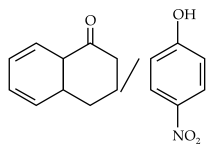
JEE (Main) CHEMISTRY SOLVED PAPER

2023
31^{st} Jan. Shift 1

Section A

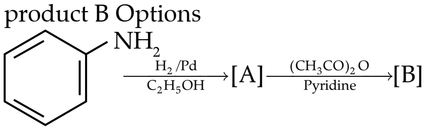
Q. 1. Match items of column I and II:

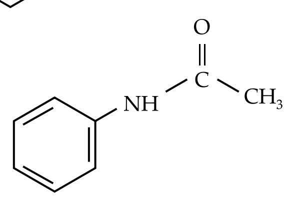
	Column I (Mixture of compounds)		Column II (Separation Technique)
A.	H_2O/CH_2Cl_2	**i.**	Crystallization
B.		**ii.**	Differential solvent extraction
C.	Kerosene / Naphthalene	**iii.**	Column chromatography
D.	$C_6H_{12}O_6$/NaCl	**iv.**	Fractional Distillation

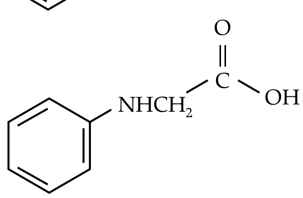
Correct match is

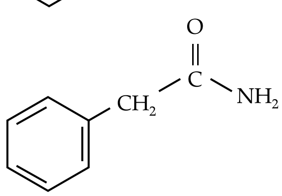
(1) A-(ii), B-(iii), C-(iv), D-(i)
(2) A-(i), B-(iii), C-(ii), D-(iv)
(3) A-(ii), B-(iv), C-(i), D-(iii)
(4) A-(iii), B-(iv), C-(ii), D-(i)

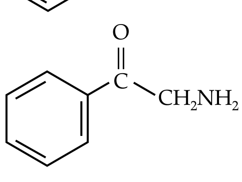
Q. 2. Consider the above reaction and identify the product B Options



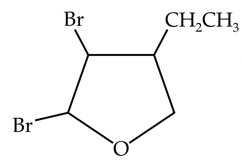
(1) 

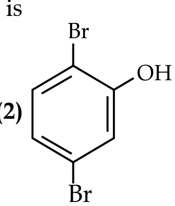
(2) 

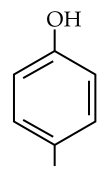
(3) 

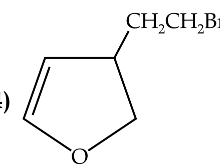
(4) 

Q. 3. An organic compound 'A' with emperical formula C_6H_6O gives sooty flame on burning. Its reaction with bromine solution in low polarity solvent results in high yield of B.B is

(1) 

(2) 

(3) 

(4) 

Q. 4. When Cu^{2+} ion is treated with KI, a white precipitate, X appears in solution. The solution is titrated with sodium thiosulphate, the compound Y is formed. X and Y respectively are

(1) $X=CuI_2$ $Y=Na_2\,S_4O_6$
(2) $X=CuI_2$ $Y=Na_2\,S_2O_3$
(3) $X=Cu_2I_2$ $Y=Na_2\,S_4O_5$
(4) $X=Cu_2I_2$ $Y=Na_2\,S_4O_6$

Q. 5. Choose the correct set of reagents for the following conversion. Trans $(Ph-CH=CH-CH_3) \rightarrow$ cis $(Ph-CH=CH-CH_3)$

(1) Br_2, aq·KOH, $NaNH_2$, Na(LiqNH_3)
(2) Br_2, alc ·KOH, $NaNH_2$, H_2 Lindlar Catalyst
(3) Br_2, aq·KOH, $NaNH_2$, H_2 Lindlar Catalyst
(4) Br_2, alc ·KOH, $NaNH_2$, Na(LiqNH_3)

Q. 6. Consider the following reaction

$$\text{Propanal} + \text{Methanal} \xrightarrow[\text{(ii) }\Delta \text{ (iii) NaCN (iv) } H_3O^+]{\text{(i) dil NaOH}} \underset{(C_5H_8O_3)}{\text{Product B}}$$

The correct statement for product B is. It is

(1) optically active alcohol and is neutral
(2) racemic mixture and gives a gas with saturated $NaHCO_3$ solution
(3) optically active and adds one mole of bromine
(4) racemic mixture and is neutral

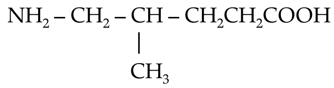
Q. 7. The methods NOT involved in concentration of ore are

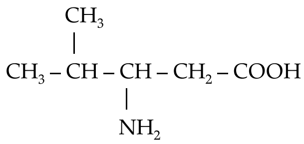
A. Liquation
B. Leaching
C. Electrolysis
D. Hydraulic washing
E. Froth floatation

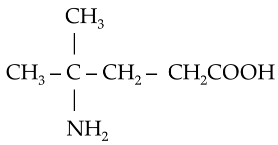
Choose the correct answer from the options given below :

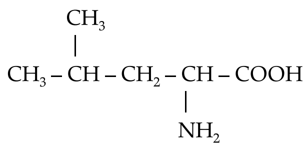
(1) C, D and E only
(2) B,D and C only
(3) A and C only.
(4) B, D and E only

Q. 8. A protein 'X' with molecular weight of 70,000u, on hydrolysis gives amino acids. One of these amino acid is:

(1) 

(2) 

(3) 

(4) 

Q. 9. Nd^{2+} =

(1) $4f^3$ **(2)** $4f^4 6s^2$ (3) $4f^4$ (4) $4f^2 6s^2$

Q. 10. Match List I with List II

List I	List II
A. XeF_4	I. See-saw
B. SF_4	II. Square planar
C. NH_4^+	III. Bent T-shaped
D. BrF_3	IV. Tetrahedral

Choose the correct answer from the options given below :

(1) A-IV, B-III, C-II, D-I **(2)** A-IV, B-I, C-II, D-III
(3) A-II, B-I, C-III, D-IV **(4)** A-II, B-I, C-IV, D-III

Q. 11. Identify X, Y and Z in the following reaction. (Equation not balanced)

$$ClO + NO_2 \rightarrow \underline{X} \xrightarrow{H_2O} \underline{Y} + \underline{Z}$$

(1) $X = ClONO_2$, $Y = HOCl$, $Z = HNO_3$
(2) $X = ClONO_2$, $Y = HOCl$, $Z = NO_2$
(3) $X = ClNO_2$, $Y = HCl$, $Z = HNO_3$
(4) $X = ClNO_3$, $Y = Cl_2$, $Z = NO_2$

Q. 12. The correct increasing order of the ionic radii is

(1) $S^{2-} < Cl^- < Ca^{2+} < K^+$
(2) $K^+ < S^{2-} < Ca^{2+} < Cl^-$
(3) $Ca^{2+} < K^+ < Cl^- < S^{2-}$
(4) $Cl^- < Ca^{2+} < K^+ < S^{2-}$

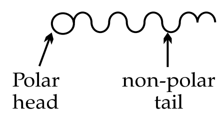
Q. 13. Cobalt chloride when dissolved in water forms pink colored complex $\underline{X}$ which has octahedral geometry. This solution on treating with conc. HCl forms deep blue complex, $\underline{Y}$ which has a $\underline{Z}$ geometry. X, Y and Z, respectively, are

(1) $X = [Co(H_2O)_6]^{2+}$, $Y = [CoCl_4]^{2-}$, Z = Tetrahedral
(2) $X = [Co(H_2O)_6]^{2+}$, $Y = [CoCl_6]^{3-}$, Z = Octahedral
(3) $X = [Co(H_2O)_4Cl_2]^+$, $Y = [CoCl_4]^{2-}$, Z = Tetrahedral
(4) $X = [Co(H_2O)_6]^{3+}$, $Y = [CoCl_6]^{3-}$, Z = Octahedral

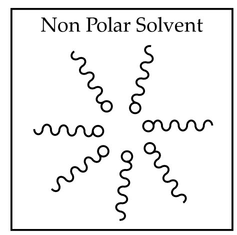
Q. 14. H_2O_2 acts as a reducing agent in

(1) $2NaOCl + H_2O_2 \rightarrow 2NaCl + H_2O + O_2$
(2) $Na_2S + 4H_2O_2 \rightarrow Na_2SO_4 + 4H_2O$
(3) $2Fe^{2+} + 2H+ + H_2O_2 \rightarrow 2Fe^{3+} + 2H_2O$
(4) $Mn^{2+} + 2H_2O_2 \rightarrow MnO_2 + 2H_2O$

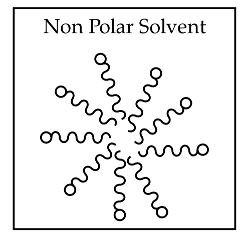
Q. 15. Adding surfactants in non polar solvent, the micelles structure will look like



(Surfactant structure)



(a)



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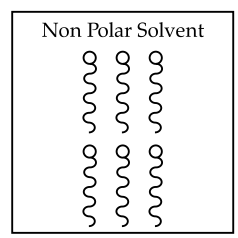

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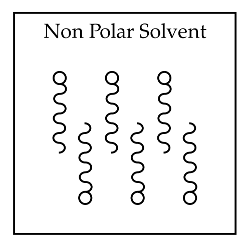
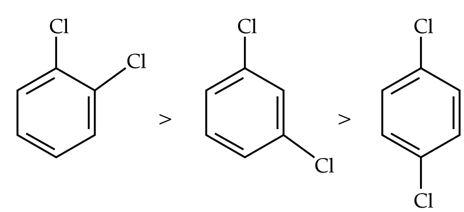
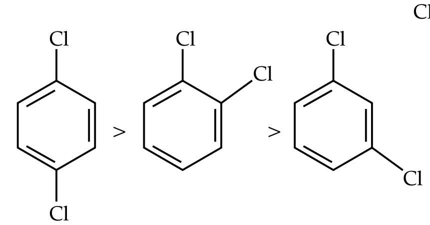


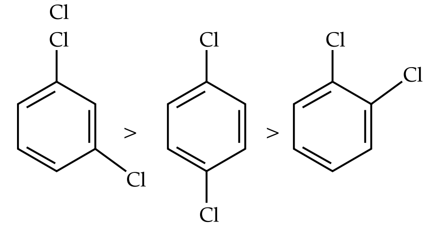
(d)

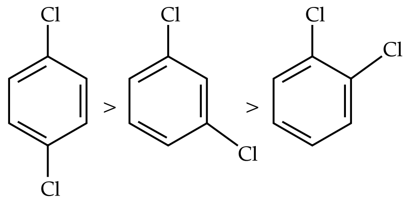
(1) a **(2)** d (3) b (4) c

Q. 16. The correct order of melting points of dichlorobenzenes is

(1) 

(2) 

(3) 

(4) 

Q. 17. The correct order of basicity of oxides of vanadium is

(1) $V_2O_5 > V_2O_4 > V_2O_3$ **(2)** $V_2O_4 > V_2O_3 > V_2O_5$

(3) $V_2O_3 > V_2O_5 > V_2O_4$ **(4)** $V_2O_3 > V_2O_4 > V_2O_5$

Q. 18. Which of the following artificial sweeteners has the highest sweetness value in comparison to cane sugar ?

(1) Sucralose **(2)** Aspartame

(3) Alitame **(4)** Saccharin

Q. 19. Which one of the following statements is correct for electrolysis of brine solution?

(1) Cl_2 is formed at cathode

(2) O_2 is formed at cathode

(3) H_2 is formed at anode

(4) OH^- is formed at cathode

Q. 20. Which transition in the hydrogen spectrum would have the same wavelength as the Balmer type transition from n=4 to n=2 of He^+ spectrum

(1) n=2 to n=1 **(2)** n=1 to n=2

(3) n=3 to n=4 **(4)** n=1 to n=3

Section B

Q. 21. The oxidation state of phosphorus in hypophosphoric acid is +

Q. 22. The enthalpy change for the conversion of $\frac{1}{2}Cl_2$ (g) to Cl^- (aq) is (-) $kJmol^{-1}$ (Nearest integer)

Given :

$$\Delta_{dis} H^{\theta}_{Cl_2(g)} = 240 \text{ kJ mol}^{-1}, \Delta_{eg} H^{\Theta}_{Cl_{(g)}}$$

$$= -350 \text{ kJ mol}^{-1}, \Delta_{hyd} H^{\Theta}_{Cl^-_{(g)}} = 380 \text{kJmol}^{-1}$$

Q. 23. The logarithm of equilibrium constant for the reaction $Pd^{2+} + 4Cl^- \rightleftharpoons PdCl_4^{2-}$ is (Nearest integer)

Given: $\frac{2.303RT}{F} = 0.06$ V

$Pd^{2+}_{(aq)} + 2e^- \rightleftharpoons Pd(s)\ E^{\Theta} = 0.83$ V

$PdCl_4^{2-}(aq) + 2e^- \rightleftharpoons Pd(s) + 4Cl^-(aq) E^{\Theta} = 0.65V$

Q. 24. On complete combustion, 0.492 g of an organic compound gave 0.792 g of CO_2.

The % of carbon in the organic compound is (Nearest integer)

Q. 25. Zinc reacts with hydrochloric acid to give hydrogen and zinc chloride. The volume of hydrogen gas produced at STP from the reaction of 11.5 g of zinc with excess HCl is L (Nearest integer)

(Given : Molar mass of Zn is 65.4 g mol^{-1} and Molar volume of H_2 at STP=22.7 L)

Q. 26. $A \rightarrow B$

The rate constants of the above reaction at 200 K and 300 K are 0.03 min−1 and 0.05 min^{-1} respectively. The activation energy for the reaction is J (Nearest integer) (Given : ln 10=2.3 R=8.3 J K^{-1} mol^{-1}

log 5=0.70 , log 3=0.48, log 2=0.30)

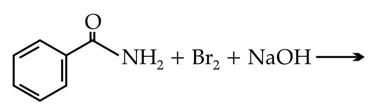
Q. 27. For reaction: $SO_2(g) + \frac{1}{2}O_2(g) \rightleftharpoons SO_3(g)$

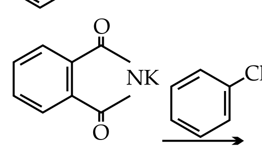
$K_p = 2 \times 10^{12}$ at 27°C and 1 atm pressure. The K_c for the same reaction is $\times 10^{13}$. (Nearest integer) (Given R=0.082 L atm K^{-1} mol^{-1})

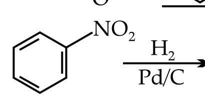
Q. 28. The total pressure of a mixture of non-reacting gases *X* (0.6 g) and (0.45 g) in a vessel is 740 mm of Hg. The partial pressure of the gas X is mm of Hg. (Nearest Integer)

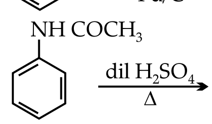
(Given : molar mass X=20 and Y=45 g mol^{-1})

Q. 29. How many of the transformations given below would result in aromatic amines ?

(1) 

(2) 

(3) 

(4) 

Q. 30. At 27°C, a solution containing 2.5 g of solute in 250.0 mL of solution exerts an osmotic pressure of 400 Pa. The molar mass of the solute is $gmol^{-1}$ (Nearest integer)

(Given: R = 0.083 L_{bar} K^{-1} mol^{-1})

Answer Key

Q. No.	Answer	Topic Name	Chapter Name
1	(1)	Separation technique	General organic chemistry
2	(1)	Chemical properties of aniline	Amines
3	(3)	Chemical properties of oxygen containing compounds	Alcohol phenol and ether

4	**(4)**	Identification of radicals	d and f block
5	**(2)**	Conversion of organic compounds	Hydrocarbon
6	**(2)**	Aldol condensation	Aldehyde and ketones
7	**(3)**	Concentration of ore methods	Metallurgy
8	**(4)**	Identification of amino acids	Biomolecules
9	**(3)**	Electronic configuration of ion	Structure of atom
10	**(4)**	Structure of compounds	Chemical bonding
11	**(1)**	Identification of reactant and product	p block
12	**(3)**	Order of ionic radii	Periodic classification of elements
13	**(1)**	Qualitative analysis	Qualitative analysis
14	**(1)**	Reducing nature of hydrogen peroxide	Hydrogen
15	**(1)**	Michelle formation	Surface chemistry
16	**(2)**	Melting points of Halo arene	Halo alkane and Halo arene
17	**(4)**	Basic nature of oxides of d block elements	d and f block
18	**(3)**	Sweetness value of sweetener	Chemistry in everyday life
19	**(4)**	Identification of product	Electro chemistry
20	**(1)**	Balmer series	Structure of atom
21	**[4]**	Oxidation state	p block elements
22	**[610]**	Enthalpy change	Thermodynamics
23	**[6]**	Equilibrium constant	Chemical equilibrium
24	**[44]**	Percentage of an element in a compounds	Some basic concepts of chemistry
25	**[4]**	Stoichiometry relationship	Some basic concepts of chemistry
26	**[2.527]**	Calculation of activation energy	Chemical kinetics
27	**[1]**	Calculation of equilibrium constant	Chemical equilibrium
28	**[555]**	Calculation of partial pressure	States of matter
29	**[3]**	Identification of aromatic compounds	Amines
30	**[62250]**	Calculation of molar mass through osmotic pressure	Liquid solution

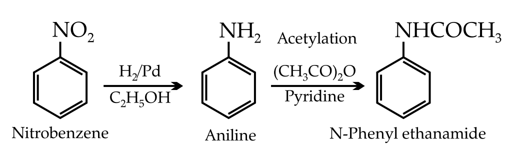
Solutions

Section A

1. **Option (1) is correct.**

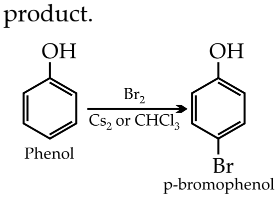
- The solvent extraction method is used to separate liquids with the difference in densities. The density of CH_2Cl_2 is greater than the density of water.
- The p-nitrophenol has intermolecular H-bonding. Hence, it is separated by column chromatography.
- Kerosene and naphthalene are separated by fractional distillation due to the difference in the boiling points.
- NaCl is an ionic compound and $C_6H_{12}O_6$ is a covalent compound. $C_6H_{12}O_6$ is soluble in an organic solvent. Hence, they can be separated by crystallization.

2. **Option (1) is correct.**



3. **Option (3) is correct.**

As the compound burns with the sooty flame, the compound is phenol (aromatic compound). In the presence of a solvent of low polarities, such as $CHCl_3$ or CS_2, it reacts with bromine to form a p-bromophenol as a major product.



4. **Option (4) is correct.**

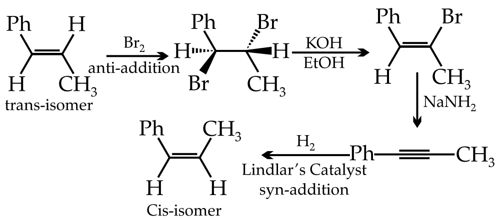
$X = Cu_2I_2$, $Y = Na_2S_4O_6$

$2CuSO_4 + 4KI \rightarrow Cu_2I_2\,(X) + 2K_2SO_4 + I_2$

$2I_2 + 2Na_2S_2O_3 \rightarrow 2NaI + Na_2S_4O_6(Y)$

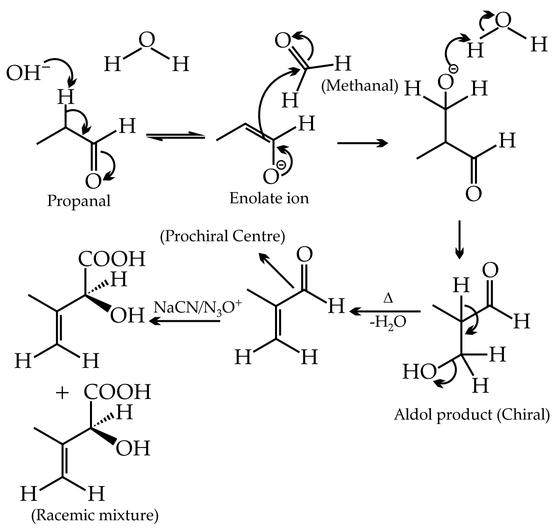
5. **Option (2) is correct.**

Br_2, alc. KOH, $NaNH_2$, H_2/Lindlar's Catalyst



6. **Option (2) is correct.**

Racemic mixture and gives a gas with saturated $NaHCO_3$ solution.



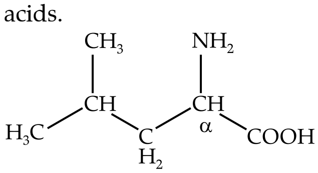
7. **Option (3) is correct.**

In liquation, the purification of a sample takes place on the basis of difference in the boiling point while in electrolysis the refining of metal hailde or oxide takes place in a molten form to obtain pure metal.

Liquation and Electrolysis are refining techniques.

8. **Option (4) is correct.**

Protein is a condensation polymer of α-amino acids. Hence, upon hydrolysis, proteins give α-amino acids.

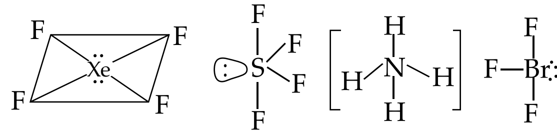


9. **Option (3) is correct.**

The electronic configuration of Nd (Z=60): $[Xe]4f^4\,6s^2$. In the (+2) state, the configuration is $[Xe]\,4f^4$.

10. **Option (4) is correct.**

$XeF_4 \rightarrow$ Square planar, $SF_4 \rightarrow$ See-Saw, $NH_4^+ \rightarrow$ Tetrahedral, $BrF_3 \rightarrow$ Bent "T" shaped.



11. **Option (1) is correct.**

$X = ClONO_2$, $(Y) = HOCl$, $(Z) = HNO_3$

$ClO + NO_2 \rightarrow ClONO_2\,(X)$

$ClONO_2\,(X) + H_2O \rightarrow HOCl(Y) + HNO_3\,(Z)$

12. **Option (3) is correct.**

For isoelectronic species,

$$\text{Ionic Radii} \propto \frac{1}{\textit{atomic number}}$$

The correct order of radii is: Ca^{2+} (Z=20) < K^+(Z=19) < Cl^- (Z=17) < S^{2-}(Z=16)

13. **Option (1) is correct.**

X= $[Co(H_2O)_6]^{2+}$, (Y)= $[CoCl_4]^{2-}$, (Z)= Tetrahedral

The $[Co(H_2O)_6]^{2+}$ when treated with excess HCl (conc.) turns deep blue in color. This is because the complex absorbs an orange light (low-frequency light). This is due to the lower splitting of d-orbitals of Co^{2+} ions. The tetrahedral complexes have a lower splitting than the octahedral complexes and absorb light of lower frequency. Hence, the geometry of the complex (Y) is tetrahedral.

14. **Option (1) is correct.**

When H_2O_2 acts as a reducing agent, one of the products of the reaction is O_2. This is because H_2O_2 oxidizes to O_2. The oxidation state of oxygen changes to (0) from (-1).

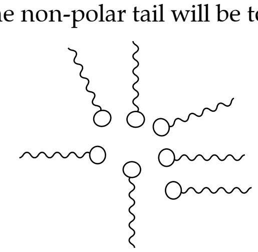
$$\underset{(-1)}{NaOCl + H_2O_2} + \rightarrow NaCl + H_2O + \underset{(0)}{O_2}$$

15. **Option (1) is correct.**

Polar

Non-polar

The non-polar tail will be towards the non-polar solvent



Non polar part will interact with non - polar solvent.

16. **Option (2) is correct.**

The p-isomer has a maximum melting point because of its symmetrical structure due to which it can fit into crystal lattice more effectively.

17. Option (4) is correct.

As positive oxidation state increases, acidic nature increases and basic nature decreases. $V_2O_3 > V_2O_4 > V_2O_5$.

18. Option (3) is correct.

Sucralose = 600

Aspartame = 100

Saccharin = 550

Alitame = 2000

Alitame is 2000 times sweeter than sugar.

19. Option (4) is correct.

OH^- is formed at the anode.

Anode: $2Cl^-(aq) \rightarrow Cl_2(g) + 2e,$

Cathode: $2H_2O(l) + 2e \rightarrow H_2(g) + 2OH^-(aq)$

20. Option (1) is correct.

$n=2$ to $n=1$.

$$\frac{1}{\lambda_H} = \frac{1}{\lambda_{He^+}}$$

$$R_H\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right](1)^2$$

$$= R_H\left[\frac{1}{(2)^2} - \frac{1}{(4)^2}\right](2)^2$$

On solving this, we get $n_1 = 1$ and $n_2 = 2$

Section B

21. The correct answer is [4].

The molecular formula of the hypo-phosphoric acid is $H_4P_2O_6$. The phosphorus in hypo-phosphoric acid is having +4-oxidation state.

$$4(+1) + 2x + 6(-2) = 0 \therefore x = +4$$

22. The correct answer is [610].

$$\begin{array}{ccc} \frac{1}{2}Cl_2 & \longrightarrow & Cl^- \text{ aq.} \\ \frac{1}{2}\text{BE} \Big\downarrow & & \Big\uparrow \Delta H_{Hyd} \text{ of } Cl_{(g)} \\ Cl\omega & \xrightarrow[\Delta H_{eg} \text{ of } Cl_{(g)}]{} & Cl\omega \end{array}$$

$\Delta H = \frac{1}{2}$(Bond enthalpy) +Electron gain enthalpy + Hydration enthalpy

$\Delta \boldsymbol{H} = \frac{1}{2}(240) + (-350) + (-380) = - +610$ ***kJ/mol***

23. The correct answer is [6].

The equilibrium constant of the reaction and cell potential is related as:

$$\log_{10} K = \left(\frac{nF \times E^\circ}{2.303\,RT}\right)$$

$$\therefore \quad \log_{10} K = \left(\frac{2 \times F \times (0.853 - 0.65)}{2.303\ RT}\right)$$

$$\therefore \quad \log_{10} K = \left(\frac{2 \times (0.18)}{0.06}\right) = \mathbf{6}$$

24. The correct answer is [44].

$$\text{Percentage of carbon} = \frac{12x \times 100}{44 \times w} = \frac{12 \times 0.792 \times 100}{44 \times 0.492}$$

$$= 44$$

x = Amount of carbon dioxide formed, w = weight of organic compound.

25. The correct answer is [4].

The reaction of Zn with the hydrochloric acid is:

$Zn + 2HCl \rightarrow ZnCl_2 + H_2(g)$

From the reaction,

Moles of Zn = Moles of Hydrogen gas

$$\therefore \quad \frac{\textit{weight of Zn}}{\textit{At.Mass of Zn}} = \frac{\textit{Volume of hydrogen gas at STP}}{22.4\ L}$$

$$\therefore \quad \frac{11.5}{65.4} = \frac{\textit{Volume of hydrogen gas at STP}}{22.4\ L}$$

$\therefore$ Volume of gas at STP = 4 L

26. The correct answer is [2.527 kJ].

As per Arrhenius equation,

$$\log\frac{K_2}{K_1} = \frac{E_a}{2.303R}\left(\frac{1}{200} - \frac{1}{300}\right)$$

$$\log\frac{0.05}{0.03} = \frac{E_a}{2.3 \times 8.3}\left(\frac{1}{600}\right)$$

$$(0.70 - 0.48) = \frac{E_a}{2.3 \times 8.3} \times \frac{1}{600}$$

$$\Rightarrow 0.22 = \frac{E_a}{2.3 \times 8.3} \times \frac{1}{600}$$

$E_a = 2.3 \times 8.3 \times 600 \times 0.22$

$= 2519.88$

≈ 2520 J

27. The correct answer is [1].

The K_p and K_c are related as:

$\Delta ng = 1 - 1.5 = -0.5r$

$K_p = K_c(RT)^{\Delta n(g)}$

$(2 \times 1012) = K_c\,(0.082 \times 300)^{-0.5}$

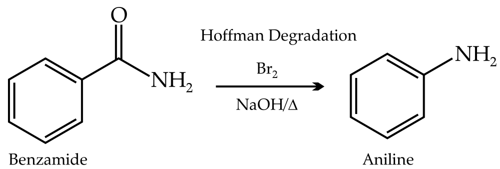
$K_c = 1 \times 10^{13}$

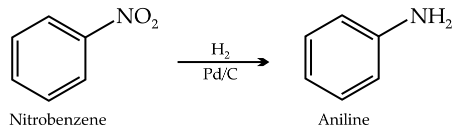
28. The correct answer is [555].

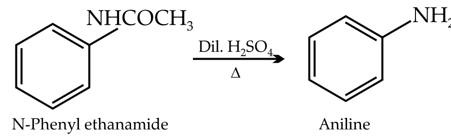
Partial Pressure = Mole Fraction × Total Pressure

$$\text{Partial Pressure (X)} = \left(\frac{\frac{0.6}{20}}{\frac{0.6}{20} + \frac{0.45}{45}}\right) \times 740 = 555$$

29. The correct answer is [3].







Chlorobenzene does not undergo S_N2 reaction. Hence, it does not produce aromatic amines.

30. The correct answer is [62250].

$$\Pi = CRT$$

$$\therefore \quad \frac{400\ Pa}{10^5} = \frac{2.5}{Mol.Mass} \times 0.83 \times 300 = 62250\ g/mol$$