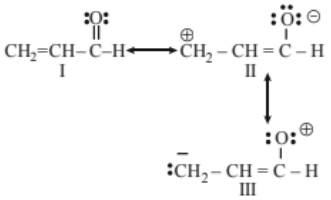
JEE Mains - 27 Jan (Shift 2) Chemistry Question Paper with Solutions

Total Time Allowed : 180 minutes	Maximum Marks : 300	Total Questions : 90	Questions to be answered : 90

Question 1: The order of relative stability of the contributing structures is:



Options:
(1) I > II > III
(2) II > I > III
(3) I = II = III
(4) III > II > I

Correct Answer: (1)

Solution:
The correct order of relative stability is:

$$I > II > III$$

Explanation:

Structure **I** is the most stable because it is a neutral resonating structure. Neutral structures are generally more stable than charged structures due to the absence of charge separation.

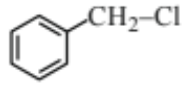
Structure **II** is less stable than **I** because it involves a positive charge on a less electronegative atom compared to structure **III**. However, it is more stable than **III** because, in structure **III**, the negative charge is located on a carbon atom, which is less favorable.

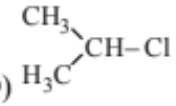
Structure **III** is the least stable among the three due to the presence of a negative charge on a carbon atom and the overall charge separation, which increases instability.

Quick Tip

Neutral structures are more stable than charged resonating forms. Stability increases when charges are on atoms with higher electronegativity.

Question 2: Which among the following halide(s) will not show S_N1 reaction:

Options:
(A) $H_2C = CH - CH_2Cl$
(B) $CH_3 - CH = CH - Cl$
(C) 

(D) 

Choose the most appropriate answer from the options given below:
(1) (A), (B), and (D) only
(2) (A) and (B) only
(3) (B) and (C) only
(4) (B) only

Correct Answer: (4)

Solution:
The S_N1 reaction mechanism proceeds through the formation of a carbocation intermediate. The stability of the carbocation plays a critical role in determining whether the reaction will proceed.
Analysis of Each Halide
Halide (A): $H_2C = CH - CH_2Cl$ forms an allylic carbocation upon ionization, which is stabilized by resonance. Therefore, it is likely to undergo an S_N1 reaction.
Halide (B): $CH_3 - CH = CH - Cl$ forms a carbocation that is not stabilized by resonance or inductive effects. This makes it unlikely to undergo an S_N1 reaction, as the carbocation formed would be highly unstable.
Halide (C): This compound forms a benzylic carbocation upon ionization, which is highly stabilized due to resonance with the aromatic ring, making it suitable for an S_N1 reaction.
Halide (D): $H_3C - C(Cl)H_2$ forms a tertiary carbocation, which is stable and favorable for the S_N1 reaction due to hyperconjugation and inductive effects.
Conclusion Therefore, the only halide that will not show an S_N1 reaction is (B).

Quick Tip

S_N1 reactions are favored by the formation of stable carbocations. Consider resonance and hyperconjugation for carbocation stability.

Question 3: Which of the following statements is not correct about rusting of iron?

Options:
(1) Coating of iron surface by tin prevents rusting, even if the tin coating is peeled off.
(2) When pH lies above 9 or 10, rusting of iron does not take place.
(3) Dissolved acidic oxides SO_2, NO_2 in water act as catalyst in the process of rusting.
(4) Rusting of iron is envisaged as setting up of electrochemical cell on the surface of iron object.

Correct Answer: (1)

Solution:
When the tin coating is peeled off, the underlying iron is exposed to the environment and begins to rust more quickly due to galvanic action. In the presence of moisture, iron acts as the anode and undergoes oxidation, while tin acts as the cathode. This accelerates the rusting process of iron, making Option (1) incorrect.
Additionally, once the tin coating is removed, tin itself does not prevent rusting as it no longer provides a barrier to protect the iron surface.

Quick Tip

Galvanic action occurs when iron comes in contact with a less reactive metal, accelerating rusting when protective coatings are compromised.

Question 4: Given below are two statements:

Statement (I): In the Lanthanides, the formation of Ce^{4+} is favored by its noble gas configuration.
Statement (II): Ce^{4+} is a strong oxidant reverting to the common +3 state.
Choose the correct option:
(1) Statement I is false but Statement II is true
(2) Both Statement I and Statement II are true
(3) Statement I is true but Statement II is false
(4) Both Statement I and Statement II are false

Correct Answer: (2)

Solution:
Ce^{4+} has a noble gas electronic configuration, which makes Statement (I) true. This stable configuration contributes to the high stability of Ce^{4+}.
Furthermore, due to its high reduction potential, the Ce^{4+}/Ce^{3+} couple acts as a strong oxidizing agent, as Ce^{4+} readily accepts electrons to achieve the Ce^{3+} state. This property confirms that Statement (II) is also true.

Quick Tip

Ce^{4+} stability is influenced by its noble gas configuration and its role as an oxidizing agent.

Question 5: Choose the correct option having all the elements with d^{10} electronic configuration from the following:

Options:
(1) Zn, Co^{2+}, Ni, Fe^{2+}, Cr
(2) Cu, Zn, Ag, Cd
(3) Pd, Ni, Fe^{2+}, Cr
(4) Ni, Zn, Fe^{2+}, Cu

Correct Answer: (2)

Solution:
Elements such as Cu, Zn, Ag, and Cd exhibit a d^{10} electronic configuration, which is a completely filled d-orbital. Their electron configurations are as follows:

$$[\text{Cu}] = [\text{Ar}]\, 3d^{10}\, 4s^1, \quad [\text{Zn}] = [\text{Ar}]\, 3d^{10}\, 4s^2,$$
$$[\text{Ag}] = [\text{Kr}]\, 4d^{10}\, 5s^1, \quad [\text{Cd}] = [\text{Kr}]\, 4d^{10}\, 5s^2.$$

This d^{10} configuration provides added stability due to the completely filled d-subshell, which minimizes the reactivity of these elements.

Quick Tip

Elements with fully filled d-orbitals (d^{10} configuration) exhibit unique chemical properties.

Question 6: Phenolic group can be identified by a positive:

Options:
(1) Phthalein dye test
(2) Lucas test
(3) Tollen's test
(4) Carbylamine test

Correct Answer: (1)

Solution:
The **Phthalein dye test** is a specific test for phenolic groups and involves the formation of colored compounds, making it useful for identifying phenols.
The **Carbylamine test** is used for the identification of primary amines.
The **Lucas test** differentiates between primary (1°), secondary (2°), and tertiary (3°) alcohols.
The **Tollen's test** is used for the identification of aldehydes.
Conclusion Therefore, the phenolic group can be identified by a positive **Phthalein dye test**.

Quick Tip

To identify phenolic groups, look for tests that form colored compounds through specific reactions, such as the Phthalein dye test.

Question 7: The molecular formula of second homologue in the homologous series of mono carboxylic acids is:

Options:
(1) $C_3H_6O_2$
(2) $C_2H_4O_2$
(3) CH_2O
(4) $C_2H_2O_2$

Correct Answer: (2)

Solution:
The first member of the homologous series of monocarboxylic acids is formic acid (HCOOH).
The second member is acetic acid (CH_3COOH).

The molecular formula for acetic acid is $C_2H_4O_2$.
Hence, the correct answer is $\mathbf{C_2H_4O_2}$.

Quick Tip

The molecular formula of homologous series increases by a CH_2 unit for each subsequent member.

Question 8: The technique used for purification of steam volatile water immiscible substance is:

Options:
(1) Fractional distillation
(2) Fractional distillation under reduced pressure
(3) Distillation
(4) Steam distillation

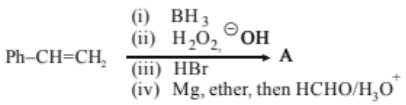
Correct Answer: (4)

Solution:
Steam distillation is used for the purification of substances that are volatile in steam and immiscible in water.
It is commonly used to separate essential oils from plant materials and other mixtures where the components have different volatilities.
Thus, the correct technique is **Steam distillation**.

Quick Tip

Steam distillation is useful for substances that are steam volatile but insoluble in water, making it ideal for purifying essential oils.

Question 9: The final product A, formed in the following reaction sequence is:



Options:
(1) Ph - CH_2 - CH_2 - CH_3

(2) Ph - CH - CH_3 (with CH_3 substituent on the CH carbon)
(3) Ph - CH - CH_3 (with CH_2OH substituent on the CH carbon)
(4) Ph - CH_2 - CH_2 - CH_2 - OH

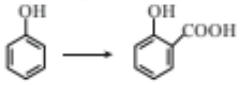
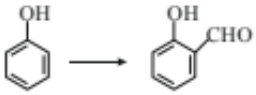
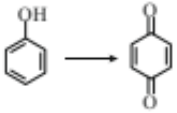
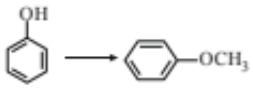
Correct Answer: (4)

Solution:
Step (i) involves hydroboration-oxidation of the double bond in Ph-CH=CH_2, resulting in the anti-Markovnikov addition of water to form Ph-CH_2-CH_2OH.
Step (ii) converts the alcohol (Ph-CH_2-CH_2OH) to the corresponding alkyl halide (Ph-CH_2-CH_2Br) using HBr.
Step (iii) involves the formation of a Grignard reagent with Mg, producing Ph-CH_2-CH_2MgBr.
Step (iv) reacts the Grignard reagent with formaldehyde (HCHO) followed by hydrolysis to yield the final primary alcohol, Ph-CH_2-CH_2-CH_2-OH.
Thus, the final product is **Ph - CH_2 - CH_2 - CH_2 - OH**.

Quick Tip

Grignard reagents react with formaldehyde to give primary alcohols.
Hydroboration-oxidation of alkenes follows the anti-Markovnikov rule, leading to the formation of alcohols.

Question 10: Match List-I with List-II.

List – I (Reaction)	**List – II (Reagent(s))**
(A) 	(I) $Na_2Cr_2O_7$, H_2SO_4
(B) 	(II) (i) NaOH (ii) CH_3Cl
(C) 	(III) (i) NaOH, $CHCl_3$ (ii) NaOH (iii) HCl
(D) 	(IV) (i) NaOH (ii) CO_2 (iii) HCl

Correct Matching:

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

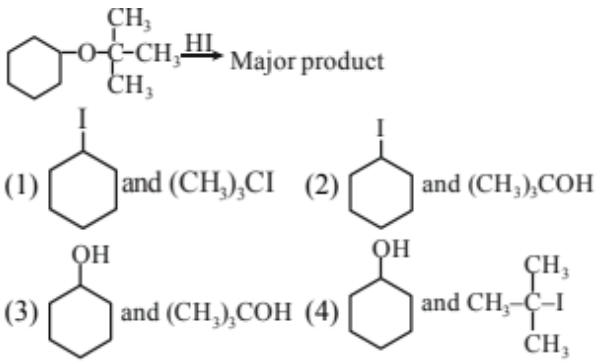
Correct Answer: (4)

Solution:
(A) **Oxidation of phenol to benzoquinone:** This reaction uses $\mathbf{Na_2Cr_2O_7}$ **and** $\mathbf{H_2SO_4}$ as the oxidizing agents.
(B) **Kolbe's reaction:** It involves carboxylation of phenol using **NaOH and** $\mathbf{CO_2}$, followed by acidification with **HCl**.
(C) **Reimer-Tiemann reaction:** This reaction introduces an aldehyde group on the phenol ring using **NaOH and** $\mathbf{CHCl_3}$.
(D) **Williamson's synthesis:** It prepares ethers by reacting phenoxide with $\mathbf{CH_3Cl}$ in the presence of **NaOH**.
Thus, the correct matching is:
(A)-(IV), (B)-(III), (C)-(I), (D)-(II).

Quick Tip

To accurately match reactions with reagents, focus on identifying unique characteristics of each reaction, such as oxidation, carboxylation, and ether formation.

Question 11: Major product formed in the following reaction is a mixture of:



Correct Answer: (4)

Solution:
The given reaction involves the cleavage of the ether bond using **HI**. The major products

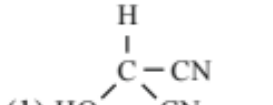
are formed through nucleophilic substitution of **HI** on the ether linkage. The reaction mechanism proceeds as follows:
1. Protonation of the ether oxygen atom by **HI**, resulting in the formation of an oxonium ion intermediate.
2. Cleavage of the C–O bond forms cyclohexanol and a tertiary carbocation $\mathbf{(CH_3)_3C^+}$.
3. The tertiary carbocation rapidly reacts with $\mathbf{I^-}$ to form $\mathbf{(CH_3)_3C–I}$ as the final product.

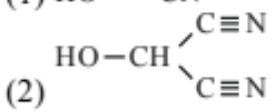
Quick Tip

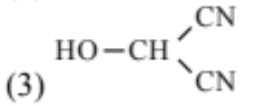
In reactions involving ether cleavage, if a tertiary carbocation can be formed, it will likely lead to the formation of stable, major products by rapid nucleophilic substitution.

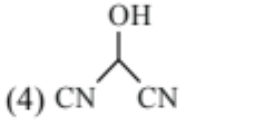
Question 12: The bond line formula of $HOCH(CN)_2$ is:

Options:

(1) 

(2) 

(3) 

(4) 

Correct Answer: (4)

Solution:
The given compound is $HOCH(CN)_2$. This structure indicates a central carbon atom bonded to a hydroxyl group (OH) and two cyano groups (CN).
Explanation: The central carbon atom is bonded to one hydroxyl group and two cyanide (CN) groups.
This structure matches the representation of option (4), showing two cyanide groups attached to the central carbon atom along with the hydroxyl group.

Quick Tip

When interpreting bond-line structures, always focus on the groups attached to the central atom and their positions to ensure an accurate representation.

Question 13 : Given below are two statements:
Statement (I) : Oxygen being the first member of group 16 exhibits only -2 oxidation state.
Statement (II) : Down the group 16, stability of +4 oxidation state decreases and +6 oxidation state increases.

In light of the above statements, choose the **most appropriate** answer from the options given below:
(1) Statement I is correct but Statement II is incorrect
(2) Both Statement I and Statement II are correct
(3) Both Statement I and Statement II are incorrect
(4) Statement I is incorrect but Statement II is correct

Correct Answer: (3)

Solution:

Statement I: Oxygen, as the first member of group 16, primarily exhibits an oxidation state of -2 due to its high electronegativity and small size, which favors electron gain rather than loss. However, it can also exist in oxidation states other than -2, such as 0 in molecular oxygen (O_2) and +1 or +2 in compounds like OF_2 and O_2F_2. Therefore, the statement that oxygen exhibits only -2 oxidation state is incorrect.
Statement II: In group 16 elements, moving down the group from oxygen to polonium, there is an observed increase in the stability of the +4 oxidation state, while the stability of the +6 oxidation state decreases. This trend is attributed to the inert pair effect, where the tendency of the s-electrons to remain unpaired increases in heavier elements, making higher oxidation states less stable. Thus, elements like tellurium and polonium prefer to exhibit the +4 oxidation state rather than +6. Hence, the statement that the stability of +4 oxidation state decreases down the group is also incorrect.
Therefore, both statements are incorrect.

Quick Tip

The inert pair effect is responsible for the observed trend in oxidation states in heavier group 16 elements, where the lower oxidation states become more stable down the group.

Question 14 : Identify from the following species in which d^2sp^3 hybridization is shown by central atom:

Options:
(1) $[Co(NH_3)_6]^{3+}$
(2) BrF_5
(3) $[PtCl_4]^{2-}$
(4) SF_6

Correct Answer: (1)

Solution:

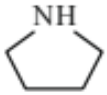
$[Co(NH_3)_6]^{3+}$ exhibits d^2sp^3 hybridization as it forms an octahedral geometry. In this complex, the central cobalt ion uses two d orbitals, one s orbital, and three p orbitals to form six coordinate bonds with ammonia molecules.
For BrF_5, the central bromine atom exhibits sp^3d^2 hybridization, resulting in a square pyramidal structure.
In $[PtCl_4]^{2-}$, platinum shows dsp^2 hybridization, resulting in a square planar geometry.
SF_6 involves sp^3d^2 hybridization, resulting in an octahedral geometry around the sulfur atom.
Conclusion Thus, the correct species showing d^2sp^3 hybridization is $[Co(NH_3)_6]^{3+}$.

Quick Tip

d^2sp^3 hybridization involves two d orbitals, one s orbital, and three p orbitals, typically resulting in an octahedral geometry.

Question 15 : Identify B formed in the reaction.
Cl-$(CH_2)_4$-Cl $\xrightarrow{\text{excess } NH_3}$ A $\xrightarrow{NaOH}$ B + H_2O + NaCl

Options:

(1) 

(2) $H_2N-(CH_2)_4-NH_2$

(3) $Cl\overset{+}{N}H_3-(CH_2)_4-\overset{+}{N}H_3Cl^-$

(4) 

Correct Answer: (2)

Solution:
The compound Cl-$(CH_2)_4$-Cl reacts with excess ammonia (NH_3) to form an intermediate A, which is NH_3-$(CH_2)_4$-$NH_3^+Cl^-$. This intermediate compound is a diammonium salt. Upon treatment with NaOH, it undergoes deprotonation to yield compound B, which is H_2N-$(CH_2)_4$-NH_2, also known as 1,4-diaminobutane or putrescine.
Therefore, the correct answer is H_2N-$(CH_2)_4$-NH_2.

> Quick Tip
>
> Ammonia reacts with dihalides to form diamines after deprotonation, especially when excess ammonia and a base are used.

Question 16 : The quantity which changes with temperature is:

Options:
(1) Molarity
(2) Mass percentage
(3) Molality
(4) Mole fraction

Correct Answer: (1)

Solution:
Molarity is defined as the number of moles of solute per liter of solution. Since the volume of a solution is affected by temperature due to thermal expansion or contraction, molarity also changes with temperature.
Mass percentage, molality, and mole fraction, however, are temperature-independent as

they depend only on the ratio of masses or moles of solute and solvent, which do not vary with temperature.
Thus, the correct answer is **Molarity**, as it is affected by temperature changes.

Quick Tip

Molarity varies with temperature because it depends on volume, which changes with thermal expansion or contraction.

Question 17 : Which structure of protein remains intact after coagulation of egg white on boiling?

Options:
(1) Primary
(2) Tertiary
(3) Secondary
(4) Quaternary

Correct Answer: (1)

Solution:
Boiling an egg causes denaturation of its protein, resulting in the loss of its quaternary, tertiary, and secondary structures. However, the primary structure remains intact, as the covalent peptide bonds between amino acids are not broken during denaturation.

Quick Tip

The primary structure of a protein is the sequence of amino acids linked by peptide bonds, which is not affected by boiling.

Question 18 : Which of the following cannot function as an oxidising agent?

Options:
(1) N^{3-}
(2) SO_4^{2-}
(3) BrO_3^-
(4) MnO_4^-

Correct Answer: (1)

Solution:
In N^{3-}, nitrogen is present in its lowest possible oxidation state. Hence, it cannot be further reduced and cannot act as an oxidizing agent.

> Quick Tip
>
> An oxidizing agent is a substance that can gain electrons and get reduced; elements in their lowest oxidation state typically cannot act as oxidizing agents.

Question 19 : The incorrect statement regarding conformations of ethane is:

Options:
(1) Ethane has an infinite number of conformations
(2) The dihedral angle in staggered conformation is 60°
(3) Eclipsed conformation is the most stable conformation
(4) The conformations of ethane are inter-convertible to one another

Correct Answer: (3)

Solution:
The eclipsed conformation of ethane is the least stable due to increased repulsion between electron clouds of C-H bonds on adjacent carbon atoms. In this arrangement, the C-H bonds align directly with each other, resulting in greater electron-electron repulsion. On the other hand, the staggered conformation is more stable because the C-H bonds on adjacent carbons are positioned further apart, minimizing these repulsive interactions.

> Quick Tip
>
> Staggered conformations are generally more stable due to minimized electron repulsion between bonds.

Question 20 : Identify the incorrect pair from the following:

Options:
(1) Photography - AgBr
(2) Polythene preparation - $TiCl_4$, $Al(CH_3)_3$
(3) Haber process - Iron

(4) Wacker process - $PtCl_2$

Correct Answer: (4)

Solution:
The catalyst used in Wacker's process is $PdCl_2$, not $PtCl_2$.

> Quick Tip
>
> Wacker's process uses palladium chloride ($PdCl_2$) as a catalyst for oxidation of ethylene to acetaldehyde.

Question 21 : Total number of ions from the following with noble gas configuration is

Options:
Sr^{2+} (Z = 38), Cs^{+} (Z = 55), La^{3+} (Z = 57), Pb^{2+} (Z = 82), Yb^{2+} (Z = 70) and Fe^{2+} (Z = 26)

Correct Answer: (2)

Solution:
To determine if an ion has a noble gas configuration, we examine its electron configuration and compare it with that of a nearby noble gas:
Sr^{2+} (Z = 38) loses two electrons, resulting in the electron configuration [Kr], which matches the noble gas krypton.
Cs^{+} (Z = 55) loses one electron, resulting in the electron configuration [Xe], matching xenon.
La^{3+} (Z = 57) loses three electrons, resulting in the electron configuration [Xe], also matching xenon.
Yb^{2+} (Z = 70) loses two electrons, resulting in the electron configuration [Xe], matching xenon.
On the other hand:
Pb^{2+} does not match any noble gas configuration due to its partially filled d-orbitals.
Fe^{2+} does not match a noble gas configuration either, as it retains electrons in the d-orbital.
Thus, only Sr^{2+}, Cs^{+}, La^{3+}, and Yb^{2+} have noble gas configurations, totaling four ions.

Quick Tip

Ions that achieve a noble gas configuration are typically more stable due to a complete electron shell.

Question 22 : The number of non-polar molecules from the following is

HF, H_2O, SO_2, H_2, CO_2, CH_4, NH_3, HCl, $CHCl_3$, BF_3

Correct Answer: (4)

Solution:
Non-polar molecules have a symmetrical arrangement of atoms that results in no net dipole moment. In the given list:
CO_2 is linear and symmetrical, so it is non-polar.
H_2 is diatomic and non-polar because it is composed of identical atoms.
CH_4 has a tetrahedral geometry with symmetrical bond distribution, making it non-polar.
BF_3 has a trigonal planar geometry, which is symmetrical and therefore non-polar.
Other molecules like HF, H_2O, SO_2, NH_3, HCl, and $CHCl_3$ are polar due to their asymmetrical shapes or differences in electronegativity.
Therefore, there are four non-polar molecules in the list.

Quick Tip

Non-polar molecules generally have symmetrical shapes or identical atoms, leading to a balanced electron distribution and no net dipole.

Question 23 : Time required for completion of 99.9% of a first-order reaction is _____ times of half life ($t_{1/2}$) of the reaction.

Correct Answer: (10)

Solution:
For a first-order reaction, the time required for a certain percentage of reaction completion can be calculated using the formula:

$$t = \frac{2.303}{k} \log \frac{[A]_0}{[A]},$$

where $[A]_0$ is the initial concentration, $[A]$ is the concentration at time t, and k is the rate constant.
For 99.9% completion, $\frac{[A]}{[A]_0} = 0.001$:

$$t = \frac{2.303}{k} \log \frac{1}{0.001} = \frac{2.303}{k} \times 3 = 10 \times t_{1/2},$$

where $t_{1/2}$ is the half-life.
Thus, the time required for 99.9% completion is 10 times the half-life.

Quick Tip

For a first-order reaction, the time to reach 99.9% completion is approximately 10 times the half-life.

Question 24 : The spin-only magnetic moment value of square planar complex $[Pt(NH_3)_2Cl(NH_2CH_3)]Cl$ is _____ B.M. (Nearest integer)

Correct Answer: (0)

Solution:
The complex $[Pt(NH_3)_2Cl(NH_2CH_3)]Cl$ contains Pt^{2+} in a square planar geometry. Pt^{2+} has a d^8 electronic configuration.
In square planar complexes, the d-electrons pair up in such a way that no unpaired electrons remain. As a result, the complex has no unpaired electrons, leading to a magnetic moment of 0 Bohr Magnetons (B.M.).
Thus, the complex is diamagnetic, with a magnetic moment of 0 B.M.

Quick Tip

Square planar complexes with d^8 configurations, like Pt^{2+}, typically have no unpaired electrons, yielding a magnetic moment of 0.

Question 25 : For a certain thermochemical reaction M $\rightarrow$ N at T = 400 K, $\Delta H^\circ = 77.2$ kJ mol^{-1}, $\Delta S^\circ = 122$ JK^{-1}, log equilibrium constant (log K) is _____ x 10^{-1}.

Correct Answer: (37)

Solution:
The relationship between Gibbs free energy change (ΔG°), enthalpy change (ΔH°), and entropy change (ΔS°) is given by:

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

Substituting the values given:

$$\Delta G^\circ = 77.2 \times 10^3 \,\text{J} - (400 \times 122)\,\text{J} = -28400\,\text{J}$$

The relationship between ΔG° and the equilibrium constant K is:

$$\Delta G^\circ = -2.303RT \log K$$

Rearranging and solving for $\log K$:

$$-28400 = -2.303 \times 8.314 \times 400 \log K$$

$$\log K = \frac{-28400}{-2.303 \times 8.314 \times 400} = 37.08 \approx 3.7 \times 10^1$$

Quick Tip

The equation $\Delta G^\circ = -RT \ln K$ is crucial in calculating the equilibrium constant from thermodynamic parameters.

Question 26: Volume of 3 M NaOH (formula weight 40 g mol^{-1}) which can be prepared from 84 g of NaOH is _ _ _ _ x 10^{-1} dm^3.

Correct Answer: (7)

Solution:

To find the volume of solution that can be prepared, we use the molarity formula:

$$\text{Molarity (M)} = \frac{n_{\text{NaOH}}}{V_{\text{sol}}}$$

Given: - Molarity (M) = 3 M - Mass of NaOH = 84 g - Molar mass of NaOH = 40 g/mol
Step 1: Calculate moles of NaOH

$$n_{\text{NaOH}} = \frac{84}{40} = 2.1\,\text{moles}$$

Step 2: Use the molarity equation to find volume:

$$V_{\text{sol}} = \frac{n_{\text{NaOH}}}{M} = \frac{2.1}{3} = 0.7\,\text{L} = 7 \times 10^{-1}\,\text{dm}^3$$

$V_{sol} = \frac{n_{NaOH}}{M} = \frac{2.1}{3} = 0.7\,L = 7 \times 10^{-1}\,dm^3$

> Quick Tip
>
> Molarity (M) is calculated using the formula $M = \frac{n}{V}$ where n is the number of moles and V is the volume in liters.

Question 27 : 1 mole of PbS is oxidized by "X" moles of O_3 to get "Y" moles of O_2. X + Y = _____

Correct Answer: (8)

Solution:
The balanced chemical equation for the oxidation of PbS by ozone is:

$$PbS + 4O_3 \rightarrow PbSO_4 + 4O_2$$

From the equation: - 1 mole of PbS reacts with 4 moles of O_3 (so $X = 4$). - 4 moles of O_2 are produced (so $Y = 4$).
Therefore:

$$X + Y = 4 + 4 = 8$$

> Quick Tip
>
> In stoichiometry, balancing the equation is key to determining the exact mole ratio of reactants and products.

Question 28 : The hydrogen electrode is dipped in a solution of pH = 3 at 25°C. The potential of the electrode will be - _____ $\times 10^{-2} V$.
Correct Answer: (18)

Solution:

The potential of the hydrogen electrode can be determined using the Nernst equation :

$$E = E^\circ - \frac{0.059}{n} \log\left(\frac{1}{[H^+]}\right)$$

For the standard hydrogen electrode, $E^\circ = 0$. Given that the pH of the solution is 3, we can express the concentration of hydrogen ions as $[H^+] = 10^{-3}$ M.

Substitute these values into the Nernst equation:

$$E = 0 - \frac{0.059}{1} \log\left(\frac{1}{10^{-3}}\right)$$

Since $\log(10^{-3}) = -3$**, the equation simplifies to:**

$$E = -0.059 \times (-3) = 0.177\,\mathbf{V}$$

Thus, the potential of the hydrogen electrode is $0.177\,\mathbf{V}$**.**

Quick Tip

For pH calculations, remember that $[\mathbf{H}^+] = 10^{-\mathbf{pH}}$**.**

Question 29 : 9.3 g of aniline is subjected to reaction with excess of acetic anhydride to prepare acetanilide. The mass of acetanilide produced if the reaction is 100% completed is $\_\_\_\_\_ \times 10^{-1} g.(Given molar massing mol^{-1} N : 14, O : 16, C : 12, H : 1)$
Correct Answer: (135)

Solution:
The reaction between aniline and acetic anhydride produces acetanilide. The balanced equation is:

$$\mathbf{C_6H_5NH_2 + CH_3COOCOCH_3 \rightarrow C_6H_5NHCOCH_3 + CH_3COOH}$$

Given: - Molar mass of aniline ($\mathbf{C_6H_7N}$**) = 93 g/mol - Molar mass of acetanilide (**$\mathbf{C_8H_9NO}$**) = 135 g/mol**
Step 1: Calculate moles of aniline

$$n_{\mathbf{aniline}} = \frac{9.3\,\mathbf{g}}{93\,\mathbf{g/mol}} = 0.1\,\mathbf{moles}$$

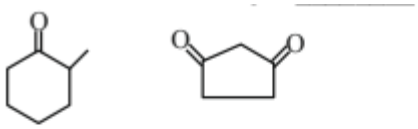
Step 2: Since the reaction is 1:1, the moles of acetanilide produced will be equal to the moles of aniline, which is 0.1 moles.
Step 3: Calculate the mass of acetanilide produced

$$\mathbf{mass\ of\ acetanilide} = n \times \mathbf{molar\ mass} = 0.1\,\mathbf{moles} \times 135\,\mathbf{g/mol} = 13.5\,\mathbf{g} = 135 \times 10^{-1}\,\mathbf{g}$$

Quick Tip

In a 100% yield reaction, the moles of product are directly based on the moles of limiting reactant in a 1:1 molar ratio.

Question 30 : Total number of compounds with Chiral carbon atoms from following is _____.



$CH_3-CH_2-CH(NO_2)-COOH$

$CH_3-CH_2-CHBr-CH_2-CH_3$

$CH_3-CH(I)-CH_2-NO_2$

$CH_3-CH_2-CH(OH)-CH_2OH$

$CH_3-\underset{\displaystyle I}{\underset{|}{CH}}-CH(I)-C_2H_5$

Correct Answer: (5)

Solution:
To identify chiral carbons, we need to find carbon atoms that are bonded to four different substituents, creating an asymmetry in the molecule:
1. CH_3-CH_2-CH(NO_2)-COOH: The second carbon is attached to four different groups (CH_3, CH_2, NO_2, COOH), making it a chiral center.
2. CH_3-CH_2-CHBr-CH_2-CH_3: The third carbon is attached to four different groups (CH_3, CH_2, Br, CH_3), making it a chiral center.
3. CH_3-CH(I)-CH_2-NO_2: The second carbon is attached to four different groups (CH_3, I, CH_2, NO_2), making it a chiral center.
4. CH_3-CH_2-CH(OH)-CH_2OH: The third carbon is attached to four different groups (CH_3, CH_2, OH, OH), making it a chiral center.
5. CH_3-CH-CH(I)-C_2H_5: The second carbon is attached to four different groups (CH_3, CH_2, I, C_2H_5), making it a chiral center.
Conclusion: Thus, all five compounds listed above contain at least one chiral carbon.

Quick Tip

A chiral carbon is attached to four different substituents, resulting in a non-superimposable mirror image.