Redox Reactions and Electrochemistry JEE Main PYQ - 2

Total Time: 25 Minute **Total Marks:** 40

Instructions

Instructions

1. Test will auto submit when the Time is up.
2. The Test comprises of multiple choice questions (MCQ) with one or more correct answers.
3. The clock in the top right corner will display the remaining time available for you to complete the examination.

Navigating & Answering a Question

1. The answer will be saved automatically upon clicking on an option amongst the given choices of answer.
2. To deselect your chosen answer, click on the clear response button.
3. The marking scheme will be displayed for each question on the top right corner of the test window.

Redox Reactions and Electrochemistry

1. In order to oxidise a mixture one mole of each of \(${FeC2O_4, Fe2(C2O4)3, FeSO4}$\) and \(${Fe2(SO4)3}$\) in acidic medium, the number of moles of \(${KMnO_4 }$\) required is - **(+4, -1)**

8 Apr 2019 Shift I

a. 3

b. 2

c. 1

d. 1.5

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2. Which of the following reactions is an example of a redox reaction? **(+4, -1)**

2017

a. $XeF_6 + H_2O \rightarrow XeOF_4 + 2HF$

b. $XeF_6 + 2H_2O \rightarrow XeO_2F_2 + 4HF$

c. $XeF_4 + O_2F_2 \rightarrow XeF_6 + O_2$

d. $XeF_2 + PF_5 \rightarrow [XeF]^+PF_6^-$

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3. Potassium dichromate when heated with concentrated sulphuric acid and a soluble chloride, gives brown-red vapours of : **(+4, -1)**

2014

a. CrO_3

b. $CrCl_3$

c. CrO_2Cl_2

d. Cr_2O_3

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4. Which one of the following species will disproportionate in the following reduction potential diagra **(+4, -1)**

a. (A) $^{+3}$, $^{+4}$

b. (B) $^{+}_{2}$, $^{+3}$

c. (C) $^{+}_{2}$, $^{+4}$

d. (D) None of these

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5. Which of following are reducing and oxidising agent respectively. **(+4, -1)**

a. Eu^{+2}, Ce^{+4}

b. Ce^{+3}, Ce^{+4}

c. Eu^{+4}, Eu^{+2}

d. Tb^{+2}, Ce^{2+}

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6. The oxidation state of Mn in $KMnO_4$ changes by 3 units in which medium? **(+4, -1)**

a. Strongly acidic **15 Apr 2023 Shift II**

b. Strongly basic

c. Aqueous neutral

d. Weakly acidic

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7. Which of the Phosphorus oxoacid can create silver mirror from $AgNO_3$ solution? **(+4, -1)**

10 Jan 2019 Shift II

a. $H_4P_2O_7$

b. $(HPO_3)_n$

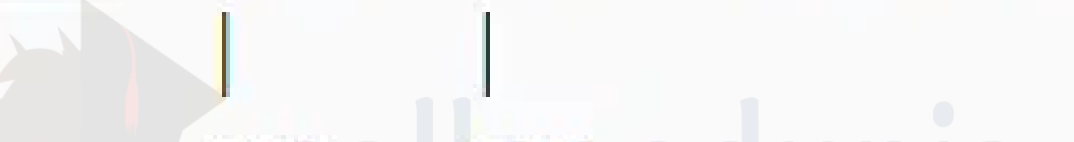
c. $H_4P_2O_6$

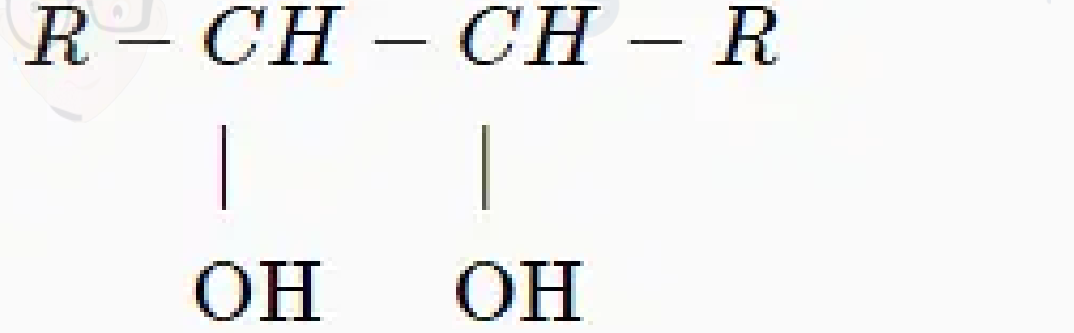
d. $H_4P_2O_5$

8. Which of the following will be oxidized by HIO_4? **(+4, -1)**

(A)

(B) 

(C) 

(D) 

a. 1, 2 and 3

b. 1, 3 and 4

c. 1, 2 and 4

d. 2, 3 and 4

9. Hydrogen ion concentration of an aqueous solution is 1×10^{-4} M. The solution is diluted with equal volume of water. Hydroxyl ion concentration of the resultant solution in terms of $p \times 10^{-10}$ mol dm^{-3} . What is the value of p? **(+4, -1)**

15 Apr 2023 Shift II

10. Which of the following have undistorted octahedral structures? **(+4, -1)**

1 Feb 2023 Shift II

1. $[Co(NH_3)_6]^{3+}$
2. $[Co(CN)_6]^{3-}$
3. $[CoF_6]^{2-}$
4. $[Co(H_2O)_6]^{3+}$

Select the correct answer using the codes given below:

a. 2, 3 and 4

b. 1, 3 and 4

c. 1, 2 and 3

d. 1, 2 and 4

Answers

1. **Answer: b**

Explanation:

\(${n_{eq} \; KMnO_4 = n_{eq} . [FeC2O4 + Fe2(C2O4)3 + FeSO4]}$\) or \($n \times 5 = 1 \times 3 + 1 \times 6 + 1 \times 1$\) \($\therefore n = 2$\)

Concepts:

1. **Redox Reactions:**

Redox Reaction:

Redox reactions are chemical reactions where oxidation and reduction take place simultaneously. In this type of reaction, there is a gain of electrons for one chemical species while the other loses electrons or simply involves transfer of electrons. The species that loses electrons is oxidized while the one that gains electrons is reduced.

Types of Redox Reactions:

Redox reactions can be differentiated into 4 categories namely combination reactions, decomposition reactions, displacement reactions, and disproportionation reactions. Each is explained separately below:

Combination Reaction:

In this, the molecules combine to form new compounds. For example, when magnesium reacts to nitrogen.

Decomposition Reaction:

Opposite to the combination reaction, here there is a breakdown of compounds to simpler substances. For example, electrolysis of water.

Displacement Reaction:

In this, the more reactive metal will displace the less reactive one in a chemical reaction. The reactivity of an element is represented in a series called the reactivity series (arranged in decreasing order of reactivity) which makes it easier to determine the chemical reaction and its products.

Disproportionation Reaction:

This is a peculiar type of reaction where an element showing a particular oxidation state will be oxidized and reduced simultaneously. Another thing to note is that these reactions will always have an element that can exhibit three oxidation states.

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2. **Answer: c**

Explanation:

Xe is oxidised from $+4$ in (XeF_4) to $+6$ in (XeF_6)
Oxygen is reduced from $+1$ (in O_2F_2) to zero (in O_2)

So, the correct option is (C): $XeF_4 + O_2F_2 \rightarrow XeF_6 + O_2$

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---

3. **Answer: c**

Explanation:

Solid potassium dichromate when heated with concentrated sulphuric acid and a soluble chloride gives orange red vapours of a volatile oily liquid CrO_2Cl_2 $K_2Cr_2O_7 + 4NaCl + 6H_2SO_4 \rightarrow 2KHSO_4 + 4NaHSO_4 + 2CrO_2Cl_2$ chromyl chloride

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4. **Answer: d**

Explanation:

Explanation:
The following electrode potential diagram:

We have to find the species which undergoes disproportionation.In general, if the value of emf at the right side of species is greater than that of left side, the species

will undergo disproportionation, therefore, will undergo disproportionation reactions. $^{+}{}_{4}{}/{}^{+3} = 2.62$ $^{+2}/{}^{+4} = 0.86$ $_{cell} = {}_{cathode} - {}_{anode} = 2.62 - 0.86 = 1.76$ Since, cell is positive $^{+4}$, $^{3+}$ can be converted to $^{+}_{2}$ simultaneously.Hence, the correct option is (D).

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5. **Answer: a**

Explanation:

$Eu^{2+} \rightarrow Eu^{3+} + e^{-}$
Eu^{2+} is a good reducing agent
$e^{-} + Ce^{4+} \rightarrow Ce^{3+}$
Ce^{4+} is a good oxidising agent

So, the correct answer is (A): Eu^{+2}, Ce^{+4}

Concepts:

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6. **Answer: c**

Explanation:

The correct option is (C): Aqueous neutral
$KMnO_4$ in the aqueous neutral medium that reduces to MnO_2
$2KMnO_4 + H_2O \rightarrow 2MnO_2 + 2KOH + \frac{3}{2} O_2$
∴ The oxidation state of Mn in $KMnO_4$ that changes from +7 to +4 i.e., by 3 units.

Concepts:

1. Oxidation Number:

Oxidation number, also called **oxidation state**, the total number of electrons that an atom either gains or loses in order to form a chemical bond with another atom.

Oxidation number of an atom is defined as the charge that an atom appears to have on forming ionic bonds with other heteroatoms. An atom having higher electronegativity (even if it forms a covalent bond) is given a negative oxidation state.

The definition, assigns oxidation state to an atom on conditions, that the atom –

1. Bonds with heteroatoms.
2. Always form ionic bonding by either gaining or losing electrons, irrespective of the actual nature of bonding.

Oxidation number is a formalized way of keeping track of oxidation state.

Read More: Oxidation and Reduction

Way To Find Oxidation Number Of An Atom?

Oxidation number or state of an atom/ion is the number of electrons an atom/ion that the molecule has either gained or lost compared to the neutral atom. Electropositive metal atoms, of group I, 2 and 3 lose a specific number of electrons and have always constant positive oxidation numbers.

In molecules, more electronegative atom gain electrons from a less electronegative atom and have negative oxidation states. The numerical value of the oxidation state is equal to the number of electrons lost or gained.

Oxidation number or oxidation state of an atom or ion in a molecule/ion is assigned by:

1. Summing up the constant oxidation state of other atoms/molecules/ions that are bonded to it and
2. Equating, the total oxidation state of a molecule or ion to the total charge of the molecule or ion.

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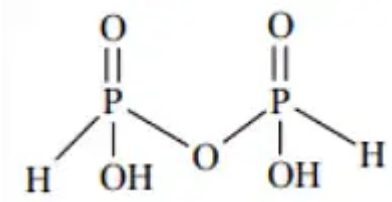
7. **Answer: d**

Explanation:



Oxyacid having P-H bond can reduce $AgNO_3$ to Ag.

So, the correct option is (D): $H_4P_2O_5$.

Concepts:

1. Balancing a redox reaction:

The method that is based on the difference in oxidation number of oxidizing agent and the reducing agent is known as oxidation number. The half-reaction method entirely depends on the division of the redox reactions into oxidation half and reduction half. It entirely depends on the individual which method to choose and use.

Oxidation Number Method:

Like various other reactions, it is very important to write the correct compositions and formulas. A very important thing to keep in mind while writing oxidation-reduction reactions is to write the compositions and formulas of the substances and the products present in the chemical reaction in a very correct manner.

Half-Reaction Method:

In this procedure, we decouple the equation into two halves. After that, we balance both the parts of the reaction separately. Finally, we add them together to get a balanced equation.

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8. Answer: c

Explanation:

Explanation:
The characteristics property of periodic acid is the oxidative cleavage of bonds with oxidisable groups such as 1,2-diols, ∝-hydroxy carbonyl compounds, 1,2-diketones, etc.For two adjacent oxidisable groups, one molecule of reagent is used which oxidises ketones to carboxylic acids and alcohols are oxidised to aldehydes by HIO4.The reaction of given compounds with HIO4 can be shown as:

1. It is 1, 2 diketones, thus undergoes oxidative cleavage, as given:2. It is ∝- hydroxy carbonyl compound, thus undergoes oxidative cleavage, as given:

3. It is 1, 3 diol, thus will not undergo oxidative cleavage as given:

4. It is 1,2 diol, thus undergoes oxidative cleavage.Hence, the correct option is (C).

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Oxidation number or oxidation state of an atom or ion in a molecule/ion is assigned by:

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2. Equating, the total oxidation state of a molecule or ion to the total charge of the molecule or ion.

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9. Answer: 2 - 2

Explanation:

Explanation:
Given:Concentration of H^+ ions, $[H^+] = 1 \times 10^{-4}$ MThe solution is diluted with an equal volume of water.Hydroxyl ion solution in the resulting solution = $p \times 10^{-10}$ mol dm^{-3}We have to find the value of p.Since, the solution is diluted with an equal volume of water, the concentration of H+ will become one-half of that of the original value. Concentration of [H+] ions = $\frac{1 \times 10^{-4}}{2} = 0.5 \times 10^{-4}$ MWhen temperature is 25°C, the ionic product of water , Kw is given as:Kw = $[H^+]\,[OH^-] = 1 \times 10^{-14}$ ..... (i)Substituting the value of $[H^+]$ in equation (i), we get$[0.5 \times 10^{-4}]\,[OH^-] = 1 \times 10^{-14}$$[OH^-] = \frac{1 \times 10^{-14}}{0.5 \times 10^{-4}} = \frac{1 \times 10^{-10}}{0.5} = 2 \times 10^{-10}$ M or 2×10^{-10} mol dm^{-3}Therefore, the value of p = 2.Hence, the correct answer is 2.00.

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10. Answer: c

Explanation:

The structures of these species can be found out by knowing the hybridisation.The atomic number of = 16Electronic configuration of P = $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^3$.Since, SF is spd hybridised having 6 bond pairs, the geometry is regular octahedral.2. $^{-}_{6}$ Atomic number of = 15Electronic configuration of P = $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^3$ Hybridisation is given as: = . $+\frac{1}{2}($ - ±).....(i)where, S.A = No. of surrounding atomsV = Number of valence electrons on the central atomn = Number of anionE = Charge on the anionC = Total charge on the species.Thus, for $^{-}_{6}$ S.A = 6V = 5n = 6E = 1C = -1Substituting the values in equation (i), we get $= 6 + \frac{1}{2}(5 - 6 + 1) = 6$ Thus, the hybridisation is sp^3d^2 having 6 bond pairs. Therefore, the geometry is regular octahedral.3. $^{2-}_{6}$ Atomic no. of Si = 14Electronic configuration of Si = 1 $s^2\,2$ $s^2\,2p^6\,3$ $s^2\,3p^2$ S.A = 6V = 4n = 6E = 1C = -2Substituting values in equation (i), we get $= 6 + \frac{1}{2}(4 - 6 + 1) = 6$Thus, the hybridisation is sp^3d^2 having 6 bond pairs.

Therefore, the geometry is regular octahedral.4. XeF6Atomic no. of Xe = 54Electronic configuration of Xe = [Kr]4 d^{10} 5 s^2 $5p^6$ S.A = 6V = 8n = 6E = 1C = 0Substituting values in equation (i), we get = 6 + $\frac{1}{2}$(8 - 6) = 6 + 1 = 7Thus, hybridisation is sp^{33} and geometry should be pentagonal bipyramidal .But there are 6 bond pairs and one lone pair due to which XeF acquires a distorted octahedral geometry.

Hence, the correct option is (C): 1, 2 and 3

Concepts:

1. Coordination Compounds:

A coordination compound holds a central metal atom or ion surrounded by various oppositely charged ions or neutral molecules. These molecules or ions are re-bonded to the metal atom or ion by a coordinate bond.

Coordination entity:

A coordination entity composes of a central metal atom or ion bonded to a fixed number of ions or molecules.

Ligands:

A molecule, ion, or group which is bonded to the metal atom or ion in a complex or coordination compound by a coordinate bond is commonly called a ligand. It may be either neutral, positively, or negatively charged.