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POLYTECHNIC TRB CHEMISTRY



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PART-A

1. The significant figure for the number 0.0304 is :

A) 3 - (Correct Alternative)

B) 2

C) 5

D) 4

Correct Answer: A) 3

Explanation:

In 0.0304, the zeros before 3 are only leading zeros and are not significant. The zero between 3 and 4 is significant because it lies between two non-zero digits. Therefore, the significant figures are 3, 0 and 4, giving a total of 3 significant figures.

2. Evaluate the following expression rounding of the answer to the appropriate number of significant figures. $42.71\ g + 9.643\ g + 8.0\ g$

A) 60.353 g

B) 60.35 g

C) 60.4 g - (Correct Alternative)

D) 60.43 g

Correct Answer: C) 60.4 g

Explanation: First add the given values: 42.71 g + 9.643 g + 8.0 g = 60.353 g. For addition, the final answer must have the same number of decimal places as the least precise measurement. Since 8.0 g has only one decimal place, 60.353 g is rounded to 60.4 g.

3. What way the magnitude of constant errors related to the size and concentration of the sample ?

A) independent - (Correct Alternative)

B) dependent

C) no change

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D) accurate

Correct Answer: A) Independent

Explanation: Constant errors, also called determinate systematic errors in this context, have a fixed magnitude under the same experimental conditions. Their absolute magnitude does not vary directly with the size or concentration of the sample. Therefore, they are considered independent of sample size and concentration.

4. The maximum uncertainty of the expression is : $(\mathbf{17.3 \pm 0.2})\mathbf{ml} - (\mathbf{9.7 \pm 0.3})\mathbf{ml} + (11.6 \pm 0.1)\text{ml}$

A) 19.0 ± 0.8ml

B) 19.8 ± 0.6 ml

C) 19.2 ± 0.6ml - (Correct Alternative)

D) 19.9 ± 0.9ml

Correct Answer: C) 19.2 ± 0.6 ml

Explanation: The central value is calculated as 17.3 - 9.7 + 11.6 = 19.2 ml. For maximum uncertainty in addition or subtraction, the absolute uncertainties are added: 0.2 + 0.3 + 0.1 = 0.6 ml. Therefore, the final result is 19.2 ± 0.6 ml.

5. In volumetric titration, the relative error increases how many times if we use a 5 ml pipette in place of a 25 ml pipette ?

A) Two times

B) Three times

C) Ten times

D) Five times - (Correct Alternative)

Correct Answer: D) Five times

Explanation: Relative error is inversely proportional to the volume measured when the absolute measurement error remains approximately the same. Replacing a 25 ml pipette with a 5 ml pipette reduces the measured volume by a factor of 5. Therefore, the relative error becomes five times greater.

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6. The pressure applied on the inlet of the column to overcome the slowness of flow of solvent in HPLC is :

A) 600 psi

B) 60 psi

C) 6000 psi - (Correct Alternative)

D) 60000 psi

Correct Answer: C) 6000 psi

Explanation: In High Performance Liquid Chromatography, the stationary phase contains very small particles that create considerable resistance to solvent flow. A high-pressure pump is therefore required to force the mobile phase through the column. Pressures around several thousand psi, such as 6000 psi, are commonly associated with conventional HPLC operation.

7. The sequence of ion movement in TLC using silica gel is :

A) Hg $> Bi > Cd > Cu > Pb$

B) Bi $> Hg > Cd > Pb > Cu$

C) Cd $> Bi > Hg > Pb > Cu$

D) Hg $> Bi > Cd > Pb > Cu$ – (Correct Alternative)

Correct Answer: D) Hg > Bi > Cd > Pb > Cu

Explanation: In thin-layer chromatography using silica gel, different metal ions interact differently with the stationary phase and the mobile phase. These differences in adsorption and affinity determine their relative movement. For the stated chromatographic system, the given migration sequence is Hg > Bi > Cd > Pb > Cu.

8. The DTA of calcium oxalate monohydrate shows ___ number of peaks.

A) 4

B) 2

C) 3 - (Correct Alternative)

D) 1

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Correct Answer: C) 3

Explanation: Differential Thermal Analysis of calcium oxalate monohydrate typically shows three major thermal events. These correspond broadly to dehydration of the monohydrate, decomposition of calcium oxalate to calcium carbonate, and subsequent decomposition of calcium carbonate to calcium oxide. Hence, three characteristic peaks are observed.

9. Why do atoms combine?

A) To acquire net attractive forces between atoms

B) To lower the energy of combining atoms

C) To obey octet rule

D) To acquire net attractive forces between atoms, To lower the energy of combining atoms and To obey octet rule - (Correct Alternative)

Correct Answer: D) To acquire net attractive forces between atoms, to lower the energy of combining atoms and to obey octet rule

Explanation: Atoms generally combine when bond formation produces a more stable, lower-energy arrangement. Attractive interactions between nuclei and electrons help stabilize the bonded atoms, and many main-group atoms attain stable valence-shell configurations often described by the octet rule. Therefore, all the listed ideas contribute to explaining bond formation.

10. Identify the one which is not related to hydrogen bond.

A) HCl - (Correct Alternative)

B) H_2O

C) NH_3

D) HF

Correct Answer: A) HCl

Explanation: Strong conventional hydrogen bonding generally occurs when hydrogen is directly bonded to a highly electronegative and small atom such as fluorine, oxygen or nitrogen. H2O, NH3 and HF can therefore form hydrogen bonds. HCl does not normally exhibit significant conventional hydrogen bonding because chlorine is larger and does not produce the required strong interaction.

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11. Which one of the following molecules is diamagnetic ?

A) CO molecule - (Correct Alternative)

B) B_2 molecule

C) O_2 molecule

D) NO molecule

Correct Answer: A) CO molecule
Explanation:
CO is diamagnetic because all the electrons present in its molecular orbitals are paired. A substance is called diamagnetic when it does not contain any unpaired electrons and is weakly repelled by an external magnetic field. In contrast, B2, O2, and NO contain unpaired electrons in their molecular orbital configurations and therefore exhibit paramagnetic behaviour. Hence, CO is the diamagnetic molecule among the given options.

12. Bond order of H_2 molecule is :

A) 1 - (Correct Alternative)

B) 2

C) 1.5

D) zero

Correct Answer: A) 1
Explanation:
The bond order of H2 can be determined using molecular orbital theory. The two electrons of the hydrogen molecule occupy the bonding sigma 1s molecular orbital, while the antibonding sigma star 1s orbital remains empty. Bond order is calculated as one-half of the difference between bonding and antibonding electrons. Thus, bond order = 1/2 (2 - 0) = 1. Therefore, H2 has a single stable covalent bond.

13. n - type extrinsic semiconductor is obtained when :

A) Carbon is added Si

B) B is added Si

C) P is added Si - (Correct Alternative)

D) Li is added Si

Correct Answer: C) P is added to Si
Explanation:

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An n-type extrinsic semiconductor is produced by doping pure silicon with a pentavalent impurity such as phosphorus. Silicon has four valence electrons, whereas phosphorus has five. Four electrons of phosphorus form covalent bonds with neighbouring silicon atoms, while the fifth electron remains loosely bound and becomes available for electrical conduction. Since electrons are the majority charge carriers in this material, phosphorus-doped silicon is called an n-type semiconductor.

14. The strongest Base is :

A) S^{2-}

B) OH^{2-}

C) O^{2-}

D) NH^{2-}

Correct Answer: D) NH2−
Explanation:
NH2−, called the amide ion, is the strongest base among the given species. The strength of a base can be compared by considering the acidity of its conjugate acid. The conjugate acid of NH2− is NH3, which is an extremely weak acid and therefore has a very strong conjugate base. NH2− readily accepts a proton to form NH3. Hence, among S2−, hydroxide, oxide, and amide ions, NH2− is the strongest base.

15. The combination of hard acid and hard base occurs through :

A) Covalent Bonding

B) Metallic Bonding

C) Ionic Bonding - (Correct Alternative)

D) Coordinate Covalent Bonding

Correct Answer: C) Ionic Bonding
Explanation:
According to the Hard and Soft Acids and Bases principle, commonly called the HSAB principle, hard acids preferentially combine with hard bases. Hard acids and hard bases generally possess high charge density and relatively low polarizability. Their interaction is mainly due to strong electrostatic attraction between oppositely charged species. Therefore, the bonding between a hard acid and a hard base predominantly possesses ionic character rather than covalent or metallic character.

16. Buffer solution can :

A) alter the pH of a solution

B) decreases the pH of a solution

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C) increases the pH of a solution

D) resist the change in pH of a solution - (Correct Alternative)

Correct Answer: D) Resist the change in pH of a solution
Explanation:
A buffer solution is a solution that resists a significant change in its pH when a small quantity of acid or base is added. It generally consists of a weak acid and its conjugate base or a weak base and its conjugate acid. When acid is added, the basic component neutralizes it, while the acidic component reacts with added base. Therefore, the primary function of a buffer is to maintain an approximately constant pH.

17. Radioactive disintegrations are :

A) Irreversible - (Correct Alternative)

B) Reversible

C) In equilibrium

D) Non-Spontaneous

Correct Answer: A) Irreversible
Explanation:
Radioactive disintegration is an irreversible process because an unstable atomic nucleus spontaneously transforms into a different nucleus by emitting alpha particles, beta particles, gamma radiation, or other forms of radiation. Once the radioactive nucleus has undergone a particular decay, the products do not spontaneously recombine to reproduce the original nucleus by reversing the same process under ordinary conditions. Therefore, radioactive disintegration is considered spontaneous and irreversible in nature.

18. Nuclear reaction is in accordance with :

A) Planck's constant

B) de-Broglie equation

C) Boltzmann distribution

D) Einstein mass-energy relationship - (Correct Alternative)

Correct Answer: D) Einstein mass-energy relationship
Explanation:
Nuclear reactions obey Einstein's mass-energy relationship, expressed as $E = mc^2$. During a nuclear reaction, the total mass of the products may differ slightly from the total mass of the original nuclei. This mass difference, called the mass defect, corresponds to an equivalent amount of energy according to Einstein's equation. Since even a very small mass can correspond to a large amount of energy, nuclear reactions can release enormous

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quantities of energy.

19. The maximum chain length of nitrogen is :

A) 2

B) 3

C) 4

D) 5

Correct Answer: B) 3
Explanation:
Nitrogen shows a relatively limited tendency for catenation, which means the ability of an element to form chains by bonding with atoms of the same element. The N-N single bond is comparatively weak because of strong repulsion between the lone pairs present on neighbouring nitrogen atoms. In the conventional treatment relevant to this question, nitrogen can form a maximum chain involving three nitrogen atoms. Therefore, the intended answer is a maximum chain length of 3.

20. $B - H_b - B$ bond in diborane is formed by :

A) $(sp^3)^1 - 1\ s^1 - (sp^3)^o$

B) $(sp^3)^1 - 1\ s^1 - (sp^3)^1$

C) $(sp^2)^1 - 1\ s^1 - (sp^3)^o$ – (Correct Alternative)

D) $(sp^3)^1 - 1\ s^1 - (sp^2)^o$

Correct Answer: C) (sp2)1 - 1s1 - (sp3)0
Explanation:
Diborane, B2H6, contains four normal terminal B-H bonds and two unusual bridging B-H-B bonds. Each bridging bond is described as a three-centre two-electron bond because a single pair of electrons is shared among two boron atoms and one bridging hydrogen atom. In the orbital description represented by the given alternatives, the occupied boron hybrid orbital interacts through the hydrogen 1s orbital with a vacant hybrid orbital on the other boron atom. Therefore, option C represents the intended orbital combination.

21. Structure of $[B_{12}H_{12}]^{2-}$ is :

A) T_d

B) oh

C) Pentagonal bipyramidal

D) Icosahedron - (Correct Alternative)

Correct Answer: D) Icosahedron

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Explanation:
The borane cluster ion [B12H12]2− has a closo structure according to Wade's rules. It contains twelve boron atoms that occupy the twelve vertices of a regular icosahedron. Each boron atom is bonded to one terminal hydrogen atom, producing a highly symmetrical and stable cluster. The closo borane [B12H12]2− therefore possesses an icosahedral cage structure rather than tetrahedral, octahedral, or pentagonal bipyramidal geometry.

22. Borazine has ___ structure.

A) Tetrahedral

B) Planar trigonal

C) Hexagonal

D) Planar hexagonal - (Correct Alternative)

Correct Answer: D) Planar hexagonal
Explanation:
Borazine has the molecular formula B3N3H6 and is often called inorganic benzene because its structure resembles that of benzene. It contains a six-membered ring consisting of alternating boron and nitrogen atoms. The atoms of the B3N3 ring lie approximately in the same plane, giving the molecule a planar hexagonal structure. Although borazine resembles benzene structurally, its B-N bonds are polar because nitrogen is more electronegative than boron.

23. P_2O_5 reacts with 3 molecules of H_2O to form :

A) Metaphosphoric acid

B) Orthophosphoric acid - (Correct Alternative)

C) Hypophosphoric acid

D) Phosphorus acid

Correct Answer: B) Orthophosphoric acid
Explanation:
Phosphorus pentoxide reacts with water to produce phosphoric acids, and complete hydration with three molecules of water per P2O5 unit produces orthophosphoric acid. The reaction can be represented as P2O5 + 3H2O → 2H3PO4. H3PO4 is known as orthophosphoric acid or simply phosphoric acid. Therefore, when one molecule of P2O5 reacts with three molecules of water, the product formed is orthophosphoric acid.

24. Which one of the following is sulphurous acid anhydride ?

A) SO_2 - (Correct Alternative)

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B) SO_3

C) H_2SO_3

D) H_2SO_4

Correct Answer: A) SO2
Explanation:
Sulphur dioxide, SO2, is regarded as the acid anhydride of sulphurous acid, H2SO3. An acid anhydride is generally a non-metal oxide that produces the corresponding acid when it reacts with water. Sulphur dioxide reacts with water and is conventionally represented as forming sulphurous acid: SO2 + H2O → H2SO3. In contrast, SO3 is the acid anhydride of sulphuric acid, H2SO4. Therefore, SO2 is the correct answer.

25. Which is strongest ligand ?

A) NH_3

B) H_2O

C) CN^{Θ} - (Correct Alternative)

D) $F^{\circledR}$

Correct Answer: C) CN−
Explanation:
According to the spectrochemical series, ligands can be arranged based on their ability to cause crystal-field splitting of the d orbitals of a metal ion. Among NH3, H2O, CN− and F−, the cyanide ion is the strongest-field ligand. CN− can produce a large crystal-field splitting and often favours electron pairing and low-spin complexes. Therefore, CN− is considered the strongest ligand among the options given in this question.

26. Strong Jahn - Teller effect expected in :

A) d^7 and d^4 (High Spin)

B) d4 (High Spin), d7 (Low Spin), d9 - (Correct Alternative)

$C: d^2, d^6$ (High Spin)

$D: d^3, d^5$ (High Spin)

Correct Answer: B) d4 (High Spin), d7 (Low Spin), d9
Explanation:
For an octahedral complex, a strong Jahn-Teller distortion is expected when the degenerate eg orbitals are occupied unsymmetrically. High-spin d4 has eg1, low-spin d7 has eg1, and d9 has eg3; all therefore show strong Jahn-Teller distortion. Octahedral d8 has symmetric eg2 occupancy and is not a strong Jahn-Teller case.

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27. The most suitable route to prepare the trans-isomer of $[Pt(Py)(PEt_3)Cl_2]$ is :

A) $[PtCl_4]^{2-}$ with PEt_3 followed by the reaction with Py - (Correct Alternative)

B) $[PtCl_4]^{2-}$ with Py followed by the reaction with PEt_3

C) $[PtCl_4]^{2-}$ with HCl followed by the reaction with PEt_3

D) $[PtCl_4]^{2-}$ with PEt_3 followed by the reaction with HCl

Correct Answer: A) [PtCl4]2− with PEt3 followed by the reaction with Py
Explanation:
The preparation of geometrical isomers of square-planar platinum(II) complexes can be controlled using the trans effect. PEt3 is a strong trans-directing ligand and has a considerably stronger trans effect than chloride. When [PtCl4]2− is first treated with PEt3, the phosphine ligand directs subsequent substitution preferentially at the position trans to itself. Addition of pyridine, Py, then leads to the required arrangement, making this sequence suitable for preparing the trans-isomer of [Pt(Py)(PEt3)Cl2].

28. The order of CO Stretching frequency in the following complex is :

(i) $Cr(CO)_6$

(ii) $[V(CO)_6]^{\ominus}$

(iii) $[Mn(CO)_6]^{\oplus}$

A) (ii) < (iii) < (i)

B) (iii) < (i) < (ii)

C) (ii) < (i) < (iii) - (Correct Alternative)

D) (iii) < (ii) < (i)

Correct Answer: C) (ii) < (i) < (iii)
Explanation:
The C-O stretching frequency in metal carbonyl complexes depends strongly on metal-to-CO pi back bonding. Greater back donation from the metal into the antibonding orbitals of CO weakens the C-O bond and lowers its stretching frequency. The negatively charged [V(CO)6]− has greater electron density and therefore stronger back bonding, giving the lowest frequency. Cr(CO)6 is intermediate, while positively charged [Mn(CO)6]+ shows weaker back bonding and therefore the highest C-O stretching frequency.

29. An intermediate formed during the oxo process is :

A) $[HCo(CO)_5]$

B) $[HCo(CO)_4]$ - (Correct Alternative)

C) $[H_2Co(CO)_4]$

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D) $[H_4Co(CO)_3]$

Correct Answer: B) [HCo(CO)4]
Explanation:
The oxo process, also called hydroformylation, converts an alkene into an aldehyde by reaction with carbon monoxide and hydrogen. A classic catalyst associated with this reaction is cobalt carbonyl, from which the active species hydridocobalt tetracarbonyl, HCo(CO)4, is generated. This species participates in important steps such as alkene coordination, hydride transfer, carbon monoxide insertion and product formation. Therefore, HCo(CO)4 is an important intermediate in the cobalt-catalysed oxo process.

30. Among the following compound which is paramagnetic ?

A) $Fe(CO)_5$

B) $V(CO)_5$ - (Correct Alternative)

C) $Cr(CO)_6$

D) $Ni(CO)_4$

Correct Answer: B) V(CO)5
Explanation:
V(CO)5 is paramagnetic because it has an odd total number of valence electrons and consequently contains an unpaired electron. Paramagnetic compounds are attracted by an external magnetic field because of the presence of one or more unpaired electrons. In contrast, Fe(CO)5, Cr(CO)6 and Ni(CO)4 are well-known metal carbonyls with paired-electron configurations and are diamagnetic. Therefore, V(CO)5 is the paramagnetic compound among the given choices.

31. Choose the suitable catalyst for the following reaction:

$\mathbf{R-H+1/2O_2 \rightarrow R-O-H}$

A) Cytochrome - C - Oxidase

B) Cytochrome - P - 450 - (Correct Alternative)

C) Nitrogenase

D) Ferredoxin

Correct Answer: B) Cytochrome-P-450
Explanation:
Cytochrome P450 enzymes catalyze monooxygenation reactions in which one oxygen atom from molecular oxygen is introduced into an organic substrate while the other oxygen atom is reduced to water. A typical transformation is the hydroxylation of a C-H bond, represented in simplified form as R-H + 1/2 O2 → R-OH. Cytochrome P450 contains a heme iron centre and plays an important role in drug metabolism,

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detoxification, and biosynthesis. Therefore, Cytochrome P450 is the suitable catalyst.

32. The correct order of ionic radius Yb^{3+}, La^{3+}, Eu^{3+} and Lu^{3+} is :

A) $Yb^{3+} < Lu^{3+} < Eu^{3+} < La^{3+}$

B) $Lu^{3+} < Eu^{3+} < La^{3+} < Yb^{3+}$

C) $Lu^{3+} < Yb^{3+} < Eu^{3+} < La^{3+}$ – (Correct Alternative)

D) $La^{3+} < Eu^{3+} < Yb^{3+} < Lu^{3+}$

Correct Answer: C) Lu3+ < Yb3+ < Eu3+ < La3+
Explanation:
The ionic radii of trivalent lanthanide ions gradually decrease from La3+ to Lu3+ as the atomic number increases. This phenomenon is known as lanthanide contraction. Across the lanthanide series, electrons are added to the 4f orbitals, which shield the increasing nuclear charge rather poorly. Consequently, the effective nuclear attraction increases and the ionic size decreases. Therefore, La3+ is the largest and Lu3+ is the smallest, giving the order Lu3+ < Yb3+ < Eu3+ < La3+.

33. The deep colour of $[CoCl_4]^{2-}$ and $[Co(H_2O)_6]^{2+}$ are due to :

A) d - d transitions in the first and MLCT transitions in the second

B) MLCT transition in the first and d - d transition in the second

C) d - d transitions in both - (Correct Alternative)

D) LMCT transition in both

Correct Answer: C) d-d transitions in both
Explanation:
The colours of [CoCl4]2− and [Co(H2O)6]2+ arise primarily from d-d electronic transitions involving the Co2+ ion. In a ligand field, the five d orbitals of the metal ion split into groups having different energies. When visible light is absorbed, electrons can move between these split d energy levels. The wavelengths that are not absorbed are observed as the characteristic colour of the complex. Therefore, d-d transitions are responsible for the colours of both cobalt complexes.

34. Which statement is false for enantiomeric properties ?

A) It interact with plane polarized light

B) Optically inactive - (Correct Alternative)

C) Chiral reagents

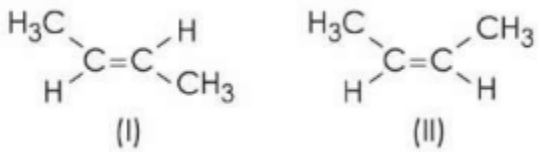
D) Non-super imposable

Correct Answer: B) Optically inactive

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Explanation:
Enantiomers are stereoisomers that exist as non-superimposable mirror images of each other. Individual enantiomers are optically active and interact with plane-polarized light by rotating its plane. One enantiomer rotates plane-polarized light in one direction, while its mirror-image form rotates it by an equal amount in the opposite direction.
Enantiomers can also behave differently toward chiral reagents or in chiral environments. Therefore, the statement that enantiomers are optically inactive is false.

35. The following compounds are



A) (I) and (II) are enantiomers

B) (I) and (II) are epimers

C) (I) and (II) are diasteromers - (Correct Alternative)

D) (I) and (II) are anomers

Correct Answer: C) (I) and (II) are diastereomers
Explanation:
The two compounds shown are geometrical isomers of 2-butene. In structure (I), the two CH3 groups are present on opposite sides of the carbon-carbon double bond, representing trans-2-butene or the E-isomer. In structure (II), the two CH3 groups are on the same side, representing cis-2-butene or the Z-isomer. Cis-trans isomers are stereoisomers that are not mirror images of each other. Such stereoisomers are classified as diastereomers. Therefore, compounds (I) and (II) are diastereomers.

36. Arrange the order of priority in the R, S configuration HO, COR, OH, NO_2, SH :

A) $SH > OH > NO_2 > COR > CHO$ – (Correct Alternative)

B) $SH > NO_2 > OH > CHO > COR$

C) $SH > OH > NO_2 > CHO > COR$

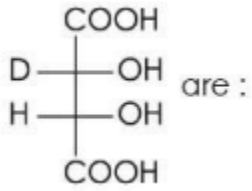
D) $OH > SH > NO_2 > COR > CHO$

Correct Answer: A) SH > OH > NO2 > COR > CHO
Explanation:
The priority in R,S configuration is assigned according to the Cahn-Ingold-Prelog rules.

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First, the atomic number of the atom directly attached to the stereogenic carbon is considered. Sulfur in SH has the highest atomic number, followed by oxygen in OH, nitrogen in NO2, and carbon in COR and CHO. Between COR and CHO, the attached atoms are compared further. COR receives higher priority than CHO because the carbonyl carbon is attached to another carbon instead of hydrogen. Therefore, the correct priority order is SH > OH > NO2 > COR > CHO.

37. Choose the correct configuration for the following compound



are :

A) 2R, 3R

B) 2S, 3S

C) 3R, 2S

D) 2R, 3S - (Correct Alternative)

Correct Answer: D) 2R, 3S
Explanation:
The structure is represented as a Fischer projection with two stereogenic centres at carbon 2 and carbon 3. According to the Cahn-Ingold-Prelog priority rules, the groups attached to each stereogenic carbon are ranked based on atomic number, with isotopic mass also considered when comparing hydrogen and deuterium. In a Fischer projection, horizontal bonds project toward the observer and vertical bonds project away. After assigning priorities and applying the required reversal when the lowest-priority group points toward the observer, carbon 2 has the R configuration and carbon 3 has the S configuration. Therefore, the compound has the 2R, 3S configuration.

38. The conversion of diastereomeric 3-bromo-2-butanol to 2,3-dibromobutane using PBr3 proceeds with inversion at C-2. Which statement is true?

A) Threo-3-bromobutan-2-ol gives meso product

B) Threo-3-bromobutan-2-ol gives racemic product

C) Erythro-3-bromobutan-2-ol gives racemic mixture

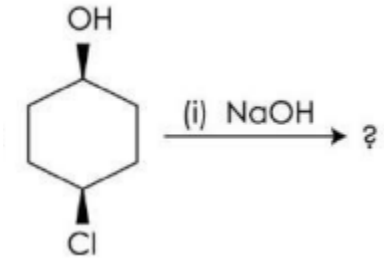
D) Both A and C are correct - (Correct Alternative)

Correct Answer: D) Both A and C are correct
Explanation:

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PBr3 converts the alcohol group into bromide by an SN2 pathway, so the configuration at C-2 is inverted while the configuration at C-3 is retained. The threo enantiomeric pair (2R,3R)/(2S,3S) therefore gives the meso 2,3-dibromobutane configuration after inversion at C-2. The erythro pair (2R,3S)/(2S,3R) gives the enantiomeric (2R,3R) and (2S,3S) products, i.e. a racemic mixture. Hence A and C are both correct.

39. Predict the product in the S_N2 reactions



A)

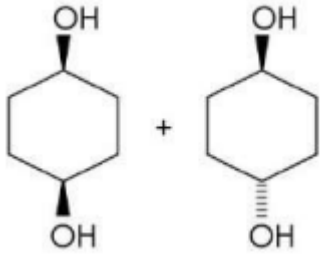


B)



– (Correct Alternative)

C)



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D) 

Correct Answer: B) trans-1,4-Cyclohexanediol
Explanation:
This reaction proceeds through an SN2 nucleophilic substitution mechanism. The hydroxide ion, OH−, acts as the nucleophile and attacks the carbon bearing the chlorine atom from the side opposite to the C-Cl bond. An SN2 reaction occurs through backside attack and therefore produces inversion of configuration at the reacting carbon. Initially, the OH and Cl groups are shown on the same side of the cyclohexane ring. When Cl is replaced by OH with inversion, the newly introduced OH group appears on the opposite side. Therefore, the product contains two OH groups in a trans relationship, corresponding to option B.

40. Acetolysis of exo and endo-norbornyl tosylates found that :

A) The Solvolysis of endo isomer is faster than exo isomer

B) The Solvolysis of exo isomer is faster than endo isomer - (Correct Alternative)

C) Both endo and exo isomers are reacts fast

D) Both endo and exo isomers are reacts slow

Correct Answer: B) The solvolysis of exo isomer is faster than endo isomer
Explanation:
During the acetolysis of norbornyl tosylates, the exo isomer undergoes solvolysis much faster than the corresponding endo isomer. This enhanced reaction rate is explained by neighbouring-group participation of the C1-C6 sigma bond. In the exo-norbornyl tosylate, the geometry permits effective participation of this neighbouring bond as the tosylate group leaves, stabilizing the developing carbocation through a bridged nonclassical norbornyl cation. The endo isomer does not receive equally favourable assistance. Therefore, the exo isomer undergoes solvolysis faster than the endo isomer.

41. Which conformation structure of cyclohexane is more stable ?

A) Boat form

B) Chair form - (Correct Alternative)

C) Twist boat

D) Half chair

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Correct Answer: B) Chair form
Explanation:
The chair conformation is the most stable conformation of cyclohexane because it has minimum angle strain and minimum torsional strain. In the chair form, all carbon-carbon bond angles are close to the normal tetrahedral angle of 109.5 degrees, and adjacent carbon-hydrogen bonds are staggered. The boat form suffers from eclipsing interactions and flagpole repulsion, while the twist-boat form is more stable than the boat but less stable than the chair. The half-chair has considerable strain and is the least stable major conformation. Therefore, the chair form is the most stable.

42. How many stereoisomers are possible for 2-isopropyl-3-methylcyclohexanol?

A) 7

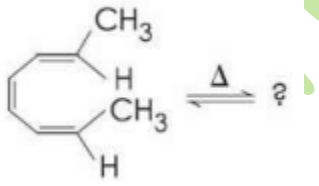
B) 6

C) 4

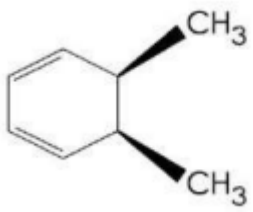
D) 8 - (Correct Alternative)

Correct Answer: D) 8
Explanation:
2-Isopropyl-3-methylcyclohexanol contains three stereogenic carbon atoms: the carbon bearing the OH group, the carbon bearing the isopropyl group, and the carbon bearing the methyl group. For a molecule containing n independent stereogenic centres, the maximum number of stereoisomers is calculated as 2^n. Here, n = 3, so the maximum number is 2^3 = 8. The molecule does not possess the internal symmetry required to produce meso forms that would reduce this number. Therefore, 2-isopropyl-3-methylcyclohexanol can have 8 stereoisomers.

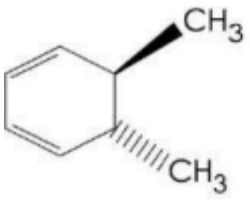
43. What is the major product of the following reaction?



A)

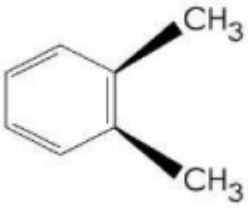


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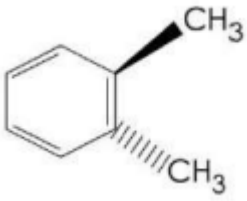


– (Correct Alternative)

B)



C)



D)

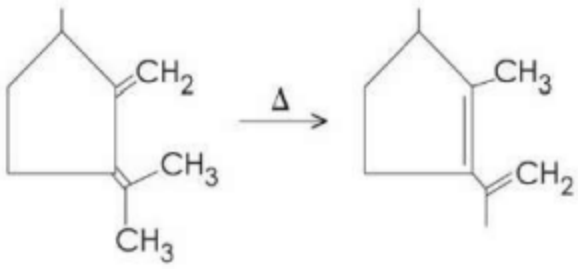
Correct Answer: B) trans product

Explanation:

On heating, the substituted cycloheptatriene system undergoes an electrocyclic ring-closure reaction to form a six-membered ring containing two double bonds. The stereochemical outcome is controlled by the Woodward-Hoffmann rules for electrocyclic reactions. The reacting conjugated system undergoes the thermally allowed mode of rotation, which determines the relative orientation of the two methyl groups in the product. As a result, one CH3 group is directed above the plane while the other is directed below the plane. Therefore, the two methyl groups are trans to each other, giving the product shown in option B.

44. Which of the following best describes the sigmatropic rearrangement that occurs in the reaction shown below ?

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A) [1, 3] sigmatropic rearrangement

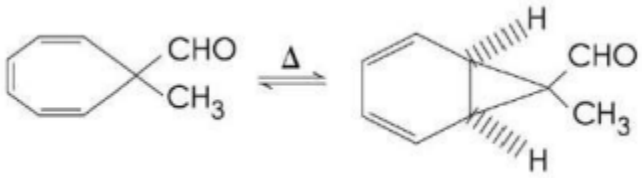
B) [2, 3] sigmatropic rearrangement

C) [3, 3] sigmatropic rearrangement

D) [1, 5] sigmatropic rearrangement - (Correct Alternative)

Correct Answer: D) [1,5] sigmatropic rearrangement
Explanation:
The reaction shown is a sigmatropic rearrangement because a sigma bond migrates across a conjugated pi-electron system while the positions of the double bonds change simultaneously. In sigmatropic nomenclature, the numbers indicate the positions of the atoms involved in migration relative to the original sigma bond. Here, the migrating group shifts from one end of a five-atom conjugated system to the other, corresponding to a [1,5] shift. Such rearrangements are concerted pericyclic processes and can occur thermally through a cyclic transition state. Therefore, the reaction is classified as a [1,5] sigmatropic rearrangement.

45. Select the correct classification for the following reaction from options I to IV.



(I) Conrotatory electrocyclic reaction

(II) Disrotatory electrocyclic reaction

(III) Valence isomerisation

(IV) $\left(\pi_s^4 + \pi_a^2\right)$ cyclo addition

A : (I) and (III)

B : (II) and (IV)

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C : (II) and (III) - (Correct Alternative)

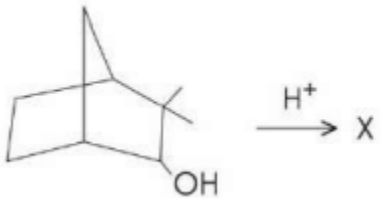
D : (I) and (IV)

Correct Answer: C) (II) and (III)

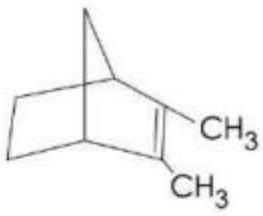
Explanation:

The reaction shown occurs on heating and involves a rearrangement of the conjugated cyclic pi-electron system without the addition or removal of atoms. It can therefore be described as a valence isomerisation, because the reactant and product differ mainly in their bonding arrangement rather than their molecular formula. The stereochemical movement of the terminal portions of the conjugated system occurs in opposite rotational directions, corresponding to a disrotatory electrocyclic process. Thus, statements II and III correctly classify the transformation, making option C the correct answer.

46. In the following reaction, ' *X* ' will be :

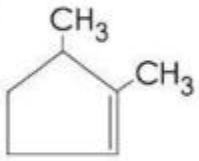


A :

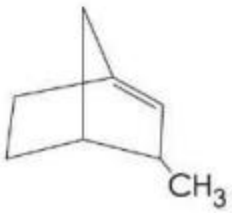


– (Correct Alternative)

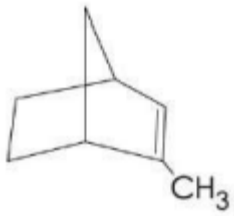
B :



C :



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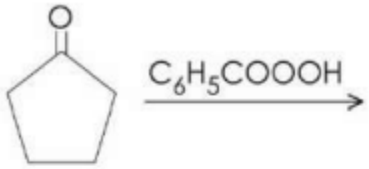
D)

Correct Answer: A)

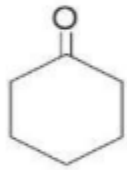
Explanation:

In the presence of H+, the alcohol group is first protonated, converting the OH group into a better leaving group as water. Loss of water produces a carbocation in the rigid bicyclic system. This carbocation undergoes a skeletal rearrangement involving neighbouring carbon-carbon bond participation, which gives a more favourable bridged carbocation intermediate. Subsequent loss of a proton produces the alkene. The rearrangement also determines the final positions of the methyl substituents and the double bond. Therefore, the rearranged bicyclic alkene structure represented in option A is the correct product.

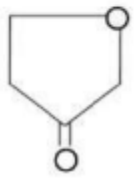
47. Predict the suitable product



A :

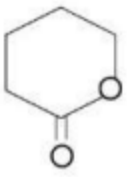


B :



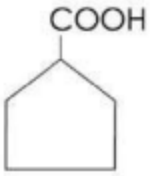
C)

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– (Correct Alternative)

D :



Correct Answer: C) Six-membered lactone
Explanation:
Cyclopentanone reacts with peroxybenzoic acid, C6H5COOOH, through the Baeyer-Villiger oxidation. In this reaction, a ketone is converted into an ester by insertion of an oxygen atom next to the carbonyl group. When the starting ketone is cyclic, oxygen insertion causes ring expansion by one member and produces a lactone, which is a cyclic ester. Therefore, the five-membered cyclopentanone ring is converted into a six-membered lactone ring containing an oxygen atom adjacent to the carbonyl carbon. Hence, the structure shown in option C is the correct product.

48. Aliphatic amines upon treatment with nitrous acid form highly unstable diazonium salts which readily lose nitrogen to give carbocations followed by rearrangement. This type of rearrangement is called:

A) Wagner Meerwein rearrangement

B) Pinacol - Pinacolone rearrangement

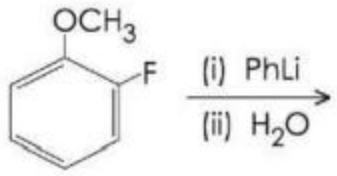
C) Demjanov rearrangement - (Correct Alternative)

D) None of the options

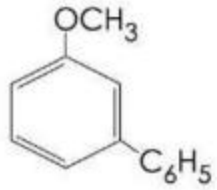
Correct Answer: C) Demjanov rearrangement
Explanation:
The Demjanov rearrangement occurs when a primary aliphatic amine is treated with nitrous acid. The amine initially forms an unstable aliphatic diazonium salt, which rapidly loses nitrogen gas to generate a carbocation intermediate. This carbocation can undergo rearrangement through migration of an adjacent carbon-carbon bond, often resulting in ring expansion or skeletal rearrangement. The rearranged carbocation subsequently reacts with water to form an alcohol. Therefore, the rearrangement associated with the decomposition of aliphatic diazonium salts is called the Demjanov rearrangement.

49. The most favoured product in the following reaction is :

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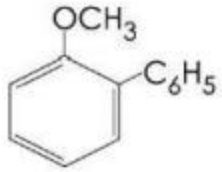


A :

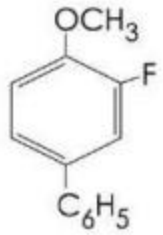


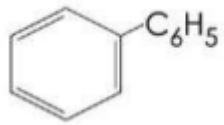
– (Correct Alternative)

B :



C :



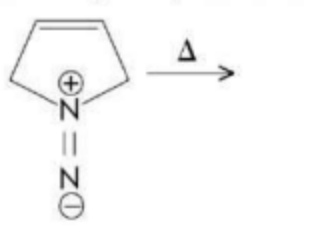


D)

Correct Answer: A) 3-Phenylanisole
Explanation:
The reaction of o-fluoroanisole with phenyllithium, PhLi, proceeds through a benzyne intermediate. PhLi acts as a strong base and removes the hydrogen adjacent to the fluorine-bearing carbon, followed by elimination of fluoride to generate benzyne. The phenyl nucleophile then adds to the benzyne intermediate. Because the methoxy group influences the electronic distribution of the benzyne, nucleophilic attack occurs preferentially at the position that ultimately places the phenyl group meta to the methoxy group after protonation with water. Therefore, 3-phenylanisole, shown in option A, is the most favoured product.

50. Identify the product obtained in the following reaction :

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A) 1,3-butadiene - (Correct Alternative)

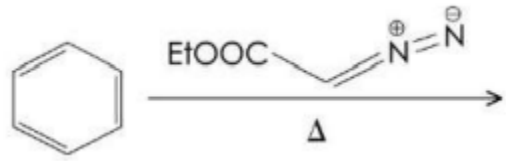
B) 1-butene

C) 2-Butene

D) Butane

Correct Answer: A) 1,3-butadiene
Explanation:
The given compound is a cyclic diazene-related system that undergoes thermal decomposition on heating. The nitrogen-containing portion is highly favourable for decomposition because molecular nitrogen, N2, is exceptionally stable and can be eliminated readily. During heating, extrusion of nitrogen is accompanied by cleavage and rearrangement of the cyclic framework, producing an open-chain conjugated diene. The resulting four-carbon product contains two alternating carbon-carbon double bonds, giving CH2=CH-CH=CH2. Therefore, the product formed in this thermal reaction is 1,3-butadiene.

51. Predict the product in the following reaction :

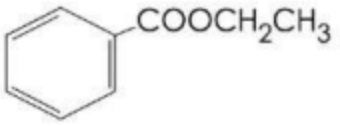


A)

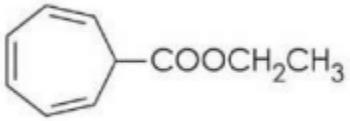


B)

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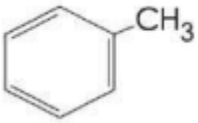


C)



– (Correct Alternative)

D)



Correct Answer: C) Ethyl cyclohepta-2,4,6-triene-1-carboxylate
Explanation:
The diazo compound shown undergoes thermal decomposition on heating and loses molecular nitrogen, N2, to generate a carbene intermediate containing the COOCH2CH3 group. This carbene reacts with benzene initially through cyclopropanation to produce a norcaradiene-type bicyclic intermediate. The strained three-membered ring then undergoes electrocyclic ring opening, resulting in ring expansion from a six-membered benzene system to a seven-membered conjugated cycloheptatriene system. The ester group remains attached to the newly incorporated carbon. Therefore, the ring-expanded cycloheptatriene ester shown in option C is the correct product.

52. The reagents used in Wolff-Kishner reduction are:

A) NaBH4, KOH / ethylene glycol

B) NH2NH2, KOH / ethylene glycol - (Correct Alternative)

C) LiAlH4, KOH / ethylene glycol

D) H2, KOH / ethylene glycol

Correct Answer: B) NH2NH2, KOH / Ethylene glycol
Explanation:
The Wolff-Kishner reduction is used to convert aldehydes and ketones into the corresponding hydrocarbons by replacing the carbonyl group, C=O, with a methylene group, CH2. The carbonyl compound first reacts with hydrazine, NH2NH2, to form a hydrazone. On heating with a strong base such as KOH in a high-boiling solvent like ethylene glycol, the hydrazone decomposes with the elimination of nitrogen gas.

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Therefore, hydrazine and KOH in ethylene glycol are the required reagents.

53. Gilman reagent is :

A) $H_2O_2/NaOH$

B) $(CH_3CH_2)_3SiCl$

C) $(CH_3)_2CuLi$ - (Correct Alternative)

D) $(CH_3)_3SiCH_2COOH$

Correct Answer: C) (CH3)2CuLi
Explanation:
Gilman reagents are organocopper compounds having the general formula R2CuLi, where R represents an alkyl or aryl group. They are also called lithium dialkylcuprates or lithium diarylcuprates. The compound (CH3)2CuLi is lithium dimethylcuprate and is a typical Gilman reagent. These reagents are particularly useful in carbon-carbon bond-forming reactions, including coupling with organic halides and conjugate 1,4-addition to alpha,beta-unsaturated carbonyl compounds. Therefore, (CH3)2CuLi is the correct answer.

54. Knoevenagel reaction involves the interaction of an aromatic aldehyde and an active methylene compound in the presence of :

A) Methylamine

B) Aniline

C) Azole

D) Pyridine - (Correct Alternative)

Correct Answer: D) Pyridine
Explanation:
The Knoevenagel reaction is a condensation reaction between an aldehyde or ketone and a compound containing an active methylene group. The reaction is generally promoted by a weak basic catalyst, commonly an amine or a nitrogen-containing base. Among the options provided, pyridine acts as the suitable basic catalyst. It facilitates removal of an acidic hydrogen from the active methylene compound, allowing carbon-carbon bond formation with the carbonyl compound, followed by dehydration to produce the condensation product.

55. Hydrogenation of cyclopropene in the presence of Raney nickel gives :

A) Cyclopropane

B) n-Propane - (Correct Alternative)

C) Ethene and methane

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D) Ethene and Ethane

Correct Answer: B) n-Propane
Explanation:
Cyclopropene contains a highly strained three-membered ring along with a carbon-carbon double bond. In the presence of hydrogen and Raney nickel, catalytic hydrogenation initially reduces the double bond. Under the stated catalytic conditions, hydrogenolysis of the highly strained carbon-carbon framework can also occur, resulting in ring opening. The final saturated open-chain hydrocarbon contains three carbon atoms and is propane, CH3-CH2-CH3. Therefore, according to the reaction conditions and the given alternatives, n-propane is the expected product.

56. What will be the >C=O stretching band in IR of $H_2C=CHCOCH_3$ compound?

A) 1700 cm^{-1}

B) 1780 cm^{-1}

C) 1710 cm^{-1}

D) 1680 cm^{-1} - (Correct Alternative)

Correct Answer: D) 1680 cm−1
Explanation:
The compound H2C=CHCOCH3 is an alpha,beta-unsaturated ketone in which the carbonyl group is conjugated with a carbon-carbon double bond. A normal saturated ketone generally shows C=O stretching absorption near 1715 cm−1. Conjugation allows electron delocalization between the C=C and C=O groups, reducing the effective bond order and strength of the carbonyl bond. As a result, its stretching frequency shifts to a lower wavenumber, typically around 1680 cm−1. Therefore, option D is correct.

57. The compound R2N-CH2-CH(R')-CO2R is called:

A) Lewis base

B) Lewis acid

C) Mannich base - (Correct Alternative)

D) Mannich acid

Correct Answer: C) Mannich base
Explanation:
A Mannich base is generally a beta-aminocarbonyl compound produced through the Mannich reaction. This reaction involves a compound containing an active hydrogen, usually an enolizable carbonyl compound, together with formaldehyde and a primary or secondary amine. The resulting product contains an amino group at the beta position relative to the carbonyl functionality. The structure R2N-CH2-CH(R′)-CO2R has this

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characteristic beta-amino carbonyl arrangement. Therefore, the given compound is classified as a Mannich base.

58. The reagents used in the oxidation of primary or secondary alcohol to the corresponding carbonyl compound in Swern oxidation is :

A) alkaline $K_2Cr_2O_7$

B) alc. $KMnO_4$

C) $COCl_2$, DMSO/-78°C, Et_3 N - (Correct Alternative)

D) Cu/573 K

Correct Answer: C) COCl2, DMSO / −78°C, Et3N
Explanation:
Swern oxidation is a mild method for converting primary alcohols into aldehydes and secondary alcohols into ketones without significant overoxidation. The reaction commonly uses dimethyl sulfoxide, DMSO, activated by oxalyl chloride, (COCl)2, at a low temperature of approximately −78°C. The alcohol is then introduced, followed by a tertiary amine base such as triethylamine, Et3N. These conditions generate the corresponding carbonyl compound efficiently. Therefore, option C contains the characteristic reagents used in Swern oxidation.

59. The reaction which combines both the Michael addition and the Aldol condensation is :

A) Robinson Annulation - (Correct Alternative)

B) Rosenmund-Von Braun Reaction

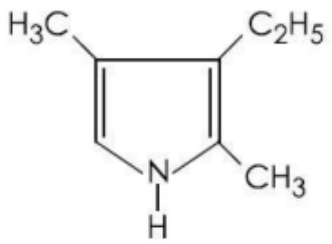
C) Rubottom Oxidation

D) Reformatsky Reaction

Correct Answer: A) Robinson Annulation
Explanation:
Robinson annulation is an important carbon-carbon bond-forming reaction that combines a Michael addition with an intramolecular aldol condensation. Initially, an enolate or related nucleophile undergoes conjugate 1,4-addition to an alpha,beta-unsaturated carbonyl compound through the Michael reaction. The resulting intermediate then undergoes intramolecular aldol condensation, forming a new six-membered ring. Dehydration usually produces a cyclohexenone derivative. Thus, because both Michael addition and aldol condensation occur in the overall transformation, the reaction is called Robinson annulation.

60. The name of the pyrrole derivative

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is :

is :

A) Opsopyrrole

B) Haemopyrrole

C) Cryptopyrrole - (Correct Alternative)

D) Phyllopyrrole

Correct Answer: C) Cryptopyrrole
Explanation:
The structure shown is cryptopyrrole. Numbering the pyrrole ring from nitrogen as position 1 gives methyl substituents at C-2 and C-4 and an ethyl substituent at C-3. Thus cryptopyrrole is 3-ethyl-2,4-dimethylpyrrole (equivalently, 2,4-dimethyl-3-ethylpyrrole).

61. Pyrrole on chlorination with SO_2Cl_2 (4 moles) in the presence of ether at 0°C to form :

A) 2,3,4,5-tetrachloro pyrrole - (Correct Alternative)

B) 2-chloro pyrrole

C) 2,5-dichloro pyrrole

D) N-chloro pyrrole

Correct Answer: A) 2,3,4,5-Tetrachloropyrrole
Explanation:
Pyrrole is a highly electron-rich aromatic heterocyclic compound and therefore undergoes electrophilic substitution reactions very readily. When pyrrole is treated with four moles of sulfuryl chloride, SO2Cl2, in ether at 0°C, extensive chlorination takes place at all four available carbon positions of the pyrrole ring. The hydrogen attached to nitrogen remains unaffected under these conditions. Consequently, chlorine atoms occupy positions 2, 3, 4, and 5 of the pyrrole ring. Therefore, the product formed is 2,3,4,5-tetrachloropyrrole.

62.

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A) Methyl 6-oxohexa-2,4-dienoate - (Correct Alternative)

B) Furfural

C) 2-Acetylfuran

D) 2,5-dinitrofuran

Correct Answer: A) Methyl 6-oxohexa-2,4-dienoate
Explanation:
Methyl diazoacetate generates a methoxycarbonyl carbene, which adds to furan to give an oxabicyclo[3.1.0]hexene-type cyclopropane adduct. On heating at about 140-160°C, this strained adduct undergoes ring opening to the conjugated dienal ester OHC-CH=CH-CH=CH-COOCH3. The methoxycarbonyl group is retained, so muconaldehyde cannot be the product.

63. When Ketone is added to furan photochemically, the product is :

A) Oxetene

B) Oxirane

C) Oxetane - (Correct Alternative)

D) Aziridines

Correct Answer: C) Oxetane
Explanation:
When a ketone reacts photochemically with furan, the excited carbonyl group undergoes a Paternò-Büchi reaction, a photochemical [2+2] cycloaddition with a carbon-carbon double bond. This produces a four-membered cyclic ether containing three carbon atoms and one oxygen atom. Such a cyclic ether is called an oxetane. Therefore, option C is correct.

64. Reduction of Indole with zinc and hydrochloric acid gives :

A) Benzene

B) Indoline - (Correct Alternative)

C) Pyrrole

D) Cyclohexane

Correct Answer: B) Indoline

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Explanation:
Indole contains a benzene ring fused with a nitrogen-containing five-membered ring. On treatment with zinc and hydrochloric acid, reduction occurs mainly at the 2,3-double bond of the pyrrole portion, while the benzene ring remains unchanged. The resulting partially hydrogenated compound is 2,3-dihydroindole, commonly called indoline. Therefore, the reduction product is indoline.

65. In Isoquinoline, electrophilic attack occurs preferentially at :

A) C_1 and C_3

B) C_5 and C_8 – (Correct Alternative)

C) C_3 and C_5

D) C_2 and C_4

Correct Answer: B) C5 and C8
Explanation:
Isoquinoline contains a benzene ring fused with a pyridine-like nitrogen-containing ring. The nitrogen atom withdraws electron density, making electrophilic substitution less favourable in the heterocyclic portion. Consequently, electrophilic substitution occurs preferentially on the fused benzene ring, particularly at C5 and C8, where the resulting intermediates retain greater aromatic stabilization. Therefore, C5 and C8 are the preferred positions.

66. Dipole moment value of azulene is :

A) 0.8 D - (Correct Alternative)

B) 0.1 D

C) 0.6 D

D) 0.4 D

Correct Answer: A) 0.8 D
Explanation:
Azulene is a non-benzenoid aromatic hydrocarbon containing fused five-membered and seven-membered rings. Important resonance structures involve charge separation, with the five-membered ring developing partial negative character and the seven-membered ring partial positive character. This internal charge separation produces a significant molecular dipole moment of approximately 0.8 Debye. Therefore, option A is correct.

67. Tropylium Cation is :

A) aromatic - (Correct Alternative)

B) non-aromatic

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C) antiaromatic

D) aliphatic

Correct Answer: A) Aromatic
Explanation:
The tropylium cation, C7H7+, is cyclic, planar, and fully conjugated, allowing continuous overlap of p orbitals around its seven-membered ring. It contains six delocalized pi electrons. According to Hückel's rule, aromatic compounds contain 4n + 2 pi electrons. Here, n = 1 gives six pi electrons. Therefore, the tropylium cation is aromatic.

68. Cyclooctatetraene is :

A) Aromatic

B) Antiaromatic

C) Non-aromatic - (Correct Alternative)

D) non conjugated diene

Correct Answer: C) Non-aromatic
Explanation:
Cyclooctatetraene contains eight pi electrons. If it were planar and fully conjugated, it would satisfy the 4n electron condition and become antiaromatic. To avoid this instability, it adopts a non-planar tub-shaped conformation that prevents continuous effective p-orbital overlap around the ring. Consequently, it satisfies neither aromatic nor antiaromatic structural requirements and is classified as non-aromatic.

69. In Compton experiment when X-rays of wavelength 1Å is used, the scattering angle is found to be 180°. The Compton shift is :

A) $\frac{h}{mc}$

B) $\frac{2\,h}{mc}$ – (Correct Alternative)

C) $\frac{3\,h}{mc}$

D) $\frac{h}{2mc}$

Correct Answer: B) 2h/mc
Explanation:
The Compton shift is given by $\Delta\lambda = (h/mc)(1 - \cos\theta)$, where θ is the scattering angle. In this question, $\theta = 180°$, and $\cos 180° = -1$. Substituting this value gives $\Delta\lambda = (h/mc)[1 - (-1)] = 2h/mc$. Thus, the maximum Compton shift occurs at 180° and option B is correct.

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70. The Hermite polynomial of degree ' n ' is defined as $H_n(y) = (-1)^n e^{y^2} \frac{\partial^n}{\partial y^n}\left(e^{-y^2}\right)$ then the value of $H_0(y)$ is :

A) 0

B) -1

C) +1 - (Correct Alternative)

D) -2

Correct Answer: C) +1

Explanation:
The Hermite polynomial of degree n is defined as:

Hn(y) = (-1)^n e^(y²) [d^n/dy^n] (e^(-y²))

For n = 0,

H0(y) = (-1)^0 e^(y²) [d^0/dy^0] (e^(-y²))

We know that:

(-1)^0 = 1

Also, the zeroth derivative of a function is the function itself.

Therefore,

[d^0/dy^0] (e^(-y²)) = e^(-y²)

So,

H0(y) = e^(y²) × e^(-y²)

H0(y) = e^(y² - y²)

H0(y) = e^0

H0(y) = 1

Therefore, the value of H0(y) is +1, and the correct answer is C) +1.

71. The effective nuclear charge for '3s' electron in sulphur is :

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A) 10.5

B) 16.2

C) 6.5

D) 5.45 - (Correct Alternative)

Correct Answer: D) 5.45
Explanation:
The effective nuclear charge, Zeff, experienced by a 3s electron in sulphur can be estimated using Slater's rules. Sulphur has atomic number 16 and electronic configuration 1s2 2s2 2p6 3s2 3p4. The other electrons shield the selected 3s electron from the full nuclear charge. Using Slater's shielding constants gives a shielding value of approximately 10.55. Therefore, Zeff = Z - S = 16 - 10.55 = 5.45. Hence, the effective nuclear charge is 5.45.

72. The valence bond wave function is given by :

A) $\Psi_{VB} = \Psi_{ionic}$

B) $\Psi_{VB} = \Psi_{covalent}$

C) $\Psi_{VB} = \Psi_{covalent} + \lambda\Psi_{ionic}$ - (Correct Alternative)

D) $\Psi_{VB} = \frac{\Psi_{ionic}}{\Psi_{covalent}}$

Correct Answer: C) ΨVB = Ψcovalent + λΨionic
Explanation:
In valence bond theory, the wave function of a molecule such as H2 cannot always be described completely by considering only the purely covalent structure. A more accurate description includes a contribution from ionic structures along with the covalent structure. Therefore, the total valence bond wave function is expressed as ΨVB = Ψcovalent + λΨionic, where λ represents the relative contribution of the ionic component to the overall wave function. This combination provides a better description of the actual bonding in the molecule.

73. Calculate the energy of the electron in the first excited state of a one dimensional box of length 1Å.

A) 152 eV - (Correct Alternative)

B) 342 eV

C) 38 eV

D) 608 eV

Correct Answer: A) 152 eV

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Explanation:
For an electron confined in a one-dimensional box, the energy is given by $E_n = n^2h^2/(8mL^2)$. The first excited state corresponds to n = 2, because n = 1 represents the ground state. For a box length of 1 Å, or 1×10^{-10} m, the ground-state energy is approximately 38 eV. Therefore, $E_2 = 2^2 \times 38 = 4 \times 38 = 152$ eV. Hence, the energy of the electron in the first excited state is approximately 152 eV.

74. The number of microstates of a carbon atom having p^2 configuration is :

A) 6

B) 45

C) 15 - (Correct Alternative)

D) 120

Correct Answer: C) 15
Explanation:
A p subshell contains three orbitals, and each orbital can accommodate two electrons with opposite spins. Therefore, there are six available spin-orbitals in a p subshell. For a p^2 configuration, two electrons must be distributed among these six available spin-orbitals. The number of possible microstates is calculated using the combination 6C2 = 6!/(2!4!) = 15. These microstates are distributed among the possible atomic terms. Therefore, a carbon atom with the p^2 configuration has 15 microstates.

75. Which is true in Harmonic Oscillator ?

(I) The energy levels are equally spaced

(II) All energy levels are degenerate

(III) The zero point energy is $\frac{1}{2}$ hν

A) (I) only

B) (II) only

C) (III) only

D) (I) and (III) only - (Correct Alternative)

Correct Answer: D) (I) and (III) only
Explanation:
For a quantum mechanical harmonic oscillator, the allowed energy levels are given by $E_n = (n + 1/2)h\nu$. Therefore, consecutive energy levels differ by exactly hν, meaning that the energy levels are equally spaced. The ground state, where n = 0, has an energy of 1/2 hν, called the zero-point energy. However, the energy levels of a one-dimensional harmonic oscillator are non-degenerate. Thus, statements I and III are true, while statement II is

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false. Therefore, option D is correct.

76. The number average molecular weight is determined by :

A) Osmometry - (Correct Alternative)

B) Sedimentation equilibrium method

C) Light Scattering Method

D) Viscometry

Correct Answer: A) Osmometry
Explanation:
The number-average molecular weight, Mn, of a polymer is determined using methods based on colligative properties because these properties depend primarily on the number of solute molecules present rather than their individual masses. Osmometry measures the osmotic pressure of a dilute polymer solution and is therefore particularly useful for determining number-average molecular weight. In contrast, light scattering and sedimentation methods generally provide other molecular-weight averages, while viscometry gives viscosity-average molecular weight. Hence, osmometry is the correct method.

77. Absolute Reaction Rate Theory also known as ___ .

A) Collision theory

B) Lindemann's theory

C) Hinshelwood's theory

D) Transition state theory - (Correct Alternative)

Correct Answer: D) Transition state theory
Explanation:
Absolute Reaction Rate Theory is another name for Transition State Theory. This theory assumes that reactant molecules first form a high-energy activated complex or transition state before being converted into products. The activated complex is considered to be in a quasi-equilibrium with the reactants, and the reaction rate depends on how rapidly this activated complex proceeds toward the products. The theory provides a molecular interpretation of activation energy and reaction rates. Therefore, Absolute Reaction Rate Theory is also known as Transition State Theory.

78. For a simple reversible unimolecular reaction A ⇌ B, the forward and backward elementary reactions are of which order?

A) Third order

B) Second order

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C) First order - (Correct Alternative)

D) Zero order

Correct Answer: C) First order
Explanation:
For the elementary reversible unimolecular reaction A ⇌ B, the forward rate is kf[A] and the backward rate is kb[B]. Each elementary direction is therefore first order. This conclusion applies to this simple A ⇌ B case; reversible reactions in general need not always have first-order forward and backward steps.

79. Linear free energy relations are also called ___ relations.

A) Gibb's

B) Hammett's - (Correct Alternative)

C) Arrhenius

D) Lewis

Correct Answer: B) Hammett's
Explanation:
Linear free-energy relationships are commonly associated with the Hammett equation in physical organic chemistry. The Hammett relationship connects the effect of substituents on the rate or equilibrium constant of a reaction with characteristic substituent constants. It is commonly written in logarithmic form using the reaction constant rho and substituent constant sigma. A linear relationship indicates that related reactions respond systematically to electronic substituent effects. Therefore, linear free-energy relationships are also commonly referred to as Hammett relationships.

80. The molecule which acts directly on an enzyme to lower its catalytic activity is :

A) Inhibitor - (Correct Alternative)

B) Promoter

C) Modulator

D) Regulator

Correct Answer: A) Inhibitor
Explanation:
An inhibitor is a molecule that interacts with an enzyme and decreases its catalytic activity. Depending on the mechanism, an inhibitor may bind directly to the enzyme's active site or to another site that influences enzyme function. This binding can reduce substrate binding, interfere with catalytic activity, or alter the enzyme's functional conformation. Enzyme inhibitors may be reversible or irreversible and include

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competitive, non-competitive, uncompetitive, and other types. Therefore, a molecule that directly lowers an enzyme's catalytic activity is called an inhibitor.

81. The mechanism of adsorption presented by Langmuir explains ___ adsorption.

A) Physical

B) Chemical - (Correct Alternative)

C) Both Physical and Chemical

D) Multilayer

Correct Answer: B) Chemical
Explanation:
The Langmuir adsorption isotherm was developed on the assumption that adsorption occurs at specific sites on a solid surface and forms only a single molecular layer. Each adsorption site can accommodate only one adsorbate molecule, and all surface sites are considered energetically equivalent. These assumptions are particularly suitable for describing chemisorption, where adsorbate molecules form relatively strong chemical interactions with the surface. Therefore, the mechanism of adsorption presented by the Langmuir model primarily explains chemical adsorption.

82. Which of the following law states that it is impossible to convert heat into work without compensation ?

A) First law of thermodynamics

B) Zeroth law of thermodynamics

C) Third law of thermodynamics

D) Second law of thermodynamics - (Correct Alternative)

Correct Answer: D) Second law of thermodynamics
Explanation:
The second law of thermodynamics states that heat cannot be completely converted into work in a cyclic process without producing some other change or compensation. According to the Kelvin-Planck statement, it is impossible to construct a heat engine operating in a cycle whose sole effect is to absorb heat from a single reservoir and convert it completely into work. Some heat must necessarily be rejected to a lower-temperature reservoir. Therefore, the given statement represents the second law of thermodynamics.

83. Which of the following relation is correct?

A) $dE = -TdS + PdV$

B) $dH = TdS + VdP$ - (Correct Alternative)

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C) $dG = -VdP + SdT$

D) $dA = TdS - SdT$

Correct Answer: B) dH = TdS + VdP
Explanation:
For a simple closed system involving only pressure-volume work, the fundamental thermodynamic relation is dE = TdS - PdV. Enthalpy is defined as H = E + PV. Differentiating gives dH = dE + PdV + VdP. Substituting dE = TdS - PdV gives dH = TdS - PdV + PdV + VdP. The PdV terms cancel, leaving dH = TdS + VdP. Therefore, option B gives the correct fundamental thermodynamic relation for enthalpy.

84. Partial molar Gibbs free energy of a constituent in a mixture at constant temperature and pressure is given the name ___ .

A) Fugacity

B) Activity

C) Chemical potential — (Correct Alternative)

D) Activity coefficient

Correct Answer: C) Chemical potential
Explanation:
The partial molar Gibbs free energy of a component in a mixture is called its chemical potential. It represents the change in the total Gibbs free energy of a system when an infinitesimal amount of that component is added while temperature, pressure, and the amounts of all other components are kept constant. Chemical potential is extremely important in describing phase equilibrium, chemical equilibrium, diffusion, and material transfer. Therefore, the partial molar Gibbs free energy of a constituent is known as its chemical potential.

85. What is the trend observed in core electron (3d) binding energy in Xe, XeF_2, XeF_4 and XeF_6 while recording the photoelectron spectrum ?

A) Increases from Xe to XeF_6 - (Correct Alternative)

B) Decreases from Xe to XeF_6

C) Increases from Xe to XeF_2 and then decreases

D) Remains constant from Xe to XeF_6

Correct Answer: A) Increases from Xe to XeF6
Explanation:
In the series Xe, XeF2, XeF4, and XeF6, the oxidation state and effective positive

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character of xenon progressively increase as more highly electronegative fluorine atoms are attached. Fluorine withdraws electron density strongly from xenon, reducing the shielding experienced by the xenon core electrons. Consequently, the core electrons experience a greater effective nuclear attraction and require more energy for removal during photoelectron spectroscopy. Hence, the 3d core-electron binding energy progressively increases from elemental Xe toward XeF6.

86. The 'g' value of transition metal ions can differ appreciably from the free electron value of 2.0023 because :

A) Spin-orbit coupling is greater in many transition metal ion complexes than in organic free radicals. - (Correct Alternative)

B) Spin-orbit coupling is lesser in many transition metal ion complexes than in organic free radicals.

C) Spin-spin coupling is lesser in many transition metal ion complexes than in organic free radicals.

D) Spin-spin coupling is greater in many transition metal ion complexes than in organic free radicals.

Correct Answer: A) Spin-orbit coupling is greater in many transition metal ion complexes than in organic free radicals.
Explanation:
For a free electron, the g value is approximately 2.0023. In many organic free radicals, orbital angular momentum is largely quenched, so their g values remain close to the free-electron value. Transition metal ions, however, can have appreciable spin-orbit coupling because their d electrons experience interactions between spin and orbital angular momentum. This interaction modifies the magnetic behaviour and shifts the observed g value away from 2.0023. Therefore, stronger spin-orbit coupling explains the larger deviations found in many transition metal complexes.

87. Statement (1) : The magnitude of the zero field splitting in transition metal ions can generally be described as arising from the crystal field.

Statement (2) : $Mn^{2+}(d^5)$ which has a spherically symmetric electron distribution so that the ^6S ground state is not split by the crystal field also shows a zero-field splitting.

A) statement (1) is true and statement (2) is false

B) statements (1)and (2) are true - (Correct Alternative)

C) statements (1)and (2) are false

D) statement (1) is false and statement (2) is true

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Correct Answer: B) Statements (1) and (2) are true
Explanation:
Zero-field splitting refers to splitting of spin energy levels even when no external magnetic field is applied. In many transition metal complexes, its magnitude is related to the ligand or crystal-field environment together with spin-orbit and spin-spin interactions. Mn2+ has a high-spin d5 configuration with a 6S ground state and approximately spherical electron distribution, so its ground state is not directly split by an ordinary first-order crystal field. Nevertheless, smaller higher-order interactions can produce measurable zero-field splitting. Therefore, both statements are considered true.

88. The lowest energy, highest wavelength transition that occurs in formaldehyde is :

A) $n \rightarrow \sigma^*$

B) $\pi \rightarrow \pi^*$

C) $n \rightarrow \pi^*$ - (Correct Alternative)

D) $\sigma \rightarrow \sigma^*$

Correct Answer: C) $n \rightarrow \pi^*$
Explanation:
Formaldehyde contains a carbonyl group, C=O, which has bonding pi orbitals, antibonding pi* orbitals, and nonbonding electrons on the oxygen atom. The lowest-energy electronic excitation involves promotion of a nonbonding electron from oxygen into the antibonding pi* orbital of the carbonyl group. This $n \rightarrow \pi^*$ transition requires less energy than the $\pi \rightarrow \pi^*$, $n \rightarrow \sigma^*$, or $\sigma \rightarrow \sigma^*$ transitions. Since wavelength is inversely related to transition energy, the lowest-energy transition also occurs at the highest wavelength. Therefore, $n \rightarrow \pi^*$ is correct.

89. Which among the molecules, H_2, NO, N_2O and CH_4 can have pure rotational spectrum ?

A) H_2 and NO

B) H_2 and CH_4

C) NO and N_2O - (Correct Alternative)

D) N_2O and CH_4

Correct Answer: C) NO and N2O
Explanation:
For a molecule to show a pure rotational microwave spectrum, it must possess a permanent electric dipole moment. H2 is a homonuclear diatomic molecule and has no permanent dipole moment, so it does not show a conventional pure rotational microwave spectrum. CH4 is highly symmetrical and also has zero permanent dipole moment. NO is a heteronuclear diatomic molecule with a permanent dipole moment, while linear N2O

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also possesses a permanent dipole moment. Therefore, NO and N2O can exhibit pure rotational spectra.

90. The permitted energy states of a molecule which is a simple harmonic oscillator is given by the expression ; [v is the vibrational quantum number].

A) $E_v = hv$ joules

B) $E_v = hv(v + 1/2)$ joules - (Correct Alternative)

C) $E_v = (v + 1/2)$ joules

D) $E_v = 2hv(v + 1/2)$ joules

Correct Answer: B) Ev = hν(v + 1/2) joules
Explanation:
According to the quantum mechanical treatment of a simple harmonic oscillator, vibrational energy is quantized rather than continuous. The permitted energy levels are expressed as Ev = hν(v + 1/2), where h is Planck's constant, ν is the characteristic vibrational frequency, and v is the vibrational quantum number with values 0, 1, 2, and so on. Even at v = 0, the molecule possesses an energy of hν/2, known as zero-point energy. Therefore, option B gives the correct expression.

91. The symmetry operation, "One or more rotation about the axis", specifies which symmetry element?

A) Improper axis of symmetry

B) Centre of symmetry

C) Proper axis of symmetry - (Correct Alternative)

D) Plane of symmetry

Correct Answer: C) Proper axis of symmetry
Explanation:
A proper axis of symmetry, represented as Cn, is a symmetry element about which a molecule can be rotated through an angle of 360°/n and still appear indistinguishable from its original configuration. One or more such rotations may be performed around the same axis. For example, a molecule possessing a C3 axis remains unchanged after rotation through 120°. Since the stated operation involves rotation about an axis without reflection, it corresponds to a proper axis of symmetry.

92. sd^3 hybridisation in C atom in CH_4 is :

A) Symmetrically allowed and energetically favoured.

B) Symmetrically allowed but energetically not favoured.

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C) Symmetrically not allowed but energetically favoured.

D) Symmetrically not allowed and energetically not favoured.

Correct Answer: B) Symmetrically allowed but energetically not favoured
Explanation:
In methane, CH4, the carbon atom normally uses sp3 hybrid orbitals to form four equivalent C-H bonds in a tetrahedral arrangement. An sd3 set can, in symmetry terms, be constructed with tetrahedral transformation properties, so it is regarded as symmetrically allowed. However, carbon has no low-energy occupied d orbitals in its valence shell. Using higher-energy d orbitals would require excessive promotion energy and would not provide favourable bonding. Therefore, sd3 hybridisation in carbon is symmetrically allowed but energetically not favoured.

93. According to Helmholtz Perrin model, the shape of electrocapillary curve is :

A) Parabola - (Correct Alternative)

B) Ellipse

C) Hyperbola

D) Straight line

Correct Answer: A) Parabola
Explanation:
According to the Helmholtz-Perrin model of the electrical double layer, the relationship between surface tension and electrode potential gives an electrocapillary curve having a parabolic shape. The surface tension reaches a maximum at the potential of zero charge, where the surface charge density becomes zero. As the electrode potential moves in either direction away from this value, the surface tension decreases. Thus, the theoretical electrocapillary curve predicted by the Helmholtz-Perrin treatment is approximately parabolic in shape.

94. The relation between ionic strength and mean ionic activity coefficient is :

A) $\log \gamma_{\pm} = -A|Z_{\oplus}Z_{\ominus}|I$

B) $\log \gamma_{\pm} = -A|Z_{\oplus}Z_{\ominus}|I^{3/2}$

C) $\log \gamma_{\pm} = -A|Z_{\oplus}Z_{\ominus}|I^{2}$

D) $\log \gamma_{\pm} = -A|Z_{\oplus}Z_{\ominus}|I^{1/2}$ - (Correct Alternative)

Correct Answer: D) log γ± = -A|Z+Z-|I^(1/2)
Explanation:
The Debye-Hückel limiting law relates the mean ionic activity coefficient of an electrolyte to its ionic strength. It is expressed as log γ± = -A|Z+Z-|√I, where γ± is the mean ionic activity coefficient, A is a constant depending mainly on the solvent and

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temperature, Z+ and Z- are the ionic charges, and I is the ionic strength. Thus, the logarithm of the mean ionic activity coefficient is proportional to the square root of ionic strength. Therefore, option D is correct.

95. The Debye-Huckel Onsager equation is :

A) $\Lambda = \Lambda_0 + (A + B\Lambda_0)\sqrt{C}$

B) $\Lambda = \Lambda_0 - (A + B\Lambda_0)C$

C) $\Lambda = \Lambda_0 - (A + B\Lambda_0)C^{3/2}$

D) $\Lambda = \Lambda_0 - (A + B\Lambda_0)C^{1/2} -$ (Correct Alternative)

Correct Answer: D) Λ = Λ0 - (A + BΛ0)C^(1/2)
Explanation:
The Debye-Hückel-Onsager equation describes how the molar conductivity of a strong electrolyte decreases as its concentration increases. It is written as Λ = Λ0 - (A + BΛ0)√C, where Λ is the molar conductivity at concentration C, Λ0 is the limiting molar conductivity at infinite dilution, and A and B are constants depending on factors such as solvent and temperature. The decrease arises mainly from electrophoretic and relaxation effects between ions. Therefore, option D gives the required equation.

96. Which is Hydrogen depolariser ?

A) CH_4

B) O_2 - (Correct Alternative)

C) C_2H_6

D) D_2

Correct Answer: B) O2
Explanation:
A hydrogen depolarizer is a substance that removes or reduces the accumulation of hydrogen at an electrode during an electrochemical process. Accumulated hydrogen can cause polarization and reduce the efficiency of the cell. Oxygen can act as a depolarizer by reacting with hydrogen or participating in electrode reduction processes, thereby preventing excessive hydrogen accumulation. CH4 and C2H6 are stable hydrocarbons and do not perform this function, while D2 is an isotope of molecular hydrogen. Therefore, O2 is the hydrogen depolarizer among the given options.

97. Which transition best represents internal conversion from a higher excited singlet state?

A) S0 → S1 by absorption

B) Sn (n > 1) → S1 without photon emission - (Correct Alternative)

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C) S1 → T1

D) S1 → S0 with photon emission

Correct Answer: B) Sn (n > 1) → S1 without photon emission
Explanation:
Internal conversion is a radiationless transition between electronic states of the same spin multiplicity. After excitation to a higher singlet state Sn, rapid internal conversion commonly brings the molecule to S1 without photon emission. S1 → T1 is intersystem crossing, while photon-emitting S1 → S0 is fluorescence.

98. For triplet-triplet energy transfer from a donor to an acceptor, which statement is true?

A) the triplet state of donor is higher in energy than triplet state of acceptor

B) the triplet state of donor is lower in energy than triplet state of acceptor

C) triplet state of donor and acceptor have same energy

D) singlet state of donor and acceptor have same energy

Correct Answer: A) The triplet state of donor is higher in energy than the triplet state of acceptor
Explanation:
For energetically favourable triplet-triplet energy transfer, the donor triplet state should lie above the acceptor triplet state. Energy can then be transferred from the excited triplet donor to populate the lower-energy triplet state of the acceptor. This process is triplet-triplet energy transfer; it should not be confused with intersystem crossing, which is a radiationless transition between states of different spin multiplicity within a molecule.

99. Consider the quenching process

$$A + hv \rightarrow A^*$$
$$A^* k_1 A + hv$$
$$A^* \xrightarrow{k_2} A$$
$$A^* + Q \xrightarrow{k_3} A + Q'$$

If $k_1 = 2$ and $k_2 = 8$, then the life-time of A^* is :

A) 2 sec

B) 8 sec

C) 10 sec

D) 0.1 sec - (Correct Alternative)

Correct Answer: D) 0.1 sec

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Explanation:
The lifetime of an excited species is determined by the total rate at which it disappears through the available decay pathways. Here, the excited species A* undergoes two unimolecular decay processes with rate constants k1 = 2 s^{-1} and k2 = 8 s^{-1}. Therefore, the total decay constant is k = k1 + k2 = 2 + 8 = 10 s^{-1}. The excited-state lifetime is τ = 1/k = 1/10 = 0.1 second. Therefore, option D is correct.

100. The cathodic high-overpotential (Tafel) form obtained from the Butler-Volmer equation is:

A) $i = i_0 e^{-\alpha\eta F/R\,T}$

B) $i = -i_0 e^{\alpha\eta F/RT}$

C) $i = -i_0 e^{(1-\alpha)\eta F/R\,T}$

D) i = -i0 exp(-αFη/RT) - (Correct Alternative)

Correct Answer: D) i = -i0 exp(-αFη/RT)
Explanation:
At sufficiently large cathodic overpotential, the anodic term in the Butler-Volmer equation becomes negligible, giving i = -i0 exp(-αFη/RT), subject to the sign convention used for η. Taking logarithms gives the conventional linear Tafel relation between overpotential and log|i|. Thus option D is the cathodic Tafel form.

101. During the Later Chola period, the dancing girls in temples were called:

A) Talaicheri Pendugal - (Correct Alternative)

B) Karanas

C) Nritya Perayan

D) Aadal Magalir

Correct Answer: A) Talaicheri Pendugal
Explanation:
During the Later Chola period, women attached to temples for performing dance and related ritual services were known as Talaicheri Pendugal. Inscriptions of the Chola period, particularly those connected with major temples, provide information about these women and their organization. They played an important role in temple ceremonies and cultural activities. The term is specifically associated with temple women in the Chola administrative and cultural context. Therefore, Talaicheri Pendugal is the correct answer. (Tamil Nadu Teachers Recruitment Board)

102. If the three angles of a triangle are in the ratio 1 : 2 : 3. What was the greatest angle ?

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A) 105°

B) 120°

C) 80°

D) 90° - (Correct Alternative)

Correct Answer: D) 90°
Explanation:
The sum of the three interior angles of any triangle is 180°. Here, the angles are in the ratio 1 : 2 : 3. The total number of ratio parts is 1 + 2 + 3 = 6. Therefore, one part is equal to 180° ÷ 6 = 30°. The three angles are 30°, 60°, and 90°. Hence, the greatest angle of the triangle is 90°, making option D correct.

103. The S.I. unit of power is:

A) watt - (Correct Alternative)

B) joule

C) newton

D) hertz

Correct Answer: A) watt
Explanation:
Power is defined as the rate at which work is done or energy is transferred. In the International System of Units, the SI unit of power is the watt, represented by the symbol W. One watt is equal to one joule of energy transferred or one joule of work done per second. Thus, 1 W = 1 J/s. Joule is the unit of energy, newton is the unit of force, and hertz is the unit of frequency. Therefore, watt is correct.

104. Which one of the following is a biodegradable co-polymer ?

A) vinyon

B) saran

C) PHBV - (Correct Alternative)

D) Dacron

Correct Answer: C) PHBV
Explanation:
PHBV stands for poly(3-hydroxybutyrate-co-3-hydroxyvalerate). It is a biodegradable copolymer belonging to the polyhydroxyalkanoate family and can be produced by microorganisms. Because microorganisms can break down PHBV naturally, it is considered environmentally preferable for certain applications compared with many conventional synthetic polymers. Vinyon, saran, and Dacron are synthetic polymers that

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are not normally classified as biodegradable polymers. Therefore, PHBV is the biodegradable copolymer among the given options.

105. Which one is the birth place of "Boothathalvar" ?

A) Kanchipuram

B) Thanjavur

C) Mamallapuram - (Correct Alternative)

D) Gangaikonda Cholapuram

Correct Answer: C) Mamallapuram
Explanation:
Boothathalvar, also written as Bhutath Alvar, is one of the first three Alvars of the Sri Vaishnava tradition, collectively known as the Mudhal Alvars. Traditional accounts associate his birthplace with Mamallapuram, the historic coastal town in present-day Tamil Nadu. He is remembered for his devotional compositions praising Lord Vishnu and occupies an important position in the early Tamil Bhakti tradition. Therefore, among Kanchipuram, Thanjavur, Mamallapuram, and Gangaikonda Cholapuram, Mamallapuram is the correct answer.

106. Kanchi Vaikunta Perumal Temple was built by:

A) Rajasimhan

B) Simhavarman

C) Nandivarman - (Correct Alternative)

D) Simha Vishnu

Correct Answer: C) Nandivarman
Explanation:
The Vaikunta Perumal Temple at Kanchipuram is attributed to the Pallava ruler Nandivarman II (Nandivarman Pallavamalla) of the 8th century CE. Rajasimha (Narasimhavarman II) is especially associated with the Kailasanatha Temple at Kanchipuram. Therefore, Nandivarman is the correct answer.

107. Which Pandya king excavated the rock-cut cave temple at Malayadikkurichi?

A) Kadungon

B) Arikesari Maravarman

C) Maran Sendan - (Correct Alternative)

D) Maravarman Avanisulamani

Correct Answer: C) Maran Sendan

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Explanation:
The rock-cut cave temple at Malayadikkurichi belongs to the early Pandya tradition of rock-cut architecture in Tamil Nadu. It is associated with the reign of the Pandya ruler Maran Sendan, also known in historical contexts as Sendan or Jayantavarman. The monument is important for understanding the development of early Pandya temple architecture and the transition toward more elaborate temple-building traditions. Therefore, among the rulers listed in the options, Maran Sendan is the correct answer.

108. Who was the first Deputy Prime Minister of India ?

A) Dr. Rajendra Prasad

B) Motilal Nehru

C) Sardar Vallabhai Patel - (Correct Alternative)

D) Lord Mountbatten

Correct Answer: C) Sardar Vallabhbhai Patel
Explanation:
Sardar Vallabhbhai Patel was the first Deputy Prime Minister of independent India. He served in the government headed by Prime Minister Jawaharlal Nehru from 1947 until his death in 1950 and also held the important Home Affairs portfolio. Patel played a central role in integrating hundreds of princely states into the Indian Union after independence, earning him the title "Iron Man of India." Therefore, Sardar Vallabhbhai Patel is the correct answer.

109. 'Sargasso sea' is found in the :

A) North Atlantic Ocean - (Correct Alternative)

B) South Atlantic Ocean

C) Indian Ocean

D) Pacific Ocean

Correct Answer: A) North Atlantic Ocean
Explanation:
The Sargasso Sea is located in the North Atlantic Ocean. Unlike most seas, it is not bounded by land but is defined largely by surrounding ocean currents forming the North Atlantic subtropical gyre. It is particularly famous for large quantities of floating Sargassum seaweed. Major currents surrounding the region include the Gulf Stream, North Atlantic Current, Canary Current, and North Equatorial Current. Therefore, the Sargasso Sea is found in the North Atlantic Ocean.

110. Where was the first rock painting discovered in Tamil Nadu ?

A) Nilagiri

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B) Mallapadi - (Correct Alternative)

C) Attirapakkam

D) Pudukottai

Correct Answer: B) Mallapadi
Explanation:
Mallapadi in Tamil Nadu is an important archaeological site known for prehistoric rock paintings. The discovery of rock art at Mallapadi was significant in the study of Tamil Nadu's prehistoric culture and helped establish the presence of an early rock-painting tradition in the state. Such paintings provide evidence about the artistic expression, social activities, and cultural practices of prehistoric communities. In standard Tamil Nadu history and archaeology examinations, Mallapadi is identified as the place where the first rock paintings in Tamil Nadu were discovered. Therefore, option B is correct.

PART B

1. Find the significant number 0.3000.

A) 3

B) 4 - (Correct Alternative)

C) 5

D) 2

Correct Answer: B. 4

Explanation:
The number given is 0.3000. In counting significant figures, zeros before the first non-zero digit are not significant because they only indicate the position of the decimal point. However, trailing zeros written after a non-zero digit in a decimal number are significant because they indicate the precision of the measurement.

Thus, in 0.3000, the significant digits are

3, 0, 0, 0.

Therefore, the number contains **4 significant figures**.

Hence, option B is correct.

2. For titrating 10 ml of a solution with the help of microburette the volume of titrant used are 9.98, 9.99, 9.98, 9.95, 10.00 and 10.02 ml. Calculate the standard

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deviation :

A) 23.240

B) 0.2324

C) 0.02338 mL - (Correct Alternative)

D) 2.3240

Correct Answer: C. 0.02338 mL

Explanation:
The measured volumes are

9.98, 9.99, 9.98, 9.95, 10.00 and 10.02 ml.

First calculate the mean:

Mean = (9.98 + 9.99 + 9.98 + 9.95 + 10.00 + 10.02)/6

= 59.92/6

= 9.9867 ml approximately.

For experimental measurements, the sample standard deviation is calculated using

$s = \sqrt{[\Sigma(x_i - \bar{x})^2/(n - 1)]}$.

The sum of the squared deviations is approximately

$\Sigma(x_i - \bar{x})^2 = 0.002733$.

Therefore,

$s = \sqrt{(0.002733/5)}$

$= \sqrt{0.0005467}$

≈ 0.02338 mL.

Thus the sample standard deviation is approximately 0.02338 mL (≈ 0.0234 mL).

Hence, option C is correct.

3. The choice of adsorbent in adsorption Chromatography depends on :

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A) Nature of the solvent

B) Nature of the substance - (Correct Alternative)

C) Nature of the chromatography

D) Nature of the stationary phase

Correct Answer: B. Nature of the substance

Explanation:
In adsorption chromatography, separation occurs because different substances are adsorbed to different extents on the surface of a solid adsorbent such as silica gel or alumina.

The choice of adsorbent therefore depends primarily on the **nature and polarity of the substances being separated**. Different compounds interact differently with different adsorbent surfaces.

For example, polar compounds generally interact more strongly with polar adsorbents such as silica gel. A suitable adsorbent must provide sufficient differential adsorption to achieve effective separation without holding the compounds too strongly.

Therefore, option B is correct.

4. The order of basicity of the conjugate bases, CH_3^-, F^-, OH^- and NH_2^- is :

A) $CH_3^- > NH_2^- > OH^- > F^-$ – (Correct Alternative)

B) $CH_3^- > F^- > OH^- > NH_2^-$

C) $NH_2^- < CH_3^- < F^- < OH^-$

D) $OH^- < CH_3^- < NH_2^- < F^-$

Correct Answer: A. $CH_3^- > NH_2^- > OH^- > F^-$

Explanation:
The basicity of a conjugate base can be compared using the acidity of its corresponding conjugate acid. A weaker acid has a stronger conjugate base.

The corresponding conjugate acids are:

$CH_3^- \rightarrow CH_4$

$NH_2^- \rightarrow NH_3$

$OH^- \rightarrow H_2O$

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$F^- \rightarrow HF$.

Their acidity increases approximately in the order

$CH_4 < NH_3 < H_2O < HF$.

Therefore, the basicity of their conjugate bases follows the reverse order:

$CH_3^- > NH_2^- > OH^- > F^-$.

CH_3^- is therefore the strongest base among the given species, while F^- is the weakest.

Hence, option A is correct.

5. Choose the correct statements from the following :

(1) Grey tin is a conductor and Lead is an insulator.

(2) In $(BeH_2)_n$, each Beryllium atom is bonded to four hydrogen atoms distributed tetrahedrally around it at ordinary temperature.

(3) Lead is a metallic conductor and grey tin is Semiconductor.

(4) Each Beryllium atom in $(BeH_2)_n$ polymer at ordinary temperature is bonded to two hydrogen atoms in a linear manner.

A) (1), (2) and (3) only

B) (2) and (3) only - (Correct Alternative)

C) (1) and (2) only

D) (3) and (4) only

Correct Answer: B. (2) and (3) only

Explanation:
Statement (1) is incorrect. Lead is a metallic conductor, whereas grey tin is a semiconductor rather than a normal metallic conductor.

Statement (2) is correct. At ordinary temperature, beryllium hydride exists as a polymeric structure, $(BeH_2)_n$. Because simple two-coordinate BeH_2 would be electron deficient, polymerization occurs through bridging hydrogen atoms. Each beryllium is effectively associated with four hydrogen atoms in a tetrahedral arrangement.

Statement (3) is correct. Lead exhibits metallic conductivity, while grey tin, also called α-tin, has semiconductor characteristics.

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Statement (4) is incorrect for ordinary solid polymeric BeH_2. A simple linear description involving only two hydrogen atoms does not represent its polymeric structure at ordinary temperature.

Therefore, statements (2) and (3) are correct.

Hence, option B is correct.

6. Match the following :

	Species		Hard/Soft - Acid/Base
(a)	H−	(i)	Soft acid
(b)	Ni4+	(ii)	Soft base
(c)	I+	(iii)	Hard acid

A) (a)-(i), (b)-(ii), (c)-(iii)

B) (a)-(iii), (b)-(i), (c)-(ii)

C) (a)-(ii), (b)-(i), (c)-(iii)

D) (a)-(ii), (b)-(iii), (c)-(i) - (Correct Alternative)

Correct Answer: D. (a)-(ii), (b)-(iii), (c)-(i)

Explanation:
According to the Hard and Soft Acids and Bases principle, or HSAB principle, species are classified according to properties such as size, charge density and polarizability.

H^- is relatively polarizable and acts as a **soft base**. Therefore,

H^- → Soft base (ii).

Ni^{4+} has a very high positive charge and consequently a high charge density. Highly charged small metal ions generally behave as **hard acids**. Therefore,

Ni^{4+} → Hard acid (iii).

I^+ is highly polarizable and is classified here as a **soft acid**. Therefore,

I^+ → Soft acid (i).

Thus, the correct matching is

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(a)-(ii), (b)-(iii), (c)-(i).

Hence, option D is correct.

7. Nuclear particle with mass in between that of electron and proton and a mass 970 times that of electron charge which may be a positive, negative or Zero is calleD)

A) μ - mesons

B) pi - meson

C) k - meson - (Correct Alternative)

D) hyperons

Correct Answer: C. K-meson, based on the given description

Explanation:
Mesons are subatomic particles whose masses historically were described as lying between those of electrons and nucleons. Different types of mesons include π-mesons, K-mesons and others.

The question specifies a particle having a mass approximately **970 times the electron mass** and states that its charge may be positive, negative or zero. This description corresponds to the **K-meson or kaon** in the classification intended by the question.

Kaons occur in charged and neutral forms, including K^+, K^- and neutral kaons. They are mesons and participate in strong interactions.

Therefore, according to the stated mass and charge characteristics, option C is correct

8. Fission process of $_{92}U^{235}$ by neutron without excited state how much neutron released ?

A) 2.5 - (Correct Alternative)

B) 3

C) 4

D) 6

Correct Answer: A. 2.5

Explanation:
When uranium-235 undergoes nuclear fission after absorbing a neutron, the compound nucleus becomes unstable and splits into two lighter nuclei. During this process,

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additional neutrons are emitted along with a very large amount of energy.

The exact number of neutrons emitted is not identical in every individual fission event. Some events release two neutrons, while others may release three or more.

Therefore, the neutron yield is commonly expressed as an **average number of neutrons per fission**. For U-235, this value is approximately 2.4 to 2.5 neutrons per fission.

These emitted neutrons are important because they can initiate additional fission reactions, producing a nuclear chain reaction.

Hence, among the given options, **2.5** is correct.

9. Ammonia with transition metals mostly forms:

A) double salt

B) complex - (Correct Alternative)

C) ion-pair

D) precipitate

Correct Answer: B. Complex

Explanation:
Ammonia, NH_3, is an important ligand in coordination chemistry. The nitrogen atom of ammonia contains a lone pair of electrons that can be donated to a transition-metal ion to form a coordinate covalent bond.

Therefore, transition metals commonly react with ammonia to form **coordination complexes**, often called ammine complexes.

For example,

$Cu^{2+} + 4NH_3 \rightarrow [Cu(NH_3)_4]^{2+}$.

Similarly, transition metals such as cobalt, nickel, silver and copper form various ammonia complexes.

The ability of transition-metal ions to form complexes arises from their relatively high charge density and availability of orbitals for interaction with ligands.

Therefore, option B is correct.

10. Choose the allowed transition.

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A) $^1\Sigma g^+ \rightarrow {}^3\Sigma u^+$

B) $^1\Sigma g^+ \rightarrow {}^3\Sigma u^-$

C) $^1\Sigma g^+ \rightarrow {}^1\Sigma u^+$ — (Correct Alternative)

D) $^1\Sigma g^+ \rightarrow {}^1\Sigma g^+$

Correct Answer: C. $^1\Sigma g^+ \rightarrow {}^1\Sigma u^+$

Explanation:
Electronic transitions in diatomic molecules are governed by selection rules.

One important rule is the **spin selection rule**:

$\Delta S = 0$.

This means that a singlet state should normally undergo an allowed transition to another singlet state, while a singlet-to-triplet transition is spin-forbidden.

Therefore, options A and B,

$^1\Sigma \rightarrow {}^3\Sigma$,

are forbidden by the spin selection rule.

For centrosymmetric molecules, the Laporte-type symmetry rule also requires a change in inversion symmetry:

$g \leftrightarrow u$ is allowed,

while

$g \leftrightarrow g$ and $u \leftrightarrow u$ are forbidden for electric-dipole transitions.

Option C is

$^1\Sigma g^+ \rightarrow {}^1\Sigma u^+$.

Here, the spin multiplicity remains singlet, and the symmetry changes from g to u. The other relevant quantum-number conditions are also satisfied.

Therefore, **$^1\Sigma g^+ \rightarrow {}^1\Sigma u^+$ is the allowed transition**, and option C is correct.

11. Identify the correct statement about [Ni(H2O)6]3+ and [Cu(H2O)6]2+.

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A) All Ni - O bond lengths are equal whereas Cu - O (equatorial) bonds are shorter than Cu - O (axial) bonds. - (Correct Alternative)

B) All Ni-O bond lengths are equal whereas Cu-O (axial) bonds are shorter than Cu-O (equatorial) bonds.

C) Ni - O (equatorial) and Cu - O (equatorial) bond lengths are shorter than Ni - O (axial) and Cu - O (axial) ones respectively.

D) All Cu - O bond lengths are equal Ni - O bond lengths are unequal.

Correct Answer: A. All Ni-O bond lengths are equal whereas Cu-O (equatorial) bonds are shorter than Cu-O (axial) bonds.

Explanation:
In $[Ni(H_2O)_6]^{3+}$, nickel is present in the +3 oxidation state. The question treats this complex as having an essentially regular octahedral arrangement, so the six Ni–O bonds are taken to have equal bond lengths.

For $[Cu(H_2O)_6]^{2+}$, Cu^{2+} has the electronic configuration $3d^9$. An octahedral d^9 complex undergoes a strong **Jahn–Teller distortion** because its electronically degenerate ground state can lower its energy by distorting the octahedron.

For the common tetragonal elongation, the two axial Cu–O bonds become longer, while the four equatorial Cu–O bonds are shorter.

Therefore,

Cu–O axial > Cu–O equatorial.

Option A correctly states that the equatorial Cu-O bonds are shorter than the axial Cu-O bonds.

Option B incorrectly reverses this Jahn-Teller elongation relationship.

Therefore, option A is correct.

12. The correct order of energy levels of d-orbitals in ferrocene is :

A) $d_{x^2-y^2} = d_{xy} > d_{z^2} = d_{xz}, d_{z^2}$

B) dxy = dx2-y2 < dz2 < dxz = dyz - (Correct Alternative)

C) $d_{z^2} > d_{xz} > d_{yz} > d_{xy} = d_{x^2-y^2}$

D) $d_{z^2} > d_{xy} > d_{x^2-y^2} > d_{y^2} > d_{x^2}$

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Correct Answer: B. dxy = dx2-y2 < dz2 < dxz = dyz

Explanation: Ferrocene, Fe(C5H5)2, has approximately D5d/D5h axial symmetry, so the metal d orbitals are grouped as e2 (dxy, dx2-y2), a1 (dz2), and e1 (dxz, dyz).

The dxy and dx2-y2 orbitals are largely nonbonding/weakly interacting and form the lower e2 pair.

The dz2 orbital has a1 symmetry and lies above the e2 pair in the conventional ligand-field ordering.

The dxz and dyz orbitals interact strongly with the cyclopentadienyl π system and form the higher e1 set in the metal d-orbital splitting picture.

Therefore, the conventional order is:

dxy = dx2-y2 < dz2 < dxz = dyz.

Hence, option B is correct.

13. The catalyst used for the oxidation of ethylene to acetaldehyde is :

A) $[RhCl(pph_3)_3]$

B) $[Ru(pph_3)_3Cl]$

C) PdCl2/CuCl2 in aqueous medium - (Correct Alternative)

D) $TiCl_4 \cdot Al(C_2H_5)_3$

Correct Answer: C. PdCl2/CuCl2 in aqueous medium

Explanation: The oxidation of ethylene to acetaldehyde is the Wacker process.

Overall reaction: CH2=CH2 + 1/2 O2 → CH3CHO.

PdCl2 is the principal palladium(II) catalyst, while CuCl2 functions as the co-catalyst/oxidizing mediator that reoxidizes Pd(0) to Pd(II).

Therefore, the standard catalytic system is PdCl2/CuCl2 in aqueous medium.

Wilkinson's catalyst is used for homogeneous hydrogenation, Co2(CO)8 is associated with hydroformylation, and TiCl4/Al(C2H5)3 is a Ziegler-Natta polymerization catalyst.

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Hence, option C is correct.

14. The compound (I) and (II) are :



A) Enantiomers

B) Diastereomers - (Correct Alternative)

C) Allene

D) Epimers

Correct Answer: B. Diastereomers

Explanation:
Compounds (I) and (II) represent stereoisomeric forms associated with a **trans-cycloalkene-type arrangement**. Because of the restricted geometry of the carbon-carbon double bond within the ring system, the groups attached to the double-bonded carbons cannot rotate freely.

Stereoisomers have the same molecular connectivity but differ in the three-dimensional arrangement of their atoms. They are broadly classified into **enantiomers** and **diastereomers**.

Enantiomers are non-superimposable mirror images of each other. The two structures shown here are **not mirror-image forms**. Instead, they differ in their spatial arrangement while retaining the same basic connectivity. Therefore, their relationship is diastereomeric.

They are also not allenes. An allene must contain the characteristic consecutive double-

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bond system

C=C=C,

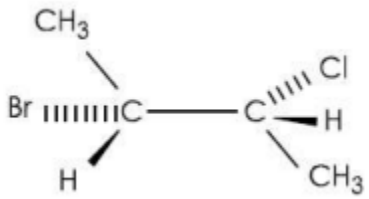
which is absent here.

They are not epimers either. Epimers are a special type of diastereomer that differ in configuration at only one stereogenic centre, which is not the relationship represented here.

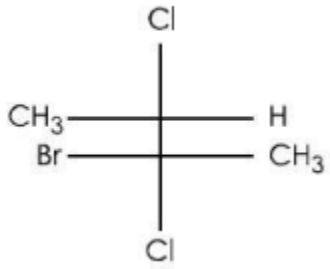
Therefore, compounds (I) and (II) are **diastereomers**.

Hence, option B is correct.

15. Select the correct structure of Fischer projection structure of the given compound

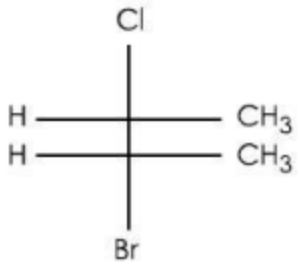


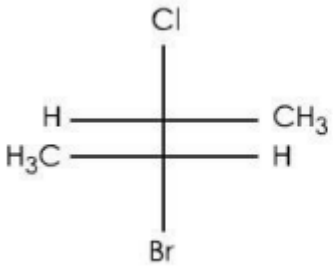
A)



B)

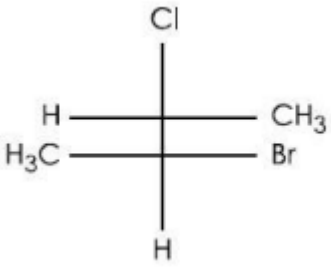
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– (Correct Alternative)

C)



D)

Correct Answer: C

Explanation:
To convert the given wedge-dash structure into a Fischer projection, the most important point is to **preserve the absolute configuration at both chiral carbon atoms**.

The molecule contains **two stereogenic centres** because each of the two central carbon atoms is attached to four different groups.

In a Fischer projection:

Horizontal bonds point **towards the observer**.

Vertical bonds point **away from the observer**.

Therefore, we cannot simply move Br, Cl, H and CH_3 into convenient positions. Their arrangement must be chosen so that the configuration of each stereogenic carbon remains identical to that in the original wedge-dash structure.

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For the **left stereogenic carbon** in the original structure, the groups are Br, H, CH_3 and the adjacent carbon. The dashed bond indicates that Br points behind the plane, while the solid wedge shows H pointing towards the observer.

For the **right stereogenic carbon**, the groups are Cl, H, CH_3 and the adjacent carbon. Here Cl is shown behind the plane and H is directed towards the observer.

When these spatial arrangements are translated correctly into Fischer-projection convention, the equivalent structure is **option C**.

In option C, the Fischer projection has:

Upper stereocentre: H on the left and CH_3 on the right.

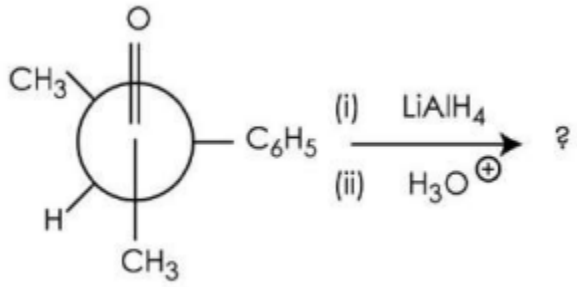
Lower stereocentre: CH_3 on the left and H on the right.

The vertical chain has Cl at the top and Br at the bottom.

This arrangement preserves the stereochemical configurations of both asymmetric carbon atoms in the original structure.

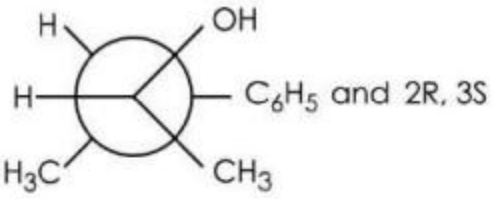
Therefore, **option C is the correct Fischer projection.**

16. The major product and configuration of the following reaction is :

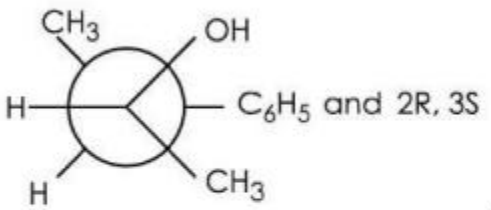


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A)

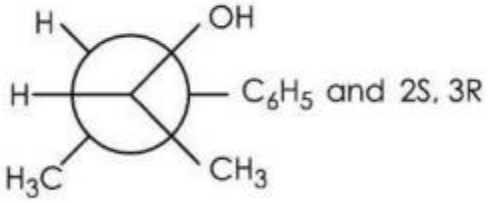


B :

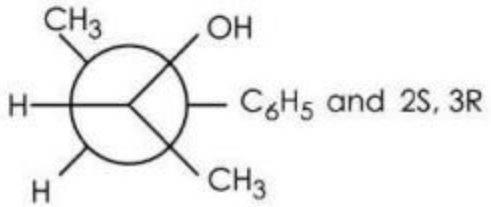


– (Correct Alternative)

C :



D :



Correct Answer: B. Major product with 2R, 3S configuration

Explanation:
The reaction involves reduction of a ketone using

(i) $LiAlH_4$
(ii) H_3O^+.

Lithium aluminium hydride, $LiAlH_4$, is a powerful reducing agent. It converts a ketone carbonyl group, C=O, into a **secondary alcohol, CH–OH**.

In the given molecule, there is already an existing stereogenic centre adjacent to the carbonyl group. Therefore, the two faces of the planar carbonyl group are **not equivalent**.

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They are diastereotopic faces.

The hydride ion supplied by $LiAlH_4$ can theoretically attack the carbonyl carbon from either face. However, the two pathways do not have equal energies because the neighbouring stereocentre creates different steric environments on the two sides.

Hydride preferentially attacks the **less sterically hindered face** of the carbonyl group. This minimizes interaction between the incoming hydride and the bulky groups, particularly the phenyl and methyl groups around the neighbouring stereocentre.

After hydride addition, an alkoxide ion is formed:

$C{=}O \rightarrow C{-}O^-$.

During the H_3O^+ work-up, this alkoxide is protonated to give the corresponding secondary alcohol:

$C{-}O^- \rightarrow C{-}OH$.

A **new stereogenic centre** is therefore created at the carbon atom that originally belonged to the carbonyl group. The configuration of the neighbouring pre-existing stereocentre is retained because no bond at that stereocentre is broken during the reduction.

For the major product shown in option B, application of the Cahn–Ingold–Prelog priority rules gives the configurations:

C-2 = R

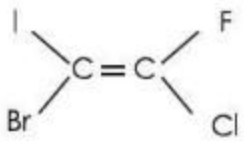
C-3 = S

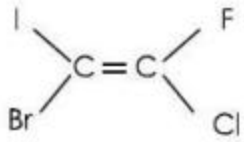
Thus, the major stereoisomer produced by $LiAlH_4$ reduction is the product having the **2R, 3S configuration** shown in option B.

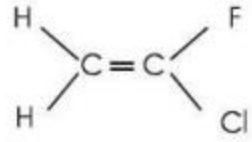
Therefore, **option B is correct.**

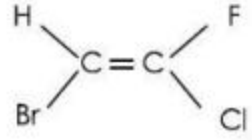
17. What is correct?

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A :  = Z - configuration

B :  = E - configuration – **(Correct Alternative)**

C :  = Z - configuration

D :  = E - configuration

Correct Answer: B. E-configuration

Explanation:
To determine whether an alkene has E or Z configuration, we use the **Cahn–Ingold–Prelog priority rules**. On each carbon of the C=C bond, the two attached groups are compared according to atomic number.

For the **left carbon**, the attached atoms are iodine (I) and bromine (Br).

Atomic numbers:

I = 53
Br = 35

Therefore,

I > Br

So **I has higher priority** on the left carbon.

For the **right carbon**, the attached atoms are fluorine (F) and chlorine (Cl).

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Atomic numbers:

Cl = 17
F = 9

Therefore,

Cl > F

So **Cl has higher priority** on the right carbon.

Now observe the positions of the two higher-priority groups:

I is **above** the double bond.

Cl is **below** the double bond.

Thus, the two higher-priority groups are on **opposite sides** of the C=C bond.

When the higher-priority groups are on opposite sides, the configuration is **E**.

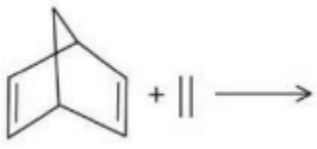
A useful memory rule is:

Z = higher-priority groups on the same side.
E = higher-priority groups on opposite sides.

Therefore, **option B is correct: E-configuration.**

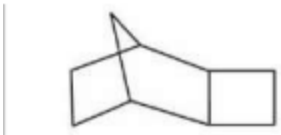
Also, option C cannot be assigned E/Z configuration because the left alkene carbon contains **two identical H atoms**. E/Z is possible only when each carbon of the C=C bond has two different substituents.

18. Find out the product of the following reaction

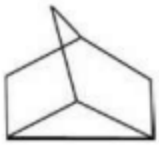


A)

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B :

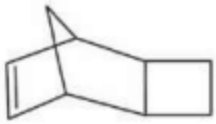


C :



– (Correct Alternative)

D :



Correct Answer: C

Explanation:
The starting compound is a **highly strained bicyclic diene** containing two carbon-carbon double bonds. The symbol shown next to it represents another unsaturated component participating in the cycloaddition.

This reaction proceeds through a **cycloaddition**, in which the π-electrons reorganize in a concerted manner to form new carbon-carbon σ bonds. Because the reacting system is held in a rigid bicyclic framework, the reacting double bonds are already positioned favourably for formation of a new cyclic structure.

During the reaction, the π bonds are consumed and **new C–C bonds are formed**, producing a more complex polycyclic framework. The stereochemical relationship of the reacting groups is controlled by the rigid geometry of the starting material.

Among the given structures, **option C** correctly represents the connectivity produced after the cycloaddition. It shows formation of the new larger ring while retaining the characteristic bridged portion of the original bicyclic system.

Option A gives an incorrect ring connectivity.
Option B does not account correctly for incorporation of the reacting unsaturated unit.
Option D retains a double bond and gives an incorrect cycloaddition product.

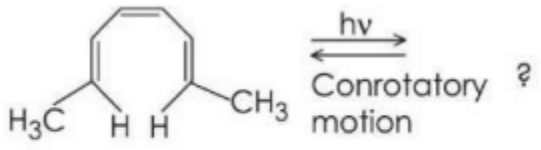
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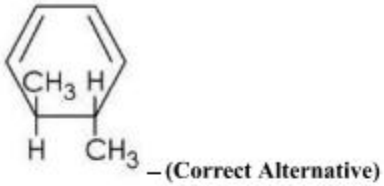
Therefore, the major product is the **polycyclic structure shown in option C**.

Hence, **option C is correct.**

19.

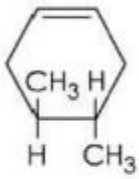


A :

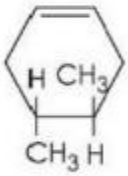


– (Correct Alternative)

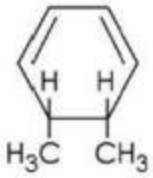
B :



C :



D :



CORRECTION TO FIGURE: Replace hν with Δ (thermal condition). For an 8π system, thermal ring closure is conrotatory.

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Correct Answer: A

Explanation: The corrected reaction is a thermal electrocyclic ring-closure of a conjugated 8π-electron system.

According to the Woodward-Hoffmann rules, a 4n π-electron system undergoes conrotatory ring closure under thermal conditions and disrotatory ring closure under photochemical conditions.

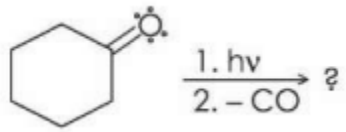
1. Here, $8\pi = 4n$ ($n = 2$), so the stated conrotatory motion is consistent with thermal conditions (Δ), not $h\nu$.
2. Following the conrotatory movement gives the stereochemical arrangement shown in option A.

Therefore, option A is correct.

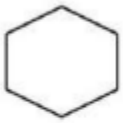
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20.



A :  – (Correct Alternative)

B : 

C : 

D : 

Correct Answer: A. Cyclopentane

Explanation:
The starting compound is **cyclohexanone**, a six-membered cyclic ketone. It is irradiated with light, hν, and subsequently undergoes loss of carbon monoxide, CO.

This is a characteristic **photochemical decarbonylation of a cyclic ketone**.

On irradiation, the carbonyl group absorbs light and reaches an electronically excited state. This promotes cleavage of the carbon-carbon bonds adjacent to the carbonyl group, called the **α-bonds**.

The photochemical process ultimately results in the elimination of the carbonyl carbon together with oxygen in the form of **carbon monoxide, CO**.

The important point is that cyclohexanone initially has a six-membered ring containing five methylene carbons and one carbonyl carbon.

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Cyclohexanone → 6 ring carbon atoms

Loss of CO → removal of the carbonyl carbon

Therefore, the remaining five carbon atoms reconnect to form a **five-membered ring**.

Thus,

Cyclohexanone → hν → loss of CO → Cyclopentane

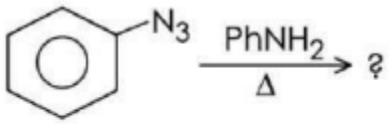
This reaction therefore causes **ring contraction by one carbon atom**.

Option B, cyclohexane, cannot be formed because simple removal of oxygen without loss of carbon would be required.

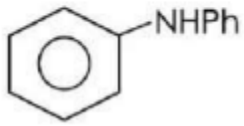
Options C and D contain oxygen within the ring, whereas the reaction specifically eliminates the carbonyl functionality as CO.

Therefore, the product is **cyclopentane**, and **option A is correct.**

21.

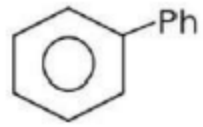


A :

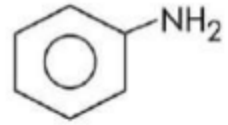


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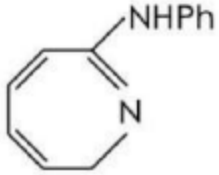
B :



C :



D :



– (Correct Alternative)

Correct Answer: D. Ring-expanded product containing nitrogen

Explanation:
The starting compound is **phenyl azide, $C_6H_5N_3$**. On heating in the presence of aniline, $PhNH_2$, phenyl azide undergoes thermal decomposition.

The important first step is the loss of molecular nitrogen:

$C_6H_5N_3 \rightarrow C_6H_5N: + N_2$

This generates a highly reactive **phenylnitrene** intermediate.

Nitrenes are neutral, electron-deficient nitrogen species analogous to carbenes. The phenylnitrene formed here can undergo rearrangement rather than simply remaining attached to the benzene ring.

A characteristic reaction of aryl nitrenes is **ring expansion**. The nitrene rearranges through migration of a neighbouring carbon-carbon bond, converting the six-membered aromatic framework into a **seven-membered nitrogen-containing ring**.

This ring-expanded intermediate can then react with the nucleophile aniline, $PhNH_2$. Aniline attacks the reactive intermediate, and subsequent proton-transfer/rearrangement steps produce the structure shown in option D.

The key transformation is therefore:

Phenyl azide → loss of N_2 → phenylnitrene → ring expansion → reaction with $PhNH_2$.

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Option A would correspond essentially to direct replacement of the azide group by NHPh, which does not represent the characteristic nitrene rearrangement occurring under these thermal conditions.

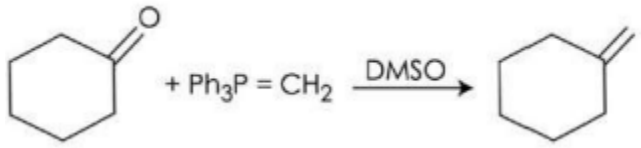
Option B gives biphenyl and does not account for incorporation of nitrogen.

Option C gives aniline and likewise does not represent the ring-expansion pathway.

Therefore, the **seven-membered nitrogen-containing ring shown in option D is the correct product.**

Hence, **option D is correct.**

22. The reaction is an example of :



A) Wittig reaction - (Correct Alternative)

B) Wolff - Kishner reduction

C) Sandmeyer reaction

D) Michael reaction

Correct Answer: A. Wittig reaction

Explanation:
The given reaction shows **cyclohexanone** reacting with the phosphorus ylide

$Ph_3P=CH_2$

to form **methylenecyclohexane**, in which the carbonyl group C=O has been replaced by a carbon-carbon double bond $C=CH_2$.

This transformation is known as the **Wittig reaction**.

The Wittig reaction involves the reaction of an **aldehyde or ketone with a phosphorus ylide**, also called a Wittig reagent, to produce an alkene.

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The general reaction can be represented as:

$R_2C=O + Ph_3P=CHR \rightarrow R_2C=CHR + Ph_3P=O$

Here, the ylide is

$Ph_3P=CH_2$.

The ylide carbon behaves as a nucleophilic carbon and attacks the electrophilic carbonyl carbon of cyclohexanone. After formation of intermediates involving phosphorus and oxygen, the reaction ultimately produces:

Methylenecyclohexane + triphenylphosphine oxide, $Ph_3P=O$.

An important feature of the Wittig reaction is that it provides a convenient method for converting **C=O into C=C** and allows control over the carbon skeleton of the resulting alkene.

Option B, Wolff-Kishner reduction, converts C=O into CH_2 using hydrazine and strong base.

Option C, Sandmeyer reaction, involves replacement of an aromatic diazonium group using copper(I) salts.

Option D, Michael reaction, is a conjugate 1,4-addition to an α,β-unsaturated carbonyl compound.

Therefore, **option A, Wittig reaction, is correct.**

23. Aldehydes and ketones to yield *α*-hydroxy phosphine oxide, which on treatment with sodium hydride to give the alkene is ?

A) Wittig - Horner reaction - (Correct Alternative)

B) Dickmann condensation

C) Knoevenagel reaction

D) Stork - Enamine reaction

Correct Answer: A. Wittig–Horner reaction

Explanation:
The reaction described is the **Wittig–Horner reaction**, a modification of the classical Wittig olefination used to convert aldehydes and ketones into alkenes.

In this reaction, a phosphorus-stabilized carbanion reacts with the carbonyl group of an

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aldehyde or ketone. Nucleophilic addition to the C=O group initially produces an intermediate that can be represented as an **α-hydroxy phosphorus compound**.

On treatment with a strong base such as sodium hydride, NaH, the intermediate undergoes elimination, resulting in formation of a carbon-carbon double bond.

Thus, the overall transformation is essentially:

Aldehyde or ketone → phosphorus-containing intermediate → alkene.

The Wittig–Horner approach is particularly useful in organic synthesis because it converts carbonyl compounds into alkenes and often provides better stereochemical control than the classical Wittig reaction. The Horner–Wadsworth–Emmons variant, which uses phosphonate-stabilized carbanions, commonly favours formation of E-alkenes.

Dickmann condensation is an intramolecular Claisen condensation used for preparing cyclic β-keto esters.

Knoevenagel reaction is the condensation of an aldehyde or ketone with a compound containing an active methylene group.

Stork enamine reaction uses enamines as carbon nucleophiles, commonly for α-alkylation or related carbon-carbon bond-forming reactions.

Therefore, **option A is correct.**

24. The decreasing order of Grignard reagent formation among following alkyl halides is :

A) $C_2H_5X > CH_3X > C_3H_7X$

B) $CH_3X > C_3H_7X > C_2H_5X$

C) $C_3H_7X > C_2H_5X > CH_3X$

D) $CH_3X > C_2H_5X > C_3H_7X$ – (Correct Alternative)

Correct Answer: D. $CH_3X > C_2H_5X > C_3H_7X$

Explanation:
Grignard reagents are generally prepared by reacting an organic halide with magnesium metal in dry ether:

RX + Mg → RMgX.

The rate and ease of Grignard reagent formation depend on several factors, including the

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nature of the halogen, the structure of the alkyl group, steric effects and the conditions of the reaction.

For the alkyl groups given here, the order stated in the answer key is:

$CH_3X > C_2H_5X > C_3H_7X$.

Methyl halide has the least steric crowding around the carbon-halogen bond, making interaction with the magnesium surface relatively favourable. As the size of the alkyl group increases from methyl to ethyl to propyl, steric effects increase.

Therefore, according to the convention intended in this question, the decreasing order of Grignard reagent formation is:

$CH_3X > C_2H_5X > C_3H_7X$.

Hence, option D is correct.

An additional important point is that the identity of X strongly influences Grignard formation. For a given alkyl group, the general reactivity trend is approximately:

RI > RBr > RCl,

while alkyl fluorides are generally unsuitable because the C–F bond is extremely strong.

25. Which one of the following on reduction with Ni – H_2 undergoes destruction of the ring?

A) Furan

B) Thiophene - (Correct Alternative)

C) Pyridine

D) Pyrrole

Correct Answer: B. Thiophene

Explanation:
Thiophene is a five-membered aromatic heterocyclic compound containing one sulfur atom. When thiophene is subjected to catalytic reduction with **hydrogen in the presence of nickel**, hydrogenation can be accompanied by **hydrogenolysis of carbon-sulfur bonds**.

Initially, hydrogenation can destroy the aromatic character of the thiophene system. Under suitable Ni/H_2 conditions, the C–S bonds can then undergo cleavage, resulting in

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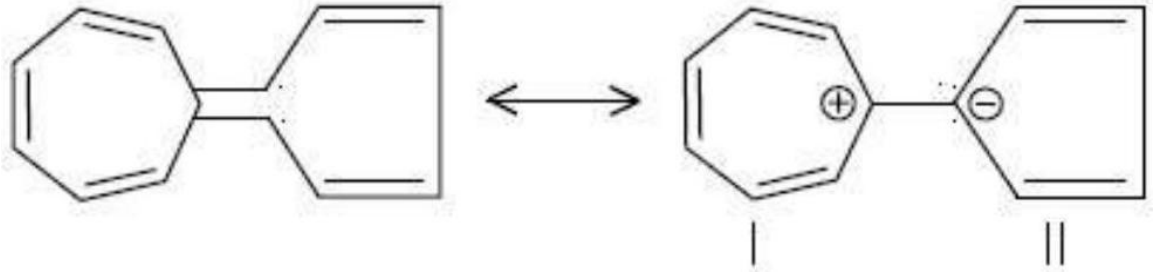
removal of sulfur and destruction or opening of the original heterocyclic ring.

This behaviour is related to the strong interaction of sulfur-containing compounds with nickel catalysts. The process is closely related to **hydrodesulfurization**, in which sulfur is removed from organic sulfur compounds by catalytic treatment with hydrogen.

Furan, pyrrole and pyridine can also undergo hydrogenation under appropriate conditions, but the characteristic ring-destructive behaviour highlighted in this question under Ni–H_2 reduction is associated with **thiophene** because of C–S bond hydrogenolysis.

Therefore, **option B. Thiophene is correct.**

26. Consider the following fulvene, which is stabilised by resonance involving a dipolar form.



In the above resonance :

A) Both I and II rings are aromatic - (Correct Alternative)

B) Both I and II rings are non-aromatic

C) Ring I is aromatic while ring II is non-aromatic

D) Ring I is aromatic while ring II is anti-aromatic

Correct Answer: A. Both I and II rings are aromatic

Explanation:
The given compound is a **fulvalene-type conjugated system**. Its stability can be understood by considering the important charge-separated or dipolar resonance structure shown in the question.

In this resonance form, the left ring, ring I, carries a **positive charge**, while the right ring, ring II, carries a **negative charge**.

For ring I, the positively charged seven-membered ring behaves like the **tropylium ion**. It contains three conjugated double bonds, giving a total of

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$3 \times 2 = 6\ \pi$ electrons.

According to Hückel's rule, a cyclic, planar and completely conjugated system is aromatic when it contains

$(4n + 2)\ \pi$ electrons.

For $6\ \pi$ electrons,

$4n + 2 = 6$

$n = 1$.

Therefore, ring I is aromatic.

For ring II, the negatively charged five-membered ring behaves like the **cyclopentadienyl anion**. The two double bonds contribute $4\ \pi$ electrons, while the negatively charged carbon contributes an additional lone pair containing $2\ \pi$ electrons.

Therefore, the total is

$4 + 2 = 6\ \pi$ electrons.

Again,

$6 = 4n + 2$, with $n = 1$.

Thus, ring II is also aromatic.

The dipolar resonance structure is particularly important because **both rings simultaneously acquire aromatic 6π-electron configurations**, which provides substantial resonance stabilization to the molecule.

Therefore:

Ring I = 6π aromatic tropylium-type ring

Ring II = 6π aromatic cyclopentadienyl-anion-type ring

Hence, **both I and II rings are aromatic, and option A is correct.**

27. Pyridine behaves as a highly deactivated aromatic nucleus towards electrophilic substitution reactions, because :

A) Greater electronegativity of nitrogen decreases the electron density of the ring - (Correct Alternative)

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B) +I effect of the ring nitrogen decreases the electron density of the ring

C) Resonance forming ability of this compound decreases the electron density of the ring

D) Greater electronegativity of nitrogen decreases the electron density of the ring, +I effect of the ring nitrogen decreases the electron density of the ring and Resonance forming ability of this compound decreases the electron density of the ring

Correct Answer: A. Greater electronegativity of nitrogen decreases the electron density of the ring

Explanation:
Pyridine is a six-membered aromatic heterocyclic compound containing five carbon atoms and one nitrogen atom. Like benzene, it contains **6 π electrons** and satisfies Hückel's rule, so it is aromatic. However, pyridine is much less reactive than benzene towards **electrophilic aromatic substitution**.

The main reason is the **greater electronegativity of nitrogen compared with carbon**. Nitrogen attracts electron density towards itself through the **negative inductive effect (−I effect)**. As a result, electron density on the carbon atoms of the pyridine ring decreases.

Electrophilic substitution requires an electron-rich aromatic ring to attack an electrophile. Since the pyridine ring is relatively **electron deficient**, attack by an electrophile becomes difficult. Hence, reactions such as nitration, sulphonation and halogenation occur much less readily in pyridine than in benzene and generally require severe conditions.

Another important point is that the lone pair on pyridine nitrogen lies in an **sp^2 hybrid orbital** and does not form part of the aromatic 6π-electron system. Therefore, it is incorrect to explain the deactivation as a +I effect of nitrogen.

Option B is incorrect because nitrogen does **not show a +I effect** here; its high electronegativity produces a **−I effect**.

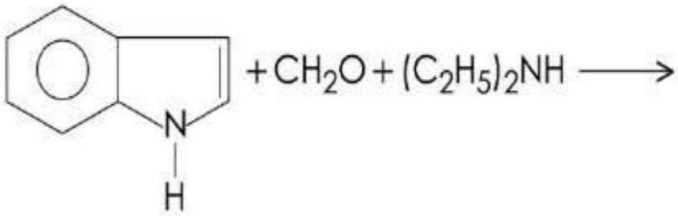
Option C does not state the primary reason correctly.

Option D is incorrect because it includes the erroneous claim that ring nitrogen shows a +I effect.

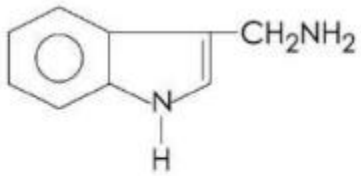
Therefore, **option A is correct.**

28. The product of the following reaction is :

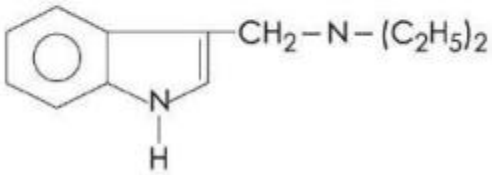
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A :

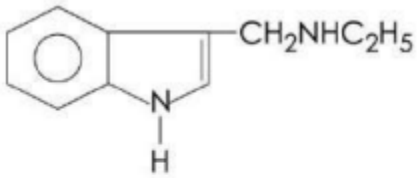


B :

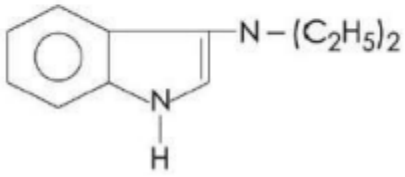


– (Correct Alternative)

C :



D :



Correct Answer: B. 3-(Diethylaminomethyl)indole

Explanation:
The starting compound is **indole**, which reacts with formaldehyde, CH_2O, and diethylamine, $(C_2H_5)_2NH$.

This reaction is an example of the **Mannich reaction**. In a Mannich reaction, a compound containing an electron-rich carbon reacts with formaldehyde and a primary or secondary amine to introduce an **aminomethyl group**.

First, formaldehyde reacts with diethylamine to generate an electrophilic **iminium ion**. It

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can be represented approximately as:

$CH_2O + HN(C_2H_5)_2 \rightarrow [CH_2=N^+(C_2H_5)_2]$

Indole is a highly electron-rich aromatic heterocycle. In electrophilic substitution reactions, the most reactive position of indole is normally the **C-3 position**.

Attack at C-3 is particularly favourable because the intermediate formed during electrophilic substitution retains the aromatic character of the benzene portion of the indole system and is strongly resonance stabilized.

Therefore, the C-3 carbon of indole attacks the electrophilic aminomethyl species. After proton transfer, the group introduced at C-3 is:

$-CH_2-N(C_2H_5)_2$.

Thus, the product is **3-(diethylaminomethyl)indole**.

The overall transformation can be summarized as:

Indole + CH_2O + $HN(C_2H_5)_2 \rightarrow$ Indole-3-CH_2-$N(C_2H_5)_2$.

Option A contains $-CH_2NH_2$ and therefore does not incorporate the diethylamine group correctly.

Option C contains $-CH_2NHC_2H_5$, corresponding to an ethylamino group rather than the required diethylamino group.

Option D lacks the methylene, $-CH_2-$, group characteristic of the Mannich product.

Therefore, **option B is correct.**

29. The zero point energy of a particle when placed in a one-dimensional box of length 1Å was found to be 2.5 eV . When the same particle is placed in a cubic box of side 1Å, its zero point energy is :

A) 2.5

B) 7.5 - (Correct Alternative)

C) 5.0

D) 10.0

Correct Answer: B. 7.5 eV

Explanation:

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For a particle in a one-dimensional box of length L, the allowed energy levels are

$E_n = n^2h^2/(8mL^2)$.

The lowest possible energy occurs for n = 1. This is called the zero-point or ground-state energy:

$E_1 = h^2/(8mL^2)$.

The question states that for a one-dimensional box of length 1 Å,

$E_1 = 2.5$ eV.

Now consider the same particle in a three-dimensional cubic box of side 1 Å. The energy is

$E = h^2/(8mL^2)(n_x^2 + n_\gamma^2 + n_z^2)$.

For the ground state,

$n_x = n_\gamma = n_z = 1$.

Therefore,

$E = h^2/(8mL^2)(1^2 + 1^2 + 1^2)$

$= 3h^2/(8mL^2)$.

Since the one-dimensional ground-state energy is 2.5 eV,

$E = 3 \times 2.5$

$= 7.5$ eV.

Thus, the zero-point energy in a cubic box is three times that in the corresponding one-dimensional box.

Therefore, **option B. 7.5 eV is correct.**

30. A particle in a one-dimensional box of length L is subjected to the perturbation H' = (1 eV/L)x. If ψn = √(2/L) sin(nπx/L), the first-order correction to the ground-state energy is:

Given: $\int_0^L x \sin^2(\pi x/L)\, dx = L^2/4$

A) 2 eV

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B) 0.15 eV

C) 0.5 eV - (Correct Alternative)

D) 16 eV

Correct Answer: C. 0.5 eV

Explanation: In first-order perturbation theory, $E1(1) = \langle \psi 1|H'|\psi 1\rangle$.

For the ground state, $\psi 1 = \sqrt{(2/L)} \sin(\pi x/L)$.

Therefore, $E1(1) = (1 \text{ eV}/L)(2/L) \int 0L\ x \sin^2(\pi x/L)\ dx$.

Using the given integral, $\int 0L\ x \sin^2(\pi x/L)\ dx = L^2/4$.

$E1(1) = (1 \text{ eV}/L)(2/L)(L^2/4) = 0.5 \text{ eV}$.

Hence, option C is correct.

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31. The commutator of d/dz and z^3 with respect to the function f is:

A) z^3

B) $3z^2$ - (Correct Alternative)

C) $3z^{-3}$

D) z

Correct Answer: B. $3z^2$

Explanation: Using [A,B] = AB - BA, take A = d/dz and B = z^3.

$[d/dz, z^3]f = (d/dz)(z^3f) - z^3(df/dz)$.

By the product rule, $(d/dz)(z^3f) = 3z^2f + z^3(df/dz)$.

Therefore, $[d/dz, z^3]f = 3z^2f$.

Hence, $[d/dz, z^3] = 3z^2$ and option B is correct.

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32. A reaction that must consist of initiation, propagation and termination steps is:

A) Chain reaction - (Correct Alternative)

B) Reverse reaction

C) Consecutive reaction

D) Opposing reaction

Correct Answer: A. Chain reaction

Explanation:
A chain reaction is a reaction mechanism in which reactive intermediates, usually free radicals, atoms or ions, are continuously generated and consumed through a sequence of elementary steps.

A typical chain reaction consists of three important stages:

Initiation: Reactive species are first generated. For example, a covalent bond may undergo homolytic cleavage to produce free radicals.

Propagation: The reactive intermediate reacts with another molecule to produce a product and simultaneously generates another reactive intermediate. This allows the reaction sequence to continue repeatedly.

Termination: Reactive intermediates combine or are otherwise destroyed, stopping the chain.

A familiar example is free-radical chlorination of methane. Chlorine radicals are generated during initiation, repeatedly react during propagation, and are removed during termination.

Thus,

Initiation → Propagation → Termination

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is the characteristic sequence of a **chain reaction**.

Therefore, **option A is correct.**

33. $\mathbf{BH^+ + S = SH^+ + B}$
$\mathbf{SH^+ + H_2O \rightarrow P + H_3O^+}$ **is the mechanism of ___ catalysis.**

A) Base catalysis

B) Acid catalysis - (Correct Alternative)

C) Enzyme catalysis

D) Metal-ion catalysis

Correct Answer: B. Acid catalysis

Explanation:
The given mechanism is

$BH^+ + S \rightarrow SH^+ + B$

followed by

$SH^+ + H_2O \rightarrow P + H_3O^+$.

Here, the substrate S first accepts a proton from the protonated species BH^+. As a result, the substrate becomes protonated:

$S \rightarrow SH^+$.

Protonation often makes a substrate more reactive by increasing its electrophilic character or converting a poor leaving group into a better leaving group.

The protonated substrate then reacts with water to produce the product P. During this process, H_3O^+ is produced or the acidic catalytic species is regenerated.

The essential feature is that **proton transfer to the substrate facilitates the reaction**, which is characteristic of acid catalysis.

In acid-catalysed reactions, the acid participates in the mechanism but is regenerated, so it is not consumed overall.

Base catalysis instead involves proton abstraction by a base. Enzyme catalysis requires an enzyme, while metal-ion catalysis involves coordination to a metal ion.

Therefore, **option B. Acid catalysis is correct.**

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34. "The fugacity of a gas in a mixture is equal to the product of its mole fraction and its fugacity in the pure state at the total pressure of the mixture". This is :

A) Gibbs - Helmholtz statement

B) Lewis - Randall rule - (Correct Alternative)

C) Henry's law

D) Planck's statement

Correct Answer: B. Lewis–Randall rule

Explanation:
The Lewis–Randall rule describes the fugacity of a component in an **ideal solution or ideal gaseous mixture**.

According to the rule, the fugacity of component i in a mixture is given by

$f_i = x_i f_i^*$,

where

f_i = fugacity of component i in the mixture,

x_i = mole fraction of component i,

f_i^* = fugacity of the pure component at the same temperature and total pressure.

Thus, the fugacity of a component in an ideal mixture is equal to its mole fraction multiplied by the fugacity of that component in its pure state at the same temperature and pressure.

This relation is essentially the fugacity-based thermodynamic analogue of ideal-solution behaviour.

Henry's law, in contrast, describes the behaviour of a solute at low concentration and relates its partial pressure or fugacity to its mole fraction through Henry's law constant.

The Gibbs–Helmholtz equation relates Gibbs free energy to enthalpy and temperature.

Therefore, the statement given in the question is the **Lewis–Randall rule**.

Hence, **option B is correct.**

35. The characteristic Raman active species of C_{2v} point group is :

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A) A_1'

B) A_1', E'

C) $A_{1\,g}$

D) A1, A2, B1, B2 - (Correct Alternative)

Correct Answer: D. A1, A2, B1, B2

Explanation: A normal mode is Raman active when its symmetry species transforms as a quadratic function (a component of the polarizability tensor).

For C2v, the quadratic functions transform as follows:

A1 → x^2, y^2, z^2

A2 → xy

B1 → xz

B2 → yz

Therefore, all four irreducible representations A1, A2, B1 and B2 can be Raman active in the C2v point group.

Hence, option D is correct.

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36. Which one of the following does not form a group ?

(i)(i) Set of integers with multiplication as the binary operation

(ii) (ii) Set of integers with division as the binary operation

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(iii) (iii) Set of all 2 × 2 singular matrices with matrix multiplication as the binary operation

(iv) (iv) Set {e^x | x is a positive integer} with multiplication as the binary operation

A) (i), (iv)

B) (i), (ii)

C) (ii), (iii), (iv)

D) (i), (ii), (iii), (iv) - (Correct Alternative)

Correct Answer: D. (i), (ii), (iii), (iv)

Explanation: Each of the four stated sets fails at least one group axiom.

(i) Integers under multiplication do not form a group because most integers do not have multiplicative inverses in the integers, and 0 has no inverse.

(ii) Integers under division do not form a group because division is not closed in the integers and is not associative.

(iii) Singular 2 × 2 matrices under multiplication do not form a group because the identity matrix is not singular and singular matrices have no multiplicative inverse.

(iv) The set {e^x | x is a positive integer} lacks the identity e^0 and the inverses e^(-x), so it is not a group.

Therefore, all four collections fail to form groups and option D is correct.

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37. The selection rule for pure rotational Raman spectrum of a diatomic molecule is :

A) $\Delta J = 0, \pm 1$

B) $\Delta J = 0, \pm 2$ - (Correct Alternative)

C) $\Delta J = 0, \pm 1, \pm 2$

D) $\Delta J = 0$ only

Correct Answer: B. $\Delta J = 0, \pm 2$

Explanation:
In rotational Raman spectroscopy, molecular rotational transitions occur because the molecular polarizability changes as the molecule rotates.

The rotational Raman selection rule is

$\Delta J = 0, \pm 2$.

Here J is the rotational quantum number.

The transition with

$\Delta J = 0$

corresponds to the **Rayleigh line**, where there is no change in rotational quantum number and hence no Raman frequency shift.

For Raman-shifted rotational lines:

$\Delta J = +2$ corresponds to **Stokes lines**.

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$\Delta J = -2$ corresponds to **anti-Stokes lines**.

This differs from pure rotational microwave spectroscopy, where the usual selection rule is

$\Delta J = \pm 1$.

Therefore, it is important not to confuse microwave rotational spectroscopy with rotational Raman spectroscopy.

Thus, for a pure rotational Raman spectrum of a diatomic molecule, the relevant selection rule is

$\Delta J = 0, \pm 2$.

Hence, **option B is correct.**

38. Ion-pair formation was suggested by :

A) Debye-Huckel

B) Helmholtz-Perrin

C) Gouy-Chapman

D) Bjerrum - (Correct Alternative)

Correct Answer: D. Bjerrum

Explanation:
The concept of **ion-pair formation** in electrolyte solutions was developed by **Niels Bjerrum**.

In a solution containing oppositely charged ions, electrostatic attraction exists between positive and negative ions. When two oppositely charged ions approach sufficiently close to one another, their electrostatic attraction can become strong enough for them to behave temporarily as an associated pair.

Such an association is called an **ion pair**.

Bjerrum introduced the idea to explain deviations in the behaviour of electrolyte solutions, particularly where simple theories treating all ions as completely independent particles become inadequate.

Debye-Hückel theory primarily describes the electrostatic interactions between ions through the concept of an **ionic atmosphere**.

Helmholtz-Perrin and Gouy-Chapman theories are primarily associated with models of

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the **electrical double layer** at an electrode-solution interface.

Therefore, ion-pair formation is associated with **Bjerrum**.

Hence, **option D is correct.**

39. Which is not true according to Gouy-Chapman model ?

(I) The excess charge density on the OHP is equivalent to that on the metal.

(II) The excess charge density in the solution decreases with distance.

(III) Sufficient for distance, the net charge density vanishes.

A) (I) only - (Correct Alternative)

B) (II) only

C) (III) only

D) (I) and (III) only

Correct Answer: A. Statement (I) only

Explanation:
The Gouy-Chapman model describes the electrical double layer at an electrode-solution interface using the concept of a **diffuse layer of ions**.

Let us examine each statement.

Statement I: The excess charge density on the OHP is equivalent to that on the metal.

This is **not true according to the Gouy-Chapman model**.

The Gouy-Chapman model does not assume that the compensating ionic charge is concentrated at a single plane such as the **Outer Helmholtz Plane (OHP)**. Instead, the countercharge is distributed throughout a diffuse region extending from the electrode into the solution.

The OHP becomes particularly important in the later **Stern model**, which combines concepts from the Helmholtz and Gouy-Chapman descriptions.

Therefore, statement I is incorrect.

Statement II: The excess charge density in the solution decreases with distance.

This is true.

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Close to a charged electrode, counterions accumulate because of electrostatic attraction. As the distance from the electrode increases, the influence of the electrode potential becomes progressively weaker.

Consequently, the excess ionic charge density decreases with increasing distance from the surface.

Statement III: At sufficiently large distance, the net charge density vanishes.

This is also true.

Far away from the electrode, the influence of the charged surface becomes negligible and the electrolyte approaches its bulk condition. The concentrations of positive and negative charges then satisfy bulk electroneutrality.

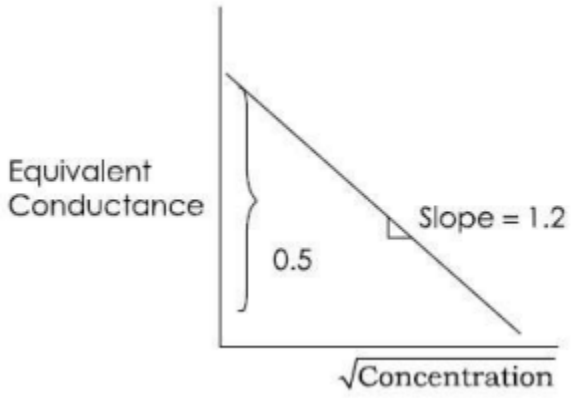
Therefore, the net excess charge density approaches zero.

Thus:

Statement I = Not true
Statement II = True
Statement III = True

Therefore, **only statement I is incorrect**, and **option A is correct.**

40. From the following graph find the Value of Onsager constant 'A'. If Onsager Constant B is equal to 2 units.



A) 0.5

B) 12

C) 0.2 - (Correct Alternative)

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D) 1.5

Correct Answer: C. 0.2

Explanation:
For a strong electrolyte, the variation of equivalent conductance with concentration is given by the **Debye-Hückel-Onsager equation**:

$\Lambda = \Lambda_0 - (A + B\Lambda_0)\sqrt{C}$

where

Λ = equivalent conductance at concentration C
Λ_0 = equivalent conductance at infinite dilution
A and B = Onsager constants
C = concentration

From the graph:

$\Lambda_0 = 0.5$

Magnitude of slope = 1.2

Given:

B = 2

From the Onsager equation, the magnitude of the slope is

Slope = $A + B\Lambda_0$

Therefore,

$1.2 = A + (2 \times 0.5)$

$1.2 = A + 1$

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Hence,

$A = 1.2 - 1$

A = 0.2

Therefore, the value of Onsager constant A is **0.2**.

Hence, **option C is correct.**

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