

JEE Main 2023 1 Feb Shift 1 Chemistry Question Paper with Solutions

Time Allowed :3 Hours

Maximum Marks :300

Total Questions :90

General Instructions

Read the following instructions very carefully and strictly follow them:

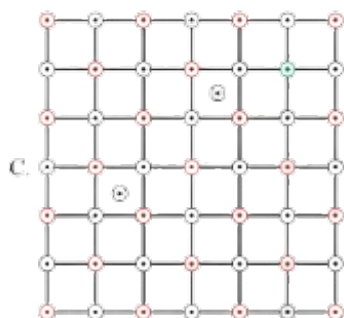
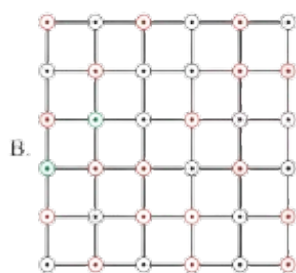
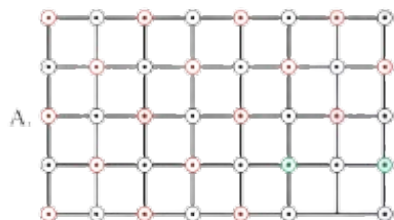
1. The test is of 3 hours duration.
2. The question paper consists of 90 questions, out of which 75 are to attempted.
The maximum marks are 300.
3. There are three parts in the question paper consisting of Physics, Chemistry and Mathematics having 30 questions in each part of equal weightage.
4. Each 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

Section-A

1. Which of the following represents the lattice structure of $A_{0.95}O$ containing A^{2+} , A^{3+} and O^{2-} ions?

$\odot A^{3+}$ $\odot A^{2+}$ $\odot O^{2-}$



- (1) B and C only
- (2) B only
- (3) A and B only
- (4) A only

Correct Answer: (4) A only

Solution:

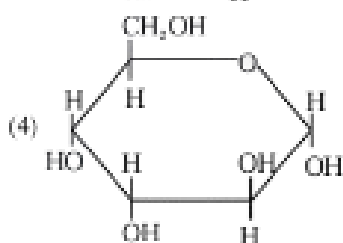
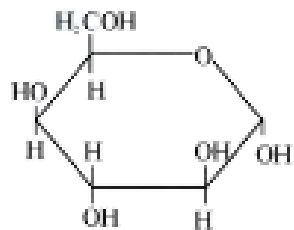
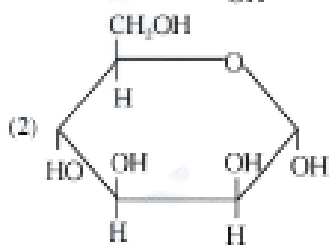
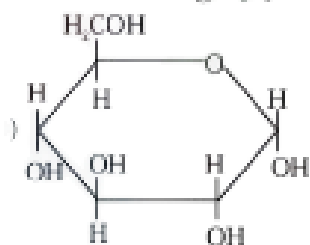
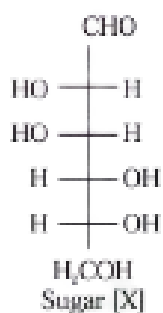
The correct representation of the lattice structure of $A_{0.95}O$ containing A^{2+} , A^{3+} , and O^{2-} ions is shown in option A. Thus, the correct answer is option (4).

Quick Tip

When identifying lattice structures, ensure that the correct stoichiometry of ions and their respective charges are accurately represented.

2. The correct representation in six-membered pyranose form for the following sugar

[X] is:



Correct Answer: (2).

Solution:

The correct representation of the six-membered pyranose form for the given sugar is option (2).

Quick Tip

In pyranose forms, the hydroxyl groups are typically positioned on either side of the ring, with the aldehyde or ketone group at the anomeric carbon.

3. Highest oxidation state of Mn is exhibited in Mn_2O_7 . The correct statements about Mn_2O_7 are:

- (A) Mn is tetrahedrally surrounded by oxygen atoms
- (B) Mn is octahedrally surrounded by oxygen atoms
- (C) Contains Mn-O-Mn bridge
- (D) Contains Mn-Mn bond

Choose the correct answer from the options given below:

- (1) A and C only
- (2) A and D only
- (3) B and D only
- (4) B and C only

Correct Answer: (1) A and C only.

Solution:

In Mn_2O_7 , Mn is in the highest oxidation state of +7. The two Mn atoms are surrounded by oxygen atoms in a way that forms a tetrahedral arrangement. The compound also features a Mn-O-Mn bridge, which is characteristic of Mn_2O_7 . Therefore, statement A and statement C are correct.

- Statement B is incorrect because Mn is tetrahedrally coordinated, not octahedrally. -

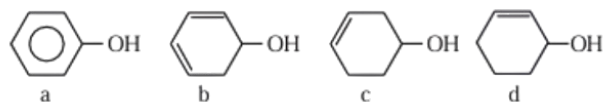
Statement D is incorrect because there is no direct Mn-Mn bond in Mn_2O_7 ; instead, the Mn atoms are linked by oxygen atoms.

Thus, the correct answer is (1) A and C only.

Quick Tip

Mn_2O_7 is a peroxide compound where the Mn atoms are in their highest oxidation state (+7), and the compound features a tetrahedral coordination around Mn.

4. Decreasing order of dehydration of the following alcohols is:



- (1) $a > d > b > c$
- (2) $b > d > c > a$
- (3) $b > a > d > c$
- (4) $d > b > c > a$

Correct Answer: (2).

Solution:

The correct decreasing order of dehydration of the alcohols is given by option (2), which corresponds to $b > d > c > a$.

Quick Tip

Dehydration reactions are influenced by the stability of the carbocation intermediates formed during the process. Tertiary alcohols are more easily dehydrated than secondary and primary alcohols.

5. Given below are two statements: One is labelled as Assertion A and the other is labelled as Reason R.

Assertion A: Amongst He, Ne, Ar, and Kr; 1 g of activated charcoal adsorbs more of Kr.

Reason R: The critical volume V_c ($\text{cm}^3 \text{mol}^{-1}$) and critical pressure P_c (atm) is highest for Krypton but the compressibility factor at critical point Z_c is lowest for Krypton. In the light of the above statements, choose the correct answer from the options given below:

- (1) A is true but R is false

- (2) A is false but R is true
 (3) Both A and R are true but R is NOT the correct explanation of A
 (4) Both A and R are true and R is the correct explanation of A

Correct Answer: (1).

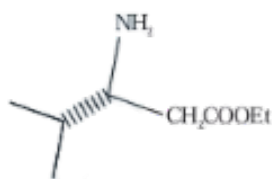
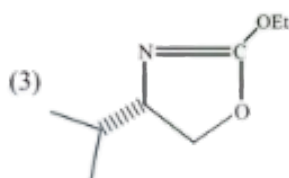
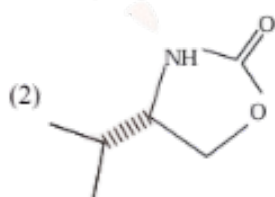
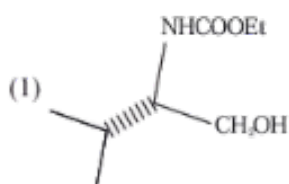
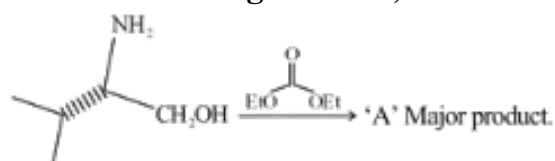
Solution:

Assertion A is true, as activated charcoal adsorbs more Krypton. Reason R is also true, but it does not explain Assertion A correctly. Thus, the correct answer is (1).

Quick Tip

When analyzing the adsorption properties of gases, the adsorbate size and intermolecular forces play a significant role in determining the amount adsorbed.

6. In the following reaction, 'A' is:



Correct Answer: (2).

Solution:

In the given reaction, the starting material is an amino alcohol, and the reaction involves the formation of an amide (NCOEt) as the major product. The reagents involved are likely to induce dehydration, leading to the formation of an amide group (NCOEt) through the reaction of the amino group with the ester group.

- The reaction typically undergoes dehydration, eliminating water, and forming a stable amide linkage. - Hence, the correct answer is NCOEt.

Quick Tip

When solving reaction mechanism questions, consider the stability of intermediates and possible side reactions that can lead to the major product.

7. Match List I with List II.

List-I	List-II
(A) Tranquilizers	(I) Anti blood clotting
(B) Aspirin	(II) Salvarsan
(C) Antibiotic	(III) Antidepressant drugs
(D) Antiseptic	(IV) Soframicine

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

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

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

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

Correct Answer: (3).

Solution:

The correct matching of List I with List II is option (3).

Quick Tip

To solve matching questions, match the functional groups with their corresponding activities or classes to ensure accurate pairings.

8. Given below are two statements:

Statement I: Chlorine can easily combine with oxygen to form oxides; and the product has a tendency to explode.

Statement II: Chemical reactivity of an element can be determined by its reaction with oxygen and halogens.

In the light of the above statements, choose the correct answer from the options given below:

- (1) Both the statements I and II are true
- (2) Statement I is true but Statement II is false
- (3) Statement I is false but Statement II is true
- (4) Both the Statements I and II are false

Correct Answer: (1) Both the statements I and II are true

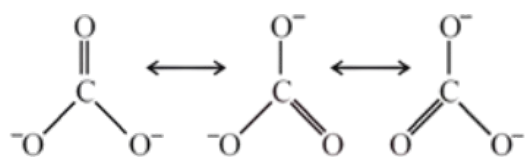
Solution:

Both statements are correct. Chlorine does react with oxygen to form oxides, which have explosive tendencies. Additionally, the reactivity of elements is often determined by their reactions with oxygen and halogens.

Quick Tip

Reactivity of halogens can be understood by their electronegativity and their tendency to form halides with metals and oxides with oxygen.

9. Resonance in carbonate ion (CO_3^{2-}) is:



Which of the following is true?

- (1) All these structures are in dynamic equilibrium with each other.
- (2) Each structure exists for equal amount of time.
- (3) CO_3^{2-} has a single structure i.e., resonance hybrid of the above three structures.
- (4) It is possible to identify each structure individually by some physical or chemical method.

Correct Answer: (4) All these structures are in dynamic equilibrium with each other.

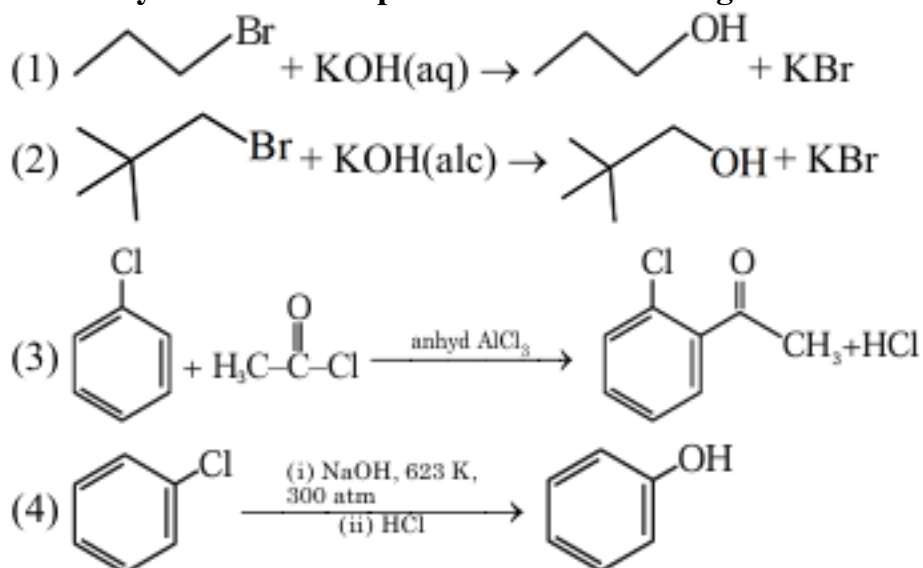
Solution:

The carbonate ion (CO_3^{2-}) exhibits resonance, where the three resonance structures are in dynamic equilibrium with each other. Each structure doesn't exist for a specific amount of time.

Quick Tip

Resonance structures are different Lewis structures of the same molecule that are in dynamic equilibrium and contribute equally to the actual structure.

10. Identify the incorrect option from the following:



Correct Answer: (2)

Solution:

Option (2) is incorrect because alcohols do not normally undergo such reactions to form KBr. Other options depict correct reactions.

Quick Tip

In reactions involving halogens and alcohols, conditions such as solvent and temperature must be carefully considered to determine the correct product.

11. A solution of $FeCl_3$, when treated with $K_4[Fe(CN)_6]$, gives a prussian blue precipitate due to the formation of:

- (1) $K_3[Fe(CN)_6]$
- (2) $Fe[Fe(CN)_6]$
- (3) $Fe_3[Fe(CN)_6]_2$
- (4) $Fe_4[Fe(CN)_6]_3$

Correct Answer: (4)

Solution:

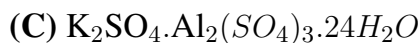
The reaction between $FeCl_3$ and $K_4[Fe(CN)_6]$ leads to the formation of $Fe_4[Fe(CN)_6]_3$, which precipitates as prussian blue.

Quick Tip

The formation of prussian blue involves a coordination reaction where Fe^{3+} reacts with $[Fe(CN)_6]^{4-}$ to form a complex salt.

12. Which of the following are examples of double salts?

- (A) $FeSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$
- (B) $CuSO_4 \cdot 4NH_3 \cdot H_2O$



Choose the correct answer:

- (1) A and C only
- (2) A and B only
- (3) A, B and D only
- (4) B and D only

Correct Answer: (1) A and C only.

Solution:

Double salts are crystalline salts that consist of two different salts crystallized together in a fixed stoichiometric ratio. - $FeSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$ (Option A) is a double salt consisting of $FeSO_4$ and $(NH_4)_2SO_4$. - $CuSO_4 \cdot 4NH_3 \cdot H_2O$ (Option B) is not a double salt; it is a complex compound. - $K_2SO_4 \cdot Al_2(SO_4)_3 \cdot 24H_2O$ (Option C) is a double salt. - $Fe(CN)_2 \cdot 4KCN$ (Option D) is not a double salt; it is a coordination complex. Thus, the correct answer is (1), which includes options A and C.

Quick Tip

Double salts are often formed when two salts crystallize together and retain their individual identities in the crystalline form. Ensure that both salts are of the same ionic nature for it to qualify as a double salt.

13. Which of the following complex will show largest splitting of d-orbitals?

- (1) $[Fe(C_2O_4)_3]^{3-}$
- (2) $[Fe_6(CN)_6]$
- (3) $[Fe(CN)_6]^{3-}$
- (4) $[Fe(NH_3)_6]^{3+}$

Correct Answer: (3).

Solution:

$[Fe(CN)_6]^{3-}$ will show the largest splitting of d-orbitals because cyanide (CN^-) is a strong field ligand, which leads to a large splitting of the d-orbitals.

Quick Tip

The splitting of d-orbitals in transition metal complexes depends on the ligand field strength, with strong field ligands like CN^- causing greater splitting.

14. How can photochemical smog be controlled?

- (1) By using tall chimneys
- (2) By complete combustion of fuel
- (3) By using catalytic converters in the automobiles/industry
- (4) By using catalyst

Correct Answer: (3) By using catalytic converters in the automobiles/industry

Solution:

Photochemical smog can be controlled by using catalytic converters in automobiles and industries. Catalytic converters help reduce emissions of nitrogen oxides and hydrocarbons, which are the primary contributors to photochemical smog.

Quick Tip

Catalytic converters are effective in reducing harmful vehicle emissions, thus reducing the formation of photochemical smog in urban areas.

15. Match List I with List II.

List I	List II
(A) Slaked lime	(I) NaOH
(B) Dead burnt plaster	(II) $Ca(OH)_2$
(C) Caustic soda	(III) $Na_2CO_3 \cdot 10H_2O$
(D) Washing soda	(IV) $CaSO_4$

Choose the correct answer from the options given below:

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

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

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

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

Correct Answer: (3) (A) - II, (B) - III, (C) - I, (D) - IV.

Solution:

Slaked lime is $Ca(OH)_2$ (Option II), Dead burnt plaster is $CaSO_4$ (Option IV), Caustic soda is $NaOH$ (Option I), and Washing soda is $Na_2CO_3 \cdot 10H_2O$ (Option III).

Quick Tip

To solve matching questions, first identify the chemical formulas and match them with the correct description of the compounds or elements.

16. Choose the correct statement(s): A. Beryllium oxide is purely acidic in nature.

B. Beryllium carbonate is kept in the atmosphere of CO_2 .

C. Beryllium sulphate is readily soluble in water.

D. Beryllium shows anomalous behavior.

Choose the correct answer from the options given below:

(1) A, B and C only

(2) B, C and D only

(3) A and B only

(4) A only

Correct Answer: (2) B, C and D only.

Solution:

Beryllium oxide is amphoteric, not purely acidic, so statement A is incorrect. Beryllium carbonate is unstable and decomposes in CO_2 atmosphere, so statement B is correct.

Beryllium sulphate is soluble in water, making statement C correct. Beryllium shows anomalous behavior because it differs from other alkaline earth metals in its properties, so statement D is also correct.

Quick Tip

When identifying the properties of elements and compounds, it's important to compare them with trends in the periodic table, such as the amphoteric nature of beryllium oxide.

17. Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R.

Assertion A: In an Ellingham diagram, the oxidation of carbon to carbon monoxide shows a negative slope with respect to temperature.

Reason R: CO tends to get decomposed at higher temperature.

In the light of the above statements, choose the correct answer from the options given below:

- (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 false but R is true
- (4) A is correct but R is incorrect

Correct Answer: (2) Both A and R are correct but R is NOT the correct explanation of A.

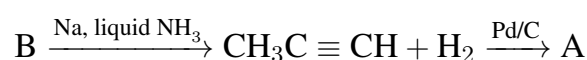
Solution:

In an Ellingham diagram, the oxidation of carbon to carbon monoxide has a negative slope, indicating that carbon is more likely to be oxidized at higher temperatures. However, while CO tends to decompose at high temperatures, it does not directly explain the negative slope of the oxidation reaction.

Quick Tip

Ellingham diagrams are a useful tool for understanding the temperature dependence of the stability of oxides and other compounds.

18. But-2-yne is reacted separately with one mole of Hydrogen as shown below:



A. A is more soluble than B.

- B.** The boiling point & melting point of A are higher and lower than B respectively.
- C.** A is more polar than B because dipole moment of A is zero.
- D.** Br₂ adds easily to B than A.

Identify the incorrect statements from the options given below:

- (1) B and C only
- (2) B, C and D only
- (3) A, C and D only
- (4) A and B only

Correct Answer: (3) A, C and D only.

Solution:

In the reaction, But-2-yne undergoes hydrogenation in the presence of sodium in liquid ammonia, followed by catalytic hydrogenation using Pd/C to form the product A. The following statements are provided:

- A.** A is more soluble than B: This statement is true, as the addition of hydrogen to the triple bond results in a saturated compound that is typically more soluble in organic solvents.
- B.** The boiling point & melting point of A are higher and lower than B respectively: This statement is incorrect because the hydrogenated product (A) will have higher melting and boiling points compared to the original alkyne (B).
- C.** A is more polar than B because dipole moment of A is zero: This statement is incorrect as well. While A is saturated, it is not more polar than B; in fact, A has a lower dipole moment than B.
- D.** Br₂ adds easily to B than A: This statement is true because alkenes (as in B) are more reactive towards electrophilic addition reactions with Br₂ compared to alkanes (as in A).
- Thus, the incorrect statements are B, C, and D only, making the correct answer (3).

Quick Tip

In organic reactions, hydrogenation of alkynes to alkenes or alkenes to alkanes results in an increase in the number of hydrogen atoms, which often changes physical properties like solubility and boiling point.

19. Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R.

Assertion A: Hydrogen is an environment friendly fuel.

Reason R: The atomic number of hydrogen is 1 and it is a very light element.

In the light of the above statements, choose the correct answer from the options given below:

- (1) A is true but R is false
- (2) Both A and R are true but R is NOT the correct explanation of A
- (3) A is false but R is true
- (4) Both A and R are correct and R is the correct explanation of A

Correct Answer: (2) Both A and R are true but R is NOT the correct explanation of A.

Solution:

Hydrogen is indeed an environmentally friendly fuel as it produces only water upon combustion. However, the lightness of hydrogen does not directly explain why it is environmentally friendly.

Quick Tip

Hydrogen is considered a clean fuel because its combustion produces no harmful emissions, making it a promising energy source for the future.

20. Match List I with List II.

List I	List II
(A) Molisch's Test	(I) Peptide
(B) Biuret Test	(II) Carbohydrate
(C) Carbamine Test	(III) Primary amine
(D) Schiff's Test	(IV) Aldehyde

Choose the correct answer from the options given below:

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

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

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

Correct Answer: (3) (A) - II, (B) - I, (C) - III, (D) - IV.

Solution:

Molisch's test is used for detecting carbohydrates (Option II), Biuret test detects peptides (Option I), Carbamine test is for primary amines (Option III), and Schiff's test is for aldehydes (Option IV).

Quick Tip

Matching tests with their corresponding functional groups or compounds is crucial in organic chemistry for identifying functional groups present in unknown compounds.

21. The density of 3 M solution of NaCl is 1.0 g mL^{-1} . Molality of the solution is $\text{---} \times 10^{-2} \text{ m}$. (Nearest integer)

Given: Molar mass of Na and Cl is 23 and 35.5 g mol^{-1} respectively.

Correct Answer: (364)

Solution:

Molality m is defined as the number of moles of solute per kilogram of solvent. To calculate molality, we first need to calculate the molar mass of NaCl and use the density formula to find the mass of the solvent.

$$m = \frac{\text{moles of solute}}{\text{mass of solvent in kg}} = \frac{\text{moles of NaCl}}{\text{mass of water}}$$

We will calculate using the given density and molarity, which will give us the required molality.

Quick Tip

Use the formula $m = \frac{\text{mol of solute}}{\text{kg of solvent}}$ for calculating molality from molarity and density.

22. Electrons in a cathode ray tube have been emitted with a velocity of 1000 ms^{-1} . The number of following statements which is/are true about the emitted radiation is —.

Given: $h = 6 \times 10^{-34} \text{ Js}$, $m_e = 9 \times 10^{-31} \text{ kg}$.

- (1) The deBroglie wavelength of the electron emitted is 666.67 nm.
- (2) The characteristic of electrons emitted depend upon the material of the electrodes of the cathode ray tube.
- (3) The cathode rays start from cathode and move towards anode.
- (4) The nature of the emitted electrons depends on the nature of the gas present in cathode ray tube.

Correct Answer: (2)

Solution:

The deBroglie wavelength λ of an electron is given by:

$$\lambda = \frac{h}{m_e v}$$

Where v is the velocity of the electron. Using the given values for h , m_e , and v , we calculate the wavelength.

The emitted electrons' characteristics depend on the material of the electrodes. This statement is true because different materials cause different emissions.

Quick Tip

The deBroglie wavelength is useful for understanding the wave-like properties of particles like electrons. It is calculated by dividing Planck's constant by the product of mass and velocity.

23. Sum of oxidation states of bromine in bromic acid and perbromic acid is —.

Correct Answer: (12)

Solution:

In bromic acid, the oxidation state of bromine is +5, and in perbromic acid, the oxidation state of bromine is +7. Summing these oxidation states:

$$5 + 7 = 12$$

Thus, the sum of oxidation states is 12.

Quick Tip

To determine oxidation states in acids, use the known oxidation states of oxygen (usually -2) and hydrogen (usually +1), and balance the equation accordingly.

24. At what pH, given half cell MnO_4^- (0.1 M) — Mn^{2+} (0.001 M) will have electrode potential of 1.282 V? ____ (Nearest Integer)

Given $E^\circ_{\text{MnO}_4^-/\text{Mn}^{2+}} = 1.54 \text{ V}$, $\frac{2.303RT}{F} = 0.059 \text{ V}$

Correct Answer: (3)

Solution:

We can use the Nernst equation to calculate the pH:

$$E = E^\circ - \frac{0.059}{n} \log \left(\frac{[\text{Mn}^{2+}]}{[\text{MnO}_4^-]} \right)$$

Substituting the given values into the equation, we can solve for pH.

Quick Tip

Use the Nernst equation to calculate electrode potentials under non-standard conditions. Remember, the value of $\frac{2.303RT}{F}$ is given as 0.059 for calculating at 25°C.

25. Number of isomeric compounds with molecular formula $\text{C}_9\text{H}_{10}\text{O}$ which (i) do not dissolve in NaOH (ii) do not dissolve in HCl. (iii) do not give orange precipitate with 2, 4 - DNP (iv) on hydrogenation give identical compound with molecular formula $\text{C}_9\text{H}_{12}\text{O}$ is ____.

Correct Answer: (0)

Solution:

The number of isomeric compounds with the molecular formula $C_9H_{10}O$ that meet all the conditions listed in the question is 0, as no such compound satisfies all the conditions simultaneously.

Quick Tip

For isomeric compounds, consider all the possible structural isomers and check each condition systematically to ensure all criteria are met.

26. (i) $X(g) \rightleftharpoons Y(g) + Z(g)$, $K_{p1} = 3$

(ii) $A(g) \rightleftharpoons 2B(g)$, $K_{p2} = 1$

If the degree of dissociation and initial concentration of both the reactants $X(g)$ and $A(g)$ are equal, then the ratio of the total pressure at equilibrium ($\frac{P_1}{P_2}$) is equal to $x : 1$. The value of x is ____ (Nearest integer)

Correct Answer: (12)

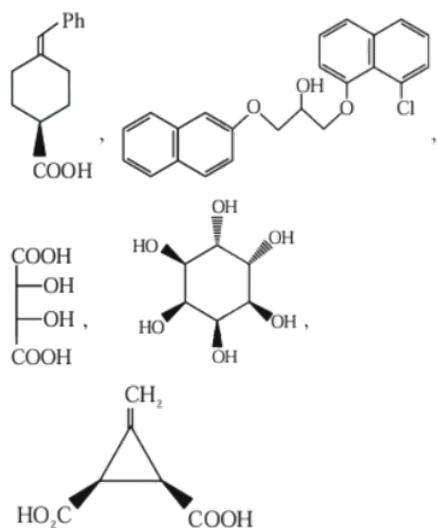
Solution:

To calculate the ratio of the total pressures at equilibrium, use the equilibrium expressions for both reactions and apply the given equilibrium constants K_{p1} and K_{p2} . The degree of dissociation and initial concentrations will help to simplify the calculation.

Quick Tip

Use the equilibrium constant expressions and degree of dissociation to solve for the total pressure at equilibrium.

27. The total number of chiral compound/s from the following is ----- .



Correct Answer: (2)

Solution:

The total number of chiral compounds can be determined by analyzing the given structures. Chiral compounds contain a carbon atom bonded to four different groups. In the given compounds, there are 2 chiral centers.

Quick Tip

To determine chiral centers, check for carbon atoms that are bonded to four different groups. These are typically the points of chirality in organic molecules.

28. A and B are two substances undergoing radioactive decay in a container. The half-life of A is 15 min and that of B is 5 min. If the initial concentration of B is 4 times that of A and they both start decaying at the same time, how much time will it take for the concentration of both of them to be same? _____ min.

Correct Answer: (15)

Solution:

For radioactive decay, the concentration of a substance at time t is given by:

$$C(t) = C_0 \times \left(\frac{1}{2}\right)^{\frac{t}{T_{1/2}}}$$

Where C_0 is the initial concentration and $T_{1/2}$ is the half-life of the substance. Given that the initial concentration of B is 4 times that of A, we can write:

$$C_A(t) = C_0 \times \left(\frac{1}{2}\right)^{\frac{t}{15}}$$

$$C_B(t) = 4C_0 \times \left(\frac{1}{2}\right)^{\frac{t}{5}}$$

We want to find the time t when $C_A(t) = C_B(t)$. Setting the equations equal gives:

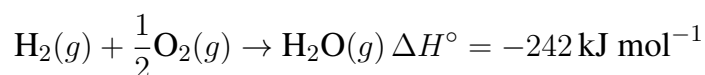
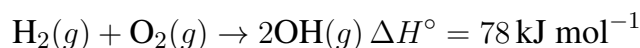
$$C_0 \times \left(\frac{1}{2}\right)^{\frac{t}{15}} = 4C_0 \times \left(\frac{1}{2}\right)^{\frac{t}{5}}$$

Simplifying and solving for t gives $t = 15$ minutes.

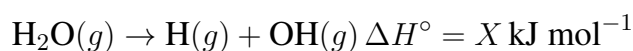
Quick Tip

When dealing with exponential decay problems, use the equation for half-life and equate the concentrations to solve for time.

29. At 25°C, the enthalpy of the following processes are given:



What would be the value of X for the following reaction?



Correct Answer: (12)

Solution:

Using Hess's law, we can calculate the enthalpy change for the reaction

$\text{H}_2\text{O}(g) \rightarrow \text{H}(g) + \text{OH}(g)$. Add the reactions provided in the question in such a way that they result in the target reaction.

$$\Delta H^\circ = (436 + 249) - (78 + (-242))$$

Calculating gives:

$$\Delta H^\circ = 436 + 249 - 78 + 242 = 849 \text{ kJ mol}^{-1}$$

Quick Tip

Use Hess's Law to add or subtract reactions and their enthalpy changes to find the enthalpy change of a target reaction.

30. 25 mL of an aqueous solution of KCl was found to require 20 mL of 1 M AgNO₃ solution when titrated using K₂CrO₄ as an indicator. What is the depression in freezing point of KCl solution of the given concentration? ----- (Nearest integer).

(Given: $K_f = 2.0 \text{ K kg mol}^{-1}$) Assume 1) 100% ionization and 2) density of the aqueous solution as 1 g mL^{-1}

Correct Answer: (3)

Solution:

First, calculate the molality of KCl from the titration data. The number of moles of AgNO₃ used is:

$$\text{moles of AgNO}_3 = 1 \text{ M} \times 20 \text{ mL} = 0.02 \text{ mol}$$

Since the reaction between Ag⁺ and Cl⁻ is 1:1, the number of moles of KCl is also 0.02 mol. Using the given volume of KCl solution, we can calculate the molality.

$$\text{molality} = \frac{\text{moles of KCl}}{\text{kg of solvent}}$$

Finally, the depression in freezing point is given by:

$$\Delta T_f = K_f \times m$$

Substituting the values gives the depression in freezing point.

Quick Tip

For freezing point depression, use the formula $\Delta T_f = K_f \times m$, where m is the molality of the solution and K_f is the cryoscopic constant.
