NATIONAL STANDARD EXAMINATION IN CHEMISTRY (NSEC) 2015-16 (CODE : C-281)

1. A bottle of H_3PO_4 solution contains 70% (w/w) acid. If the density of the solution is 1.54 g cm^{-3}, the volume of the H_3PO_4 solution required to prepare 1 L of I N solution is

(A) 90 mL (B) 45 mL (C) 30 mL (D) 23 mL

Ans. **(C)**

Sol. H_3PO_3 solution contains 70% w/w acid

d = 1.54 gm/ml

70 gm H_3PO_4 ——— in 100 gm soution

$$d = \frac{M}{V} \qquad 1.54 = \frac{100}{V} \qquad V = \frac{100}{1.54}\text{ml}$$

$$N_1V_1 = N_2V_2$$

$$3 \times V_1 \times \frac{70}{98} \times \frac{1000}{100} \times 1.54 = 1 \times 1000$$

$$V_1 = \frac{98000}{70 \times 1.54 \times 1000} = \frac{98}{70 \times 1.54}$$

V_1 = 30 ml.

2. Wood or cattle dung ash is used for cleaning cooking utensils in many parts of India. The statement that is not true for this ash is:

(A) it largely consists of metal oxides and silicates because non-metals are removed as gaseous compounds during burning of the wood/dung cakes.

(B) when added to water, ii forms alkaline solution with pH~8 and above, which helps to remove oily substances from the utensils.

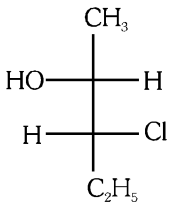
(C) several chemical components of ash remain undissolved as solids in water and these solids help in cleaning by providing scrubbing action.

(D) if left moist for a few hours in air, it slowly turns acidic because of oxidative decomposition

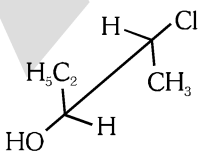
Ans. **(D)**

Sol. Fact based.

3. The two projection formulae that represent a pair of enantiomers are



(I)



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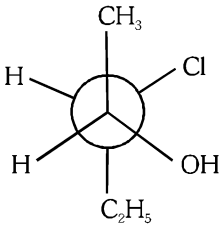
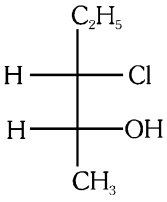


(III)



(IV)

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

Ans. **(C)**

Sol. I and IV are diastereomers

I and II are constitutional isomers

I and III are enantiomers.

4. When 1 L of 0.1 M sulphuric acid solution is allowed to react with 1 L of 0.1 M sodium hydroxide solution, the amount of sodium sulphate (anhydrous) that can be obtained from the solution formed and the concentration of H^+ in the solution respectively are

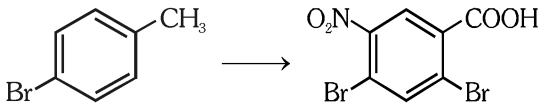
(A) 3.55 g, 0.1 M (B) 7.10 g, 0.025 M (C) 3.55 g, 0.025 M (D) 7.10 g, 0.05 M

Ans. (D)

Sol. 0.1 M, 1L H_2SO_4 + 1L, 0.1 M NaOH $\longrightarrow$ Na_2SO_4

$$2NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + 2H_2O$$
$$0.1\times1 \quad 0.1\times1 \quad 0.05\,M$$

5. The beat sequence of reactions for the following conversion is



(A) (i) 1 mol $Br_2/FeBr_3$ (ii) $KMnO_4$, heat (iii) $HNO_3 + H_2SO_4$

(B) (i) $HNO_3 + H_2SO_4$ (ii) 1 mol $Br_2/FeBr_3$ (iii) $KMnO_4$, heat

(C) (i) $KMnO_4$, heat (ii) $HNO_3 + H_2SO_4$ (iii) 1 mol $Br_2/FeBr_3$

(D) (i) 1 mole $Br_2/FeBr_3$ (ii) $HNO_j + H_2SO_4$ (iii) $KMnO_4$, heat

Ans. (A)

Sol. 1st Bromination than oxidation by $KMnO_4$ follwoed by nitration using HNO_3/H_2SO_4

6. If λ_0 and λ are the threshold wavelength and the wavelength of the incident ligh respectively on a metal surface, the velocity of the photoelectron ejected from the metal surface is (m_e = mass of electron, h = Planck's constant, c = speed of light)

(A) $\sqrt{\frac{2h(\lambda_0-\lambda)}{m_e}}$ (B) $\sqrt{\frac{2hc(\lambda_0-\lambda)}{m_e}}$ (C) $\sqrt{\frac{2hc}{m_e}\left(\frac{\lambda_0-\lambda}{\lambda\lambda_0}\right)}$ (D) $\sqrt{\frac{2h}{m_e}\left(\frac{1}{\lambda_0}-\frac{1}{\lambda}\right)}$

Ans. (C)

Sol. $\frac{hc}{\lambda} = \frac{hc}{\lambda_0} + \frac{1}{2}m_e v^2$

on solving $v = \sqrt{\frac{2hc}{m_e}\left(\frac{\lambda_0-\lambda}{\lambda\lambda_0}\right)}$

7. A current of 5.0 A flows for 4.0 h through an electrolytic cell containing a molten salt of metal M. This results in deposition of 0.25 mol of the metal M at the cathode. The oxidation state of M in the molten salt is (1 Faraday = 96485 C mol^{-1})

(A) +1 (B) +2 (C) +3 (D) +4

Ans. (C)

Sol. W = ZIt

$$W = \frac{E}{96500}I.t$$
$$\frac{W}{E} = \frac{I.t}{96500}$$
$$n \times V_F = \frac{5\times3600\times4}{96500}$$
$$V_F = \frac{5\times3600\times4}{96500\times0.25} = 3$$

8. Glacial acetic acid dissolves in
(I) liquid H_2S, as H_2S is a polar covalent compound
(II) liquid NH_3, as it can form hydrogen bond
(III) liquid $HClO_4$, as it can protonate aceiic acid
The correct option is
(A) only I (B) only II (C) only III (D) I, II and III

Ans. **(D)**

Sol. Glacial acetic acid is souble in H_2S because it is a polar solvent. It is soluble in both NH_3 and $HClO_4$ ttoo due to acid base reactions.

9. The energy of an electron in the first Bohr orbit is –13.6 eV. The energy of Be^{3+} in the first excited state is
(A) –30.6 eV (B) –40.8 eV (C) –54.4 eV (D) + 40.8 eV

Ans. **(C)**

Sol. Be^{3+}
First excited state n = 2

$$-13.6 \times \frac{(4)^2}{(2)^2}$$

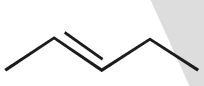
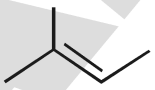
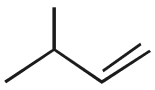
$$-13.6 \times \frac{16}{4} = -56.4 \text{ eV}$$

10. Many proicin-based biomateriatst such as waste hair and feathers, can absorb heavy metal ions from waste water. It has been observed that metal uptake by these materials increases in alkaline condition. The enhanced uptake in alkaline conditions is due to
(A) generation of many ligand sites in the protein molecules due to removal of H^+
(B) availability of a high concentration of OH^- ions as ligands
(C) increased cross-linkages in the protein chains by formation of amide bonds
(D) increase in solubility of the proteins

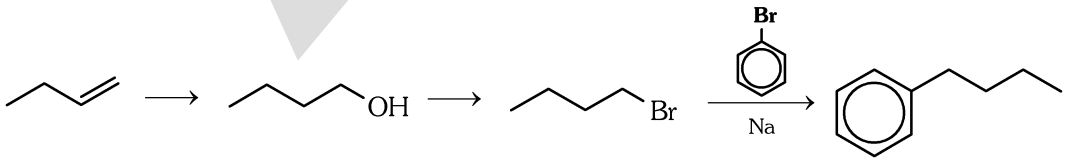
Ans. **(A)**

Sol. Alkaline medium enhances the ligand strength due to removal of H^+.

11. Compound "X" reacts with diboranc followed by alkaline hydrogen peroxide to form compound "Y". "Y" on reaction with a mixture of sodium bromide in sulphuric acid followed by bromobenzene and sodium in ether gives n-pentylbenzcne. Compound "X" is

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

Ans. **(D)**

Sol. 

12. When any solution passes through a cation exchange resin that is in acidic form, H^+ ion of the resin is replaced by cations of the solution. A solution containing 0.319 g of an isomer with molecular formula $CrCl_3.6H_2O$ is passed through a cation exchange resin in acidic form. The eluted solution requires $19cm^3$ of 0.125 N NaOH. The isomer is

(A) triaquatrichloro chrominum (III) chloride trihydrate
(B) hexaaqua chromium (III) chloride
(C) pentaaquamonochloro chromium (III) chloride monohydrate
(D) tetraaquadichloro chromium (III) chloride dihydrate

Ans. **(C)**

Sol. 0.319 g

$CrCl_3.6H_2O \longrightarrow$ eluted solution requires 19ml, 0.125 N NaOH , 2.375 m mole OH^-

$\frac{0.319}{266.5} = 0.00119$

$CrCl_3.6H_2O \longrightarrow 0.00119$ mole

$[Cr(H_2O)_5Cl]Cl_2.H_2O \longrightarrow 2Cl^- \longrightarrow 2H^+$

$2H^+$ requires $\longrightarrow 2OH^-$

0.00119×2 moles of Cl– = nH^+

$1000 \times 0.00238 = 2.38$ moles

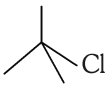
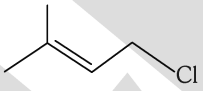
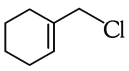
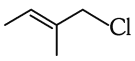
13. In an experiment, it was found that for a gas at constant temperature, PV = C. The value of C depends on

(A) atmospheric pressure
(B) quantity of gas
(C) molecular weight of gas
(D) volume of chamber

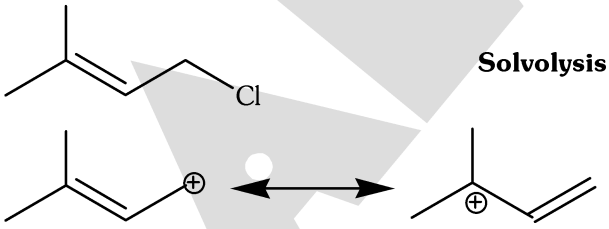
Ans. **(B)**

Sol. At constant temperature
PV = C
constant depends on quantity of gas
C = O not universal constant .

14. The compound that undergoes solvolysis in aq. ethanol most easily is

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

Ans. **(B)**

Sol. 

Solvolysis

15. Silver nitrate solution when added to a colorless aqueous solution E forms a white precipitate which dissolves in excess of E. If the white precipitate is heated with water it turns black and the supernatant solution gives a white precipitate with acidified barium nitrate solution. Therefore, E is

(A) Na_2S (B) $Na_2S_2O_3$ (C) Na_2SO_3 (D) Na_2SO_4

Ans. **(B)**

Sol. $\underset{(E)}{S_2O_3^{2-}} \Rightarrow$ Colorless aq. solution $\rightarrow$ white ppt with $AgNO_3 \rightarrow$ dissolves in excess of E due to formation of complex $Na_3[Ag(S_2O_3)_2]$

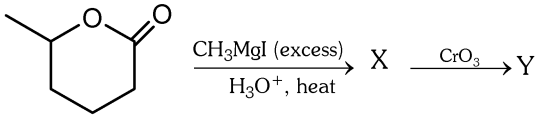
16. The metal M crystallizes in a body centered lattice with cell edge 400 pm. The atomic radius of M is
(A) 200 pm (B) 100 pm (C) 173 pm (D) 141 pm

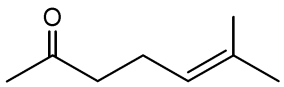
Ans. **(C)**

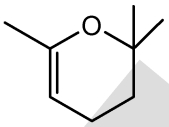
Sol. $\sqrt{3}\,a = 4R$

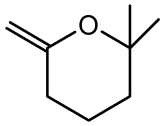
$$R = \frac{\sqrt{3}a}{4} = 173.2\,pm$$

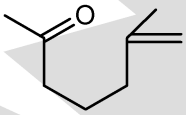
17. The major product (Y) of the following reaction is-



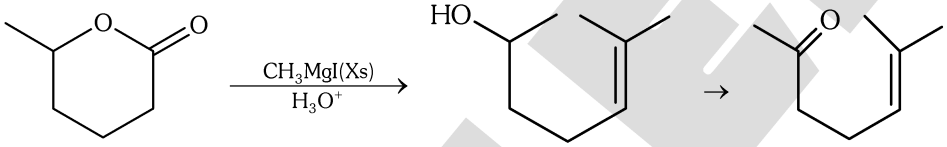
(A) 

(B) 

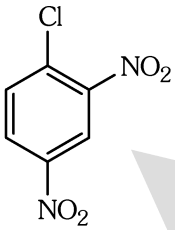
(C) 

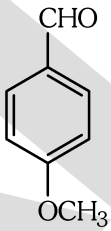
(D) 

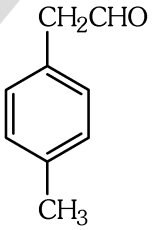
Ans. **(A)**

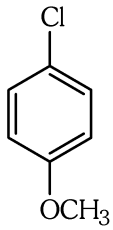
Sol. 

18. The compound that will NOT react with hot concentrated aqueous alkali at atmospheric pressure is

(A) 

(B) 

(C) 

(D) 

Ans. **(D)**

Sol. ArSN reaction requires electron withdrawing group.

19. The nature of $CsAuCl_3$ is (this compuond contains Au in two oxidation states and there is no Au-Au bond)
(A) diamagnetic (B) paramagnetic (C) ferromagnetic (D) antiferromagnetic

Ans. **(A)**

Sol. $Cs^+ (AuCl_3)$

According to the question Au axis is two oxidation state i.e. Au Exist in + 1 + 3.

$Au^+ = d^{10}$

$Au^{+++} = d^8$

both care

i + exist in diamag form

20. The standard electrode potentials, E° of Fe^{3+}/Fe^{2+} and Fe^{2+}/Fe at 300 K are +0.77 V and –0.44 V, respectively. The E° of Fe^{3+}/Fe at the same temperature is

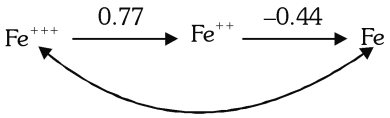
(A) 1.21 V (B) 0.33 V (C) –0.036 V (D) 0.036 V

Ans. **(C)**

Sol. $e^- + Fe^{+3} \longrightarrow Fe^{2+} \quad \varepsilon^0 = 0.77V$

$2e^- + Fe^{2+} \longrightarrow Fe \quad \varepsilon^0 = -0.44V$

$3e^- + Fe^{+3} \longrightarrow Fe \quad \varepsilon^0 = ?$



$$E°Fe^{+++}/Fe = \frac{0.77\times1+(-0.44)\times2}{3} = -0.036$$

21. The incorrect statement for lanthanides among the following statements is

(A) 4f and 5d orbitals are so close in enery that it is very difficult to locate the exact position of electrons in lanthanides

(B) most common stable oxidation state is +3

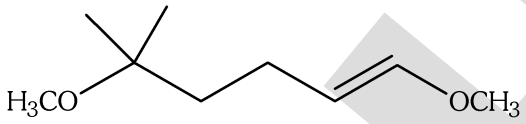
(C) tripositive lanthanide ions have characteristic color pedending on nature of group with which they combine to form compounds

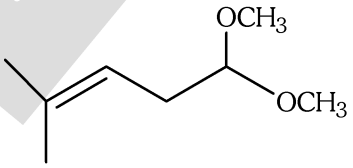
(D) some lanthanide ions either in infrared or ultraviolet region of electromagnetic spectrum

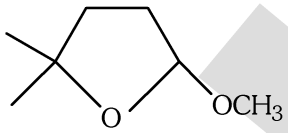
Ans. **(D)**

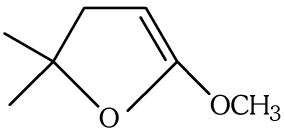
Sol. Lanthanide ion absorb color in the visible region.

22. 4-Hydroxy-4- methylpentanal on heating with excess of methanol in the pressure of an acid catalyst followed by dehydration of the product gives

(A) 

(B) 

(C) 

(D) 

Ans. **(C)**

Sol. Hemiacetal is formed first followed by acetal formation.

23. Ice crystallizes in a hexagonal lattice. At a certain low temperature the lattice constants are a = 4.53 Å and c = 7.41 Å. The number of H_2O molecules contained in a unit cell ($d \approx 0.92$ g cm^{-3} at the given temperature)

(A) 4 (B) 8 (C) 12 (D) 24

Ans. **(A)**

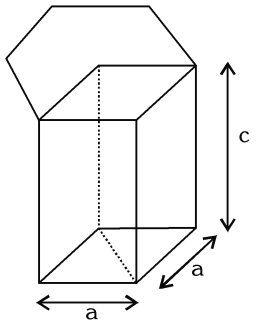
Sol. Volume of unit cell

$$= 2\times\frac{\sqrt{3}}{4}9^2\times c$$

$$= 131.6 \times 10^{-24}\ cm^3$$

$$d = \frac{Z\times M_{H_2O}}{N_A\times V}$$

$$Z = \frac{dN_AV}{M_{H_2O}}$$



$$= \frac{0.92 \times 131.6 \times 10^{-24} \times 6.023 \times 10^{23}}{18}$$

$$= \frac{0.92 \times 13.16 \times 6.023}{18} \simeq 4$$

24. In the redox reaction $2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \rightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$
20 mL of 0.1 M $KMnO_4$ react quantitatively with
(A) 20 mL of 0.1 M oxalate
(B) 40 mL of 0.1 M oxalate
(C) 50 mL of 0.25 M oxalate
(D) 50 mL of 0.1 M oxalate

Ans. **(D)**

Sol. Milli equivalents of MnO_4^- = Milli equivalents of $C_2O_4^{-2}$
$20 \times 0.1 \times 5 = 50 \times 0.1 \times 2$

25. The unbalanced equation for the reaction of P_4S_3 with nitrate in aqueous acidic medium is given below :
$P_4S_3 + NO_3^- \longrightarrow H_3PO_4 + SO_4^{2-} + NO$
The number of mol of water required per mol of P_4S_3 is :
(A) 18 (B) 8/3 (C) 8 (D) 28

Ans. **(C)**

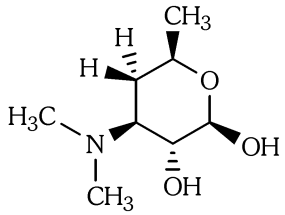
Sol. $20H^+ + 8H_2O + 3P_4S_3 + 38NO_3^- \longrightarrow 12H_3PO_4 + 9SO_4^{2-} + 38NO$

26. Certain combinations of cations and anions lead to the formation of colored salts in solid state even though each of these ions with other counter ions may produce colorless salts. This phenomenon is due to temporary charge transfer between the two ions. Out of the following, the salt that can exhibit this behavior is
(A) $SnCl_2$ (B) $SnCl_4$ (C) $SnBr_2$ (D) SnI_4

Ans. **(D)**

Sol. Due to the high polarisability of I^- and due to the high polarising power of Sn^{+4}.

27. Desosamine has the following structure

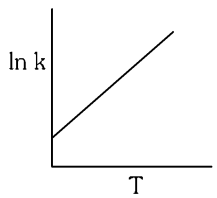


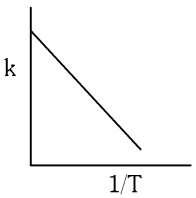
The number of functional groups which react with hydroiodic acid, the number of chiral centres, and the number of stereoisomers possible respectively are
(A) 4, 5, 8 (B) 3, 4, 16 (C) 3, 4, 8 (D) 4, 4, 16

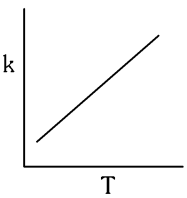
Ans. **(B)**

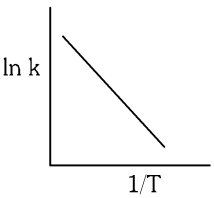
Sol. Functional groups that react with HI are amine (acid-base reaction), alcohol and hemiacetal.
There are 4 chiral centers and no two are similar. So, total number of stereoisomers = 16.

28. If k is the rate constant of the reaction and T is the absolute temperature, the correct plot is :

(A) 

(B) 

(C) 

(D) 

Ans. **(D)**

Sol. $k = Ae^{-Ea/RT}$

$$\ln k = \ln A - \frac{Ea}{RT}$$

29. 1,3-pentadiene and 1,4-pentadiene are compared with respect to their intrinsic stability and reaction with HI. The correct statement is :

(A) 1,3-pentadiene is more stable and more reactive than 1,4-pentadiene

(B) 1,3-pentadiene is less stable and less reactive than 1,4-pentadiene

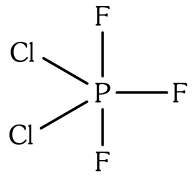
(C) 1,3-pentadiene is more stable but less reactive than 1,4-pentadiene

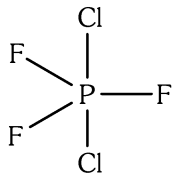
(D) 1,3-pentadiene is less stable but more reactive than 1,4-pentadiene

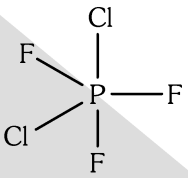
Ans. **(A)**

Sol. 1,3-pentadiene is resonance stabilised towards the reaction with HI, more the stability of the first carbocation, more is the reactivity.

30. From the given structures, the correct structure(s) of PF_3Cl_2 is/are

(I) 

(II) 

(II) 

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

Ans. **(A)**

Sol. In trigonal bipyramidal structure, more electronegative atoms preferably occupy axial positions.

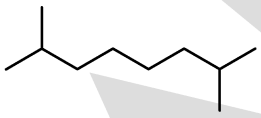
31. The ratio of the masses of methane and ethane in a gas mixture is 4 : 5. The ratio of number of their molecules in the mixture is :

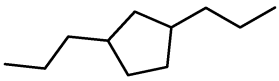
(A) 4 : 5 (B) 3 : 2 (C) 2 : 3 (D) 5 : 4

Ans. **(B)**

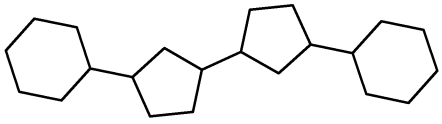
Sol. $$\frac{n_{CH_4}}{N_{C_2H_6}} = \frac{4x}{16} \times \frac{30}{5x} = \frac{3}{2}$$

32. The hydrocarbon that cannot be prepared effectively by Wurtz reaction is

(A) 

(B) 

(C) 

(D) 

Ans. **(D)**

Sol. 2° radical is sterically hindered.

33. The vapor pressure of benzene is 53.3 kPa at 60.6°, but it fall to 51.5 kPa when 19g of a nonvolatile organic compound is dissolved in 500 g benzene. The molar mass of the nonvolatile compound is

(A) 82 (B) 85 (C) 88 (D) 92

Ans. **(B)**

Sol. $$\frac{53.3 - 51.5}{53.5} = \frac{19}{M} \times \frac{72}{500}$$

$M = 82$

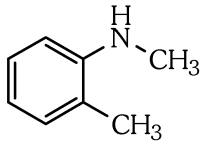
34. Sodium metal dissolves in liquid ammonia and forms a deep blue solution. The color is due to absorption of light by

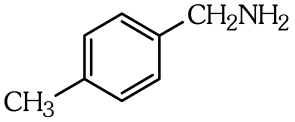
(A) sodium ions (B) ammoniated electrons (C) free electrons (D) ammoniated sodium ions

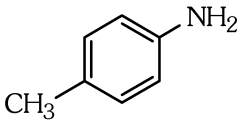
Ans. (B)

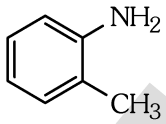
Sol. Energy of ammonated electrons become quantised. Colour is due to transition between the quantised levels.

35. An organic base (X) reacts with nitrous acid of 0°C to give a clear solution. Heating the solution with KCN and cuprous cyanide followed by continued heating with conc. HCl gives a crystalline solid. Heating this solid with alkaline potassium permanganate gives a compound which deydrates on heating to a crystalline solid, 'X' is

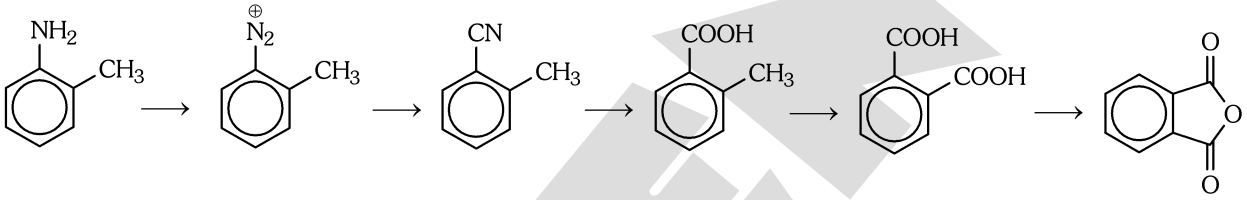
(A) 

(B) 

(C) 

(D) 

Ans. (D)

Sol. 

36. The de Broglie wavelength of an object of mass 33 g moving with a velocity of 200 ms^{-1} is of the order of

(A) 10^{-31} m (B) 10^{-34} m (C) 10^{-37} m (D) 10^{-41} m

Ans. (B)

Sol. $\lambda = \frac{h}{mv}$

$= \frac{6.63 \times 10^{-34}}{33 \times 10^{-3} \times 200} = 10^{-34}\,m$

37. A person having osteoporosis is suffering from lead poisoning. Ethylene diamine tetraacetic acid (EDTA) is administered for this condition. The best form of EDTA to be used for such administration is :

(A) EDTA (B) tetrasodium salt (C) disodium salt (D) calcium dihydrogen salt

Ans. (B)

Sol. EDTA should be used in alkaline medium tetrasodium salt should be used to bind with Ca^{2+}.

38. A water sample from a municipal water supply was found to have a pH = 7.0. On evaporating 2L of this water, 2.016 g of white solid was left behind in the evaporation vessel, i.e., the total dissolved solid (TDS) content of this water was 1008 mg L^{-1}. However, addition of soap to a bucket of this water did not produce any visible scum. Based on these fundings, one can conclude that

(A) there are no Ca^{2+} or Mg^{2+} ion in the water

(B) there are no CO_3^{2-} or HCO_3^- ion in the water

(C) concentration of any ion in the water is lower than 0.038 M

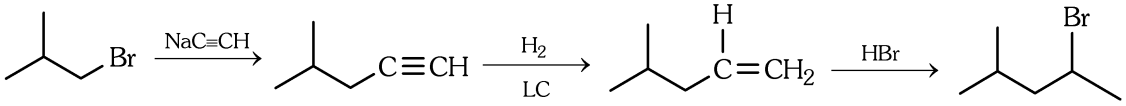
(D) water may be containing Na+ ions in concentration > 0.04 M

Ans. (B)

Sol. The given sample is hard water. There can not be CO_3^{-2} or HCO_3^- because its pH = 7.
As a result, the hardness is permanent.

39. The best reaction sequence to convert 2–methyl–1–bromopropane into 4–methyl–2–bromopentane is
(A) (i) Mg is ether (ii) acetaldehyde (iii) H^+, H_2O (iv) Δ (v) HBr, H_2O_2
(B) (i) NaC≡CH in ether (ii) H_2, Lindlar catalyst (iii) HBr, no peroxide
(C) (i) alcoholic KOH (ii) CH_3COOOH (iii) H_2/Pt (iv) HBr, heat
(D) (i) NaC≡CH in ether (ii) H_3O^+ + $HgSO_4$ (iii) HBr, heat

Ans. **(B)**

Sol. 

40. Metallic copper dissolves in
(A) dilute HCl (B) concentrated HCl (C) aqueous KCN (D) pure ammonia

Ans. **(NA)**

Sol. Copper dissolves in HCl, KCN and ammonia all in the presence of oxygen.

41. A 50 mL solution of pH = 1 is mixed with a 50 mL solution of pH = 2. The pH of the mixture is
(A) 0.86 (B) 1.26 (C) 1.76 (D) 2.26

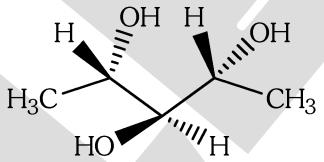
Ans. **(B)**

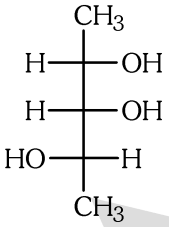
Sol. $[H^+] = \dfrac{10^{-1} \times 50 + 10^{-2} \times 50}{100}$

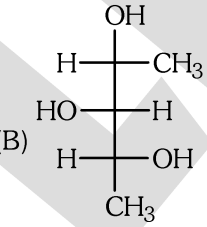
$= \dfrac{5 + 0.5}{100} = \dfrac{5.5}{100} = 5.5 \times 10^{-2}$

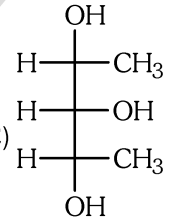
pH = 2 – log 5.5 = 1.26

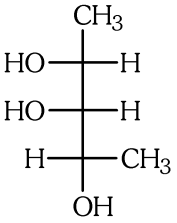
42. The Fischer projection formula that represents the following compound is



(A) 

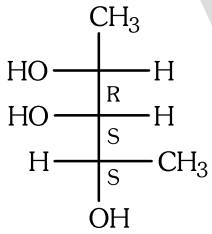
(B) 

(C) 

(D) 

Ans. **(D)**

Sol. The given configuration is S, S, R



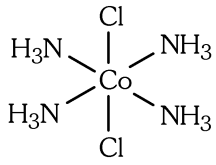
43. Four statements for the following reaction given below

$$[CoCl_2(NH_3)_4]^+ + Cl^- \rightarrow [CoCl_3(NH_3)_3] + NH_3$$

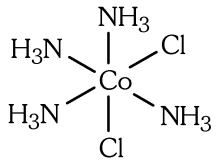
(I) Only one isomer is produced if the reactant complex ion is a trans isomer.
(II) Three isomers are produced if the reactant complex ion is a cis isomer.
(III) Two isomers are produced if the reactant complex ion is a trans isomer.
(IV) Two isomers are produced if the reactant complex ion is cis isomer.
The correct statements are
(A) I and II (B) III and IV (C) I and IV (D) II and III

Ans. (D)

Sol.

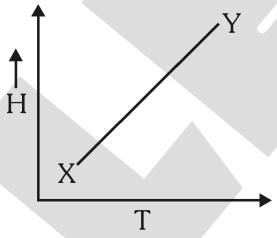


All four positions are equivalent.



Only two isomers (fac, mer) are possible.

44. The process in which an ideal gas undergoes change from X to Y as shown in the following diagram is



(A) isothermal compression (B) adiabatic compression
(C) isothermal expansion (D) adiabatic expansion

Ans. (B)

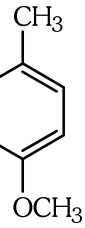
Sol. In adiabatic compression final temperature is greater than the initial and ΔH = positive.

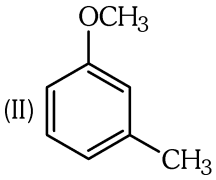
45. With respect to halogens, four statements are given below
(I) The bond dissociation energies for halogens ae in the order : $I_2 < F_2 < Br_2 < Cl_2$
(II) The only oxidation state is –1
(III) The amount of energy required for the excitation of electrons to first excited state decreases progressively as we move from F to I.
(IV) They form HX_2^- species in their aqueous solutions (X = halogen)
The correct statement are
(A) I, II, IV (B) I, III, IV (C) II, III, IV (D) I, III

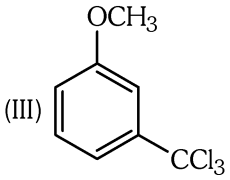
Ans. (D)

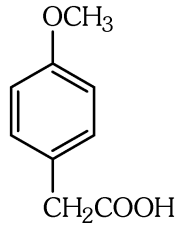
Sol. Statement-I & II are correct.

46. The order of reactivity of the following compounds in electrophilic monochlorination at the most favourable position is

(I) 

(II) 

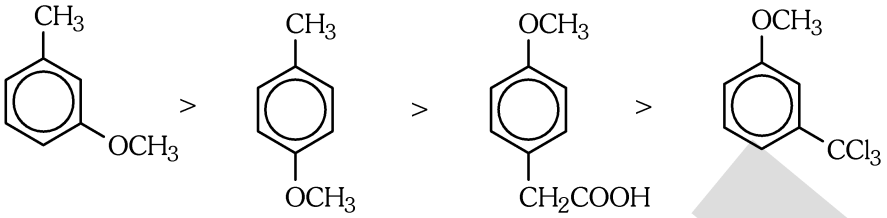
(III) 

(IV) 

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

Ans. (B)

Sol. Order is



47. The limiting molar conductivities of KCl, KNO_3 and $AgNO_3$ are 149.9, 145.0 and 133.4 S cm^2 mol^{-1}, respectively at 25°C. The limiting molar conductivity of AgCl at the same temperature in S cm^2 mol^{-1} is

(A) 128.5 (B) 138.3 (C) 161.5 (D) 283.3

Ans. (B)

Sol. $\Lambda^{\circ}_{KCl} = 149.9 \text{ S cm}^2 \text{ mol}^{-1}$

$\Lambda^{\circ}_{KCl} = 145 \text{ S cm}^2 \text{ mol}^{-1}$

$\Lambda^{\circ}_{AgNO_3} = 133.4 \text{ S cm}^2 \text{ mol}^{-1}$

$\Lambda^{\circ}_{AgCl} = \Lambda^{\circ}_{AgNO_3} + \Lambda^{\circ}_{KCl} - \Lambda^{\circ}_{KNO_3}$

$= 138.3 \text{ S cm}^2 \text{ mol}^{-1}$

48. Imagine that in any atom about 50% of the space is occupied by the atomic nucleus. If a silver foil is bombarded with α–particles, majority of the α–particles would

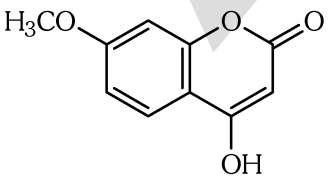
(A) be scattered (B) be absorbed by the nuclei

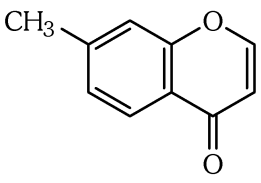
(C) pass through the foil undeflected (D) get converted into photons

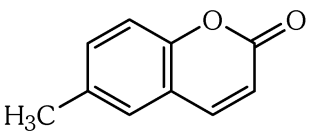
Ans. (A)

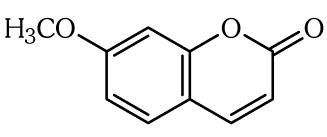
Sol. As size of nucleus is 50% of the size of atom so majority of α-particles will be scattered.

49. An organic compound ("X") is a disubstituted benzene containing 77.8% carbon and 7.5% hydrogen. Heating an alkaline solution of "X" with chloroform gives a steam volatile compound "Y". Heating "Y" with acetic anhydride and sodium acetate gives a sweet smelling crystalline solid "Z". "Z" is

(A) 

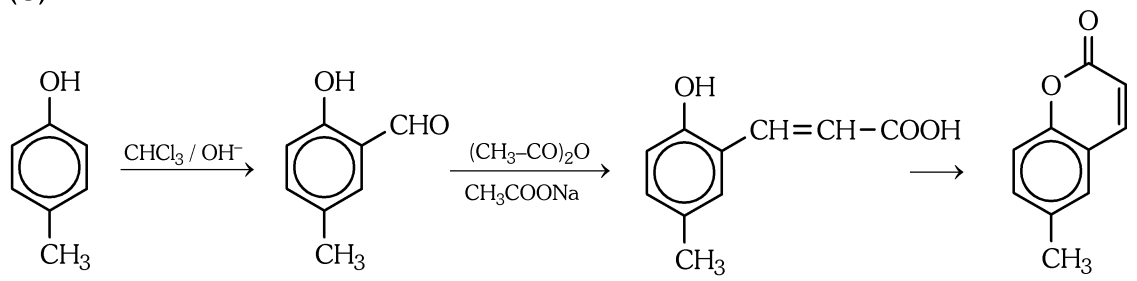
(B) 

(C) 

(D) 

Ans. (C)

Sol.



50. The emf of a cell corresponding to the following reaction is 0.199 V at 298 K.

$Zn(s) + 2H^+(aq) \rightarrow Zn^{2+}(0.1\ M) + H_2(g)$ $\left(E^\circ_{Zn/Zn^{2+}} = 0.76\,V\right)$

The approximate pH of the solution at the electrode where hydrogen is being produced is (p_{HZ} = 1 atm)

(A) 8 (B) 9 (C) 10 (D) 11

Ans. (C)

Sol. $E = F^o - \frac{0.0591}{2}\log Q$

$$0.199 = 0 + 0.76 - \frac{0.0591}{2}\log\frac{(Zn^{2+})(p_{H_2})}{[H^{2+}]}$$

$$\frac{0.561\times 2}{0.0591} = \log\frac{0.1\times 10}{[H^{2+}]}$$

$18.98 = -1 - 2\log[H^+]$

$19.98 = 2pH$

$pH \approx 10$

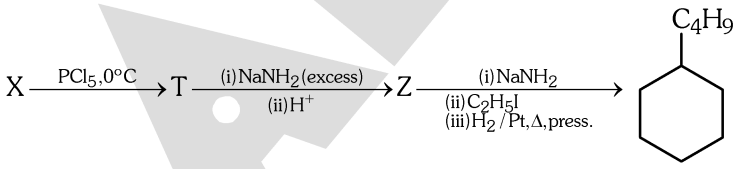
51. The vapour pressure of two pure isomeric liquids X and Y are 200 torr and 100 torr respectively at a given temperature. Assuming a solution of these components to obey Raoult's law, the mole fraction of component X in vapour phase in quilibrium with the solution containing equal amounts of X and Y, at the same temperature is

(A) 0.33 (B) 0.50 (C) 0.66 (D) 0.80

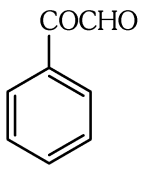
Ans. (C)

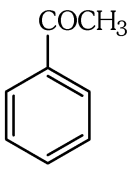
Sol. $Y_x = \frac{P^\circ_X X_X}{P^\circ_X X_X + P^\circ_Y X_Y} = \frac{200}{200+100} = \frac{2}{3} = 0.66$

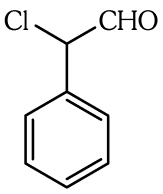
52. n–Butycyclohexane is formed through the following sequence of reactions.

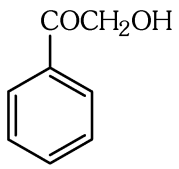


In the above scheme of reactions, "X" is

(A) 

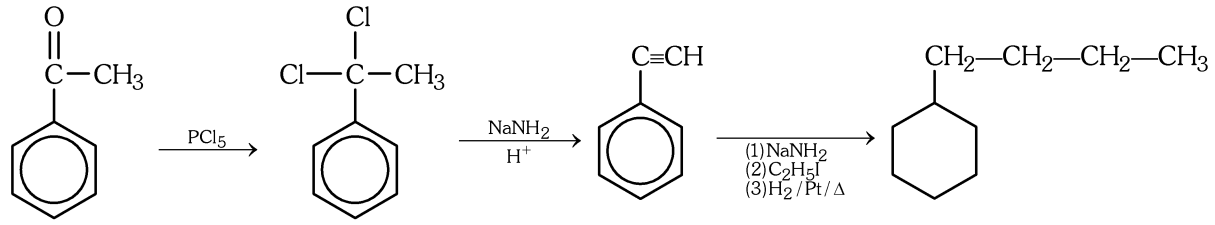
(B) 

(C) 

(D) 

Ans. (B)

Sol.



53. In a first order reaction, 75% of the reactant disappears in 1.386 h, the rate constant of the reaction is close to

(A) $7.2 \times 10^{-1}\ s^{-1}$ (B) $3.6 \times 10^{-3}\ s^{-1}$ (C) $1.8 \times 10^{-3}\ s^{-1}$ (D) $2.8 \times 10^{-4}\ s^{-1}$

Ans. (D)

Sol. $$K = \frac{2.303}{1.386 \times 3600} \log_{10} \frac{a}{3/4}$$

$$K = \frac{2.303}{1.386 \times 3600} \times 2 \times 0.301$$

$$K = 2.8 \times 10^{-4}\ s^{-1}$$

54. Four statements for Cr and Mn are given below.

(I) Cr^{2+} and Mn^{3+} have the same electronic configuration.

(II) Cr^{2+} is a reducing agent while Mn^{3+} is an oxidizing agent.

(III) Cr^{2+} is an oxidizing agent while Mn^{3+} is a reducing agent.

(IV) Both Cr and Mn are oxidizing agent.

The correct statements are

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

Ans. (B)

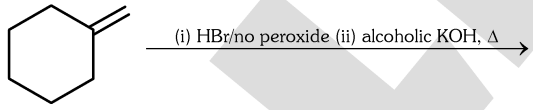
Sol. (i) $Cr^{2+} = 3d^4$

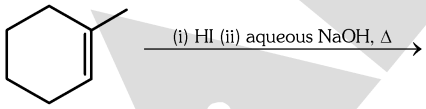
$Mn^{3+} = 3d^4$

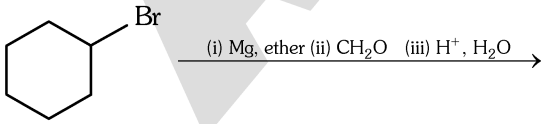
(ii) $Cr^{2+} \rightarrow Cr^{3+} + e^-$

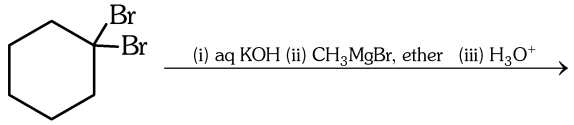
$Mn^{3+} + e^- \rightarrow Mn^{2+}$

55. Four processes are indicated below :

(I) 

(II) 

(III) 

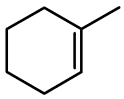
(IV) 

The processes that do not produce l-methylcyclohexanol are

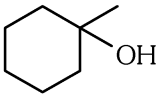
(A) II, IV (B) I, II (C) III, IV (D) I, III

Ans. (D)

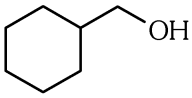
Sol.



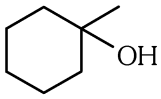
(I)



(II)



(III)



(IV)

56. The reaction that is least feasible is

(A) $Li_2CO_3 \rightarrow Li_2O + CO_2$

(B) $4Li + O_2 \rightarrow 2Li_2O$

(C) $6Li + N_2 \rightarrow 2Li_3N$

(D) $2C_6H_5C \equiv CH + 2Li \rightarrow 2C_6H_5C \equiv CLi + H_2$

Ans. (A)

Sol. $Li_2CO_3 \longrightarrow Li_2O + CO_2$

Without heating, thermal decomposition will not take place.

Li in open air gives Li_2O & Li_3N readily.

57. Glucose when dissolved in water leads to cooling of the solution. Suppose you take 250 mL water at room temperature in an open container (such as a bowl) made of thermally insulated material and dissolve a spoonful of glucose in it. If you are able to accurately measure the heat absorbed by this solution in reaching back to room temperature (assuming negligible changes in the composition and the amount of solution during this process), you will be measuring

(A) the enthalpy of dissolution of the glucose in water

(B) the Gibbs free energy of dissolution of the glucose in water

(C) the work done by the atmosphere on the system during the dissolution process

(D) the heat capacity of the solution

Ans. (D)

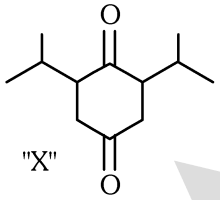
Sol. Measuring heat capacity of solution.

(Coffee cup calorimeter methodology)

$$C = \frac{q_P}{\Delta T} \qquad q_P = C.\Delta T$$

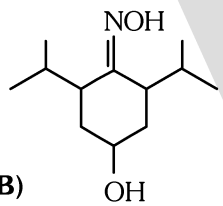
q_P (open container under constant atmosphere pressure)

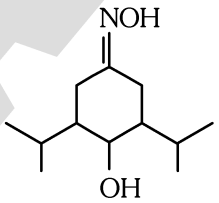
58. Compound "X" undergoes the following sequence of reactions to form "Y".

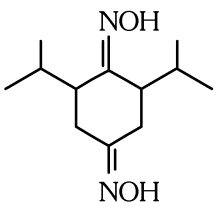


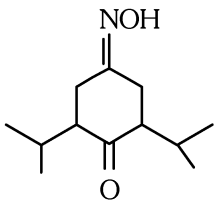
$$\xrightarrow[\text{(iii) } H_3O^+,\ \text{heat (iv) } NH_2OH]{\text{(i)ethylene glycol, H+ (ii) } LiAlH_4} \text{"Y"}$$

Compound "Y" is

(A) 

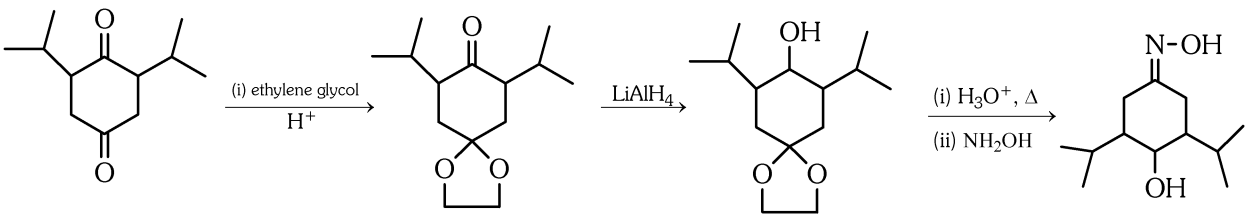
(B) 

(C) 

(D) 

Ans. (B)

Sol.

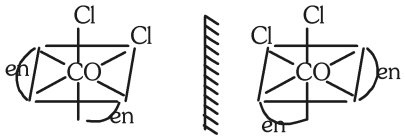


59. The complex that shows optical activity is

(A) trans-$[CoCl_2(en)_2]^+$ (B) cis-$[CoCl_2(en)_2]^+$ (C) trans-$[PtCl_2(NH_3)_2]$ (D) $[CoCl_2(NH_3)_2(en)]^+$

Ans. **(B)**

Sol.



Non super imposable mirror image

60. 100 mL of 0.3 M acetic acid is shaken with 0.8 g wood charcoal. The final concentration of acetic acid in the solution after adsorption is 0.125 M. The mass of acetic acid adsorbed per gram of charcoal is

(A) 1.05 g (B) 0.0131 g (C) 1.31 g (D) 0.131 g

Ans. **(C)**

Sol. Amount of acetic acid in given solution = 0.03 mole = 0.03 × 60 = 1.8 g

Amounts of acetic acid in remaining solution = 0.125 × 0.1 = 0.0125 mole
= 0.0125 × 60
= 0.75 g
Amount absorbed = 1.8 × 0.75 = 0.05 g

mass of acetic acid absorbed per gram = $=\frac{1.05}{0.8}=1.31$ g

61. The reaction that does not produce nitrogen is

(A) heating $(NH_4)_2Cr_2O_7$ (B) NH_3 + excess of Cl_2 (C) heating of NaN_3 (D) heating of NH_4NO_3

Ans. **(B)**

Sol. $NH_3 + 3Cl_2 \xrightarrow[\text{(excess)}]{} NCl_3 + 3HCl$

62. The species having highest bond energy is

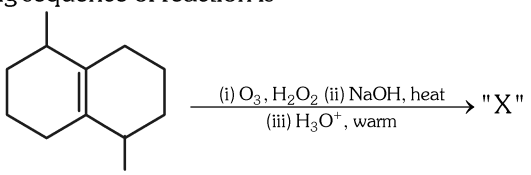
(A) O_2 (B) O_2^+ (C) O_2^- (D) O_2^{2-}

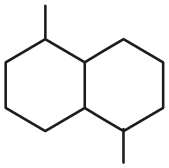
Ans. **(B)**

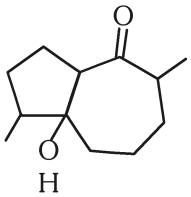
Sol. Bond energy ∝ Bond order

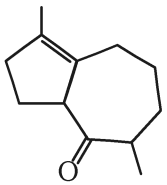
species	**Bond Order**
O_2	2
O_2^+	2.5 (Maximum. bond order – Highest bond energy)
O_2^-	1.5
O_2^{2-}	1.0

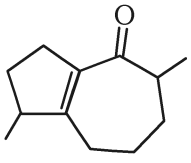
63. The product ("X") of the following sequence of reaction is



(A) 

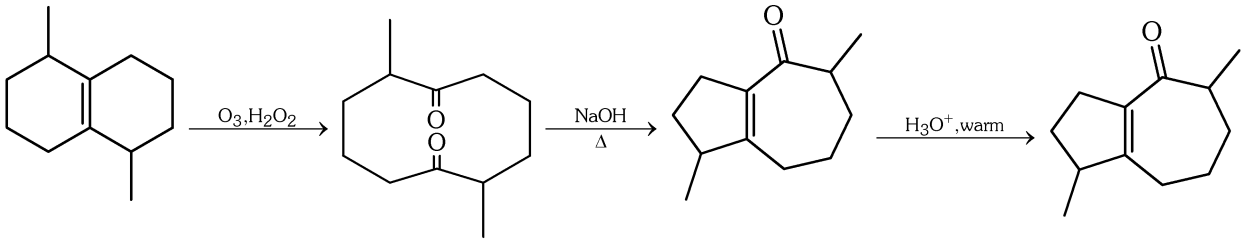
(B) 

(C) 

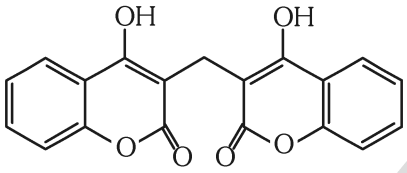
(D) 

Ans. (B)

Sol.



64. Dicoumarol (X) is an anticoagulant. The number of possible monochloro substituted isomeric derivatives and the volume of hydrogen liberated at STP by the reaction of 0.5 mol of dicoumarol with sodium are respectively

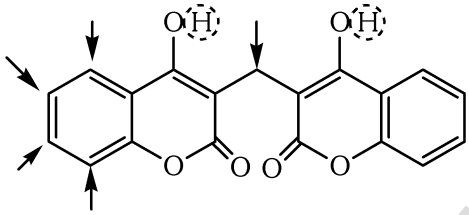


(X)

(A) 5, 22.4 dm^3 (B) 5, 11.2 dm^3 (C) 6, 11.2 dm^3 (D) 4, 22.4 dm^3

Ans. (B)

Sol.



⇒ Indicated arrow heads are positions to be substituted by chlorine.
⇒ Circled hydrogen will be liberated when treated with sodium.
1 mole of X gives 1 mole of $H_2(g)$
0.5 mole of X gives 0.5 mole of $H_2(g)$
Volume released at STP = 11.2 L

65. The structure of a molecule of $N(SiMe_3)_3$ is
(A) Pyramidal with angle close to 110° (B) T-shaped with angle 90°
(C) Bent T-shaped with angle close to 89° (D) Trigonal planar with bond angle close to 120°

Ans. (D)

Sol. The hybridisation of nitrogen is sp^2 due to back bonding.

66. For an electron whose x-positional uncertainty is 1.0×10^{-10}m, the uncertainty in the x-component of the velocity in ms^{-1} will be of the order of
(A) 10^6 (B) 10^9 (C) 10^{12} (D) 10^{15}

Ans. (A)

Sol. $\Delta x \cdot \Delta v = \frac{h}{2\pi m} = \frac{6.626 \times 10^{-34}}{2 \times 3.14 \times 9.1 \times 10^{-31}}$

$$\Delta v = \frac{6.626 \times 10^{-34}}{2 \times 3.14 \times 9.1 \times 10^{-31} \times 10^{-10}} = 0.1158 \times 10^7$$
$$= 01.158 \times 10^6.$$

67. The order of pπ-dπ interaction in the compounds containing bond between Si/P/S/Cl and oxygen is in the order
(A) P > Si > Cl > S (B) Si < P < S < Cl (C) S < Cl < P < Si (D) Si > P > S > Cl

Ans. **(B)**

Sol. From Si to Cl in 3rd period, decreasing size increases strength of pπ-dπ bond with oxygen.

68. The solubility products (K_{sp}) of three salts MX, MY_2, and MZ_3 are 1×10^{-8}, 4×10^{-9} and 27×10^{-8}, respectively. The correct order for solubilities of these salts is
(A) MX > MY_2 > MZ_3 (B) MZ_3 > MY_2 > MX (C) MZ_3 > MX > MY_2 (D) MY_2 > MX > MZ_3

Ans. **(B)**

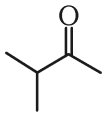
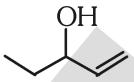
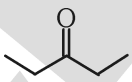
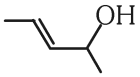
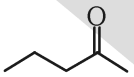
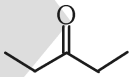
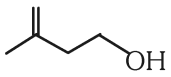
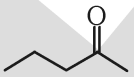
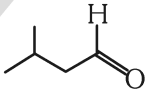
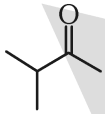
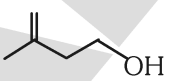
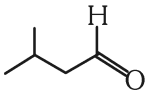
Sol. MX, $K_{sp} = S^2$

$$S_1 = \sqrt{K_{sp}} = \sqrt{1\times10^{-8}} = 1\times10^{-4}$$

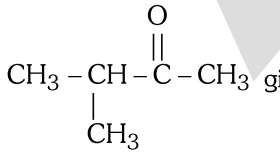
MY_2, $S_2 = \sqrt[3]{\frac{K_{sp}}{4}} = \sqrt[3]{1\times10^{-9}} = 1\times10^{-3}$

MZ_3, $S_3 = \sqrt[4]{\frac{K_{sp}}{27}} = \sqrt[4]{1\times10^{-8}} = 1\times10^{-2}$

69. Three isomeric compounds M, N and P ($C_5H_{10}O$) give the following tests
(i) M and P react with sodium bisulfite to form an adduct
(ii) N consumes 1 mol of bromine and also gives turbidity with conc. HCl/anhydrous $ZnCl_2$ after prolong heating
(iii) M reacts with excess of iodine in alkaline solution to give yellow crystalline compound with a characteristic smell
(iv) p-Rosaniline treated with sulphur dioxide develops pink colour on shaking with P
The structures of M, N and P, respectively are

	M	**N**	**P**
(A)			
(B)			
(C)			
(D)			

Ans. **(D)**

Sol.  gives +ve iodoform test.

(N) should be 1° alcohol (not allylic) as it gives turbidity with conc. HCl on prolonged heating.
(P) should be an aldehyde as it gives pink colour with schiff reagent.

70. The reaction that does not proceed in forward direction is

(A) $BeF_2 + HgI_2 \rightarrow BeI_2 + HgF_2$ (B) $LiI + CsF \rightarrow LiF + CsI$

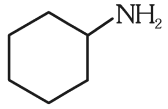
(C) $CuI_2 + 2CuF \rightarrow CuF_2 + 2CuI$ (D) $CaS + H_2O \rightarrow CaO + H_2S$

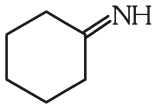
Ans. **(D)**

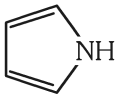
Sol. $CaS + H_2O \longrightarrow CaO + H_2S$

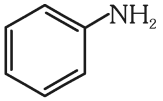
Products of option (D) are acid and base which react to form CaS and H_2O. Thus reaction will not proceed in forward direction.

71. The order of basicity of the following compounds is

(I) 

(II) 

(III) 

(IV) 

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

Ans. **(A)**

Sol. (III) is least basic due to the lone pair being involved in aromaticity.

72. The appropriate sequence of reactions for obtaining 2-phenylbutanoic acid from benzene is

(A) (i) 1-chlorobutane/$AlCl_3$ (ii) limited Cl_2, light (iii) aq NaCN (iv) H^+, H_2O, heat

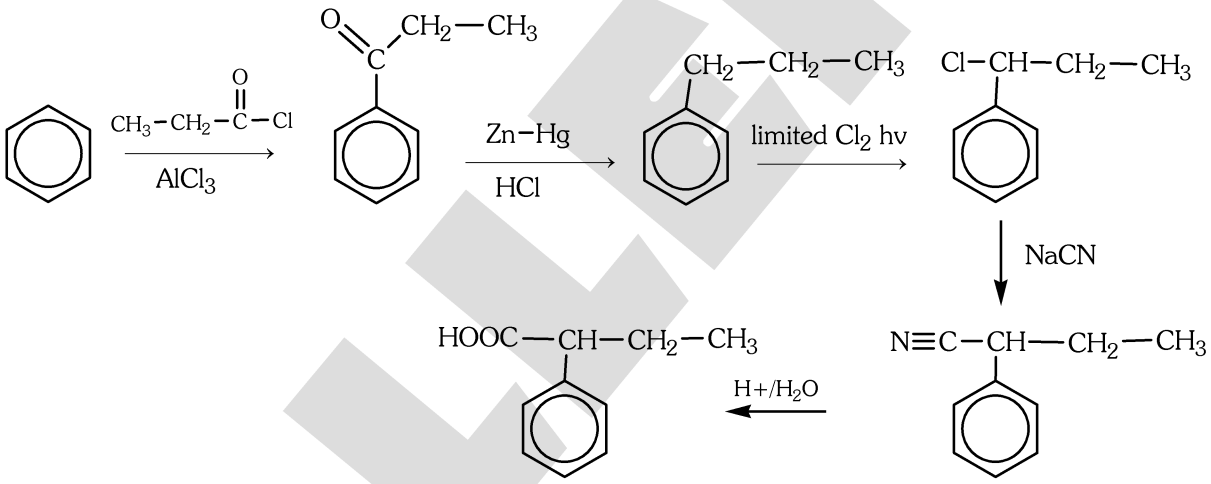
(B) (i) 2-chlorobutane/$AlCl_3$ (ii) $K_2Cr_2O_7/H_2SO_4$

(C) (i) propanoyl chloride/$AlCl_3$ (ii) Zn-Hg/HCl (iii) limited Cl_2, light (iv) aq. NaCN (v) H^+, H_2O, heat

(D) (i) butanoyl chloride/$AlCl_3$ (ii) $NaBH_4$ (iii) CuCN (iv) H^+, H_2O, heat

Ans. **(C)**

Sol.



(2-phenyl butanoic acid)

73. The quantity that does not change for a sample of a gas in a sealed rigid container when it is cooled from 120°C to 90°C at constant volume is

(A) average energy of the molecule (B) pressure of the gas

(C) density of the gas (D) average speed of the molecules

Ans. **(C)**

Sol. Mass and volume are constant.

74. An ideal gas taken in an insulated chamber is released into interstellar space. The statement that is nearly true for this process is

(A) $Q = 0, W \neq 0$ (B) $W = 0, Q \neq 0$ (C) $\Delta U = 0, Q \neq 0$ (D) $Q = W = \Delta U = 0$

Ans. **(D)**

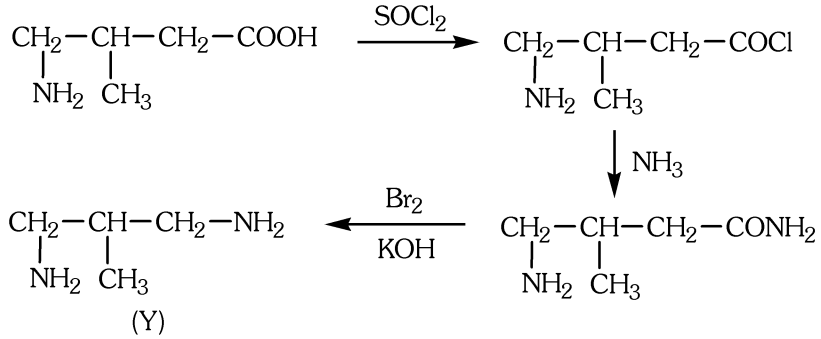
Sol. It is a free expansion. So $Q = W = \Delta U = 0$

75. 4-amino-3-methylbutanoic acid is treated with thionyl chloride followed by ammonia to obtain compound "X". "X" on reaction with bromine in an alkaline medium gave compound "Y". For estimation, "Y" was titrated with perchloric acid. The volume of 0.1 M perchloric acid needed to react with 0.22 g of "Y" is

(A) 50 mL (B) 80 mL (C) 120 mL (D) 200 mL

Ans. **(A)**

Sol.



$$Y + 2HClO_4 \rightarrow \text{Salt}$$

1 mole 2 mole

No. of moles of $HClO_4$ needed $= \frac{0.22 \times 2}{88} = \frac{1}{200}$

$$\frac{1}{200} = 0.1 \times V_L$$

$$V_L = \frac{1}{20} = 0.05 \text{ L} = 50 \text{ ml}$$

76. For $[FeF_6]^{3-}$ and $[CoF_6]^{3-}$, the statement that is correct is

(A) both are colored

(B) both are colorless

(C) $[FeF_6]^{3-}$ is colored and $[CoF_6]^{3-}$ is colorless

(D) $[FeF_6]^{3-}$ is colorless and $[CoF_6]^{3-}$ is colored

Ans. **(A)**

Sol. Both have unpaired electron.

77. Cotton fibers consist of cellulose polymers with neighboring polymers chains held together by hydrogen bonds between –OH groups in the glucose units. Due to these hydrogen bonds

(A) cotton is insoluble in water

(B) cotton can easily absorb ghee and oils and therefore are used to make wicks in traditional lamps

(C) it is easier to iron cotton clothes when they are slightly wet or by applying steam to the clothes

(D) cotton clothes have a high wear and tear than other fibers

Ans. **(A)**

Sol. As –OH groups are already involved in intramolecular hydrogen bonding, cellulose fibres are insoluble in water.

78. For the following reaction, formation of the product is favored by

$A_2(g) + 4B_2(g) << 2AB_4(g)$, $\Delta H < 0$

(A) low temperature and high pressure (B) high temperature and low pressure

(C) low temperature and low pressure (D) high temperature and high pressure

Ans. **(A)**

Sol. An exothermic reaction is favoured by low temperature. High pressure favours a reaction with Δ_{ng} = –ve.

79. Imagine a hypothetical situation in which capacity of any molecular orbital is 3 instead of 2 and the combination rules for the formation of molecular orbitals remain the same. The number of delocalized pi-electrons stipulated by the modified Huckel's rule of aromaticity is (n=integer, including zero)

(A) (3n + 2) (B) (4n + 3) (C) (2n + 3) (D) (6n + 3)

Ans. **(D)**

Sol. Total number of bonding and non-bonding orbitals stipulated by Huckel's rule is 2n+1. If each orbital can accommodate 3 electrons, the number of delocated pi-electrons would be 6n+3

80. One mole crystal of a metal halide of the type MX with molecular weight 119 g having face centered cubic structure with unit cell length 6.58 Å was recrystallized. The density of the recrystallized crystal was found to be 2.44 g cm^{-3}. The type of defect introduced during the recrystalization is
(A) additional M^+ and X^- ions at interstitial sites
(B) Schottky defect
(C) F-centre
(D) Frenkel defect

Ans. **(B)**

Sol. $D = \frac{ZM}{a^3 \times NA} = \frac{4 \times 119}{\left(6.58 \times 10^{-8}\right)^3 \times 6.02 \times 10^{23}} = 2.785 \text{ g/cm}^3$

density after recrystallisation = 2.44 g/cm^3
Since density decreases during recrystallisation thus defect should be schottky.

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