MHT-CET Chemistry Sample Paper-13

Duration: 45 Minutes **Maximum Marks: 50**

Instructions

- This paper contains a total of **50** Multiple Choice Questions.
- Each correct answer carries **+1 marks**.
- No negative marking for incorrect questions.
- Use of mobile phones, smartwatches, or any electronic gadgets is strictly prohibited.
- No marks will be deducted for questions that are left unattempted.

Q1. Which of the following molecules has a non-zero dipole moment?

(A) BF_3

(B) CCl_4

(C) NH_3

(D) CO_2

Q2. The IUPAC name of $CH_3 - CH(Cl) - CH(Br) - CH_3$ is:

(A) 2-Bromo-3-chlorobutane

(B) 3-Bromo-2-chlorobutane

(C) 2-Chloro-3-bromobutane

(D) 1-Bromo-2-chlorobutane

Q3. Which of the following is the most stable carbocation?

(A) $(CH_3)_3C^+$

(B) $(CH_3)_2CH^+$

(C) $CH_3CH_2^+$

(D) CH_3^+

Q4. In the E1 mechanism, the rate of reaction depends on the concentration of:

(A) Substrate only

(B) Nucleophile only

(C) Both Substrate and Nucleophile

(D) Solvent only

Q5. Identify the major product when 2-Bromobutane reacts with alcoholic KOH:

(A) But-1-ene

(B) But-2-ene

(C) Butan-2-ol

(D) Butan-1-ol

Q6. The Lucas test is used to distinguish between:

(A) Aldehydes and Ketones

(B) 1°, 2°, and 3° Alcohols

(C) Amines and Amides

(D) Phenols and Alcohols

Q7. The reaction of Phenol with $CHCl_3$ and aqueous $NaOH$ at 340 K followed by hydrolysis gives:

(A) Salicylaldehyde

(B) Salicylic acid

(C) Benzene

(D) Picric acid

Q8. Which of the following does NOT reduce Fehling's solution?

(A) Glucose
(B) Fructose
(C) Benzaldehyde
(D) Acetaldehyde

Q9. The product formed in the Gatterman-Koch reaction is:

(A) Benzyl chloride
(B) Benzaldehyde
(C) Benzophenone
(D) Chlorobenzene

Q10. The basic strength of amines in the gaseous phase follows the order:

(A) $3^\circ > 2^\circ > 1^\circ > NH_3$
(B) $NH_3 > 1^\circ > 2^\circ > 3^\circ$
(C) $2^\circ > 1^\circ > 3^\circ > NH_3$
(D) $3^\circ > 1^\circ > 2^\circ > NH_3$

Q11. Amylopectin is a polymer of:

(A) α-D-Glucose
(B) β-D-Glucose
(C) α-D-Fructose
(D) β-D-Galactose

Q12. Buna-S is a copolymer of 1,3-Butadiene and:

(A) Acrylonitrile

(B) Styrene

(C) Vinyl chloride

(D) Isoprene

Q13. According to MOT, the bond order of O_2^{2-} is:

(A) 1

(B) 1.5

(C) 2

(D) 2.5

Q14. The magnetic moment of Fe^{2+} (Z=26) is approximately:

(A) 4.90 BM

(B) 5.92 BM

(C) 3.87 BM

(D) 1.73 BM

Q15. Which of the following is a neutral ligand?

(A) CN^-

(B) en (Ethylenediamine)

(C) Ox^{2-}

(D) Cl^-

Q16. The number of P-O-P bonds in cyclic metaphosphoric acid is:

(A) 2

(B) 3

(C) 4

(D) 0

Q17. Which of the following noble gases is used in magnetic resonance imaging (MRI)?

(A) He

(B) Ne

(C) Ar

(D) Xe

Q18. Lanthanoid contraction is due to poor shielding of:

(A) $4f$ electrons

(B) $5d$ electrons

(C) $6s$ electrons

(D) $4p$ electrons

Q19. The oxidation state of Oxygen in OF_2 is:

(A) -2

(B) +2

(C) -1

(D) +1

Q20. Which quantum number determines the orientation of the orbital in space?

(A) Principal

(B) Azimuthal

(C) Magnetic

(D) Spin

Q21. The edge length of a face-centered cubic (fcc) unit cell is 400 pm. The atomic radius is:

(A) 141.4 pm

(B) 173.2 pm

(C) 200 pm

(D) 100 pm

Q22. The van't Hoff factor (i) for K_2SO_4 assuming 100% dissociation is:

(A) 1

(B) 2

(C) 3

(D) 4

Q23. The unit of rate constant for a second-order reaction is:

(A) $mol\ L^{-1}\ s^{-1}$

(B) s^{-1}

(C) $L\ mol^{-1}\ s^{-1}$

(D) $L^2\ mol^{-2}\ s^{-1}$

Q24. In the extraction of Aluminium (Hall-Heroult process), cryolite is added to:

(A) Increase conductivity

(B) Lower the melting point

(C) Both A and B

(D) Prevent oxidation

Q25. For a reversible process at equilibrium, the change in Gibbs free energy (ΔG) is:

(A) Positive

(B) Negative

(C) Zero

(D) Maximum

Q26. Which of the following shows the highest number of oxidation states?

(A) Sc

(B) Mn

(C) Zn

(D) Fe

Q27. The relationship between C_p and C_v for an ideal gas is:

(A) $C_p - C_v = R$

(B) $C_v - C_p = R$

(C) $C_p/C_v = R$

(D) $C_p + C_v = R$

Q28. The pH of a 0.01 M $NaOH$ solution is:

(A) 2

(B) 12

(C) 7

(D) 10

Q29. The coordination number of Co in $[Co(en)_3]^{3+}$ is:

(A) 3

(B) 4

(C) 6

(D) 2

Q30. Which of the following is a greenhouse gas?

(A) N_2

(B) O_2

(C) CH_4

(D) Ar

Q31. The IUPAC name of Mesityl oxide is:

(A) 4-Methylpent-3-en-2-one

(B) 3-Methylpent-3-en-2-one

(C) 2-Methylpent-2-en-4-one

(D) 4-Methylpent-4-en-2-one

Q32. Identify the product formed when Phenol is treated with Neutral $FeCl_3$:

(A) White precipitate

(B) Violet coloration

(C) Red coloration

(D) Yellow coloration

Q33. The monomer of Natural Rubber is:

(A) Isoprene

(B) Chloroprene

(C) Styrene

(D) Butadiene

Q34. Glucose on reaction with Bromine water gives:

(A) Saccharic acid

(B) Gluconic acid

(C) n-Hexane

(D) Sorbitol

Q35. The half-life of a zero-order reaction is proportional to:

(A) Initial concentration

(B) Square of initial concentration

(C) Inverse of initial concentration

(D) Independent of initial concentration

Q36. Which of the following p-block hydrides is the strongest reducing agent?

(A) NH_3

(B) PH_3

(C) AsH_3

(D) BiH_3

Q37. The entropy of a perfectly crystalline substance is zero at:

(A) $0°C$

(B) $273\ K$

(C) $0\ K$

(D) $100°C$

Q38. The solubility of a gas in liquid increases with:

(A) Increase in temperature

(B) Decrease in pressure

(C) Increase in pressure

(D) Decrease in surface area

Q39. Which of the following is used as a refrigerant?

(A) CF_4

(B) CF_2Cl_2 (Freon-12)

(C) CH_2Cl_2

(D) CH_3Cl

Q40. The functional group present in an Ester is:

(A) $-OH$

(B) $-CHO$

(C) $-COOR$

(D) $-CONH_2$

Q41. The crystal field stabilization energy (CFSE) for a high spin d^4 octahedral complex is:

(A) $-0.6\Delta_o$

(B) $-1.6\Delta_o$

(C) $-0.4\Delta_o$

(D) $-1.2\Delta_o$

Q42. The process of converting a precipitate into a colloidal sol is called:

(A) Peptization

(B) Dialysis

(C) Coagulation

(D) Tyndall effect

Q43. Which of the following elements has the lowest electronegativity?

(A) F

(B) Cl

(C) Cs

(D) Li

Q44. The geometry of PCl_5 in the gaseous state is:

(A) Octahedral

(B) Trigonal bipyramidal

(C) Square pyramidal

(D) Tetrahedral

Q45. In the titration of a strong acid with a strong base, the indicator used is:

(A) Phenolphthalein

(B) Methyl orange

(C) Both A and B

(D) Starch

Q46. The number of tetrahedral voids in a ccp unit cell containing n atoms is:

(A) n

(B) $2n$

(C) $n/2$

(D) $4n$

Q47. Specific conductance increases with:

(A) Increase in dilution

(B) Increase in concentration

(C) Decrease in temperature

(D) Decrease in number of ions

Q48. Which of the following is a non-polar molecule?

(A) H_2O

(B) SO_2

(C) CH_4

(D) NH_3

Q49. Bakelite is a:

(A) Thermoplastic

(B) Thermosetting plastic

(C) Fiber

(D) Elastomer

Q50. The standard reduction potential of H^+/H_2 electrode is:

(A) $1\ V$

(B) $0\ V$

(C) $-1\ V$

(D) $0.5\ V$

Detailed Solutions

Q1.

Solution

Concept:
The dipole moment (μ) of a molecule is a vector quantity that depends on the bond polarity and the spatial arrangement (geometry) of the bonds. A molecule has a non-zero dipole moment if the individual bond dipoles do not cancel each other out due to symmetry.
Solution:
1. BF_3 (Boron trifluoride): It has a trigonal planar geometry (sp^2 hybridization). The three $B - F$ bond dipoles are oriented at 120° to each other, resulting in a net dipole moment of zero ($\mu = 0$).
2. CCl_4 (Carbon tetrachloride): It has a perfectly symmetrical tetrahedral geometry (sp^3 hybridization). The four $C - Cl$ bond dipoles cancel each other out completely ($\mu = 0$).
3. NH_3 (Ammonia): It has a pyramidal geometry (sp^3 hybridization with one lone pair). The three $N - H$ bond dipoles and the lone pair dipole all point in a similar direction (towards the nitrogen and upwards), meaning they do not cancel out. Thus, $\mu \neq 0$.
4. CO_2 (Carbon dioxide): It is a linear molecule ($O = C = O$). The two $C = O$ bond dipoles are equal and opposite, cancelling each other out ($\mu = 0$).
Final Answer: NH_3 has a non-zero dipole moment.

Answer: (C)

Q2.

Solution

Concept:
IUPAC nomenclature for substituted alkanes requires identifying the longest carbon chain and numbering it from the end that gives the lowest locants to the substituents. If locants are identical from both ends, numbering follows alphabetical order.
Solution:
1. Structure: $CH_3 - CH(Cl) - CH(Br) - CH_3$.
2. Longest Chain: There are 4 carbons in the parent chain, so the root name is "butane".
3. Substituents: A Chlorine atom (chloro) and a Bromine atom (bromo).
4. Numbering: - Left to right: Cl is at C2 and Br is at C3. (Locants 2, 3) - Right to left: Br is at C2 and Cl is at C3. (Locants 2, 3)
5. Alphabetical Rule: Since both directions give locants 2 and 3, we number from the end that gives the lower number to the substituent that comes first alphabetically. "Bromo" comes before "Chloro".
6. Therefore, Bromine gets position 2 and Chlorine gets position 3. The name is 2-Bromo-3-chlorobutane.
Final Answer: The IUPAC name is 2-Bromo-3-chlorobutane.

Answer: (A)

Q3.

Solution

Concept:
The stability of carbocations is determined by the dispersal of the positive charge. This occurs through the inductive effect ($+I$) of alkyl groups and hyperconjugation. The more alkyl groups attached to the cationic carbon, the more stable the carbocation.

Solution:
1. $(CH_3)_3C^+$: This is a tertiary (3°) carbocation. It has three methyl groups providing $+I$ effect and 9 α-hydrogens for hyperconjugation. It is highly stable.
2. $(CH_3)_2CH^+$: This is a secondary (2°) carbocation. It has two methyl groups and 6 α-hydrogens.
3. $CH_3CH_2^+$: This is a primary (1°) carbocation. It has one ethyl group and 3 α-hydrogens.
4. CH_3^+: This is a methyl carbocation. It has no alkyl groups and no α-hydrogens. It is the least stable.
5. Stability Order: $3° > 2° > 1° >$ methyl.

Final Answer: $(CH_3)_3C^+$ is the most stable carbocation.

Answer: (A)

Q4.

Solution

Concept:
The E1 mechanism (Elimination Unimolecular) is a two-step process. In the first and rate-determining step, the leaving group departs to form a carbocation intermediate. The second step involves the removal of a proton by a base.

Solution:
1. Rate Law: Because the rate-determining step involves only the dissociation of the substrate (alkyl halide), the rate is proportional only to the concentration of the substrate.

$$\text{Rate} = k[\text{Substrate}]$$

2. Role of Nucleophile/Base: In an E1 reaction, the base (usually a weak one) is not involved in the slow step. Therefore, changing its concentration does not affect the overall reaction rate.
3. Contrast with E2: In E2 (Elimination Bimolecular), the rate depends on both the substrate and the base.
4. Dependence: The rate of an E1 reaction depends solely on the substrate concentration.

Final Answer: The rate depends on the Substrate only.

Answer: (A)

Q5.

Solution

Concept:
Dehydrohalogenation of alkyl halides with alcoholic KOH follows Saytzeff's Rule (Zaitsev's Rule). This rule states that in an elimination reaction, the most substituted alkene (the one with the most alkyl groups attached to the double-bonded carbons) is the major product.
Solution:
1. Reactant: 2-Bromobutane ($CH_3 - CH(Br) - CH_2 - CH_3$).
2. Reagent: Alcoholic KOH (a strong base used for β-elimination).
3. Possible β-carbons: - C_1 (terminal): Removal of H from C_1 gives But-1-ene. - C_3 (internal): Removal of H from C_3 gives But-2-ene.
4. Saytzeff's Rule Application: But-2-ene is a disubstituted alkene, whereas But-1-ene is a monosubstituted alkene.
5. Result: But-2-ene is more stable and is formed as the major product ($\approx 80\%$).
Final Answer: The major product is But-2-ene.

Answer: (B)

Q6.

Solution

Concept:
The Lucas test is a qualitative chemical test used to differentiate between primary (1°), secondary (2°), and tertiary (3°) alcohols. The reagent used is Lucas reagent, which is a mixture of anhydrous $ZnCl_2$ and concentrated HCl. The reaction involves the formation of an alkyl chloride, which appears as turbidity (cloudiness).
Solution:
1. Tertiary alcohols (3°): React almost instantaneously with Lucas reagent at room temperature to form a cloudy solution or a distinct layer of alkyl chloride.
2. Secondary alcohols (2°): React within 5 to 10 minutes at room temperature, showing gradual turbidity.
3. Primary alcohols (1°): Do not react significantly with Lucas reagent at room temperature. Turbidity only appears upon heating.
4. The test relies on the stability of the carbocation intermediate formed during the S_N1 mechanism: $3° > 2° > 1°$.
Final Answer: The Lucas test distinguishes between 1°, 2°, and 3° Alcohols.

Answer: (B)

Q7.

Solution

Concept:

The Reimer-Tiemann reaction is a classic organic reaction used to ortho-formylate phenols. When phenol is treated with chloroform ($CHCl_3$) in the presence of sodium hydroxide ($NaOH$), a functional group is introduced onto the aromatic ring.

Solution:

1. Reaction Mechanism: The reaction proceeds via the generation of a highly reactive intermediate called dichlorocarbene ($: CCl_2$).
2. Intermediate Step: The carbene attacks the phenoxide ion (formed from phenol and $NaOH$) primarily at the ortho position due to the directing effect of the $-OH$ group.
3. Hydrolysis: The resulting intermediate is hydrolyzed by the base to form an aldehyde group ($-CHO$).
4. Product: The final product is 2-hydroxybenzaldehyde, commonly known as Salicylaldehyde.
5. Note: If carbon tetrachloride (CCl_4) were used instead of $CHCl_3$, the product would be Salicylic acid.

Final Answer: The product is Salicylaldehyde.

Answer: (A)

Q8.

Solution

Concept:

Fehling's solution is a mild oxidizing agent used to detect the presence of reducing sugars and aliphatic aldehydes. A positive test is indicated by the formation of a reddish-brown precipitate of cuprous oxide (Cu_2O).

Solution:

1. Aliphatic Aldehydes: Acetaldehyde (CH_3CHO) is an aliphatic aldehyde and easily reduces Fehling's solution.
2. Reducing Sugars: Glucose and fructose (which isomerizes to glucose in basic medium) are reducing sugars and give a positive Fehling's test.
3. Aromatic Aldehydes: Benzaldehyde (C_6H_5CHO) is an aromatic aldehyde. In aromatic aldehydes, the carbonyl group is in resonance with the benzene ring, making the $C-H$ bond of the aldehyde group stronger and less susceptible to oxidation by mild agents like Fehling's solution.
4. Result: Benzaldehyde reduces Tollens' reagent but does **not** reduce Fehling's solution.

Final Answer: Benzaldehyde does **not** reduce Fehling's solution.

Answer: (C)

Q9.

Solution

Concept:
The Gatterman-Koch reaction is an electrophilic aromatic substitution reaction used to introduce a formyl group ($-CHO$) into a benzene ring to synthesize aromatic aldehydes.

Solution:
1. Reagents: Benzene is treated with carbon monoxide (CO) and hydrogen chloride (HCl) in the presence of a catalyst like anhydrous $AlCl_3$ or $CuCl$.
2. Formyl Cation: The mixture of CO and HCl acts as if it were formyl chloride ($HCOCl$), which is unstable. The $AlCl_3$ helps generate the formyl cation ($[HC \equiv O]^+$).
3. Attack: The formyl cation attacks the benzene ring to form an intermediate.
4. Final Product: After the loss of a proton, Benzaldehyde is formed.

$$C_6H_6 + CO + HCl \xrightarrow{AlCl_3} C_6H_5CHO + HCl$$

Final Answer: The product formed is Benzaldehyde.

Answer: (B)

Q10.

Solution

Concept:
The basicity of amines is defined by their ability to donate a lone pair of electrons. In the gaseous phase, there is no solvent (like water) to provide stabilization via solvation. Therefore, the basic strength depends entirely on the electronic effects of the substituent groups.

Solution:
1. Inductive Effect ($+I$): Alkyl groups are electron-donating. As the number of alkyl groups attached to the nitrogen increases, the electron density on the nitrogen atom increases, making the lone pair more available for donation.
2. Tertiary Amines (3°): Have three alkyl groups (R_3N), providing the maximum $+I$ effect.
3. Secondary Amines (2°): Have two alkyl groups (R_2NH).
4. Primary Amines (1°): Have one alkyl group (RNH_2).
5. Ammonia (NH_3): Has no alkyl groups to provide $+I$ effect.
6. Gaseous phase order: $3° > 2° > 1° > NH_3$. (Note: In aqueous phase, the order changes due to solvation and steric effects).

Final Answer: The order is $3° > 2° > 1° > NH_3$.

Answer: (A)

Q11.

Solution

Concept:
Starch is a mixture of two polysaccharides: amylose and amylopectin. While amylose is a linear polymer, amylopectin is a highly branched-chain polymer. Both are composed of glucose units.

Solution:
1. Amylopectin is a branched-chain polymer of α-D-glucose units.
2. The main chain is formed by glycosidic linkages between the C_1 of one glucose and the C_4 of the next glucose (α-1,4-glycosidic linkage).
3. Branching occurs by the formation of a glycosidic bond between the C_1 of one glucose at the end of a side chain and the C_6 of a glucose in the main chain (α-1,6-glycosidic linkage).
4. It is insoluble in water and constitutes about 80-85% of starch.
5. Since all building blocks are α-D-glucose, it is a homopolymer of this specific monosaccharide.

Final Answer: Amylopectin is a polymer of α-D-Glucose.

Answer: (A)

Q12.

Solution

Concept:
Buna-S is a synthetic rubber and a copolymer, meaning it is derived from more than one species of monomer. The name "Buna-S" is derived from its components: **Bu**tadiene, **Na** (sodium, used as a catalyst), and **S**tyrene.

Solution:
1. Monomer 1: 1,3-Butadiene ($CH_2 = CH - CH = CH_2$).
2. Monomer 2: Styrene ($C_6H_5CH = CH_2$), also known as vinyl benzene.
3. Polymerization: These monomers undergo addition polymerization (copolymerization) in the presence of sodium or a peroxide initiator.
4. Characteristics: It is very tough and is a good substitute for natural rubber. It is extensively used in the manufacture of automobile tires, floor tiles, and cable insulation.
5. Comparison: Buna-N uses acrylonitrile, while Natural rubber is a polymer of isoprene.

Final Answer: Buna-S is a copolymer of 1,3-Butadiene and Styrene.

Answer: (B)

Q13.

Solution

Concept:
According to Molecular Orbital (MO) Theory, the bond order of a diatomic molecule or ion is calculated as:

$$\text{Bond Order (B.O.)} = \frac{N_b - N_a}{2}$$

where N_b is the number of electrons in bonding orbitals and N_a is the number of electrons in antibonding orbitals.

Solution:

1. Total Electrons: O_2^{2-} (Peroxide ion) has $16 + 2 = 18$ electrons.
2. MO Configuration:

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

3. Counting Electrons: - Bonding (N_b): $2(\sigma 1s) + 2(\sigma 2s) + 2(\sigma 2p_z) + 4(\pi 2p) = 10$. - Antibonding ($N_a$): $2(\sigma^* 1s) + 2(\sigma^* 2s) + 4(\pi^* 2p) = 8$.
4. Calculation:

$$\text{B.O.} = \frac{10 - 8}{2} = \frac{2}{2} = 1$$

5. Interpretation: A bond order of 1 indicates a single covalent bond between the two oxygen atoms, consistent with the Lewis structure of $O - O^{2-}$.

Final Answer: The bond order is 1.

Answer: (A)

Q14.

Solution

Concept:

The spin-only magnetic moment (μ_s) is calculated using the formula:

$$\mu_s = \sqrt{n(n+2)} \text{ BM}$$

where n is the number of unpaired electrons and BM stands for Bohr Magnetons.

Solution:

1. Ion: Fe^{2+} (Atomic number $Z = 26$).
2. Electronic Configuration: - Neutral Fe: $[Ar]3d^6 4s^2$. - Fe^{2+}: $[Ar]3d^6$ (the $4s$ electrons are removed first).
3. Orbitals in $3d^6$: According to Hund's rule, the 5 orbitals are first filled singly, and the 6th electron pairs up. - Configuration: $(\uparrow\downarrow)(\uparrow)(\uparrow)(\uparrow)(\uparrow)$
4. Number of unpaired electrons (n): 4.
5. Calculation:

$$\mu_s = \sqrt{4(4+2)} = \sqrt{4 \times 6} = \sqrt{24}$$

6. Since $\sqrt{25} = 5.0$, $\sqrt{24}$ is slightly less than 5, which is approximately $4.899 \approx 4.90$ BM.

Final Answer: The magnetic moment is approximately 4.90 BM.

Answer: (A)

Q15.

Solution

Concept:

Ligands are classified based on their charge as anionic (negatively charged), cationic (positively charged), or neutral (no charge). Neutral ligands are often stable molecules that have at least one lone pair of electrons to donate to the metal center.

Solution:

1. CN^- (Cyanido): This is an anionic ligand with a charge of -1.
2. Ox^{2-} (Oxalato, $C_2O_4^{2-}$): This is a bidentate anionic ligand with a charge of -2.
3. Cl^- (Chlorido): This is an anionic ligand with a charge of -1.
4. en (Ethylenediamine, $NH_2 - CH_2 - CH_2 - NH_2$): This is a bidentate ligand. Both nitrogen atoms have lone pairs available for bonding, but the molecule itself carries no net electrical charge.
5. Therefore, Ethylenediamine is a neutral ligand. Other common neutral ligands include H_2O (aqua), NH_3 (ammine), and CO (carbonyl).

Final Answer: Ethylenediamine (en) is a neutral ligand.

Answer: (B)

Q16.

Solution

Concept:
Cyclic metaphosphoric acid $(HPO_3)_n$ typically exists as a trimer ($n = 3$), known as cyclotrimetaphosphoric acid. In this structure, phosphorus atoms are linked to each other through bridging oxygen atoms to form a ring.

Solution:
1. The molecular formula for the trimer is $H_3P_3O_9$.
2. The structure consists of a six-membered ring made of alternating Phosphorus and Oxygen atoms.
3. In this ring, there are 3 Phosphorus atoms and 3 Oxygen atoms.
4. Therefore, there are exactly 3 $P - O - P$ linkages that complete the cyclic structure.
5. Each Phosphorus atom is also bonded to two terminal Oxygen atoms (one as $P = O$ and one as $P - OH$).

Final Answer: The number of P-O-P bonds is 3.

Answer: (B)

Q17.

Solution

Concept:
Noble gases have specific industrial and medical applications based on their physical properties, such as boiling point, solubility, and chemical inertness.

Solution:
1. Helium (He): It has the lowest boiling point of any element.
2. In Magnetic Resonance Imaging (MRI), powerful superconducting magnets are used to generate the necessary magnetic fields.
3. These magnets must be kept at extremely low temperatures to maintain superconductivity (zero electrical resistance).
4. Liquid Helium is used as a cryogenic agent to cool these superconducting magnets to temperatures near absolute zero.
5. While Xenon (Xe) is sometimes used in specialized lung imaging, Helium is the essential noble gas for the operation of standard MRI machines.

Final Answer: Helium (He) is used in MRI.

Answer: (A)

Q18.

Solution

Concept:
Lanthanoid contraction refers to the steady decrease in the atomic and ionic radii of the lanthanide elements (from Lanthanum to Lutetium) with increasing atomic number.

Solution:
1. As we move across the lanthanide series, electrons are added to the $4f$ subshell.
2. The shape of f-orbitals is very diffused. Because of this diffused shape, $4f$ electrons are very poor at shielding the outer electrons from the increasing nuclear charge.
3. Due to this imperfect shielding, the effective nuclear charge experienced by the outer electrons increases steadily.
4. This results in a greater inward pull on the entire electron cloud, causing the size of the atom/ion to shrink.
5. This effect is specifically attributed to the poor shielding of $4f$ electrons.

Final Answer: It is due to poor shielding of $4f$ electrons.

Answer: (A)

Q19.

Solution

Concept:
The oxidation state of an atom is defined by the rules of electronegativity. Fluorine is the most electronegative element in the periodic table and is always assigned an oxidation state of -1 in its compounds.

Solution:
1. Formula: OF_2 (Oxygen difluoride).
2. Rule: Fluorine (F) is more electronegative than Oxygen (O). Therefore, each F atom takes an oxidation state of -1.
3. Calculation: Let the oxidation state of Oxygen be x.

$$x + 2(-1) = 0$$

$$x - 2 = 0$$

$$x = +2$$

4. Note: OF_2 is one of the rare cases where Oxygen exhibits a positive oxidation state because it is bonded to an element even more electronegative than itself.

Final Answer: The oxidation state of Oxygen is +2.

Answer: (B)

Q20.

Solution

Concept:
Atomic orbitals are described by a set of four quantum numbers: Principal (n), Azimuthal (l), Magnetic (m_l), and Spin (s). Each number provides specific information about the electron's "address."

Solution:
1. Principal Quantum Number (n): Determines the size and energy of the main shell.
2. Azimuthal Quantum Number (l): Determines the shape of the subshell (s, p, d, f).
3. Magnetic Quantum Number (m_l): For a given value of l, m_l can have values from $-l$ to $+l$. This quantum number specifies the orientation of the orbital in three-dimensional space. For example, for p-orbitals ($l = 1$), m_l values of -1, 0, and +1 correspond to p_x, p_y, and p_z orientations.
4. Spin Quantum Number (s): Describes the direction of the electron's spin (clockwise or anti-clockwise).

Final Answer: The Magnetic quantum number determines the orientation.

Answer: (C)

Q21.

Solution

Concept:
In a face-centered cubic (fcc) unit cell, the atoms are located at the corners and the centers of all the faces of the cube. The atoms along the face diagonal touch each other.

Solution:
1. Relationship: For an fcc lattice, the relationship between the radius of the atom (r) and the edge length of the unit cell (a) is derived from the face diagonal.
2. The face diagonal length is $\sqrt{2}a$.
3. In an fcc unit cell, the diagonal consists of $4r$ (one diameter from the center atom and two radii from the corner atoms).

$$4r = \sqrt{2}a \implies r = \frac{\sqrt{2}a}{4} = \frac{a}{2\sqrt{2}}$$

4. Calculation: Given $a = 400\ pm$.

$$r = \frac{400}{2 \times 1.414} = \frac{400}{2.828} \approx 141.4\ pm$$

Final Answer: The atomic radius is 141.4 pm.

Answer: (A)

Q22.

Solution

Concept:
The van't Hoff factor (i) represents the ratio of the actual concentration of particles produced when the substance is dissolved to the concentration of a substance as calculated from its mass. For 100% dissociation, i is equal to the total number of ions produced per formula unit.

Solution:
1. Compound: Potassium sulphate (K_2SO_4).
2. Dissociation equation:

$$K_2SO_4(aq) \rightarrow 2K^+(aq) + SO_4^{2-}(aq)$$

3. Ion Count: - 2 Potassium ions (K^+) - 1 Sulphate ion (SO_4^{2-})
4. Total number of particles (n) = 2 + 1 = 3.
5. Since the salt is assumed to be 100% dissociated, $i = n = 3$.

Final Answer: The van't Hoff factor is 3.

Answer: (C)

Q23.

Solution

Concept:
The general formula for the units of a rate constant (k) for a reaction of order n is:

$$\text{Unit} = (mol\ L^{-1})^{1-n} \cdot s^{-1}$$

Solution:
1. For a second-order reaction, $n = 2$.
2. Substitute $n = 2$ into the formula:

$$\text{Unit} = (mol\ L^{-1})^{1-2} \cdot s^{-1}$$

$$\text{Unit} = (mol\ L^{-1})^{-1} \cdot s^{-1}$$

3. Simplifying the expression:

$$\text{Unit} = mol^{-1}\ L\ s^{-1} \text{ or } L\ mol^{-1}\ s^{-1}$$

4. Comparison: - 0th order: $mol\ L^{-1}\ s^{-1}$ - 1st order: s^{-1} - 2nd order: $L\ mol^{-1}\ s^{-1}$

Final Answer: The unit is $L\ mol^{-1}\ s^{-1}$.

Answer: (C)

Q24.

Solution

Concept:
The Hall-Heroult process is used for the electrolytic reduction of molten alumina (Al_2O_3). Pure alumina has a very high melting point and is a poor conductor of electricity.

Solution:
1. Challenges: Alumina melts at approximately 2050°C, which is difficult and expensive to maintain.
2. Role of Cryolite (Na_3AlF_6): Adding cryolite (along with fluorspar, CaF_2) serves two main purposes: - It significantly lowers the melting point of the mixture to around 950°C. - It increases the electrical conductivity of the molten mass.
3. Both factors (A and B) are critical for making the industrial extraction of aluminium feasible.

Final Answer: Both A and B.

Answer: (C)

Q25.

Solution

Concept:
Gibbs free energy (ΔG) is a thermodynamic potential that can be used to calculate the maximum of reversible work that may be performed by a thermodynamic system at a constant temperature and pressure.

Solution:
1. Spontaneity criteria: - $\Delta G < 0$: The process is spontaneous in the forward direction. - $\Delta G > 0$: The process is non-spontaneous (spontaneous in reverse). - $\Delta G = 0$: The system has reached dynamic equilibrium.
2. At equilibrium, the rate of the forward reaction equals the rate of the backward reaction, and there is no net change in the free energy of the system.
3. Therefore, for any reversible process at equilibrium, ΔG must be zero.

Final Answer: ΔG is Zero.

Answer: (C)

Q26.

Solution

Concept:
The variety of oxidation states shown by transition elements is due to the small energy difference between the $(n-1)d$ and ns subshells. The maximum number of oxidation states is usually shown by elements in the middle of the series.

Solution:
1. Electronic configurations: - Sc ($Z = 21$): $3d^1 4s^2$. Shows only +3. - Zn ($Z = 30$): $3d^{10}4s^2$. Shows only +2. - Fe ($Z = 26$): $3d^6 4s^2$. Commonly shows +2 and +3 (can show up to +6 in rare cases). - Mn ($Z = 25$): $3d^5 4s^2$.
2. Manganese has the maximum number of unpaired electrons in the $3d$ subshell (5) plus 2 electrons in the $4s$ subshell.
3. Because all these 7 electrons can participate in bonding, Manganese shows the widest range of oxidation states: +2, +3, +4, +5, +6, and +7.
4. This makes Manganese the element with the highest number of oxidation states in the $3d$ series.

Final Answer: Manganese (Mn) shows the highest number of oxidation states.

Answer: (B)

Q27.

Solution

Concept:
C_p (Molar heat capacity at constant pressure) and C_v (Molar heat capacity at constant volume) are related to the work done by a gas during expansion.

Solution:
1. For an ideal gas, the internal energy (U) depends only on temperature.
2. Enthalpy is defined as $H = U + PV$. For one mole of an ideal gas, $PV = RT$, so $H = U + RT$.
3. Differentiating with respect to temperature (T):

$$\frac{dH}{dT} = \frac{dU}{dT} + R$$

4. By definition, $\frac{dH}{dT} = C_p$ and $\frac{dU}{dT} = C_v$.
5. Therefore, $C_p = C_v + R$ or $C_p - C_v = R$.
6. This indicates that C_p is always greater than C_v by the value of the universal gas constant R, because at constant pressure, heat is used not just to increase internal energy but also to do expansion work.

Final Answer: The relationship is $C_p - C_v = R$.

Answer: (A)

Q28.

Solution

Concept:
The pH of a basic solution is calculated using the concentration of hydroxide ions (OH^-). The relationship between pH and pOH is $pH + pOH = 14$ at $25°C$.

Solution:
1. $NaOH$ is a strong base and dissociates completely: $NaOH \rightarrow Na^+ + OH^-$.
2. Concentration $[OH^-] = 0.01\ M = 10^{-2}\ M$.
3. Calculate pOH:

$$pOH = -\log[OH^-] = -\log(10^{-2}) = 2$$

4. Calculate pH:

$$pH = 14 - pOH$$

$$pH = 14 - 2 = 12$$

5. Since the solution is basic, the pH must be greater than 7, confirming that 12 is the correct value.

Final Answer: The pH of the solution is 12.

Answer: (B)

Q29.

Solution

Concept:
The coordination number (C.N.) is the total number of coordinate bonds formed between the central metal atom/ion and the ligands. It depends on the denticity of the ligands.

Solution:
1. Complex: $[Co(en)_3]^{3+}$.
2. Ligand: *en* (Ethylenediamine) is a bidentate ligand, meaning each molecule of *en* has two donor atoms (Nitrogen) that can bond to the metal simultaneously.
3. Number of ligands: There are 3 *en* ligands.
4. Calculation:

$$\text{C.N.} = (\text{Number of ligands}) \times (\text{Denticity})$$

$$\text{C.N.} = 3 \times 2 = 6$$

5. Therefore, Cobalt is octahedrally coordinated by six Nitrogen atoms.

Final Answer: The coordination number is 6.

Answer: (C)

Q30.

Solution

Concept:
Greenhouse gases are atmospheric gases that absorb and emit infrared radiation, trapping heat in the Earth's atmosphere and contributing to the greenhouse effect.

Solution:
1. N_2 and O_2: These are homonuclear diatomic molecules. They do not have a dipole moment and do not absorb infrared radiation. They are not greenhouse gases.
2. Ar: Noble gases are monatomic and do not contribute to the greenhouse effect.
3. CH_4 (Methane): This is a potent greenhouse gas. Although its concentration is lower than CO_2, its global warming potential (GWP) is much higher.
4. Other common greenhouse gases include Carbon dioxide (CO_2), Nitrous oxide (N_2O), and water vapor.

Final Answer: Methane (CH_4) is a greenhouse gas.

Answer: (C)

Q31.

Solution

Concept:
Mesityl oxide is a common name for an α, β-unsaturated ketone. It is typically prepared by the aldol condensation of acetone followed by dehydration.

Solution:
1. Structure: Mesityl oxide has the formula $(CH_3)_2C = CH - C(O)CH_3$.
2. Numbering the chain: The longest chain containing the carbonyl group and the double bond has 5 carbons. We number from the end closer to the carbonyl group ($C = O$). - C_1: Methyl group attached to carbonyl. - C_2: Carbonyl carbon. - C_3: Carbon involved in the double bond. - C_4: Carbon involved in the double bond with a methyl substituent. - C_5: Terminal methyl of the parent chain.
3. Name components: - Parent: pent-3-en-2-one. - Substituent: A methyl group is at position 4.
4. Combined Name: 4-Methylpent-3-en-2-one.

Final Answer: The IUPAC name is 4-Methylpent-3-en-2-one.

Answer: (A)

Q32.

Solution

Concept:
The reaction with neutral Ferric chloride ($FeCl_3$) is a characteristic test used to identify the presence of a phenolic hydroxyl group.

Solution:
1. Reaction: When phenol reacts with neutral $FeCl_3$ solution, it forms a coordination complex.
2. Observation: The formation of this iron-phenol complex results in a characteristic deep violet or purple coloration.

$$6C_6H_5OH + FeCl_3 \rightarrow [Fe(OC_6H_5)_6]^{3-} + 3H^+ + 3HCl$$

3. Note: Different phenols can give different colors (e.g., catechol gives green, resorcinol gives dark violet), but for simple phenol, the result is violet.
4. Alcohols do not give this test, making it a useful way to distinguish phenols from alcohols.

Final Answer: The observation is a violet coloration.

Answer: (B)

Q33.

Solution

Concept:
Natural rubber is a linear polymer derived from a specific diene monomer. It is a polyterpene known as cis-1,4-polyisoprene.

Solution:
1. Monomer: The repeating unit in natural rubber is derived from Isoprene.
2. IUPAC name of Isoprene: 2-Methyl-1,3-butadiene ($CH_2 = C(CH_3) - CH = CH_2$).
3. Polymerization: Thousands of isoprene units join via 1,4-addition.
4. Stereochemistry: In natural rubber, all the double bonds have the *cis* configuration. If the configuration is *trans*, the polymer is known as Gutta-percha.
5. Chloroprene is the monomer for Neoprene (synthetic rubber).

Final Answer: The monomer is Isoprene.

Answer: (A)

Q34.

Solution

Concept:
The reaction of glucose with mild and strong oxidizing agents helps determine the nature of its functional groups. Bromine water (Br_2/H_2O) is a mild oxidizing agent.
Solution:
1. Glucose contains an aldehyde group ($-CHO$) at C_1 and five hydroxyl groups ($-OH$).
2. Bromine water is selective; it is strong enough to oxidize the aldehyde group to a carboxylic acid group but not strong enough to oxidize the primary or secondary alcohol groups.
3. Reaction:

$$\text{Glucose} \xrightarrow{Br_2/H_2O} \text{Gluconic acid}$$

4. Structure: The $-CHO$ at C_1 becomes $-COOH$.
5. Note: If concentrated HNO_3 (a strong oxidant) were used, both the aldehyde and the terminal primary alcohol group would be oxidized to form Saccharic acid (a dicarboxylic acid).
Final Answer: The product is Gluconic acid.

Answer: (B)

Q35.

Solution

Concept:
The half-life ($t_{1/2}$) of a reaction is the time required for the concentration of a reactant to decrease to half of its initial value. Its dependence on initial concentration $[A]_0$ varies with the order of the reaction.
Solution:
1. Zero-order Rate Law: $[A] = [A]_0 - kt$.
2. At $t = t_{1/2}$, $[A] = \frac{[A]_0}{2}$.
3. Substitution:

$$\frac{[A]_0}{2} = [A]_0 - k \cdot t_{1/2}$$

$$k \cdot t_{1/2} = \frac{[A]_0}{2} \implies t_{1/2} = \frac{[A]_0}{2k}$$

4. Observation: The half-life is directly proportional to the initial concentration ($t_{1/2} \propto [A]_0$).
5. Contrast: In a first-order reaction, $t_{1/2} = \frac{0.693}{k}$, which is independent of initial concentration.
Final Answer: The half-life is proportional to the initial concentration.

Answer: (A)

Q36.

Solution

Concept:
The reducing power of hydrides in Group 15 (p-block) depends on the thermal stability of the $M-H$ bond. As we move down the group, the size of the central atom increases, resulting in poor overlapping with the small $1s$ orbital of hydrogen.

Solution:
1. Trend: The $M-H$ bond length increases and bond dissociation enthalpy decreases from NH_3 to BiH_3.
2. Stability: NH_3 is the most stable, and BiH_3 is the least stable.
3. Reducing Action: A hydride acts as a reducing agent by releasing hydrogen. Since the $Bi-H$ bond is the weakest, BiH_3 releases hydrogen most easily.
4. Therefore, BiH_3 is the strongest reducing agent in the group.

Final Answer: BiH_3 is the strongest reducing agent.

Answer: (D)

Q37.

Solution

Concept:
The Third Law of Thermodynamics states that the entropy of a perfectly crystalline substance approaches zero as the absolute temperature approaches zero.

Solution:
1. Entropy (S) represents the degree of disorder. In a "perfect" crystal, every atom is in a perfectly ordered position.
2. At absolute zero ($0\ K$ or $-273.15°C$), all molecular motion (vibrational, rotational, and translational) ceases.
3. Under these conditions, there is only one possible microstate for the system, making the entropy zero.
4. Note: This law does not apply to glass or solid solutions, which have "residual entropy" due to disorder even at $0\ K$.

Final Answer: The entropy is zero at 0 K.

Answer: (C)

Q38.

Solution

Concept:
The solubility of gases in liquids is governed by Henry's Law and Le Chatelier's principle. Solubility is influenced by both pressure and temperature.
Solution:
1. Effect of Pressure: According to Henry's Law ($S = K_H \cdot P$), the solubility of a gas is directly proportional to its partial pressure above the liquid. Increasing pressure "forces" more gas molecules into the liquid.
2. Effect of Temperature: The dissolution of a gas in a liquid is typically an exothermic process. According to Le Chatelier's principle, increasing temperature shifts the equilibrium toward the gas phase, decreasing solubility.
3. Therefore, gas solubility is highest at high pressure and low temperature.
Final Answer: Solubility increases with an increase in pressure.

Answer: (C)

Q39.

Solution

Concept:
Freons are chlorofluorocarbon (CFC) compounds of methane and ethane. They are extremely stable, unreactive, non-toxic, and non-corrosive, which made them ideal for industrial use before their ozone-depleting properties were fully understood.
Solution:
1. Freon-12 (CF_2Cl_2) is one of the most common freons used in industrial applications.
2. Due to its low boiling point and high heat of vaporization, it was extensively used as a refrigerant in air conditioning and refrigerators.
3. It was also used as an aerosol propellant.
4. Today, many CFCs like CF_2Cl_2 are being phased out in favor of hydrofluorocarbons (HFCs) to protect the ozone layer.
Final Answer: CF_2Cl_2 (Freon-12) is used as a refrigerant.

Answer: (B)

Q40.

Solution

Concept:
Organic compounds are classified into different families based on their functional groups—the specific groups of atoms responsible for the characteristic chemical reactions of those molecules.

Solution:
1. $-OH$ (Hydroxyl group): Present in Alcohols and Phenols.
2. $-CHO$ (Aldehyde group): Present in Aldehydes.
3. $-COOR$ (Alkoxycarbonyl group): Present in Esters ($R - CO - O - R'$).
4. $-CONH_2$ (Amide group): Present in Amides.
5. Esters are formed by the reaction between a carboxylic acid and an alcohol (esterification).

Final Answer: The functional group in an Ester is $-COOR$.

Answer: (C)

Q41.

Solution

Concept:
Crystal Field Stabilization Energy (CFSE) is calculated based on the distribution of electrons in the t_{2g} and e_g orbitals. For an octahedral field, t_{2g} orbitals are stabilized by $-0.4\Delta_o$ per electron, and e_g orbitals are destabilized by $+0.6\Delta_o$ per electron.

Solution:
1. Configuration: High spin d^4 in an octahedral field.
2. Distribution: In a high-spin complex, the pairing energy is greater than Δ_o, so electrons occupy orbitals singly before pairing. - 3 electrons go into the lower t_{2g} level. - 1 electron goes into the higher e_g level.
3. Calculation:

$$\text{CFSE} = [3 \times (-0.4\Delta_o)] + [1 \times (+0.6\Delta_o)]$$

$$\text{CFSE} = -1.2\Delta_o + 0.6\Delta_o = -0.6\Delta_o$$

4. Note: If it were low spin, all 4 electrons would be in t_{2g}, giving $-1.6\Delta_o$.

Final Answer: The CFSE is $-0.6\Delta_o$.

Answer: (A)

Q42.

Solution

Concept:
Peptization is a method of preparing colloidal solutions. It is the reverse of coagulation/precipitation.
Solution:
1. Definition: Peptization is the process of converting a freshly prepared precipitate into a colloidal sol by shaking it with the dispersion medium in the presence of a small amount of an electrolyte.
2. Peptizing Agent: The electrolyte used is called the peptizing agent.
3. Mechanism: The precipitate adsorbs one of the ions of the electrolyte on its surface. This preferred adsorption of a common ion gives the particles a positive or negative charge, causing them to repel each other and break down into particles of colloidal size.
4. Example: Freshly precipitated $Fe(OH)_3$ can be peptized by adding a small amount of $FeCl_3$ solution.
Final Answer: The process is called Peptization.

Answer: (A)

Q43.

Solution

Concept:
Electronegativity is the tendency of an atom to attract a shared pair of electrons. In the periodic table, electronegativity increases across a period (left to right) and decreases down a group (top to bottom).
Solution:
1. Fluorine (F): Top-right of the periodic table, highest electronegativity (4.0).
2. Chlorine (Cl): Below Fluorine, high electronegativity (3.0).
3. Lithium (Li): Top-left of the table (Group 1), low electronegativity (1.0).
4. Cesium (Cs): Bottom-left of the table (Group 1). Since electronegativity decreases down the group, Cesium has a lower value than Lithium.
5. Result: Cesium is one of the most electropositive (least electronegative) elements known (≈ 0.7).
Final Answer: Cesium (Cs) has the lowest electronegativity.

Answer: (C)

Q44.

Solution

Concept:
The geometry of Phosphorus pentachloride (PCl_5) is determined by the VSEPR theory. The central Phosphorus atom has 5 valence electrons, and it forms 5 single bonds with Chlorine atoms.
Solution:
1. Steric Number: 5 bond pairs + 0 lone pairs = 5.
2. Hybridization: sp^3d.
3. Geometry: To minimize repulsion, the 5 $P-Cl$ bonds arrange themselves toward the corners of a Trigonal Bipyramid.
4. Structure Details: - Three Cl atoms are in the equatorial plane (bond angles 120°). - Two Cl atoms are in the axial positions (bond angles 90° to the plane).
5. Note: Axial bonds are longer than equatorial bonds due to greater repulsion. In the solid state, PCl_5 exists as an ionic solid $[PCl_4]^+[PCl_6]^-$.
Final Answer: The geometry is Trigonal bipyramidal.

Answer: (B)

Q45.

Solution

Concept:
Acid-base indicators change color at specific pH ranges. For a titration, the indicator's range should coincide with the sharp change in pH at the equivalence point.
Solution:
1. Strong Acid vs Strong Base (e.g., HCl and $NaOH$): The pH change at the equivalence point is very large and steep, usually jumping from about pH 3 to pH 11.
2. Phenolphthalein: Range is approximately 8.3 to 10.0 (colorless to pink). This falls within the vertical portion of the titration curve.
3. Methyl Orange: Range is approximately 3.1 to 4.4 (red to yellow). This also falls within the vertical portion of the titration curve.
4. Result: For a strong acid-strong base titration, multiple indicators can be used successfully because the pH change is so drastic.
Final Answer: Both Phenolphthalein and Methyl orange (Both A and B).

Answer: (C)

Q46.

Solution

Concept:
In crystal structures, voids (interstitial spaces) are the empty spaces between the constituent particles. In a cubic close-packed (ccp) or face-centered cubic (fcc) arrangement, there are two types of voids: Octahedral and Tetrahedral.
Solution:
1. If the number of close-packed atoms in the unit cell is n: - The number of Octahedral voids generated is n. - The number of Tetrahedral voids generated is $2n$.
2. In a ccp (fcc) unit cell: - Total number of atoms (n) = 4. - Number of Octahedral voids = 4. - Number of Tetrahedral voids = $2 \times 4 = 8$.
3. Location: Tetrahedral voids are located on the body diagonals (two on each diagonal). Since there are 4 body diagonals, there are 8 tetrahedral voids.
Final Answer: The number of tetrahedral voids is $2n$.

Answer: (B)

Q47.

Solution

Concept:
Specific conductance (κ) is the conductance of a solution of 1 cm length and 1 cm^2 area of cross-section (conductance of 1 cm^3 of solution). It depends on the number of ions present per unit volume.
Solution:
1. On dilution: The total number of ions increases (for weak electrolytes) or remains the same (for strong electrolytes), but the volume of the solution increases significantly.
2. Therefore, the number of ions per unit volume (1 cm^3) decreases.
3. Since specific conductance depends on the concentration of ions in that unit volume, specific conductance decreases with dilution.
4. Conversely, specific conductance increases with an increase in concentration, as there are more charge carriers (ions) in a given volume.
5. Note: Molar conductivity (Λ_m) behaves differently; it increases with dilution.
Final Answer: Specific conductance increases with an increase in concentration.

Answer: (B)

Q48.

Solution

Concept:
A non-polar molecule is one where the vector sum of all individual bond dipoles is zero. This happens when the molecule is perfectly symmetrical and the central atom has no lone pairs that disrupt the symmetry.

Solution:
1. H_2O: Bent shape with two lone pairs. Dipoles do not cancel. (Polar).
2. SO_2: Bent shape with one lone pair. Dipoles do not cancel. (Polar).
3. NH_3: Pyramidal shape with one lone pair. Dipoles do not cancel. (Polar).
4. CH_4 (Methane): Tetrahedral geometry (sp^3). The four $C-H$ bond dipoles are directed toward the corners of a regular tetrahedron. Because of this perfect symmetry, the resultant dipole moment is zero.
5. Therefore, CH_4 is a non-polar molecule.

Final Answer: CH_4 is a non-polar molecule.

Answer: (C)

Q49.

Solution

Concept:
Polymers are classified based on their molecular forces and behavior upon heating.

Solution:
1. Thermoplastics: Become soft on heating and hard on cooling (e.g., Polythene, PVC).
2. Thermosetting Plastics: Undergo a chemical change on heating to create a heavily cross-linked, three-dimensional network. Once set, they cannot be remelted or reshaped.
3. Bakelite: Formed from phenol and formaldehyde, it develops extensive cross-linking during the molding process. It is a classic example of a thermosetting plastic.
4. Elastomers: Have elastic properties (e.g., Rubber).
5. Fibers: Have high tensile strength (e.g., Nylon).

Final Answer: Bakelite is a thermosetting plastic.

Answer: (B)

Q50.

Solution

Concept:

The Standard Hydrogen Electrode (SHE) is used as a reference electrode for measuring the electrode potentials of all other electrodes.

Solution:

1. The SHE consists of platinum wire coated with platinum black, immersed in a 1 M H^+ solution, with pure hydrogen gas bubbled at 1 bar pressure.

2. By convention, the standard electrode potential (reduction or oxidation) of the hydrogen electrode is assigned a value of exactly 0.0000 V at all temperatures.

3. $2H^+ + 2e^- \rightarrow H_2 \quad E^o = 0\,V$.

4. This zero-point allows for the construction of the electrochemical series.

Final Answer: The standard reduction potential is 0 V.

Answer: (B)

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	C	2	A	3	A	4	A	5	B
6	B	7	A	8	C	9	B	10	A
11	A	12	B	13	A	14	A	15	B
16	B	17	A	18	A	19	B	20	C
21	A	22	C	23	C	24	C	25	C
26	B	27	A	28	B	29	C	30	C
31	A	32	B	33	A	34	B	35	A
36	D	37	C	38	C	39	B	40	C
41	A	42	A	43	C	44	B	45	C
46	B	47	B	48	C	49	B	50	B