MANZIL

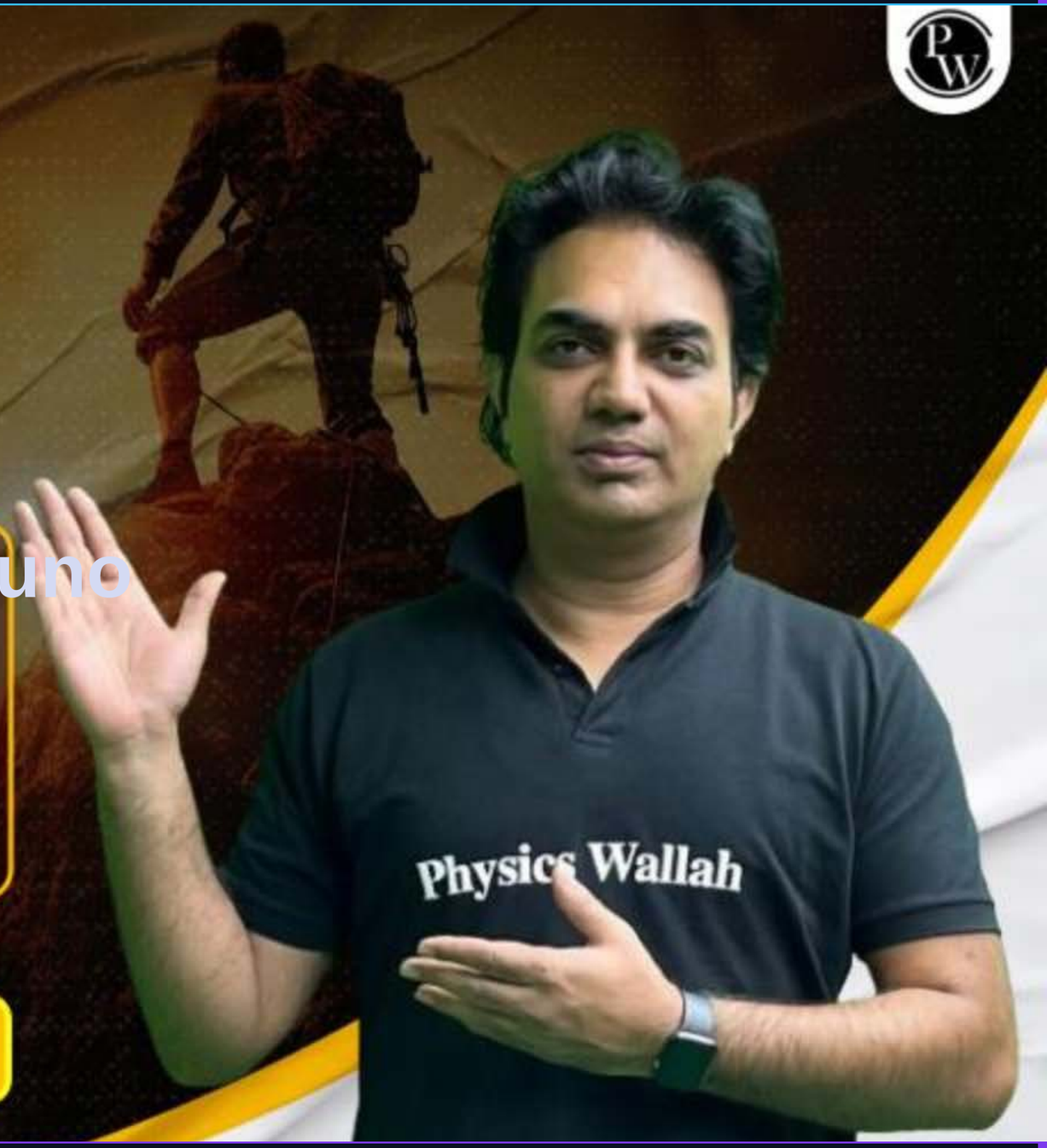
FOR JEE ASPIRANTS

CHEMISTRY

REDOX REACTION

In One Shot

FAISAL RAZAQ



Topics to be covered

1. Oxidation and Reduction
2. Calculation of Oxidation state
3. n-factor Calculations
4. Law of Equivalence

FOR NOTES & DPP CHECK DESCRIPTION

Topics to be covered

5. Simple Titration
6. Disproportionation Reactions
7. Balancing of Redox Reactions
8. Volume Strength of H_2O_2 and labelling of oleum.

FOR NOTES & DPP CHECK DESCRIPTION

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TELEGRAM CHANNEL

OLD CONCEPT OF OXIDATION

(a) Oxidation is a chemical reaction in which oxygen is added

$2HNO_2 + O_2 \longrightarrow 2HNO_3$; $CH_3CHO + O \longrightarrow CH_3COOH$

(b) Hydrogen is removed i.e. hydrogen becomes less

$\overset{0}{Zn} + 2HCl \longrightarrow \overset{+2}{Zn}Cl_2 + H_2$; $Cu + 4HNO_3 \longrightarrow Cu(NO_3)_2 + 2NO_2 + 2H_2O$

oxid.

(c) Electronegative element is added

$2FeCl_2 + Cl_2 \longrightarrow 2FeCl_3$; $2Sb + 3Cl_2 \longrightarrow 2SbCl_3$

(d) Electropositive element is removed

$2NaI + H_2O_2 \longrightarrow 2NaOH + I_2$;

(e) Valency of electropositive element increases

$SnCl_2 + Cl_2 \longrightarrow SnCl_4$

+2 +4 oxidation of $SnCl_2$

electron loss ⇒ Oxidation

+3 +5

HNO_2 HNO_3

$1 + x + 2(-2) = 0$ $1 + x + 3(-2) = 0$

$x = +3$ $x = +5$

OLD CONCEPT OF REDUCTION

(a) Hydrogen is added. For example

$H_2 + Cl_2 \longrightarrow 2HCl$ $\quad N_2 + 3H_2 \longrightarrow 2NH_3$

(b) Oxygen is lost. For example

$Fe_2O_3 + 2Al \longrightarrow 2Fe + Al_2O_3$ $\quad Cr_2O_3 + 2Al \longrightarrow 2Cr + Al_2O_3$

(c) Electropositive element is added. For example

$2HgCl_2 + SnCl_2 \longrightarrow Hg_2Cl_2 + SnCl_4$ $\quad CuCl_2 + Cu \longrightarrow Cu_2Cl_2$

(d) Electronegative element is removed. For example

$2FeCl_3 + H_2 \longrightarrow 2FeCl_2 + 2HCl$ $\quad PbS + H_2 \longrightarrow Pb + H_2S$

(e) Valency of electropositive element decreases. For example

$CuSO_4 + Fe \longrightarrow FeSO_4 + Cu$

(Cu^{+2}) $\quad (Cu^{0})$

$FeCl_3 + H_2S \longrightarrow FeCl_2 + 2HCl + S$

(Fe^{+3}) $\quad (Fe^{+2})$

MODERN CONCEPT OF OXIDATION (Important) electron loss

(a) Neutral atom : When a neutral atom loses electron, it gets converted to a positive ion.

$$Na \longrightarrow Na^{+1} + e^-$$

$$Al \longrightarrow Al^{+3} + 3e^-$$

(b) Cation : When a cation loses electron, there is an increase in its positive charge.

$$Sn^{+2} \longrightarrow Sn^{+4} + 2e^-$$

$$Hg^{+1} \longrightarrow Hg^{+2} + e^-$$

(c) Anion : When an anion loses electron equal to its negative charge, it gets converted to a neutral atom.

$$2O^{-2} \longrightarrow O_2 + 4e^-$$

$$2N^{-3} \longrightarrow N_2 + 6e^-$$

(d) **Complex Anion :** When a complex anion loses electron, its negative charge decreases.

$$[Fe(CN)_6]^{-4} \longrightarrow [Fe(CN)_6]^{-3} + e^-$$ (electron loss)

(e) **Molecule :** When a molecule loses electrons, it breaks up into it constituents.

$$H_2O_2 \longrightarrow 2H^{+1} + O_2 + 2e^-$$

Therefore in oxidation reactions–

(i) Positive charge increases and negative charge decreases

(ii) Oxidation number increases

?

Positive charge ↑ electron loss

Negative charge ↓ electron loss

Oxidation

MODERN CONCEPT OF REDUCTION (electron gain)

(a) **Neutral Atom :** When a neutral element or atom accepts electrons it gets converted into an anion.

$N + 3e^- \longrightarrow N^{-3}$ $\qquad$ $S + 2e^- \longrightarrow S^{-2}$

(b) **Cation :** When a cation accepts electron equal to its charge, it gets converted into a neutral atom.

$Mg^{+2} + 2e^- \longrightarrow Mg^{o}$ $\qquad$ $Al^{+3} + 3e^- \longrightarrow Al^{o}$

(c) Similarly, when a cation accepts less electrons than its charge, its positive charge decreases. For example

$Cu^{+2} + e^- \longrightarrow Cu^{+1}$ $\qquad$ $Fe^{+3} + e^- \longrightarrow Fe^{+2}$

(d) **Anion :** When an anion accepts electron, its negative charge increases.

$MnO_4^{-1} + e^- \longrightarrow MnO_4^{-2}$

$[Fe(CN)_6]^{-3} + e^- \longrightarrow [Fe(CN)_6]^{-4}$

(e) **Molecule :** When a molecule accepts electron, it is a reduction reaction.

$O_2 + 4e^- \longrightarrow 2O^{-2}$ $\qquad$ $I_2 + 2e^- \longrightarrow 2I^{-1}$

Therefore in reduction reactions–

(i) Positive charge decreases and negative charge increases

(ii) Oxidation number decreases

electron gain → redⁿ

positive charge ↓ electron gain

negative charge ↑ electron gain } Reduction.

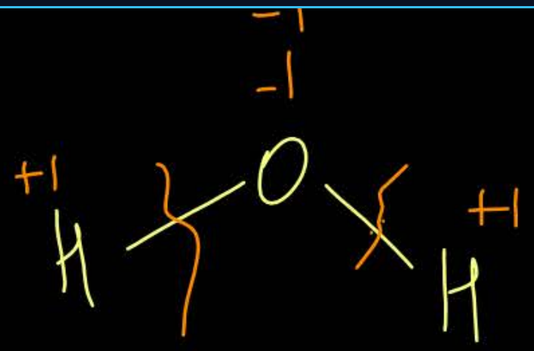
K.B.

Electron loss ⟶ oxidation

Electron Gain ⟶ Reduction.

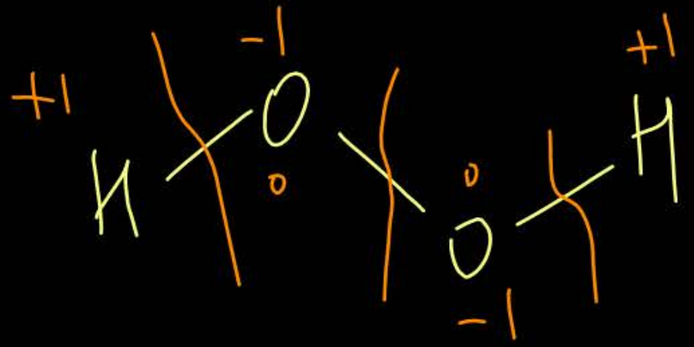
Oxidation State

"The oxidation state of an atom can be defined as the hypothetical charge that would be held by that atom if all of its bonds to other atoms were completely ionic in nature."



O·S of O in H_2O = −2

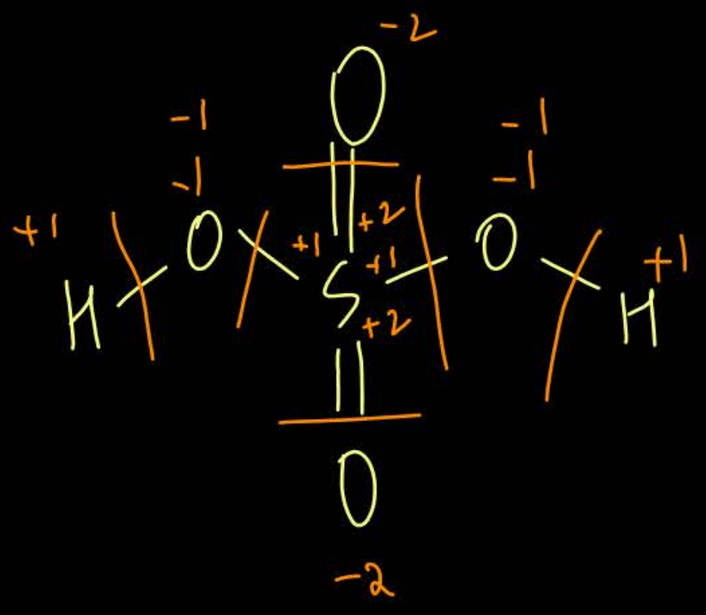
O·S of both the H-atoms = +1



O·S of both the O-atoms = −1

O·S of both the H-atoms = +1

H_2SO_4

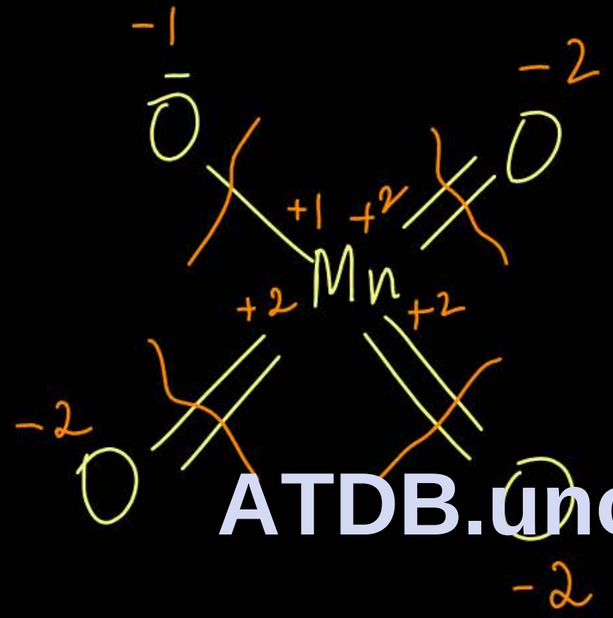


O.S of S = +6

O.S of O = −2, −2, −2, −2

O.S of H = +1, +1

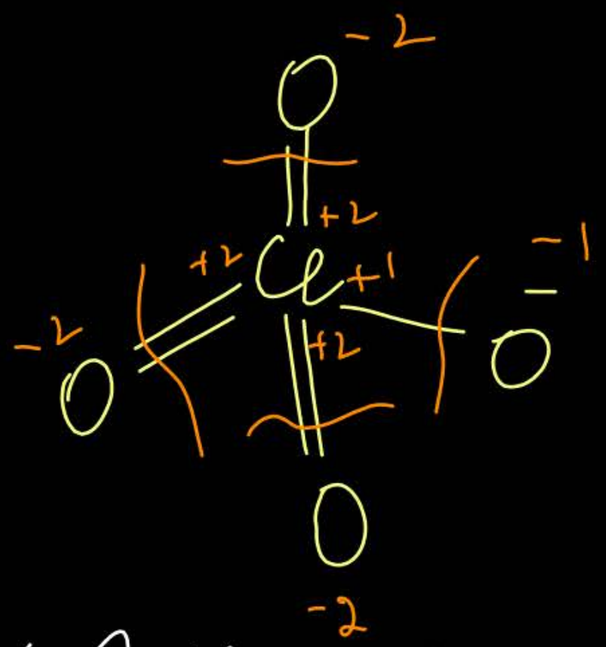
MnO_4^-



Mn = +7

O.S of all the O-atoms = −2

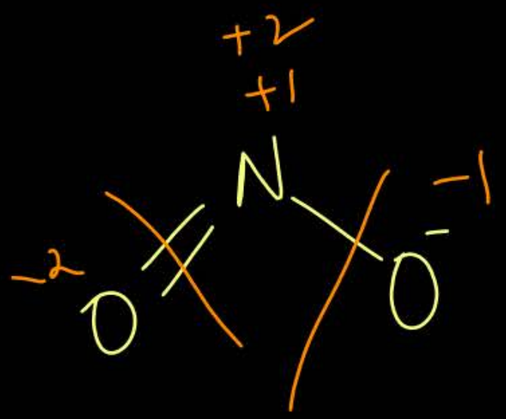
ClO_4^-



O.S of Cl = +7

O.S of all O-atoms = −2

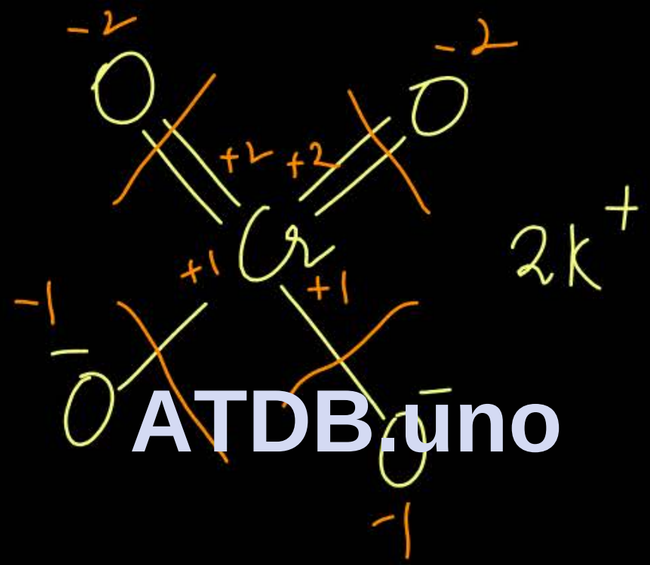
NO_2^-



O.S of N = +3

O.S of both O = -2

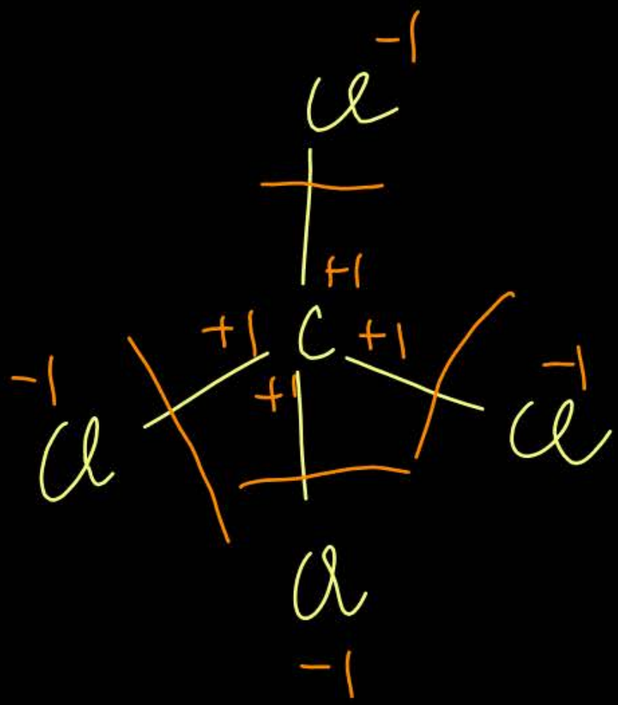
$K_2CrO_4 \longrightarrow 2K^+ + CrO_4^{2-}$



O.S of Cr = +6

O.S of all O = -2

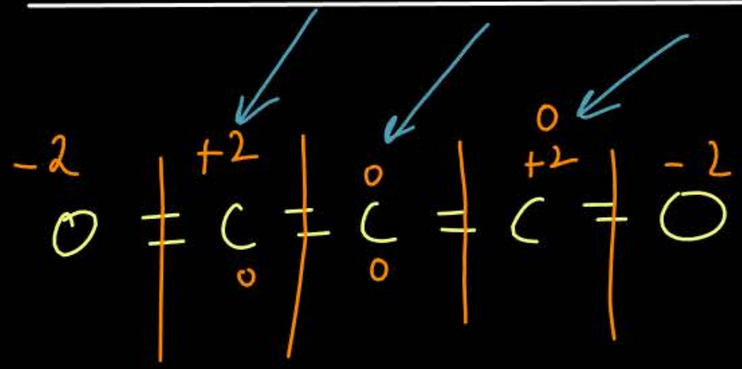
CCl_4



O.S of C = +4

O.S of all Cl = -1

Carbon Suboxide (C_3O_2)

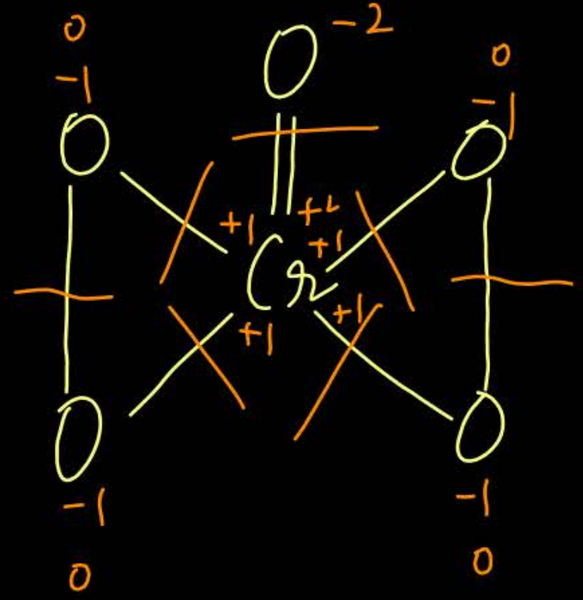


* Out of 3-carbon atoms, two carbon atoms have +2 O.S and one carbon has 0 o.s.

* Both the O-atoms = -2

Avg O.S of Carbon = $\frac{2+0+2}{3} = \frac{4}{3}$

CrO_5 (Butterfly Structure)

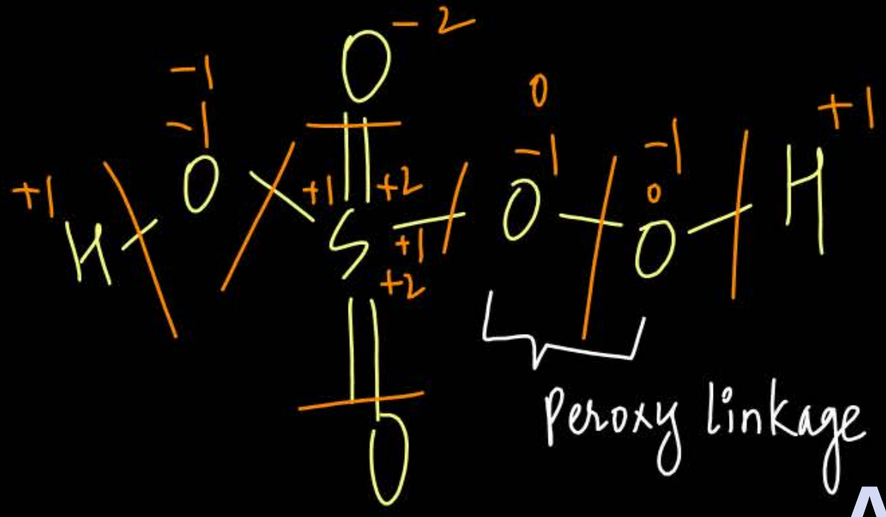


O.S of Cr = +6

O.S of 4 O-atoms = -1

O.S of one O-atom = -2

Caro's Acid (H_2SO_5)

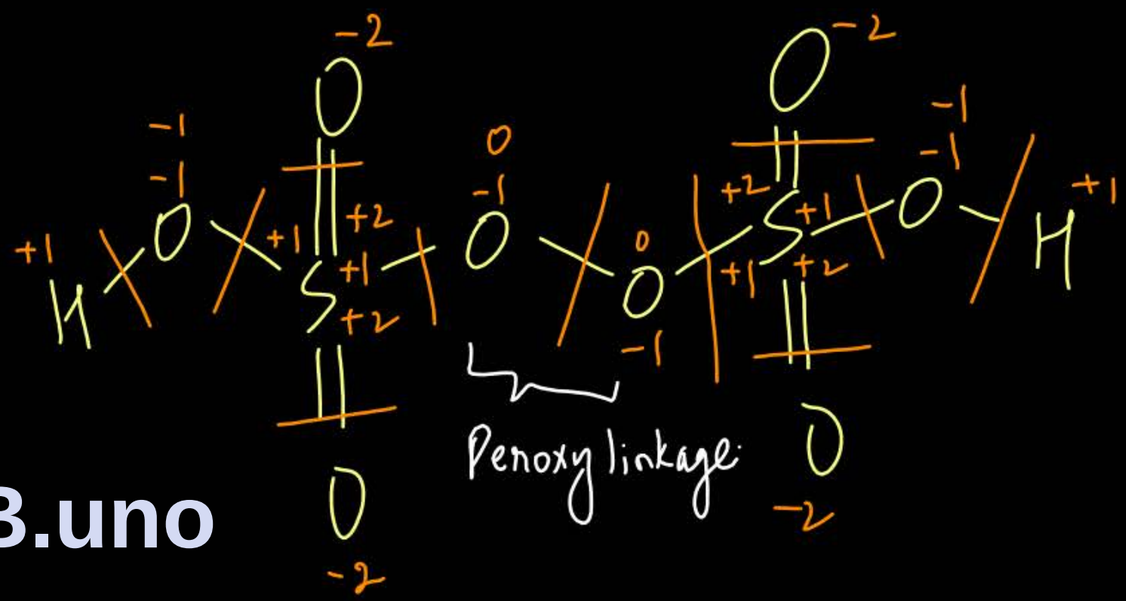


O·S of S-atom = +6

O·S of 2-O-atoms = −1

O·S of 3 O-atoms = −2

Marshal's Acid ($H_2S_2O_8$)

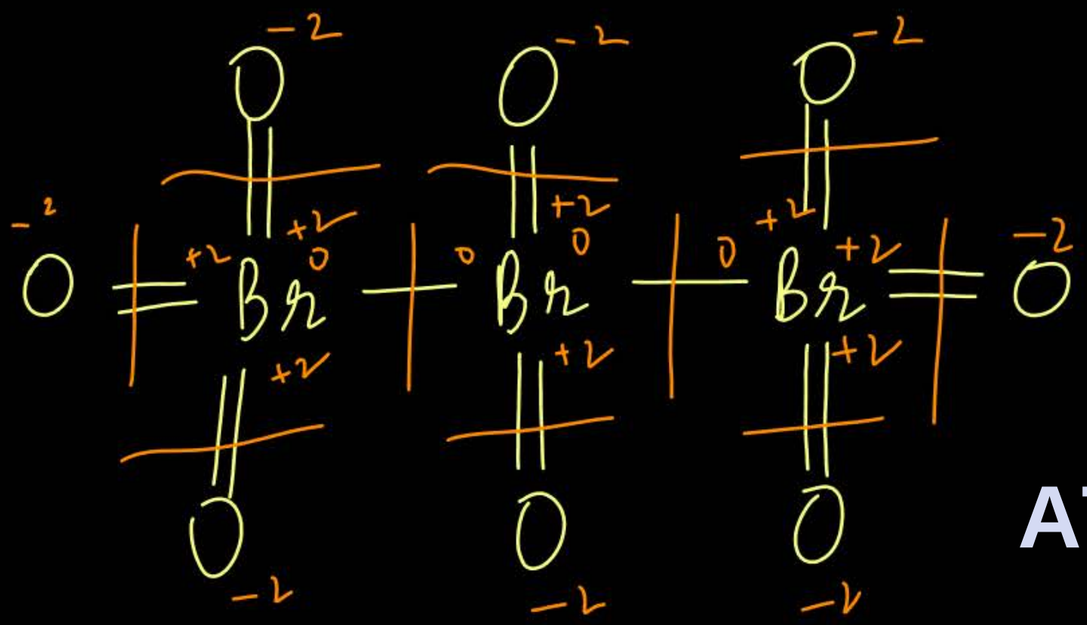


O·S of S-atom = +6 , +6

O·S of 6 O-atoms = −2

O·S of 2 O-atoms = −1

Tribromooctaoxide (Br_3O_8)

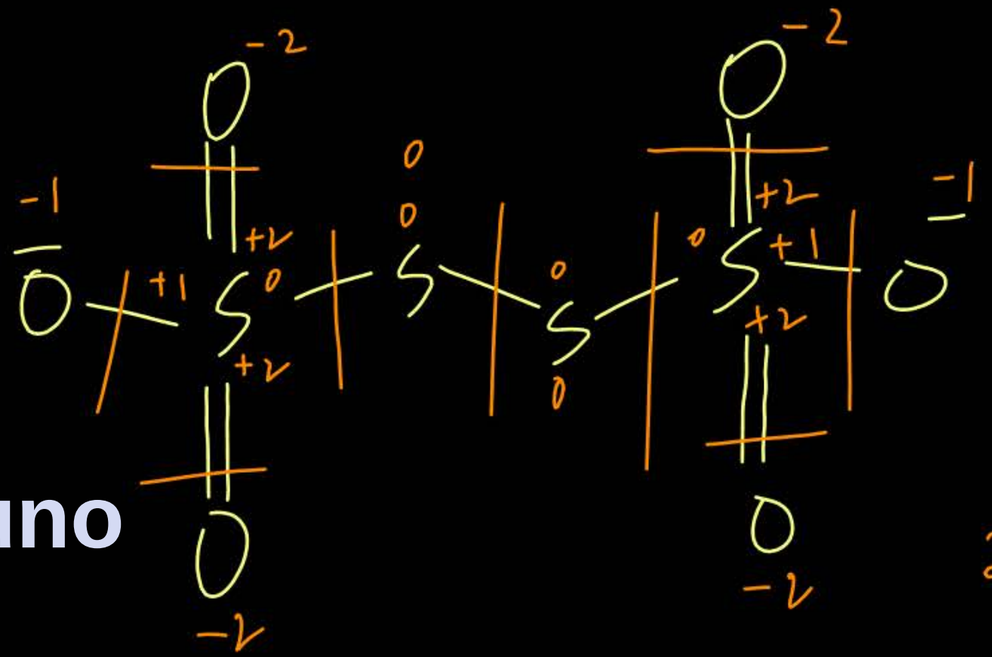


O.S of Br-atoms = +6, +4, +6

O.S of all the O-atoms = −2

Avg O.S of Br = $\frac{+6+4+6}{3} = \frac{16}{3}$

Tetrathionate ion ($S_4O_6^{-2}$)

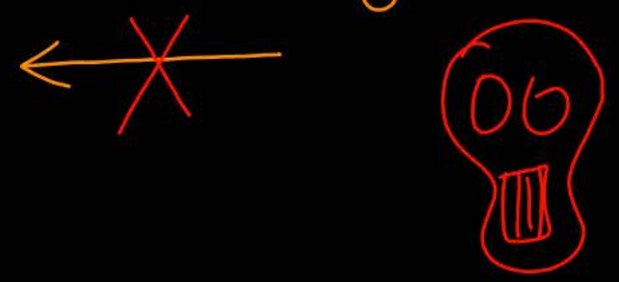


O.S of two S-atoms = +5

O.S of two S-atoms = 0

Avg O.S of S-atom = $\frac{+5+0+0+5}{4}$ = 2.5

absolute O·S of a particular element ⟶ Avg O·S of that element



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JEE Adv. 2011 Paper 1

diff = 5 − 0 = 5

The difference in the oxidation states of two types of sulphur atoms in $Na_2S_4O_6$ is

$S_4O_6^{2-}$

- $S = +5$
- $S = 0$
- $S = 0$
- $S = +5$

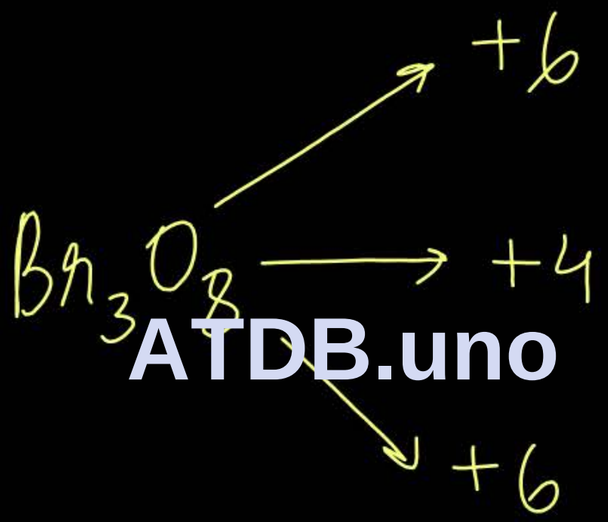
$2Na^{+} + S_4O_6^{2-}$

Question

JEE Adv - 2025

Mains

Find out the difference in O.S of two types of Br atoms in Br_3O_8 –



difference in O.S = 6 − 4 = 2

Rules governing Oxidation state

i) Fluorine Atom

* Fluorine is most electronegative element. It always has Oxidation number equal to -1 in all its compounds.

* In case of F_2 it is zero.

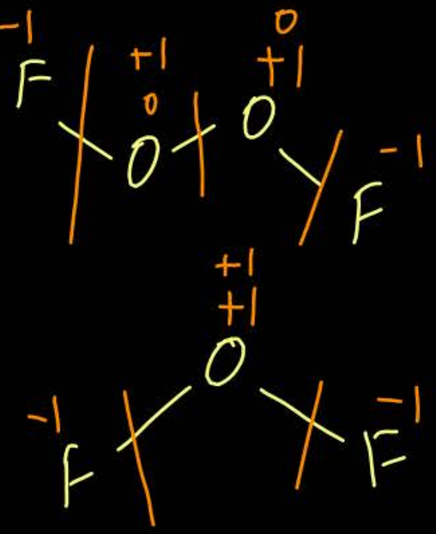
ii) Oxygen Atom

a) In general as well as in its oxides = −2

b) In Peroxide (H_2O_2, Na_2O_2 etc) = −1

c) In superoxide (KO_2 etc) = $-\frac{1}{2}$

d) In ozonide (KO_3 etc) = $-\frac{1}{3}$

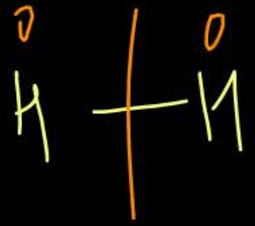


e) In O_2F_2 and OF_2 = +1, +2 respectively

f) In Oxygen molecule (O_2) = 0

iii) Hydrogen Atom

* In general hydrogen atom has oxidation number equal to +1.
* In metallic hydrides (NaH, KH etc) it is −1.
* In H_2 molecule = 0

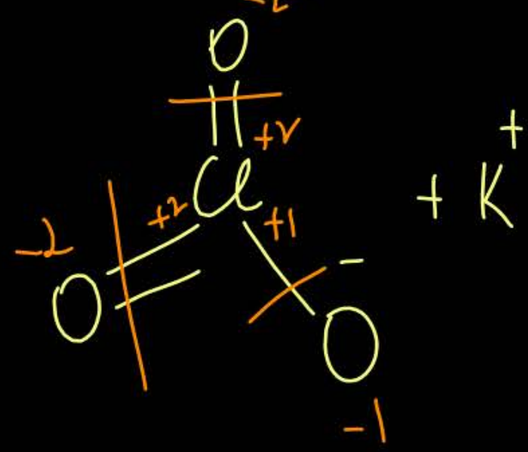


(V) Halogen Atom

* In general halogen (Cl, Br, I) has oxidation number = −1

* When halogen is attached with more electronegative element then it will show positive oxidation state.

$\overset{+5}{KClO_3}$ $\overset{+5}{HIO_3}$ $\overset{+5}{KBrO_3}$ $\overset{+7}{HClO_4}$



V) Metals

* Alkali metals (Li, Na, K, Rb ...) = +1
* Alkaline Earth metals (Be, Mg, Ca, Sr ...) = +2
* Aluminium always has +3 oxidation number.

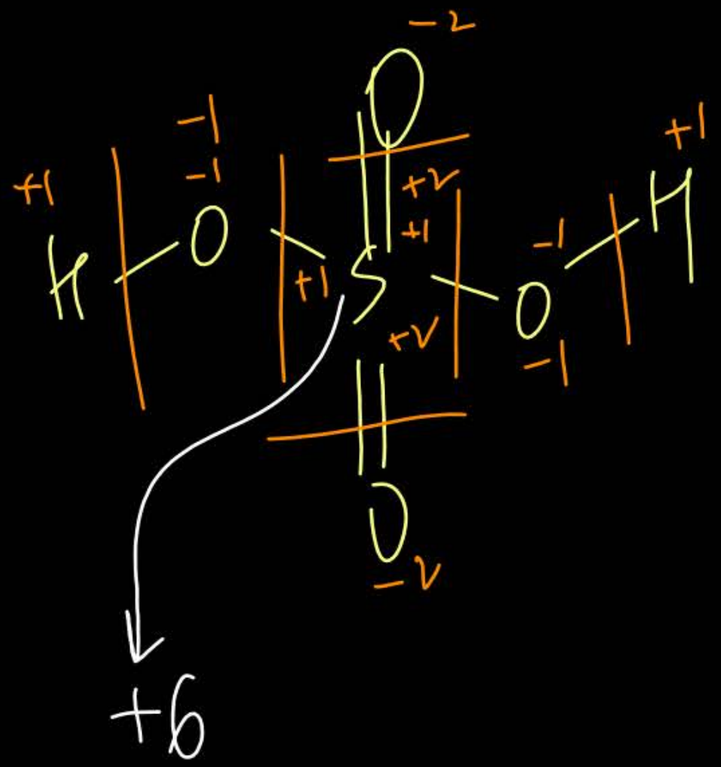
vi) Oxidation number of an element in free state or in allotropic forms is always zero. $Na_{(s)}$ $C_{(s)}$ $Fe_{(s)}$ S_8

vii) Sum of charges of elements in a molecule is zero.

viii) Sum of charges of all elements in an ion is equal to the charge on that ion.

H_2SO_4

Let the O.S of S = x



$$2(+1) + x + 4(-2) = 0$$

$$\boxed{x = +6}$$

$KMnO_4$

$+1 + x + 4(-2) = 0$

$\boxed{x = +7}$

$K_2Cr_2O_7$

$2(+1) + 2(x) + 7(-2) = 0$

$\boxed{x = +6}$

K_2CrO_4

$2(+1) + x + 4(-2) = 0$

$\boxed{x = +6}$

ClO_4^-

$x + 4(-2) = -1$

$\boxed{x = +7}$

NO_3^-

$x + 3(-2) = -1$

$\boxed{x = +5}$

CCl_4

$x + 4(-1) = 0$

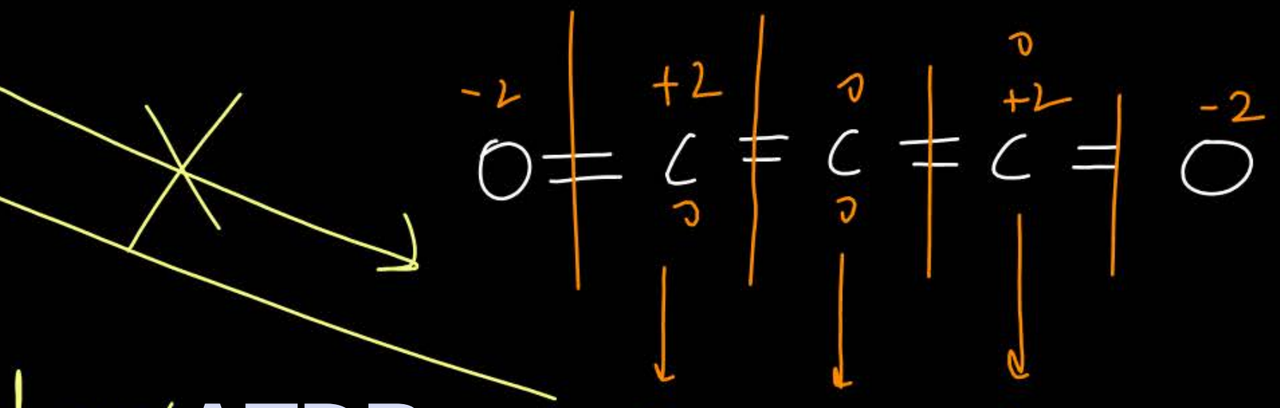
$\boxed{x = +4}$

C_3O_2 (suboxide)

$3(x) + 2(-2) = 0$

$x = +\frac{4}{3}$

This 'x' wala Method always gives avg O.S



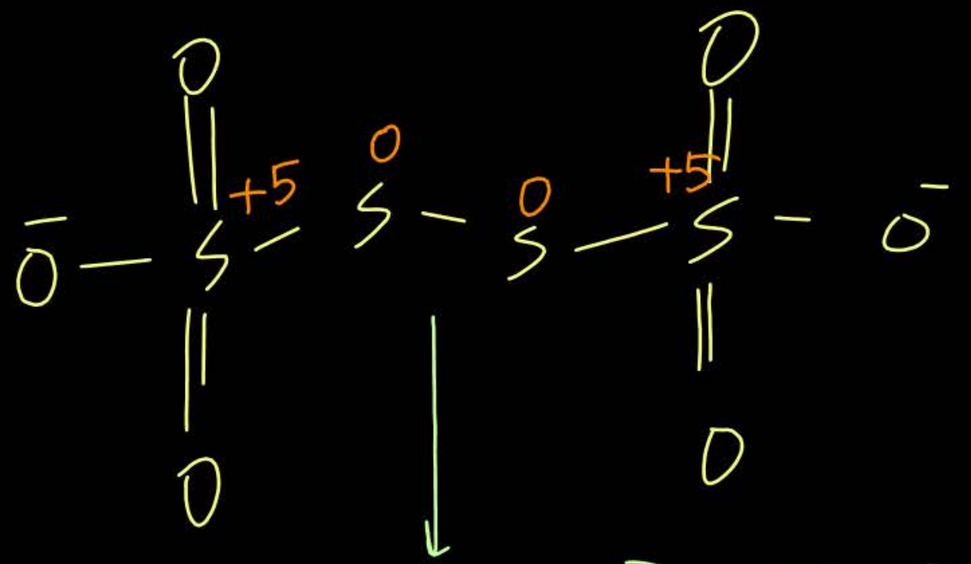
+2 0 +2

$\text{Avg} = \frac{2+0+2}{3} = +\frac{4}{3}$

$S_4O_6^{a}$

$4(x) + 6(-2) = -2$

$x = \frac{5}{2} = 2.5$



$Avg = \frac{5+0+0+5}{4} = \frac{5}{2} = 2.5$

Caro's Acid H_2SO_5

$$2(+1) + x + 5(-2) = 0$$

→ we assumed that all 5 O-atoms are of (-2) O.S.

$$x = +8$$

O.S of S varies from −2 to +6

O.S of N varies from −3 to +5

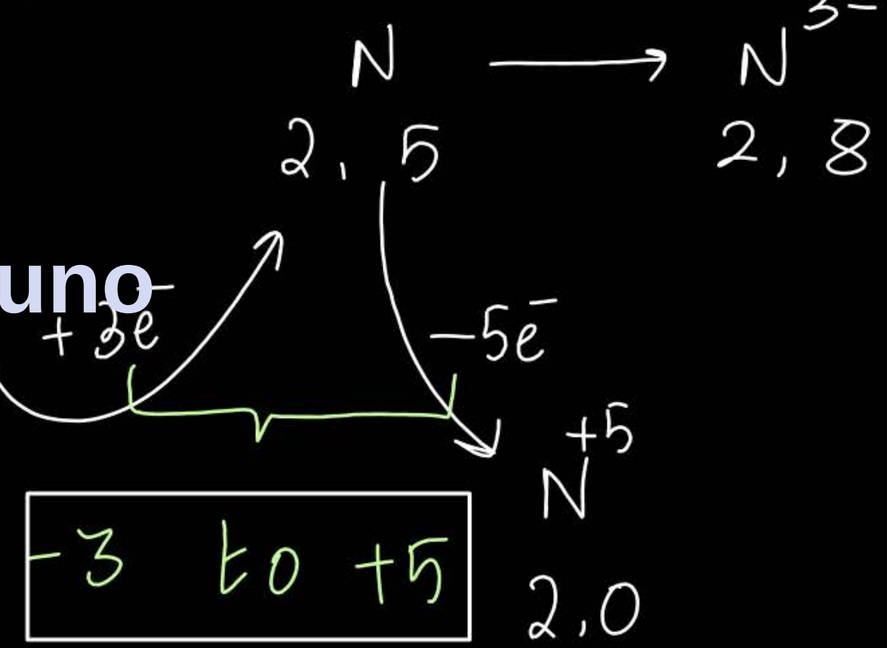
=

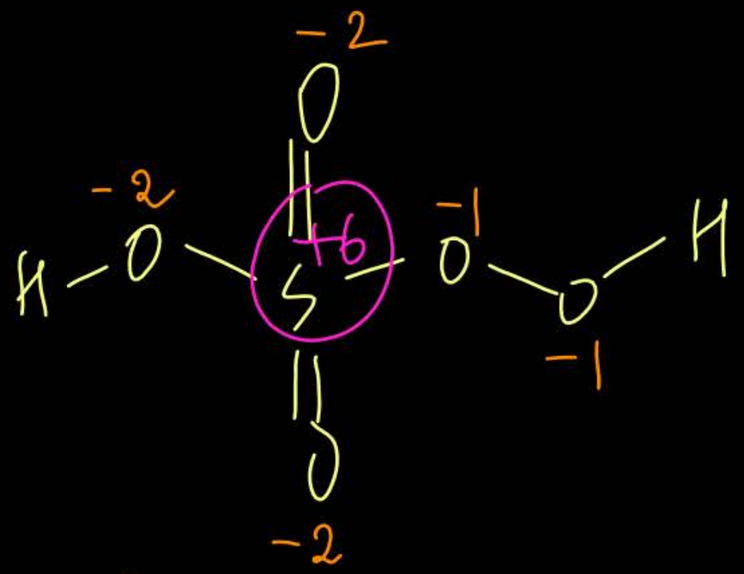
−3 to +5

O, S = 2, 6

N, P = 2, 5

C = 2, 4





H_2SO_5

$2 + x + 5(-2) = 0$

$x = +8$

K-BO Jugaad !

When ever the O.S of an element comes out more than its maximum O.S by this (x-wala) Method then the answer is its maximum O.S.

$H_2S_2O_8$

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

$x = +7$ X

Answer ⇒ +6

LIST OF IONS (Learn)

→ important ion

Cl^-	chloride	$C_2O_4^{2-}$	oxalate
Br^-	bromide	NO_3^-	nitrate
F^-	fluoride	N^{3-}	nitride
I^-	iodide	NO_2^-	nitrite
CO_3^{2-}	carbonate	ClO_4^-	perchlorate
CN^-	cyanide	ClO_3^-	chlorate
NC^-	isocyanide	ClO_2^-	chlorite
SO_4^{2-}	sulphate	ClO^-	hypochlorite
SO_3^{2-}	sulphite	CrO_4^{2-}	chromate
$S_2O_3^{2-}$	thiosulphate	$Cr_2O_7^{2-}$	dichromate
S^{2-}	sulphide	MnO_4^-	permanganate
P^{3-}	phosphide	PO_4^{3-}	phosphate

NH_4^+ = ammonium ion

Fe^{+2} = Ferrous

Fe^{+3} = Ferric

Sn^{+2} = Stennous

Sn^{+4} = Stennic

Cu^{+} = Cuprous

Cu^{+2} = Cupric

Hg_2^{+2} = Mercurous

Hg^{2+} = Mercuric

$CuSO_4$

SO_4^{2-}

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

$x = +6$

$(NH_4)_2Cr_2O_7$

$Cr_2O_7^{2-}$

$2x + 7(-2) = -2$

$x = +6$

NH_4^+

$x + 4(+1) = +1$

$x = -3$

CuS

S^{2-} = sulphide ion

$x - 2 = 0$

$x = +2$

Question

If three electrons are lost by a metal ion M^{3+}, its final oxidation number should be :

A 0

B +6

C +2

D +4

Question

Oxidation number of Sulphur in Na_2SO_4 is

A −2

B +6

C +2

D −6

JEE Main 2 Sep 2022 Shift-2

The oxidation states of transition metal atoms in $K_2Cr_2O_7$ $KMnO4$ and K_2FeO_4, respectively, are x, y and z. The sum of x, y and z is 19.

$K_2Cr_2O_7 = 2 + 2x + 7(-2) = 0 \quad x = +6$

$KMnO_4 = 1 + y + 4(-2) = 0 \quad y = +7$

$K_2FeO_4 = 2 + z + 4(-2) = 0 \quad z = +6$

$x + y + z = 19$

Question

Oxidation number of Sulphur in S_2Cl_2 is :

A +1

B 0

C −1

D +6

JEE Main 2019

N_2O_3, NO, NO_2, N_2O arrange the increasing order of O.S. of nitrogen –

+1 +2 +3 +4

A N_2O, NO, N_2O_3, NO_2

B N_2O, NO_2, N_2O_3, NO

C NO_2, N_2O_3, N_2O, NO

D N_2O_3, NO, N_2O, NO_2

Question

In which of the following compound oxidation number of Cl is +3?

A ICl

B ClO_3

C ClF_3

D $HClO_4$

Question

Which of the following is the correct oxidation number of phosphorus in $Mg_2P_2O_7$

A −3

B +2

C +5

D +3

Question

Oxidation numbers of the two nitrogen atoms present in ammonium nitrate are respectively ?

A +3 and +3

B 0 and 0

C −3 and +5

D −1 and −1

Question

The oxidation number of cobalt in $[Co(CN)_6]^{3-}$ is –

A +3

B −3

C +6

D −6

Question

Oxidation number of Sulphur in $S_2O_2^{2-}$ is :

A −2

B +1

C +6

D 0

Question

In which of the following compound oxidation number of iron is not +3

A Fe_3O_4

B Fe_2O_3

C $FeCl_3$

D $FePO_4$

Question

In which of the following compound oxidation number of iron is not +3

A Fe_3O_4

B Fe_2O_3

C $FeCl_3$

D $FePO_4$

Question

Oxidation number of Sulphur in H_2SO_5 is

A +2

B +4

C +8

D +6

Question

Oxidation number of Fe in $K_3[Fe(CN)_6]$ is

A +2

B +3

C +1

D +4

ATDB.uno

$x - 6 = -3$

$x = +3$

Question

In which of the following compound, iodine is in its highest oxidation state

A KI

B KIO_4

C KI_3

D IF_5

1. Oxidant (Oxidizing Agent):

An **oxidizing agent** is a substance that **gains electrons** in a redox (reduction-oxidation) reaction. This means that the oxidizing agent itself is **reduced** (its oxidation state decreases). The role of the oxidizing agent is to cause the oxidation of another substance by accepting the electrons that are being lost by that substance.

- **How it works**: The oxidizing agent essentially "pulls" electrons from the substance that is being oxidized.
- **Change in oxidation state**: The oxidizing agent becomes **reduced** because it gains the electrons.

Example 1: Oxidation of Hydrogen by Oxygen

Consider the reaction:

$$2H_2 + O_2 \rightarrow 2H_2O$$

In this reaction:

- **Oxygen (O_2)** is the **oxidizing agent**.
- Oxygen **gains electrons** (it goes from an oxidation state of 0 in O_2 to -2 in H_2O), thus it is reduced.
- As oxygen gains electrons, **hydrogen (H_2) loses electrons** and is oxidized.

So, **oxygen** is the oxidant because it takes electrons from hydrogen, causing the hydrogen atoms to lose electrons and thus get oxidized.

Example 2: Chlorine in the Reaction with Sodium

In the reaction between sodium and chlorine:

$$2Na + Cl_2 \rightarrow 2NaCl$$

- **Chlorine (Cl_2)** is the **oxidizing agent**.
- Chlorine gains electrons (is reduced) as it changes from Cl_2 (oxidation state 0) to Cl^- (oxidation state -1).
- Sodium (Na) loses electrons and is oxidized.

2. Reductant (Reducing Agent):

A **reducing agent** is a substance that **loses electrons** in a redox reaction. This means that the reducing agent itself is **oxidized** (its oxidation state increases). The role of the reducing agent is to cause the reduction of another substance by donating electrons to it.

- **How it works**: The reducing agent donates its electrons to another substance, which leads to the reduction of that substance (gain of electrons).
- **Change in oxidation state**: The reducing agent becomes **oxidized** because it loses the electrons.

Example 1: Oxidation of Hydrogen by Oxygen (continued)

In the previous reaction:

$$2H_2 + O_2 \rightarrow 2H_2O$$

- **Hydrogen (H_2)** is the **reducing agent**.
- Hydrogen **loses electrons** (it goes from an oxidation state of 0 in H_2 to +1 in H_2O), thus it is oxidized.
- As hydrogen loses electrons, **oxygen** gains electrons and is reduced.

So, **hydrogen** is the reductant because it donates electrons to oxygen, causing oxygen to be reduced.

Example 2: Zinc and Copper Ion Reaction

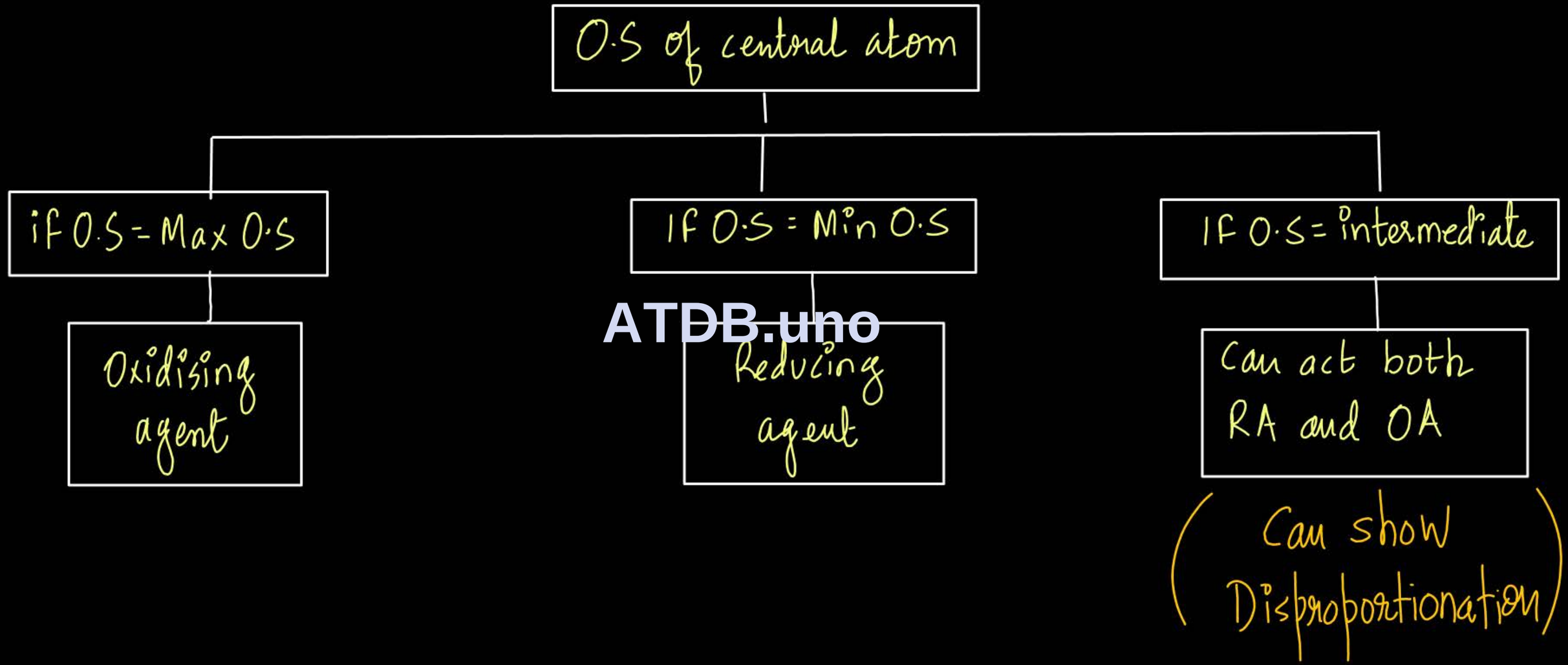
Consider the reaction between zinc metal and copper sulfate ($CuSO_4$):

$$Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$$

- **Zinc (Zn)** is the **reducing agent**.
- Zinc **loses electrons** (its oxidation state increases from 0 in Zn to +2 in Zn^{2+}) and is thus oxidized.
- The **copper ions (Cu^{2+})** in $CuSO_4$ **gain electrons** (their oxidation state decreases from +2 to 0) and are thus reduced.

So, **zinc** is the reductant because it donates electrons to copper ions, reducing them to copper metal.

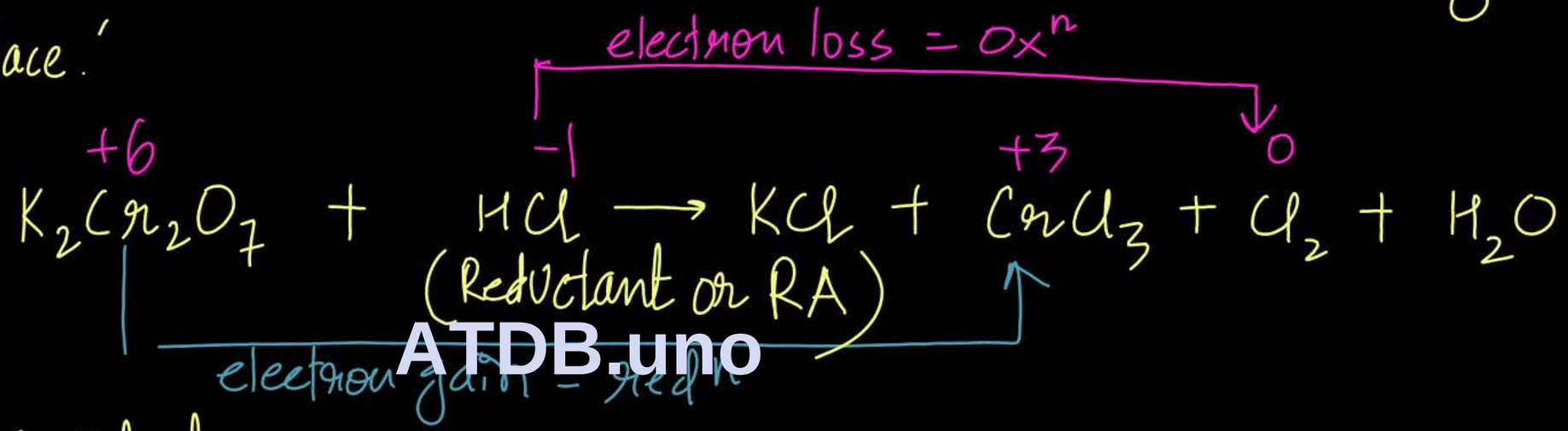
How to identify whether a particular substance is an OA or RA



Redox Reaction

electron gain = Red
electron loss = Ox^n

'A reaction in which reduction and oxidation simultaneously takes place.'



(Oxidant or Oxidising agent)

Kobo

In a Redox Reaction —

electron loss → Oxidation → Reductant or (RA)

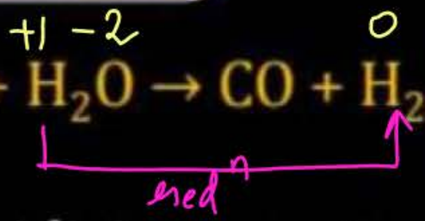
electron gain → reduction → Oxidant or (OA)

* Reducing agent wo hai Jo samne wale ko reduce Karta hai khud oxidise ho kar!

* Oxidising agent wo hai Jo samne wale ko oxidise karta hai khud reduce ho kar!

Question

In $C + H_2O \rightarrow CO + H_2$, H_2O acts as



A Oxidising agent

B Reducing agent

C Both

D None

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Which of the following reactions is an example of a redox reaction?

(A) $XeF_6 + H_2O \rightarrow XeOF_4 + 2HF$

+6 -1 +1 -2 +6 -2 -1 +1 -1

(B) $XeF_6 + 2H_2O \rightarrow XeO_2F_2 + 4HF$

red^n

(C) $XeF_4 + O_2F_2 \rightarrow XeF_6 + O_2$

+4 -1 +1 -1 +6 0

Ox^n

(D) $XeF_2 + PF_5 \rightarrow [XeF]^+ PF_6^-$

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JEE Main 2017 Online

In which of the following reactions, hydrogen peroxide acts as an oxidizing agent?

(A) $I_2 + H_2O_2 + 2OH \rightarrow 2I^- + 2H_2O + O_2$

(B) $PbS + 4H_2O_2 \rightarrow PbSO_4 + 4H_2O$

(C) $2MnO_4^- + 3H_2O_2 \rightarrow 2MnO_2 + 3O_2 + 2H_2O + 2OH^-$

(D) $HOCl + H_2O_2 \rightarrow H_3O^+ + Cl^- + O_2$

Stumper

One mole of X_2H_4 releases 10 moles of electrons to form a compound Y. What should be the oxidation number of X in the compound Y ?

A +3

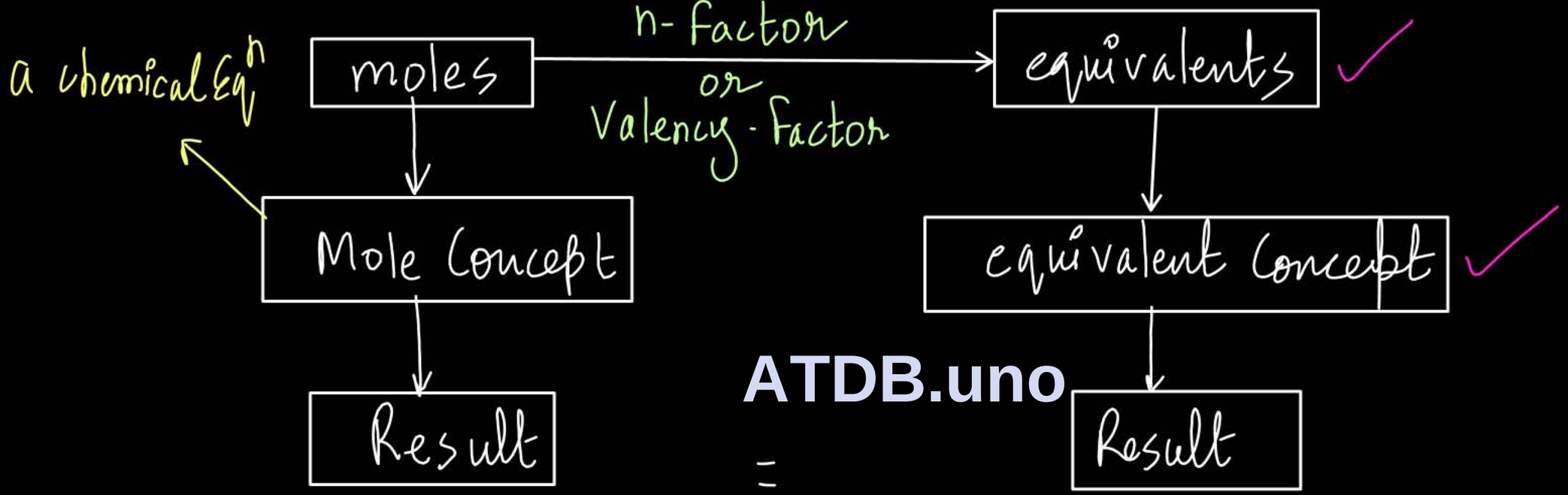
B −3

C −6

D +1

Limitation of Mole Concept

Moles x n-factor = equivalents



Important :-

moles × n-factor = Equivalents

$$\frac{\text{given weight}}{\text{Equivalent weight}} = \text{Equivalents}$$

$$\text{Equivalent wt} = \frac{\text{Molecular weight}}{\text{n-factor}}$$

Since n-factor of a substance depends on chemical reaction. So eq. wt also depends on reaction.

n-Factor Calculation for acids

n-Factor = Replaceable H^+ ions

HCl = monobasic acid
(Basicity = 1)
Basicity = max H^+ replaceable.

$HCl + NaOH \longrightarrow NaCl + H_2O$
(n=1)

$H_2SO_4 + NaOH \longrightarrow Na_2SO_4$
(n=2)

$H_2SO_4 + NaOH \longrightarrow NaHSO_4$
(n=1)

H_2SO_4 Basicity = 2

n = 1, 2

H_3PO_4 Basicity = 3

$H_3PO_4 + NaOH \xrightarrow{M/1} NaH_2PO_4$

(n = 1)

$H_3PO_4 + NaOH \xrightarrow{M/2} Na_2HPO_4$

(n = 2)

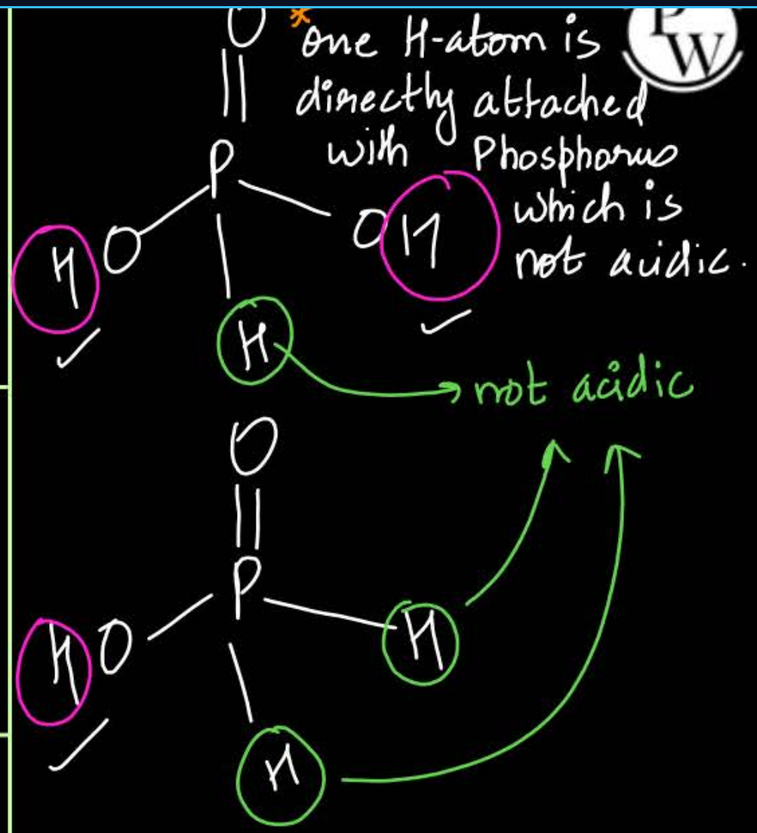
$H_3PO_4 + NaOH \xrightarrow{M/3} Na_3PO_4$

(n = 3)

As an acid

n-factor ≤ Basicity.

Please Remember	Basicity	n-Factor
H_3PO_3	2	1, 2
H_3PO_2	1	1
H_3BO_3	1	1

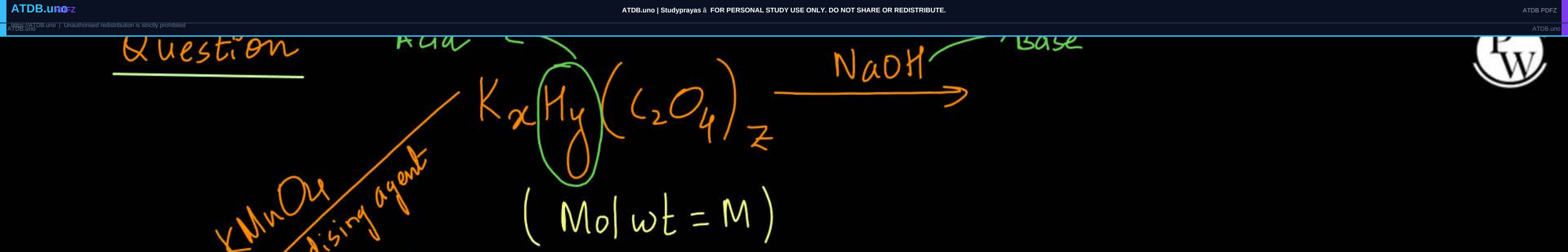


$$\text{Equivalent weight} = \frac{\text{Molecular Weight}}{\text{n-Factor}}$$

Kabo

Eq wt depends on n-Factor and n-factor depends on reaction. Since n-factor for a particular substance varies RX to RX so eq wt also varies from Rx to Rx.

Question



What will be the Eq. wt of this salt in the given Rx^n?

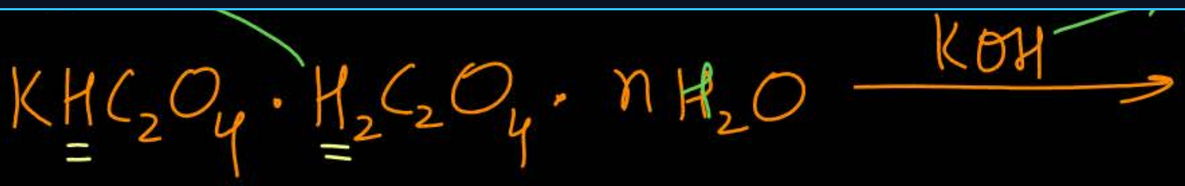
अभी पढ़ा नहीं !

it has 'y' moles of H^+ ions per mol so

n-factor = y

$$\text{Eq Wt} = \frac{M}{y}$$

Question



$KHC_2O_4 \cdot H_2C_2O_4 \cdot nH_2O$

$(n = ?)$

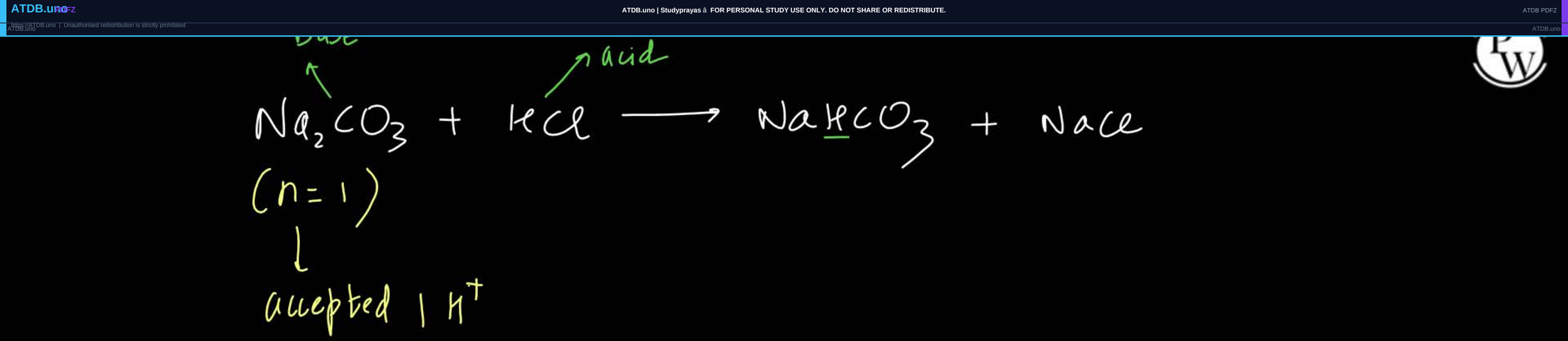
$(n = 3$

$$\text{Eq wt} = \frac{M}{3}$$

n-Factor Calculation for Base

n-Factor = replaceable $\bar{O}H$ ions or acceptable H^+ ion

	Acidity	n-Factor
$NaOH$ =	1	1
$Ca(OH)_2$ =	2	1 , 2
$Al(OH)_3$ =	3	1 , 2 , 3



n-factor Calculation for Salts

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SALTS WHICH REACT SUCH THAT NO ATOM UNDERGOES CHANGE IN OXIDATION STATE

n-factor = Total cationic or Total anionic charge

$\overset{+2\ +4\ -2}{CaCO_3} \xrightarrow{\Delta} \overset{+2\ -2}{CaO} + \overset{+4\ -2}{CO_2}$

$CaCO_3$

$2+x+3(-2)=0$

$x=+4$

Ca^{+2} CO_3^{2-}

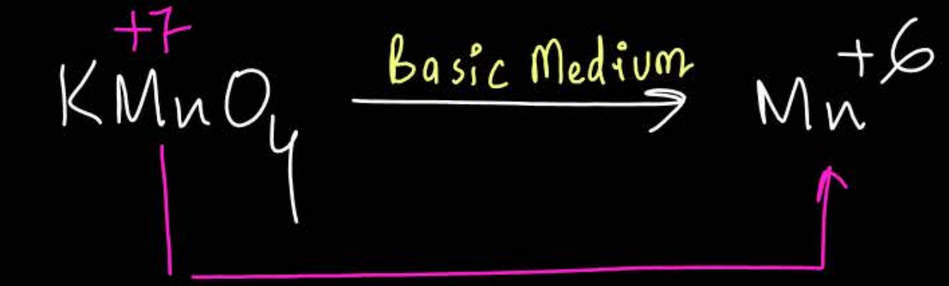
$(n=2)$

SALTS WHICH REACT IN A MANNER THAT ONLY ONE ATOM UNDERGOES CHANGE IN OXIDATION STATE AND GOES IN ONLY ONE PRODUCT

n-factor = moles of electron transfer by per mole of salt

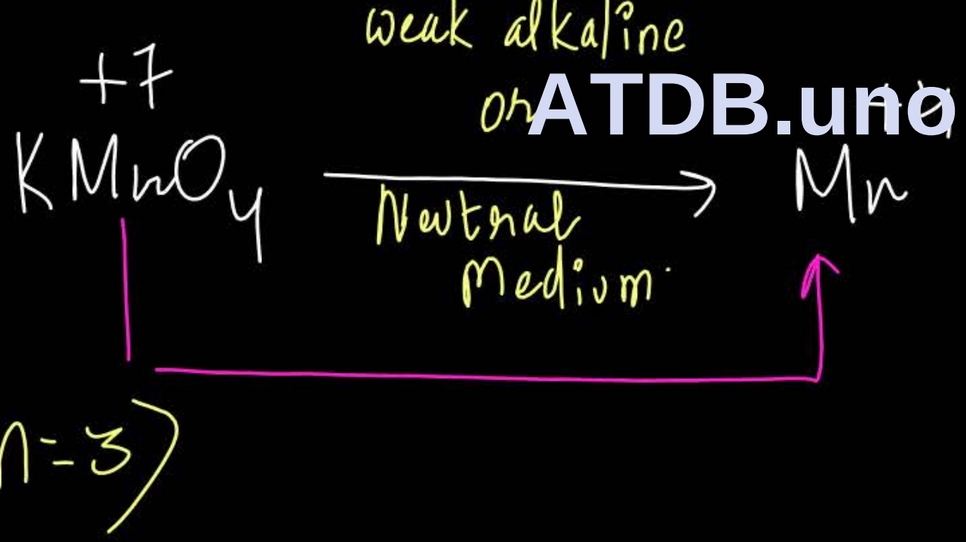
$$\text{Eq wt} = \frac{M}{5}$$

$(n = 5)$



$$\text{Eq wt} = \frac{M}{1}$$

(n = 1)



$$\text{Eq wt} = \frac{M}{3}$$

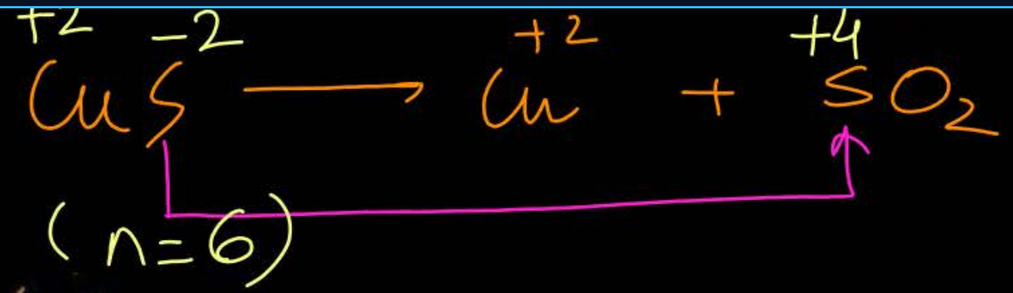
(n = 3)

$K_2Cr_2O_7$ $(n = 3 \times 2 = 6)$

$2 + 2x - 14 = 0$

$x = +6$

Q



Eq. wt of CuS.

$$\text{Eq wt} = \frac{M_{CuS}}{6}$$

Cu^{+1} Cuprous ✓	Cu^{+2} Cupric ✓
Fe^{+2} Ferrous ✓	Fe^{+3} Ferric ✓
Sn^{+2} Stannous ✓	Sn^{+4} Stannic ✓
Hg_2^{+2} Mercurous ✓	Hg^{2+} Mercuric ✓

Find out the Eq. wt of $Fe_2(C_2O_4)_3$ in this n_{x^n} –

HoWo

$$O.A + Fe_2(C_2O_4)_3 \longrightarrow Fe^{+3} + CO_2$$

#

(RA)

$K_x H_y (C_2O_4)_z$ —$KMnO_4$ oxidising agent→ $\frac{M}{27}$

$C_2O_4 = 2x - 8 = -2$

$x = +3$

Learn

KB

$C_2O_4^{2-} \xrightarrow{[O]} CO_2$

+3 +4

(oxalate ion)

(n=2)

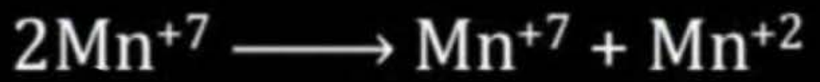
$K_x H_y (C_2O_4)_z \xrightarrow{[O]} CO_2$

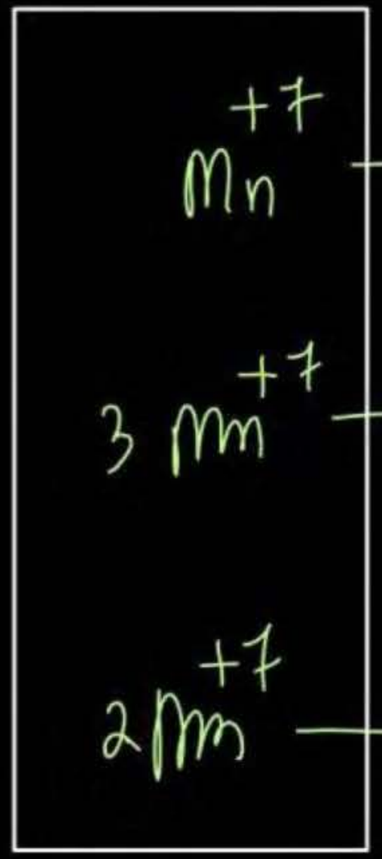
(n=27)

$\frac{M}{y}$

SALTS WHICH REACT IN A MANNER THAT ONLY ONE ATOM UNDERGOES CHANGE IN OXIDATION STATE BUT GOES IN TWO PRODUCTS WITH DIFFERENT OXIDATION STATE (DIFFERENT THAN IN THE REACTANT) AS A RESULT OF EITHER OXIDATION OR REDUCTION

SALTS WHICH REACT IN A FASHION THAT ONLY ONE ATOM UNDERGOES CHANGE IN OXIDATION STATE BUT GOES IN TWO PRODUCTS WITH DIFFERENT OXIDATION STATE (IN ONE PRODUCT WITH SAME OXIDATION STATE AND IN OTHER WITH DIFFERENT OXIDATION STATE THAN IN THE REACTANT)





$Mn^{+7} \rightarrow Mn^{+2}$ (sirf change)

$3Mn^{+7} \rightarrow 2Mn^{+7} + Mn^{+2}$ (change nahi bhi hua and hua bhi)

$2Mn^{+7} \rightarrow Mn^{+4} + Mn^{+2}$ (Do logo mein change hua)

SALTS THAT REACT IN A MANNER THAT TWO TYPE OF ATOMS IN THE SALT UNDERGO CHANGE IN OXIDATION STATE (BOTH THE ATOMS ARE EITHER GETTING OXIDISED OR REDUCED).

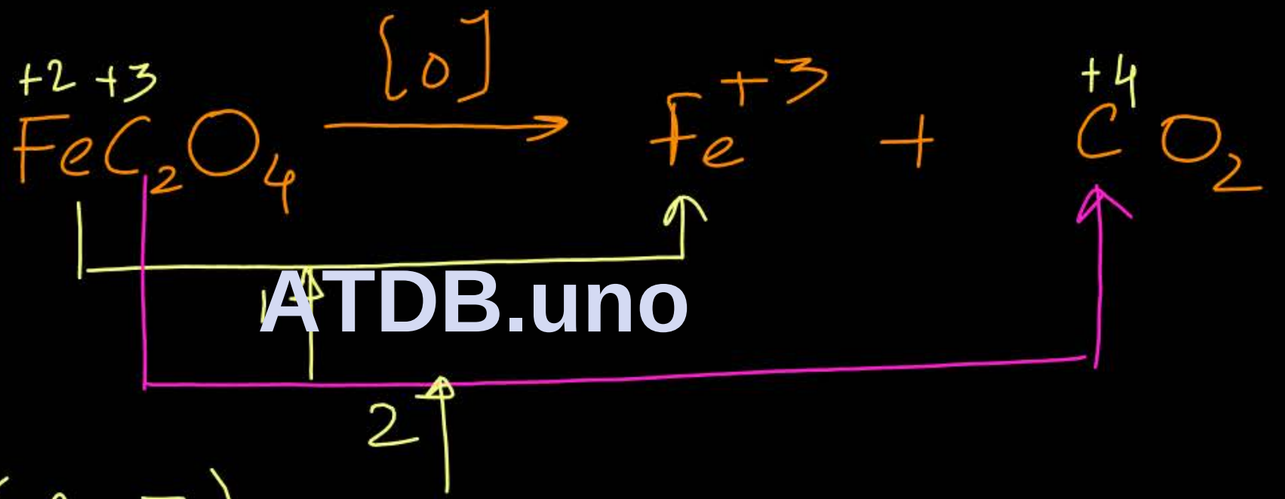
1) Both are getting oxidised

(n = Total moles of electron transfer by per mol salt)

$C_2O_4^{2-}$

$2x - 8 = -2$

$x = +3$



(n = 3)

Question What is the equivalent wt of Cu_2S in this reaction?

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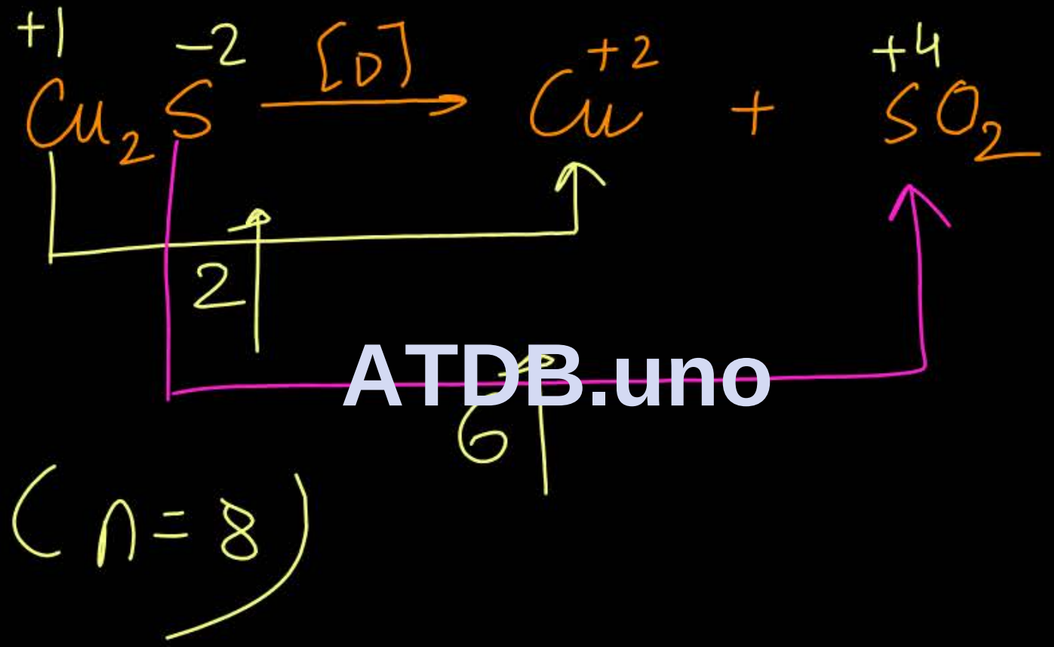


$(n = 8)$

Question

Find out the equivalent weight of SnC_2O_4 in the reaction with $KMnO_4$ in acidic Medium.

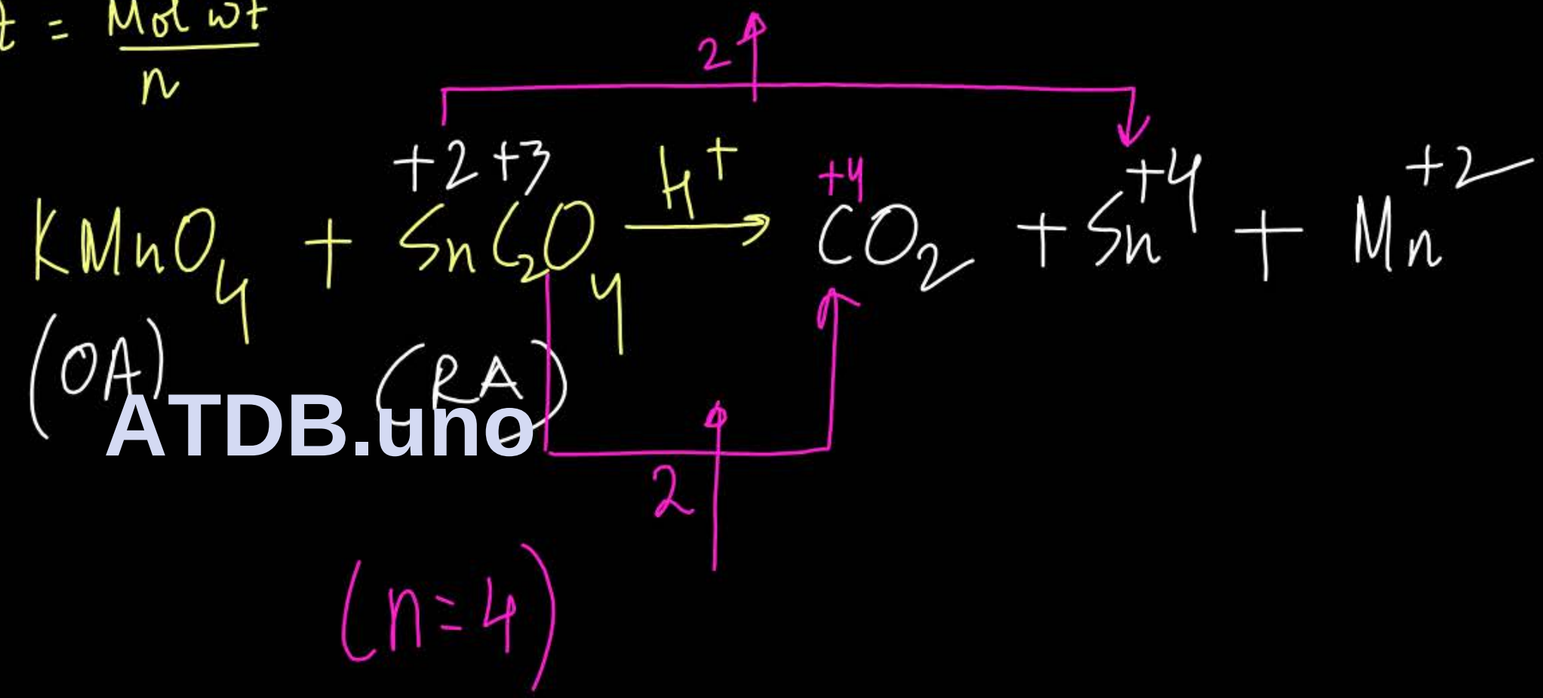
A) M/2

B) M/3

C) M/1

D) ~~M/4~~

$$\text{Eq wt} = \frac{\text{Mol wt}}{n}$$



$(n = 4)$

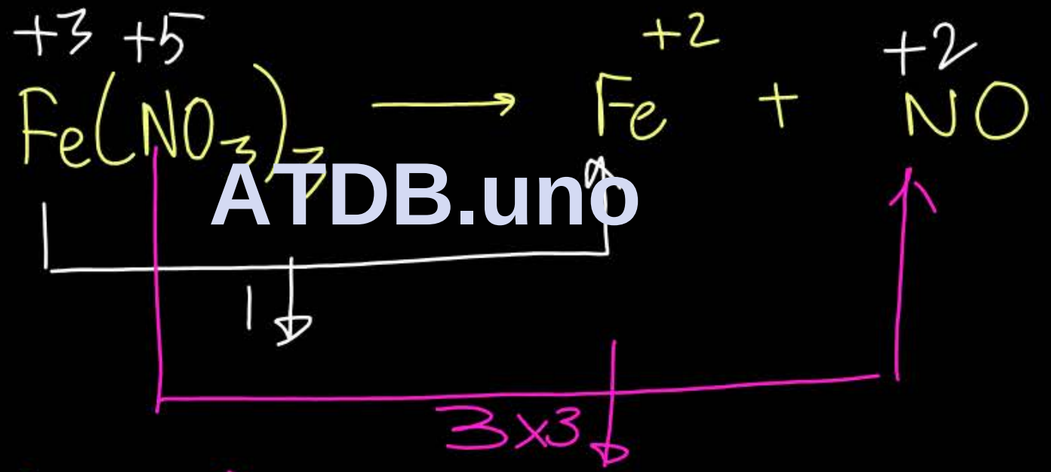
27 More than one atoms are getting reduced

n-factor = Total moles of electrons gained per mol salt

NO_3^-

$x - 6 = -1$

$x = +5$



$(n = 10)$

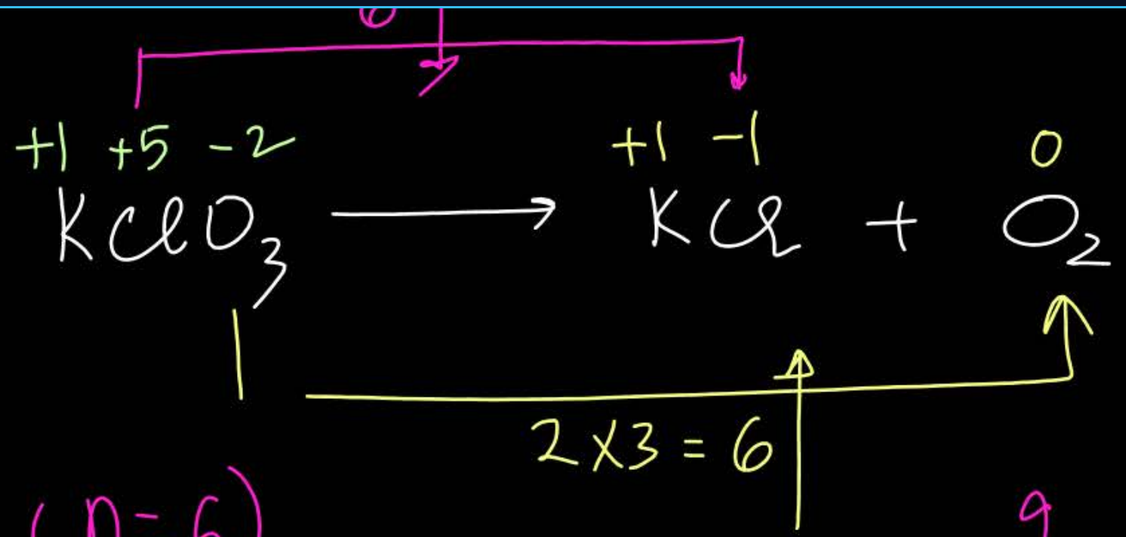
3) Some are getting oxidised and some are getting reduced.

if gain = loss

n = gain or loss

if gain ≠ loss

n = |gain - loss|



$1 + x - 6 = 0$

$x = +5$

$(n = 6)$

9 मोल = 6 loss = 9 मोल : 6 gain

$A + KClO_3 \longrightarrow KCl + O_2 + \ldots$

Adv. 2025

Behaviour of A ?

i) Reducing agent

ii) Oxidising agent

iii) Both

iv) ~~None~~

$A + (NH_4)_2Cr_2O_7 \longrightarrow N_2 + Cr_2O_3 + H_2O + \cdots$

Behaviour of A —

i) O.A

ii) R.A.

iii) Both

iv) None

v) Mujhe kya pata

Question

$$[SCN]^- \longrightarrow SO_4^{2-} + [CN]^-$$

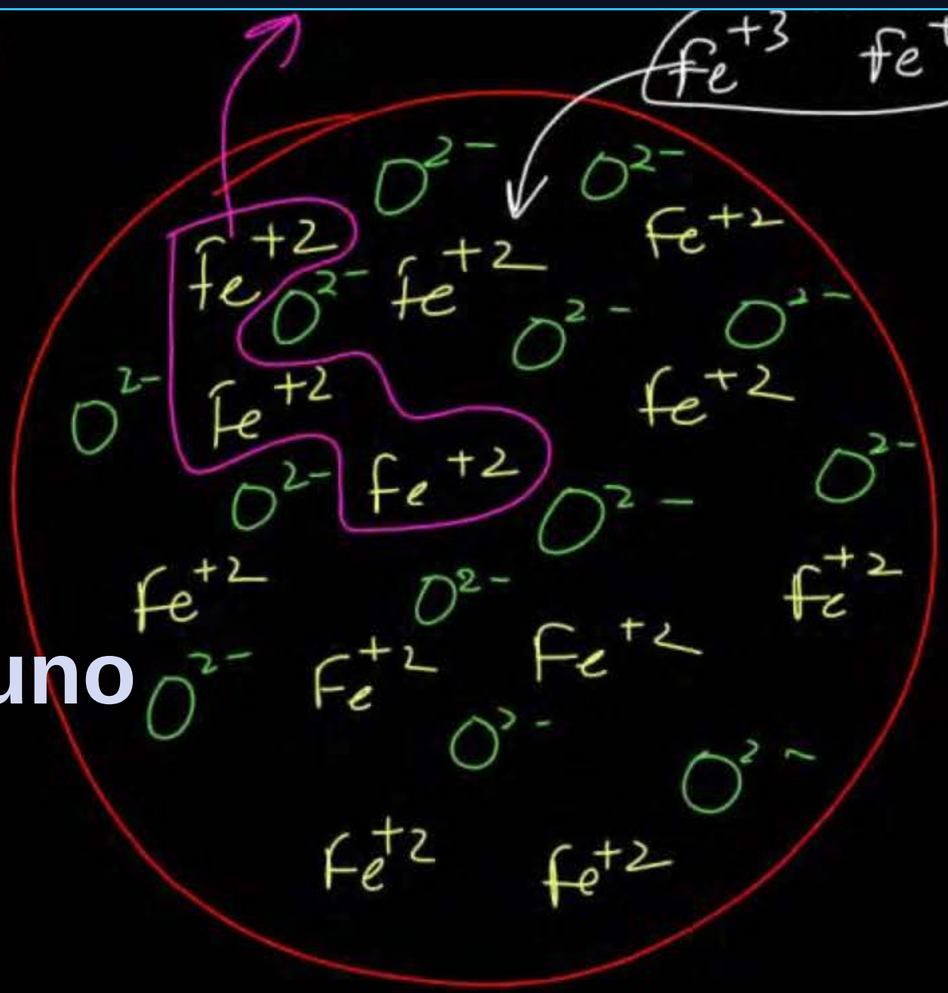
#Q

$Fe_{0.93}O \longrightarrow Fe^{+3}$

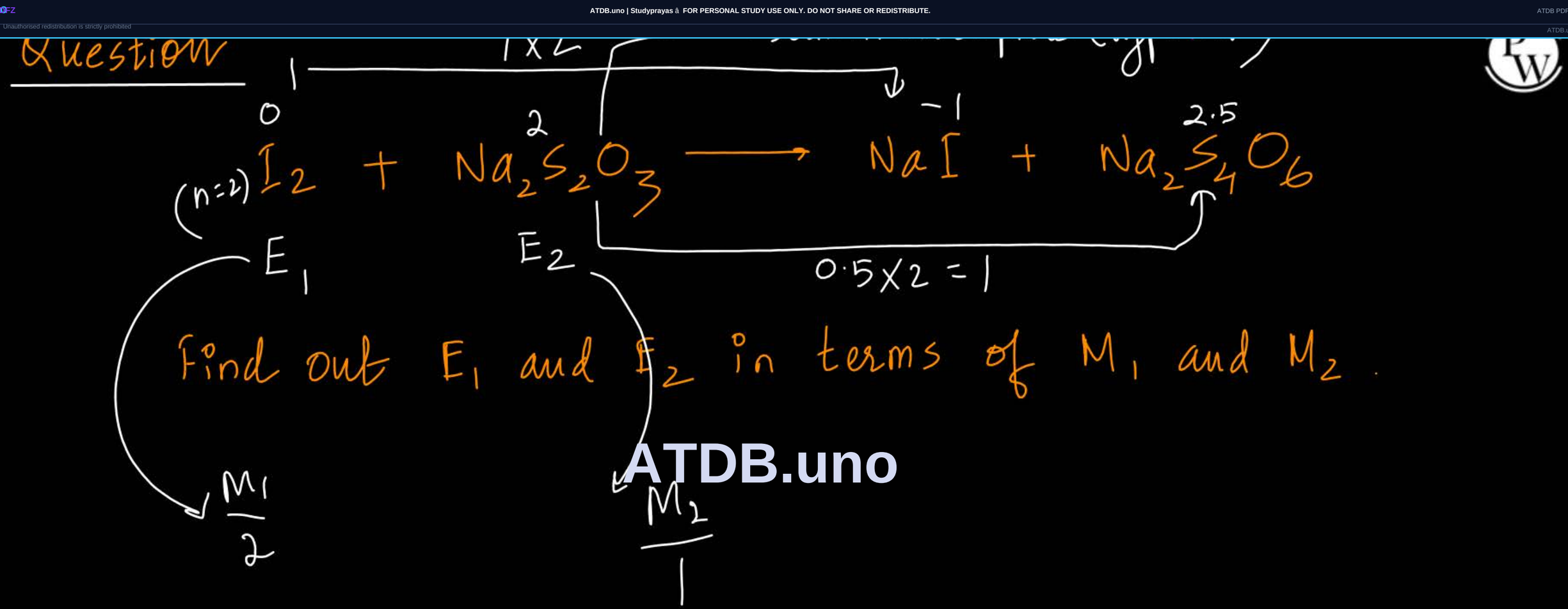
non-stoichiometric

(Berthelloids)

$Fe^{+3}, Fe^{+2} \longrightarrow Fe^{+3}$



Question



Find out E_1 and E_2 in terms of M_1 and M_2.

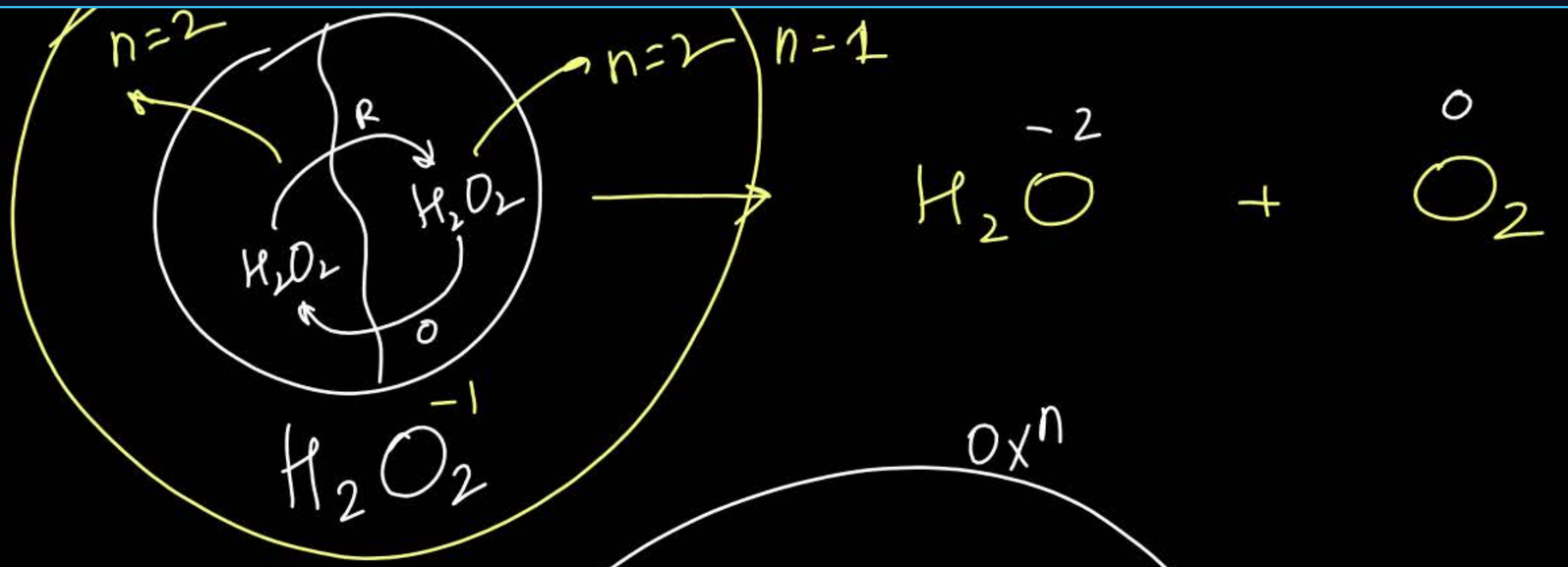
$$E_1 = \frac{M_1}{2}$$

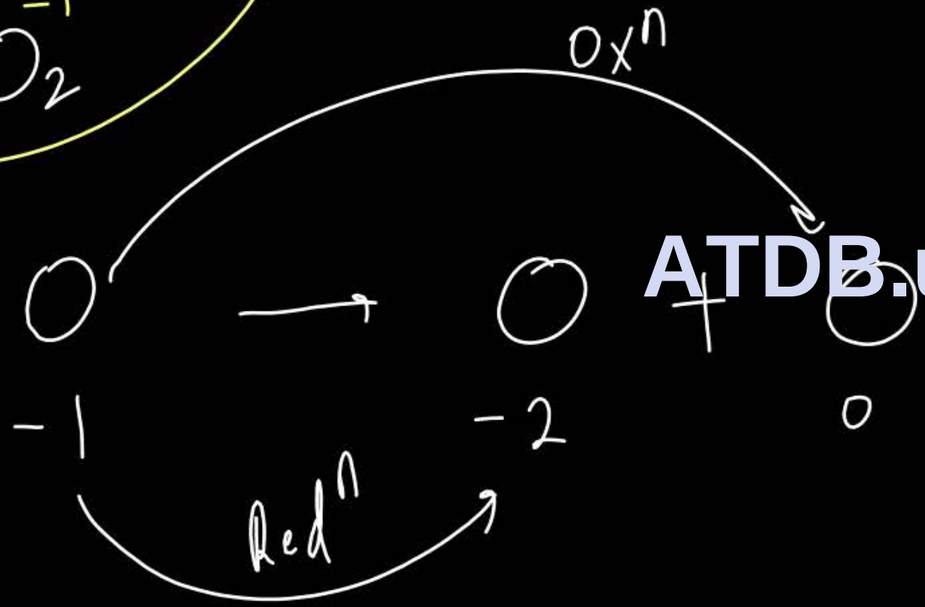
$$E_2 = \frac{M_2}{1}$$

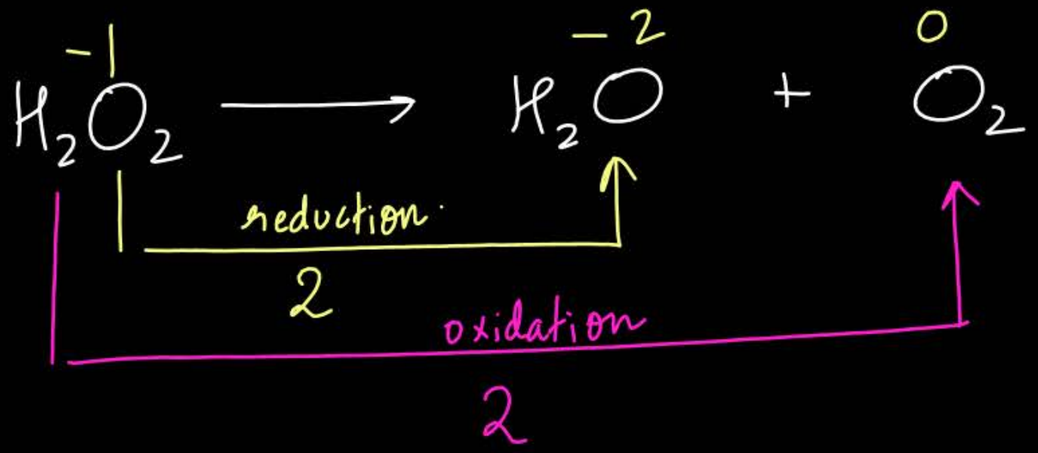
N - Factor Calculation in a Disproportionation Reaction

A redox reaction in which a same element present in a particular compound in a definite O.S is oxidised as well as reduced.

One of the reactant in a disproportionation reaction always contain an element that can exist in an atleast three oxidation state.







H_2O_2 as an OA ($n = 2$)

H_2O_2 as a RA ($n = 2$)

$$E_{net} = E_1 + E_2$$

$$\frac{M_{H_2O_2}}{n_{net}} = \frac{M_{H_2O_2}}{2} + \frac{M_{H_2O_2}}{2}$$

$$\boxed{n_{net} = 1}$$

K.B.

H_2O_2 as an O.A the n-Factor always = 2

H_2O_2 as a R.A the n-Factor always = 2

H_2O_2 in its disproportionation Rxn $n = 1$

Some example of disproportionation Rxn

i) $H_2O_2 \longrightarrow H_2O + O_2$

ii) $\overset{0}{X_2} + \overset{-}{OH}\ (dil) \longrightarrow \overset{-1}{X^-} + \overset{+1}{XO^-}$

red: $0 \to -1$

Ox: $0 \to +1$

$x - 2 = -1$

$x = +1$

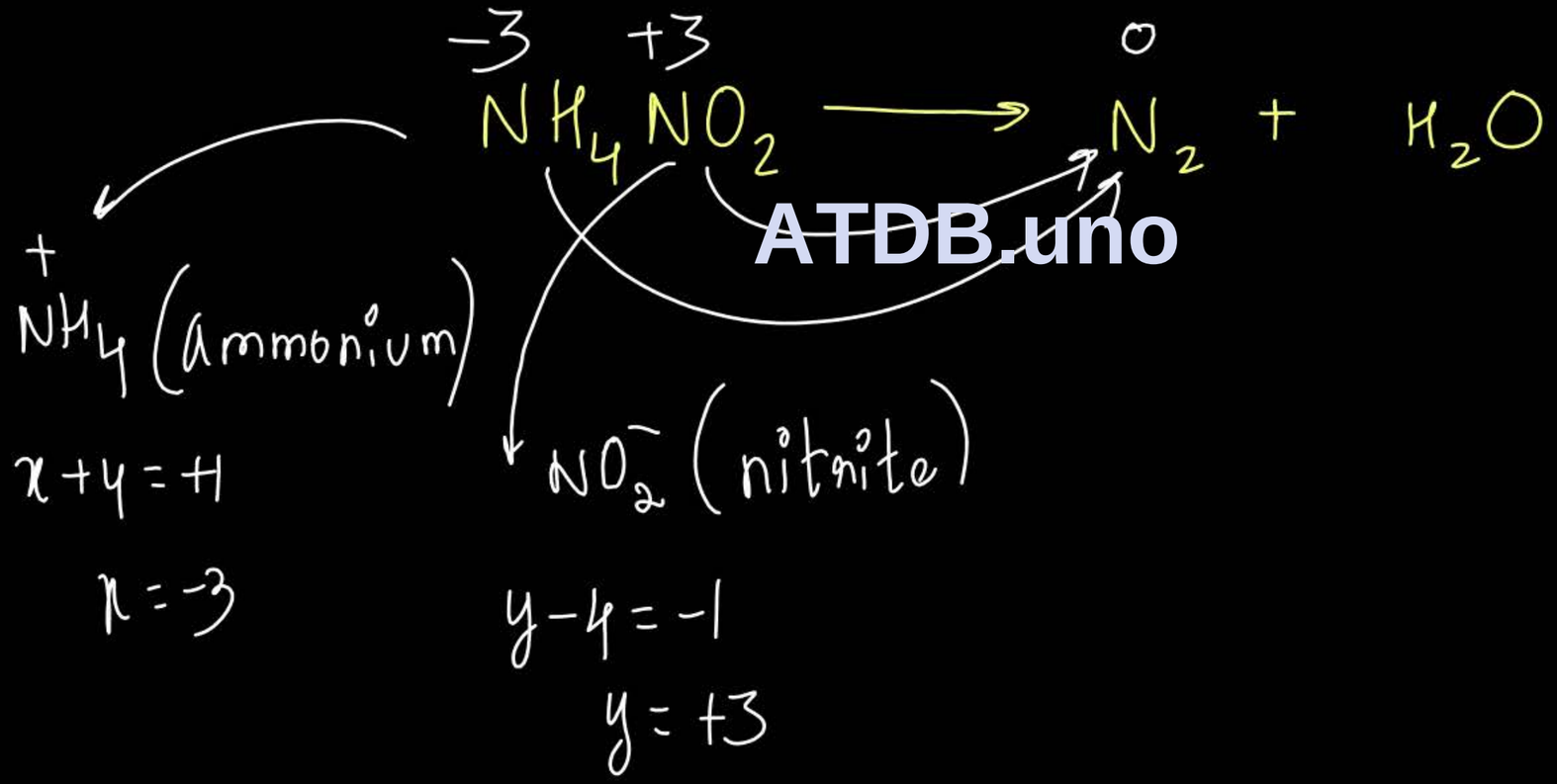
iii) $X_2 + \overset{-}{OH}\ (conc) \longrightarrow X^- + XO_3^-$

iv) $S_8 + \overset{-}{OH} \longrightarrow S^{2-} + S_2O_3^{2-} + H_2O$

v) $KClO_3 \longrightarrow KClO_4 + KCl$

Comproportionation Reaction

A class of redox reaction in which element from two different oxidation state gets converted into single O.S.



Break to Banta Hai!

Till

* Normality = $\frac{\text{No of equivalents of solute}}{\text{Volume of solution in lt.}}$

* Equivalents of solute = Normality × volume of solution in lt.

* Equivalent = moles × n-factor

* Equivalents = $\frac{\text{Given mass}}{\text{Equivalent wt}}$

* Normality $= \dfrac{\text{Eq of solute}}{\text{Volume of solution in lt}}$

$= \dfrac{\text{Moles} \times \text{n-Factor}}{\text{volume of soln in lt.}}$

* Normality = molarity × n-factor

* Equivalent = Normality × volume of soln in lt

* Equivalents = molarity × n-factor × volume of soln in lt

* Equivalents = moles × n-factor

* Equivalents = $\frac{\text{given mass}}{\text{Eq. mass}}$

* Equivalent mass = $\frac{\text{Mol. wt.}}{\text{n-factor}}$

* Eq = normality × volume
= N × V
= n-factor × molarity × vol.

* Normality = $\frac{\text{no. of equivalents of solute}}{\text{volume of solution in lt.}}$

$$\text{Normality} = \frac{\text{no. of eq. of solute}}{\text{vol. of soln in lt}}$$

$$= \text{n-factor} \times \left(\frac{\text{moles of solute}}{\text{vol. of soln in lt.}} \right)$$

$$\text{Normality} = \text{n-factor} \times \text{Molarity}$$

no. of equivalents of solute = Normality x vol. of soln in lt.

Law of Equivalence

$$A + B \longrightarrow C$$

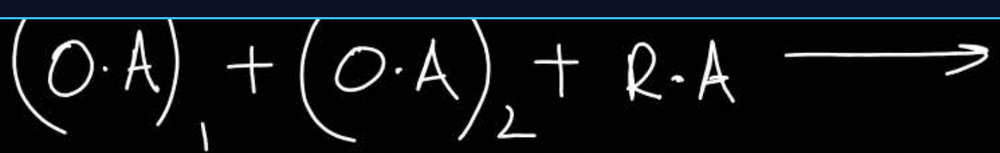
$$\text{Eq of } A = \text{Eq of } B = \text{Eq of } C$$

$$A + B + C \longrightarrow D$$

acid 1 Base acid 2

$$\text{Eq of } A = \text{Eq of } B = \text{Eq of } C = \text{Eq of } D$$ ✗

$$\text{Eq of } A + \text{Eq of } C = \text{Eq of } B = \text{Eq of } D$$ ✓



$$(O \cdot A)_1 + (O \cdot A)_2 + R \cdot A \longrightarrow$$

$$\text{Eq of } (OA)_1 + \text{Eq of } (OA)_2 = \text{Eq of } (RA)$$

Question How many moles of $KMnO_4$ are required to completely oxidise 2 moles of SnC_2O_4 in acidic medium?

$$4\,KMnO_4 + 5\,SnC_2O_4 + H^+ \longrightarrow$$

5 mol SnC_2O_4 ⟶ 4 mol $KMnO_4$

1 " ⟶ $\frac{4}{5}$ mol $KMnO_4$

2 " ⟶ $\frac{4}{5} \times 2$ mol $KMnO_4$

" $\frac{8}{5}$ mol

$$\overset{+7}{KMnO_4} + \overset{+2+3}{SnC_2O_4} + H^+ \longrightarrow \overset{+2}{Mn} + \overset{+4}{Sn} + \overset{+4}{CO_2}$$

$\frac{8}{5}$ mol ⟵ ÷5 ⟵ 2 mole ⟶ ×4 ⟶

8 eq ⟵ 8 eq

moles × n = Eq

Titration (Reaction)

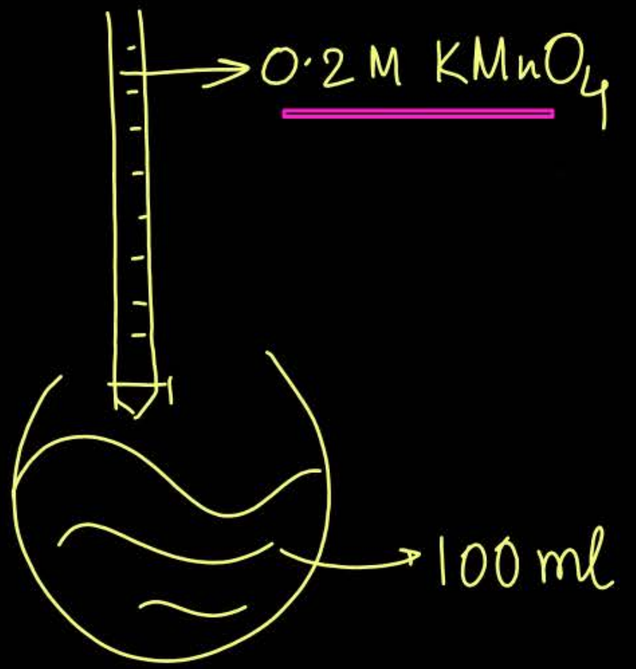
Acid - Base Titration

Redox titration

Find out the volume of 0·2 M $KMnO_4$ consumed to completely oxidised 100 ml 0·08 M SnC_2O_4 soln in acidic medium.

(RA)

Redox Titration



m·Eq of $KMnO_4$ = m·eq of SnC_2O_4

$N_1V_1 = N_2V_2$

$n_1M_1V_1 = n_2M_2V_2$

m Eq = normality × vol (ml)

m·eq = n- × molarity × vol (ml)

Let the volume of $KMnO_4$ used $= V$ ml.

m. Eq of $KMnO_4$ = n-factor × Molarity × Volume (V ml)

$= 5 \times 0.2 \times V$

m. eq of $SnC_2O_4 = 4 \times 0.08 \times 100$

LOE

m. eq of $KMnO_4$ = m. eq of SnC_2O_4

$5 \times 0.2 \times V = 4 \times 0.08 \times 100$

n M V n M V

$V = 32$ ml

Simple Titration —

$$N_1V_1 = N_2V_2$$

$$n_1M_1V_1 = n_2M_2V_2$$

we have 6 variables.

$$\left\{ \begin{array}{l} N_1 = n_1M_1 \\ N_2 = n_2M_2 \end{array} \right\}$$

Normality = n-factor × Molarity

Question When metal is burnt with oxygen and weight of oxygen used or wt of oxide formed is given—

$$\text{Metal} + \overset{0}{O_2} \longrightarrow \text{Metal oxide}^{-2}$$

$(n = 4)$

given { let the wt of metal $= x$ g
wt of oxygen reacted $= y$ g

LOE Eq of metal = Eq of O_2

$$\frac{\text{wt of metal}}{\text{Eq wt of metal}} = \frac{\text{wt of } O_2}{\text{Eq wt of } O_2}$$

$$\frac{x}{E} = \frac{y}{32/4}$$

$$\boxed{E = \frac{8x}{y}}$$

Question

JEE-2025

Metal oxidises into its oxide. The weight gain is 24%. Find out the equivalent wt of metal.

$$\underset{x\,g}{\text{Metal}} + \overset{0}{O_2} \longrightarrow \underset{(n=4)}{\text{Metal Oxide}}\ (O^{-2})$$

LOE

Eq of metal = Eq of O_2

$$\frac{x}{E} = \frac{24x/100}{32/4} \Rightarrow E = \frac{100}{3} = 33.3.$$

Question When metal reacts with chlorine to give chloride—

$$\text{Metal} + \overset{0}{Cl_2} \longrightarrow \text{metal } \overset{-1}{\text{chloride}}$$

$(n = 2)$

LOE

$$\text{Eq of metal} = \text{Eq of } Cl_2$$

$$\frac{x}{E} = \frac{w}{71/2}$$

$$E = \frac{35.5 \times x}{y}$$

x → wt of metal

y → wt of chlorine

Question When metal reacts with nitrogen to give its nitride –

$$\text{Metal} + \overset{0}{N_2} \longrightarrow \text{metal nitride.}\ \overset{-3}{}$$

$$(n = 6)$$

LOE $\quad$ Eq of metal = Eq of N_2

$$\frac{\text{wt of metal}}{E} = \frac{\text{wt of } N_2}{28/6}$$

Simple Titrations

The aim of simple titration is to find the concentration of an unknown solution with the help of the known concentration of another solution.

(a) Acid-base titrations
(b) Redox titrations

Question

When 30 ml of acid is neutralized by 15 ml of 0.2 N alkali, the acid concentration is _____

A 0.1 N

B 0.2 N

C 0.3 N

D 0.4 N

H.W.

Question

If 83 mL of 0.45 M NaOH solution neutralizes a 235 mL HCl solution. Calculate the molarity of the HCl solution.

H.W.

IIT JEE

x $0.561-x$

A mixture of pure $K_2Cr_2O_7$ and pure $KMnO_4$ weighing 0.561g was treated with excess of KI in acidic medium. Iodine liberated required 100 ml of 0.15 M of sodium thiosulphate solution of exact oxidation. What is the percentage of each in the mixture?

$$\overset{OA}{KMnO_4} + \overset{OA}{K_2Cr_2O_7} + \overset{RA}{KI} \xrightarrow{H^+} Mn^{+2} + Cr^{+3} + I_2$$

$$I_2 + Na_2S_2O_3 \longrightarrow NaI + Na_2S_4O_6$$

$(n=2)$ $(n=1)$

Eq of $KMnO_4$ + Eq of $K_2Cr_2O_7$ = Eq of KI = Eq of I_2 = Eq of Hypo

$$\frac{(0.561-x)}{M/5} + \frac{x}{M/6} = \frac{100\times0.15\times1}{1000}$$

IIT JEE Adv.

A 10 g mixture of Cu_2S and CuS was treated with 400 ml of 0.4 M - MnO_4^- in acid solution producing SO_2, Cu^{2+} and Mn^{2+}. The SO_2 was boiled off and the excess of MnO_4^- was titrated with 200 ml of 1 M - Fe^{2+} solution. The percentage of CuS in original mixture is (Cu = 64)

H.W.

JEE Main 27 July 2022 Shift-1

In the titration of $KMnO_4$ and oxalic acid in acidic medium, the change in oxidation number of carbon at the end point is 1

$$KMnO_4 + \overset{+3}{H_2C_2O_4} \longrightarrow \overset{+2}{Mn} + \overset{+4}{CO_2}$$

Change in O.S. of Carbon $\longrightarrow +3 \longrightarrow +4$

$= 1$

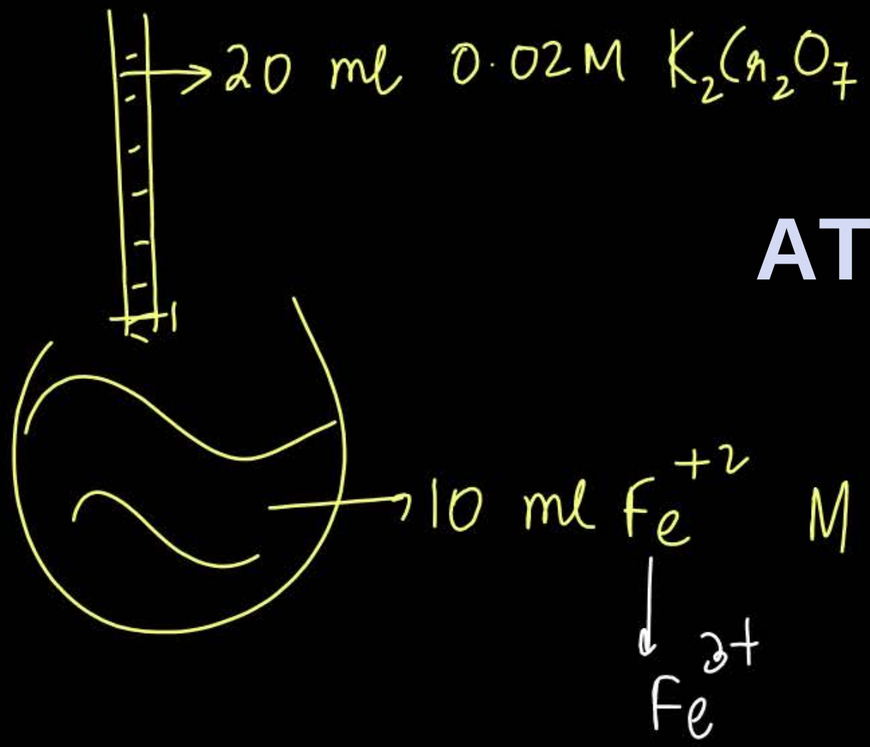
JEE Adv. 1998

An aqueous solution containing 0.10 g KIO_3 (formula weight = 214.0) was treated with an excess of KI solution. The solution was acidified with HCl. The liberated I_2 consumed 45.0 mL of thiosulphate solution to decolourise the blue strach-iodine complex. Calculate the molarity of the sodium thiosulphate solution.

H.W.

JEE Main 27 July 2022 Shift-1

20 mL of 0.02 M $K_2Cr_2O_7$ solution is used for the titration of 10 mL of Fe^{2+} solution in the acidic medium. The molarity of Fe^{2+} solution is ___24___ × 10^{-2} M. (Nearest Integer)



LOE $N_1V_1 = N_2V_2$

$n_1M_1V_1 = n_2M_2V_2$

$6 \times 0.02 \times 20 = 1 \times M_2 \times 10$

$M_2 = 0.24$ M

$= 24 \times 10^{-2}$ M

JEE Main 5 Sep 2020 Shift-2

The volume, in ml, of 0.02 M $K_2Cr_2O_7$ solution required to react with 0.288 g of ferrous oxalate in acidic medium is _____.

(Molar Mass of $FeC_2O_4 = 144$ g/mol)

H.W.

JEE Main 26 June 2022 Shift-2

20 mL of 0.02 M hypo solution is used for the titration of 10 mL of copper sulphate solution, in the presence of excess of KI using starch as an indicator. The molarity of Cu^{2+} is found to be_____ $\times 10^{-2}$ M [nearest integer]

Given : $2Cu^{2+} + 4I^- \longrightarrow Cu_2I_2 + I_2$

$I_2 + 2S_2O_3^{2-} \longrightarrow 2I^- + S_4O_6^{2-}$

H.W.

Question

0.3 g of an oxalate salt was dissolved in 100 mL solution. The solution required 90 mL of N/20 $KMnO_4$ for complete oxidation. The % of oxalate ion in salt is

(A) 33%

(B) 66%

(C) 70%

(D) 40%

Question

The equivalent weight of Br_2 is 96 in the following disproportionation reaction.

$Br_2 + OH^- \rightarrow Br^- + H_2O + ?$ (Oxidized product)

The oxidation state of Br in the oxidized product is(Br = 80)

H.W.

Question

Molecular masses of NH_3 and N_2 are x_1 and x_2, respectively. In the reaction.

$N_2 + 3H_2 \rightarrow 2NH_3$,

Their equivalent weights are y_1 and y_2. The $(y_1 - y_2)$ is

A $\left(\frac{2x_1 - x_2}{6}\right)$

B $(x_1 - x_2)$

C $(3x_1 - x_2)$

D $(x_1 - 3x_2)$

H.W.

JEE Adv. 2023 Paper 2 Online

H_2S (5 moles) reacts completely with acidified aqueous potassium permanganate solution. In this reaction, the number of moles of water produced is x, and the number of moles of electrons involved is y. The value of (x + y) is _____.

H.W.

Question

0.7 gm of $Na_2CO_3.xH_2O$ is dissolved in 100 ml, 20 ml of which required 19.8 ml of 0.1 N HCl. The value of x is

A 4

B 3

C 2

D 1

H.W.

IIT JEE Adv.

A solution of 0.2 g of a compound containing Cu^{2+} and $C_2O_4^{2-}$ ions on titration with 0.02M $KMnO_4$ in presence of H_2SO_4 consumes 22.6 ml. of the oxidant. The resultant solution in neutralized with Na_2CO_3, acidified with dil. acetic acid and treated with excess KI. The liberated iodine requires 11.3 ml of 0.05M $Na_2S_2O_3$ solution for complete reduction. Find out the molar ratio of Cu^{2+} to $C_2O_4^{2-}$ in the compound.

H.W.

Balancing Redox Reaction

Reduction Half
Oxidation Half

1. Balance all the atoms other than O and H.

2. Find change in oxidation number in reduction and oxidation and equate them.

3. Balance charge on both the sides.

4. Balance O and H with water.

$Fe^{+2} + Cr_2O_7^{-} \longrightarrow Fe^{+3} + Cr^{+3}$

Balance in acidic Mediom.

$$Fe^{+2} \longrightarrow Fe^{+3} + e^- \quad \times 6$$

$$6e^- + Cr_2^{+6}O_7^{2-} \longrightarrow 2Cr^{+3}$$

$$6Fe^{+2} \longrightarrow 6Fe^{+3} + 6e^-$$

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

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

$$MnO_4^- + I^- \longrightarrow MnO_2 + IO_3^-$$

Balance in basic medium

$$3e^- + \overset{+7}{Mn}O_4^- \longrightarrow \overset{+4}{Mn}O_2 \quad \times 2$$

$$I^- \longrightarrow \overset{+5}{I}O_3^- + 6e^-$$

$$4H_2O + 6e^- + 2MnO_4^- \longrightarrow 2MnO_2 + 8OH^-$$

$$6OH^- + I^- \longrightarrow IO_3^- + 6e^- + 3H_2O$$

$$H_2O + 2MnO_4^- + I^- \longrightarrow IO_3^- + 2MnO_2 + 2OH^-$$

$Br_2 \longrightarrow Br^- + BrO_3^-$

Balance in basic medium.

H.W.

3. $Br_2 \longrightarrow Br^- + BrO_3^-$

Balance in Basic medium.

$$2e^- + \overset{0}{Br_2} \longrightarrow 2\overset{-1}{Br^-} \quad \times 5$$

$$\overset{0}{Br_2} \longrightarrow 2\overset{+5}{BrO_3^-} + 10e^-$$

$$10e^- + 5Br_2 \longrightarrow 10Br^-$$

$$12OH^- + Br_2 \longrightarrow 2BrO_3^- + 10e^- + 6H_2O$$

$$12OH^- + 6Br_2 \longrightarrow 2BrO_3^- + 10Br^- + 6H_2O$$

In the following redox equation,

$$xUO^{2+} + Cr_2O_7^{2-} + yH^+ \longrightarrow aUO_2^{2+} + zCr^{+3} + bH_2O$$

the values of coefficients x, y and z respectively,

(1) 3, 8, 2

(2) 3, 8, 7

(3) 3,2,4

(4) 3,1,8

H·W

For the redox reaction

$$MnO_4^- + C_2O_4^{2-} + H^+ \longrightarrow Mn^{2+} + CO_2 + H_2O$$

the correct coefficient of the reactants for the balanced equation are

$$5e^- + \overset{+7}{Mn}O_4^- \longrightarrow \overset{+2}{Mn} \quad \times 2$$

$$\overset{+3}{C_2}O_4^{2-} \longrightarrow 2\overset{+4}{C}O_2 + 2e^- \quad \times 5$$

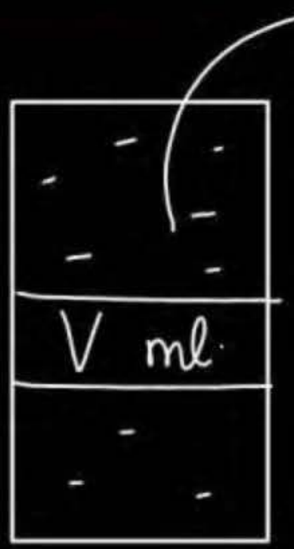
$$16H^+ + 10e^- + 2MnO_4^- \longrightarrow 2Mn^{2+} + 8H_2O$$

$$5C_2O_4^{2-} \longrightarrow 10CO_2 + 10e^-$$

$$2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \longrightarrow 10CO_2 + 2Mn^{2+} + 8H_2O$$

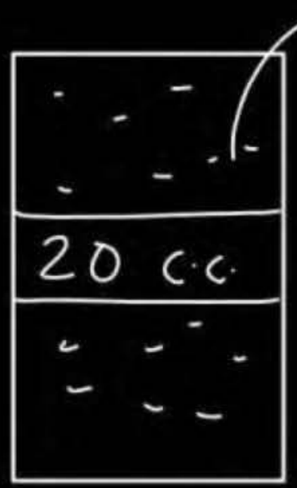
Volume Strength of H_2O_2

$H_2O_2 \rightarrow H_2O + O_2$



1 ml H_2O_2 solution → O_2

V ml O_2 at STP दिया।



1 ml H_2O_2 soln → 20 ml O_2 gas at STP.

Question

100 ml O_2 at STP was Produced after complete decomposition of 5 ml H_2O_2 solution. find out the V·S of H_2O_2 soln.

5 ml H_2O_2 $\xrightarrow{\text{decomposition}}$ 100 ml O_2 at STP

1 " " $\longrightarrow \frac{100}{5}$ = 20 ml O_2 at STP

V·S = 20 ml·

Volume Strength = 5.6 × Normality

Volume Strength = 11.2 × Molarity

IIT-JEE 1992

The volume strength of 1.5 N H_2O_2 solution is

(A) 4.8

(B) 8.4

(C) 3.0

(D) 8.0

$V \cdot 5 = 5 \cdot 6 \times N$

$= 5 \cdot 6 \times 1 \cdot 5$

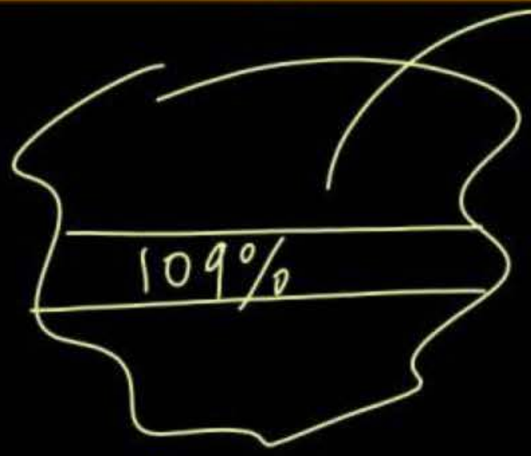
$= 8 \cdot 4$

IIT-JEE 1995

A 5.0 cm^3 solution of H_2O_2 liberates 0.508 g of iodine from an acidified KI solution. Calculate the strength of H_2O_2 solution in terms of volume strength at STP.

H.W.

Percentage Labelling of Oleum



Oleum sample

Fuming $H_2SO_4 = (H_2SO_4 + SO_3)$

$H_2S_2O_7$

$(H_2SO_4)_{init.} + SO_3$

H_2O

dilute

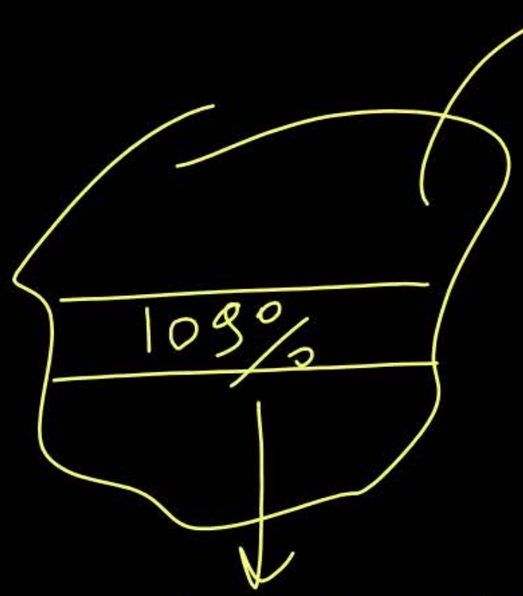
100 gm → 109 gm total H_2SO_4

$SO_3 + H_2O \longrightarrow (H_2SO_4)_{new}$

Total $H_2SO_4 = (H_2SO_4)_{initial} + (H_2SO_4)_{new}$

Question

Find out the percentage of free SO_3 in 109% oleum.



100 gm

x g SO_3 $\xrightarrow{H_2O}$ H_2SO_4 $\left(\frac{x}{80} \times 98 \text{ g}\right)$

$(100 - x)$ H_2SO_4

40% SO_3

$H_2SO_4 + SO_3$

$SO_3 + H_2O \longrightarrow H_2SO_4$

$\frac{x}{80}$ $\quad$ $\frac{x}{80} \times 98$

Total $H_2SO_4 = (100 - x) + \frac{x \times 98}{80} = 109$

$x = 40$ g

$100\,g \xrightarrow{H_2O\downarrow} 109\,g\ H_2SO_4$

9 gm H_2O is added ($\frac{1}{2}$ mol पानी)

$1\,H_2O + 1\,SO_3 \longrightarrow H_2SO_4$

$40\,g \longrightarrow 40\%$

Question find out the labelling of oleum sample having 40% free SO_3.

40% free SO_3 ⟶ 40 gm SO_3 in 100 g oleum

100 gm $\xrightarrow{9\text{ gm}}$ 109 gm.

$\frac{1}{2}$ mol SO_3

$\frac{1}{2}$ mol H_2O

9 gm

Labelling = 109%

For max Labelling => 100 gm SO_3 + 0 g H_2SO_4

$$\%\ \text{Labelling} = \left(100 + \frac{100}{80} \times 18\right) = 122.5$$

Labelling < 122.5 %

For minimum labelling => 0 g SO_3 + 100 g H_2SO_4

$$\%\ \text{Labelling} = \left(100 + \frac{0}{80} \times 18\right) = 100$$

Labelling > 100%

Minimum labelling of oleum = greater than 100%

assuming 0 g SO_3 + 100 g H_2SO_4 $\xrightarrow{H_2O\ (0\ g)}$ 100 g H_2SO_4

For Maximum labelling ज्यादा से ज्यादा H_2O add करना चाहिये।

assuming 100 g SO_3 + 0 g H_2SO_4 $\xrightarrow{H_2O}$ H_2SO_4 (total) $\frac{100}{80} \times 98 = 122.5$ g.

ATDB.uno