JEE Main 2024 Chemistry Question Paper April 5 Shift 1 with Solutions

Time Allowed :3 Hours	Maximum Marks :300	Total Questions :90

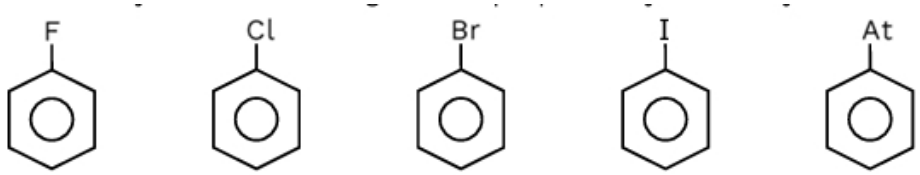
General Instructions

Read the following instructions very carefully and strictly follow them:

1. The test is of 3 hours duration.
2. The question paper consists of 90 questions, out of which 75 are to attempted. The maximum marks are 300.
3. There are three parts in the question paper consisting of Physics, Chemistry and Mathematics having 30 questions in each part of equal weightage.
4. Each part (subject) has two sections.
   (i) Section-A: This section contains 20 multiple choice questions which have only one correct answer. Each question carries 4 marks for correct answer and –1 mark for wrong answer.
   (ii) Section-B: This section contains 10 questions. In Section-B, attempt any five questions out of 10. The answer to each of the questions is a numerical value. Each question carries 4 marks for correct answer and –1 mark for wrong answer. For Section-B, the answer should be rounded off to the nearest integer

Chemistry

1. How many of the following can be prepared by Sandmeyer reaction:



Correct Answer: (B) Cl

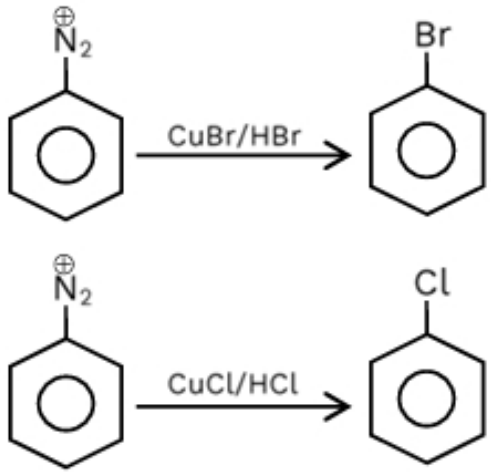
Solution:

Step 1: Understanding Sandmeyer reaction.
The Sandmeyer reaction is used for the preparation of aryl halides from aryl diazonium salts, where a halide ion (Cl^-, Br^-, or I^-) replaces the diazonium group. It is applicable to fluorine, chlorine, bromine, and iodine but not astatine.

Step 2: Analysis of options.
(A) F: Fluorine is not typically used in the Sandmeyer reaction due to the instability of the

reaction intermediates with fluoride ions.
(B) Cl: Chlorine can be introduced into the aryl ring using copper chloride (CuCl) in the Sandmeyer reaction.
(C) Br: Bromine can also be introduced using CuBr.
(D) I: Iodine can be introduced using CuI.
(E) At: Astatine is highly radioactive and not commonly involved in Sandmeyer reactions.

Step 3: Conclusion.
The correct answer is **(B) Cl**, as chlorine can be introduced by the Sandmeyer reaction using copper chloride.

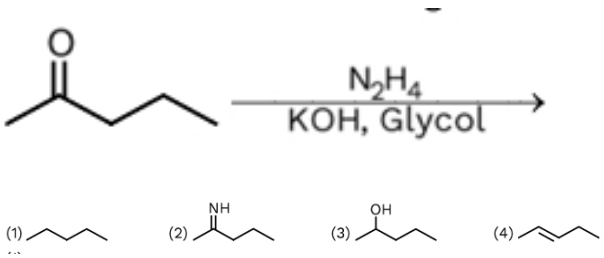


Quick Tip

In the Sandmeyer reaction, halides such as Cl, Br, and I can replace the diazonium group in aromatic compounds. Fluorine and astatine are typically not used due to instability and scarcity.

---

2. Which of the following is the correct product for the given reaction?



Correct Answer: (1) Product 1

Solution:

Step 1: Understanding Wolff-Kishner reduction.
Wolff-Kishner reduction is a reaction that reduces aldehydes and ketones to the corresponding alkanes by using hydrazine (N_2H_4) and a base such as KOH in glycol.

Step 2: Analysis of options.
(1) Product 1: This is the correct product as it corresponds to the reduction of a carbonyl group to a methylene group.
(2) Product 2: This is incorrect because it suggests a different type of product, possibly a hydroxylated product.
(3) Product 3: This is incorrect as it suggests an alcohol, which is not the expected outcome of a Wolff-Kishner reduction.
(4) Product 4: This is incorrect because it does not correspond to the reduction of the carbonyl group.

Step 3: Conclusion.
The correct answer is **(1) Product 1**, as it correctly shows the reduction of a carbonyl group to an alkane.

Quick Tip

The Wolff-Kishner reduction is a strong reduction method for converting carbonyl compounds (like aldehydes and ketones) into alkanes, using hydrazine and a base.

---

3. Which of the following elements shows maximum oxidation state?

(1) Mn
(2) Ti
(3) Co
(4) Na

Correct Answer: (1) Mn

Solution:

Step 1: Understanding maximum oxidation states.
The maximum oxidation state of an element corresponds to the highest number of electrons it can lose in a compound.

Step 2: Analysis of options.
(1) Mn: Manganese has a maximum oxidation state of +7, as seen in compounds like $KMnO_4$ (potassium permanganate).

(2) Ti: Titanium can have a maximum oxidation state of +4, as seen in TiO_2.
(3) Co: Cobalt typically has a maximum oxidation state of +3 in most of its compounds.
(4) Na: Sodium has a maximum oxidation state of +1, as it typically loses one electron to form Na^+.

Step 3: Conclusion.
The correct answer is **(1) Mn**, as manganese can show a maximum oxidation state of +7.

Quick Tip

In transition metals, the maximum oxidation state is often observed in the highest oxidation state compound, which can vary depending on the element's electron configuration.

---

4. Which of the following has lowest paramagnetic character in +2 oxidation state with water?

(1) Fe
(2) Co
(3) Ni
(4) Mn

Correct Answer: (3) Ni

Solution:

Step 1: Understanding paramagnetic character.
Paramagnetism is caused by the presence of unpaired electrons in an atom or ion. The more unpaired electrons, the higher the paramagnetic character.

Step 2: Electron configurations in the +2 oxidation state.
Fe^{2+}: The electron configuration for Fe^{2+} is d^6, with 4 unpaired electrons.
Co^{2+}: The electron configuration for Co^{2+} is d^7, with 3 unpaired electrons.
Ni^{2+}: The electron configuration for Ni^{2+} is d^8, with 2 unpaired electrons.
Mn^{2+}: The electron configuration for Mn^{2+} is d^5, with 5 unpaired electrons.

Step 3: Conclusion.
The ion with the least number of unpaired electrons is Ni^{2+}, which has the lowest paramagnetic character. Hence, the correct answer is **(3) Ni**.

Quick Tip

In paramagnetism, the number of unpaired electrons determines the strength of the magnetic character. The fewer unpaired electrons, the weaker the paramagnetic character.

---

5. In the Lewis dot structure for NO_2^-, total numbers of valence electrons around nitrogen is:

Correct Answer: (3) 8

Solution:

Step 1: Understanding Lewis dot structure.
The Lewis dot structure is a representation of atoms and their valence electrons. The total number of valence electrons is crucial for constructing the correct structure.

Step 2: Count the valence electrons.
For NO_2^-, nitrogen has 5 valence electrons, and each oxygen has 6 valence electrons. The negative charge adds 1 electron. Thus, the total number of valence electrons is:

$$5\,(\text{from N}) + 2 \times 6\,(\text{from O}) + 1\,(\text{from the charge}) = 18.$$

When drawing the Lewis structure, the electrons are distributed to ensure the most stable configuration.

Step 3: Conclusion.
In the structure of NO_2^-, nitrogen will be surrounded by 8 valence electrons in total. Hence, the correct answer is **(3) 8**.

Quick Tip

When counting valence electrons for the Lewis structure, always account for the atoms' valence electrons and the charge on the molecule or ion.

---

6. Find the total numbers of σ and π bonds in ethylene, respectively.

(1) 4,1
(2) 5,1
(3) 4,0

(4) 5,0

Correct Answer: (2) 5,1

Solution:

Step 1: Understanding the bonding in ethylene.
Ethylene (C_2H_4) consists of a double bond between two carbon atoms. A double bond consists of one σ bond and one π bond. Each carbon-hydrogen single bond is a σ bond.

Step 2: Counting the bonds.
- The σ bonds: There are 5 σ bonds — 4 between carbon and hydrogen, and 1 between the two carbon atoms.
- The π bond: There is 1 π bond between the two carbon atoms.

Step 3: Conclusion.
The total number of σ bonds is 5, and the total number of π bonds is 1. Hence, the correct answer is **(2) 5,1**.

Quick Tip

In a double bond, there is always one σ bond and one π bond. σ bonds are formed from head-on overlap, while π bonds arise from sideways overlap.

---

7. Which of the following are correct statement(s) for the given species:
O^{2-}, F^-, Na^+, Mg^{2+}
(a) O^{2-} is largest in size
(b) Mg^{2+} is smallest in size
(c) All have same effective nuclear charge
(d) All are isoelectronic

(1) a, b and c
(2) a, b and d
(3) b, c and d
(4) a, c and d

Correct Answer: (2) a, b and d

Solution:

Step 1: Analyzing the species.
The species provided are O^{2-}, F^{-}, Na^{+}, and Mg^{2+}. These species all have the same number of electrons (10 electrons) and are isoelectronic. Isoelectronic species have the same number of electrons, but their sizes vary due to differing nuclear charges.

Step 2: Evaluating the statements.
- (a) O^{2-} is the largest in size because it has the fewest protons (8 protons) compared to the others, leading to the least effective nuclear charge.
- (b) Mg^{2+} is the smallest in size because it has the highest effective nuclear charge (12 protons), pulling its electrons closer.
- (c) All have the same effective nuclear charge: This is incorrect, as the effective nuclear charge varies with the number of protons in each species.
- (d) All are isoelectronic: This is correct, as all species have 10 electrons.

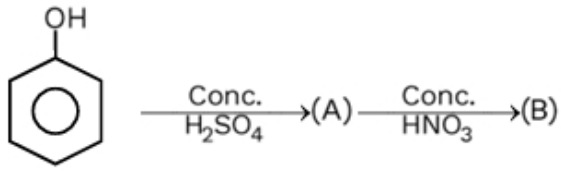
Step 3: Conclusion.
The correct statements are (a), (b), and (d). Hence, the correct answer is **(2) a, b and d**.

Quick Tip

Isoelectronic species have the same number of electrons but different sizes due to differences in nuclear charge. The higher the nuclear charge, the smaller the size.

---

8. Find the sum of total number of O atom(s) in A and B.



Correct Answer: 14

Solution:

Step 1: Understanding the reaction.
The given reaction involves the transformation of a phenol (C_6H_5OH) with concentrated sulfuric acid (H_2SO_4) followed by treatment with concentrated nitric acid (HNO_3). This forms two compounds, A and B.

Step 2: Identifying compound A.
When phenol is treated with concentrated sulfuric acid (H_2SO_4), it undergoes sulfonation to form compound A, which is 2-hydroxybenzenesulfonic acid ($C_6H_4(OH)SO_3H$). In this compound, there are 7 oxygen atoms in total: 2 from the hydroxyl group (OH), 1 from the sulfonic

acid group (SO_3H), and 4 from the sulfonate group.

Step 3: Identifying compound B.
When compound A is treated with concentrated nitric acid (HNO_3), it undergoes nitration to form compound B, which is 2-hydroxy-5,6-dinitrobenzenesulfonic acid ($C_6H_3(OH)(NO_2)_2SO_3H$). In this compound, there are also 7 oxygen atoms: 1 from the hydroxyl group (OH), 2 from the nitro groups (NO_2), 1 from the sulfonic acid group (SO_3H), and 3 from the nitro groups attached to the benzene ring.

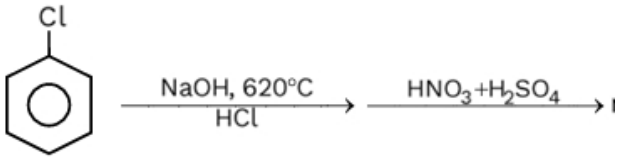
Step 4: Conclusion.
The total number of oxygen atoms in both compounds A and B is 7 in A and 7 in B, adding up to a total of 14 oxygen atoms. Therefore, the correct answer is **(3) 14**.

Quick Tip

In reactions involving aromatic compounds, common reactions like sulfonation and nitration involve adding functional groups that contain oxygen. Always count the oxygen atoms from each functional group.

---

9. Find the major product in the following reaction:



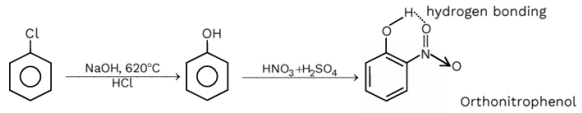
(1) Orthonitrophenol
(2) Paranitrophenol
(3) Picric acid
(4) Metanitrophenol

Correct Answer: (1) Orthonitrophenol

Solution:

Step 1: Understanding the reaction.
The reaction involves chlorobenzene, which undergoes a nucleophilic substitution with NaOH at high temperature (620°C), followed by nitration using a mixture of HNO_3 and H_2SO_4. This forms a nitro group at the ortho position with respect to the hydroxyl group, resulting in orthonitrophenol.

Step 2: Conclusion.
The major product formed is ortho-nitrophenol due to the strong activating effect of the hydroxyl group at the ortho position. Hence, the correct answer is **(1) Orthonitrophenol**.



Quick Tip

In aromatic substitution reactions, electron-donating groups like OH activate the ring, making the ortho and para positions more reactive toward electrophilic substitution.

---

10. Which of the following will give a positive Ninhydrin test?

(1) Cellulose
(2) Starch
(3) Polyvinyl chloride
(4) Egg albumin

Correct Answer: (4) Egg albumin

Solution:

Step 1: Understanding the Ninhydrin test.
The Ninhydrin test is used to detect amino acids and proteins. The test forms a colored complex when amino acids or proteins are present, as they contain free amine groups.

Step 2: Evaluating the options.
(1) Cellulose: This is a carbohydrate and does not contain amine groups, so it will not give a positive Ninhydrin test.
(2) Starch: This is also a carbohydrate and does not contain amine groups, so it will not give a positive Ninhydrin test.
(3) Polyvinyl chloride: This is a polymer and does not contain amine groups, so it will not give a positive Ninhydrin test.
(4) Egg albumin: This is a protein and contains amine groups, so it will give a positive Ninhydrin test.

Step 3: Conclusion.
The correct answer is **(4) Egg albumin**, as it is a protein and will give a positive Ninhydrin test due to the presence of amine groups.

Quick Tip

Ninhydrin is a chemical reagent used primarily to detect amino acids and proteins by reacting with the free amine groups.

---

11. Correct order of boiling point for
(P) Diethyl ether
(Q) n-butanol
(R) n-butane
(S) Ethylmethyl ketone

(1) P ¿ Q ¿ R ¿ S
(2) Q ¿ S ¿ P ¿ R
(3) S ¿ R ¿ Q ¿ P
(4) S ¿ Q ¿ P ¿ R

Correct Answer: (2) Q ¿ S ¿ P ¿ R

Solution:

Step 1: Understanding the boiling points.
The boiling point of a compound depends on its intermolecular forces. Compounds with stronger intermolecular forces will have higher boiling points.

Step 2: Intermolecular forces and their effects on boiling points.
- (P) Diethyl ether: Diethyl ether has a dipole moment but is not involved in hydrogen bonding. Its boiling point is relatively lower than compounds with hydrogen bonding.
- (Q) n-butanol: n-Butanol has hydrogen bonding, which significantly raises its boiling point.
- (R) n-butane: n-Butane has only London dispersion forces, which are weak, leading to the lowest boiling point.
- (S) Ethylmethyl ketone: Ethylmethyl ketone has dipole-dipole interactions, which are stronger than London dispersion forces but weaker than hydrogen bonding.

Step 3: Conclusion.
The correct order of boiling points is **(Q ¿ S ¿ P ¿ R)**. Hence, the correct answer is **(2) Q ¿ S ¿ P ¿ R**.

Quick Tip

When comparing boiling points, remember that hydrogen bonding increases boiling points, followed by dipole-dipole interactions and London dispersion forces.

12. Assertion: Cis-but-2-ene is polar while trans-but-2-ene is non-polar.
Reason: Dipole moment of trans but-2-ene is zero.

(1) Both A and R are correct and R is the correct explanation of A.
(2) Both A and R are correct, but R is not the correct explanation of A.
(3) A is correct but, R is incorrect.
(4) R is correct but, A is incorrect.

Correct Answer: (1) Both A and R are correct and R is the correct explanation of A.

Solution:

Step 1: Understanding the polarity of cis and trans isomers.
Cis-but-2-ene has polar bonds due to the difference in electronegativity between the carbon and hydrogen atoms, and its molecular geometry causes an overall dipole moment.
Trans-but-2-ene, however, has a symmetrical arrangement of substituents, resulting in no net dipole moment and making it non-polar.

Step 2: Evaluating the reason.
The dipole moment of trans-but-2-ene is indeed zero due to its symmetrical structure, which results in the cancellation of individual bond dipoles. This justifies the assertion that cis-but-2-ene is polar and trans-but-2-ene is non-polar.

Step 3: Conclusion.
Both the assertion and reason are correct, and the reason correctly explains the assertion. Hence, the correct answer is **(1) Both A and R are correct and R is the correct explanation of A.**

Quick Tip

In cis-trans isomerism, cis isomers usually have a net dipole moment due to the unsymmetrical distribution of substituents, while trans isomers often do not.

13. Assertion: For group 13 element stability of +1 oxidation state increases down the group.
Reason: Atomic size of Ga is greater than Al.

(1) Both A and R are true and R is the correct explanation of A
(2) Both A and R are true but R is not the correct explanation of A

(3) If A is true but R is false
(4) If A is false but R is true

Correct Answer: (3) If A is true but R is false

Solution:

Step 1: Understanding the assertion.
The assertion states that for group 13 elements, the stability of the +1 oxidation state increases as we move down the group. This is due to the inert pair effect, where the s-electrons become less available for bonding as we move down the group.

Step 2: Evaluating the reason.
The reason states that the atomic size of Ga is greater than that of Al. While it is true that Ga is larger than Al, this does not directly explain the increase in stability of the +1 oxidation state. The actual reason lies in the inert pair effect, which is more pronounced for heavier elements in the group.

Step 3: Conclusion.
The assertion is correct, but the reason is false as it does not correctly explain the phenomenon. Hence, the correct answer is **(3) If A is true but R is false**.

Quick Tip

In group 13 elements, the stability of the +1 oxidation state increases down the group due to the inert pair effect, not just atomic size.

---

14. $\mathbf{Fe_2O_3(s) + 3CO(g) \rightarrow 2Fe(s) + 3CO_2(g)}$
Equilibrium does not shift according to Le Chatelier's principle.
Which of the following is correct?

(1) Removal of CO_2
(2) Addition of CO_2
(3) Removal of CO
(4) Addition of Fe_2O_3

Correct Answer: (4) Addition of Fe_2O_3

Solution:

Step 1: Understanding Le Chatelier's principle.
Le Chatelier's principle states that if a system at equilibrium is subjected to a change in conditions (concentration, pressure, or temperature), the system will shift in a direction that opposes the change.

Step 2: Evaluating the options.
- (1) Removal of CO_2: This would shift the equilibrium to the right to replace the removed CO_2.
- (2) Addition of CO_2: This would shift the equilibrium to the left to counteract the increase in CO_2.
- (3) Removal of CO: This would shift the equilibrium to the left to replace the removed CO.
- (4) Addition of Fe_2O_3: This would shift the equilibrium to the right, as it provides more reactant for the reaction to proceed. This is consistent with Le Chatelier's principle.

Step 3: Conclusion.
The correct answer is **(4) Addition of Fe_2O_3**, as it will shift the equilibrium to the right according to Le Chatelier's principle.

Quick Tip

When a system at equilibrium is disturbed, the equilibrium will shift to counteract the change. Adding more reactant shifts the equilibrium to the right.

---

15. Predict the correct order of strength of ligands: Br^-, H_2O, NH_3

(1) Br^- ¡ H_2O ¡ F^- ¡ NH_3
(2) H_2O ¡ Br^- ¡ F^- ¡ NH_3
(3) Br^- ¡ F^- ¡ H_2O ¡ NH_3
(4) Br^- ¡ H_2O ¡ NH_3 ¡ F^-

Correct Answer: (3) Br^- ¡ F^- ¡ H_2O ¡ NH_3

Solution:

Step 1: Understanding ligand strength.
Ligand strength is determined by the ability of the ligand to donate electron pairs to the metal center. The order of strength is influenced by factors such as the charge and size of the ligand.

Step 2: Evaluating the ligands.
- Br^- is a weak ligand due to its larger size and lower charge density.
- F^- is stronger than Br^- due to its smaller size and higher charge density.

- H_2O is a neutral molecule and is a stronger ligand than halides due to its ability to form hydrogen bonds and donate electron pairs.
- NH_3 is a strong ligand due to its lone pair of electrons and small size.

Step 3: Conclusion.
The correct order of strength is $\mathbf{Br^-}$ ¡ $\mathbf{F^-}$ ¡ $\mathbf{H_2O}$ ¡ $\mathbf{NH_3}$. Hence, the correct answer is **(3)**.

Quick Tip

In general, smaller and highly charged ligands (like NH_3) are stronger than larger, less charged ones (like halides).

---

16. Molar conductivity of divalent cation and anion are 57 and 73 S cm^{-1} mol^{-1}. The molar conductivity of solution is .....

Correct Answer: (1) 130

Solution:

Step 1: Understanding molar conductivity.
Molar conductivity (λ_m) is the sum of the conductivity of the cation and anion. The total molar conductivity is given by:

$$\lambda_m = \lambda_{\text{cation}} + \lambda_{\text{anion}}$$

Step 2: Substituting the given values.
We are given:

$$\lambda_{\text{cation}} = 57\,\text{S cm}^{-1}\text{mol}^{-1}, \quad \lambda_{\text{anion}} = 73\,\text{S cm}^{-1}\text{mol}^{-1}$$

So,

$$\lambda_m = 57 + 73 = 130\,\text{S cm}^{-1}\text{mol}^{-1}$$

Step 3: Conclusion.
The molar conductivity of the solution is **130 S cm^{-1} mol^{-1}**. Hence, the correct answer is **(1) 130**.

Quick Tip

Molar conductivity is the sum of the conductivities of the individual ions in the solution. For divalent ions, the total conductivity is the sum of the cation and anion conductivities.

---

17. For the reaction 2A + B → C, the following data is given:

[A] (mol/L)	0.1	0.4	0.4
[B] (mol/L)	0.1	0.1	0.2
Rate (mol/L/s)	6×10^{-3}	12×10^{-3}	48×10^{-3}

Find the order of reaction.

Correct Answer: (2.5)

Solution:

Step 1: Rate law.
The rate law is given by:

$$\text{Rate} = k[A]^x[B]^y$$

Where x and y are the orders of reaction with respect to A and B, respectively.
Step 2: Using the given data to find x (order with respect to A).
Using the first two trials, we compare the rates with respect to the concentration of A, keeping B constant:

$$\frac{6 \times 10^{-3}}{12 \times 10^{-3}} = \frac{[0.1]^x}{[0.4]^x}$$

Simplifying the equation:

$$\frac{1}{2} = \left(\frac{0.1}{0.4}\right)^x = \left(\frac{1}{4}\right)^x$$

Taking the logarithm:

$$\frac{1}{2} = \left(\frac{1}{4}\right)^x \quad \Rightarrow \quad x = 1/2$$

Step 3: Using the given data to find y (order with respect to B).
Using the first and third trials, we compare the rates with respect to the concentration of B, keeping A constant:

$$\frac{12 \times 10^{-3}}{48 \times 10^{-3}} = \frac{[0.4]^x[0.1]^y}{[0.4]^x[0.2]^y}$$

Simplifying the equation:

$$\frac{1}{4} = \left(\frac{0.1}{0.2}\right)^y \quad \Rightarrow \quad y = 2$$

Step 4: Conclusion.
Thus, the order with respect to A is 0.5 and the order with respect to B is 2. Hence, the overall order of reaction is $0.5 + 2 = 2.5$. Therefore, the correct answer is **(2.5)**.

Quick Tip

When determining the overall order of reaction, combine the individual orders with respect to each reactant. The order can be fractional if it doesn't follow simple integer values.

18. Most abundant isotopes of boron has X number of neutrons.
B + O_2 → Oxidation number of boron (Y)
Find X + Y?

Correct Answer: (9)

Solution:

Step 1: Understanding the isotope of boron.
The most abundant isotope of boron is ^{11}B, which has 5 protons and 6 neutrons (X = 6).

Step 2: Oxidation state of boron.
In the reaction, boron (B) reacts with oxygen (O_2), and the oxidation number of boron is +3 (Y = 3).

Step 3: Finding the sum of X and Y.
Since X = 6 (number of neutrons) and Y = 3 (oxidation state), the sum is:

$$X + Y = 6 + 3 = 9$$

Step 4: Conclusion.
Hence, the correct answer is **(9)**.

Quick Tip

To determine the number of neutrons, subtract the number of protons from the atomic mass number. The sum of neutrons and the oxidation state can help in finding the correct answer.

---

19. Find the spin-only magnetic moment of the strongest oxidizing agent?

(1) Ti^{2+}
(2) V^{2+}
(3) Mn^{2+}
(4) Co^{3+}

Correct Answer: (4) Co^{3+}

Solution:

Step 1: Understanding the spin-only magnetic moment formula.
The spin-only magnetic moment (μ) is given by the formula:

$$\mu = \sqrt{n(n+2)}$$

Where n is the number of unpaired electrons. The strongest oxidizing agent will be the one with the highest number of unpaired electrons, as it will have the highest magnetic moment.
Step 2: Evaluating each species.
- Ti^{2+}: Ti^{2+} has 1 unpaired electron. Thus,

$$\mu = \sqrt{1(1+2)} = \sqrt{3} \approx 1.73\,\mu_B$$

- V^{2+}: V^{2+} has 3 unpaired electrons. Thus,

$$\mu = \sqrt{3(3+2)} = \sqrt{15} \approx 3.87\,\mu_B$$

- Mn^{2+}: Mn^{2+} has 5 unpaired electrons. Thus,

$$\mu = \sqrt{5(5+2)} = \sqrt{35} \approx 5.92\,\mu_B$$

- Co^{3+}: Co^{3+} has 6 unpaired electrons. Thus,

$$\mu = \sqrt{6(6+2)} = \sqrt{48} \approx 6.93\,\mu_B$$

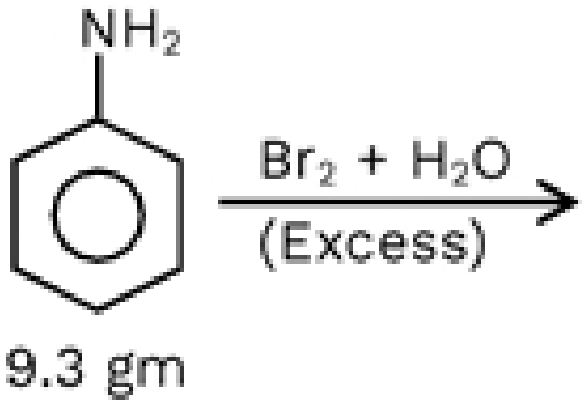
Step 3: Conclusion.
Co^{3+} has the highest magnetic moment, making it the strongest oxidizing agent. Hence, the correct answer is **(4) Co^{3+}**.

Quick Tip

The higher the number of unpaired electrons, the stronger the magnetic moment, and typically, the stronger the oxidizing agent.

---

20. 9.3 gm of NH_2 reacts with excess Br_2 and H_2O to form white ppt. 24.6 gm of white ppt is obtained.
Find the % yield of the white ppt product.



Correct Answer: (2) 70%

Solution:

Step 1: Understanding the stoichiometry of the reaction.
The reaction is between NH_2 and Br_2 in the presence of H_2O to form a white ppt. The molar masses of the compounds involved are used to determine the number of moles.

Step 2: Calculating moles.
- Moles of $NH_2 = \frac{9.3}{93} = 0.1$ mol (Molar mass of $NH_2 = 93$ g/mol)
- Moles of white ppt $= \frac{24.6}{348} = 0.07$ mol (Molar mass of white ppt $= 348$ g/mol)

Step 3: Calculating the percentage yield.
The theoretical yield would be 0.1 mol of white ppt, and the actual yield is 0.07 mol. Thus, the percentage yield is:

$$\text{Percentage yield} = \frac{0.07}{0.1} \times 100 = 70\%$$

Step 4: Conclusion.
The percentage yield of the white ppt product is **70%**. Hence, the correct answer is **(2) 70%**.

Quick Tip

To calculate percentage yield, divide the actual yield by the theoretical yield and multiply by 100.

---

21. Which of the following cations will give a green color in reducing flame in borax bead test?

(1) Iron
(2) Cobalt
(3) Manganese
(4) Nickel

Correct Answer: (1) Iron

Solution:

Step 1: Understanding the borax bead test.
In the borax bead test, certain metal cations produce characteristic colors when heated in a reducing flame. The colors depend on the metal ion and its oxidation state.

Step 2: Analyzing the options.
- (1) Iron: Iron ions produce a green color in the flame due to the formation of iron borate in the borax bead test.
- (2) Cobalt: Cobalt typically gives a blue color in the borax bead test.
- (3) Manganese: Manganese gives a pale brown or pink color.
- (4) Nickel: Nickel produces a green color, but it is not typically the same shade as that produced by iron.

Step 3: Conclusion.
The correct answer is **(1) Iron**, as iron gives a green color in the reducing flame in the borax bead test.

Quick Tip

In the borax bead test, metal ions like iron (Fe^2+) give a characteristic green color in a reducing flame.

---

22. Which postulate of Dalton's theory is wrong?

(1) Matter consists of indivisible atoms.
(2) All atoms of a given element have identical properties but different masses.
(3) Compounds are formed when atoms of different elements combine in a fixed ratio.
(4) Chemical reaction involves rearrangement of atoms.

Correct Answer: (2) All atoms of a given element have identical properties but different masses.

Solution:

Step 1: Dalton's Atomic Theory.
Dalton's atomic theory was based on several postulates, the first of which stated that all matter is made up of indivisible atoms. Another postulate states that atoms of the same element are identical in mass and properties. However, we know today that this statement is incorrect, as atoms of the same element can have different masses (due to isotopes).

Step 2: Evaluating the postulates.
- (1) Matter consists of indivisible atoms: This is largely true, but later discoveries like subatomic particles (electrons, protons, neutrons) showed that atoms are divisible. However, this does not invalidate Dalton's basic theory.
- (2) All atoms of a given element have identical properties but different masses: This is false, as isotopes of the same element have different masses.

- (3) Compounds are formed when atoms of different elements combine in a fixed ratio: This is correct.
- (4) Chemical reactions involve the rearrangement of atoms: This is also correct.

Step 3: Conclusion.
The incorrect postulate is **(2)**, which states that all atoms of a given element have identical properties but different masses.

Quick Tip

Isotopes of the same element have identical chemical properties but different masses due to differing numbers of neutrons.

---

23. The heat of combustion of solid benzoic acid at constant volume is $-321.30\,\mathbf{K}$ at $27^\circ\mathbf{C}$.
The heat of combustion at constant pressure is $(-321.30-x)\,\mathbf{KJ}$. Find the value of x.

Correct Answer: (1) 1.25

Solution:

Step 1: Formula for heat of combustion at constant volume and pressure.
The relationship between the heat of combustion at constant volume (ΔU) and constant pressure (ΔH) is given by:

$$\Delta H = \Delta U + \Delta n_g RT$$

Where: - Δn_g is the change in the number of moles of gas, - R is the gas constant ($8.314\,\text{J/mol·K}$), - T is the temperature in Kelvin.
Step 2: Substituting the given values.
We know that $\Delta U = -321.30\,\text{KJ/mol}$, and the temperature is $T = 27^\circ C = 300\,\text{K}$. The change in the number of moles of gas, Δn_g, is $\frac{15}{2} - 7 = 1$.
Using the formula:

$$\Delta H = -321.30 + (1) \times \left(\frac{8.314}{1000} \times 300\right)$$

$$\Delta H = -321.30 + 1.25 = -322.55\,\text{KJ/mol}$$

Thus, $x = 1.25$.

Step 3: Conclusion.
The value of x is **1.25**. Hence, the correct answer is **(1) 1.25**.

Quick Tip

The heat of combustion at constant pressure can be calculated using the formula: $\Delta H = \Delta U + \Delta n_g RT$, where Δn_g is the change in the number of moles of gas.
