WBJEE Chemistry Sample Paper-10

Duration: 60 Minutes **Maximum Marks: 50**

Instructions

- This paper contains **40** Multiple Choice Questions divided into **3 Categories**.
- **Section 1 (Q1–Q30):** Each correct answer carries **+1 mark**. Incorrect answer: **−0.25** marks. Only **one** correct option.
- **Section 2 (Q31–Q35):** Each correct answer carries **+2 marks**. Incorrect answer: **−0.5** marks. Only **one** correct option.
- **Section 3 (Q36–Q40):** Each correct answer carries **+2 marks**. **No negative marking**. One or **more** correct options may be correct; full marks only if all correct options are marked.
- Use of mobile phones, smartwatches, or any electronic gadgets is strictly prohibited.

Section–A — 30 Questions × 1 Mark Each
(Negative Marking: −0.25) [Single Correct]

Q1. The number of stereoisomers possible for the complex $[Co(en)_2Cl_2]^+$ is:

(A) 2

(B) 3

(C) 4

(D) 5

Q2. The pH of a solution obtained by mixing 100 mL of 0.1 M CH_3COOH with 100 mL of 0.1 M NaOH is:

(A) 7

(B) Less than 7

(C) Greater than 7

(D) Cannot be determined

Q3. For the reaction $2NO_2(g) \rightleftharpoons N_2O_4(g)$, if pressure is increased at constant temperature, then:

(A) K_p increases

(B) Degree of dissociation increases

(C) Equilibrium shifts backward

(D) Equilibrium shifts forward

Q4. The major product formed when anisole reacts with HI under vigorous conditions is:

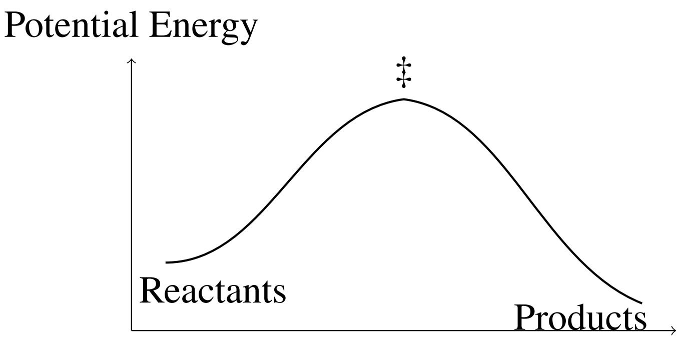
(A) Phenol + CH_3I

(B) Iodobenzene + CH_3OH

(C) Phenol + CH_3OH

(D) Benzene + CH_3I

Q5. Refer to the following potential energy diagram:



If the forward activation energy is 120 kJ mol^{-1} and $\Delta H = -40$ kJ mol^{-1}, then the backward activation energy is:

(A) 40 kJ mol^{-1}

(B) 80 kJ mol^{-1}

(C) 120 kJ mol^{-1}

(D) 160 kJ mol^{-1}

Q6. The incorrect statement regarding lanthanoids is:

(A) Most common oxidation state is +3

(B) They show poor shielding effect

(C) Ionic radii decrease with atomic number

(D) All lanthanoids are radioactive

Q7. The reagent used to distinguish between benzaldehyde and acetophenone is:

(A) Fehling's solution

(B) Tollen's reagent

(C) Both A and B

(D) $NaHSO_3$

Q8. Among the following, the strongest reducing agent is:

(A) Li

(B) Na

(C) K

(D) Cs

Q9. Refer to the following galvanic cell representation:

$$\text{Zn} \mid \text{ZnSO}_4\,(1\,\text{M}) \parallel \text{CuSO}_4\,(1\,\text{M}) \mid \text{Cu}$$

If $E^\circ_{\text{cell}} = 1.10$ V, then the standard reduction potential of Zn^{2+}/Zn is:

(A) +0.34 V

(B) −0.34 V

(C) −0.76 V

(D) +0.76 V

Q10. The major product obtained when propene reacts with HBr in the presence of peroxide is:

(A) 1-bromopropane

(B) 2-bromopropane

(C) Propan-1-ol

(D) Propan-2-ol

Q11. The hybridisation of Xe in $XeOF_4$ is:

(A) sp^3

(B) sp^3d

(C) sp^3d^2

(D) dsp^2

Q12. The correct order of acidic strength is:

(A) HF > HCl > HBr > HI

(B) HI > HBr > HCl > HF

(C) HCl > HF > HBr > HI

(D) HI > HCl > HBr > HF

Q13. The number of sigma and pi bonds in benzene respectively are:

(A) 12, 3

(B) 6, 3

(C) 12, 6

(D) 9, 3

Q14. Refer to the molecular orbital energy diagram for O_2:

$$\pi^*2p_x = \pi^*2p_y \quad \underline{\;\;\uparrow\;\;\uparrow\;\;}$$

The magnetic nature of O_2 is due to:

(A) Presence of paired electrons

(B) Presence of two unpaired electrons

(C) Complete filling of antibonding orbitals

(D) Zero bond order

Q15. The product obtained on heating ethanol with excess concentrated H_2SO_4 at 443 K is:

(A) Ethene

(B) Diethyl ether

(C) Acetaldehyde

(D) Ethane

Q16. For a first order reaction, the unit of rate constant is:

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

(B) s^{-1}

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

(D) mol^{-1} L s^{-1}

Q17. Which of the following exhibits optical isomerism?

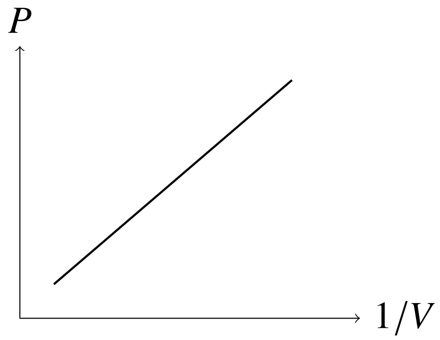
(A) 2-butanol

(B) Propan-2-ol

(C) Acetone

(D) Ethanal

Q18. Refer to the following graph of pressure versus inverse volume:



The graph verifies:

(A) Charles' law

(B) Boyle's law

(C) Avogadro's law

(D) Dalton's law

Q19. The IUPAC name of $CH_3 - CH(CH_3) - CH_2 - CHO$ is:

(A) 3-methylbutanal

(B) 2-methylbutanal

(C) 3-methylbutanone

(D) 2-ethylpropanal

Q20. Which of the following has the highest boiling point?

(A) Pentane

(B) 2-methylbutane

(C) Neopentane

(D) Cyclopentane

Q21. The coordination number and oxidation state of Fe in $K_4[Fe(CN)_6]$ are respectively:

(A) 4, +2

(B) 6, +2

(C) 6, +3

(D) 4, +3

Q22. The reagent used for ozonolysis is:

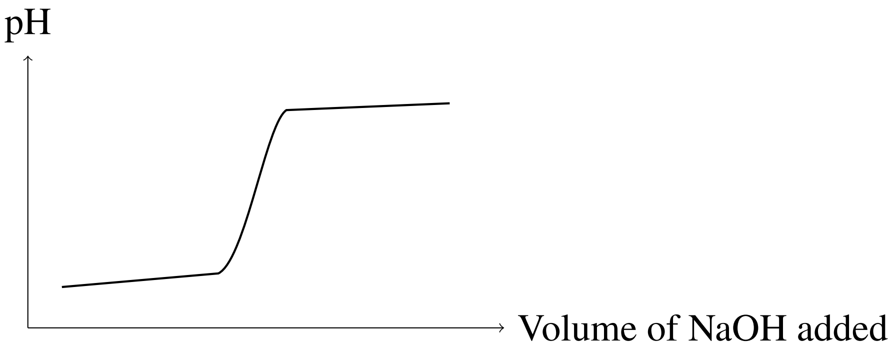
(A) O_3/Zn-H_2O

(B) $KMnO_4$

(C) H_2/Ni

(D) $NaBH_4$

Q23. Refer to the following titration curve:



The curve most likely represents:

(A) Strong acid vs strong base

(B) Weak acid vs strong base

(C) Strong acid vs weak base

(D) Weak acid vs weak base

Q24. Which of the following compounds gives iodoform test?

(A) Methanol

(B) Ethanol

(C) Benzaldehyde

(D) Formic acid

Q25. The shape of IF_5 molecule is:

(A) Square planar

(B) Trigonal bipyramidal

(C) Square pyramidal

(D) Octahedral

Q26. The entropy change is maximum in:

(A) Melting of ice

(B) Vaporisation of water

(C) Condensation of steam

(D) Freezing of water

Q27. The correct order of bond dissociation enthalpy is:

(A) $F_2 > Cl_2 > Br_2 > I_2$

(B) $Cl_2 > Br_2 > F_2 > I_2$

(C) $Br_2 > Cl_2 > I_2 > F_2$

(D) $I_2 > Br_2 > Cl_2 > F_2$

Q28. The major product formed when acetaldehyde reacts with HCN is:

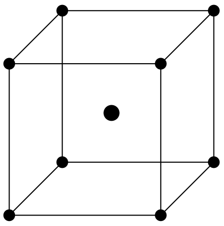
(A) Cyanohydrin

(B) Acetal

(C) Carboxylic acid

(D) Alcohol

Q29. Refer to the following crystal lattice representation:



The packing efficiency of the lattice is:

(A) 52%

(B) 68%

(C) 74%

(D) 60%

Q30. The major product formed on nitration of chlorobenzene is:

(A) *m*-nitrochlorobenzene

(B) Only *p*-nitrochlorobenzene

(C) Mixture of *o*- and *p*-nitrochlorobenzene

(D) Benzene

Section–B — 5 Questions × 1 Mark Each
(Negative Marking: −0.5) [Single Correct]

Q31. The number of molecules in 11.2 L of O_2 at STP is:

(A) 3.01×10^{23}

(B) 6.02×10^{23}

(C) 1.204×10^{24}

(D) 2.24×10^{22}

Q32. Which of the following is not amphoteric?

(A) ZnO

(B) Al_2O_3

(C) PbO

(D) CaO

Q33. The major product obtained when toluene is oxidised using alkaline $KMnO_4$ is:

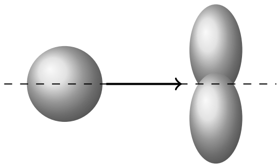
(A) Benzyl alcohol

(B) Benzaldehyde

(C) Benzoic acid

(D) Benzene

Q34. Refer to the following orbital overlap diagram:



The bond formed is:

(A) $p\pi - p\pi$ bond

(B) $s - s$ sigma bond

(C) $s - p$ sigma bond

(D) $p - p$ sigma bond

Q35. The incorrect statement regarding adsorption is:

(A) Adsorption is a surface phenomenon

(B) Physical adsorption decreases with increase in temperature

(C) Chemisorption has low enthalpy of adsorption

(D) Activated charcoal is a good adsorbent

Section C — 5 Questions × 2 Marks Each (No Negative Marking) [One or More Correct]

Q36. Which of the following species are paramagnetic?

(A) O_2

(B) NO

(C) N_2

(D) O_2^-

Q37. Which of the following reactions involve oxidation?

(A) $Fe^{2+} \longrightarrow Fe^{3+}$

(B) $Cl_2 \longrightarrow 2Cl^-$

(C) $H_2S \longrightarrow S$

(D) $Cu^{2+} \longrightarrow Cu$

Q38. Which of the following compounds can exhibit geometrical isomerism?

(A) But-2-ene

(B) $[Pt(NH_3)_2Cl_2]$

(C) 1,1-dichloroethene

(D) Hex-3-ene

Q39. Which of the following statements are correct?

(A) Graphite conducts electricity

(B) Diamond is harder than graphite

(C) Graphite has tetrahedral structure

(D) Diamond is a good conductor of electricity

Q40. Which of the following compounds give positive Tollen's test?

(A) Formaldehyde

(B) Benzaldehyde

(C) Acetone

(D) Formic acid

Detailed Solutions

Q1.

Solution

Concept: Stereoisomerism in coordination complexes arises from the different spatial arrangements of ligands around the central metal atom. For an octahedral complex with the general formula $[MA_2B_2]^{n\pm}$ where AA represents a bidentate ligand like ethylenediamine (en), both geometrical isomerism (cis-trans) and optical isomerism can exist, leading to a distinct set of stereoisomers.

Solution: The complex is $[Co(en)_2Cl_2]^+$. Here, ethylenediamine (en) is a bidentate ligand and the complex has octahedral geometry.

Step 1: Geometrical Isomerism
The two Cl^- ligands can be arranged in two different ways:
1. *trans-isomer*: The two Cl^- ligands are opposite to each other.
2. *cis-isomer*: The two Cl^- ligands are adjacent to each other.
Thus, the complex shows geometrical isomerism.

Step 2: Optical Isomerism
The trans-isomer has a plane of symmetry and is therefore optically inactive.
The cis-isomer does not possess a plane of symmetry and exists as two non-superimposable mirror images. Hence, the cis-form is optically active and exists as a pair of enantiomers.

Step 3: Total Number of Stereoisomers

(a) trans-$[Co(en)_2Cl_2]^+$

(b) cis-$[Co(en)_2Cl_2]^+$ (d-form)

(c) cis-$[Co(en)_2Cl_2]^+$ (l-form)

Therefore, the total number of stereoisomers is:

$$1 + 2 = 3$$

Hence, the complex exhibits **3 stereoisomers**.

Final Answer: $\boxed{3}$

Answer: (B)

Go Back to Question 1

Q2.

Solution

Concept: The pH of a solution resulting from the mixing of a weak acid and a strong base depends on the extent of their neutralization reaction. If equimolar amounts are mixed, a salt of the weak acid and strong base is formed, which undergoes hydrolysis to produce a basic solution.

Solution: The reaction between acetic acid (CH_3COOH, a weak acid) and sodium hydroxide (NaOH, a strong base) is a neutralization reaction:
$CH_3COOH(aq) + NaOH(aq) \rightarrow CH_3COONa(aq) + H_2O(l)$

Step 1: Calculate the moles of reactants.
Volume of CH_3COOH solution = 100 mL = 0.1 L
Molarity of CH_3COOH solution = 0.1 M
Moles of CH_3COOH = Molarity × Volume = 0.1 mol/L × 0.1 L = 0.01 mol

Volume of NaOH solution = 100 mL = 0.1 L
Molarity of NaOH solution = 0.1 M
Moles of NaOH = Molarity × Volume = 0.1 mol/L × 0.1 L = 0.01 mol

Step 2: Determine the extent of reaction.
From the stoichiometry, 1 mole of CH_3COOH reacts with 1 mole of NaOH. Since we have equal molar amounts (0.01 mol each) of the acid and the base, they will react completely.

Step 3: Identify the product and its nature.
The complete reaction will produce 0.01 mol of sodium acetate (CH_3COONa) and water. The total volume of the solution is 100 mL + 100 mL = 200 mL = 0.2 L.
The concentration of CH_3COONa is $\frac{0.01 \text{ mol}}{0.2 \text{ L}} = 0.05$ M.

Step 4: Analyze the hydrolysis of the salt.
Sodium acetate (CH_3COONa) is a salt formed from a weak acid and a strong base. In water, it dissociates into Na^+ (spectator ion) and CH_3COO^- (conjugate base of the weak acid). The acetate ion undergoes hydrolysis:
$CH_3COO^-(aq) + H_2O(l) \rightleftharpoons CH_3COOH(aq) + OH^-(aq)$

Step 5: Determine the effect on pH.
The hydrolysis of the acetate ion produces hydroxide ions (OH^-), which increases the concentration of OH^- in the solution. This makes the solution basic. For a basic solution, the pH is greater than 7.

Final Answer: $\boxed{Greaterthan7}$

Answer: (C)

Go Back to Question 2

Q3.

Solution

Concept: Le Chatelier's principle is used to predict the effect of external changes on a chemical equilibrium. For gaseous reactions, changes in pressure are significant if the number of moles of gas changes. The equilibrium constant (K_p) is solely dependent on temperature.

Solution: The reversible reaction is:
$2NO_2(g) \rightleftharpoons N_2O_4(g)$

Step 1: Analyze the number of moles of gas.
On the reactant side, there are 2 moles of NO_2 gas.
On the product side, there is 1 mole of N_2O_4 gas.
The total number of moles of gas decreases in the forward reaction (from 2 to 1).

Step 2: Apply Le Chatelier's Principle for pressure change.
The problem states that the pressure is increased at constant temperature. According to Le Chatelier's principle, the equilibrium will shift in the direction that reduces the total number of gas molecules. In this reaction, the forward direction results in a decrease in the number of moles of gas.

Step 3: Determine the shift in equilibrium.
Therefore, the equilibrium will shift forward, favoring the formation of N_2O_4.

Step 4: Consider the effect on K_p.
The equilibrium constant K_p depends only on temperature. Since the temperature is kept constant, K_p will not change.

Step 5: Analyze the options.
(A) K_p increases: Incorrect, as temperature is constant.
(B) Degree of dissociation increases: Incorrect. The forward shift means NO_2 is consumed more, so its dissociation decreases.
(C) Equilibrium shifts backward: Incorrect, it shifts forward.
(D) Equilibrium shifts forward: Correct, as explained by Le Chatelier's principle.

Final Answer: $\boxed{Equilibrium shifts forward}$

Answer: (D)

Go Back to Question 3

Q4.

Solution

Concept: Ethers can be cleaved by strong protic acids like hydroiodic acid (HI). The cleavage of aryl alkyl ethers involves nucleophilic attack by the halide ion on the carbon atom adjacent to the oxygen. The regioselectivity of this cleavage is governed by the stability of the potential carbocation or the ease of S_N2 attack.

Solution: Anisole is an aryl alkyl ether with the structure $C_6H_5 - O - CH_3$. It reacts with HI under vigorous conditions.

Step 1: Protonation of the ether oxygen.
The oxygen atom of the ether gets protonated by HI, forming an oxonium ion:
$C_6H_5 - O - CH_3 + HI \rightarrow [C_6H_5 - OH^+ - CH_3] + I^-$

Step 2: Nucleophilic attack by iodide (I^-).
The iodide ion (I^-) acts as a nucleophile and attacks one of the carbon atoms bonded to the oxygen. There are two possibilities:
a) Attack on the methyl carbon: This leads to the cleavage of the methyl-oxygen bond ($CH_3 - O$). Since the methyl group is primary, this reaction typically proceeds via an S_N2 mechanism.
$[C_6H_5 - OH^+ - CH_3] \xrightarrow{I^-} C_6H_5 - OH + CH_3I$
This yields phenol and methyl iodide.

b) Attack on the phenyl carbon: This leads to the cleavage of the phenyl-oxygen bond ($C_6H_5 - O$). Nucleophilic attack on an aromatic ring is generally difficult. While very strong conditions might lead to some reaction, this pathway is less favored for aryl alkyl ethers compared to the cleavage of the alkyl-oxygen bond.

Step 3: Determine the major product.
Under vigorous conditions, the alkyl-oxygen bond is preferentially cleaved due to the greater ease of S_N2 attack on the methyl carbon. Therefore, the major products are phenol ($C_6H_5 - OH$) and methyl iodide (CH_3I).

Final Answer: $\boxed{Phenol + CH_3I}$

Answer: (A)

Go Back to Question 4

Q5.

Solution

Concept: A potential energy diagram illustrates the energy changes during a chemical reaction. The forward activation energy (E_{af}) is the energy difference between the reactants and the transition state. The backward activation energy (E_{ab}) is the energy difference between the products and the transition state. The enthalpy change of the reaction (ΔH) is the difference in energy between the products and the reactants. These quantities are related by the equation: $\Delta H = E_{af} - E_{ab}$.

Solution: We are given the following information from the potential energy diagram and problem statement:

- Forward activation energy (E_{af}) = 120 kJ mol^{-1}. This represents the energy barrier from reactants to the transition state.
- Enthalpy change (ΔH) = -40 kJ mol^{-1}. The negative sign indicates that the reaction is exothermic, meaning the products are at a lower energy level than the reactants.

We need to find the backward activation energy (E_{ab}), which is the energy barrier from the products back to the transition state.

Using the relationship:
$\Delta H = E_{af} - E_{ab}$

Substitute the given values into the equation:
$-40 \text{ kJ mol}^{-1} = 120 \text{ kJ mol}^{-1} - E_{ab}$

To find E_{ab}, we rearrange the equation:
$E_{ab} = E_{af} - \Delta H$
$E_{ab} = 120 \text{ kJ mol}^{-1} - (-40 \text{ kJ mol}^{-1})$
$E_{ab} = 120 \text{ kJ mol}^{-1} + 40 \text{ kJ mol}^{-1}$
$E_{ab} = 160 \text{ kJ mol}^{-1}$

The backward activation energy is 160 kJ mol^{-1}.

Final Answer: $\boxed{160 \text{ kJ mol}^{-1}}$

Answer: (D)

Go Back to Question 5

Q6.

Solution

Concept: The lanthanoids are a series of 14 elements from Cerium (Ce) to Lutetium (Lu) that follow Lanthanum (La) in the periodic table. Their chemical properties are largely determined by the filling of the 4f orbitals and exhibit several characteristic trends.

Solution: Let's evaluate each statement about lanthanoids:

A. Most common oxidation state is +3.
This statement is correct. Most lanthanoids exhibit a +3 oxidation state because it involves the loss of the two 6s electrons and one 4f electron, leading to a stable electronic configuration in many cases.

B. They show poor shielding effect.
This statement is correct. The 4f electrons are located deep within the electron shell and are not very effective at shielding the outer electrons from the attraction of the nucleus. This poor shielding contributes significantly to the lanthanoid contraction.

C. Ionic radii decrease with atomic number.
This statement is correct. As the atomic number increases across the lanthanoid series, the effective nuclear charge experienced by the electrons increases. Despite the addition of electrons to the 4f subshell, the poor shielding effect results in a gradual decrease in ionic radii, a phenomenon known as lanthanoid contraction.

D. All lanthanoids are radioactive.
This statement is incorrect. While most lanthanoids are radioactive, Lutetium (Lu, Z=71) is the only naturally occurring stable lanthanoid. Therefore, it is not true that all lanthanoids are radioactive.

Final Answer: $\boxed{All lanthanoids are radioactive}$

Answer: (D)

Go Back to Question 6

Q7.

Solution

Concept: Aldehydes and ketones are carbonyl compounds that can be distinguished based on their different reactivity patterns, particularly towards mild oxidizing agents. Aldehydes, having a hydrogen atom directly attached to the carbonyl group, are readily oxidized, while ketones, having two carbon groups attached to the carbonyl, are generally resistant to oxidation by mild reagents.

Solution: We need to identify a reagent that can differentiate between benzaldehyde (an aldehyde) and acetophenone (a ketone).

- Benzaldehyde ($C_6H_5 - CHO$): Contains a -CHO group, making it an aldehyde.
- Acetophenone ($C_6H_5 - CO - CH_3$): Contains a -CO- group where the carbonyl carbon is bonded to two carbon atoms, making it a ketone.

Let's examine the given reagents:

1. Fehling's solution: This is a mild oxidizing agent. Aldehydes react with Fehling's solution upon heating to form a red precipitate of copper(I) oxide (Cu_2O). Ketones generally do not react. Therefore, benzaldehyde would give a positive test, while acetophenone would not.

2. Tollen's reagent: This is another mild oxidizing agent (ammoniacal silver nitrate). Aldehydes react with Tollen's reagent to form a silver mirror (deposition of metallic silver). Ketones do not typically react. Thus, benzaldehyde would give a positive test, and acetophenone would not.

3. $NaHSO_3$ (Sodium bisulfite): This reagent reacts with both aldehydes and ketones to form crystalline bisulfite addition products. This reaction is often used for purification or identification of carbonyl compounds but does not distinguish between aldehydes and ketones.

Since both Fehling's solution and Tollen's reagent can selectively react with benzaldehyde but not acetophenone, they can be used to distinguish between the two. Option (C) includes both A and B, making it the most appropriate answer.

Final Answer: $\boxed{Both A and B}$

Answer: (C)

Go Back to Question 7

Q8.

Solution

Concept: Reducing agents are species that donate electrons in a redox reaction. In aqueous solutions, the strength of a metal as a reducing agent is related to its tendency to lose electrons, which is quantified by its standard electrode potential. For alkali metals, a more negative standard reduction potential ($E°$) indicates a greater ease of oxidation and thus a stronger reducing power.

Solution: The elements given are Lithium (Li), Sodium (Na), Potassium (K), and Cesium (Cs), all of which are alkali metals (Group 1). We need to determine the strongest reducing agent among them. The reducing strength is related to the ease with which they can be oxidized, i.e., lose an electron.

The standard reduction potentials for these metals are:
- $Li^+(aq) + e^- \rightarrow Li(s) \quad E° = -3.04\ V$
- $Na^+(aq) + e^- \rightarrow Na(s) \quad E° = -2.71\ V$
- $K^+(aq) + e^- \rightarrow K(s) \quad E° = -2.92\ V$
- $Cs^+(aq) + e^- \rightarrow Cs(s) \quad E° = -2.92\ V$

A more negative standard reduction potential means that the metal has a greater tendency to get oxidized (i.e., the reverse reaction, $M(s) \rightarrow M^+(aq) + e^-$, occurs more readily). Therefore, the metal with the most negative reduction potential is the strongest reducing agent.

Comparing the values:
- Li: -3.04 V
- Na: -2.71 V
- K: -2.92 V
- Cs: -2.92 V

The most negative value is -3.04 V, which corresponds to Lithium (Li). This indicates that Lithium is the strongest reducing agent among the given options in aqueous solution. Despite the general trend of increasing reducing strength down the group, Lithium is an exception due to its high hydration energy of Li^+ which compensates for its high ionization energy.

Final Answer: $\boxed{Li}$

Answer: (A)

Go Back to Question 8

Q9.

Solution

Concept: A galvanic cell involves spontaneous redox reactions that generate an electric current. The standard cell potential (E°_{cell}) is the potential difference between the two half-cells under standard conditions (1 M concentration for solutions). It is calculated as the difference between the standard reduction potential of the cathode and the standard reduction potential of the anode: $E^\circ_{\text{cell}} = E^\circ_{\text{cathode}} - E^\circ_{\text{anode}}$.

Solution: The galvanic cell is represented as:
Zn | $ZnSO_4$ (1 M) || $CuSO_4$ (1 M) | Cu

This representation tells us that:
- The left half-cell is the anode, where oxidation occurs: $Zn(s) \rightarrow Zn^{2+}(aq) + 2e^-$
- The right half-cell is the cathode, where reduction occurs: $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$
- The concentrations are 1 M, indicating standard conditions.

The standard cell potential is given as $E^\circ_{\text{cell}} = 1.10$ V.

We know the standard reduction potential for the copper half-cell:
$E^\circ_{Cu^{2+}/Cu} = +0.34$ V

We need to find the standard reduction potential for the zinc half-cell: $E^\circ_{Zn^{2+}/Zn}$.

Using the formula for standard cell potential:
$E^\circ_{\text{cell}} = E^\circ_{\text{cathode}} - E^\circ_{\text{anode}}$
$1.10\text{ V} = E^\circ_{Cu^{2+}/Cu} - E^\circ_{Zn^{2+}/Zn}$

Substituting the known value for $E^\circ_{Cu^{2+}/Cu}$:
$1.10\text{ V} = +0.34\text{ V} - E^\circ_{Zn^{2+}/Zn}$

Now, we solve for $E^\circ_{Zn^{2+}/Zn}$:
$E^\circ_{Zn^{2+}/Zn} = +0.34\text{ V} - 1.10\text{ V}$
$E^\circ_{Zn^{2+}/Zn} = -0.76\text{ V}$

Thus, the standard reduction potential of Zn^{2+}/Zn is -0.76 V.

Final Answer: $\boxed{-0.76\text{ V}}$

Answer: (C)

Go Back to Question 9

Q10.

Solution

Concept: The addition of hydrogen halides (HX) to alkenes follows specific regioselectivity rules. In the absence of peroxides, Markovnikov's rule applies. However, in the presence of peroxides, the addition of HBr follows an anti-Markovnikov pathway due to a free-radical mechanism.

Solution: The reaction involves propene ($CH_3 - CH = CH_2$) and HBr in the presence of peroxides.

Step 1: Identify the alkene and reaction conditions.
The alkene is propene, $CH_3 - CH = CH_2$. The reaction is with HBr, and the presence of peroxides indicates a free-radical addition mechanism.

Step 2: Apply the anti-Markovnikov rule.
In the presence of peroxides, HBr adds to the double bond such that the bromine atom attaches to the carbon atom that has the greater number of hydrogen atoms, and the hydrogen atom attaches to the carbon atom with fewer hydrogen atoms. This is known as anti-Markovnikov addition.

Step 3: Analyze propene for anti-Markovnikov addition.
Propene has a double bond between C_2 (carrying one H) and C_3 (carrying two H atoms).
$CH_3 - \overset{2}{C}H = \overset{3}{C}H_2$

According to the anti-Markovnikov rule:
- The hydrogen atom from HBr will add to C_2 (which has fewer hydrogens).
- The bromine atom from HBr will add to C_3 (which has more hydrogens).

Step 4: Determine the product.
The addition will result in the formation of $CH_3 - CH(H) - CH_2(Br)$, which is $CH_3 - CH_2 - CH_2Br$. This compound is named 1-bromopropane.

Let's compare with the options:
(A) 1-bromopropane: This matches our predicted product.
(B) 2-bromopropane: This would be the product of Markovnikov addition.
(C) Propan-1-ol: This is an alcohol, not an alkyl halide.
(D) Propan-2-ol: This is also an alcohol.

Final Answer: $\boxed{1 - bromopropane}$

Answer: (A)

Go Back to Question 10

Q11.

Solution

Concept: The hybridization of an atom in a molecule is determined by the number of sigma bonds and lone pairs it forms, collectively known as the steric number. The steric number dictates the type of hybrid orbitals involved (sp, sp^2, sp^3d, sp^3d^2, etc.).

Solution: To determine the hybridization of Xenon (Xe) in $XeOF_4$, we first construct its Lewis structure and then calculate the steric number of Xenon.

Step 1: Determine the total number of valence electrons.
Xenon (Xe) is in Group 18, so it has 8 valence electrons.
Oxygen (O) is in Group 16, so it has 6 valence electrons.
Fluorine (F) is in Group 17, so it has 7 valence electrons.
Total valence electrons = 8(Xe) + 6(O) + 4 × 7(F) = 8 + 6 + 28 = 42 valence electrons.

Step 2: Draw the Lewis structure.
Xenon is the central atom. It is bonded to one oxygen atom and four fluorine atoms. Oxygen typically forms a double bond, and Xenon can expand its octet.
The structure is: Xe is bonded to O via a double bond ($O = Xe$) and to each of the four F atoms via single bonds ($Xe - F$).
To satisfy the octet (or expanded octet) rules and distribute all valence electrons:
- The double bond Xe=O uses 4 electrons.
- The four single bonds Xe-F use $4 \times 2 = 8$ electrons.
- The four F atoms each have 3 lone pairs (6 electrons), totaling $4 \times 6 = 24$ electrons.
- The oxygen atom has 2 lone pairs (4 electrons) to complete its octet.
- The remaining electrons are $42 - 4(\text{in } O = Xe) - 8(\text{in } Xe - F) - 24(\text{on } F) - 4(\text{on } O) = 2$ electrons. These form one lone pair on Xenon.

Step 3: Calculate the steric number of Xenon.
The steric number (SN) is the sum of the number of sigma bonds and the number of lone pairs on the central atom. - Number of sigma bonds on Xe = 1 (from Xe=O) + 4 (from Xe-F) = 5.
- Number of lone pairs on Xe = 1.
- Steric Number (SN) = 5 (sigma bonds) + 1 (lone pair) = 6.

Step 4: Determine the hybridization.
A steric number of 6 corresponds to sp^3d^2 hybridization. This arrangement leads to an octahedral electron geometry.

Final Answer: $\boxed{sp^3d^2}$

Answer: (C)

Go Back to Question 11

Q12.

Solution

Concept: The acidic strength of the hydrogen halides (HF, HCl, HBr, HI) increases down the halogen group in the periodic table. This trend is primarily attributed to the variation in the bond strength of the H-X bond. As the size of the halogen atom increases, the H-X bond length increases, leading to a decrease in bond strength and thus increased acidity.

Solution: The acidic strength of a hydrogen halide (HX) is determined by the ease with which it can donate a proton (H^+). This ease is directly related to the strength of the H-X bond.

Step 1: Consider the atomic size of halogens.
The atomic radii of the halogens increase down the group: F < Cl < Br < I.

Step 2: Analyze the H-X bond length and strength.
As the size of the halogen atom increases, the H-X bond length increases. For example, the H-I bond is longer than the H-Cl bond.
Longer bonds are generally weaker. Therefore, the bond strength of the H-X bond decreases in the order: H-F > H-Cl > H-Br > H-I

Step 3: Relate bond strength to acidic strength.
A weaker H-X bond is easier to break, which means it can more readily release a proton (H^+). Consequently, the acidic strength of the hydrogen halides increases as the H-X bond strength decreases.

Step 4: Establish the order of acidic strength.
Based on the decreasing bond strength, the order of acidic strength is:
$HI > HBr > HCl > HF$

- HI is the strongest acid because the H-I bond is the weakest.
- HF is the weakest acid because the H-F bond is the strongest.

Step 5: Compare with the given options.
Option (B) correctly lists the order of acidic strength as $HI > HBr > HCl > HF$.

Final Answer: $\boxed{HI > HBr > HCl > HF}$

Answer: (B)

Go Back to Question 12

Q13.

Solution

Concept: Sigma (σ) bonds are formed by head-on overlap of orbitals, while pi (π) bonds are formed by sidewise overlap. A single bond contains one σ bond, a double bond contains one σ and one π bond, and a triple bond contains one σ and two π bonds. Benzene (C_6H_6) contains delocalized π electrons due to its aromatic structure.

Solution: Benzene has the molecular formula C_6H_6. Its structure is a hexagonal ring of six carbon atoms, with each carbon atom bonded to one hydrogen atom. According to the Kekulé structures, benzene exhibits resonance, with alternating single and double bonds in the ring. However, in reality, all C-C bonds in benzene are equivalent and intermediate between single and double bonds due to delocalization of pi electrons.

Step 1: Determine the types of bonds in benzene.
Benzene has:
- Carbon-Carbon bonds (within the ring)
- Carbon-Hydrogen bonds (connecting carbons to hydrogens)

Step 2: Count the number of sigma bonds.
- There are 6 C-C bonds in the hexagonal ring. Each C-C bond is a sigma bond.
- There are 6 C-H bonds, one attached to each carbon atom. Each C-H bond is a sigma bond.

Total number of sigma bonds = (Number of C-C sigma bonds) + (Number of C-H sigma bonds) = 6 + 6 = 12.

Step 3: Count the number of pi bonds.
Benzene has a delocalized pi electron system. In the context of resonance structures (Kekulé structures), each structure contains three double bonds. Each double bond consists of one sigma bond and one pi bond.
So, in each Kekulé structure, there are 3 C=C double bonds, which contribute 3 pi bonds.
Due to resonance, these pi bonds are delocalized over the entire ring, but the total number of pi electrons is 6, and this corresponds to 3 pi bonds.

Total number of pi bonds = 3.

Step 4: Combine the counts.
Number of sigma bonds = 12
Number of pi bonds = 3

Therefore, benzene has 12 sigma bonds and 3 pi bonds.

Final Answer: $\boxed{12, 3}$

Answer: (A)

Go Back to Question 13

Q14.

Solution

Concept: Molecular Orbital Theory (MOT) explains the bonding and magnetic properties of molecules based on the formation of molecular orbitals from atomic orbitals. The presence of unpaired electrons in molecular orbitals leads to paramagnetism, while the absence of unpaired electrons leads to diamagnetism.

Solution: The oxygen molecule (O_2) contains 16 electrons. According to Molecular Orbital Theory (MOT), its electronic configuration is:

$$(\sigma_{2s})^2(\sigma^*_{2s})^2(\sigma_{2p_z})^2(\pi_{2p_x})^2(\pi_{2p_y})^2(\pi^*_{2p_x})^1(\pi^*_{2p_y})^1$$

The two electrons in the degenerate π^*_{2p} antibonding orbitals remain unpaired according to Hund's rule.

Since the molecule contains unpaired electrons, O_2 is paramagnetic in nature and is attracted towards a magnetic field.
Thus, the magnetic nature of O_2 is due to the presence of two unpaired electrons.

Final Answer: $\boxed{\text{Presence of two unpaired electrons}}$

Answer: (B)

Go Back to Question 14

Q15.

Solution

Concept: Alcohols can undergo dehydration reactions when heated with strong dehydrating agents like concentrated sulfuric acid (H_2SO_4). The temperature at which the reaction is carried out determines the product. Dehydration can lead to alkene formation or ether formation.

Solution: The reaction involves ethanol (CH_3CH_2OH) heated with excess concentrated H_2SO_4 at 443 K.

Step 1: Consider the reaction of ethanol with concentrated H_2SO_4.
Concentrated sulfuric acid acts as a dehydrating agent and a catalyst.

Step 2: Analyze the effect of temperature.
- At around 413 K, the reaction between two molecules of ethanol leads to the formation of diethyl ether ($CH_3CH_2OCH_2CH_3$) via intermolecular dehydration:
$2CH_3CH_2OH \xrightarrow{H_2SO_4,413\ K} CH_3CH_2OCH_2CH_3 + H_2O$
- At a higher temperature, around 443 K, the reaction proceeds via intramolecular dehydration of ethanol to form an alkene:
$CH_3CH_2OH \xrightarrow{H_2SO_4,443\ K} CH_2 = CH_2 + H_2O$ This is the formation of ethene (ethylene).

Step 3: Identify the product.
Since the reaction is carried out at 443 K with excess concentrated H_2SO_4, the primary product is ethene, formed by the elimination of a water molecule from a single ethanol molecule.

Let's check the options:
(A) Ethene: Consistent with intramolecular dehydration at 443 K.
(B) Diethyl ether: Formed at a lower temperature (around 413 K) via intermolecular dehydration.
(C) Acetaldehyde: This would be an oxidation product, not a dehydration product.
(D) Ethane: This is an alkane that could be formed by reduction, not dehydration.

Final Answer: $\boxed{Ethene}$

$\boxed{\textbf{Answer: (A)}}$

Go Back to Question 15

Q16.

Solution

Concept: Chemical kinetics deals with the rates of chemical reactions. The rate law expresses the relationship between the rate of a reaction and the concentrations of reactants. For a first-order reaction, the rate is directly proportional to the concentration of one reactant raised to the power of one. The rate constant, k, is a proportionality constant that has specific units depending on the order of the reaction.

Solution: A first-order reaction is defined by the rate law:
Rate $= k[A]^1$
where:
- Rate is the reaction rate.
- k is the rate constant.
- $[A]$ is the concentration of the reactant.

We know that the units of Rate are typically mol L^{-1} s^{-1} (or M s^{-1}).
The units of concentration $[A]$ are mol L^{-1} (or M).

Let's determine the units of the rate constant, k:
Units of Rate = Units of $k \times$ Units of $[A]$
mol L^{-1} s^{-1} = Units of $k \times$ mol L^{-1}

To find the units of k, we can rearrange the equation:
Units of $k = \frac{\text{Units of Rate}}{\text{Units of }[A]}$
Units of $k = \frac{\text{mol L}^{-1}\text{ s}^{-1}}{\text{mol L}^{-1}}$

The 'mol L^{-1}' terms cancel out, leaving:
Units of $k = \text{s}^{-1}$

Alternatively, for a general n^{th} order reaction, the units of the rate constant are:
Units of $k = (\text{mol}^{1-n}\ \text{L}^{n-1}\ \text{s}^{-1})$
For a first-order reaction, $n = 1$.
Units of $k = (\text{mol}^{1-1}\ \text{L}^{1-1}\ \text{s}^{-1}) = (\text{mol}^0\ \text{L}^0\ \text{s}^{-1}) = \text{s}^{-1}$.

Final Answer: $\boxed{s^{-1}}$

Answer: (B)

Go Back to Question 16

Q17.

Solution

Concept: Optical isomerism (enantiomerism) occurs in molecules that are chiral. A molecule is chiral if it is non-superimposable on its mirror image. Chirality often arises from a carbon atom bonded to four different groups (a chiral center or stereocenter).

Solution: Optical isomerism is shown by compounds that contain at least one chiral carbon atom. A chiral carbon is a carbon atom bonded to four different groups. Such compounds exist as non-superimposable mirror images called enantiomers.

1. 2-butanol ($CH_3 - CH(OH) - CH_2 - CH_3$):
In this compound, the second carbon atom is attached to four different groups:
- $-CH_3$
- $-OH$
- $-CH_2CH_3$
- $-H$

Since all four groups are different, the second carbon atom is chiral. Therefore, 2-butanol exhibits optical isomerism.

2. Propan-2-ol ($CH_3 - CH(OH) - CH_3$):
Here, the second carbon atom is attached to two identical methyl groups ($-CH_3$). Since all four groups are not different, the carbon atom is not chiral. Hence, propan-2-ol does not show optical isomerism.

3. Acetone ($CH_3 - CO - CH_3$):
Acetone contains a carbonyl group and has no carbon atom bonded to four different groups. Therefore, it is achiral and optically inactive.

4. Ethanal ($CH_3 - CHO$):
Ethanal also does not contain any chiral carbon atom. The carbonyl carbon is sp^2 hybridized and cannot act as a chiral center. Hence, ethanal does not exhibit optical isomerism.

Therefore, among the given compounds, only 2-butanol shows optical isomerism.

Final Answer: $\boxed{\text{2-butanol}}$

Answer: (A)

Go Back to Question 17

Q18.

Solution

Concept: The gas laws describe the relationship between the pressure, volume, temperature, and amount of a gas. Boyle's law states that at constant temperature and amount of gas, pressure is inversely proportional to volume ($P \propto 1/V$). Charles's law states that at constant pressure and amount of gas, volume is directly proportional to temperature ($V \propto T$). Avogadro's law states that at constant temperature and pressure, volume is directly proportional to the number of moles ($V \propto n$). Dalton's law deals with partial pressures.

Solution: The graph shows pressure (P) on the y-axis and the inverse of volume ($1/V$) on the x-axis. The relationship plotted is P versus $1/V$.

Step 1: Recall the gas laws.
- Boyle's Law: $P \propto 1/V$ (at constant T and n) or $PV =$ constant.
- Charles's Law: $V \propto T$ (at constant P and n). This would be a plot of V vs T, or if plotted as P vs 1/V, it would not be a straight line through the origin.
- Avogadro's Law: $V \propto n$ (at constant P and T). This relates volume to the number of moles.
- Dalton's Law of Partial Pressures: The total pressure of a mixture of gases is the sum of the partial pressures of individual gases.

Step 2: Analyze the given graph.
The graph is a plot of P versus $1/V$. We observe a straight line passing through the origin.
This means that P is directly proportional to $1/V$.
$P \propto 1/V$

Step 3: Relate the proportionality to the gas laws.
The relationship $P \propto 1/V$ is the mathematical statement of Boyle's Law, provided that the temperature (T) and the amount of gas (n) are kept constant. A straight line passing through the origin in a plot of P vs $1/V$ represents this direct proportionality.

Step 4: Evaluate the options.
(A) Charles's law: Relates V and T ($V \propto T$), not P and 1/V.
(B) Boyle's law: States $P \propto 1/V$, which is represented by the graph.
(C) Avogadro's law: Relates V and n ($V \propto n$).
(D) Dalton's law: Deals with partial pressures in gas mixtures.

The graph directly verifies Boyle's Law.

Final Answer: $\boxed{Boyle'slaw}$

Answer: (B)

Go Back to Question 18

Q19.

Solution

Concept: In IUPAC nomenclature of aldehydes, the longest carbon chain containing the aldehyde group $(-CHO)$ is selected as the parent chain. The suffix "-al" is used for aldehydes, and numbering always starts from the aldehyde carbon atom. Substituents are identified and numbered accordingly.

Solution: The given compound is:

$$CH_3 - CH(CH_3) - CH_2 - CHO$$

Step 1: Identify the parent chain
The functional group present is an aldehyde $(-CHO)$. The longest chain containing the aldehyde carbon has 4 carbon atoms. Therefore, the parent chain is *butanal*.

The structure can be written as:

$$CHO - CH_2 - CH(CH_3) - CH_3$$

Step 2: Number the carbon chain
Numbering starts from the aldehyde carbon because it has the highest priority.

$$C_1HO - C_2H_2 - C_3H(CH_3) - C_4H_3$$

Thus, the methyl substituent is attached to carbon 3.

Step 3: Write the IUPAC name
Parent name = butanal
Substituent = methyl at carbon 3

Hence, the IUPAC name of the compound is:

$$\boxed{\text{3-methylbutanal}}$$

Final Answer: $\boxed{\text{3-methylbutanal}}$

$\boxed{\textbf{Answer: (A)}}$

Go Back to Question 19

Q20.

Solution

Concept: Boiling point depends on intermolecular forces. In hydrocarbons, stronger London dispersion forces give higher boiling points. Branching decreases surface area and lowers boiling point, while cyclic structures generally increase boiling point due to better packing.

Solution: Boiling point mainly depends on the strength of intermolecular forces. Greater surface area and better molecular packing lead to stronger London dispersion forces and hence higher boiling point.
1. Pentane (n-pentane):
It has a straight-chain structure:

$$CH_3 - CH_2 - CH_2 - CH_2 - CH_3$$

The linear shape provides a larger surface area, resulting in stronger intermolecular forces.

2. 2-methylbutane:
This is a branched-chain isomer of pentane.

$$CH_3 - CH(CH_3) - CH_2 - CH_3$$

Branching decreases surface area, so intermolecular forces become weaker than in pentane.

3. Neopentane $(2, 2\text{-dimethylpropane})$:
It is a highly branched and nearly spherical molecule.

$$C(CH_3)_4$$

Due to maximum branching, it has the smallest surface area and therefore the weakest intermolecular forces among the pentane isomers.

4. Cyclopentane:
Cyclopentane has a cyclic structure which allows molecules to pack more closely together. This increases intermolecular attraction and raises the boiling point.
The boiling point order is:

$$\text{Cyclopentane} > \text{Pentane} > \text{2-methylbutane} > \text{Neopentane}$$

Hence, cyclopentane has the highest boiling point among the given compounds.

Final Answer: $\boxed{Cyclopentane}$

$\boxed{\textbf{Answer: (D)}}$

Go Back to Question 20

Q21.

Solution

Concept: In coordination compounds, the coordination number of the central metal ion is the number of ligand atoms directly bonded to it. The oxidation state of the central metal ion is the hypothetical charge it would have if all ligands were removed as ions with their full negative charges.

Solution: The coordination compound is $K_4[Fe(CN)_6]$.

Step 1: Identify the central metal ion and the ligands.
- Central metal ion: Iron (Fe).
- Ligands: Cyanide ions (CN^-).
- Counter ions: Potassium ions (K^+).

Step 2: Determine the coordination number of Fe.
The coordination number is the number of ligand atoms directly attached to the central metal ion. In $[Fe(CN)_6]^{4-}$, there are six cyanide ions (CN^-) coordinated to the iron ion. Each CN^- acts as a monodentate ligand.
Therefore, the coordination number of Fe is 6.

Step 3: Determine the oxidation state of Fe.
Let the oxidation state of Fe be x.
The complex ion is $[Fe(CN)_6]^{4-}$.
The charge of each cyanide ligand (CN^-) is -1.
The overall charge of the complex ion is -4.

The sum of the oxidation states of the metal and the ligands must equal the overall charge of the complex ion:
Oxidation state of Fe + (Number of CN^- ligands × Charge of CN^- ligand) = Charge of complex ion
$x + (6 \times -1) = -4$
$x - 6 = -4$
$x = -4 + 6$
$x = +2$

So, the oxidation state of Iron (Fe) is +2.

Step 4: Combine the coordination number and oxidation state.
Coordination number of Fe = 6
Oxidation state of Fe = +2

Final Answer: $\boxed{6, +2}$

$\boxed{\textbf{Answer: (B)}}$

Go Back to Question 21

Q22.

Solution

Concept: Ozonolysis is a chemical reaction in which ozone (O_3) is used to cleave carbon-carbon double bonds (alkenes) or triple bonds (alkynes). The reaction proceeds in two steps: first, the formation of an ozonide, and second, the cleavage of the ozonide to form carbonyl compounds (aldehydes, ketones, or carboxylic acids) and other products, depending on the work-up conditions.

Solution: Ozonolysis is used to break down alkenes and alkynes. The reaction involves treating the unsaturated compound with ozone (O_3). The intermediate formed is an ozonide. The ozonide is then cleaved in a subsequent step to yield carbonyl compounds. The nature of the cleavage products depends on the work-up reagent used.

The question asks for the reagent used for ozonolysis. Ozonolysis is a two-step process. The first step involves reaction with ozone (O_3). The second step is the work-up, which cleaves the ozonide. Common work-up reagents are:

1. Reducing work-up: Using zinc and water (Zn/H_2O) or dimethyl sulfide (DMS). This cleaves the ozonide to form aldehydes and/or ketones.
$R_1R_2C = CR_3R_4 \xrightarrow{O_3} \text{Ozonide} \xrightarrow{Zn/H_2O \text{ or } DMS} R_1R_2C = O + R_3R_4C = O$
2. Oxidative work-up: Using hydrogen peroxide (H_2O_2). This cleaves the ozonide to form aldehydes, ketones, and possibly carboxylic acids. If an aldehyde is formed, it can be further oxidized to a carboxylic acid.

Let's look at the options:
(A) O_3/Zn-H_2O: This represents the ozonolysis reaction with a reducing work-up. Ozone (O_3) is used to form the ozonide, and then Zn-H_2O is used to cleave it. This is a standard ozonolysis reagent system.
(B) $KMnO_4$: Potassium permanganate is a strong oxidizing agent, but it is not used for ozonolysis. It can cleave double bonds under certain conditions (e.g., hot, acidic $KMnO_4$), but it is not called ozonolysis.
(C) H_2/Ni: Catalytic hydrogenation is used to reduce double bonds to single bonds, forming alkanes. It is not ozonolysis.
(D) $NaBH_4$ (Sodium borohydride): This is a mild reducing agent used to reduce aldehydes and ketones to alcohols. It is not used for ozonolysis.

Therefore, the reagent used for ozonolysis (including the work-up) is represented by option (A).

Final Answer: $\boxed{O_3/Zn - H_2O}$

Answer: (A)

Go Back to Question 22

Q23.

Solution

Concept: A titration curve plots the change in pH of a solution as a titrant is added. The shape of the curve, particularly the initial pH, the pH at the equivalence point, and the shape of the steep rise in pH, provides information about the strengths of the acid and base involved in the titration.

Solution: The titration curve begins at a very low pH, which indicates that the solution initially contains a strong acid. As the titrant is added, the pH increases slowly at first and then rises sharply near the equivalence point.

The equivalence point is identified by the steep vertical rise in the curve. In the given graph, the pH at the equivalence point is less than 7, showing that the solution is acidic even at equivalence.

This situation occurs when a strong acid is titrated against a weak base. At the equivalence point, the salt formed undergoes hydrolysis and produces H^+ ions, making the solution acidic.

Comparison with standard titration curves:

- Strong acid vs strong base → equivalence point at pH 7
- Weak acid vs strong base → equivalence point above pH 7
- Strong acid vs weak base → equivalence point below pH 7
- Weak acid vs weak base → less sharp change in pH

Since the equivalence point lies below pH 7 and the curve starts with a very low pH, the graph represents the titration of a strong acid with a weak base.

Final Answer: $\boxed{Strong acid vs weak base}$ (Assuming option C represents this scenario)

$\boxed{\textbf{Answer: (C)}}$

Go Back to Question 23

Q24.

Solution

Concept: The iodoform test is a qualitative test used to detect the presence of certain organic compounds. Specifically, it tests for methyl ketones (compounds with the structure R-CO-CH_3) or alcohols that can be oxidized to methyl ketones. It also detects compounds with the structure R-CH(OH)-CH_3.

Solution: The iodoform test involves treating the compound with iodine (I_2) in the presence of a base (like NaOH). A positive test is indicated by the formation of a yellow precipitate of iodoform (CHI_3).

We need to identify which of the given compounds will give a positive iodoform test.

1. Methanol (CH_3OH): Methanol is a primary alcohol. It can be oxidized by iodine and base, but it does not have the required structural feature (a methyl ketone or a secondary alcohol with a methyl group adjacent to the hydroxyl). The initial product of oxidation would be formaldehyde ($HCHO$), which does not yield iodoform.

2. Ethanol (CH_3CH_2OH): Ethanol is a primary alcohol. When treated with iodine and base, it is first oxidized to ethanal (CH_3CHO). Ethanal has the structure $CH_3 - CHO$. This structure contains a methyl group directly attached to the carbonyl carbon ($CH_3 - CO-$ part of ethanal). Therefore, ethanal reacts further to form iodoform.
The reaction sequence is:
$CH_3CH_2OH \xrightarrow{I_2, NaOH} CH_3CHO \xrightarrow{I_2, NaOH} CHI_3$ (yellow precipitate) + formate salt.
Thus, ethanol gives a positive iodoform test.

3. Benzaldehyde ($C_6H_5 - CHO$): Benzaldehyde is an aldehyde, but it does not have a methyl group attached to the carbonyl carbon (it has a phenyl group). The structure is $C_6H_5 - CO - H$. It does not have the R-CO-CH_3 or R-CH(OH)-CH_3 structure. Therefore, benzaldehyde does not give a positive iodoform test.

4. Formic acid ($HCOOH$): Formic acid is the simplest carboxylic acid. It does not contain the necessary structural features (methyl ketone or the appropriate alcohol) to give a positive iodoform test. It can be oxidized, but not in a way that leads to iodoform formation.

Therefore, ethanol is the compound that gives the iodoform test.

Final Answer: $\boxed{Ethanol}$

Answer: (B)

Go Back to Question 24

Q25.

Solution

Concept: The shape of a molecule is determined by the arrangement of its atoms in space, which is dictated by the VSEPR (Valence Shell Electron Pair Repulsion) theory. VSEPR theory states that electron pairs (both bonding and lone pairs) around a central atom repel each other and arrange themselves to minimize this repulsion, leading to specific molecular geometries. The shape is determined by the number of sigma bonds and lone pairs around the central atom.

Solution: To determine the shape of IF_5, we use VSEPR theory.

Step 1: Count valence electrons
Iodine (I) belongs to Group 17 and has 7 valence electrons. Each fluorine atom also has 7 valence electrons.

$$\text{Total valence electrons} = 7 + 5 \times 7 = 42$$

Step 2: Determine bonding and lone pairs
Iodine forms five single bonds with five fluorine atoms. After completing the octets of fluorine atoms, one lone pair remains on the central iodine atom.

Thus, around iodine there are:
- 5 bond pairs
- 1 lone pair

Step 3: Find steric number and geometry
Steric number:

$$\text{SN} = 5 + 1 = 6$$

A steric number of 6 gives an octahedral electron pair geometry. Since one position is occupied by a lone pair, the molecular shape becomes square pyramidal.

Step 4: Conclusion
The molecule has five fluorine atoms arranged in the form of a square pyramid around the iodine atom.

Therefore, the shape of IF_5 is:

$$\boxed{\text{Square pyramidal}}$$

Final Answer: $\boxed{Square pyramidal}$

Answer: (C)

Go Back to Question 25

Q26.

Solution

Concept: Entropy measures the degree of disorder or randomness in a system. A process that increases molecular freedom or randomness has positive entropy change ($\Delta S > 0$), while a process that increases order has negative entropy change ($\Delta S < 0$). Phase changes such as melting, vaporization, and sublimation generally increase entropy.

Solution: Entropy is a measure of randomness or disorder in a system. A process that increases molecular freedom leads to an increase in entropy, while a process that makes the system more ordered decreases entropy.

1. Melting of ice:
When ice melts, water changes from the solid state to the liquid state. In the solid state, molecules are closely packed in a fixed arrangement. In the liquid state, the molecules can move more freely. Therefore, entropy increases.

$$S_{\text{solid}} < S_{\text{liquid}}$$

2. Vaporisation of water:
During vaporisation, liquid water changes into steam. Gas molecules move freely in all directions and occupy a much larger volume than liquids. Hence, the randomness and disorder increase greatly. Therefore, this process produces a very large positive entropy change.

$$S_{\text{liquid}} \ll S_{\text{gas}}$$

3. Condensation of steam:
Condensation is the reverse of vaporisation. Steam changes into liquid water, causing a decrease in molecular freedom and randomness. Hence, entropy decreases.

4. Freezing of water:
During freezing, liquid water changes into solid ice. Molecules become fixed in an ordered crystal lattice, so disorder decreases and entropy decreases.

Comparing all the processes, the greatest increase in randomness occurs during the conversion of liquid water into steam. Therefore, the entropy change is maximum during vaporisation of water.

Final Answer: $\boxed{Vaporisation of water}$

Answer: (B)

Go Back to Question 26

Q27.

Solution

Concept: Bond dissociation enthalpy is the energy required to break one mole of bonds in the gaseous state. In halogens (X_2), bond energy generally decreases down the group because atomic size and bond length increase. However, F_2 shows an anomalously low bond dissociation enthalpy due to strong repulsion between the lone pairs of electrons on the small fluorine atoms.

Solution: Bond dissociation enthalpy is the energy required to break one mole of bonds in the gaseous state. Stronger bonds have higher bond dissociation enthalpy, while weaker bonds have lower values.

In the halogen family, atomic size increases down the group from fluorine to iodine. As atomic size increases, the bond length between the two halogen atoms also increases. Longer bonds are weaker and therefore require less energy to break. Hence, bond dissociation enthalpy generally decreases down the group.

Based on this trend, the expected order would be:

$$F_2 > Cl_2 > Br_2 > I_2$$

However, F_2 shows anomalous behaviour. The fluorine atom is very small, so the lone pairs of electrons present on the two fluorine atoms experience strong inter-electronic repulsion. This weakens the $F - F$ bond significantly, making it less stable than expected.

As a result, the bond dissociation enthalpy of F_2 becomes lower than that of both Cl_2 and Br_2.

The approximate bond dissociation enthalpy values are:

$$Cl_2 \approx 242 \text{ kJ mol}^{-1}$$

$$Br_2 \approx 193 \text{ kJ mol}^{-1}$$

$$F_2 \approx 159 \text{ kJ mol}^{-1}$$

$$I_2 \approx 151 \text{ kJ mol}^{-1}$$

Therefore, the correct order of bond dissociation enthalpy is:

$$Cl_2 > Br_2 > F_2 > I_2$$

Hence, the correct answer is:

$$\boxed{Cl_2 > Br_2 > F_2 > I_2}$$

Final Answer: $\boxed{Cl_2 > Br_2 > F_2 > I_2}$

Answer: (B)

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Q28.

Solution

Concept: Aldehydes and ketones undergo nucleophilic addition reactions. When they react with hydrogen cyanide (HCN), the cyanide ion (CN^-) acts as a nucleophile and attacks the electrophilic carbonyl carbon. This addition reaction leads to the formation of a cyanohydrin.

Solution: The reaction is between acetaldehyde (CH_3CHO) and hydrogen cyanide (HCN).

Step 1: Understand the reactivity of acetaldehyde.
Acetaldehyde (CH_3CHO) is an aldehyde. The carbonyl carbon ($C = O$) is electrophilic due to the polarization of the double bond, making it susceptible to nucleophilic attack.

Step 2: Understand the role of HCN.
Hydrogen cyanide (HCN) is a weak acid, but it provides the cyanide ion (CN^-) as a potent nucleophile. In the presence of a base catalyst (or even weakly basic conditions), HCN can dissociate to produce H^+ and CN^-.

Step 3: Describe the nucleophilic addition reaction.
The cyanide ion (CN^-) attacks the electrophilic carbonyl carbon of acetaldehyde:
$CH_3 - CHO + CN^- \rightarrow CH_3 - CH(O^-) - CN$

Step 4: Protonation of the alkoxide intermediate.
The resulting alkoxide ion is then protonated by H^+ (from HCN or solvent) to form the final product:
$CH_3 - CH(O^-) - CN + H^+ \rightarrow CH_3 - CH(OH) - CN$

Step 5: Identify the product.
The product formed, $CH_3 - CH(OH) - CN$, is called a cyanohydrin. Specifically, it is lactaldehyde cyanohydrin or 2-hydroxypropanenitrile.

Step 6: Evaluate the options.
(A) Cyanohydrin: This matches the product formed.
(B) Acetal: Acetals are formed by the reaction of aldehydes/ketones with alcohols.
(C) Carboxylic acid: Carboxylic acids can be formed by oxidation of aldehydes, but not directly from reaction with HCN.
(D) Alcohol: While the cyanohydrin contains a hydroxyl group, it is a more complex molecule (a hydroxy nitrile). The term "alcohol" alone is too general and doesn't describe the specific product.

Final Answer: $\boxed{Cyanohydrin}$

Answer: (A)

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Q29.

Solution

Concept: Packing efficiency is the percentage of the unit cell volume occupied by atoms. It is given by:

$$\text{Packing Efficiency} = \frac{\text{Volume of atoms}}{\text{Volume of unit cell}} \times 100\%$$

Different crystal structures have different packing efficiencies.

Solution: The given lattice has atoms at all corners and one atom at the body centre, which represents a Body-Centered Cubic (BCC) structure.

In a BCC unit cell:
- Corner atoms contribute $8 \times \frac{1}{8} = 1$ atom.
- Body-centred atom contributes 1 atom.

Thus, total atoms per unit cell = 2.

For BCC structures, atoms touch along the body diagonal:

$$a\sqrt{3} = 4r$$

Packing efficiency is:

$$\text{Packing efficiency} = \frac{\text{Volume of atoms}}{\text{Volume of unit cell}} \times 100$$

Substituting the BCC relations gives:

$$\text{Packing efficiency} = \frac{\pi\sqrt{3}}{8} \times 100 \approx 68\%$$

Hence, the packing efficiency of a BCC lattice is:

$$\boxed{68\%}$$

Final Answer: $\boxed{68\%}$

Answer: (B)

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Q30.

Solution

Concept: In electrophilic aromatic substitution reactions, substituents on the benzene ring influence both the reactivity and the position of substitution. Substituents may be activating or deactivating and direct the incoming electrophile to ortho, meta, or para positions. Halogens such as chlorine are deactivating due to their $-I$ effect, but they are ortho-para directing because of resonance donation of lone pair electrons.

Solution: The reaction is the nitration of chlorobenzene, which is an electrophilic aromatic substitution reaction. In this reaction, the electrophile is the nitronium ion (NO_2^+).

Chlorine attached to the benzene ring is a deactivating group because of its electron-withdrawing $-I$ effect. However, chlorine also has lone pairs that can participate in resonance, making it an ortho, para-directing group.

Therefore, the incoming nitronium ion preferentially attacks the ortho and para positions of the benzene ring relative to the chlorine atom. As a result, nitration of chlorobenzene produces mainly ortho-nitrochlorobenzene and para-nitrochlorobenzene.

The para product is generally formed in greater amount due to lower steric hindrance, but both ortho and para products are obtained.

$$\boxed{\text{Mixture of o- and p-nitrochlorobenzene}}$$

Final Answer: $\boxed{\text{Mixture of o- and p-nitrochlorobenzene}}$

$\boxed{\textbf{Answer: (C)}}$

Go Back to Question 30

Q31.

Solution

Concept: At Standard Temperature and Pressure (STP), one mole of any ideal gas occupies a volume of 22.4 liters. This is known as the molar volume of a gas at STP. Avogadro's number (N_A) states that one mole of any substance contains 6.022×10^{23} elementary entities (atoms, molecules, ions, etc.).

Solution: We are given 11.2 L of O_2 gas at STP and asked to find the number of molecules.

Step 1: Determine the number of moles of O_2 gas.
At STP, 1 mole of a gas occupies 22.4 L.
Given volume = 11.2 L.
Number of moles = $\frac{\text{Given volume}}{\text{Molar volume at STP}}$
Number of moles of $O_2 = \frac{11.2\text{ L}}{22.4\text{ L/mol}} = 0.5$ mol.

Step 2: Calculate the number of molecules.
One mole of any substance contains Avogadro's number of entities.
Avogadro's number (N_A) = 6.022×10^{23} molecules/mol.
Number of molecules = Number of moles × Avogadro's number
Number of molecules of $O_2 = 0.5$ mol $\times 6.022 \times 10^{23}$ molecules/mol Number of molecules of $O_2 = 3.011 \times 10^{23}$ molecules.

Step 3: Compare with the options.
(A) 3.01×10^{23}: This matches our calculated value.
(B) 6.02×10^{23}: This would be the number of molecules in 1 mole (22.4 L) of gas.
(C) 1.204×10^{24}: This is approximately twice Avogadro's number, corresponding to 2 moles of gas.
(D) 2.24×10^{22}: This is significantly less than Avogadro's number.

Final Answer: $\boxed{3.01 \times 10^{23}}$

Answer: (A)

Go Back to Question 31

Q32.

Solution

Concept: Amphoteric oxides and hydroxides are substances that can react with both acids and bases to form salts. Oxides of certain metals and metalloids exhibit amphoteric behavior.

Solution: We need to identify which of the given compounds is not amphoteric.

1. ZnO (Zinc oxide): Zinc oxide is a well-known amphoteric oxide. It reacts with acids to form zinc salts and with strong bases to form zincates.
$ZnO(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2O(l)$
$ZnO(s) + 2NaOH(aq) + H_2O(l) \rightarrow Na_2[Zn(OH)_4](aq)$ (sodium tetrahydroxozincate(II))

2. Al_2O_3 (Aluminum oxide): Aluminum oxide is also an amphoteric oxide. It reacts with both acids and bases.
$Al_2O_3(s) + 6HCl(aq) \rightarrow 2AlCl_3(aq) + 3H_2O(l)$
$Al_2O_3(s) + 2NaOH(aq) + 3H_2O(l) \rightarrow 2Na[Al(OH)_4](aq)$ (sodium tetrahydroxoaluminate(III))

3. PbO (Lead(II) oxide): Lead(II) oxide is an amphoteric oxide. It reacts with acids and strong bases.
$PbO(s) + 2HCl(aq) \rightarrow PbCl_2(aq) + H_2O(l)$
$PbO(s) + 2NaOH(aq) + H_2O(l) \rightarrow Na_2[Pb(OH)_4](aq)$ (sodium tetrahydroxoplumbate(II))

4. CaO (Calcium oxide): Calcium oxide is the oxide of an alkaline earth metal (Group 2). It is a basic oxide. It reacts readily with water to form calcium hydroxide ($Ca(OH)_2$), which is a base. It reacts with acids but does not react with bases.
$CaO(s) + H_2O(l) \rightarrow Ca(OH)_2(aq)$
$CaO(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l)$
CaO does not react with bases. Therefore, it is not amphoteric.

Final Answer: $\boxed{CaO}$

Answer: (D)

Go Back to Question 32

Q33.

Solution

Concept: Oxidation of alkyl side chains on an aromatic ring with strong oxidizing agents like alkaline potassium permanganate ($KMnO_4$) typically results in the formation of a carboxylic acid group, regardless of the length of the alkyl chain (provided there is at least one benzylic hydrogen).

Solution: The reaction involves the oxidation of toluene using alkaline potassium permanganate ($KMnO_4$). Toluene is methylbenzene ($C_6H_5 - CH_3$).

Step 1: Identify the reactant and the oxidizing agent.
Reactant: Toluene ($C_6H_5 - CH_3$).
Oxidizing agent: Alkaline potassium permanganate ($KMnO_4$ in basic medium).

Step 2: Understand the oxidation of alkyl side chains on aromatic rings.
Strong oxidizing agents like alkaline $KMnO_4$ or chromic acid (H_2CrO_4) oxidize alkyl side chains attached to an aromatic ring. The benzylic carbon atom (the carbon directly attached to the ring) is oxidized. If there is at least one hydrogen atom on the benzylic carbon, the oxidation proceeds all the way to the carboxylic acid stage.

Step 3: Apply the rule to toluene.
Toluene has a methyl group ($-CH_3$) attached to the benzene ring. The benzylic carbon atom has three hydrogen atoms.
Oxidation with alkaline $KMnO_4$ will oxidize the methyl group to a carboxylic acid group. The reaction proceeds in stages:
$\text{Toluene} \xrightarrow{\text{Oxidation}} \text{Benzaldehyde} \xrightarrow{\text{Oxidation}} \text{Benzoic acid}$

Step 4: Determine the final product.
The reaction with strong oxidizing agents like alkaline $KMnO_4$ goes to completion, yielding the carboxylic acid. Therefore, toluene is oxidized to benzoic acid ($C_6H_5 - COOH$).

Step 5: Evaluate the options.
(A) Benzyl alcohol: This would be formed by milder reduction, not oxidation.
(B) Benzaldehyde: This is an intermediate product, but the reaction with a strong oxidizing agent proceeds further.
(C) Benzoic acid: This is the final product of complete oxidation.
(D) Benzene: This implies removal of the methyl group, which is not the primary outcome of side-chain oxidation.

Final Answer: $\boxed{Benzoicacid}$

Answer: (C)

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Q34.

Solution

Concept: Covalent bonds are formed by the sharing of electrons between atoms. The type of bond formed depends on the types of atomic orbitals that overlap and the manner of overlap. Overlap along the internuclear axis forms a sigma (σ) bond, while lateral overlap forms a pi (π) bond.

Solution: The orbital overlap diagram shows:
- An s orbital, which is spherical and represented by a circle.
- A p orbital, which is dumbbell-shaped and represented by two lobes.
- The overlap occurs along the internuclear axis, indicated by the dashed line.

Step 1: Identify the orbitals involved in the overlap.
The diagram shows an s orbital overlapping with a p orbital.

Step 2: Determine the type of overlap.
The overlap is occurring end-to-end (head-on) along the internuclear axis. This type of overlap results in the formation of a sigma (σ) bond.

Step 3: Classify the bond formed.
Since the overlap is between an s orbital and a p orbital, and it is head-on, the bond formed is an $s-p$ sigma bond.

Step 4: Evaluate the options.
(A) $p\pi - p\pi$ bond: This involves lateral overlap of p orbitals, forming a pi bond. The diagram shows head-on overlap.
(B) $s-s$ sigma bond: This involves head-on overlap of two s orbitals. The diagram shows overlap between an s and a p orbital.
(C) $s-p$ sigma bond: This involves head-on overlap of an s orbital and a p orbital, forming a sigma bond. This matches the diagram.
(D) $p-p$ sigma bond: This involves head-on overlap of two p orbitals. The diagram shows overlap between an s and a p orbital.

Final Answer: $\boxed{s-p \text{ sigma bond}}$

Answer: (C)

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Q35.

Solution

Concept:
Adsorption is a surface phenomenon where atoms, ions, or molecules from one phase adhere to the surface of another phase. It can be physical adsorption (physisorption) or chemical adsorption (chemisorption), each with different characteristics related to enthalpy, temperature dependence, and selectivity.

Solution:
Let's evaluate each statement about adsorption:

A. Adsorption is a surface phenomenon.
This statement is correct. Adsorption specifically refers to the accumulation of a substance on the surface of another substance, distinguishing it from absorption where the substance penetrates the bulk.

B. Physical adsorption decreases with increase in temperature.
This statement is correct. Physical adsorption is an exothermic process (releases heat). According to Le Chatelier's principle, increasing the temperature (adding heat) will shift the equilibrium towards desorption (the reverse process), thus decreasing the extent of physical adsorption.

C. Chemisorption has low enthalpy of adsorption.
This statement is incorrect. Chemisorption involves the formation of chemical bonds between the adsorbate and the adsorbent. This process is highly exothermic and therefore has a high enthalpy of adsorption (large negative value), typically in the range of 80-400 kJ/mol. Physical adsorption, on the other hand, involves weaker van der Waals forces and has a low enthalpy of adsorption (typically 20-40 kJ/mol).

D. Activated charcoal is a good adsorbent.
This statement is correct. Activated charcoal has a highly porous structure with a large surface area, making it an excellent adsorbent for various gases and dissolved substances.

Therefore, the incorrect statement regarding adsorption is that chemisorption has a low enthalpy of adsorption.

Final Answer: $\boxed{Chemisorptionhaslowenthalpyofadsorption}$

Answer: (C)

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Q36.

Solution

Concept: Paramagnetism in molecules arises from the presence of unpaired electrons in their molecular orbitals. Diamagnetism occurs when all electrons are paired. Molecular Orbital Theory (MOT) helps determine the electronic configuration and magnetic properties of molecules.

Solution: We need to identify which of the given species are paramagnetic. This means they should have unpaired electrons in their molecular orbital configuration.

1. O_2 (Oxygen molecule):
O_2 has 16 electrons. Its molecular orbital electronic configuration is:

$$(\sigma_{2s})^2(\sigma_{2s}^*)^2(\sigma_{2p_z})^2(\pi_{2p_x})^2(\pi_{2p_y})^2(\pi_{2p_x}^*)^1(\pi_{2p_y}^*)^1$$

The two electrons in the degenerate π_{2p}^* antibonding orbitals remain unpaired. Therefore, O_2 is paramagnetic in nature.

2. NO (Nitric oxide):
NO has 7(N) + 8(O) = 15 electrons.
Its MOT configuration is $(\sigma_{2s})^2(\sigma_{2s}^*)^2(\sigma_{2p_z})^2(\pi_{2p_x})^2(\pi_{2p_y})^2(\pi_{2p_x}^*)^1(\pi_{2p_y}^*)^0$.
It has one unpaired electron in a π_{2p}^* orbital. Thus, NO is paramagnetic.

3. N_2 (Nitrogen molecule):
N_2 has $7 + 7 = 14$ electrons.
Its MOT configuration is $(\sigma_{2s})^2(\sigma_{2s}^*)^2(\pi_{2p_x})^2(\pi_{2p_y})^2(\sigma_{2p_z})^2$.
All electrons are paired. Thus, N_2 is diamagnetic.

4. O_2^- (Superoxide ion):
O_2^- has $16(\text{from } O_2) + 1(\text{extra electron}) = 17$ electrons.
Its MOT configuration is $(\sigma_{2s})^2(\sigma_{2s}^*)^2(\sigma_{2p_z})^2(\pi_{2p_x})^2(\pi_{2p_y})^2(\pi_{2p_x}^*)^2(\pi_{2p_y}^*)^1$.
It has one unpaired electron in a π_{2p}^* orbital. Thus, O_2^- is paramagnetic.

The paramagnetic species are O_2, NO, and O_2^-.

Final Answer: $\boxed{O_2, NO, O_2^-}$

Answer: (A, B, D)

Go Back to Question 36

Q37.

Solution

Concept: Oxidation is defined as the loss of electrons or an increase in oxidation state. Reduction is the gain of electrons or a decrease in oxidation state. A redox reaction involves both oxidation and reduction.

Solution: We need to identify the reactions that involve oxidation. This means we look for an increase in oxidation state.

1. $Fe^{2+} \rightarrow Fe^{3+}$
The oxidation state of iron changes from +2 to +3. This is an increase in oxidation state, meaning iron has lost an electron. This is oxidation.

2. $Cl_2 \rightarrow 2Cl^-$
The oxidation state of chlorine in Cl_2 (elemental form) is 0. The oxidation state of chlorine in Cl^- is -1. The oxidation state decreases from 0 to -1. This is a decrease in oxidation state, meaning chlorine has gained electrons. This is reduction.

3. $H_2S \rightarrow S$
In H_2S, the oxidation state of sulfur is -2 (since H is +1, $2(+1) + S = 0 \Rightarrow S = -2$).
In elemental sulfur (S), the oxidation state is 0.
The oxidation state of sulfur changes from -2 to 0. This is an increase in oxidation state, meaning sulfur has lost electrons. This is oxidation.

4. $Cu^{2+} \rightarrow Cu$
The oxidation state of copper changes from +2 to 0. This is a decrease in oxidation state, meaning copper has gained electrons. This is reduction.

The reactions involving oxidation are $Fe^{2+} \rightarrow Fe^{3+}$ and $H_2S \rightarrow S$.

Final Answer: $\boxed{Fe^{2+} \rightarrow Fe^{3+}, H_2S \rightarrow S}$

Answer: (A, C)

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Q38.

Solution

Concept: Geometrical isomerism (cis-trans isomerism) arises when there is restricted rotation around a bond (like a double bond or in a ring) and different groups are attached to the atoms involved. In coordination complexes, it occurs when ligands can be arranged in different spatial positions (cis or trans) around the central metal ion.

Solution: Geometrical isomerism is shown by compounds having restricted rotation and different groups attached to the bonded atoms.

1. But-2-ene ($CH_3 - CH = CH - CH_3$):
Each carbon of the double bond is attached to a hydrogen atom and a methyl group. Therefore, cis and trans forms are possible. Hence, but-2-ene exhibits geometrical isomerism.

2. $[Pt(NH_3)_2Cl_2]$:
This coordination compound has square planar geometry. The two NH_3 groups and two Cl^- groups can be arranged either adjacent to each other (cis form) or opposite to each other (trans form). Hence, geometrical isomerism is possible.

3. 1,1-dichloroethene ($Cl_2C = CH_2$):
One carbon atom of the double bond is attached to two identical chlorine atoms. Since geometrical isomerism requires different groups on each double bonded carbon, it is not possible here.

4. Hex-3-ene ($CH_3CH_2 - CH = CH - CH_2CH_3$):
Each carbon of the double bond is attached to a hydrogen atom and an ethyl group. Therefore, cis and trans forms are possible. Hence, hex-3-ene exhibits geometrical isomerism.

Thus, But-2-ene, $[Pt(NH_3)_2Cl_2]$, and Hex-3-ene exhibit geometrical isomerism.

Final Answer: $\boxed{But - 2 - ene, [Pt(NH_3)_2Cl_2], Hex - 3 - ene}$

Answer: (A, B, D)

Go Back to Question 38

Q39.

Solution

Concept: Allotropes are different structural modifications of an element, existing in the same physical state. Diamond and graphite are the most common allotropes of carbon. Their structures differ significantly, leading to contrasting physical properties like hardness, electrical conductivity, and bonding.

Solution: Let's evaluate each statement about the allotropes of carbon:

A. Graphite conducts electricity.
This statement is correct. Graphite has a layered structure where carbon atoms within each layer are bonded by covalent bonds and are arranged in hexagonal rings. Each carbon atom is sp^2 hybridized and forms sigma bonds with three other carbon atoms. The remaining valence electron is delocalized in a pi system above and below the plane of the layers. These delocalized electrons are mobile and allow graphite to conduct electricity.

B. Diamond is harder than graphite.
This statement is correct. Diamond has a three-dimensional tetrahedral structure where each carbon atom is covalently bonded to four other carbon atoms. This rigid, highly cross-linked structure makes diamond extremely hard. Graphite, with its layered structure and weaker inter-layer forces, is soft and can be easily cleaved.

C. Graphite has tetrahedral structure.
This statement is incorrect. Graphite has a layered structure. Within each layer, carbon atoms are arranged in hexagonal rings, and each carbon atom is sp^2 hybridized. Tetrahedral structure is characteristic of diamond, where each carbon atom is sp^3 hybridized and bonded to four other carbon atoms.

D. Diamond is a good conductor of electricity.
This statement is incorrect. In diamond, all valence electrons of carbon atoms are localized in strong covalent sigma bonds. There are no delocalized electrons, and the structure is a rigid network. Therefore, diamond is an electrical insulator, not a conductor.

The correct statements are A and B.

Final Answer: $\boxed{Graphiteconductselectricity, Diamondisharderthangraphite}$

Answer: (A, B)

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Q40.

Solution

Concept: Tollen's reagent is used to detect aldehydes. Aldehydes reduce Ag^+ to metallic silver, forming a silver mirror, while being oxidized to carboxylic acids. Ketones generally do not react, except α-hydroxy ketones. Formic acid is an exception among carboxylic acids.

Solution: We need to identify which of the given compounds give a positive Tollen's test. A positive test is indicated by the formation of a silver mirror.

1. Formaldehyde ($HCHO$):
Formaldehyde is the simplest aldehyde. It has the structure $H-CHO$. The carbonyl carbon is bonded to two hydrogen atoms. It readily undergoes oxidation by Tollen's reagent to form formic acid, which is then further oxidized by Tollen's reagent to carbon dioxide and water, producing a silver mirror.
$HCHO \xrightarrow{Tollen's} HCOOH \xrightarrow{Tollen's} CO_2 + H_2O + Ag$
So, formaldehyde gives a positive Tollen's test.

2. Benzaldehyde (C_6H_5-CHO):
Benzaldehyde is an aromatic aldehyde. The carbonyl carbon is bonded to a phenyl group and a hydrogen atom. It is readily oxidized by Tollen's reagent to benzoate salt, producing a silver mirror.
$C_6H_5-CHO \xrightarrow{Tollen's} C_6H_5-COO^- + Ag$
So, benzaldehyde gives a positive Tollen's test.

3. Acetone ($CH_3-CO-CH_3$):
Acetone is a ketone. Ketones do not generally react with Tollen's reagent because they do not have a hydrogen atom directly attached to the carbonyl carbon that can be oxidized. Thus, acetone does not give a positive Tollen's test.

4. Formic acid ($HCOOH$):
Formic acid is a carboxylic acid. However, it is unique among carboxylic acids because it has a hydrogen atom directly attached to the carboxyl group ($H-COOH$). This structure resembles an aldehyde ($H-CHO$ moiety). Therefore, formic acid can be oxidized by Tollen's reagent to carbon dioxide and water, forming a silver mirror.
$HCOOH \xrightarrow{Tollen's} CO_2 + H_2O + Ag$
So, formic acid gives a positive Tollen's test.

The compounds that give a positive Tollen's test are Formaldehyde, Benzaldehyde, and Formic acid.

Final Answer: $\boxed{Formaldehyde, Benzaldehyde, Formicacid}$

$\boxed{\textbf{Answer: (A, B, D)}}$

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Answer Key

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