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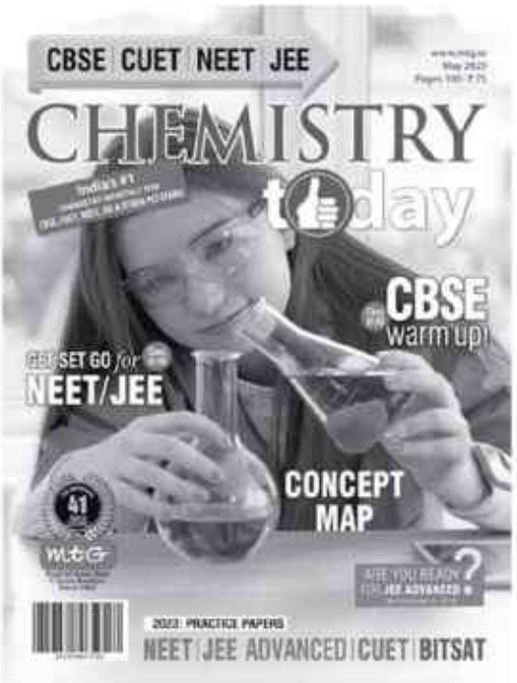

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Contents

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PRACTICE PAPER

NEET 2023

SECTION - A

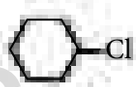
1. Non-isostructural pair amongst the following is
   (a) XeF_2, Br_3^- (b) XeF_4, ICl_4^-
   (c) CO_2, I_3^- (d) MnO_4^-, ClO_3^-

2. Which of the following relations is not correctly matched with the formula?
   (a) In case of association, $\alpha = \dfrac{i-1}{\frac{1}{n}-1}$
   (b) In case of dissociation, $\alpha = \dfrac{i-1}{n+1}$
   (c) Relative lowering of vapour pressure
   $$= \frac{p_A^\circ - p_T}{p_A^\circ} = i\frac{n_B}{n_A + n_B}$$
   (d) Elevation in boiling point,
   $$\Delta T_b = K_b \times \frac{W_B \times 1000}{M_B \times W_A}$$

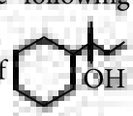
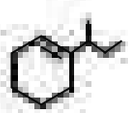
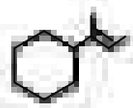
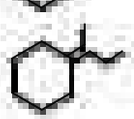
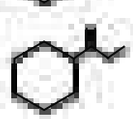
3. **Statement 1 :** If five successive ionization energies of an element are 700, 2145, 3478, 30450 and 38748 kJ/mol respectively, then the number of valence electrons is three.
   Statement 2 : Ionization energy increases abruptly at third ionization.
   (a) Both statements 1 and 2 are true.
   (b) Statement 1 is true but statement 2 is false.
   (c) Statement 1 is false but statement 2 is true.
   (d) Both statements 1 and 2 are false.

4. Standard electrode potentials of redox couples A^{2+}/A, B^{2+}/B, C^{2+}/C and D^{2+}/D are 0.3 V, –0.5 V, –0.75 V and 0.9 V respectively. Which of these is best oxidising agent and reducing agent respectively?
   (a) D^{2+}/D and B^{2+}/B (b) B^{2+}/B and D^{2+}/D
   (c) D^{2+}/D and C^{2+}/C (d) C^{2+}/C and D^{2+}/D

5. On passing C ampere of current for time t sec through 1 litre of 2 M $CuSO_4$ solution (atomic weight of Cu = 63.5), the amount m of Cu (in g) deposited on cathode will be
   (a) $m = \dfrac{Ct}{(63.5 \times 96500)}$ (b) $m = \dfrac{Ct}{(31.25 \times 96500)}$
   (c) $m = \dfrac{C \times 96500}{(31.75 \times t)}$ (d) $m = \dfrac{31.75 \times C \times t}{96500}$

6. Which of the following haloalkanes would undergo S_N2 reaction faster?
   I.  II. 
   III.  IV. 
   (a) I (b) II (c) III (d) IV

7. **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) 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.

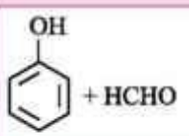
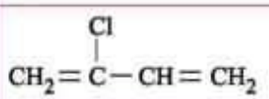
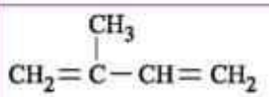
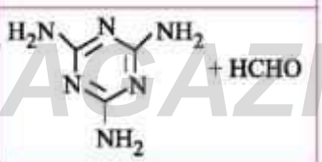
8. Which of the following is not the product of dehydration of  ?
   (a)  (b) 
   (c)  (d) 

9. $SiCl_4 \xrightarrow{H_2O} X \xrightarrow{Heat} Y \xrightarrow{NaOH} Z$

X, Y, and Z in the above reaction are

	X	Y	Z
(a)	SiO_2	Si	NaSi
(b)	$Si(OH)_4$	SiO_2	Na_2SiO_3
(c)	$Si(OH)_4$	Si	SiO_2
(d)	SiO_2	$SiCl_4$	Na_2SiO_3

10. Match the polymers given in column I with monomers in column II and mark the appropriate choice.

Column I		Column II	
(A)	Melamine-formaldehyde polymer	(i)	
(B)	Bakelite	(ii)	
(C)	Neoprene	(iii)	
(D)	Natural rubber	(iv)	

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

11. The K_p value for the reaction, $H_2 + I_2 \rightleftharpoons 2HI$, at 460 °C is 49. If the initial pressure of H_2 and I_2 is 0.5 atm respectively, what will be the partial pressure of H_2 at equilibrium?

(a) 0.111 atm (b) 0.123 atm
(c) 0.133 atm (d) 0.222 atm

12. The degeneracy of hydrogen atom that has energy equal to $-\frac{R_H}{9}$ (where, R_H is Rydberg constant) is

(a) 4 (b) 6 (c) 9 (d) 12

13. Which one of the following shows highest magnetic moment?

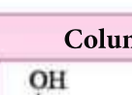
(a) V^{3+} (b) Cr^{3+} (c) Fe^{3+} (d) Co^{3+}

14. For a reaction : $X \rightarrow Y + Z$

Absolute entropies are X = 120 J K^{-1} mol^{-1}, Y = 213.8 J K^{-1} mol^{-1} and Z = 197.9 J K^{-1} mol^{-1}. What will be the entropy change at 298 K and 1 atm?

(a) 291.7 J K^{-1} (b) 255 J K^{-1}
(c) 213.8 J K^{-1} (d) 257.3 J K^{-1}

15. An organic compound B is formed by the reaction of ethyl magnesium iodide with a substance A, followed by treatment with dilute aqueous acid. Compound B on treating with a mixture of conc. HCl and anhydrous $ZnCl_2$ at room temperature, immediately gives turbidity. Which of the following is a possible structure of A?

(a) 
(b)
(c) $CH_3CH_2CH_2COOH$ (d) $H_2C{=}O$

16. The C—C single bond length is 1.54 Å and that of Cl—Cl is 1.98 Å. If the electronegativity of Cl and C are 3.0 and 2.5 respectively, the C—Cl bond length will be equal to

(a) 3.12 Å (b) 1.67 Å (c) 1.71 Å (d) 2.12 Å

17. Identify the statement that is not correct for Ellingham diagrams.

(a) These are the plots of $\Delta_f G°$ *vs* T.
(b) Each plot is a straight line unless phase change occurs.
(c) These plots tell about the kinetics of reduction process.
(d) These plots are based on thermodynamic concepts.

18. 10 g of a mixture of $CaCO_3$ and $MgCO_3$ has 37.5% $MgCO_3$. What amount of CO_2 is produced at STP when the mixture is strongly heated?

(a) 1.3 L (b) 2.4 L (c) 0.9 L (d) 4.6 L

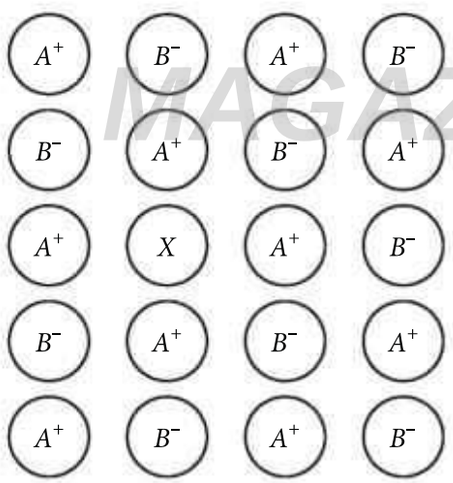
19. Match the column I with column II and mark the appropriate choice.

Column I		Column II	
(A)	Water loving colloids	(i)	Irreversible
(B)	Liquid dispersed in gas	(ii)	Emulsifying agent
(C)	Hydrophobic sol	(iii)	Hydrophilic
(D)	Soap	(iv)	Aerosol
(E)	Micelles	(v)	Coagulation
(F)	Hardy-Schulze rule	(vi)	Associated colloids

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

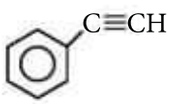
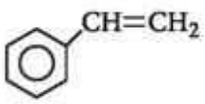
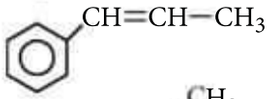
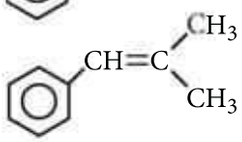
20. Some statements about heavy water are given below :
(i) Heavy water is used as a moderator in nuclear reactors.
(ii) Heavy water is more associated than ordinary water.
(iii) Heavy water is more effective solvent than ordinary water.
Which of the above statements are correct?
(a) (i) and (ii) only (b) (i), (ii) and (iii) only
(c) (ii) and (iii) only (d) (i) and (iii) only

21. In the following figure, the blank *X* is known as _____ and why?



(a) Electron trap, because an electron is present here.
(b) Metal deficient centre, since negative charge is present here.
(c) *F*-centre, since it imparts colour to the crystal.
(d) *F*-centre, since it is responsible for positive charge on the crystal.

22. **Assertion :** Most carboxylic acids exist as dimers in the vapour phase or in aprotic solvents.
Reason : Higher carboxylic acids are practically insoluble in water due to the increased hydrophobic interaction of hydrocarbon part.
(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.

23. $X \xrightarrow[\text{(Reductive)}]{\text{Ozonolysis}} Y + Z$
Y can be obtained by Etard's reaction. *Z* undergoes disproportionation reaction with concentrated alkali. *X* could be
(a) 
(b) 
(c) 
(d) 

24. If doubling the concentration of a reactant '*A*' increases the rate 4 times and tripling the concentration of '*A*' increases the rate 9 times, the rate is proportional to
(a) concentration of '*A*'
(b) square of concentration of '*A*'
(c) under root of the concentration of '*A*'
(d) cube of concentration of '*A*'.

25. $[Ti(H_2O)_6]^{2+}$ is a $3d^2$ system, the value of crystal field stabilization energy decreases by
(a) $4 \times 10^{-1}\ \Delta_o$ (b) $4.0\ \Delta_o$
(c) $8.0\ \Delta_o$ (d) $8 \times 10^{-1}\Delta_o$

26. Match the column I with column II and select the correct option from the given codes.

Column I		Column II	
(P)	Troposphere	(i)	Prevents from UV rays coming to earth
(Q)	Stratosphere	(ii)	Ionization of gases
(R)	Mesosphere	(iii)	Maintenance of heat balance
(S)	Thermosphere	(iv)	Non sound waves propagation

	(P)	(Q)	(R)	(S)
(a)	(ii)	(iv)	(iii)	(i)
(b)	(iv)	(ii)	(i)	(iii)
(c)	(iii)	(i)	(iv)	(ii)
(d)	(i)	(iii)	(ii)	(iv)

27. Which are correct statements about P_4O_6 and P_4O_{10}?

(i) Both form oxyacids H_3PO_3 and H_3PO_4 respectively.

(ii) In P_4O_6, each P is joined to four O and in P_4O_{10}, each P is joined to six O atoms.

(iii) In P_4O_6, each P is joined to three O and in P_4O_{10}, each P is joined to four O atoms.

(iv) In P_4O_6, each P is joined to three O and in P_4O_{10}, each P is joined to five O atoms.

(a) (i) and (iii) only (b) (i) and (iv) only

(c) (ii) and (iii) only (d) (iii) and (iv) only

28. Which of the following is an incorrect statement about soaps and detergents?

(a) Soaps do not form micelles below a particular concentration.

(b) Detergents can be used both in hard water and soft water.

(c) Calcium and magnesium salts of higher fatty acids are insoluble in water.

(d) Hydrolysis of fat by an acid is called saponification.

29. The compound *A* on heating gives a colourless gas and a residue that is dissolved in water to obtain *B*. Excess of CO_2 is bubbled through aqueous solution of *B*, *C* is formed which is recovered in the solid form. Solid *C* on gentle heating gives back *A*. The compound *A* is

(a) $CaCO_3$ (b) Na_2CO_3

(c) K_2CO_3 (d) $CaSO_4 \cdot 2H_2O$

30. Identify *A* in the following sequence of reactions :

$$A \xrightarrow[1\text{ mole}]{NH_3} B \xrightarrow[alc.\ KOH]{CHCl_3} C \xrightarrow{\text{Reduction}} (CH_3)_2CHNHCH_3$$

(a) Ethyl halide (b) *Iso*-propylamine

(c) *n*-Propyl halide (d) *Iso*-propyl halide

31. An organic compound contains 69% carbon and 4.8% hydrogen, the remainder being oxygen. What will be the masses of carbon dioxide and water produced when 0.20 g of this substance is subjected to complete combustion.

(a) 0.69 g and 0.048 g (b) 0.506 g and 0.086 g

(c) 0.345 g and 0.024 g (d) 0.91 g and 0.72 g

32. Limiting molar conductivity for some ions is given below (in S cm^2 mol^{-1}) :

Na^+ - 50.1, Cl^- - 76.3, H^+ - 349.6, CH_3COO^- - 40.9, Ca^{2+} - 119.0.

What will be the limiting molar conductivities (Λ°_m) of $CaCl_2$, CH_3COONa and NaCl respectively?

(a) 97.65, 111.0 and 242.8 S cm^2 mol^{-1}

(b) 195.3, 182.0 and 26.2 S cm^2 mol^{-1}

(c) 271.6, 91.0 and 126.4 S cm^2 mol^{-1}

(d) 119.0, 1024.5 and 9.2 S cm^2 mol^{-1}

33. 5 moles of SO_2 and 5 moles of O_2 react in a closed vessel. At equilibrium 60% of the SO_2 is consumed. The total number of gaseous moles (SO_2, O_2 and SO_3) in the vessel is

(a) 5.1 (b) 3.9 (c) 10.5 (d) 8.5

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

35. Alkene (*Z*) $\xrightarrow[Zn,\ H_2O]{O_3}$ $CH_3-\underset{\underset{O}{\|}}{C}-Ph$ +

$CH_3-\underset{\underset{O}{\|}}{C}-CH=O + CH_3-CH=O$

Alkene (*Z*) can be

(a) $CH_3-\underset{\underset{CH_3-C-CH_3}{\|}}{C}-CH=CH-Ph$

(b) $CH_3-\underset{\underset{CH_3-C-CH=CH-CH_3}{\|}}{C}-Ph$

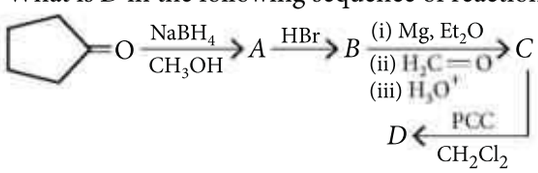
(c) $CH_3-\underset{\underset{CH_3-C=CH-CH_3}{|}}{C=CH}-Ph$

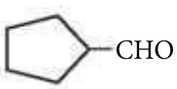
(d) $Ph-\underset{\underset{CH_3-C-CH_3}{\|}}{C}-CH=CH-CH_3$

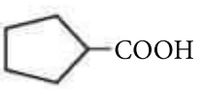
SECTION - B

Attempt any 10 questions out of 15.

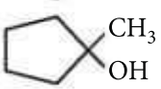
36. What is *D* in the following sequence of reactions?



(a) 

(b) 

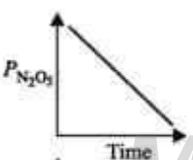
(c) 

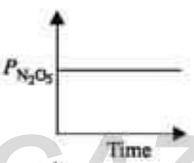
(d) 

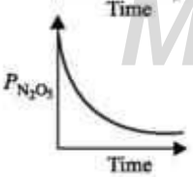
37. Which of the following statements regarding lanthanides is false?
(a) All lanthanides are solid at room temperature.
(b) Their usual oxidation state is +3.
(c) They can be separated from one another by ion-exchange method.
(d) Ionic radii of trivalent lanthanides steadily increase with increase in atomic number.

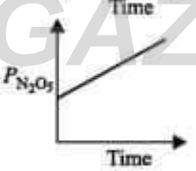
38. An element X of atomic mass 25.0 exists as X_4 in benzene to the extent of 100%. When 10.30 g of saturated solution of X in benzene is added to 20.0 g of benzene, the depression in freezing point of the resulting solution is 0.51 K. If K_f for benzene is 5.1 K kg mol^{-1}, the solubility of X in 100 g of benzene will be
(a) 3.0 g (b) 2.7 g (c) 0.30 g (d) 0.27 g.

39. Which of the following graphs will show the variation of partial pressure of N_2O_5 decomposing into NO_2 and O_2 following the first order kinetics?

(a) 

(b) 

(c) 

(d) 

40. Match the List I (complex) and List II (geometry and magnetic moment) and pick the correct option from the codes given below.

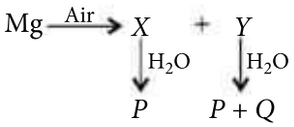
List I		List II	
(A)	$[Ag(CN)_2]^-$	1.	Square planar and 1.73 B.M.
(B)	$[Cu(CN)_4]^{3-}$	2.	Linear and zero
(C)	$[Cu(CN)_6]^{4-}$	3.	Octahedral and zero
(D)	$[Cu(NH_3)_4]^{2+}$	4.	Tetrahedral and zero
(E)	$[Fe(CN)_6]^{4-}$	5.	Octahedral and 1.73 B.M.

(a) A – 2, B – 4, C – 5, D – 1, E – 3
(b) A – 5, B – 4, C – 1, D – 3, E – 2
(c) A – 1, B – 3, C – 4, D – 2, E – 5
(d) A – 4, B – 5, C – 2, D – 1, E – 3

41. 3-Nitroaniline is subjected to the treatment of various reagents in the following sequence.
(i) $NaNO_2$/HCl, 280 K (ii) KI (iii) Cu powder
The final product will be
(a) 3,3′-diaminobiphenyl
(b) 3-iodoaniline
(c) 3-nitroiodobenzene
(d) 3,3′-dinitrobiphenyl.

42. The number of antibonding electron pairs in O_2^{2-} molecular ion on the basis of molecular orbital theory is (Atomic number of O is 8.)
(a) 3 (b) 2 (c) 5 (d) 4

43. What happens when magnesium is burnt in air and the products X and Y are treated with water?



	X	***Y***	***P***	***Q***
(a)	MgO	$Mg(OH)_2$	$Mg(OH)_2$	N_2
(b)	MgO	Mg_3N_2	$Mg(OH)_2$	NH_3
(c)	MgO	Mg_3N_2	$Mg(OH)_2$	N_2
(d)	MgO	$MgCO_3$	$Mg(OH)_2$	CO_2

44. **Assertion :** S_N1 reactions are generally carried out in polar protic solvents (like water, alcohol, acetic acid, etc.)
Reason : $C_6H_5CH(C_6H_5)Br$ is less reactive than $C_6H_5CH(CH_3)Br$ in S_N1 reactions.
(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.

45. Which of the following hexoses will form the same osazone when treated with excess phenyl-hydrazine?
(a) *D*-glucose, *D*-fructose and *D*-galactose
(b) *D*-glucose, *D*-fructose and *D*-mannose
(c) *D*-glucose, *D*-mannose and *D*-galactose
(d) *D*-fructose, *D*-mannose and *D*-galactose

46. **Statement 1 :** The presence of a large number of Schottky defects in NaCl lowers its density.
Statement 2 : In NaCl, there are approximately 10^6 Schottky pairs per cm^3 at room temperature.
(a) Both statements 1 and 2 are true.
(b) Statement 1 is true but statement 2 is false.
(c) Statement 1 is false but statement 2 is true.
(d) Both statements 1 and 2 are false.

47. Arrange the following compounds in order of their increasing boiling points :
n-butane, 1-butanol, ethoxyethane and 1-propanol

(a) 1-propanol < *n*-butane < ethoxyethane < 1-butanol
(b) *n*-butane < ethoxyethane < 1-propanol < 1-butanol
(c) *n*-butane < 1-propanol < ethoxyethane < 1-butanol
(d) 1-propanol < *n*-butane < 1-butanol < ethoxyethane.

48. The time taken for a certain volume of a gas *X* to diffuse through a small hole is 2 minutes. It takes 5.65 minutes for oxygen to diffuse under the similar conditions. The molecular weight of *X* is
(a) 8 (b) 4 (c) 16 (d) 32

49. Which one of the following is a chain growth polymer?
(a) Polymethyl methacrylate
(b) Nucleic acid
(c) Polystyrene
(d) Protein

50. The major role of fluorspar (CaF_2) which is added in small quantity in the electrolytic reduction of alumina dissolved in fused cryolite (Na_3AlF_6) is
1. as a catalyst
2. to make the fused mixture very conducting
3. to lower the fusion temperature
4. to decrease the rate of oxidation of carbon at the anode.

(a) 2, 3 (b) 1, 2 (c) 2, 3, 4 (d) 3, 4

SOLUTIONS

1. (d):

Molecule	Hybridisation	Structure
MnO_4^-	d^3s	Tetrahedral
ClO_3^-	sp^3	Pyramidal

2. (b): In case of dissociation : $A_n \rightarrow nA$

Initial number of moles	1	0
After dissociation	$1-\alpha$	$n\alpha$

No. of particles = $1 - \alpha + n\alpha$

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

$i - 1 = n\alpha - \alpha = (n-1)\alpha \quad \therefore \quad \alpha = \frac{i-1}{n-1}$

3. (b): Ionization energy increases abruptly at fourth ionization.

4. (c): The redox couple with maximum reduction potential will be the best oxidising agent and with minimum reduction potential will be best reducing agent.

5. (d): According to Faraday's law of electrolysis,
$m \propto Ct$ or $m = ZCt$, where C = current, t = time

$Z = \frac{\text{Equivalent weight of substance}}{96500}$

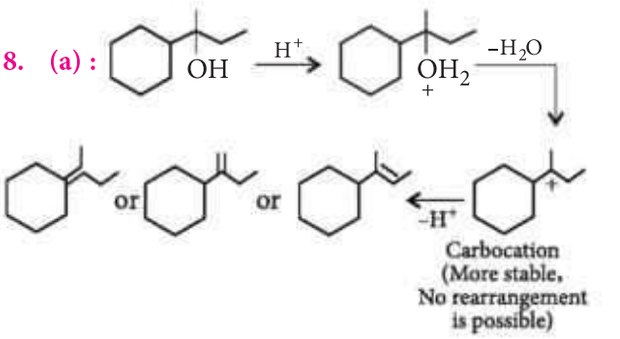
Eq. wt. of Cu = $\frac{63.5}{2}$ ($\because$ $Cu^{2+} \rightarrow Cu$)

$\therefore \quad m = \frac{63.5 \times C \times t}{2 \times 96500} = \frac{31.75 \times C \times t}{96500}$

6. (c)

7. (c): Adenine forms hydrogen bonds with thymine whereas cytosine forms hydrogen bonds with guanine. Due to specific pairing of bases, the two strands are complementary.

8. (a):



9. (b): $SiCl_4 + H_2O \rightarrow \underset{(X)}{Si(OH)_4} \xrightarrow{\text{Heat}} \underset{(Y)}{SiO_2} \xrightarrow{NaOH} \underset{(Z)}{Na_2SiO_3}$

10. (c)

11. (a):

	H_2	+ I_2	$\rightleftharpoons$ 2HI
Initial pressure	0.5	0.5	0
Equil. pressure	$0.5-x$	$0.5-x$	$2x$

Thus, $K_p = \frac{(p_{HI})^2}{(p_{H_2})(p_{I_2})} \Rightarrow 49 = \frac{(2x)^2}{(0.5-x)(0.5-x)}$

$7 = \frac{2x}{(0.5-x)} \Rightarrow x = 0.389$

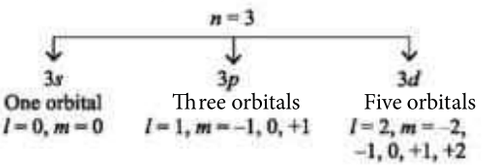
$p_{H_2} = 0.5 - x = 0.5 - 0.389 = 0.111$ atm

12. (c): Energy in H atom $\frac{-R_H}{n^2}$

But, given that, $E = -\frac{R_H}{9}$

$\therefore \quad n^2 = 9 \quad \Rightarrow \quad n = 3$

As, $n = 3$ thus, there are three subshells.

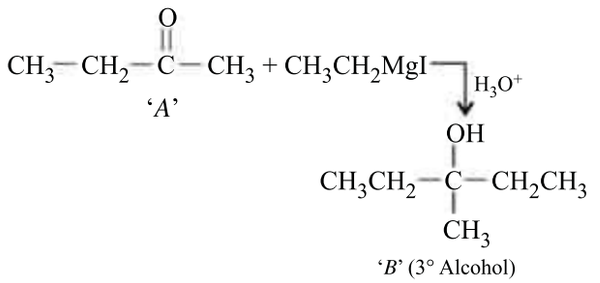


Degeneracy = 1 + 3 + 5 = 9

13. (c)

14. (a): $\Delta S° = \Sigma S°_P - \Sigma S°_R$
$= (213.8 + 197.9) - 120 = 291.7 \text{ J K}^{-1}$

15. (b): '*B*' is a tertiary alcohol based on the given Lucas test. Tertiary alcohols are formed by the reaction of ketones with Grignard reagent.



16. (c)

17. (c) : Ellingham diagrams simply suggest whether the reduction process is feasible or not based on thermodynamic concepts but it cannot tell anything about kinetics of reaction.

18. (b) : Both the carbonates decompose.

$MgCO_3$ is 37.5 % of 10 g = 3.75 g

$$\underset{\substack{84\text{ g}\\3.75\text{ g}}}{MgCO_3} \xrightarrow{\Delta} MgO + \underset{\substack{22.4\text{ L}\\V_1}}{CO_2}$$

$$\frac{84}{3.75} = \frac{22.4}{V_1} \Rightarrow V_1 = 1\text{ L}$$

$CaCO_3$ is (10 – 3.75) = 6.25 g

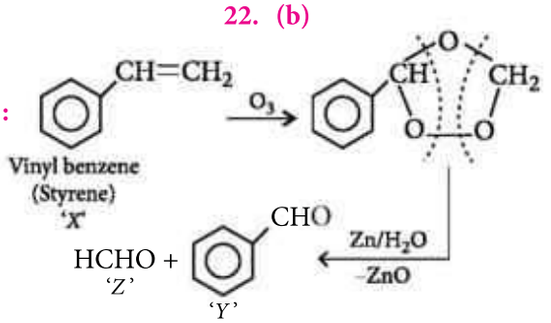
$$\underset{\substack{100\text{ g}\\6.25\text{ g}}}{CaCO_3} \xrightarrow{\Delta} CaO + \underset{\substack{22.4\text{ L}\\V_2}}{CO_2}$$

$$\frac{100}{6.25} = \frac{22.4}{V_2} \Rightarrow V_2 = 1.4\text{ L};\ V = V_1 + V_2 = 2.4\text{ L}$$

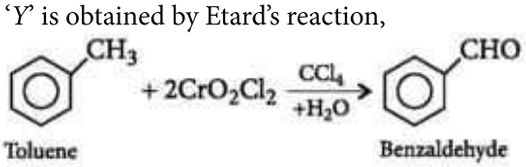
19. (a) **20. (a)**

21. (c) **22. (b)**

23. (b) :



'*Y*' is obtained by Etard's reaction,



'*Z*' reacts with conc. NaOH,

$$\underset{\text{Formaldehyde}}{2HCHO} + NaOH \xrightarrow[\text{Cannizzaro's reaction}]{\text{Disproportionation}} \underset{\text{Sodium formate}}{HCOONa} + \underset{\text{Methanol}}{CH_3OH}$$

(*Z*)

24. (b) : When concentration of the reactant increases by 2 times then reaction rate becomes 4 times. It means order of the reaction is 2. Then reaction rate, $R \propto [A]^2$.

25. (d) : For a $3d^2$ system, electrons will go into more stable t_{2g} orbitals and each electron going into a t_{2g} orbital is stabilized by $0.4\Delta_o$ *i.e.*, 2 electrons will be stabilized by $0.8\Delta_o$ or $8 \times 10^{-1}\Delta_o$.

26. (c) **27. (a)**

28. (d) : Saponification is the hydrolysis of fat by an aqueous alkali (NaOH or KOH).

29. (a) : The reactions can be summarised as follow:

$$A \xrightarrow{\Delta} \text{colourless gas + residue}$$

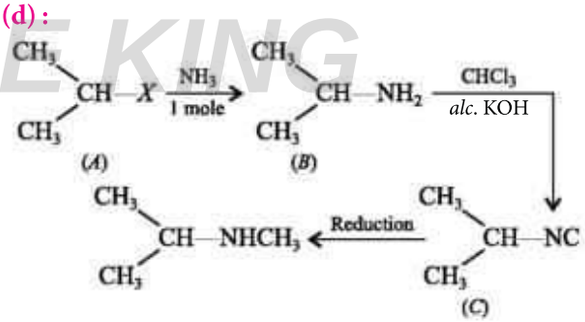
$$\text{Residue} + H_2O \longrightarrow B \xrightarrow{\text{excess } CO_2} C \xrightarrow{\Delta} A$$

This is possible only when *A* is $CaCO_3$.

$$\underset{(A)}{CaCO_3} \xrightarrow{\Delta} \underset{\text{(Colourless gas)}}{CO_2} + \underset{\text{(Residue)}}{CaO}$$

$$CaO + H_2O \longrightarrow \underset{(B)}{Ca(OH)_2} \xrightarrow[\text{(Excess)}]{CO_2} \underset{(C)}{Ca(HCO_3)_2} \xrightarrow{\Delta} \underset{(A)}{CaCO_3}$$

30. (d) :



31. (b) : $$\%\,C = \frac{12}{44} \times \frac{\text{mass of } CO_2 \text{ formed}}{\text{mass of substance taken}} \times 100$$

Let the mass of CO_2 formed be *x*.

$$69 = \frac{12}{44} \times \frac{x}{0.2} \times 100$$

$$\therefore \text{ Mass of } CO_2 \text{ formed} = \frac{69 \times 44 \times 0.2}{12 \times 100} = 0.506\text{ g}$$

$$\%\,H = \frac{2}{18} \times \frac{\text{mass of } H_2O \text{ formed}}{\text{mass of substance taken}} \times 100$$

Let the mass of H_2O formed be *y*.

$$4.8 = \frac{2}{18} \times \frac{y}{0.2} \times 100;\ y = \frac{4.8 \times 18 \times 0.2}{2 \times 100} = 0.086\text{ g}$$

$x = 0.506$ g, $y = 0.086$ g.

32. (c) : $\Lambda^\circ_{m\,(CaCl_2)} = \lambda^\circ_{Ca^{2+}} + 2\lambda^\circ_{Cl^-}$

$= 119.0 + (2 \times 76.3) = 271.6\text{ S cm}^2\text{ mol}^{-1}$

$\Lambda^\circ_{m(CH_3COONa)} = \lambda^\circ_{CH_3COO^-} + \lambda^\circ_{Na^+}$

$= 40.9 + 50.1 = 91.0\ S\ cm^2\ mol^{-1}$

$\Lambda^\circ_{m(NaCl)} = \lambda^\circ_{Na^+} + \lambda^\circ_{Cl^-}$

$= 50.1 + 76.3 = 126.4\ S\ cm^2\ mol^{-1}$

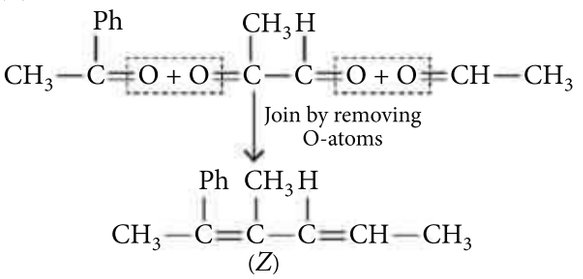
33. (d) :

	$2SO_2$	+	O_2	$\rightleftharpoons$	$2SO_3$
Initial moles	5		5		0
At equ.	5 – 3		5–3/2		3

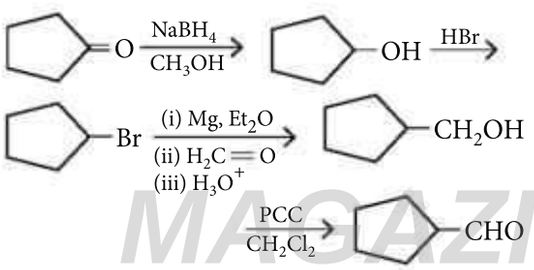
Total number of moles in the vessel = 2 + 3.5 + 3 = 8.5

34. (a)

35. (b) :



36. (a) :



37. (d) : Lanthanide contraction is that phenomenon where the ionic radii of trivalent lanthanides steadily decrease with increase in atomic number.

38. (a) : Suppose saturated solution of X in benzene contains w g of X (present as X_4). Hence, amount of benzene present = (10.30 – w) g.

$\therefore$ Total amount of benzene present = 20 + (10.30 – w) g

$= (30.30 - w)$ g; $\Delta T_f = \dfrac{1000 \times K_f \times w_2}{w_1 \times M_2}$

$0.51 = \dfrac{1000 \times 5.1 \times w}{(30.30 - w) \times 100}$ (M_2 of $X_4 = 25 \times 4 = 100$)

or $51(30.30 - w) = 5100\ w$ or $30.30 - w = 100\ w$

or $101\ w = 30.30$ or $w = 0.3$ g

Thus, 10.30 g of saturated solution contains 0.3 g of X and 10 g of benzene.

$\therefore$ Solubility of X in 100 g of benzene = 3.0 g

39. (c) : For first order, $(a - x) = ae^{-kt}$; partial pressure or conc. of the reactant decreases exponentially with time.

40. (a) **41. (d)**

42. (d) : $O_2^{2-}(18) \rightarrow \sigma 1s^2,\ \sigma^* 1s^2,\ \sigma 2s^2,\ \sigma^* 2s^2,\ \sigma 2p_z^2,\ \pi 2p_x^2 = \pi 2p_y^2,\ \pi^* 2p_x^2 = \pi^* 2p_y^2$

* represents antibonding molecular orbitals. Thus the no. of antibonding electrons in O_2^{2-} ion is 8 (4 pairs).

43. (b) : Magnesium reacts with air to form oxide and nitride. On reaction with water, the oxide gives hydroxide and nitride gives hydroxide and ammonia.

$2Mg + O_2 \rightarrow \underset{(X)}{2MgO}$

$3Mg + N_2 \rightarrow \underset{(Y)}{Mg_3N_2}$

$MgO + H_2O \rightarrow \underset{(P)}{Mg(OH)_2}$

$Mg_3N_2 + 6H_2O \rightarrow \underset{(P)}{3Mg(OH)_2} + \underset{(Q)}{2NH_3}$

44. (c)

45. (b) : Glucose, fructose and mannose differ only in the configuration at C_1 and C_2 while rest of the molecules have the same stereochemistry and hence give the same osazone.

46. (a) : When an atom or an ion is missing from its normal lattice site, a lattice vacancy or defect is created, which is called Schottky defect. Due to missing atoms or ions, density of the crystal will be lowered.

47. (b)

48. (b) : $\dfrac{r_X}{r_{O_2}} = \sqrt{\dfrac{M_{O_2}}{M_X}}$

$\dfrac{V/2}{V/5.65} = \sqrt{\dfrac{32}{M_X}} \Rightarrow \dfrac{5.65}{2} = \sqrt{\dfrac{32}{M_X}} \Rightarrow M_X = 4$

49. (c)

50. (a) : Fluorspar (CaF_2) is added in small quantity in the electrolytic reduction of alumina dissolved in fused cryolite (Na_3AlF_6) to make the fused mixture more conducting as alumina is a bad conductor of electricity and to lower the m.pt. of fused mixture as alumina has very high m.pt.

PRACTICE PAPER 2023

CUET (UG)

Exam on 21st to 31st May 2023

Section II of CUET (UG) is domain specific. In this section of Chemistry 40 questions to be attempted out of 50.

Time Allowed : 45 Minutes **Maximum Marks :** 200

Section A

(All questions are compulsory.)

1. A carbonyl compound with molecular weight 86 does not reduce Fehling's solution but forms crystalline bisulphite derivatives and gives iodoform test. The possible compounds can be
(a) 2-pentanone and 3-pentanone
(b) 2-pentanone and 3-methyl-2-butanone
(c) 2-pentanone and pentanal
(d) 3-pentanone and 3-methyl-2-butanone.

2. The ionic radii (in Å) of N^{3-}, O^{2-} and F^- respectively are
(a) 1.71, 1.40, 1.36 (b) 1.71, 1.36, 1.40
(c) 1.36, 1.40, 1.71 (d) 1.36, 1.71, 1.40

3. Select the correct statements from the following.
(A) True particles are able to pass through filter paper and not in semipermeable membrane.
(B) Colloidal particles are able to pass through filter paper and not in semipermeable membrane.
(C) Solubility of a substance is its maximum amount that can be dissolved in a specified amount of solvent at a specified temperature.
(D) A mixture of a *n*-hexane and *n*-heptane forms an ideal solution.
(E) The solutions which show a large positive deviation from Raoult's law form maximum boiling azeotropes.
(a) (B), (C) and (D) only (b) (A), (B) and (D) only
(c) (A), (E) and (D) only (d) (B) and (E) only

4. For a reaction $A + B \rightarrow C + D$, if concentration of A is doubled without altering that of B, rate doubles. If concentration of B is increased nine times without altering that of A, rate triples. Order of the reaction is
(a) $1\frac{1}{2}$ (b) $1\frac{1}{3}$ (c) 2 (d) 1

5. 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

6. The transition metal ion that has 'spin-only' magnetic moment value of 5.92 is
(a) Mn^{2+} (b) Fe^{2+} (c) V^{2+} (d) Cu^{2+}

7. Which of the following represents the correct order of decreasing number of S ═ O bonds?
(a) $H_2SO_3 > H_2S_2O_8 > H_2SO_4$
(b) $H_2S_2O_8 > H_2SO_4 > H_2SO_3$
(c) $H_2S_2O_8 > H_2SO_3 > H_2SO_4$
(d) $H_2SO_4 > H_2SO_3 > H_2S_2O_8$

8. Match List I with List II and choose the correct option.

List I		List II	
A.	PCl_5	1.	Linear
B.	IF_7	2.	Pyramidal
C.	H_3O^+	3.	Trigonal bipyramidal
D.	ClO_2	4.	Tetrahedral
E.	NH_4^+	5.	Pentagonal bipyramidal
		6.	Angular

(a) A-3, B-5, C-2, D-1, E-4
(b) A-3, B-5, C-4, D-1, E-2
(c) A-3, B-5, C-6, D-1, E-2
(d) A-3, B-5, C-2, D-6, E-4

9. Which one of the following statements is not true?
(a) Buna-S is a copolymer of buta-1-3-diene and styrene.
(b) PHBV is a biodegradable polymer.
(c) In vulcanization, the formation of sulphur bridges between different chains make rubber harder and stronger.
(d) Natural rubber has the *trans*-configuration at every double bond.

10. Standard electrode potentials of redox couples X^{2+}/X, Y^{2+}/Y, Z^{2+}/Z and U^{2+}/U are 0.2 V, –0.5 V, –0.75 V and 0.8 V respectively. Which of these is best oxidising agent and reducing agent respectively?
(a) U^{2+}/U and Y^{2+}/Y (b) Y^{2+}/Y and U^{2+}/U
(c) U^{2+}/U and Z^{2+}/Z (d) Z^{2+}/Z and U^{2+}/U

11. What is the amount of chlorine evolved when 2 ampere of current is passed for 30 minutes in an aqueous solution of NaCl?
(a) 66 g (b) 1.32 g (c) 33 g (d) 99 g

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

Column I		Column II	
(A)	Glucose + HI	(I)	Gluconic acid
(B)	Glucose + Br_2 water	(II)	Glucose pentacetate
(C)	Glucose + acetic anhydride	(III)	Saccharic acid
(D)	Glucose + HNO_3	(IV)	Hexane

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

13. Increasing order of acid strength among *p*-methoxyphenol, *p*-methylphenol and *p*-nitrophenol is
(a) *p*-nitrophenol, *p*-methoxyphenol, *p*-methylphenol
(b) *p*-methylphenol, *p*-methoxyphenol, *p*-nitrophenol
(c) *p*-nitrophenol, *p*-methylphenol, *p*-methoxyphenol
(d) *p*-methoxyphenol, *p*-methylphenol, *p*-nitrophenol.

14. 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.

15. **Statement-I :** Molecules that are not superimposable on their mirror images are chiral.
Statement-II : All chiral molecules have chiral centres.
(a) Statement-I and statement-II are correct and statement-II is the correct explanation of statement-I.
(b) Statement-I and statement-II are correct but statement-II is not the correct explanation of statement-I.
(c) Statement-I is correct but statement-II is wrong.
(d) Statement-I is wrong but statement-II is correct.

Section B

(Attempt any 25 questions.)

16. Which of the statements given below are true for the structure of water molecule?
(i) Oxygen undergoes sp^3 hybridisation.
(ii) Due to presence of two lone pairs of electrons on oxygen, the H — O — H bond angle is 118.4°.
(iii) Due to angular geometry, the net dipole moment of water is not zero, μ = 1.84 D.
(a) (i) and (ii) (b) (ii) and (iii)
(c) (i) and (iii) (d) only (ii)

17. Which of the following xenon compounds has the same number of lone pairs as in I_3^-?
(a) XeO_4 (b) XeF_4 (c) XeF_2 (d) XeO_3

18. The activation energy in a chemical reaction is defined as
(a) the difference in energies of reactants and products
(b) the sum of energies of reactants and products
(c) the difference in energy of intermediate complex with the average energy of reactants and products
(d) the difference in energy of intermediate complex and the average energy of reactants.

19. The hybridisation, oxidation number of central metal ion and shape of Wilkinson's catalyst are
(a) dsp^2, +1, square planar
(b) sp^3, +4, tetrahedral
(c) sp^3d, +2, trigonal bipyramidal
(d) d^2sp^3, +6, octahedral.

20. What is the problem faced while using alitame as artificial sweetener?
(a) It decomposes when added to the food items.
(b) It provides a huge number of calories to the food.
(c) It is difficult to control the sweetness of food while using it.
(d) It increases the volume of the contents to a large extent.

21. Which of the following statements is correct regarding the slag obtained during the extraction of a metal like copper or iron?

(a) The slag is lighter and has higher melting point than the metal.

(b) The slag is lighter and has lower melting point than the metal.

(c) The slag is heavier and has higher melting point than the metal.

(d) The slag is heavier and has lower melting point than the metal.

22. The number of unit cells in 15 g of ^{60}Co having *ccp* system is

(a) $N_A/2$ (b) $8N_A$

(c) $N_A/8$ (d) $N_A/16$

23. Consider the reactions :

(i) $(CH_3)_2CH - CH_2Br \xrightarrow{C_2H_5OH} (CH_3)_2CH - CH_2OC_2H_5 + HBr$

(ii) $(CH_3)_2CH - CH_2Br \xrightarrow{C_2H_5O^-} (CH_3)_2CH - CH_2OC_2H_5 + Br^-$

The mechanisms of reactions (i) and (ii) are respectively

(a) S_N1 and S_N2 (b) S_N1 and S_N1

(c) S_N2 and S_N2 (d) S_N2 and S_N1

24. Which of the following statements is not correct?

(a) Proteins are polyamides formed from amino acids.

(b) Except glycine, all other amino acids show optical activity.

(c) Natural proteins are commonly made up of *L*-isomer of amino acids.

(d) In α-amino acids, $-NH_2$ and – COOH groups are attached to different carbon atoms.

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

Column I		Column II	
(A)	$CH_3NH_2 + CHCl_3 + KOH \xrightarrow{\Delta}$	(i)	CH_3NH_2
(B)	$CH_3CONH_2 + Br_2 + KOH \longrightarrow$	(ii)	CH_3OH
(C)	$CH_3NH_2 + NaNO_2 + HCl \longrightarrow$	(iii)	CH_3NHCH_3
(D)	$CH_3NC + 4H \xrightarrow{Pt}$	(iv)	CH_3NC

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

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

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

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

26. Consider the following statements :

I. $La(OH)_3$ is least basic among hydroxides of lanthanides.

II. Zr^{4+} and Hf^{4+} possess almost the same ionic radii.

III. Ce^{4+} can act as an oxidizing agent.

Which of the above is/are true?

(a) I and III (b) II and III

(c) II only (d) I and II

27. The best oxidising agent for oxidation of $CH_3CH{=}CHCHO$ to $CH_3CH{=}CH - COOH$ is

(a) acidified $KMnO_4$ (b) alkaline $KMnO_4$

(c) acidified $K_2Cr_2O_7$ (d) $[Ag(NH_3)_2]^+$

28. What is the $[OH^-]$ in the final solution prepared by mixing 20.0 mL of 0.050 M HCl with 30.0 mL of 0.10 M $Ba(OH)_2$?

(a) 0.40 M (b) 0.0050 M

(c) 0.12 M (d) 0.10 M

29. Select the correct statements from the following :

(A) Lyophilic colloids are reversible sols.

(B) Froth is an aerosol.

(C) The formation of micelles takes place only above a particular temperature called Kraft temperature.

(D) Finely divided iron is used as a catalyst in the Haber's process.

(E) Zymase enzyme converts maltose to glucose.

(a) (B), (D) and (E) only

(b) (A), (C) and (D) only

(c) (C) and (E) only

(d) (A) and (D) only

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

Column I		Column II	
(A)	$>C=O \xrightarrow{LiAlH_4}$	(i)	$-COONa$
(B)	$>C=O \xrightarrow[conc.\ HCl]{Zn/Hg}$	(ii)	$-COOH$
(C)	$H>C=O \xrightarrow{Ag_2O/OH^-}$	(iii)	$>CH_2$
(D)	$>C=O \xrightarrow{NaOX}$	(iv)	$>CHOH$

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

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

32. The pair in which phosphorus atoms have a formal oxidation state of +3 is
(a) orthophosphorous and pyrophosphorous acids
(b) pyrophosphorous and hypophosphoric acids
(c) orthophosphorous and hypophosphoric acids
(d) pyrophosphorous and pyrophosphoric acids.

33. An organic compound *X* is oxidised by using acidified $K_2Cr_2O_7$ solution. The product obtained reacts with phenyl hydrazine but does not answer silver mirror test. The compound *X* is
(a) 2-propanol (b) ethanal
(c) ethanol (d) propane.

34. **Statement-I :** Bromobenzene upon reaction with Br_2/Fe gives 1,4-dibromobenzene as the major product.
Statement-II : In bromobenzene, the inductive effect of the bromo group is more dominant than the mesomeric effect in directing the incoming electrophile.
(a) Statement-I and statement-II are correct and statement-II is the correct explanation of statement-I.
(b) Statement-I and statement-II are correct but statement-II is not the correct explanation of statement-I.
(c) Statement-I is correct but statement-II is wrong.
(d) Statement-I is wrong but statement-II is correct.

35. *n*-Propyl alcohol and isopropyl alcohol are the examples of
(a) position isomerism
(b) chain isomerism
(c) tautomerism
(d) geometrical isomerism.

36. A 0.001 molal solution of $Pt(NH_3)_4Cl_4$ in water has a freezing point depression of 0.0054 °C. If K_f for water is 1.80 °C m^{-1}, the correct formulation for the above molecule is
(a) $[Pt(NH_3)_4Cl_3]Cl$ (b) $[Pt(NH_3)_4Cl_2]Cl_2$
(c) $[Pt(NH_3)_4Cl]Cl_3$ (d) $[Pt(NH_3)_4Cl_4]$

37. Complete the following reaction by identifying *X* and *Y*.

$$CH_3CH_2C\equiv CH \xrightarrow{NaNH_2} X \xrightarrow{C_2H_5Br} Y$$

(a) $X = CH_3CH_2COONa$, $Y = CH_3CH_2CH{=}CH_2$
(b) $X = CH_3CH_2C\equiv CNa$, $Y = CH_3CH_2C\equiv CC_2H_5$
(c) $X = CH_3CH_2CH_2CH_2Na$, $Y = CH_3CH_2CH_2CH_3$
(d) $X = CH_3CH_2CH\equiv CNa$, $Y = CH_3CH_2-\underset{\displaystyle C_2H_5}{\underset{|}{CH}}-CH_3$

38. Match each coordination compound in List I with an appropriate pair of characteristics from List II and select the correct answer using the codes 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

39. **Statement-I :** Alkali metals are obtained by electrolysis of molten salt and not aqueous solution.
Statement-II : The discharge potential of H^+ ions is lower than alkali metal cation hence hydrogen is discharged at cathode instead of metal.
(a) Statement-I and statement-II are correct and statement-II is the correct explanation of statement-I.
(b) Statement-I and statement-II are correct but statement-II is not the correct explanation of statement-I.
(c) Statement-I is correct but statement-II is wrong.
(d) Statement-I is wrong but statement-II is correct.

40. What is the decreasing order of basicity of primary, secondary and tertiary ethylamines and NH_3?

(a) $NH_3 > C_2H_5NH_2 > (C_2H_5)_2NH > (C_2H_5)_3N$

(b) $(C_2H_5)_3N > (C_2H_5)_2NH > C_2H_5NH_2 > NH_3$

(c) $(C_2H_5)_2NH > C_2H_5NH_2 > (C_2H_5)_3N > NH_3$

(d) $(C_2H_5)_2NH > (C_2H_5)_3N > C_2H_5NH_2 > NH_3$

Case I : Read the given passage and answer the questions from 41 to 45.

Molar conductivity (Λ_m) of an electrolyte is the conducting power of all the ions produced by one mole of it in a solution placed between two large electrodes one centimetre apart. The molar conductivity of a solution at any concentration is related to its conductivity (κ) by the relation $C_m \times \Lambda_m = \kappa \times 1000$. Molar conductivity of the electrolyte is highest at infinite dilution when each ion of the electrolyte makes a definite contribution towards the molar conductivity. Molar conductivity at infinite dilution is called limiting molar conductivity (Λ°_m). The degree of dissociation of electrolyte at any concentration can be obtained from the ratio of $\Lambda_m/\Lambda^\circ_m$.

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

41. Molar ionic conductivities of a bivalent electrolyte are 57 and 73. The molar conductivity of the solution will be

(a) 130 S cm^2 mol^{-1} (b) 65 S cm^2 mol^{-1}

(c) 260 S cm^2 mol^{-1} (d) 187 S cm^2 mol^{-1}

42. At 25 °C, molar conductance of 0.1 molar aqueous solution of ammonium hydroxide is 9.54 ohm^{-1} cm^2 mol^{-1} and at infinite dilution, its molar conductance is 238 ohm^{-1} cm^2 mol^{-1}. The degree of ionisation of ammonium hydroxide at the same concentration and temperature is

(a) 4.008% (b) 40.800%

(c) 2.080% (d) 20.800%

43. Molar conductivity of a solution is 1.26×10^2 ohm^{-1} cm^2 mol^{-1}. Its molarity is 0.01. Its specific conductivity will be

(a) 1.26×10^{-25} ohm^{-1} cm^{-1}

(b) 1.26×10^{-3} ohm^{-1} cm^{-1}

(c) 1.26×10^{-4} ohm^{-1} cm^{-1}

(d) 0.0063 ohm^{-1} cm^{-1}

44. Molar conductivity of 0.15 M solution of KCl at 298 K, if its conductivity is 0.0152 S cm^{-1} will be

(a) 124 Ω^{-1} cm^2 mol^{-1} (b) 204 Ω^{-1} cm^2 mol^{-1}

(c) 101 Ω^{-1} cm^2 mol^{-1} (d) 300 Ω^{-1} cm^2 mol^{-1}

45. Molar conductivity of NH_4OH can be calculated by the equation,

(a) $\Lambda^\circ_{NH_4OH} + \Lambda^\circ_{Ba(OH)_2} + \Lambda^\circ_{NH_4Cl} - \Lambda^\circ_{BaCl_2}$

(b) $\Lambda^\circ_{NH_4OH} = \Lambda^\circ_{BaCl_2} + \Lambda^\circ_{NH_4Cl} - \Lambda^\circ_{Ba(OH)_2}$

(c) $\Lambda^\circ_{NH_4OH} = \dfrac{\Lambda^\circ_{Ba(OH)_2} + 2\Lambda^\circ_{NH_4Cl} - \Lambda^\circ_{Ba(OH)_2}}{2}$

(d) $\Lambda^\circ_{NH_4OH} = \dfrac{\Lambda^\circ_{NH_4Cl} + \Lambda^\circ_{Ba(OH)_2}}{2}$

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

The *f*-block elements are those in which the differentiating electron enters the $(n-2)f$ orbital. There are two series of *f*-block elements corresponding to filling of 4*f* and 5*f*-orbitals. The series of 4*f*-orbitals is called lanthanides. Lanthanides show different oxidation states depending upon stability of f^0, f^7 and f^{14} configurations, though the most common oxidation state is +3. There is a regular decrease in size of lanthanides ions with increase in atomic number which is known as lanthanide contraction.

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

46. The atomic numbers of three lanthanide elements *X*, *Y* and *Z* are 65, 68 and 70 respectively, their Ln^{3+} electronic configuration is

(a) $4f^8, 4f^{11}, 4f^{13}$ (b) $4f^{11}, 4f^8, 4f^{13}$

(c) $4f^0, 4f^2, 4f^{11}$ (d) $4f^3, 4f^7, 4f^9$

47. Lanthanide contraction is observed in

(a) Gd (b) At (c) Xe (d) Te

48. Which of the following is not the configuration of lanthanoid?

(a) $[Xe]4f^{10}6s^2$ (b) $[Xe]4f^{1}5d^{1}6s^2$

(c) $[Xe]4d^{14}5d^{10}6s^2$ (d) $[Xe]4f^{7}5d^{1}6s^2$

49. Name a member of the lanthanoid series which is well known to exhibit +4 oxidation state.

(a) Cerium ($Z = 58$) (b) Europium ($Z = 63$)

(c) Lanthanum ($Z = 57$) (d) Gadolinium ($Z = 64$)

50. Identify the incorrect statement among the following.

(a) Lanthanoid contraction is the accumulation of successive shrinkages.

(b) The different radii of Zr and Hf due to consequence of the lanthanoid contraction.

(c) Shielding power of 4*f* electrons is quite weak.

(d) There is a decrease in the radii of the atoms or ions as one proceeds from La to Lu.

SOLUTIONS

1. (b): Since the compound does not reduce Fehling's solution but forms crystalline bisulphite derivative, hence it is a ketone. Since it gives iodoform test, the compound can be a methyl ketone. Hence, the possible compounds can be 2-pentanone and 3-methyl-2-butanone.

2. (a) **3. (a)**

4. (a): Order of reaction with respect to A,

Rate $(r_1) \propto [A]^n$

On doubling concentration of A,

Rate $(r_2) = 2r_1 \propto [2A]^n$ thus, $n = 1$.

Order of reaction with respect to B,

Rate $(r_1) \propto [B]^n$

On increasing concentration of B nine times,

Rate $(r_2) = 3r_1 \propto [9B]^n$ thus, $n = 1/2$.

Overall order of reaction $= 1 + \frac{1}{2} = 1\frac{1}{2}$

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

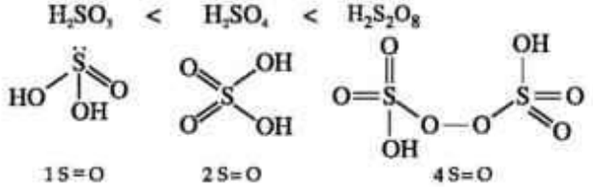
$\log 2 = \frac{E_a}{2.303 \times 2}\left[\frac{300 - 290}{290 \times 300}\right]$ $(\because k_2 = 2\,k_1)$

$E_a = 12062$ calories ≈ 12 kcal

6. (a)

7. (b):

H_2SO_3 < H_2SO_4 < $H_2S_2O_8$



8. (d) **9. (d)**

10. (c): The redox couple with maximum reduction potential will be best oxidising agent and with minimum reduction potential will be best reducing agent.

11. (b): At Anode : $Cl^- \longrightarrow 1/2Cl_2 + e^-$

$E_{Cl_2} = \frac{35.5 \times 2}{2} = 35.5$

$w_{Cl_2} = \frac{E_{Cl_2} \times I \times t}{96500} = \frac{35.5 \times 2 \times 30 \times 60}{96500} = 1.32$ g

12. (a)

13. (d): Electron donating groups ($-OCH_3$, $-CH_3$, etc.) tend to decrease and electron withdrawing groups ($-NO_2$, $-CN$, etc.) tend to increase the acidic character of phenols. Since $-OCH_3$ is a more powerful electron donating group than $-CH_3$ group, therefore, *p*-methylphenol is slightly more acidic than *p*-methoxyphenol while *p*-nitrophenol is the strongest acid.

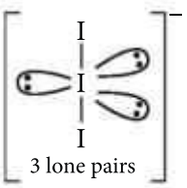
14. (b): Potassium chromate is oxidised to potassium dichromate on reaction with an acid.

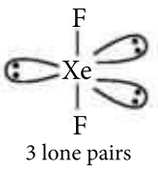
i.e., $2CrO_4^{2-} + 2H^+ \longrightarrow Cr_2O_7^{2-} + H_2O$

15. (c): Suitably substituted allenes (2,3-pentadiene) and biphenyls are optically active although they don't have asymmetric carbon atom.

16. (c): Due to presence of two lone pairs of electrons on oxygen atom, the bond angle H – O – H is 104.5°.

17. (c):





18. (d) **19. (a)**

20. (c): Alitame is a high potency sweetener although, it is more stable than aspartame, the control of sweetness of food is difficult while using it.

21. (a): Slag is lighter, has lower m.pt. than metal, hence it floats and can be skimmed off.

TRIO

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.

PEP – – – E
COORD – – – TION
– – – HIONATE
AMMO – – –
– – – LULOSE
CY – – – DE
E – – – TROPHORESIS
DARMSTA – – – UM
NU – – – IC

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.

22. (d): Number of unit cells $= \frac{x \times N_A}{Z \times M} = \frac{15 \times N_A}{4 \times 60} = \frac{N_A}{16}$

23. (c): If reaction is S_N1, there will be the formation of carbocation and the rearrangement takes place. In the given reactions, there is no rearrangement, hence both follow S_N2 mechanism.

24. (d) **25. (c)**

26. (b): $La(OH)_3$ is most basic. Hence, (I) is wrong. (II) is correct due to lanthanoid contraction. (III) is correct because Ce^{4+} tends to change to stable Cr^{3+}.

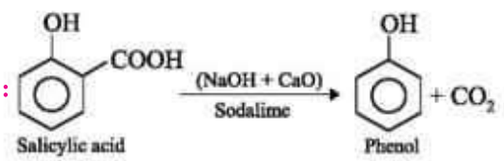
27. (d): Tollens' reagent oxidises only –CHO to –COOH group.

$$CH_3 - CH = CHCHO \xrightarrow{[Ag(NH_3)_2]^+} CH_3CH = CHCOOH$$

28. (d) **29. (b)**

30. (b)

31. (a):

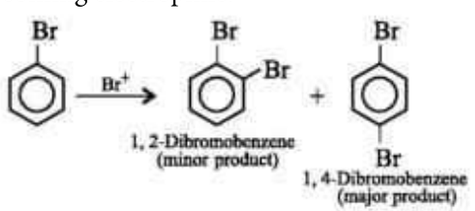


32. (a) **33. (a)**

34. (c): Bromobenzene shows both *–I* effect as well as *+M* effect; but mesomeric effect dominates over the *–I* character and becomes the directing factor for incoming electrophile.

Mechanism :

1. Formation of electrophile takes place.
   $Br - Br + FeBr_3 \longrightarrow Br^+ + FeBr_4^-$
2. Bromobenzene acts as an *ortho-para* director for upcoming electrophile.



35. (a) **36. (b)**

37. (b) **38. (b)**

39. (a)

40. (d): In case of ethylamines, the combined effect of inductive effect, steric effect and solvation effect gives the order of basic strength as

$$\underset{(2^\circ)}{(C_2H_5)_2NH} > \underset{(3^\circ)}{(C_2H_5)_3N} > \underset{(1^\circ)}{C_2H_5NH_2} > NH_3$$

41. (a): $\lambda_m = \lambda_{Cation} + \lambda_{Anion} = 57 + 73 = 130\ S\ cm^2\ mol^{-1}$

42. (a): Degree of dissociation (α) $= \frac{\text{Molar conductivity at conc. } (\Lambda_m^c)}{\text{Molar conductivity at infinite dilution } (\Lambda_m^\infty)}$

$$\alpha = \frac{9.54\ ohm^{-1}\ cm^2\ mol^{-1}}{238\ ohm^{-1}\ cm^2\ mol^{-1}} = 0.04008 = 4.008\%$$

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

$$\kappa = \frac{1.26 \times 10^2 \times 0.01}{1000} = 1.26 \times 10^{-3}\ ohm^{-1}\ cm^{-1}$$

44. (c): $\Lambda_m = \frac{\kappa \times 1000}{M} = \frac{1.52 \times 10^{-2} \times 1000}{0.15}$

$= 101.3\ \Omega^{-1}\ cm^2\ mol^{-1}$

45. (c): $\Lambda^\circ_{Ba(OH)_2} = \Lambda^\circ_{Ba^{2+}} + 2\Lambda^\circ_{OH^-}$ .....(i)

$\Lambda^\circ_{BaCl_2} = \Lambda^\circ_{Ba^{2+}} + 2\Lambda^\circ_{Cl^-}$ .....(ii)

$\Lambda^\circ_{NH_4Cl} = \Lambda^\circ_{NH_4^+} + \Lambda^\circ_{Cl^-}$ .....(iii)

After substituting the above in eq. (iv)

$$\Lambda^\circ_{NH_4OH} = \frac{\Lambda^\circ_{Ba(OH)_2} + 2\Lambda^\circ_{NH_4Cl} - \Lambda^\circ_{BaCl_2}}{2} \quad \text{....(iv)}$$

we get, $\Lambda^\circ_{NH_4OH} = \Lambda^\circ_{NH_4^+} + \Lambda^\circ_{OH^-}$

46. (a): Terbium (65), $4f^8$; Dysprosium (66), $4f^9$; Ytterbium (70), $4f^{13}$.

47. (a) **48. (c)**

49. (a)

50. (b): The almost identical radii of Zr (160 pm) and Hf (159 pm) a consequence of lanthanoid contraction.

EXAM ALERT 2023

Exam	Date
NEET	7th May
MHT CET PCM	9th to 13th May
MHT CET PCB	15th to 20th May
KCET BM	20th May
KCET PC	21st May
CUET	21st to 31st May
KCET Language Test	22nd May
BITSAT Session I	22nd to 26th May
JEE Advanced	4th June
BITSAT Session II	18th to 22nd June

JEE 2023 ADVANCED

PRACTICE PAPER

Exam on 4th June

PAPER-I

SECTION 1 (MAXIMUM MARKS : 24)

- *This section contains EIGHT (08) 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 onscreen 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 Only if the correct numerical value is entered;*

  Zero Marks : *0 In all other cases.*

1. Aluminium reacts with sulphuric acid to form aluminium sulphate and hydrogen. What is the volume of hydrogen gas in liters (L) produced at 300 K and 1.0 atm pressure, when 5.4 g of aluminium and 50.0 mL of 5.0 M sulphuric acid are combined for the reaction? (Use molar mass of aluminium as 27.0 g mol^{-1}, R = 0.082 atm L mol^{-1} K^{-1})

2. The total number of stereoisomers that can exist for molecule *M* is_____

M

3. A chloro compound "*A*"

(i) forms aldehydes on ozonolysis followed by the hydrolysis.

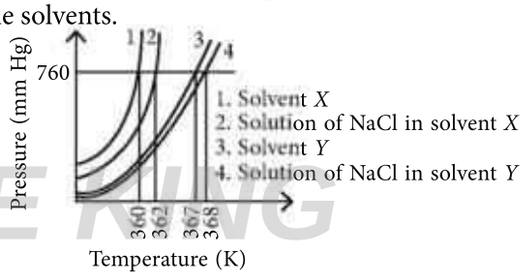
(ii) when vaporized completely 1.53 g of *A*, gives 448 mL of vapour at STP.

The number of carbon atoms in a molecule of compound *A* is _____

4. Reaction of $[Co(H_2O)_6]^{2+}$ with excess ammonia and in the presence of oxygen results into a diamagnetic product. Number of electrons present in t_{2g} orbitals of the product is _____.

5. The volume, in mL, of 0.02 M $K_2Cr_2O_7$ solution required to react with 0.288 g of ferrous oxalate in acidic medium is _____.

6. The plot given below shows *P*—*T* curves (where *P* is the pressure and *T* is the temperature) for two solvents *X* and *Y* and isomolal solutions of NaCl in these solvents. NaCl completely dissociates in both the solvents.



On addition of equal number of moles of a non-volatile solute *S* in equal amount (in kg) of these solvents, the elevation of boiling point of solvent *X* is three times that of solvent *Y*. Solute *S* is known to undergo dimerization in these solvents. If the degree of dimerization is 0.7 in solvent *Y*, the degree of dimerization in solvent *X* is ____.

7. The work function of sodium metal is 4.41×10^{-19} J. If photons of wavelength 300 nm are incident on the metal, the kinetic energy of the ejected electrons will be _____ $\times 10^{-21}$ J. ($h = 6.63 \times 10^{-34}$ J s; $c = 3 \times 10^8$ m/s)

8. The ammonia prepared by treating ammonium sulphate with calcium hydroxide is completely used by $NiCl_2 \cdot 6H_2O$ to form a stable coordination compound. Assume that both the reactions are 100% complete. If 1584 g of ammonium sulphate and 952 g of $NiCl_2 \cdot 6H_2O$ are used in the preparation, the combined weight (in grams) of gypsum and the nickel-ammonia coordination compound thus produced is _____.

(Atomic weights in g mol^{-1}: H = 1, N = 14, O = 16, S = 32, Cl = 35.5, Ca = 40, Ni = 59)

SECTION 2 (MAXIMUM MARKS : 24)

- *This section contains SIX (06) 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.*

9. The colour of the X_2 molecules of group 17 elements changes gradually from yellow to violet down the group. This is due to

(a) the physical state of X_2 at room temperature changes from gas to solid down the group

(b) decrease in HOMO-LUMO gap down the group

(c) decrease in π^*–σ^* gap down the group

(d) decrease in ionization energy down the group.

10. The correct statement(s) about surface properties is (are)

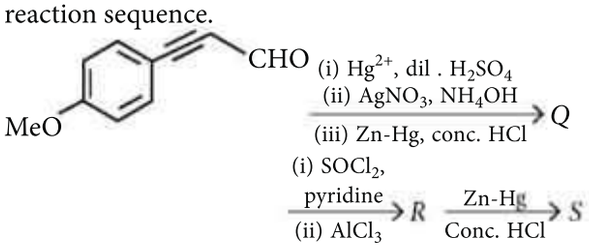
(a) cloud is an emulsion type of colloid in which liquid is dispersed phase and gas is dispersion medium

(b) the critical temperatures of ethane and nitrogen are 563 K and 126 K, respectively. The adsorption of ethane will be more than that of nitrogen on same amount of activated charcoal at a given temperature

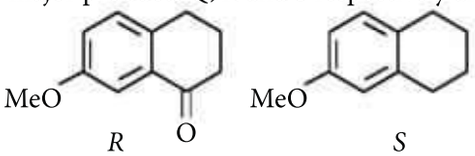
(c) adsorption is accompanied by decrease in enthalpy and decrease in entropy of the system

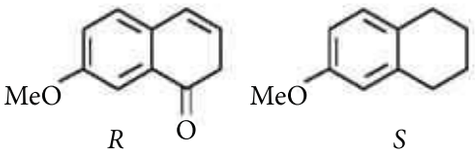
(d) Brownian motion of colloidal particles does not depend on the size of the particles but depends on viscosity of the solution.

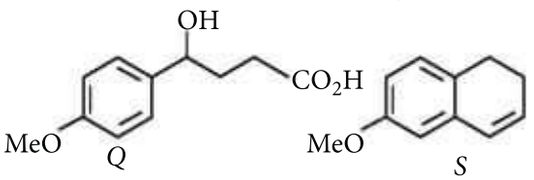
11. Choose the correct option(s) for the following reaction sequence.

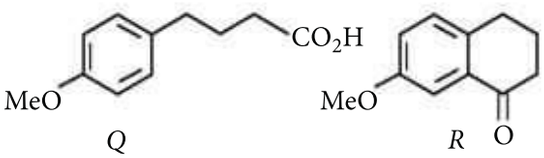


The major products Q, R and S respectively are

(a) 

(b) 

(c) 

(d) 

12. For diatomic molecules, the correct statement(s) about the molecular orbitals formed by the overlap of two $2p_z$ orbitals is(are)

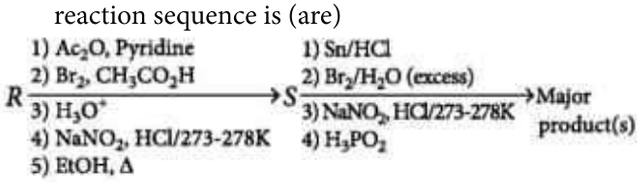
(a) σ orbital has a total of two nodal planes.

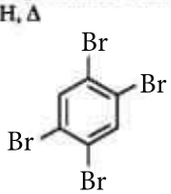
(b) σ^* orbital has one node in the xz-plane containing the molecular axis.

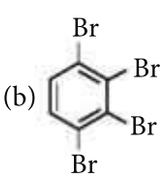
(c) π orbital has one node in the plane which is perpendicular to the molecular axis and goes through the center of the molecule.

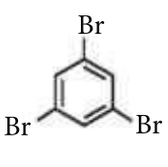
(d) π^* orbital has one node in the xy-plane containing the molecular axis.

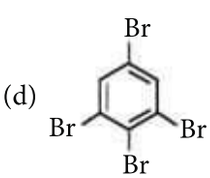
13. Aniline reacts with mixed acid (conc. HNO_3 and conc. H_2SO_4) at 288 K to give P (51 %), Q (47%) and R (2%). The major product(s) of the following reaction sequence is (are)



(a) 

(b) 

(c) 

(d) 

14. Which among the following statement(s) is(are) true for the extraction of aluminium from bauxite?

(a) Hydrated Al_2O_3 precipitates, when CO_2 is bubbled through a solution of sodium aluminate.

(b) Addition of Na_3AlF_6 lowers the melting point of alumina.

(c) CO_2 is evolved at the anode during electrolysis.

(d) The cathode is a steel vessel with a lining of carbon.

SECTION 3 (MAXIMUM MARKS : 12)

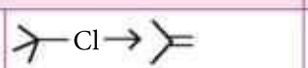
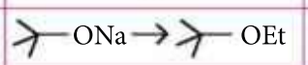
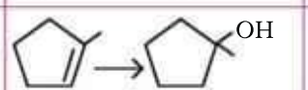
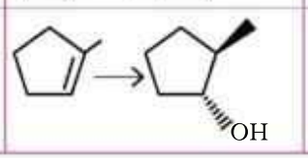
- ***This section contains FOUR (04) Matching List Sets.***
- ***Each set has ONE Multiple Choice Question.***
- ***Each set has TWO lists: List-I and List-II.***
- ***List-I has Four entries and List-II has Four/Five entries.***
- ***FOUR options are given in each Multiple Choice Question based on List-I 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.***

15. Match the chemical conversions in List I with the appropriate reagents in List II and select the correct option.

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

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

16. Match the crystal system/unit cells mentioned in Column I with their characteristic features mentioned in Column II and select the correct option.

Column I		Column II	
(A)	Simple cubic and face-centred cubic	(p)	have these cell parameters $a = b = c$ and $\alpha = \beta = \gamma$
(B)	Cubic and rhombohedral	(q)	are two crystal systems
(C)	Cubic and tetragonal crystallographic	(r)	have only two angles of 90°
(D)	Hexagonal and monoclinic	(s)	belong to same crystal system

(a) A – q, s; B – r; C – q, p; D – p

(b) A – p, s; B – q; C – q; D – q, r

(c) A – p, q; B – q, r; C – r; D – s

(d) A – q, r; B – p, q; C – r; D – q

17. Dilution processes of different aqueous solutions, with water, are given in List-I. The effects of dilution of the solutions on $[H^+]$ are given in List-II.
(Note: Degree of dissociation (α) of weak acid and weak base is <<1; degree of hydrolysis of salt<<1; $[H^+]$ represents the concentration of H^+ ions)

List-I		List-II	
P.	(10 mL of 0.1 M NaOH + 20 mL of 0.1 M acetic acid) diluted to 60 mL	1.	The value of $[H^+]$ does not change on diution.
Q.	(20 mL of 0.1 M NaOH + 20 mL of 0.1 M acetic acid) diluted to 80 mL	2.	The value of $[H^+]$ changes to half of its initial value on dilution.
R.	(20 mL of 0.1 M HCl + 20 mL of 0.1 M ammonia solution) diluted to 80 mL	3.	The value of $[H^+]$ changes to two times of its initial value on dilution.
S.	10 mL saturated solution of $Ni(OH)_2$ in equilibrium with excess solid $Ni(OH)_2$ is diluted to 20 mL (solid $Ni(OH)_2$ is still present after dilution).	4.	The value of $[H^+]$ changes to $\frac{1}{\sqrt{2}}$ times of its initial value on dilution.
		5.	The value of $[H^+]$ changes to $\sqrt{2}$ times of its initial value on dilution.

Match each process given in List-I with its effect in List-II, and select the correct option.

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

18. Match the thermodynamic processes given under Column I with the expressions given under Column II and select the correct option.

Column I		Column II	
I.	Freezing of water at 273 K and 1 atm	p.	$q = 0$
II.	Expansion of 1 mol of an ideal gas into a vacuum under isolated conditions	q.	$w = 0$
III.	Mixing of equal volumes of two ideal gases at constant temperature and pressure in an isolated container	r.	$\Delta S_{sys} < 0$
IV.	Reversible heating of $H_{2(g)}$ at 1 atm from 300 K to 600 K, followed by reversible cooling to 300 K at 1 atm	s.	$\Delta U = 0$
		t.	$\Delta G = 0$

(a) I – r, t; II – p, q, s; III – p, q, s; IV – p, q, s, t
(b) I – p, q; II – p, r, s; III – p, q, t; IV – r, t
(c) I – p, r, t; II – p, q, s; III – p, r, t; IV – p, q
(d) I – p, q, s; II – p, r; III – p, q, r; IV – p, q, s

PAPER-II

SECTION 1 (MAXIMUM MARKS : 24)

- ***This section contains EIGHT (08) questions.***
- ***The answer to each question is a SINGLE DIGIT INTEGER ranging from 0 TO 9, BOTH INCLUSIVE.***
- ***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:***

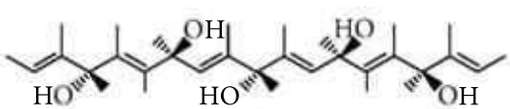
Full Marks : ***+3 If ONLY the correct integer is entered;***

Zero Marks : ***0 If the question is unanswered;***

Negative Marks : ***–1 In all other cases.***

1. The atomic masses of He and Ne are 4 and 20 a.m.u., respectively. The value of the de Broglie wavelength of He gas at –73°C is M times that of the de Broglie wavelength of Ne at 727°C. M is _____.

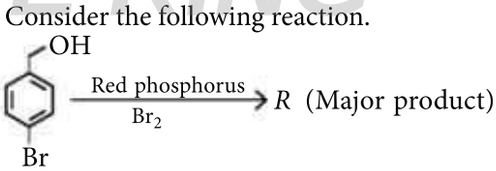
2. The total number of chiral molecules formed from one molecule of P on complete ozonolysis (O_3, Zn/H_2O) is _____.



P

3. The conductance of a 0.0015 M aqueous solution of a weak monobasic acid was determined by using a conductivity cell consisting of platinized Pt electrodes. The distance between the electrodes is 120 cm with an area of cross section of 1 cm^2. The conductance of this solution was found to be 5×10^{-7} S. The pH of the solution is 4. The value of limiting molar conductivity (Λ°_m) of this weak monobasic acid in aqueous solution is $Z \times 10^2$ S cm^2 mol^{-1}. The value of Z is _____.

4. Consider the following reaction.



On estimation of bromine in 1.00 g of R using Carius method, the amount of AgBr formed (in g) is $x \times 10^{-2}$. The value of x is _____.

[Given : Atomic mass of H = 1, C = 12, O = 16, P = 31, Br = 80, Ag = 108]

5. Ionic solid Na^+A^- crystallise in rock salt type structure. 2.592 g of ionic solid salt NaA dissolved in water to make 2 L solution. The pH of this solution is 8.5. If distance between cation and anion is 300 pm, the density of ionic solid (in g/cm^3) is _____.

(Given : $pK_w = 14$, $pK_a(HA) = 5$, $N_A = 6 \times 10^{23}$)

6. Thermal decomposition of $AgNO_3$ produces two paramagnetic gases. The total number electrons present in the antibonding molecular orbitals of the gas that has the higher number of unpaired electrons is _____.

7. 10 g of a mixture of hexane and ethanol are allowed to react with sodium to give 214.12 mL hydrogen at 27°C and 760 mm pressure. The percentage of ethanol in mixture is_____.

8. An acidified solution of potassium chromate was layered with an equal volume of amyl alcohol. When it was shaken after the addition of 1 mL of 3% H_2O_2, a blue alcohol layer was obtained. The blue colour is due to the formation of a chromium(VI) compound '*X*'. What is the number of oxygen atoms bonded to chromium through only single bonds in a molecule of *X*?

SECTION 2 (MAXIMUM MARKS : 24)

- ***This section contains SIX (06) 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 options;***
Zero Marks	:	***0 If unanswered;***
Negative Marks	:	***–2 In all other cases.***

9. Among the following, the correct statement(s) about polymers is(are)
   (a) the polymerization of chloroprene gives natural rubber.
   (b) teflon is prepared from tetrafluoroethene by heating it with persulphate catalyst at high pressures.
   (c) PVC are thermoplastic polymers.
   (d) ethene at 350-570 K temperature and 1000-2000 atm pressure in the presence of a peroxide initiator yields high density polythene.

10. Some standard electrode potentials at 298 K are given below :

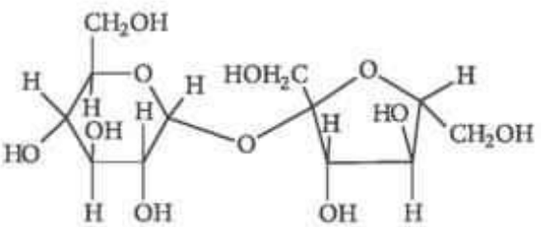
Pb^{2+}/Pb	– 0.13 V
Ni^{2+}/Ni	– 0.24 V
Cd^{2+}/Cd	– 0.40 V
Fe^{2+}/Fe	– 0.44 V

To a solution containing 0.001 M of X^{2+} and 0.1 M of Y^{2+}, the metal rods *X* and *Y* are inserted (at 298 K) and connected by a conducting wire. This resulted in dissolution of *X*. The correct combination(s) of *X* and *Y*, respectively, is (are)
(Given : Gas constant, R = 8.314 J K^{-1} mol^{-1}, Faraday constant, F = 96500 C mol^{-1})
   (a) Cd and Ni (b) Cd and Fe
   (c) Ni and Pb (d) Ni and Fe

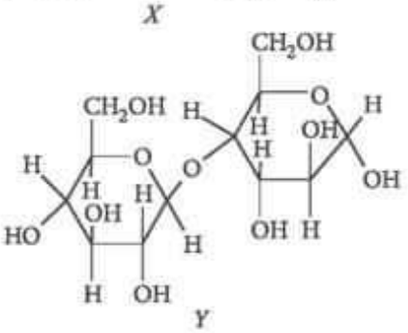
11. Consider the redox reaction,
$2S_2O_3^{2-} + I_2 \rightarrow S_4O_6^{2-} + 2I^-$
Select the correct statement(s).
   (a) $2S_2O_3^{2-}$ gets reduced to $S_4O_6^{2-}$
   (b) $2S_2O_3^{2-}$ get oxidised to $S_4O_6^{2-}$
   (c) I_2 gets reduced to I^-
   (d) I_2 gets oxidised to I^-.

12. Which of the following statements are correct?
   (a) $2.303 \log \frac{P_2}{P_1} = \frac{\Delta H_{vap.}}{R}\frac{[T_2 - T_1]}{T_1T_2}$ is Clausius – Clapeyron equation.
   (b) $\frac{\Delta H_{vap}}{\text{Boiling point}}$ = 88 J mol^{-1} K^{-1} is called Trouton's rule.
   (c) $\Delta C_V = \frac{\Delta H_2 - \Delta H_1}{T_2 - T_1}$ is Kirchoff's equation.
   (d) $T_i = 2a/Rb$ is van der Waals equation.

13. The correct statement(s) about the following sugars *X* and *Y* is (are)



X



Y

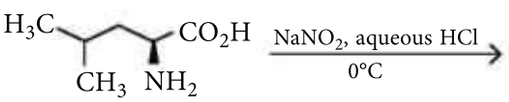
(a) X is a reducing sugar and Y is a non-reducing sugar

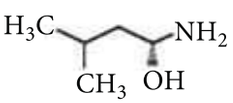
(b) X is a non-reducing sugar and Y is a reducing sugar

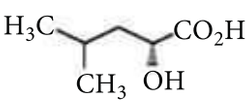
(c) the glycosidic linkages in X and Y are α and β respectively

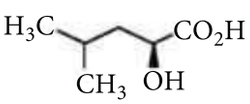
(d) the glycosidic linkages in X and Y are β and α respectively.

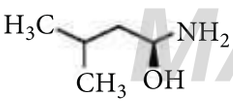
14. The major product of the reaction is



(a) 

(b) 

(c) 

(d) 

SECTION 3 (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;***

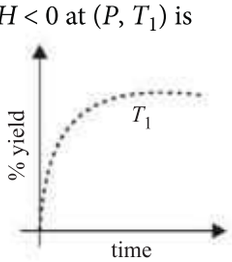
Zero Marks : ***0 If none of the options is chosen (i.e. the question is unanswered);***

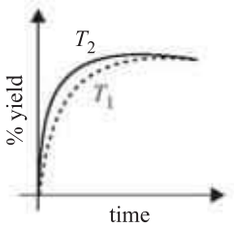
Negative Marks : ***−1 In all other cases.***

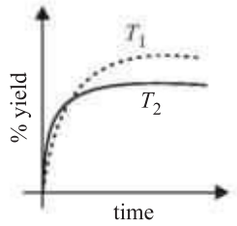
15. The % yield of ammonia as a function of time in the reaction

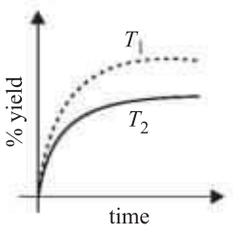
$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$, $\Delta H < 0$ at (P, T_1) is given as :

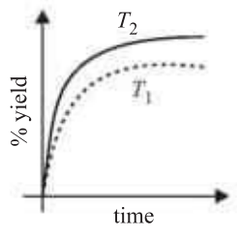
If this reaction is conducted at (P, T_2), with $T_2 > T_1$, the % yield of ammonia as a function of time is represented by



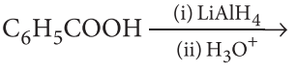
(a) 

(b) 

(c) 

(d) 

16. The organic product formed in the reaction is



(a) $C_6H_5CH_2OH$

(b) C_6H_5COOH and CH_4

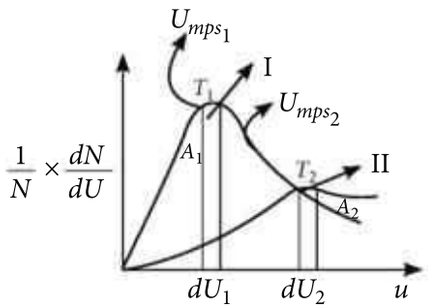
(c) $C_6H_5CH_3$ and CH_3OH

(d) $C_6H_5CH_3$ and CH_4

17. The given graph represents the Maxwell distribution curve for an ideal gas at two temperature T_1 and T_2. Which of the following options is incorrect ?

A_1 = Area of small rectangle I

A_2 = Area of small rectangle II



(a) Total area under the two curves is independent of moles of gas.

(b) If $dU_1 = fU_{mps_1}$ and $dU_2 = fU_{mps_2}$ then $A_1 = A_2$.

(c) $T_1 > T_2$ and hence higher the temperature, sharper the curve.

(d) The fraction of molecules having speed = U_{mps} decreases as temperature increases.

18. Among the following species, identify the isostructural pairs and select the correct option.

NF_3, NO_3^-, F_3, H_3O^+, NH_3

(a) $[NF_3, NO_3^-]$ and $[BF_3, H_3O^+]$

(b) $[NF_3, NH_3]$ and $[NO_3^-, BF_3]$

(c) $[NF_3, H_3O^+]$ and $[NO_3^-, BF_3]$

(d) $[NF_3, H_3O^+]$ and $[HN_3, BF_3]$.

SOLUTIONS

PAPER - I

1. (6.15) : Given : T = 300 K, P = 1 atm, w_{Al} = 5.4 g
$M_{H_2SO_4}$ = 5.0 M, $V_{H_2SO_4}$ = 50.0 mL

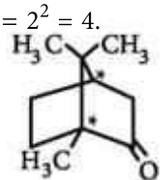
$$\underset{\left(\frac{5.4}{27}=0.2\text{ mol}\right)}{2Al} + \underset{\left(\frac{5}{1000}\times 50=0.25\text{ mol}\right)}{3H_2SO_4} \longrightarrow Al_2(SO_4)_3 + \underset{3\text{ moles}}{3H_2}$$
2 moles 3 moles

Thus, for 2 moles of Al, 3 moles of H_2SO_4 is required *i.e.*, for 0.2 mol of Al, 0.3 mol of H_2SO_4 is required, but the moles of H_2SO_4 available is 0.25 mol thus, H_2SO_4 is the limiting reagent. So, 0.25 mol of H_2 will be produced *i.e.*, n = 0.25 mol.

$PV = nRT$

$1 \times V = 0.25 \times 0.082 \times 300$ or V = 6.15 L

2. (2) : M has two chiral C–atoms thus, no. of stereoisomers = $2^n = 2^2 = 4$.



(M)

But due to bridging, rotation is not possible so, only two stereoisomers exist.

3. (3) : 448 mL vapour come from 1.53 g of A while 22400 mL of vapours will come from

$$\frac{1.53}{448}\times 22400 = 76.5\text{ g}.$$

Thus, the molecular weight of A is 76.5 g. The compound must contain one Cl and one C = C bond. Hence, the compound will be $CH_3 - CH = CH - Cl$.
Number of C atoms = 3

4. (6)

5. (50) : $FeC_2O_4 + Cr_2O_7^{2-} \rightarrow Fe^{3+} + CO_2 + Cr^{3+}$

$$\therefore \quad \frac{M_1V_1}{3}=\frac{M_2V_2}{6}$$

$$\frac{0.02\times V_1}{3}=\frac{0.288}{144\times 6}\times 1000$$

$$V_1=\frac{0.288}{144\times 6}\times\frac{1000\times 3}{0.02}=50\text{ mL}$$

6. (0.05)

7. (222) : Given : $w_0 = 4.41 \times 10^{-19}$ J, λ = 300 nm
$K.E.$ = ?, $h = 6.63 \times 10^{-34}$ J s, $c = 3 \times 10^8$ m s^{-1}
$w_0 = h\upsilon - K.E.$

$$4.41\times 10^{-19}\text{ J}=\frac{6.63\times 10^{-34}\times 3\times 10^{8}}{300\times 10^{-9}}-K.E.$$

$$4.41\times 10^{-19}\text{ J}=\frac{19.89\times 10^{-26}}{300\times 10^{-9}}-K.E.$$

4.41×10^{-19} J = 6.63×10^{-19} – $K.E.$

$K.E. = 6.63\times 10^{-19} - 4.41\times 10^{-19} = 2.22\times 10^{-19}\text{ J} = 222\times 10^{-21}\text{ J}$

8. (2992) : $(NH_4)_2SO_4 + Ca(OH)_2 \rightarrow \underset{\text{Gypsum}}{CaSO_4\cdot 2H_2O} + 2NH_3$

$$n=\frac{1584}{132}=12\text{ mol} \qquad 12\text{ mol}$$

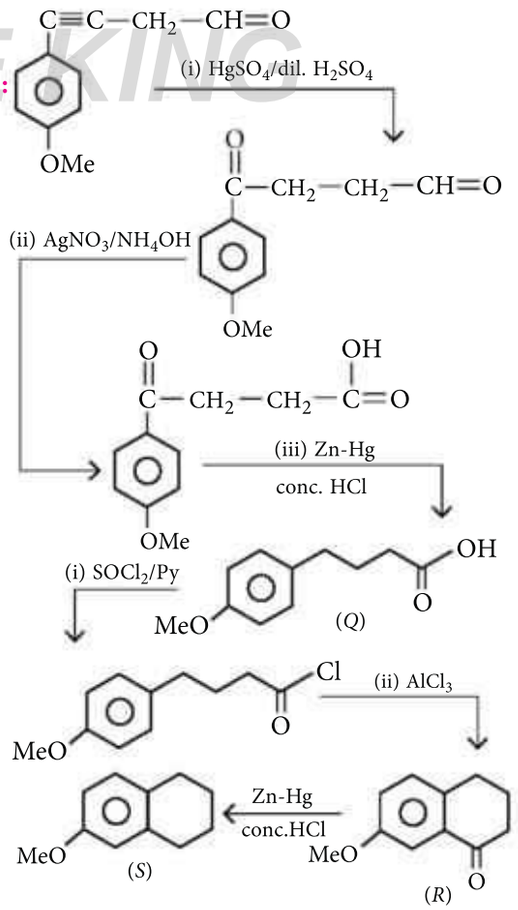
$$NiCl_2\cdot 6H_2O + 6NH_3 \longrightarrow [Ni(NH_3)_6]Cl_2 + 6H_2O$$

$$n=\frac{952}{238}=4\text{ mol} \qquad 4\text{ mol}$$

Combined weight of Gypsum and nickel - ammonia coordination compound
= 12 × $M_{CaSO_4.2H_2O}$ + 4$M_{[Ni(NH_3)_6]Cl_2}$
= (12 × 172) + (4 × 232) = 2992 g

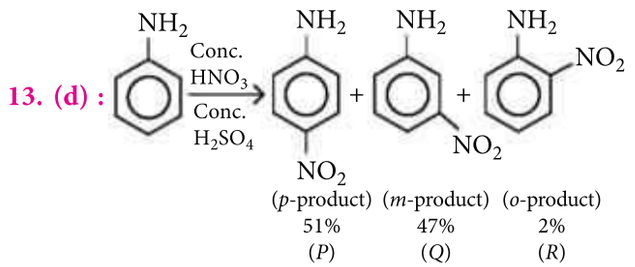
9. (b,c) **10. (b, c)**

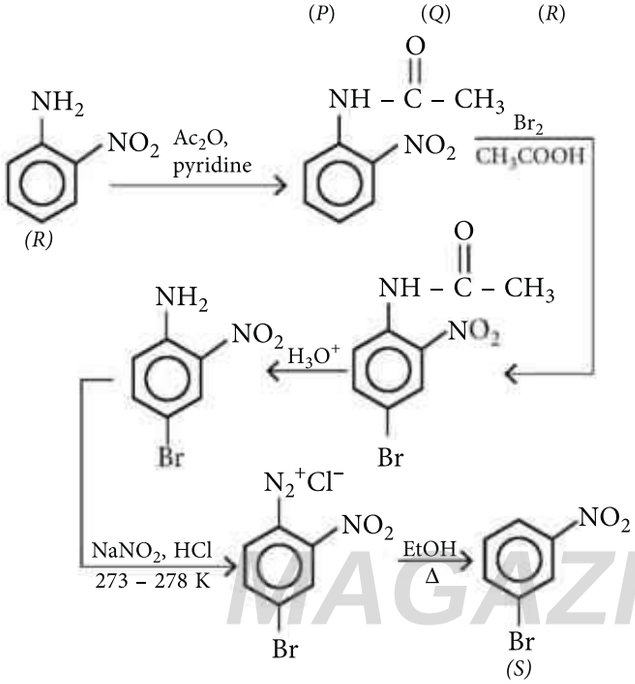
11. (a,d):

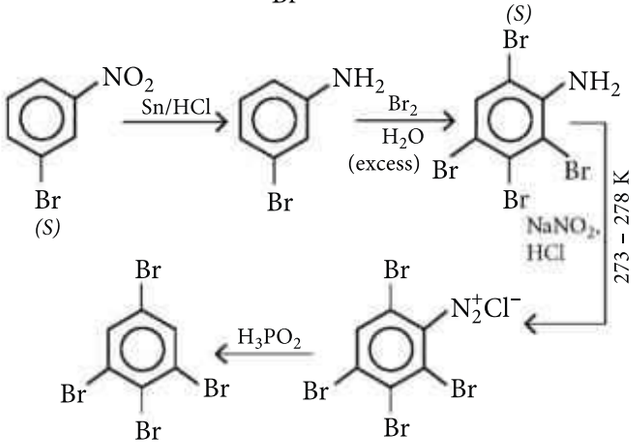


12. (a, d)

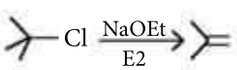
13. (d) :

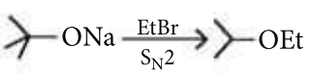


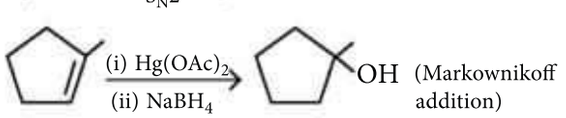


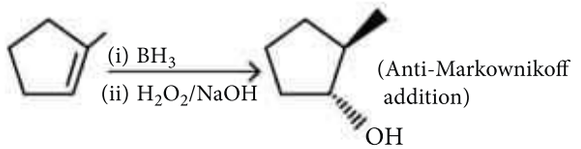


14. (a,b,c,d)

15. (a) : P : 

Q : 

R : 

S : 

16. (b) : A→ p, s ; B → q ; C → q ; D → q, r

For cubic crystal system, $a = b = c$ and $\alpha = \beta = \gamma$.

For monoclinic : $\alpha = \gamma = 90°$ and $\beta \neq 90°$.

For hexagonal : $\alpha = \beta = 90°$ and $\gamma = 120°$

17. (d) : (P) $[CH_3COOH]_{old} = \frac{20\times0.1-10\times0.1}{30} = \frac{1}{30}$

$[CH_3COO^-]_{new} = \frac{1}{30}$

Buffer with [Salt] = [Acid]

pH does not change on dilution.

(P) → (1)

(Q) $[CH_3COO^-]_{old} = \frac{20\times0.1}{40} = \frac{2}{40}$

$[CH_3COO^-]_{new} = \frac{2}{80}$

$\underset{c}{CH_3COO^-} + H_2O \longrightarrow \underset{x}{CH_3COOH} + \underset{x}{OH^-}$

$K_h = \frac{x^2}{c} = \frac{[OH^-]^2_{old}}{2/40} = \frac{[OH^-]^2_{new}}{2/80}$

ANSWERS APRIL 2023

The 3 sets of trio are **(ACE, ECA, CAE), (ART, RAT, TRA), (TON, NTO, ONT)**

PARACETAMOL

DECAY

CAESIUM

QUARTZ

STEARATES

TETRAHYDROFURAN

SEROTONIN

PENTOSE

STRONTIUM

Winner : Kaushikkumar Kevadiya

or $[OH^-]^2_{new} = \frac{[OH^-]^2_{old}}{2}$ or $[OH^-]_{new} = \frac{[OH^-]_{old}}{\sqrt{2}}$

$\therefore\ [H^+]_{new} = \sqrt{2}\,[H^+]_{old}$

(Q) $\rightarrow$ (5)

(R) $[NH_4^+]_{old} = \frac{20\times0.1}{40} = \frac{2}{40}$

$[NH_4^+]_{new} = \frac{2}{80}$

$$\underset{c}{NH_4^+} + H_2O \rightleftharpoons \underset{y}{NH_4OH} + \underset{y}{H^+}$$

$$K_h = \frac{y^2}{c} = \frac{[H^+]^2_{old}}{2/40} = \frac{[H^+_{new}]^2}{2/80}$$

or $[H^+_{new}]^2 = \frac{[H^+_{old}]^2}{2} \Rightarrow [H^+_{new}] = \frac{[H^+]_{old}}{\sqrt{2}}$

(R) $\rightarrow$ (4)

(S) For a saturated solution,

$$\underset{s}{Ni(OH)_2} \rightleftharpoons \underset{s}{Ni^{2+}} + \underset{2s}{2OH^-}$$

$K_{sp} = s \times (2s)^2 = 4s^3$

$s = [OH^-] = \sqrt[3]{\frac{K_{sp}}{4}}$

Irrespective of volume of solution, $[H^+]$ remains constant.

(S) $\rightarrow$ (1)

18. (a) : (I) $\rightarrow$ (r and t)

Freezing of water, $H_2O_{(l)} \underset{273\ K}{\overset{1\ atm}{\rightleftharpoons}} H_2O_{(s)}$

The system is cooled *i.e.*; heat is released during the process so, $q < 0$.

Water $\rightleftharpoons$ Ice + heat

(Less volume) (More volume)

Volume is increased *i.e.*; ΔV = +ve.

$w = -P\Delta V$ = –ve; *i.e.*; $w < 0$ (expansion)

Entropy of system is decreased, $\Delta S_{sys} < 0$.

$\Delta U = q + w$. As $q < 0$, $w < 0$ so, $\Delta U < 0$.

At equilibrium, $\Delta G = 0$.

(II) $\rightarrow$ (p, q and s)

Expansion of 1 mol of an ideal gas into a vacuum under isolated conditions, $w = 0$, $q = 0$ so, $\Delta U = 0$

For expansion, $\Delta S_{sys} > 0$ as entropy increases.

$$\Delta G = -nRT\ln\frac{V_2}{V_1}$$

For expansion, $V_2 > V_1$

ΔG = –ve *i.e.*; $\Delta G < 0$.

(III) $\rightarrow$ (p, q and s)

Mixing of equal volumes of two ideal gases at constant temperature and pressure in an isolated container.

$q = 0$ (isolated)

$w = -P\Delta V$; $w = 0$ $\quad (\because \Delta V = 0)$

$\Delta S_{sys} > 0$ (mixing of gases)

$\Delta U = q + w = 0$; $\Delta G = \Delta H - T\Delta S$

$\Delta G = q_p - T\Delta S$ (at constant P, T)

$\Delta G = 0 - T\Delta S = -T\Delta S$

$\Delta G < 0$ $\quad (\because\ \Delta S_{sys} > 0)$

(IV) $\rightarrow$ (p, q, s and t)

$$\underset{(300\ K)}{H_{2(g)}} \underset{Cool}{\overset{Heat,\ 1\ atm}{\rightleftharpoons}} \underset{(600\ K)}{H_{2(g)}}$$

Internal energy (U), entropy (S) and free energy (G) are state functions which depend only upon the state of the system and do not depend upon the path by which the state is attained.

Thus, $\Delta U = 0$, $\Delta S = 0$ and $\Delta G = 0$

Work and heat are path functions but the same path is retraced so, $q = 0$ and $w = 0$.

PAPER - II

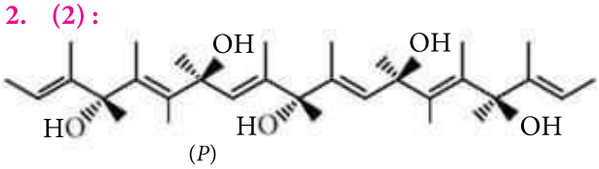
1. (5) : $\lambda = \frac{h}{\sqrt{2m\times K.E.}}$; $\frac{\lambda_{He}}{\lambda_{Ne}} = \sqrt{\frac{m_{Ne}\times K.E._{\cdot Ne}}{m_{He}\times K.E._{\cdot He}}}$

$\frac{\lambda_{He}}{\lambda_{Ne}} = \sqrt{\frac{m_{Ne}\times T_{Ne}}{m_{He}\times T_{He}}}$ $\quad [\because\ K.E. \propto T]$

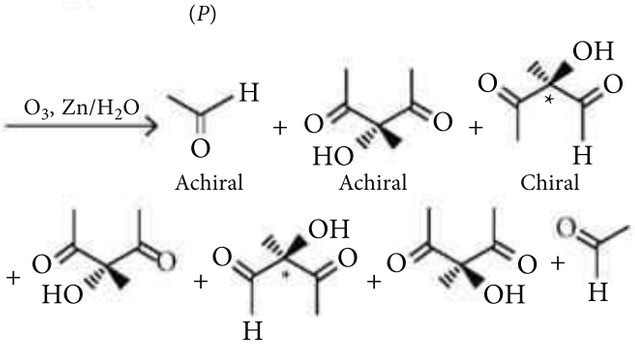
$= \sqrt{\frac{20\times1000}{4\times200}}$

$\frac{\lambda_{He}}{\lambda_{Ne}} = \sqrt{\frac{20000}{800}} = 5 \Rightarrow \lambda_{He} = 5\lambda_{Ne}$

2. (2) :



(*P*)



Achiral Achiral Chiral

Achiral Chiral Achiral Achiral

3. (6) : $\kappa = G \times \frac{l}{a} = 5 \times 10^{-7} \times \frac{120}{1} = 6 \times 10^{-5}$ S cm^{-1}

$$\Lambda_m^c = \frac{\kappa \times 1000}{\text{Molarity}} = \frac{6 \times 10^{-5} \times 1000}{0.0015} = 40 \text{ S cm}^2 \text{ mol}^{-1}$$

pH = 4 = $-\log[H^+]$ $\therefore$ $[H^+] = 10^{-4}$ M

	HA	$\rightleftharpoons$	H^+	+	A^-
Initial conc. :	0.0015		0		0
Equi. conc.	0.0015 – 0.0015α		0.0015α		0.0015α

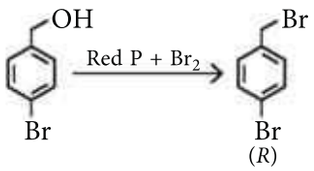
Thus, $[H^+] = 0.0015\ \alpha = 10^{-4} \Rightarrow \alpha = \frac{10^{-4}}{0.0015}$

Also, $\alpha = \frac{\Lambda_m^c}{\Lambda_m^\circ}$ $\therefore$ $\frac{10^{-4}}{0.0015} = \frac{40}{\Lambda_m^\circ}$

$$\Lambda_m^\circ = \frac{40 \times 0.0015}{10^{-4}} = 600 = 6 \times 10^2 \text{ S cm}^2 \text{ mol}^{-1}$$

On comparing it with $Z \times 10^2$ S cm^2 mol^{-1}, we get $Z = 6$.

4. (150) :



(*R*)

1 mol of '*R*' has 2 mol of Br.

So, $\frac{1}{250}$ mol of *R* contains $\frac{2}{250}$ mol of AgBr.

Hence, $\frac{2}{250} = \frac{w}{188} \Rightarrow w = 1.50$ g or 150×10^{-2} g

Therefore, value of *x* is 150.

5. (4) : Na*A* is salt of strong base and weak acid,

$$\text{pH} = \frac{pK_w}{2} + \frac{1}{2}(pK_a + \log C)$$

$8.5 = 7 + \frac{1}{2}(5 + \log C)$; 1.5 × 2 = 5 + log *C*

log *C* = –2

$$C = 0.01 = \frac{2.592}{M \times 2} \Rightarrow M = \frac{2.592}{2 \times 0.01} = 129.6$$

$d = \frac{ZM}{N_A a^3}$, $(Z = 4, a = 2 \times 300 = 600 \text{ pm}) \Rightarrow d = 4$ g/cm^3

6. (6) : $AgNO_3 \longrightarrow NO_2 + \frac{1}{2}O_2 + Ag$

$NO_{2(g)}$: Number of unpaired electron = 1

$O_{2(g)}$: Number of unpaired electron = 2

$O_2 = \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \sigma 2p_z^2, \pi 2p_x^2 = \pi 2p_y^2, \pi^* 2p_x^1 = \pi^* 2p_y^1$

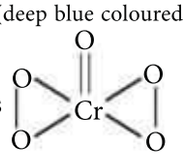
No. of electrons is antibonding orbital = 6.

7. (8)

8. (4) : If an acidic solution of chromate ion (CrO_4^{2-}) is treated with H_2O_2, a deep blue solution of chromium pentaoxide (CrO_5) is obtained.

$$CrO_4^{2-} + 2H^+ + 2H_2O_2 \longrightarrow \underset{\substack{\text{Chromium (VI)} \\ \text{compound } (X) \\ \text{(deep blue coloured solution)}}}{CrO_5} + 3H_2O$$

The structure of CrO_5 is



Thus, the number of O-atoms bonded to chromium through single bonds in CrO_5 is 4.

9. (b, c)

10. (a, b, c) : $Pb^{2+}/Pb = -0.13$ V; $Ni^{2+}/Ni = -0.24$ V
$Cd^{2+}/Cd = -0.40$ V; $Fe^{2+}/Fe = -0.44$ V
As *X* is getting dissolved that means reactions taking place are

At anode : $X \longrightarrow \underset{(0.001\text{ M})}{X^{2+}} + 2e^-$

At cathode : $\underset{(0.1\text{ M})}{Y^{2+}} + 2e^- \longrightarrow Y$

$$X + Y^{2+} \longrightarrow X^{2+} + Y$$

$$E_{cell} = E^\circ_{cell} - \frac{0.059}{2}\log\frac{[X^{2+}]}{[Y^{2+}]}$$

$E_{cell} = E^\circ_{cell} + 0.06$

For Cd/Ni cell, $E^\circ_{cell} = E^\circ_{red} - E^\circ_{oxid}$
$= -0.24 - (-0.40) = +0.16$ V

$E_{cell} = 0.22$ V

For Cd/Fe cell, $E^\circ_{cell} = -0.04$, $E_{cell} = 0.02$

For Ni/Pb cell, $E^\circ_{cell} = 0.11$ V, $E_{cell} = 0.17$ V

For Ni/Fe cell, $E^\circ_{cell} = -0.2$ V, $E_{cell} = -0.14$ V

11. (b, c)

12. (a, b, d): $\Delta C_P = \frac{\Delta H_2 - \Delta H_1}{T_2 - T_1}$ or $\Delta C_V = \frac{\Delta E_2 - \Delta E_1}{T_2 - T_1}$ is Kirchoff's equation.

13. (b, c) : In *X* reducing ends of both the sugars are not free whereas in *Y* reducing end at C-1 is free. So, *Y* is a reducing sugar. The glycosidic linkage is α in *X* and β in *Y*.

MONTHLY TEST DRIVE CLASS XII ANSWER KEY

1.	(a)	**2.**	(b)	**3.**	(b)	**4.**	(b)	**5.**	(b)
6.	(d)	**7.**	(a)	**8.**	(d)	**9.**	(c)	**10.**	(c)
11.	(c)	**12.**	(c)	**13.**	(b)	**14.**	(c)	**15.**	(c)
16.	(d)	**17.**	(b)	**18.**	(d)	**19.**	(d)	**20.**	(b,d)
21.	(b,c,d)	**22.**	(b,d)	**23.**	(a,c)	**24.**	(4)	**25.**	(150)
26.	(12)	**27.**	(a)	**28.**	(d)	**29.**	(a)	**30.**	(a)

14. (c)

15. (b) : $N_{2(g)} + 3H_{2(g)} \underset{\text{Endo}}{\overset{\text{Exo}}{\rightleftharpoons}} 2NH_{3(g)}$; $\Delta H < 0$

Initially, with increase in temperature ($T_2 > T_1$) % yield increases.

Afterwards, equilibrium is reached and if the temperature is increased, *i.e.*, heat is supplied to the system, then according to Le Chatelier's principle, the equilibrium will shift in the backward direction, where the heat is absorbed. Hence, the % yield decreases.

16. (a) : $C_6H_5COOH \xrightarrow[H_3O^+]{LiAlH_4} C_6H_5CH_2OH$

17. (c) : $T_1 < T_2$ *i.e.* T_2 is the higher temperature, hence the option (c) is incorrect.

18. (c) : NF_3 and H_3O^+ are pyramidal while NO_3^- and BF_3 are planar. Hence answer (c) is correct.

Ancient ice cores show how Earth's massive carbon cycle shaped temperatures — and life

John A. Higgins is Associate Professor of Geosciences at Princeton University. Speaking to Srijana Mitra Das at Times Evoke, he explains how ancient ice helps us understand Earth's past — and its future:

What is the core of your research?

My research group is fundamentally centred around using measurements of the chemical composition of various natural archives to understand Earth's climate history — that includes ice cores, sediments laid down in oceans millions of years ago, etc.

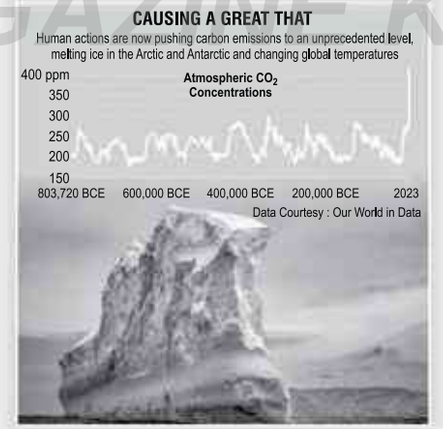
What are your timelines?

We look at the entirety of Earth's history — there are different questions depending on the period studied. If we're looking at the ice core record, we're researching back 8,00,000 years for information on Earth's climate system, the chemistry in the atmosphere, etc. We also use other archives which go back billions of years — my speciality is studying marine sedimentary rocks. The archives differ but the ultimate goal is understanding the role of the global carbon cycle in Earth's climate history.

What are some important events in how Earth's carbon cycle evolved?

Our understanding of nuclear physics suggests that Earth's sun has gotten brighter over the last four and a half billion years. So, with increasing solar brightness, if everything else held constant, Earth should have become warmer and warmer over time. But Earth isn't that warm today, so projections back in time could show Earth being frozen about two billion years ago. However, we have very good geologic evidence that there was water on the planet's surface and this wasn't frozen by any stretch then. So, scientists have proposed a solution to this 'Faint Young Sun' paradox being that concentrations of carbon dioxide (CO_2) or greenhouse gases were much higher three or four billion years ago. This compensated for a dimmer sun, giving us a climate system that wasn't dramatically different from today. The idea that the carbon cycle played this fundamental role in regulating Earth's temperature over its lifespan is very exciting.

There is also an interesting relationship between the global carbon cycle and the global oxygen cycle which is the oxygen we breathe in the atmosphere. Photosynthesis produces oxygen but it also takes CO_2 and converts it into organic matter, allowing oxygen to stay in the atmosphere. In this way, the global carbon and oxygen cycles are linked. There is a lot of study of how these two cycles played off each other over Earth's history.



Another perspective is thinking about Earth's climate going forward over the next fifty to hundred years. The geologic record provides examples of when Earth warmed because significant CO_2 was added to the atmosphere and oceans. During the Paleocene-Eocene Thermal Maximum about 55 million years ago, considerable carbon was added — Earth warmed and the oceans acidified. Understanding this event helps us learn how sensitive Earth's climate is to CO_2 being added to the atmosphere.

Can you tell us about your team's discovery of an ancient ice core in Antarctica?

We've dated samples from the Allan Hills in East Antarctica which are between two and four million years old. This is an ongoing project funded by the Center for Oldest Ice Exploration (COLDEX). Ice cores are arguably the best archive of Earth's atmosphere, the closest to entering a time machine and travelling back for a sample of Earth's ancient air. They allow us to precisely reconstruct the amount of greenhouse gases in the atmosphere.

We now know that Earth has been progressively cooling — a big question is whether this was because of changes in CO_2 levels in the atmosphere? Also, a period called the Pliocene, two to three million years ago, is an analog for the coming decades — Earth was a couple of degrees warmer then, sea levels were ten to twenty metres higher and we know of greenhouse gases from shells buried in the ocean. We are now relying on ice cores to learn what role these gases played when Earth was warmer than today.

Is ancient ice at risk from global warming?

Where we're working, not currently as it is so cold, the oldest ice is preserved since it gets stuck to the bedrock. But in west Antarctica, ice is both melting and fresh snow is falling. Researchers there doing ice core science to study Earth's climate face their records being gone in around another decade or so.

What does ancient ice teach us about life?

Ice cores give us a wonderful way to understand Earth's atmosphere in the past. This is just a thin layer of gas on top of this giant planet — yet, it is the most important thing in keeping the climate what it is, us breathing and life growing. Understanding the records of how this atmosphere changed is important for learning how Earth's system operates. I also research the role the carbon cycle plays in setting our planet's temperature — that highlights the implications of human perturbations or impacts on that system which set Earth's temperature for four billion years. We should be very cautious before tampering with it.

Courtesy : The Times of India

PRACTICE PAPER 2023

BITSAT

Exam Dates
Session-I
22nd May to 26th May
Session-II
18th June to 22nd June

1. What quantity (in mL) of 45% acid solution of a monoprotic strong acid must be mixed with a 20% solution of the same acid to produce 800 mL of a 29.875% acid solution?
(a) 330 (b) 316 (c) 320 (d) 32

2. The root mean square velocity of one mole of a monoatomic gas having molar mass M is $u_{r.m.s.}$. The relation between the average kinetic energy (E) of the gas and $u_{r.m.s.}$ is

(a) $u_{r.m.s.}=\sqrt{\frac{3E}{2M}}$ (b) $u_{r.m.s.}=\sqrt{\frac{2E}{3M}}$

(c) $u_{r.m.s.}=\sqrt{\frac{2E}{M}}$ (d) $u_{r.m.s.}=\sqrt{\frac{E}{3M}}$

3. Experimentally it was found that a metal oxide has formula $M_{0.98}O$. Metal M is present as M^{2+} and M^{3+} in its oxide. Fraction of the metal which exists as M^{3+} would be
(a) 5.08% (b) 7.01% (c) 4.08% (d) 6.05%

4. The kinetic energy of an electron in the second Bohr orbit of a hydrogen atom is [a_0 is Bohr radius]

(a) $\frac{h^2}{4\pi^2 ma_0^2}$ (b) $\frac{h^2}{16\pi^2 ma_0^2}$

(c) $\frac{h^2}{32\pi^2 ma_0^2}$ (d) $\frac{h^2}{64\pi^2 ma_0^2}$

5. The increasing order of the ionic radii of the given isoelectronic species is
(a) S^{2-}, Cl^-, Ca^{2+}, K^+ (b) Ca^{2+}, K^+, Cl^-, S^{2-}
(c) K^+, S^{2-}, Ca^{2+}, Cl^- (d) Cl^-, Ca^{2+}, K^+, S^{2-}

6. κ_1 and κ_2 are specific conductance values of the solutions A and B in the same conductivity cell. If equal volumes of solutions A and B are mixed, what will be the resistance of the mixture using the same conductivity cell whose cell constant is x? (Assume there is no change in the degree of dissociation on mixing).

(a) $R=\frac{\kappa_1+\kappa_2}{2x}$ (b) $R=\frac{2(\kappa_1+\kappa_2)}{x}$

(c) $R = 2x(\kappa_1 + \kappa_2)$ (d) $R=\frac{2x}{\kappa_1+\kappa_2}$

7. Solubility product of silver bromide is 5.0×10^{-13}. The quantity of potassium bromide (molar mass taken as 119 g mol^{-1}) to be added to 1 litre of 0.05 M solution of silver nitrate to start the precipitation of AgBr is
(a) 5.0×10^{-8} g (b) 1.1×10^{-10} g
(c) 1.1×10^{-9} g (d) 6.2×10^{-5} g

8. The standard electrode potential $E°$ and its temperature coefficient $\left(\frac{dE°}{dT}\right)$ for a cell are 2 V and -5×10^{-4} V K^{-1} at 300 K respectively. The cell reaction is $Zn_{(s)} + Cu^{2+}_{(aq)} \longrightarrow Zn^{2+}_{(aq)} + Cu_{(s)}$

The standard reaction enthalpy ($\Delta_r H°$) at 300 K in kJ mol^{-1} is
[Use R = 8 J K^{-1} mol^{-1} and F = 96,000 C mol^{-1}]
(a) −412.8 (b) 192.0 (c) −384.0 (d) 206.4

9. The molecular formula of a commercial resin used for exchanging ions in water softening is $C_8H_7SO_3Na$ (Mol. wt. 206). What would be the maximum uptake of Ca^{2+} ions by the resin when expressed in mole per gram resin?
(a) $\frac{2}{309}$ (b) $\frac{1}{412}$ (c) $\frac{1}{103}$ (d) $\frac{1}{206}$

10. $MgSO_4$ on reaction with NH_4OH and Na_2HPO_4 forms a white crystalline precipitate. What is its formula?
(a) $Mg(NH_4)PO_4$ (b) $Mg_3(PO_4)_2$
(c) $MgCl_2 \cdot MgSO_4$ (d) $MgSO_4$

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

List-I		List-II	
A.	Ester test	P.	Tyr
B.	Carbylamine test	Q.	Asp
C.	Phthalein dye test	R.	Ser
		S.	Lys

(a) A → R, B → Q, C → P
(b) A → R, B → S, C → Q
(c) A → Q, B → S, C → R
(d) A → Q, B → S, C → P

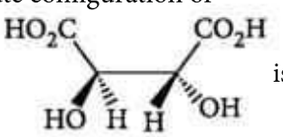
12. 500 mL of a sample of water required 19.6 mg of $K_2Cr_2O_7$ for the oxidation of dissolved organic matter in it in the presence of H_2SO_4. The COD of water sample is
(a) 8 ppm (b) 6.4 ppm
(c) 16.8 ppm (d) 4.9 ppm

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

$XeF_6 \xrightarrow{\text{Complete hydrolysis}} P$ + other product
$P \xrightarrow{OH^-/H_2O} Q$
$Q \xrightarrow[\text{in } OH^-/H_2O]{\text{slow disproportionation}}$ products

(a) 0 (b) 1 (c) 2 (d) 3

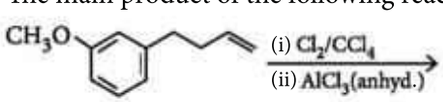
14. The absolute configuration of

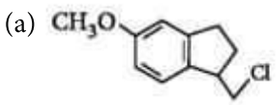
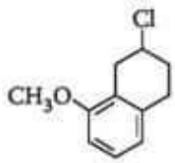
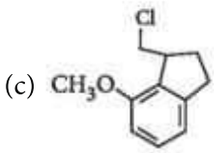
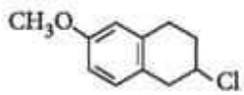


is
(a) *S*, *R* (b) *S*, *S* (c) *R*, *R* (d) *R*, *S*

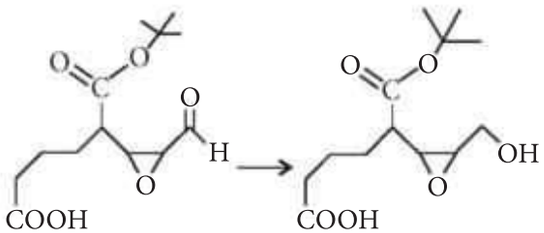
15. Consider a reaction $aG + bH \rightarrow$ products. When concentration of both the reactants *G* and *H* is doubled, the rate increases eight times. However, when concentration of *G* is doubled keeping the concentration of *H* fixed, the rate is doubled. The overall order of the reaction is
(a) 0 (b) 1 (c) 2 (d) 3

16. The main product of the following reaction is



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

17. The reagent which can be used to bring about the following transformation is



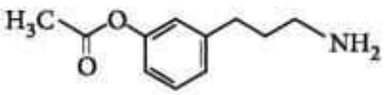
(a) $LiAlH_4$ in $(C_2H_5)_2O$ (b) BH_3 in THF
(c) $NaBH_4$ in C_2H_5OH (d) Raney Ni/H_2 in THF.

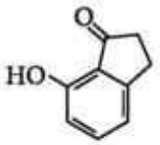
18. On treating a compound with warm dil. H_2SO_4, gas *X* is evolved which turns $K_2Cr_2O_7$ paper acidified with dil. H_2SO_4 to a green coloured compound *Y*. *X* and *Y* respectively are
(a) $X = SO_2$, $Y = Cr_2(SO_4)_3$
(b) $X = SO_2$, $Y = Cr_2O_3$
(c) $X = SO_3$, $Y = Cr_2(SO_4)_3$
(d) $X = SO_3$, $Y = Cr_2O_3$

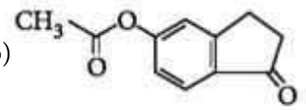
19. The actinoids exhibit more number of oxidation states in general than the lanthanoids. This is because
(a) the 5*f* orbitals extend further from the nucleus than the 4*f* orbitals
(b) the 5*f* orbitals are more buried than the 4*f* orbitals
(c) there is a similarity between 4*f* and 5*f* orbitals in their angular part of the wave function
(d) the actinoids are more reactive than the lanthanoids.

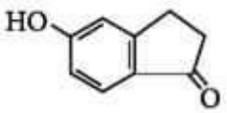
20. An aqueous solution contains Hg^{2+}, Hg_2^{2+}, Pb^{2+} and Cd^{2+} ions. The addition of HCl of 6 N will precipitate
(a) Hg_2Cl_2 only (b) $PbCl_2$ only
(c) $PbCl_2$ and Hg_2Cl_2 (d) $PbCl_2$ and $HgCl_2$

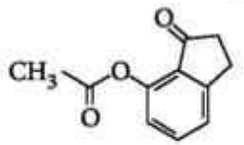
21. The major product of the following reaction is



(a) 

(b) 

(c) 

(d) 

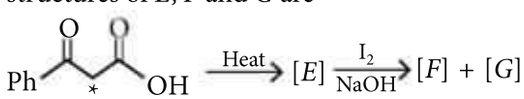
22. Match List-I with List-II and select the correct option.

List-I		List-II	
(A)	$\Psi_{MO} = \Psi_A - \Psi_B$	(I)	Dipole moment
(B)	$\mu = q \times r$	(II)	Bonding molecular orbital
(C)	$\frac{N_b - N_a}{2}$	(III)	Anti-bonding molecular orbital
(D)	$\Psi_{MO} = \Psi_A + \Psi_B$	(IV)	Bond order

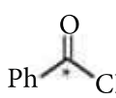
(a) (A)-(II), (B)-(I), (C)-(IV), (D)-(III)
(b) (A)-(III), (B)-(IV), (C)-(I), (D)-(II)
(c) (A)-(III), (B)-(I), (C)-(IV), (D)-(II)
(d) (A)-(III), (B)-(IV), (C)-(II), (D)-(I)

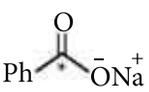
23. In the $\ln K$ *vs* $\frac{1}{T}$ plot of a chemical process having $\Delta S° > 0$ and $\Delta H° < 0$ the slope is proportional to (where K is equilibrium constant)
(a) $-|\Delta H°|$ (b) $|\Delta H°|$ (c) $\Delta S°$ (d) $-\Delta S°$

24. In the following reaction sequence, the correct structures of *E*, *F* and *G* are

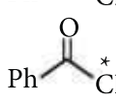


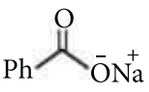
(* implies ^{13}C labelled carbon)

(a) *E* = 

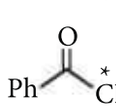
F = 

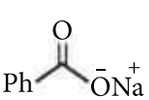
G = CHI_3

(b) *E* = 

F = 

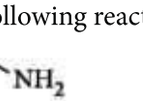
G = CHI_3

(c) *E* = 

F = 

G = $\overset{*}{C}HI_3$

(d) *E* =

F = 

G = $\overset{*}{C}H_3I$

25. 5 g of Na_2SO_4 was dissolved in *x* g of H_2O. The change in freezing point was found to be 3.82 °C. If Na_2SO_4 is 81.5% ionised, then what will be the value of *x*?
(K_f for water is approximately 1.86 °C kg mol^{-1}; Molar mass of S = 32 g mol^{-1} and Na = 23 g mol^{-1})
(a) 15 g (b) 45 g (c) 25 g (d) 65 g

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

List-I		List-II	
(A)	Sol	(i)	Dust
(B)	Aerosol	(ii)	Cheese
(C)	Gel	(iii)	Soap lather
(D)	Foam	(iv)	Plant's cell fluids

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

27. Heat treatment of muscular pain involves radiation of wavelength of about 900 nm. Which spectral line of H–atom is suitable for this purpose?
[$R_H = 1 \times 10^5$ cm^{-1}, $h = 6.6 \times 10^{-34}$ J s, $c = 3 \times 10^8$ m s^{-1}]
(a) Balmer, $\infty \rightarrow 2$ (b) Paschen, $\infty \rightarrow 3$
(c) Lyman, $\infty \rightarrow 1$ (d) Paschen, $5 \rightarrow 3$

28. Consider the following reaction,
$xMnO_4^- + yC_2O_4^{2-} + zH^+ \rightarrow$
$xMn^{2+} + 2yCO_2 + \frac{z}{2}H_2O$
The values of *x*, *y* and *z* in the reaction are respectively
(a) 5, 2 and 8 (b) 5, 2 and 16
(c) 2, 5 and 8 (d) 2, 5 and 16

29. Among the following, the compound that is both paramagnetic and coloured is
(a) $K_2Cr_2O_7$ (b) $(NH_4)_2(TiCl_6)$
(c) $CoSO_4$ (d) $K_3[Cu(CN)_4]$

30. For the process
$H_2O_{(l)}$ (1 bar, 373 K) ⟶ $H_2O_{(g)}$ (1 bar, 373 K),
the correct set of thermodynamic parameters is
(a) $\Delta G = 0$, ΔS = +ve (b) $\Delta G = 0$, ΔS = –ve
(c) ΔG = +ve, $\Delta S = 0$ (d) ΔG = –ve, ΔS = +ve.

SOLUTIONS

1. (b): $\frac{V\times 45}{100}+\frac{(800-V)20}{100}=\frac{800\times 29.875}{100}$

$\frac{9V}{20}+160-\frac{V}{5}=239\,;\ \frac{5V}{20}=79\ \Rightarrow\ V=316$ mL

2. (c): Average *K.E.*, $E=\frac{1}{2}Mu_{rms}^2$

$\therefore\ u_{rms}^2=\frac{2E}{M}$ or $u_{rms}=\sqrt{\frac{2E}{M}}$

3. (c): Let the fraction of metal which exists as M^{3+} be x.

Then the fraction of $M^{2+} = (0.98 - x)$

$\therefore\ 3x + 2(0.98 - x) = 2 \Rightarrow x + 1.96 = 2 \Rightarrow x = 0.04$

$\therefore\ \%$ of $M^{3+}=\frac{0.04}{0.98}\times 100 = 4.08\%$

4. (c): For Bohr orbit, angular momentum is

$mvr_n=\frac{nh}{2\pi};\ v=\frac{nh}{2\pi mr_n}$ ... (i)

Kinetic energy, $K.E.=\frac{1}{2}mv^2$ ... (ii)

By putting the value of v from (i) to (ii),

$$K.E.=\frac{1}{2}m\times\frac{n^2h^2}{4\pi^2m^2r_n^2}=\frac{n^2h^2}{8\pi^2mr_n^2}$$

For second Bohr orbit, $n = 2$

$r_n = a_0 \times n^2$ (a_0 = Bohr radius)

$r_n = 4a_0$

$K.E.=\frac{(2)^2h^2}{8\pi^2m(4a_0)^2}$. Thus, $K.E.=\frac{h^2}{32\pi^2ma_0^2}$

5. (b): Ionic radius $\propto e/Z$

(e is the number of electrons and Z is the atomic number)

As the number of electrons is same for isoelectronic species.

$\therefore$ Higher the atomic number, lower is the ionic radius.

6. (d): When equal volumes of A and B are mixed both the solutions get doubly diluted, hence individual contribution of $A=\frac{\kappa_1}{2}$ and that of $B=\frac{\kappa_2}{2}$.

Total specific conductance of the mixture

$=\frac{1}{2}(\kappa_1+\kappa_2)=\frac{1}{R}x$. Thus, $R=\frac{2x}{\kappa_1+\kappa_2}$

7. (c): Given, $K_{sp(AgBr)} = 5.0 \times 10^{-13}$

The required equation is,

$KBr + AgNO_3 \longrightarrow AgBr + KNO_3$

Given, $[AgNO_3] = 0.05$ M

$\Rightarrow [Ag^+] = [NO_3^-] = 0.05$ M

$[Ag^+][Br^-] = K_{sp(AgBr)}$

$\Rightarrow 0.05 \times [Br^-] = 5 \times 10^{-13}$

$\Rightarrow\ [Br^-]=\frac{5\times10^{-13}}{5\times10^{-2}}=1\times10^{-11}$ M

$\because\ [K^+] = [Br^-] = [KBr]$

$\therefore\ [KBr] = 1 \times 10^{-11}$ M

$\text{Molarity}=\frac{n_{KBr}}{V_{Solution}\,(\text{in L})}\,;\ 1\times10^{-11}=\frac{w_{KBr}/119}{1}$

(Mol. wt. of KBr = 119 g mol^{-1})

$\Rightarrow w_{KBr} = 1 \times 10^{-11} \times 119 = 119 \times 10^{-11}$ g

$\Rightarrow w_{KBr} = 1.1 \times 10^{-9}$ g

8. (a): $\Delta_rH^\circ = -nFE^\circ + nFT\left(\frac{dE^\circ}{dT}\right)$

$= -2 \times 96000 \times 2 + 2 \times 96000 \times 300\ (-5 \times 10^{-4})$

$= -384000 - 28800 = -412.8$ kJ mol^{-1}

9. (b): $\underset{2\text{ mol}\ (2\times206=412\text{ g})}{2C_8H_7SO_3^-Na^+}+Ca^{2+}\longrightarrow\underset{1\text{ mol}}{(C_8H_7SO_3^-)_2Ca^{2+}}+2Na^+$

1 mol of $Ca^{2+} \equiv 412$ g of resin

Maximum uptake of Ca^{2+} ions by the resin

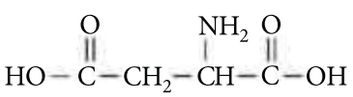
$=\frac{1\text{ mol}}{412\text{ g}}=\frac{1}{412}$ mol/g

10. (a): $MgSO_4 + Na_2HPO_4 + NH_4OH$ (Disodium hydrogen phosphate)

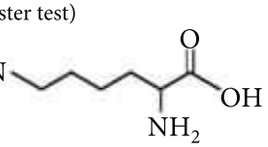
$\longrightarrow Mg(NH_4)PO_4 + Na_2SO_4 + H_2O$

Magnesium ammonium phosphate (white ppt.)

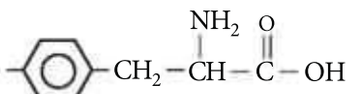
11. (d): (Q) Aspartic acid :



(Ester test)

(S) Lysine : 

(Carbylamine test)

(P) Tyrosine : 

(Phthalein dye test)

12. (b): $K_2Cr_2O_7 + 4H_2SO_4 \rightarrow K_2SO_4 + Cr_2(SO_4)_3 + 4H_2O + 3[O]$

294 mg $K_2Cr_2O_7$ corresponds to $16 \times 3 = 48$ mg of [O]

19.6 mg $K_2Cr_2O_7$ corresponds to $\frac{48}{294} \times 19.6 = 6.4$ mg of [O]

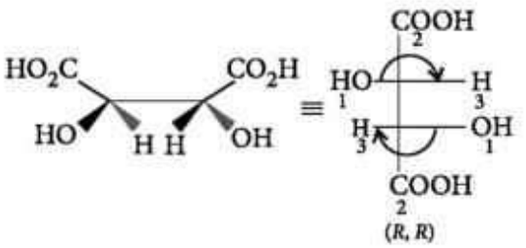
This is for 500 mL of sample.

For 1000 mL of sample, COD $= 3.2 \times \frac{1000}{500} = 6.4$ ppm

13. (c): $XeF_6 + 3H_2O \xrightarrow[\text{hydrolysis}]{\text{Complete}} \underset{\text{'P'}}{XeO_3} + 6HF$

$\underset{\text{'Q'}}{HXeO_4^-} \xrightarrow[\text{in } OH^-/H_2O]{\text{Slow disproportionation}} XeO_6^{4-} + Xe_{(g)} + H_2O + O_{2(g)}$

14. (c):



15. (d):

Exp. No.	[G] mole/lit	[H] mole/lit	Rate mol L^{-1} $time^{-1}$
1.	a	b	r
2.	$2a$	$2b$	$8r$
3.	$2a$	b	$2r$

Applying, $r = k[G]^x[H]^y$ ...(i)

$8r = k[2G]^x [2H]^y$

$8r = k \cdot 2^{x+y} [G]^x [H]^y$

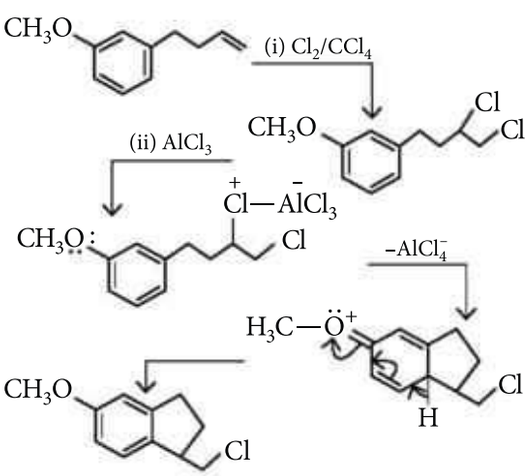
Substituting here the value of r from eq. (i), we get

$8k [G]^x [H]^y = k \cdot 2^{x+y} [G]^x [H]^y$

$2^{x+y} = 8 \Rightarrow 2^{x+y} = 2^3 \Rightarrow x + y = 3.$

$\therefore$ Overall order is 3.

16. (a):



17. (c): $NaBH_4$ in C_2H_5OH reduces aldehyde to alcohol specifically and do not reduce acid, ester and epoxide.

18. (a): Sulphur dioxide is the gas that turns $K_2Cr_2O_7$ paper acidified with dilute H_2SO_4 to a green compound. It is formed when sulphur reacts with sulphuric acid.

$S_{(s)} + 2H_2SO_{4(aq)} \longrightarrow 3SO_{2(g)} + 2H_2O_{(aq)}$

Due to production of chromium(III) sulphate $[Cr_2(SO_4)_3]$, the orange coloured dichromate solution will turn green.

$K_2Cr_2O_{7(s)} + H_2SO_{4(aq)} + 3SO_{2(g)} \longrightarrow K_2SO_{4(s)} + Cr_2(SO_4)_{3(s)} + H_2O_{(l)}$

Hence, the gas X is SO_2 and the compound Y is $Cr_2(SO_4)_3$.

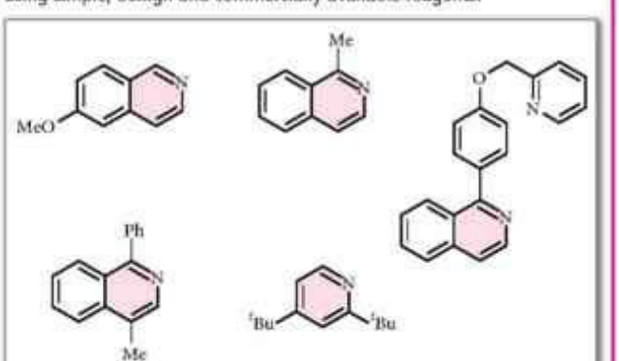
19. (a): As the distance between the nucleus and 5*f* orbitals (actinoids) is more than the distance between the nucleus and 4*f* orbitals (lanthanoids) hence the hold of nucleus on valence electron decreases in actinoids. For this reason, the actinoids exhibit more number of oxidation states in general.

Chemistry bulletin

Skeletal editing provides a simple route to access isoquinolines

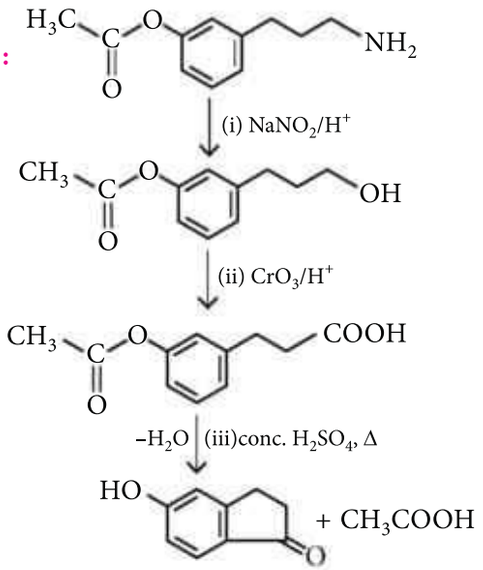
Direct nitrogen atom insertion into a broad range of indenes and cyclopentadienes

Researchers in Switzerland have developed a method to synthesise isoquinolines from indenes using skeletal editing. The one-step protocol enables easy access to an important building block in organic chemistry using simple, benign and commercially available reagents.



20. (c) : The group reagent for group I is dil. HCl. Only $PbCl_2$ and Hg_2Cl_2 will get precipitated as Pb^{2+} and Hg_2^{2+} both are group I basic radicals. Their solubility product is less than that of other radicals.

21. (c) :



22. (c)

23. (b) : $\Delta S° > 0$

$\Delta H° < 0$

$\Delta G° = \Delta H° - T\Delta S°$ ...(i)

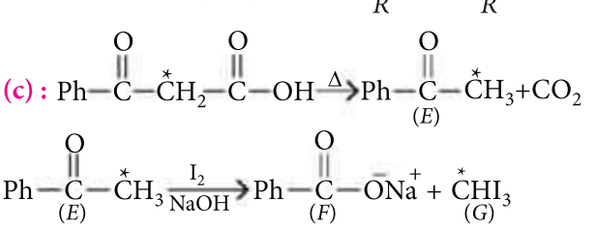
$\Delta G° = -RT \ln K$ ...(ii)

Then, $-RT \ln K = \Delta H° - T\Delta S°$

$$\ln K = \frac{-\Delta H°}{RT} + \frac{\Delta S°}{R}$$

On plotting $\ln K$ *vs* $\frac{1}{T}$, a straight line graph is obtained with slope equal to $-\frac{\Delta H°}{R}$ or $\frac{|\Delta H°|}{R}$

24. (c) :



25. (b) :

	$Na_2SO_4 \rightarrow$	$2Na^+$	SO_4^{2-}
Initially :	1 mol	0	0
After ionisation :	$1 - \alpha$	2α	α

Total no. of moles = $1 + 2\alpha$

$i = 1 + 2\alpha \Rightarrow 1 + (2 \times 0.815) = 2.63$

$$\therefore \quad \Delta T_f = \frac{1000 \times K_f \times w_2 \times i}{M_2 \times w_1}$$

$$\Rightarrow \quad 3.82 = \frac{1.86 \times 2.63 \times 5 \times 1000}{142 \times x}$$

$$\therefore \quad x = \frac{1.86 \times 2.63 \times 5000}{142 \times 3.82} = 45 \text{ g}$$

26. (b) : Dust – Solid in gas (Aerosol)
Cheese – Liquid in solid (Gel)
Soap lather – Gas in liquid (Foam)
Plant's cell fluids – Solid in liquid (Sol)

27. (b) : $\frac{1}{\lambda} = R_H\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right) = 10^7\left(\frac{1}{3^2} - \frac{1}{\infty}\right)$

$\lambda = 9 \times 10^{-7}$ m = 900 nm

28. (d) : The balanced chemical equation is

$2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \rightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$

$\therefore \quad x = 2, y = 5, z = 16$

29. (c) : In $K_2Cr_2O_7$, O.S. of Cr is +6 *i.e.* Cr^{6+}. The electronic configuration of Cr^{6+} is $(3d^0 4s^0)$. It has no unpaired electron. Thus, it is diamagnetic and colourless (absence of *d*-electrons).

In $(NH_4)_2TiCl_6$, the O.S. of Ti is +4, *i.e.*, Ti^{4+}. The electronic configuration of Ti^{4+} is $3d^0 4s^0$. It has no unpaired electron, hence it is diamagnetic and colourless (absence of *d*-electrons).

In $CoSO_4$, the O.S. of Co is +2 *i.e.* Co^{2+}. Its configuration is $3d^7$. It has three unpaired electrons in 3*d*-orbitals, so it is paramagnetic. Because of incompletely filled *d*-orbitals, it is coloured.

In $K_3[Cu(CN)_4]$, the O.S. of Cu is +1, *i.e.*, Cu^+. Its configuration is $3d^{10}4s^0$. It has no unpaired electron, so it is diamagnetic and colourless.

30. (a) : The change given is occurring at the boiling point of the liquid, where, at given pressure and temperature, the liquid-vapour system virtually remains at equilibrium and hence $\Delta G = 0$. Also due to absorption of heat as latent heat of vaporisation or due to change from liquid to gaseous state, the randomness has also increased, $\Delta S > 0$.

UNSCRAMBLED WORDS

APRIL 2023

1-i- CALOMEL	2-f- DOLERITE
3-a- NOVESTROL	4-e- OLEUM
5-b- RIBOSE	6-j- EPOXIDE
7-c- DEICER	8-d- AUTUNITE
9-g- ENEDIOL	10-h-SPECTROMETER

Winner : Kaushikkumar Kevadiya

Quiz CLUB

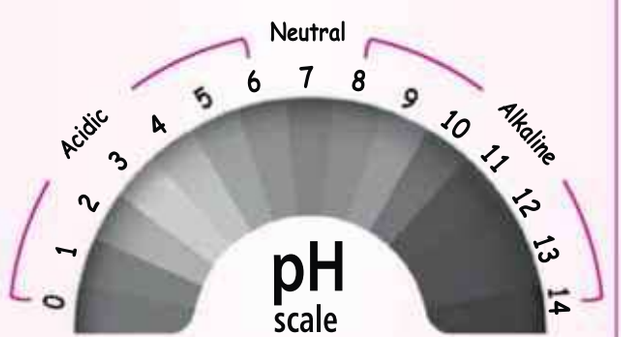
Unlock Your Knowledge!

1. The compounds in which two halogen atoms are attached to two adjacent carbon atoms are called _____ dihalides.
2. The solutions which resist change in pH on dilution are called _____ solutions.
3. The solution sprayed on TLC plate to detect amino acids is _____.
4. The orbitals having the same energy are said to be _____.
5. _____ chemistry deals with the qualitative and quantitative analysis of a substance.
6. The region inside the atom where the probability of finding an electron is zero is called _____ surface.
7. The recurrence of similar properties of the elements after certain definite intervals is called _____.
8. _____ is the process by which a single DNA molecule produces two identical copies of itself.
9. The condition of vitamin deficiency is known as _____.
10. Reduction of nitriles by Na(Hg) and C_2H_5OH is known as _____ reaction.
11. _____ is used to preserve biological specimens.
12. The enzyme which can catalyse the conversion of glucose to ethanol is _____.
13. The C—O—C bond angle in methoxymethane is about_____.
14. _____ is commercially manufactured by using fermentation of sugar.
15. The synthesis of alkyl fluorides is best accomplished by _____ reaction.
16. Chloroform is oxidised to a poisonous gas called _____ which causes liver damage.
17. The compound used in the treatment of lead poisoning is _____.
18. _____ is found in plants and it is a coordination compound of magnesium.
19. _____ is a protein which stores oxygen in the muscles.
20. The aqueous solution of sodium chromate is _____ in colour.

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.

COMIC CAPSULE

Why is the pH of Youtube very stable?



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GK CORNER

Enhance Your General Knowledge with Current Updates!

SUMMITS AND CONFERENCES

- The Minister of State for Electronics & Information Technology and Skill Development & Entrepreneurship, Shri Rajeev Chandrasekhar addressed the 5th ASEAN-India Business Summit 2023 on March 6. Its theme was "Strengthening and Moving Forward ASEAN-India Economic Relations for a Strategic Business Partnership". In addition to speaking about the catalysing impact of UPI in developing India's Fintech ecosystem, the Minister also spoke about other digital public infrastructure created by the Indian government such as Aadhaar, Cowin, GeM.
- The Prime Minister of India, Shri Narendra Modi inaugurated the Diamond Jubilee Celebrations of the Central Bureau of Investigation (CBI) at Vigyan Bhawan in New Delhi on 3 April 2023. He also conferred medals for Distinguished Service and Best Investigating Officers of CBI, inaugurated the newly constructed office complexes of CBI and released a Postage Stamp and Commemorative Coin marking the Diamond Jubilee Celebration year and launched the Twitter handle of CBI.
- The '**International Conference on Human-Wildlife Conflict and Coexistence**' was organised in Oxford, United Kingdom from 30 March to 1 April 2023. Human-wildlife conflict is one of the most pressing threats to biodiversity conservation and achievement of sustainable development. These conflicts threaten the healthy co-existence of people and wildlife and undermine conservation efforts.
- The first **B2B Global Conference & Expo on Traditional Medicine** under Shanghai Cooperation Organisation (SCO) was held from 2 to 5 March 2023. More than 150 delegates from 17 countries of SCO participated in the summit. It will provide an opportunity to regulators, industries and business leaders in all the SCO and partner countries to deliberate on various aspects of Traditional Medicine aspects such as products, services, education, skill development, cosmetics, herbal extracts and further deepen the trade and friendship.
- The valedictory function of the 4th edition of **National Youth Parliament Festival (NYPF) 2023** took place in the Central Hall of Parliament, New Delhi with the theme "Ideas for a Better tomorrow: India for the World". The objective of the NYPF is to hear the voice of the youth, who will join various careers in coming years, including public services. Out of 85 national winners of NYPF this year, 61 are girls.
- The **UN 2023 Water Conference** opened on World Water Day (22 March) and concluded on 24 March. It was co-hosted by the Government of Tajikistan and the Kingdom of the Netherlands. This will be only the second UN Conference dedicated to water, following the Conference in Mar del Plata, Argentina in 1977, and will provide a unique opportunity to undertake commitments and accelerate action towards achieving SDG 6 and other internationally agreed water-related goals

and targets, including those set out in the 2030 Development Agenda.

- The first edition of the **Naval Commanders' Conference of 2023** commenced on 6 March 2023. The first phase of the Commanders' Conference was held at sea, and for the first-time, onboard India's first indigenous aircraft carrier, INS Vikrant. The conference serves as a platform for Naval Commanders to discuss important security issues at the military-strategic level as well as interact with Senior Government functionaries through an institutionalized forum.

Test Yourself!

1. India's biggest youth summit 'National Youth Conclave' was organised by which ministry?
   (a) Ministry of Housing and Urban Affairs
   (b) Ministry of Youth Affairs and Sports
   (c) Ministry of Parliamentary Affairs
   (d) Ministry of External Affairs

2. The recent Trade and Investment Working Group (TIWG) meeting was held under the aegis of
   (a) World Bank (b) IMF
   (c) G7 (d) G20.

3. Select the incorrect statement regarding Global Millets (Shree Anna) Conference.
   (a) It was held at Subramaniam Hall, New Delhi.
   (b) The year 2022 was declared as the International Year of Millets (IYM) by the United Nations General Assembly (UNGA).
   (c) The Indian Institute of Millets Research of ICAR was declared as a Global Centre of Excellence.
   (d) Shree Anna may provide solution for the problem of food security as well as of food habits.

4. The 23rd Commonwealth Law Conference was inaugurated in which state?
   (a) Goa (b) Maharashtra
   (c) Delhi (d) Karnataka

5. What was the theme of National Youth Parliament Festival 2023?
   (a) Human Rights, Inclusion and Empowerment
   (b) Invest to Skill
   (c) Ideas for a better tomorrow: India for the World
   (d) YUVAAH - Utsah Naye Bharat Ka

6. IUCN, one of the organisers of the Human-Wildlife Conflict and Coexistence conference, stands for
   (a) Indian Union for Conservation of Nature
   (b) International Union for Conservation of Nature
   (c) International United Conference for Nature
   (d) International United Campaign for Nature.

7. The B2B Conference & Expo on Traditional Medicine was held in
   (a) New Delhi
   (b) Shanghai, China
   (c) Mumbai, Maharashtra
   (d) Guwahati, Assam.

8. When was the International Dharma Dhamma Conference organised?
   (a) 1 March 2023 (b) 7 March 2023
   (c) 3 March 2023 (d) 2 March 2023

9. Select the incorrect statement regarding UN 2023 Water Conference.
   (a) It took place in United Nations from 22-24 March 2023.
   (b) It was formally known as the 2023 Conference for the Midterm Comprehensive Review of Implementation of the UN Decade for Action on Water and Sanitation.
   (c) The UN 2023 Water Conference was co-hosted by Netherlands and Tajikistan.
   (d) None of the above.

10. In the One World TB Summit held in Varanasi this year, India aimed to end TB by the year
    (a) 2024 (b) 2025
    (c) 2030 (d) 2040.

Answer Key

1.	(a)	2.	(d)	3.	(b)	4.	(a)	5.	(c)
6.	(b)	7.	(d)	8.	(c)	9.	(a)	10.	(b)

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"You keep on learning and learning, and pretty soon you learn something no one has learned before."

Richard Feynman

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Bachelor of Science in Environment and Water Management is a three-year Undergraduate course which includes understanding earth processes, analysing alternative energy sources, pollution control and mitigation, natural resource management, the consequences of global climate change, and other related topics.

Eligibility

- The candidate must have passed Class XII Examination or its equivalent from a recognised board in Science stream with 60% aggregate marks.
- Many universities have also made it mandatory for the candidates to appear in CUET(UG) while some conduct their own entrance exams.

Top Careers

B.Sc. Environment and Water Management allows you to choose from a wide range of work areas like - Agriculture industry, Colleges and Universities, Fertiliser plants, Food processing industries, Forest and environment departments, Oil refineries, Pollution control boards, Textile mills, Waste treatment industries, Water resources management companies, etc.

Job Profiles :

- Hydrologist
- Environmental Scientist
- Environment Journalists/Photographer
- Teacher and Lecturer
- Research Assistant

Top Recruiters :

AECOM Technology Corporation, Doshion Ltd., Earth Water Group, Swelect Energy Systems Ltd., Gujarat Enviro Protection & Infrastructure Ltd., Enviro Control Associates India Private Ltd., etc.

Top Colleges

- **N.S.S. College, Cherthala, Kerala**
- Maharaja's College, Ernakulam
- Sri Pratap College, Srinagar
- Fergusson College, Pune

N.S.S. COLLEGE, CHERTHALA, KERALA

N.S.S. College, Cherthala is an aided college under the N.S.S. Management affiliated to the University of Kerala. B.Sc. Environment and Water Management courses were started in 2001. Most of the students passing out of the department opt for higher studies and it has a large number of highly placed alumni. The department has several well-equipped labs. The Environment and Water Management lab has got approved by C-grade by the Kerala State Pollution Control Board and is capable for providing various consultancy services such as water testing, guidance for student/teacher projects, Environment auditing-ISO 14001-14004, Environmental impact analysis, etc.

UNSCRAMBLE ME

Unscramble the words given in column I and match them with their explanations in column II.

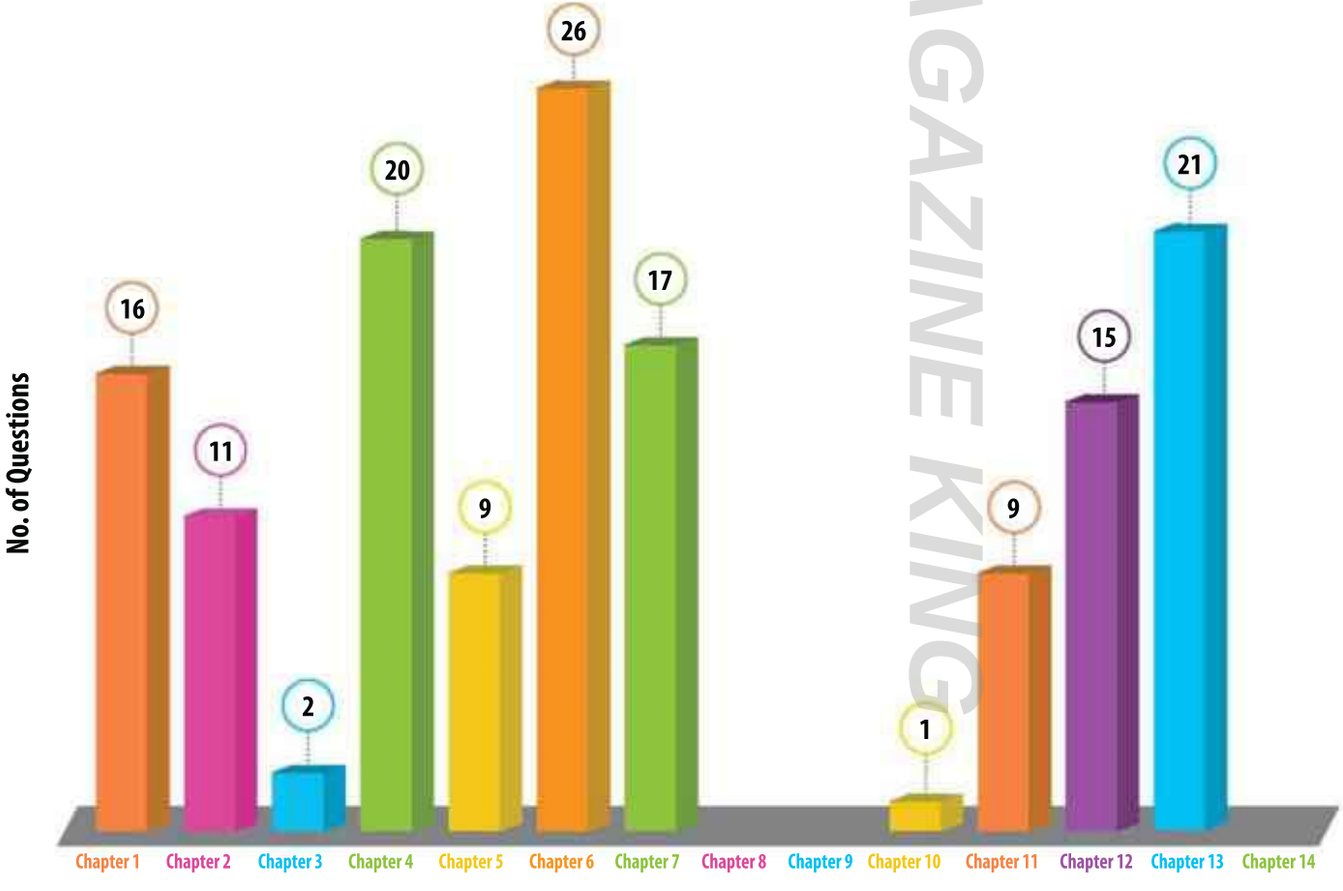
Column I	Column II
1. ANLLIVNI	(a) A water soluble component, which constitutes about 15-20% of starch.
2. MYAOSLE	(b) A vitamin whose deficiency causes convulsions.
3. YRIPODNIEX	(c) A unit formed by the attachment of a base to 1′ position of sugar.
4. UNLCOEISED	(d) A member of the class of benzaldehydes carrying methoxy and hydroxy substituents at positions 3 and 4 respectively.
5. ANDLECA	(e) The process of making of shaped objects in metals, plastics or other materials.
6. ASINMKG	(f) The SI unit of luminous intensity in a given direction.
7. OUMDLGNI	(g) A catalytic process that involves platinum catalyst to convert petroleum fraction into high-octane fuels.
8. VREONOTSE	(h) The weak vibrational absorption corresponding to multiples or adducts of fundamental frequencies.
9. LATPORFMNGI	(i) The separation of a racemate into its two constituent enantiomers.
10. ERSOULTNIO	(j) An analytical technique involving addition of a masking agent which stops interfering species participating in a reaction.

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.

Are You Ready for JEE Advanced?

CLASS-11

Past 10 Years (2013-2022) Chapterwise Trend Analysis of JEE Advanced Questions



*These are the chapters from where given number of questions have been asked in JEE Advanced in the past 10 years.

Weightage Percentage

CHAPTERS

Chapter 1 : Some Basic Concepts of Chemistry
Chapter 2 : Structure of Atom
Chapter 3 : Classification of Elements and Periodicity in Properties
Chapter 4 : Chemical Bonding and Molecular Structure
Chapter 5 : States of Matter (Gaseous and Liquids)
Chapter 6 : Thermodynamics
Chapter 7 : Equilibrium
Chapter 8 : Redox Reactions
Chapter 9 : Hydrogen
Chapter 10 : The *s*-Block Elements
Chapter 11 : The *p*-Block Elements (Group 13 and 14)
Chapter 12 : Organic Chemistry – Some Basic Principles and Techniques
Chapter 13 : Hydrocarbons
Chapter 14 : Environmental Chemistry

Thermodynamics

Types of System

Isolated System

No exchange of matter and heat

Closed System

No exchange of matter, only exchange of heat

Open System

Exchange of both matter and heat

Macroscopic Properties of a System

Intensive Properties

Independent of the quantity of matter present in the system *e.g.*, temperature, pressure, viscosity, surface tension, refractive index, etc.

Extensive Properties

Dependent upon the quantity of matter present in the system *e.g.*, mass, volume, entropy, enthalpy, free energy, internal energy, etc.

State Function

Variables that depend only on the initial and final states of a system *e.g.*, pressure, volume, etc.

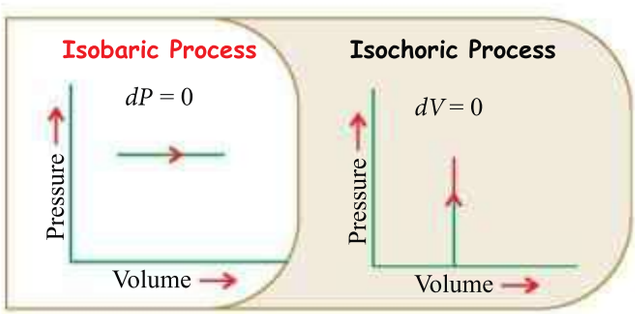
Thermodynamic Equilibrium

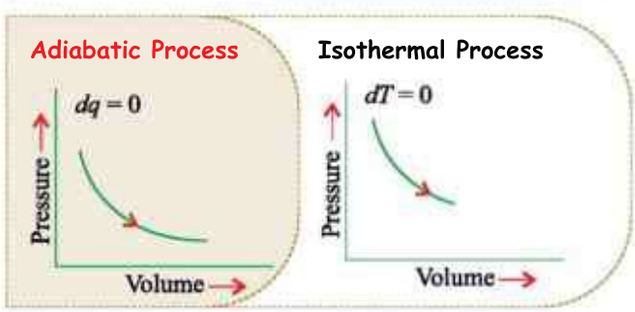
Macroscopic properties that do not undergo any change with time.

Path Function

Variables whose values depend upon the path followed by the system on attaining that state.

Thermodynamic Processes





First Law of Thermodynamics

It states that energy can neither be created nor destroyed, although it can be converted from one form to another.

ΔE or $\Delta U = q + W$ or $q = \Delta U - W$

Enthalpy (H) : $\Delta H = \Delta U + P\Delta V$

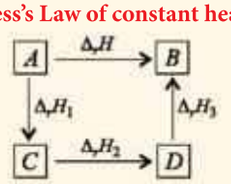
- For exothermic reaction, ΔH is negative whereas for endothermic reaction, ΔH is positive.

  Enthalpy change at constant pressure $(q_p) = \Delta H$

  Enthalpy change at constant volume $(q_v) = \Delta U$

  $q_p = q_v + P\Delta V$ or $q_p = q_v + \Delta n_g RT$

Hess's Law of constant heat summation



$\Delta_r H = \Delta_r H_1 + \Delta_r H_2 + \Delta_r H_3$

- **Calorimetry** is the quantitative measurement of the heat required or evolved during a chemical process.

  $q = (w + m) \times C \times (T_2 - T_1)$

Second Law of Thermodynamics

- This law states that it is impossible to convert heat into equal amount of work without compensation.

Entropy (*S*)

- Entropy is defined as a measure of randomness or disorder of the system. The order of randomness or entropy of solid, liquid and gas is
  Gas > Liquid > Solid.

$$\Delta S = \frac{q_{rev}}{T}$$

Free Energy (*G*)

- Free energy of a system is defined as the maximum amount of energy available to the system during a process which can be converted into useful work.

$$\Delta G = -W_{max}$$

Mathematically given as

$$G = H - TS$$

For a reaction to be spontaneous, ΔG must be negative.

Sign of ΔH	Sign of ΔS	$\Delta G = \Delta H - T\Delta S$	Remark
Negative	Positive	Always negative	Spontaneous at all temperatures
Positive	Negative	Always positive	Non-spontaneous at all temperatures
Positive	Positive	Positive at low temperature, negative at high temperature	Non-spontaneous at low temperature, spontaneous at high temperature
Negative	Negative	Negative at low temperature, positive at high temperature	Spontaneous at low temperature, non-spontaneous at high temperature

Third Law of Thermodynamics

- This law states that entropy of all perfectly crystalline solids approaches zero at absolute zero (zero Kelvin). Mathematically, it can be expressed as $\lim_{T \to 0\,K} S \to 0$
- This law helps in calculating absolute entropies of pure substances at any temperature.

$$\Delta S = S_T - S_0 = \int_0^T \frac{C_P\, dT}{T} = C_p \ln T = 2.303 C_p \log T$$

Equilibrium

Le Chatelier's Principle

Change imposed at equilibrium	Direction of equilibrium shift
1. Increase in the concentration of one or more reactants	Forward direction
2. Increase in the concentration of one or more products	Backward direction
3. Increase in temperature	Towards endothermic reaction
4. Decrease in temperature	Towards exothermic reaction
5. Increase of pressure	Towards lesser number of gaseous moles
6. Decrease of pressure	Towards larger number of gaseous moles
7. Addition of catalyst	No effect
8. Addition of inert gas : (a) at constant volume (b) at constant pressure	 No effect Towards larger number of gaseous moles

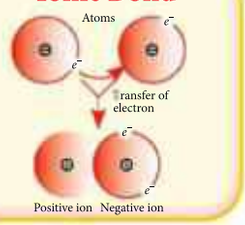
CONCEPT MAP

CHEMICAL

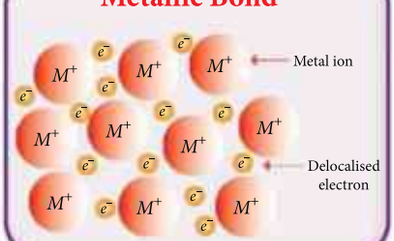
CHEMICAL BONDING AND MOLECULAR STRUCTURE

Chemical Bond

Ionic Bond



Metallic Bond



Primary Bonds

Coordinate Bond

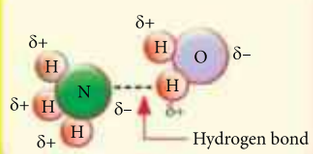
It is a type of alternate covalent bond that is formed by sharing of electron pair from a single atom.

Covalent Bond

Covalent bond formation takes place due to the sharing of electrons. There are mainly two types of covalent bonds, *i.e.*, polar covalent bonds and non-polar covalent bonds.

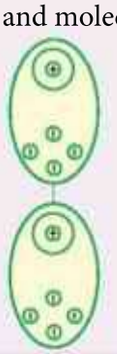
Secondary Bonds

Hydrogen Bonding



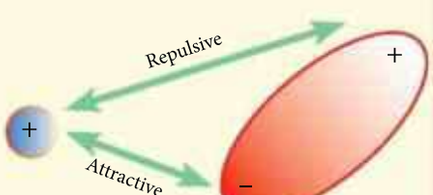
van der Waals Forces

These are the weak intermolecular forces that are dependent on the distance between atoms and molecules.



Dipole Interactions

The dipole-dipole interaction arises when the partial positive charge of one molecule is attracted to the partial negative charge of another molecule.



Hybridisation and Molecular Structure

VSEPR Theory

- The shape of a molecule depends upon the number of valence shell electron pairs (bonded or non bonded) surrounding the central atom.
- Electron pairs tend to occupy such positions in space which minimise repulsions.
- The repulsive interactions of electron pairs decrease in the order : $lp - lp > lp - bp > bp - bp$

Order of Energy of Molecular Orbitals

From H_2 to N_2 molecules

$\sigma(1s) < \sigma^*(1s) < \sigma(2s) < \sigma^*(2s) < \pi(2p_x) = \pi(2p_y) < \sigma(2p_z) < \pi^*(2p_x) = \pi^*(2p_y) < \sigma^*(2p_z)$

For O_2, F_2 and Ne_2 molecules

$\sigma(1s) < \sigma^*(1s) < \sigma(2s) < \sigma^*(2s) < \sigma(2p_z) < \pi(2p_x) = \pi(2p_y) < \pi^*(2p_x) = \pi^*(2p_y) < \sigma^*(2p_z)$

Hybrid Orbitals and Geometry

Atomic orbitals used	Hybrid orbitals formed	Geometry	Examples
s,p	Two *sp* orbitals	180° Linear	CO_2, BeF_2
s,p,p	Three sp^2 orbitals	120° Trigonal Planar	SO_3, BF_3, BCl_3
s,p,p,p	Four sp^3 orbitals	109.5° Tetrahedral	CH_4, $GeCl_4$
s,p,p,p,d	Five dsp^3 orbitals	90°, 120° Trigonal Bipyramidal	PCl_5, PF_5
s,p,p,p,d,d	Six d^2sp^3 orbitals	90°, 90° Octahedral	SF_6, $Mo(CO)_6$

CHEMICAL KINETICS

Rate of Reaction

- For a reaction, $aA + bB \rightarrow xX + yY$

$$\text{Rate} = -\frac{1}{a}\frac{d[A]}{dt} = -\frac{1}{b}\frac{d[B]}{dt} = +\frac{1}{x}\frac{d[X]}{dt} = +\frac{1}{y}\frac{d[Y]}{dt}$$

- Greater the concentration of reactants, faster is the rate of reaction.
- Rate becomes double for every 10° rise in temperature.
- Greater the surface area of reactants, faster is the rate of reaction.
- Rate of the reaction depends on the following factors :

Molecular orientation
Temperature
Concentration
Nature of solvent
Catalysts

Pressure
Surface area
Intensity of light
Nature of reactants

Order and Molecularity of a Reaction

- Order of a reaction is equal to the sum of powers of concentration terms involved in the rate law expression.
- For a general reaction, $aA + bB \rightarrow cC + dD$

  Order of reaction = $a + b$
- Molecularity is the number of atoms, ions or molecules that must collide simultaneously with one another to result into a chemical reaction.

Examples :

Unimolecular : $NH_4NO_2 \longrightarrow N_2 + 2H_2O$

Bimolecular : $2HI \longrightarrow H_2 + I_2$

Trimolecular : $2NO + O_2 \longrightarrow 2NO_2$

	Molecularity	Order
1.	Theoretical concept.	An experimentally determined quantity.
2.	It cannot be zero, fractional, infinite and imaginary.	It can be equal to zero, positive, negative and fractional.
3.	It cannot be greater than three.	Greater than three is also possible.

Integrated Rate Equation and Half-Life

Order	Integrated rate equation	Half-life ($t_{1/2}$)
0	$[A]_t = -kt + [A]_0$	$[A]_0/2k$
1	$\ln[A]_t = -kt + \ln[A]_0$	$0.693/k$
2	$1/[A]_t = kt + 1/[A]_0$	$1/k[A]_0$
n	$(n-1)kt = \frac{1}{[A]_t^{n-1}} - \frac{1}{[A]_0^{n-1}}$	$\frac{2^{n-1}-1}{k(n-1)[A]_0^{n-1}}$

- Relationships between half-life and time taken for different fractions of a first order reaction to complete.

$t_{3/4}$ or $t_{75\%} = 2t_{1/2}$
$t_{87.5\%} = 3t_{1/2} = 3/2t_{75\%}$
$t_{93.75\%} = 4t_{1/2} = 2t_{75\%}$
$t_{96.87\%} = 5t_{1/2}$; $t_{99.9\%} = 10t_{1/2}$

Temperature Dependence of Rate of Reaction and Effect of Catalyst

- **Arrhenius equation :** $k = Ae^{-E_a/RT}$

or $\log\frac{k_2}{k_1} = \frac{E_a}{2.303R}\left[\frac{T_2 - T_1}{T_1T_2}\right]$

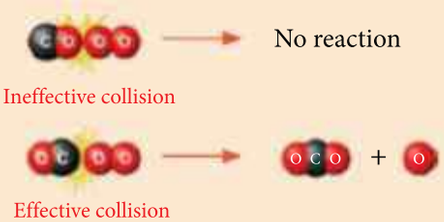
- **Activation energy :** The minimum energy that the reacting molecule must possess before undergoing a reaction is known as activation energy.

Activation energy = Threshold energy = Average kinetic energy of reactants

Collision Theory of Chemical Reaction

- **Collision theory :** $k = PZe^{-E_a/RT}$

where, P is steric factor and Z is collision frequency.



- Catalyst increases the rate of a reaction without undergoing any permanent chemical change itself.

Ionic Equilibrium

Acids and Bases

Arrhenius concept
Acid : Gives H^+ ion in aqueous solution
Base : Gives OH^- ion in aqueous solution

Lewis concept
Acid : Electron pair acceptor
Base : Electron pair donor

Brönsted-Lowry concept
Acid : Proton donor
Base : Proton acceptor

Buffer Solution

Acidic buffer
Contains an equimolar mixture of a weak acid and its salt with a strong base. *e.g.*, CH_3COOH and CH_3COONa

Basic buffer
Contains an equimolar mixture of a weak base and its salt with a strong acid. *e.g.*, NH_4OH and NH_4Cl

Conjugate Acid-Base Pair

Brönsted-Lowry Base — Conjugate Acid

H_2SO_4 + H_2O ⇌ HSO_4^- + H_3O^+

Sulphuric acid — Water — Bisulphate ion — Hydronium ion

Brönsted-Lowry Acid — Conjugate Base

Conjugate Acid-Base Pair

Strong acids : HCl, H_2SO_4, HNO_3 > Weak acids : CH_3COOH, H_2CO_3, HNO_2 > Strong bases : NaOH, KOH, CsOH > Weak bases : NH_4OH, $Al(OH)_3$, $Pb(OH)_2$

Solubility Product

A solid salt of the general formula, $M_x^{p+}X_y^{q-}$ with molar solubility 'S' in equilibrium with its saturated solution may be represented by the equation :

$M_xX_{y(s)} \rightleftharpoons xM^{p+}_{(aq)} + yX^{q-}_{(aq)}$ (where $x \times p^+ = y \times q^-$)

and its solubility product constant is given by :

$K_{sp} = [M^{p+}]^x[X^{q-}]^y = (xS)^x(yS)^y = x^x \cdot y^y \cdot S^{(x+y)}$

$S^{(x+y)} = K_{sp}/x^x \cdot y^y$; $S = (K_{sp}/x^x \cdot y^y)^{1/x+y}$

K_{sp} is given by Q_{sp}, when the concentration of one or more species is not the concentration under equilibrium, and under equilibrium conditions $K_{sp} = Q_{sp}$.

Salt type	Relation between K_{sp} and S	Examples
AB_2	$K_{sp} = (S)(2S)^2 = 4S^3$	$PbCl_2$, $HgCl_2$
A_2B	$K_{sp} = (2S)^2(S) = 4S^3$	Ag_2CrO_4, $Ag_2C_2O_4$, Ag_2SO_4
AB_3	$K_{sp} = (S)(3S)^3 = 27S^4$	$Fe(OH)_3$, $Al(OH)_3$, $Cr(OH)_3$
A_3B_2	$K_{sp} = (3S)^3(2S)^2 = 108S^5$	$Ca_3(PO_4)_2$, $Zn_3(PO_4)_2$
AB	$K_{sp} = (S)(S) = S^2$	$AlPO_4$, AgCl, AgBr, $PbSO_4$, $BaSO_4$, ZnS

Some Important Points

Henderson equation

For an acidic buffer, $pH = pK_a + \log \frac{[Salt]}{[Acid]}$

For a basic buffer, $pOH = pK_b + \log \frac{[Salt]}{[Base]}$

Buffer capacity

No. of moles of acid or base added to 1L of buffer divided by change in pH = $n/\Delta pH$

Applications of Equilibrium Constant

- Predict the extent of reaction on the basis of magnitude.
- Predict the direction of reaction.
- Calculation of equilibrium concentrations.

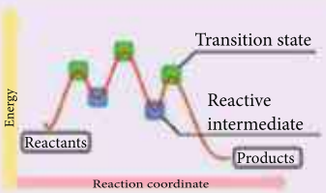
Organic Chemistry–Some Basic Principles and Techniques

Stability of Intermediates

- Stability of free radicals and carbocations

  $\propto +I$ effect $\propto \frac{1}{-I \text{ effect}}$ $\propto +R$ effect $\propto \frac{1}{-R \text{ effect}}$

- Stability of carbanions $\propto -I$ effect $\propto \frac{I}{+I \text{ effect}}$ $\propto -R$ effect $\propto \frac{1}{+R \text{ effect}}$



- Stability of Carbene : Triplet > Singlet
- Number of hyperconjugation structures $\propto$ Number of α-hydrogens $\propto$ stability $\propto$ 1/Heat of hydrogenation $\propto$ Polarity $\propto$ Dipole moment $\propto$ 1/Bond length

Quantitative Analysis

- $\%\text{ of C} = \frac{12}{44} \times \frac{\text{Mass of } CO_2 \text{ formed}}{\text{Mass of compound taken}} \times 100$
- $\%\text{ of H} = \frac{2}{18} \times \frac{\text{Mass of } H_2O \text{ formed}}{\text{Mass of compound taken}} \times 100$

(Liebig's combustion method)

- $\%\text{ of N} = \frac{28}{22400} \times \frac{\text{Vol. of } N_2 \text{ at STP}}{\text{Mass of compound taken}} \times 100$ (Dumas method)
- $\%\text{ of N} = \frac{1.4 \times \text{Molarity of acid} \times \text{Vol. of acid used} \times \text{Basicity of acid}}{\text{Mass of compound taken}} \times 100$ (Kjeldahl's method)
- $\%\text{ of } X = \frac{\text{Molar mass of } X}{\text{Molar mass of AgX}} \times \frac{\text{Mass of AgX formed}}{\text{Mass of compound taken}} \times 100$
- $\%\text{ of S} = \frac{32}{233} \times \frac{\text{Mass of } BaSO_4 \text{ formed}}{\text{Mass of compound taken}} \times 100$
- $\%\text{ of P} = \frac{62}{222} \times \frac{\text{Mass of } Mg_2P_2O_4 \text{ formed}}{\text{Mass of compound taken}} \times 100$
- $\%\text{ of O} = \frac{32}{88} \times \frac{\text{Mass of } CO_2 \text{ formed}}{\text{Mass of compound taken}} \times 100$

Types of Isomerism

Isomerism

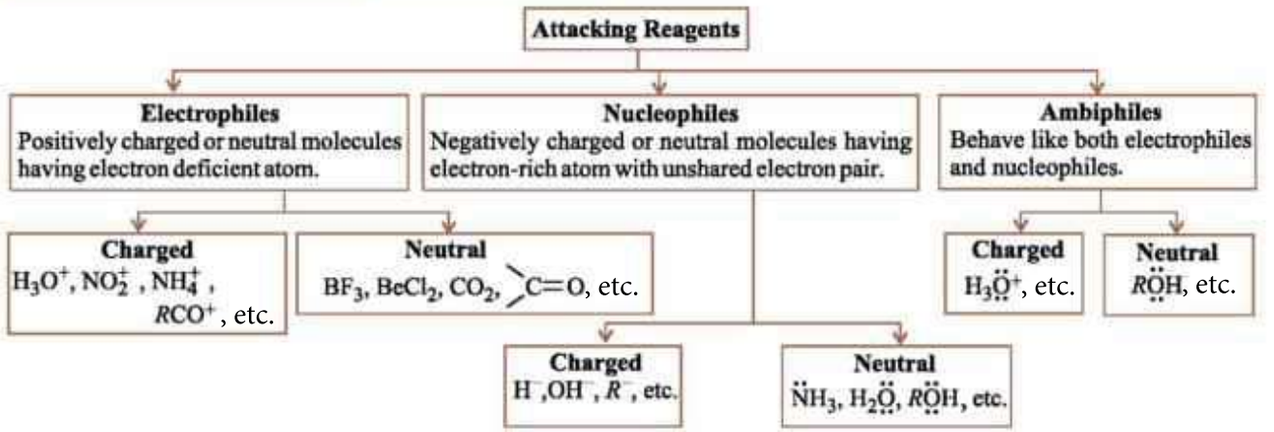
Structural isomerism
(Having same molecular formula but different structures)

- **Chain isomerism** (Having different carbon skeletons)
- **Position isomerism** (Having same carbon skeleton but different positions of the same functional groups on or in the C-chain)
- **Functional group isomerism** (Having different functional groups)
- **Metamerism** (Having different alkyl groups on either side of the functional group)
- **Tautomerism** (Arises due to migration of an H atom from one polyvalent atom to the other within the same molecule with necessary rearrangement of linkages)

Stereoisomerism
(Having same molecular formula and structure but different configuration, *i.e.*, arrangement of the atoms in space)

- **Geometrical isomerism (*cis*, *trans*-isomerism)**
- **Optical isomerism (*d*, *l*-isomerism)**

Attacking Reagents



Hydrocarbons

Chemical Properties

Chemical Properties of Alkanes

- Alkanes show least reactivity because of strong C–C and C–H σ-bonds.
- Undergo only substitution reaction.

$$CH_3CH_2CH_3 \xrightarrow{Cl_2} \begin{cases} CH_3CH_2CH_2Cl \\ CH_3-\underset{\displaystyle Cl}{\underset{|}{CH}}-CH_3 \end{cases}$$

- Halogenation and sulphonation occur by free radical mechanism.
- Oxidation : Combustion or complete oxidation

$$C_nH_{2n+2} + \left(\frac{3n+1}{2}\right)O_2 \rightarrow nCO_2 + (n+1)H_2O + \text{heat}$$

Chemical Properties of Alkenes

- Addition of unsymmetrical reagents (HX, H_2O, HOX, etc.) → Markovnikov's rule → always give 2°/3° haloalkanes

$$CH_3-CH=CH_2 + HBr \xrightarrow[\text{rule}]{\text{Markovnikov's}} CH_3-\underset{\displaystyle Br}{\underset{|}{CH}}-CH_3$$

- In presence of peroxides, addition follows anti-Markovnikov's rule (give primary haloalkanes) known as peroxide or Kharasch effect.
- Undergo electrophilic addition reactions.
- Test for unsaturation : Br_2 water and Baeyer's test.

$$CH_2=CH_2 + Br_2 \xrightarrow{CCl_4} \text{Colourless}$$

Chemical Properties of Alkynes

- Acidity : Alkynes > alkenes > alkanes (s-character ∝ acidity).
- Acidic nature

$$CH\equiv CH + Na \xrightarrow{\text{liq. } NH_3} CH\equiv C^-Na^+ + 1/2H_2$$

- Addition reactions

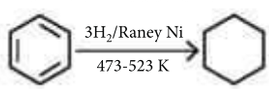
$$CH\equiv CH \xrightarrow[H_2]{Pt/Pd/Ni} CH_3-CH_3$$

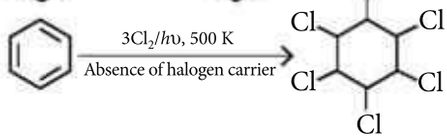
$$CH_3-C\equiv CH \xrightarrow[CCl_4]{Br_2} CH_3-CBr_2-CHBr_2$$

- Test for unsaturation-gives bromine water and Baeyer's test.
- Undergo electrophilic and nucleophilic addition reactions.

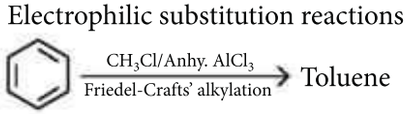
Chemical Properties of Benzene

- Addition reactions

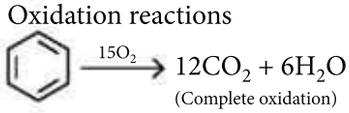




- Electrophilic substitution reactions



- Oxidation reactions



JEE WORK OUTS

SINGLE OPTION CORRECT TYPE

1. **Statement-1 :** $[Fe(H_2O)_5NO]SO_4$ is paramagnetic.
Statement-2 : Fe in $[Fe(H_2O)_5NO]SO_4$ has three unpaired electrons.
(a) Statements-1 and 2 are true and statement-2 is a correct explanation for statement-1.
(b) Statements-1 and 2 are true and statement-2 is not a correct explanation for statement-1.
(c) Statement-1 is true, statement-2 is false.
(d) Statement-1 is false, statement-2 is true.

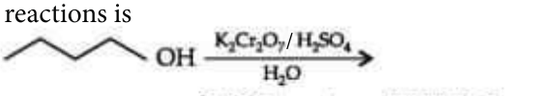
2. **Statement-1 :** Glucose gives a reddish-brown precipitate with Fehling's solution.
Statement-2 : Reaction of glucose with Fehling's solution gives CuO and gluconic acid.
(a) Statements-1 and 2 are true and statement-2 is a correct explanation for statement-1.
(b) Statements-1 and 2 are true and statement-2 is not a correct explanation for statement-1.
(c) Statement-1 is true, statement-2 is false.
(d) Statement-1 is false, statement-2 is true.

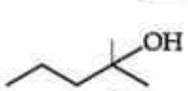
3. **Statement-1 :** For every chemical reaction at equilibrium, standard Gibbs energy of reaction is zero.
Statement-2 : At constant temperature and pressure, chemical reactions are spontaneous in the direction of decreasing Gibbs energy.
(a) Statements-1 and 2 are true and statement-2 is a correct explanation for statement-1.
(b) Statements-1 and 2 are true and statement-2 is not a correct explanation for statement-1.
(c) Statement-1 is true, statement-2 is false.
(d) Statement-1 is false, statement-2 is true.

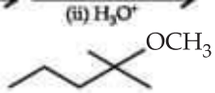
4. A compound of a metal ion M^{x+} ($Z = 25$) has a spin only magnetic moment of $\sqrt{24}$ B.M. The number of unpaired electrons in the compound and the oxidation state of the metal ion are respectively
(a) 4 and +2 (b) 5 and +3
(c) 3 and +2 (d) 4 and +3

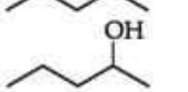
5. The ionisation energy and electron affinity of an element are 13.0 eV and 3.8 eV respectively. Its electronegativity on the Pauling scale is
(a) 3.0 (b) 3.5 (c) 4.0 (d) 2.8

6. The end product of the following sequence of reactions is



(a) 

(b) 

(c) 

(d) 

7. 25.3 g of sodium carbonate, Na_2CO_3 is dissolved in enough water to make 250 mL of solution. If sodium carbonate dissociates completely, molar concentration of sodium ion, Na^+ and carbonate ion, CO_3^{2-} are respectively
(Molar mass of Na_2CO_3 = 106 g mol^{-1})
(a) 0.955 M and 1.910 M
(b) 1.910 M and 0.955 M
(c) 1.90 M and 1.910 M
(d) 0.477 M and 0.477 M

8. The order of reactivity of the following compounds in S_N2 reaction is
$C_6H_5CH_2Br$, $C_6H_5CH(C_6H_5)Br$, $C_6H_5CH(CH_3)Br$, $C_6H_5C(CH_3)(C_6H_5)Br$
(a) $C_6H_5CH(C_6H_5)Br < C_6H_5C(CH_3)(C_6H_5)Br < C_6H_5CH_2Br < C_6H_5CH(CH_3)Br$
(b) $C_6H_5C(CH_3)(C_6H_5)Br < C_6H_5CH(C_6H_5)Br < C_6H_5CH(CH_3)Br < C_6H_5CH_2Br$
(c) $C_6H_5CH_2Br < C_6H_5CH(CH_3)Br < C_6H_5CH(C_6H_5)Br < C_6H_5C(CH_3)(C_6H_5)Br$
(d) $C_6H_5CH(CH_3)Br < C_6H_5CH_2Br < C_6H_5C(CH_3)(C_6H_5)Br < C_6H_5CH(C_6H_5)Br$

ONE OR MORE THAN ONE OPTIONS CORRECT TYPE

9. For the first order reaction, $2N_2O_{5(g)} \rightarrow 4NO_{2(g)} + O_{2(g)}$
(a) the concentration of the reactant decreases exponentially with time
(b) the half-life of the reaction decreases with increasing temperature
(c) the half-life of the reaction depends on the initial concentration of the reactant
(d) the reaction proceeds to 99.6% completion in eight half-life duration.

10. Which of the following molecules contain(s) two lone pairs of electrons on the central atoms?
(a) H_2O (b) $SnCl_2$ (c) PCl_3 (d) XeF_2

11. Which reaction(s) is/are useful in exchange of halogen in alkyl chloride by iodide?
(a) Wurtz reaction
(b) Finkelstein reaction
(c) Reimer-Tiemann reaction
(d) Williamson synthesis

12. 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) $E_X = E_Y = \frac{3}{2}k_BT$

13. The correct statement(s) regarding, (i) HClO, (ii) $HClO_2$, (iii) $HClO_3$ and (iv) $HClO_4$, is(are)
(a) the sum of number of Cl=O bonds in (ii) and (iii) is two
(b) the sum of number of lone pairs of electrons on Cl in (ii) and (iii) is three
(c) the hybridisation of Cl in (iv) is sp^3
(d) the strongest acid amongst (i) to (iv) is (i).

14. There are 3 samples of hydrogen peroxide labelled 10 vol, 15 vol and 20 vol. Half litre of each was mixed. Identify the correct statement(s).
(a) The volume strength of the new solution is 15 vol.
(b) Normality of the new solution is $\frac{15}{5.6}$ N.
(c) The volume strength of the new solution is 10 vol.
(d) Normality of the new solution is $\frac{10}{5.6}$ N.

15. A ketone upon reaction with ethyl magnesium bromide (Grignard reagent) followed by hydrolysis gave a product which on dehydration gave an alkene. The alkene on ozonolysis gave diethyl ketone and acetaldehyde. The ketone will be
(a) dimethyl ketone (b) ethyl methyl ketone
(c) diethyl ketone (d) ethyl propyl ketone.

PARAGRAPH BASED QUESTIONS

Paragraph for Q. No. 16 and 17

Aliphatic amines are more basic than ammonia while the aromatic amines are less basic than ammonia. Among aliphatic amines, the basic strength of 1°, 2° and 3° amines is different and also depends on the nature of electron withdrawing or electron repelling substituents present in the structure. The basic strength is expressed in terms of dissociation constant (K_b) or the values of pK_b, larger the value of K_b or smaller the value of pK_b, more is the basic strength of amine.

16. Which one of the following is the correct order of increasing basic strength of nitrogen compounds in aqueous solution?
(a) $NH_3 < C_2H_5NH_2 < C_6H_5NH_2 < (C_2H_5)_2NH < C_6H_5CH_2NH_2$
(b) $C_6H_5NH_2 < NH_3 < C_6H_5CH_2NH_2 < C_2H_5NH_2 < (C_2H_5)_2NH$
(c) $(C_2H_5)_2NH < C_6H_5CH_2NH_2 < NH_3 < C_2H_5NH_2 < C_6H_5NH_2$
(d) $C_6H_5CH_2NH_2 < C_2H_5NH_2 < NH_3 < C_6H_5NH_2 < (C_2H_5)_2NH$

17. Which of the following statements is not correct?
(a) Methylamine is more basic than NH_3.
(b) Amines form hydrogen bonds.

(c) Ethylamine has higher boiling point than propane.

(d) Dimethylamine is less basic than methylamine.

Paragraph for Q. No. 18, 19 and 20

A solution containing weak acid and its salt with strong base resists change in pH on addition of small amounts of acids or bases and is called a buffer solution. Similarly, a solution containing weak base and its salt with strong acid behaves as a buffer solution. pH of a buffer solution can be calculated by applying Henderson–Hasselbalch equation.

18. The Henderson's equation for acetic acid and sodium acetate buffer is given by the expression

(a) $pH = pK_a - \log \frac{[CH_3COONa]}{[CH_3COOH]}$

(b) $pH = pK_a + \log \frac{[CH_3COONa]}{[CH_3COOH]}$

(c) $pOH = pK_a - \log \frac{[CH_3COONa]}{[CH_3COOH]}$

(d) $pOH = pK_a - \log \frac{[CH_3COOH]}{[CH_3COONa]}$

19. 1×10^{-3} mole of HCl is added to a buffer solution made up of 0.01 M acetic acid and 0.01 M sodium acetate. The final pH of the buffer will be
(Given, pK_a of acetic acid is 4.75 at 25°C)
(a) 4.60 (b) 4.66 (c) 4.75 (d) 4.8

20. Aqueous solutions of HNO_3, KOH, CH_3COOH and CH_3COONa of identical concentrations are provided. The pair of solutions which forms a buffer upon mixing is
(a) HNO_3 and CH_3COOH
(b) KOH and CH_3COONa
(c) HNO_3 and CH_3COONa
(d) CH_3COOH and CH_3COONa

NUMERICAL/INTEGER ANSWER TYPE

21. For hydrogen – oxygen fuel cell at one atm and 298 K,

$H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O_{(l)}$; $\Delta G° = -240$ kJ

$E°$ for the cell is approximately _____ V.
(Given : $F = 96{,}500$ C)

22. 0.24 g of a volatile liquid upon vaporisation gives 48 mL of vapours at STP. The vapour density of the substance will be _____.

23. The total number of B—O—B and B—OH bonds in borax is _____.

MATCHING LIST TYPE

24. Match column I with column II and select the correct option.

Column I (Molecule/Ion)		Column II (Magnetic property)	
(i)	C_6H_6	(1)	Antiferromagnetic
(ii)	CrO_2	(2)	Ferrimagnetic
(iii)	MnO	(3)	Ferromagnetic
(iv)	Fe_3O_4	(4)	Paramagnetic
(v)	Fe^{3+}	(5)	Diamagnetic

(a) (i)-(5), (ii)-(3), (iii)-(2), (iv)-(1), (v)-(4)
(b) (i)-(3), (ii)-(5), (iii)-(1), (iv)-(4), (v)-(2)
(c) (i)-(5), (ii)-(3), (iii)-(1), (iv)-(2), (v)-(4)
(d) (i)-(5), (ii)-(3), (iii)-(1), (iv)-(4), (v)-(2)

25. Match column I with column II and select the correct option.

Column I		Column II	
(A)	Sphalerite	(i)	$FeCO_3$
(B)	Malachite	(ii)	$ZnCO_3$
(C)	Calamine	(iii)	Na_3AlF_6
(D)	Cryolite	(iv)	$CuCO_3 \cdot Cu(OH)_2$
(E)	Siderite	(v)	ZnS

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

SOLUTIONS TO APRIL 2023 QUIZ CLUB

1. Crystalline
2. Electrochemical
3. $NaNO_3$
4. Nitrogen
5. Schottky
6. Negative
7. Tyndall effect
8. +3
9. Zinc
10. FeS_2
11. 2-Acetoxybenzoic acid
12. Methyl salicylate
13. Stoichiometry
14. Reimer-Tiemann reaction
15. Bithional
16. Hydrogen economy
17. Ascorbic acid
18. Polytetrafluoroethylene
19. Aluminium
20. Classical

Winner : Krati Trigunait

SOLUTIONS

1. (a): In compound $[Fe(H_2O)_5NO]SO_4$, oxidation state of Fe is

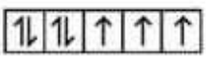
$x + 5 \times 0 + 1 = +2$

$\therefore \quad x = +1$

Here, Fe has +1 oxidation state.

$Fe^+ \rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^6\ 4s^1$

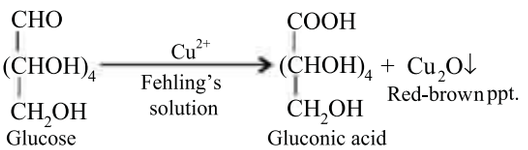
Due to strong field ligand, one electron is shifted from 4*s* to 3*d*, thus showing $3d^7$ configuration.



$\Rightarrow$ 3 unpaired electrons

3*d*

2. (c):



3. (d): At equilibrium, $\Delta G = 0$, but standard Gibbs energy ($\Delta G°$) of a reaction may or may not be zero. For reaction to be spontaneous, ΔG (Gibbs energy) should be negative, *i.e.*, $\Delta G < 0$.

4. (d): Given, $\mu = \sqrt{24} = \sqrt{n(n+2)}$

where, n = no. of unpaired electrons

$\therefore \quad 24 = n(n+2)$ or $n = 4$

M has $Z = 25$, thus its electronic configuration is $[Ar]3d^5 4s^2$.

Since the number of unpaired electrons is 4, it is possible only when M^{x+} has the configuration $[Ar]3d^4$.

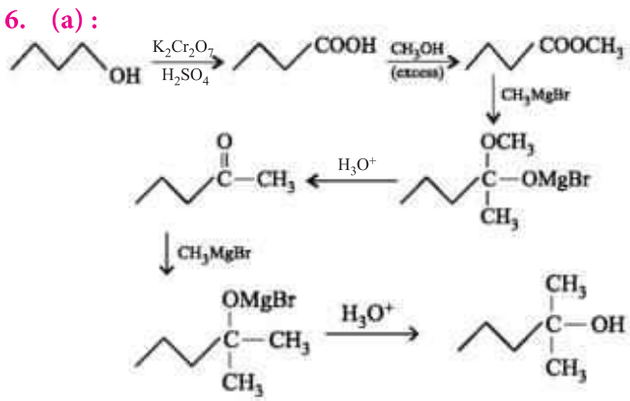
$\therefore$ Oxidation state of the metal ion = +3

5. (a): Electronegativity on the Mulliken's scale

= 1/2 (13.0 + 3.8) = 8.4

Since Mulliken's values are nearly 2.8 times as large as Pauling values, therefore, electronegativity of the element on Pauling scale is 8.4/2.8 = 3.0

6. (a):



7. (b): Given, mass of Na_2CO_3 = 25.3 g

Molar mass of Na_2CO_3 = 106 g/mol

$\therefore$ Molarity of solution $= \dfrac{25.3 \times 1000}{106 \times 250} = 0.955$ M

$Na_2CO_3 \longrightarrow 2Na^+ + CO_3^{2-}$

$[Na^+] = 2[Na_2CO_3] = 2 \times 0.955 = 1.910$ M

$[CO_3^{2-}] = [Na_2CO_3] = 0.955$ M

8. (b): As steric hindrance increases, reactivity towards S_N2 reaction decreases.

9. (a, b, d) : For a first order reaction, $[A] = [A]_0 e^{-kt}$ concentration of reactant decreases exponentially with time.

Also, $t_{1/2} = \dfrac{0.693}{k}$

This relation shows that half-life is independent of initial concentration of reactant and $t_{1/2}$ decreases with the increase of temperature.

The reaction proceeds to 99.6% completion in eight half-life duration.

$$k = \frac{0.693}{t_{1/2}} \qquad \text{...(i)}$$

and $k = \dfrac{2.303}{t} \log \dfrac{a}{(a-x)}$

For 99.6% completion; $a = 100$, $x = 99.6$, $a - x = 0.4$

$$k = \frac{2.303}{t_{99.6\%}} \log \frac{100}{0.4} = \frac{2.303}{t_{99.6\%}} \log 250 \qquad \text{...(ii)}$$

From eq. (i) and (ii), we get

$$t_{99.6\%} = \frac{2.303}{0.693} \times 2.4 \times t_{1/2} = 7.975 \times t_{1/2} \approx 8 \times t_{1/2}$$

10. (a): H_2O (two lone pairs), $SnCl_2$ (one lone pair), PCl_3 (one lone pair) and XeF_2 (three lone pairs).

11. (b): Iodoalkanes can be easily prepared from the corresponding chloroalkanes by heating chloroalkane with sodium iodide in acetone or methanol. This reaction is called Finkelstein reaction.

$$R - Cl + NaI \xrightarrow{\text{Acetone, } \Delta} R - I + NaCl$$

12. (b, d) : Average kinetic energy per molecule of gas, $\bar{E}_k = \dfrac{3}{2} k_B T$ where, k_B = Boltzmann constant

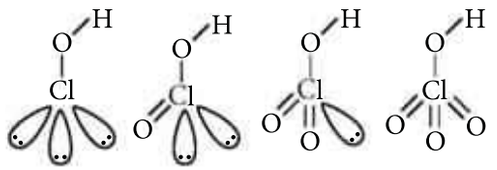
$\Rightarrow \quad \bar{E}_k = \dfrac{3}{2} \dfrac{RT}{N_A} \qquad \left(\because \ k_B = \dfrac{R}{N_A}\right)$

$C_X = \sqrt{\dfrac{3RT}{M_X}}; \ C_Y = \sqrt{\dfrac{3RT}{M_Y}}$

$\dfrac{C_X}{C_Y} = \sqrt{\dfrac{3RT}{M_X} \times \dfrac{M_Y}{3RT}} = \sqrt{\dfrac{M_Y}{M_X}} > 1 \qquad [\because M_Y > M_X]$

$\therefore \quad C_X > C_Y$

13. (b, c):



Hypochlorous acid ($HClO$) | Chlorous acid ($HClO_2$) | Chloric acid ($HClO_3$) | Perchloric acid ($HClO_4$)

In all these oxoacids, Cl is sp^3-hybridised.

Acidic strength of oxoacids of the same halogen increases with increase in oxidation number of the halogen, *e.g.*,

$\overset{+7}{HClO_4} > \overset{+5}{HClO_3} > \overset{+3}{HClO_2} > \overset{+1}{HClO}$

14. (a, b) : $\text{Normality} = \dfrac{\text{Volume strength}}{5.6}$

$N_1 = \dfrac{10}{5.6}, N_2 = \dfrac{15}{5.6}, N_3 = \dfrac{20}{5.6}$

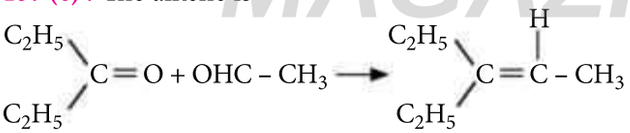
$\text{New normality} = \dfrac{N_1V_1 + N_2V_2 + N_3V_3}{V_1 + V_2 + V_3}$

$N = \dfrac{\left(\frac{10}{5.6} \times 0.5\right) + \left(\frac{15}{5.6} \times 0.5\right) + \left(\frac{20}{5.6} \times 0.5\right)}{0.5 + 0.5 + 0.5}$

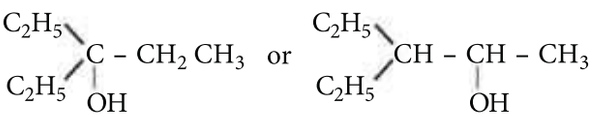
On solving, $N = 15/5.6$

New volume strength $= N \times 5.6 = 15/5.6 \times 5.6 = 15$ vol.

15. (c) : The alkene is

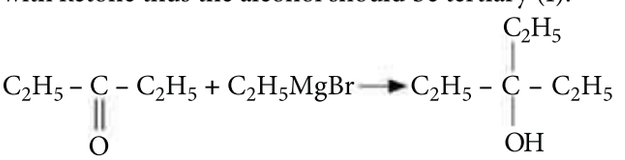


This alkene can be obtained from



(I) (II)

As the alcohol is produced by reaction of C_2H_5MgBr with ketone thus the alcohol should be tertiary (I).



16. (b): Stronger bases have higher value of K_b while weak bases have low values.

Compound	K_b
$(C_2H_5)_2NH$	1.1×10^{-3}
$C_2H_5NH_2$	5.1×10^{-4}
$C_6H_5CH_2NH_2$	2×10^{-5}
NH_3	1.8×10^{-5}
$C_6H_5NH_2$	4.2×10^{-10}

So, correct order of basic strength of nitrogen compounds is $(C_2H_5)_2NH > C_2H_5NH_2 > C_6H_5CH_2NH_2 > NH_3 > C_6H_5NH_2$

17. (d): Dimethylamine is more basic than methyl amine.

18. (b)

19. (b): $\underset{0.01}{CH_3COO^-} + \underset{0.001}{H^+} \rightarrow \underset{0.01}{CH_3COOH}$

$\underset{0.01 - 0.001 = 0.009}{} \quad - \quad \underset{0.01 + 0.001 = 0.011}{}$

$\text{pH} = pK_a + \log \dfrac{[\text{Salt}]}{[\text{Acid}]} = 4.75 + \log \dfrac{0.009}{0.011} = 4.66$

20. (d): Buffer solution is the one in which pH is not altered to any great extent by the addition of small quantities of either an acid or a base. Buffer solutions can be obtained by mixing:

(i) a weak acid and its salt with a strong base

(ii) a weak base and its salt with a strong acid.

Thus, option (d) CH_3COOH and CH_3COONa is the only buffer solution among the given options.

21. (1.24) : $\Delta G° = -nFE°$; $-240000 = -2 \times 96{,}500 \times E°$

$E° = 1.24$ V

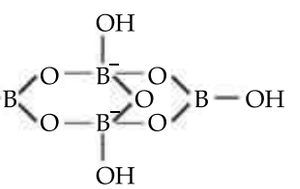
22. (56) : 0.24 g of a volatile substance gives 48 mL at STP.

22400 mL (or 1 mole) at STP will give $\dfrac{0.24}{48} \times 22400 = 112$ g

The vapour density is one-half the molecular weight, so

$\text{vapour density} = \dfrac{\text{mol. wt.}}{2} = \dfrac{112}{2} = 56.$

23. (9):



No. of B—O—B bonds = 5 ; No. of B—OH bonds = 4

Total number of B—O—B and B—OH bonds in borax is 9.

24. (c) **25. (d)**

MONTHLY TEST DRIVE CLASS XI ANSWER KEY

1. (b)	**2.** (a)	**3.** (b)	**4.** (a)	**5.** (d)
6. (d)	**7.** (b)	**8.** (a)	**9.** (d)	**10.** (c)
11. (c)	**12.** (c)	**13.** (c)	**14.** (d)	**15.** (c)
16. (d)	**17.** (b)	**18.** (a)	**19.** (b)	**20.** (b,c)
21. (b,c,d)	**22.** (a,b,c,d)		**23.** (a,c)	**24.** (4.8)
25. (5.27)	**26.** (7)	**27.** (a)	**28.** (c)	**29.** (a)
30. (b)				

WORD GRID

Readers are requested to send their responses of word grid. Be the Winner!

Find and encircle the words in the given grid, running in one of the possible directions; horizontal, vertical or diagonal by reading the clues given below.

O	P	S	U	E	F	F	U	S	I	O	N	Y	P	Z
S	U	A	N	T	I	O	X	I	D	A	N	T	D	A
H	G	M	I	C	R	O	S	T	A	T	E	Z	N	B
I	F	P	T	S	G	L	Y	C	O	S	I	D	I	S
W	B	H	U	T	H	I	J	L	W	U	T	V	W	O
Q	P	I	E	R	Q	P	O	S	I	L	S	I	L	R
T	E	P	G	C	B	R	E	R	T	V	R	E	I	B
B	S	R	S	R	N	O	N	H	H	F	Q	I	T	A
I	T	O	B	C	Q	S	C	M	E	K	T	Z	H	N
C	I	T	U	V	W	E	T	K	R	E	L	Y	A	C
T	C	I	V	Q	T	J	X	V	I	T	I	M	R	E
Q	I	C	W	A	S	O	H	Y	T	S	Q	E	G	O
R	D	R	C	C	F	T	P	Q	E	T	H	S	E	N
S	E	T	U	I	N	I	R	P	Z	X	J	Q	P	Q
D	V	A	P	O	R	I	Z	A	T	I	O	N	O	N
G	E	O	C	H	E	M	I	S	T	R	Y	A	R	S
N	P	O	A	B	A	K	E	L	I	T	E	Q	T	S
A	B	E	C	Q	U	E	R	E	L	C	S	T	X	V

Clues

1. The substance that can act as a proton donor or a proton acceptor.
2. The unit of radioactivity equal to 1 decay per second.
3. The movement of gas molecules from one container to another via a tiny hole.
4. The term used to describe the number of different possible arrangements of molecular position and kinetic energy at a particular thermodynamic state.
5. The compound barium carbonate in mineral form which is sometimes used as a rodenticide.
6. The study of chemistry and chemical composition of the Earth and geological processes.
7. The phase transition of a substance from a liquid to a gas above its boiling point.
8. The degree of absorbing a specific wavelength of light by a substance.

*Please send entries of solutions both with words and scanned copy of the grid by 10th of every month.

GET SET GO JEE for Class XI

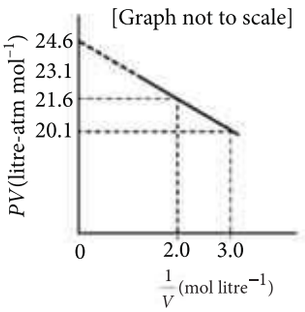
with exclusive and brainstorming MCQs

Practicing these MCQs help to strengthen your concepts and give you extra edge in your JEE preparation

1. If 0.5 mol of $BaCl_2$ is mixed with 0.2 mol of Na_3PO_4, the maximum number of moles of $Ba_3(PO_4)_2$ that can be formed is

(a) 0.7 (b) 0.5 (c) 0.2 (d) 0.1

2. For one mole of a van der Waals gas when $b = 0$ and $T = 300$ K, the PV *vs* $1/V$ plot is shown below. The value of the van der Waals constant a (atm litre^2 mol^{-2}) is



(a) 1.0 (b) 4.5 (c) 1.5 (d) 3.0

3. Consider the following ionization enthalpies of two elements '*A*' and '*B*' :

Element	Ionization enthalpy (kJ/mol)		
	1st	2nd	3rd
A	899	1757	14847
B	737	1450	7731

Which of the following statements is correct?

(a) Both '*A*' and '*B*' belong to group-2 where '*A*' comes below '*B*'.

(b) Both '*A*' and '*B*' belong to group-2 where '*B*' comes below '*A*'.

(c) Both '*A*' and '*B*' belong to group-1 where '*B*' comes below '*A*'.

(d) Both '*A*' and '*B*' belong to group-1 where '*A*' comes below '*B*'.

4. The molecular formula of a commercial resin used for exchanging ions in water softening is $C_8H_7SO_3Na$ (Mol. wt. 206). What would be the maximum uptake of Ca^{2+} ions by the resin when expressed in mole per gram resin?

(a) 2/309 (b) 1/412 (c) 1/103 (d) 1/206

5. 50 mL of 0.2 M ammonia solution is treated with 25 mL of 0.2 M HCl. If pK_b of ammonia solution is 4.75, the pH of the mixture will be

(a) 4.75 (b) 3.75 (c) 9.25 (d) 8.25

6. A water sample has ppm level concentration of following anions, F^- = 10; SO_4^{2-} = 100; NO_3^- = 50. The anion/anions that makes/make the water sample unsuitable for drinking is/are

(a) only F^- (b) only SO_4^{2-}

(c) only NO_3^- (d) both SO_4^{2-} and NO_3^-

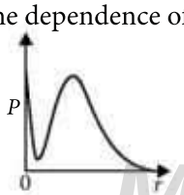
7. Match List-I with List-II.

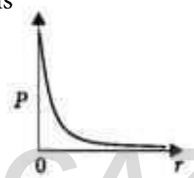
List-I (Species)		List-II (Hybrid Orbitals)	
(A)	SF_4	(i)	sp^3d^2
(B)	IF_5	(ii)	d^2sp^3
(C)	NO_2^+	(iii)	sp^3d
(D)	NH_4^+	(iv)	sp^3
		(v)	sp

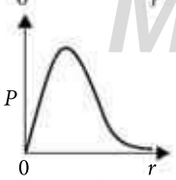
Choose the correct answer from the options given below:

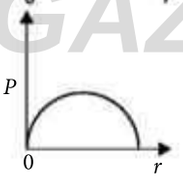
(a) (A) – (iii), (B) – (i), (C) – (v), (D) – (iv)
(b) (A) – (ii), (B) – (i), (C) – (iv), (D) – (v)
(c) (A) – (iv), (B) – (iii), (C) – (ii), (D) – (v)
(d) (A) – (i), (B) – (ii), (C) – (v), (D) – (iii)

8. *P* is the probability of finding the 1*s* electron of hydrogen atom in a spherical shell of infinitesimal thickness *dr*, at a distance *r* from the nucleus. The volume of this shell is $4\pi r^2 dr$. The qualitative sketch of the dependence of *P* on *r* is

(a) 

(b) 

(c) 

(d) 

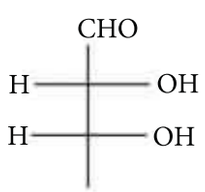
9. At 25°C and 1 atm pressure, the enthalpies of combustion are as given below:

Substance	H_2	$C_{(graphite)}$	$C_2H_{6(g)}$
$\Delta_c H°$/(kJ mol^{-1})	–286.0	–394.0	–1560.0

The enthalpy of formation of ethane is

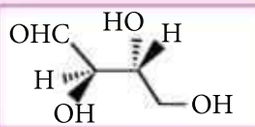
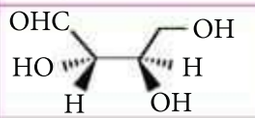
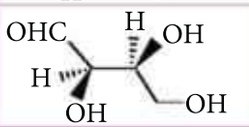
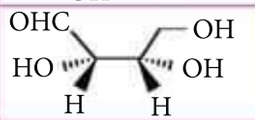
(a) +54.0 kJ mol^{-1} (b) –68.0 kJ mol^{-1}
(c) –86.0 kJ mol^{-1} (d) +97.0 kJ mol^{-1}

10. The Fischer projection of *D*-erythrose is shown below :



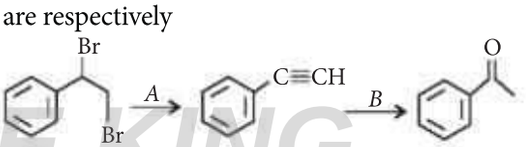
D-Erythrose

D-Erythrose and its isomers are listed as *P*, *Q*, *R*, and *S* in Column-I. Choose the correct relationship of *P*, *Q*, *R*, and *S* with *D*-erythrose from Column-II.

Column-I		Column-II	
P.		1.	Diastereomer
Q.		2.	Identical
R.		3.	Enantiomer
S.			

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

11. The reagents *A* and *B* in the following transformations are respectively



(a) Alc. KOH and H_2O, $HgSO_4$, H_2SO_4
(b) Alc. KOH and $KMnO_4/H^+$
(c) $NaNH_2$ and H_2O, $HgSO_4$, H_2SO_4
(d) $NaNH_2$ and $KMnO_4/H^+$

12. Propyne and propene can be distinguished by

(a) concentrated H_2SO_4 (b) Br_2 in CCl_4
(c) dilute $KMnO_4$ (d) $AgNO_3$ in ammonia.

NUMERICAL PROBLEMS

13. Total number of isomers considering both structural and stereoisomers of cyclic ethers with the molecular formula C_4H_8O is _____.

14. At 298 K, the equilibrium constant is 2×10^{15} for the reaction : $Cu_{(s)} + 2Ag^+_{(aq)} \rightleftharpoons Cu^{2+}_{(aq)} + 2Ag_{(s)}$
The equilibrium constant for the reaction
$\frac{1}{2}Cu^{2+}_{(aq)} + Ag_{(s)} \rightleftharpoons \frac{1}{2}Cu_{(s)} + Ag^+_{(aq)}$ is $x \times 10^{-8}$.
The value of *x* is _____. (Nearest Integer)

15. A metal surface is exposed to 500 nm radiation. The threshold frequency of the metal for photoelectric current is 4.3×10^{14} Hz. The velocity of ejected electron is _____ $\times 10^5$ m s^{-1}. (Nearest integer)
[Use : $h = 6.63 \times 10^{-34}$ J s, $m_e = 9.0 \times 10^{-31}$ kg]

SOLUTIONS

1. **(d) :** The reaction can be represented as

$$3BaCl_2 + 2Na_3PO_4 \rightarrow Ba_3(PO_4)_2 + 6NaCl$$

0.5 mol 0.2 mol

From the above balanced equation, it is clear that 3 moles of $BaCl_2$ require 2 moles of Na_3PO_4 .

$\therefore$ 0.5 moles of $BaCl_2$ will require $= \frac{2}{3} \times 0.5 = 0.33$ moles of Na_3PO_4

Since only 0.2 moles of Na_3PO_4 are available, so Na_3PO_4 is the limiting reagent.

Since 1 mole of $Ba_3(PO_4)_2$ is formed when 2 moles of Na_3PO_4 react, so the moles of $Ba_3(PO_4)_2$ formed when 0.2 moles of Na_3PO_4 reacts $= \frac{1}{2} \times 0.2 = 0.1$ mol

2. **(c) :** van der Waals equation for one mole of a gas is $\left(P + \frac{a}{V^2}\right)(V - b) = RT$

As given that $b = 0$

$$PV + \frac{a}{V} = RT \quad \text{or} \quad PV = RT - \frac{a}{V}$$

Comparing with $y = mx + c$

Intercept $(c) = RT$

Slope $(m) = -a$

$$\text{Slope} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{20.1 - 21.6}{3 - 2} = -1.5$$

Thus, $a = 1.5$

3. **(b) :** As the third ionization energy of *A* and *B* are very high as compared to corresponding second ionization energy, thus, there must be two electrons in their valence shells. Hence, elements *A* and *B* belong to group-2. On going down the group, the atomic size increases, so force of attraction between valence electron and nucleus decreases. Hence, ionization energy decreases. Thus, '*B*' comes below '*A*'.

4. **(b)**

5. **(c) :**

	NH_3	+ HCl	$\longrightarrow$	NH_4Cl
Initial millimole:	$50 \times 0.2 = 10$	$25 \times 0.2 = 5$		0
After reaction :	5	0		5

For buffer solution,

$$pOH = pK_b + \log \frac{[salt]}{[base]} = 4.75$$

$pH = 14 - 4.75 = 9.25$

6. **(a)** **7.** **(a)** **8.** **(b)**

9. **(c) :** Given, $H_{2(g)} + \frac{1}{2}O_{2(g)} \longrightarrow H_2O_{(l)}$;

$\Delta H^\circ = -286.0$ kJ/mol ...(i)

$C(\text{graphite}) + O_{2(g)} \longrightarrow CO_{2(g)}$;

$\Delta H^\circ = -394.0$ kJ/mol ...(ii)

$C_2H_{6(g)} + \frac{7}{2}O_{2(g)} \longrightarrow 2CO_{2(g)} + 3H_2O_{(l)}$;

$\Delta H^\circ = -1560.0$ kJ/mol ...(iii)

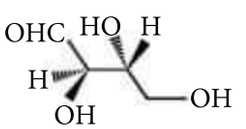
Enthalpy of formation of $C_2H_{6(g)}$ can be written as

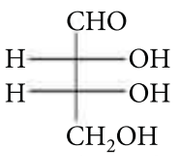
$2C(\text{graphite}) + 3H_{2(g)} \longrightarrow C_2H_{6(g)}$

So, by doing 3(i) + 2(ii) – (iii) we can get desired relation.

$$\Delta H^\circ_{f(C_2H_6)} = 3 \times (-286) + 2 \times (-394) - (-1560)$$
$$= -86.0 \text{ kJ mol}^{-1}$$

10. **(c) :** P.

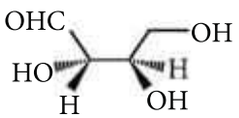


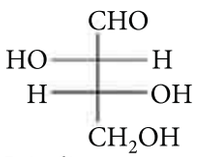


It is identical.

P → 2

Q.

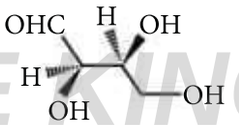


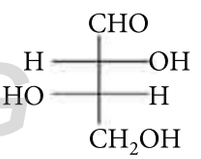


It is diastereomer.

Q → 1

R.

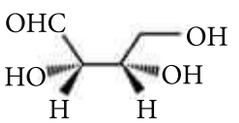


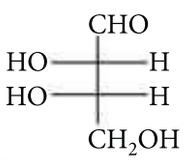


It is diastereomer.

R → 1

S.





It is enantiomer.

S → 3

11. **(c)**

12. **(d) :** The terminal hydrogen in $CH_3C \equiv CH$ (propyne) is acidic and it reacts with ammoniacal $AgNO_3$. In propene, $CH_3CH = CH_2$, there is no acidic hydrogen.

13. **(10)**

14. **(2) :** $Cu_{(s)} + 2Ag^+_{(aq)} \rightleftharpoons Cu^{2+}_{(aq)} + 2Ag_{(s)}$; $K_c = 2 \times 10^{15}$

$$\frac{1}{2}Cu^{2+}_{(aq)} + Ag_{(s)} \rightleftharpoons \frac{1}{2}Cu_{(s)} + Ag^+_{(aq)}; \; K'_c = \left(\frac{1}{K_c}\right)^{1/2}$$

$$K'_c = \left(\frac{1}{2 \times 10^{15}}\right)^{1/2} = (5 \times 10^{-16})^{1/2} = 2.24 \times 10^{-8}$$

The value of '*x*' is 2.

15. **(5)**

CBSE warm-up!

CLASS-XI

Chapterwise practice questions for CBSE Exams as per the latest pattern and rationalised syllabus by CBSE for the academic session 2023-24.

Series-1 Some Basic Concepts of Chemistry

Time Allowed : 3 hours
Maximum Marks : 70

General Instructions

Read the following instructions carefully.

(a) There are 33 questions in this question paper with internal choice.
(b) SECTION-A consists of 16 multiple-choice questions carrying 1 mark each.
(c) SECTION-B consists of 5 short answer questions carrying 2 marks each.
(d) SECTION-C consists of 7 short answer questions carrying 3 marks each.
(e) SECTION-D consists of 2 case-based questions carrying 4 marks each.
(f) SECTION-E consists of 3 long answer questions carrying 5 marks each.
(g) All questions are compulsory.
(h) Use of log tables and calculators is not allowed.

SECTION-A

The following questions are multiple-choice questions with one correct answer. Each question carries 1 mark. There is no internal choice in this section.

1. The mass of 1×10^{22} molecules of $CuSO_4 \cdot 5H_2O$ is
(a) 4.14 g (b) 8.28 g (c) 2.64 g (d) 5.29 g

2. The number of atoms of oxygen present in 10.6 g of Na_2CO_3 will be
(a) 6.02×10^{22} (b) 12.04×10^{22}
(c) 1.806×10^{23} (d) 31.8×10^{20}

3. 3 g of a hydrocarbon on combustion with excess of oxygen produces 8.8 g of CO_2 and 5.4 g of H_2O. The data illustrates the law of
(a) conservation of mass
(b) multiple proportions
(c) constant proportions
(d) gaseous volumes.

4. Law of constant composition does not hold good for
(a) exothermic compounds
(b) stoichiometric compounds
(c) endothermic compounds
(d) non-stoichiometric compounds.

5. 4.24 g of an organic compound on combustion produces 8.45 g of CO_2 and 3.46 g of water. The mass percentage of C and H in the compound respectively are
(a) 27.2, 18.2 (b) 54.4, 9.1
(c) 9.1, 54.4 (d) 18.2, 27.2

6. Which of the following postulates of Dalton's atomic theory explains the law of constant proportions?
(a) Atoms of a given element are identical in mass and chemical properties.
(b) Atoms combine in the ratio of small whole numbers to form compounds.
(c) The relative number and kind of atoms are constant in a given compound.
(d) All of these.

7. The masses of oxygen which combine with a fixed mass of hydrogen to form H_2O and H_2O_2, respectively, bear the simple ratio 1 : 2.
The above statement illustrates which of the following laws?
(a) Law of definite composition
(b) Law of multiple proportions
(c) Gay Lussac's law of gaseous volumes
(d) Avogadro's law

8. Which of the following contains the maximum number of atoms?
(a) 1.0 g of butane (C_4H_{10})
(b) 1.0 g of nitrogen (N_2)
(c) 1.0 g of silver (Ag)
(d) 1.0 g of water (H_2O)

9. Which of the following statements is incorrect?
(a) Pure substances have a definite chemical composition.
(b) Composition of a mixture can be varied to any extent.
(c) Water and baking soda are examples of compounds.
(d) The constituents of a compound can be easily separated by physical methods.

10. What is the percentage of carbon in urea?
(At. mass : C = 12, H = 1, N = 14, O = 16)
(a) 20% (b) 26.6% (c) 6.67% (d) 46.0%

11. Mass of 0.1 mole of methane is
(a) 1.6 g (b) 0.1 g (c) 1 g (d) 16 g

12. How many grams of H_2SO_4 are present in 0.25 mole of H_2SO_4?
(a) 2.45 (b) 24.5 (c) 0.245 (d) 0.25

13. Given below are two statements labelled as Assertion (A) and Reason (R).
Assertion (A) : One mole of a substance always contain the same number of entities, no matter what the substance may be.
Reason (R) : One mole is the amount of a substance that contains as many particles or entities as there are atoms in exactly 12 g of the ^{12}C isotope.
Select 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.

14. Given below are two statements labelled as Assertion (A) and Reason (R).
Assertion (A) : Molecular formula shows the exact number of different types of atoms present in a molecule of a compound.
Reason (R) : Molecular formula of a compound of known molar mass can be obtained from empirical formula which represents the simplest whole number ratio of various atoms present in a compound.
Select 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.

15. Given below are two statements labelled as Assertion (A) and Reason (R).
Assertion (A) : Elements and compounds are the examples of pure substances.
Reason (R) : The properties of a compound are different from those of its constituent elements.
Select 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.

16. Given below are two statements labelled as Assertion (A) and Reason (R).
Assertion (A) : The mass of a substance is constant whereas its weight may vary from one place to another.
Reason (R) : Mass of a substance is the amount of matter present in it while weight is the force exerted by gravity on an object.
Select 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.

SECTION-B

This section contains 5 questions with internal choice in one question. The following questions are very short answer type and carry 2 marks each.

17. Briefly explain the difference between precision and accuracy.

18. Express the result of the following data to the appropriate number of significant figures :

$$\frac{4.84 \times 0.0744}{6.016}$$

19. What are the postulates of Dalton's atomic theory of matter?

20. **(i)** What mass of N_2 will be required to produce 34.0 g of NH_3 by the reaction,
$N_2 + 3H_2 \longrightarrow 2NH_3$?

(ii) Write the formula and name of two compounds containing same percentage composition of C, H and O.

OR

If the density of methanol is 0.793 kg L^{-1}, what is its volume needed for making 2.5 L of its 0.25 M solution?

21. 25 kg of N_2 and 6 kg of H_2 are mixed to produce NH_3.

(i) Identify the limiting reagent.

(ii) Calculate the amount of ammonia formed in this reaction.

SECTION-C

This section contains 7 questions with internal choice in one question. The following questions are short answer type and carry 3 marks each.

22. Determine the percentage of water of crystallisation, iron, sulphur and oxygen in pure ferrous sulphate ($FeSO_4 \cdot 7H_2O$).

23. If 4.80 g of N_2F_4 is obtained when 4.00 g of NH_3 is reacted with 14.0 g of F_2 according to the following reaction, $2NH_3 + 5F_2 \longrightarrow N_2F_4 + 6HF$,
what is the percent yield?

24. 5 g of an organic compound contains 2.925 g of carbon, 0.205 g of hydrogen, 0.570 g of nitrogen and 1.30 g of oxygen. Find out the simplest formula.

25. When a mixture of $MgCO_3$ and $CaCO_3$ was heated for a long time, the weight was decreased by 50%. Calculate the percentage composition of the mixture.

26. How many grams of chlorine are required to completely react with 0.40 g of hydrogen to yield hydrochloric acid? Also calculate the amount of hydrochloric acid formed.

27. **(i)** A solution of oxalic acid, $(COOH)_2 \cdot 2H_2O$ is prepared by dissolving 0.63 g of the acid in 250 cm^3 of the solution. Calculate molarity of the solution.

(ii) If ten volumes of dihydrogen gas reacts with five volumes of dioxygen gas, how many volumes of water vapour would be produced?

OR

A compound made up of two elements *A* and *B* has *A* = 70%, *B* = 30%. Their relative number of moles in the compound are 1.25 and 1.88. Calculate :

(a) atomic masses of the elements *A* and *B*.

(b) molecular formula of the compound, if its molecular mass is found to be 160.

28. Calculate the number of atoms of each type in 5.3 g of Na_2CO_3.

SECTION-D

The following questions are case-based questions. Each question has an internal choice and carries 4 (1+1+2) marks each. Read the passage carefully and answer the questions that follow.

29. Molarity equation is, $\frac{M_1V_1}{n_1} = \frac{M_2V_2}{n_2}$

Where, M_1 and V_1 are the molarity and volume respectively of the first solution and M_2 and V_2 are the molarity and volume of the second solution/ reactant. n_1 and n_2 are the number of moles of first reactant and second reactant or product respectively.

For dilution of a solution, molarity equation can be used as

$$\underset{\text{(Before dilution)}}{M_1V_1} = \underset{\text{(After dilution)}}{M_2V_2}$$

(a) Calculate the volume of 0.1 M $K_2Cr_2O_7$ required to oxidise 35 mL of 0.5 M $FeSO_4$ solution.

OR

250 mL of a sodium carbonate solution contains 2.65 g of Na_2CO_3. If 10 mL of this solution is diluted to one litre, what is the concentration of the resultant solution?
(Molecular weight of Na_2CO_3 = 106)

(b) Calculate the molarity of concentrated sulphuric acid (density = 1.834 g cm^{-3}) containing 90% of H_2SO_4 by mass.

(c) Calculate the volume of concentrated sulphuric acid, which is 98% by mass (density = 1.84 g cm^{-3}), required to prepare 5 dm^3 of 0.5 mol dm^{-3} solution of sulphuric acid.

30. In the reactions where more than one reactant is involved, the amount of product is formed in proportion to the amount of the reactant which is entirely consumed. For example,

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

If one mole of nitrogen is reacted with excess of hydrogen then ammonia formed will be 2 moles in proportion to nitrogen. In this case, nitrogen is said to be limiting reagent because its amount limits the amount of product formed.

The reactant with the least number of equivalents (or milliequivalents) is the limiting reagent.

(a) What is the weight of oxygen required for the complete combustion of 2.8 kg of ethylene?

(b) The reaction of calcium with water is represented by the equation, $Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$, what volume of H_2 at STP would be liberated when 8 g of calcium completely reacts with water?

(c) In a reaction mixture, 8 moles of *P* react with 9 moles of *Q* in the following manner :

$2P + 3Q \rightarrow 2R$.

Calculate the number of moles of *R* formed.

OR

A mixture of N_2 and H_2 is made to react in a closed container to form NH_3. The reaction ceases before either reactants has been totally consumed. At this stage, 2.0 mol each of N_2, H_2 and NH_3 are present. Calculate the number of moles of N_2 and H_2 present originally.

SECTION-E

The following questions are long answer type and carry 5 marks each. All questions have an internal choice.

31. Attempt **any five** of the following :

(a) Write the expression for (i) mass percent and (ii) mole fraction.

(b) Out of molality and molarity which is more fundamental?

(c) What is the difference between empirical formula and molecular formula and how are they related to each other?

(d) An organic compound contains 43.98% C, 2.09% H and 37.2% Cl. Calculate its empirical formula.

(e) Calculate the mass percentage of each element of water.

(f) 50·0 kg of $N_{2(g)}$ and 10·0 kg of $H_{2(g)}$ are mixed to produce $NH_{3(g)}$. Calculate the amount of $NH_{3(g)}$ formed. Identify the limiting reagent in the production of NH_3 in this situation.

(g) Calculate the mass of sodium acetate required to make 500 mL of 0.375 molar aqueous solution. Molar mass of sodium acetate is 82.0245 g/mol.

32. What are the rules for determining the number of significant figures in answers involving :

(i) addition or subtraction

(ii) multiplication or division

(iii) calculation involving a number of steps.

Explain each case with a suitable example.

OR

Define :

(i) Atomic mass **(ii)** Gram atomic mass

(iii) Molecular mass **(iv)** Gram molecular mass

(v) Formula mass.

Give suitable example in each case.

33. (a) Calculate the number of moles in each of the following :

(i) 11 g of CO_2

(ii) 3.01×10^{22} molecules of CO_2

(iii) 1.12 L of CO_2 at STP

(b) Calculate number of molecules in each of the following :

(i) 14 g of nitrogen

(ii) 3.4 g of H_2S

OR

(a) Define the terms :

(i) Limiting reagent

(ii) Mole

(b) 20 g of $CaCO_3$ and 20 g of H_2SO_4 react to give $CaSO_4$ along with water and CO_2.

(i) Determine the limiting reagent for the above reaction.

(ii) How much $CaSO_4$ will be formed?

(iii) If 1 mole of gas occupies 22.4 L at STP, then calculate the volume of CO_2 evolved in the above reaction.

[Ca = 40, C = 12, O = 16, H = 1, S = 32]

SOLUTIONS

1. (a) **2.** (c) **3.** (a) **4.** (d)
5. (b) **6.** (b) **7.** (b) **8.** (a)
9. (d) **10.** (a) **11.** (a) **12.** (b)
13. (a) **14.** (b) **15.** (b) **16.** (a)

17. If the average value of different measurements is close to the correct value, the measurement is said to be accurate (the individual measurements may not be close to each other). If the values of different measurements are close to each other and hence close to their average value, the measurement is said to be precise (the average value of different measurements may not be close to the correct value).

18. $\frac{4.84 \times 0.0744}{6.016} = 0.059856$

As 4.84 or 0.0744 has least number of three significant figures, the result should contain three significant figures only. Hence, the result after rounding off is 0.0598.

19. Main postulates of Dalton's atomic theory are :
(i) All matters are made of atoms. Atoms are indivisible and indestructible.
(ii) All atoms of a given element are identical in mass and properties.
(iii) Atoms of different elements differ in properties and have different masses and sizes.
(iv) Compounds are formed by a combination of two or more different kinds of atoms.
(v) A chemical reaction is a rearrangement of atoms. These are neither created nor destroyed in a chemical reaction.

20. **(i)** The reaction is,

N_2	+	$3H_2$	⟶	$2NH_3$
1 mol		3 mol		2 mol
(2 × 14.0) g				(2 × 17.0) g
= 28.0 g				= 34.0 g

Thus, to produce 34.0 g of ammonia (NH_3), 28 g of nitrogen is required.
(ii) Compounds with same percentage composition of C, H and O will have the same empirical formula. Hence, the two compounds can be HCHO (formaldehyde) and $C_6H_{12}O_6$ (glucose) with same empirical formula CH_2O.

OR

Number of moles of $CH_3OH = V \times M$
$= 2.5\ L \times 0.25\ mol\ L^{-1} = 0.625\ mol$
Mass of methanol (CH_3OH)
$= 0.625\ mol \times 32\ g\ mol^{-1} = 20.0\ g$
0.793×10^3 g of CH_3OH is the mass of 1 L of methanol.
So, 20 g of CH_3OH is the mass of $\frac{1}{0.793 \times 10^3} \times 20$ L
$= \frac{20}{793}$ L $= \frac{20000}{793}$ mL = 25.22 mL of methanol.

21. $N_2 + 3H_2 \rightarrow 2NH_3$
(i) 1 mole of N_2 requires 3 moles of H_2
28 kg of N_2 requires 6 kg of H_2
$\therefore$ 25 kg of N_2 will require $6/28 \times 25 = 5.36$ kg of H_2
H_2 is present in excess, hence, N_2 is the limiting reagent.
(ii) 1 mole of N_2 produces 2 moles of NH_3
28 kg of N_2 produces 34 kg of NH_3
25 kg of N_2 will produce $34/28 \times 25 = 30.35$ kg of NH_3

22. The formula mass of ferrous sulphate
= (At. mass of Fe) + (At. mass of S) + 4 × (At. mass of O)
+ (7 × Mol. mass of H_2O)
= 56.0 + 32.0 + (4 × 16.0) + (7 × 18.0) = 278.0

So, % of water of crystallisation $= \frac{126}{278} \times 100 = 45.32$

% of iron $= \frac{56}{278} \times 100 = 20.14$

% of sulphur $= \frac{32}{278} \times 100 = 11.51$

% of oxygen $= \frac{64}{278} \times 100 = 23.02$

(Oxygen present in water molecules is not taken into account.)

23. The balanced equation is

$2NH_3$	+	$5F_2$	⟶	N_2F_4	+	6HF
2 moles		5 moles		1 mole		
34 g		190 g		104 g		

34 g of NH_3 react with fluorine = 190 g
4 g of NH_3 react with fluorine $= \frac{190}{34} \times 4 = 22.35$ g
This shows that fluorine is a limiting reagent.
190.0 g of fluorine produce N_2F_4 = 104.0 g
14.0 g of fluorine produce $N_2F_4 = \frac{104.0}{190.0} \times 14.0 = 7.66$ g
i.e., theoretical yield = 7.66 g ; Actual yield = 4.80 g
Percent yield $= \frac{4.80}{7.66} \times 100 = 62.66\ \%$

24. Mass per cent of carbon $= \frac{2.925}{5} \times 100 = 58.5\%$

Mass percent of hydrogen $= \frac{0.205}{5} \times 100 = 4.1\%$

Mass percent of nitrogen $= \frac{0.570}{5} \times 100 = 11.4\%$

Mass percent of oxygen $= \frac{1.30}{5} \times 100 = 26.0\%$

Element	Percentage	Molar ratio $\left(\frac{\text{\% age}}{\text{at. wt.}}\right)$	Simple ratio
C	58.5	58.5/12 = 4.87	6
H	4.1	4.1/1 = 4.1	5
N	11.4	11.4/14 = 0.81	1
O	26.0	26.0/16 = 1.6	2

Simplest formula is $C_6H_5NO_2$.

25. Suppose weight of the mixture taken initially was 100 g.

Let weight of $CaCO_3$ present in the mixture be x g.

Then, weight of $MgCO_3$ present in the mixture = $(100 - x)$ g

Weight loss is 50%, therefore residue of CaO + MgO weighs 50 g. Let weight of CaO formed be y g.

Then, weight of MgO formed = $(50 - y)$ g

$$\underset{x}{CaCO_3} + \underset{(100-x)}{MgCO_3} \rightarrow \underset{y}{CaO} + \underset{(50-y)}{MgO} + CO_2$$

Now, according to molar relationship,

100 g of $CaCO_3$ (1 mol) gives = 56 g CaO (1 mol)

$$x \text{ g of } CaCO_3 \text{ give} = \frac{56}{100} \times x \text{ g CaO} = y \qquad \text{...(i)}$$

84 g of $MgCO_3$ (1 mol) gives = 40 g MgO (1 mol)

$(100 - x)$ of $MgCO_3$ gives

$$= \frac{40}{84}(100 - x) = (50 - y) \text{ MgO} \qquad \text{...(ii)}$$

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

x = weight of $CaCO_3$ = 28.41 g,

Weight of $MgCO_3$ = 100 – x = 71.59 g

Percentage composition = $CaCO_3$

$$= \frac{28.41}{100} \times 100 = 28.41\%$$

$$MgCO_3 = \frac{71.59}{100} \times 100 = 71.59\%$$

26. The balanced chemical equation is

$$\underset{\substack{1 \text{ mol} \\ 2 \text{ g}}}{H_2} + \underset{\substack{1 \text{ mol} \\ 2 \times 35.5 = 71 \text{ g}}}{Cl_2} \longrightarrow 2HCl$$

2 g of H_2 reacts with 71 g of Cl_2.

0.40 g of H_2 would react with = $71/2 \times 0.4 = 14.2$ g of Cl_2.

Now, $\underset{\substack{2 \text{ mol} \\ 2 \text{ g}}}{H_2} + Cl_2 \longrightarrow \underset{\substack{2 \text{ mol} \\ 73 \text{ g}}}{2HCl}$

2 g of hydrogen gives 73 g of HCl

0.40 g of hydrogen will give $73/2 \times 0.4 = 14.6$ g of HCl

27. (i) Molar mass of oxalic acid,

$$\begin{matrix} COOH \\ | \\ COOH \end{matrix} .2H_2O = 126 \text{ g mol}^{-1}$$

$$\therefore \quad 0.63 \text{ g of oxalic acid} = \frac{0 \cdot 63}{126} = 0.005 \text{ moles of oxalic acid}$$

Volume of the solution = 250 cm^3 = 0.25 L

Molarity of the solution

$$= \frac{\text{Moles of the solute}}{\text{Volume of solution (in L)}} = \frac{0 \cdot 005 \text{ mol}}{0 \cdot 25 \text{ L}} = 0.02 \text{ mol L}^{-1}$$

(ii) The reaction is,

$$\underset{\substack{2 \text{ vol.} \\ 10 \text{ vol.}}}{2H_{2(g)}} + \underset{\substack{1 \text{ vol.} \\ 5 \text{ vol.}}}{O_{2(g)}} \longrightarrow \underset{\substack{2 \text{ vol.} \\ 10 \text{ vol.}}}{2H_2O_{(g)}}$$

Thus, ten volumes of water vapour will be produced in the reaction.

OR

(a)

Element	%	Atomic mass	Relative no. of moles	Molar ratio	Simplest whole no. ratio
A	70	a	1.25	$\frac{1.25}{1.25} = 1$	2
B	30	b	1.88	$\frac{1.88}{1.25} = 1.5$	3

$\therefore$ Empirical formula = A_2B_3

Atomic mass of $A = a = 70/1.25 = 56$

Atomic mass of $B = b = 30/1.88 = 16$

(b) Molecular mass of the compound = 160

$$n = \frac{160}{(56 \times 2) + (16 \times 3)} = \frac{160}{160} = 1$$

$\therefore$ Molecular formula of the compound = A_2B_3 or Fe_2O_3

28. Molar mass of Na_2CO_3

$= (2 \times 23) + (1 \times 12) + (3 \times 16)$ g mol^{-1}

$= (46 + 12 + 48)$ g $mol^{-1} = 106.0$ g mol^{-1}

So, number of moles of Na_2CO_3 in 5.3 g of Na_2CO_3

$$= \frac{5.3 \text{ g}}{106.0 \text{ g mol}^{-1}} = 0.05 \text{ mol}$$

Now,

$$\underset{\substack{1 \text{ mol} \\ 0.05 \text{ mol}}}{Na_2CO_3} \equiv \underset{\substack{2 \text{ mol} \\ 2 \times 0.05 \text{ mol} \\ = 0.1 \text{ mol}}}{2Na} + \underset{\substack{1 \text{ mol} \\ 1 \times 0.05 \text{ mol} \\ = 0.05 \text{ mol}}}{C} + \underset{\substack{3 \text{ mol} \\ 3 \times 0.05 \text{ mol} \\ = 0.15 \text{ mol}}}{3O}$$

Since, 1 mole of any substance contains 6.023×10^{23} chemical units, hence,

No. of Na atoms in 5.3 g of Na_2CO_3

$= 0.1 \text{ mol} \times 6.023 \times 10^{23} \text{ mol}^{-1} = 6.023 \times 10^{22}$

No. of C atoms in 5.3 g of Na_2CO_3

$= 0.05 \text{ mol} \times 6.023 \times 10^{23} \text{ mol}^{-1} = 3.011 \times 10^{22}$

No. of O atoms in 5.3 g of Na_2CO_3
$= 0.15 \text{ mol} \times 6.023 \times 10^{23} \text{ mol}^{-1} = 9.033 \times 10^{22}$

29. (a) The reaction involved is as follows,

$$K_2Cr_2O_7 + 7H_2SO_4 + 6FeSO_4 \rightarrow K_2SO_4 + Cr_2(SO_4)_3 + 7H_2O + 3Fe_2(SO_4)_3$$

$$\frac{M_1V_1}{n_1} = \frac{M_2V_2}{n_2}$$

$(K_2Cr_2O_7)$ $(FeSO_4)$

$$\frac{0.1 \times V_1}{1} = \frac{0.5 \times 35}{6} \Rightarrow V_1 = \frac{0.5 \times 35}{6 \times 0.1} = 29.2 \text{ mL}$$

OR

Molarity of Na_2CO_3 solution $= \frac{2.65}{106} \times \frac{1000}{250} = 0.1$ M

$M_1V_1 = M_2V_2$

$0.1 \times 10 = M_2 \times 1000 \Rightarrow M_2 = 0.001$ M

(b) 90% by mass means 100 g of acid contains 90 g H_2SO_4.

Volume of acid $= \frac{100}{1.834}$ mL

Molarity $= \frac{90}{98} \times \frac{1.834}{100} \times 1000 = 16.84$ M

(c) Molarity of given sulphuric acid

$= \frac{98}{98} \times \frac{1.84}{100} \times 1000 = 18.4 \text{ mol dm}^{-3}$

$M_1V_1 = M_2V_2$

$$V_1 = \frac{0.5 \times 5}{18.4} = 0.136 \text{ dm}^3 = 136 \text{ mL}$$

30. (a) $\underset{1 \text{ mol}}{C_2H_4} + \underset{3 \text{ mol}}{3O_2} \rightarrow 2CO_2 + 2H_2O$

28 g (*i.e.*, 1 mol) C_2H_4 requires 96 g (*i.e.*, 3 mol) O_2 for combustion.

2800 g (*i.e.*, 2.8 kg) C_2H_4 will require $= \frac{96}{28} \times 2800$

$= 9600 \text{ g} = 9.6 \text{ kg } O_2$

(b) $\underset{\substack{1 \text{ mol (40 g)} \\ \frac{8}{40} = \frac{1}{5} \text{ mol}}}{Ca} + 2H_2O \longrightarrow \underset{\substack{1 \text{ mol (22400 cm}^3\text{)} \\ \frac{1}{5} \text{ mol } (22400 \times \frac{1}{5} = 4480 \text{ cm}^3\text{)}}}{Ca(OH)_2 + H_2}$

(c) *P* and *Q* react in the molar ratio of 2 : 3. It means 8 moles of *P* will react with 12 moles of *Q*.

∴ *Q* is the limiting reagent with 9 moles only and limits the amount of product formed. *Q* and *R* have the molar ratio 3 : 2 respectively.

∴ Number of moles of *R* formed = 9 × 2/3 = 6 mol

OR

$N_2 + 3H_2 \rightarrow 2NH_3$

It is clear from the balanced chemical equation that formation of 2 mol of NH_3 must consume 1 mol of N_2 and 3 mol of H_2.

∴ Number of moles of N_2 present originally = 2 + 1 = 3 mol

Number of moles of H_2 present originally = 2 + 3 = 5 mol

31. (a) (i) Mass percent $= \frac{\text{Mass of the solute}}{\text{Mass of solution}} \times 100$

(ii) Mole fraction of solute (2) in the solution,

$$x_2 = \frac{n_2}{n_1 + n_2}$$

(b) Molality is more fundamental because it does not change with temperature during quantitative analysis.

(c) The empirical formula of a compound is the chemical formula which expresses the simplest whole number ratio of the atoms of the various elements present in one molecule of the compound. The molecular formula of a compound is the chemical formula which represents the true formula of its molecule. It expresses the actual number of atoms of various elements present in one molecule of the compound.

Molecular formula = $n \times$ Empirical formula

(d) % of O = 100 – 43.98 – 2.09 – 37.2 = 16.73

Element	Moles	Least ratio	Whole number ratio
C	$\frac{43.98}{12} = 3.66$	$\frac{3.66}{1.04} = 3.5$	7
H	$\frac{2.09}{1} = 2.09$	$\frac{2.09}{1.04} = 2$	4
Cl	$\frac{37.2}{35.5} = 1.04$	$\frac{1.04}{1.04} = 1$	2
O	$\frac{16.73}{16} = 1.04$	$\frac{1.04}{1.04} = 1$	2

Hence, the empirical formula is $C_7H_4Cl_2O_2$.

(e) Molecular mass of water (H_2O) = 18

∴ Mass % of hydrogen $= \frac{2 \times 1}{18} \times 100 = 11.11\%$

and mass % of oxygen $= \frac{16.00}{18} \times 100 = 88.89\%$

(f) $N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$

Now, 28 kg of N_2 reacts with 6 kg of H_2.

∴ 50 kg of N_2 reacts with $\frac{6}{28} \times 50 = 10.71$ kg of H_2.

Since, H_2 is present in small amount, therefore H_2 is the limiting reagent.

Also, 6 kg of H_2 gives 2 × 17 kg of NH_3

Hence, 10 kg of H_2 gives $\frac{2 \times 17}{6} \times 10 = 56.66$ kg of NH_3

(g) Molar mass of sodium acetate
$= (2 \times 12) + (3 \times 1) + (2 \times 16) + (1 \times 23) = 82 \text{ g mol}^{-1}$
Mass of CH_3COONa required to make 500 mL of 0.375 M solution $= \frac{0.375 \times 82 \times 500}{1000} = 15.38 \text{ g}$

32. (i) The result of an addition or subtraction should be reported to the same number of decimal places as that of the term with least number of decimal places. The number of significant figures of different numbers have no role to play.
Example, $4{\cdot}523 + 2.3 + 6.24 = 13{\cdot}063$
Actual sum = $13{\cdot}063$
Reported sum = $13{\cdot}1$
First number has three decimal places, second has one and third has two. Hence, answer should be reported only upto one decimal place. Note that the significant figures in the three numbers are 4, 2 and 3 respectively.
(ii) The result of a multiplication or division should be reported to the same number of significant figures as is possessed by the least precise term used in the calculation, other than exact numbers.
Example, $4.327 \times 2.8 = 12.1156$
Actual product = 12.1156
Reported product = 12
The first number has four significant figures while the second has two. The actual product has been rounded off to give a reported product of 12, *i.e.*, containing two significant figures only. This is because the least precise term in the calculation (*viz.*, 2.8) has only two significant figures.
(iii) If a calculation involves a number of steps, the result should contain the same number of significant figures as that of the least precise number involved, other than the exact numbers.
Example, $\frac{42.967 \times 0.02435}{0.34 \times 4} = 0.769298$ (Actual result)
Leaving the exact number 4, the least precise term has two significant figures. Hence, after rounding off, the reported result will be 0·77, *i.e.*, containing two significant figures.

OR

(i) The atomic mass of an element is the number of times an atom of that element is heavier than an atom of carbon taken as 12. *e.g.*, the atomic mass of hydrogen is 1.008 amu while that of oxygen is 15.9994 amu (or taken as 16 amu).
(ii) The atomic mass of an element expressed in grams is called gram atomic mass *e.g.*, gram atomic mass of oxygen (or one gram atom of oxygen) is 16 g.
(iii) The molecular mass of a substance is the average relative mass of its molecules as compared with an atom of carbon-12 isotope taken as 12. *e.g.*, molecular mass of $H_2SO_4 = 2 \times$ At. mass of H + At. mass of S + $4 \times$ At. mass of O $= (2 \times 1.0) + (32.0) + (4 \times 16.0) = 98.0$ u
(iv) The molecular mass of a substance expressed in grams is called gram molecular mass *e.g.*, gram molecular mass of H_2SO_4 (or one gram molecule of H_2SO_4) is 98.0 g.
(v) Formula mass is defined as the sum of the atomic masses of all atoms in a formula unit of a compound. It is applicable to ionic compounds, *e.g.*, formula mass of $CaCl_2 = 40 + (2 \times 35.5) = 40 + 71 = 111$ u

33. (a) (i) 44 g of CO_2 = 1 mol
11 g of $CO_2 = 1/44 \times 11 = 1/4 = 0.25$ mol
(ii) 6.023×10^{23} molecules = 1 mol
3.01×10^{22} molecules $= \frac{1 \times 3.01 \times 10^{22}}{6.023 \times 10^{23}} = 0.05$ mol
(iii) 22.4 L of CO_2 = 1 mol
1.12 L of $CO_2 = \frac{1 \times 1.12}{22.4} = 0.05$ mol
(b) (i) 1 mol of $N_2 = 28$ g
28 g of $N_2 = 6.023 \times 10^{23}$ molecules
14 g of $N_2 = \frac{6.023 \times 10^{23}}{28} \times 14$
$= 3.01 \times 10^{23}$ molecules
(ii) 34 g of $H_2S = 6.023 \times 10^{23}$ molecules
3.4 g of $H_2S = \frac{6.023 \times 10^{23}}{34} \times 3.4$
$= 6.023 \times 10^{22}$ molecules

OR

(a) (i) The reactant which gets consumed in a reaction and limits the amount of product formed is called the limiting reagent.
(ii) The amount of substance which contains same number of particles (atoms, molecules or ions) as the number of atoms present 12 g of carbon-12 is called mole.
(b) $CaCO_3 + H_2SO_4 \rightarrow CaSO_4 + H_2O + CO_2$
(i) 1 mole of $CaCO_3$ requires 1 mole of H_2SO_4
100 g of $CaCO_3$ requires 98 g of H_2SO_4
$\therefore$ 20 g of $CaCO_3$ will require $98/100 \times 20$
$= 19.6$ g of H_2SO_4
As H_2SO_4 is present in excess, hence, $CaCO_3$ is the limiting reagent.
(ii) 1 mole of $CaCO_3$ produces 1 mole of $CaSO_4$
100 g of $CaCO_3$ produces 136 g of $CaSO_4$
20 g of $CaCO_3$ will produce $136/100 \times 20$
$= 27.2$ g of $CaSO_4$
(iii) 1 mol $CaCO_3$ gives 1 mol CO_2
$\therefore$ 0.2 moles of $CaCO_3$ will gives 0.2 moles of CO_2
$= 0.2 \times 22.4$ L $= 4.48$ L of CO_2

MONTHLY TEST DRIVE

Practice Paper

XI

This specially designed column enables students to self analyse their extent of understanding the specified chapters. Give yourself four marks for correct answer and deduct one mark for wrong answer. Self check table given at the end will help you to check your readiness.

Total Marks : 120 **Time Taken : 60 Min.**

NEET

Only One Option Correct Type

1. An ideal gas at pressure P_0 in a vessel. If the masses of all the molecules are halved and their *rms* speeds are doubled, the resulting pressure *P* will be
(a) $4P_0$ (b) $2P_0$ (c) P_0 (d) $P_0/2$

2. Volume strength of hydrogen peroxide is 22.4. What volume of this sample is required for the oxidation of 3.4 g of hydrogen sulphide?
(a) 50 mL (b) 200 mL (c) 100 mL (d) 5 mL

3. Consider the following reaction occurring in an automobile.
$2C_8H_{18(g)} + 25O_{2(g)} \rightarrow 16CO_{2(g)} + 18H_2O_{(g)}$
The sign of ΔH, ΔS and ΔG would be
(a) +, –, + (b) –, +, – (c) –, +, + (d) +, +, –

4. Which of the following statements are correct?
As the *s*-character of a hybrid orbital decreases,
(I) the bond angle decreases
(II) the bond strength increases
(III) the bond length increases.
(a) (I) and (III) only (b) (II) and (III) only
(c) (I) and (II) only (d) All are correct

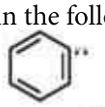
5. The standard reduction electrode potentials of the three electrodes *P*, *Q* and *R* are respectively –1.76 V, 0.34 V and 0.8 V. Then
(a) metal *Q* will displace the cation of *P* from its aqueous solution and deposit the metal *P*
(b) both metals *Q* and *R* will displace the cation of *P* from its aqueous solution and deposit the metal *P*
(c) metal *R* will displace the cation of *P* from its aqueous solution and deposit the metal *R*
(d) metal *P* will displace the cation of *R* from its aqueous solution and deposit the metal *R*.

6. Which of the following statements is/are incorrect?
(a) Among O_2^+, O_2 and O_2^- the stability decreases in the order $O_2^+ > O_2 > O_2^-$.
(b) He_2 molecule does not exist as the effect of bonding and anti-bonding molecular orbitals cancel each other.
(c) C_2, O_2^{2-} and Li_2 are diamagnetic.
(d) In F_2 molecule, the energy of $\sigma 2p_z$ is more than $\pi 2p_x$ and $\pi 2p_y$.

7. The stable bivalency of Pb and trivalency of Bi is
(a) due to *d*-contraction in Pb and Bi
(b) due to relativistic contraction of the 6*s*-orbitals of Pb and Bi, leading to inert pair effect
(c) due to screening effect
(d) due to attainment of noble configuration.

8. Consider the following statements regarding compounds which cause global warming. '*X*' is a hydrocarbon, *A* and *B* are neutral oxides of nitrogen, '*C*' is a blue coloured gas and '*D*' is released when H_2S is reacted with oxygen. Identify the correct statements about *X*, *A*, *B*, *C* and *D*.
(I) '*X*' is mainly present in natural gas.
(II) In *A* and *B* one is diamagnetic and another one is paramagnetic.
(III) '*C*' can be identified by using liquid element in *d*-block.
(IV) '*D*' causes acid rain.
(a) All are correct (b) I, II and III only
(c) II, III and IV only (d) I, III and IV only

9. The stability of carbanions in the following

(i) $RC\equiv\overset{\ominus}{C}$ (ii) 

(iii) $R_2C=\overset{\ominus}{C}H$ (iv) $R_3C-\overset{\ominus}{C}H_2$

is in the order

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

10. Equal masses of hydrogen, nitrogen and oxygen are taken in a container in identical conditions. The ratio of gaseous volumes are

(a) 2 : 28 : 32 (b) 1 : 1 : 1
(c) $16 : \frac{8}{7} : 1$ (d) 1 : 14 : 16

11. A mixture of Na_2CO_3 and K_2CO_3 is used as fusion mixture because

(a) it has lower m.pt than Na_2CO_3 and converts metal salts to carbonates which decompose to metal oxides
(b) it has higher m.pt than K_2CO_3 and converts metal salts to carbonates, which decompose to metal oxides
(c) it has lower m.pt. than both Na_2CO_3 and K_2CO_3 and converts the metal salts to carbonates, which decompose to metal oxides
(d) it has higher m.pt. than both Na_2CO_3 and K_2CO_3 and converts the metal salts to carbonates which decompose to metal oxide.

12. Which one of the following statements is not true?

(a) The conjugate base of $H_2PO_4^-$ is HPO_4^{2-}.
(b) pH + pOH = 14 for all aqueous solutions.
(c) The pH of 1×10^{-8} M HCl is 8.
(d) pH decreases with rise in temperature.

Assertion & Reason Type

Directions : In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as :

(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.

13. **Assertion :** Compressibility factor (Z) is the ratio of actual molar volume of a gas to the molar volume of it, if it were an ideal gas at that temperature and pressure.
Reason : At high pressure all the gases have $Z < 1$ and can be easily compressed.

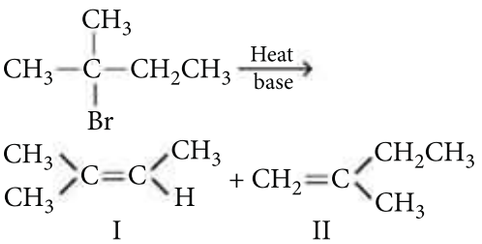
14. **Assertion :** When inductive and electromeric effects operate in opposite directions, the inductive effect predominates.
Reason : Inductive effect is the complete transfer of shared pair of π electrons to one of the atoms.

15. **Assertion :** If both ΔH° and ΔS° are positive, then reaction will be spontaneous at high temperature.
Reason : All processes with positive entropy change are spontaneous.

JEE MAIN / JEE ADVANCED

Only One Option Correct Type

16. Consider the following reaction,



Which of the following base will give the best yield of the alkene II as the major product?

(a) CH_3O^- (b) $C_2H_5O^-$
(c) $(CH_3)_3CO^-$ (d) $(C_2H_5)_3CO^-$

17. An inorganic compound '*A*' shows the following reactions :

(i) It is white solid, exists as dimer and fumes in wet air.
(ii) It sublimes at 180 °C and forms monomer if heated to 400 °C.
(iii) Its aqueous solution turns blue litmus to red and gives a white precipitate with $AgNO_3$ solution, which is soluble in NH_4OH.
(iv) Addition of NH_4OH and NaOH separately to the solution of '*A*' gives a gelatinous precipitate which in however soluble in excess of NaOH.

The compound '*A*' is

(a) $Al(OH)_3$ (b) Al_2Cl_6
(c) Al_2O_3 (d) $Al_2(SO_4)_3$

18. Two samples of water *A* and *B* have concentrations 16.2 ppm of $Ca(HCO_3)_2$ and 13.6 ppm of $CaCl_2$ respectively. Then
(a) hardness is more in sample '*B*' than in '*A*'
(b) hardness is more in sample '*A*' than in '*B*'
(c) hardness in sample '*A*' is twice that of the sample '*B*'
(d) hardness is same in both cases.

19. Arrange the following metals in increasing order of their reducing power.
[Given : $E°_{K^+/K} = -2.93$ V, $E°_{Ag^+/Ag} = +0.80$ V, $E°_{Al^{3+}/Al} = -1.66$ V, $E°_{Au^{3+}/Au} = +1.40$ V, $E°_{Li^+/Li} = -3.05$ V]
(a) Li < K < Al < Ag < Au
(b) Au < Ag < Al < K < Li
(c) K < Al < Au < Ag < Li
(d) Al < Ag < Au < Li < K

More than One Option Correct Type

20. Which of the following statements are correct for an electron that has $n = 4$ and $m = -2$?
(a) The electron may be in a *p*-orbital.
(b) The electron is in the fourth principal electronic shell.
(c) The electron may be in a *d*-orbital.
(d) The electron must have the spin quantum number = –1/2.

21. The van der Waals' parameters *a* and *b* for two gases are given as,

Gas *A*	Gas *B*
$a = 6.5$ dm^6 bar/mole^2	$a = 18.0$ dm^6 bar/mole^2
$b = 0.056$ dm^3 mole^{-1}	$b = 0.011$ dm^3 mole^{-1}

Which of the following options are incorrect?
(a) $(V_c)_A > (V_c)_B$ (b) $(P_c)_A > (P_c)_B$
(c) $(T_c)_A > (T_c)_B$ (d) $(P_c)_A = (P_c)_B$

22. A organic compound having molecular formula C_3H_4, react with sodium metal to give a colourless and odourless gas. Select the correct statements about organic compound.
(a) It gives Bromine water test.
(b) It reacts with Bayer's reagent.
(c) It reacts with Tollen's reagent.
(d) It reacts with Ammonical cuprous chloride.

23. According to molecular orbital theory,
(a) C_2^{2-} is expected to be diamagnetic
(b) O_2^{2+} is expected to have a longer bond length than O_2

(c) N_2^+ and N_2^- have the same bond order

(d) He_2^+ has the same energy as two isolated He atoms.

Integer / Numerical Value Type

24. The electron affinity of chlorine is 3.7 eV. How much energy in kcal is released when 2 g of chlorine is completely converted to Cl^- ion in a gaseous state?

25. A dust particle having mass equal to 10^{-11} g, diameter of 10^{-4} cm and velocity 10^{-4} cm sec^{-1}. The error in measurement of velocity is 0.1%. The uncertainty in its position will be ____ $\times 10^{-6}$ cm.

26. In 1 L saturated solution of AgCl [K_{sp}(AgCl) = 1.6 $\times 10^{-10}$], 0.1 mol of CuCl [K_{sp}(CuCl) = 1.0 $\times 10^{-6}$] is added. The resultant concentration of Ag^+ in the solution is 1.6×10^{-x}. The value of x is _____.

Comprehension Type

An empirical formula represents the simplest whole number ratio of various atoms present in a compound whereas the molecular formula shows the exact number of different types of atoms present in a molecule of a compound.

If the mass percent of various elements present in a compound is known, its empirical formula can be determined. Molecular formula can further be obtained, if the molar mass is known.

27. 0.30 g of an organic compound containing C, H and O on combustion gave 0.44 g CO_2 and 0.18 g H_2O. If 1 mole of compound weighs 60, then molecular formula of the compound is

(a) $C_2H_4O_2$ (b) CH_2O

(c) C_3H_8O (d) C_4H_{12}

28. In a compound C, H and N are present in 9 : 1 : 3.5 by weight. If molecular weight of the compound is 108, then the molecular formula of the compound is

(a) $C_2H_6N_2$ (b) C_3H_4N

(c) $C_6H_8N_2$ (d) $C_9H_{12}N_3$

Matching Type

29. Match the Column I with Column II and choose the correct option.

Column I		Column II	
(A)	Syngas	(i)	Causes sequestration of Ca^{2+} and Mg^{2+} ions
(B)	Hydride gap	(ii)	Repeated electrolysis of water
(C)	Calgon	(iii)	Elements of groups 7, 8 and 9
(D)	Heavy water	(iv)	$CO + H_2$

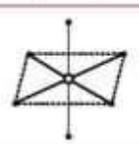
(a) (A) → (iv), (B) → (iii), (C) → (i), (D) → (ii)

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

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

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

30. Match the Column I with Column II and choose the correct option.

Column I (Molecule)		Column II (Shape)	
(A)	SF_6	(i)	
(B)	$SiCl_4$	(ii)	
(C)	AsF_5	(iii)	
(D)	BCl_3	(iv)	

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

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

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

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

Keys are published in this issue. Search now! ☺

SELF CHECK

No. of questions attempted .....

No. of questions correct .....

Marks scored in percentage .....

Check your score! If your score is

> 90%	EXCELLENT WORK !	You are well prepared to take the challenge of final exam.
90-75%	GOOD WORK !	You can score good in the final exam.
74-60%	SATISFACTORY !	You need to score more next time.
< 60%	NOT SATISFACTORY!	Revise thoroughly and strengthen your concepts.

GET SET GO for NEET

Exam on 7th May 2023

with exclusive and brainstorming MCQs

Practicing these MCQs help to strengthen your concepts and give you extra edge in your NEET preparation

1. Which of the following statements is not correct?
(a) The number of carbon atoms in a unit cell of diamond is 8.
(b) The number of Bravais lattices in which a crystal can be categorized is 14.
(c) The fraction of the total volume occupied by the atoms in a primitive cell is 0.48.
(d) Molecular solids are generally volatile.

2. Raoult's law is obeyed by a binary liquid solution when
(a) the forces of attraction between like molecules are greater than those between unlike molecules
(b) the forces of attraction between like molecules are smaller than those between unlike molecules
(c) the forces of attraction between like molecules are more or less identical with those between unlike molecules
(d) the volume occupied by unlike molecules are different.

3. According to Kohlrausch law, the limiting value of molar conductivity of an electrolyte, A_2B is
(a) $\lambda^{\infty}_{(A^+)} + \lambda^{\infty}_{(B^-)}$ (b) $\lambda^{\infty}_{(A^+)} - \lambda^{\infty}_{(B^-)}$
(c) $2\lambda^{\infty}_{(A^+)} + \frac{1}{2}\lambda^{\infty}_{(B^-)}$ (d) $2\lambda^{\infty}_{(A^+)} + \lambda^{\infty}_{(B^-)}$

4. Which one of the following equations is correct for the reaction, $N_{2(g)} + 3H_{2(g)} \longrightarrow 2NH_{3(g)}$?
(a) $\frac{3d[H_2]}{dt} = \frac{2d[N_2]}{dt}$
(b) $\frac{2d[N_2]}{dt} = \frac{1}{3}\frac{d[H_2]}{dt}$
(c) $\frac{2d[NH_3]}{dt} = \frac{-3d[H_2]}{dt}$
(d) $\frac{3d[NH_3]}{dt} = \frac{-2d[H_2]}{dt}$

5. List I contains the types of colloid while List II contains the examples.

List I		List II	
(A)	Sol	(i)	Fog
(B)	Aerosol	(ii)	Whipped cream
(C)	Gel	(iii)	Paints
(D)	Foam	(iv)	Jellies

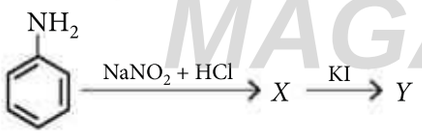
Choose the correct match.
(a) (A) - (iv), (B) - (iii), (C) - (i), (D) - (ii)
(b) (A) - (iv), (B) - (i), (C) - (ii), (D) - (iii)
(c) (A) - (iii), (B) - (iv), (C) - (ii), (D) - (i)
(d) (A) - (iii), (B) - (i), (C) - (iv), (D) - (ii)

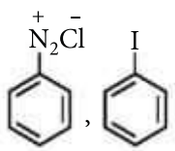
6. The process of zone refining is used in the purification of
(a) Al (b) Ge
(c) Cu (d) Ag

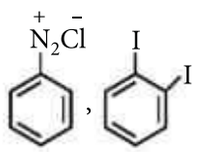
7. Which of the following is the correct order of increasing oxidising character of oxoacids of chlorine?
(a) $HClO_3 < HClO_4 < HClO_2 < HClO$
(b) $HClO_4 < HClO_3 < HClO_2 < HClO$
(c) $HClO < HClO_4 < HClO_3 < HClO_2$
(d) $HClO < HClO_2 < HClO_3 < HClO_4$

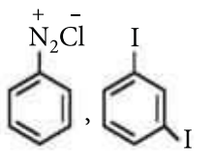
8. Permanganate ions are
(a) tetrahedral and paramagnetic
(b) tetrahedral and diamagnetic
(c) octahedral and paramagnetic
(d) octahedral and diamagnetic.

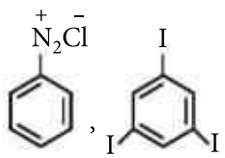
9. Pick out the correct statement with respect to $[Mn(CN)_6]^{3-}$.
(a) It is sp^3d^2 hybridised and tetrahedral.
(b) It is d^2sp^3 hybridised and octahedral.
(c) It is dsp^2 hybridised and square planar.
(d) It is sp^3d^2 hybridised and octahedral.

10. 

X and *Y* in the reaction are
(a) 

(b) 

(c) 

(d) 

11. The decreasing order of boiling points of the following alcohols is
(a) 3-methylbutan-2-ol > 2-methylbutan-2-ol > pentan-1-ol
(b) pentan-1-ol > 3-methylbutan-2-ol > 2-methylbutan-2-ol
(c) 2-methylbutan-2-ol > 3-methylbutan-2-ol > pentan-1-ol
(d) 2-methylbutan-2-ol > pentan-1-ol > 3-methylbutan-2-ol

12. **Assertion :** Aromatic aldehydes and formaldehyde undergo Cannizzaro reaction.
Reason : Aromatic aldehydes are almost as reactive as formaldehyde.
(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.

13. Which one of the following forms propane nitrile as the major product ?
(a) Ethyl bromide + alcoholic KCN
(b) Propyl bromide + alcoholic KCN
(c) Propyl bromide + alcoholic AgCN
(d) Ethyl bromide + alcoholic AgCN

14. Which of the following hormones contains iodine?
(a) Testosterone (b) Adrenaline
(c) Thyroxine (d) Insulin

15. The biodegradable polymer is
(a) buna-S (b) nylon-6,6
(c) nylon-2-nylon-6 (d) nylon-6.

SOLUTIONS

1. **(c) :** Packing fraction for a cubic unit cell is given by $f = \frac{Z \times \frac{4}{3}\pi r^3}{a^3}$
where, a = edge length, r = radius of the sphere. Efficiency of packing in simple cubic or primitive cell = $\pi/6 = 0.52$ *i.e.* 52% of unit cell is occupied by atoms and 48% is empty.

2. **(c) :** Ideal solutions obey Raoult's law where the intermolecular interactions between the different components ($A - B$ interactions) are of the same magnitude as the intermolecular interactions found in the pure components ($A - A$ and $B - B$ interactions).

3. **(d)**

4. **(d) :** $N_{2(g)} + 3H_{2(g)} \longrightarrow 2NH_{3(g)}$

$$-\frac{d[N_2]}{dt} = \frac{-1}{3}\frac{d[H_2]}{dt} = \frac{1}{2}\frac{d[NH_3]}{dt}$$

$$\therefore \quad 3\frac{d[NH_3]}{dt} = -2\frac{d[H_2]}{dt}$$

5. **(d)**

6. **(b) :** Zone refining is done to obtain ultra pure substances of semiconductors and other metals of high purity. *e.g.* germanium, boron, silicon, etc.

7. **(b) :** Oxidising power of the oxoacids decreases as the oxidation number increases, *i.e.*,

$$\overset{+1}{HClO} > \overset{+3}{HClO_2} > \overset{+5}{HClO_3} > \overset{+7}{HClO_4}$$

8. **(b)**

9. **(b) :** $[Mn(CN)_6]^{3-}$

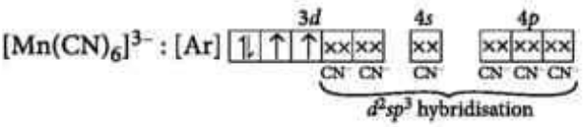
Let oxidation state of Mn be x.

$x + 6 \times (-1) = -3 \quad \Rightarrow \quad x = +3$

Electronic configuration of Mn : $[Ar]4s^2 3d^5$

Electronic configuration of Mn^{3+} : $[Ar]3d^4$

CN^- is a strong field ligand thus, it causes pairing of electrons in $3d$-orbital.



Thus, $[Mn(CN)_6]^{3-}$ has d^2sp^3 hybridisation and has octahedral geometry.

10. **(a)** 11. **(b)**

12. **(c) :** Aromatic aldehydes and formaldehyde do not contain α-hydrogen and thus undergo Cannizzaro reaction. Formaldehyde is more reactive than aromatic aldehydes.

13. **(a) :** $C_2H_5Br + alc.\ KCN \longrightarrow C_2H_5CN + KBr$
Ethyl bromide — Propane nitrile

14. **(c)** 15. **(c)**

CBSE warm-up!

CLASS-XII

Chapterwise practice questions for CBSE Exams as per the latest pattern and rationalised syllabus by CBSE for the academic session 2023-24.

Series-1 Solutions

Time Allowed : 3 hours
Maximum Marks : 70

General Instructions

Read the following instructions carefully.

(a) There are 33 questions in this question paper with internal choice.
(b) SECTION-A consists of 16 multiple-choice questions carrying 1 mark each.
(c) SECTION-B consists of 5 short answer questions carrying 2 marks each.
(d) SECTION-C consists of 7 short answer questions carrying 3 marks each.
(e) SECTION-D consists of 2 case-based questions carrying 4 marks each.
(f) SECTION-E consists of 3 long answer questions carrying 5 marks each.
(g) All questions are compulsory.
(h) Use of log tables and calculators is not allowed.

SECTION-A

The following questions are multiple-choice questions with one correct answer. Each question carries 1 mark. There is no internal choice in this section.

1. If 3 g of glucose (molecular weight 180) is dissolved in 60 g of water at 15 °C, the osmotic pressure of the solution will be
(a) 0.34 atm (b) 0.65 atm
(c) 6.57 atm (d) 5.57 atm

2. KBr is 80% dissociated in a solution. The freezing point of a 0.5 molal solution is
(K_f for water = 1.86 °C/m)
(a) 273.128 K (b) 277.562 K
(c) 271.326 K (d) 269.032 K

3. Which of the following statements is correct?
(a) Lowering of vapour pressure takes place only in ideal solutions.
(b) Lowering of vapour pressure does not depend upon the solvent at a given concentration of the solute.
(c) Lowering of vapour pressure is dependent on the nature of solute particles.
(d) Relative lowering of vapour pressure does not depend upon the solvent at a given concentration of the solute.

4. The order of increasing freezing point of C_2H_5OH, $Ba_3(PO_4)_2$, Na_2SO_4, KCl and Li_3PO_4 is
(a) $Ba_3(PO_4)_2 < Na_2SO_4 < Li_3PO_4 < C_2H_5OH < KCl$
(b) $Ba_3(PO_4)_2 < C_2H_5OH < Li_3PO_4 < Na_2SO_4 < KCl$
(c) $C_2H_5OH < KCl < Na_2SO_4 < Ba_3(PO_4)_2 < Li_3PO_4$
(d) $Ba_3(PO_4)_2 < Li_3PO_4 < Na_2SO_4 < KCl < C_2H_5OH$

5. Which of the following pairs shows a negative deviation from Raoult's law?
(a) Acetone-benzene (b) Acetone-ether
(c) Acetone-chloroform (d) Benzene-methanol

6. The mole fraction of methanol in its 4.5 molal aqueous solution is
(a) 0.250 (b) 0.125
(c) 0.100 (d) 0.075

7. 25 mL of 3.0 M HCl are mixed with 75 mL of 4.0 M HCl. If the volumes are additive, the molarity of the final mixture will be
(a) 4.0 M (b) 3.75 M (c) 4.25 M (d) 3.50 M

8. van't Hoff factor of aq. K_2SO_4 at infinite dilution will be
(a) 1 (b) 2
(c) 3 (d) between 2 and 3.

9. 18 g of glucose is dissolved in 178.2 g of water. The vapour pressure of the solution at 100°C is (vapour pressure of pure water at 100°C is 760 mm Hg)
(a) 767.6 mm Hg (b) 760 mm Hg
(c) 752.4 mm Hg (d) 725.4 mm Hg

10. Which of the following is a colligative property?
(a) Lowering of vapour pressure
(b) Osmotic pressure
(c) Boiling point
(d) Change in entropy

11. The depression in freezing point of a solution that contains 30 g urea in 200 g water is
(K_f for H_2O = 1.86°C/m)
(a) 4.65°C (b) –4.65°C
(c) –0.744°C (d) +0.744°C

12. Identify the law which is stated as
"For any solution, the partial vapour pressure of each volatile component in the solution is directly proportional to its mole fraction."
(a) Henry's law (b) Raoult's law
(c) Dalton's law (d) Gay-Lussac's Law

13. Given below are two statements labelled as Assertion (A) and Reason (R).
Assertion (A) : A raw mango placed in saline solution loses water and shrivels into pickle.
Reason (R) : Through the process of reverse osmosis, raw mango shrivels into pickle.
Select 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.

14. Given below are two statements labelled as Assertion (A) and Reason (R).
Assertion (A) : Aquatic species are more comfortable in cold water rather than warm water.
Reason (R) : Different gases have different K_H values at the same temperature.
Select 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.

15. Given below are two statements labelled as Assertion (A) and Reason (R).
Assertion (A) : Nitric acid and water form maximum boiling azeotropes.
Reason (R) : Azeotropes are binary mixtures having the same composition in liquid and vapour phase.
Select 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.

16. Given below are two statements labelled as Assertion (A) and Reason (R).
Assertion (A) : If a liquid solute, more volatile than the solvent, is added to the solvent, the vapour pressure of the solution may increase *i.e.*, $p_s > p°$.
Reason (R) : In the presence of a more volatile liquid solute, only the solute will form the vapours and solvent will not.
Select 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.

SECTION-B

This section contains 5 questions with internal choice in one question. The following questions are very short answer type and carry 2 marks each.

17. 0.90 g of a non-electrolyte was dissolved in 87.90 g of benzene. This raised the boiling point of benzene by 0.25 °C. If the molecular mass of the non-electrolyte is 103.0 g mol^{-1}, calculate the molal elevation constant for benzene.

18. Calculate the mass of compound (molar mass = 256 g mol^{-1}) to be dissolved in 75 g of benzene to lower its freezing point by 0.48 K.
(K_f = 5.12 K kg mol^{-1})

19. The density of a solution containing 13% by mass of sulphuric acid is 1.09 g/mL. Calculate the molarity of the solution.

20. What type of azeotropic mixture will be formed by a solution of acetone and chloroform? Justify on the basis of strength of intermolecular interactions that develop in the solution.

OR

Define azeotropes. What type of azeotrope is formed by positive deviation from Raoult's law? Give an example.

21. Assuming complete dissociation, calculate the expected freezing point of a solution prepared by dissolving 6.00 g of Glauber's salt, $Na_2SO_4 \cdot 10H_2O$ in 0.100 kg of water.
(K_f for water = 1.86 K kg mol^{-1},
Atomic masses : Na = 23, S = 32, O = 16, H = 1)

SECTION-C

This section contains 7 questions with internal choice in one question. The following questions are short answer type and carry 3 marks each.

22. An aqueous solution containing 12.48 g of barium chloride in 1.0 kg of water boils at 373.0832 K. Calculate the degree of dissociation of barium chloride.
[Given : K_b for H_2O = 0.52 K m^{-1};
Molar mass of $BaCl_2$ = 208.34 g mol^{-1}]

23. 30 g of urea (M = 60 g mol^{-1}) is dissolved in 846 g of water. Calculate the vapour pressure of water for this solution if vapour pressure of pure water at 298 K is 23.8 mm Hg.

24. Calculate the boiling point elevation for a solution prepared by adding 10 g of $CaCl_2$ to 200 g of water.
(K_b for water = 0.52 K kg mol^{-1},
Molar mass of $CaCl_2$ = 111 g mol^{-1})

25. Find the molarity and molality of a 15% solution of H_2SO_4 (density of H_2SO_4 = 1.020 g/cc).

26. In 100 g of naphthalene, 2.423 g of S was dissolved. Melting point of naphthalene = 80.1 °C. ΔT_f = 0.661°C, L_f = 35.7 cal/g of naphthalene. Determine the molecular formula of sulphur added.

27. 3.9 g of benzoic acid dissolved in 49 g of benzene shows a depression in freezing point of 1.62 K. Calculate the van't Hoff factor and predict the nature of solute (associated or dissociated).
(Given : Molar mass of benzoic acid = 122 g mol^{-1}, K_f for benzene = 4.9 K kg mol^{-1})

28. A 10% solution (by mass) of sucrose in water has freezing point of 269.15 K. Calculate the freezing point of 10% glucose in water, if freezing point of pure water is 273.15 K.
(Given : Molar mass of sucrose = 342 g mol^{-1},
Molar mass of glucose = 180 g mol^{-1})

OR

Define the following terms :
(i) Osmotic pressure
(ii) Colligative properties
(iii) van't Hoff factor

SECTION-D

The following questions are case-based questions. Each question has an internal choice and carries 4 (1+1+2) marks each. Read the passage carefully and answer the questions that follow.

29. The solubility of gases increases with increase of pressure. William Henry made a systematic investigation of the solubility of a gas in a liquid. According to Henry's law, "the mass of a gas dissolved per unit volume of the solvent at constant temperature is directly proportional to the pressure of the gas in equilibrium with the solution".
Dalton during the same period also concluded independently that the solubility of a gas in a liquid solution depends upon the partial pressure of the gas. If we use the mole fraction of gas in the solution as a measure of its solubility, then Henry's law can be modified as "the partial pressure of the gas in the vapour phase is directly proportional to the mole fraction of the gas in the solution".

Answer the following questions :

(a) Henry's law constant for the solubility of methane in benzene at 298 K is 4.27×10^5 mm Hg. What will be the solubility of methane in benzene at 298 K under 760 mm Hg?

OR

The partial pressure of ethane over a saturated solution containing 6.56×10^{-2} g of ethane is 1 bar. If the solution contains 5.00×10^{-2} g of ethane then what will be the partial pressure (in bar) of the gas?

(b) K_H (kbar) values for $Ar_{(g)}$, $CO_{2(g)}$, $HCHO_{(g)}$ and $CH_{4(g)}$ are 40.39, 1.67, 1.83×10^{-5} and 0.413 respectively.
Arrange these gases in the order of their increasing solubility.

(c) When a gas is bubbled through water at 298 K, a very dilute solution of the gas is obtained. Henry's law constant for the gas at 298 K is 150 kbar. If the gas exerts a partial pressure of 2 bar, then what will be number of millimoles of the gas dissolved in 1 L of water?

30. At the freezing point of a solvent, the solid and the liquid are in equilibrium. Therefore, a solution will freeze when its vapour pressure becomes equal to the vapour pressure of the pure solid solvent.
It has been observed that when a non-volatile solute is added to a solvent, the freezing point of the solution is always lower than that of the pure solvent. Depression in freezing point can be given as, $\Delta T_f = K_f m$
Where, K_f = Molal freezing point depression constant or cryoscopic constant

or we can write, $\Delta T_f = \frac{K_f \times w_B \times 1000}{w_A \times M_B}$

Answer the following questions :

(a) Why does the freezing point of a solution decrease on adding non-volatile solute?

(b) Define cryoscopic constant.

(c) Nisha took two aqueous solutions – one containing 7.5 g of urea (Molar mass = 60 g/mol) and the other containing 42.75 g of substance *Z* in 100 g of water. It was observed that both the solutions froze at the same temperature. Calculate the molar mass of *Z*.

OR

An aqueous solution of sodium chloride freezes below 273 K. Explain the lowering in freezing point of water with the help of a suitable diagram.

SECTION-E

The following questions are long answer type and carry 5 marks each. All questions have an internal choice.

31. Attempt **any five** of the following :

(a) The vapour pressure of two liquids '*P*' and '*Q*' are 80 and 60 torr respectively. Calculate the total vapour pressure of the solution obtained by mixing 3 moles of *P* and 2 moles of *Q*.

(b) Explain why 0.1 M KCl has higher boiling point than 0.1 M glucose.

(c) Why is salting used to preserve meat for a longer period of time?

(d) Why does a solution containing non-volatile solute have higher boiling point than the pure solvent? Why is elevation of boiling point a colligative property?

(e) The vapour pressure of pure benzene at 88°C is 957 mm Hg and that of toluene at the same temperature is 379.5 mm Hg. Calculate the composition of a benzene - toluene mixture boiling at 88°C.

(f) An aqueous solution of glucose (molecular weight = 180) containing 12 g of glucose in 100 g of water was found to boil at 100.34 °C while the boiling point of pure water was 100 °C. Calculate molal elevation constant for water.

(g) State Henry's law. Calculate the solubility of CO_2 in water at 298 K under 760 mm Hg.
(K_H for CO_2 in water at 298 K is 1.25×10^6 mm Hg)

32. A solution of glucose in water is labelled as 20% (*w*/*W*). The density of the solution is 1.20 g mL^{-1}. Calculate :

(i) molality,

(ii) molarity and

(iii) mole fraction of each component in solution.

OR

(i) When is the value of van't Hoff factor more than 1?

(ii) An aqueous solution of glucose is made by dissolving 10 g of glucose ($C_6H_{12}O_6$) in 90 g of water at 303 K. If the vapour pressure of pure water at 303 K be 32.8 mm of Hg, what would be the vapour pressure of the solution?

(iii) Outer hard shells of two eggs are removed. One of the egg is placed in pure water and the other is placed in saturated solution of sodium chloride. What will be observed and why?

33. (i) H_2S is a toxic gas used in qualitative analysis. If solubility of H_2S in water at NTP is 0.195 m, what is the value of K_H?

(ii) Define negative deviation from Raoult's law. Give an example of solution showing negative deviation from ideal behaviour.

(iii) What are minimum boiling azeotropes? Give an example.

OR

Calculate the osmotic pressure and the vapour pressure of 0.6% aqueous solution of non-volatile, non-electrolyte urea at 25 °C. The vapour pressure of pure water at 25°C is 24 mm of Hg. Take density to be 1 g mL^{-1} and assume ideal solution behaviour.

SOLUTIONS

1. (c) : $\pi = CRT = \frac{n}{V}RT = \frac{3}{180} \times \frac{1000}{60} \times 0.0821 \times 288$

$= 6.57$ atm

2. (c) : For KBr, $i = 1 + \alpha = 1 + 0.80 = 1.80$

$\Delta T_f = iK_f m = 1.80 \times 1.86 \times 0.5 = 1.674$

$T_f = 273 - 1.674 = 271.326$ K

3. (d) **4. (d)**

5. (c) : When acetone and chloroform are mixed, the hydrogen-bonding takes place between the two, due to which escaping tendency of either of the liquid solutions becomes less.

6. (d) : Let 'x' mole of methanol (CH_3OH) and 'y' mole of water be present in solution.

$\therefore$ Mass of water = $y \times 18$ g

Thus molality

$$= \frac{x}{y \times 18} \times 1000 = 4.5 \text{ m} \Rightarrow \frac{x}{y} = \frac{18 \times 4.5}{1000} = 0.081$$

So, mole fraction of $CH_3OH = \frac{x}{x+y}$ or $\frac{1}{1+(y/x)}$

$$= \frac{1}{1+\frac{1}{0.081}} = \frac{1}{1+12.34} = 0.075$$

7. (b) **8. (c)**

9. (c) : $\frac{p^\circ - p_s}{p^\circ} = \frac{n_2}{n_1 + n_2}$ p° is given as 760 mm Hg.

$n_2 = \frac{18}{180} = 0.1$; $n_1 = \frac{178.2}{18} = 9.9$

$\frac{760 - p_s}{760} = \frac{0.1}{9.9 + 0.1} \Rightarrow 760 - p_s = 760 \times 0.01$

$760 - p_s = 7.6 \Rightarrow p_s = 760 - 7.6 = 752.4$ mm Hg

10. (b)

11. (a) : $\Delta T_f = K_f \times m = 1.86 \times \frac{30}{60} \times \frac{1000}{200} = 4.65°C$

12. (b) : $p_A = p_A^\circ x_A$ and $p_B = p_B^\circ x_B$

13. (c) : A raw mango shrivels into pickle due to osmosis.

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

16. (c) : Both the solute and solvent will form the vapours but vapour phase will become richer with the more volatile component.

17. Molal elevation constant,

$\Delta T_b = \frac{K_b \times 1000 \times w_B}{w_A \times M_B}$ or $K_b = \frac{\Delta T_b \times w_A \times M_B}{1000 \times w_B}$

$K_b = \frac{0.25 \times 87.90 \times 103.0}{1000 \times 0.90} = 2.515$ K m^{-1}

18. $\Delta T_f = \frac{K_f \times w_2 \times 1000}{M_2 \times w_1}$

$w_2 = \frac{\Delta T_f \times M_2 \times w_1}{K_f \times 1000} = \frac{0.48 \times 256 \times 75}{5.12 \times 1000} = 1.8$ g

19. Volume of 100 g of the solution $= \frac{100}{d} = \frac{100}{1.09}$ mL

Molarity = $\frac{13 \times 1000 \times 1.09}{98 \times 100} = 1.44$ M

20. Mixture of chloroform and acetone shows negative deviation from Raoult's law, thus it forms maximum boiling azeotrope. This is because chloroform molecule is able to form hydrogen bond with acetone molecule as :

This decreases the escaping tendency of molecules of each component and consequently the vapour pressure decreases resulting in negative deviation from Raoult's law.

OR

Azeotropes are the binary mixtures of solutions that have the same composition in liquid and vapour phase and boil at constant temperature.

A minimum boiling azeotrope is formed by solutions showing a large positive deviation from Raoult's law at a specific composition, for example, an ethanol-water mixture containing approximately 95% ethanol by volume.

21. Molecular mass of Glauber's salt ($Na_2SO_4 \cdot 10H_2O$)

$= [(2 \times 23) + 32 + (16 \times 4) + 10 \times (2 \times 1 + 16)]$

$= (46 + 32 + 64 + 180)$ g $mol^{-1} = 322$ g mol^{-1}

$Na_2SO_4 \cdot 10H_2O$ ionises as :

$Na_2SO_4 \cdot 10H_2O \rightleftharpoons 2Na^+ + SO_4^{2-} + 10H_2O$; $i = 3$

$m = \frac{n_B}{w_A} = \frac{w_B}{M_B \times w_A} = \frac{6.00 \text{ g}}{322 \text{ g mol}^{-1} \times 0.1 \text{ kg}}$

$= 0.186$ mol $kg^{-1} = 0.186$ m

Also, $\Delta T_f = i K_f \cdot m = 3 \times 1.86$ K $m^{-1} \times 0.186$ m $= 1.04$ K

$\Rightarrow T_f = T_f^\circ - \Delta T_f = (273 - 1.04)$ K $= 271.96$ K

22. Here, $n = 3$ because 1 mole of $BaCl_2$ on dissociation gives three moles of ions ($1Ba^{2+} + 2Cl^-$).

$w_2 = 12.48$ g, $w_1 = 1.0$ kg $= 1000$ g

T_b = 373.0832 K, K_b for H_2O = 0.52 K m^{-1}
and $M_2(BaCl_2)$ = 208.34 g mol^{-1}
$\Delta T_b = T_b - T_b^\circ$ = 373.0832 K – 373 K = 0.0832 K

$$M_{2(\text{observed})} = \frac{K_b \times w_2 \times 1000}{\Delta T_b \times w_1}$$

$$M_{2(\text{observed})} = \frac{0.52 \times 12.48 \times 1000}{0.0832 \times 1000} = 78$$

$$i = \frac{M_{2(\text{calculated})}}{M_{2(\text{observed})}} = \frac{208.34 \text{ g mol}^{-1}}{78 \text{ g mol}^{-1}} = 2.67$$

$$\alpha = \frac{i-1}{n-1} = \frac{2.67-1}{3-1} = \frac{1.67}{2} = 0.835 = 83.5\%$$

23. Given, weight of urea (w_2) = 30 g
Weight of water (w_1) = 846 g
Vapour pressure of water (p_1°) = 23.8 mm Hg

$$n_B = \frac{30}{60} = 0.5, \quad n_A = \frac{846}{18} = 47$$

$$\text{Mole fraction of water } (x_A) = \frac{n_A}{n_A + n_B}$$

$$= \frac{47}{47+0.5} = \frac{47}{47.5} = 0.99$$

$p_A = p_A^\circ \times x_A$ = 23.8 × 0.99 = 23.5 mm Hg

24. Mass of $CaCl_2$ (w_2) = 10 g
Mass of water (w_1) = 200 g
Molar mass of $CaCl_2$ (M_2) = 111 g mol^{-1}
Molal elevation constant (K_b) = 0.52 K kg mol^{-1}

$$m = \frac{w_2 \times 1000}{M_2 \times w_1} \Rightarrow m = \frac{10}{111} \times \frac{1000}{200} = 0.450 \text{ mol kg}^{-1}$$

$\Delta T_b = iK_b m = 3 \times 0.52 \times 0.450 = 0.702$ K

25. 15% solution of H_2SO_4 means 15 g of H_2SO_4 have been dissolved in 100 g of solution *i.e.*,
Weight of H_2SO_4 = 15 g
Weight of solution = 100 g
∴ Weight of water (solvent) = 85 g

$$\text{Moles of } H_2SO_4 = \frac{15}{98} = 0.153 \text{ moles}$$

$$\text{Molality of } H_2SO_4 \ (m) = \frac{0.153}{85} \times 1000 = 1.8 \text{ m}$$

∵ Density of solution = 1.02 g/cc

Volume of solution

$$= \frac{\text{Weight of solution}}{\text{Density}} = \frac{100}{1.02} = 98.04 \text{ cc}$$

$$\therefore \text{ Molarity of } H_2SO_4 \ (M) = \frac{0.153}{98.04} \times 1000 = 1.56 \text{ M}$$

26. $$M_2 = \frac{1000 K_f w_2}{w_1 \Delta T_f} = \frac{1000 w_2}{w_1 \Delta T_f} \times \frac{RT_f^2}{1000 L_f}$$

w_2 = 2.423 g; w_1 = 100 g; R = 2 cal degree^{-1} mol^{-1}
T_f = 80.1 + 273 = 353.1 K, ΔT_f = 0.661°C, L_f = 35.7 cal/g

$$M_2 = \frac{1000 \times 2.423}{100 \times 0.661} \times \frac{2 \times (353.1)^2}{1000 \times 35.7} = 256$$

(Value of R in terms of calories is taken as 2)
Say, S_x is the molecular formula
then, $x = \frac{256}{32} = 8$
Thus, molecular formula of sulphur is S_8.

27. w_2 = 3.9 g, w_1 = 49 g,
ΔT_f = 1.62 K, M_2 = 122 g mol^{-1}, K_f = 4.9 K kg mol^{-1}

$$\Delta T_f = i K_f m = i \times K_f \times \frac{w_2 \times 1000}{M_2 \times w_1}$$

$$\Rightarrow \quad 1.62 = \frac{i \times 4.9 \times 3.9 \times 1000}{122 \times 49}$$

$$\Rightarrow \quad i = \frac{1.62 \times 122 \times 49}{4.9 \times 3.9 \times 1000} = 0.506$$

As i < 1, solute is associated.

28. Molality (m) of sucrose solution

$$= \frac{w_2 \times 1000}{M_2 \times w_1} = \frac{10}{342} \times \frac{1000}{90} = 0.325 \text{ m}$$

ΔT_f for sucrose solution $= T_f^\circ - T_f$
= (273.15 – 269.15) K = 4 K

∵ $\Delta T_f = K_f \times m$

$$\therefore \quad K_f = \frac{\Delta T_f}{m} = \frac{4 \text{ K}}{0.325 \text{ m}} = 12.308 \text{ K/m}$$

$$\text{Molality of glucose solution} = \frac{10}{180} \times \frac{1000}{90} = 0.617 \text{ m}$$

$\Delta T_f = K_f \times m$

COMIC CAPSULE

Me : I have a phD in organic chemistry.
The phD:

$\therefore$ $\Delta T_f = 12.308$ K/m $\times$ 0.617 m = 7.59 = 7.6 K

$\therefore$ Freezing point of glucose solution,

$T_f = T_f^\circ - \Delta T_f = (273.15 - 7.60)$ K = 265.55 K

OR

(i) Osmotic pressure is the extra pressure which is applied on the solution to prevent the flow of solvent into the solution through a semi-permeable membrane.

(ii) Properties which depend upon the number of solute particles irrespective of their nature relative to the total number of particles present in the solution are called colligative properties.

(iii) van't Hoff factor is defined as the ratio of the experimental value of colligative property to the calculated value of the colligative property and is used to find out the extent of dissociation or association.

$$i = \frac{\text{Experimental (or observed) value of colligative property}}{\text{Calculated (or normal) value of colligative property}}$$

29. (a) $K_H = 4.27 \times 10^5$ mm Hg

$p = 760$ mm Hg

According to Henry's law, $p = K_H \times x_{CH_4}$

$$x_{CH_4} = \frac{p}{K_H} = \frac{760}{4.27 \times 10^5} = 1.78 \times 10^{-3}$$

OR

For a gas that has a very high solubility, we may assume that the partial pressure of the gas is directly proportional to its mass.

Hence, $p \propto m$

$$\Rightarrow \frac{p_2}{p_1} = \frac{m_2}{m_1} \Rightarrow p_2 = p_1 \times \frac{m_2}{m_1} = 1 \times \frac{0.05}{0.0656} = 0.762 \text{ bar}$$

(b) Higher the value of K_H at a given pressure, the lower is the solubility of the gas.

Hence, the order of increasing solubility is

$Ar < CO_2 < CH_4 < HCHO$

(c) The mole fraction of the gas in solution,

$$x = \frac{p}{K_H} = \frac{1}{150 \times 10^3}$$

If n is the number of moles of gas in a solution of 1 L of water containing 55.5 mol then

$$x = \frac{n}{n + 55.5} \text{ or, } \frac{n}{55.5} = \frac{1}{150 \times 10^3}$$

[$n + 55.5 \approx 55.5$, as n is very small]

$$n = \frac{55.5}{150} \times 10^{-3} \text{ moles} = 0.37 \text{ millimoles}$$

30. (a) On adding non-volatile solute to a liquid, its vapour pressure decreases and hence freezing point decreases.

(b) Cryoscopic constant is the depression in freezing point of a liquid, when one mole of solute is dissolved in one kilogram of solvent. It is denoted by K_f.

(c) Molality (m) of urea $= \frac{7.5 \times 1000}{60 \times 100} = 1.25$ m ...(i)

Molality of substance $Z = \frac{42.75 \times 1000}{\text{Molar mass} \times 100}$

$$= \frac{427.5}{\text{Molar mass}} \quad \text{...(ii)}$$

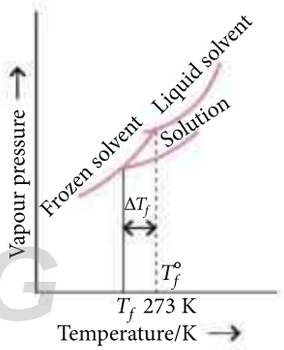
As both the solutions have same depression in freezing point so they have same molality.

From eqn. (i) and (ii), we get $1.25 = \frac{427.5}{\text{Molar mass}}$

Molar mass of Z = 342 g/mol

OR

When a non-volatile solute is added to a solvent, the freezing point of the solution is always lower than that of pure solvent as the vapour pressure of the solvent decreases in the presence of non-volatile solute.



31. (a) Mole fraction of P,

$$x_P = \frac{3}{3+2} = 0.6$$

Mole fraction of Q, $x_Q = \frac{2}{3+2} = 0.4$

$P_{Total} = p_P + p_Q$

$= p_P^\circ x_P + p_Q^\circ x_Q = 80 \times 0.6 + 60 \times 0.4 = 72$ torr

(b) As KCl is an electrolyte and one formula unit of KCl dissociates to give two ions (K^+ and Cl^-), therefore molar concentration of particles in the solution = 0.1 $\times$ 2 M = 0.2 M

As elevation of boiling point is directly proportional to number of particles in solution, hence 0.1 M KCl has a higher boiling point than 0.1 M glucose.

(c) Salting is used because most bacteria, fungi and other potentially pathogenic organisms cannot survive in a highly salty environment, due to the hypertonic nature of salt. Any living cell in such an environment will become dehydrated through osmosis and die or become temporarily deactivated.

(d) The boiling point of the solution is always higher than that of the pure solvent. As the vapour pressure of the solution is lower than that of the pure solvent and vapour pressure increases with increase in temperature,

hence, the solution has to be heated more to make the vapour pressure equal to the atmospheric pressure.
Elevation of boiling point is a colligative property because it depends on number of solute particles present in a solution.

(e) At boiling point, total vapour pressure becomes equal to atmospheric pressure.

$760 = 957 \times x_{\text{benzene}} + 379.5 \times x_{\text{toluene}}$

$760 = 957 \times x_{\text{benzene}} + 379.5 \times (1 - x_{\text{benzene}})$

$x_{\text{benzene}} = 0.6589$; $x_{\text{toluene}} = 1 - 0.6589 = 0.3411$

(f) $\Delta T_b = 100.34 - 100 = 0.34\ °C$

$$\Delta T_b = \frac{K_b \times w_2 \times 1000}{M_2 \times w_1}$$

$$K_b = \frac{0.34 \times 180 \times 100}{12 \times 1000} = 0.51\ °C\ \text{kg mol}^{-1}$$

(g) Henry's law states that the partial pressure of the gas in vapour phase (p) is proportional to the mole fraction of the gas (x) in the solution.

$p = K_H \cdot x$ where, K_H = Henry's law constant. Different gases have different K_H values at the same temperature.

$$\text{Solubility of } CO_2 = \frac{p}{K_H} = \frac{760}{1.25 \times 10^6} = 6.08 \times 10^{-4}$$

32. 20% (w/W) solution of glucose means that 20 g of glucose is present in 100 g of solution or in 80 g of water.

(i) $$\text{Molality} = \frac{\text{Moles of solute}}{\text{Mass of solvent (in g)}} \times 1000$$

Moles of glucose = 20/180 = 0.11

Mass of solvent (water) = 80 g

$$\therefore \quad \text{Molality} = \frac{0.11}{80} \times 1000 = 1.38\ \text{m}$$

(ii) $$\text{Molarity} = \frac{\text{Moles of solute}}{\text{Volume of solution (in mL)}} \times 1000$$

$$\text{Volume of solution} = \frac{\text{Mass}}{\text{Density}} = \frac{100}{1.20} = 83.33\ \text{mL}$$

$$\therefore \quad \text{Molarity} = \frac{0.11}{83.33} \times 1000 = 1.32\ \text{M}$$

(iii) Moles of water = 80/18 = 4.44

Total moles = 4.44 + 0.11 = 4.55

$$\text{Mole fraction of glucose} = \frac{0.11}{4.55} = 0.024$$

$$\text{Mole fraction of water} = \frac{4.44}{4.55} = 0.976$$

OR

(i) When the solute molecules undergo dissociation in the solution then the value of van't Hoff factor is more than 1.

(ii) Here, $w_A = 90$ g, $w_B = 10$ g $M_A = 18$ g

$M_B = 72 + 12 + 96 = 180$ g, $p_A^\circ = 32.8$ mm of Hg,

$$M_B = \frac{w_B M_A}{w_A} \times \frac{p_A^\circ}{p_A^\circ - p_s}\ ;\ 180 = \frac{10 \times 18}{90} \times \frac{32.8}{32.8 - p_s}$$

$$\text{or} \quad 32.8 - p_s = \frac{10 \times 18 \times 32.8}{90 \times 180} = 0.36$$

$p_s = 32.8 - 0.36 = 32.44$ mm of Hg

(iii) The egg placed in pure water will swell because the concentration of proteins is high inside the egg as compared to water. Therefore, endosmosis occurs and water diffuses through the semipermeable membrane. The egg which is placed in sodium chloride solution will shrink due to exosmosis of water out of the egg.

33. (i) No. of moles of H_2S = 0.195

No. of moles of H_2O = 1000/18 = 55.55

$$\text{Mole fraction of } H_2S = \frac{0.195}{0.195 + 55.55} = 0.0035$$

Pressure at NTP = 1 atm

According to Henry's law, $p = K_H \cdot x$

$$\text{or} \quad K_H = \frac{p_{H_2S}}{x_{H_2S}} = \frac{1}{0.0035} = 285.71\ \text{atm}$$

(ii) The liquid pair for which A–B interactions are stronger than A–A and B–B attractive forces, the vapour pressure is less than that for ideal solutions. So, they show negative deviations from Raoult's law. *e.g.,* acetone- chloroform solution.

(iii) Minimum boiling azeotropes : A mixture of liquids which boils at a temperature lower than the boiling temperature of both the components in pure state *e.g.,* ethanol and water.

OR

$w_2 = 0.6$ g, $w_{\text{sol}} = 100$ g, $V = 0.1$ L, $T = 298$ K

$w_1 = 100 - 0.6 = 99.4$ g, $M_2 = 60\ \text{g mol}^{-1}$; $\pi V = nRT$

$$\pi \times 0.1 = \frac{w_2}{M_2} \times RT; \quad \pi \times 0.1 = \frac{0.6}{60} \times 0.0821 \times 298$$

$$\pi = \frac{0.6 \times 0.0821 \times 298}{60 \times 0.1} = 2.446\ \text{atm}$$

Again, $p_A^\circ = 24$ mm of Hg, $p_s = ?$

$$\Rightarrow \quad \frac{p_A^\circ - p_s}{p_A^\circ} = \frac{\frac{w_2}{M_2}}{\frac{w_1}{M_1} + \frac{w_2}{M_2}} \Rightarrow 1 - \frac{p_s}{p_A^\circ} = \frac{\frac{0.6}{60}}{\frac{0.6}{60} + \frac{99.4}{18}}$$

$$\Rightarrow \quad 1 - \frac{p_s}{24} = \frac{0.01}{0.01 + 5.52} \Rightarrow \frac{p_s}{24} = 1 - \frac{0.01}{5.53}$$

$$\Rightarrow \quad \frac{p_s}{24} = \frac{5.53 - 0.01}{5.53} \Rightarrow \frac{p_s}{24} = \frac{5.52}{5.53} \Rightarrow p_s = \frac{24 \times 5.52}{5.53}$$

$\therefore \quad p_s = 23.957$ mm of Hg

MONTHLY TEST DRIVE

Practice Paper

XII

This specially designed column enables students to self analyse their extent of understanding the specified chapters. Give yourself four marks for correct answer and deduct one mark for wrong answer. Self check table given at the end will help you to check your readiness.

Total Marks : 120 **Time Taken : 60 Min.**

NEET

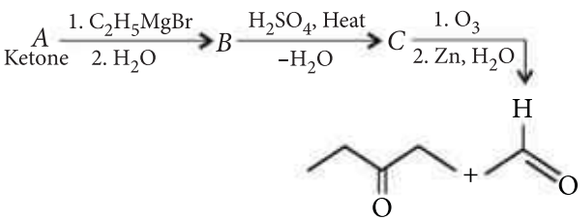
Only One Option Correct Type

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

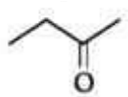
I, II and III are

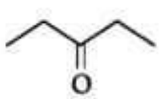
	I	II	III
(a)	Na_2CO_3/air, Δ	NH_4Cl, Δ	Al
(b)	NaOH/air, Δ	C, heat	C, heat
(c)	Na_2CO_3/air, Δ	C, heat	C, heat
(d)	NaOH/air, heat	Al, heat	C, heat

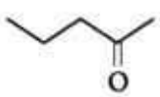
2. Consider the following sequence of reactions,



The compound (*A*) is

(a) 

(b) 

(c) 

(d) 

3. Which one of the following statements is correct?

(a) All amino acids are optically active.

(b) All amino acids except glycine are optically active.

(c) All amino acids except glutamic acid are optically active.

(d) All amino acids except lysine are optically active.

4. The emf of a Daniell cell at 298 K is E_1,

$Zn \mid ZnSO_4(0.01\ M) \parallel CuSO_4\ (1.0\ M) \mid Cu$

When the concentration of $ZnSO_4$ is 1.0 M and that of $CuSO_4$ is 0.01 M, the emf is changed to E_2.

What is the relationship between E_1 and E_2?

(a) $E_2 = 0 \approx E_1$ (b) $E_1 > E_2$

(c) $E_1 < E_2$ (d) $E_1 = E_2$

5. $[Co(NH_3)_6]^{3+}$ forms an inner orbital complex whereas $[CoF_6]^{3-}$ forms an outer orbital complex. This is because

(a) $[Co(NH_3)_6]^{3+}$ has Co in +3 state and $[CoF_6]^{3-}$ has Co in –3 state

(b) NH_3 is a strong field ligand and causes pairing of electrons in Co

(c) F^- is a strong field ligand and causes pairing of electrons in Co

(d) NH_3 is a weak field ligand and hence, its electrons occupy the hybrid orbitals.

6. Which of the following statements is not correct about the structure of PCl_5?

(a) PCl_5 has a trigonal bipyramidal structure.

(b) Three equatorial P–Cl bonds are equivalent.

(c) The two axial bonds are different and longer than equatorial bonds.

(d) Equatorial bond pairs suffer more repulsion than that of the axial bond pairs.

7. Which of the following compounds will be formed when methoxybenzene is reacted with HBr?

(a) Phenol and bromomethane

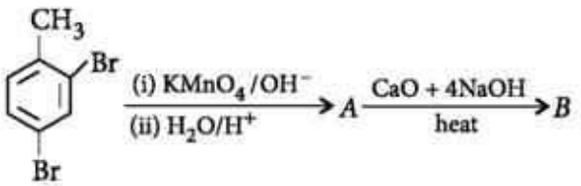
(b) Methanol and bromobenzene

(c) Phenol and methanol

(d) Bromobenzene and bromomethane

8. Which of the following sets contain only addition homopolymers?
   (a) Polythene, natural rubber, terylene
   (b) Nylon, polyester, melamine resin
   (c) Teflon, bakelite, orlon
   (d) Neoprene, PVC, polythene

9. What will be the end product (B) in the following sequence of reactions?



   (a) 1, 2-Dibromobenzene
   (b) 1, 2-Dibromobenzaldehyde
   (c) 1, 3-Dibromobenzene
   (d) 1, 4-Dibromobenzene

10. Reactant (A) forms two products :

$A \xrightarrow{k_1} B$; Activation energy, E_{a_1}

$A \xrightarrow{k_2} C$; Activation energy, E_{a_2}

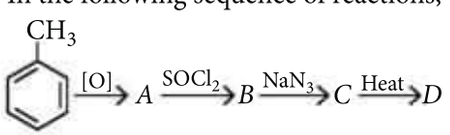
If $E_{a_2} = 2E_{a_1}$, then k_1 and k_2 are related as

(a) $k_2 = k_1 e^{E_{a_1}/RT}$ (b) $k_2 = k_1 e^{E_{a_2}/RT}$

(c) $k_1 = Ak_2 e^{E_{a_1}/RT}$ (d) $k_1 = 2k_2 e^{E_{a_2}/RT}$

11. Pick the correct statement among the following :
   (a) Sodium dodecylbenzenesulphonate used in toothpaste is a cationic detergent.
   (b) Sodium lauryl sulphate forms an insoluble scum with hard water.
   (c) Cetyltrimethylammonium bromide is a popular cationic detergent used in hair conditioner.
   (d) Non-ionic detergents are formed when polyethylene glycol reacts with adipic acid.

12. In the following sequence of reactions, what is D?



   (a) Primary amine (b) An amide
   (c) Phenyl isocyanate (d) Ethyl benzene

Assertion & Reason Type

Directions : In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as :
(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.

13. **Assertion :** E_a of the forward reaction is higher than that of backward reaction in a reversible endothermic reaction.
Reason : Increasing the temperature of the substance increases the fraction of molecules which collide with energies greater than E_a.

14. **Assertion :** Magnesium metal is not used for the reduction of alumina in the metallurgy of aluminium.
Reason : MgO curve lies above Al_2O_3 curve in Ellingham diagram.

15. **Assertion :** In acidic medium, $K_2Cr_2O_7$ exists as $Cr_2O_7^{2-}$ (orange) while in basic medium it is converted to CrO_4^{2-} (yellow).
Reason : $K_2Cr_2O_7$ is hygroscopic in nature and changes colour on reaction with water.

JEE MAIN / JEE ADVANCED

Only One Option Correct Type

16. If K_1 and K_2 are the ionization constants of $H_3N^+CHRCOOH$ and $H_3N^+CHRCOO^-$, respectively, the pH of the solution at the isoelectric point is

Winners : *Kaushikkumar Kevadiya, Krati Trigunait*

SOLUTIONS TO APRIL 2023 WORD GRID

O	P	S	U	V	X	Z	I	W	R	X	R	Y	P	Z
S	U	A	N	T	I	O	X	I	D	A	N	T	D	Q
H	G	H	I	X	S	T	U	V	T	O	P	Z	N	V
I	F	R	T	S	G	L	Y	C	O	S	I	D	I	C
W	B	R	U	T	H	I	J	L	N	U	T	V	W	X
Q	P	S	E	R	Q	P	O	S	X	L	S	I	L	S
T	E	M	G	C	B	R	E	R	O	V	R	E	I	J
B	S	W	S	R	N	O	N	H	U	F	Q	I	T	K
I	T	X	B	C	Q	S	C	M	L	K	T	Z	H	L
C	I	T	U	V	W	E	T	K	V	E	L	Y	A	I
T	C	H	V	Q	T	J	X	V	R	T	I	M	R	S
Q	I	Q	W	A	S	O	H	Y	U	S	Q	E	G	O
R	D	R	C	C	F	T	P	Q	O	T	H	S	E	N
S	E	T	U	I	N	I	R	P	Z	X	J	Q	P	Q
D	S	S	F	C	A	L	C	I	N	A	T	I	O	N
E	O	N	Y	N	N	I	J	M	L	S	Q	A	R	S
N	P	O	A	B	A	K	E	L	I	T	E	Q	T	S
A	N	T	I	P	Y	R	E	T	I	C	S	T	X	V

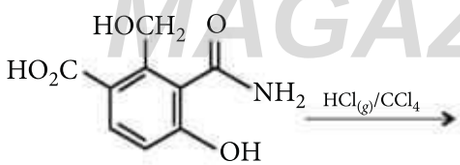
1. Catechol
2. Litharge
3. Calcination
4. Pesticides
5. Glycosidic
6. Bakelite
7. Antioxidant
8. Antipyretics

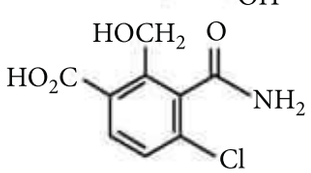
(a) $pH = pK_1 + pK_2$
(b) $pH = (pK_1\ pK_2)^{1/2}$
(c) $pH = (pK_1 + pK_2)^{1/2}$
(d) $pH = (pK_1 + pK_2)/2$

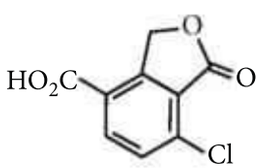
17. The vapour pressure of the solution of two liquids *A* ($p° = 80$ mm Hg) and *B* ($p° = 120$ mm Hg) is found to be 100 mm Hg when $X_A = 0.4$. The result shows that
(a) solution exhibits ideal behaviour
(b) $\Delta H_{solution} < 0$
(c) solution shows positive deviation
(d) solution will show positive deviation for lower concentration and negative deviation for higher concentration.

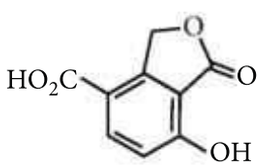
18. Which statement about sulphur dioxide gas is incorrect?
(a) It has an angular shape.
(b) It decolourises acidified potassium permanganate solution.
(c) Two S—O bonds are equal.
(d) It is a dehydrating agent.

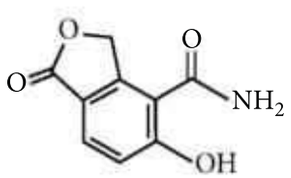
19. The major product expected from the following reaction is



(a) 

(b) 

(c) 

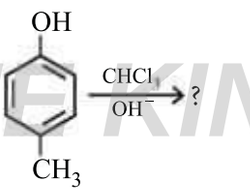
(d) 

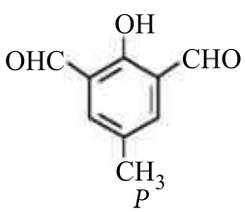
More than One Option Correct Type

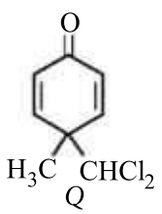
20. The pairs of coordination complexes/ions exhibiting the same kind of isomerism are
(a) $[Cr(NH_3)_5Cl]Cl_2$ and $[Cr(NH_3)_4Cl_2]Cl$
(b) $[Co(NH_3)_4Cl_2]^+$ and $[Pt(NH_3)_2(H_2O)Cl]^+$
(c) $[CoBr_2Cl_2]^{2-}$ and $[PtBr_2Cl_2]^{2-}$
(d) $[Pt(NH_3)_3(NO_3)]Cl$ and $[Pt(NH_3)_3Cl]Br$

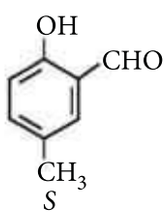
21. With reference to aqua regia, choose the correct options.
(a) Reaction of gold with aqua regia produces NO_2 in the absence of air.
(b) The yellow colour of aqua regia is due to the presence of NOCl and Cl_2.
(c) Aqua regia is prepared by mixing conc. HCl and conc. HNO_3 in 3 : 1 (*v*/*v*) ratio.
(d) Reaction of gold with aqua regia produces an anion having Au in +3 oxidation state.

22. In the following reaction, the products formed are



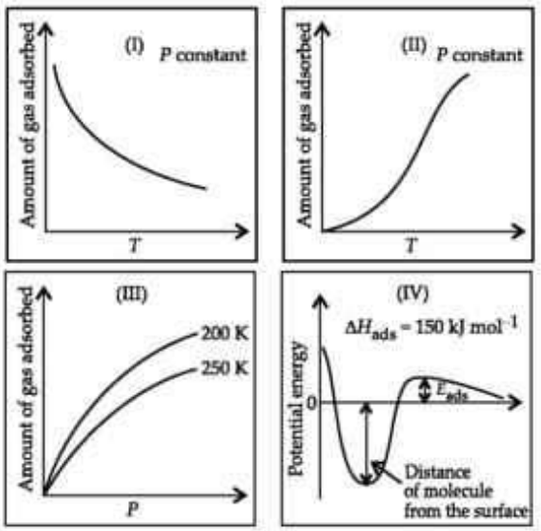






(a) *P* (major)
(b) *Q* (minor)
(c) *R* (minor)
(d) *S* (major)

23. The given graphs/data I, II, III and IV represent general trends observed for different physisorption and chemisorption processes under mild conditions of temperature and pressure. Which of the following choices about I, II, III and IV are correct?



(a) I is physisorption and II is chemisorption.
(b) I is physisorption and III is chemisorption.
(c) IV is chemisorption and II is chemisorption.
(d) IV is chemisorption and III is chemisorption.

Integer / Numerical Value Type

24. The maximum number of possible optical isomers in 1-bromo-2-methyl cyclobutane is_____.

25. The rate constant for a reaction at the initial concentration of 2×10^{-2} mol L^{-1} is 4×10^{-3} mol L^{-1} min^{-1}. The half-life period for this reaction in seconds is_____.

26. The sum of the total number of bonds between chromium and oxygen atoms in chromate and dichromate ions is _____.

Comprehension Type

In hexagonal systems of crystals, a frequently encountered arrangement of atoms is described as a hexagonal prism. Here, the top and bottom of the cell are regular hexagons and three atoms are sandwiched in between them. A space-filling model of this structure, called hexagonal close-packed (*hcp*), is constituted of a sphere on a flat surface surrounded in the same plane by six identical spheres as closely as possible. Three spheres are then placed over the first layer so that they touch each other and represent the second layer. Each one of these spheres touches three spheres of the bottom layer. Finally, the second layer is covered with a third layer that is identical to the bottom layer in relative position. Assume radius of every sphere to be '*r*'.

27. The volume of this *hcp* unit cell is

(a) $24\sqrt{2}\,r^3$ (b) $16\sqrt{2}\,r^3$ (c) $12\sqrt{2}\,r^3$ (d) $\frac{64}{3\sqrt{3}}r^3$

28. The empty space in this *hcp* unit cell is

(a) 74% (b) 47.6% (c) 32% (d) 26%

Matching Type

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

	Column I		Column II
(A)	$CH_3(CH_2)_3OH \xrightarrow[H_2SO_4,\,\Delta]{NaBr}$	(i)	$CH_3CH(Br)(CH_2)_2CH_3$
(B)	$(CH_3)_3COH \xrightarrow[\text{room temp.}]{\text{Conc. HCl}}$	(ii)	$CH_3CH_2CH_2Cl$
(C)	$CH_3CH(OH)(CH_2)_2CH_3 \xrightarrow{PBr_3}$	(iii)	$(CH_3)_3CCl$
(D)	$CH_3CH_2CH_2OH \xrightarrow{SOCl_2}$	(iv)	$CH_3(CH_2)_3Br$

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

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

	Column I (Anionic species)		Column II (Ore)
(P)	Carbonate	1.	Siderite
(Q)	Sulphide	2.	Malachite
(R)	Hydroxide	3.	Bauxite
(S)	Oxide	4.	Calamine
		5.	Argentite

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

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SELF CHECK

No. of questions attempted .....
No. of questions correct .....
Marks scored in percentage .....

Check your score! If your score is

> 90%	EXCELLENT WORK !	You are well prepared to take the challenge of final exam.
90-75%	GOOD WORK !	You can score good in the final exam.
74-60%	SATISFACTORY !	You need to score more next time.
< 60%	NOT SATISFACTORY!	Revise thoroughly and strengthen your concepts.