	IV.	$t_{2g}^6 e_g^2$

Choose the correct answer from the options given below :

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

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

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

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

Ans. (4)

Sol:- $\left[Cr(H_2O)_6\right]^{3+}$ Contains $Cr^{3+}:[Ar]3d^3:t_{2g}^3e_g^o$

$\left[Fe(H_2O)_6\right]^{3+}$ Contains $Fe^{3+}:[Ar]3d^5:t_{2g}^3\ e_g^2$

$\left[Ni(H_2O)_6\right]^{2+}$ Contains $Ni^{2+}:[Ar]3d^8:t_{2g}^6\ e_g^2$

$\left[V(H_2O)_6\right]^{3+}$ Contains $V^{3+}:[Ar]3d^2:t_{2g}^2\ e_g^o$

62. A sample of $CaCO_3$ and $MgCO_3$ weighed 2.21 g is ignited to constant weight of 1.152 g. The composition of mixture is :

(Given molar mass in g mol^{-1}
$CaCO_3:100, MgCO_3:84$)

(1) 1.187 g $CaCO_3$ + 1.023 g $MgCO_3$

(2) 1.023 g $CaCO_3$ + 1.023 g $MgCO_3$

(3) 1.187 g $CaCO_3$ + 1.187 g $MgCO_3$

(4) 1.023 g $CaCO_3$ + 1.187 g $MgCO_3$

Ans. (1)

Sol:- $CaCO_3(s) \xrightarrow{\Delta} CaO(s) + CO_2(g)$

$MgCO_3(s) \xrightarrow{\Delta} MgO(s) + CO_2(g)$

Let the weight of $CaCO_3$ be x gm

$\therefore$ weight of $MgCO_3 = (2.21 - x)$gm

Moles of $CaCO_3$ decomposed = moles of CaO formed

$\frac{x}{100}$ = moles of CaO formed

$\therefore$ weight of CaO formed $= \frac{x}{100} \times 56$

Moles of $MgCO_3$ decomposed = moles of MgO formed

$\frac{(2.21 - x)}{84}$ = moles of MgO formed

$\therefore$ weight of MgO formed $= \frac{2.21 - x}{84} \times 40$

$\Rightarrow \frac{2.21 - x}{84} \times 40 + \frac{x}{100} \times 56 = 1.152$

$\therefore x = 1.1886$ g = weight of $CaCO_3$

& weight of $MgCO_3 = 1.0214$ g

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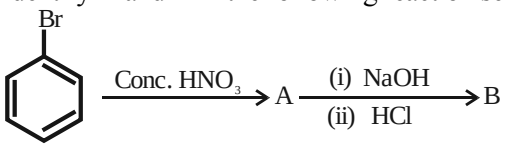
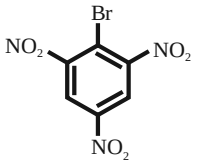
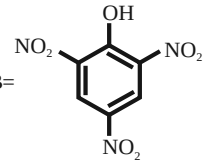
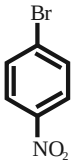
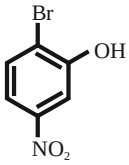
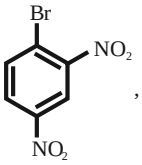
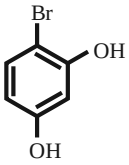
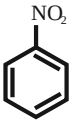
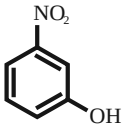
63. Identify A and B in the following reaction sequence.



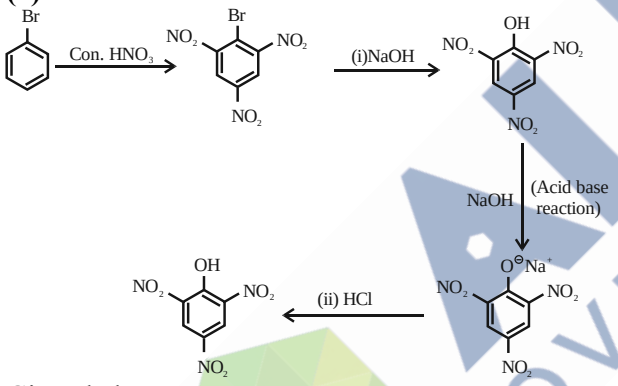
(1) A=  , B= 

(2) A=  , B= 

(3) A=  , B= 

(4) A=  , B= 

Ans. (1)

Sol:- 

64. Given below are two statements :

Statement I: S_8 solid undergoes disproportionation reaction under alkaline conditions to form S^{2-} and $S_2O_3^{2-}$

Statement II: ClO_4^- can undergo disproportionation reaction under acidic condition.

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) Statement I is incorrect but statement II is correct

(3) Both statement I and statement II are incorrect

(4) Both statement I and statement II are correct

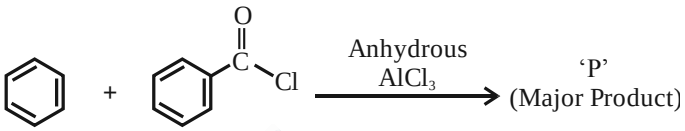
Ans. (1)

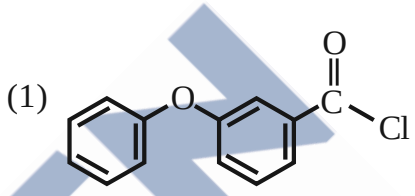
Sol:-

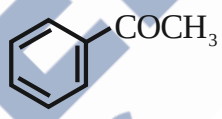
$$S_1: S_8 + 12\,OH^{\ominus} \rightarrow 4S^{2-} + 2S_2O_3^{2-} + 6H_2O$$

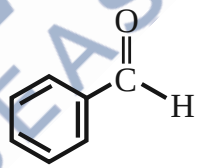
$S_2: ClO_4^{\ominus}$ cannot undergo disproportionation reaction as chlorine is present in it's highest oxidation state.

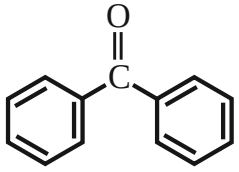
65. Identify major product 'P' formed in the following reaction.



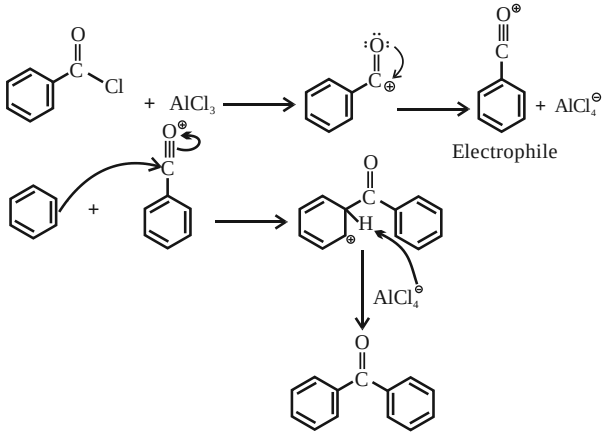
(1) 

(2) 

(3) 

(4) 

Ans. (4)

Sol:- 

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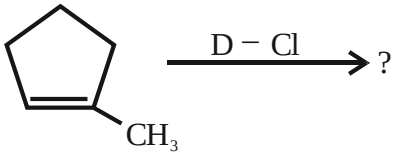
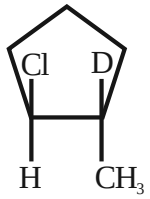
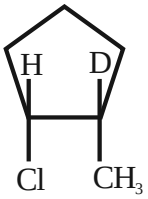
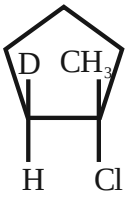
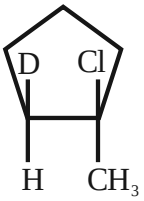
66. Major product of the following reaction is –



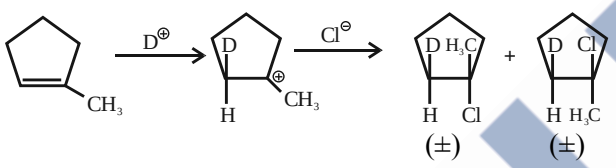
(1) 

(2) 

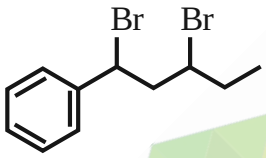
(3) 

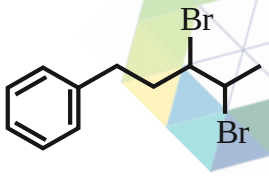
(4) 

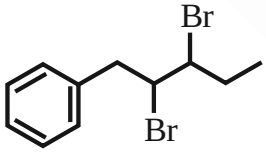
Ans. (3 or 4)

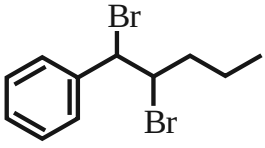
Sol:- 

67. Identify structure of 2,3-dibromo-1-phenylpentane.

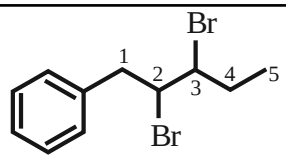
1. 

2. 

3. 

4. 

Ans. (3)

Sol:- 

2, 3-dibromo -1-phenylpentane

68. Select the option with correct property -

(1) $\left[Ni(CO)_4\right]$ and $\left[NiCl_4\right]^{2-}$ both diamagnetic

(2) $\left[Ni(CO)_4\right]$ and $\left[NiCl_4\right]^{2-}$ both paramagnetic

(3) $\left[NiCl_4\right]^{2-}$ diamagnetic, $\left[Ni(CO)_4\right]$ paramagnetic

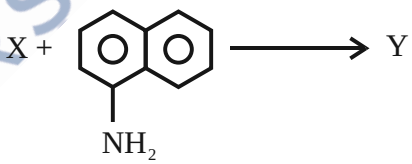
(4) $\left[Ni(CO)_4\right]$ diamagnetic, $\left[NiCl_4\right]^{2-}$ paramagnetic

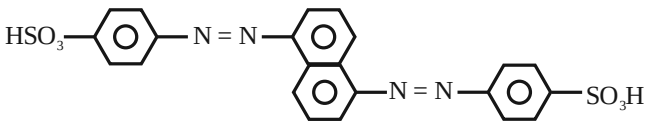
Ans. (4)

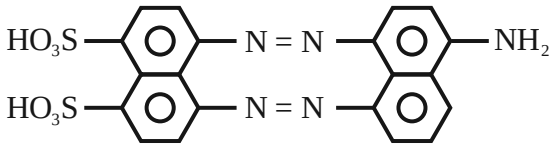
Sol:- $\left[Ni(CO)_4\right] \rightarrow$ diamagnetic, sp^3 hybridisation, number of unpaired electrons = 0

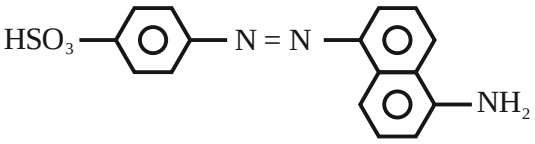
$\left[NiCl_4\right]^{2-}$, $\rightarrow$ paramagnetic, sp^3 hybridisation, number of unpaired electrons = 2

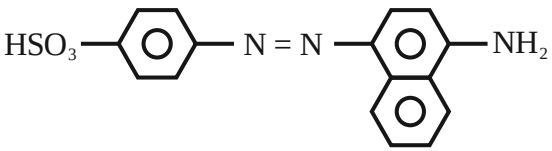
69. The azo-dye (Y) formed in the following reactions is Sulphanilic acid + $NaNO_2 + CH_3COOH \rightarrow X$



1. 

2. 

3. 

4. 

Ans. (4)

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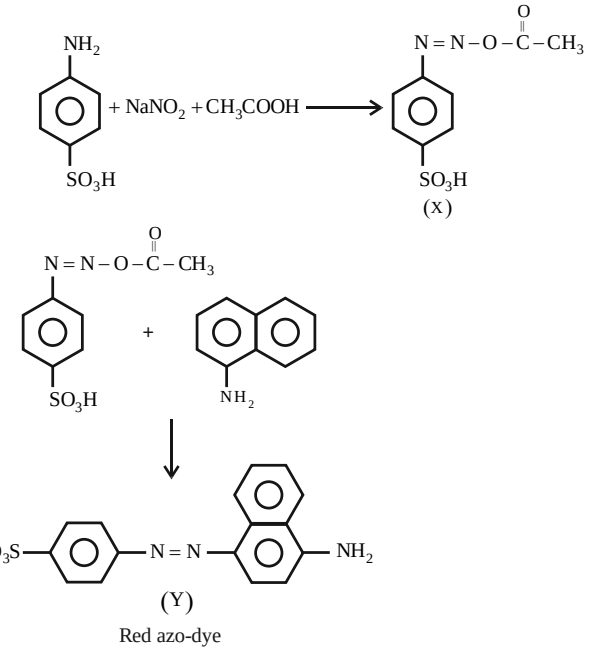
Sol:-



This is known as Griess-Ilosvay test.

70. Given below are two statements :

Statement I: Aniline reacts with con. H_2SO_4 followed by heating at 453-473 K gives p-aminobenzene sulphonic acid, which gives blood red colour in the 'Lassaigne's test'.

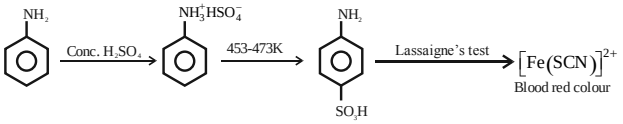
Statement II: In Friedel - Craft's alkylation and acylation reactions, aniline forms salt with the $AlCl_3$ catalyst. Due to this, nitrogen of aniline aquires a positive charge and acts as deactivating group.

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

1. Statement I is false but statement II is true
2. Both statement I and statement II are false
3. Statement I is true but statement II is false
4. Both statement I and statement II are true

Ans. (4)

Sol:-



71. $A_{(g)} \rightleftharpoons B_{(g)} + \frac{C}{2}(g)$ The correct relationship between K_P, α and equilibrium pressure P is

(1) $K_P = \frac{\alpha^{1/2} P^{1/2}}{(2+\alpha)^{1/2}}$

(2) $K_P = \frac{\alpha^{3/2} P^{1/2}}{(2+\alpha)^{1/2}(1-\alpha)}$

(3) $K_P = \frac{\alpha^{1/2} P^{3/2}}{(2+\alpha)^{3/2}}$

(4) $K_P = \frac{\alpha^{1/2} P^{1/2}}{(2+\alpha)^{3/2}}$

Ans. (2)

Sol:- $A_{(g)} \rightleftharpoons B_{(g)} + \frac{C}{2}(g)$

$t = t_{eq}$ $(1-\alpha)$ α $\frac{\alpha}{2}$

$$P_B = \frac{\alpha}{\left(1+\frac{\alpha}{2}\right)}.P,\ P_A = \frac{(1-\alpha)}{\left(1+\frac{\alpha}{2}\right)}.P,\ P_C = \frac{\frac{\alpha}{2}}{\left(1+\frac{\alpha}{2}\right)}.P$$

$$K_P = \frac{P_B . P_C^{\frac{1}{2}}}{P_A}$$

$$= \frac{(\alpha)^{\frac{3}{2}} (P)^{\frac{1}{2}}}{(1-\alpha)(2+\alpha)^{\frac{1}{2}}}$$

72. Choose the correct statements from the following

A. All group 16 elements form oxides of general formula EO_2 and EO_3 where E = S, Se, Te and Po. Both the types of oxides are acidic in nature.

B. TeO_2 is an oxidising agent while SO_2 is reducing in nature.

C. The reducing property decreases from H_2S to H_2Te down the group.

D. The ozone molecule contains five lone pairs of electrons.

Choose the correct answer from the options given below:

1. A and D only
2. B and C only
3. C and D only
4. A and B only

Ans. (4)

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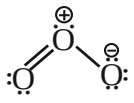
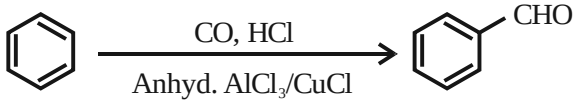
Sol:- **(A)** All group 16 elements form oxides of the EO_2 and EO_3 type where $E = S, Se, Te$ or Po.

(B) SO_2 is reducing while TeO_2 is an oxidising agent.

(C) The reducing property increases from H_2S to H_2Te down the group.

(D)  have six lone pairs

73. Identify the name reaction.



(1) Stephen reaction

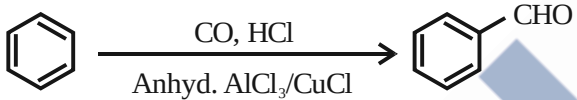
(2) Etard reaction

(3) Gatterman-koch reaction

(4) Rosenmund reduction

Ans. **(3)**

Sol:-



Gatterman-Koch reaction

74. Which of the following is least ionic ?

(1) $BaCl_2$ (2) $AgCl$

(3) KCl (4) $CoCl_2$

Ans. **(2)**

Sol:- $AgCl < CoCl_2 < BaCl_2 < KCl$ (ionic character)

Reason : Ag^+ has pseudo inert gas configuration.

75. The fragrance of flowers is due to the presence of some steam volatile organic compounds called essential oils. These are generally insoluble in water at room temperature but are miscible with water vapour in vapour phase. A suitable method for the extraction of these oils from the flowers is -

1. crystallisation
2. distillation under reduced pressure
3. distillation
4. steam distillation

Ans. **(4)**

Sol:- Steam distillation technique is applied to separate substances which are steam volatile and are immiscible with water.

76. Given below are two statements :

Statement I: Group 13 trivalent halides get easily hydrolyzed by water due to their covalent nature.

Statement II: $AlCl_3$ upon hydrolysis in acidified aqueous solution forms octahedral $\left[Al(H_2O)_6\right]^{3+}$ ion.

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

1. Statement I is true but statement II is false
2. Statement I is false but statement II is true
3. Both statement I and statement II are false
4. Both statement I and statement II are true

Ans. **(4)**

Sol:- In trivalent state most of the compounds being covalent are hydrolysed in water. Trichlorides on hydrolysis in water form tetrahedral $\left[M(OH)_4\right]^-$ species, the hybridisation state of element M is sp^3.

In case of aluminium, acidified aqueous solution forms octahedral $\left[Al(H_2O)_6\right]^{3+}$ ion.

77. The four quantum numbers for the electron in the outer most orbital of potassium (atomic no. 19) are

(1) $n = 4,\ l = 2,\ m = -1,\ s = +\frac{1}{2}$

(2) $n = 4,\ l = 0,\ m = 0,\ s = +\frac{1}{2}$

(3) $n = 3,\ l = 0,\ m = 1,\ s = +\frac{1}{2}$

(4) $n = 2,\ l = 0,\ m = 0,\ s = +\frac{1}{2}$

Ans. **(2)**

Sol:- ${}_{19}K\ \ 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^1$.

Outermost orbital of potassium is 4s orbital

$n = 4, l = 0, m_l = 0, s = \pm\frac{1}{2}$.

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78. Choose the correct statements from the following

A. Mn_2O_7 is an oil at room temperature

B. V_2O_4 reacts with acid to give VO_2^{2+}

C. CrO is a basic oxide

D. V_2O_5 does not react with acid

Choose the correct answer from the options given below :

1. A, B and D only

2. A and C only

3. A, B and C only

4. B and C only

Ans. (2)

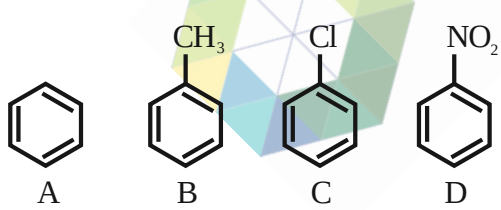
Sol:- **(A)** Mn_2O_7 is green oil at room temperature.

(B) V_2O_4 dissolve in acids to give VO^{2+} salts.

(C) CrO is basic oxide

(D) V_2O_5 is amphoteric it reacts with acid as well as base.

79. The correct order of reactivity in electrophilic substitution reaction of the following compounds is :



1. $B > C > A > D$

2. $D > C > B > A$

3. $A > B > C > D$

4. $B > A > C > D$

Ans. (4)

Sol:- $-CH_3$ shows $+M$ and $+I$.

$-Cl$ shows $+M$ and $-I$ but inductive effect dominates.

$-NO_2$ shows $-M$ and $-I$.

Electrophilic substitution $\alpha \frac{1}{-M \text{ and } -I}$

$$\alpha + M \text{ and } + I$$

Hence, order is $B > A > C > D$.

80. Consider the following elements.

Group ↓ $A'B'$ → Period
$C'D'$

Which of the following is/are true about A', B', C' and D' ?

A. Order of atomic radii: $B' < A' < D' < C'$

B. Order of metallic character : $B' < A' < D' < C'$

C. Size of the element : $D' < C' < B' < A'$

D. Order of ionic radii : $B'^{+} < A'^{+} < D'^{+} < C'^{+}$

Choose the correct answer from the options given below :

1. A only
2. A, B and D only
3. A and B only
4. B, C and D only

Ans. (2)

Sol:- In general along the period from left to right, size decreases and metallic character decrease.

In general down the group, size increases and metallic character increases.

$B' < A'(\text{size})$ $C' > A'(\text{size})$

$D' < C'(\text{size})$ $D' > B'(\text{size})$

$B' < A'(\text{metallic character})$

$D' < C'(\text{metallic character})$

$B'^{+} < A'^{+}(\text{size})$

$D'^{+} < C'^{+}(\text{size})$

$\therefore$ C statement is incorrect.

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SECTION-B

81. A diatomic molecule has a dipole moment of 1.2 D. If the bond distance is 1Å, then fractional charge on each atom is _____ $\times 10^{-1}$ esu.

(Given $1\,D = 10^{-18}$ esu cm)

Ans. (0)

Sol:- $\mu = 1.2\,D = q \times d$

$\Rightarrow 1.2 \times 10^{-10}\,esu\,Å = q \times 1Å$

$\therefore q = 1.2 \times 10^{-10}$ esu

82. $r = k[A]$ for a reaction, 50% of A is decomposed in 120 minutes. The time taken for 90% decomposition of A is _____ minutes.

Ans. (399)

Sol:- $r = k[A]$

So, order of reaction = 1

$t_{1/2} = 120$ min

For 90% completion of reaction

$$\Rightarrow k = \frac{2.303}{t}\log\left(\frac{a}{a-x}\right)$$

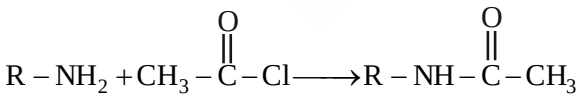
$$\Rightarrow \frac{0.693}{t_{1/2}} = \frac{2.303}{t}\log\frac{100}{10}$$

$\therefore t = 399$ min.

83. A compound (x) with molar mass 108 g mol^{-1} undergoes acetylation to give product with molar mass 192 g mol^{-1}. The number of amino groups in the compound (x) is _____.

Ans. (2)

Sol:-



$$R-NH_2 + CH_3-\overset{\overset{O}{\|}}{C}-Cl \longrightarrow R-NH-\overset{\overset{O}{\|}}{C}-CH_3$$

Gain in molecular weight after acylation with one $-NH_2$ group is 42.

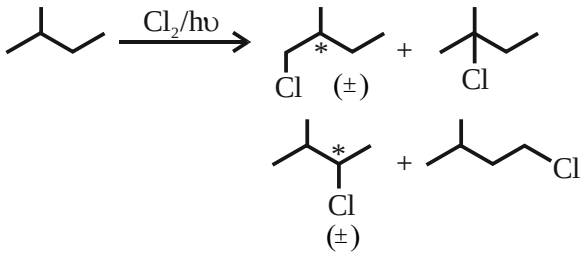
Total increase in molecular weight = 84

$\therefore$ Number of amino group in $x = \frac{84}{42} = 2$

84. Number of isomeric products formed by mono-chlorination of 2-methylbutane in presence of sunlight is _____.

Ans. (6)

Sol:-



$\therefore$ Number of isomeric products = 6

85. Number of moles of H^+ ions required by 1 mole of MnO_4^- to oxidise oxalate ion to CO_2 is ____.

Ans. (8)

Sol:-

$$2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \longrightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$$

$\therefore$ Number of moles of H^+ ions required by 1 mole of MnO_4^- to oxidise oxalate ion to CO_2 is 8

86. In the reaction of potassium dichromate, potassium chloride and sulfuric acid (conc.), the oxidation state of the chromium in the product is (+)_____.

Ans. (6)

Sol:- $K_2Cr_2O_7(s) + 4KCl(s) + 6H_2SO_4(conc.)$

$\rightarrow 2CrO_2Cl_2(g) + 6KHSO_4 + 3H_2O$

This reaction is called chromyl chloride test.

Here oxidation state of Cr is +6.

87. The molarity of 1L orthophosphoric acid (H_3PO_4) having 70% purity by weight (specific gravity 1.54 g cm^{-3}) is _____M.

(Molar mass of $H_3PO_4 = 98$ g mol^{-1})

Ans. (11)

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Sol:- Specific gravity (density) = 1.54 g/cc.

Volume $=1\text{L}=1000\text{ ml}$

Mass of solution $=1.54\times1000$
$=1540\text{ g}$

% purity of H_2SO_4 is 70%

So weight of $H_3PO_4=0.7\times1540=1078\text{ g}$

Mole of $H_3PO_4=\dfrac{1078}{98}=11$

Molarity $=\dfrac{11}{1\text{L}}=11$

88. The values of conductivity of some materials at 298.15 K in Sm^{-1} are 2.1×10^3, $1.0\times10^{-16}, 1.2\times10, 3.91, 1.5\times10^{-2}$, $1\times10^{-7}, 1.0\times10^3$. The number of conductors among the materials is _____.

Ans. (4)

Sol:-

Conductivity (S m^{-1})

2.1×10^3, 1.2×10, 3.91, 1×10^3 } conductors at 298.15 K

1×10^{-16} Insulator at 298.15 K

1.5×10^{-2}, 1×10^{-7} } Semiconductor at 298.15 K

Therefore number of conductors is 4.

89. From the vitamins A, B_1, B_6, B_{12}, C, D, E and K, the number vitamins that can be stored in our body is _____.

Ans. (5)

Sol:- Vitamins A, D, E, K and B_{12} are stored in liver and adipose tissue.

90. If 5 moles of an ideal gas expands from 10 L to a volume of 100 L at 300 K under isothermal and reversible condition then work, w, is $-x$ J. The value of x is _____.

(Given $R=8.314\text{ J K}^{-1}\text{mol}^{-1}$)

Ans. (28721)

Sol:- It is isothermal reversible expansion, so work done negative

$$W=-2.303\,nRT\log\left(\frac{V_2}{V_1}\right)$$

$$=-2.303\times5\times8.314\times300\log\left(\frac{100}{10}\right)$$

$$=-28720.713\text{ J}$$

$$\equiv-28721\text{ J}$$

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