Redox Reactions

Question1

If the number of moles of Fe^{2+} ions oxidised by one mole of acidified MnO_4^- is x, the number of moles of Fe^{2+} ions oxidised by one mole of acidified $Cr_2O_7^{2-}$ is

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Options:

A.

$\frac{5x}{8}$

B.

$\frac{6x}{5}$

C.

$\frac{8x}{5}$

D.

$\frac{5x}{6}$

Answer: B

Solution:

The reactions that happen are:

$$MnO_4^- + 5e^- \longrightarrow Mn^{2+} \quad \text{(1 mole of } MnO_4^- \text{ takes 5 electrons)}$$
$$Cr_2O_7^{2-} + 14H^+ + 6e^- \longrightarrow 2Cr^{3+} + 7H_2O \quad \text{(1 mole of } Cr_2O_7^{2-} \text{ takes 6 electrons)}$$
$$Fe^{2+} \longrightarrow Fe^{3+} \quad \text{(Each } Fe^{2+} \text{ loses 1 electron.)}$$

Step 1: How many Fe^{2+} ions does 1 mole of MnO_4^- oxidize?

1 mole of MnO_4^- can take in 5 electrons. Each Fe^{2+} gives up 1 electron to get oxidized. So, 1 mole of MnO_4^- can oxidize 5 moles of Fe^{2+}. This number is called x.

Step 2: How many Fe^{2+} ions does 1 mole of $Cr_2O_7^{2-}$ oxidize?

1 mole of $Cr_2O_7^{2-}$ can take in 6 electrons. That means it can oxidize 6 moles of Fe^{2+}.

Step 3: What is the answer in terms of x?

Since $x = 5$, and $Cr_2O_7^{2-}$ can oxidize 6 moles, the answer is $\frac{6x}{5}$ moles of Fe^{2+} ions.

Question2

In acidic medium one mole each of MnO_4^- and $Cr_2O_7^{2-}$ is reduce by x and y moles of ferrous ions. The sum of x and y is

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Options:

A.

14

B.

12

C.

10

D.

11

Answer: D

Solution:

In acidic medium,

$5Fe^{2+} + MnO_4^- + 8H^+ \longrightarrow Mn^{2+} + 4H_2O + 5Fe^{3+}$

1 mole of MnO_4^- requires 5 moles of $Fe^{2+} x = 5$

$Cr_2O_7^{2-} + 14H^+ + 6Fe^{2+} \longrightarrow 2Cr^{3+} + 7H_2O + 6Fe^{3+}$

1 mole of $Cr_2O_7^{2-}$ are needed to give 6 moles of $Fe^{3+}, y = 6.$

$x + y = 5 + 6 = 11$

Question3

$$C + \text{Conc. } H_2SO_4 \xrightarrow{\Delta} X + Y + H_2O$$

X and Y in the above reaction are

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Options:

A. CO, SO_3

B. CO_2, SO_2

C. CO, SO_2

D. C_3O_2, SO_2

Answer: B

Solution:

The balanced chemical reaction is:

$C + 2H_2SO_4 \longrightarrow CO_2 + 2SO_2 + 2H_2O$

In this reaction:

Product X is Carbon dioxide (CO_2)

Product Y is Sulphur dioxide (SO_2)

Question4

Observe the following reaction,

$$2KClO_3(s) \xrightarrow{\Delta} 2KCl(\ s) + 3O_2(\ g)$$

In this reaction

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Options:

A. Cl is oxidised and O is reduced

B. Cl is reduced and O is oxidised

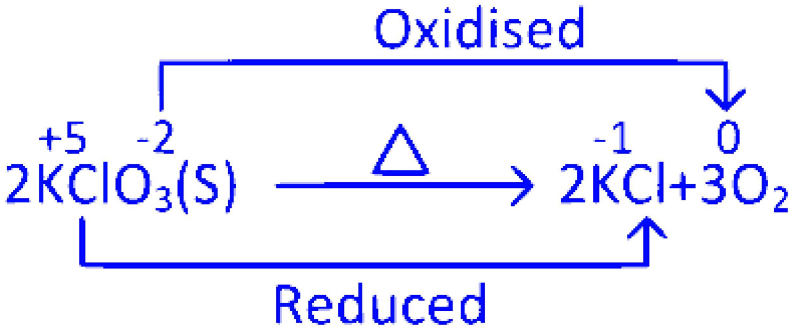
C. K is oxidised and O is reduced

D. K is reduced and Cl is also reduced

Answer: B

Solution:

Given reaction is,



In this reaction,

Cl of $KClO_3$ (oxidation number $= +5$) is reduced to Cl^- and O of $KClO_3$

$KClO_3$ (oxidation number $= -2$) is oxidised to O_2.

Question5

Match the following.

List.l (Substance)	List II (Equivalent weight)
A Na_2CO_3	I. $\frac{M}{5}$
B $KMnO_4/H^+$	II. $\frac{M}{3}$
C $K_2Cr_2O_7/H^+$	III. $\frac{M}{2}$
D $KMnO_4/H_2O$	IV. $\frac{M}{6}$

(M = Formula weight)

The correct answer is

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Options:

A. A-III, B-I, C-IV, D-II

B. A -III, B -IV, C-I, D-II

C. $A-II, B-III, C-IV, D-I$

D. A -IV, B-II, C-III, D-I

Answer: A

Solution:

The correct match is A-III, B-I, C-IV, D-II.

For Na_2CO_3 the equivalent weight is $\frac{M}{2}$ as it is diprotic base.

In acidic medium, the n-factor for $KMnO_4$ is 5 . So, its equivalent weight is $\frac{M}{5}$.

In neutral medium, the n-factor for $K_2 2_2 r_2$ is 6 . So, its equivalent weight is $\frac{M}{6}$. In neutural medium, the n-factor for $KMnO_4$ is 3. So, its equivalent weight is $\frac{M}{3}$.

Question6

The normality of 20 volume solution of hydrogen peroxide is

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Options:

A. 0.892 N .

B. 1.785 N

C. 2.678 N

D. 3.570 N

Answer: D

Solution:

20 Volume of H_2O_2 solution refers to 1 L of H_2O_2 solution that will liberale 20 L of O_2 at NTP.

$$\underset{68\text{ g}}{2H_2O_2} \rightarrow 2H_2O + \underset{22.4\text{ L at NTP}}{O_2}$$

22.4 L of O_2 at NTP produce from $H_2O_2 = 68$ g

20 L of O_2 at NTP produce from H_2O_2

$= \frac{68}{22.4} \times 20 = 60.71$ g

Strength of $H_2O_2 = 60.71$ g/L

Equivalent weight of $H_2O_2 = \frac{68}{32} \times 8 = 17$

$$\text{Normality} = \frac{\text{Strength}}{\text{Equivalent weight}} = \frac{60.71}{17}$$

Normality ≈ 3.570 N

Question7

In which of the following, ions are correctly arranged in the increasing order of oxidising power?

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Options:

A. $Cr_2O_7^{2-} < MnO_4^- < VO_2^+$

B. $VO_2^+ < Cr_2O_7^{2-} < MnO_4^-$

C. $VO_2^+ < MnO_4^- < Cr_2O_7^{2+}$

D. $MnO_4^- < Cr_2O_7^{2-} < VO_2^+$

Answer: B

Solution:

In the given three oxoanions, the oxidation state of V, Cr and Mn in VO_2^+, $Cr_2O_7^{2-}$ and MnO_4^- are $+5$, $+6$ and $+7$ respectively.

Hence, the correct increasing order is, $VO_2^+ < Cr_2O_7^{2-} < MnO_4^-$

Question8

Observe the following reactions.

I. $H_2O(l) + 2Na(s) \longrightarrow 2NaOH(aq) + H_2(g)$

II. $2H_2O(l) + 2\,F_2(g) \longrightarrow 4H^+(aq) + 4\,F^-(aq) + O_2(g)$

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Options:

A. In both reaction I and reaction II, water is oxidised.

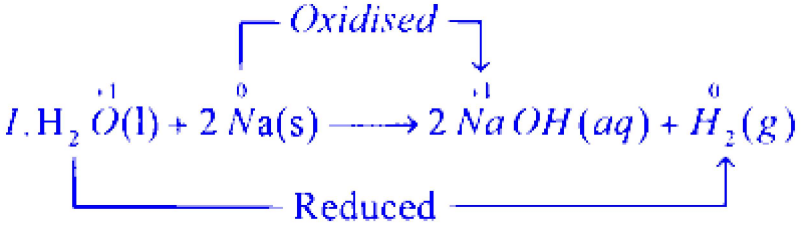
B. In both reaction I and reaction II, water is reduced.

C. In reaction I water is reduced and in reaction II water is oxidised.

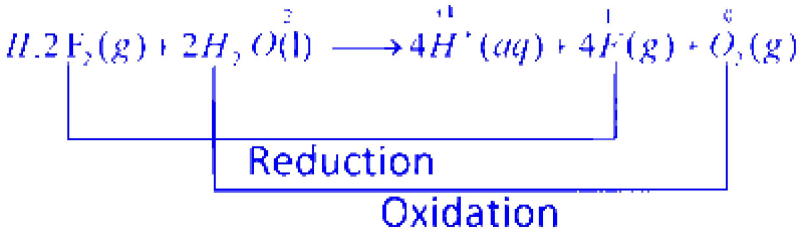
D. In reaction I water is oxidised and in reaction II water is reduced.

Answer: C

Solution:



Sodium is oxldised from 0 to +1. Water is reduced from +1 to 0.



Fluorine is reduced from 0 to -1. Water is oxidised from -2 to 0.

Question9

Which of the following is only a redox reaction but not a disproportionation reaction?

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Options:

A. $4H_3PO_3 \longrightarrow 3H_3PO_4 + PH_3$

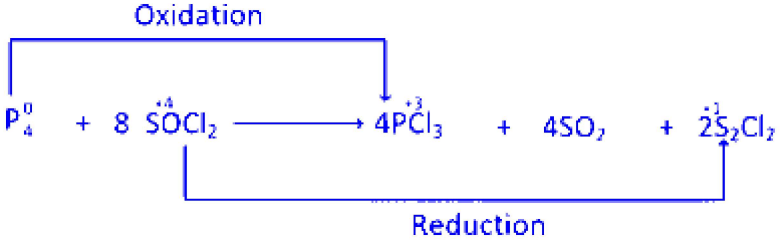
B. $2H_2O_2 \longrightarrow 2H_2O + O_2$

C. $P_4 + 3NaOH + 3H_2O \longrightarrow 3NaH_2PO_2 + PH_3$

D. $P_4 + 8SOCl_2 \longrightarrow 4PCl_3 + 2\,S_2Cl_2 + 4SO_2$

Answer: D

Solution:



In above reaction, oxidation and reduction takes place simultaneously that means it is a redox reaction but it is not a disproportionation reaction because same element is not simultaneously oxidised and reduced.

Question10

The equivalent weight of which of the following is maximum?(Given : atomic weights $\mathrm{Na}=23, \mathrm{Mn}=55$, $\mathrm{Cr}=52,\ \mathrm{K}=39, \mathrm{O}=16, \mathrm{C}=12$)

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Options:

A. $\mathrm{Na_2C_2O_4 \cdot 2H_2O}$

B. $\mathrm{KMnO_4/H^+}$

C. $\mathrm{KMnO_4/H_2O}$

D. $\mathrm{K_2Cr_2O_7/H^+}$

Answer: A

Solution:

To determine which compound has the maximum equivalent weight, let's calculate the equivalent weights for each:

For $\mathrm{Na_2C_2O_4 \cdot 2H_2O}$:

The formula for calculating equivalent weight is:

$$\text{Equivalent weight} = \frac{\text{Molar mass}}{\text{n-factor}}$$

Here, n-factor is 2 because it involves a two-electron transfer process. The molar mass of $\mathrm{Na_2C_2O_4 \cdot 2H_2O}$ is:

$$2(23) + 2(12) + 4(16) + 2(18) = 170$$

$$\text{Equivalent weight} = \frac{170}{2} = 85\,\mathrm{g\,eq^{-1}}$$

For $\mathrm{KMnO_4/H^+}$:

This reaction has an n-factor of 5 due to the change in oxidation state from +7 to +2 for Mn. The molar mass is:

$39 + 55 + 4(16) = 158$

Equivalent weight $= \frac{158}{5} = 31.6\,\text{g eq}^{-1}$

For $KMnO_4/H_2O$:

When Mn changes from +7 to +4, the n-factor is 3. The molar mass calculation remains the same:

$39 + 55 + 64 = 158$

Equivalent weight $= \frac{158}{3} = 52.6\,\text{g eq}^{-1}$

For $K_2Cr_2O_7/H^+$:

The n-factor is 6 because chromium changes from an oxidation state of +6 to +3. The molar mass is:

$2(39) + 2(52) + 7(16) = 294$

Equivalent weight $= \frac{294}{6} = 49\,\text{g eq}^{-1}$

The compound $Na_2C_2O_4 \cdot 2H_2O$ has the highest equivalent weight of 85 g eq^{-1}.
