FINAL NATIONAL STANDARD EXAMINATION - 2019

(Held On Sunday 24th November, 2019)

CHEMISTRY — TEST PAPER WITH SOLUTION

1. Myoglobin (Mb) , an oxygen storage protein, contains 0.34% Fe by mass and in each molecule of myoglobin one ion of Fe is present. Molar mass of Mb(g mol^{-1}) is -

(Molar mass of Fe = 55.845 g mol^{-1})

(A) 16407 (B) 164206 (C) 16425 (D) 164250

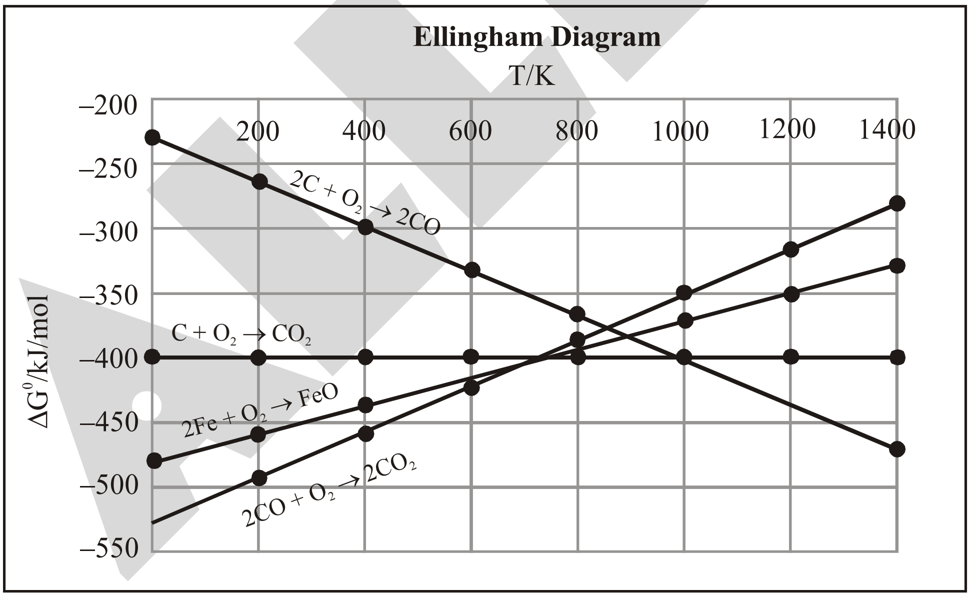
Ans. (C)

Sol. $\%Fe \text{ by wt.} = \dfrac{\text{wt. of Fe}}{\text{wt. of molecule}} \times 100 = 0.34$

$\Rightarrow \quad \dfrac{1 \times 55.845}{(M.M.)_{Mb}} \times 100 = 0.34$

$\Rightarrow \quad M.M = 16425$

2. The following Ellingham diagram depicts the oxidation of 'C' , 'CO' and 'Fe'. Which of the following is correct ?



I. FeO can be reduced by C below 600 K

II. FeO can be reduced by CO below 600 K

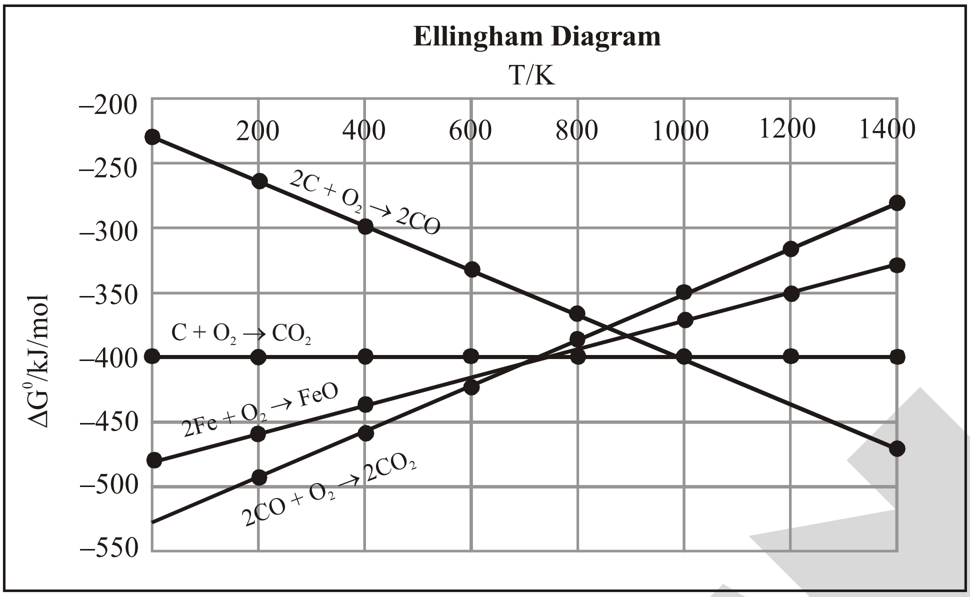
III. FeO can be reduced by C above 1000 K

IV. FeO can be reduced by CO above 1000 K

(A) II and III (B) I and IV (C) I & III (D) II and IV

Ans. (A)

Sol.



From the given plot "CO" is better reducing agent than carbon "C" below 600 K while "C" is better reducing agent than "CO" above 1000K

3. A balance having a precision of 0.001 g was used to measure a mass of a sample of about 15g. The number of significant figures to be reported in this measurement is -

(A) 2 (B) 3 (C) 5 (D) 1

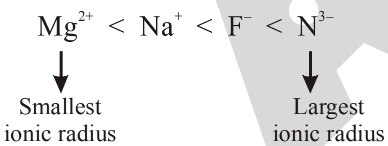
Ans. (C)

4. N^{3-}, F^-, Na^+ and Mg^{2+} have the same number of electrons. Which of them will have the smallest and the largest ionic radii respectively -

(A) Mg^{2+} and N^{3-} (B) Mg^{2+} and Na^+ (C) N^{3-} and Na^+ (D) F^- and N^{3-}

Ans. (A)

Sol. In the given isoelectonic species ; N^{3-}, F^-, Na^+ and Mg^{2+}. The correct order of ionic radius is

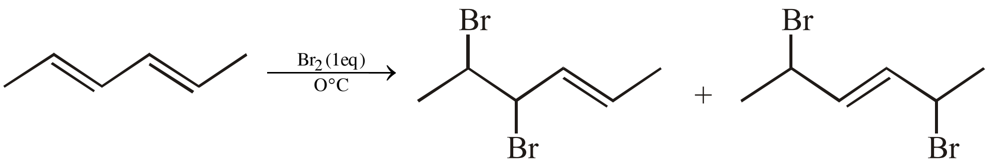


5. The reaction of 2, 4-hexadiene with one equivalent of bromine at 0°C gives a mixture of two compounds 'X' and 'Y'. If 'X' is 4, 5 - dibromohex-2-ene, 'Y' is -

(A) 2,5-dibromohex-2-ene (B) 2,5-dibromohex-3-ene

(C) 2,3-dibromohex-3-ene (D) 3,4-dibromohex-3-ene

Ans. (B)

Sol. 

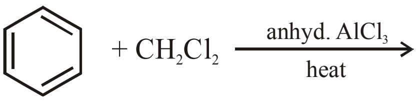
KCP (X) (1,2-addition) 4,5-dibromohex-2-ene

TCP (Y) (1,4-addition) 2,5-dibromohex-3-ene

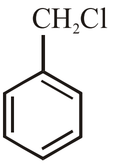
(X) is kinetically controlled product, (1,2-product)

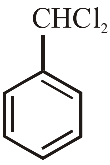
(Y) is Thrmodynamically controlled product (1, 4-product)

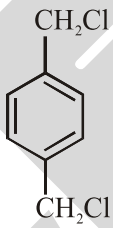
6. The major product of the following reaction is -

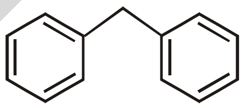


Excess

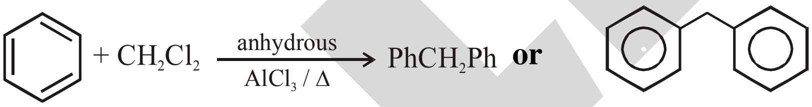
(A) 

(B) 

(C) 

(D) 

Ans. (D)

Sol. 

(excess)

It is example of Friedel Craft alkylation (twice)

7. An electrochemical cell was constructed with Fe^{2+} / Fe and Cd^{2+} at 25ºC with initial concentration of $[Fe^{2+}]$ = 0.800 M and $[Cd^{2+}]$ = 0.250 M. The EMF of the cell when $[Cd^{2+}]$ becomes 0.100 M is -

Half Cell	E^0 (V)
Fe^{2+}(aq.) / Fe(s)	–0.44
Cd^{2+}(aq.) / Cd(s)	0.40

(A) 0.013 V (B) 0.011 V (C) 0.051 V (D) 0.002 V

Ans. (B)

Sol. **Anode :**

$Fe_{(s)} \longrightarrow Fe^{+2}_{(aq)} + 2e^{-}$ $\quad E^{o}_{Fe/Fe^{+2}} = 0.44V$

Cathode :

$Cd^{+2}_{(aq)} + 2e^{-} \longrightarrow Cd_{(s)}$ $\quad E^{o}_{Cd^{+2}/Cd} = -0.4V$

Cell reaction :

$Fe_{(s)} + Cd^{+2}_{(aq)} \longrightarrow Cd_{(s)} + Fe^{+2}_{(aq)}; E^{o}_{cell} = 0.04\ V$

$\Rightarrow \quad 0.1 \qquad\qquad 0.95$

$$E_{cell} = E^{o}_{cell} - \frac{0.0591}{n}\log Q$$

$$E_{cell} = 0.04 - \frac{0.0591}{2}\log\frac{0.95}{0.1}$$

$$\cong 0.011V$$

8. The kinetic energy of the photoelectrons ejected by a metal surface increased from 0.6 eV to 0.9 eV when the energy of the incident photons was increased by 20%. The work function of the metal is-

(A) 0.66 eV (B) 0.72 eV (C) 0.90 eV (D) 0.30 eV

Ans. (C)

Sol. Photoelectric effect

$h\nu_{incident} = h\nu_{0\ threshold} + (K.E.)$

Initially $\quad (h\nu)_i = (h\nu_0) + (KE)_i$

$(h\nu)_i = (h\nu)_0 + (0.6\ eV)$ .... (1)

Finally $\quad (h\nu)_f = (h\nu)_e + (KE)_b$

$(1.2)(h\nu)_i = (h\nu)_0 + 0.9eV$ .... (2)

Dividing (1) & (2)

$$\frac{1.2}{1} = \frac{\phi_0 + 0.9eV}{\phi_0 + 0.6eV}$$

$\Rightarrow \quad 0.2\phi_0 = 0.9 - 0.72 = 0.18$

$\Rightarrow \quad \phi_0 = 0.9\ eV$

9. The alkene ligand ($\pi - C_2R_4$) is both a 'σ' donor and a 'π' acceptor , similar to the CO ligand in metal carbonyls, and exhibits synergic bonding with metals. Correct order of C–C bond length in $K[PtCl_3(\pi - C_2R_4)]$ complexes in which R = H, F or CN is -

(A) H > F > CN (B) H > CN > F (C) CN > F > H (D) F > H > CN

Ans. (C)

Sol. The correct order of C – C bond length ∝ extent of synergic bond (S.B.)

Extent of S.B. ∝ (–I) effect order [R = CN > F > H]

10. The correct order of CFSE among $[Zn(NH_3)_4]^{2+}$, $[Co(NH_3)_6]^{2+}$ and $[Co(NH_3)_6]^{3+}$ is-

(A) $[Co(NH_3)_6]^{3+} > [Co(NH_3)_6]^{2+} > [Zn(NH_3)_4]^{2+}$

(B) $[Zn(NH_3)_4]^{2+} > [Co(NH_3)_6]^{2+} > [Co(NH_3)_6]^{3+}$

(C) $[Co(NH_3)_6]^{3+} > [Zn(NH_3)_4]^{2+} > [Co(NH_3)_6]^{2+}$

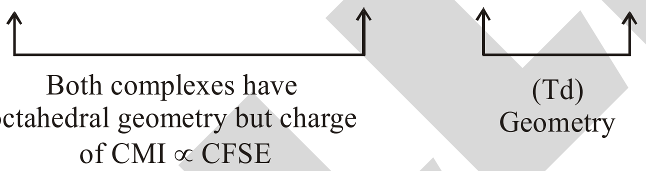
(D) $[Co(NH_3)_6]^{2+} > [Co(NH_3)_6]^{3+} > [Zn(NH_3)_4]^{2+}$

Ans. (A)

Sol. CFSE ∝ charge of CMI (central metal ion)

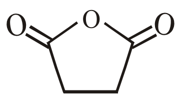
CFSE ∝ Nature of geometry = [Sq. planar > octahedral > tetrahedral]

CFSE = $[Co(NH_3)_6]^{3+} > [Co(NH_3)_6]^{2+} > [Zn(NH_3)_4]^{2+}$

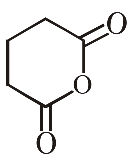


11. When acid 'X' is heated to 230ºC, along with CO_2 and H_2O, a compound 'Y' is formed. If 'X' is HOOC $(CH_2)_2CH(COOH)_2$, the structure of 'Y' is -

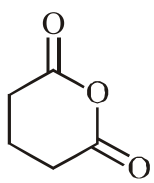
(A) $HOOC(CH_2)_3(COOH)$

(B) 

(C) $CH_3CH_2CH(COOH)_2$

(D) 

Ans. (D)

Sol. $HOOC{-}CH_2{-}CH_2{-}CH(COOH)_2 \xrightarrow{230^\circ C} CO_2 + H_2O +$ 

(X) (Y)

12. Which of the following is correct about the isoelectronic species, Li^{2+} and H^- ?

I. H^- is larger is size that Li^+

II. Li^+ is a better reducing agent than H^-

III. It requires more energy to remove an electron from H^- than from Li^+

IV. The chemical properties of the two ions are the same

(A) I only (B) II & III (C) I, II and IV (D) I and II

Ans. (A)

Sol. I Size order $H^{\ominus} > Li^{\oplus}$

II $Li^{\oplus}$ cannot act as Reducing agent while $H^{\ominus}$ can act as reducing agent

III $H^{\ominus}$ require less energy to remove than electron $Li^{\oplus}$

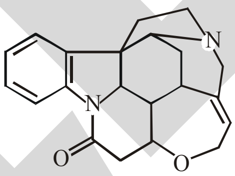
IV Chemical properties of two ions are not same

13. Number of products formed (ignoring stereoisomerism) in the monochlorination of ethylcyclohexane is -

(A) 6 (B) 8 (C) 5 (D) 4

Ans. (A)

14. The number of asymmetric carbon atoms in strychnine, whose structure given below is

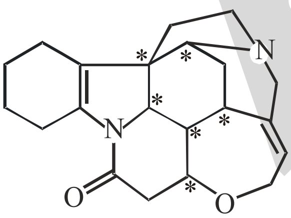


Strychnine

(A) 5 (B) 4 (C) 6 (D) 7

Ans. (C)

Sol.



* ⇒ Assymmetric carbon atoms

15. Molten NaCl is electrolysed for 35 minutes with a current of 3.50 A at 40°C and 1 bar pressure. Volume of chlorine gas evolved in this electrolysis is

(A) 0.016 L (B) 0.98 L (C) 9.8 L (D) 1.96 L

Ans. (B)

Sol. $q = i \times t = (3.5 \times 35 \times 60)$ coulomb

$= 7350$ coulomb

$\Rightarrow \quad n_{e^-} = \dfrac{7350}{96487} \cong 0.0762$

Anode : $Cl^- \longrightarrow \dfrac{1}{2}Cl_2 + e^-$

$\Rightarrow \quad \dfrac{n_{Cl_2}}{\left(\dfrac{1}{2}\right)} = \dfrac{n_{e^-}}{1}$

$\Rightarrow \quad n_{Cl_2} = \dfrac{1}{2} \times 0.0762 = 0.038$

$\Rightarrow \quad V_{Cl_2} = \dfrac{(0.038)\times(0.082)\times 313}{1.013} = 0.98\,L$

16. Which of the following pairs of compounds can be stable while retaining the identity of each compound in the pair over a period of time ?

(I) $FeCl_3$, $SnCl_2$ (II) $HgCl_2$, $SnCl_2$ (III) $FeCl_2$, $SnCl_2$ (IV) $FeCl_3$, KI

(A) I only (B) I and III (C) III only (D) II and IV

Ans. (C)

Sol. (A) $\underset{S.O.A}{FeCl_3} + \underset{S.R.A}{SnCl_2} \rightarrow FeCl_2 + SnCl_4$

(B) $\underset{S.O.A}{HgCl_2} + \underset{S.R.A}{SnCl_2} \rightarrow Hg + SnCl_4$

(C) $FeCl_2 + SnCl_2$ retaining identity of each compound in pair over a period of time because $FeCl_2$ is not strong oxidizing agent

(D) $\underset{S.O.A}{FeCl_3} + \underset{S.R.A}{KI} \rightarrow FeI_2 + I_2 + KCl$

17. The reaction $xX(g) \rightleftharpoons yY(g) + zZ(g)$ was carried out at a certain temperature with an initial pressure of X = 30 bar. Initially 'Y' and 'Z' were not present. If the equilibrium partial pressures of 'X', 'Y' and 'Z' are 20, 5 and 10 bar respectively x : y : z is

(A) 4 : 1 : 2 (B) 2 : 1 : 2 (C) 1 : 2 : 1 (D) 1 : 1 : 2

Ans. (B)

Sol. $xX_{(g)} \rightleftharpoons yY_{(g)} + zZ_{(g)}$

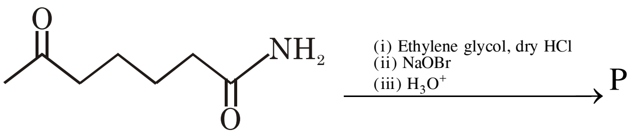
t = 0 30 bar

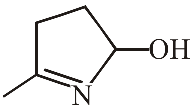
t_{eq} 20 bar 5 bar 10 bar

$$\Rightarrow \frac{p_x \text{ reacted / decreased}}{x} = \frac{p_y \text{ increased}}{y} = \frac{p_z \text{ increased}}{z}$$

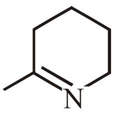
$$\Rightarrow \frac{10}{x} = \frac{5}{y} = \frac{10}{z} \quad \Rightarrow x : y : z :: 2 : 1 : 2$$

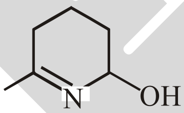
18. The major product 'P' formed in the following sequence of reactions is



(A) 

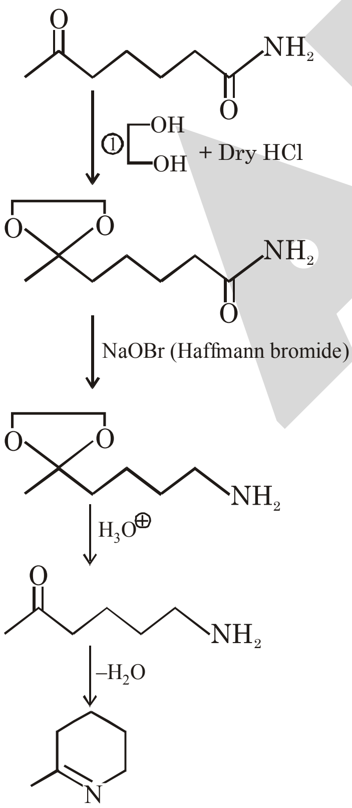
(B) 

(C) 

(D) 

Ans. (C)

Sol.



19. Sodium lauryl sulphate (SLS) is a surface active agent, which is adsorbed on water surface. The number of molecules of SLS that can be adsorbed on the surface of a spherical water droplet of diameter 3.5 mm is (effective area of one molecule of SLS = 4.18 nm^2)

(A) 9.20×10^{12} (B) 9.20×10^{18}

(C) 1.15×10^{12} (D) 3.68×10^{13}

Ans. (A)

Sol. No. of molecules adsorbed = $\dfrac{\text{Surface area of droplet}}{\text{Area of one SLS molecule}}$

$$= \frac{4\pi\left(\frac{3.5}{2}\times10^{-3}\right)^2}{4.18\times10^{-9}\times10^{-9}} \simeq 9.2\times10^{12}$$

20. The unit of Planck's constant, 'h', is the same as that of

(A) angular momentum (B) energy

(C) wavelength (D) frequency

Ans. (A)

Sol. $\underset{\substack{\text{Angular}\\\text{momentum}}}{mvr} = \dfrac{nh}{2\pi}$

21. The set in which all the species are diamagnetic is

(A) B_2, O_2, NO (B) O_2, O_2^+, CO

(C) N_2, O_2^-, CN^- (D) C_2, O_2^{2-}, NO^+

Ans. (D)

Sol. (A) B_2 Paramagnetic
O_2 Paramagnetic
NO Paramagnetic

(B) O_2 Paramagnetic
$O_2^{\oplus}$ Paramagnetic
CO Diamagnetic

(C) N_2 Diamagnetic
$O_2^{\ominus}$ Paramagnetic
$\overset{\ominus}{C}N$ Diamagnetic

(D) C_2 Diamagnetic
O_2^{2-} Diamagnetic
$NO^{\oplus}$ Diamagnetic

22. A solid comprises of three types of elements 'P', 'Q' and 'R'. 'P' forms an FCC lattice in which 'Q' and 'R' occupy all the tetrahedral voids and half the octahedral voids respectively. The molecular formula of the solid is :

(A) P_2Q_4R (B) PQ_2R_4

(C) P_4Q_2R (D) P_4QR

Ans. (A)

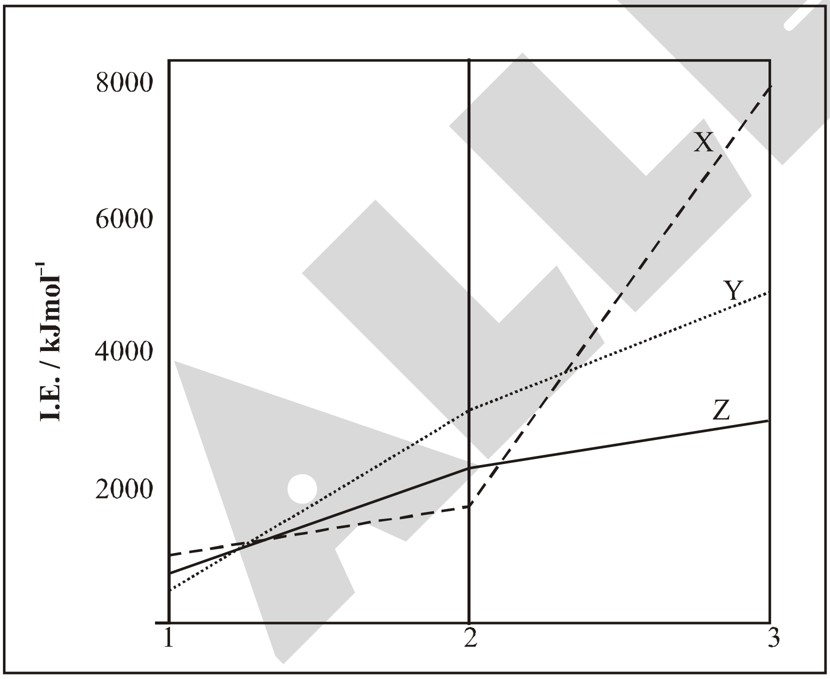
Sol. P : Effective atoms = 4

Q : All tetrahedral voids = 8

R : All octahedral voids = $\frac{4}{2} = 2$

$\Rightarrow P_4Q_8R_{4/2} :: P_2Q_4R$

23. The following qualitative plots depict the first, second and third ionization energies (I.E.) of Mg, Al and K. Among the following, the correct match of I.E. and the metal is



(A) X–Al; Y–Mg; Z–K

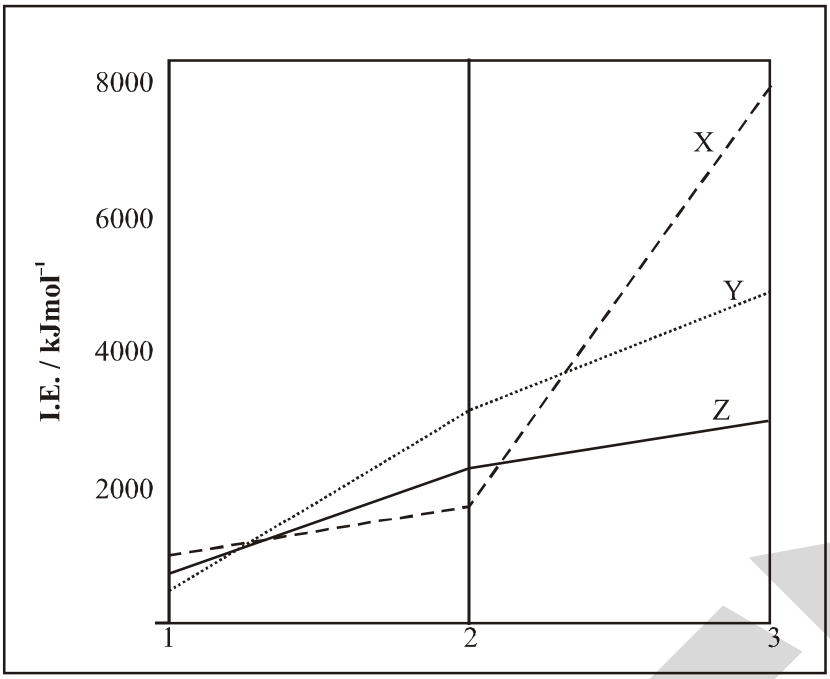
(B) X–Mg; Y–Al; Z–K

(C) X–Mg; Y–K; Z–Al

(D) X–Al; Y–K; Z–Mg

Ans. (C)

Sol.

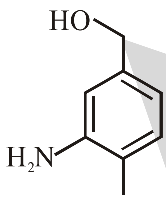


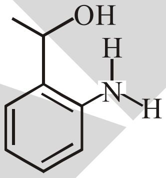
The valence shell electronic configuration of K($4s^1$) , Mg($3s^2$), Al($3s^2 3p^1$)

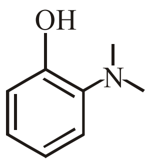
The correct order of IE_1 from the given graph is : (Y → K) < (Z → Al) < (X → Mg)

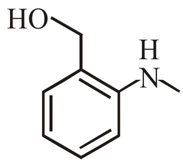
24. The structure of compound 'X' ($C_8H_{11}NO$) based on the following tests and observations is

Reagent / s	Observation
Neutral $FeCl_3$	No coloration
Lucas reagent	Turbidity
$NaNO_2$ / HCl at 273 K	Yellow oil

(A) 

(B) 

(C) 

(D) 

Ans. **(D)**

Sol. According to observation compound does not have phenolic-OH group. It has alcoholic-OH group & 2°–Amine group.

25. The number of stereoisomers is maximum for

(A) $[Co(en)_3]^{3+}$ (B) $[Co(en)_2ClBr]^+$

(C) $[Co(NH_3)_4Cl_2]^+$ (D) $[Co(NH_3)_4ClBr]^+$

Ans. **(B)**

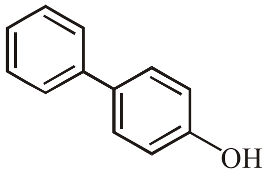
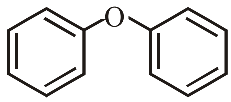
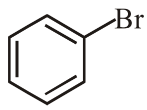
Sol. (A) $[Co(en)_3]^{3+}$ = two stereoisomers

(B) $[Co(en)_2ClBr]$ = three stereoisomers

(C) $[Co(NH_3)_4Cl_2]$ = two stereoisomers

(D) $[Co(NH_3)_4(Cl)Br]^+$ = two stereoisomers

26. Reaction of C_6H_5MgBr with phenol gives

(A)  (B)  (C)  (D) 

Ans. (A)

Sol. PhMgBr + PhOH $\rightarrow$ PhH + PhOMgBr

So benzene is formed in acid base reaction

27. The power and wavelength emitted by a laser pointer commonly used in Power Point presentations are 1.0 mW and 670 nm respectively. Number of photons emitted by this pointer during a presentation of 5 minutes is

(A) 1.01×10^9 (B) 1.01×10^{21} (C) 1.6×10^{16} (D) 1.01×10^{18}

Ans. (D)

Sol. Energy emitted during 5 minutes.

$$= \left(1 \times 10^{-3} \frac{J}{s} \times (5 \times 60) s\right)$$

If 'n' photons are emitted

$$\Rightarrow \quad (10^{-3} \times 5 \times 60) = n \times \frac{hc}{\lambda}$$

$$= \frac{n \times 6.626 \times 10^{-34} Js \times 3 \times 10^8 m/s}{(670 \times 10^{-9} m)}$$

$$\Rightarrow \quad n = 1.01 \times 10^{18}$$

28. The work done (kJ) in the irreversible isothermal compression of 2.0 moles of an ideal gas from 1 bar to 100 bar at 25°C at constant external pressure of 500 bar is

(A) 2452 (B) 490 (C) 2486 (D) –490

Ans. (A)

Sol. $-w = p_{ext}(v_{final} - v_{initial})$

$$= (500 \text{ bar}) \left(\frac{nRT}{p_f} - \frac{nRT}{p_i}\right)$$

$$= 500 \text{ bar} \left(\frac{1}{100 \text{ bar}} - \frac{1}{1 \text{ bar}}\right) \times 2 \times 8.314 \times 298 \text{ J}$$

$$\Rightarrow \quad w = 2452.8 \text{ kJ}$$

29. Atropine ($C_{17}H_{23}O_3N$) is a naturally occurring compound used to treat certain types of poisoning. The degree of unsaturation in atropine is

(A) 7 (B) 6 (C) 5 (D) 4

Ans. (A)

Sol. $C_{17}H_{23}O_3N$

$$DU = \frac{1}{2} \times (2 \times 17 + 2 - 23 + 1) = 7$$

30. $MnCl_2.4H_2O$ (molar mass = 198 g mol^{-1}) when dissolved in water forms a complex of Mn^{2+}. An aqueous solution containing 0.400 g of $MnCl_2.4H_2O$ was passed through a column of a cation exchanged resin and the acid solution coming out was neutralized with 10 mL of 0.20 M NaOH. The formula of the complex formed is :

(A) $[Mn(H_2O)_4Cl_2]$ (B) $[Mn(H_2O)_6]Cl_2$ (C) $[Mn(H_2O)_5Cl]Cl$ (D) $Na[Mn(H_2O)_3Cl_3$

Ans. (C)

Sol. n_{H^+} neutralised $= \frac{10 \times 0.2}{1000} = 2 \times 10^{-3}$ mol

$\Rightarrow$ Equivalents of $MnCl_2.4H_2O = n_{H^+}$

$\Rightarrow$ $\left(\frac{0.4}{198}\right) \times$ (n-factor) $= 2 \times 10^{-3}$

$\Rightarrow$ n-factor = 1

$\Rightarrow$ $(Mn(H_2O)_5Cl)Cl$

31. Which of the following is NOT correct about hydrides?

I. Saline hydrides are stoichiometric and metallic hydrides are non-stoichiometric

II. BeH_2 is monomeric whereas MgH_2 is polymeric

III. Hydrides of the elements of Group 13 are electron deficient and those of Group 15 are electron rich

IV. NaH reacts with water and liberates H_2 whereas B_2H_6 does not react with water

(A) IV only (B) I and III (C) III only (D) II and IV

Ans. (D)

Sol. NaH, KH, CaH_2 are saline Hydrides, hence they are stoichiometric.

Metallic Hydride are Interstitial and are non stoichiometric.

BeH_2 = Polymeric

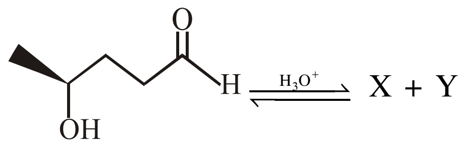
BH_3 = electron deficient

$\ddot{N}H_3$, $\ddot{P}H_3$ = electron rich

$NaH + H_2O \longrightarrow NaOH + H_2\uparrow$

$B_2H_6 + 6H_2O \longrightarrow 2H_3BO_3 + 6H_2\uparrow$

32. The compounds 'X' and 'Y' formed in the following reaction are



(A) hemiacetals with identical physical and chemical properties

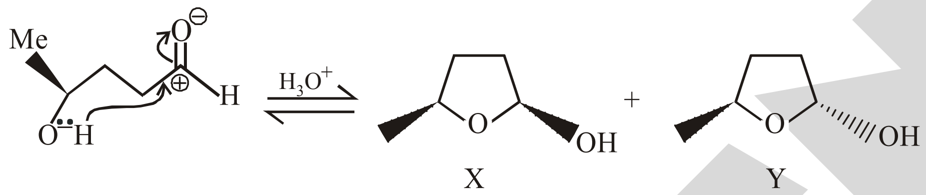
(B) acetals with identical physical and chemical properties

(C) hemiacetals with different physical and chemical properties

(D) acetals with different physical and chemical properties

Ans. (C)

Sol.



Products are diastereomer

33. Aqueous solution of slaked lime, $Ca(OH)_2$, is extensively used in municipal waste water treatment. Maximum pH possible in an aqueous solution of slaked lime is (K_{sp} of $Ca(OH)_2 = 5.5 \times 10^{-6}$)

(A) 1.66 (B) 8.14 (C) 12.04 (D) 12.34

Ans. (D)

Sol. $Ca(OH)_{2(s)} \rightleftharpoons \underset{(s)}{Ca^{+2}_{(aq.)}} + \underset{(2s)}{2OH^-_{(aq.)}}$

$\Rightarrow$ $K_{sp} = s(2s)^2 = 4s^3 = 5.5 \times 10^{-6}$

$\Rightarrow$ $s = 0.011$ M

$\Rightarrow$ $(OH^-) = 2s = 0.022$ M

$\Rightarrow$ $pOH = -\log(OH^-) = 1.652$

$\Rightarrow$ $pH = 14 - 1.652$

$= 12.34$

34. An electron present in the third excited state of a H atom returns to the first excited state and then to the ground state. If λ_1 and λ_2 are the wavelengths of light emitted in these two transitions respectively, $\lambda_1 : \lambda_2$ is

(A) 4 : 1 (B) 5 : 9 (C) 3 : 1 (D) 2 : 1

Ans. (A)

Sol. $n_{initial} = 4$; $n_{intermediate} = 2$; $n_{final} = 1$

$\lambda_1 = (E_4 - E_2)$ & $\lambda_2 = E_2 - E_1$

$\lambda_1 : \lambda_2 :: (E_2 - E_1) : (E_4 - E_2)$

$= [-3.4 - (-13.6)] : [-0.85 - (-3.4)]$

$10.2 : 2.55$

$= 4 : 1$

35. The percentage dissociation of 0.08 M aqueous acetic acid solution at 25°C is (K_a of acetic acid at 25°C = 1.8×10^{-5})

(A) 2.92 (B) 1.5 (C) 1.2 (D) 4.8

Ans. (B)

Sol. $CH_3COOH_{(aq)} \rightleftharpoons CH_3COO^-_{(aq.)} + H^+_{(aq.)}$

t = 0 0.08 M

$t = t_{eq}$ $0.08(1-\alpha)$ 0.08α 0.08α

$$\Rightarrow K_a = 1.8 \times 10^{-5} = \frac{[CH_3COO^-][H^+]}{[CH_3COOH]} = \frac{0.08\alpha^2}{1-\alpha}$$

$$\Rightarrow \frac{0.08\alpha^2}{1-\alpha} = 1.8 \times 10^{-5}$$

$$\Rightarrow \frac{\alpha^2}{1-\alpha} = \frac{1.8 \times 10^{-5}}{0.08} = 2.25 \times 10^{-4}$$

$$\Rightarrow \alpha \simeq 0.015$$

36. In which of the following, is a new C-C bond formed in the product ?

I. $CH_3CHO \xrightarrow{\text{dil.NaOH}}$

II. $CH_3MgCl + C_2H_5OH \xrightarrow{\text{heat}}$

III. $CO_2 + CH_3MgBr \xrightarrow{H_3O^+}$

IV. $C_2H_2 + NaNH_2 \xrightarrow{CH_3Br}$

(A) I, III and IV (B) II and III (C) III only (D) III and IV

Ans. (A)

Sol. $CH_3CH = O \xrightarrow{\text{dil.NaOH}} CH_3 - \underset{\underset{OH}{|}}{CH} - CH_2 - CH = O$

Aldol

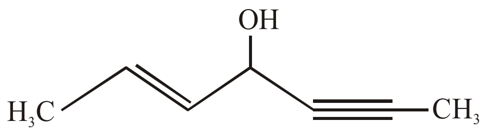
$CH_3MgCl + C_2H_5 - OH \xrightarrow{\Delta} CH_4 + C_2H_5 - OMgCl$

$CO_2 + CH_3MgCl \xrightarrow{H_3O^+} CH_3 - CO_2H$

$C_2H_2 + NaNH_2 \xrightarrow{CH_3Br} HC \equiv C - CH_3$

So new C – C bond is found in I, III, IV

37. IUPAC name of the following molecule is

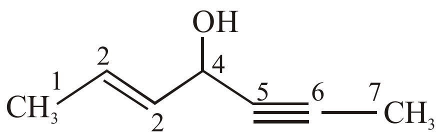


(A) 4-hydroxyhept2-en-5-yne (B) hept-2-en-5-yn-4-ol

(C) hept-5-en-2-yn-4-ol(D) 4-hydroxyhept-5-en-2-yne

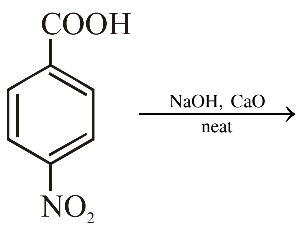
Ans. (B)

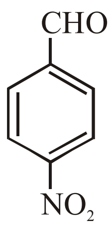
Sol.



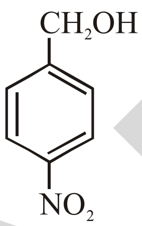
hept-2-en-5-yn-4-ol

38. The product/s of the following reaction is/are

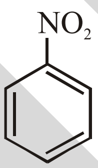




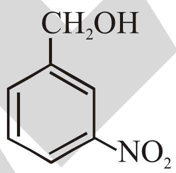
I



II



III

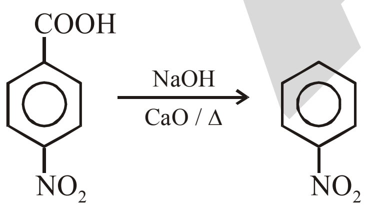


IV

(A) I and II (B) II (C) III (D) IV

Ans. (C)

Sol.



(iii)

39. For which of the following processes, carried out in free space, energy will be absorbed ?

I. Separating an electron from an electron

II. Removing an electron from a neutral atom

III. Separating a proton from a proton

IV. Separating an electron from a proton

(A) I only (B) II and IV (C) I and III (D) II only

Ans. (B)

Sol. Two electrons repel each other and two protons repel each other so I and III are incorrect

II and IV involves attraction hence are correct

40. Decay of radioisotopes follows first order kinetics. Radioisotope U^{238} undergoes decay to a stable isotope, Th^{234}. The ratio of the number of atoms of U^{238} to that of Th^{234} after three half lives is

(A) 1/3 (B) 3/4 (C) 1/4 (D) 1/7

Ans. (D)

Sol.

	U^{238}	$\longrightarrow Th^{234}$
t = 0	a_0	
$3(t_{1/2})$	$\frac{a_0}{8}$	$\left(\frac{a_0}{2}+\frac{a_0}{4}+\frac{a_0}{8}\right)$

$$\Rightarrow \frac{U_{238}}{Th^{234}} = \frac{\frac{a_0}{8}}{\frac{a_0}{2}+\frac{a_0}{4}+\frac{a_0}{8}} = \frac{1}{7}$$

41. The anhydride of HNO_3 is

(A) NO (B) NO_2 (C) N_2O (D) N_2O_5

Ans. (D)

Sol. $2HNO_3 \xrightarrow[-H_2O]{\Delta} N_2O_5$

42. Which of the following is correct ?

I. Sodium (Na) is present as metal in nature

II. Na_2O_2 is paramagnetic

III. NaO_2 is paramagnetic

IV. Na reacts with N_2 to form Na_3N

(A) III only (B) II and IV (C) I, III and IV (D) II, III and IV

Ans. (A)

Sol. Sodium is present in form of Na^+ in salts. Na_2O_2 is diamagnetic , due to O_2^{-2} and Na^+. NaO_2 is paramagnetic , due to O_2^- (one unpaired electron in antibonding molecular orbital). Na does not form stable nitride with N_2.

43. An excess of aqueous ammonia is added to three different flasks (F_1, F_2, F_3) containing aqueous solutions of $CuSO_4$, $Fe_2(SO_4)_3$ and $NiSO_4$ respectively.

Which of the following is correct about this addition ?

I. A precipitate will be formed in all three flasks

II. Ammonia acts as a base as well as a ligand exchange reagent in F_1 and F_3

III. A soluble complex of NH_3 and the metal ion is formed in F_1 and F_3

IV. A precipitate will be formed only in F_2

(A) I only (B) IV only (C) II and IV (D) II, III and IV

Ans. **(D)**

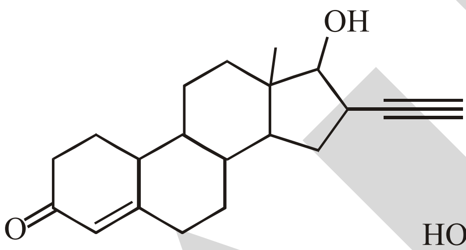
Sol.

$$\underset{}{CuSO_4} + \underset{\text{(excess)}}{aq.NH_3} \longrightarrow \underset{\text{Soluble}}{[Cu(NH_3)_4]^{2+}}$$

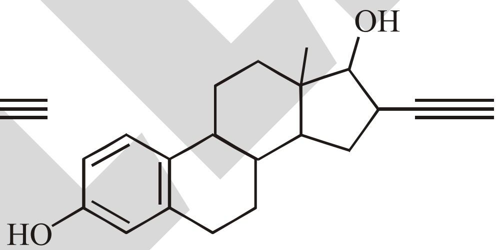
$$Fe_2(SO_4)_3 + \underset{\text{(excess)}}{aq.NH_3} \longrightarrow \underset{\text{Brown ppt}}{Fe(OH)_3\downarrow}$$

$$NiSO_4 + \underset{\text{(excess)}}{aq.NH_3} \longrightarrow \underset{\text{Soluble}}{[Ni(NH_3)_6]^{+2}}$$

44. The reagent/s that can be used to separate norethindrone and novestrol from their mixture is/are



Norethindrone



Novestrol

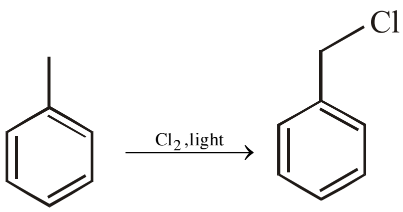
I. HCl II. NaOH III. $NaHCO_3$ IV. $NaNH_2$

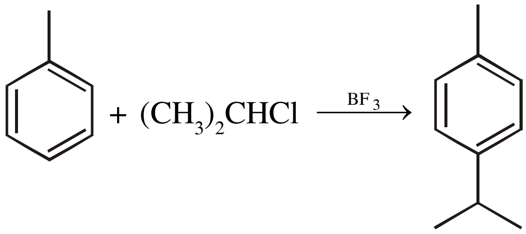
(A) III (B) I and IV (C) I, II and III (D) II

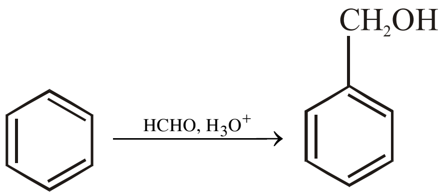
Ans. **(D)**

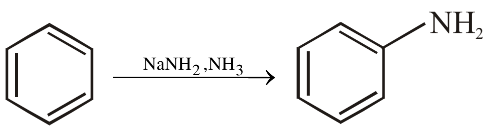
Sol. NaOH react with phenol in novestrol but does not shows reaction with norethindrone as alcohol group is there. So NaOH can separate both the compounds.

45. Which of the following is/are electrophilic aromatic substitution reaction/s ?

I 

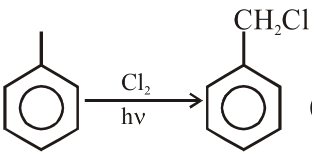
II 

III 

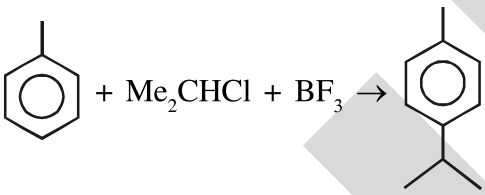
IV 

(A) II, III and IV (B) II and III (C) I, II and III (D) II only

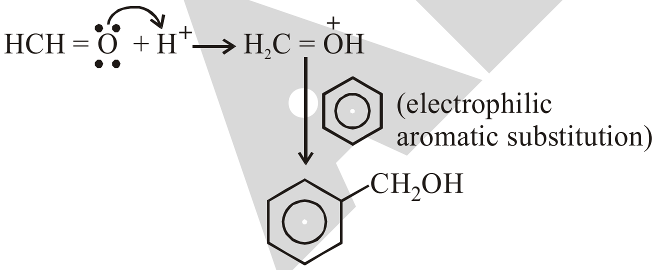
Ans. (B)

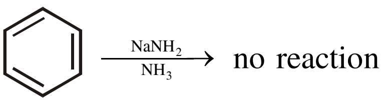
Sol. 

(Free radical substitution)



Fridel Craft alkylation (electrophilic aromatic substitution)





46. Among the halides NCl_3(I), PCl_3(II) and $AsCl_3$(III), more than one type of acid in aqueous solution is formed with

(A) I, II and III (B) II only (C) I and II (D) II and III

Ans. (D)

Sol. $NCl_3 + H_2O \text{ (excess)} \rightarrow NH_3 + 3HOCl$

$PCl_3 + H_2O \text{ (excess)} \rightarrow H_3PO_3 + 3HCl$

$AsCl_3 + H_2O \text{ (excess)} \rightarrow H_3AsO_3 + 3HCl$

47. The normal boiling point and ΔH_{vap} of a liquid 'X' are 400 K and 40 kJ mol^{-1} respectively. Assuming ΔH_{vap} to be constant, which of the following is correct ?

(I) $\Delta S_{vap} > 100 \text{ J K}^{-1} \text{ mol}^{-1}$ at 400 K and 0.5 atm

(II) $\Delta S_{vap} < 100 \text{ J K}^{-1} \text{ mol}^{-1}$ at 400 K and 1 atm

(III) $\Delta S_{vap} < 100 \text{ J K}^{-1} \text{ mol}^{-1}$ at 400 K and 2 atm

(IV) $\Delta S_{vap} = 100 \text{ kJ K}^{-1} \text{ mol}^{-1}$ at 400 K and 1 atm

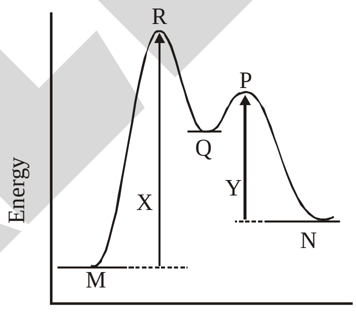
(A) II and IV (B) II only (C) I and III (D) I, III and IV

Ans. (C)

Sol. $\Delta S_{vap.} = \dfrac{\Delta H_{vap.}}{T_{bp}}$

$$= \frac{40 \times 10^3 \text{ J / mol}}{400 \text{ K}} = 100 \text{ J K}^{-1} \text{mol}^{-1}$$

48. About the energy level diagram given below, which of the following statement/s is/are correct?



(I) The reaction is of two steps and 'R' is an intermediate

(II) The reaction is exothermic and step 2 is rate determining

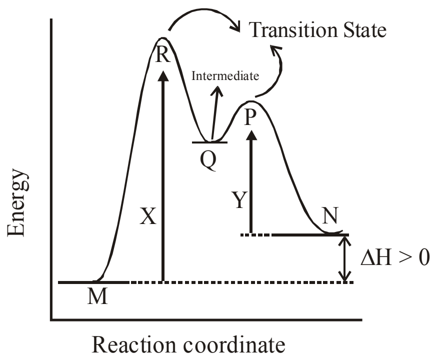
(III) 'Q' is an intermediate and 'R' is the transition state for the reaction $M \rightarrow Q$

(IV) 'P' is the transition state for the reaction $Q \rightarrow N$

(A) III and IV (B) I, III and IV (C) I, II and IV (D) III only

Ans. (A)

Sol.

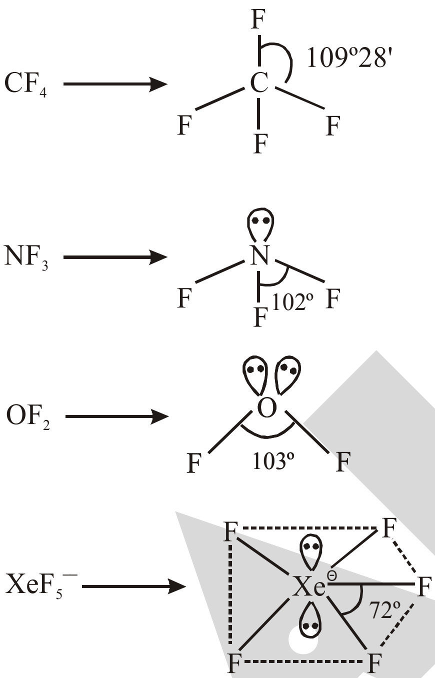


49. The F–X–F bond angle is the smallest in (X is the central atom)

(A) CF_4 (B) NF_3 (C) OF_2 (D) XeF_5^-

Ans. (D)

Sol.



50. The correct IUPAC name of the compound, $[Pt(py)_4][Pt(Br)_4]$ is

(A) tetrapyridineplatinum(II) tetrabromidoplatinate(II)

(B) tetrabromidoplatinum (IV) teterapyridineplatinate(II)

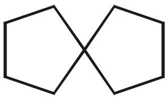
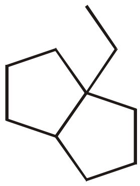
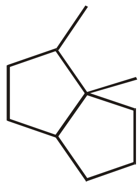
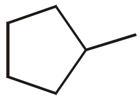
(C) tetrabromidoplatinate(II) tetrapyridineplatinum(II)

(D) tetrapyridineplatinum (IV) tetrabromidoplatinate (IV)

Ans. (A)

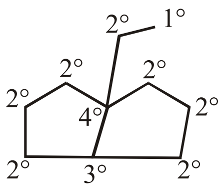
Sol. $[Pt(py)_4]^{2+} [Pt(Br)_4]^{-2}$

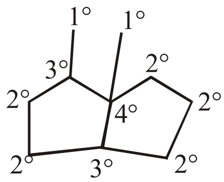
51. All four types of carbon (1°, 2°, 3° and 4°) are present in

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

(A) I, II and III (B) II, III and IV (C) I, II and IV (D) II and III

Ans. (D)

Sol. (II) 

(III) 

52. The mass (g) of NaCl that has to be dissolved to reduce the vapuor pressure of 100 g of water by 10 % (Molar mass of NaCl = 58.5 $gmol^{-1}$) is

(A) 36.11 g (B) 17.54 g (C) 81.25 g (D) 3.61 g

Ans. (B)

Sol. $$\frac{p^o - p}{p^o} = 0.1 = X_{NaCl}$$

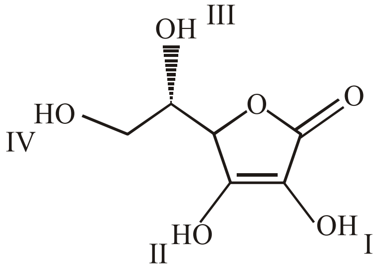
$$\frac{2n_{NaCl}}{n_{H_2O}} = \frac{0.1}{0.9}$$

$$2n_{NaCl} = \left(\frac{1}{9} \times \frac{100}{18}\right)$$

$$2n_{NaCl} = \frac{100}{9 \times 18} \times 58.5$$

n = 18.05 gm

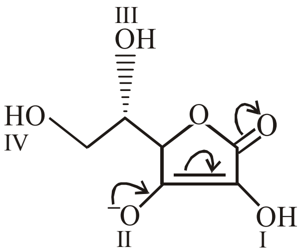
53. The most acidic hydrogen in the following molecule is



(A) I (B) II (C) III (D) (IV)

Ans. (B)

Sol.

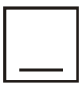
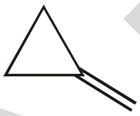


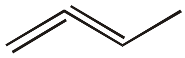
Conjugate base most stable because of extended resonance.

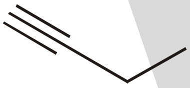
So $\overset{\text{II}}{\text{OH}}$ is most acidic

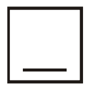
54. Two isomeric hydrocarbons 'X' and 'Y" (C_4H_6), give the same produce (C_4H_8O) on catalytic hydration with dilute acid. However, they form different products but with same molecular formula ($C_4H_6Br_4$) when treated with excess bromine.

'X' and 'Y' are

(A)  & 

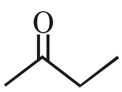
(B)  & 

(C)  & 

(D)  & 

Ans. (C)

Sol. $CH \equiv C - CH_2 - CH_3 \xrightarrow{H^+/H_2O} CH_3 - \overset{O}{\overset{||}{C}} - CH_2 - CH_3$

$CH_3 - C \equiv C - CH_3 \xrightarrow{H^+/H_2O}$ 

$CH_3 - C \equiv C - CH_3 \xrightarrow{Br_2} CH_3 - C(Br)_2 - C(Br)_2 - CH_3$

$CH \equiv C - CH_2 - CH_3 \xrightarrow{Br_2} CH(Br)_2 - C(Br)_2 - CH_2 - CH_3$

55. Mercury is highly hazardous and hence its concentration is expressed in the units of ppb (micrograms of Hg present in 1 L of water). Permissible level of Hg in drinking water is 0.0335 ppb. Which of the following is an alternate representation of this concentration ?

(A) 3.35×10^{-2} mg dm^{-3} (B) 3.35×10^{-5} mg dm^{-3}

(C) 3.35×10^{-5} mg m^{-3} (D) 3.35×10^{-4} g L^{-1}

Ans. (B)

Sol. V = 1 lit.

m = 0.0335×10^{-6} gm/lit. = 0.0335×10^{-3} mg/lit.

= 3.35×10^{-5} mg/lit.

56. The correct sequence of reactions which will yield 4-nitrobenzoic acid from benzene is

(A) CH_3Cl; HNO_3/H_2SO_4; $KMnO_4/OH^-$

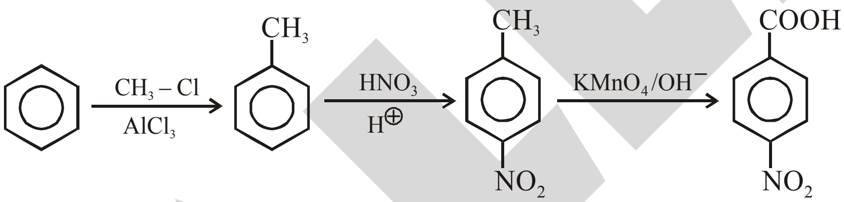
(B) HNO_3/H_2SO_4; $CH_3Cl/AlCl_3$; $KMnO_4/OH^-$

(C) $CH_3Cl/AlCl_3$; $KMnO_4/OH$; HNO_3/H_2SO_4

(D) $CH_3Cl/AlCl_3$; HNO_3/H_2SO_4; $KMnO_4/OH^-$

Ans. (D)

Sol.



57. The volume of *one* drop of aqueous solution from an eyedropper is approximately 0.05 mL. One such drop of 0.2 M HCl is added to 100 mL of distilled water. The pH of the resulting solution will be:

(A) 4.0 (B) 7.0 (C) 3.0 (D) 5.5

Ans. (A)

Sol. $[HCl] = \dfrac{0.2 \times 0.05}{100.05} = [H^+]$

$pH \simeq 4$

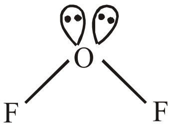
58. In which of the following species the octet rule is NOT obeyed?

I. I_3^- II. N_2O III. OF_2 IV. NO^+

(A) I and IV (B) II and III (C) I only (D) IV only

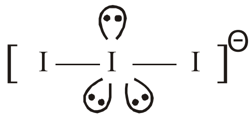
Ans. (C)

Sol. N≡N→O   octet rule followed



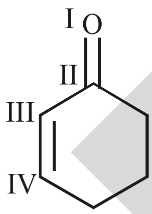
octet rule followed

$N \equiv O^{+}$ octet rule followed



octet rule **NOT** followed

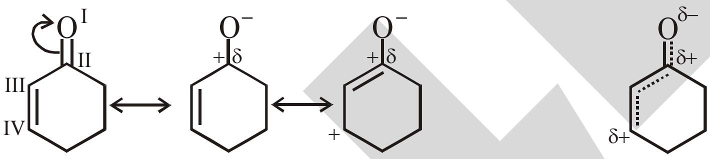
59. Which atom/s will have a δ^{+} charge in the following molecule ?



(A) I and III   (B) II only   (C) II and III   (D) II and IV

Ans. (D)

Sol.



So carbon II and IV have δ+ charge

60. 2.0 moles of an ideal gas expands isothermlly (27°C) and reversibly from a pressure of 1 bar to 10 bar. The heaviest mass that can be lifted through a height of 10 m by the work of this expansion is

(A) 50.8 kg   (B) 50.8 g   (C) 117.1 kg   (D) 117.1 g

Ans. (C)

Sol. $w = -2 \times \frac{25}{3} \times 300 \times \ln \frac{10}{1}$

$= -2 \times \frac{25}{3} \times 300 \times 2.303$

$|w| = |50 \times 100 \times 2.303| = m \times g \times h$

$= m \times 100$

$m = 114.15$ kg

61. A commercial sample of oleum ($H_2S_2O_7$) labeled as '106.5% oleum' contains 6.5 g of water. The percentage of free SO_3 in this oleum sample is

(A) 2.88 (B) 28.8 (C) 0.029 (D) 0.28

Ans. (B)

Sol. $\%SO_3 = \frac{80x}{18} = \frac{80 \times 6.5}{18} = 28.88$

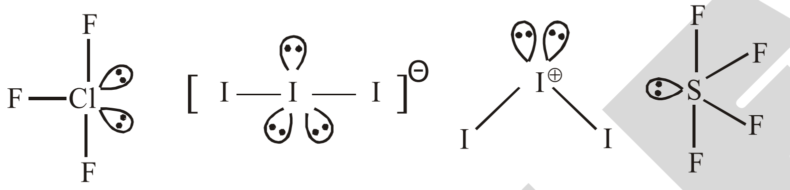
Free SO_3

62. Which of the following species has *one* lone pair of electrons on the central atom ?

(A) ClF_3 (B) I_3^- (C) I_3^+ (D) SF_4

Ans. (D)

Sol.



63. Among the following, the complex ion/s that will have a magnetic moment of 2.82 B.M. is/are

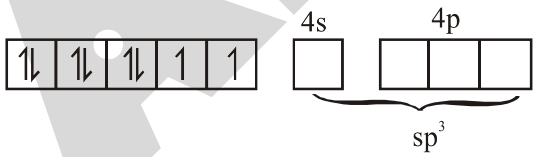
I. $[Ni(CO)_4]$ II. $[NiCl_4]^{2-}$ III. $[Ni(H_2O)_6]^{2+}$ IV. $[Ni(CN)_4]^{2-}$

(A) I and IV (B) II only (C) II and III (D) II, III and IV

Ans. (C)

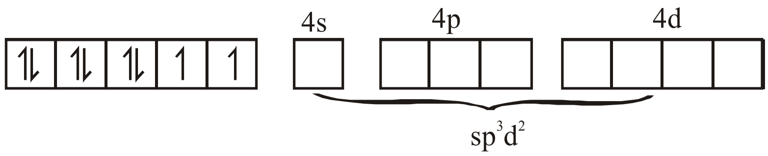
Sol. $[Ni(CO)_4] \longrightarrow sp^3$ hybridized, diamagnetic

$[NiCl_4]^{-2} \longrightarrow sp^3$ hybridized, paramagnetic

Ni^{+2} = [Ar] 

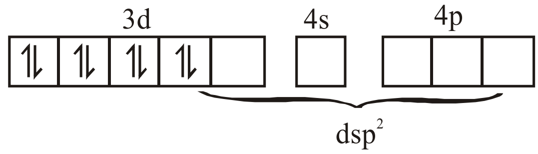
μ = 2.82 BM,

$[Ni(H_2O)_6]^{+2} \longrightarrow sp^3d^2$ hybridized, paramagnetic

Ni^{+2} = [Ar] 

μ = 2.82 BM

$[Ni(CN)_4]^{-2} \longrightarrow dsp^2$ hybridized, diamagnetic

Ni^{+2} = [Ar] 

64. Morphine, a pain killer is basic with the molecular formula $C_{17}H_{19}NO_3$. The conjugate acid of morphine is

(A) $C_{17}H_{19}NO_3^+$ (B) $C_{17}H_{18}NO_3$ (C) $C_{17}H_{19}NO_3^-$ (D) $C_{17}H_{20}NO_3^+$

Ans. (D)

Sol. Conjugate acid is formed by protonation so Ans. will be $C_{17}H_{20}NO_3^{\oplus}$

65. A suboxide of carbon, C_3O_2, has a linear structure. Which of the following is correct about C_3O_2?

I. Oxidation state of all three C atoms is +2

II. Oxidation state of the central C atom is zero

III. The molecule contains 4σ and 4π bonds

IV. Hybridization of the central carbon atom is sp^2

(A) I and IV (B) II and III (C) II and IV (D) III only

Ans. (B)

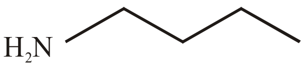
Sol.

$$\overset{-2}{O}=\overset{+2}{C}=\overset{0}{C}=\overset{+2}{C}=\overset{-2}{O}$$

↓ sp hybridized (+2, –2 indicate oxidation state)

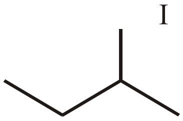
4σ, 4π bonds

66. Among the following, the compounds with highest and lowest boiling points respectively are

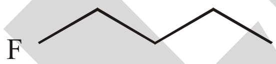


I

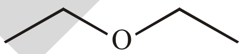
II



III



IV



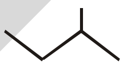
V

(A) I and III (B) II and III (C) I and IV (D) II and V

Ans. (B)

Sol. Highest B.P. → II due to H-bond

Lowest B.P. → III Non polar



67. At 25°C K_a of HPO_4^{2-} and HSO_3^- are 4.8×10^{-13} and 6.3×10^{-8} respectively. Which of the following is correct ?

(A) HPO_4^{2-} is a stronger acid than HSO_3^- and PO_4^{3-} is a weaker base than SO_3^{2-}

(B) HPO_4^{2-} is a weaker acid than HSO_3^- and PO_4^{3-} is a weaker base than SO_3^{2-}

(C) HPO_4^{2-} is a weaker acid than HSO_3^- and PO_4^{3-} is a stronger base than SO_3^{2-}

(D) HPO_4^{2-} is a stronger acid than HSO_3^- and PO_4^{3-} is a stronger base than SO_3^{2-}

Ans. (C)

Sol. Acidic strength ↑ ⇒ Conjugate base ↓

68. The change in internal energy (ΔU) for the reaction $H_2(g) + Br_2(g) \rightarrow 2HBr(\ell)$ when 2.0 moles each of Br_2 (g) and H_2(g) react is

($H_2(g) + Br_2(g) \rightarrow 2HBr(g)$; $\Delta H_{reaction} = -109$ kJ; ΔH_{vap} of HBr = 213 kJ mol^{-1})

(A) –644 kJ (B) 644 kJ (C) –322 kJ (D) –1070 kJ

Ans. (D)

Sol. $H_{2(g)} + Br_{2(g)} \longrightarrow 2HBr_{(g)}$ $\Delta H = -109$ kJ

$\Delta H = x$ → $2HBr(\ell)$ → 2×213

$x + 2 \times 213 = -109$

$\Delta H = x = -535$ kJ

$H_{2(g)} + Br_{2(g)} \longrightarrow 2HBr_{(\ell)}$

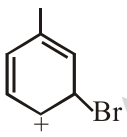
$-535 = \Delta U - 2 \times \frac{8.314 \times 298}{1000}$

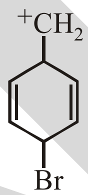
$\Delta U = -530.03$ kJ/mol

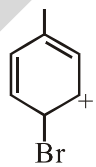
For 2 mole

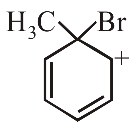
$\Delta U = 2 \times -530.03 = -1060$

69. The structure that represents the major intermediate formed in the bromination of toluene is :

(A) 

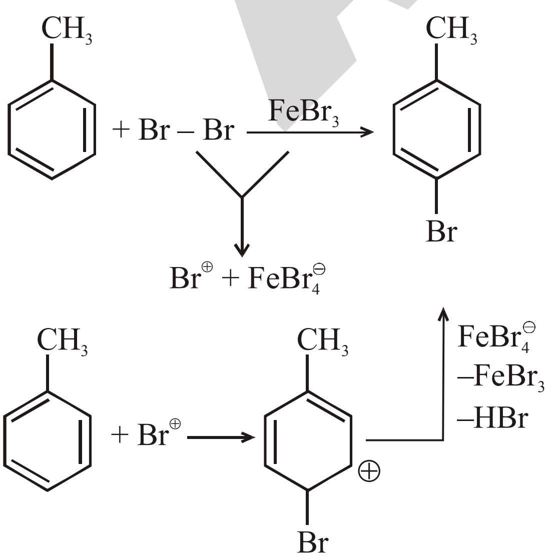
(B) 

(C) 

(D) 

Ans. (C)

Sol.



70. About sea water, which of the following statement/s is/are correct ?

I. Frozen sea water melts at a lower temperature than pure ice

II. Boiling point of sea water increases as it evaporates

III. Sea water boils at a lower temperature than fresh water

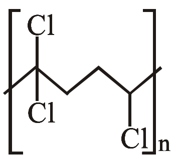
IV. Density of sea water at STP is same as that of fresh water

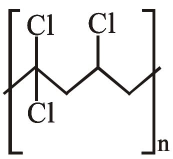
(A) I only (B) I and II (C) I, II and III (D) III only

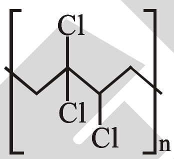
Ans. (B)

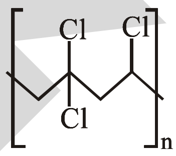
Sol. I and II are correct.

71. Saran wrap, a polymer used in food packaging is a copolymer of 1, 1-dichloroethene and vinyl chloride. In the chain initiation step, 1, 1-dichloroethene generates a free radical which reacts with vinyl chloride. Structure of Saran wrap is

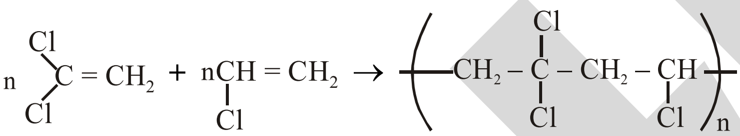
(A) 

(B) 

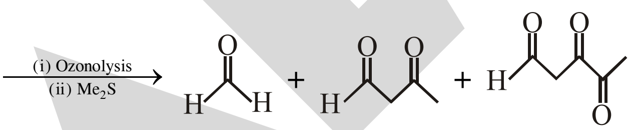
(C) 

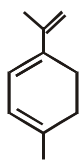
(D) 

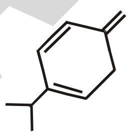
Ans. (D)

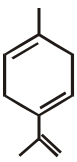
Sol. 

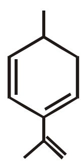
72. The alkene 'Y' in the following reaction is

Alkene Y 

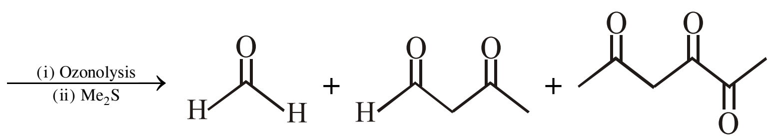
(A) 

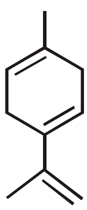
(B) 

(C) 

(D) 

Ans. (C)

Sol. Y 

So Y is 

73. In solid state, PCl_5 exists as $[PCl_4]^+$ $[PCl_6]^-$. The hybridization of P atoms in this solid is/are :

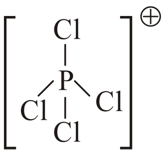
(A) sp^3d $(d = d_{x^2-y^2})$ (B) $sp^3d\,(d = d_{z^2})$

(C) sp^3 and sp^3d^2 $(d = d_{x^2-y^2}, d_{z^2})$ (D) sp^3d and dsp^3 $(d = d_{z^2})$

Ans. (C)

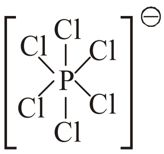
Sol.

$PCl_4^{\oplus}$



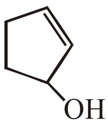
sp^3

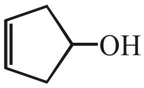
$PCl_6^{\ominus}$

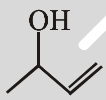


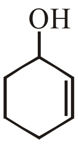
sp^3d^2

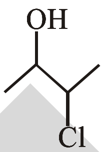
74. Which of the following compounds have chiral carbon atom/s ?

I. 

II. 

III. 

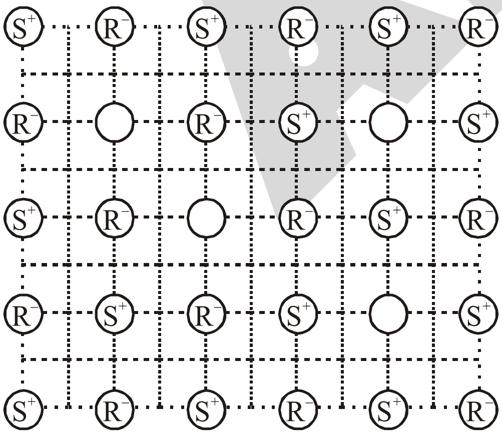
IV. 

V. 

(A) I and II (B) I, III, IV and V (C) II, IV and V (D) II, III and IV

Ans. (B)

75. The crystal defect indicated in the diagram below is :



(A) Frenkel defect (B) Schottky defect

(C) Frenkel and Schottky defects (D) Interstitial defect

Ans. (B)

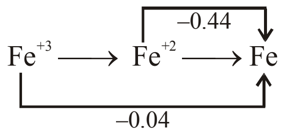
Sol. Cations and anions both are missing in stoichiometric ratio so it is schottky defect.

76. If the standard electrode potentials of Fe^{3+}/Fe and Fe^{2+}/Fe are –0.04V and –0.44V respectively then that of Fe^{3+}/Fe^{2+} is :

(A) 0.76 V (B) –0.76 V (C) 0.40 V (D) –0.40 V

Ans. (A)

Sol.



$$-0.04 = \frac{1\times E^{o}_{Fe^{+3}/Fe^{+2}} + 2\times(-0.44)}{-3}$$

$$E^{o}_{Fe^{+3}/Fe^{+2}} = 0.76\,V$$

77. Given below is the data for the reaction $2NO(g) \rightleftharpoons N_2(g) + O_2(g)$

where 'k_f' and 'k_b' are rate constants of the forward and reverse reactions respectively

Temperature (K)	k_f ($mol^{-1}\,dm^{3}\,s^{-1}$)	k_b ($mol^{-1}\,dm^{3}\,s^{-1}$)
1400	0.2	1.1×10^{-6}
1500	1.3	1.4×10^{-5}

The reaction is :

(A) Exothermic and K_{eq} at 1400 K = 3.79×10^{-6}

(B) Endothermic and K_{eq} at 1400 K = 2.63×10^{-5}

(C) Exothermic and K_{eq} at 1400 K = 1.8×10^{5}

(D) Endothermic and K_{eq} at 1500 K = 9.28×10^{-4}

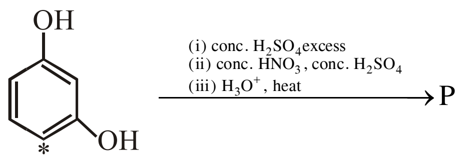
Ans. (C)

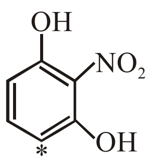
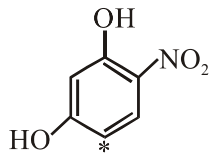
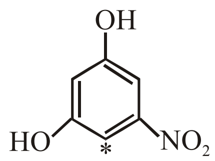
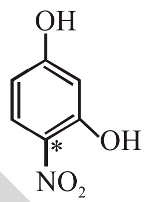
Sol. $K_{eq} = \frac{0.2}{1.1\times10^{-6}} = 1.81 \times 10^{+5}$ at 1400 K

$K_{eq} = \frac{1.3}{1.4\times10^{-5}} = 9.2 \times 10^{4}$ at 1500 K

$T\uparrow \Rightarrow K_{eq}\downarrow \Rightarrow \Delta H = -ve$

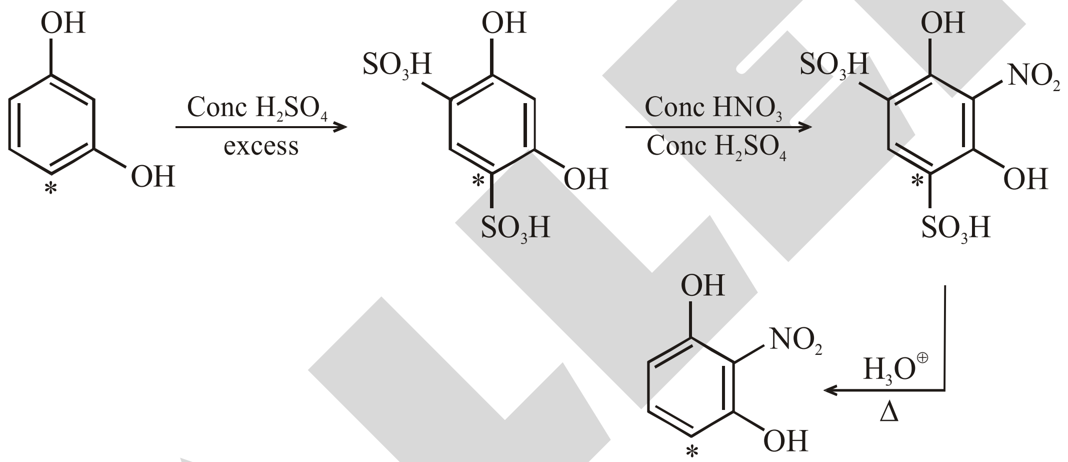
78. The major product 'P' formed in the following reaction is (*denotes radioactive carbon)



(A)  (B)  (C)  (D) 

Ans. (A)

Sol.



79. A helium cylinder in which the volume of gas = 2.24L at STP (1 atm, 273 K) developed a leak and when the leak was plugged the pressure in the cylinder was seen to have dropped to 550 mm of Hg. The number of moles of He gas that had escaped due to this leak is :

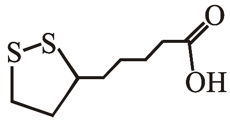
(A) 0.028 (B) 0.072 (C) 0.972 (D) 0.099

Ans. (A)

Sol. $\Delta n = \dfrac{\Delta P.V}{RT}$

$$= \frac{\left(\frac{760-550}{760}\right)\times 2.24}{0.0821\times 273} = 0.0276 \simeq 0.028$$

80. Lipoic acid with the following structure is a growth factor required by many organisms. Percentages of 'S' and 'O' in lipoic acid respectively are (atomic masses of 'S' and 'O' are 32.065 g mol^{-1} respectively)



Lipoic acid

(A) 33.03, 16.48 (B) 31.11, 18.24 (C) 31.11, 15.52 (D) 31.42, 15.68

Ans. (C)

Sol. $C_8H_{14}O_2S_2$

$$\%S = \frac{64.13}{206.128} \times 100 = 31.11$$

$$\%O = \frac{2 \times 15.999}{206.126} \times 100 = 15.52$$