

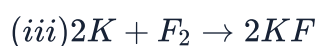
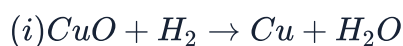
Chapter 8: Redox Reactions

NCERT Exemplar · Class 11 · Chemistry

Multiple Choice Questions (Type-I)

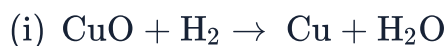
Question 1

Which of the following is not an example of redox reaction?



Solution

Ans: Redox reaction is defined as the simultaneous oxidation and reduction of reacting species. Thus, change in oxidation state will decide whether a reaction is redox or not. Thus, assigning the oxidation states as:



Here, oxidation of H and reduction of Cu is taking place.



Here, oxidation of C and reduction of Fe is taking place.



Here, the oxidation of K and reduction of F is taking place.



This is not a redox reaction, but it is a double displacement reaction.

Hence, option(iv) is the correct answer.

Question 2

The more positive the value of $E^\ominus$, the greater is the tendency of the species to get reduced. Using the standard electrode potential of redox couples given below find out which of the following is the strongest oxidising agent. $E^\ominus$ values:

$\text{Fe}^{3+}/\text{Fe}^{2+} = +0.77$; $\text{I}_2(\text{s})/\text{I}^- = +0.54$; $\text{Cu}^{2+}/\text{Cu} = +0.34$; $\text{Ag}^+/\text{Ag} = +0.80\text{V}$

(i)



(ii)



(s)

(iii)



(iv)



Solution

Ans: The strongest oxidising agent means it has greater tendency to oxidise other species and itself gets easily reduced. So higher the



values, stronger is the oxidising agent it is. Thus, Ag^+ having highest positive



value among the given systems, is the strongest oxidising agent. Hence, option (iv) is the correct answer.

Question 3



values of some redox couples are given below. On the basis of these values choose the correct option.



values:

$$\text{Br}_2/\text{Br} = +1.90; \text{Ag}^+/\text{Ag(s)} = +0.80; \text{Cu}^{2+}/\text{Cu(s)} = +0.34; \text{I}_2(\text{s})/\text{I} = +0.54$$

(i) Cu will reduce



(ii) Cu will reduce Ag

(iii) Cu will reduce



(iv) Cu will reduce



.

Solution

Ans: Reduction potential is defined as the tendency of the specie to get reduced. More positive the value of



, greater is the tendency of the species to get reduced and stronger is the oxidising agent.

On the basis of the given



values, the order of getting reduced is:



Hence, Cu has the least tendency to get reduced and will itself gets oxidise and reduce other species as:



,



and



. Hence, option (iv) is the correct answer.

Question 4

Using the standard electrode potential, find out the pair between which redox reaction is not feasible.



values:

$$\text{Fe}^{3+}/\text{Fe}^{2+} = +0.77; \text{I}_2/\text{I} = +0.54; \text{Cu}^{2+}/\text{Cu} = +0.34; \text{Ag}^+/\text{Ag} = +0.80 \text{ V}$$

(i)



and



(ii) Ag^+ and Cu

(iii)



and Cu

(iv) Ag and



.

Solution

Ans:



will be negative for the pair Ag and



. Hence the reaction is not feasible. Hence, option(iv) is the correct answer.

Question 5

Thiosulphate reacts differently with iodine and bromine in the reactions given below:



Which of the following statements justifies the above dual behaviour of thiosulphate?

- (i) Bromine is a stronger oxidant than iodine.
- (ii) Bromine is a weaker oxidant than iodine.
- (iii) Thiosulphate undergoes oxidation by bromine and reduction by iodine in these reactions.
- (iv) Bromine undergoes oxidation and iodine undergoes reduction in these reactions.

Solution

Ans: Standard reduction potential of bromine is higher than iodine, hence Bromine is a stronger oxidant than iodine. Therefore, option (i) is the correct answer.

Question 6

The oxidation number of an element in a compound is evaluated on the basis of certain rules. Which of the following rules is not correct in this respect?

- (i) The oxidation number of hydrogen is always +1.
- (ii) The algebraic sum of all the oxidation numbers in a compound is zero.
- (iii) An element in the free or the uncombined state bears oxidation number zero.
- (iv) In all its compounds, the oxidation number of fluorine is – 1.

Solution

Ans: In ionic hydrides hydrogen exists in -1 oxidation state because the hydrogen acquires negative charge in the presence of its companion. Hence, option(i) is the correct answer.

Question 7

In which of the following compounds, an element exhibits two different oxidation states.

**Solution**

Ans: The oxidation states are given below-

In NH_2OH oxidation of N is -1.

NH_4NO_3 exists as



Thus, the oxidation state of N in



is -3 while in



is +5.

In N_2H_4 oxidation of N is -2

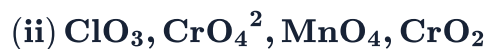
In N_3H oxidation of N is

$$\frac{-1}{3}$$

Hence, option (ii) is the correct answer.

Question 8

Which of the following arrangements represent increasing oxidation number of the central atom?



Solution

Ans: Let the oxidation number of central atom be 'y'.

Oxidation number of O = -2



$$: y + 2 \times (-2) = -1$$

$$y - 4 = -1 \text{ or } y = +3$$



$$: y + 4 \times (-2) = -2$$

$$y - 8 = -2 \text{ or } y = +6$$



$$: y + 3 \times (-2) = -1$$

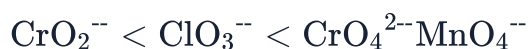
$$y - 6 = -1 \text{ or } y = +5$$



$$: y + 4 \times (-2) = -1$$

$$y - 8 = -1 \text{ or } y = +7$$

increasing order of oxidation number of the central atom is:



.

Hence, option (i) is the correct answer.

Question 9

The largest oxidation number exhibited by an element depends on its outer electronic configuration. With which of the following outer electronic configurations the element will exhibit largest oxidation number?



Solution

Ans: For



can exhibit highest oxidation state as $2+1 = +3$,

For



can exhibit highest oxidation state as $2+3 = +5$

For



can exhibit the highest oxidation state as $1+5 = +6$

For

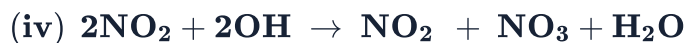
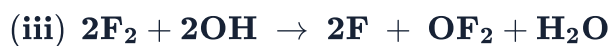
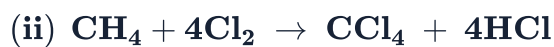


can exhibit highest oxidation state as $2+5 = +7$.

Hence, option(iv) is the correct answer.

Question 10

Identify disproportionate reaction

**Solution**

Ans: Disproportionate reactions are defined as the reactions in which the same substance is oxidized as well as reduced. Here, the below reaction is given as-



In this reaction, N is both oxidized as well as reduced since O.N. of N increases from +4 in



to +5 in NO_2 and decreases from +4 in NO to +3 in



.

Hence, option(iv) is the correct answer.

Question 11

Which of the following elements does not show disproportionate tendency?

(i) Cl

(ii) Br

(iii) F

(iv) I

Solution

Ans: As, Cl, Br, I all are having -1 to +7 oxidation state. But Oxidation state of F is fixed (-1) as it is the most electronegative element and do not loose electron. Hence, it does not show disproportionate tendency. Hence, option(iii) is the correct answer.

Multiple Choice Questions (Type-II)

Question 12

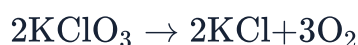
Which of the following statement(s) is/are not true about the following decomposition reaction.



- (i) Potassium is undergoing oxidation
- (ii) Chlorine is undergoing oxidation
- (iii) Oxygen is reduced
- (iv) None of the species are undergoing oxidation or reduction

Solution

Ans: As, in the given reaction below-



Potassium remains in same oxidation state and oxygen is being oxidized. Hence, options(iii) and (iv) are the correct answers.

Question 13

Identify the correct statement (s) in relation to the following reaction:



- (i) Zinc is acting as an oxidant
- (ii) Chlorine is acting as a reductant

(iii) Hydrogen ion is acting as an oxidant

(iv) Zinc is acting as a reductant

Solution

Ans: The given equation is as-



In this Zn has a negative

$$E^\ominus$$

value, which means it will undergo oxidation and will act as a reducing agent (reductant). Zn can produce



gas with HCl, as hydrogen has higher standard reduction potential than Zn, hydrogen will undergo reduction and will act as oxidant. Hence, option(iii) and (iv) is the correct answer.

Question 14

The exhibition of various oxidation states by an element is also related to the outer orbital electronic configuration of its atom. Atom(s) having which of the following outermost electronic configurations will exhibit more than one oxidation state in its compounds.

(i) $3s^1$

(ii) $3d^1 4s^2$

(iii) $3d^2 4s^2$

(iv) $3s^2 3p^3$

Solution

Ans: Elements that are having only s-electrons in the valence shell do not show more than one oxidation state (shows only one oxidation state of +1). Hence, (b), (c) having incompletely filled d-orbital's in the outermost shell show variable oxidation states. Element with outer electronic configuration as $3d^1 4s^2$ shows variable oxidation states of +2 and +3 and the element with outer electronic configuration as $3d^2 4s^2$ shows variable oxidation states of +2, +3 and +4. P-Block elements

also show variable oxidation states due to involvement of d-orbital's and inert pair effect. Hence, element having $3s^2 3p^3$ as the outer electronic configuration shows variable oxidation states of +3 and +5 due to involvement of d-orbital's. Hence, option(ii), (iii) and (iv) are the correct answers.

Question 15

Identify the correct statements with reference to the given reaction-



- (i) Phosphorus is undergoing reduction only.
- (ii) Phosphorus is undergoing oxidation only.
- (iii) Phosphorus is undergoing oxidation as well as reduction.
- (iv) Hydrogen is undergoing neither oxidation nor reduction.

Solution

Ans: The given reaction is as below-



The above reaction is a kind of disproportionate reaction in which phosphorous is being reduced as well as oxidized whereas hydrogen remains same in +1 oxidation state. Hence, option(iii) and (iv) are the correct answers.

Question 16

Which of the following electrodes will act as anodes, when connected to Standard Hydrogen Electrode?

- (i) Al/Al^{3+} $E^\ominus = 1.66$
- (ii) Fe/Fe^{2+} $E^\ominus = 0.44$
- (iii) Cu/Cu^{2+} $E^\ominus = + 0.34$
- (iv) $F_2(g)/2F^-(aq)$ $E^\ominus = + 2.87$

Solution

Ans: The ones which will act as anodes when connected to standard hydrogen electrode as they have more negative standard reduction potential as compared to standard hydrogen electrode. The one which will act as cathodes when connected to standard hydrogen electrode as they have more positive standard reduction potential as compared to standard hydrogen electrode. Hence, option(i) and (ii) are the correct answers.

Short Answer Questions

Question 17

The reaction



represents the process of bleaching. Identify and name the species that bleaches the substances due to its oxidising action.

Solution

Ans: The given reaction is as below-



In the given reaction, oxidation number of Cl increases from 0 (in Cl_2) to +1 (in ClO^-) and decreases to -1 (in Cl^-). Therefore, Cl_2 is both oxidized to ClO^- and reduced to Cl^- . Since Cl^- ion cannot act as an oxidizing agent (because it cannot decrease its O.N. lower than -1), hence, Cl_2 bleaches substances due to oxidizing action of hypochlorite, ClO^- ion.

Question 18



undergoes disproportionate reaction in acidic medium but



does not. Give reason.

Solution

Ans: In



, Mn is in highest oxidation state that is +7 hence here manganese cannot undergo oxidation that is why disproportionate is not possible whereas in



manganese is in +6 oxidation state which can be oxidized as well as reduced.

Question 19

PbO and PbO₂ react with HCl according to following chemical equations:



Why do these compounds differ in their reactivity?

Solution

Ans: The given compound can differ in reactivity as Lead is present in +4 oxidation state, whereas the stable oxidation state of lead in PbO is +2. PbO₂ thus, can act as an oxidant (oxidising agent) and, therefore, can oxidise chloride ions of HCl into chlorine.

Question 20

Nitric acid is an oxidising agent and reacts with PbO, but it does not react with PbO₂. Explain why?

Solution

Ans: Since nitric acid itself is an oxidising agent therefore, it is unlikely that the reaction may occur between PbO₂ and nitric acid. However, the acid-base reaction occurs between PbO and nitric acid because PbO is a basic oxide.

Question 21

Write balanced chemical equation for the following reactions:

(i) Permanganate ion (



) reacts with sulphur dioxide gas in acidic medium to produce



and hydrogen sulphate ion. (Balance by ion electron method).

(ii) Reaction of liquid hydrazine (N_2H_2) with chlorate ion (



) in basic medium produces nitric oxide gas and chloride ion in gaseous state. (Balance by oxidation number method).

(iii) Dichlorine heptaoxide (Cl_2O_7) in gaseous state combines with an aqueous solution of hydrogen peroxide in acidic medium to give chlorite ion



and oxygen gas. (Balance by ion electron method).

Solution

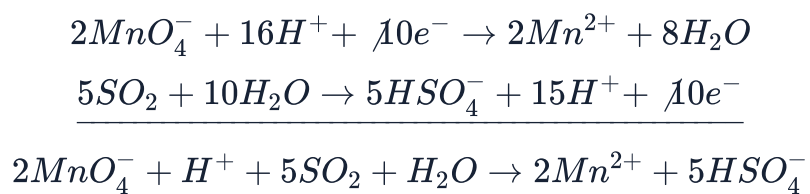
Ans: We can balance the given reaction by ion electron method as-



Balancing by ion electron method

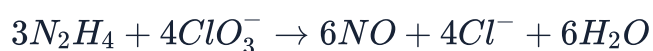


The balanced chemical is given as-

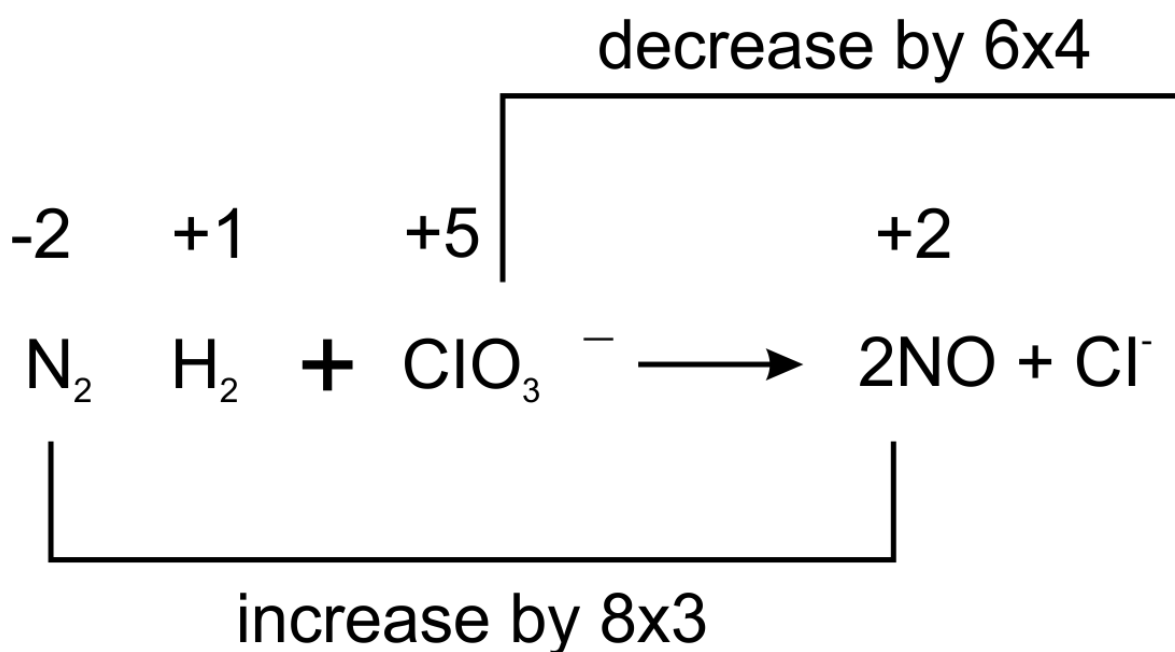


Ans: We can balance the given reaction by oxidation number method-

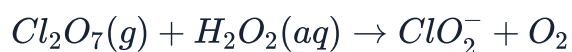
Balancing by oxidation number method as to make the electron gain and loss equal as given -



The balanced chemical is given as-



Ans: We can balance the given reaction by ion electron method as



(acidic medium)

Balancing by ion electron method



The balanced chemical is given as-



Question 22

Calculate the oxidation number of phosphorus in the following species. (a)



and (b)



(a)



(b)



Solution

Ans:

Let the oxidation number of P in



be x.

Therefore, $+1 + x + (-6) = -2$

$$x = +3$$

Oxidation number of phosphorus is= +3.

Ans:

Let the oxidation number of P in



be x.

Therefore, $x + (-8) = -3$

$$x = +5$$

Oxidation number of phosphorus is= +5.

Question 23

Calculate the oxidation number of each sulphur atom in the following compounds:

(a) $\text{Na}_2\text{S}_2\text{O}_3$

(b) $\text{Na}_2\text{S}_4\text{O}_6$

(c) Na_2SO_3

Solution

Ans: let x= oxidation number of sulphur, and +1 is oxidation number of Na, -2 is oxidation number of O, also we can assume total charge on compound = 0 then solving we get.

$$+2 + 2x - 6 = 0$$

$$x = +2.$$

Ans: let x= oxidation number of sulphur, and +1 is oxidation number of Na, -2 is oxidation number of O, also we can assume total charge on compound = 0 then solving we get.

$$+2 + 4x - 12 = 0$$

$$x = +2.5$$

Ans: let x = oxidation number of sulphur, and $+1$ is oxidation number of Na, -2 is oxidation number of O, also we can assume total charge on compound = 0 then solving we get.

$$+2 + x - 6 = 0$$

$$x = +4$$



Ans: let x = oxidation number of sulphur, and $+1$ is oxidation number of Na, -2 is oxidation number of O, also we can assume total charge on compound = 0 then solving we get.

$$+2 + x - 8 = 0$$

$$x = +6.$$

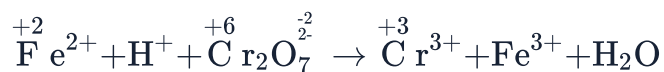
Question 24

Balance the following equations by the oxidation number method.

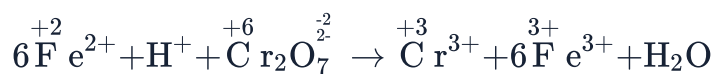


Solution

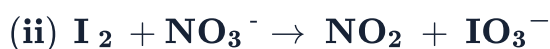
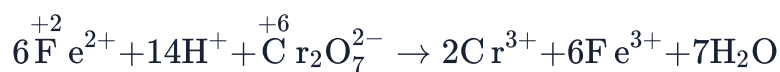
Ans: We can balance the given equation by oxidation number method-



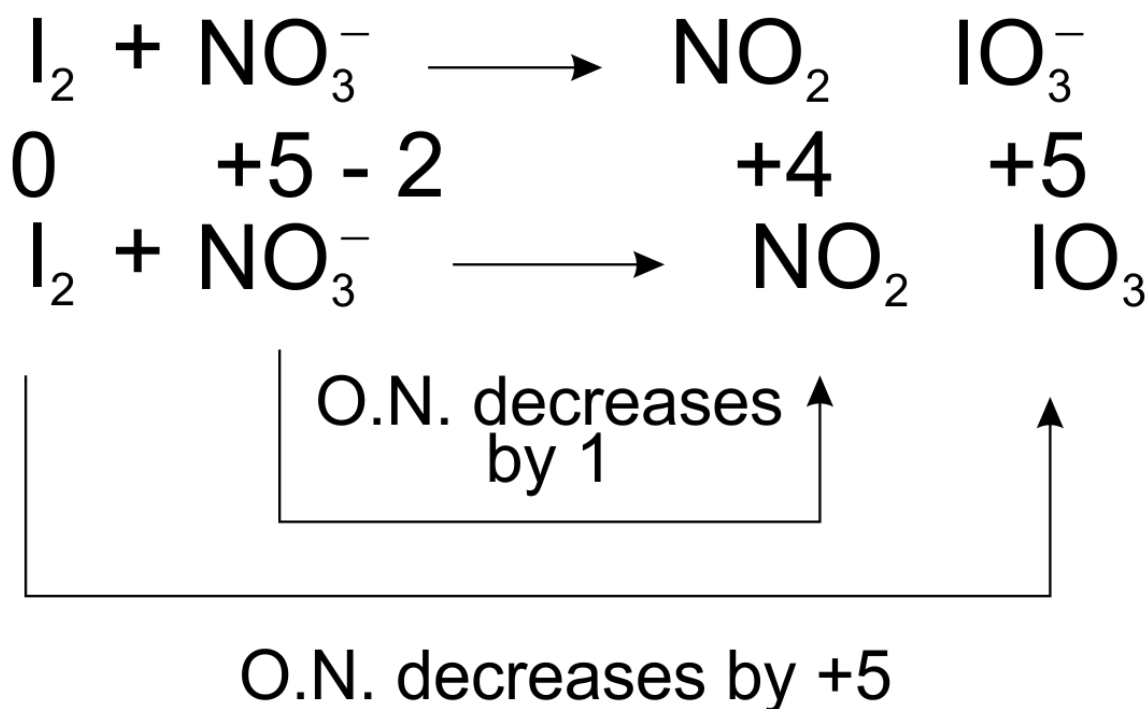
(a) Balance the increase and decrease in O.N.



(b) Balancing H and O atoms by adding H^+ and H_2O molecules



Ans: We can balance the given equation by oxidation number method-



Total decrease in O.N. = 1

To equilibrate O.N. multiply NO_3^- by 10



Balancing atoms other than O and H



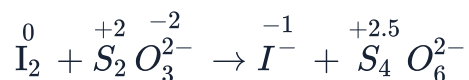
Balancing O and H





.

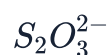
Ans: We can balance the given equation by oxidation number method



Total increase in O.N. = $0.5 \times 4 = 2$

Total increase in O.N. = $1 \times 2 = 2$

To equilibrate O.N. multiply

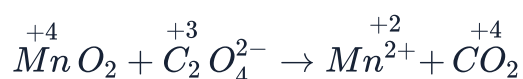


and I- by 2.



.

Ans: We can balance the given equation by oxidation number method-



The balanced chemical reaction is given as-

Total increase in O.N. = $5 \times 2 = 10$

To equalize O.N. multiply CO_2 by 2.



Balance H and O by adding $2\text{H}_2\text{O}$ on right side, and 4H^+ on left side of equation.

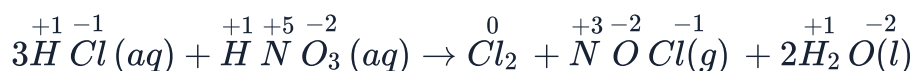


Question 25

Identify the redox reactions out of the following reactions and identify the oxidising and reducing agents in them.

**Solution**

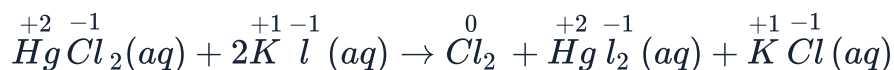
Ans: We can write the given reaction along with their oxidation numbers as-



As, chlorine is oxidised in hydrochloric acid (behaving as reducing agent) -as its oxidation number is increases during the reaction from -1 to 0) and nitric acid is reduced (behaving as oxidising agent) as its oxidation number is decreases during the reaction from +5 to +3). Hence, it is the redox reaction.



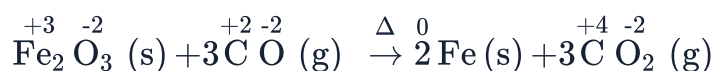
Ans: We can write the given reaction along with their oxidation numbers as-



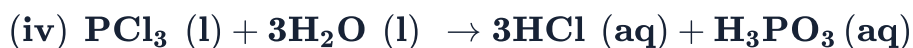
Here, oxidation number of none of the atoms change hence it is not a redox reaction.



Ans: We can write the given reaction along with their oxidation numbers as-



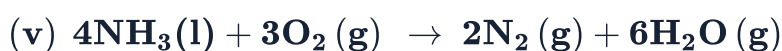
As, carbon is oxidised in carbon monoxide (behaving as reducing agent) -as its oxidation number is increases during the reaction from +2 to +4) and ferric oxide is reduced (behaving as oxidising agent) as its oxidation number is decreases during the reaction from +3 to 0). Hence, it is the redox reaction.



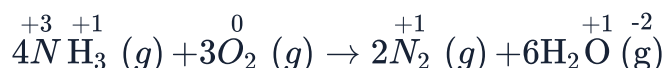
Ans: We can write the given reaction along with their oxidation numbers as-



Here, oxidation number of none of the atoms change hence it is not a redox reaction.



Ans: We can write the given reaction along with their oxidation numbers as-



As, nitrogen is oxidised in ammonia (behaving as reducing agent) -as its oxidation number is increases during the reaction from -3 to 0) and oxygen is reduced (behaving as oxidising agent) as its oxidation number is decreases during the reaction from 0 to -2). Hence, it is the redox reaction.

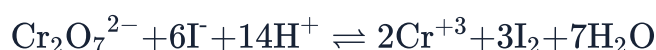
Question 26

Balance the following ionic equations-

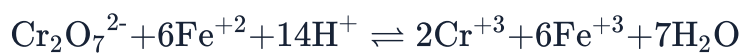


Solution

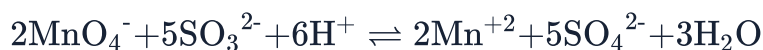
Ans: The balanced chemical is given as -



Ans: The balanced chemical is given as -



Ans: The balanced chemical is given as -



Ans: The balanced chemical is given as -



Matching Type

Question 27

Match Column I with Column II for the oxidation states of the central atoms.

Column I	Column II
(i) $\text{Cr}_2\text{O}_7^{2-}$	(a) + 3
(ii) MnO_4^-	(b) + 4
(iii) VO_3^-	(c) + 5
(iv) FeF_6^{3-}	(d) + 6
	(e) + 7

Solution

Ans: (i)

→

(d); (ii)

→

(e); (iii)

→

(c); (iv)

→

(a)

Question 28

Match the items in Column I with relevant items in Column II.

Column I	Column II
(i) Ions having positive charge	(a) +7
(ii) The sum of oxidation number of all atoms in a neutral molecule.	(b) -1
(iii) Oxidation number of hydrogen ion (H ⁺).	(c) +1
(iv) Oxidation number of fluorine in NaF.	(d) 0
(v) Oxidation number of fluorine in NaF.	(e) Cation
	(f) Anion

Solution

Ans: (i)

→

(e); (ii)

→

(d); (iii)

→

(c); (iv)

→

(b); (v)

→

(f).

Assertion and Reason Type

In the following questions a statement of Assertion (A) followed by a statement of Reason (R) is given. Choose the correct option out of the choices given below each question.

Question 29

Assertion (A): Among halogens fluorine is the best oxidant.

Reason (R): Fluorine is the most electronegative atom.

- (i) Both A and R are true and R is the correct explanation of A.
- (ii) Both A and R are true but R is not the correct explanation of A.
- (iii) A is true but R is false.
- (iv) Both A and R are false.

Solution

Ans: Fluorine is most electronegative element that is why it is best oxidant among halogens. Option (i) is the correct answer.

Question 30

Assertion (A): In the reaction between potassium permanganate and potassium iodide, permanganate ions act as oxidising agent.

Reason (R): Oxidation state of manganese changes from +2 to +7 during the reaction.

- (i) Both A and R are true and R is the correct explanation of A.
- (ii) Both A and R are true but R is not the correct explanation of A.
- (iii) A is true but R is false.
- (iv) Both A and R are false.

Solution

Ans: As permanganate ion changes to



. Option(iii) is the correct answer.

Question 31

Assertion(A): The decomposition of hydrogen peroxide to form water and oxygen is an example of disproportionate reaction.

Reason (R): The oxygen of peroxide is in -1 oxidation state and it is converted to zero oxidation state in O_2 and -2 oxidation state in H_2O .

- (i) Both A and R are true and R is the correct explanation of A.
- (ii) Both A and R are true but R is not the correct explanation of A.
- (iii) A is true but R is false.
- (iv) Both A and R are false.

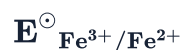
Solution

Ans: Here the oxygen of peroxide, which is present in -1 state, is converted to zero oxidation state in O_2 undergoing oxidation and decreases to -2 oxidation state in H_2O undergoing reduction. Option (i) is the correct answer.

Question 32

Assertion (A): Redox couple is the combination of oxidised and reduced form of a substance involved in an oxidation or reduction half-cell.

Reason (R): In the representation,



and



, Cu^{2+}/Cu are redox couples.

(i) Both A and R are true and R is the correct explanation of A.

(ii) Both A and R are true but R is not the correct explanation of A.

(iii) A is true but R is false.

(iv) Both A and R are false.

Solution

Ans: A redox couple is defined as pair of compounds or elements having together the oxidised and reduced forms of it and taking part in an oxidation or reduction half reaction. Option(ii) is the correct answer.

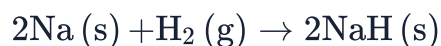
Long Answer Questions

Question 33

Explain redox reactions on the basis of electron transfer. Give suitable examples.

Solution

Ans: The given reaction is a redox change.



The half reaction is:



The other half reaction is:



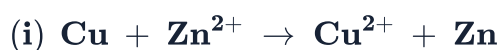
This splitting of the reaction into two half-reactions automatically reveals here that sodium is oxidized, and hydrogen is reduced. Any substance which loses electron is oxidized and gains electron is reduced hence is the case of sodium and hydrogen atoms respectively. Hence, the complete reaction is a redox change.

Question 34

On the basis of standard electrode potential values, suggest which of the following reactions would take place? (Consult the book for

$$E^\ominus$$

value).



Solution

Ans: On the basis of standard reduction potential suggested in the reactivity series (ii) reaction can take place as Mg has more negative value of

$$E^\ominus$$

cell. Hence, Mg will be oxidized by losing electron and iron will be reduced by gaining electron.

Question 35

Why does fluorine not show disproportionate reaction?

Solution

Ans: Disproportionate is defined as the reaction in which one compound of intermediate oxidation state converts to two compounds, one of higher and one of lower oxidation states. So, to occur such type of redox reaction, the element should exist in at least three oxidation states. So that element present in the intermediate state and it can change to both higher and lower oxidation state during disproportionate reaction. Fluorine is the most electronegative element and a strong oxidizing agent and is the smallest in size of all the halogens. It does not show a positive oxidation state (shows only -1 oxidation state) and hence, does not undergo disproportionate reaction.

Question 36

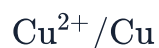
Write redox couples involved in the reactions (i) to (iv) given in question 34.

Solution

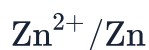
Ans: The given reactions are as given below-



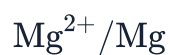
Redox couples are given as-



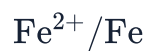
and



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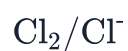
and



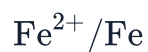
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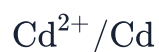
and



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and



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Question 37

Find out the oxidation number of chlorine in the following compounds and arrange them in increasing order of oxidation number of chlorine.



which oxidation state is not present in any of the above compounds?

Solution

Ans: We can calculate the oxidation states by -]

NaClO_4 Oxidation no. of chlorine = +7

Suppose oxidation number of chlorine is x then, $1 + x + 4 \times (-2) = 0$

$$\therefore x - 7 = 0$$

$$x = +7$$

We can calculate, the oxidation states, as given below-

NaClO₃ Oxidation no. of chlorine = +5

NaClO Oxidation no. of chlorine = +1

KClO₂ Oxidation no. of chlorine = +3

Cl₂O₇ Oxidation no. of chlorine = +7

ClO₃ Oxidation no. of chlorine = +6

Cl₂O Oxidation no. of chlorine = +1

NaCl Oxidation no. of chlorine = -1

Cl₂ Oxidation no. of chlorine = 0

ClO₂ Oxidation no. of chlorine = +4.

Oxidation state (+2) is not present in any of the above compounds.

Question 38

Which method can be used to find out strength of reductant/oxidant in a solution? Explain with an example.

Solution

Ans: We can Measure the electrode potential of the given species by connecting the redox couple of the given species with standard hydrogen electrode. If it is positive, the electrode of the given species acts as reductant and if it is negative, it acts as an oxidant. Find the electrode potentials of the other given species in the same way, compare the values and determine their comparative strength as an reductant or oxidant. Example Measurement of standard electrode potential of electrode

$$E_{\text{Zn}^{2+}/\text{Zn}}^{\ominus}$$

using SHE as a reference electrode.

Types of Redox Reactions

The different types of Redox Reactions are:

- Decomposition Reaction
 - Combination Reaction
 - Displacement Reaction
 - Disproportionation Reactions
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