JEE MAIN 2024 SESSION-2
Paper with Solution

CHEMISRY | 06th April 2024 _ Shift-2

SECTION – A

61. Evaluate the following statements related to group 14 elements for their correctness.

(A) Covalent radius decreases down the group from C to Pb in a regular manner.

(B) Electronegativity decreases from C to Pb down the group gradually.

(C) Maximum covalance of C is 4 whereas other elements can expand their covalance due to presence of d orbitals.

(D) Heavier elements do not form $p\pi - p\pi$ bonds.

(E) Carbon can exhibit negative oxidation states.

Choose the correct answer from the options given below :

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

Sol. **2**

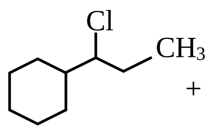
(A) Down the group, radius increases

(B) EN does not decreases gradually from C to Pb.

(C) Correct

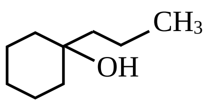
(D) Correct

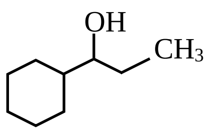
(E) Range of oxidation state of carbon –4 to +4

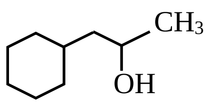
62. 

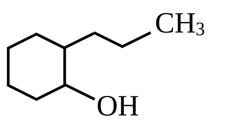
+ NaOH $\xrightarrow{H_2O}$ Major Product “A”

Consider the above chemical reaction. Product “A” is :

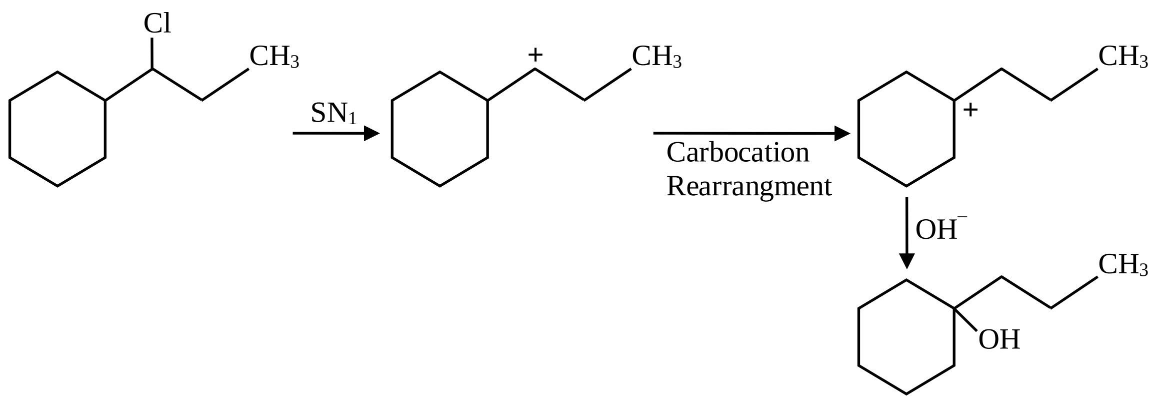
(1) 

(2) 

(3) 

(4) 

Sol. **1**



63. Arrange the following elements in the increasing order of number of unpaired electrons in it.

(A) Sc (B) Cr (C) V (D) Ti

(E) Mn

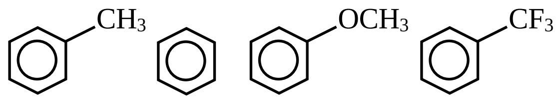
Choose the correct answer from the option given below :

(A) (C) < (E) < (B) < (A) < (D)
(2) (B) < (C) < (D) < (E) < (A)
(3) (A) < (D) < (C) < (E) < (B)
(4) (A) < (D) < (C) < (B) < (E)

Sol. **3**

	Unpaired e^-
$Sc = [Ar]4s^2 3d^1$	1
$Cr = [Ar]4s^1 3d^5$	6
$V = [Ar]4s^2 3d^3$	3
$Ti = [Ar]4s^2 3d^2$	2
$Mn = [Ar]4s^2 3d^5$	5

64.



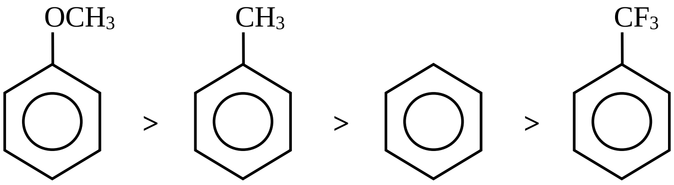
(I) (II) (III) (IV)

The correct arrangement for decreasing order of electrophilic substitution for above compounds is :

(1) (II) > (IV) > (III) > (I)
(2) (IV) > (I) > (II) > (III)
(3) (III) > (I) > (II) > (IV)
(4) (III) > (IV) > (II) > (I)

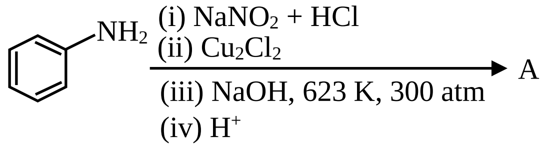
Sol. **3**

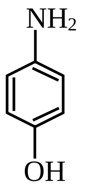
Electrophilic substitution reaction α EDG

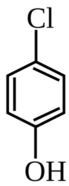


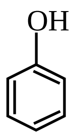
(+M) (+H) (–I)

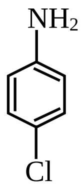
65. Identify the product "A" in the following reaction.



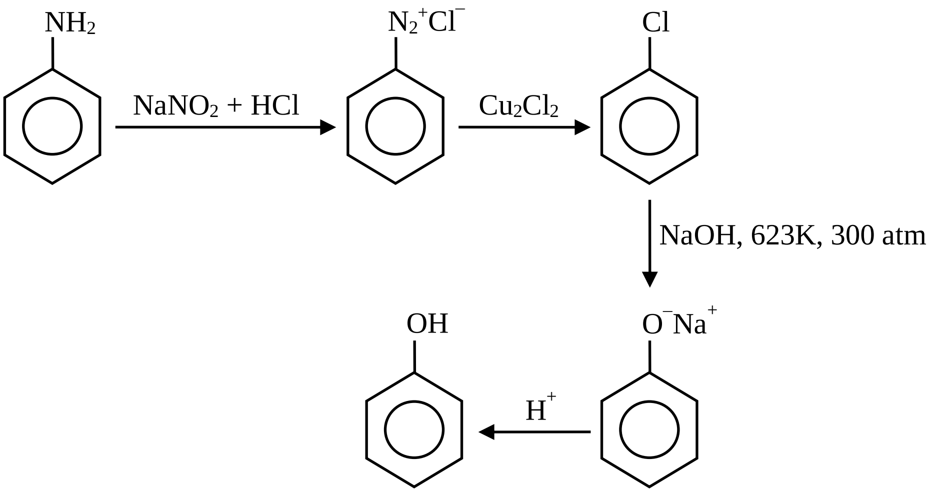
(1) 

(2) 

(3) 

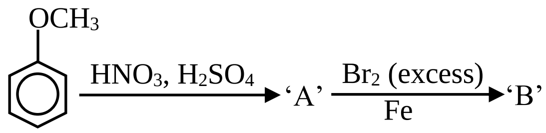
(4) 

Sol. **3**

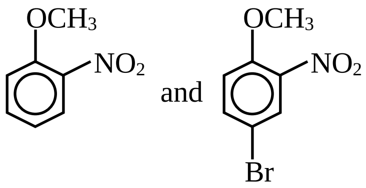


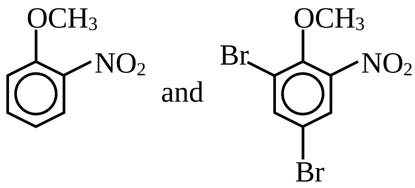
Phenol

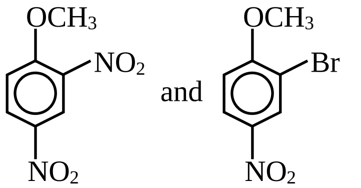
66. The major products formed :

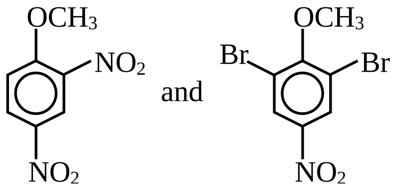


A and B respectively are :

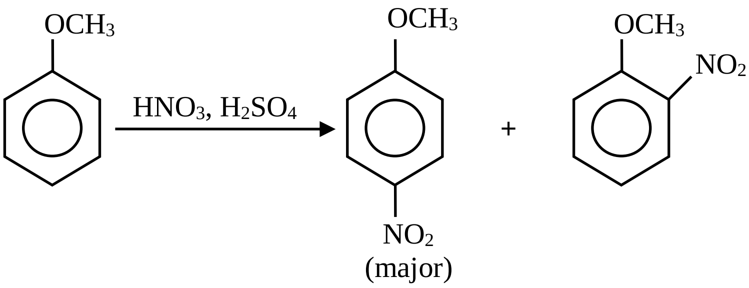
(1) 

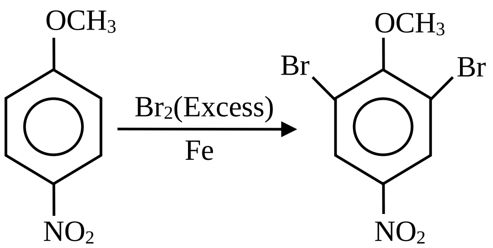
(2) 

(3) 

(4) 

Sol. **4**





67. Molality (m) of 3M aqueous solution of NaCl is :

(Given : Density of solution = 1.25 g mL^{-1}, Molar mass in g mol^{-1} : Na-23, Cl-35.5)

(1) 3.85 m (2) 2.90 m (3) 2.79 m (4) 1.90 m

Sol. **3**

$$\text{Molality } = \frac{M \times 1000}{1000d - M \times \text{ mol. wt. of solute}}$$

$$= \frac{3 \times 1000}{1000 \times 1.25 - 3 \times 58.5}$$

$$= \frac{3000}{1250 - 175.5}$$

$$= \frac{3000}{1074.5} = 2.79 \text{ m}$$

68. Match List-I with List-II.

List-I (Alkali Metal)		List-II (Emission Wavelength in nm)	
(A)	Li	(I)	589.2
(B)	Na	(II)	455.5
(C)	Rb	(III)	670.8
(D)	Cs	(IV)	780.0

Choose the correct answer from the options give below :

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

Sol. **3**

Fact based

69. Match List-I with List-II.

List-I (Reaction)		List-II (Type of redox reaction)	
(A)	$N_{2(g)} + O_{2(g)} \rightarrow 2NO_{(g)}$	(I)	Decomposition
(B)	$2Pb(NO_3)_{2(s)} \rightarrow 2PbO_{(s)} + 4NO_{2(g)} + O_{2(g)}$	(II)	Displacement
(C)	$2Na_{(s)} + 2H_2O_{(1)} \rightarrow 2NaOH_{(aq.)} + H_{2(g)}$	(III)	Disproportionation
(D)	$2NO_{2(g)} + 2^{-}OH(aq.) \rightarrow NO^{-}_{2(aq.)} + NO^{-}_{3(aq.)} + H_2O_{(1)}$	(IV)	Combination

Choose the correct answer from the options give below :

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

Sol. **1**

Fact

70. How can an electrochemical cell be converted into an electrolytic cell ?
(1) Applying an external opposite potential lower than E^0 cell.
(2) Reversing the flow of ions in salt bridge.
(3) Exchanging the electrodes at anode and cathode.
(4) Applying an external opposite potential greater than E^0 cell.

Sol. **4**

Electrochemical cell $\rightarrow$ Electrolytic cell

If external opposite potential $>$ E^o_{cell}

71. During the detection of acidic radical present in a salt, a student gets a pale yellow precipitate soluble with difficulty in NH_4OH solution when sodium carbonate extract was first acidified with dil. NHO_3 and then $AgNO_3$ solution was added. This indicates presence of :

(1) Br^- (2) I^- (3) Cl^- (4) CO_3^{2-}

Sol. **2**

When Na_2CO_3 extract of the salt acidified with dil HNO_3 and $AgNO_3$ solution is added to it, a yellow ppt of AgI which is insoluble in excess NH_4OH confirms the presence of I^- ion.

$$NaI + AgNO_3 \rightarrow NaNO_3 + \underset{\text{yellow ppt}}{AgI}$$

72. The ratio $\frac{K_P}{K_C}$ for the reaction :

$$CO_{(g)} + \frac{1}{2}O_{2(g)} \rightleftharpoons CO_{2(g)} \text{ is :}$$

(1) $(RT)^{1/2}$ (2) $\frac{1}{\sqrt{RT}}$ (3) RT (4) 1

Sol. **2**

$$CO(g) + \frac{1}{2}O_2(g) \rightleftharpoons CO_2(g)$$

$$\Delta ng = 1 - 1 - \frac{1}{2} = -\frac{1}{2}$$

$$k_P = k_C(RT)^{-1/2}$$

$$kp = \frac{kc}{\sqrt{RT}}$$

$$\frac{k_p}{k_c} = \frac{1}{\sqrt{RT}}$$

73. Given below are two statements :

Statement-I : PF_5 and BrF_5 both exhibit sp^3d hybridisation.

Statement-II : Both SF_6 and $[Co(NH_3)_6]^{3+}$ exhibit sp^3d^2 hybridisation.

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

Sol. **3**

$PF_5 \rightarrow sp^3d$

$BrF_5 \rightarrow sp^3d^2$

$SF_6 \rightarrow sp^3d^2$

$[Co(NH_3)_6]^{3+} \rightarrow d^2sp^3$

74. Consider the given reaction, identify the major product P.

$$CH_3-COOH \xrightarrow[\text{(iv)}H_2O/\overline{O}H,\Delta]{\text{(i)}LiAlH_4\text{(ii)}PCC\text{(iii)}HCN/\overline{O}H} \text{“P”}$$

(1) $CH_3-\overset{O}{\overset{\|}{C}}-CH_2CH_3$ (2) $CH_3-CH_2-CH_2-OH$ (3) $CH_3-CH_2-\overset{O}{\overset{\|}{C}}-NH_2$ (4) $CH_3-\overset{OH}{\overset{|}{C}H}-COOH$

Sol. **4**

$$CH_3-COOH \xrightarrow[\text{(Reduction)}]{LiAlH_4} CH_3-CH_2-OH \xrightarrow[\text{(oxidation)}]{PCC} CH_3-CHO$$

$$CH_3-CHO \xrightarrow[\text{(Nucleophillic Addition \& reaction)}]{HCN/OH^-} CH_3-\underset{OH}{\underset{|}{\overset{CN}{\overset{|}{C}}}}-H \xrightarrow{H2O/OH^-} CH_3-\underset{OH}{\underset{|}{CH}}-COOH$$

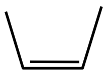
75. The correct statement among the following, for a "chromatography" purification method is :
(1) R_f of a polar compound is smaller than that of a non-polar compound.
(2) Non-polar compounds are retained at top and polar compounds come down in column chromatography.
(3) Organic compounds run faster than solvent in the thin layer chromatographic plate.
(4) R_f is an integral value.

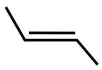
Sol. **1**
Non polar compound are having higher value of R_f then polar compound

$$R_f = \frac{\text{Distance traveled by compound}}{\text{Distance traveled by solvent}}$$

76. The incorrect statement regarding the geometrical isomers of 2-butenne is :
(1) cis-2-butenne has less dipole moment than trans-2-butene.
(2) cis-2-butene and trans-2-butene are not interconvertible at room temperature.
(3) cis-2-butene and trans-2-butene are stereoisomers.
(4) trans-2-butene is more stable than cis-2-butene

Sol. **1**


cis-2-butene


trans-2-butene

cis-2-butene has more dipole moment than trans-2-butene and due to restrict rotation (double bond) they are not inter convertible.
Both are geometrical isomers (stereoisomer) to each other.

77. The number of ions from the following that are expected to behave as oxidizing agent is :
Sn^{4+}, Sn^{2+}, Pb^{2+}, Tl^{3+}, Pb^{4+}, Tl^{+}
(1) 2 (2) 3 (3) 1 (4) 4

Sol. **1**
Due to inert pair effect, Ti^{3+} and Pb^{4+} can behave as oxidising agent.

78. The incorrect statements regarding enzymes are :
(A) Enzymes are biocatalysts.
(B) Enzymes are non-specific and can catalyse different kinds of reactions.
(C) Most enzymes are globular proteins
(D) Enzyme-oxidase catalyses the hydrolysis of maltose into glucose
Choose the correct answer from the option given below :
(1) (B), (C) and (D) (2) (A), (B) and (C) (3) (B) and (C) (4) (B) and (D)

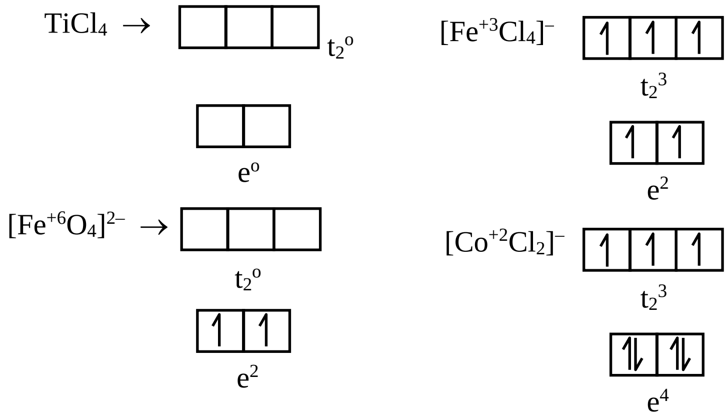
Sol. **4**
– Enzymes are biocatalysts which are specific in nature.
– Enzymes are mainly globular proteins.
– Maltase is an enzyme secreted by small intestine that catalyses the hydrolysis of maltose into glucose.

79. Match List-I with List-II.

List-I (Tetrahedral complex)		List-II (Electronic configuration)	
(A)	$TiCl_4$	(I)	e^2, t_2^0
(B)	$[FeO_4]^{2-}$	(II)	e^4, t_2^3
(C)	$[FeCl_4]^{-}$	(III)	e^0, t_2^0
(D)	$[CoCl_4]^{2-}$	(IV)	e^2, t_2^3

Choose the correct answer from the options given below :
(1) (A)-(III), (B)-(IV), (C)-(II), (D)-(I) (2) (A)-(I), (B)-(III), (C)-(IV), (D)-(II)
(3) (A)-(III), (B)-(I), (C)-(IV), (D)-(II) (4) (A)-(IV), (B)-(III), (C)-(I), (D)-(II)

Sol. **3**



80. The correct IUPAC name of $[PtBr_2(PMe_3)_2]$ is :

(1) bis(trimethylphosphine)dibromoplatinum(II)
(2) dibromodi(trimethylphosphine)platinum(II)
(3) dibromobis(trimethylphosphine)platinum(II)
(4) bis[bromo(trimethylphosphine)]platinum(II)

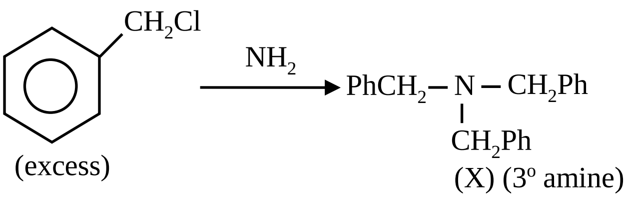
Sol. **3**

Dibronobis(trimethylphosphine) platinum (II)

SECTION – B

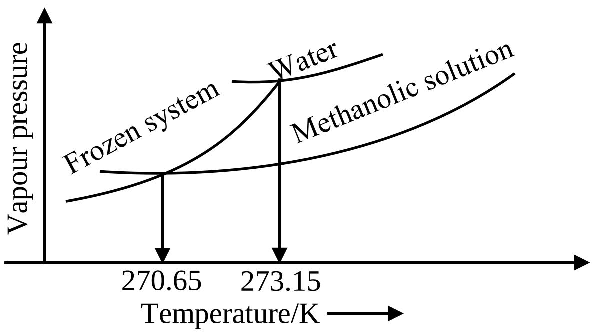
81. An amine (X) is prepared by ammonolysis of benzyl chloride. On adding p-toluenesulphonyl chloride to it the solution remains clear. Molar mass of the amine (X) formed is _______ g mol^{-1}.
(Given molar mass in $gmol^{-1}$ C : 12, H : 1, O : 16, N : 14)

Sol. **287**



Molar mass of (X) is 287 g mol^{-1}

82. When 'X' × 10^{-2} ml methanol (molar mass = 32 g; density = 0.792 g/cm^3) is added to 100 mL water (density = 1 g/cm^3), the following diagram is obtained.



x = _________ (nearest integer).

[Given : Molal freezing point depression constant of water at 273.15 K is 1.86 K kg mol^{-1}]

Sol. **543**

$\Delta T_f = T_f^0 - T_f = 273.15 - 270.65 = 2.5\,K$

$\Delta T_f = k_f \times \text{ molality } \Rightarrow 2.5 = 1.86 \times \dfrac{n}{0.1}$

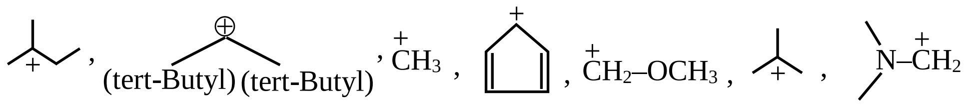
$n_{CH_3OH} = 0.1344$ moles

mass of $CH_3OH = 0.1344 \times 32 = 4.3$ g

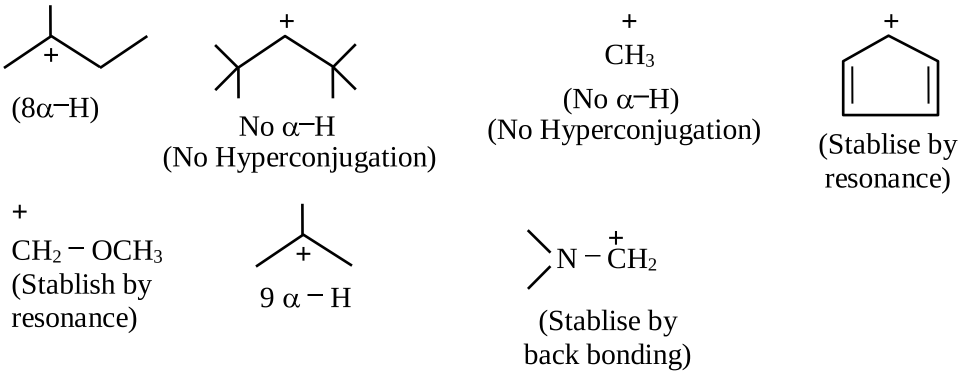
Volume of $CH_3OH = \dfrac{\text{mass}}{\text{density}} = \dfrac{4.3}{0.792} = 5.43$ ml $= 543 \times 10^{-2}$ ml

Ans. $\rightarrow$ 543

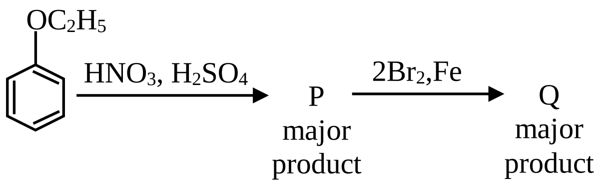
83. Number of carbocations from the following that are not stabilized by hyperconjugation is-



Sol. **5**

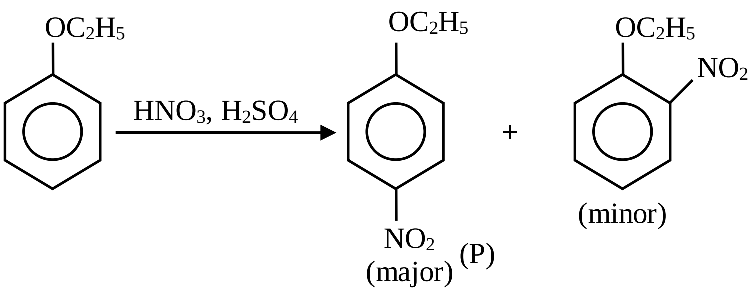


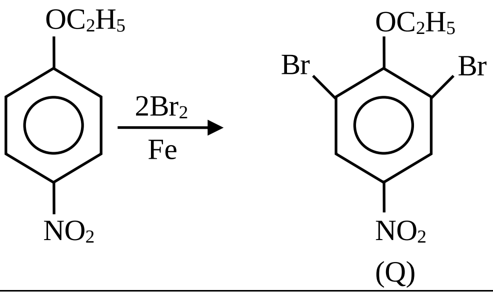
84.



The ratio of number of oxygen atoms to bromine atoms in the product Q is_______ $\times 10^{-1}$.

Sol. **15**





In Q Total oxygen atoms = 3
Total Bromine atoms = 2
ration = $\frac{3}{2} = 1.5 = 15 \times 10^{-1}$

85. Consider the two different first order reactions given below
A + B $\rightarrow$ C (Reaction 1)
P $\rightarrow$ Q (Reaction 2)

The ratio of the half life of reaction 1 : Reaction 2 is 5 : 2 If t_1 and t_2 represent the time taken to complete $\frac{2}{3}^{rd}$ and $\frac{4}{5}^{th}$ of reaction 1 and Reaction 2, respectively, then the value of the ratio $t_1 : t_2$ is _______ $\times 10^{-1}$ (nearest integer).
[Given : $\log_{10}(3) = 0.477$ and $\log_{10}(5) = 0.699$]

Sol. **17**

$$\frac{(t_{1/2})_I}{(t_{1/2})_{II}} = \frac{k_2}{k_1} = \frac{5}{2}$$

$$k_1 t_1 = \ln \frac{1}{1-\frac{2}{3}} = \ln 3 \qquad \ldots(1)$$

$$k_2 t_2 = \ln \frac{1}{1-\frac{4}{5}} = \ln 5 \qquad \ldots(2)$$

eq (1) / (2)

$$\frac{k_1 t_1}{k_2 t_2} = \frac{0.4771}{0.6991}$$

$$\frac{t_1}{t_2} = \frac{0.47791}{0.6991} \times \frac{5}{2} = 1.7$$

= 17×10^{-1}
Ans $\rightarrow$ 17

86. For hydrogen atom, energy of an electron in first excited state is – 3.4 eV, K.E. of the same electron of hydrogen atom is ***x*** eV. Value of ***x*** is _____ $\times 10^{-1}$ eV. (Nearest integer)

Sol. **34**
KE = – T. E.
= – (– 3.4) = + 3.4 ev
= 34×10^{-1}
Ans. $\rightarrow$ 34

87. Consider the following reaction

$$NiS + HNO_3 + HCl \rightarrow A + NO + S + H_2O$$

$A + NH_4OH + H_3C - C = N - OH$
$\qquad\qquad\qquad\qquad |$
$\qquad\qquad\quad H_3C - C = N - OH \rightarrow B + NH_4Cl + H_2O$

The number of protons that do not involve in hydrogen bonding in the product B is _______ .

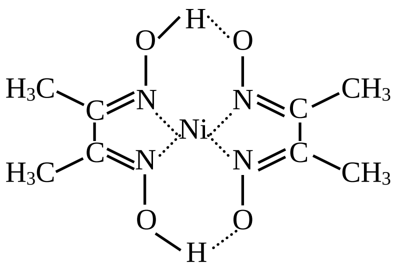
Sol. **12**

$$3NiS + 2HNO_3 + 6HCl \rightarrow 3NiCl_2 + 2NO + 3S + 4H_2O$$

$NiCl_2 + 2NH_4OH + H_3C\text{–}C = N\text{–}OH \rightarrow NH_4Cl + H_2O + (B)$

$H_3C\text{–}C{=}N\text{–}OH$

B→



88. Total number of species from the following with central atom utilizing sp^2 hybrid orbitals for bonding is ______.

NH_3, SO_2, SiO_2, $BeCl_2$, C_2H_2, C_2H_4, BCl_3, $HCHO$, C_6H_6, BF_3, $C_2H_4Cl_2$

Sol. **6**

Species with sp^2 hyb^n on central atom are.

SO_2, C_2H_4, BCl_3, $HCHO$, C_6H_6, BF_3

89. Among VO_2^+, MnO_4^- and $Cr_2O_7^{2-}$, the spin-only magnetic moment value of the species with least oxidizing ability is ______ BM (Nearest integer).

(Given atomic number V = 23, Mn = 25, Cr = 24)

Sol. **0**

For 3d series

oxidising power $V^{5+} < Cr^{6+} < Mn^{7+}$

$V^{5+} \Rightarrow [Ar]4s^0 3d^0$

Number of uinpaired e^- = 0

$\mu = 0$

90. For the reaction at 298 K, 2A + B $\rightarrow$ C, $\Delta H = 400 kJmol^{-1}$ and $\Delta S = 0.2 kJmol^{-1}K^{-1}$. The reaction will become spontaneous above _______ K.

Sol. **2000**

$$\Delta G = \Delta H - T\Delta S$$

$$\Delta G = 0 \rightarrow \Delta H = T\Delta S$$

$$T = \frac{\Delta H}{\Delta S} = \frac{400}{0.2} = 2000k$$

Ans. $\rightarrow$ 2000