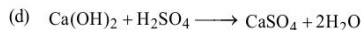


## 8

## Redox Reactions


**TOPIC 1 Oxidation and Reduction Reactions**


- The compound that cannot act both as oxidising and reducing agent is: **[Jan. 09, 2020 (I)]**  
 (a)  $\text{H}_3\text{PO}_4$  (b)  $\text{HNO}_2$  (c)  $\text{H}_2\text{SO}_3$  (d)  $\text{H}_2\text{O}_2$
- The redox reaction among the following is: **[Jan. 07, 2020 (II)]**  
 (a) formation of ozone from atmospheric oxygen in the presence of sunlight  
 (b) reaction of  $[\text{Co}(\text{H}_2\text{O})_6]\text{Cl}_3$  with  $\text{AgNO}_3$   
 (c) reaction of  $\text{H}_2\text{SO}_4$  with  $\text{NaOH}$   
 (d) combination of dinitrogen with dioxygen at 2000 K
- Which of the following reactions is an example of a redox reaction? **[2017]**  
 (a)  $\text{XeF}_4 + \text{O}_2\text{F}_2 \rightarrow \text{XeF}_6 + \text{O}_2$   
 (b)  $\text{XeF}_2 + \text{PF}_5 \rightarrow [\text{XeF}]^+ \text{PF}_6^-$   
 (c)  $\text{XeF}_6 + \text{H}_2\text{O} \rightarrow \text{XeOF}_4 + 2\text{HF}$   
 (d)  $\text{XeF}_6 + 2\text{H}_2\text{O} \rightarrow \text{XeO}_2\text{F}_2 + 4\text{HF}$
- Copper becomes green when exposed to moist air for a long period. This is due to: **[Online April 12, 2014]**  
 (a) the formation of a layer of cupric oxide on the surface of copper.  
 (b) the formation of a layer of basic carbonate of copper on the surface of copper.  
 (c) the formation of a layer of cupric hydroxide on the surface of copper.  
 (d) the formation of basic copper sulphate layer on the surface of the metal.
- Which of the following chemical reactions depict the oxidizing behaviour of  $\text{H}_2\text{SO}_4$ ? **[2006]**  
 (a)  $\text{NaCl} + \text{H}_2\text{SO}_4 \longrightarrow \text{NaHSO}_4 + \text{HCl}$   
 (b)  $2\text{PCl}_5 + \text{H}_2\text{SO}_4 \longrightarrow 2\text{POCl}_3 + 2\text{HCl} + \text{SO}_2\text{Cl}_2$



- Several blocks of magnesium are fixed to the bottom of a ship to **[2003]**  
 (a) make the ship lighter  
 (b) prevent action of water and salt  
 (c) prevent puncturing by under-sea rocks  
 (d) keep away the sharks
- Which of the following is a redox reaction? **[2002]**  
 (a)  $\text{NaCl} + \text{KNO}_3 \rightarrow \text{NaNO}_3 + \text{KCl}$   
 (b)  $\text{CaC}_2\text{O}_4 + 2\text{HCl} \rightarrow \text{CaCl}_2 + \text{H}_2\text{C}_2\text{O}_4$   
 (c)  $\text{Mg}(\text{OH})_2 + 2\text{NH}_4\text{Cl} \rightarrow \text{MgCl}_2 + 2\text{NH}_4\text{OH}$   
 (d)  $\text{Zn} + 2\text{AgCN} \rightarrow 2\text{Ag} + \text{Zn}(\text{CN})_2$

**TOPIC 2 Oxidation Number**


- The oxidation states of iron atoms in compounds (A), (B) and (C), respectively, are  $x$ ,  $y$  and  $z$ . The sum of  $x$ ,  $y$  and  $z$  is **[NV, Sep. 02, 2020 (I)]**  

$$\text{Na}_4[\text{Fe}(\text{CN})_5(\text{NOS})] \quad \text{Na}_4[\text{FeO}_4] \quad [\text{Fe}_2(\text{CO})_9]$$

(A)
(B)
(C)
- The oxidation states of transition metal atoms in  $\text{K}_2\text{Cr}_2\text{O}_7$ ,  $\text{KMnO}_4$  and  $\text{K}_2\text{FeO}_4$ , respectively, are  $x$ ,  $y$  and  $z$ . The sum of  $x$ ,  $y$  and  $z$  is **[NV, Sep. 02, 2020 (II)]**.
- Oxidation number of potassium in  $\text{K}_2\text{O}$ ,  $\text{K}_2\text{O}_2$  and  $\text{KO}_2$ , respectively, is: **[Jan. 07, 2020 (I)]**  
 (a) +2, +1 and  $+\frac{1}{2}$  (b) +1, +1 and +1  
 (c) +1, +4 and +2 (d) +1, +2 and +4
- The oxidation states of Cr in  $[\text{Cr}(\text{H}_2\text{O})_6]\text{Cl}_3$ ,  $[\text{Cr}(\text{C}_6\text{H}_5)_2]$ , and  $\text{K}_2[\text{Cr}(\text{CN})_2(\text{O})_2(\text{O}_2)(\text{NH}_3)]$  respectively are: **[2018]**  
 (a) +3, +4, and +6 (b) +3, +2, and +4  
 (c) +3, 0, and +6 (d) +3, 0, and +4

12. Amongst the following, identify the species with an atom in +6 oxidation state: [Online April 19, 2014]

(a)  $[\text{MnO}_4]^-$  (b)  $[\text{Cr}(\text{CN})_6]^{3-}$   
(c)  $\text{Cr}_2\text{O}_3$  (d)  $\text{CrO}_2\text{Cl}_2$

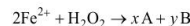
13. Oxidation state of sulphur in anions  $\text{SO}_3^{2-}$ ,  $\text{S}_2\text{O}_4^{2-}$  and  $\text{S}_2\text{O}_6^{2-}$  increases in the orders: [Online April 22, 2013]

(a)  $\text{S}_2\text{O}_6^{2-} < \text{S}_2\text{O}_4^{2-} < \text{SO}_3^{2-}$   
(b)  $\text{SO}_3^{2-} < \text{S}_2\text{O}_4^{2-} < \text{S}_2\text{O}_6^{2-}$   
(c)  $\text{S}_2\text{O}_4^{2-} < \text{SO}_3^{2-} < \text{S}_2\text{O}_6^{2-}$   
(d)  $\text{S}_2\text{O}_4^{2-} < \text{S}_2\text{O}_6^{2-} < \text{SO}_3^{2-}$

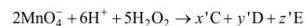
### TOPIC 3 Disproportionation and Balancing of Redox Reactions



14. Consider the following equations:



(in basic medium)



(in acidic medium)

The sum of the stoichiometric coefficients  $x, y, x', y'$  and  $z'$  for products A, B, C, D and E, respectively, is \_\_\_\_\_.

[NV, Sep. 04, 2020 (II)]

15. An example of a disproportionation reaction is:

[April 12, 2019 (I)]

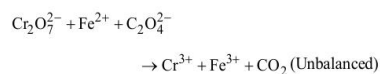
(a)  $2\text{MnO}_4^- + 10\text{I}^- + 16\text{H}^+ \rightarrow 2\text{Mn}^{2+} + 5\text{I}_2 + 8\text{H}_2\text{O}$   
(b)  $2\text{NaBr} + \text{Cl}_2 \rightarrow 2\text{NaCl} + \text{Br}_2$   
(c)  $2\text{KMnO}_4 \rightarrow \text{K}_2\text{MnO}_4 + \text{MnO}_2 + \text{O}_2$   
(d)  $2\text{CuBr} \rightarrow \text{CuBr}_2 + \text{Cu}$

16. In order to oxidise a mixture of one mole of each of  $\text{FeC}_2\text{O}_4$ ,  $\text{Fe}_2(\text{C}_2\text{O}_4)_3$ ,  $\text{FeSO}_4$  and  $\text{Fe}_2(\text{SO}_4)_3$  in acidic medium, the number of moles of  $\text{KMnO}_4$  required is:

[April 8, 2019 (I)]

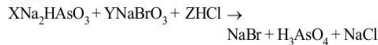
(a) 2 (b) 1 (c) 3 (d) 1.5

17. How many electrons are involved in the following redox reaction? [Online April 19, 2014]



(a) 3 (b) 4 (c) 6 (d) 5

18. Given:

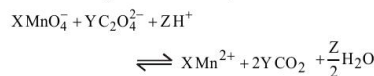


The values of X, Y and Z in the above redox reaction are respectively:

[Online April 9, 2013]

(a) 2, 1, 2 (b) 2, 1, 3 (c) 3, 1, 6 (d) 3, 1, 4

19. In the following balanced reaction,



values of X, Y and Z respectively are

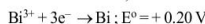
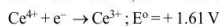
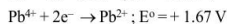
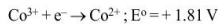
[Online May 12, 2012; 2013]

(a) 2, 5, 16 (b) 8, 2, 5 (c) 5, 2, 16 (d) 5, 8, 4

### TOPIC 4 Electrode Potential and Oxidising, Reducing Agents



20. Given:

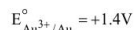
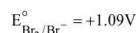
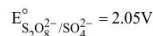


oxidizing power of the species will increase in the order:

[April 12, 2019 (I)]

(a)  $\text{Ce}^{4+} < \text{Pb}^{4+} < \text{Bi}^{3+} < \text{Co}^{3+}$   
(b)  $\text{Bi}^{3+} < \text{Ce}^{4+} < \text{Pb}^{4+} < \text{Co}^{3+}$   
(c)  $\text{Co}^{3+} < \text{Ce}^{4+} < \text{Bi}^{3+} < \text{Pb}^{4+}$   
(d)  $\text{Co}^{3+} < \text{Pb}^{4+} < \text{Ce}^{4+} < \text{Bi}^{3+}$

21. Given that  $E^\circ_{\text{O}_2/\text{H}_2\text{O}} = +1.23 \text{ V}$ ;

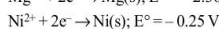
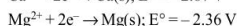
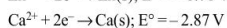
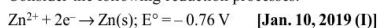


[April 8, 2019 (I)]

The strongest oxidising agent is:

(a)  $\text{Au}^{3+}$  (b)  $\text{O}_2$  (c)  $\text{S}_2\text{O}_8^{2-}$  (d)  $\text{Br}_2$

22. Consider the following reduction processes:



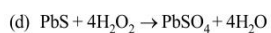
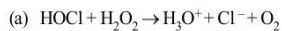
The reducing power of the metals increases in the order:

(a)  $\text{Ca} < \text{Zn} < \text{Mg} < \text{Ni}$  (b)  $\text{Ni} < \text{Zn} < \text{Mg} < \text{Ca}$   
(c)  $\text{Zn} < \text{Mg} < \text{Ni} < \text{Ca}$  (d)  $\text{Ca} < \text{Mg} < \text{Zn} < \text{Ni}$

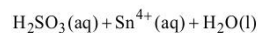
23. In the reaction of oxalate with permanganate in acidic medium, the number of electrons involved in producing one molecule of  $\text{CO}_2$  is: [Jan. 10, 2019 (II)]

(a) 1 (b) 10 (c) 2 (d) 5

24. In which of the following reactions, hydrogen peroxide acts as an oxidizing agent? [Online April 8, 2017]



25. Consider the reaction:



Which of the following statements is correct?

[Online April 19, 2014]

(a)  $\text{Sn}^{4+}$  is the oxidizing agent because it undergoes oxidation

(b)  $\text{Sn}^{4+}$  is the reducing agent because it undergoes oxidation

(c)  $\text{H}_2\text{SO}_3$  is the reducing agent because it undergoes oxidation

(d)  $\text{H}_2\text{SO}_3$  is the reducing agent because it undergoes reduction

26. Which one of the following cannot function as an oxidising agent? [Online April 25, 2013]

(a)  $\text{I}^-$  (b)  $\text{S}(\text{s})$  (c)  $\text{NO}_3^-(\text{aq})$  (d)  $\text{Cr}_2\text{O}_7^{2-}$

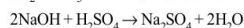
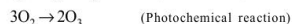


## Hints & Solutions

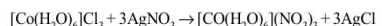


1. (a) In  $\text{H}_3\text{PO}_4$  oxidation state of P is +5, which cannot be oxidised further to a higher oxidation state. Hence, it cannot act as reducing agent.

2. (d)  $\text{N}_2 + \text{O}_2 \rightarrow 2\text{NO}$  (Redox reaction)

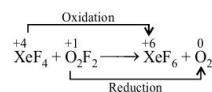


(Neutralisation reaction)



(Neutralisation reaction)

3. (a) In the reaction

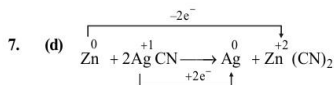


4. (b) Copper when exposed to moist air having  $\text{CO}_2$ . It gets superficially coated with a green layer of basic carbonate  $\text{CuCO}_3 \cdot \text{Cu}(\text{OH})_2$ .

5. (c)  $2\text{HI} + \text{H}_2\text{SO}_4 \longrightarrow \text{I}_2 + \text{SO}_2 + 2\text{H}_2\text{O}$

in this reaction oxidation number of S is decreasing from +6 to +4 hence undergoing reduction and for HI oxidation number of I is increasing from -1 to 0 hence undergoing oxidation, therefore  $\text{H}_2\text{SO}_4$  is acting as oxidising agent.

6. (b) Magnesium provides cathodic protection and prevents rusting or corrosion.



The oxidation state shows a change only in (d)

8. (6)

The oxidation states of iron in these compounds will be -

$$\text{In A, } x + 5(-1) + (-1) = -4 \Rightarrow x = +2$$

$$\text{In B, } y + 4(-2) = -4 \Rightarrow y = +4$$

$$\text{In C, } z = 0$$

The sum of oxidation states will be  $= 4 + 2 + 0 = 6$ .

9. (19)

| Compound                              | Oxidation state of transition element |
|---------------------------------------|---------------------------------------|
| (i) $\text{K}_2\text{Cr}_2\text{O}_7$ | $x = +6$                              |
| (ii) $\text{KMnO}_4$                  | $y = +7$                              |
| (iii) $\text{K}_2\text{FeO}_4$        | $z = +6$                              |

$$\text{So, } (x + y + z) = 6 + 7 + 6 = 19.$$

10. (b)  $\text{K}_2\text{O} : 2x - 2 = 0 \Rightarrow x = +1$

$$\text{K}_2\text{O}_2 : 2x - 2 = 0 \Rightarrow x = +1$$

$$\text{KO}_2 : x - 1 = 0 \Rightarrow x = +1$$

Thus, potassium shows +1 state in all its oxides, superoxides and peroxides.

11. (c)  $[\text{Cr}(\text{H}_2\text{O})_6]\text{Cl}_3$

$$\Rightarrow x + 6 \times 0 + (-1) \times 3 = 0$$

$$\Rightarrow x = +3$$

$$[\text{Cr}(\text{C}_6\text{H}_5)_2]$$

$$x + 2 \times 0 = 0 ; x = 0$$

$$\text{K}_3[\text{Cr}(\text{CN})_2(\text{O})_2(\text{O}_2)(\text{NH}_3)]$$

$$[\text{Here } (\text{O})_2 \text{ is OXO, } (2x - 2) \text{ and}$$

$$(\text{O}_2) \text{ is per OXO, } (1x - 2)]$$

$$2 \times 1 + x + 2 \times (-1) + 2 \times (-2) + (-2) + 0 = 0$$

$$x = +6$$

12. (d)  $\text{CrO}_2\text{Cl}_2$

Let O. No. of Cr = x

$$\therefore x + 2(-2) + 2(-1) = 0$$

$$x - 4 - 2 = 0$$

$$\therefore x = +6$$

13. (e) In  $\text{SO}_3^{2-}$

$$x + 3(-2) = -2 ; x = +4$$

$$\text{In } \text{S}_2\text{O}_4^{2-}$$

$$2x + 4(-2) = -2$$

$$2x - 8 = -2$$

$$2x = 6 ; x = +3$$

$$\text{In } \text{S}_2\text{O}_6^{2-}$$

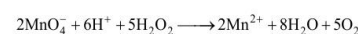
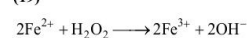
$$2x + 6(-2) = -2$$

$$2x = 10 ; x = +5$$

hence the correct order is

$$\text{S}_2\text{O}_4^{2-} < \text{SO}_3^{2-} < \text{S}_2\text{O}_6^{2-}$$

14. (19)

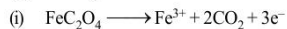
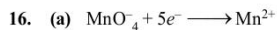


$$\therefore x = 2, y = 2, x' = 2, y' = 8, z' = 5$$

$$\therefore x + y + x' + y' + z' = 19$$

15. (d)  $\text{CuBr} \longrightarrow \text{Cu} + \text{CuBr}_2$

It is an example of disproportionation reaction, as Cu undergoes both oxidation and reduction.



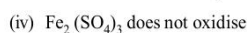
1 mole of  $\text{FeC}_2\text{O}_4$  reacts with  $\frac{3}{5}$  mole of acidified  $\text{KMnO}_4$



1 mole of  $\text{Fe}_2(\text{C}_2\text{O}_4)_3$  reacts with  $\frac{6}{5}$  moles of  $\text{KMnO}_4$

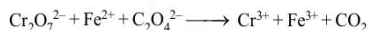


1 mole of  $\text{FeSO}_4$  react with  $\frac{1}{5}$  moles of  $\text{KMnO}_4$

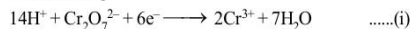


$$\therefore \text{Total moles required} = \frac{3}{5} + \frac{6}{5} + \frac{1}{5} = 2$$

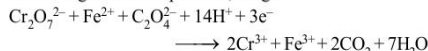
17. (a) The reaction given is



On balancing

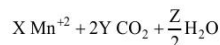
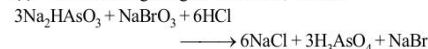


On adding all three equations, we get



Hence the total no. of electrons involved in the reaction = 3

18. (c) On balancing the given reaction, we find



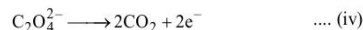
On balancing



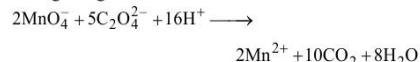
Second half reaction



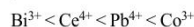
On balancing



On multiplying eqn. (ii) by 5 and (iv) by 2 and then adding we get



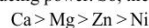
20. (b) Higher the reduction potential, higher will be oxidising power. So,



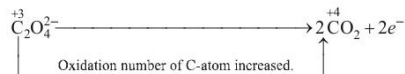
21. (c) More positive is the reduction potential stronger is the oxidising agent.

Reduction potential is maximum for  $\text{S}_2\text{O}_8^{2-}$ , therefore, it is the strongest oxidising agent amongst the given species.

22. (b) Higher the oxidation potential, higher will be the reducing power. So, the order of reducing behaviour is:

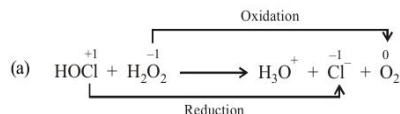


23. (a) Reaction involved:

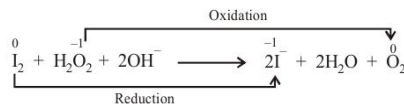


$\therefore$  The number of electrons involved in producing one mole of  $\text{CO}_2$  is 1.

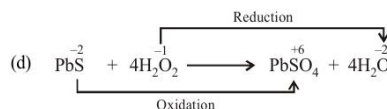
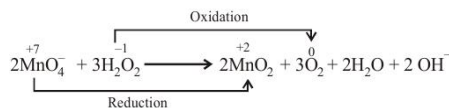
24. (d)



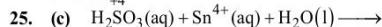
(b)



(c)



Notice that the oxidation state of oxygen goes from -1 on the  $\text{H}_2\text{O}_2$  to -2 on the  $\text{H}_2\text{O}$  means  $\text{H}_2\text{O}_2$  is being reduced. On the other hand the oxidation state of sulfur is going from -2 on the  $\text{PbS}$  to +6 on the  $\text{PbSO}_4$ , i.e. Sulfur is being oxidised.



Hence  $\text{H}_2\text{SO}_3$  is the reducing agent because it undergoes oxidation.

26. (a) If an electronegative element is in its lowest possible oxidation state in a compound or in free state. It can function as a powerful reducing agent. e.g.  $\text{I}^-$