Date: 23/11/2025

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Answers & Solutions

Time : 120 Minute **Max. Marks : 216**

for

Association of Chemistry Teachers
National Standard Examination in
CHEMISTRY (NSEC)-2025

INSTRUCTIONS TO CANDIDATES

(1) There are 60 questions in this paper. Attempt all the 60 Questions.

(2) Question paper has two parts. In **Part A-1** (Q. No. 1 to 48) each question has four alternatives, out of which **only one** is correct. Choose the correct alternative and fill the appropriate bubble, as shown.

Q. No. 12 (a) ● (c) (d)

In **Part A-2** (Q. No. 49 to 60) each question has four alternatives, out of which **any number of alternative (s)** (1, 2, 3 or 4) may be correct. You have to choose ALL correct alternative(s) and fill the appropriate bubble(s), as shown.

Q. No. 52 (a) ● (c) ●

(3) For **Part A-1**, each correct answer carries **3 marks** whereas 1 mark will be deducted for each wrong answer. In **Part A-2**, you get **6 marks** if all the correct alternatives are marked and no incorrect. No negative marks in this part.

A - 1

ONLY ONE OUT OF FOUR OPTIONS IS CORRECT. BUBBLE THE CORRECT OPTION

1. The spin-only magnetic moment for $[Ni(H_2O)_6](ClO_4)_2$ should be

(a) 3.87 (b) 2.83

(c) 1.72 (d) 5.92

Answer (b)

Sol. $[Ni(H_2O)_6](ClO_4)_2 \Rightarrow [Ni(H_2O)_6]^{2+}$

$\Rightarrow Ni^{+2} \Rightarrow 3d^8$

Since H_2O is a weak field ligand so no pairing takes place

$\therefore 3d^8 \Rightarrow$ 

$\therefore n = 2$

$\mu = \sqrt{n(n+2)}\,BM \Rightarrow 2.83\ BM$

2. The correct order of Δ_o for the following given transition metal complexes is

(a) $Rh(CN)_6^{3-} > Rh(NH_3)_6^{3+} > RhCl_6^{3-}$ (b) $Rh(NH_3)_6^{3+} > RhCl_6^{3-} > Rh(CN)_6^{3-}$

(c) $RhCl_6^{3-} > Rh(CN)_6^{3-} > Rh(NH_3)_6^{3+}$ (d) $Rh(CN)_6^{3-} > RhCl_6^{3-} > Rh(NH_3)_6^{3+}$

Answer (a)

Sol. $\therefore$ Since central metal ion is same having same oxidation state in all the complexes

$\therefore$ Crystal field splitting energy $(\Delta_o) \propto$ strength of the ligand

$\therefore$ Strength of ligand order : $CN^- > NH_3 > Cl^-$

$\therefore \Delta_o$ order :

$[Rh(CN)_6]^{3-} > [Rh(NH_3)_6]^{3+} > [RhCl_6]^{3-}$

3. The correct rank of bond order for O_2^+, O_2^-, CO and O_2^{2-} is

(a) 3, 1.5, 3, 1 (b) 2, 5, 1, 1

(c) 1.5, 2.5, 3, 2 (d) 2.5, 1.5, 3, 1

Answer (d)

Sol. Bond order : $\frac{1}{2}(N_b - N_a)$

Species (Total e^-)		Bond order
• $O_2^+(15e^-)$	$\rightarrow$	2.5
• $O_2^-(17e^-)$	$\rightarrow$	1.5
• CO $(14e^-)$	$\rightarrow$	3
• O_2^{2-} $(18e^-)$	$\rightarrow$	1

Order of bond order :

$O_2^{2-} < O_2^- < O_2^+ < CO$

4. The correct basicity order in water for the following is

(a) $NMe_3 > NH_3 > NH_2NH_2 > NF_3$ (b) $NH_2OH > NH_3 > NF_3 > NMe_3$

(c) $NH_3 < NF_3 < NMe_3 < NH_2NH_2$ (d) $NMe_3 < NH_2OH < NH_3 < NF_3$

Answer (a)

Sol. Electron donating group increases the basicity

Order of basicity:

NMe_3 (+I effect) > NH_3 > NH_2NH_2 (–I of N) > NF_3 (–I of F)

5. A 1.25 g Shelcal 500 tablet contains 1250 mg of $CaCO_3$. A student dissolved one tablet in water to make 1.0 L solution (X). 10.0 mL of solution (X) was titrated with 0.0198 M EDTA-MgEDTA mixture in the burette and found the $CaCO_3$ content matched the label claim. (Molar mass of $CaCO_3$ = 100.0 g/mol). The correct option is

(a) The burette reading is 6.31 mL and molarity of Shelcal solution is 0.125 M

(b) The burette reading is 10.00 mL and molarity of Shelcal solution is 0.0125 M

(c) The burette reading is 6.31 mL and molarity of Shelcal solution is 0.0125 M

(d) The burette reading is 10.00 mL and molarity of Shelcal solution is 0.125 M

Answer (c)

Sol. $M = \frac{1.250}{100 \times 1} M = 1.25 \times 10^{-2} M$

$= 0.0125$ M

$(M_1V_1)_{Ca^{2+}} = (M \times V)_{Mg-(EDTA)_2}$

$0.0125 \times 10 = 0.0198 \times V$

$= V = 6.31$ mL

6. When 10 mL of 0.01 HCl was added to a mixture of 0.5 M NH_3 and 0.5 M NH_4Cl, the pH of the resultant solution will be (pK_b of NH_3 is 4.75)

(a) 9.07 (b) 9.75

(c) 9.25 (d) 8.75

Answer (c)

Sol. Initially mixture contains

$[NH_3] = 0.5$ M

$[NH_4Cl] = 0.5$ M

Solution behaves as buffer solution

$$pOH = p^{Kb} + \log\frac{[NH_4^+]}{[NH_3]}$$

$$= 4.75 + \log\frac{0.5}{0.5}$$

$= 4.75$

pH = 14 – 4.75 = 9.25

As buffer solution resist the pH change on addition of small amount of acid or base, on addition of 10 mL, 0.01 M HCl to the buffer solution which is very less, pH of solution remain same. So, pH of final solution is 9.25.

7. The correct order of CO triple bond character in the given metal carbonyl complexes is

(a) $[Fe(CO)_4]^{-2} > [Co(CO)_4]^{-1} > [Mn(CO)_6]^{+} > Ni(CO)_4$

(b) $Ni(CO)_4 > [Mn(CO)_6]^{+} > [Co(CO)_4]^{-1} > [Fe(CO)_4]^{-2}$

(c) $[Mn(CO)_6]^{+} > [Fe(CO)_4]^{-2} > [Co(CO)_4]^{-1} > Ni(CO)_4$

(d) $[Mn(CO)_6]^{+} > Ni(CO)_4 > [Co(CO)_4]^{-1} > [Fe(CO)_4]^{-2}$

Answer (d)

Sol. More the electron density on metal, more the synergic bonding, less will be CO triple bond character.

Lesser the synergic bonding, more will be the CO triple bond character.

Negative charge on metal $\Rightarrow$ more synergic bonding $\Rightarrow$ less CO triple bond character.

Positive charge density on metal $\Rightarrow$ less synergic bonding $\Rightarrow$ more CO triple bond character.

Correct order will be $[Mn(CO)_6]^{+} > [Ni(CO)_4] > [Co(CO_4)]^{-} > [Fe(CO)_4]^{2-}$.

8. Consider the following statements for the square planar complex $[Pt(en)(NCS)_2]$. Identify the correct statements.

I. It is thermodynamically more stable than $[Pt(NH_3)_2(NCS)_2]$.

II. It can exhibit stereoisomerism.

III. It can exhibit structural isomerism.

IV. It is not easily soluble in polar solvents.

The correct option is

(a) I, II, IV (b) II, III, IV

(c) I, III, IV (d) I, II, III

Answer (c)

Sol. I. Due to formation of chelate ring by en ligand $[Pt(en)(NCS)_2]$ is more stable than $[Pt(NH_3)_2(NCS)_2]$.

$\Rightarrow$ Correct

II. Due to presence of plane of symmetry this complex does not exhibit optical isomerism.

$\Rightarrow$ Incorrect

III. Due to the presence of ambidentate ligand it can show linkage isomerism.

$\Rightarrow$ Correct

IV. Since the ligand is neutral unlike ionic salts, it is not easily soluble in polar solvents.

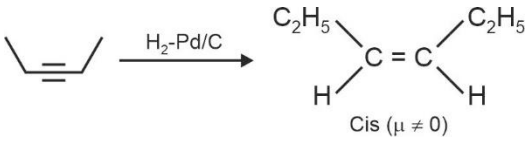
$\Rightarrow$ Correct

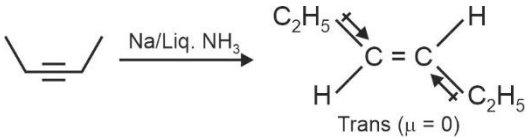
9. Which one of the following reactions will give a product that has zero net dipole moment?

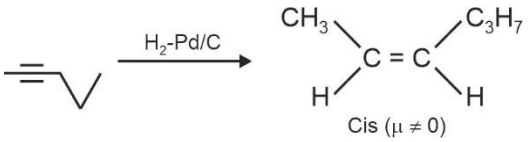
(a) Hex-3-yne with H_2-Pd/C (b) Hex-3-yne with Na in liquid ammonia

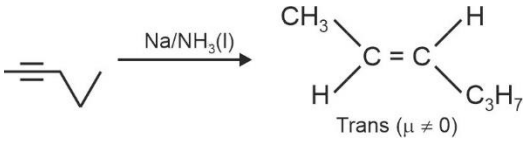
(c) Hex-2-yne with H_2-Pd/C (d) Hex-2-yne with Na in liquid ammonia

Answer (b)

Sol. (a) 

(b) 

(c) 

(d) 

Option (b) has zero net dipole moment.

10. Which of the following statements is ***not*** correct regarding the aromatic electrophilic substitution reactions of aniline or its derivatives under standard laboratory conditions?

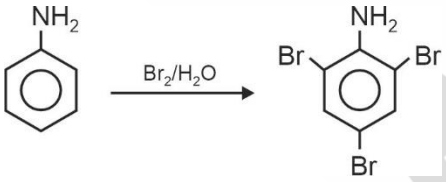
(a) *Aniline*, when subjected to bromination with Br_2/H_2O, undergoes rapid tribromination to form 2,4,6-tribromoaniline as the major product.

(b) During direct nitration of aniline with a nitrating mixture, meta-substitution is observed predominantly due to protonation of the amino group under acidic conditions.

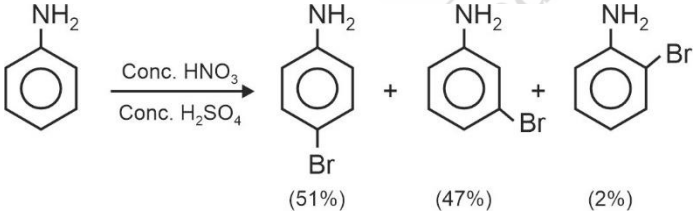
(c) The acetamido group ($-NHCOCH_3$), being less basic than $-NH_2$, shows stronger +M (mesomeric) effect and thus activates the ring more than the free amino group.

(d) Acetylation of aniline reduces its reactivity towards electrophilic substitution and facilitates controlled monosubstitution at ortho and para position.

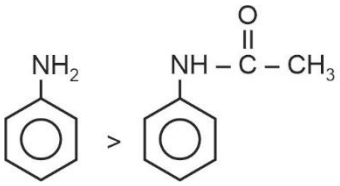
Answer (c)

Sol. (a) 

⇒ Correct

(b) 

⇒ Correct

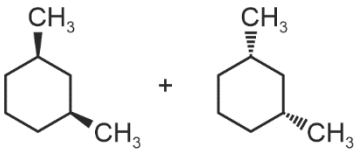
(c)  (Reactivity towards electrophilic substitution)

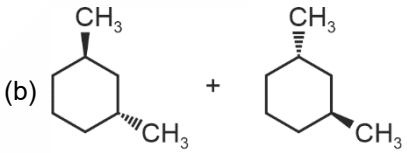
⇒ Incorrect

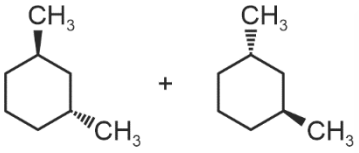
(d) Acetylation of aniline reduces its reactivity due to presence of less +M effect of $-NH-\overset{\overset{O}{\|}}{C}-CH_3$ group.

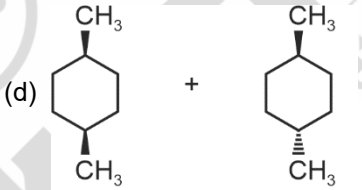
⇒ Correct

11. The optically active mixtures from the following is

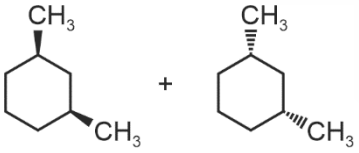
(a)  (75%) (25%)

(b)  (50%) (50%)

(c)  (75%) (25%)

(d)  (75%) (25%)

Answer (c)

Sol. (a)  ⇒ Both have POS hence optically inactive

(b) Both are equal in amount, hence O.I.

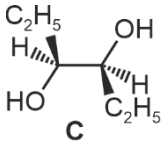
(c) Both are in unequal amount, hence optically active

12. Alkenes can be converted to *cis*-diols using OsO_4 + $NaHCO_3$ and *trans*-diols via the epoxide followed by acid hydrolysis.

Compound **C** given below is formed from:

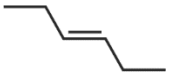
(i) alkene **A** by treatment with OsO_4 + $NaHCO_3$

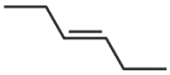
(ii) the epoxide of alkene **B** followed by acid hydrolysis.

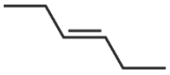
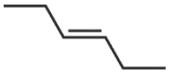


C

The structures of **A** and **B** are

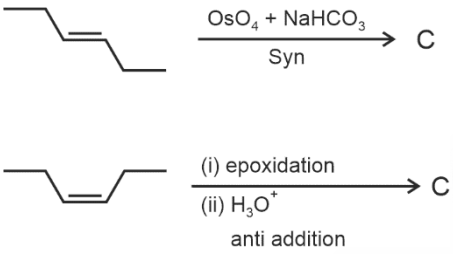
(a) **A**  **B** 

(b) **A**  **B** 

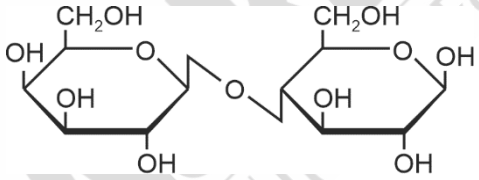
(c) **A**  **B** 

(d) **A**  **B** 

Answer (b)

Sol. 

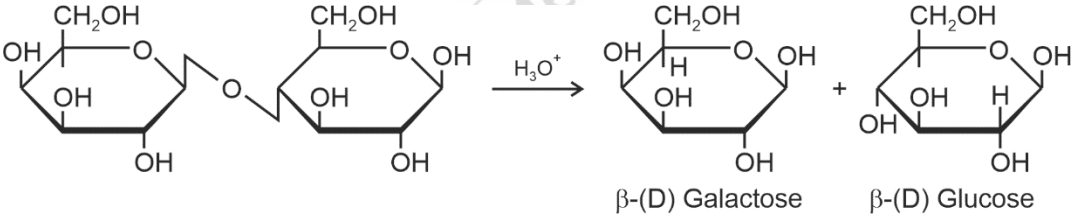
13. The disaccharide shown below undergoes enzymatic hydrolysis. The monosaccharide units formed upon complete hydrolysis of the disaccharide are



(a) Glucose and Glucose (b) Glucose and Galactose

(c) Galactose and Fructose (d) Galactose and Galactose

Answer (b)

Sol. 

β-(D) Galactose β-(D) Glucose

14. The correct order of the isoelectric points (pI) of Alanine (Ala), Arginine (Arg), and Glutamic acid (Glu) is

(a) Ala > Arg > Glu (b) Arg > Ala > Glu

(c) Glu > Arg > Ala (d) Glu > Ala > Arg

Answer (b)

Sol. The general order of isoelectric point (pI) of different amino acids ⇒ Acidic > Neutral > Basic.

Isoelectric point of

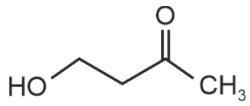
Alanine (Neutral) – 6.11

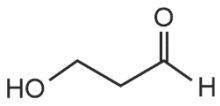
Arginine (Basic) – 10.8

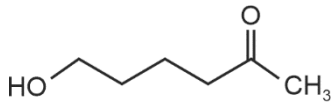
Glutamic acid (Acidic) – 3.2

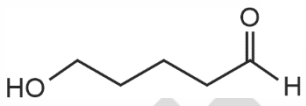
Arg > Ala > Glu

15. Which of the following most readily forms a cyclic hemiacetal in the presence of an acid catalyst?

(a) 

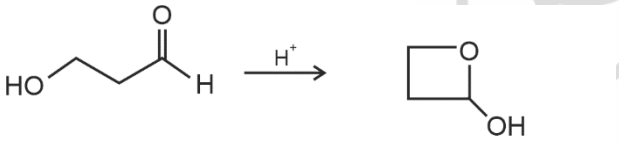
(b) 

(c) 

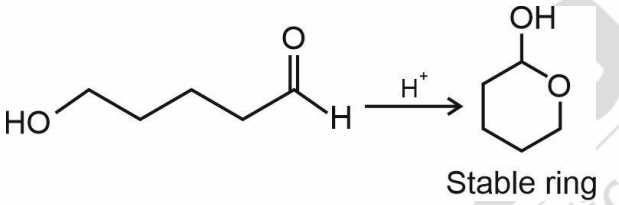
(d) 

Answer (d)

Sol. Ketones have low reactivity towards nucleophilic addition reaction

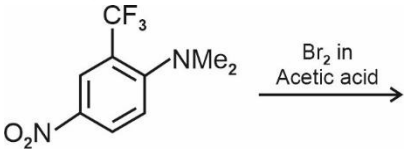


Low reactivity because of strained ring in product

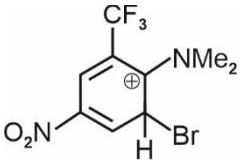


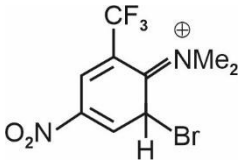
Stable ring

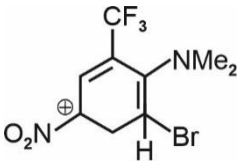
16. A medicinal chemist is exploring halogenated aromatic compounds as potential precursors for drug molecules. In one experiment, she attempts bromination of a substituted aromatic ring in the presence of acetic acid, a typical aromatic electrophilic substitution (AES) condition.

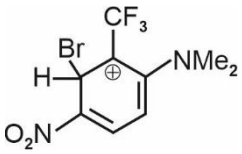


The chemist proposed an intermediate for the above reaction with the following resonance structures. Which of the following structures contributes the most to the stability of the intermediate?

(a) 

(b) 

(c) 

(d) 

Answer (b)

Sol. All atoms have octet configuration in the resonating structure (b). So it is the most stable.

(a) Carbon having +ve charge has 6 electrons.

(b) Carbon having +ve charge has 6 electrons plus close to electron withdrawing group, similar in (d)

17. Which sequence of reagents, when used in the correct order, will convert benzene to m-nitro-n-propylbenzene?

(a) (i) $CH_3COCl/AlCl_3$, (ii) HNO_3/H_2SO_4, (iii) Zn/Hg, HCl

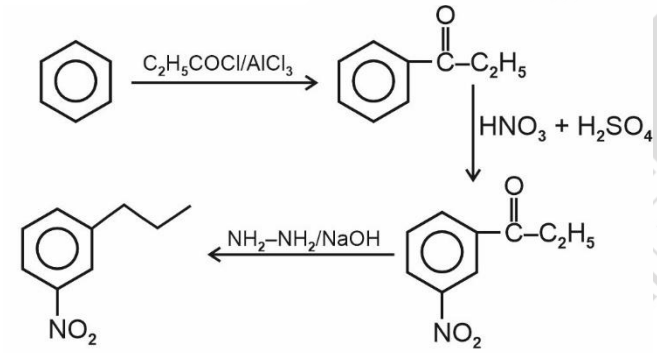
(b) (i) HNO_3/H_2SO_4, (ii) $CH_3CH_2CH_2Cl/AlCl_3$

(c) (i) HNO_3/H_2SO_4, (ii) $CH_3CH_2COCl/AlCl_3$, (iii) $H_2NNH_2/NaOH$

(d) (i) $CH_3CH_2COCl/AlCl_3$, (ii) HNO_3/H_2SO_4, (iii) $H_2NNH_2/NaOH$

Answer (d)

Sol.



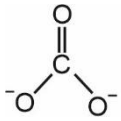
m-nitro-n-propyl benzene

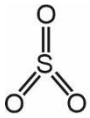
18. Which of the following molecules is odd one out in its bonding properties?

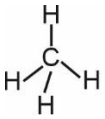
(a) CO_3^{2-} (b) SO_3

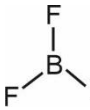
(c) CH_4 (d) BF_3

Answer (c)

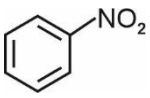
Sol. (a) CO_3^{2-}  sp^2 → Trigonal planar

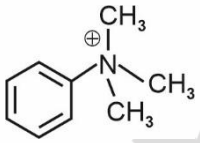
(b) SO_3  sp^2 → Trigonal planar

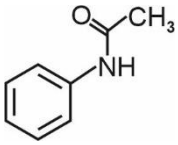
(c) CH_4  sp^3 → Tetrahedral shape

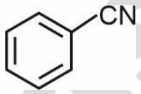
(d) BF_3  sp^2 → Trigonal planar

19. Which of the following compounds predominantly gives the *para*-nitro product as the major isomer upon nitration using a nitrating mixture ($HNO_3 + H_2SO_4$)?

(a) 

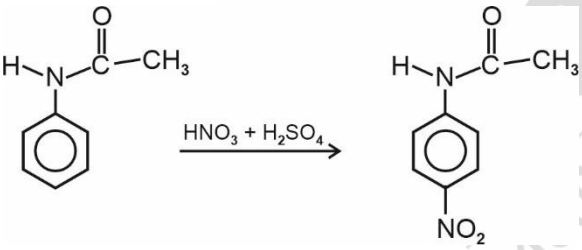
(b) 

(c) 

(d) 

Answer (c)

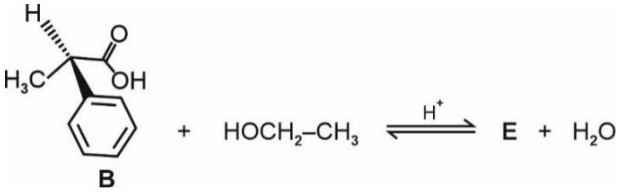
Sol.



$-NH-\overset{\overset{O}{\|}}{C}-CH_3$ is p-directing (major) due to steric hindrance.

NO_2, CN and $(CH_3)_3\overset{+}{N}$ are m-directors

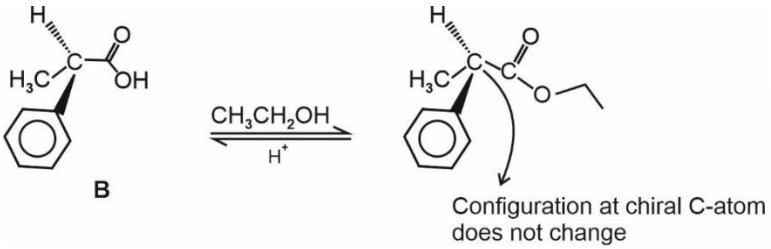
20. Product E formed in the following chemical reaction will



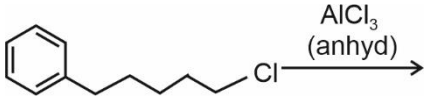
(a) have the same configuration as **B**
(b) have inverted configuration as compared to **B**
(c) be a racemic mixture
(d) be optically inactive

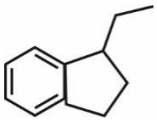
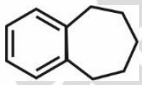
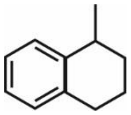
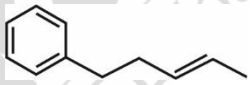
Answer (a)

Sol.



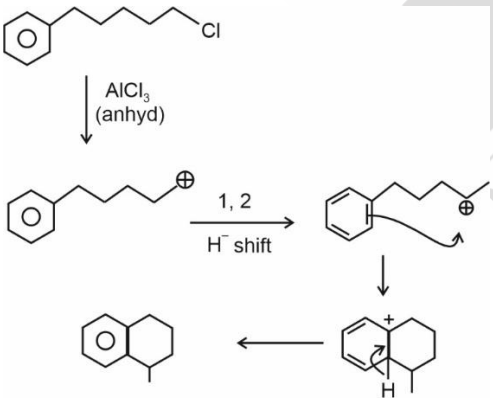
21. The most predominant product of the following reaction will be:



(a) 
(b) 
(c) 
(d) 

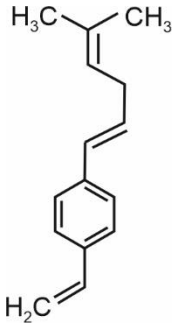
Answer (c)

Sol. This is Friedal craft reaction that involves formation of carbocation and rearrangement.

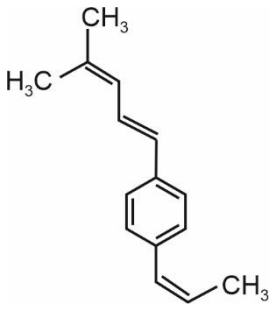


22. Which of the following molecules will react with ozone and hydrogen peroxide to form 1, 4-benzene dicarboxylic acid, formic acid, oxalic acid and acetone?

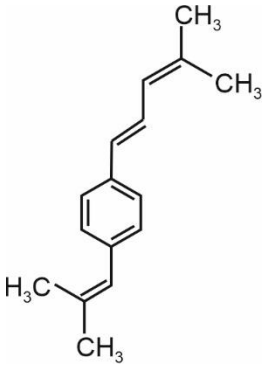
(a)



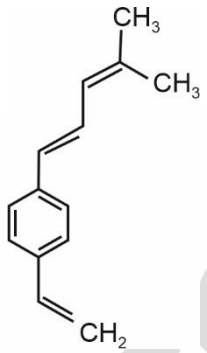
(b)



(c)

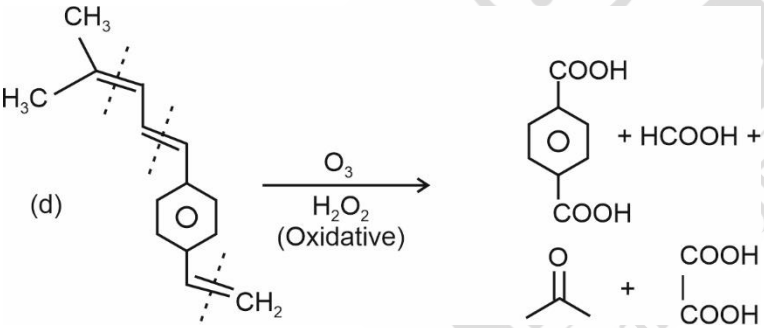


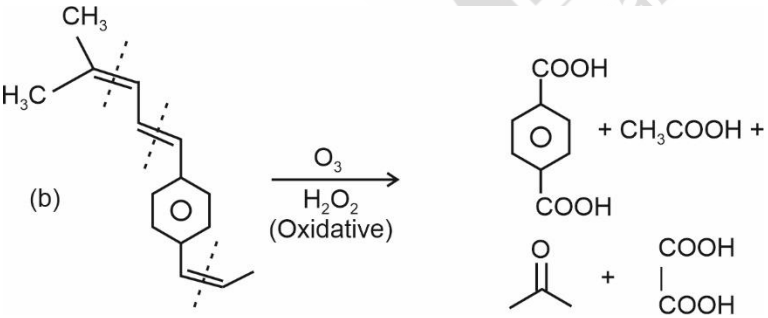
(d)



Answer (d)

Sol.

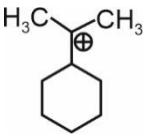




23. The correct numerical answers for the following is:

(i) The number of NOT-aromatic compounds from the following is

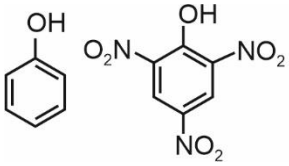
(ii) The number of α hydrogen atoms in the following structure is



(iii) The number of geometrical isomers possible in

$CH_3CH = CH - CH = CH_2$

(iv) The number of compounds more acidic than CH_3COOH from:



CF_3COOH CH_3SO_3H C_2H_5OH

(a) (i) = 3; (ii) = 6; (iii) = 2; (iv) = 3

(b) (i) = 2; (ii) = 6; (iii) = 2; (iv) = 3

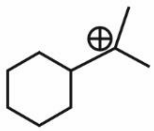
(c) (i) = 2; (ii) = 7; (iii) = 4; (iv) = 2

(d) (i) = 3; (ii) = 7; (iii) = 4; (iv) = 3

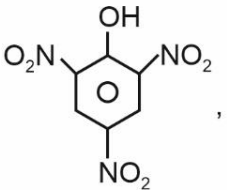
Answer (d)

Sol.

(i)  (3) Not aromatic

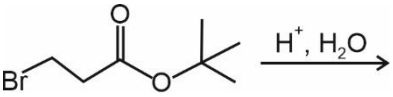
(ii)  $\Rightarrow$ 7 α-hydrogen

(iii) $CH_3\underset{n=1}{CH} = CH - CH = CH_2$ $\Rightarrow$ 2 geometrical isomers

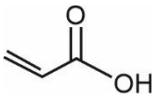
(iv)  , CF_3COOH, CH_3SO_3H

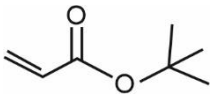
3 compounds are more acidic than CH_3COOH

24. The following reaction is performed and multiple products are observed.

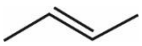


One of the products (X) can decolourize Br_2 water. The product (X) is

(a) 

(b) 

(c) 

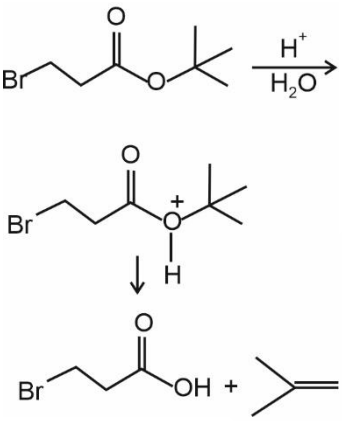
(d) 

Answer (c)

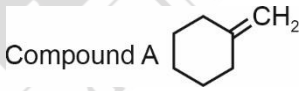
Sol.

Acid catalyzed alkyl bond cleavage

(AAL^1)



25. Compound A can be prepared from a suitable alkyl halide and appropriate reagent and conditions. The most appropriate combination of the requirements to give the highest yield is:



(a) 1-bromo-1-methylcyclohexane, CH_3O^-, CH_3OH

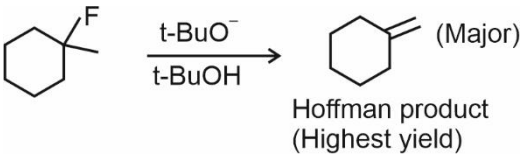
(b) 1-fluoro-1-methylcyclohexane, CH_3O^-, CH_3OH

(c) 1-bromo-1-methylcyclohexane, $(CH_3)_3CO^-$, $(CH_3)_3COH$

(d) 1-fluoro-1-methylcyclohexane, $(CH_3)_3CO^-$, $(CH_3)_3COH$

Answer (d)

Sol.



26. Among Ca, V, Cr and Mn, the second Ionization energy is the highest for

(a) V (b) Ca

(c) Cr (d) Mn

Answer (c)

Sol. IE_2 of Ca = 1145 kJ/mol

V = 1414 kJ/mol

Cr = 1592 kJ/mol

Mn = 1509 kJ/mol

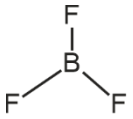
Cr has half filled *d*-orbital configuration and electron will be removed from *d*-orbital, hence highest 2^{nd} ionisation enthalpy.

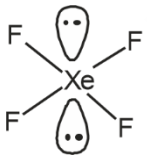
27. Among the given compounds, the permanent dipole moment is exhibited by

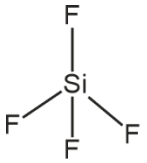
(a) BF_3 (b) XeF_4

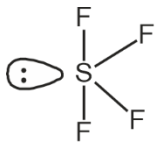
(c) SiF_4 (d) SF_4

Answer (d)

Sol. (a)  $\mu = 0$

(b)  $\mu = 0$

(c)  $\mu = 0$

(d)  $\mu \neq 0$

28. Choose the correct statement

(a) XeO_4 and XeO_2F_2 have tetrahedral geometry with no lone pairs

(b) XeO_2F_2 is trigonal planar with two oxygen atoms in the trigonal plane

(c) XeO_4 has square planar geometry with no lone pair of electrons

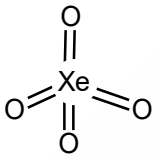
(d) XeO_2F_2 is distorted tetrahedral and XeO_4 is square planar

Answer (N/A)

Sol. (a) XeO_4

4σ bond + 4π bond + 0 lone pair on Xe

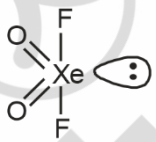
Hybridisation = sp^3 (Tetrahedral)



XeO_2F_2

4σ bond +1 lp + 2pi bond

Hybridisation = sp^3d (TBP)



$\Rightarrow$ Incorrect

None option is matching

29. $HClO_4$ is used in etching of liquid crystal displays whereas $H_2C_2O_4$ is present in vegetables like spinach which causes itching to throat. Consider the following statements for these compounds

(i) $HClO_4$ is a stronger acid than $H_2C_2O_4$

(ii) $HClO_4$ is a weaker acid than $H_2C_2O_4$

(iii) $H_2C_2O_4$ is reducing agent and $HClO_4$ is oxidizing agent

(iv) The conjugate base of $HClO_4$ is stronger than the conjugate base of $H_2C_2O_4$

The correct statements are

(a) (i) and (iii)

(b) (ii) and (iii)

(c) (ii) and (iv)

(d) (i) and (iv)

Answer (a)

Sol. (i) $HClO_4$ is more acidic than $H_2C_2O_4$

$\Rightarrow$ Correct

(ii) incorrect

(iii) In $H_2C_2O_4$, C is in +3 oxidation state, can behaves as reducing agent and in $HClO_4$, Cl is in maximum +7 oxidation state, can behaves as oxidising agent

$\Rightarrow$ Correct

(iv) Stronger the acid weaker is the conjugate base and vice versa

$\Rightarrow$ Incorrect

30. Compounds A, B, C and D are solid trihalides, all containing the same central atom. Compounds A, B, C are pale lilac (pale purple) in colour but compound D is dark green. Compound A is insoluble in water and alcohol but rest of the three are soluble in both the solvents.

The correct statement indicating the central atom and halides present in each of the compounds is

(a) Central atom is As, halides are F^-, Cl^-, Br^-, I^- respectively

(b) Central atom is Co, halides are F^-, Cl^-, Br^-, I^- respectively

(c) Central atom is Cr, halides are F^-, Cl^-, Br^-, I^- respectively

(d) Central atom is Nd, halides are F^-, Cl^-, Br^-, I^- respectively

Answer (d)

Sol. NdF_3, $NdCl_3$ and $NdBr_3$ are purple or pale lilac or violet colour

NdF_3 is insoluble in water and alcohol

$NdCl_3$, $NdBr_3$ and NdI_3 are soluble in water and alcohol

So correct answer is (d)

31. You are given a set of oxides: SrO, MoO_3 and ZrO_2. All the three show different reactions with water. Two of these oxides react with water whereas the third one is insoluble in water at room temperature (25-30ºC). The statement that is correct about these oxides is

(a) MoO_3 is insoluble in water, SrO gives a basic solution and ZrO_2 gives an acidic solution in water

(b) MoO_3 is insoluble in water, SrO gives an acidic solution and ZrO_2 gives a basic solution in water

(c) ZrO_2 is insoluble in water, SrO gives a basic solution and MoO_3 gives an acidic solution in water

(d) ZrO_2 is insoluble in water, MoO_3 gives a basic solution and SrO gives an acidic solution in water

Answer (c)

Sol. ZrO_2 is insoluble in water

MoO_3 is acidic

SrO is basic

32. The complex that shows maximum number of isomers is (where gly = glycine, PEt_3 = triethylphosphine)

(a) $[Pt(ox)(NH_3)_2]$

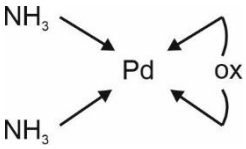
(b) $[Pd(PEt_3)_2BrCl]$

(c) $[Pd(gly)(ox)]$

(d) $[Pt(NH_3)(NO_2)(PEt_3)_2]^+$

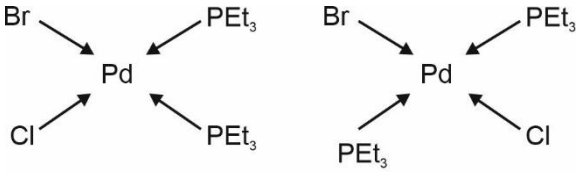
Answer (d)

Sol. $[Pt(ox)NH_3)_2]$ → square planar



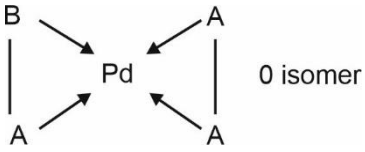
0 isomer

$[Pd(PEt_3)BrCl]$ → Square planar



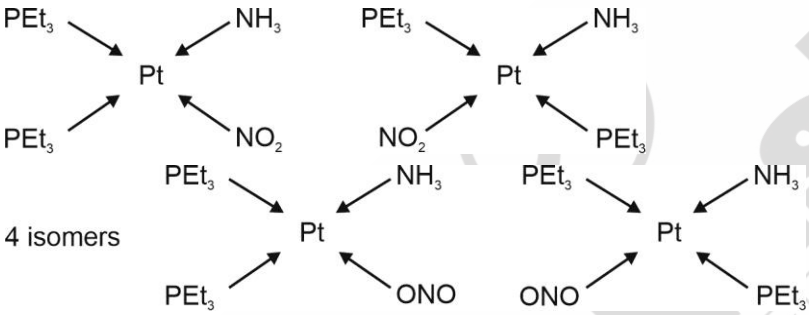
2 isomers

[Pd(gly)(ox)] ⇒ square planar of type [M(AB)(AA)]



0 isomer

$[Pt(NH_3)(NO_2)(PEt_3)_2]^+$



4 isomers

33. A sample(X) of MCl_2 was found to contain a small quantity of $M(OH)_2$ as an impurity, both of the compounds are soluble in water. In an experiment 30 g of the above sample (X) was dissolved in 60 mL of 0.4 M HCl to give solution (Y). 20 mL of 0.4 M NaOH was required to neutralise the excess HCl in solution(Y). The percentage of $M(OH)_2$ in sample(X) is:

Given: Molar mass of $M(OH)_2$ = 65 g mol^{-1}

(a) 1.7 (b) 3.5

(c) 0.17 (d) 0.35

Answer (a)

Sol. Let W be weight of $M(OH)_2$

Meq of $M(OH)_2$ + Meq of NaOH = Meq of HCl

$$\frac{W}{65}\times 1000\times 2+0.4\times 20=0.4\times 60$$

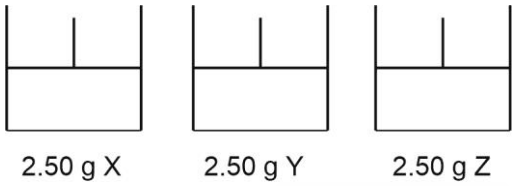
$$\frac{W}{65}\times 1000\times 2+8=24$$

$$W=\frac{16\times 65}{2000}=0.52\text{ g}$$

$$\%\text{ of } M(OH)_2=\frac{0.52}{30}\times 100=1.73$$

34. Consider three cylinders of capacity 2.24 L each fitted with piston. Each containing 2.50 g of an ideal gas (X, Y and Z) as specified below at 273 K. The pressure is not specified.

Given: Molar mass (in g mol^{-1}) as X = 40, Y = 80 and Z = 20.



The correct set of statement(s) is/are

(i) The number of molecules in each cylinder is the same.

(ii) The average velocity of the molecules in each cylinder is the same.

(iii) The pressure of gas Z is the highest.

(iv) If the pressure in each cylinder is adjusted to one atmosphere at constant temperature, the volume of the gas Z will increase and those of the other two will decrease.

(a) (i) and (ii) are correct

(b) (i) and (iii) are correct

(c) (ii) and (iv) are correct

(d) (iii) and (iv) are correct

Answer (d)

Sol. $n_X=\frac{2.5}{40}=0.0625$

$$n_Y=\frac{2.5}{80}=0.03125$$

$$n_Z=\frac{2.5}{20}=0.125$$

Number of molecules are different as moles are different

Average speed will not be same as number of molecules are different

$P \propto n \therefore$ Pressure of gas Z is highest

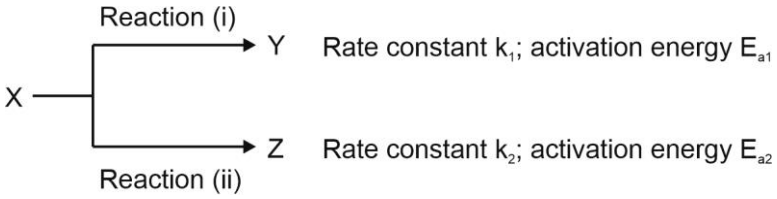
If P = 1 atm, T = 273 K

$$V_X=\frac{0.0625\times 0.0821\times 273}{1}=1.4\text{ L}$$

$$V_Y = \frac{0.03125 \times 0.0821 \times 273}{1} = 0.7\ L$$

$$V_Z = \frac{0.125 \times 0.0821 \times 273}{1} = 2.8\ L$$

35. Consider the following reactions (i) and (ii) occurring at 298 K, such that $E_{a2} = 3E_{a1}$ and the Arrhenius constant A has the same value for both the reactions. The relation between k_1 and k_2 is



(a) $k_1 = 3k_2 e^{E_{a2}/RT}$ (b) $k_1 = k_2 e^{2E_{a1}/RT}$

(c) $k_2 = k_1 e^{2E_{a1}/RT}$ (d) $k_2 = k_1 e^{3E_{a1}/RT}$

Answer (b)

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

$$k_1 = Ae^{-E_{a_1}/RT}$$

$$k_2 = Ae^{-3E_{a_1}/RT}$$

$$\frac{k_1}{k_2} = \frac{Ae^{-E_{a_1}/RT}}{Ae^{-3E_{a_1}/RT}} = e^{2E_{a_1}/RT}$$

$$k_1 = k_2 e^{2E_{a_1}/RT}$$

36. In the spacecrafts of NASA, the oxygen required for the astronauts is obtained from the following chemical reaction.

$$KClO_3(s) + Fe(s) \rightarrow O_2(g) + KCl(s) + FeO(s)$$

The requirement of O_2 per astronaut per day is 500 L as measured at 1 atm and 300 K. The minimum mass of $KClO_3$ (Molar mass of $KClO_3$ = 122.5 g mol^{-1}) needed for two astronauts to be in the spacecraft for ten days in a space mission is

(a) 49.8 kg (b) 426 g

(c) 213 g (d) 498.0 kg

Answer (a)

Sol. $n_{O_2} = n_{KClO_3}$ (from the balanced chemical reaction)

$$\text{Now, } n_{O_2} = \frac{500 \times 1}{0.0821 \times 300} \times 10 \times 2 = n_{KClO_3}$$

$$M_{KClO_3} = n_{KClO_3} \times 122.5 \simeq 49.8\ kg$$

37. When 15.0 g of steam at 373 K is passed in 250.0 g of $H_2O(l)$ in closed container at 298 K at constant pressure of 1 bar, then the correct statement, if this is isolated system, will be (Assume that the final state is liquid water)

(a) Both the volume and entropy will increase

(b) Both the volume and entropy will decrease

(c) The volume will increase and the entropy will decrease

(d) The volume will decrease and the entropy will increase

Answer (d)

Sol. Volume decreases as steam is gaseous and transferred to 250 g $H_2O(l)$.

Mixing of steam to liquid water is spontaneous, $\Delta S_{total} > 0$.

$\because$ It is isolated system, so entropy increases.

38. A certain quantity of a hydrocarbon fuel sample (C_xH_y) is burnt in excess $O_2(g)$ to ensure complete combustion. The combustion produced 11.93 g $CO_2(g)$, 2.19 g $H_2O(g)$, and 311 kJ of heat. Mass of the fuel burnt in this combustion is

(a) 3.493 g (b) 14.02 g

(c) 11.93 g (d) 3.250 g

Answer (a)

Sol. $C_xH_y + \left(x + \frac{y}{4}\right)O_2 \rightarrow xCO_2 + \frac{y}{2}H_2O + 311\,kJ$

Mass of C = $\frac{11.93}{44} \times 12 = 3.2536$ g

Mass of H = $\frac{2.19}{18} \times 2 \times 1 = 0.2433$ g

Mass of C_xH_y (using law of mass conservation) = 3.2536 + 0.2433 = 3.4969 g

39. Consider the given equilibrium reaction at 473 K

$Li_3N(s) + 2H_2(g) \rightleftharpoons LiNH_2(s) + 2LiH(s)$ $\Delta H_{rxn}^\circ = -200$ kJ/mol

The number of moles of $H_2(g)$ present at equilibrium can be maximised by

	Temperature	**Pressure**
(a)	increasing	increasing
(b)	increasing	decreasing
(c)	decreasing	increasing
(d)	decreasing	decreasing

Answer (b)

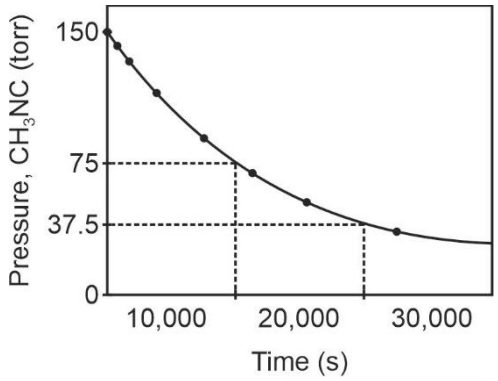
Sol. As 'P' decreases, equilibrium shifts backward.

$\Rightarrow$ n_{H_2} increases

As 'T' increases, equilibrium shifts backward.

$\Rightarrow$ n_{H_2} increases

40. The following concentration vs time plot represents the conversion of $CH_3NC(g)$ to $CH_3CN(g)$. Which of the following statements (I to IV) is/are true?



I. The reaction is of zero order

II. Unit of rate constant of this reaction is s^{-1}

III. Unit of rate constant of the reaction is torr s^{-1}

IV. Unit of rate of the reaction is torr s^{-1}

(a) I only (b) I, II

(c) III only (d) II, IV

Answer (d)

Sol. $\underset{(A)}{CH_3NC(g)} \rightarrow CH_3CN(g)$

$$\frac{-dA}{dt} = k[A]^n$$

If first order reaction, then

$$k = \frac{2.303}{t}\log\frac{A_0}{A}$$

$$\left.\begin{aligned} k_1 &= \frac{2.303}{10^4}\log\frac{150}{75} \\ k_2 &= \frac{2.303}{2\times10^4}\log\frac{150}{37.5} \end{aligned}\right] \; k_1 = k_2$$

So, it is first order reaction.

'k' has unit sec^{-1}.

$r = -\frac{dA}{dt} \Rightarrow r$ has unit torr/sec.

41. Consider the chemical reaction $A \rightarrow C + D$

The observations for kinetic study of the above unimolecular elementary reaction at 298 K are given in the table below:

Time (minute)	[A] (M)
0	0.35
10	0.035
t	0.00035

The value of time t (minute) is

(a) 20 (b) 30

(c) 40 (d) 35

Answer (b)

Sol. $A \rightarrow C + D$

The reaction is unimolecular, elementary and first order.

$$kt = \ln\frac{[A_o]}{[A_t]}$$

$$k \times 10 = \ln\frac{0.35}{0.035}$$

$\Rightarrow$ $k \times 10 = \ln 10$

$\therefore$ $k = \frac{\ln 10}{10} = 0.2303$

$\therefore$ $kt = \ln\frac{0.35}{0.00035}$

$\Rightarrow$ $0.2303t = 2.303 \log 10^3$

$t = \frac{2.303}{0.2303} \times 3 = 30$ min

t = 30 min

42. Propanoic acid (PA) is an organic acid. At 298 K, the pH of a 50.0 mL sample of 0.20 M of it is 3.0. The pH of solution formed by mixing 25.0 mL 0.2 M sodium propanoate solution with 25.0 mL 0.1 M propanoic acid will be:

(a) 3.3 (b) 5.3

(c) 5.6 (d) 6.3

Answer (c)

Sol. $\Rightarrow$ pH of 50 mL of 0.2M = 3.0

$\Rightarrow [H^+] = 10^{-3}$

$\Rightarrow [H^+] = \sqrt{C \cdot K_a} = 10^{-3}$

$\Rightarrow C \cdot K_a = 10^{-6}$

$\Rightarrow K_a = \frac{10^{-6}}{0.2} \Rightarrow 5 \times 10^{-6}$

$\left(\underset{CH_3CH_2COO^-Na^+}{25\text{ mL of }0.2M} + \underset{CH_3CH_2COOH}{25\text{ mL of }0.1M}\right)$

$pH = pK_a + \log\frac{[Salt]}{[Acid]}$

$= -\log(5 \times 10^{-6}) + \log\frac{0.1}{0.05}$

= 6 – log5 + log2

= 6 – 0.699 + 0.301

= 5.6

43. M is an alkaline earth metal. 1.0 M solution of MCl_2 is added dropwise to a solution that is 0.01 M each in fluoride, sulfite, and phosphate ions. The order of precipitation of corresponding salts is

Solid	Ksp
MSO_3	7×10^{-7}
MF_2	5×10^{-9}
$M_3(PO_4)_2$	1×10^{-25}

(a) $M_3(PO_4)_2$, MF_2, MSO_3 (b) $M_3(PO_4)_2$, MSO_3, MF_2

(c) MSO_3, MF_2, $M_3(PO_4)_2$ (d) MF_2, MSO_3, $M_3(PO_4)_2$

Answer (a)

Sol. To precipitate MSO_3, $[M^{2+}]$ needed will be

$[M^{2+}][SO_3^{2-}] = K_{sp}$

$[M^{2+}] = \frac{K_{sp}}{[SO_3^{2-}]}$

$[M^{2+}] = \frac{7 \times 10^{-7}}{10^{-2}}$

$[M^{2+}] = 7 \times 10^{-5}$ M

To precipitate MF_2, $[M^{2+}]$ required will be

$[M^{2+}][F^-]^2 = K_{sp}$

$$[M^{2+}] = \frac{K_{sp}}{[F^-]^2}$$

$$= \frac{5\times10^{-9}}{(10^{-2})^2} = 5\times10^{-5}\ M$$

To precipitate $M_3(PO_4)_2$, $[M^{2+}]$ needed will be

$$[M^{2+}]^3[PO_4^{3-}]^2 = K_{sp}$$

$$[M^{2+}]^3 = \frac{10^{-25}}{(10^{-2})^2} = 10^{-21}$$

$[M^{2+}] = 10^{-7}$

Order of precipitation according to $[M^{2+}]$ required $M_3(PO_4)_2$, MF_2, MSO_3

44. $CrCl_3.xNH_3$ can exist as an octahedral complex (P). 0.1 molal aqueous solution of this complex (P) shows a depression in freezing point of 0.558 °C. The molecular formula of the complex (P) is:
(Given K_f for water = 1.86 K Kg mol^{-1})
(Assuming 100% ionization of the complex)

(a) $[Cr(NH_3)_6]Cl_3$ (b) $[Cr(NH_3)_5Cl]Cl_2$

(c) $[Cr(NH_3)_4Cl_2]Cl$ (d) $[Cr(NH_3)_3Cl_3]$

Answer (b)

Sol. $\Delta T_f = iK_fm$

$0.558 = i \times 1.86 \times 0.1$

$$i = \frac{0.558}{0.186} = 3$$

$$\alpha = \frac{i-1}{n-1}$$

$$1 = \frac{3-1}{n-1}$$

$n - 1 = 2$

$n = 3$

(a) $[Cr(NH_3)_6]Cl_3 \xrightarrow{aq} \underset{n=4}{[Cr(NH_3)_6]^{3+}} + 3Cl^-$

(b) $[Cr(NH_3)_5Cl]Cl_2 \xrightarrow{aq} \underset{n=3}{[Cr(NH_3)_5Cl]^{2+}} + 2Cl^-$

(c) $[Cr(NH_3)_4Cl_2]Cl \xrightarrow{aq} \underset{n=2}{[Cr(NH_3)_4Cl_2]^{+}} + Cl^-$

(d) $[Cr(NH_3)_3Cl_3] \xrightarrow[n=1]{aq}$ no dissociation

45. Aspirin ($C_9H_8O_4$) is produced by the reaction between salicylic acid ($C_7H_6O_3$) and acetic anhydride ($C_4H_6O_3$) as per the reaction $C_7H_6O_3 + C_4H_6O_3 \rightarrow C_9H_8O_4 + C_2H_4O_2$

In the reaction of 155 g salicylic acid and 105 g acetic anhydride, assuming 80% conversion of the limiting reactant, the mass of aspirin formed is:

Given molar mass in g mol^{-1} salicylic acid = 138, acetic anhydride = 102 and aspirin = 180

(a) 148 g (b) 162 g

(c) 202 g (d) 184 g

Answer (a)

Sol. $\underset{155\text{ g}}{C_7H_6O_3} + \underset{105\text{ g}}{C_4H_6O_3} \rightarrow C_9H_8O_4 + C_2H_4O_2$

Moles of $C_7H_6O_3 = \frac{155}{138} = 1.123$

Moles of $C_4H_6O_3 = \frac{105}{102} = 1.029$

Limiting reagent is acetic anhydride

Moles of aspirin formed = moles of $C_4H_6O_3$

Mass of aspirin = 1.029 × 180 × 0.8 (80% yield)

= 148 g

46. A voltaic cell is constructed as shown below

$Ni(s)|Ni^{2+}(aq)||Ag^{+}(aq)|Ag(s)$

$E^{\circ}_{Ni^{2+}(aq)/Ni(s)} = -0.236$ V, $E^{\circ}_{Ag^{+}(aq)/Ag(s)} = 0.799$ V. The initial concentration of $Ag^{+}(aq)$ in the $Ag^{+}(aq)/Ag(s)$ half-cell is 0.005 M and the corresponding cell voltage is +0.95 V at 298 K. Identify the correct option from the following

(a) Initial $[Ni^{2+}](aq)$ = 0.019 M; it will increase with time

(b) Initial $[Ni^{2+}](aq)$ = 0.120 M; it will increase with time

(c) Initial $[Ni^{2+}](aq)$ = 0.019 M; it will decrease with time

(d) Initial $[Ni^{2+}](aq)$ = 0.120 M; it will decrease with time

Answer (a)

Sol.

$$\begin{array}{rcl} Ni(s) & \rightarrow & Ni^{2+}(aq) + 2e^{-} \\ 2Ag^{+}(aq) + 2e^{-} & \rightarrow & 2Ag(s) \\ \hline Ni(s) + 2\,Ag^{+}(aq) & \rightarrow & Ni^{2+}(aq) + 2Ag(s) \end{array}$$

$$Q = \frac{[Ni^{2+}]}{[Ag^{+}]^2}$$

$E°_{cell} = 0.799 - (-0.236) = 1.035$ V

$$E_{cell} = E°_{cell} - \frac{0.059}{n}\log\frac{[Ni^{2+}]}{[Ag^{+}]^2}$$

$$0.95 = 1.035 - \frac{0.059}{2}\log\frac{[Ni^{2+}]}{[0.005]^2}$$

$$\frac{0.059}{2}\log\frac{[Ni^{2+}]}{[Ag^{+}]^2} = 1.035 - 0.95$$

$$\log\frac{[Ni^{2+}]}{[0.005]^2} = \frac{0.085 \times 2}{0.059}$$

$$\log\frac{[Ni^{2+}]}{[0.005]^2} = 2.88$$

$$\frac{[Ni^{2+}]}{[0.005]^2} \approx 758.6$$

$[Ni^{2+}] \approx 0.019$ M

$[Ni^{2+}]$ increases with time

47. The photon with the longest wavelength required for the electronic transition in an atom of hydrogen is:

(a) $n = 1 \rightarrow n = 3$

(b) $n = 2 \rightarrow n = 6$

(c) $n = 3 \rightarrow n = 1$

(d) $n = 1 \rightarrow n = 6$

Answer (b)

Sol. λ_{max} refers to $(\Delta E)_{min.}$

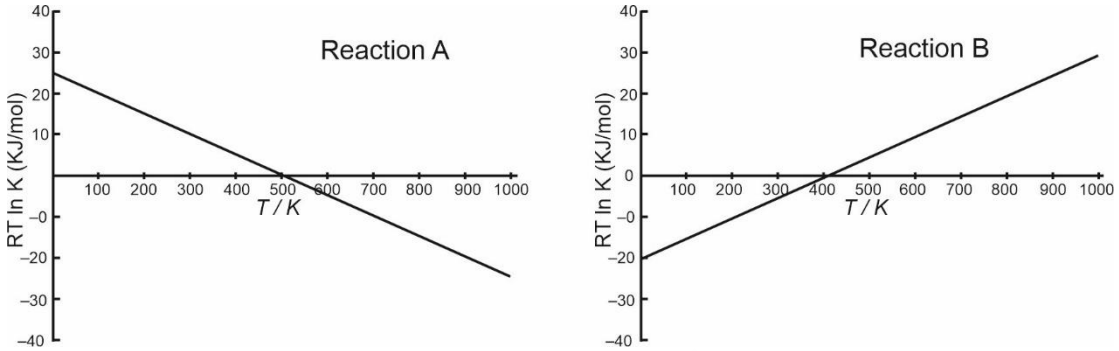
(a) $|\Delta E| = |E_1| - |E_3| = 13.6 - 1.5 = 12.1$ eV

(b) $|\Delta E| = |E_2| - |E_6| = 3.4 - 0.37 = 3.03$ eV

(c) In transition $3 \rightarrow 1$ energy is released

(d) $|\Delta E| = |E_1| - |E_6| = 13.6 - 0.37 = 13.23$ eV

48. Consider two reactions A and B for which the variation of RT In K with temperature is given in the plots below. If the enthalpy change for the reactions are –25 kJ/mol and 20 kJ/mol, respectively for A and B, the correct statement is :



(a) The equilibrium constant for Reaction B decreases as temperature increases

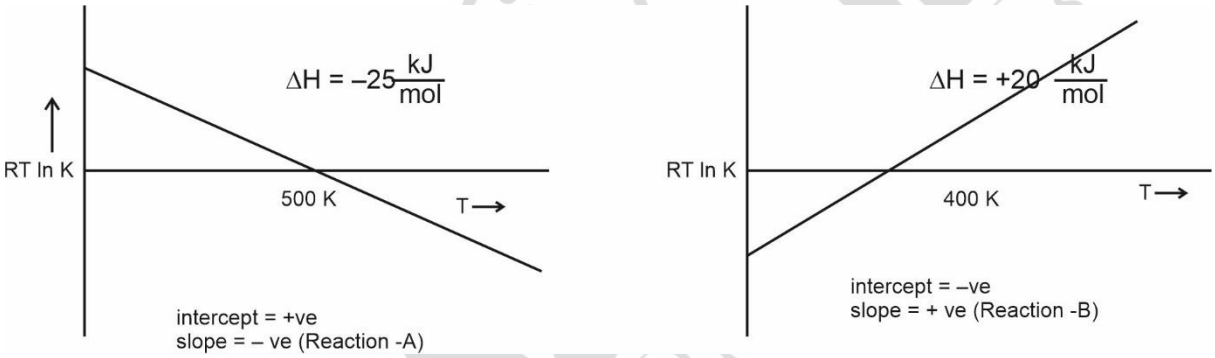
(b) The entropy change for Reaction A is 50 kJ/mol

(c) Reaction A remains spontaneous only at temperatures less than 500 K

(d) At 400 K, reaction B changes from exothermic to endothermic reaction

Answer (c)

Sol.



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

$-RT\ln K = \Delta H - T\Delta S$

$RT\ln K = -\Delta H + T\Delta S$

Intercept = $-\Delta H$

Slope = ΔS

For reaction A, below 500K, RTlnK is +ve,

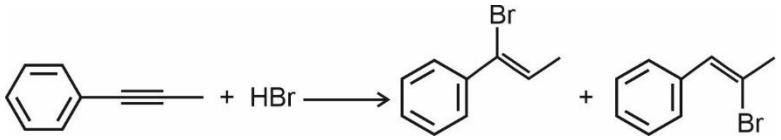
So ΔG = –ve

A – 2

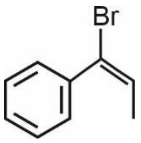
ANY NUMBER OF OPTIONS (4, 3, 2 or 1) MAY BE CORRECT

MARKS WILL BE AWARDED ONLY IF ALL THE CORRECT OPTIONS ARE BUBBLED AND NO INCORRECT

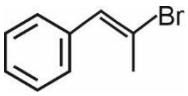
49. The following reaction was performed.



However, on investigation it was discovered that there were additional product(s) in the reaction mixture. The additional product(s) is/are

(a) 

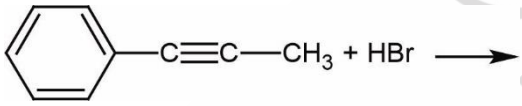
(b) a vicinal dibromide

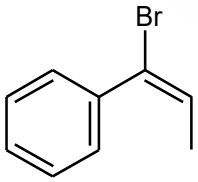
(c) 

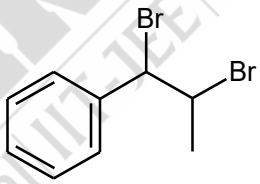
(d) a geminal dibromide

Answer (a, b, c, d)

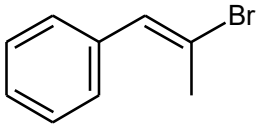
Sol. The products formed in the following reaction are

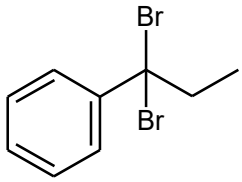


(a) 

(b) 

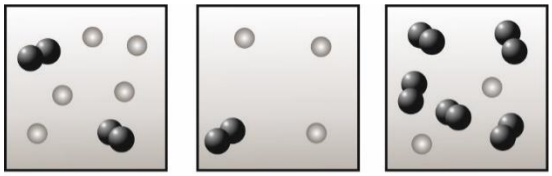
Vicinal dibromide

(c) 

(d) 

Geminal dibromide

50. Three different gaseous mixtures (i), (ii) and (iii) of helium and nitrogen are placed in boxes of equal volume as shown below :



The true statement(s) from the following is/are

(a) Box (ii) has the lowest pressure

(b) Box (ii) has the lowest partial pressure of helium

(c) Box (ii) has the lowest density

(d) Pressure of box (iii) is less than pressure of box (i)

Answer (a, c)

Sol. Box (i) has 2 molecules of N_2 and 5 molecules of He

Box (ii) has 1 molecule of N_2 and 3 molecules of He

Box (iii) has 5 molecules of N_2 and 2 molecules of He

$\therefore$ Box (ii) has the lowest pressure, and Box (ii) has the lowest density

51. Identify the isotonic solution(s) from the following mixtures of aqueous solutions at 298 K. (Assume complete dissociation of the electrolytes in water)

(a) 100 mL 0.5 M glucose solution and 110 mL 0.2 M $CuSO_4$ solution

(b) 200 mL 0.5 M acetamide solution and 300 mL. 0.1 M NaCl solution

(c) 400 mL 0.1 M $BaCl_2$ solution and 100 mL. 0.2 M KCl solution

(d) 200 mL 0.13 M $CaCl_2$ solution and 200 mL 0.125 M HCl solution

Answer (b, c, d)

Sol. (a) m moles of Glucose = 50

m moles of Cu^{2+} ions and SO_4^{2-} ions = 44

Effective concentration of mixture = $\frac{94}{210}$ = 0.4476 M

(b) m moles of acetamide = 100

m moles of Na^+ ions and Cl^- ions = 60

Effective concentration of mixture= $\frac{160}{500}$ = 0.32 M

(c) m moles of Ba^{2+} ions and Cl^- ions = 120

m moles of K^+ ions and Cl^- ions = 40

Effective concentration of mixture = $\frac{160}{500}$ = 0.32 M

(d) m moles of Ca^{2+} ions and Cl^- ions = 78

m moles of H^+ ions and Cl^- ions = 50

Effective concentration of mixture = $\frac{128}{400}$ = 0.32 M

$\therefore$ mixtures (b), (c) and (d) are isotonic

52. Alkyl lithium compounds are of interest in organic synthesis as efficient alkylating agents. Consider the following two reactions

(i) $C_4H_9Li + C_6H_6 \rightarrow C_6H_5Li + C_4H_{10}$

(ii) $C_5H_5Li + C_6H_6 \rightarrow C_6H_5Li + C_5H_6$

The CORRECT statement(s) for the above two reactions is/are

(a) Reaction (i) will proceed because the more acidic hydrocarbon will react with the Li-derivative of less acidic hydrocarbon to liberate less acidic hydrocarbon

(b) Reaction (ii) will proceed because the less acidic hydrocarbon will react with the Li-derivative of more acidic hydrocarbon to liberate more acidic hydrocarbon

(c) Both the reactions will proceed because the more acidic hydrocarbon will act with the Li-derivative of more acidic hydrocarbon to liberate less acidic hydrocarbon

(d) Both the reactions proceed because the less acidic hydrocarbon will react with the Li-derivative of more acidic hydrocarbon to liberate less acidic hydrocarbon

Answer (a)

Sol. Out of the two given reactions, only reaction (i) will proceed.

(i) $C_4H_9Li + C_6H_6 \rightarrow C_6H_5Li + C_4H_{10}$

In this reaction more acidic hydrocarbon (C_6H_6) will react with Li derivative of less acidic C_4H_{10} to liberate less acidic hydrocarbon (C_4H_{10}).

Reaction (ii) will not proceed as it involves conversion of less acidic hydrocarbon (C_6H_6) to more acidic hydrocarbon (C_5H_6)

53. A mixture gave light yellow precipitate with silver nitrate which did not dissolve completely with ammonia solution. It gave positive chromyl chloride test. When organic layer test was performed with addition of excess of concentrated nitric acid, a violet coloured organic layer first formed which then changed to orange colour. Brown ring test was positive but brown coloured gas was not intensified on heating the mixture with copper turnings and concentrated sulphuric acid. Which of the anions were present?

(a) Chloride, bromide, iodide

(b) Chloride, nitrate, iodide

(c) Fluoride, nitrate, bromide

(d) Chloride, iodide, nitrite

Answer (a, d)

Sol. The mixture is likely to contain Cl^- ions, Br^- ions and I^- ions as confirmed by the following test.

With $AgNO_3$: $Br^- + AgNO_3 \rightarrow \underset{\text{(light yellow)}}{AgBr} \downarrow + NO_3^-$

AgBr is partially soluble in aqueous ammonia solution.

Chromyl chloride test:

$$Cr_2O_7^{2-} + 6H^+ + 4Cl^- \rightarrow \underset{\text{(Red)}}{CrO_2Cl_2(g)} + 3H_2O$$

Organic layer test:

$$6I^- + 2HNO_3 + 6H^+ \rightarrow \underset{\text{(violet)}}{3I_2} + 2NO + 4H_2O$$

The mixture is also likely to contains Cl^- ions, I^- ions and NO_2^-.

The presence of NO_2^- ions is confirmed by brown ring test.

$$NO_2^- + H^+ \rightarrow HNO_2$$

$$3HNO_2 \rightarrow 2NO + HNO_3 + H_2O$$

$$FeSO_4 + 5H_2O + NO \rightarrow \underset{\text{(Brown ring)}}{[Fe(H_2O)_5NO]SO_4}$$

Presence of NO_3^- ions is ruled out as brown colour gas is not intensified on addition of copper turnings.

54. Consider the following half-cell reactions

$$H^+_{(aq)} + e^- \rightleftharpoons 1/2H_{2(g)} \quad E^o = 0.00\,V$$

$$V^{3+}_{(aq)} + e^- \rightleftharpoons V^{2+}_{(aq)} \quad E^o = -0.255\,V$$

$$VO^{2+} + e^- + 2H^+ \rightleftharpoons V^{3+}_{(aq)} + H_2O_{(l)} \quad E^o = +0.337\,V$$

$$1/2O_{2(g)} + 2e^- + 2H^+ \rightleftharpoons H_2O_{(l)} \quad E^o = +1.23\,V$$

Using above equations, the correct statement(s) is/are

(a) Oxidation of $V^{2+}_{(aq)}$ to $V^{3+}_{(aq)}$ by H^+ is a spontaneous reaction

(b) Oxidation of $V^{3+}_{(aq)}$ to $V^{4+}_{(aq)}$ by H^+ is a nonspontaneous reaction

(c) H^+ is a better oxidizing agent than O_2.

(d) O_2 will be able to oxidize $V^{2+}_{(aq)}$ to $V^{3+}_{(aq)}$

Answer (a, b, d)

Sol. (i) $H^+_{(aq)} + e^- \rightarrow \frac{1}{2} H_2(g)$ $E° = 0.00$ V

(ii) $V^{3+}_{(aq)} + e \rightarrow V^{2+}_{(aq)}$ $E° = -0.255$ V

(iii) $VO^{2+}_{(aq)} + e^- + 2H^+_{(aq)} \rightarrow V^{3+}_{(aq)} + H_2O$ (l) $E° = 0.337$ V

(iv) $\frac{1}{2} O_2(g) + 2e^- + 2H^+_{(aq)} \rightarrow H_2O$ (l) $E° = +1.23$ V

Subtracting (ii) from (i)

$H^+(aq) + V^{2+}(aq) \rightarrow \frac{1}{2} H_2(g) + V^{3+}(aq)$ $\quad E^\circ_{cell} = +0.255$ V

$\therefore$ Oxidation of $V^{2+}(aq)$ to $V^{3+}(aq)$ by H^+ is a spontaneous reaction.

Since E°_{cell} of reaction (iii) is +ve, reduction of VO^{2+} to V^{3+} by H^+ is spontaneous and the reverse reaction will be non spontaneous.

O_2 will be better oxidising agent than H^+ because it's SRP is higher than that of H^+.

Subtracting 2(ii) from (iv)

$$\frac{1}{2}O_2 + 2V^{2+} + 2H^+_{(aq)} \rightarrow 2V^{3+}_{(aq)} + H_2O_{(l)} \quad E^\circ_{cell} = +1.485 \text{ V}$$

$\therefore$ $O_2(g)$ will oxidise $V^{2+}(aq)$ to $V^{3+}(aq)$

55. The suitable combinations of physico-chemical methods that can be used to assign the correct formula to the compound $CoCl_3.4NH_3$ are

(a) Addition of Ag^+ ions

(b) Electrical conductance of aqueous solution

(c) Depression in freezing point

(d) Thermal decomposition of the complex under controlled conditions

Answer (a, b, c, d)

Sol. The correct formula to the compound $CoCl_3 \cdot 4NH_3$ can be assigned by any one of the following methods:

(i) Addition of Ag^+ ion will result in precipitation of AgCl for all the chloride ions present in the ionisation sphere

(ii) Electrical conductance of aqueous solutions will give an idea of the charge on complex ion and other free ions in solutions.

(iii) Depression in freezing point will provide an information on extent of ionisation of the complex

(iv) Thermal decomposition of the complex under controlled conditions will provide information on total number of dissociated species.

56. Two open beakers A and B are kept inside a sealed box. Initially, beaker A contains 30 mL of 0.050 M glucose solution and beaker B contains 30 mL of 0.035 M fructose solution. Enough time was given to ensure that the water vapour in the system is in equilibrium. Under the equilibrium conditions, Assume density of solution to be 1 gm/cm^3

(a) Volume of solution in A decreased to 25 mL

(b) Volume of solution in B decreased to 25 mL

(c) Volume of solution in A increased to 35 mL

(d) Volume of solution in B increased to 35 mL

Answer (b, c)

Sol. Let x ml of water vapours condense in beaker (A)

$\therefore$ Final volume of solution in beaker (A) = (30 + x) mL

Final volume of solution in beaker (B) = (30 – x) mL

At equilibrium, conc. of both the solutions will be same

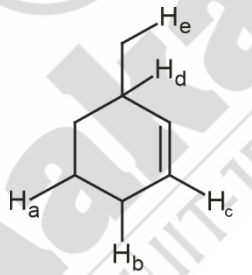
$$\therefore \quad \frac{1.5}{30+x} = \frac{1.05}{30-x}$$

On solving, x = 5.29 mL

$\therefore$ Volume of solution in (A) increased to 35 mL (approx.)

Volume of solution in (B) decreased to 25 mL (approx.)

57. Given below is the structure of a compound X. Identify the correct statement(s) from below.



(X)

(a) Compound X has two vinylic protons, and two allylic protons

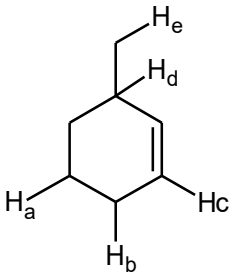
(b) Compound X (9.6 gram) will react with excess of bromine to give a dibromide (25.6 gram)

(c) The carbon radical that generated by cleavage of C-H_d bond will be more stable than that generated by cleavage of C-H_b bond

(d) Compound X on ozonolysis followed by treatment with Zn/H_2O will give a dial

Answer (b, c, d)

Sol. Compound (X) has two vinylic and three allylic protons



(X)

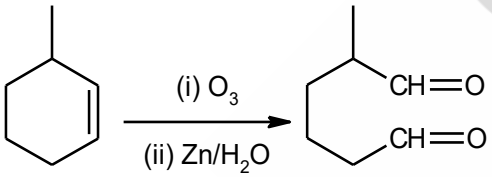
Mass of (X) = 9.6 g

Number of moles of (X) = $\frac{9.6}{96} = 0.1$

Number of moles of dibromide of (X) = 0.1

Mass of dibromide of (X) = 0.1 × 256 = 25.6 g

The allyl radical formed by cleavage of C–H_d bond will be stabilised by resonance and 5 hyperconjugative structures whereas the allyl radical formed by cleavage of C–H_b bond will be stabilised by resonance and 2 hyperconjugative structures. So former will be more stable than the latter.



Dial

58. Which of the following statement(s) is/are incorrect for sugars?

(a) If a disaccharide is dextrorotatory, it means both its monosaccharides will also be essentially dextrorotatory.

(b) The designations (+) and (–) can also be referred to as D- and L- respectively

(c) The predominant hemiacetal form of glucose is formed by bond formation between C_1 and C_6

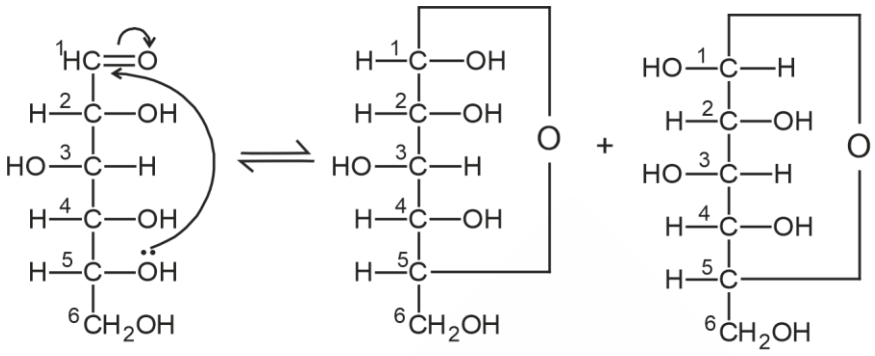
(d) All nucleic acids contain 2-deoxy-D-ribose as the aldopentose

Answer (a, b, c, d)

Sol. (a) If a disaccharide is dextrorotatory, it does not imply that both its monosaccharides are essentially dextrorotatory. For example, sucrose is dextrorotatory but its monosaccharides, glucose and fructose are dextrorotatory and laevorotatory respectively.

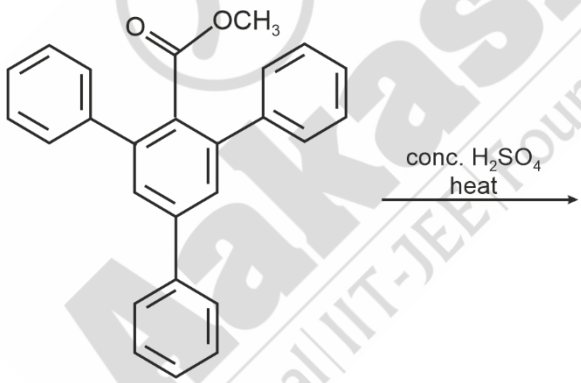
(b) The designations (+) and (–) refer to the direction of rotation of the plane of plane polarised light to the right and left respectively. They do not refer to D- and L-configurations.

(c) The predominant hemiacetal form of glucose is formed by bond formation between C_1 and C_5 but not C_6



(d) Only DNA contains 2-deoxy-D-ribose.

59. When the following reaction was performed, the product obtained gave a bright orange red precipitate with 2, 4-dinitrophenylhydrazine and does not react with saturated solution of $NaHCO_3$.



This implies :

(a) hydrolysis has taken place

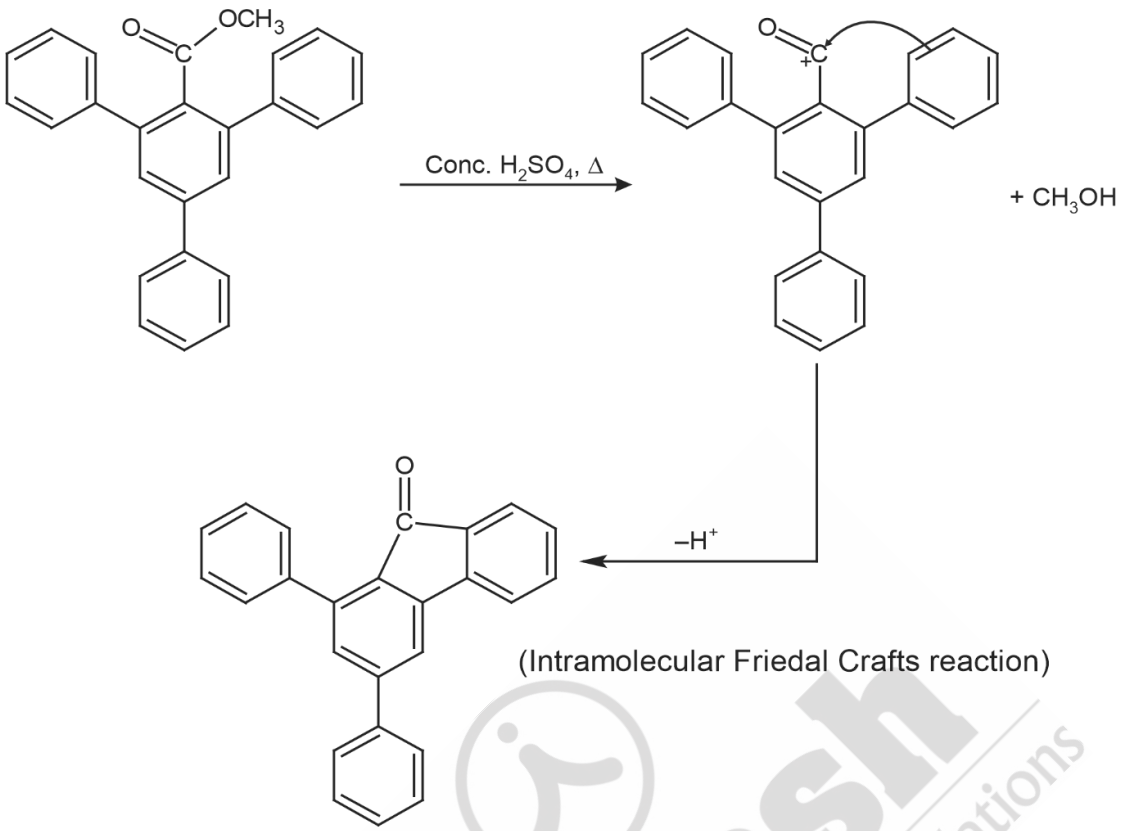
(b) intramolecular Friedal Crafts reaction has been favoured

(c) intermolecular Friedal Crafts reaction has taken place

(d) the product has a carbonyl functional group

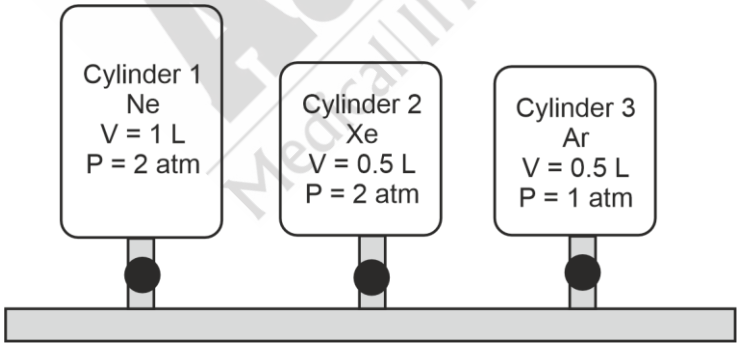
Answer (b, d)

Sol.



First step is acid catalysed hydrolysis of ester. Second step is acid catalysed intramolecular Friedal Crafts acylation reaction. Final product is a ketone which gives orange red precipitate with 2, 4-DNP.

60. Three cylinders connected with valves are shown in the diagram. All the cylinders are at same temperature. Which of the following statement(s) is/are true once the valves are opened and the system is allowed to reach equilibrium?



NOTE : Volume of connecting tubes may be neglected.

(a) Total pressure of the system will be 1.75 atm

(b) The partial pressure of Ne in cylinder 1 will be higher than that in cylinder 2 and 3

(c) The correct order of partial pressures will be p(Ne) > p(Xe) > p(Ar)

(d) Number of moles of gas in cylinder 2 will be lower than its initial value.

Answer (a, c, d)

Sol. No. of moles of Ne in Cylinder (1) = $\frac{2\times1}{RT}=\frac{2}{RT}$

No. of moles of Xe in cylinder (2) = $\frac{2\times0.5}{RT}=\frac{1}{RT}$

No. of moles of Ar in cylinder (3) = $\frac{1\times0.5}{RT}=\frac{0.5}{RT}$

Total number of moles = $\frac{3.5}{RT}$

Total pressure of the system = $\frac{1}{2}\times\frac{3.5}{RT}\times RT$ = 1.75 atm

Partial pressure of Ne will be same in all the three cylinders.

Partial pressure of the gases will be directly proportional to the number of moles of these gases.

Number of moles of gas in cylinder (2) after mixing will be $\frac{1.75\times0.5}{RT}=\frac{0.875}{RT}$ which is lower than its initial value.

❑ ❑ ❑