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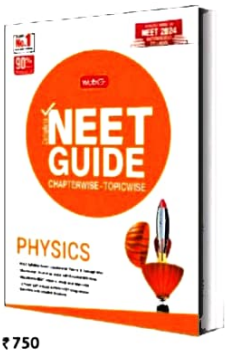

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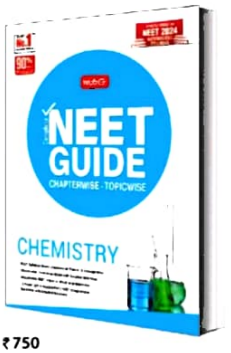

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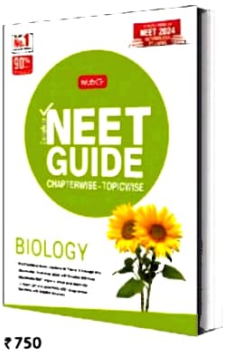

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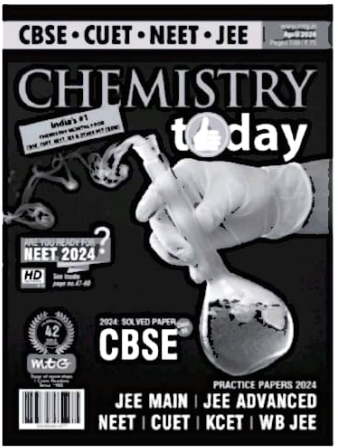

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Managing Editor
Mahabir Singh

Editor
Anil Ahlawat

Corporate Office:
Plot 99, Sector 44 Institutional area, Gurugram -122 003 (HR).
Tel : 0124-6601200 e-mail : info@mtg.in website : www.mtg.in

Regd. Office:
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Contents

Practice Paper NEET 2024

Exam on 5th May

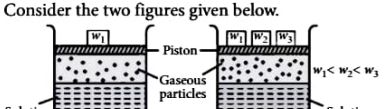
SECTION - A

1. An alcohol (*A*) gives Lucas test within 5 minutes. 7.4 g of alcohol when treated with sodium metal liberates 1120 mL of H_2 at STP. What will be alcohol (*A*)?
   (a) $CH_3(CH_2)_3OH$
   (b) $CH_3CH(OH)CH_2CH_3$
   (c) $(CH_3)_3COH$
   (d) $CH_3CH(OH)CH_2CH_2CH_3$

2. Propanoic acid undergoes HVZ reaction to give chloropropanoic acid. The product obtained is
   (a) stronger acid than propanoic acid
   (b) as stronger as propanoic acid
   (c) weaker acid than propanoic acid
   (d) stronger than dichloropropanoic acid.

3. A compound contains 21.9% magnesium, 27.8% phosphorus and 50.3% oxygen. What will be the simplest formula of the compound?
   (a) $Mg_2P_2O_7$ (b) $MgPO_3$
   (c) $Mg_2P_2O_2$ (d) MgP_2O_4

4. Consider the two figures given below.



   Which of the following statements regarding the experiment is true?
   (a) The solubility of a gas in liquid in beaker (i) is greater than that in beaker (ii).
   (b) The solubility of a gas in beaker (i) is less than that in beaker (ii).
   (c) The solubility of a gas is equal in both beakers.
   (d) The solubility of a gas remains unaffected by change in weights.

5. The electrode potential of standard hydrogen electrode is assumed to be
   (a) negative (b) zero
   (c) positive (d) fractional.

6. Which of the statements about solutions of electrolytes is not correct?
   (a) Conductivity of solution depends upon size of ions.
   (b) Conductivity depends upon viscosity of solution.
   (c) Conductivity does not depend upon solvation of ions present in solution.
   (d) Conductivity of solution increases with temperature.

7. Among the elements with atomic numbers 9, 12, 16 and 36 which is highly electropositive ?
   (a) Element with atomic number 9
   (b) Element with atomic number 12
   (c) Element with atomic number 16
   (d) Element with atomic number 36

8. For a reaction $P + Q \rightarrow 3R + S$. Which of the following statements is incorrect?
   (a) Rate of disappearance of P = Rate of appearance of S
   (b) Rate of disappearance of Q = 2 × Rate of appearance of R
   (c) Rate of disappearance of P = Rate of disappearance of Q
   (d) Rate of disappearance of $Q = \frac{1}{3} \times$ Rate of appearance of R

9. After understanding the assertion and reason, choose the correct option.
Assertion : In the bonding molecular orbital (MO) of H_2, electron density is increased between the nuclei.
Reason : The bonding MO is $\psi_A + \psi_B$, which shows destructive interference of the combining electron waves.
(a) Assertion and reason are correct and reason is the correct explanation for the assertion.
(b) Assertion and reason are correct, but reason is not the correct explanation for the assertion.
(c) Assertion is correct, reason is incorrect.
(d) Assertion is incorrect, reason is correct

10. The IUPAC name of $[Co(NH_3)_4Cl(NO_2)]Cl$ is
(a) tetraaminechloridonitrito-N-cobalt(III) chloride
(b) tetraaminechloridonitriocobalt(II) chloride
(c) tetraaminechloridonitriocobalt(I) chloride
(d) tetraaminechloridonitrocobalt(III) chloride.

11. If ΔH is the heat of reaction at constant pressure, ΔU is the heat of reaction at constant volume and Δn is the difference in number of moles of gaseous products and reactants, then the relation between them is
(a) $\Delta U = \Delta H + \Delta nRT$ (b) $\Delta H = \Delta U + \Delta nRT$
(c) $\frac{\Delta H}{\Delta U} = \Delta nRT$ (d) $\frac{\Delta U}{\Delta H} = \Delta nRT$

12. Actinoids in general show more oxidation states than the lanthanoids. The main reason for this is
(a) higher energy difference between 5*f* and 6*d* orbitals than between 4*f* and 5*d* orbitals
(b) lower energy difference between 5*f* and 6*d* orbitals than between 4*f* and 5*d* orbitals
(c) higher reactivity of actinoids than lanthanoids
(d) actinoids are more basic than lanthanoids.

13. What will be the solubility of AgCl in 0.05 M NaCl aqueous solution if solubility product of AgCl is 1.5×10^{-10}?
(a) 3×10^{-9} mol L^{-1} (b) 0.05 mol L^{-1}
(c) 1.5×10^{-5} mol L^{-1} (d) 3×10^{9} mol L^{-1}

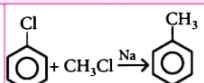
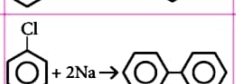
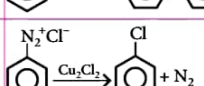
14. Mark the incorrect statement.
(a) The chemical reactions of H_2SO_4 are as a result of its ability to act as an oxidising agent.
(b) Dilution of oleum with water gives H_2SO_4.
(c) The key step in the manufacture of H_2SO_4, is the catalytic reduction of SO_2.
(d) H_2SO_4, because of its low volatility can be used to manufacture more volatile acids from their corresponding salts.

15. 2.5 moles of hydrazine, N_2H_4 loses 25 moles of electrons to form a new compound *X*. Assuming that all of the nitrogen appears in the new compound, what is the oxidation state of nitrogen in compound *X*?
(a) –1 (b) –2 (c) +3 (d) +4

16. Given below are two statements :
Statement-I : In the titration between strong acid and weak base methyl orange is suitable as an indicator.
Statement-II : For titration of acetic acid with NaOH phenolphthalein is not a suitable indicator.
In the light of the above statements, choose the most appropriate answer from the options given below:
(a) Statement-I is false but statement-II is true.
(b) Both statement I and statement-II are true.
(c) Both statement I and statement-II are false.
(d) Statement-I is true but statement-II is false.

17. Distillation under reduced pressure is generally used to purify those liquids which
(a) have very low boiling points
(b) are volatile
(c) have high boiling points and which decompose below their boiling points
(d) have a large difference in their boiling points.

18. Match List I with List II.

List I		List II	
A.		I.	Fittig reaction
B.		II.	Wurtz-Fittig reaction
C.		III.	Finkelstein reaction
D.	$C_2H_5Cl + NaI \longrightarrow C_2H_5I + NaCl$	IV.	Sandmeyer reaction

Choose the correct answer from the options given below:

(a) A → III; B → II; C → IV; D → I
(b) A → II; B → I; C → IV; D → III
(c) A → IV; B → II; C → III; D → I
(d) A → II; B → I; C → III; D → IV

19. An alkene *X* is obtained by dehydration of an alcohol *Y*. *X* on ozonolysis gives two molecules of ethanal for every molecule of alkene. *X* and *Y* are
(a) *X* = 3-hexene, *Y* = 3-hexanol
(b) *X* = 2-butene, *Y* = 2-butanol
(c) *X* = 1-butene, *Y* = 1-butanol
(d) *X* = 1-hexane, *Y* = 1-hexanol.

20. Secondary structure of protein refers to
(a) mainly denatured proteins and structure of prosthetic groups
(b) three-dimensional structure, especially the bond between amino acid residues that are distant from each other in the polypeptide chain
(c) linear sequence of amino acid residues in the polypeptide chain
(d) regular folding patterns of continuous portions of the polypeptide chain.

21. The stability of +1 oxidation state among Al, Ga, In and Tl increases in the sequence
(a) Al < Ga < In < Tl (b) Tl < In < Ga < Al
(c) In < Tl < Ga < Al (d) Ga < In < Al < Tl

22. Given below are two statements : one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : Experimental reaction of CH_3Cl with aniline and anhydrous $AlCl_3$ does not give *o*- and *p*-methylaniline.
Reason (R) : The $-NH_2$ group of aniline becomes deactivating because of salt formation with anhydrous $AlCl_3$ and hence yields *m*-methyl aniline as the product.
In the light of the above statements, choose the most appropriate answer from the options given below:
(a) Both (A) and (R) are true and (R) is the correct explanation of (A).
(b) Both (A) and (R) are true but (R) is not the correct explanation of (A).
(c) (A) is true, but (R) is false.
(d) (A) is false, but (R) is true.

23. In both DNA and RNA, heterocyclic base and phosphate ester linkages are at
(a) C_5' and C_2' respectively of the sugar molecule
(b) C_2' and C_5' respectively of the sugar molecule
(c) C_1' and C_5' respectively of the sugar molecule
(d) C_5' and C_1' respectively of the sugar molecule.

24. Carboxylic acids are more acidic than phenol and alcohol because of
(a) intermolecular hydrogen bonding
(b) formation of dimers
(c) highly acidic hydrogen
(d) resonance stabilization of their conjugate base.

25. Aniline can be converted into benzylamine by which of the following processes in sequence?
(a) $NaNO_2$ + HCl, CuCN, H_2/Ni
(b) Br_2/CCl_4, KCN, $LiAlH_4$
(c) HNO_2, $K_2Cr_2O_7/H^+$, Sn + HCl
(d) CH_3OH, $KMnO_4$, OH^-, H_3O^+

26. What is the energy of activation of a reaction if its rate doubles when the temperature is raised from 290 K to 300 K?
(a) 12 kcal (b) 41 kcal
(c) 13.8 kcal (d) 52 kcal

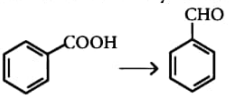
27. A solution containing a group-IV cation gives a precipitate on passing H_2S. A solution of this precipitate in dil. HCl produces a white precipitate with NaOH solution and bluish white precipitate with basic potassium ferrocyanide. The cation is
(a) Co^{2+} (b) Ni^{2+} (c) Zn^{2+} (d) Mn^{2+}

28. Which of the following is wrong regarding fuel cells?
(a) They are light mass.
(b) They are efficient.
(c) They cause no pollution.
(d) They cannot work continuously.

29. Name of the structure of silicates in which three oxygen atoms of $[SiO_4]^{4-}$ are shared is
(a) pyrosilicate (b) sheet silicate
(c) linear chain silicate
(d) three dimensional silicate.

30. Salicylic acid on heating with sodalime forms
(a) phenol (b) benzyl alcohol
(c) benzene (d) benzoic acid.

31. The reagent, from the following, which converts benzoic acid to benzaldehyde in one step is



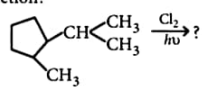
(a) $LiAlH_4$ (b) $KMnO_4$
(c) MnO (d) $NaBH_4$

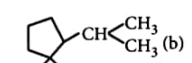
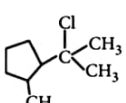
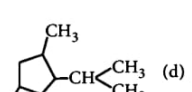
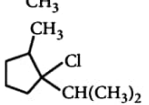
32. Reaction of thionyl chloride with white phosphorus forms a compound [A], which on hydrolysis gives [B], a dibasic acid. [A] and [B] are respectively
(a) P_4O_6 and H_3PO_3 (b) PCl_5 and H_3PO_4
(c) PCl_3 and H_3PO_3 (d) $POCl_3$ and H_3PO_4

33. $B \xleftarrow[HI]{Cold} (CH_3)_3C{-}OCH_3 \xrightarrow[Excess\ HI]{Hot} A$
(a) A is the mixture of $(CH_3)_3C{-}OH$ and $CH_3{-}I$
B is the mixture of $(CH_3)_3C{-}I$ and $CH_3{-}OH$
(b) A is the mixture of $(CH_3)_3$ C—I and $CH_3{-}I$
B is the mixture of $(CH_3)_3C{-}I$ and $CH_3{-}OH$
(c) A and B are identical mixtures of CH_3I and $(CH_3)_3C{-}OH$
(d) None of these

34. When but-2-yne is treated with Na in liquid ammonia
(a) *cis*-2-butene is obtained
(b) *trans*-2-butene is formed
(c) *n*-butane is the major product
(d) it rearranges to but-1-yne.

35. Which of these compounds represents the major monochlorination isomer formed in the following reaction?

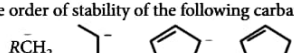


(a) 
(b) 
(c) 
(d) 

SECTION - B

Attempt any 10 questions out of 15.

36. The order of stability of the following carbanions is



I II III IV
(a) I > II > III > IV (b) I > III > II > IV
(c) IV > III > II > I (d) III > IV > I > II

37. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : $[CoCl(NH_3)_5]^{2+}$ absorbs at lower wavelength of light with respect to $[Co(NH_3)_5(H_2O)]^{3+}$.
Reason (R) : The wavelength of the light absorbed depends on the oxidation state of the metal ion.
In the light of the above statements, choose the correct answer from the options given below :
(a) A is false but R is true.
(b) Both A and R are true but R is not the correct explanation of A.
(c) Both A and R are true and R is the correct explanation of A.
(d) A is true but R is false.

38. In the redox reaction,
$MnO_4^- + 8H^+ + 5Br^- \rightarrow Mn^{2+} + 4H_2O + \frac{5}{2}Br_2$
which one is the reducing agent?
(a) H^+ (b) MnO_4^- (c) Br^- (d) Mn^{2+}

39. In which of the following pairs, the outermost electronic configuration will be the same?
(a) Cr^+ and Mn^{2+} (b) Ni^{2+} and Cu^+
(c) V^{2+} and Cr^+ (d) Fe^{2+} and Co^+

40. At temperature T, a compound $AB_{2(g)}$ dissociates according to the reaction, $2AB_{2(g)} \rightleftharpoons 2AB_{(g)} + B_{2(g)}$ with a degree of dissociation x, which is small compared with unity. The expression for K_p, in terms of x and the total pressure, P is
(a) $\frac{Px^3}{2}$ (b) $\frac{Px^2}{3}$ (c) $\frac{Px^3}{3}$ (d) $\frac{Px^2}{2}$

41. In a first order reaction, 75% of the reactants disappeared in 1.386 hours. What is the rate constant ?
(a) 3.6×10^{-3} sec^{-1} (b) 2.7×10^{-4} sec^{-1}
(c) 72×10^{-3} sec^{-1} (d) 1.8×10^{-3} sec^{-1}

42. Identify the correct statement regarding a spontaneous process.
(a) Lowering of energy in the reaction process is the only criterion for spontaneity.
(b) For a spontaneous process in an isolated system, the change in entropy is positive.
(c) Endothermic processes are never spontaneous.
(d) Exothermic processes are always spontaneous.

43. Specific conductance of 0.1 M nitric acid is 6.3×10^{-2} ohm^{-1} cm^{-1}. The molar conductance of the solution is
(a) 630 ohm^{-1} cm^2 mol^{-1}
(b) 315 ohm^{-1} cm^2 mol^{-1}
(c) 6.300 ohm^{-1} cm^2 mol^{-1}
(d) 63.0 ohm^{-1} cm^2 mol^{-1}

44. The bond order of N_2^+ on the basis of molecular orbital theory is [At. number of N = 7]
(a) 3 (b) 2.5 (c) 2 (d) 1.5

45. Benzoic acid is dissolved in benzene, the value of van't Hoff factor will be
(a) less than 1 (b) equal to 1
(c) more than 1 (d) zero.

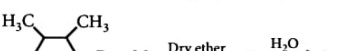
46. The species Ar, K^+ and Ca^{2+} contain the same number of electrons. In which order do their radii increase?
(a) $Ca^{2+} < K^+ < Ar$ (b) $K^+ < Ar < Ca^{2+}$
(c) $Ar < K^+ < Ca^{2+}$ (d) $Ca^{2+} < Ar < K^+$

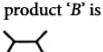
47. Match List I with List II.

List I (Test)	List II (Functional group/Class of Compound)
A. Molisch's Test	I. Peptide
B. Biuret Test	II. Carbohydrate
C. Carbylamine Test	III. Primary amine
D. Schiff's Test	IV. Aldehyde

Choose the correct answer from the options given below:
(a) (A)–III, (B)–IV, (C)–II, (D)–I
(b) (A)–II, (B)–I, (C)–III, (D)–IV
(c) (A)–III, (B)–IV, (C)–I, (D)–II
(d) (A)–I, (B)–II, (C)–III, (D)–IV

48. The wave number of first line of Balmer series of hydrogen is 15200 cm^{-1}. The wave number of the first Balmer line of Li^{2+} ion is
(a) 15200 cm^{-1} (b) 60800 cm^{-1}
(c) 76000 cm^{-1} (d) 136800 cm^{-1}

49. 

The product '*B*' is
(a) 

(b) 

(c) 

(d) 

50. The amount of sugar($C_{12}H_{22}O_{11}$) required to prepare 2 L of its 0.1 M aqueous solution is
(a) 136.8 g (b) 34.2 g
(c) 68.4 g (d) 17.1 g

SOLUTIONS

1. **(b):** $ROH + Na \longrightarrow RONa + 1/2\ H_2\uparrow$
We have to get molecular mass of alcohol corresponding to half mole of H_2 only.
$$\frac{1120}{11200} = \frac{7.4}{M} \Rightarrow M = 74$$
$C_nH_{2n+1}OH = 74 \longrightarrow C_nH_{2n+1} = 74 - 17 = 57$
$\Rightarrow C_nH_{2n} = 57 - 1 = 56$ *i.e.*, $12n + 2n = 56$
$\Rightarrow n = 56/14 = 4$
Thus molecular formula of (*A*) is C_4H_9OH. As (*A*) gives Lucas test within 5 min., thus 2° alcohol corresponding to molecular formula C_4H_9OH is $CH_3CH(OH)CH_2CH_3$ (butan-2-ol).

2. **(a)**

3. **(a):**

Element	Percentage	Molar ratio	Relative ratio	Whole no. ratio
Mg	21.9	21.9/24 = 0.91	1	2
P	27.8	27.8/31 = 0.90	1	2
O	50.3	50.3/16 = 3.14	3.48	7

Formula of the compound = $Mg_2P_2O_7$

4. **(b):** The solubility of gas in a liquid increases with increase in pressure and is directly proportional to the pressure of the gas.

5. **(b):** $E°$ for SHE has been assumed to be zero.

6. **(c):** Conductivity depends upon solvation of ions present in solution. Greater the solvation of ions, lesser is the conductivity.

7. **(b)**

8. **(b):** Rate of disappearance of $Q = \frac{1}{3} \times$ rate of appearance of *R*

9. **(c):** Bonding molecular orbital involves constructive interference.

10. **(a)**

11. **(b):** $\Delta H = \Delta U + P\Delta V$
But $P\Delta V = \Delta nRT$ at constant temperature for gases.

12. **(b):** Due to lesser energy gap between 5*f* and 6*d*-orbitals, a large number of oxidation states are shown by actinoids.

13. **(a):** $K_{sp} = [Ag^+]\,[Cl^-]$; $[Cl^-] = NaCl = 0.05$ M
$$[Ag^+] = \frac{1.5\times10^{-10}}{0.05} = 3\times10^{-9}\ M$$
$[Ag^+]$ = solubility = 3×10^{-9} M

14. (c) : The key step in the formation of sulphuric acid is catalytic oxidation of sulphur dioxide to sulphur trioxide with atmospheric oxygen.

15. (c) : Let the oxidation no. of N in new compound X be x.

$\overset{-2}{N_2}H_4 \longrightarrow \overset{+x}{2N} + ne^-$

Suppose no. of electron lost per mole = n

$\therefore \quad 2(-2) = 2x + n(-1)$ or $n = 2x + 4 = 2(x + 2)$

No. of electrons lost per mole = $2(x + 2)$

No. of electrons lost by 2.5 mole = $2.5 \times 2\,(2 + x)$

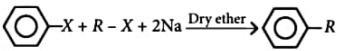
Now, $2.5 \times 2(2 + x) = 25$

$5(2 + x) = 25$ or $2 + x = 5$ or $x = +3$

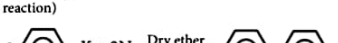
16. (d)

17. (c) : Compounds which decompose below their boiling points or which have very high boiling points are distilled under reduced pressure.

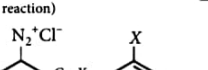
18. (b) :

(A) 

(Wurtz-Fittig reaction)

(B) 

(Fittig reaction)

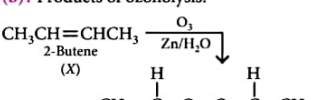
(C) 

(Sandmeyer reaction)

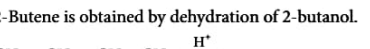
(D) $C_2H_5Cl + NaI \longrightarrow C_2H_5I + NaCl$

(Finkelstein reaction)

19. (b) : Products of ozonolysis:



2-Butene is obtained by dehydration of 2-butanol.



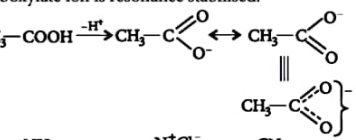
20. (d) : Secondary structure of protein refers to regular folding patterns of continuous portions of the polypeptide chain.

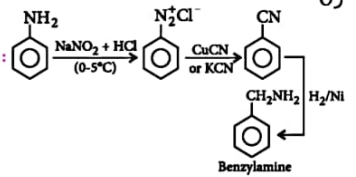
21. (a) : In group 13 elements, stability of +3 oxidation state decreases down the group while that of +1 oxidation state increases due to inert pair effect.

Hence, stability of +1 oxidation state increases in the sequence : Al < Ga < In < Tl.

22. (c) **23. (c)**

24. (d) : Conjugate base of carboxylic acids *i.e.* carboxylate ion is resonance stabilised.



25. (a) : 

Benzylamine

26. (a) : $\log \frac{k_2}{k_1} = \frac{E_a}{2.303R}\left[\frac{T_2 - T_1}{T_1 T_2}\right]$

$\log 2 = \frac{E_a}{2.303 \times 2}\left[\frac{300 - 290}{290 \times 300}\right]$

($k_2 = 2\,k_1$, $R = 2$ cal/K/mole)

$E_a = 12062$ calories ≈ 12 kcal.

27. (c) : $Zn^{2+} + H_2S \longrightarrow ZnS \xrightarrow{\text{dil. HCl}} ZnCl_2$

$ZnCl_2 \xrightarrow{NaOH} Zn(OH)_2$ (white ppt.)

$ZnCl_2 \xrightarrow{K_4[Fe(CN)_6]} Zn_2[Fe(CN)_6]$ (Bluish white ppt.)

28. (d)

29. (b) : When three oxygen atoms of each $[SiO_4]^{4-}$ are shared, it results in a two dimensional sheet structure.

30. (a) : 

Salicylic acid — Phenol

31. (c)

32. (c) : White phosphorus reacts with thionyl chloride to form PCl_3 :

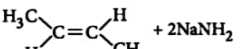
$P_4 + 8SOCl_2 \longrightarrow \underset{[A]}{4PCl_3} + 4SO_2 + 2S_2Cl_2$

PCl_3 hydrolyses in presence of moisture :

$PCl_3 + 3H_2O \longrightarrow \underset{[B]}{H_3PO_3} + 3HCl$

33. (b): When one of the alkyl group is a tertiary group, the halide formed is a tertiary halide. When HI is in excess and the reaction is carried out at high temperature, the alcohol formed reacts with another molecule of HI and is converted to corresponding alkyl iodide.

34. (b): $CH_3-\underset{\text{But-2-yne}}{C\equiv C-CH_3} + 2Na \xrightarrow{\text{liq. } NH_3}$



$+ 2NaNH_2$

trans-2-butene

35. (b): 3° radicals are more stable.

36. (d): III and IV are resonance stabilized as negative charge is in conjugation with double bond, also 1° carbanion is more stable than 2° carbanion.

37. (a): Co in +3 oxidation state will absorb greater energy at lower wavelength as compared to Co in +2 oxidation state.

38. (c): Increase in oxidation number (reducing agent)

$\overset{+7}{MnO_4^-} + 8H^+ + 5\overset{-1}{Br^-} \rightarrow \overset{+2}{Mn} + 4H_2O + \frac{5}{2}\overset{0}{Br_2}$

Decrease in oxidation number (oxidising agent)

39. (a)

40. (a):

	$2AB_{2(g)}$	$\rightleftharpoons$	$2AB_{(g)}$	+	$B_{2(g)}$
Initially	1		0		0
At equilibrium	$(1-x)$		x		$x/2$

Total no. of moles $= (1-x)+x+\frac{x}{2}=1+\frac{x}{2}=\frac{2+x}{2}$

Partial pressure = Mole fraction × total pressure

Applying, $K_p = \frac{p_{AB}^2 \times p_{B_2}}{p_{AB_2}^2}$

$$= \frac{\left(\frac{x}{\frac{2+x}{2}}\times P\right)^2 \times \left(\frac{\frac{x}{2}}{\frac{2+x}{2}}\times P\right)}{\left(\frac{1-x}{\frac{2+x}{2}}\times P\right)^2} = \frac{Px^3}{(2+x)(1-x)^2}$$

Since $x << 1$ so $(1-x)^2$ can be neglected and $(2+x)$ can be taken as 2.

$\therefore \quad K_p = \frac{Px^3}{2}$

41. (b): $k = \frac{2.303}{1.386\times 60\times 60}\log\frac{100}{100-75}$

$$= \frac{2.303}{1.386\times 3600}\log 4 = 2.7\times 10^{-4}\ \text{sec}^{-1}$$

(Time 1.386 hours need to be changed to seconds)

42. (b)

43. (a): Applying $\Lambda_m = \kappa \times \frac{1000}{\text{Molarity}}$

$= 6.3\times 10^{-2}\times\frac{1000}{0.1} = 630\ \text{ohm}^{-1}\ \text{cm}^2\ \text{mol}^{-1}$

44. (b): $N_2^+(13): \sigma 1s^2\sigma^*1s^2\sigma 2s^2\sigma^*2s^2\pi 2p_x^2 = \pi 2p_y^2\sigma 2p_z^1$

Bond order $= \frac{N_b - N_a}{2} = \frac{9-4}{2} = \frac{5}{2} = 2.5$

45. (a)

46. (a): In case of isoelectronic species, radius decreases with increase in nuclear charge.

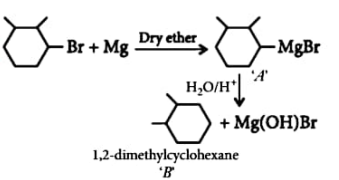
47. (b):

Molisch's test	–	Carbohydrate (A–II)
Biuret test	–	Peptide (B–I)
Carbylamine test	–	Primary amine (C–III)
Schiff's test	–	Aldehyde (D–IV)

48. (d): Applying $\bar{\upsilon} = R\left[\frac{1}{n_1^2}-\frac{1}{n_2^2}\right]Z^2$

$\bar{\upsilon}_{Li^{2+}} = \bar{\upsilon}_H \times 3^2 = 15200\times 9 = 136800\ \text{cm}^{-1}$

49. (d):



1,2-dimethylcyclohexane
'B'

50. (c): We know, $M = \frac{\text{wt.}}{\text{Mol. wt.}}\times\frac{1}{V(L)}$

$0.1 = \frac{m}{342}\times\frac{1}{2} \Rightarrow m = 342\times 2\times 0.1 = 68.4\ \text{g}$

Quotable Quote

"Chance favours only the prepared mind."

Louis Pasteur

PRACTICE PAPER

JEE Main

2024

Exam Dates
Session-2
Between 4th April and 15th April 2024

SECTION-A (MULTIPLE CHOICE QUESTIONS)

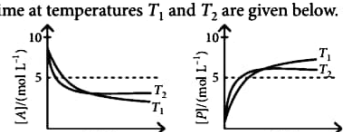
1. For per gram of reactant, the maximum quantity of N_2 gas is produced in which of the following thermal decomposition reactions?
(Given : Atomic wt. Cr = 52 u, Ba = 137 u)
(a) $2NH_4NO_{3(s)} \rightarrow 2N_{2(g)} + 4H_2O_{(g)} + O_{2(g)}$
(b) $Ba(N_3)_{2(s)} \rightarrow Ba_{(s)} + 3N_{2(g)}$
(c) $(NH_4)_2Cr_2O_{7(s)} \rightarrow N_{2(g)} + 4H_2O_{(g)} + Cr_2O_{3(s)}$
(d) $2NH_{3(g)} \rightarrow N_{2(g)} + 3H_{2(g)}$

2. Identify the correct statement.
(a) Quantum numbers (*n, l, m, s*) are obtained arbitrarily.
(b) All the quantum numbers (*n, l, m, s*) for any pair of electrons in an atom can be identical under special circumstance.
(c) All the quantum numbers (*n, l, m, s*) may not be required to describe an electron of an atom completely.
(d) All the quantum numbers (*n, l, m, s*) are required to describe an electron of an atom completely.

3. Given below are two statements : One is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : Metallic character decreases and non-metallic character increases on moving from left to right in a period.
Reason (R) : It is due to increase in ionisation enthalpy and decrease in electron gain enthalpy, when one moves from left to right in a period.
In the light of the above statements, choose the most appropriate answer from the options given below.
(a) Assertion is false but reason is true.
(b) Both assertion and reason are correct and reason is the correct explanation of assertion.
(c) Both assertion and reason are correct but reason is not the correct explanation of assertion.
(d) Assertion is true but reason is false.

4. A piston filled with 0.04 mol of an ideal gas expands reversibly from 50.0 mL to 375 mL at a constant temperature of 37.0°C. As it does so, it absorbs 208 J of heat. The values of q and w for the process will be (R = 8.314 J/mol K) (ln 7.5 = 2.01)
(a) q = + 208 J, w = 208 J
(b) q = + 208 J, w = – 208 J
(c) q = – 208 J, w = – 208 J
(d) q = – 208 J, w = + 208 J

5. For a reaction, $A \rightleftharpoons P$, the plots of [A] and [P] with time at temperatures T_1 and T_2 are given below.



If $T_2 > T_1$, the correct statement is
(Assume $\Delta H°$ and $\Delta S°$ are independent of temperature and ratio of ln$K$ at T_1 to ln$K$ at T_2 is greater than T_2/T_1. Here H, S, G and K are enthalpy, entropy, Gibbs energy and equilibrium constant, respectively.)
I. $\Delta H° < 0, \Delta S° < 0$
II. $\Delta G° < 0, \Delta H° > 0$
III. $\Delta G° < 0, \Delta S° < 0$
IV. $\Delta G° < 0, \Delta S° > 0$
(a) I, II
(b) III, IV
(c) I, III
(d) II, IV

6. Which of the following options are correct for the reaction

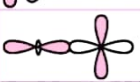
$2[Au(CN)_2]^-_{(aq)} + Zn_{(s)} \longrightarrow 2Au_{(s)} + [Zn(CN)_4]^{2-}_{(aq)}$

(A) Redox reaction
(B) Displacement reaction
(C) Decomposition reaction
(D) Combination reaction

Choose the correct answer from the options given below :

(a) A and B only (b) A only
(c) A and D only (d) C and D only

7. Match the orbital overlap figures shown in List-I with the description given in List-II and select the correct answer using the code given below the lists.

List I		List II
P.		1. *p* - *d* π anti-bonding
Q.		2. *d* - *d* σ bonding
R.		3. *p* - *d* π bonding
S.		4. *d* - *d* σ anti-bonding

Code :

	P	Q	R	S
(a)	2	1	3	4
(b)	4	3	1	2
(c)	2	3	1	4
(d)	4	1	3	2

8. Match the items in column I with its main use listed in column II.

Column I		Column II	
(A)	Silica gel	(i)	Transistor
(B)	Silicon	(ii)	Ion-exchanger
(C)	Silicone	(iii)	Drying agent
(D)	Silicate	(iv)	Sealant

(a) (A) – (iii), (B) – (i), (C) – (iv), (D) – (ii)
(b) (A) – (iv), (B) – (i), (C) – (ii), (D) – (iii)
(c) (A) – (ii), (B) – (i), (C) – (iv), (D) – (iii)
(d) (A) – (ii), (B) – (iv), (C) – (i), (D) – (iii)

9. Given below are two statements : One is labelled as Assertion A and the other is labelled as Reason R.

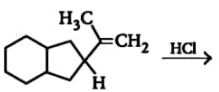
Assertion A : Thin layer chromatography is an adsorption chromatography.

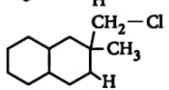
Reason R : A thin layer of silica gel is spread over a glass plate of suitable size in thin layer chromatography which acts as an adsorbent.

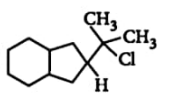
In the light of the above statements, choose the correct answer from the options given below.

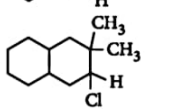
(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true but R is not the correct explanation of A.
(c) A is true but R is false.
(d) A is false but R is true.

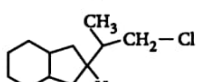
10. The major product of the following reaction is



(a) 

(b) 

(c) 

(d) 

11. Given the equilibrium constant K_c of the reaction : $Cu_{(s)} + 2Ag^+_{(aq)} \rightarrow Cu^{2+}_{(aq)} + 2Ag_{(s)}$ is 10×10^{15}, calculate the E°_{cell} of this reaction at 298 K.

$\left[2.303\frac{RT}{F} \text{ at } 298 \text{ K} = 0.059 \text{ V}\right]$

(a) 0.0472 V (b) 0.472 V
(c) 0.472 mV (d) 0.0472 mV

12. The decreasing order of electrical conductivity of the following aqueous solution is
0.1 M formic acid (*A*), 0.1 M acetic acid (*B*),
0.1 M benzoic acid (*C*)

(a) $C > A > B$ (b) $A > C > B$
(c) $A > B > C$ (d) $C > B > A$

13. From the following data for the reaction between *A* and *B*,

	[*A*] mol L^{-1}	[*B*] mol L^{-1}	Initial rate mol L^{-1} s^{-1}
I	2.5×10^{-4}	3.0×10^{-5}	5.0×10^{-4}
II	5.0×10^{-4}	6.0×10^{-5}	4.0×10^{-3}
III	1.0×10^{-3}	6.0×10^{-5}	1.6×10^{-2}

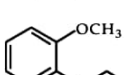
the order of reaction with respect to *A* is 2 and with respect to *B* is 1.
Using the value of activation energy 55.3 kJ mol^{-1}, calculate the pre-exponential factor.
Given $T = 27°C$.
(a) 2.280×10^{18} (b) 1.131×10^{18}
(c) 2.280×10^{15} (d) 1.140×10^{15}

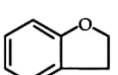
14. In aqueous solution, Cr^{2+} is stronger reducing agent than Fe^{2+}. This is because
(a) Cr^{2+} ion is more stable than Fe^{2+}
(b) Cr^{3+} ion with d^3 configuration has favourable crystal field stabilisation energy
(c) Cr^{3+} has half-filled configuration and hence more stable
(d) Fe^{3+} in aqueous solution is more stable than Cr^{3+}

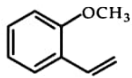
15. The pair having the same magnetic moment is
[At. No.: Cr = 24, Mn = 25, Fe = 26, Co = 27]
(a) $[Cr(H_2O)_6]^{2+}$ and $[CoCl_4]^{2-}$
(b) $[Cr(H_2O)_6]^{2+}$ and $[Fe(H_2O)_6]^{2+}$
(c) $[Mn(H_2O)_6]^{2+}$ and $[Cr(H_2O)_6]^{2+}$
(d) $[CoCl_4]^{2-}$ and $[Fe(H_2O)_6]^{2+}$

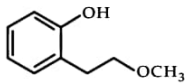
16. The correct combination is
(a) $[Ni(CN)_4]^{2-}$ – tetrahedral; $[Ni(CO)_4]$ – paramagnetic
(b) $[NiCl_4]^{2-}$ – paramagnetic; $[Ni(CO)_4]$ – tetrahedral
(c) $[NiCl_4]^{2-}$ – diamagnetic; $[Ni(CO)_4]$ – square-planar
(d) $[NiCl_4]^{2-}$ – square-planar; $[Ni(CN)_4]^{2-}$ – paramagnetic

17. The major product of the following reaction is

(a) 

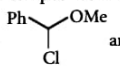
(b) 

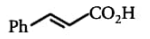
(c) 

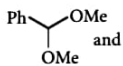
(d) 

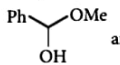
18. Benzaldehyde + Methanol $\xrightarrow[HCl]{dry} A$

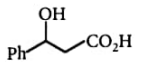
$\xrightarrow[2.\ (CH_3CO)_2O + CH_3COONa]{1.\ dil.\ HCl} B$

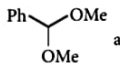
The compounds *A* and *B* above are respectively
(a) 

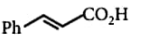
and 

(b) 

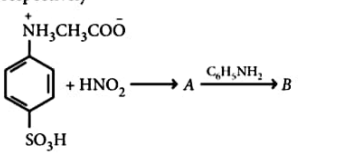
and $PhCOCH_3$
(c) 

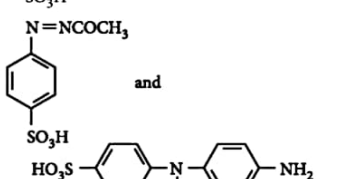
and 

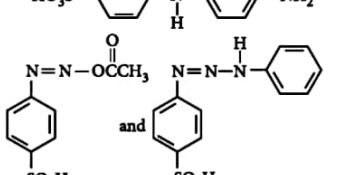
(d) 

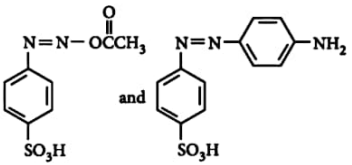
and 

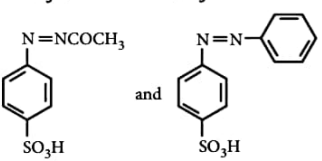
19. Products *A* and *B* formed in the following reactions are respectively



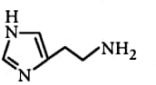
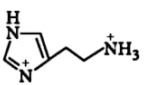
(a) 

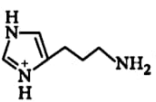
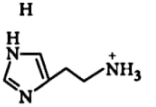
(b) 

(c)  and

(d)  and

20. The predominant form of histamine present in human blood is (pK_a, Histidine = 6.0)

(a)  (b) 

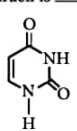
(c)  (d) 

SECTION-B (NUMERICAL TYPE QUESTIONS)

Attempt any 5 questions out of 10.

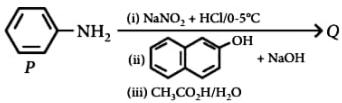
21. Consider the sulphides HgS, PbS, CuS, Sb_2S_3, As_2S_3 and CdS. Number of these sulphides soluble in 50% HNO_3 is _____.

22. A Uracil is a base present in RNA with the following structure. % of N in uracil is _____.



Given : Molar mass N = 14 g mol^{-1}
O = 16 mol^{-1}
C = 12 g mol^{-1}
H = 1 g mol^{-1}

23. Consider the reaction sequence from *P* to *Q* shown below. The overall yield of the major product *Q* from *P* is 75%. What is the amount in grams of *Q* obtained from 9.3 mL of *P*?
(Use density of *P* = 1.00 g mL^{-1}; Molar mass of C = 12.0, H =1.0, O =16.0 and N = 14.0 g mol^{-1})



24. Among the following, the number of compounds that can react with PCl_5 to give $POCl_3$ is
O_2, CO_2, SO_2, H_2O, H_2SO_4, P_4O_{10}

25. The reaction of sulphur in alkaline medium is given below
$S_{8(s)} + a\ OH^-_{(aq)} \longrightarrow b\ S^{2-}_{(aq)} + c\ S_2O^{2-}_{3(aq)} + d\ H_2O_{(l)}$
The value of '*a*' is _____. (Integer answer)

26. The mole fraction of urea in an aqueous urea solution containing 900 g of water is 0.05. If the density of the solution is 1.2 g cm^{-3}, the molarity of urea solution is _____.
(Given data : Molar masses of urea and water are 60 g mol^{-1} and 18 g mol^{-1}, respectively.)

27. The dihedral angle in staggered form of Newman projection of 1, 1, 1-trichloro ethane is _____ degree.

28. 50 mL of 0.1 M CH_3COOH is being titrated against 0.1 M NaOH. When 25 mL of NaOH has been added, the pH of the solution will be _____ $\times 10^{-2}$. (Nearest integer) (Given : pK_a (CH_3COOH) = 4.76)
log2 = 0.30, log3 = 0.48, log5 = 0.69
log7 = 0.84, log11 = 1.04

29. Electromagnetic radiation of wavelength 663 nm is just sufficient to ionise the atom of metal *A*. The ionization energy of metal *A* in kJ mol^{-1} is _____. (Rounded-off to the nearest integer)
[$h = 6.63 \times 10^{-34}$ Js, $c = 3.00 \times 10^8$ ms^{-1}, $N_A = 6.02 \times 10^{23}$ mol^{-1}]

30. To measure the quantity of $MnCl_2$ dissolved in an aqueous solution, it was completely converted to $KMnO_4$ using the reaction,
$MnCl_2 + K_2S_2O_8 + H_2O \rightarrow KMnO_4 + H_2SO_4 + HCl$ (equation not balanced)
Few drops of concentrated HCl were added to this solution and gently warmed. Further, oxalic acid (225 mg) was added in portions till the colour of the permanganate ion disappeared. The quantity of $MnCl_2$ (in mg) present in the initial solution is _____.
(Atomic weights in g mol^{-1}: Mn = 55, Cl = 35.5)

SOLUTIONS

1. (d): (a) $2NH_4NO_{3(s)} \longrightarrow 2N_{2(g)} + 4H_2O_{(g)} + O_{2(g)}$

Mol. mass = 80 g mol^{-1} ; Mol. mass = 28 g mol^{-1}

2×80 g of NH_4NO_3 gives 2×28 g of N_2

$\therefore$ 1 g of NH_4NO_3 will give $\frac{28}{80} \times 1 = 0.35$ g

(b) $Ba(N_3)_{2(g)} \longrightarrow Ba_{(s)} + 3N_{2(g)}$

Mol. mass = 221 g mol^{-1}

221 g of $Ba(N_3)_2$ gives 3×28 g of N_2

$\therefore$ 1 g of $Ba(N_3)_2$ will give $\frac{3\times28}{221} \times 1 = 0.38$ g

(c) $(NH_4)_2Cr_2O_{7(s)} \longrightarrow N_{2(g)} + 4H_2O_{(g)} + Cr_2O_{3(s)}$

Mol. mass = 252 g mol^{-1}

252 g of $(NH_4)_2Cr_2O_7$ gives 28 g of N_2

1 g of $(NH_4)_2Cr_2O_7$ will give $\frac{28}{252} \times 1 = 0.111$ g

(d) $2NH_{3(g)} \longrightarrow N_{2(g)} + 3H_{2(g)}$

Mol. mass = 17 g mol^{-1}

2×17 g of NH_3 gives 28 g of N_2

$\therefore$ 1 g of NH_3 will give $\frac{28}{2\times17} \times 1 = 0.823$ g

2. (d)

3. (d): *I.E.* increases on going from left to right in a period. Electron gain enthalpy becomes more negative on going from left to right in a period.

4. (b): As it absorbs heat, $q = +208$ J

$$w_{rev} = -2.303nRT\log_{10}\left(\frac{V_2}{V_1}\right)$$

$$w_{rev} = -2.303\times(0.04)\times8.314 \times310 \log_{10}\left(\frac{375}{50}\right)$$

$\therefore$ $w_{rev} = -207.76 \approx -208$ J

5. (c): $\frac{\ln K_1}{\ln K_2} > \frac{T_2}{T_1}$ (Given)

On increasing temperature, concentration of product decreases and hence, K decreases.

Since, reaction is exothermic, therefore, $\Delta H° < 0$

From the graph, $[P]_{eq} > 5$, $[A]_{eq} < 5$

$K_{eq} = \frac{[P]}{[A]} > 1$

$\Delta G° = -RT\ln K_{eq} \Rightarrow \Delta G° < 0$

$$\frac{\ln K_1}{\ln K_2} = \frac{\frac{-\Delta H°}{T_1R} + \frac{\Delta S°}{R}}{\frac{-\Delta H°}{T_2R} + \frac{\Delta S°}{R}} > \frac{T_2}{T_1}$$

$$\frac{(-\Delta H° + T_1\Delta S°)}{(-\Delta H° + T_2\Delta S°)}\frac{T_2}{T_1} > \frac{T_2}{T_1}$$

$-\Delta H° + T_1\Delta S° > -\Delta H° + T_2\Delta S° \Rightarrow \Delta S° < 0$

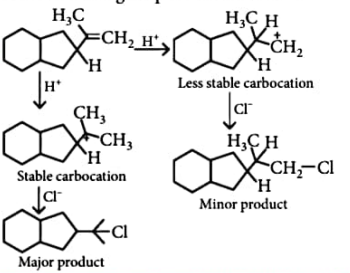
6. (a): The given reaction is redox reaction as well as displacement reaction.

7. (c)

8. (a): Silica gel absorbs moisture thus, acts as drying agent. Silicon being a semiconductor is used in transistors. Silicone is a sealant while silicates including zeolites are ion-exchangers.

9. (a): Adsorption chromatography involves differential adsorption of the various components of a mixture on a suitable adsorbent such as silica gel or alumina. In TLC, the mixture is passed over adsorbent on a thin glass plate of suitable size.

10. (b):



11. (b): $E^\circ_{cell} = \frac{2.303\,RT}{nF}\log K_c$

$= \frac{0.059}{2}\log(10\times10^{15}) = \frac{0.059\times16}{2} = 0.472\ V$

12. (b): Electrical conductivity of the given aqueous solutions depends on the degree of ionization. Degree of ionisation is directly proportional to the acidic strength.

The acidic strength decreases in the order :

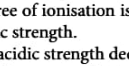
$HCOOH > C_6H_5COOH > CH_3COOH$

(*A*) (*C*) (*B*)

13. (b)

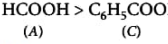
14. (b): Cr^{3+} ion with d^3 (t_{2g}^3) configuration has favourable crystal field stabilisation energy.

15. (b): $[Cr(H_2O)_6]^{2+} : Cr^{2+} \rightarrow [Ar]3d^4 4s^0$



4 unpaired electrons

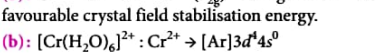
$[Fe(H_2O)_6]^{2+} : Fe^{2+} \rightarrow [Ar]3d^6 4s^0$



4 unpaired electrons

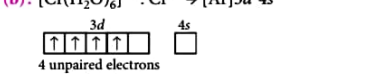
$[Cr(H_2O)_6]^{2+}$ and $[Fe(H_2O)_6]^{2+}$ have same number of unpaired electrons. Therefore, both the complexes have same magnetic moment.

16. (b): $[NiCl_4]^{2-}$: Oxidation state of Ni in $[NiCl_4]^{2-} = +2$



Cl^- is a weak field ligand and cannot cause pairing of electrons.

$[NiCl_4]^{2-}$:



sp^3 hybridisation

Hence, the complex is tetrahedral and paramagnetic with two unpaired electrons.

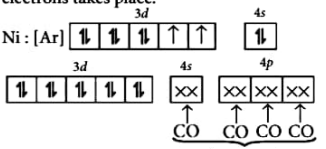
Oxidation state of Ni in $[Ni(CN)_4]^{2-} = +2$

CN^- is a strong field ligand, thus pairing of electrons takes place in *d*-orbitals.

dsp^2 hybridisation

Hence, the complex is square planar and diamagnetic.

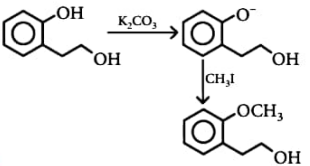
$[Ni(CO)_4]$: Oxidation state of Ni in $[Ni(CO)_4]$ is zero. CO is a strong field ligand, thus pairing of electrons takes place.



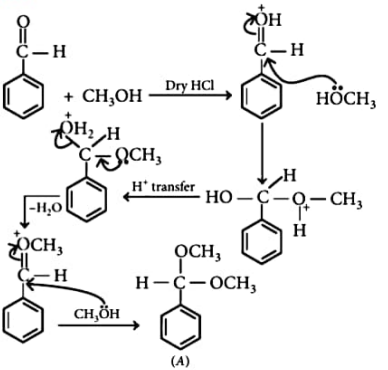
sp^3-hybridisation

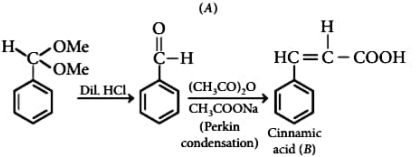
Hence, the complex is tetrahedral and diamagnetic.

17. (a) :



18. (d):





19. (c) **20. (d)**

21. (4) : CdS, PbS, As_2S_3 and CuS are soluble in 50% HNO_3.

22. (25) : Molecular mass of uracil

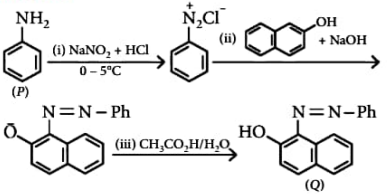
$= 14\times n_N + 16\times n_O + 12\times n_C + 1\times n_H$

$= 14\times2 + 16\times2 + 12\times4 + 1\times4$

$= 28 + 32 + 48 + 4 = 112\ g\ mol^{-1}$

$$\therefore \ \%N = \frac{28}{112} \times 100 = 25\%$$

23. (18.60) :



Molecular weight of Q ($C_{16}H_{12}ON_2$)
$= 16 \times 12 + 12 \times 1 + 16 + 2 \times 14 = 248 \text{ g mol}^{-1}$
Molecular weight of aniline (P) = C_6NH_7
$= 12 \times 6 + 14 + 7 \times 1 = 93 \text{ g mol}^{-1}$
Density = 1 g/mL, 9.3 mL of P = 9.3 g of P

$$\text{Moles of } P = \frac{9.3}{93} = 0.1 \text{ mol}$$

Moles of Q obtained = $0.1 \times 0.75 = 0.075$
Mass of $Q = 248 \times 0.075 = 18.6$ g

24. (4): $PCl_5 + SO_2 \longrightarrow POCl_3 + SOCl_2$
$PCl_5 + H_2O \longrightarrow POCl_3 + 2HCl$
$2PCl_5 + H_2SO_4 \longrightarrow 2POCl_3 + SO_2Cl_2 + 2HCl$
$6\,PCl_5 + P_4O_{10} \longrightarrow 10POCl_3$

25. (12) : Balanced equation can be written as
$S_8 + 12OH^- \longrightarrow 4S^{2-} + 2S_2O_3^{2-} + 6H_2O$
The value of a is 12.

26. (2.98) : Mole fraction of urea = 0.05

$$0.05 = \frac{n_{\text{urea}}}{n_{\text{urea}} + \frac{900}{18}}$$

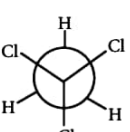
$$0.05 = \frac{n_{\text{urea}}}{n_{\text{urea}} + 50} \Rightarrow n_{\text{urea}} = 2.63$$

Mass of urea = $2.63 \times 60 = 157.8$ g
Mass of solution = 157.8 + 900 = 1057.8 g

$$\text{Volume of solution} = \frac{1057.8}{1.2} = 881.5 \text{ cm}^3$$

$$\text{Molarity} = \frac{n_{\text{solute}}}{V_{\text{solution}}} \times 1000 = \frac{2.63}{881.5} \times 1000 = 2.98 \text{ M}$$

27. (60) : Staggered form of 1, 1, 1-trichloro ethane is given as,



28. (476) :

	$CH_3COOH_{(aq)}$	+	$NaOH_{(aq)}$	→
Before reaction (millimoles)	5		2.5	
After reaction	2.5		–	

	$CH_3COONa_{(aq)}$	+	$H_2O_{(l)}$
Before reaction (millimoles)	0		0
After reaction (millimoles)	2.5		2.5

Resultant solution is acidic buffer solution with same concentration of acid and salt.

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

$pH = pK_a = 4.76 = 476 \times 10^{-2}$

29. (181) : Energy required to ionize an atom of metal A

$$= \frac{hc}{\lambda} = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{663 \times 10^{-9}} = 3 \times 10^{-19} \text{ J atom}^{-1}$$

I.E. per mole = $3 \times 10^{-19} \times 6.02 \times 10^{23}$
$= 18.06 \times 10^4 \text{ J} = 180.6 \text{ kJ} \approx 181 \text{ kJ}$

30. (126) : From principle of atom conservation,

$2MnCl_2 + 5K_2S_2O_8 + 8H_2O \longrightarrow$
$2KMnO_4 + 4K_2SO_4 + 6H_2SO_4 + 4HCl$ ...(i)

mmoles of $MnCl_2$ = mmoles of $KMnO_4 = x$(let)

$2KMnO_4 + 5H_2C_2O_4 + 3H_2SO_4 \longrightarrow$
$K_2SO_4 + 2MnSO_4 + 8H_2O + 10CO_2$ ...(ii)

meq of $KMnO_4$ = meq of oxalic acid

$$x \times 5 = \left(\frac{225}{90}\right) \times 2 \Rightarrow x = 1$$

($\therefore$ mass of oxalic acid added = 225 mg)
$\therefore$ mmoles of $MnCl_2$ = 1 m mol
Quantity of $MnCl_2$ present = 1 m mol $\times$ 126 g mol^{-1}
= 126 mg

EXAM ALERT 2024

Exam	Date
JEE Main Session 2	Between 4th April and 15th April
KARNATAKA CET MATHS / BIOLOGY	18th April
KARNATAKA CET PHYSICS / CHEMISTRY	19th April
WB JEE	28th April
NEET	5th May
COMEDK (Engg.)	12th May
CUET	Between 15th May and 31st May
JEE Advanced	26th May
BITSAT Session 1	Between 19th May to 24th May
BITSAT Session 2	Between 22nd June to 26th June

JEE 2024 ADVANCED

PRACTICE PAPER

Exam on 26th May

PAPER-I

SECTION 1 (MAXIMUM MARKS : 12)

- *This section contains THREE (03) questions.*
- *Each question has FOUR options (a), (b), (c) and (d). ONE OR MORE THAN ONE of these four option(s) is(are) correct answer(s).*
- *For each question, choose the option(s) corresponding to (all) the correct answer(s).*
- *Answer to each question will be evaluated according to the following marking scheme:*

Full Marks	*: +4*	*ONLY if (all) the correct option(s) is(are) chosen;*
Partial Marks	*: +3*	*If all the four options are correct but ONLY three options are chosen;*
Partial Marks	*: +2*	*If three or more options are correct but ONLY two options are chosen, both of which are correct;*
Partial Marks	*: +1*	*If two or more options are correct but ONLY one option is chosen and it is a correct option;*
Zero Marks	*: 0*	*If none of the options is chosen (i.e., the question is unanswered);*
Negative Marks	*: –2*	*In all other cases.*

- *For example, in a question, if (a), (b) and (d) are the ONLY three options corresponding to correct answers, then*
  choosing ONLY (a), (b) and (d) will get +4 marks;
  choosing ONLY (a) and (b) will get +2 marks;
  choosing ONLY (a) and (d) will get +2 marks;
  choosing ONLY (b) and (d) will get +2 marks;
  choosing ONLY (a) will get +1 mark;
  choosing ONLY (b) will get +1 mark;
  choosing ONLY (d) will get +1 mark;
  choosing no option (i.e., the question is unanswered) will get 0 marks; and choosing any other combination of options will get –2 marks.

1. Copper is purified by electrolytic refining of blister copper. The correct statement(s) about this process is(are)

(a) impure Cu strip is used as cathode

(b) acidified aqueous $CuSO_4$ is used as electrolyte

(c) pure Cu deposits at cathode

(d) impurities settle as anode-mud.

2. When O_2 is adsorbed on a metallic surface, electron transfer occurs from the metal to O_2. The true statement(s) regarding this adsorption is(are)

(a) O_2 is physisorbed

(b) heat is released

(c) occupancy of π^*_{2p} orbitals of O_2 is increased

(d) bond length of O_2 is increased.

3. $A \xrightarrow[\text{(green)}]{4KOH,\,O_2} 2B + 2H_2O$

$3B \xrightarrow[\text{(purple)}]{4HCl} 2C + MnO_2 + 2H_2O$

$2C \xrightarrow{H_2O,\,KI} 2A + 2KOH + D$

In the above sequence of reactions, A and D, respectively are

(a) KI and $KMnO_4$ (b) KIO_3 and MnO_2

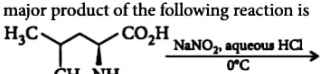
(c) KI and K_2MnO_4 (d) MnO_2 and KIO_3

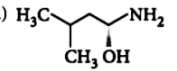
SECTION 2 (MAXIMUM MARKS : 12)

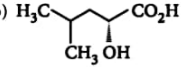
- *This section contains FOUR (04) questions.*
- *Each question has FOUR options (a), (b), (c) and (d). Only one of these four option is the correct answer.*
- *For each question, choose the option corresponding to the correct answer.*
- *Answer to each question will be evaluated according to the following marking scheme:*

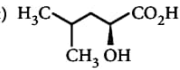
Full Marks	*: +3*	*If ONLY the correct option is chosen;*
Zero Marks	*: 0*	*If none of the options is chosen (i.e., the question is unanswered);*
Negative Marks	*: –1*	*In all other cases.*

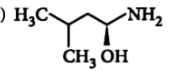
4. The major product of the following reaction is



(a) 

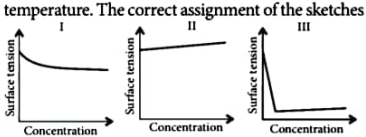
(b) 

(c) 

(d) 

5. Under hydrolytic conditions, the compounds used for preparation of linear polymer and for chain termination, respectively, are
   (a) CH_3SiCl_3 and $Si(CH_3)_4$
   (b) $(CH_3)_2SiCl_2$ and $(CH_3)_3SiCl$
   (c) $(CH_3)_2SiCl_2$ and CH_3SiCl_3
   (d) $SiCl_4$ and $(CH_3)_3SiCl$

6. The qualitative sketches I, II and III given below show the variation of surface tension with molar concentration of three different aqueous solutions KCl, CH_3OH and $CH_3(CH_2)_{11}OSO_3^-Na^+$ at room temperature. The correct assignment of the sketches is



   (a) I : KCl II : CH_3OH III : $CH_3(CH_2)_{11}OSO_3^-Na^+$
   (b) I : $CH_3(CH_2)_{11}OSO_3^-Na^+$ II : CH_3OH III : KCl
   (c) I : KCl II : $CH_3(CH_2)_{11}OSO_3^-Na^+$ III : CH_3OH
   (d) I : CH_3OH II : KCl III : $CH_3(CH_2)_{11}OSO_3^-Na^+$

7. The standard state Gibbs free energies of formation of $C_{(graphite)}$ and $C_{(diamond)}$ at $T = 298$ K are
   $\Delta_fG^\circ[C_{(graphite)}] = 0$ kJ mol^{-1}
   $\Delta_fG^\circ[C_{(diamond)}] = 2.9$ kJ mol^{-1}
   The standard state means that the pressure should be 1 bar, and substance should be pure at a given temperature. The conversion of graphite $[C_{(graphite)}]$ to diamond $[C_{(diamond)}]$ reduces its volume by 2×10^{-6} m^3 mol^{-1}. If $C_{(graphite)}$ is converted to $C_{(diamond)}$ isothermally at $T = 298$ K, the pressure at which $C_{(graphite)}$ is in equilibrium with $C_{(diamond)}$, is [Useful information: 1 J = 1 kg m^2 s^{-2}; 1 Pa = 1 kg m^{-1} s^{-2}; 1 bar = 10^5 Pa]
   (a) 29001 bar (b) 58001 bar
   (c) 14500 bar (d) 1450 bar

SECTION 3 (MAXIMUM MARKS : 24)

- ***This section contains SIX (06) questions.***
- ***The answer to each question is a NON-NEGATIVE INTEGER.***
- ***For each question, enter the correct integer corresponding to the answer using the mouse and the onscreen virtual numeric keypad in the place designated to enter the answer.***
- ***Answer to each question will be evaluated according to the following marking scheme:***

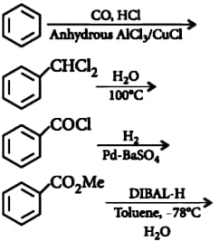
  Full Marks : +4 If ONLY the correct integer is entered;

  Zero Marks : 0 In all other cases.

8. Among the triatomic molecules/ions, $BeCl_2$, N_3^-, N_2O, NO_2^+, O_3, SCl_2, ICl_2^-, I_3^- and XeF_2, the total number of linear molecule(s)/ion(s) where the hybridisation of the central atom does not have contribution from the *d*-orbital(s) is _____.

9. For the octahedral complexes of Fe^{3+} in SCN^- (thiocyanato-S) and in CN^- ligand environments, the difference between the spin-only magnetic moments in Bohr magnetons (when approximated to the nearest integer) is _____.
   [Atomic number of Fe = 26]

10. Among the following, the number of reaction(s) that produce(s) benzaldehyde is _____.

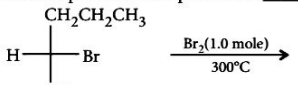


11. In dilute aqueous H_2SO_4, the complex diaquadioxalatoferrate(II) is oxidised by MnO_4^-. For this reaction, the ratio of the rate of change of $[H^+]$ to the rate of change of $[MnO_4^-]$ is _____.

12. The molar conductivity of a solution of a weak acid HX (0.01 M) is 10 times smaller than the molar conductivity of a solution of a weak acid

HY (0.10 M). If $\lambda^{\circ}_{X^-} \approx \lambda^{\circ}_{Y^-}$, the difference in their pK_a values, $pK_{a(HX)} - pK_{a(HY)}$, is _____. (consider degree of ionisation of both acids to be << 1).

13. In the following monobromination reaction, the number of possible chiral products is _____.



(1.0 mole)

(enantiomerically pure)

SECTION 4 (MAXIMUM MARKS : 12)

- ***This section contains FOUR (04) Matching List Sets.***
- ***Each set has ONE Multiple Choice Question.***
- ***Eact set has TWO lists : List-I and List-II.***
- ***List-I has Four entries (P), (Q), (R) and (S) and List-II has Five entries (1), (2), (3), (4) and (5).***
- ***FOUR options are given in each Multiple Choice Question based on List-I and List-II and ONLY ONE of these four options satisfies the condition asked in the Multiple Choice Question.***
- ***Answer to each question will be evaluated according to the following marking scheme:***

Full Marks : +3 ONLY if the option corresponding to the correct combination is chosen;

Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered);

Negative Marks : -1 In all other cases.

14. Match the List-I with List-II.

List-I (Catalyst)		List-II (Process)	
(P)	$TiCl_4$	1.	Wacker process
(Q)	$PdCl_2$	2.	Ziegler–Natta polymerisation
(R)	$CuCl_2$	3.	Contact process
(S)	V_2O_5	4.	Deacon's process
		5.	Ostwald process

(a) (P) → (2), (Q) → (3), (R) → (4), (S) → (5)
(b) (P) → (3), (Q) → (1), (R) → (2), (S) → (5)
(c) (P) → (3), (Q) → (2), (R) → (4), (S) → (1)
(d) (P) → (2), (Q) → (1), (R) → (4), (S) → (3)

15. Match List-I with List-II.

List-I		List-II	
(P)	Phenol-formaldehyde resin	1.	Glyptal
(Q)	Copolymer of 1,3-butadiene and styrene	2.	Novolac
(R)	Polyester of glycol and phthalic acid	3.	Buna-S
(S)	Polyester of glycol and terephthalic acid	4.	Dacron
		5.	Neoprene

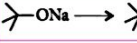
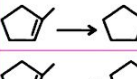
Choose the correct answer from the options given below:
(a) (P) → 2, (Q) → 3, (R) → 4, (S) → 5
(b) (P) → 2, (Q) → 3, (R) → 1, (S) → 4
(c) (P) → 2, (Q) → 1, (R) → 5, (S) → 4
(d) (P) → 3, (Q) → 2, (R) → 4, (S) → 1

16. Match the transformations in List I with appropriate options in List II.

List I		List II	
(P)	$CO_{2(s)} \longrightarrow CO_{2(g)}$	1.	Phase transition
(Q)	$CaCO_{3(s)} \longrightarrow CaO_{(s)} + CO_{2(g)}$	2.	Allotropic change
(R)	$2H^{\bullet} \longrightarrow H_{2(g)}$	3.	ΔH is positive
(S)	$P_{(white,\ solid)} \rightarrow P_{(red,\ solid)}$	4.	ΔS is positive
		5.	ΔS is negative

(a) (P) → 4, (Q) → 2, (R) → 5, (S) → 1
(b) (P) → 5, (Q) → 1, (R) → 4, (S) → 2
(c) (P) → 2, (Q) → 1, (R) → 3, (S) → 4
(d) (P) → 1, (Q) → 3, (R) → 5, (S) → 2

17. Match the chemical conversions in List-I with the appropriate reagents in List-II and select the correct answer using the code given below the lists:

List-I		List-II	
(P)		1.	(i) $Hg(OAc)_2$; (ii) $NaBH_4$
(Q)		2.	NaOEt
(R)		3.	Et-Br
(S)		4.	(i) BH_3; (ii) H_2O_2/ NaOH
		5.	$Pd/BaSO_4$

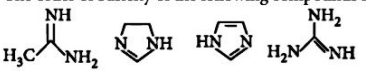
(a) (P) → 2, (Q) → 3, (R) → 1, (S) → 4
(b) (P) → 3, (Q) → 2, (R) → 4, (S) → 1
(c) (P) → 2, (Q) → 5, (R) → 4, (S) → 1
(d) (P) → 5, (Q) → 4, (R) → 1, (S) → 2

SECTION 1 (MAXIMUM MARKS : 12)

- *This section contains FOUR (04) questions.*
- *Each question has FOUR options (a), (b), (c) and (d). Only one of these four options is the correct answer.*
- *For each question, choose the option corresponding to the correct answer.*
- *Answer to each question will be evaluated according to the following marking scheme:*

Full Marks	*: +3*	*If ONLY the correct option is chosen;*
Zero Marks	*: 0*	*If none of the options is chosen (i.e., the question is unanswered);*
Negative Marks	*: –1*	*In all other cases.*

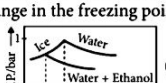
1. The order of basicity of the following compounds is

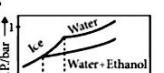


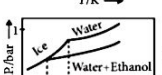
I II III IV

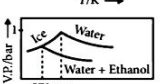
(a) IV > II > III > I (b) II > I > IV > III
(c) I > IV > III > II (d) IV > I > II > III

2. Pure water freezes at 273 K and 1 bar. The addition of 34.5 g of ethanol to 500 g of water changes the freezing point of the solution. Use the freezing point depression constant of water as 2 K kg mol^{-1}. The figures shown below represent plots of vapour pressure (*V.P.*) versus temperature (*T*).
[Molecular weight of ethanol is 46 g mol^{-1}]
Among the following, the option representing change in the freezing point is

(a) 

(b) 

(c) 

(d) 

3. The green colour produced in the borax bead test of a chromium(III) salt is due to
(a) $CrBO_3$ (b) Cr_2O_3
(c) $Cr(BO_2)_3$ (d) $Cr_2(B_4O_7)_3$

4. The cyanide process of gold extraction involves leaching out gold from its ore with CN^- in the presence of *Q* in water to form *R*. Subsequently, *R* is treated with *T* to obtain Au and *Z*. Select the incorrect option about these reactions.
(a) *R* is $[Au(CN)_4]^-$ (b) *T* is Zn
(c) *Q* is O_2 (d) *Z* is $[Zn(CN)_4]^{2-}$

SECTION 2 (MAXIMUM MARKS : 12)

- *This section contains THREE (03) questions.*
- *Each question has FOUR options (a), (b), (c) and (d). ONE OR MORE THAN ONE of these four option(s) is(are) correct answer(s).*
- *For each question, choose the option(s) corresponding to (all) the correct answer(s).*
- *Answer to each question will be evaluated according to the following marking scheme:*

Full Marks	*: +4*	*ONLY if (all) the correct option(s) is(are) chosen;*
Partial Marks	*: +3*	*If all the four options are correct but ONLY three options are chosen;*
Partial Marks	*: +2*	*If three or more options are correct but ONLY two options are chosen, both of which are correct;*
Partial Marks	*: +1*	*If two or more options are correct but ONLY one option is chosen and it is a correct option;*
Zero Marks	*: 0*	*If unanswered;*
Negative Marks	*: –2*	*In all other cases.*

- *For example, in a question, if (a), (b) and (c) are the ONLY three options corresponding to correct answers, then choosing ONLY (a), (b) and (d) will get +4 marks; choosing ONLY (a) and (b) will get +2 marks; choosing ONLY (a) and (d) will get +2 marks; choosing ONLY (b) and (d) will get +2 marks; choosing ONLY (a) will get +1 mark; choosing ONLY (b) will get +1 mark; choosing ONLY (d) will get +1 mark; choosing no option(s) (i.e., the question is unanswered) will get 0 marks; and choosing any other option(s) will get –2 marks.*

5. For 'invert sugar', the correct statement(s) is(are)
(Given : specific rotations of (+)-sucrose, (+)-maltose, *L*-(–)-glucose and *L*-(+)-fructose in aqueous solution are +66°, +140°, –52° and +92°, respectively)
(a) 'invert sugar' is prepared by acid catalyzed hydrolysis of maltose
(b) 'invert sugar' is an equimolar mixture of *D*-(+)-glucose and *D*-(–)-fructose
(c) specific rotation of 'invert sugar' is –20°
(d) on reaction with Br_2 water, 'invert sugar' forms saccharic acid as one of the products.

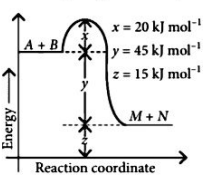
6. The nitrogen containing compound produced in the reaction of HNO_3 with P_4O_{10}
(a) can also be prepared by reaction of P_4 and HNO_3
(b) is diamagnetic
(c) contains one N—N bond
(d) reacts with Na metal producing brown gas.

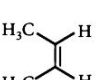
7. The correct statement(s) for cubic close packed (*ccp*) three dimensional structure is(are)
   (a) the number of the nearest neighbours of an atom present in the topmost layer is 12
   (b) the efficiency of atom packing is 74%
   (c) the number of octahedral and tetrahedral voids per atom are 1 and 2, respectively
   (d) the unit cell edge length is $2\sqrt{2}$ times the radius of the atom.

SECTION 3 (MAXIMUM MARKS : 24)

- ***This section contains SIX (06) questions.***
- ***The answer to each question is a NON-NEGATIVE INTEGER.***
- ***For each question, enter the correct integer corresponding to the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.***
- ***Answer to each question will be evaluated according to the following marking scheme:***
  Full Marks : +4 If ONLY the correct integer is entered;
  Zero Marks : 0 In all other cases.

8. According to the following figure, the magnitude of the enthalpy change of the reaction
   $A + B \rightarrow M + N$ in kJ mol^{-1}
   is equal to _____. (Integer answer)



9. 

$+ Br_2 \xrightarrow{CCl_4}$ Product *X*.

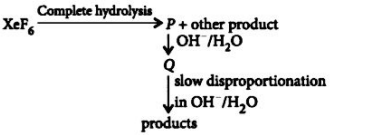
   Consider the above chemical reaction. The total number of stereoisomers possible for product '*X*' is _____.

10. The difference in the oxidation numbers of the two types of sulphur atoms in $Na_2S_4O_6$ is _____.

11. Among the complex ions,
    $[Co(NH_2CH_2CH_2NH_2)_2Cl_2]^+$, $[CrCl_2(C_2O_4)_2]^{3-}$,
    $[Fe(H_2O)_4(OH)_2]^+$, $[Fe(NH_3)_2(CN)_4]^-$,
    $[Co(NH_2CH_2CH_2NH_2)_2(NH_3)Cl]^{2+}$ and
    $[Co(NH_3)_4(H_2O)Cl]^{2+}$, the number of complex ion(s) that show(s) *cis-trans* isomerism is _____.

12. The mass of ammonia in grams produced when 2.8 kg of dinitrogen quantitatively reacts with 1 kg of dihydrogen is _____.

13. Under ambient conditions, the total number of gases released as products in the final step of the reaction scheme shown below is



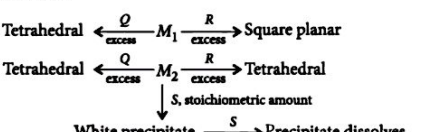
SECTION 4 (MAXIMUM MARKS : 12)

- ***This section contains TWO (02) paragraphs.***
- ***Based on each paragraph, there are TWO (02) questions.***
- ***The answer to each question is a NUMERICAL VALUE.***
- ***For each question, enter the correct numerical value of the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.***
- ***If the numerical value has more than two decimal places, truncate/round-off the value to TWO decimal places.***
- ***Answer to each question will be evaluated according to the following marking scheme:***
  Full Marks : +3 If ONLY the correct numerical value is entered in the designated place;
  Zero Marks : 0 In all other cases.

PARAGRAPH-I

An aqueous solution of metal ion M_1 reacts separately with reagents *Q* and *R* in excess to give tetrahedral and square planar complexes, respectively. An aqueous solution of another metal ion M_2 always forms tetrahedral complexes with these reagents. Aqueous solution of M_2 on reaction with reagent *S* gives white precipitate which dissolves in excess of *S*. The reactions are summarised in the scheme given below :

Scheme :

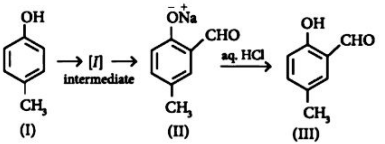


14. M_1, Q and R, respectively are
(a) Zn^{2+}, KCN and HCl (b) Ni^{2+}, HCl and KCN
(c) Cd^{2+}, KCN and HCl (d) Co^{2+}, HCl and KCN

15. Reagent S is
(a) $K_4[Fe(CN)_6]$ (b) Na_2HPO_4
(c) K_2CrO_4 (d) KOH

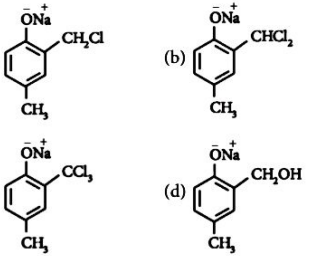
PARAGRAPH-II

Reimer-Tiemann reaction introduces an aldehyde group, on to the aromatic ring of phenol, *ortho* to the hydroxyl group. This reaction involves electrophilic aromatic substitution. This is a general method for the synthesis of substituted salicylaldehydes as depicted below.



16. Which of the following reagents is used in the above reaction?
(a) aq. NaOH + CH_3Cl
(b) aq. NaOH + CH_2Cl_2
(c) aq. NaOH + $CHCl_3$
(d) aq. NaOH + CCl_4

17. The structure of the intermediate I is



SOLUTIONS

PAPER-I

1. (b, c, d) : (a) Impure copper is made the anode and a thin sheet of pure copper is made the cathode, while copper sulphate solution acidified with sulphuric acid is taken as the electrolyte. Pure copper deposits at the cathode and impurities settle as anode-mud.

At anode : $Cu_{(s)} \longrightarrow Cu^{2+}_{(aq)} + 2e^-$

At cathode : $Cu^{2+}_{(aq)} + 2e^- \longrightarrow Cu_{(s)}$

2. (b, c, d) : As electron transfer occurs from the metal to O_2, it is chemisorption.

Adsorption is an exothermic process *i.e.*; heat is released.

The electronic configuration of O_2 molecule is $KK\,\sigma 2s^2$, $\sigma^* 2s^2$, $\sigma 2p_z^2$, $(\pi 2p_x^2 = \pi 2p_y^2)$, $(\pi^* 2p_x^1 = \pi^* 2p_y^1)$.

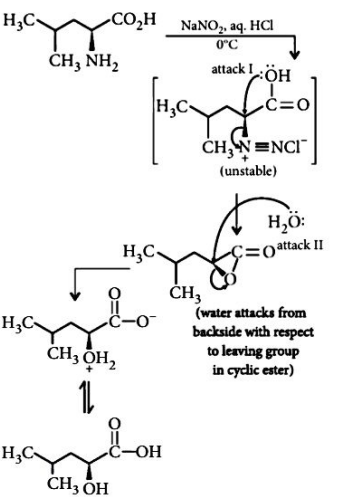
When electron transfer occurs, it occupies $\pi^* 2p_x$ orbital, so bond order decreases, hence the bond length increases.

3. (d) : $\underset{(A)}{2MnO_2} + 4KOH + O_2 \longrightarrow \underset{\text{Green } (B)}{2K_2MnO_4} + 2H_2O$

$3K_2MnO_4 + 4HCl \longrightarrow \underset{\text{Purple } (C)}{2KMnO_4} + MnO_2 + 2H_2O$

$\underset{(C)}{2KMnO_4} + H_2O + KI \longrightarrow 2KOH + \underset{(A)}{2MnO_2} + \underset{(D)}{KIO_3}$

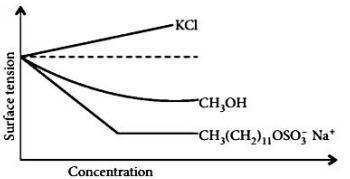
4. (c) :



In attack I, inversion of configuration takes place and in attack II again inversion of configuration takes place which finally leads to retention of configuration.

5. (b)

6. (d) :



For KCl curve — Increase of surface tension for inorganic salts.

For CH_3OH curve — Decrease of surface tension progressively for alcohols.

For $CH_3(CH_2)_{11}OSO^-{}_3Na^+$ curve — Decrease of surface tension before CMC (Critical Micelle Concentration) and then almost unchanged.

7. (c) : $C_{(graphite)} \longrightarrow C_{(diamond)}$ (Isothermally)

$\Delta_f G° = \Delta G°_{(diamond)} - \Delta G°_{(graphite)} = 2.9 - 0 = 2.9\ kJ\ mol^{-1}$

Gibbs free energy is the maximum useful work, then

$-\Delta G = w_{max} = P\Delta V$

$-2.9 \times 10^3 = -P \times 2 \times 10^{-6}$

$$P = \frac{2.9 \times 10^3}{2 \times 10^{-6}} = 1.45 \times 10^9\ Pa = 1.45 \times 10^9 \times 10^{-5}\ bar$$

$= 1.45 \times 10^4\ bar = 14500\ bar$

8. (4) :

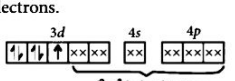
Molecule/ion	Hybridisation	Shape
$BeCl_2$	sp	linear
N_3^-	sp	linear
N_2O	sp	linear
NO_2^+	sp	linear
O_3	sp^2	bent
SCl_2	sp^3	bent
ICl_2^-	sp^3d	linear
I_3^-	sp^3d	linear
XeF_2	sp^3d	linear

Thus, there are total four linear molecules/ions where the hybridisation of the central atom does not have contribution from the *d*-orbitals.

9. (4) : Fe (26) : [Ar] $3d^6 4s^2$

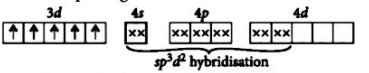
Fe^{3+} : [Ar] $3d^5$

In $[Fe(CN)_6]^{3-}$, CN^- is a strong field ligand which causes pairing of electrons.



$\mu = \sqrt{n(n+2)} = \sqrt{1(1+2)} = \sqrt{3} = 1.732$ BM

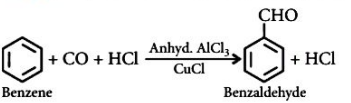
In $[Fe(SCN)_6]^{3-}$, SCN^- being a weak field ligand does not cause pairing of electrons.



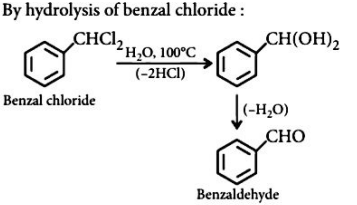
$\mu = \sqrt{n(n+2)} = \sqrt{5(5+2)} = \sqrt{35} = 5.916$ BM

Difference = 5.916 – 1.732 = 4.184 ≈ 4 BM

10. (4) : I. Gattermann-Koch aldehyde synthesis :



II. By hydrolysis of benzal chloride :

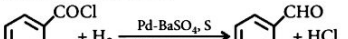


Here are the nine shuffled words containing 3 sets of trio. The three letters of trio can be arranged in any sequence. Complete these words by finding 3 sets of trio.

— — — OXALATE
MON — — — OTOPHOS
— — — CITRATES
B — — — YNTHESIS
MONO — — — MATIC
CARBOZANTI — — —
MAC — — — YCLIC
PHY — — — CHEMICAL
SU — — — TRILE

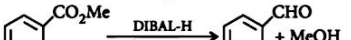
Readers can send their responses at editor@mtg.in or post us with complete address by 10th of every month. Winners' names will be published in next issue.

III. Rosenmund reduction :



Benzoyl chloride — Benzaldehyde

IV. Esters are reduced to aldehydes with DIBAL-H :



Methyl benzoate — Benzaldehyde

11. (8) : In complex, $[Fe(C_2O_4)_2(H_2O)_2]^{2-}$, diaquadioxalatoferrate (II)

Fe is in +2 oxidation state.

In acidic medium, $KMnO_4$ oxidises Fe^{2+} to Fe^{3+} as shown :

$2MnO_4^- + 16H^+ + 10Fe^{2+} \longrightarrow 2Mn^{2+} + 8H_2O + 10Fe^{3+}$

or

$MnO_4^- + 8H^+ + 5Fe^{2+} \longrightarrow Mn^{2+} + 4H_2O + 5Fe^{3+}$

$$\text{Hence, } \frac{-d}{dt}[MnO_4^-] = \frac{-1}{8}\frac{d}{dt}[H^+] \Rightarrow \frac{\frac{d}{dt}[H^+]}{\frac{d}{dt}[MnO_4^-]} = \frac{8}{1} = 8$$

Hence, the ratio of the rate of change of $[H^+]$ to the rate of change of $[MnO_4^-]$ is 8.

12. (3) : Given : $\Lambda^c_{m(HX)} = \frac{\Lambda^c_{m(HY)}}{10}$

$\Lambda^\circ_{m(HX)} = \Lambda^\circ_{m(HY)}$ $\quad (\because \lambda^\circ_{X^-} \approx \lambda^\circ_{Y^-})$

$$K_{a(HX)} = \left(\frac{C\alpha^2}{1-\alpha}\right)_{HX}$$

$K_{a(HX)} = 0.01(\alpha_{HX})^2$ $\quad (\because \alpha <<< 1)$ $\quad ...(i)$

Similarly, $K_{a(HY)} = 0.10(\alpha_{HY})^2$ $\quad ...(ii)$

On dividing equation (i) by (ii), we get

$$\frac{K_{a(HX)}}{K_{a(HY)}} = \frac{0.01}{0.10}\left(\frac{\alpha_{HX}}{\alpha_{HY}}\right)^2 \quad ...(iii)$$

$$\alpha = \frac{\Lambda^c_m}{\Lambda^\circ_m}$$

$$\frac{\alpha_{HX}}{\alpha_{HY}} = \frac{\left(\Lambda^c_m/\Lambda^\circ_m\right)_{HX}}{\left(\Lambda^c_m/\Lambda^\circ_m\right)_{HY}} = \left(\frac{1}{10}\Lambda^c_{m(HY)}\right) \times \frac{1}{\Lambda^c_{m(HY)}} = \frac{1}{10}$$

Substituting above value in equation (iii),

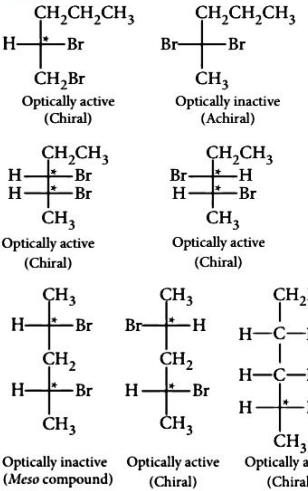
$$\frac{K_{a(HX)}}{K_{a(HY)}} = \frac{0.01}{0.10}\left(\frac{1}{10}\right)^2 = 1 \times 10^{-3}$$

$\log K_{a(HX)} - \log K_{a(HY)} = \log(1 \times 10^{-3})$

$-\log K_{a(HX)} - (-\log K_{a(HY)}) = -\log(1 \times 10^{-3})$

$pK_{a(HX)} - pK_{a(HY)} = 3$

13. (5) : Total five products are formed.



14. (d) **15. (b)**

16. (d) : (P)→(1); (Q)→(3); (R)→(5); (S)→(2)

(P) → (1) $CO_{2(s)} \rightarrow CO_{2(g)}$

(i) It is an example of phase transition.

(ii) Conversion of solid into gas *i.e.*, sublimation, which is endothermic, therefore, ΔH = positive

(iii) For $s \rightarrow g$ $\quad \Delta S$ = positive

because, $\Delta S = S_g - S_{(s)}$; $S_g > S_{(s)}$

(Q) → (3)

$CaCO_{3(s)} \longrightarrow CaO_{(s)} + CO_{2(g)}$

It is endothermic process so,

ΔH = positive

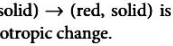
(R) → (5)

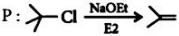
$2H^\bullet \longrightarrow H_{2(g)}$

Conversion of radical in molecular form is exothermic. Two particles give one gaseous particle. So, ΔS = –ve.

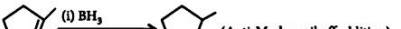
(S) → (2)

Allotropes are considered as different phase, hence *P*(white, solid) → (red, solid) is a phase transition as well as allotropic change.

17. (a) : P : 

Q : 

R : 

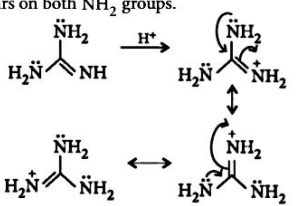
S : 

PAPER-II

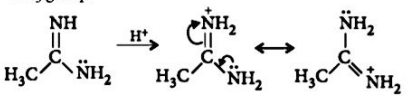
1. (d) : Greater the electron density on nitrogen, more basic is the compound. Thus, order of basicity of the given compounds is :

IV > I > II > III.

The conjugate acid of IV is stabilised by resonance with lone pairs on both $\ddot{N}H_2$ groups.



The conjugate acid of I is stabilised by resonance with lone pair on $-\ddot{N}H_2$ group and by hyperconjugation of $-CH_3$ group.



The conjugate acid of II is stabilised by resonance with lone pair on $\ddot{N}H$ group.

In compound III, the lone pair of nitrogen is involved in aromaticity. So, it is least basic.

2. (b)

3. (c) :

$$Na_2B_4O_7 \cdot 10H_2O \xrightarrow{\Delta} Na_2B_4O_7 \xrightarrow{\Delta} \underbrace{2NaBO_2 + B_2O_3}_{\text{Glassy beads}}$$

$$Cr_2O_3 + 3B_2O_3 \xrightarrow{\Delta} \underset{\substack{\text{Chromium metaborate}\\(\text{Green})}}{2Cr(BO_2)_3}$$

4. (a) :

$$\underset{(Q)}{4Au + 8NaCN + 2H_2O + O_2} \longrightarrow \underset{(R)}{4Na[Au(CN)_2] + 4NaOH}$$

$$\underset{(R)}{2[Au(CN)_2]^-} + \underset{(T)}{Zn} \longrightarrow \underset{(Z)}{[Zn(CN)_4]^{2-}} + 2Au$$

5. (b, c) : Invert sugar is prepared by acid catalyzed hydrolysis of sucrose.

$$\underset{\text{Sucrose}}{C_{12}H_{22}O_{11}} + H_2O \xrightarrow{HCl} \underbrace{C_6H_{12}O_6 + C_6H_{12}O_6}_{\substack{\text{Invert sugar}\\ D\text{-}(+)\text{-Glucose}\quad D\text{-}(-)\text{-Fructose}}}$$

Specific rotation of invert sugar is

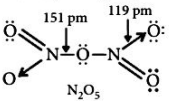
$[\alpha]_{mix} = 0.5 \times (+52) + 0.5 \times (-92) = +26 - 46 = -20°$

On reaction with Br_2 water, invert sugar forms gluconic acid as one of the products. Br_2 water oxidises glucose into gluconic acid and fructose is not oxidised by it.

6. (b, d) : $P_4O_{10} + 4HNO_3 \rightarrow 2N_2O_5 + 4HPO_3$

N_2O_5 cannot be obtained by reaction of P_4 and HNO_3.

$P_4 + 20HNO_3 \rightarrow 20NO_2 + 4H_3PO_4 + 4H_2O$



Hence, it is diamagnetic and does not have N–N bond.

N_2O_5 is decomposed by alkali metals.

$N_2O_5 + Na \rightarrow NaNO_3 + \underset{\substack{\uparrow\\(\text{Brown gas})}}{NO_2}$

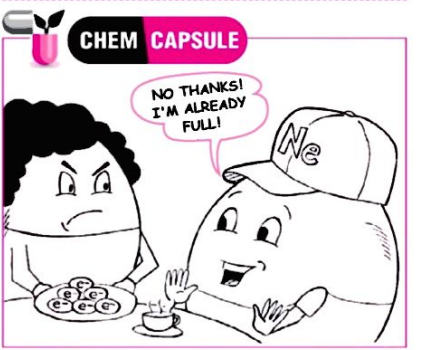
7. (b, c, d) : (a) The number of the nearest neighbours of an atom present in the topmost layer is 9 as a sphere is in contact with 6 other spheres in its own layer and it also touches directly 3 spheres in the layer below.

(b) For *ccp*, packing fraction = 74%.

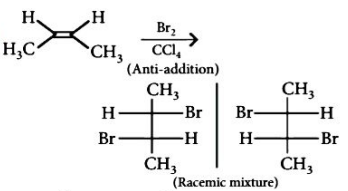
(c) In *ccp*, there are two tetrahedral voids per sphere and one octahedral void per sphere.

(d) For *ccp*, $a = \frac{4}{\sqrt{2}} r = 2\sqrt{2}\, r$

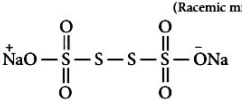
8. (45) : Enthalpy change = Difference in energy of product and reactant = y = 45 kJ/mol



9. (2) :



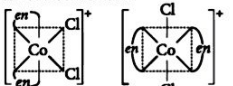
10. (5) :



S will have oxidation number = +5, 0

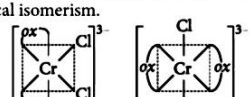
Difference in oxidation number = 5

11. (6) : $[Co(en)_2Cl_2]^+$ – $[M(AA)_2B_2]$ type complex, shows geometrical isomerism.



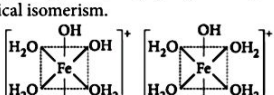
cis-form *trans*-form

$[CrCl_2(C_2O_4)_2]^{3-}$ – $[M(AA)_2B_2]$ type complex, shows geometrical isomerism.



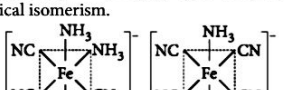
cis-form *trans*-form

$[Fe(H_2O)_4(OH)_2]^+$ – $[MA_4B_2]$ type complex, shows geometrical isomerism.



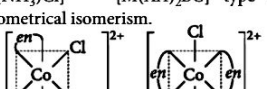
cis-form *trans*-form

$[Fe(NH_3)_2(CN)_4]^-$ – $[MA_4B_2]$ type complex, shows geometrical isomerism.



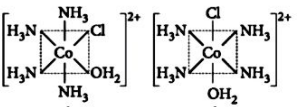
cis-form *trans*-form

$[Co(en)_2(NH_3)Cl]^{2+}$ – $[M(AA)_2BC]$ type complex, shows geometrical isomerism.



cis-form *trans*-form

$[Co(NH_3)_4(H_2O)Cl]^{2+}$ – $[MA_4BC]$ type complex, shows geometrical isomerism.



trans-form *cis*-form

12. (3400) : Reaction can be represented as :

$N_2 + 3H_2 \longrightarrow 2NH_3$

$$\text{Moles of nitrogen} = \frac{2.8\times10^3}{28} = 10^2 \text{ moles}$$

$$\text{Moles of hydrogen} = \frac{1\times10^3}{2} = 5\times10^2 \text{ moles}$$

For 10^2 moles of N_2, H_2 needed is 3×10^2 moles.

But 5×10^2 moles of hydrogen are present.

Hence H_2 is present in excess.

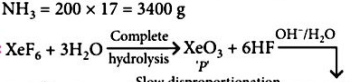
and N_2 is the limiting reagent.

1 mole of N_2 gives 2 moles of NH_3.

So, 100 moles of N_2 give 2×100 moles of NH_3

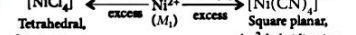
Mass of $NH_3 = 200 \times 17 = 3400$ g

13. (2) :

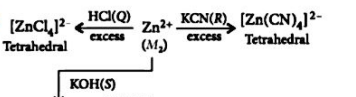


Hence, the so total number of gases produced in the final step of the reaction scheme is 2.

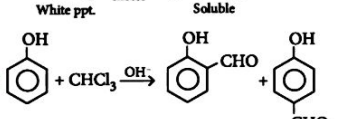
14. (b) :



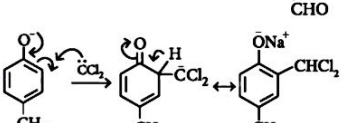
15. (d) :



16. (c) :



17. (b) :



CUET (UG)

Exam between 15th to 31st May 2024

PRACTICE PAPER 2024

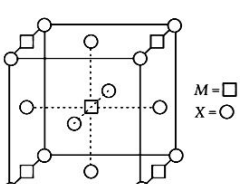
In this practice paper 40 questions to be attempted out of 50.

Time Allowed : 60 Minutes **Maximum Marks :** 200

1. Among statements (1)-(4), the correct ones are
   (1) Limestone is decomposed to CaO during the extraction of iron from its oxides.
   (2) In the extraction of silver, silver is extracted as an anionic complex.
   (3) Nickel is purified by Mond's process.
   (4) Zr and Ti are purified by van Arkel method.
   (a) (1), (3) and (4) only (b) (2), (3) and (4) only
   (c) (1), (2), (3) and (4) (d) (3) and (4) only

2. The value of Henry's law constant for some gases at 293 K is given below. Arrange the gases in the increasing order of their solubility.
   He : 144.97 kbar, H_2 : 69.16 kbar,
   N_2 : 76.48 kbar, O_2 : 34.86 kbar
   (a) $He < N_2 < H_2 < O_2$ (b) $O_2 < H_2 < N_2 < He$
   (c) $H_2 < N_2 < O_2 < He$ (d) $He < O_2 < N_2 < H_2$

3. A compound M_pX_q has cubic close packing (*ccp*) arrangement of *X*. Its unit cell structure is shown below.



   The empirical formula of the compound is
   (a) MX (b) MX_2 (c) M_2X (d) M_5X_{14}

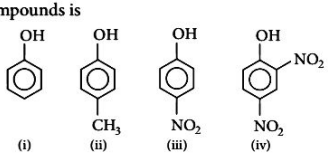
4. The electrolytes usually used in the electroplating of gold and silver, respectively, are
   (a) $[Au(CN)_2]^-$ and $[AgCl_2]^-$
   (b) $[Au(NH_3)_2]^+$ and $[Ag(CN)_2]^-$
   (c) $[Au(CN)_2]^-$ and $[Ag(CN)_2]^-$
   (d) $[Au(OH)_4]^-$ and $[Ag(OH)_2]^-$

5. Match List-I with List-II and select the correct option.

List-I		List-II	
A.	$[Co(NH_3)_6]$ $[Cr(CN)_6]$	(i)	Linkage isomerism
B.	$[Co(NH_3)_3(NO_2)_3]$	(ii)	Solvate isomerism
C.	$[Cr(H_2O)_6]Cl_3$	(iii)	Co-ordination isomerism
D.	*cis*-$[CrCl_2(ox)_2]^{3-}$	(iv)	Optical isomerism

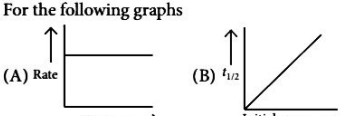
   (a) A-ii, B-i, C-iii, D-iv (b) A-iv, B-ii, C-iii, D-i
   (c) A-iii, B-i, C-ii, D-iv (d) A-i, B-ii, C-iii, D-iv

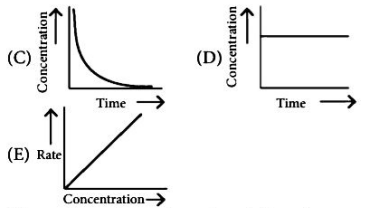
6. The correct order of acidic strength of the following compounds is



   (a) (ii) > (i) > (iii) > (iv) (b) (i) > (ii) > (iii) > (iv)
   (c) (iv) > (iii) > (ii) > (i) (d) (iv) > (iii) > (i) > (ii)

7. For the following graphs

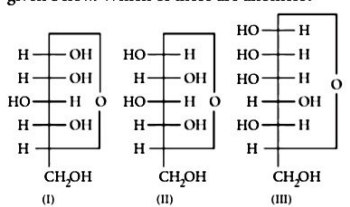




Choose from the options given below, the correct one regarding order of reaction is

(a) (B) and (D) zero order, (E) first order
(b) (A) and (B) zero order, (E) first order
(c) (A) and (B) zero order, (C) and (E) first order
(d) (B) zero order, (C) and (E) first order.

8. Three cyclic structures of monosaccharides are given below. Which of these are anomers?



(a) I and II
(b) II and III
(c) I and III
(d) III is anomer of I and II.

9. Which of the following represents the correct order of increasing pK_a values of the given acids?

(a) $HClO_4 < HNO_3 < H_2CO_3 < B(OH)_3$
(b) $HNO_3 < HClO_4 < B(OH)_3 < H_2CO_3$
(c) $B(OH)_3 < H_2CO_3 < HClO_4 < HNO_3$
(d) $HClO_4 < HNO_3 < B(OH)_3 < H_2CO_3$

10. Match List I with List II and select the correct option.

List I		List II	
A.	Physisorption	I.	Heat of adsorption is 40-400 kJ mol^{-1}
B.	Chemisorption	II.	Heat of adsorption is 20-40 kJ mol^{-1}
C.	$N_{2(g)} + 3H_{2(g)} \xrightarrow{Fe_{(s)}} 2NH_{3(g)}$	III.	Homogeneous catalysis
D.	$2SO_{2(g)} + O_{2(g)} \xrightarrow{NO_{(g)}} 2SO_{3(g)}$	IV.	Heterogeneous catalysis

(a) A - III, B - IV, C - I, D - II
(b) A - II, B - III, C - I, D - IV
(c) A - II, B - I, C-IV, D - III
(d) A - IV, B - II, C - III, D - I

11. The correct order of spin-only magnetic moments among the following is

(Atomic number : Mn = 25, Co = 27, Ni = 28, Zn = 30)

(a) $[ZnCl_4]^{2-} > [NiCl_4]^{2-} > [CoCl_4]^{2-} > [MnCl_4]^{2-}$
(b) $[CoCl_4]^{2-} > [MnCl_4]^{2-} > [NiCl_4]^{2-} > [ZnCl_4]^{2-}$
(c) $[MnCl_4]^{2-} > [CoCl_4]^{2-} > [NiCl_4]^{2-} > [ZnCl_4]^{2-}$
(d) $[NiCl_4]^{2-} > [CoCl_4]^{2-} > [MnCl_4]^{2-} > [ZnCl_4]^{2-}$

12. What are the correct oxidation state, coordination number, configuration, magnetic character and magnetic moment of $K_4[Mn(CN)_6]$?

	O.S.	C.N.	Configuration	Magnetic Character	Magnetic Moment
(a)	+6	6	t_{2g}^5	Diamagnetic	0 B.M.
(b)	+4	6	$t_{2g}^4 e_g^1$	Paramagnetic	1.732 B.M.
(c)	+2	6	t_{2g}^5	Paramagnetic	1.732 B.M.
(d)	+4	6	$t_{2g}^3 e_g^2$	Diamagnetic	0

13. Match List I with List II and select the correct option.

List I (Name of oxo acid)		List II (Oxidation state of 'P')	
(A)	Hypophosphorous acid	(i)	+5
(B)	Orthophosphoric acid	(ii)	+4
(C)	Hypophosphoric acid	(iii)	+3
(D)	Orthophosphorous acid	(iv)	+2
		(v)	+1

(a) (A) – (iv), (B) – (v), (C) – (ii), (D) – (iii)
(b) (A) – (iv), (B) – (i), (C) – (ii), (D) – (iii)
(c) (A) – (v), (B) – (iv), (C) – (ii), (D) – (iii)
(d) (A) – (v), (B) – (i), (C) – (ii), (D) – (iii)

14. Henry's law constant for molality of methane in benzene at 298 K is 4.27×10^5 mm Hg. The mole fraction of methane in benzene at 298 K under 760 mm Hg is

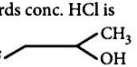
(a) 1.78×10^{-3}
(b) 17.43
(c) 0.114
(d) 2.814

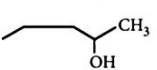
15. Match List I with List II and select the correct option.

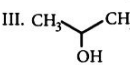
List I (Name of reaction)		List II (Reagent used)	
A.	Hell–Volhard–Zelinsky reaction	I.	$NaOH + I_2$
B.	Iodoform reaction	II.	(i) CrO_2Cl_2, CS_2 (ii) H_2O
C.	Etard reaction	III.	(i) Br_2/red phosphorous (ii) H_2O
D.	Gattermann–Koch reaction	IV.	CO, HCl, anhyd. $AlCl_3$

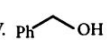
(a) A-I, B-II, C-III, D-IV
(b) A-III, B-I, C-II, D-IV
(c) A-III, B-I, C-IV, D-II
(d) A-III, B-II, C-I, D-IV

16. The order of reactivity of the following alcohols towards conc. HCl is

I. 

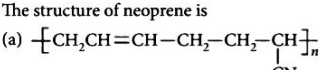
II. 

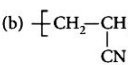
III. 

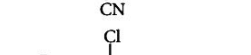
IV. 

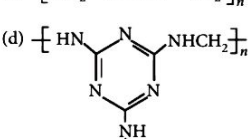
(a) I > II > III > IV (b) I > III > II > IV
(c) IV > III > II > I (d) IV > III > I > II

17. The structure of neoprene is

(a) 

(b) 

(c) 

(d) 

18. Which of the following atomic numbers are the atomic numbers of the inner transition elements?
(A) Atomic number 29 (B) Atomic number 59
(C) Atomic number 74 (D) Atomic number 95
(E) Atomic number 102
(a) (C), (D) and (E) (b) (A), (C) and (D)
(c) (B), (D) and (E) (d) (A), (D) and (E)

19. The rate of a reaction is expressed in different ways as follows :

$$+\frac{1}{2}\frac{d[C]}{dt} = -\frac{1}{3}\frac{d[D]}{dt} = +\frac{1}{4}\frac{d[A]}{dt} = -\frac{d[B]}{dt}$$

The reaction is
(a) $4A + B \rightarrow 2C + 3D$ (b) $B + 3D \rightarrow 4A + 2C$
(c) $A + B \rightarrow C + D$ (d) $B + D \rightarrow A + C$

20. In the following question, a statement of assertion is followed by a statement of reason. Mark the correct choice.
Assertion :Activation energy for both the forward and backward reactions is lowered to the same extent by a catalyst.
Reason : A reaction cannot become fast by itself unless a cataylst is added.
(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true but reason is not the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Both assertion and reason are false.

21. Which one of the following types of drugs reduces fever?
(a) Analgesic (b) Antipyretic
(c) Antibiotic (d) Tranquiliser

22. What type of isomerism exists in the following pairs of complexes?
(i) $[Co(NH_3)_5NO_3]SO_4$ and $[Co(NH_3)_5SO_4]NO_3$
(ii) $[Co(en)(H_2O)_2Cl_2]Cl$ and $[Co(en)(H_2O)Cl_3]H_2O$
(a) (i) Ionisation (ii) Hydrate
(b) (i) Linkage (ii) Hydrate
(c) (i) Ionisation (ii) Linkage
(d) (i) Linkage (ii) Coordination

23. $C_7H_8 \xrightarrow{3Cl_2,\ Heat/h\nu} A \xrightarrow{Fe/Br_2} B \xrightarrow{Zn/HCl} C$
In this reaction, the compound *C* is
(a) 3-bromo-2,4,6-trichlorotoluene
(b) *o*-bromotoluene
(c) *p*-bromotoluene
(d) *m*-bromotoluene.

24. Which of the following gives aldol condensation reaction?

(a) C_6H_5OH (b) $C_6H_5-\overset{O}{\overset{\|}{C}}-C_6H_5$

(c) $CH_3CH_2-\overset{O}{\overset{\|}{C}}-CH_3$ (d) $(CH_3)_3C-\overset{O}{\overset{\|}{C}}-H$

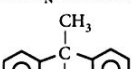
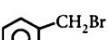
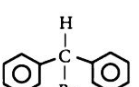
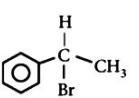
25. Reaction between acetone and methylmagnesium chloride followed by hydrolysis will give

(a) *iso*-propyl alcohol (b) *sec*-butyl alcohol
(c) *tert*-butyl alcohol (d) *iso*-butyl alcohol.

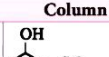
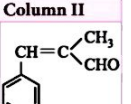
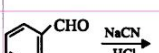
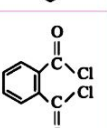
26. A conductivity cell filled with 0.02 M $AgNO_3$ gives at 25°C resistance of 947 ohms. If the cell constant is 2.3 cm^{-1}, what is the molar conductivity of 0.02 M $AgNO_3$ at 25° C?

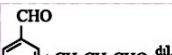
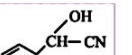
(a) 73.1 Ω^{-1} cm^2 mol^{-1} (b) 100.5 Ω^{-1} cm^2 mol^{-1}
(c) 300.4 Ω^{-1} cm^2 mol^{-1} (d) 121.5 Ω^{-1} cm^2 mol^{-1}

27. In several which of the following is most reactive towards S_N1 reaction?

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

28. Match the column I with column II and mark the appropriate choice.

Column I		Column II	
(A)		(i)	
(B)		(ii)	
(C)		(iii)	

(D)		(iv)	

(a) (A) → (i), (B) → (ii), (C) → (iii), (D) → (iv)
(b) (A) → (iii), (B) → (iv), (C) → (i), (D) → (ii)
(c) (A) → (iv), (B) → (i), (C) → (ii), (D) → (iii)
(d) (A) → (ii), (B) → (iii), (C) → (iv), (D) → (i)

29. $FeCr_2O_4 \xrightarrow{I} Na_2CrO_4 \xrightarrow{II} Cr_2O_3 \xrightarrow{III} Cr$

I, II and III respectively are

	II	III
(a) Na_2CO_3/air, Δ	NH_4Cl, Δ	Al
(b) NaOH/air, Δ	C, heat	C, heat
(c) Na_2CO_3/air, Δ	C, heat	C, heat
(d) NaOH/air, heat	Al, heat	C, heat

30. Reactions with electrode potential data are given below:

$Fe^{3+}_{(aq)} + e^- \rightarrow Fe^{2+}_{(aq)}$; $E^\circ = +0.77$ V

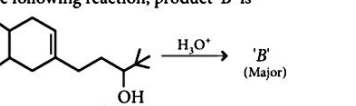
$Al^{3+}_{(aq)} + 3e^- \rightarrow Al_{(s)}$; $E^\circ = -1.66$ V

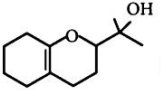
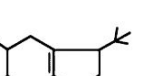
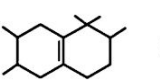
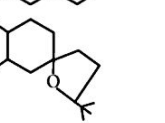
$Br_{2(aq)} + 2e^- \rightarrow 2Br^-_{(aq)}$; $E^\circ = +1.08$ V

Based on the data, the reducing power of Fe^{2+}, Al and Br^- will increase in the order

(a) $Br^- < Fe^{2+} < Al$ (b) $Fe^{2+} < Al < Br^-$
(c) $Al < Br^- < Fe^{2+}$ (d) $Al < Fe^{2+} < Br^-$

31. In the following reaction, product '*B*' is



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

32. What type of crystal defect is indicated in the diagram below?

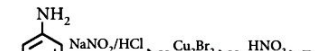
Na^+ Cl^- Na^+ Cl^- Na^+ Cl^-
Cl^- □ Cl^- Na^+ □ Na^+
Na^+ Cl^- □ Cl^- Na^+ Cl^-
Cl^- Na^+ Cl^- Na^+ □ Na^+

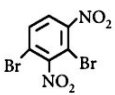
(a) Frenkel defect
(b) Schottky defect
(c) Interstitial defect
(d) Frenkel and Schottky defect

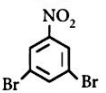
33. For a reaction, $pA + qB \longrightarrow$ products, the rate law expression is $r = k[A]^m[B]^n$, then
(a) $(p + q) \neq (m + n)$
(b) $(p + q) = (m + n)$
(c) $(p + q)$ may or may not be equal to $(m + n)$
(d) $(p + q) > (m + n)$

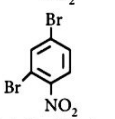
34. Time required to deposit one millimole of aluminium metal by the passage of 9.65 A through molten electrolyte containing aluminium ion is
(a) 30 s (b) 10 s
(c) 30,000 s (d) 10,000 s

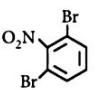
35. The major product Z obtained in the following reaction scheme is



(a) 

(b) 

(c) 

(d) 

36. Match the List-I and List-II and select the correct option.

	List-I		List-II
(A)	$R-\overset{\overset{O}{\|\|}}{C}-Cl \longrightarrow R-CHO$	(i)	Br_2/NaOH
(B)	$R-CH_2-COOH \rightarrow R-\underset{\underset{Cl}{\|}}{CH}-COOH$	(ii)	H_2/Pd–$BaSO_4$
(C)	$R-\overset{\overset{O}{\|\|}}{C}-NH_2 \longrightarrow R-NH_2$	(iii)	Zn(Hg)/ Conc. HCl
(D)	$R-\overset{\overset{O}{\|\|}}{C}-CH_3 \rightarrow R-CH_2-CH_3$	(iv)	Cl_2/Red P, H_2O

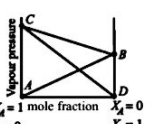
(a) (A)-(iii), (B)-(iv), (C)-(i), (D)-(ii)
(b) (A)-(iii), (B)-(i), (C)-(iv), (D)-(ii)
(c) (A)-(ii), (B)-(iv), (C)-(i), (D)-(iii)
(d) (A)-(ii), (B)-(i), (C)-(iv), (D)-(iii)

37. Which of the following will be colourless in aqueous solution?
(I) Ti^{3+} (II) V^{3+}
(III) Cu^{+} (IV) Mn^{2+}
(V) Co^{2+} (VI) Sc^{3+}
(a) (I), (II) and (IV) (b) (III) and (V)
(c) (II), (IV) and (VI) (d) (III) and (VI)

38. Which of the following compounds are not used as disinfectants?
A. Chloroxylenol B. Bithional
C. Veronal D. Prontosil
E. Terpineol
(a) A, B and E only (b) C and D only
(c) A and B only (d) B, D and E only

39. **Assertion :** The two strands of DNA are complementary to each other.
Reason : Adenine specifically forms hydrogen bonds with guanine whereas cytosine forms hydrogen bonds with thymine.
(a) If both assertion and reason are true and reason is the correct explanation of assertion.
(b) If both assertion and reason are true but reason is not the correct explanation of assertion.
(c) If assertion is true but reason is false.
(d) If both assertion and reason are false.

40. In the mixtures of two miscible volatile liquids obeying Raoult's law, the correct behaviour is explained by



(a) AB stands for the vapour pressure of component B in presence of solute A
(b) CD stands for the vapour pressure of solvent A in presence of solute B
(c) BC stands for the total vapour pressure in accordance with the Dalton's law of partial pressures
(d) all of these.

Case I : Read the given passage and answer the questions from 41 to 45.
When a solution of an α-amino acid is placed in an electric field depending on the pH of the medium, following three cases may happen.

$$\underset{\text{II}}{H_2NCH(R)COO^-} \underset{OH^-}{\overset{H^+}{\rightleftharpoons}} \underset{\text{I}}{H_3\overset{+}{N}CH(R)COO^-}$$

$$\underset{OH^-}{\overset{H^+}{\rightleftharpoons}} \underset{\text{III}}{H_3\overset{+}{N}CH(R)COOH}$$

In alkaline solution, α-amino acids exist as anion II, and there is a net migration of amino acid towards the anode. In acidic solution, α-amino acids exist as cation III, and there is a net migration of amino acid towards the cathode.

If II and III are exactly balanced there is no net migration; under such conditions any one molecule exists as a positive ion and as a negative ion for exactly the same amount of time, and any small movement in the direction of one electrode is subsequently cancelled by an equal movement back toward the other electrode.

In nucleic acid, the particles in nucelus of the cell, responsible for heredity, are called chromosomes which are made up of proteins and another type of biomolecules called nucelic acids.

The organic compounds required in the diet in small amounts to perform specific biological function for normal maintenance of optimum growth and health of the organism are called vitamins.

The following questions are multiple choice questions. Choose the most appropriate answer :

41. 

Arrange *X*, *Y* and *Z* in order of their increasing acidic strengths.

(a) $X > Z > Y$ (b) $Z < X < Y$

(c) $X > Y > Z$ (d) $Z > X > Y$

42. In aqueous solutions, amino acids mostly exist as

(a) $NH_2 - CHR - COOH$

(b) $NH_2 - CHR - COO^-$

(c) $\overset{+}{N}H_3CHRCOOH$

(d) $H_3\overset{+}{N}CH(R)COO^-$

43. Amino acids are least soluble

(a) at pH 1

(b) at pH 7

(c) at their isoelectric points

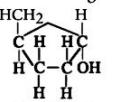
(d) none of these.

44. Which of the following statements is not correct?

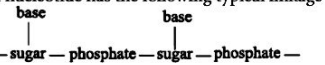
(a) DNA contains four bases *viz* adenine, guanine, cytosine and thymine.

(b) Nucleotides are joined together by phosphodiester linkage between 5′ and 3′ carbon atoms of the pentose sugar.

(c) The structure of a ribose sugar is



(d) A nucleotide has the following typical linkage



45. Match items in Column I with those in Column II and select the correct option.

Column I		Column II	
I.	Pepsin	A.	Genetic material
II.	Nucleic acid	B.	Digestive enzyme
III.	Ascorbic acid	C.	Antibiotic
IV.	Testosterone	D.	Sex hormone
		E.	Vitamin

(a) I—B; II—A; III—C; IV—E

(b) I—B; II—A; III—E; IV—D

(c) I—A; II—B; III—E; IV—C

(d) I—C; II—B; III—A; IV—D

Case I : Read the given passage and answer the questions from 46 to 50.

The EMF *E* is related to change in Gibbs free energy, ΔG as $\Delta G = -nFE$, where *n* is the number of electrons transferred during the redox process and *F* is called Faraday constant whose value is 96,500 C. The redox reaction of an electrochemical cell is spontaneous if EMF of the cell is positive. If the EMF comes out to be negative then the reverse reaction would be spontaneous. Also, for a reaction to be spontaneous, ΔG must be negative and ΔG would be negative only if E_{cell} is positive.

46. For the reduction of silver ions with copper metal, the standard cell potential was found to be +0.46 V at 25°C. The value of standard Gibbs energy, ΔG° will be

(a) – 66.0 kJ (b) – 89.0 kJ

(c) – 56.0 kJ (d) – 59.0 kJ

47. The standard redox potential for the reactions.

$Mn^{2+} + 2e^- \longrightarrow Mn$ and

$Mn^{3+} + e^- \rightarrow Mn^{2+}$ are –1.18 V and 1.51 V respectively. The redox potential for the reaction,

$Mn^{3+} + 3e^- \rightarrow Mn$ will be

(a) – 0.28 V (b) – 0.78 V

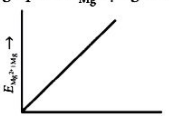
(c) – 0.60 V (d) – 0.56 V

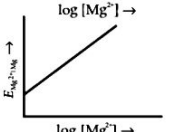
48. For spontaneity of a cell, which of the following is correct?
(a) $\Delta G = 0$ (b) $\Delta G = -ve$
(c) $\Delta G = +ve$ (d) None of these

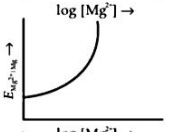
49. Electrode potential for Mg electrode varies according to the equation

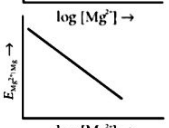
$$E_{Mg^{2+}/Mg} = E^{\circ}_{Mg^{2+}/Mg} - \frac{0.059}{2}\log\frac{1}{[Mg^{2+}]}$$

The graph of $E_{Mg^{2+}|Mg}$ *vs* log $[Mg^{2+}]$ is

(a)


(b)


(c)


(d)


50. Standard reduction electrode potentials of three metals *A*, *B* and *C* are +0.5 V, –3.0 V and –1.2 V respectively. The reducing power of these metals are
(a) $B > C > A$ (b) $A > B > C$
(c) $C > B > A$ (d) $A > C > B$

SOLUTIONS

1. **(c) :** All the given statements are correct.

2. **(a) :** Higher the value of K_H, lower is the solubility of gas in the liquid.

3. **(b) :** 8 *X* atoms are present at the corners.

Atoms contribute to 1 unit cell $= \frac{1}{8}\times 8 = 1$

6 *X* atoms are present at the face centres.

Atoms contribute to 1 unit cell $= 6\times\frac{1}{2} = 3$

Total *X* atoms = 3 + 1 = 4

4 *M* atoms are present at edge centres.

Atoms present in 1 unit cell $= 4\times\frac{1}{4} = 1$

1 *M* atom is present at body centre and it contributes completely to 1 unit cell.

Thus, total *M* atoms in one unit cell = 1 + 1 = 2

Ratio is $M : X :: 2 : 4 :: 1 : 2$

Thus, empirical formula is MX_2.

4. **(c)**

5. **(c) :** NO_2 ligand can donate electron from nitrogen as well as O, so it will show linkage isomerism.

6. **(d)**

7. **(b) :** Graph (A) is for zero order reaction as the rate remains constant at any time.

Graph (B) is for zero order reaction.

According to the formula, $t_{1/2} = \frac{a_0}{2k}$. So, $t_{1/2} \propto a_0$

Graph (E) is for 1st order reaction as the rate of reaction is directly proportional to concentration.

According to the equation, $r = k[A]_t^1 \Rightarrow r \propto [A]_t$

8. **(a) :** Structures (I and II) differ only in the position of OH at C-1 and hence are anomers.

9. **(a) :** More electronegative elements form more stronger acids. Electronegativity of nitrogen and chlorine is almost same still $HClO_4$ is stronger acid than HNO_3 because of higher oxidation state of Cl in $HClO_4$. H_2CO_3 is a stronger acid than $B(OH)_3$ but weaker than HNO_3.

Thus, order of acidic strength is

$HClO_4 > HNO_3 > H_2CO_3 > B(OH)_3$

CHEM CAPSULE

What do chemists call a benzene ring in which hydrogen atoms are replaced by iron atoms?

A FERROUS (FERRIS) WHEEL

Since acidic strength $\propto \frac{1}{pK_a}$

Thus, order of pK_a values is :

$HClO_4 < HNO_3 < H_2CO_3 < B(OH)_3$

10. (c) **11. (c)**

12. (c) : O.S. = + 2, C.N. = 6, configuration = t_{2g}^5

$Mn^{2+} = [Ar]3d^5$

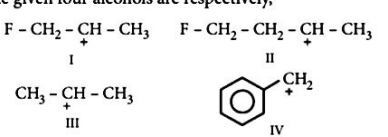
$[Mn(CN)_6]^{4-}$:

It has one unpaired electron and hence it is paramagnetic in nature.

$\mu = \sqrt{1(1+2)} = \sqrt{3} = 1.732$ B.M.

13. (d) **14. (a)** **15. (b)**

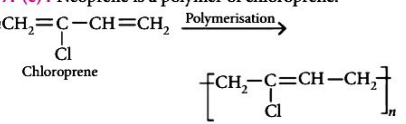
16. (c) : Alcohols react with HX or HCl by the cleavage of C — OH bond resulting in the formation of carbocation intermediate. More the stability of carbocation, more is the reactivity of alcohol. Carbocations produced from the given four alcohols are respectively,



Carbocation IV is more stable due to resonance. An electron withdrawing group decreases the stability of carbocation by virtue of electron withdrawing inductive effect (*–I* effect). Hence carbocation III is more stable than I and II. In carbocation I, electron withdrawing –F is more near to positively charged carbon atom than that in II. Thus carbocation II is comparatively more stable than I.

Therefore, order of stability of carbocations and thus respective order of reactivity of given alcohols towards HCl is given as IV > III > II > I.

17. (c) : Neoprene is a polymer of chloroprene.



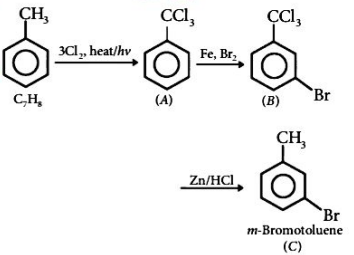
18. (c) : Elements with atomic numbers 59, 95 and 102 are inner transition elements because they belong to lanthanoid and actinoid series.

19. (b) : Minus signs are for reactants and positive signs are for products. Dividing numbers are the stoichiometric coefficients.

20. (c) : Peptization involves conversion of freshly prepared precipitate into colloidal particles using a suitable electrolyte.

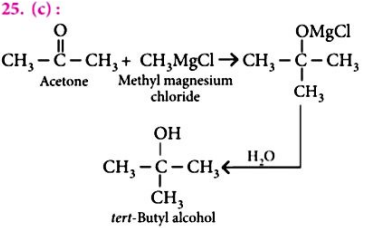
21. (b) **22. (a)**

23. (d) :



24. (c) : Carbonyl compounds containing α-hydrogen atom give aldol condensation.

25. (c) :



26. (d) : Concentration = C = 0.02 M

Resistance of solution = R_{soln} = 947 Ω

Cell constant = G^* = 2.3 cm^{-1}

Molar conductivity = Λ_m = ?

Conductivity of solution $= \kappa = \dfrac{\text{Cell constant}}{R_{soln}}$

$= \dfrac{2.3}{947} = 0.002429\ \Omega^{-1}\,cm^{-1}$

Molar conductivity, $\Lambda_m = \dfrac{\kappa \times 1000}{C}$

$= \dfrac{0.002429 \times 1000}{0.02} = 121.5\ \Omega^{-1}\,cm^2\,mol^{-1}$

27. (a) : Since it is 3° halide, carbocation is stabilised by resonance.

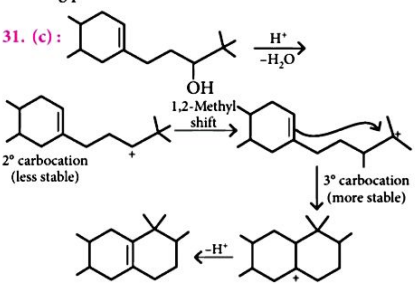
28. (d)

29. (a) : $FeCr_2O_4 + Na_2CO_3 + O_2 \xrightarrow{\text{Heat}} 2Na_2CrO_4$

$\xrightarrow[\text{Heat}]{NH_4Cl} Cr_2O_3 \xrightarrow{2Al} Al_2O_3 + 2Cr$

30. (a) : Lower the reduction potential, more is the reducing power.

31. (c) :



32. (b): As equal number of Na^+ and Cl^- ions are missing from their lattice site, it is Schottky defect.

33. (c)

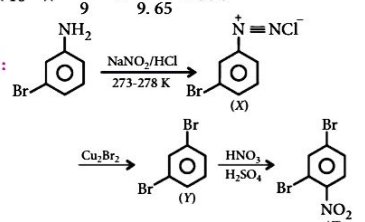
34. (a) : Applying $W = Z \times I \times t$

1 millimole of Al $= 27 \times 10^{-3}$ g

$Z = \dfrac{\text{Eq. wt.}}{96500} = \dfrac{27/3}{96500} = \dfrac{9}{96500}$

$t = 27 \times 10^{-3} \times \dfrac{96500}{9} \times \dfrac{1}{9.65} = 30$ s

35. (c) :



36. (c)

37. (d): (i) $Ti^{3+} - 3d^1\,4s^0$ — 1 unpaired electron

(ii) $V^{3+} - 3d^2\,4s^0$ — 2 unpaired electrons

(iii) $Cu^+ - 3d^{10}\,4s^0$ — No unpaired electron

(iv) $Mn^{2+} - 3d^5\,4s^0$ — 5 unpaired electrons

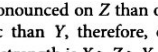
(v) $Co^{2+} - 3d^7\,4s^0$ — 3 unpaired electrons

(vi) $Sc^{3+} - 3d^0\,4s^0$ — No unpaired electron

38. (b) **39. (c)** **40. (d)**

41. (a) : Carboxylic acids are stronger acids than $-\overset{+}{N}H_3$, therefore *X* is the strongest acid. Since –COOH has *–I* effect which decreases with distance therefore, effect is more pronounced on *Z* than on *Y*. As a result *Z* is more acidic than *Y*, therefore, overall order of increasing acidic strength is $X > Z > Y$.

42. (d): In aqueous solutions, amino acids mostly exist as Zwitter ion or dipolar ion.



Zwitter ion

43. (c) : Amino acids are least soluble at their isoelectric points. At a specific pH, called isoelectric point, the positive and negative charges balance each other and the net charge becomes zero. If there is a charge, the amino acid prefers to interact with water, rather than other amino acid molecules, this charge makes it more soluble.

44. (c) **45. (b)**

46. (b): $Cu + 2Ag^+ \longrightarrow Cu^{2+} + 2Ag$

$\Delta G^\circ = -nFE^\circ = -2 \times 96500 \times 0.46 = -88780\ J \approx -89.0\ kJ$

47. (a) : $Mn^{2+} + 2e^- \longrightarrow Mn$; $\Delta G^\circ = -nFE^\circ = 2.36$ F ...(i)

$Mn^{3+} + e^- \longrightarrow Mn^{2+}$; $\Delta G^\circ = -nFE^\circ = -1.51$ F ...(ii)

On adding equations, (i) and (ii), we get

$Mn^{3+} + 3e^- \longrightarrow Mn$; $\Delta G^\circ = 2.36$ F + (−1.51 F)= 0.85 F

$\Delta G^\circ = -nFE^\circ$

$\Rightarrow 0.85\ F = -3 \times F \times E^\circ$

$E^\circ = \dfrac{-0.85}{3} = -0.28$ V

48. (b): For spontaneity of cell, ΔG should be negative.

49. (b): $E_{Mg^{2+}/Mg} = E^\circ_{Mg^{2+}/Mg} + \dfrac{0.059}{2}\log[Mg^{2+}]$

Compare this equation with the equation of straight line $y = mx + c$.

The graph of $E_{Mg^{2+}/Mg}$ *vs* $\log[Mg^{2+}]$ is a straight line with a positive slope and intercept = $E^\circ_{Mg^{2+}/Mg}$.

50. (a)

Unique Career in Demand

Explore the available Unique Career Options!

B.Sc. Clinical Research and Healthcare Management

This programme oversees the study designs, great clinical practice rules, preliminary clinical guidelines, and research techniques involved in delivering a potential medicine from the lab to the marketplace. It is a 3-year undergraduate degree programme that combines the fields of clinical research and healthcare management. The first year is spent learning the fundamentals of management sciences, while the second and third years are focused on specialising in topics related to healthcare and clinical research. Students from this programme could perform a vital role in researching the pharmacology, biochemical causes of disease and evaluating new medications and treatment techniques.

Eligibility

- Admission to this programme is either merit-based or entrance exam-based. To apply for the programme, students need to have completed their 10+2 from a recognised board with a minimum of 50% marks in aggregate.

Prospects

- This programme manages the clinical preliminary guidelines, great clinical practice rules, study plans and research approach associated with bringing a potential medication from the lab to the market. An imaginative educational plan of this programme will empower understudies to get essential clinical aptitudes for completing moral research with logical legitimacy and furthermore to ensure the rights, security and prosperity of patients partaking in clinical preliminaries.

Recruiters

Bioengineering Companies : Serum Institute of India, Panacea Biotec Ltd., Bharat Serums and Vaccines Ltd., etc.

- CROs : Excel Life Sciences Pvt. Ltd., Clinigene, IQVIA, Parexel, etc.
- Hospitals : Apollo Hospitals, Max Healthcare, Fortis Healthcare, etc.
- Life-Division of IT Companies : Accenture, TCS, Cognizant, etc.
- Pharma Company : Cipla, Novartis, Ranbaxy Laboratories, etc.
- Medical Device Companies : Abbott Laboratories, Johnson & Johnson, Siemens Healthineers, General Electric, etc.
- Medical Colleges : AIIMS, BAMC, Maulana Azad Medical College, etc.
- Cosmetic Companies : Biotique, Lakmé Cosmetics, Sugar Cosmetics, Mamaearth, etc.

Jobs

Clinical Research Associates : To monitor clinical trials, ensure compliance with the clinical trial protocol, checks clinical sites activities, make on-site visits, CRFs.

- Clinical Research Investigators : Conduct BA/BE studies, writing/revising SOP, review of protocols, investigators brochures, ICF and CRFs Protocol, CRF and ICF preparations plans and conduct of BA/BEIEC/IRB affairs-GC.
- Study Coordinators : Provides safety and protection while collecting and managing the study data.
- Data Manager/Biostatistician : Design, study and predict the seriousness of the disease, evaluate new treatment and effectiveness of medication, participate in research design, data collection, choosing and implementing appropriate methodologies, interpreting the results.
- Regulatory Affairs Managers : Review and registration of documents, evaluation of technical data, liaison with regulatory authorities.
- Business Development Manager : Identify potential clients, establish business relations, responsible for meeting new clients, following up on leads, market research.
- Medical Writer : Documentation, manuscripts, abstracts, external communication tools.

College Info

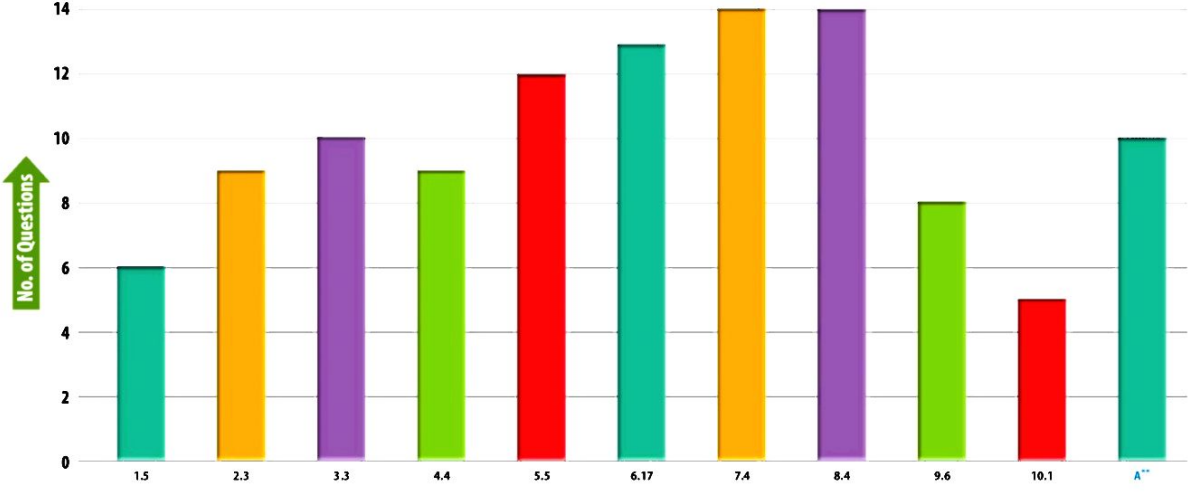
ICRI - Institute of Clinical Research (India), Mumbai

ICRI is a leading institution in India with more than 14 campuses, 4 centres of excellence and global alumnus of more than 19,000+ students. ICRI's B.Sc. Clinical Research and Healthcare Management programme is an award-winning programme and is India's first and till date the most sought-after programme within the science fraternity. This programme trains students in both Clinical Research and Healthcare sector. ICRI has been India's first and most awarded institution in Clinical Research and Healthcare since 2004. With a pan-India presence and association with leading institutions in India, ICRI focuses on futuristic industries that are specifically designed to make student job-ready.

Are You Ready for NEET 2024?

Class 12

Past 10 Years (2014-2023) Chapterwise Trend Analysis of NEET Questions



*These are the NCERT topics from where maximum number of questions have been asked in the past 10 years.

**A represents the topic 'Group 17 Elements'

***Chapter 'Principles Related to Practical Chemistry' is newly introduced in NEET Syllabus from the year of 2024.

Methods of Expressing the Concentration of Solutions

Molarity

$$\frac{w_{solute} \times 1000}{M_{solute} \times V_{soln}(\text{in mL})}$$

Molality

$$\frac{w_{solute} \times 1000}{M_{solute} \times w_{solvent}(\text{in g})}$$

Mass percentage

$$\frac{\text{Weight of solute}}{\text{Weight of solution}} \times 100$$

Volume percentage

$$\frac{\text{Volume of solute}}{\text{Volume of solution}} \times 100$$

Solution of Gas in a Liquid

Henry's law

The partial pressure of the gas in vapour phase (p) is proportional to the mole fraction of the gas (x) in the solution and is expressed as :

$$p = k_H x$$

Solution of a Liquid in a Liquid

Raoult's law

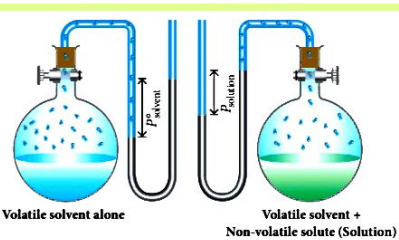
For a solution of volatile liquids, the partial vapour pressure of each component of the solution is directly proportional to its mole fraction present in solution, *i.e.*, $p = p^\circ x$.

Colligative Properties

Relative lowering of vapour pressure

$$\frac{p_A^\circ - p_A}{p_A^\circ} = x_B = \frac{n_B}{n_A + n_B} = \frac{n_B}{n_A} = \frac{W_B \times M_A}{M_B \times W_A}$$

($\because$ for dilute solutions, $n_B << n_A$)



Elevation in boiling point

$$\Delta T_b = T_b - T_b^\circ$$

$$\Delta T_b \propto m \text{ or } \Delta T_b = K_b m = K_b\left(\frac{W_B \times 1000}{M_B \times W_A}\right) \text{ or } M_B = \frac{W_B \times K_b \times 1000}{\Delta T_b \times W_A}$$

K_b is called molal elevation constant having unit K kg mol^{-1}.

Depression in freezing point

$$\Delta T_f = T_f^\circ - T_f$$

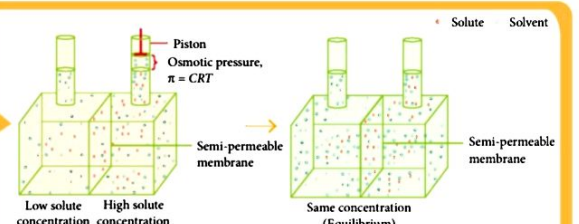
$$\Delta T_f \propto m \text{ or } \Delta T_f = K_f m = K_f\left(\frac{W_B \times 1000}{M_B \times W_A}\right) \text{ or } M_B = \frac{K_f \times W_B \times 1000}{\Delta T_f \times W_A}$$

K_f is known as molal depression constant having unit K kg mol^{-1}.

Osmosis and osmotic pressure

$$\pi = CRT = \left(\frac{n_B}{V}\right)RT$$

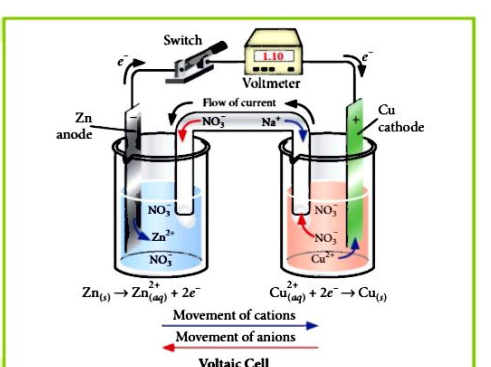
$$\pi V = \frac{W_B RT}{M_B} \text{ or } M_B = \frac{W_B RT}{\pi V}$$



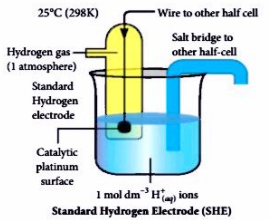
02 Electrochemistry

Electrochemical Cells

Electrochemical cells are the devices in which chemical energy of a spontaneous redox reaction is converted into electrical energy. These are also called Galvanic cells or Voltaic cells.



Measurement of Electrode Potential



Standard Hydrogen Electrode (SHE)

Absolute value of electrode potential cannot be determined because oxidation or reduction half reaction cannot occur alone. Moreover, a reference electrode is required. Standard Hydrogen Electrode is used as a reference electrode when calculating the standard electrode potential of a half-cell.

An electrode in which pure and dry hydrogen gas is bubbled at 1 atm pressure around a platinised platinum plate immersed in 1 M H^+ ion solution is called Standard Hydrogen Electrode (SHE).

Electrochemical Series

The arrangement of electrodes in contact with their ions with the electrode half reactions in order of decreasing standard potentials is called electrochemical series.

Nernst Equation

For a general reaction $M^{n+}_{(aq)} + ne^- \longrightarrow M_{(s)}$

Nernst equation is written as $E = E^\circ - \frac{RT}{nF} \ln \frac{[M]}{[M^{n+}]}$

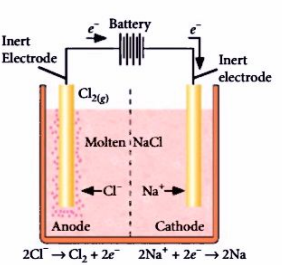
Electrolytic Cells and Electrolysis

- Electrolytic cells are the cells in which electricity is passed through the solution of an electrolyte so as to bring about redox reaction.
- Electrolysis is defined as the process of chemical decomposition of an electrolyte in solution or molten state, by passage of electricity.

Faraday's Law of Electrolysis

- **Faraday's first law :** "Weight of ions deposited proportional to the quantity of electricity passed" *i.e.*, $w \propto Q$ or $w = ZQ = Zit$
- **Faraday's second law :** "When same quantity of electricity is passed through different electrolytes, the amount of different substances deposited at the electrodes is directly proportional to their equivalent weights" *i.e.*,

$$\frac{w_1}{w_2} = \frac{E_1}{E_2} \text{ or } \frac{Z_1 It}{Z_2 It} = \frac{E_1}{E_2} \text{ or } \frac{Z_1}{Z_2} = \frac{E_1}{E_2}$$



Electrolytic Cell

Integrated Rate Law, Half Life and Unit of Rate Constant for the Reactions of Different Orders

Order	Integrated Rate Law	Half-life	Unit of Rate Constant
Zero	$[A]_t = -kt + [A]_0$	$t_{1/2} = [A]_0/2k$	mol L^{-1} s^{-1}
First	$\ln[A]_t = -kt + \ln [A]_0$	$t_{1/2} = 0.693/k$	s^{-1}
Second	$1/[A]_t = kt + 1/[A]_0$	$t_{1/2} = 1/k\,[A]_0$	L mol^{-1} s^{-1}

Arrhenius Equation

Calculation of Activation Energy

Arrhenius proposed a quantitative relationship between rate constant and temperature as $k = Ae^{-E_a/RT}$

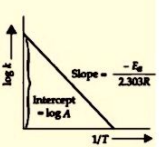
k = rate constant, A = pre-exponential factor (called frequency factor),

E_a = activation energy, T = temperature

The minimum energy that the reacting molecule must possess before undergoing a reaction is called activation energy.

$k = Ae^{-E_a/RT}$ (Arrhenius equation)

$$2.303 \log k = 2.303 \log A - \frac{E_a}{RT}$$



$$\log k = \log A - \frac{E_a}{2.303R}\left(\frac{1}{T}\right)$$

When log k is plotted against $1/T$,

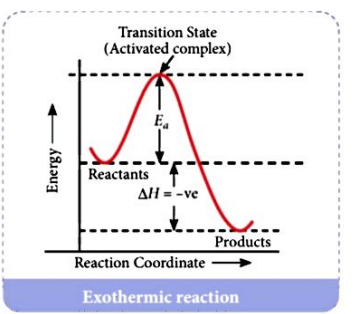
$$\text{slope} = -\frac{E_a}{2.303R}$$

$E_a = -2.303R \times \text{slope}$

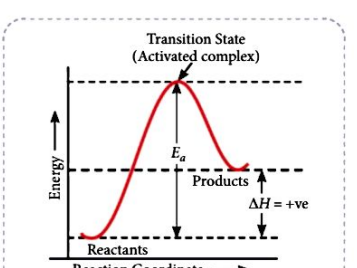
Alternatively, let k_1 and k_2 be the rate constants for the reaction at two different temperatures T_1 and T_2 respectively.

$$\log \frac{k_2}{k_1} = \frac{E_a}{2.303R}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$$

Energy Diagrams

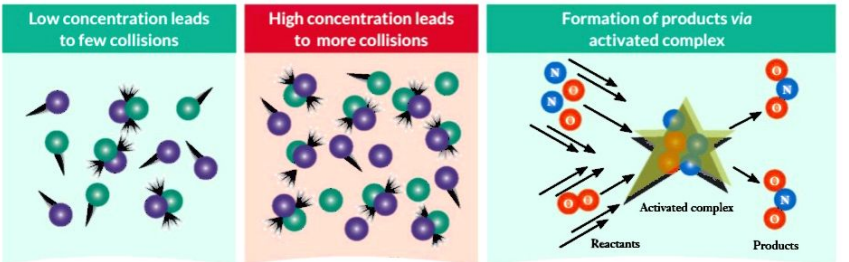


Exothermic reaction



Endothermic reaction

Collision Theory of Chemical Reactions

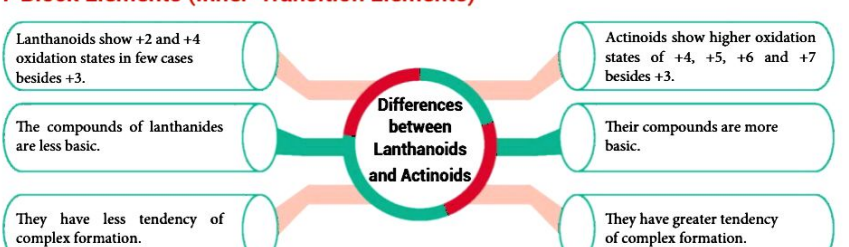


04 The *d*- and *f*-Block Elements

General Properties of the Transition Elements (*d*-Block)

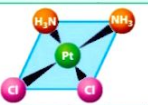
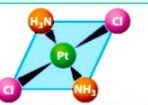
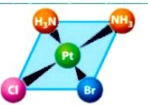
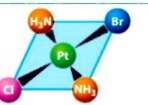
Property	Trends
Magnetic properties	Transition metal ions and their compounds are paramagnetic due to the presence of unpaired electrons in the $(n-1)d$-orbitals.
Formation of coloured ions	Transition metal compounds are coloured both in solid state and in aqueous solutions due to *d*-*d* transitions of unpaired electrons. 
Formation of complex compounds	Form a large number of complexes due to large charge/size ratio and availability of empty *d*-orbitals.

f-Block Elements (Inner-Transition Elements)



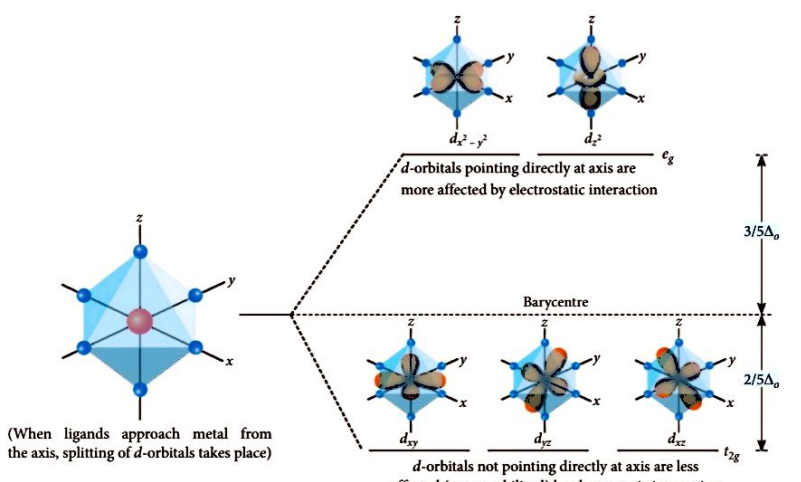
Isomerism in Coordination Compounds

Geometrical Isomerism in Square Planar Complexes

Type	Example	
	Cis-Isomer	*Trans*-Isomer
MA_2B_2		
MA_2BC		

Crystal Field Theory

***d*-orbitals and Ligands Interaction (Octahedral Complex)**



Methods of Preparation of Haloalkanes

- **From alkanes**

$$R-H \xrightarrow[X_2,\ h\nu,\ 250-400^\circ C]{\text{By halogenation}} R-X + HX$$

- **From alkenes**

$$R-CH=CH_2 \xrightarrow{HX} \begin{cases} \xrightarrow{\text{Peroxide}} R-CH_2-CH_2X\ [X=Br] \\ \rightarrow R-CHX-CH_3 \end{cases}$$

- **From alcohols**

$$R-OH \xrightarrow{PCl_5} R-Cl + POCl_3 + HCl$$
$$R-OH \xrightarrow{\text{Red } P/Br_2} R-Br + PBr_3$$
$$R-OH \xrightarrow{SOCl_2} R-Cl + SO_2\uparrow + HCl\uparrow$$

- **Halide exchange method :**
  - **Finkelstein reaction :**

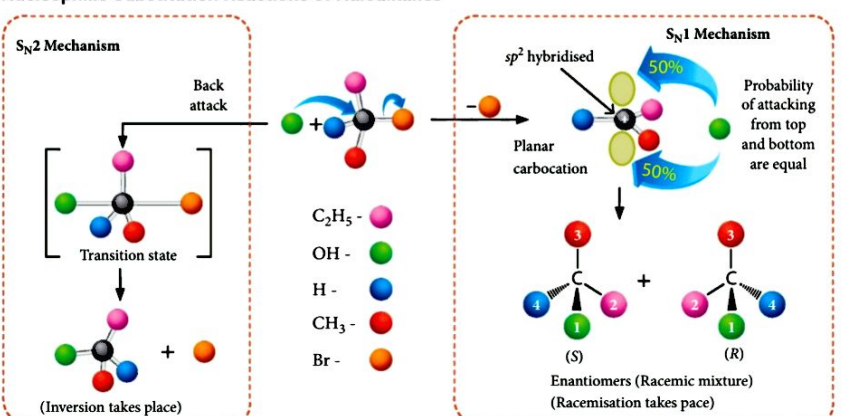
$$R-X + NaI \xrightarrow{\text{Dry acetone}} R-I + NaX$$

  - **Swarts reaction :**

$$RX + AgF \longrightarrow R-F + AgBr$$

Chemical Properties of Haloalkanes

Nucleophilic Substitution Reactions of Haloalkanes



Stereochemistry

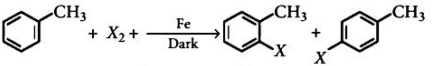
Compounds having similar physical and chemical properties but differ in the behaviour towards plane polarised light are called optical isomers and the phenomenon is called optical isomerism.

Compounds that have the ability to rotate the plane polarised light to the right (clockwise) are dextro-rotatory or to the left (anti-clockwise) are laevo-rotatory. These substances are optically active substances.

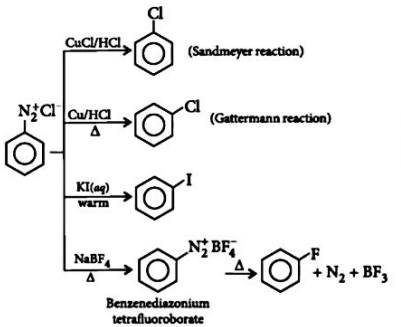
In order to exhibit optical activity, an object must be chiral.

Methods of Preparation of Haloarenes

- **By Electrophilic substitution of hydrocarbons**



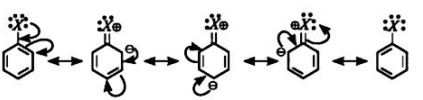
- **From Benzenediazonium Salt :**



Chemical Properties of Haloarenes

Nucleophilic Aromatic Substitution Reactions

- As compared to alkyl halides, aryl halides are very less reactive towards nucleophilic substitution.
- The low reactivity of haloarenes can be explained on the basis of :
  - **Delocalisation of electrons by resonance**



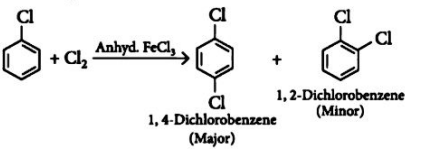
(*A*) (*B*) (*C*) (*D*) (*E*)

The haloarenes are stabilised by resonance. Structures *B*, *C* and *D* show a double bond between carbon and chlorine (halogen) atom which strengthens the bond and makes it more stable towards nucleophilic substitution.

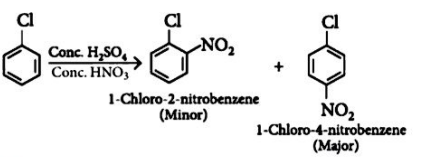
- **Difference in hybridisation of carbon atom in C–*X* bond :** The sp^2 hybridised carbon of aryl halide is more electronegative than that of sp^3 hybridised carbon of alkyl halide. Hence, the *C*–*X* bond is shorter and stronger resulting in lower reactivity.

Electrophilic Substitution Reactions

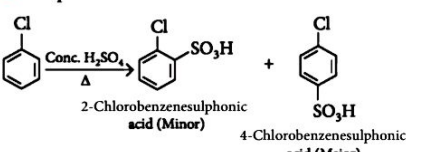
- **Halogenation :**



- **Nitration :**



- **Sulphonation :**



07 Alcohols, Phenols and Ethers

- Alcohols are hydroxy derivatives of hydrocarbons, formed by the replacement of one or more hydrogen atoms by a corresponding number of hydroxyl groups (–OH).

$$\underset{\text{Hydrocarbon}}{R-H} \xrightarrow[-H]{+OH} \underset{\text{Alcohol}}{R-OH}$$

- The compounds in which hydroxyl group is attached to a saturated carbon atom are called as alcohols. However, if a hydroxyl group is attached to a benzene ring, the compound is called as phenol.

Methods of Preparation of Alcohols

- **From alkene :**

$$CH_3-CH=CH_2 \xrightarrow[H_2SO_4]{H_2O} CH_3-\underset{OH}{CH}-CH_3$$

- **From aldehydes or ketones :**

$$\underset{\text{Ketone}}{RCOR} \xrightarrow[H_2/Ni \text{ or}]{\text{Reduction}} \underset{2^\circ \text{ alcohol}}{RCHOHR}$$

$$RCHO \xrightarrow{\text{Reduction}} \underset{1^\circ \text{ alcohol}}{RCH_2OH}$$

- **By hydroboration oxidation of alkenes :**

$$3RCH=CH_2 \xrightarrow{BH_3 \text{ in THF}} (RCH_2CH_2)_3B$$

$$\xrightarrow{H_2O_2,\ OH} 3RCH_2CH_2OH + B(OH)_3$$

Chemical Properties of Alcohols

Reactions Involving Cleavage of O–H Bond

$$\underset{\text{Alcohol}}{R-\ddot{\underset{\cdot\cdot}{O}}-H} + \underset{\text{Base}}{B:} \rightleftharpoons \underset{\text{Alkoxide ion}}{R-\ddot{O}:^-} + \underset{\text{Protonated base}}{B-H}$$

- **Ester formation :**

$$R-\overset{O}{\overset{\|}{C}}-O-H + H-O-R' \xrightleftharpoons{\text{Conc. } H_2SO_4} RCOOR' + H_2O$$

The order of ease of formation of ester :

$CH_3OH > 1^\circ > 2^\circ > 3^\circ$ alcohol

- **Reaction with acid chlorides :**

$$R'CO\text{-}\boxed{Cl + H}\text{-}OR \longrightarrow \underset{\text{Ester}}{R'COOR} + HCl$$

Acid chloride

Reactions Involving Alcohol Molecule as a Whole

- **Dehydration of alcohols :**

$$CH_3CH_2OH \xrightarrow[383\ K]{H_2SO_4} \underset{\text{Ethyl hydrogensulphate}}{C_2H_5OSO_2OH} + H_2O$$

$$CH_3CH_2OH \xrightarrow[443\ K]{H_2SO_4} \underset{\text{Ethylene}}{CH_2=CH_2} + H_2O$$

$$CH_3CH_2OH \xrightarrow[413\ K]{H_2SO_4} \underset{\text{Diethyl ether}}{C_2H_5OC_2H_5} + H_2O$$

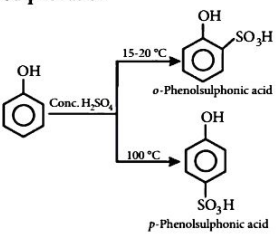
- **Action of copper :** When vapours of 1°, 2° and 3° alcohols are passed over hot reduced copper at 300°C, they give different products.

Chemical Properties of Phenols

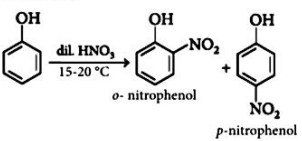
Electrophilic Substitution Reactions of Phenols

The hydroxyl group in phenol is *o*– and *p*– directing and it activates the benzene nucleus towards electrophilic substitutions.

- **Sulphonation**

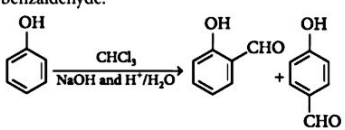


- **Nitration**



- **Reimer–Tiemann Reaction**

Phenol reacts with chloroform and aqueous alkali followed by hydrolysis to yield a hydroxy benzaldehyde.



Chemical Properties of Ethers

- **Action of dil. H_2SO_4 :**

$$CH_3OCH_3 \xrightarrow{\text{dil. } H_2SO_4} 2CH_3OH$$

- **Action of conc. H_2SO_4 :**

$$R-OR + \text{conc. } H_2SO_4 \longrightarrow 2RHSO_4$$

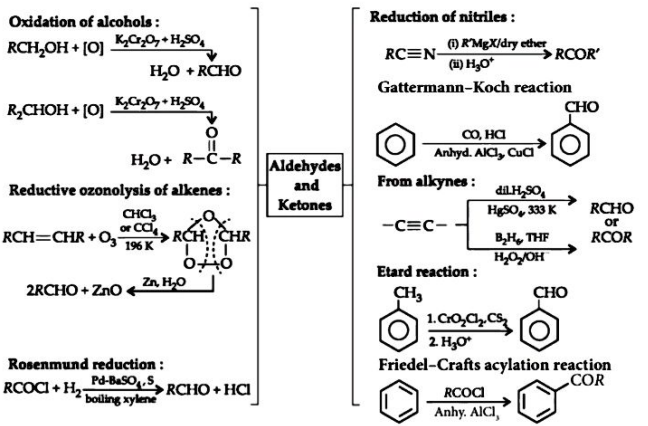
- **Action of PCl_5 :**

$$R-O-R + PCl_5 \xrightarrow{\Delta} 2RCl + POCl_3$$

- **Action of acid chloride and acid anhydride :**

$$R-O-R + CH_3COCl \xrightarrow[AlCl_3]{ZnCl_2 \text{ or}} RCl + CH_3COOR$$

Preparation of Aldehydes and Ketones



Chemical Reactions of the Carbonyl Group

Nucleophilic Addition Reactions

- $>C=O \xrightarrow{NaHSO_3} >C(OSO_2Na)(OH)$ (Bisulphite)
- $>C=O \xrightarrow[(ii)\ H_3O^+]{(i)\ RMgX} >C(R)(OH)$ (Alcohol)

Nucleophilic Addition-Elimination Reactions

- $>C=O \xrightarrow[(ii)\ \Delta]{(i)\ NH_3} >C=NH$ (Imine)
- $>C=O \xrightarrow[(ii)\ \Delta]{(i)\ NH_2-Z} >C=N-Z$

Aldol Condensation

$$2R-\overset{\alpha}{C}H_2-C(=O)-H \xrightarrow{dil.\ NaOH} R-CH_2-CH(OH)-CH(R)-C(=O)-H$$ (Aldol)

$$R-CH_2-CH=C(R)-C(=O)-H \xleftarrow[\Delta]{-H_2O}$$ (Aldol)

α,β-Unsaturated aldehyde

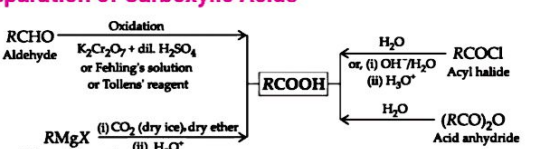
Cannizzaro's Reaction

- Aldehydes containing no α-hydrogen atom on warming with 50% NaOH or KOH undergo disproportionation *i.e.*, self oxidation-reduction known as Cannizzaro's reaction.

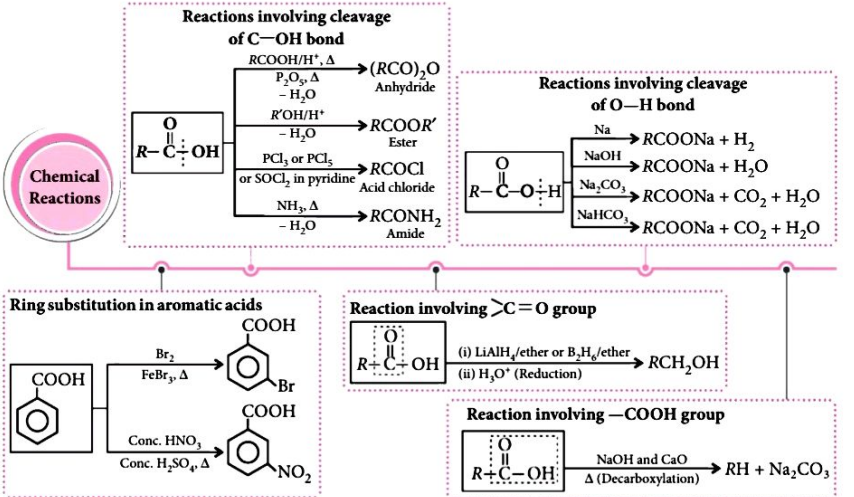
$$2HCHO + NaOH \xrightarrow{50\%\ NaOH} HCOONa + CH_3OH$$

$$2C_6H_5CHO + NaOH \xrightarrow{50\%\ NaOH} C_6H_5COONa + C_6H_5CH_2OH$$

Methods of Preparation of Carboxylic Acids



Chemical Reactions of Carboxylic Acids

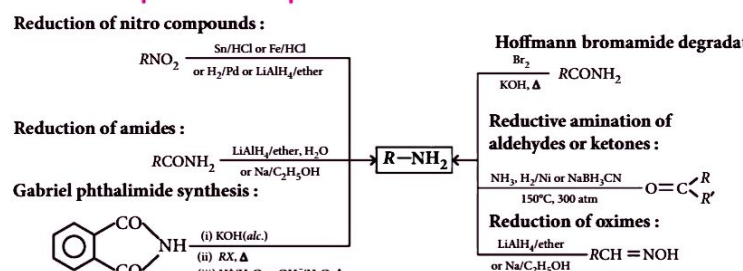


09 Amines

Amines

Amines are alkyl or aryl derivatives of ammonia. When hydrogen atoms of ammonia are replaced by one, two or three aromatic rings, they are called as 1°, 2° and 3° aryl amines respectively.

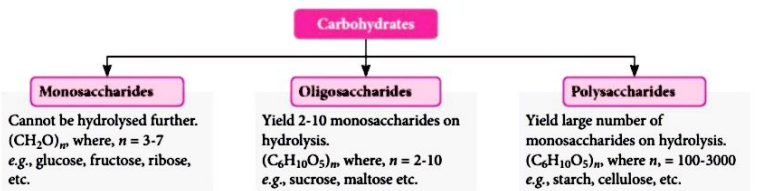
Methods of Preparation of Aliphatic Amines



Carbohydrates

Carbohydrates are defined as optically active polyhydroxy aldehydes or ketones or substances which give such units on hydrolysis and contain at least one chiral carbon. Most of them have a general formula, $C_x(H_2O)_y$ and were considered as hydrates of carbon from where the name carbohydrates was derived. They occur naturally in animal and plant kingdom and are composed of carbon, hydrogen and oxygen only.

On the basis of their behaviour on hydrolysis :



On the basis of reducing properties :

- **Reducing sugars :** Contain **free** aldehydic or ketonic group and **reduce** Fehling's solution and Tollens' reagent. All monosaccharides and disaccharides having free aldehydic or ketonic group are reducing sugars. *e.g.*, maltose and lactose.
- **Non-reducing sugars : Do not** have free aldehydic or ketonic group and **do not reduce** Fehling's solution and Tollens' reagent. In disaccharides, if the reducing groups of monosaccharides, *i.e.* aldehydic or ketonic groups are bonded, they are non-reducing in nature. *e.g.*, sucrose.

Proteins

Proteins are the polymers of about twenty different α-amino acids connected by a peptide bond.

A**

The *p*-Block Elements (Group 15 to 18)

(This chapter is not part of latest NCERT Textbooks.)**

- The electronic configuration of *p*-block elements (Group 15 to 18) is $ns^2np^{3\text{ to }6}$ (n = 2 to 7).

General Trends for Group 15 Elements :

Hydrides :

- **Bond angle, Thermal stability and Basic strength :** $NH_3 > PH_3 > AsH_3 > SbH_3 > BiH_3$
- **B.Pt. :** $PH_3 < AsH_3 < NH_3 < SbH_3 < BiH_3$
- **M.Pt. :** $PH_3 < AsH_3 < SbH_3 < NH_3$
- **Reducing nature :** $NH_3 < PH_3 < AsH_3 < SbH_3 < BiH_3$

Halides :

- **Stability :** $NF_3 > NCl_3 > NBr_3$
- **Lewis base strength :** $NI_3 > NBr_3 > NCl_3 > NF_3$

General Trends for Group 16 Elements :

Hydrides :

- **Bond angle and Thermal stability :** $H_2O > H_2S > H_2Se > H_2Te$
- **Volatility :** $H_2S > H_2Se > H_2Te > H_2O$
- **Acidic strength and Reducing nature :** $H_2O < H_2S < H_2Se < H_2Te$

Halides :

- **Stability :** $SF_6 > SeF_6 > TeF_6$

Oxides :

- **Acidic nature :**
  $SO_2 > SeO_2 > TeO_2 > PoO_2$
  $SO_3 > SeO_3 > TeO_3$

General Trends for Group 17 Elements :

- **Oxidising power :** $F_2 > Cl_2 > Br_2 > I_2$
- **Bond energy :** $Cl_2 > Br_2 > F_2 > I_2$
- **Electron gain enthalpy :** $Cl > F > Br > I$

Hydrogen halides :

- **B.Pt. and M.Pt. :** $HF > HI > HBr > HCl$
- **Dipole moment, Bond dissociation energy and Thermal stability :** $HF > HCl > HBr > HI$
- **Bond length, Acidic strength and Reducing nature :**
  $HF < HCl < HBr < HI$

Oxoacids of halogens :

- **Acidic strength :**
  $HClO < HClO_2 < HClO_3 < HClO_4$
  $HOCl > HOBr > HOI$
  $HClO_3 > HBrO_3 > HIO_3$

General Trends for Group 18 Elements :

- **M.Pt., B.Pt., Ease of liquefaction, Solubility, Adsorption and Polarizability :** $He < Ne < Ar < Kr < Xe$
- **Thermal conductivity :** $He > Ne > Ar > Kr > Xe$

***

Principles Related to Practical Chemistry

(* This chapter is newly introduced in NEET syllabus from the year of 2024.)**

Colours of Beads in Borax Bead Test

Colour of bead in oxidising flame	Ion indicated
Green in hot, blue in cold	Copper
Pinkish violet in both hot and cold	Manganese
Yellowish brown in hot and pale yellow in cold	Iron
Brown in hot and pale brown in cold	Nickel

Distinction Test

Test	Phenol	Alcohol
Blue litmus test	Turns red	×
$FeCl_3$ test	Gives blue, violet, green or red colouration	×
Azo dye test	Forms orange-red colour dye	×
Br_2-water test	Gives white ppt.	×

Test	Phenol	Carboxylic acid
$NaHCO_3$ test	×	Gives brisk effervescence

Test	Aldehyde	Ketone
Tollens' test	Gives shiny silver mirror	×
Fehling's solution test	Gives red ppt.	×
Schiff's reagent test	Gives pink colour	×
Reduction with $LiAlH_4$	Reduced to 1° alcohol	Reduced to 2° alcohol
Peroxy acid (Caro's acid, peroxy benzoic acid)	Acid is formed.	Ester is formed.

Enthalpy of Solution of $CuSO_4$

It is the heat change involved during the dissolution of one mole of a solute in such a large excess of solvent so that no further heat change occurs on dilution.

$$CuSO_{4(s)} + H_2O \longrightarrow CuSO_{4(aq)}$$

Dissolution of $CuSO_4$ in water is exothermic. The enthalpy of solution of $CuSO_{4(s)}$ is calculated from the highest temperature attained during its dissolution.

Calculations : If dissolution of w g of $CuSO_4$ in 200 g solvent (water) causes Δt °C change in temperature, then

Heat evolved (q) = Mass × Specific heat × Change in temperature

$q = (200 + W) \times 4.2 \times \Delta t$ J

where, W is water equivalent of calorimeter.

Exam on 28th April 2024

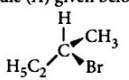
WB JEE

PRACTICE PAPER 2024

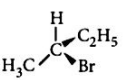
CATEGORY-I (Q. 1 to 30)

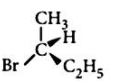
Carry-1 mark each. Only one option is correct. Negative marks : 1/4.

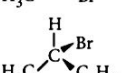
1. Which of the following structures is enantiomeric with the molecule (*A*) given below?

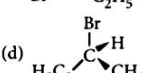


(*A*)

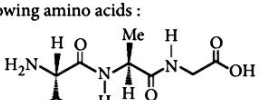
(a) 

(b) 

(c) 

(d) 

2. The following tripeptide can be synthesized from the following amino acids :



(a) Glycine, Leucine and Alanine
(b) Alanine, Isoleucine and Glycine
(c) Valine, Alanine and Glycine
(d) Alanine, Serine and Glycine

3. The threshold frequency of a metal corresponds to the wavelength of *x* nm. In two separate experiments '*A*' and '*B*', incident radiations of wavelength $\frac{1}{2}x$ nm and $\frac{1}{4}x$ nm respectively are used.

The ratio of kinetic energies of the released electrons in experiment '*B*' to that in experiment '*A*' is

(a) $\frac{1}{3}$ (b) 2 (c) 4 (d) 3

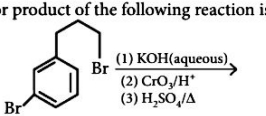
4. The correct order of the spin-only magnetic moment of metal ions in the following low-spin complexes, $[V(CN)_6]^{4-}$, $[Fe(CN)_6]^{4-}$, $[Ru(NH_3)_6]^{3+}$, and $[Cr(NH_3)_6]^{2+}$, is

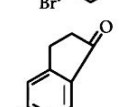
(a) $Cr^{2+} > Ru^{3+} > Fe^{2+} > V^{2+}$
(b) $V^{2+} > Ru^{3+} > Cr^{2+} > Fe^{2+}$
(c) $Cr^{2+} > V^{2+} > Ru^{3+} > Fe^{2+}$
(d) $V^{2+} > Cr^{2+} > Ru^{3+} > Fe^{2+}$

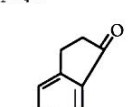
5. At 35 °C, the vapour pressure of CS_2 is 512 mm Hg and that of acetone is 344 mmHg. A solution of CS_2 in acetone has a total vapour pressure of 600 mmHg. The false statement amongst the following is

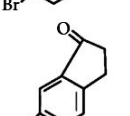
(a) heat must be absorbed in order to produce the solution at 35°C
(b) a mixture of 100 mL CS_2 and 100 mL acetone has a volume < 200 mL
(c) CS_2 and acetone are less attracted to each other than to themselves
(d) Raoult's law is not obeyed by this system.

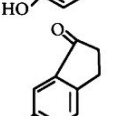
6. The major product of the following reaction is



(a) 

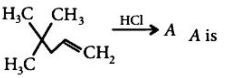
(b) 

(c) 

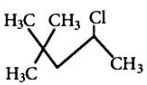
(d) 

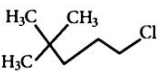
7. $H_2O + H_3PO_4 \rightleftharpoons H_3O^+ + H_2PO_4^-$, $pK_1 = 2.15$
$H_2O + H_2PO_4^- \rightleftharpoons H_3O^+ + HPO_4^{2-}$, $pK_2 = 7.20$
hence pH of 0.01 M NaH_2PO_4 is
(a) 9.35 (b) 4.675 (c) 2.675 (d) 7.350

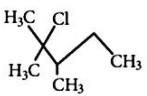
8. The charge/size ratio of a cation determines its polarizing power. Which one of the following sequences represents the increasing order of the polarizing power of the cationic species, K^+, Ca^{2+}, Mg^{2+}, Be^{2+}?
(a) $Ca^{2+} < Mg^{2+} < Be^+ < K^+$
(b) $Mg^{2+} < Be^{2+} < K^+ < Ca^{2+}$
(c) $Be^{2+} < K^+ < Ca^{2+} < Mg^{2+}$
(d) $K^+ < Ca^{2+} < Mg^{2+} < Be^{2+}$

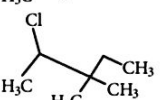
9. 

A is

(a) 

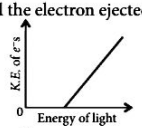
(b) 

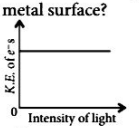
(c) 

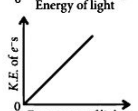
(d) 

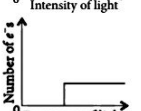
10. Complex *X* of composition $Cr(H_2O)_6Cl_n$ has a spin only magnetic moment of 3.83 BM. It reacts with $AgNO_3$ and shows geometrical isomerism. The IUPAC nomenclature of *X* is
(a) tetraaquadichloridochromium(IV) chloride dihydrate
(b) hexaaquachromium(III) chloride
(c) dichloridotetraaquachromium(IV) chloride dihydrate
(d) tetraaquadichloridochromium(III) chloride dihydrate.

11. Which of the graphs shown below does not represent the relationship between incident light and the electron ejected from metal surface?

(a) 

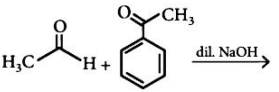
(b) 

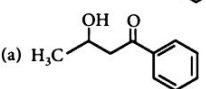
(c) 

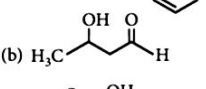
(d) 

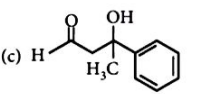
12. Acetic acid dimerizes when dissolved in benzene. As a result, boiling point of the solution rises by 0.36°C, when 100 g of benzene is mixed with '*X*' g of acetic acid. In this solution, if experimentally measured molecular weight of acetic acid is 117.8 g mol^{-1} and molal elevation constant of benzene is 2.57 K kg mol^{-1}, what is the weight % and degree of dissociation (in %) of acetic acid in benzene?
(a) 1.65 and 98.0 (b) 0.81 and 98.3
(c) 0.5 and 86 (d) 1 and 98.3

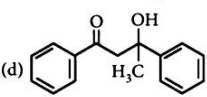
13. The major product formed in the following reaction is



(a) 

(b) 

(c) 

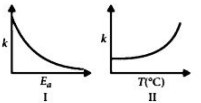
(d) 

14. In the hydrolysis of a salt of weak acid and weak base, the hydrolysis constant K_h is equal to
(a) $\frac{K_w}{K_b}$ (b) $\frac{K_w}{K_a}$ (c) $\frac{K_w}{K_a \cdot K_b}$ (d) $K_a \cdot K_b$.

15. Using MO theory predict which of the following species has the shortest bond length?
(a) O_2^{2+} (b) O_2^+ (c) O_2^- (d) O_2^{2-}

16. The electronic configuration of an element is $1s^2, 2s^2, 2p^6, 3s^2, 3p^3$. What is the atomic number of the element which is just below the given element in the periodic table?
(a) 34 (b) 49
(c) 33 (d) 31

17. Consider the given plots for a reaction obeying Arrhenius equation (0°C < *T* < 300°C) : (*k* and E_a are rate constant and activation energy, respectively)



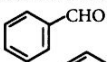
Choose the correct option.

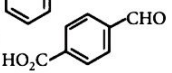
(a) I is right but II is wrong.
(b) Both I and II are wrong.
(c) I is wrong but II is right.
(d) Both I and II are correct.

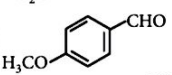
18. A radioisotope has a $t_{1/2}$ of 10 days. If today 125 g of it is left, what was its weight 40 days earlier?

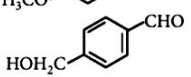
(a) 600 g (b) 1000 g (c) 1250 g (d) 2000 g

19. The aldehydes which will not form Grignard product with one equivalent Grignard reagent are

(A) 

(B) 

(C) 

(D) 

(a) (C, D) (b) (B, D)
(c) (B, C, D) (d) (B, C)

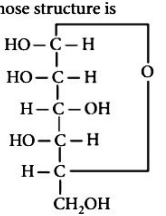
20. 20 mL 0.1M acetic acid is mixed with 10 mL 0.1 M solution of NaOH. The pH of the resulting solution is (pK_a of acetic acid is 4.74)

(a) 3.74 (b) 4.74 (c) 5.74 (d) 6.74.

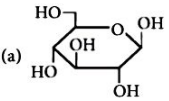
21. Which of the following grouping represents a collection of isoelectronic species?

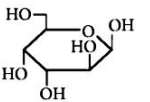
(a) N^{3-}, F^-, Na^+ (b) Ca^{2+}, Cs^+, Br^-
(c) Be, Al^{3+}, Cl^- (d) Na^+, Ca^{2+}, Mg^{2+}

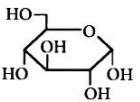
22. For the below given cyclic hemiacetal (*X*), the correct pyranose structure is

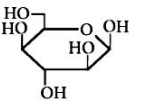


(*X*)

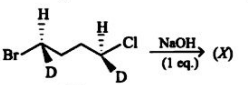
(a) 

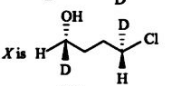
(b) 

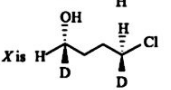
(c) 

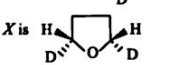
(d) 

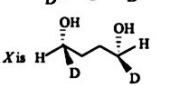
23. What is the product *X* in the following reaction?



(a) *X* is 

(b) *X* is 

(c) *X* is 

(d) *X* is 

24. The rate of a chemical reaction doubles for every 10°C rise of temperature. If the temperature is raised by 50°C, the rate of the reaction increases by about

(a) 10 times (b) 24 times
(c) 32 times (d) 64 times.

25. What would happen when a solution of potassium chromate is treated with an excess of dilute nitric acid?

(a) Cr^{3+} and $Cr_2O_7^{2-}$ are formed.
(b) $Cr_2O_7^{2-}$ and H_2O are formed.
(c) CrO_4^{2-} is reduced to +3 state of Cr.
(d) CrO_4^{2-} is oxidised to +7 state of Cr.

26. Which of the following statements about colloids is false?

(a) When excess of electrolyte is added to colloidal solution, colloidal particle will be precipitated.
(b) Freezing point of colloidal solution is lower than true solution at same concentration of a solute.

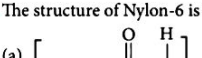
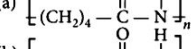
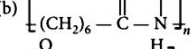
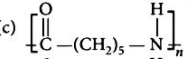
(c) When silver nitrate solution is added to potassium iodide solution, a negatively charged colloidal solution is formed.
(d) Colloidal particles can pass through ordinary filter paper.

27. Diamond and graphite are shown to be allotropic forms of carbon by the fact that
(a) diamond is hard but graphite is soft
(b) diamond is transparent while graphite is opaque
(c) they have different crystal structures
(d) both form CO_2 when burnt.

28. At 90 °C, pure water has H_3O^+ ion concentration of 10^{-6} mol/L. The K_w at 90 °C is
(a) 10^{-6} (b) 10^{-14} (c) 10^{-12} (d) 10^{-8}

29. Adsorption of a gas on a surface follows Freundlich adsorption isotherm. Plot of $\log\frac{x}{m}$ versus $\log p$ gives a straight line with slope equal to 0.5, then (x/m is the mass of the gas adsorbed per gram of adsorbent)
(a) adsorption is proportional to the pressure
(b) adsorption is proportional to the square root of pressure
(c) adsorption is proportional to the square of pressure
(d) adsorption is independent of pressure.

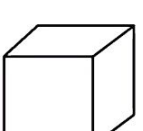
30. The structure of Nylon-6 is

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

CATEGORY-II (Q. 31 to 35)

Carry-2 marks each. Only one option is correct. Negative marks : 1/2.

31. Consider that a d^6 metal ion (M^{2+}) forms a complex with aqua ligands, and the spin only magnetic moment of the complex is 4.90 BM. The geometry and the crystal field stabilisation energy of the complex is


A

(a) octahedral and $-2.4\Delta_o + 2P$
(b) tetrahedral and $-0.6\,\Delta_t$
(c) octahedral and $-1.6\,\Delta_o$
(d) tetrahedral and $-1.6\,\Delta_t + 1P$

32. A 1% solution of KCl (I), NaCl (II), $BaCl_2$ (III) and urea (IV) have their osmotic pressure at the same temperature in the ascending order (molar masses of NaCl, KCl, $BaCl_2$ and urea are respectively 58.5, 74.5, 208.4 and 60 g $mole^{-1}$). Assume 100% ionization of the electrolytes at this temperature.
(a) I < III < II < IV (b) III < I < II < IV
(c) I < II < III < IV (d) III < IV < I < II

33. Which of the following is not a correct statement for primary aliphatic amines?
(a) Primary amines can be prepared by the Gabriel phthalimide synthesis.
(b) Primary amines are less basic than the secondary amines.
(c) The intermolecular association in primary amines is less than the intermolecular association in secondary amines.
(d) Primary amines on treating with nitrous acid solution form corresponding alcohols except methyl amine.

34. The standard (reduction) electrode potentials for metal-metal ion (M/M^{2+}) electrodes P, Q, R and S are respectively – 0.44 V, + 0.34 V, – 0.76 V and –0.25 V. The increasing order of their reducing capacities is
(a) $P < R < S < Q$ (b) $Q < S < P < R$
(c) $Q < S < R < P$ (d) $P < R < Q < S$

35. 20 mL of 0.1 M NH_4OH is mixed with 40 mL of 0.05 M HCl. The pH of the mixture is nearest to
(Given : $K_b(NH_4OH) = 1 \times 10^{-5}$, log 2 = 0.30, log 3 = 0.48, log 5 = 0.69, log 7 = 0.84, log 11 = 1.04)
(a) 3.2 (b) 4.2 (c) 5.2 (d) 6.2

CATEGORY-III (Q. 36 to 40)

Carry-2 marks each. One or more options are correct. No negative marks.

36. Which of the following easily undergo(es) nucleophilic substitution by S_N1 mechanism in butanol?
(a) $C_6H_5CH_2Br$ (b) $BrCH_2CH{=}CH_2$
(c) $(CH_3)_3CBr$ (d) $(CH_3)_3CCH_2Br$

37. Two gases X (Mol. wt. M_X) and Y (Mol. wt. M_Y; $M_Y > M_X$) are at the same temperature T in two different containers. Their root mean square velocities are C_X and C_Y respectively. If the average

kinetic energies per molecule of two gases X and Y are E_X and E_Y respectively, then which of the following relation(s) is (are) true?

(a) $E_X > E_Y$ (b) $C_X > C_Y$

(c) $E_X = E_Y = \frac{3}{2}RT$ (d) $E_X = E_Y = \frac{3}{2}k_BT$

38. The hemiacetal form of glucose is indicated by

(a) reaction with $(CH_3CO)_2O$

(b) oxidation with Tollens' reagent

(c) reduction with HI/P

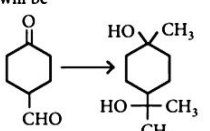
(d) glycoside formation.

39. The energies of activation for forward and reverse reactions for $A_2 + B_2 \rightarrow 2AB$ are 180 kJ mol^{-1} and 200 kJ mol^{-1} respectively. The presence of a catalyst lowers the activation energy of both (forward and reverse) reactions by 100 kJ mol^{-1}. The enthalpy change of the reaction ($A_2 + B_2 \rightarrow 2AB$) in the presence of a catalyst will be (in kJ mol^{-1})

(a) 20 (b) –20

(c) 380 (d) –380

40. The correct sequence of reagents for the following conversion will be



(a) CH_3MgBr, $[Ag(NH_3)_2]^+OH^-$, H^+/CH_3OH

(b) $[Ag(NH_3)_2]^+OH^-$, CH_3MgBr, H^+/CH_3OH

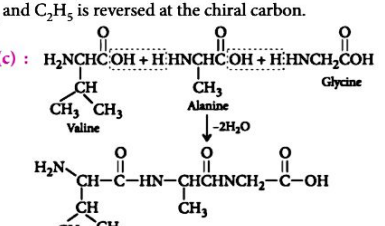
(c) $[Ag(NH_3)_2]^+OH^-$, H^+/CH_3OH, CH_3MgBr

(d) CH_3MgBr, H^+/CH_3OH, $[Ag(NH_3)_2]^+OH^-$

SOLUTIONS

1. (a) : Structure (a) is enantiomer of molecule (*A*) because in this, the configuration of two groups, *i.e.*, CH_3 and C_2H_5 is reversed at the chiral carbon.

2. (c) :



3. (d) : $E = W_0 + KE \quad [\because E = \frac{hc}{\lambda}]$

In experiment '*A*', $\frac{hc}{x/2} = \frac{hc}{x} + K.E.$

$\therefore \quad K.E. = \frac{2hc}{x} - \frac{hc}{x} = \frac{hc}{x}$

In experiment '*B*', $\frac{hc}{x/4} = \frac{hc}{x} + K.E.$

$K.E. = \frac{4hc}{x} - \frac{hc}{x} = \frac{3hc}{x}$

Ratio of kinetic energies of the released electrons in experiment '*B*' to that in experiment '*A*' $= \frac{3hc/x}{hc/x} = 3$

4. (d) : $[V(CN)_6]^{4-}$ *i.e.*, $V^{2+} \Rightarrow 3d^3$

Magnetic moment

$(\mu) = \sqrt{3(3+2)} = \sqrt{15} = 3.87$ B.M.

$[Fe(CN)_6]^{4-}$ *i.e.*, $Fe^{2+} \Rightarrow 3d^6$;

Unpaired electron = 0; $\mu = 0$

$[Ru(NH_3)_6]^{3+}$ *i.e.*, $Ru^{3+} \Rightarrow 4d^5$; Unpaired electron = 1

$\mu = \sqrt{1(1+2)} = \sqrt{3} = 1.73$

$[Cr(NH_3)_6]^{2+}$ *i.e.*, $Cr^{2+} \Rightarrow 3d^4$;

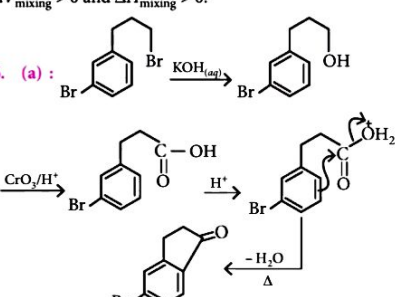
Unpaired electrons = 2 ($t_{2g}^4 e_g^0$)

$\mu = \mu = \sqrt{2(2+2)} = \sqrt{8} = 2.83$

Thus, the correct order is, $V^{2+} > Cr^{2+} > Ru^{3+} > Fe^{2+}$

5. (b) : Mixture of pure CS_2 and CH_3COCH_3 shows positive deviation from Raoult's law. For such solution, $\Delta V_{mixing} > 0$ and $\Delta H_{mixing} > 0$.

6. (a) :



7. (b) : $H_2PO_4^-$ is amphiprotic.

$H_2PO_4^- + H_2O \rightleftharpoons H_3PO_4 + OH^-$

$H_2PO_4^- + H_2O \rightleftharpoons HPO_4^{2-} + H_3O^+$

$pH = \frac{pK_1 + pK_2}{2} = \frac{2.15 + 7.20}{2} = 4.675$

8. (d) : High charge and small size of the cations increases polarisation.

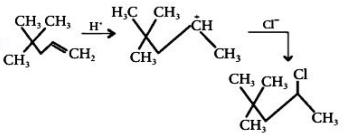
As the size of the given cations decreases as

$K^+ > Ca^{2+} > Mg^{2+} > Be^{2+}$

Hence, polarising power decreases as

$K^+ < Ca^{2+} < Mg^{2+} < Be^{2+}$

9. (a) :



10. (d) : Magnetic moment (μ) of X ($Cr(H_2O)_6Cl_n$) = 3.83 B.M.

i.e., $\mu = \sqrt{n(n+2)}$

$3.83 = \sqrt{n(n+2)}$

$\Rightarrow n \approx 3$

Therefore, Cr is in +3 oxidation state and the formula of complex X will be $Cr(H_2O)_6Cl_3$.

As complex shows geometrical isomerism. Therefore the formula of complex is $[Cr(H_2O)_4Cl_2]\,Cl{\cdot}2H_2O$.

Due to presence of Cl^- in ionisation sphere, it reacts with $AgNO_3$.

The IUPAC name of the complex is tetraaquadichlorido-chromium(III) chloride dihydrate.

11. (c)

12. (a) : $\Delta T_b = 0.36°C$

Mass of acetic acid = 'X' g

Mass of benzene = 100 g

Experimental molar mass = 117.8 g/mol

$K_b = 2.57$ K kg mol^{-1}

$$i = \frac{\text{normal molar mass}}{\text{observed molar mass}} = \frac{60}{117.8} = 0.51$$

$$\Delta T_f = i\,K_b\,m = 0.51 \times 2.57 \times \frac{X}{60} \times \frac{1000}{100}$$

$$0.36 = 0.51 \times 2.57 \times \frac{X}{6} \Rightarrow X = \frac{6 \times 0.36}{0.51 \times 2.57}$$

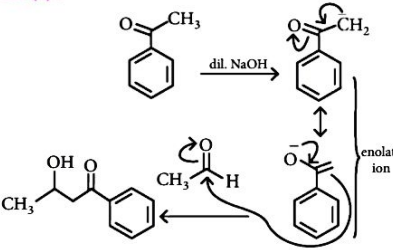
$X = 1.65$ g

Thus, % of acetic acid = 1.65 %

Degree of association

$$\alpha = \frac{1-i}{1-\frac{1}{n}} = \frac{1-0.51}{1-\frac{1}{2}} = \frac{0.49}{1/2} = 0.98 \text{ } i.e., \text{ } 98\%$$

13. (a) :



14. (c) : $K_h = \dfrac{K_w}{K_a \cdot K_b}$

where, K_w = ionic product of water, K_a and K_b are dissociation constants of the weak acid and base respectively.

15. (a) : $O_2^{2+} : (\sigma 1s)^2(\sigma^* 1s)^2(\sigma 2s)^2(\sigma^* 2s)^2(\sigma 2p_z)^2(\pi 2p_x)^2 = (\pi 2p_y)^2$

$$\therefore \text{ B.O} = \frac{10-4}{2} = 3$$

$O_2^+ : (\sigma 1s)^2(\sigma^* 1s)^2(\sigma 2s)^2(\sigma^* 2s)^2(\sigma 2p_z)^2(\pi 2p_x)^2 = (\pi 2p_y)^2\,(\pi^* 2p_x)^1$

$$\therefore \text{ B.O} = \frac{10-5}{2} = 2.5$$

$O_2^- : (\sigma 1s)^2(\sigma^* 1s)^2(\sigma 2s)^2(\sigma^* 2s)^2(\sigma 2p_z)^2(\pi 2p_x)^2 = (\pi 2p_y)^2\,(\pi^* 2p_x)^2 = (\pi^* 2p_y)^1$

$$\therefore \text{ B.O} = \frac{10-7}{2} = 1.5$$

$O_2^{2-} : (\sigma 1s)^2(\sigma^* 1s)^2(\sigma 2s)^2(\sigma^* 2s)^2(\sigma 2p_z)^2(\pi 2p_x)^2 = (\pi 2p_y)^2\,(\pi^* 2p_x)^2 = (\pi^* 2p_y)^2$

$$\therefore \text{ B.O} = \frac{10-8}{2} = 1.0$$

$$\because \text{ B.O} \propto \frac{1}{\text{Bond length}}$$

$\therefore$ O_2^{2+} has the shortest bond length.

16. (c)

17. (d) : According to Arrhenius equation, $k = Ae^{-E_a/RT}$

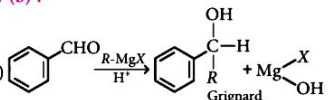
On increasing the value of E_a, k is decreasing. So, curve I is correct.

On increasing temperature (T), k is increasing. So, curve II is also correct.

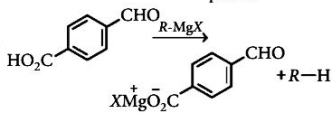
18. (d) : $n = \dfrac{40}{10} = 4,125\text{ g} = \dfrac{1}{2^4}[A_0]$

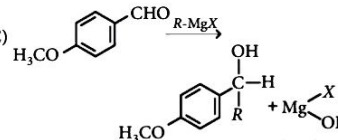
or $[A_0] = 2000$ g.

19. (b) :

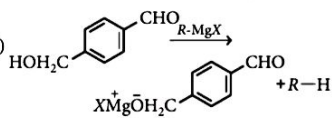
(A) 

Grignard product

(B) 

(C) 

Grignard product

(D) 

20. (b) : Number of moles of NaOH in 10 mL

$$= \frac{0.1 \times 10}{1000} = 0.001$$

Number of moles of acetic acid in 20 mL $= \frac{0.1 \times 20}{1000} = 0.002$

When NaOH is added to acetic acid, sodium acetate is formed.

$$CH_3COOH + NaOH \longrightarrow CH_3COONa + H_2O$$

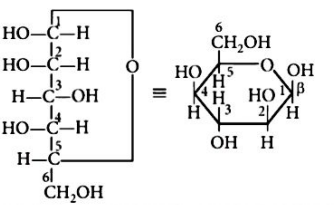
	1 mol	1 mol	1 mol	1 mol
Initially	0.002	0.001	–	–
After reaction	0.002 – 0.001 = 0.001	0	0.001	0.001

According to Henderson's equation

$$pH = pK_a + \log \frac{[salt]}{[acid]} = 4.74 + \log \frac{[0.001]}{[0.001]}$$

$$pH = 4.74$$

21. (a)

22. (d) : 

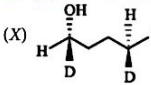
UNSCRAMBLE ME

Unscramble the words given in column I and match them with their explanations in column II.

Column I	Column II
1. UGCAFTIY	(a) It is an alloy of Fe, Ni, Al and Co which is used for making permanent magnets.
2. LNCIAO	(b) A phenomenon in which the molecules of the dispersion medium are allowed to move under the influence of an electric field whereas colloidal particles are not allowed to move.
3. LEMITSGN	(c) The process of separating the particles of colloids from those of crystalloids by diffusion of the mixture through a parchment or an animal membrane.
4. ROTECLESMOOSIS	(d) It is an effective partial pressure which replaces the mechanical partial pressure in an accurate computation of chemical equilibrium.
5. ALSYSIDI	(e) The process of extracting a metal by reduction of its oxide with carbon (in form of coke, charcoal or carbon monoxide).
6. UTGNTSNE	(f) The formation of Hg (II) derivatives of aromatic compounds by direct substitution.
7. ALMOCLE	(g) A distinct kind of atom or nucleus characterised by a specific number of protons and neutrons.
8. ERMUCRAITNO	(h) It is the transition metal with highest melting point.
9. EDLICNU	(i) A mercury compound which is used for making a reference electrode.
10. EDURTCNOE	(j) A special class of organic compounds that contain a carboxyl group adjacent to the enediol group.

Readers can send their responses at editor@mtg.in or post us with complete address by 10th of every month. Winners' names and answers will be published in next issue.

23. (b) : Br^- is better leaving group than Cl^- hence

(*X*)  is formed by S_N2 mechanism involving replacement of Br^- by OH^-.

24. (c) : $\dfrac{\text{Rate at } 50^\circ C}{\text{Rate at } T_1^\circ C} = 2^{\frac{50}{10}} = 2^5 = 32$ times.

25. (b) : Dilute nitric acid converts chromate into dichromate and H_2O.

$2K_2CrO_4 + 2HNO_3 \rightarrow K_2Cr_2O_7 + 2KNO_3 + H_2O$

or, $\underset{\text{Yellow}}{2CrO_4^{2-}} \overset{H^+}{\rightleftharpoons} \underset{\text{Orange}}{Cr_2O_7^{2-}} + H_2O$

26. (b) : Freezing point of colloidal solution is higher than true solution at the same concentration of a solute.

27. (d) : Diamond and graphite are the allotropes of carbon because both on burning produce CO_2 and thus show similar chemical properties.

28. (c) : In pure water, $[H_3O^+] = [OH^-]$

Hence $K_w = 10^{-6} \times 10^{-6} = 10^{-12}$.

29. (b) : $\log\left(\dfrac{x}{m}\right) = \dfrac{1}{2}\log(p) + \log k$; $\dfrac{x}{m} = kp^{1/2}$

Hence, adsorption is proportional to the square root of pressure.

30. (c)

31. (b) : The spin only magnetic moment is 4.90 B.M. which indicates that the number of unpaired electrons is four ($n = 4$) from the formula $\mu = \sqrt{n(n+2)}$ B.M.

For M^{2+} ion (d^6) : $\boxed{\uparrow\downarrow}\boxed{1}\boxed{1}\boxed{1}\boxed{1}$; the two possibilities are :

Octahedral	Tetrahedral
$\boxed{1}\boxed{1}$ e_g	$\boxed{1}\boxed{1}\boxed{1}\boxed{1}$ t_2
$\boxed{\uparrow\downarrow}\boxed{1}\boxed{1}$ t_{2g}	$\boxed{\uparrow\downarrow}\boxed{1}$ e
CFSE = $-0.4\,\Delta_o$	CFSE = $-0.6\,\Delta_t$

32. (d) : 1% solution means 1 g of the solute is present in 100 g of solution.

The values of *R* and *T* are same for all the solutes. However, all of them undergo 100% dissociation.

$\therefore\ \pi \propto i \times C$; $\pi = iCRT$

$i_{KCl} = 2$, $i_{NaCl} = 2$, $i_{BaCl_2} = 3$ and $i_{urea} = 1$

$C_{KCl} = \dfrac{1/74.5}{100} \times 1000 = 0.13$; $\pi_{KCl} = 2 \times 0.13 = 0.26$

$C_{NaCl} = \dfrac{1/58.5}{100} \times 1000 = 0.17$;

$\pi_{NaCl} = 2 \times 0.17 = 0.34$

$C_{BaCl_2} = \dfrac{1/208.4}{100} \times 1000 = 0.048$;

$\pi_{BaCl_2} = 3 \times 0.048 = 0.144$

$C_{urea} = \dfrac{1/60}{100} \times 1000 = 0.16$; $\pi_{urea} = 1 \times 0.16 = 0.16$

$\therefore\ \pi_{BaCl_2} < \pi_{urea} < \pi_{KCl} < \pi_{NaCl}$

or III < IV < I < II.

33. (c) : As primary amines contain 2–H so intermolecular association (due to H-bonding) is more in primary amines as compared to secondary amines.

34. (b) : More negative the reduction potential of a metal, higher is its reducing capacity. Therefore, the increasing order of reduction capacities is

$\underset{+0.34\text{ V}}{Q} < \underset{-0.25\text{ V}}{S} < \underset{-0.44\text{ V}}{P} < \underset{-0.76\text{ V}}{R}$

35. (c) :

	HCl	$+\ NH_4OH$	$\longrightarrow NH_4Cl$	$+\ H_2O$
No. of millimoles initially	2	2	–	–
No. of millimoles after reaction	0	0	2	

$[NH_4Cl] = \dfrac{\text{No. of millimoles}}{\text{Total volume (in mL)}} = \dfrac{2}{60} = \dfrac{1}{30}$ M

For salts of strong acid and weak base,

$pH = \dfrac{1}{2}[pK_w - pK_b - \log C] = \dfrac{1}{2}[14 - pK_b - \log C]$

$pH = 7 - \dfrac{1}{2}pK_b - \dfrac{1}{2}\log C$

$= 7 - \dfrac{5}{2} - \dfrac{1}{2}\log\left(\dfrac{1}{30}\right)$ $\quad[\because\ pK_b = -\log(1 \times 10^{-5}) = 5]$

$= 7 - 2.5 + \dfrac{1}{2}\log(30) = 7 - 2.5 + \dfrac{1}{2}[1 + 0.48]$

$= 7 - 2.5 + 0.74 = 5.24$

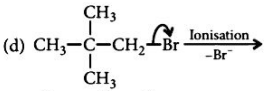
36. (a, b, c, d) : All form stable carbocations therefore, all options are correct.

(a) $C_6H_5\overset{+}{C}H_2$ is stabilised by resonance over the phenyl ring.

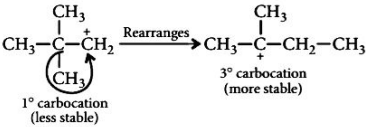
(b) $CH_2{=}CH{-}\overset{+}{C}H_2 \longleftrightarrow \overset{+}{C}H_2{-}CH{=}CH_2$ is also stabilised by resonance.

(c) $CH_3 \rightarrow \underset{\displaystyle \overset{\uparrow}{CH_3}}{\overset{+}{C}} \leftarrow CH_3$

is stabilised by +*I*-effect of $-CH_3$ groups.

(d) 

Neopentyl bromide



37. (b, d) : Average kinetic energy per molecule of gas,

$$\bar{E}_k = \frac{3}{2} k_B T$$

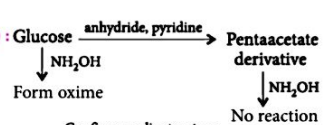
where, k_B = Boltzmann constant

$$\Rightarrow \quad \bar{E}_k = \frac{3}{2}\frac{RT}{N_A} \qquad \left(\because \quad k_B = \frac{R}{N_A}\right)$$

$$C_X = \sqrt{\frac{3RT}{M_X}}; \quad C_Y = \sqrt{\frac{3RT}{M_Y}}$$

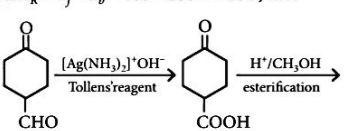
$$\frac{C_X}{C_Y} = \sqrt{\frac{3RT}{M_X} \times \frac{M_Y}{3RT}} = \sqrt{\frac{M_Y}{M_X}} > 1 \qquad [\because M_Y > M_X]$$

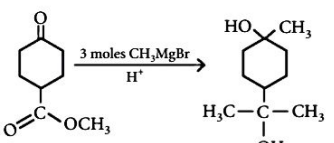
$$\therefore \quad C_X > C_Y$$

38. (a, d) : 

Glycoside is functionally acetal which is formed from hemiacetal.

39. (b) : $\Delta H_R = E_f - E_b = 180 - 200 = -20 \text{ kJ mol}^{-1}$

40. (c) : 



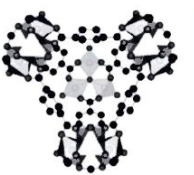
◆◆

Chemistry bulletin

Puffed-up MOFs for improved drug delivery

The sponge like structure of Metal Organic Frameworks (MOFs) allows these polymers to possibly carry and deliver a range of therapeutic compounds. Now, researchers treated a chromium-containing MOF with a dose of acetic acid, more concentrated than in vinegar, to expand its pore size and surface area. The puffed-up MOFs held more ibuprofen or chemotherapy drug compared to the original version and had improved performance as a potential drug-delivery vehicle.

Taking medications by mouth is a convenient way to administer pharmaceuticals. However, this method sometimes involves ingesting several pills per day, or requires large pills that can be difficult to swallow. So, researchers are investigating how to use MOFs for drug delivery to minimize dosing frequency and maximize treatment efficiency. By customizing the polymers' pore sizes and structures, scientists have created nanoscale vehicles that may offer more controlled and targeted drug release. However, to carry and deliver even more drug molecules, the pores would need to expand further than current versions can. Researchers wanted to optimize an existing MOF and improve the polymer's delivery of two common therapeutics of different molecular sizes: the anti-inflammatory drug ibuprofen and a smaller compound 5-fluorouracil, a chemotherapy drug used to treat cancer.



Increasing the pore size of this chromium-containing MOF improved its ability to carry and deliver two common drugs: ibuprofen and 5-fluorouracil.

Increasing the pore size of this chromium-containing MOF improved its ability to carry and deliver two common drugs: ibuprofen and 5-fluorouracil. They started with an established method to synthesize a biocompatible chromium-containing MOF and added a step with an acetic acid rinse. The acid caused the polymer's pores to expand from about 2.5 nanometers (nm) to 5 nm wide. In laboratory experiments to characterize the MOF's drug-loading capability, the researchers observed that the puffed-up version took in more ibuprofen and 5-fluorouracil molecules than the chromium-containing framework with standard-sized pores. Then, in drug-delivery experiments, they loaded the pore-expanded and standard MOFs with either ibuprofen or 5-flurouracil and measured how quickly the drugs passed into a saline solution. They found that the new frameworks released both drugs substantially faster than the original ones. The researchers attributed the higher drug loading and release rates to the larger pores and surface area of the expanded framework, which provides larger "doors" for the drug molecules to enter and exit through.

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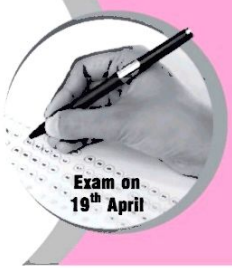
Karnataka CET



1. How many moles of lead (II) chloride will be formed from a reaction between 6.5 g of PbO and 3.2 g of HCl?
   (a) 0.339 (b) 0.011 (c) 0.029 (d) 0.044

2. A microscope using suitable photons is employed to locate an electron in an atom within a distance of 0.1 Å. What is the uncertainty involved in the measurement of its velocity?
   (a) 5.79×10^6 cm s^{-1} (b) 5.79×10^6 m s^{-1}
   (c) 5.79×10^{10} cm s^{-1} (d) 5.79×10^{10} m s^{-1}

3. Na^+, Mg^{2+}, Al^{3+} and Si^{4+} are isoelectronic ions. Their ionic size follows the order
   (a) $Na^+ < Mg^{2+} < Al^{3+} < Si^{4+}$
   (b) $Na^+ < Mg^{2+} < Al^{3+} > Si^{4+}$
   (c) $Na^+ < Mg^{2+} > Al^{3+} > Si^{4+}$
   (d) $Na^+ > Mg^{2+} > Al^{3+} > Si^{4+}$

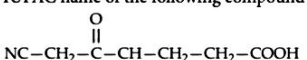
4. Mark the incorrect statement in the following:
   (a) The bond order in the species O_2, O_2^+ and O_2^- decreases as $O_2^+ > O_2 > O_2^-$.
   (b) The bond energy in a diatomic molecule always increases when an electron is lost.
   (c) Electrons in antibonding M.O. contribute to repulsion between two atoms.
   (d) With increase in bond order, bond length decreases and bond strength increases.

5. For the reaction, $CaCO_{3(s)} \rightleftharpoons CaO_{(s)} + CO_{2(g)}$ partial pressure of CO_2 at 1000 K is 0.003 atm. $\Delta G° = 27.2$ kcal. Calculate the value of ΔG.
   (a) 12.6 kcal (b) 15.6 kcal
   (c) 13.4 kcal (d) 14.2 kcal

6. If reaction quotient Q_c for a given reaction is greater than K_c, then reaction will proceed
   (a) from left to right
   (b) from right to left
   (c) in both forward and backward direction
   (d) stop, *i.e.* no net reaction will occur.

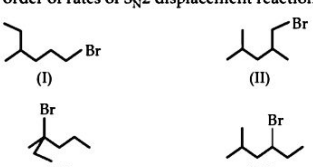
7. Which of the following chemical reactions depicts the oxidising behaviour of H_2SO_4?
   (a) $2HI + H_2SO_4 \rightarrow I_2 + SO_2 + 2H_2O$
   (b) $Ca(OH)_2 + H_2SO_4 \rightarrow CaSO_4 + 2H_2O$
   (c) $NaCl + H_2SO_4 \rightarrow NaHSO_4 + HCl$
   (d) $2PCl_5 + H_2SO_4 \rightarrow 2POCl_3 + 2HCl + SO_2Cl_2$

8. IUPAC name of the following compound is



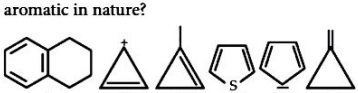
   (a) 6-carboxy-3-oxo-4-sulphohexanenitrile
   (b) 1-cyano-2-oxo-3 sulphohexane-6-oic acid
   (c) 7-cyano-5-oxo-4-sulphoheptan-1-oic acid
   (d) 6-cyano-5-oxo-4-sulphohexan-1-oic acid.

9. Arrange the following alkyl bromides in decreasing order of rates of S_N2 displacement reaction.



   (a) II > III > I > IV (b) I > II > IV > III
   (c) III > IV > I > II (d) III > IV > II > I

10. Which among the following compounds are aromatic in nature?



   (a) II, IV, VI (b) II, III, V
   (c) II, IV, V (d) All are aromatic.

11. The correct pair(s) of the ambident nucleophiles is (are)
(A) AgCN/KCN (B) RCOOAg/RCOOK
(C) $AgNO_2/KNO_2$ (D) AgI/KI
(a) (A) and (C) only (b) (A) only
(c) (B) and (C) only (d) (B) only.

12. The set of elements that differ in mutual relationship from those of the other set is
(a) B – Si (b) Be – Al
(c) Li – Na (d) Li – Mg

13. A certain orbital has no angular nodes and two radial nodes. The orbital is
(a) 3*p* (b) 2*p*
(c) 3*s* (d) 2*s*

14. A non-reducing sugar "*A*" hydrolyses to give two reducing monosaccharides. Sugar *A* is
(a) sucrose (b) glucose
(c) fructose (d) galactose.

15. The ionic radius of Na^+ ion is 1.02 Å. The ionic radii (in Å) of Mg^{2+} and Al^{3+}, respectively are
(a) 1.05 and 0.99 (b) 0.68 and 0.72
(c) 0.85 and 0.99 (d) 0.72 and 0.54

16. Consider the following reactions

'*A*' (C_7H_{14}) $\xrightarrow{\text{ozonolysis}}$ '*B*' + '*C*'

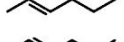
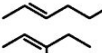
'*B*' $\xrightarrow[\Delta]{(I_2 + NaOH)}$ yellow ppt.

'*B*' $\xrightarrow[\Delta]{Ag_2O}$ silver mirror

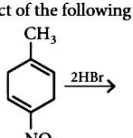
'*C*' $\xrightarrow[\Delta]{(I_2 + NaOH)}$ no yellow ppt.

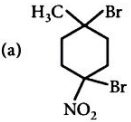
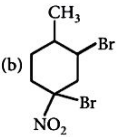
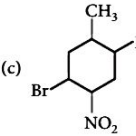
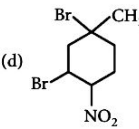
'*C*' $\xrightarrow{LiAlH_4}$ '*D*' $\xrightarrow[\text{\& Conc. HCl}]{\text{Anhydrous } ZnCl_2}$ gives white turbidity within 5 minutes

'*A*' is

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

17. The major product of the following reaction is



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

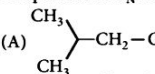
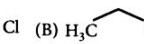
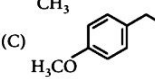
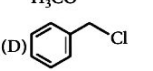
18. For the reaction, $Fe_2N_{(s)} + \frac{3}{2} H_{2(g)} \rightleftharpoons 2Fe_{(s)} + NH_{3(g)}$
(a) $K_c = K_p(RT)$ (b) $K_c = K_p(RT)^{-1/2}$
(c) $K_c = K_p(RT)^{1/2}$ (d) $K_c = K_p(RT)^{3/2}$

19. The species that has a spin-only magnetic moment of 5.9 BM, is (T_d = tetrahedral)
(a) $[Ni(CN)_4]^{2-}$ (square planar)
(b) $[NiCl_4]^{2-}(T_d)$
(c) $Ni(CO)_4$ (T_d) (d) $[MnBr_4]^{2-}(T_d)$

20. The lanthanoid that does NOT show +4 oxidation state is
(a) Dy (b) Ce (c) Eu (d) Tb

21. Among the following species, the diamagnetic molecule is
(a) B_2 (b) NO (c) O_2 (d) CO

22. Increasing order of reactivity of the following compounds for S_N1 substitution is

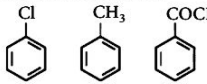
(A)  (B) 
(C) 
(D) 

(a) (B) < (C) < (A) < (D)
(b) (B) < (C) < (D) < (A)
(c) (A) < (B) < (D) < (C)
(d) (B) < (A) < (D) < (C)

23. What would be the molality of 20% (mass/mass) aqueous solution of KI?
(molar mass of KI = 166 g mol^{-1})
(a) 1.51 (b) 1.08 (c) 1.48 (d) 1.35

24. Molal depression constant for a solvent is 4.0 K kg mol^{-1}. The depression in the freezing point of the solvent for 0.03 mol kg^{-1} solution of K_2SO_4 is (Assume complete dissociation of the electrolyte)
(a) 0.36 K (b) 0.18 K (c) 0.12 K (d) 0.24 K

25. The increasing order of the reactivity of the following compounds towards electrophilic aromatic substitution reaction is



(I) (II) (III)

(a) (III) < (I) < (II) (b) (III) < (II) < (I)
(c) (I) < (III) < (II) (d) (II) < (I) < (III)

26. Which of the following is not true about a catalyst?
(a) Mechanism of the reaction in presence and absence of catalyst could be different.
(b) Enthalpy of the reaction does not change with catalysts.
(c) Catalyst enhances both forward and backward reaction at equal rate.
(d) Use of catalyst cannot change the order of the reaction.

27. It has been found that for a chemical reaction with rise in temperature by 10°, the rate constant is
(a) nearly doubled (b) nearly halved
(c) increases 5 times (d) increases 4 times.

28. Which of the following cannot be considered as application of electrochemical series?
(a) Relative strength of reducing agent
(b) Use of SHE in automobile battery
(c) Relative strength of oxidising agent
(d) Spontaneity of redox reaction

29. Which one of the following solutions will have highest conductivity?
(a) 0.1 M CH_3COOH (b) 0.1 M NaCl
(c) 0.1 M KNO_3 (d) 0.1 M HCl

30. An alkyl bromide is formed as the major product on reaction of 3-methyl-2-butene with hydrobromic acid under thermodynamic conditions. Which of the following is the correct IUPAC name of this product?
(a) 2-Bromo-3-methylbutane
(b) 1-Bromo-3-methylbutane
(c) 2-Bromo-2-methylbutane
(d) 1-Bromo-3-methyl-2-butene

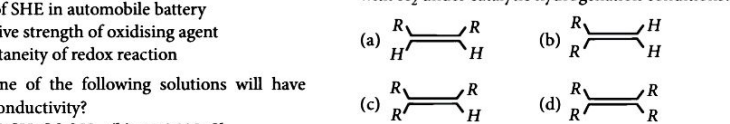
31. The arrangement of following compounds
(i) bromomethane (ii) bromoform
(iii) chloromethane (iv) dibromomethane
in the increasing order of their boiling point is
(a) iv < iii < i < ii (b) i < ii < iii < iv
(c) iii < i < iv < ii (d) ii < iii < i < iv.

32. The IUPAC name of the complex $[Co(NH_3)_2(H_2O)_4]Cl_3$ is
(a) diamminetetraaquacobalt(III) trichloride
(b) diamminetetraaquacobalt(II) chloride
(c) diamminetetraaquacobalt(III) chloride
(d) tetraaquadiamminecobalt(III) trichloride

33. The standard enthalpy of formation of $H_2O_{(l)}$ and $Fe_2O_{3(s)}$ are respectively −286 kJ mol^{-1} and − 824 kJ mol^{-1}. What is the standard enthalpy change for the following reaction?
$Fe_2O_{3(s)} + 3H_{2(g)} \longrightarrow 3H_2O_{(l)} + 2Fe_{(s)}$
(a) − 538 kJ mol^{-1} (b) + 538 kJ mol^{-1}
(c) − 34 kJ mol^{-1} (d) + 34 kJ mol^{-1}

34. Which of the following reaction is expected to readily give a hydrocarbon product in good yields?
(a) $CH_3CH_3 \xrightarrow[h\upsilon]{Cl_2}$
(b) $(CH_3)_2CHCl \xrightarrow{C_2H_5OH}$
(c) $RCOOK \xrightarrow[\text{Oxidation}]{\text{Electrolysis}}$
(d) $RCOOAg \xrightarrow{I_2}$

35. Which one of the following alkenes will react faster with H_2 under catalytic hydrogenation conditions?



(R = alkyl substituent)

36. Which one of the following is an essential amino acid?
(a) Methionine (b) Tyrosine
(c) Proline (d) Glycine

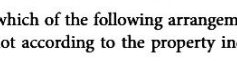
37. The difference between amylose and amylopectin is
(a) amylopectin have 1 → 4 α-linkage and 1 → 6 α-linkage
(b) amylose have 1 → 4 α-linkage and 1 → 6 β-linkage

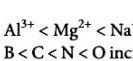
(c) amylopectin have 1 → 4 α-linkage and 1 → 6 β-linkage
(d) amylose is made up of glucose and galactose.

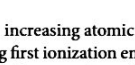
38. For the reaction $2N_2O_5 \longrightarrow 4NO_2 + O_2$, the rate is directly proportional to $[N_2O_5]$. At 45 °C, 90% of the N_2O_5 reacts in 3600 seconds. The value of the rate constant is
(a) 3.20×10^{-4} sec^{-1} (b) 3.20×10^{-3} sec^{-1}
(c) 6.40×10^{-4} sec^{-1} (d) 6.40×10^{-3} sec^{-1}

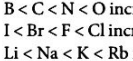
39. In which of the following arrangements, the order is not according to the property indicated against it?
(a) $Al^{3+} < Mg^{2+} < Na^+ < F^-$ increasing atomic size
(b) B < C < N < O increasing first ionization energy
(c) I < Br < F < Cl increasing electron gain enthalpy
(d) Li < Na < K < Rb increasing metallic radii

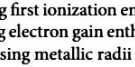
40. The product in the following reaction is



(a) 

(b) 

(c) 

(d) 

41. The relative lowering in vapour pressure of a solution containing a non-volatile solute is directly proportional to the mole fraction of the solute. This statement is called
(a) Henry's Law (b) Raoult's law
(c) Knonwaloff's rule (d) Lever rule.

42. Consider the following sets of quantum numbers:

	n	*l*	*m*	*s*
(i)	3	0	0	+ 1/2
(ii)	2	2	1	+ 1/2
(iii)	4	3	–2	– 1/2
(iv)	1	0	–1	– 1/2
(v)	3	2	3	+ 1/2

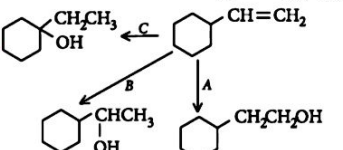
Which of the following sets of quantum number is not possible?
(a) (i), (ii), (iii) and (iv) (b) (ii), (iv) and (v)
(c) (i) and (iii) (d) (ii), (iii) and (iv)

43. *n* g of substance *X* react with *m* g of substance *Y* to form *p* g of substance *R* and *q* g of substance *S*. This reaction can represented as, $X + Y = R + S$. The relation which can be established in the amount of the reactants and the products will be
(a) $n - m = p - q$ (b) $n + m = p + q$
(c) $n = m$ (d) $p = q$

44. Which of the following halide shows highest reactivity towards S_N1 reaction?
(a) CH_3-CH_2Cl
(b) $CH_3-CH_2-CH_2-CH_2I$
(c) C_6H_5Cl
(d) $C_6H_5CH_2Cl$

45. For a binary solution exhibiting negative deviation from Raoult's law, which of the following set of conditions is true?
(a) $\Delta_{mix}H < \Delta_{mix}H_{(ideal)}$; $\Delta_{mix}S < \Delta_{mix}S_{(ideal)}$
$\Delta_{mix}G < 0$; $p_A < p_{A(ideal)}$
(b) $\Delta_{mix}H < \Delta_{mix}H_{(ideal)}$; $\Delta_{mix}S < \Delta_{mix}S_{(ideal)}$
$\Delta_{mix}G > 0$; $p_A > p_{A(ideal)}$
(c) $\Delta_{mix}H > \Delta_{mix}H_{(ideal)}$; $\Delta_{mix}S < \Delta_{mix}S_{(ideal)}$
$\Delta_{mix}G < 0$; $p_A < p_{A(ideal)}$
(d) $\Delta_{mix}H < \Delta_{mix}H_{(ideal)}$; $\Delta_{mix}S > \Delta_{mix}S_{(ideal)}$
$\Delta_{mix}G < 0$; $p_A > p_{A(ideal)}$

46.



Schemes *A*, *B*, *C* are respectively
I. acid-catalysed hydration
II. hydroboration-oxidation
III. oxymercuration-demercuration
(a) I in all cases (b) I, II, III
(c) II, III, I (d) III, I, II

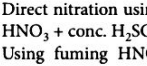
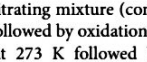
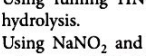
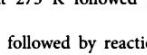
47. The number of radial nodes and angular nodes for *d*-orbital can be represented as
(a) $(n - 2)$ radial nodes + 1 angular node
$= (n - 1)$ total nodes
(b) $(n - 1)$ radial nodes + 1 angular node
$= (n - 1)$ total nodes
(c) $(n - 3)$ radial nodes + 2 angular nodes
$= (n - l - 1)$ total nodes
(d) $(n - 3)$ radial nodes + 2 angular nodes
$= (n - l)$ total nodes

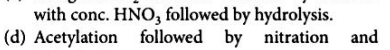
48. The oxidation numbers of sulphur in S_8, S_2F_2, H_2S respectively, are
(a) 0, +1 and –2 (b) +2, +1 and –2
(c) 0, +1 and +2 (d) –2, +1, and –2

49. A dihaloalkane '*X*' having formula $C_3H_6Cl_2$, on hydrolysis gives a compound, that can reduce Tollens' reagent. The compound '*X*' is
(a) 1, 2-dichloropropane
(b) 1, 1-dichloropropane
(c) 1, 3-dichloropropane
(d) 2, 2-dichloropropane.

50. E° values of some redox couples are given below. On the basis of these values, choose the correct option.
E° values : $Br_2 \mid Br^- = +1.90$; $Ag^+ \mid Ag_{(s)} = +0.80$
$Cu^{2+} \mid Cu_{(s)} = +0.34$; $I_{2(s)} \mid I^- = +0.54$
(a) Cu will reduce Br^-. (b) Cu will reduce Ag.
(c) Cu will reduce I^-. (d) Cu will reduce Br_2.

51. For the nitration of aniline, which of the following steps is followed?
(a) Direct nitration using nitrating mixture (conc. HNO_3 + conc. H_2SO_4) followed by oxidation.
(b) Using fuming HNO_3 at 273 K followed by hydrolysis.
(c) Using $NaNO_2$ and HCl followed by reaction with conc. HNO_3 followed by hydrolysis.
(d) Acetylation followed by nitration and hydrolysis.

52. 
the products *A* and *B* are
(a) 
(b) 
(c) 
(d) 

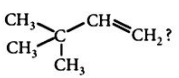
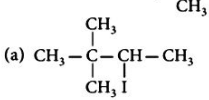
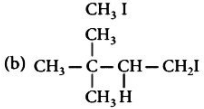
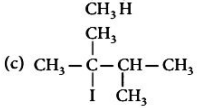
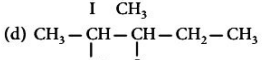
53. 
The products *B* and *C* are respectively
(a) phenol and acetic acid
(b) phenol and acetaldehyde
(c) benzoic acid and acetone
(d) phenol and acetone.

54. The correct sequence of bond enthalpy of 'C — *X*' bond is
(a) $CH_3-Cl > CH_3-F > CH_3-Br > CH_3-I$
(b) $CH_3-F < CH_3-Cl < CH_3-Br < CH_3-I$
(c) $CH_3-F > CH_3-Cl > CH_3-Br > CH_3-I$
(d) $CH_3-F < CH_3-Cl > CH_3-Br > CH_3-I$

55. Match each coordination compound in List-I with an appropriate pair of characteristics from List-II and select the correct answer using the code given below the lists. {*en* = $H_2NCH_2CH_2NH_2$; atomic numbers : Ti = 22; Cr = 24; Co = 27; Pt = 78}

List-I		List-II	
(P)	$[Cr(NH_3)_4Cl_2]Cl$	1.	Paramagnetic and exhibits ionisation isomerism
(Q)	$[Ti(H_2O)_5Cl](NO_3)_2$	2.	Diamagnetic and exhibits *cis-trans* isomerism
(R)	$[Pt(en)(NH_3)Cl]NO_3$	3.	Paramagnetic and exhibits *cis-trans* isomerism
(S)	$[Co(NH_3)_4(NO_3)_2]NO_3$	4.	Diamagnetic and exhibits ionisation isomerism

	P	Q	R	S
(a)	4	2	3	1
(b)	3	1	4	2
(c)	2	1	3	4
(d)	1	3	4	2

56. What is the major product formed by HI on reaction with

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

57. The hormone that controls the contraction of the uterus after child birth and releases milk from the mammary glands is
(a) oxytocin (b) vasopressin
(c) thyroxine (d) adrenaline.

58. The maximum concentration of M^+ ions that can be attained in a saturated solution of M_2SO_4 at 298 K is ($K_{sp} = 1.2 \times 10^{-5}$)

(a) 7.0×10^{-3} M (b) 3.46×10^{-3} M

(c) 2.88×10^{-2} M (d) 14.4×10^{-3} M

59. Given $\Lambda^\circ\left(\frac{1}{3}Al^{3+}\right) = 63\ \Omega^{-1}\ cm^2\ mol^{-1}$ and $\Lambda^\circ\left(\frac{1}{2}SO_4^{2-}\right) = 80\ \Omega^{-1}\ cm^2\ mol^{-1}$. The value of $\Lambda^\infty[Al_2(SO_4)_3]$ would be (in $\Omega^{-1}\ cm^2\ mol^{-1}$)

(a) 143 (b) 206 (c) 286 (d) 858

60. The structure of *neo*-pentyl group in an organic compound is

(a) $CH_3-CH_2-CH_2-CH_2-CH_2-$

(b) $CH_3-CH_2-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CH_2-$

(c) $CH_3-\underset{\displaystyle CH_3}{\underset{|}{\overset{\displaystyle CH_3}{\overset{|}{C}}}}-CH_2-$

(d) $CH_3-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CH_2-CH_2-$

SOLUTIONS

1. (c): The reaction equation is

$PbO + 2HCl \rightarrow PbCl_2 + H_2O$.

Molar mass of PbO = 223 g mol^{-1}.

Now, moles of PbO = $\frac{6.5}{223} = 0.029$ mol

and moles of HCl = $\frac{3.2}{36.5} = 0.088$ mol

1 mol of PbO reacts with 2 moles of HCl.

Therefore, PbO is a limiting reagent.

0.029 mol of PbO will produce $PbCl_2 = 0.029$ mol

2. (b): $\Delta x \Delta p = \frac{h}{4\pi}$ or $\Delta x\, m\Delta v = \frac{h}{4\pi}$

$\Rightarrow \Delta v = \frac{h}{4\pi \Delta x\, m}$

$$\Delta v = \frac{6.626\times10^{-34}\ \text{J s}}{4\times3.14\times0.1\times10^{-10}\ \text{m}\times9.11\times10^{-31}\ \text{kg}}$$

$= 0.579 \times 10^7\ m\ s^{-1}$ ($1\ J = 1\ kg\ m^2\ s^{-2}$) $= 5.79 \times 10^6\ m\ s^{-1}$.

3. (d): $\frac{Z}{e}$ for $Na^+ = 1.1$, $Mg^{2+} = 1.2$, $Al^{3+} = 1.3$ and $Si^{4+} = 1.4$

As $\frac{Z}{e}$ increases, size decreases.

4. (b)

5. (b): $CaCO_{3\,(s)} \rightleftharpoons CaO_{(s)} + CO_{2\,(g)}$

$K_p = p_{CO_2} = 0.003$ atm

$\Delta G = \Delta G^\circ + 2.303RT \log K_p$

$= 27200 + 2.303 \times 2 \times 1000 \times \log 0.003$

$= 15.6$ kcal. ($R = 2$ cal $mol^{-1}\ K^{-1}$)

6. (b): If $Q_c > K_c$, net reaction proceed from right to left.

7. (a): In the reaction,

$$\overset{+1-1}{2HI} + \overset{+1+6-2}{H_2SO_4} \rightarrow \overset{0}{I_2} + \overset{+4}{SO_2} + \overset{+1\ -2}{2H_2O}$$

H_2SO_4 oxidises HI to I_2 and itself gets reduced to SO_2 and thus, acts as oxidising agent.

8. (d)

9. (b): The order of reactivity towards S_N2 displacement reaction is

$$\underset{1^\circ}{RX} > \underset{1^\circ}{RCH_2X} > \underset{2^\circ}{\overset{R}{\underset{R'}{\diagup\!\diagdown}}CHX} > \underset{3^\circ\ \text{alkyl halides}}{(R)_2R'CX}$$

Hence, correct order is I > II > IV > III.

10. (c)

11. (a): —CN and $—NO_2$ have more than one electron donating sites and hence act as ambident nucleophiles.

12. (c): Li and Na both are elements of group 1 and do not show diagonal relationship.

13. (c) **14. (a)**

15. (d): Na^+, Mg^{2+}, Al^{3+} all are isoelectronic species. So, greater is the charge, smaller will be the size.

$$\underset{\text{Decreasing order of size}}{\xrightarrow{Na^+ > Mg^{2+} > Al^{3+}}}$$

So, Al^{3+} is the smallest ion and Mg^{2+} lies in between Na^+ and Al^{3+} ions. Hence, option (d) is correct.

16. (d):

$$\underset{(A)}{CH_3-CH=\overset{\displaystyle CH_2-CH_3}{\overset{|}{C}}-CH_2-CH_3} \xrightarrow[Zn/H_2O]{O_3} \underset{(B)}{CH_3CHO} + \underset{(C)}{CH_3-CH_2\diagdown\ \diagup CH_2-CH_3\ C=O}$$

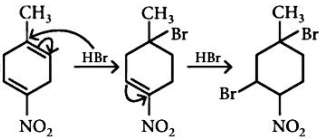
(*B*) will give +ve iodoform test and Tollens' test.

(*C*) is a ketone which does not give iodoform test as it does not contain $CH_3—CO$ group.

$$\underset{(C)}{CH_3-CH_2\diagdown\ \diagup CH_2-CH_3\ C=O} \xrightarrow{LiAlH_4} \underset{2^\circ\ \text{Alcohol}\ (D)}{CH_3-CH_2\diagdown\ \diagup CH_2-CH_3\ CH-OH}$$

2° alcohols give turbidity within five minutes with Lucas reagent (anhyd. $ZnCl_2$ + conc. HCl).

17. (d):



18. (c): $K_P = K_c(RT)^{\Delta n_g}$

For the given reaction, $\Delta n_g = 1 - 3/2 = -1/2$

$\therefore \quad K_P = K_c(RT)^{-1/2}$

$K_c = K_P(RT)^{1/2}$

19. (d): As magnetic moment, $\mu = \sqrt{n(n+2)}$ B.M. = 5.9 B.M.

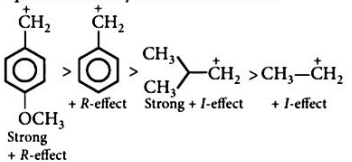
Hence, $n = 5$

$[MnBr_4]^{2-} \Rightarrow Mn^{2+} \Rightarrow 3d^5$

$d^5(T_d)$ is a high spin complex because Br^- is a weak field ligand.

20. (c) **21. (d)**

22. (d): Reactivity towards S_N1 substitution depends upon the stability of the carbocation :



23. (a): 20% (mass/mass) aqueous solution of KI means 20 g of KI is present in 100 g of solution *i.e.*,

Mass of KI dissolved = 20 g

Mass of solution = 100 g

Mass of water (solvent) = 100 – 20 = 80 g

$$= \frac{80}{1000} \text{ kg} = 0.08 \text{ kg}$$

Molar mass of KI = 166 g mol^{-1}

$$\text{No. of moles of KI} = \frac{20 \text{ g}}{166 \text{ g mol}^{-1}} = 0.12 \text{ mole}$$

$$\text{Molality} = \frac{\text{No. of moles of solute}}{\text{Mass of solvent in kg}} = \frac{0.12 \text{ mol}}{0.08 \text{ kg}} = 1.5 \text{ m}$$

24. (a): $\Delta T_f = iK_f m$

K_f = Molal depression constant = 4.0 K kg mol^{-1}

ΔT_f = Depression in freezing point = ?

Molality (m) = 0.03 mol kg^{-1}

$\Delta T_f = 3 \times 4 \times 0.03 = 3 \times 0.12$ K = 0.36 K

25. (a)

26. (d): Use of catalyst may change the order of the reaction as the reaction mechanism in presence of catalyst could be different than that in absence of it.

27. (a)

28. (b): Use of SHE in automobile battery cannot be considered as application of electrochemical series.

29. (d): CH_3COOH is a weak electrolyte, so does not dissociate completely and has lowest conductivity. KNO_3 and NaCl are salts of strong acids and strong bases. HCl is a strong electrolyte. H^+ ion has a smaller size as compared to Na^+ and K^+ ions. Hence, 0.1 M HCl will have highest conductivity.

30. (c)

31. (c): The intermolecular forces of attraction become stronger with the increase in size of the molecules. Hence, the order of boiling points will be :

$$\underset{\text{(iii)}}{CH_3Cl} < \underset{\text{(i)}}{CH_3Br} < \underset{\text{(iv)}}{CH_2Br_2} < \underset{\text{(ii)}}{CHBr_3}$$

32. (c)

33. (c): $Fe_2O_{3(s)} + 3H_{2(g)} \rightarrow 3H_2O_{(l)} + 2Fe_{(s)}$

$\Delta_r H^\circ = \Sigma\Delta_f H^\circ_{(\text{Products})} - \Sigma\Delta_f H^\circ_{(\text{Reactants})}$

$\Delta_r H^\circ = 3(-286) - (-824) \quad [\because \Delta_f H^\circ \text{ for } Fe_{(s)}, H_{2(g)} = 0]$

$= -858 + 824 = -34$ kJ mol^{-1}

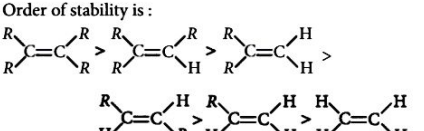
34. (c): When an aqueous solution of sodium or potassium salt of carboxylic acid is electrolysed, hydrocarbon is evolved at anode.

$$2R\text{COOK} \xrightarrow[\text{Oxidation}]{\text{Electrolysis}} \underset{\text{Anode}}{2R\text{COO}^-} + \underset{\text{Cathode}}{2K^+}$$

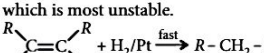
At anode : $2R\text{COO}^- - 2e^- \rightarrow \underset{\text{Alkane}}{R - R} + 2CO_2$

35. (a): The relative rates of hydrogenation decrease with the increase of steric hindrance. Most stable the alkene, slowly it undergoes hydrogenation to give the product. Least substituted alkene is less stable and more reactive.

Order of stability is :



Hence, alkene which will react faster with H_2 is that which is most unstable.



36. (a) **37. (a)**

38. (c): Given, $2N_2O_5 \longrightarrow 4NO_2 + O_2$

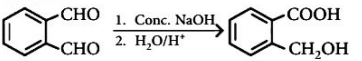
$r \propto [N_2O_5]$ *i.e.*, first order.

For first order reactions,

$$k = \frac{2.303}{t}\log\frac{[A]_0}{[A]} = \frac{2.303}{3600\ \text{sec}}\log\frac{100}{10} = 6.4 \times 10^{-4}\ \text{sec}^{-1}$$

39. (b)

40. (b): It is an intramolecular Cannizzaro reaction.



41. (b) **42. (b)**

43. (b): $\underset{ng}{X} + \underset{mg}{Y} \rightleftharpoons \underset{pg}{R} + \underset{qg}{S}$

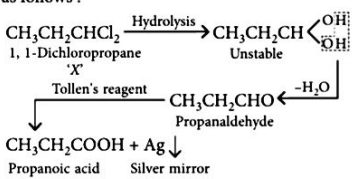
$n + m = p + q$

by law of conservation of mass.

44. (d) **45. (a)** **46. (c)**

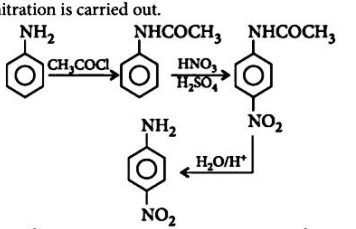
47. (d) **48. (a)**

49. (b): As the obtained compound reduces Tollens' reagent, it must be an aldehyde. Thus, it is obvious that both the —Cl atoms are present at C – 1. Hence, the compound '*X*' is 1, 1-dichloropropane and the reactions are as follows :

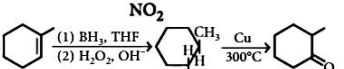


50. (d): Cu will reduce Br_2 and not Br^-.

51. (d): $-NH_2$ group is oxidised on direct nitration hence $-NH_2$ group is first protected by acetylation and then nitration is carried out.



52. (a):



53. (d)

54. (c): The correct order of bond enthalpy is

$CH_3 — F > CH_3 — Cl > CH_3 — Br > CH_3 — I$

55. (b): P : Cr^{3+} has $3d^3$ configuration, with 3 unpaired electrons. Hence, it shows paramagnetic behaviour. Complex of the type Ma_4b_2 shows *cis-trans* isomerism.

Q : Ti^{3+} has $3d^1$ configuration, hence shows paramagnetic behaviour. Complex gives Cl^- and NO_3^- ions in solution hence, shows ionisation isomerism.

R : Pt^{2+} has $3d^8$ configuration but ligands are strong field ligands hence, it forms square planar complex. Thus, all electrons are paired and it also exhibits ionisation iosmerism.

S : Co^{3+} has $3d^6$ configuration. But, ligands present are strong enough to cause electron pairing, hence, it shows diamagnetic behaviour and exhibits *cis-trans* isomerism as it is Ma_4b_2 type complex.

56. (c) **57. (a)**

58. (c): $M_2SO_4 \rightleftharpoons 2M^+ + SO_4^{2-}$

$K_{sp} = [M^+]^2[SO_4^{2-}] = (2s)^2(s) = 4s^3$

or $s = \left(\frac{1.2\times10^{-5}}{4}\right)^{1/3} = 1.44\times10^{-2}$

$\therefore$ Concentration of M^+ ions $= 2s = 2.88 \times 10^{-2}$ M

59. (d): $\Lambda°(Al^{3+}) = 3\Lambda°\left(\frac{1}{3}\,Al^{3+}\right)$

$= 3 \times 63 = 189\ \Omega^{-1}\ cm^2\ mol^{-1}$

$\Lambda°\left(SO_4^{2-}\right) = 2\Lambda°\left(\frac{1}{2}SO_4^{2-}\right)$

$= 2 \times 80 = 160\ \Omega^{-1}\ cm^2\ mol^{-1}$

$\Lambda°[Al_2(SO_4)_3] = 2\,\Lambda°(Al^{3+}) + 3\Lambda°\left(SO_4^{2-}\right)$

$= 2 \times 189 + 3 \times 160 = 858\ \Omega^{-1}\ cm^2\ mol^{-1}$

60. (c)

GK CORNER

Enhance Your General Knowledge with Current Updates!

INDIAN ECONOMY

- Gross **Goods and Services Tax (GST)** revenue collected for February 2024 is ₹1,68,337 crore, marking a robust 12.5% increase compared to that in the same month in 2023. This growth was driven by a 13.9% rise in GST from domestic transactions and 8.5% increase in GST from import of goods. GST revenue net of refunds for February 2024 is ₹1.51 lakh crore which is a growth of 13.6% over that for the same period last year.
- According to data released by the **National Payments Corporation of India (NPCI)**, UPI transactions reported a slight decrease in both volume and value in February 2024. The number of UPI transactions for the month stood at 12.1 billion, compared to 12.2 billion in January, with a transaction value of ₹18.28 lakh crore, down from ₹18.41 lakh crore.
- The manufacturing industry of India enjoyed a powerful growth in February as indicated by the **HSBC India Manufacturing Purchasing Managers' Index (PMI)** with 60.6 in February, although slightly less than January (61.6). It suggests that the rate of expansion in the services sector toned down in February from January due to a decrease in growth in new orders and output.
- The two fintech startups, Juspay and Decentro were given the official license by **Reserve Bank of India (RBI)** to function as payment aggregators in February. While Zoho became the first enterprise SaaS (Software-as-a-Service) player in India to receive the payment aggregator license from the RBI.
- Indian economy remained resilient with robust 7.6% growth rate of **Gross Domestic Product (GDP)** in FY 2023-24 over and above 7% growth rate in FY 2022-23. The GDP of India grew 8.4% in the October-December quarter (Q3) with the help of the double-digit growth in Manufacturing sector (11.6%), followed by a good growth rate of Construction sector (9.5%).
- According to **World Poverty Clock**, India has successfully entered the 'Poverty Below 3%' countries with only around 2% people living in extreme poverty in 2024. The World Poverty Clock provides real-time poverty estimates through 2030 for nearly every country in the world. Developed by the World Data Lab, the World Poverty Clock monitors progress against Ending Extreme Poverty, which is the UN's first Sustainable Development Goal (SDG). The escape rate calculates the current rate of poverty reduction in the world.
- Union Minister for Steel and Civil Aviation, Sh. Jyotiraditya M. Scindia virtually inaugurated India's 1st **Green Hydrogen Plant** in Stainless Steel Sector located at Jindal Stainless Limited, Hisar, Haryana on 4 March 2024. It will be the world's first off-grid green hydrogen plant for the stainless-steel industry and the world's first green hydrogen plant with rooftop and floating solar. This project is also a state-of-the-art green hydrogen facility with a target to reduce carbon emissions considerably by around 2,700 metric tonnes per annum and 54,000 tonnes of CO_2 emissions over next two decades.

Test Yourself!

1. Which of the following companies has/have been approved by RBI this year as payment aggregators?
   (a) Zoho (b) Juspay
   (c) Decentro (d) All of these

2. How much did the Goods and Services Tax (GST) grow in the month of February?
   (a) 18.3% (b) 17.4%
   (c) 12.5% (d) 15.6%

3. What is the expanded form of UPI?
   (a) Unified Payments Interface
   (b) Unified Pay-out Individually
   (c) Unitary Payment Interactions
   (d) Unitary Pay-outs Interface

4. India's first underwater metro tunnel has been built under which of the following rivers?
   (a) Ganga (b) Hooghly
   (c) Brahmaputra (d) Son

5. What does the Global Rating Agency, Moody's do?
   (a) Provides investors with a comprehensive view of global debt markets through credit ratings and research
   (b) Provides data, analytics and insights to equip leaders of financial, non-financial and government organizations
   (c) Offers domestic credit ratings in Latin America using experienced teams of local analysts and customized methodologies.
   (d) All of these.

6. How much population is still living under extreme poverty, according to World Poverty Clock?
   (a) Less than 1% (b) Less than 2%
   (c) Less than 3% (d) Less than 4%

7. Who is the current Minister of State for Ministry of Ports, Shipping and Waterways of India?
   (a) Dinesh Menon
   (b) Rocktim Saikia
   (c) Shantanu Thakur
   (d) Anurag Thakur

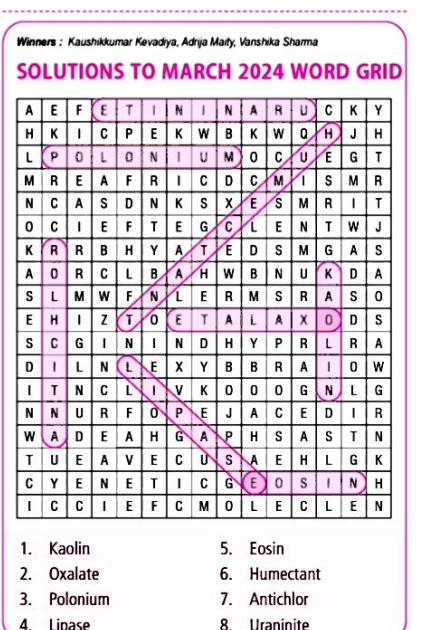
8. What was India's manufacturing PMI in February 2024?
   (a) 55.8 (b) 60.6
   (c) 57.8 (d) 58.9

9. What was India's GDP growth rate during the October-December quarter of FY 2023-24?
   (a) 8.2 (b) 8.6
   (c) 8.4 (d) 8.8

10. Where did Union Minister of Steel inaugurate the India's 1st Green Hydrogen Plant?
    (a) Jindal Stainless Limited, Hisar
    (b) Tata Steel Limited, Mumbai
    (c) Steel Authority of India Limited, New Delhi
    (d) JSW Steel Limited, Mumbai

Answer Key

1.	(p)	2.	(q)	3.	(e)	4.	(q)	5.	(p)
6.	(c)	7.	(c)	8.	(p)	9.	(c)	10.	(e)



CRYSTAL CLEAR

Dr. Abdul Ashik Khan*

This article aims to provide NEET and JEE students with a concise and comprehensive introduction to the essential concepts in chemistry, empowering them with knowledge and understanding necessary to succeed in their examination.

CARBOCATIONS

A carbocation is a reactive intermediate species that consists of a positively charged carbon atom and is trivalent, resulting in only six bound electrons. Hence, a carbocation can be represented as :

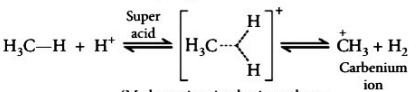
Carbocation

Examples of carbocations include :

$\overset{+}{C}H_3$, $CH_3\overset{+}{C}H_2$, $(CH_3)_3\overset{+}{C}$ etc.

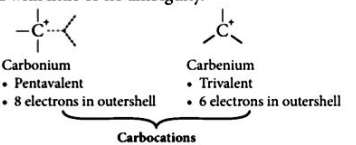
Nomenclature

For many years, these species were referred to as 'carbonium ions', but the word was later discovered to be non-systematic and incorrect. But the most perplexing scenario arose when Olah *et al.* described another type of carbocationic intermediate in which the positively charged carbon atom had a formal covalency of five rather than three. The simplest example of this category is methanonium ion ($\overset{+}{C}H_5$).



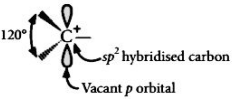
(Methanonium ion having a three-centre, two electron bond) [detected spectroscopically]

Olah *et al.* (1971) recommended using the word 'carbonium ion' for penta-coordinated ions with a positive charge on carbon and 'carbenium ion' for tri-coordinated ions with a positive charge on carbon. He also proposed the term "carbocation" to describe both carbonium and carbenium ions. The IUPAC has approved these definitions. Because pentavalent species (carbonium ions) are far less common than trivalent species (carbenium ions), the term 'carbocation' can be used with little or no ambiguity.



Geometry

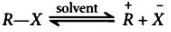
Carbocations are electron-deficient species. The valence shell of positively charged carbon atom contains just six electrons and is connected to three other atoms. The carbon atom carrying the positive charge is sp^2 hybridised, with planar shape and bond angles of approximately 120°. The unhybridised *p*-orbital is unoccupied and perpendicular to the plane.



Generation

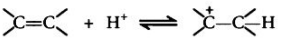
Carbocations, stable or unstable, can be formed by the following reactions :

(i) Direct ionisation :

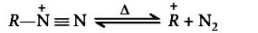


*Assistant Professor Dept. of Chemistry, Darjeeling Government College, Darjeeling, West Bengal

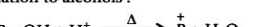
(ii) Addition of a proton or an electrophile to an unsaturated system :



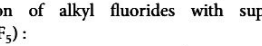
(iii) Decomposition reaction :



(iv) Protonation to alcohols :



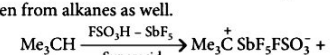
(v) Reaction of alkyl fluorides with superacids (FSO_3H/SbF_5) :



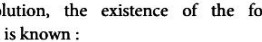
Isolated Carbocations

Carbocations are highly reactive species that are quite unstable. However, it is feasible to retain many of these species as stable solutions in a mixture of fluorosulphuric acid (FSO_3H) and antimony pentafluoride (SbF_5). The original experiment, carried out by Olah *et al.* (1964), involved the addition of alkyl fluorides with antimony pentafluoride (as a Lewis acid) in either liquid SO_2 or excess SbF_5 as solvent.

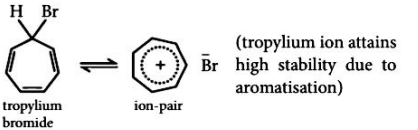
Mixtures of fluorosulphuric acid (FSO_3H) and antimony pentafluoride (SbF_5), usually dissolved in SO_2 (liq.) or SO_2ClF, are known as superacids (also known as 'magic acids'). The use of superacid allows the generation of carbocations not only from alcohols (in superacid, SO_2 at –60°C) and from alkenes at low temperatures, but even from alkanes as well.



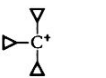
In SO_2 solution, the existence of the following equilibrium is known :



Both triphenylmethyl and diphenylmethyl cations have been isolated as solid salts : $Ph_3C^+BF_4^-$ and related salts are available commercially. Methoxymethyl cation ($MeOCH_2^+SF_6^-$) is also obtained as a stable solid. 2, 4, 6-Cycloheptatrienylium bromide (is known as tropylium bromide) exists as a crystalline solid (m.p. 208°C) which is highly soluble in water yielding bromide ions in solutions, *i.e.*, the compound exists as an ion-pair.



Tri-cyclopropylmethyl cation has also been prepared from its corresponding alcohol in 96% H_2SO_4.

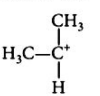


(Tri-cyclopropylmethyl cation, even more stable than benzyl cations)

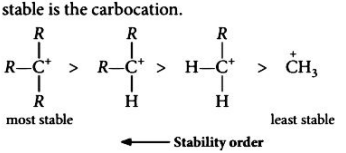
It is to be noted that till date, no primary cation has survived long enough for its detection.

Factors affecting the carbocation stability

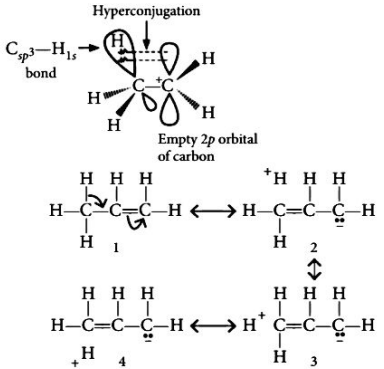
- **Inductive effect :** An alkyl group linked to a carbocation's positively charged carbon atom exerts an electron-releasing inductive effect (*+I*). The attatched alkyl group tends to release electrons towards the positively charged carbon. In doing so, it reduces the positive charge on carbon. In other words, the positive charge gets dispersed as the alkyl group becomes somewhat positively charged itself. The dispersal of the charge stabilises the carbocation. More the number of alkyl groups, the greater the dispersal of positive charge and, therefore, more the stability of carbocation.



Thus, greater the *+I* effect, the more stable is the carbocation.



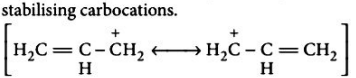
- **Hyperconjugative effect :** An alkyl substitution can also diminish the positive charge density on carbocationic carbon *via* a hyperconjugative action. Alkyl groups have filled sp^3 orbitals that can overlap with the vacant *p*-orbital of positively charged carbon, stabilising the species. Even if the connected alkyl group spins, one of its sigma-bonds remains aligned with the carbocation's empty *p*-orbital. The pair of electrons in this sigma-bond spreads out into the empty *p*-orbital, stabilising the electron-deficient carbon atom.



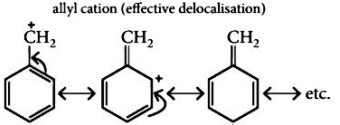
With increase in number of α-hydrogens (that increase the number of hyperconjugative forms), the stability of a carbocation also increases.

$$\overset{+}{C}Me_3 > \overset{+}{C}HMe_2 > \overset{+}{C}H_2Me > \overset{+}{C}H_3$$

➢ **Resonance effect :** Resonance stabilisation is a major influencing factor. If a π-bond is adjacent (α) to the positively charged carbon of a carbocation, the filled *p*-orbitals of the π-bond will overlap with the empty *p*-orbital of the central carbon atom. The result is a delocalised ion having positive charge shared by two atoms. This is said to be resonance stabilisation, and it is of prime importance in stabilising carbocations.

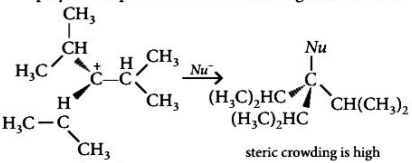


allyl cation (effective delocalisation)



(benzyl cation is resonance stabilised)

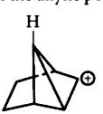
➢ **Steric effect :** Steric impact increases the stability of tertiary carbocations with bulky alkyl groups. Isopropyl groups in triisopropyl cations (planar geometry of bond angle ≃120°) are far apart, resulting in minimal steric repulsion. But if they want to attain a tetrahedral geometry (when hybridisation state of central carbon changes from $sp^2 \rightarrow sp^3$; bond angle ≃109°) on addition with a nucleophile, there occurs a strong steric repulsion between the bulky groups and as a result of this steric strain, the carbocation is much reluctant to undergo this reaction. Hence, steric reason also plays an important role in stabilising carbocations.



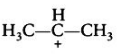
➢ **Solvation effect :** Carbocation solvation is efficient in polar solvents as long as there is no chemical interaction between them. Thus, when solvent polarity increases, carbocation stability increases.

Non-classical and Classical Carbocations

A classical carbocation (*i.e.*, carbenium ion) is represented by a single Lewis structure involving only two-electron, two-centre bonds, and the positive charge is localised on one carbon atom or delocalised by resonance, involving an unshared pair of electrons or a double or triple bond in the allylic position). On the contrary, a non-classical carbocation cannot be represented by a single Lewis structure because it has one or more carbon or hydrogen bridges connecting two electron-deficient centres. The coordination numbers of the bridging atoms are greater than typical. The positive charge is not localised to a specific carbon atom, instead it is delocalised by a double or triple bond that is not in the allylic position, or by a single bond.



2-Norbornyl cation
Non-classical carbocation



Isopropyl cation
(Classical carbocation)

❖❖

UNSCRAMBLED WORDS

MARCH 2024

1-c-TACHYON	2-g-ARSPHENAMINE
3-e-FLUORESCEIN	4-a-UNGERADE
5-j- HYDROLITH	6-d-FERRITIN
7-i-CAESIUM	8-b-CAROTENE
9-f-YTTERBIA	10-h-DIMERIC

Winners : *Kaushikkumar Kevadiya, Karan Kumar*

Quiz CLUB

Unlock Your Knowledge!

1. The thermal stability of tetrahalides of group 14 elements with a common halogen _____ with increasing atomic number.
2. PbO exists as a red form called _____ and a yellow form called _____.
3. Boranes having general formula B_nH_{n+6} are called _____ while boranes having general formula B_nH_{n+4} are called _____.
4. Benzyl alcohol and *o*-cresol are _____ isomers.
5. The reaction in which alkyl halides on treatment with sodium metal in dry ethereal (free from moisture) solution give higher alkanes is called as _____ reaction.
6. Column chromatography is an example of _____ chromatography.
7. The electron withdrawing groups like $-NO_2$, $-CN$, $>C=O$ _____ the stability of carbanions.
8. The cyclic compounds which contain one or more heteroatoms (atom other than C and H) in their ring are called _____ compounds.
9. The bond energy of C = C bond is _____ than that of C—C bond.
10. A negative E° means that the redox couple is a _____ reducing agent than the H^+/H_2 couple.
11. The reactions in which a single species is oxidised as well as reduced simultaneously are called as _____ reactions.
12. A decrease in pH by one unit indicates _____ times increase in hydronium ion concentration.
13. The bond order of Li_2 molecule is _____.
14. _____ Mn = O bonds are present in one molecule of Mn_2O_7.
15. ZnO, PbO, SnO and BeO are examples of _____ oxides.
16. A catalyst _____ the activation energy of a chemical reaction.
17. _____ involves the treatment of an ore with a suitable reagent which can selectively dissolve the ore while impurities remain insoluble.
18. The electrolysis of aqueous solution of sodium chloride produces _____ gas at anode.
19. Square planar complexes of the type *MABCD* form _____ isomers.
20. A blue coloured solution of the complex $[Cu(NH_3)_4]SO_4$ used for dissolving cellulose in the manufacture of artificial silk is called _____ reagent.

◆◆

Readers can send their responses at editor@mtg.in or post us with complete address by 10th of every month. Winners' names and answers will be published in next issue.

SOLUTIONS TO MARCH 2024 QUIZ CLUB

1. deamination
2. riboflavin
3. degenerate
4. ammonia
5. compressibility factor
6. greater
7. No bond
8. Birch
9. higher
10. helium
11. 7
12. suppression
13. path
14. less
15. primary
16. +6
17. Ester
18. Urotropine
19. linear
20. platinum

Winners : *Kaushikkumar Kevadiya, Neha Bhatiya, Shubham Yadav*

Class 12

CBSE

SOLVED PAPER 2024

Held on 27th February

Hurray!! We are happy to inform our readers that in CBSE 2024 Chemistry question papers more than 90% questions were either exactly same or of similar type from **MTG Books**.

The references of few questions of paper having code - 056/4/3 are given here :

Paper Q. No.	P. No.	Q. No.	MTG Book
2	280	6	CBSE Champion
4	92	6	CBSE Champion
8	235	1	CBSE Champion
15	202	78	CBSE Champion
17 (a)	65	39	CBSE Champion
19 (a)	147	50	CBSE Champion
20 (b) (i)	201	72	CBSE Champion
21 (a)	268	14	CBSE Champion
21 (b)	270	83	CBSE Champion
22 (a)	122	50 (iii)	CBSE Champion
22(b)	124	81 (b)	CBSE Champion
22(c)	124	85 (a)	CBSE Champion
23 (a)	175	88 (ii)	CBSE Champion
23(b)	174	84	CBSE Champion
23(c)	174	79	CBSE Champion
23(d)	174	72 (b) (i)	CBSE Champion
24 (a) (i)	202	91	CBSE Champion
24 (a) (ii)	200	54 (a)	CBSE Champion
26(a)	269	31 (i)	CBSE Champion
26(b)	269	58 (ii)	CBSE Champion
27(b)	145	14	CBSE Champion
29 (a)	38	62 (b)	CBSE Champion
29 (b)	38	62 (c)	CBSE Champion
29 OR (c) (i)	38	66	CBSE Champion
29 OR (c) (ii)	38	67	CBSE Champion
30 (a)	123	64 (i)	CBSE Champion
30 (c) (ii)	287	29 (a)	CBSE Champion
31 (a)	241	103	CBSE Champion
31 (b) (i) (1)	239	72 (ii)	CBSE Champion
31 (b) (i) (2)	237	36	CBSE Champion
31 (b) (ii) (1)	256	18 (ii)	CBSE Champion
31 (b) (ii) (2)	239	70 (ii), 83 (i)	CBSE Champion
31 (b) (ii) (3)	239	71 (iii)	CBSE Champion
32 (a)	92	1	CBSE Champion
32 (d)	94 / 95	41(i), 51(a) / 62(ii)	CBSE Champion
32 (e)	93 / 94	18 / 41(ii), 48(ii)	CBSE Champion
32 (g)	95	71 (b)	CBSE Champion
33 (a) (i)	9	65	CBSE Champion
33 (a) (ii)	6	12	CBSE Champion
33 (a) (iii)	24, 288	22 (ii), 32 (b)	CBSE Champion
33 (b) (i)	10	82 (b) (ii)	CBSE Champion
33 (b) (ii)	7	25	CBSE Champion
33 (b) (iii)	11	94	CBSE Champion

and many more……

General Instructions : Read the following instructions carefully and follow them :

Time Allowed : 3 hours
Maximum Marks : 70

(i) This question paper contains 33 questions. All questions are compulsory.
(ii) Question paper is divided into five sections – Section A, B, C, D and E.
(iii) Section A – questions number 1 to 16 are multiple choice type questions. Each question carries 1 mark.
(iv) Section B – questions number 17 to 21 are very short answer type questions. Each question carries 2 marks.
(v) Section C – questions number 22 to 28 are short answer type questions. Each question carries 3 marks.
(vi) Section D – questions number 29 to 30 are case-based questions. Each question carries 4 marks.
(vii) Section E – questions number 31 to 33 are long answer type questions. Each question carries 5 marks.
(viii) There is no overall choice given in the question paper. However, an internal choice has been provided in few questions in all the sections except section A.
(ix) Kindly note that there is a separate question paper for Visually Impaired candidates.
(x) Use of calculators is not allowed.

SECTION-A

Question No. 1 to 16 are multiple choice type questions carrying 1 mark each.

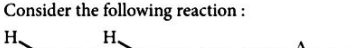
1. The molar ionic conductivities of Al^{3+} and SO_4^{2-} are 189 S cm^2 mol^{-1} and 160 S cm^2 mol^{-1} respectively. The value of limiting molar conductivity of $Al_2(SO_4)_3$ will be
   (a) 198 S cm^2 mol^{-1} (b) 858 S cm^2 mol^{-1}
   (c) 588 S cm^2 mol^{-1} (d) 891 S cm^2 mol^{-1}

2. Which of the following acids represents vitamin C?
   (a) Saccharic acid (b) Gluconic acid
   (c) Ascorbic acid (d) Benzoic acid

3. Rosenmund reduction is used for the preparation of aldehydes. The catalyst used in this reaction is
   (a) Pd - $BaSO_4$ (b) anhydrous $AlCl_3$
   (c) Iron(III) oxide (d) $HgSO_4$

4. From the elements of 3*d* series given below, which element shows the maximum number of oxidation states?
   (a) Scandium (b) Manganese
   (c) Chromium (d) Titanium

5. Consider the following reaction :



   Identify *A* and *B* from the given options:
   (a) *A* - Methanol, *B* - Potassium formate
   (b) *A* - Ethanol, *B* - Potassium formate
   (c) *A* - Methanal, *B* - Ethanol
   (d) *A* - Methanol, *B* - Potassium acetate

6. Which alkyl halide from the given options will undergo S_N1 reaction faster ?
   (a) $(CH_3)_3C - Br$ (b) $(CH_3)_2CH - Br$
   (c) $CH_3 - CH_2 - Br$ (d) $(CH_3)_3C-CH_2 - Br$

7. The fraction of molecules having energy equal to or greater than activation energy is
   (a) *A* (b) $e^{-E_a/RT}$
   (c) *K* (d) $A\,e^{-E_a/RT}$

8. Identify the primary amine from the given options.
   (a) $(C_2H_5)_3N$ (b) $(C_2H_5)_2NH$
   (c) $C_2H_5NH_2$ (d) $(CH_3)_3N$

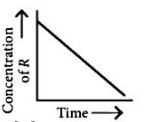
9. The general electronic configuration of *d*-block elements is
   (a) $(n - 1)\,d^{1-10}\,ns^{1-2}$ (b) $(n - 1)\,d^{10}\,ns^{1-2}$
   (c) $(n - 1)\,d^{10}\,ns^{2-3}$ (d) $(n - 1)\,d^{0}\,ns^{1-2}$

10. Match the reagents required for the given reactions.

I. Oxidation of primary alcohols to aldehydes	(p) $NaBH_4$
II. Butan-2-one to butan-2-ol	(q) 85% phosphoric acid at 440 K
III. Bromination of phenol to 2, 4, 6-tribromophenol	(r) PCC
IV. Dehydration of propan-2-ol to propene	(s) Bromine water

   (a) I - (r), II - (p), III - (s), IV - (q)
   (b) I - (q), II - (r), III - (p), IV - (s)
   (c) I - (s), II - (q), III - (p), IV - (r)
   (d) I - (p), II - (s), III - (r), IV - (q)

11. In a given graph of zero order reaction, the slope and intercept are



   (a) Slope = *k*, intercept = $[R]_o$
   (b) Slope = $-k$, intercept = $[R]_o$
   (c) Slope = $k/2.303$, intercept = $\ln [R]_o$
   (d) Slope = $-k/2.303$, intercept = $\ln A$

12. Nucleophilic addition of Grignard reagent to ketones followed by hydrolysis with dilute acids forms
   (a) alkene (b) primary alcohol
   (c) tertiary alcohol (d) secondary alcohol.

For questions number 13 to 16, two statements are given - one labelled as Assertion (A) and the other labelled as Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:

   (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
   (b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
   (c) Assertion (A) is true, but Reason (R) is false.
   (d) Assertion (A) is false, but Reason (R) is true.

13. **Assertion (A) :** Phenols are stronger acids than alcohols.
   Reason (R) : Alkoxide ion is more stable than phenoxide ion.

14. **Assertion (A) :** For a Daniell cell, $Zn/Zn^{2+}(1\ M) \,||\, Cu^{2+}\ (1\ M)/Cu$ with $E^\circ_{cell} = 1.1$ V, if the external opposing potential is more than 1.1 V, the electrons flow from Cu to Zn.
   Reason (R) : Cell acts like a galvanic cell.

15. **Assertion (A) :** Benzoic acid does not undergo Friedel – Crafts reaction.
Reason (R) : Carboxyl group is deactivating and the catalyst aluminium chloride gets bonded to the carboxyl group.

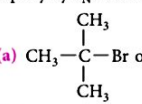
16. **Assertion (A) :** Fructose is a reducing sugar.
Reason (R) : Fructose does not reduce Fehling solution and Tollens' reagent.

SECTION-B

17. Define the following terms :
(a) Half life period ($t_{1/2}$)
(b) Effective collisions

18. A solution containing 60 g of a non-volatile solute in 250 g of water freezes at 270.67 K. Calculate the molar mass of the solute.
(K_f of water = 1.86 K kg mol^{-1})

19. Which of the following compounds will react more rapidly by S_N1 reaction and why?

(a)  or CH_2CH_2Br

(b) Arrange the following compounds in the increasing order of their boiling points :
Bromoform, Dibromomethane,
Chloromethane, Bromomethane

20. (a) Write the stepwise mechanism of nucleophilic addition reactions in the carbonyl compounds.

OR

(b) How will you convert the following :
(i) Toluene to benzoic acid
(ii) Ethanol to 3-hydroxybutanal

21. (a) What happens when glucose reacts with nitric acid? Write chemical equation.
(b) Write one structural difference between DNA and RNA.

SECTION-C

22. (a) Draw the geometrical isomers of the given complex : $[Pt(NH_3)_2Cl_2]^{2+}$
(b) Write the electronic configuration of d^5 ion if $\Delta_o < P$.
(c) What is an ambidentate ligand?

23. Write chemical equations for the following reactions **(Do any three)** :
(a) Hydroboration - oxidation reaction
(b) Williamson synthesis
(c) Friedel–Crafts alkylation of anisole
(d) Reimer–Tiemann reaction

24. (a) Give chemical tests to distinguish between the following pairs of compounds:
(i) Phenol and benzoic acid
(ii) Propanal and propanone
(b) Which one of the given compounds is a stronger acid and why ?
$CH_2FCH_2CH_2COOH$ or CH_3CHFCH_2COOH

25. Show that the time required for 99.9% completion in a first order reaction is 10 times of half-life ($t_{1/2}$) of the reaction. [log 2 = 0.3010, log 10 = 1]

26. Define the following terms :
(a) Glycosidic linkage
(b) Primary structure of protein
(c) Disaccharides

27. (a) Write the IUPAC name of the given compound : $CH_2{=}CH{-}CH_2{-}CH_2{-}Cl$
(b) Why is thionyl chloride preferred for preparing alkyl halides from alcohols?
(c) What happens when methyl bromide reacts with KCN?

28. Calculate emf of the following cell at 25 °C :
$Sn \mid Sn^{2+}$ (0.001 M) $\| H^+$ (0.01 M) $\mid H_{2(g)}$ (1 bar) $\mid Pt_{(s)}$
[Given : $E^\circ_{(Sn^{2+}/Sn)} = -0.14$ V,
$E^\circ_{(H^+/H_2)} = 0.00$ V, log 10 = 1]

SECTION-D

The following questions are case-based questions. Read the case carefully and answer the questions that follow :

29. In a galvanic cell, chemical energy of a redox reaction is converted into electrical energy, whereas in an electrolytic cell the redox reaction occurs on passing electricity. The simplest galvanic cell is in which Zn rod is placed in a solution of $ZnSO_4$ and Cu rod is placed in a solution of $CuSO_4$. The two rods are connected by a metallic wire through a voltmeter. The two solutions are joined by a salt bridge. The difference between the two electrode potentials of the two electrodes is known as electromotive force. In the process of electrolysis, the decomposition of a substance takes place by passing an electric current. One mole of electric

charge when passed through a cell will discharge half a mole of a divalent metal ion such as Cu^{2+}. This was first formulated by Faraday in the form of laws of electrolysis.

Answer the following questions:

(a) What is the function of a salt bridge in a galvanic cell ?

(b) When does galvanic cell behave like an electrolytic cell ?

(c) Can copper sulphate solution be stored in a pot made of zinc ? Explain with the help of the value of E°_{cell}.

($E^\circ_{Cu^{2+}/Cu}$ = 0.34 V); ($E^\circ_{Zn^{2+}/Zn}$ = −0.76 V)

OR

(c) How much charge in terms of Faraday is required for the following :

(i) 1 mol of MnO_4^- to Mn^{2+}

(ii) 1 mol of H_2O to O_2

30. The nature of bonding structure of the coordination compound can be explained to some extent by valence bond theory. The central metal atom/ion makes available a number of vacant orbitals equal to its coordination number. The appropriate atomic orbitals (*s*, *p* and *d*) of the metal hybridise to give a set of equivalent orbitals of definite geometry such as square planar, tetrahedral, octahedral and so on. A strong covalent bond is formed only when the orbitals overlap to the maximum extent. The *d*-orbitals involved in the hybridisation may be either inner *d*-orbitals *i.e.*, $(n - 1)$ *d* or outer *d*-orbitals *i.e.*, *nd*. The complexes formed are called inner orbital complex (low spin complex) and outer orbital complex (high spin complex) respectively. Further, the complexes can be paramagnetic or diamagnetic in nature. The drawbacks of this theory are that this involves number of assumptions and also does not explain the colour of the complex.

Answer the following questions:

(a) Predict whether $[CoF_6]^{3-}$ is diamagnetic or paramagnetic and why?

[Atomic number : Co = 27]

(b) What is the coordination number of Co in $[Co(en)_2Cl_2]^+$?

(c) (i) Write the IUPAC name of the given complex :$[Pt(NH_3)_2Cl_2]^{2+}$

(ii) Explain $[Co(NH_3)_6]^{3+}$ is an inner orbital or outer orbital complex.

OR

(c) Using valence bond theory, deduce the shape and hybridisation of $[Ni(NH_3)_6]^{2+}$.

[Atomic number of Ni = 28]

SECTION-E

31. (a) An amide '*A*' with molecular formula $C_7H_7O_n$ undergoes Hoffmann bromamide degradation reaction to give amine '*B*'. '*B*' on treatment with nitrous acid at 273-278 K forms '*C*' and on treatment with chloroform and ethanolic potassium hydroxide forms '*D*'. '*C*' on treatment, with ethanol gives '*E*'. Identify '*A*', '*B*', '*C*', '*D*' and '*E*'. Write the sequence of chemical equations.

OR

(b) (i) (1) What is Hinsberg's reagent ?

(2) Arrange the following compounds in the increasing order of their basic strength in gaseous phase:

$C_2H_5NH_2$, $(C_2H_5)_3N$, $(C_2H_5)_2NH$

(ii) Give reasons for the following :

(1) Methyl amine is more basic than aniline.

(2) Aniline readily reacts with bromine water to give 2, 4, 6-tribromoaniline.

(3) Primary amines have higher boiling points than tertiary amines.

32. Attempt any five of the following:

(a) Why zinc is not regarded as a transition element?

(b) What is lanthanoid contraction?

(c) Why is first ionisation enthalpy of chromium lower than that of Zn?

(d) Why are transition elements good catalysts?

(e) Compounds of transition metals are generally coloured. Give reason.

(f) Out of $KMnO_4$ and K_2MnO_4, which one is paramagnetic and why?

(g) Complete the following ionic equation :

$Cr_2O_7^{2-} + 14H^+ + 6e^- \longrightarrow$

33. (a) (i) Define reverse osmosis.

(ii) Why are aquatic species more comfortable in cold water in comparison to warm water?

(iii) A solution containing 2 g of glucose (M = 180 g mol^{-1}) in 100 g of water is prepared at 303 K. If the vapour pressure of pure water at 303 K is 32.8 mm Hg, what would be the vapour pressure of the solution?

OR

(b) (i) Predict whether van't Hoff factor will be less or greater than one, when ethanoic acid is dissolved in benzene.

(ii) Define ideal solution.

(iii) Calculate the mass of $CaCl_2$ (molar mass = 111 g mol^{-1}) to be dissolved in 500 g of water to lower its freezing point by 2 K , assuming that $CaCl_2$ undergoes complete dissociation.

(K_f for water = 1.86 K kg mol^{-1})

SOLUTIONS

1. (b) : Molar conductivity of Al^{3+};

$\lambda_{Al^{3+}} = 189\ S\ cm^2 mol^{-1}$

Molar conductivity of SO_4^{2-}; $\lambda_{SO_4^{2-}} = 160\ S\ cm^2\ mol^{-1}$

$\Lambda_m^\circ = \nu_+ \lambda_+^\circ + \nu_- \lambda_-^\circ$

$\lambda_{Al_2(SO_4)_3} = (2 \times \lambda_{Al^{3+}}) + (3 \times \lambda_{SO_4^{2-}})$

$= (2 \times 189) + (3 \times 160) = 378 + 480$

$= 858\ S\ cm^2\ mol^{-1}$

2. (c) : The chemical name of vitamin C is ascorbic acid.

3. (a) : The catalyst used in Rosenmund reduction is Pd in presence of $BaSO_4$.

$$\underset{\text{Ethanoyl chloride (Acetyl chloride)}}{CH_3COCl} + H_2 \xrightarrow[\text{Boiling xylene}]{Pd/BaSO_4} \underset{\text{Ethanal (Acetaldehyde)}}{CH_3CHO} + HCl$$

4. (b) : Manganese shows maximum number of oxidation states.

5. (a) :

$$\underset{\text{Formaldehyde}}{2H-\overset{\overset{O}{\|}}{C}-H} + KOH_{(conc.)} \xrightarrow{\Delta} \underset{\text{Methanol}}{CH_3OH} + \underset{\text{Potassium formate}}{H\overset{\overset{O}{\|}}{C}OO^-K^+}$$

(A) (B)

6. (a) : The order of reactivity for S_N1 reactions followed by alkyl halides is 3° > 2° > 1°. $(CH_3)_3C-Br$ is a 3° halide. So, S_N1 reaction is fastest in this case.

7. (b) : The fraction of molecules having energy equal to or greater than activation energy is $e^{-E_a/RT}$.

8. (c) : $(CH_3)_3N$ and $(C_2H_5)_3N$ are tertiary amines.

$(C_2H_5)_2NH$ is a secondary amine.

$C_2H_5NH_2$ is a primary amine.

9. (a) : The general electronic configuration of *d*-block elements is $(n-1)\,d^{1-10}\,ns^{1-2}$.

10. (a) : Controlled oxidation of primary alcohols to aldehydes is done by PCC. (I – r)

Conversion of butan–2–one to butan–2–ol is done by $NaBH_4$. (II – p)

Bromination of phenol to 2,4,6-tribromophenol is done by bromine water. (III – s)

Dehydration of propan–2–ol is done in presence of 85% phosphoric acid at 440 K temperature. (IV – q)

11. (b) : The integrated rate equation for zero order reaction is as follows :

$[R]_0 - [R] = kt$

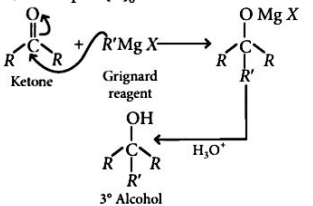
$\therefore \quad [R] = [R]_0 - kt$

$[R] = -kt + [R]_0$

Thus, on plotting $[R]$ *vs* t, we get

Slope = $-k$, intercept = $[R]_0$

12. (c) :



13. (c) : Phenoxide ion is more stable due to resonance as compared to alkoxide ion, thus phenols are more acidic than alcohols.

14. (c) : When external opposing potential is more than 1.1 V, the cell acts as an electrolytic cell.

15. (a) : Benzoic acid does not undergo Friedel-Crafts reaction as carboxyl group itself reacts with the catalyst.

16. (c) : Reducing sugars are those which can reduce Fehling solution and Tollens' reagent *e.g.*, Glucose and Fructose.

17. (a) Half life period ($t_{1/2}$) is the time in which half of the reaction has been completed, *i.e.*, half of the reactant has been converted to product.

(b) According to collision theory, a chemical reaction takes place due to collision between the reacting molecules. The number of collisions taking place per second per unit volume of the reaction mixture is known as collision frequency. All collisions are not effective, only a small fraction of the collisions results a reaction. The collisions that actually produce the products are effective collisions.

18. Given, mass of solute (W_2) = 60 g

Mass of solvent (W_1) =250 g, ΔT_f = 2.33 K

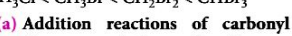
$$M_2 = \frac{K_f \times W_2 \times 1000}{\Delta T_f \times W_1} = \frac{1.86\ K\ kg\ mol^{-1} \times 60\ g \times 1000}{2.33\ K \times 250\ g}$$

M_2 = 191.58 g/mol

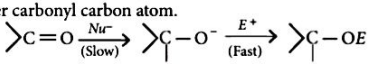
19. (a) $CH_3-\underset{\underset{Br}{|}}{\overset{\overset{CH_3}{|}}{C}}-CH_3$ will undergo S_N1 reaction faster due to the formation of stable 3° carbocation.

(b) Boiling point increases with increase in molecular mass. Thus the correct increasing order of boiling point is, $CH_3Cl < CH_3Br < CH_2Br_2 < CHBr_3$

20. (a) Addition reactions of carbonyl group : Carbonyl compounds have >C=O group which is polar because of more electronegative oxygen atom. This results in polarization of π-electrons as

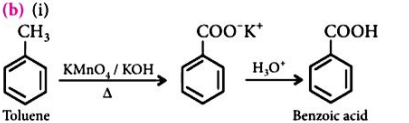


From the structure, it is clear that the nucelophile can attack the carbonyl carbon. The attack of nucleophile precedes the attack of electrophile as anion formed here after nucleophilic attack is more stable than the cation. Thus, rate determining step is the attack of nucleophile over carbonyl carbon atom.



OR

(b) (i)

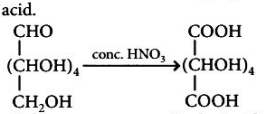


(ii) $CH_3CH_2OH \xrightarrow[\text{Ethanol}]{PCC} \underset{\text{Ethanal}}{CH_3CHO} \xrightarrow{\text{dil.NaOH}}$

$CH_3-\underset{\underset{OH}{|}}{CH}-CH_2-CHO$

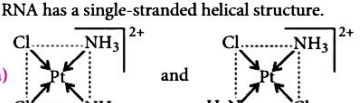
3-Hydroxybutanal

21. (a) On oxidation with nitric acid, *D*-glucose yields saccharic acid.

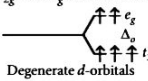


(b) The sugar in DNA is deoxyribose while that in RNA is ribose. DNA has a double-stranded helical structure, while RNA has a single-stranded helical structure.

22. (a)



(b) According to crystal field theory for octahedral complexes, five *d*-orbitals, split into two different energy levels termed as t_{2g} and e_g as shown below :



Degenerate *d*-orbitals

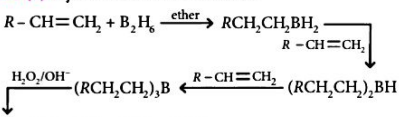
For d^5 ion with $\Delta_o < P$, electronic configuration will be $t_{2g}^3 e_g^2$

(c) Ambidentate ligand : Ligands having two different atoms through which it can act as a ligand.

For example,

CN^- : $\underset{\text{Cyanido-C}}{\leftarrow {}^-C\equiv N}$ or $\underset{\text{Cyanido-N}}{\ddot{C}=\ddot{N}:\rightarrow}$

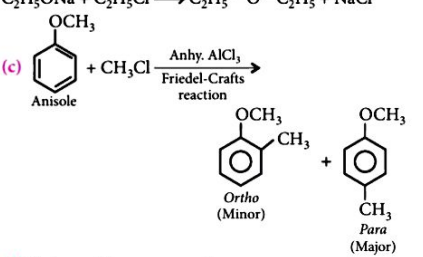
23. (a) Hydroboration-oxidation :



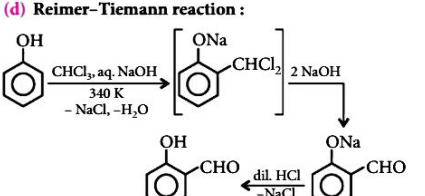
(b) Williamson synthesis : Alkyl halide when treated with sodium alkoxide gives dialkyl ether.

$C_2H_5ONa + C_2H_5Cl \longrightarrow C_2H_5-O-C_2H_5 + NaCl$

(c)



(d) Reimer–Tiemann reaction :



24. (a) (i) Phenol and benzoic acid can be distinguished by their reactions with sodium bicarbonate solution. Benzoic acid will give effervescence with $NaHCO_3$ but phenol will not react.

$C_6H_5COOH + NaHCO_3 \longrightarrow C_6H_5COONa + CO_2\uparrow$
Effervescence
$+ H_2O$

$C_6H_5OH + NaHCO_3 \longrightarrow$ No reaction

(ii) Propanal and propanone can be distinguished by their reactions with Tollens' reagent. Propanal reacts with Tollens' reagent to give silver mirror while propanone does not react.

$CH_3CH_2CHO + 2[Ag(NH_3)_2]^+ \xrightarrow{OH^-}$
Propanal
$CH_3CH_2COO^- + 2Ag\downarrow$

$CH_3COCH_3 + 2[Ag(NH_3)_2]^+ \xrightarrow{OH^-}$ No reaction
Propanone

(b) Acidic strength increases as $-I$ effect of substituent increases. If electronegative atom is close to –COOH group, acidic nature will be more.
Thus, CH_3CHFCH_2COOH is more acidic than $CH_2FCH_2CH_2COOH$.

25. $k = \frac{2.303}{t}\log\frac{a}{a-x}$

when $t = t_{1/2}$, If $a = 100$, $a-x = 100 - 50 = 50$

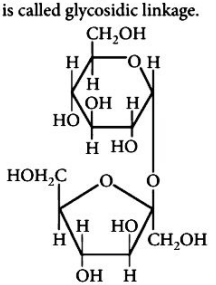
$k = \frac{2.303}{t_{1/2}}\log\frac{100}{50}$; $t_{1/2} = \frac{2.303}{k}\log 2 = \frac{0.693}{k}$

If $t = t_{99.9\%}$ then, $a - x = 100 - 99.9 = 0.1$

$t_{99.9} = \frac{2.303}{k}\log\frac{100}{0.1} = \frac{2.303}{k}\log 10^3 = \frac{6.909}{k}$

Hence, $t_{99.9} = 10t_{1/2}$

26. (a) The two monosaccharides are joined together by an oxide linkage formed by the loss of water molecule. Such linkage is called glycosidic linkage.



(b) Primary structure : The specific sequence in which the various amino acids present in a protein are linked to one another is called its primary structure. Any change in the primary structure creates a different protein.

(c) Disaccharides are the carbohydrates which on hydrolysis give two molecules of the same or different monosaccharides. Their general formula is $C_{12}H_{22}O_{11}$. In disaccharides, the two monosaccharides are joined together by glycosidic linkage.

27. (a) $\overset{1}{C}H_2 = \overset{2}{C}H - \overset{3}{C}H_2 - \overset{4}{C}H_2 - Cl$
4-Chlorobut-1-ene

(b) Thionyl chloride is preferred because in this reaction alkyl halide is formed along with gases SO_2 and HCl. These two gaseous products are escapable, hence the reaction gives pure alkyl halides.

(c) Methyl cyanide is formed.

$CH_3—Br \xrightarrow[\text{Methyl cyanide}]{KCN} CH_3CN$

28. At anode : $Sn_{(s)} \longrightarrow Sn^{2+} + 2e^-$ (0.001 M)
At cathode: $2H^+$ (0.01 M) + $2e^- \longrightarrow H_2$ (1 bar)
Overall reaction: $Sn_{(s)} + 2H^+$ (0.01 M) $\rightarrow Sn^{2+}$ (0.001 M) $+ H_2$ (1 bar)

According to Nernst equation,

$E_{cell} = E^\circ_{cell} - \frac{0.059}{n}\log\frac{[Sn^{2+}]p_{H_2}}{[H^+]^2}$

$E^\circ_{cell} = E^\circ_{cathode} - E^\circ_{anode}$

$E^\circ_{cell} = 0.000\ V - (-0.14\ V) = +0.14\ V$

$E_{cell} = 0.14 - 0.029\log\frac{0.001\times 1}{(0.01)^2}$

$= 0.14 - (0.029 \log 10) = 0.14 - 0.0296$

$E_{cell} = 0.111\ V$

29. (a) The function of salt bridge in an electrochemical cell is to maintain electrical neutrality in solutions and prevent voltage drop. If the salt bridge is removed, voltage will drop to zero and no current will flow.

(b) If external potential applied becomes greater than E°_{cell} of electrochemical cell then it behaves as an electrolytic cell and the direction of flow of current is reversed.

(c) Copper is less reactive than zinc. Zinc will replace the copper from its salt solution. When the copper sulphate solution is stored in a zinc pot, copper is replaced by zinc from the copper sulphate solution. So, copper sulphate solution cannot be stored in a zinc pot.

OR

(c) (i) The given reaction is

$\underset{1\ mol}{MnO^-_{4(aq)}} + 8H^+ + \underset{5\ mol}{5e^-} \rightarrow Mn^{2+}_{(aq)} + 4H_2O_{(l)}$

$\therefore$ 5 mol electrons are needed for reduction of 1 mol of MnO_4^- to Mn^{2+}.

5 mol electrons = 5 Faradays

(ii) The electrode reaction for 1 mol of H_2O is given as

$$H_2O \longrightarrow \frac{1}{2}O_2$$

i.e., $O^{2-} \longrightarrow \frac{1}{2}O_2 + 2e^-$

∴ Quantity of electricity required = 2 F

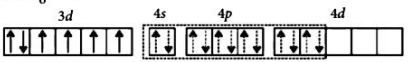
30. (a) Compound $[CoF_6]^{3-}$ is paramagnetic in nature due to the presence of unpaired electrons.

$[CoF_6]^{3-}$: Co(27) has electronic configuration [Ar] $4s^2 3d^7$.

Co^{3+} : [Ar]$4s^0 3d^6$

F^- being a weak field ligand, cannot cause pairing of electrons.

$[CoF_6]^{3-}$:



sp^3d^2 hybridisation, octahedral shape

(b) The coordination number of a metal ion in a complex can be defined as the number of ligand or donor atoms to which the metal is directly bonded. Coordination number of Co in $[Co(en)_2Cl_2]^+$ is six as '*en*' is a bidentate and Cl is a monodentate ligand.

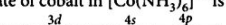
(c) (i) $[Pt(NH_3)_2Cl_2]^{2+}$:

Diamminedichloridoplatinum(II) ion

(ii) $[Co(NH_3)_6]^{3+}$ is an inner orbital complex.

Oxidation state of cobalt in $[Co(NH_3)_6]^{3+}$ is +3.

Co^{3+} :



Ground State

$[Co(NH_3)_6]^{3+}$ ion :

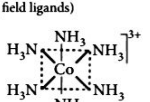
d^2sp^3 hybridisation
six pairs of electrons
from six NH_3 ligand
(Strong field ligands)

Hybridisation – d^2sp^3

Structure – Octahedral

(low spin)

Nature – Diamagnetic

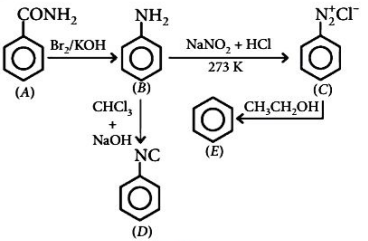


OR

(c) According to valence bond theory, $[Ni(NH_3)_6]^{2+}$ complex formation involves outer *d*-orbitals, thus the complex is called outer orbital complex.

Hybridisation and shape of $[Ni(NH_3)_6]^{2+}$ are sp^3d^2 and octahedral respectively. Outer orbital complex are generally high spin complex since they have large number of unpaired electrons.

31. (a) The given amide (*A*) is benzamide ($C_6H_5CONH_2$) which undergoes Hoffmann bromamide reaction to give aniline (*B*). Aniline on treatment with nitrous acid at 273-278 K form benzene diazonium chloride (*C*) which on treatment with ethanol gives benzene (*E*). Aniline on treatment with chloroform and ethanolic potassium hydroxide forms phenyl isocyanide (*D*).



OR

(b) (i) (1) Benzenesulphonyl chloride is Hinsberg's reagent and it is used for the distinction and separation of primary, secondary and tertiary amines from a mixture.

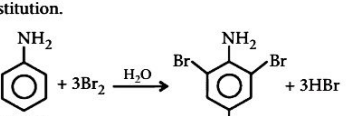
Benzenesulphonyl chloride

(2) Increasing order of basic strength in gaseous phase is : $C_2H_5NH_2 < (C_2H_5)_2NH < (C_2H_5)_3N$

More the number of alkyl groups, more is the basicity of the amine in gaseous state.

(ii) (1) CH_3NH_2 is more basic than $C_6H_5NH_2$ because in aniline the lone pair of electrons on nitrogen is involved in resonance.

(2) Aniline on reaction with aqueous solution of halogens yields trisubstituted product. Since $-NH_2$ is highly activating group, all the three *ortho* and *para* positions get activated and undergo electrophilic substitution.



Aniline

2,4,6-Tribromoaniline

(3) Primary amines ($R - NH_2$) have two hydrogen atoms on nitrogen which can undergo intermolecular hydrogen bonding whereas no such hydrogen bonding is present in tertiary amines (R_3N). So, primary amines boil at a higher temperature than tertiary amines.

32. (a) The transition elements are those elements which have incomplete *d*-orbital in their ground state or common oxidation state. Zinc has fully-filled electronic configuration in its ground state, [Ar] $3d^{10}4s^2$ and in its common oxidation state, *i.e.*, +2 state, [Ar]$3d^{10}$. Hence, zinc is not regarded as a transition element.

(b) The steady decrease in atomic and ionic radii of lanthanides as we move from La to Lu, is known as lanthanide contraction.

(c) Outer electronic configuration of chromium is $3d^5 4s^1$ whereas outer electronic configuration of zinc is $3d^{10}4s^2$. Due to stable completely filled electronic configuration, zinc has higher first ionisation enthalpy than chromium. Also chromium achieves stable half-filled configuration after losing one electron.

(d) The transition elements are known for their catalytic activity. This activity is ascribed due to their ability to adopt multiple oxidation states, ability to absorb the reactant(s) and ability to form complexes.

(e) Due to presence of vacant *d*-orbitals and *d-d* transitions, compounds of the transition metals are generally coloured.

When an electron from a lower energy *d*-orbital is excited to a higher energy *d*-orbital, the energy of excitation corresponds to the frequency which generally lies in the visible region. The colour observed corresponds to the complementary colour of the light absorbed. The frequency of the light absorbed is determined by the nature of the ligand.

(f) Due to the presence of one unpaired electron, $KMnO_4$ is paramagnetic. K_2MnO_4 is diamagnetic due to the absence of unpaired electron.

(g) $Cr_2O_7^{2-} + 14H^+ + 6e^- \longrightarrow 2Cr^{3+} + 7H_2O$

33. (a) (i) When the external pressure applied becomes more than the osmotic pressure of solution then the solvent molecules from the solution pass through the semi-permeable membrane to the solvent side and the process is called reverse osmosis.

(ii) Increase in temperature decreases the solubility of oxygen in water. As a result, amount of dissolved oxygen decreases in warm water. It becomes more difficult to breathe as oxygen is less. Hence, the aquatic species are not comfortable in warm water.

(iii) Given, weight of glucose (W_2) = 2 g

Weight of water (W_1) = 100 g

Vapour pressure of water P° = 32.8 mm Hg

$$n_B = \frac{2}{180} = 0.011,\ n_A = \frac{100}{18} = 5.55$$

$$\frac{P^\circ - P_s}{P^\circ} = \frac{n_B}{n_A} \text{ or, } \frac{32.8 - P_s}{32.8} = \frac{0.011}{5.55}$$

$$32.8 - P_s = \frac{32.8 \times 0.011}{5.55}$$

or, $32.8 - P_s = 0.065$ or, $P_s = 32.8 - 0.065 = 32.735$

$\therefore$ The vapour pressure of the solution is 32.735 mm Hg.

OR

(b) (i) van't Hoff factor, $i > 1$ if there is dissociation of the solute in the solution and $i < 1$ if there is association of the solute in the solution.

Ethanoic acid dimerises in benzene *i.e.*, undergoes association. Hence, van't Hoff factor will be less than one.

(ii) A solution which obeys Raoult's law of vapour pressure for all compositions is called ideal solution.

For ideal solution $\Delta V_{mix} = 0$, $\Delta H_{mix} = 0$

$A-B$ interaction = $A-A$ and $B-B$ interactions.

(iii) Given, mass of water (W_1) = 500 g

$\Delta T_f = 2$ K ; $K_f = 1.86$ K kg mol^{-1}

$CaCl_2 \longrightarrow Ca^{2+} + 2Cl^- \Rightarrow i = 3$

$$\Delta T_f = i \times K_f \times m = i \times K_f \times \frac{W_2 \times 1000}{m_2 \times W_1}$$

$$\text{or, } W_2 = \frac{\Delta T_f \times m_2 \times W_1}{i \times K_f \times 1000} = \frac{2 \times 111 \times 500}{3 \times 1.86 \times 1000} = 19.89 \text{ g}$$

◆◆

TRIO

ANSWERS MARCH 2024

The 3 sets of trio are **(ORP, POR, PRO), (RBO, BOR, BRO), (POL, OLP, LOP)**

MORPHINE

PORPHYRIN

CYCLOPROPENE

CARBONATE

LABORATORY

BROMIDE

POLARISIBILITY

PHENOLPHTHALEIN

CYCLOPENTANONE

***Winners** : Kaushikkumar Kevadiya, Adrija Maity, Aditya Khatri*