



Topics To Be Covered

PYD's
2024
2023
2019-2021

PC → 9 Chapter

Mole Concept
Redox
Solution

120 Slide
Questions
3 hrs

Atomic Struc.
Thermodynamics
Chemical Eqbⁿ

120 Slide
3:30 hrs

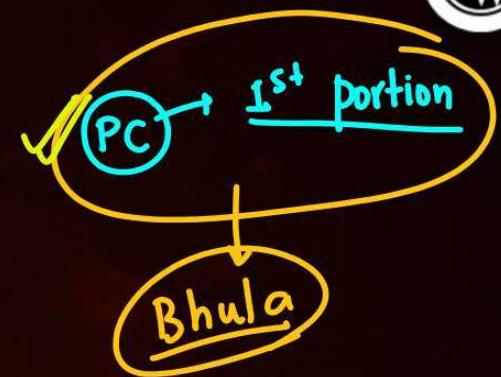
Ionic Eqb^m
Electrochemistry
Chemical Kinetics

120 Slides
(3:30-4)hr

① Question → Theory

② Theory
(Formula)
Crisp

$\frac{(20-30 \text{ mins})}{\text{Imp Topics}}$





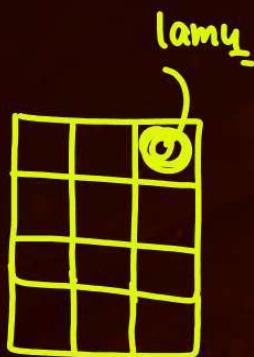
Mole Concept

① Masses

atom (unit) = amu or 'u'
(atomic mass Unit)

$$\frac{1\text{-}^{12}\text{C atom}}{12} = 1\text{amu}$$

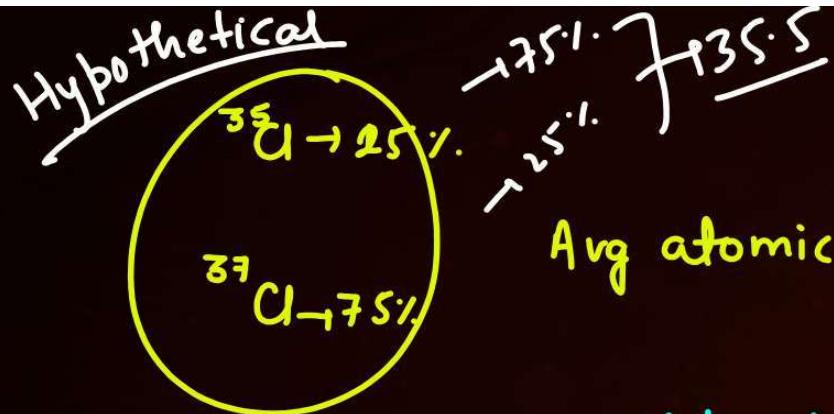
$$\begin{aligned}\text{1amu} &= \text{mass of 1 proton} \\ &= 1.66 \times 10^{-24} \text{ g}\end{aligned}$$



'u' एटोमी
'g' एटोमी

- | <u>Atom</u> | Mass of unit) |
|----------------------------------|-------------------------|
| (1) Atomic Mass → | 1 atom (u) |
| (2) Relative Atomic Mass (RAM) → | 1 atom (without unit) |
| (3) Gram Atomic Mass (GAM) → | 1 mol atom Ka mass |
| (4) Average atomic Mass → | Multiple isotopic form. |

$$AAM = \frac{(Mass\ of\ Isotope)_I \times abundance\ of\ Isotope_I + (Mass\ of\ Isotope)_{II} \times abundance\ of\ Isotope_{II}}{\text{Total Abundance.}}$$



$$\text{Avg atomic mass of U} = \frac{35 \times 25 + 37 \times 75}{100} = \underline{\underline{36.5}}$$

Molecule



① Molecular Mass = 44 u

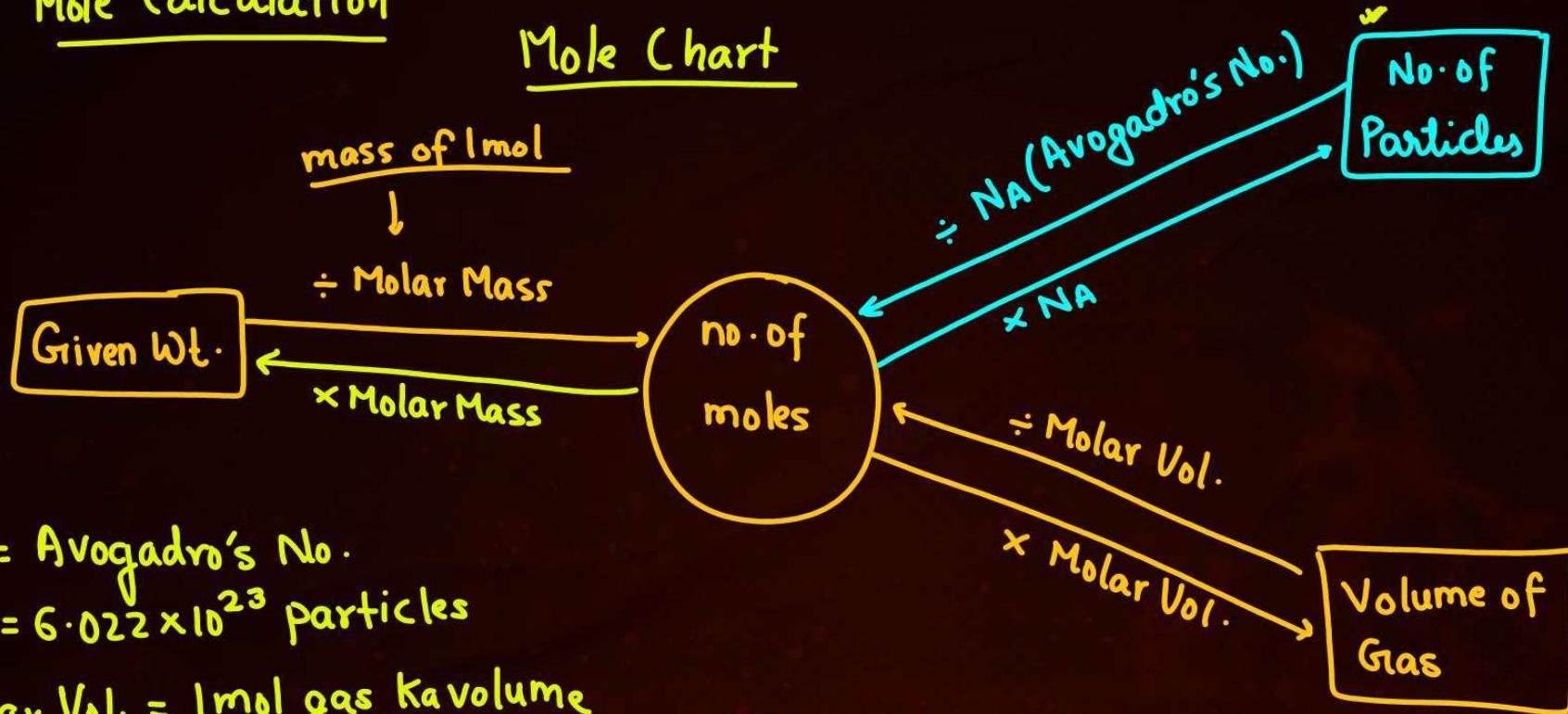
② R.MM = 44

③ GMM = 44 g

(1) Molecular Mass = 1 molecule (u)

(2) Relative Molecular Mass = 1 molecule (unit less)

(3) Gram Molecular Mass = 1 mol^{-1} molecule ka mass.

Mole CalculationMole Chart

N_A = Avogadro's No.

$$= 6.022 \times 10^{23} \text{ particles}$$

Molar Vol. = 1 mol gas ka volume

STP

$$\begin{aligned} T &= 0^\circ\text{C} \\ P &= 1 \text{ bar} \\ V_m &= 22.7 \text{ L} \end{aligned}$$

$$\begin{aligned} T &= 0^\circ\text{C} && \text{NTP} \\ P &= 1 \text{ atm} \\ V_m &= 22.4 \text{ L} \end{aligned}$$

(Q) Find no. of moles

$$n = \frac{1.7}{17} = \underline{0.1 \text{ mol}}$$

(1) 1.7 g NH₃

(2) 6.022×10^{24} molecules of NH₃

(3) 11.2 mL of NH₃ at (0°C, 1 atm)

$$n = \frac{11.2 \text{ mL}}{V_m}$$

$$= \frac{11.2}{22.4 \times 1000} = \frac{1}{2000} \text{ mol}$$

$$n = \frac{\text{no. of part}}{N_A} = \frac{6.022 \times 10^{24}}{6.022 \times 10^{23}} = \underline{10}$$

$$\begin{aligned} V_m &= 22.4 \text{ L} \\ &= 22.4 \times 1000 \text{ mL} \end{aligned}$$

Type → Find no. of individual atom & their mass.

(Q) 1 mol Sugar ($C_{12}H_{22}O_{11}$)

a) Find no. of moles of C, H, O.

b) wt of C, H & O atom.

#RBI

$$n_{\text{individual atom}} = n_{\text{molecule}} \times \text{atomicity}$$

$$W_{\text{individual atom}} = n_{\text{individual atom}} \times \text{Molar Mass}$$

Atomicity

C → 12

H → 22

O → 11

Sugar
0.5 mol

C → 6 mol

H → 11 mol

O → 5.5 mol

$$n_{\text{C-atom}} = (\text{atomicity})_C \times n_{\text{sugar}} \\ = 12 \times 1 = 12 \text{ mol}$$

$$n_{\text{H-atom}} = 22 \times n_{\text{sugar}} = 22 \text{ mol}$$

$$n_{\text{O-atom}} = 11 \times n_{\text{sugar}} = 11 \text{ mol}$$

$$W_C = 12 \times 12 = 144 \text{ g} \quad | \quad W_O = 11 \times 16 \\ W_H = 22 \times 1 = 22 \text{ g} \quad | \quad = 176 \text{ g}$$

No. of moles e⁻, p & neutron

No. of proton = Z

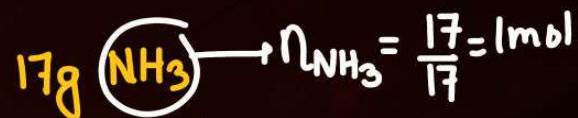
No. of neutron = A-Z

No. of e⁻ = Z - (charge)

A → Mass no.

Z = Atomic No.

Q5



$$n_{\text{proton}} = 10 \text{ mol}$$

$$n_{\text{neutron}} = 7 \text{ mol}$$

$$n_{\text{electrons}} = 10 \text{ mol}$$



$$\sum Z = 7 + 3 \times 1 = 10$$

$$\begin{aligned} \text{neutrons} &= \sum (A-Z) = 7 + 3(0) \\ &= 7 \end{aligned}$$

Stoichiometry + Limiting Reagent

Balanced rxn me mole concept apply Karna.



$$(\text{CO})_{\text{formed}} = 2 \text{ mol}$$

$$(\text{C})_{\text{required}} = 2 \text{ mol}$$

$$\frac{(\text{N}_\text{C})_\text{r}}{2} = \frac{(\text{N}_{\text{O}_2})_\text{r}}{1} = \frac{(\text{N}_{\text{CO}})_{\text{formed}}}{2}$$

Karna
dara

* Limiting Reagent (LR)



Reactant jo sabse pehle khatam hu jaye.

LR Ki pehchan.

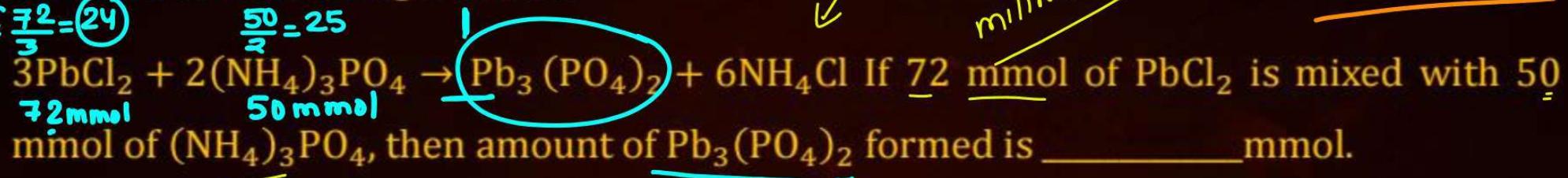
- ① Write balanced rxn.
- ② Find no. of moles of each reactant.
- ③ Find a ratio ' r ' = $\frac{n_{\text{Reactant}}}{\text{Stoic. Coeff}}$
- ④ Reactant with smallest ' r ' will be L.R.
- ⑤ Saare calculation L.R se honge.



QUE



Consider the following reaction:



(nearest integer)

$$\frac{n_{\text{PbCl}_2}}{3} = \frac{n_{\text{Pb}_3(\text{PO}_4)_2}}{1}$$

$$n_{\text{Pb}_3(\text{PO}_4)_2} = \frac{72}{3} = 24 \text{ mmol}$$

10^3 mol
millimoles

m m

$n_{\text{NH}_4\text{Cl}}$ formed

[01 Feb 2024 (Shift 1)]

$$\frac{n_{\text{PbCl}_2}}{3} = \frac{n_{\text{NH}_4\text{Cl}}}{62}$$

$$n_{\text{NH}_4\text{Cl}} = 2 n_{\text{PbCl}_2}$$

Ans.

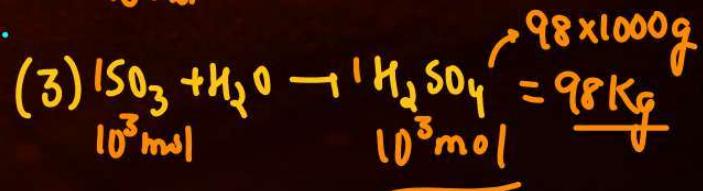
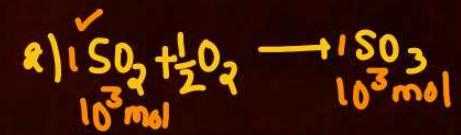
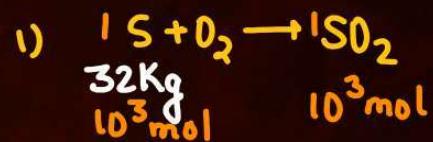
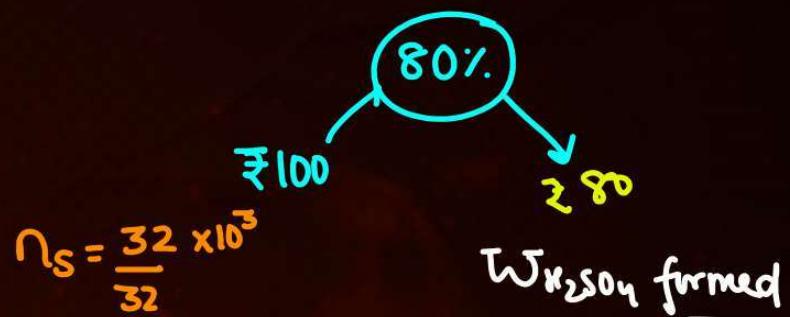
Application of Stoichio + LR

$$\textcircled{1} \quad \% \text{ Purity} = \frac{\text{W}_{\text{Pure Substance}}}{\text{W}_{\text{Total}}} \times 100$$

(Pure sample undergoes rxn)

$$\textcircled{2} \quad \% \text{ Yield} (\text{efficiency of rxn}) = \frac{(\text{Wt Sample})_{\text{exp}}}{(\text{Wt Sample})_{\text{Theory}}} \times 100$$

\textcircled{3} Sequential Rxn
 (एक rxn का product dusre ka reactant)
 mol ko product se reactant me le jao.



Conc^o Terms

Mole Wala

- (1) Molarity (M)
- (2) Molality (m)
- (3) Mole fraction (x)

Bina Mole Wala

- (1) w/w%
- (2) w/v%
- (3) v/v%
- (4) ppm
- (5) ppb

$$M = \frac{n_{\text{solute}}}{V_{(\text{sol})}^{\circ} \text{ L}}$$

$$m = \frac{n_{\text{solute}}}{W_{\text{solvent}} (\text{kg})}$$

Relation b/w 'm' & M

$$m = \frac{1000 M}{1000d - M(MM)_{\text{solute}}}$$

m = molality

M = Molarity

d = density of solⁿ

(MM)_{solute} = Molar Mass of Solute.

$$X_A = \frac{n_A}{n_A + n_B}$$



◎ Conc² Terms jisme volume aaye wo temp dependent .

eg → $\frac{w/v\%}{V/V''}$, M etc

QUE



10 mL of gaseous hydrocarbon on combustion gives 40 mL of $\text{CO}_2(\text{g})$ and 50 mL of water vapour. Total number of carbon and hydrogen atoms in the hydrocarbon is $4+10=14$.



[01 Feb 2024 (Shift 2)]

$$\frac{V_{C_xH_y}}{1} = \frac{\bar{V}_{CO_2}}{x}$$

40mL 50mL 2n+


$$\frac{V_{C_6H_5Y}}{1} = \frac{V_{H_2O}}{\frac{4}{2}}$$

$$10 = \frac{50}{\frac{4}{2}} \quad \left| \begin{array}{l} n \cdot y = 5 \times 2 \\ = 10 \end{array} \right.$$

Ans.

QUE

PW

$$12 \times 7 = 84$$

Volume of 3 M NaOH (formula weight 40 g mol⁻¹) which can be prepared from 84 g of NaOH is 7 $\times 10^{-1} \text{ dm}^3$. 1dm³ = 1L [27 Jan 2024 (Shift 2)]

$$M = 3 \text{ M}$$

$$V = ?$$

$$3 \times V \quad \checkmark \quad n_{\text{solute}} = M \times V_{(\text{sol})} (L)$$

$$\frac{84}{40} \quad \leftarrow \quad \checkmark \quad n_{\text{solute}} = \frac{\text{Given wt}}{\text{Molar Mass}}$$

$$\frac{84}{40} = 3 \times V$$

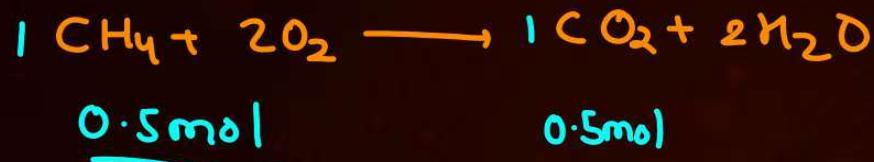
$$V = \frac{7}{3 \times 10 \times 3} = \frac{7}{30} \text{ L} = \underline{\underline{7 \times 10^{-1} \text{ dm}^3}}$$

Ans.

QUE



Number of moles of methane required to produce $22\text{g CO}_{2(\text{g})}$ after combustion is $x \times 10^{-2}$ moles. The value of x is [31 Jan 2024 (Shift 1)]



$$n_{\text{CH}_4} = 0.5 \text{ mol}$$
$$= 50 \times 10^{-2} \text{ mol}$$

Ans.

QUE



$$W_{CO_2} = \frac{22}{44} = 0.5 \text{ mol}$$

Mass of methane required to produce 22 g of CO_2 after complete combustion is ____ g.

(Given Molar mass in g mol⁻¹

W_{H_2O} formed = ?

C = 12.0

H = 1.0

O = 16.0



$$\frac{n_{CH_4}}{1} = \frac{n_{O_2}}{2} = \frac{n_{CO_2}}{1} = \frac{n_{H_2O}}{2}$$

[27 Jan 2024 (Shift 1)]

$$n_{CH_4} = n_{CO_2}$$

$$n_{CH_4} = 0.5 \text{ mol}$$

$$W_{CH_4} = 0.5 \times 16 = 8 \text{ g}$$

$$n_{H_2O} = 2 \times n_{CO_2} \\ = 2 \times 0.5 \\ = 1$$

Ans.



QUE
 $2.21-x \text{ g}$
 $x \text{ g}$
 2.21 g

Mixture \rightarrow Sabka rxn
alag alag

A sample of CaCO_3 and MgCO_3 weighed 2.21 g is ignited to constant weight of 1.152 g .

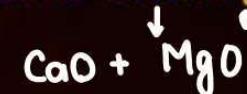
$n_{\text{CaCO}_3} = \frac{2.21-x}{100}$

The composition of mixture is :

$$\frac{2.21-x}{100} \xrightarrow{-1.152} w_{\text{CO}_2}$$

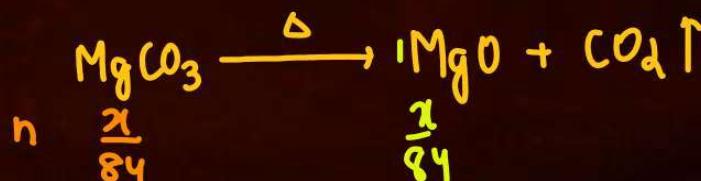
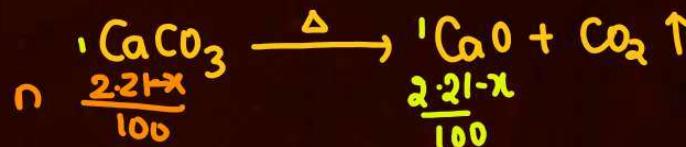
(Given molar mass in gmol^{-1} CaCO_3 : 100, MgCO_3 : 84)

[31 Jan 2024 (Shift 2)]



- A** $1.187 \text{ g CaCO}_3 + 1.023 \text{ g MgCO}_3$
- B** $1.023 \text{ g CaCO}_3 + 1.023 \text{ g MgCO}_3$
- C** $1.187 \text{ g CaCO}_3 + 1.187 \text{ g MgCO}_3$
- D** $1.023 \text{ g CaCO}_3 + 1.187 \text{ g MgCO}_3$

Process



$w_{\text{CaO}} = \frac{2.21-x+56}{100}$
 $w_{\text{MgO}} = \frac{x+40}{84}$

Ans.

QUE

$$\frac{100}{48.5}$$

100
2

$$MF = (EF)m$$

PW

An organic compound has 42.1% carbon, 6.4% hydrogen and remainder is oxygen. If its molecular weight is 342, then its molecular formula is :

Calculation EF (Dabba Method) [05 Apr 2024 (Shift 1)]

- A $C_{11}H_{18}O_{12}$
- B $C_{12}H_{20}O_{12}$
- C $C_{12}H_{22}O_{11}$
- D $C_{14}H_{20}O_{10}$

| Element | wt | n |
|---------|------|-------------------|
| C | 42.1 | $\frac{42.1}{12}$ |
| H | 6.4 | $\frac{6.4}{1}$ |
| O | 51.5 | $\frac{51.5}{16}$ |

S.R
2
4
2

$$EF = C_x H_y O_z$$

$$m = \frac{MF \text{ mass}}{EF \text{ mass}}$$

Ans.

QUE

$$\text{CH}_4 \rightarrow 0.25\text{ mol}$$

$$0.25\text{ mol}$$



The number of moles of methane required to produce 11gCO₂(g) after complete combustion is :

(Given molar mass of methane in gmol⁻¹: 16)

[05 Apr 2024 (Shift 2)]

- A 0.35
- B 0.5
- C 0.75
- D 0.25

Ans.

QUE



The density of 'x' M solution ('X' molar) of NaOH is 1.12 g mL⁻¹, while in molality, the concentration of the solution is 3 m(3molal). Then x is

(Given : Molar mass of NaOH is 40 g/mol)

[06 Apr 2024 (Shift 1)]

- A 3.5
- B 3.8
- C 2.8
- D 3.0

$$m = \frac{1000M}{1000d - M(40)}$$

$$3 = \frac{1000M}{1120 - M(40)}$$

$$3360 - 120M = 1000M$$

$$1120M = 3360$$

$$M = \frac{3360}{1120} = 3$$

Ans.

QUE

3X1000



Molality (m) of 3 M aqueous solution of NaCl is :

(Given : Density of solution = 1.25 g mL⁻¹, Molar mass in gmol⁻¹: Na – 23, Cl – 35.5)

31

$$m = \frac{1000 M}{1000d - M(MM)_{\text{NaCl}}}$$
$$= \frac{3000}{1250 - 3 \times 58.5}$$

[06 Apr 2024 (Shift 2)]

- A ~~1.9 m~~
- B ~~3.85 m~~
- C ~~2.79 m~~
- D 2.90 m

Ans.



QUE

$$n_{\text{Glu}} = \frac{900}{180} = 5 \text{ mol}$$

Combustion of glucose ($C_6H_{12}O_6$) produces CO_2 and water. The amount of oxygen (in g) required for the complete combustion of 900 g of glucose is :

[Molar mass of glucose in $\text{gmol}^{-1} = 180$] 18

[08 Apr 2024 (Shift 1)]

A 480



B 800

$$\frac{n_{\text{Glu}}}{1} = \frac{n_{O_2}}{6}$$

C 960

$$n_{O_2} = 6 \times n_{\text{Glu}}$$

D 32

$$\begin{aligned} & : 6 \times 5 = 30 \text{ mol} \\ & = 30 \times 32 = \underline{\underline{960 \text{ g}}} \end{aligned}$$

Ans.

Q.



The number of units, which are used to express concentration of solution from the following is _____. [JEE Main 2023]

Mass percent, Mole, Mole fraction, Molarity, ppm, Molarity

- Mass percent
- Mole
- Mole fraction
- Molarity
- ppm
- Molarity

Q.



What is the mass ratio of ethylene glycol ($C_2H_6O_2$, molar mass = 62 g/mol) required for making 500 g of 0.25 molal aqueous solution and 250 mL of 0.25 molar aqueous solution

[JEE Main 2023]

- A** 1 : 1
- B** 3 : 1
- C** 2 : 1
- D** 1 : 2

Q.



When 0.01 mol of an organic compound containing 60% carbon was burnt completely, 4.4 g of CO_2 was produced. The molar mass of compound is ____ g mol^{-1} (nearest integer) [JEE Main 2023]



Q.

The density of 3 M solution of NaCl is 1.0 g mL^{-1} . Molality of the solution is $\underline{\quad} \times 10^{-2} \text{ m}$. (Nearest integer) [Given: Molar mass of Na and Cl is 23 and 35.5 g mol^{-1} respectively]

[JEE Main 2023]



Easy to score

Redox

Redox

Oxidation No.

Rules

(1) Element in their atomic form / Elemental form)

$$\text{ON} = \text{Zero}$$



$\left[\begin{array}{l} \text{Na}, \text{Mg}, \text{Ca}, \text{Sr}, \text{Ba}, \\ \text{Cl}_2, \text{O}_2, \text{O}_3, \text{N}_2, \text{H}_2, \text{Br}_2, \\ \text{F}_2, \text{P}_4, \text{S}_8 \text{ etc} \end{array} \right]$

(2) Only one O-S other than zero

⦿ Grp 1 elements = $(\text{Li}, \text{Na}, \text{K}, \text{Rb}, \text{Cs}) \rightarrow +1$

⦿ Grp 2 elements = $(\text{Be}, \text{Mg}, \text{Ca}, \text{Sr}, \text{Ba}) \rightarrow +2$

⦿ Al $\rightarrow +3$

⦿ F $\rightarrow -1$

(3) Oxygen

General = -2

✗ Oxide (O^{2-}) = -2

Peroxide (O_2^{2-}) = -1

Superoxide (O_2^{-1}) = $-\frac{1}{2}$

Ozonide (O_3^-) = $-\frac{1}{3}$

Oxygen with Flourine

have +ve O's



(4) Hydrogen

→ Generally $\rightarrow +1$

✓ Metal Hydride $\rightarrow -1$

(Metal + Hydrogen)
Only

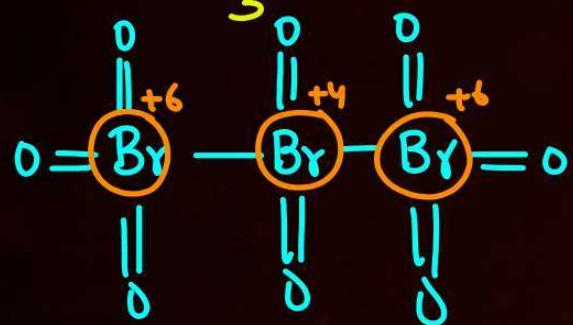
(5) Sum of O.N of all the element in a compound/ion is equal to charge on that ion.



1) Br_3O_8

$$3x + 8(-2) = 0$$

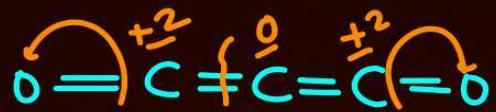
$$x = \frac{+16}{3}$$



(2) C_3O_2

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

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



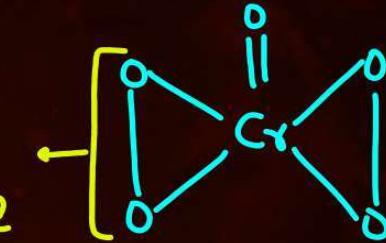
(3) CrO_5

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

$$x = +10$$

Quintat
स्टेक्विंट

Peroxide
Linkage



Balancing
Simplest Method

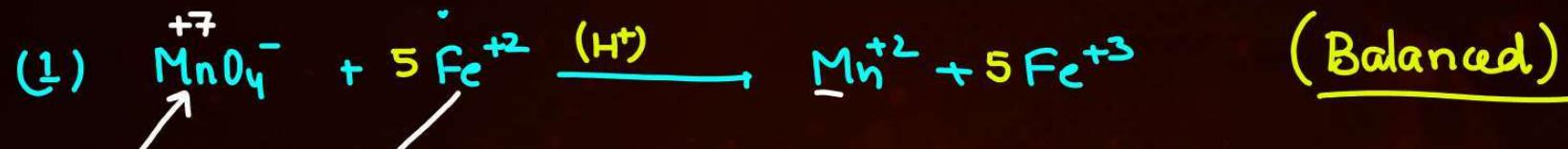
→ atom balance & Charge balance)

PW

LCM

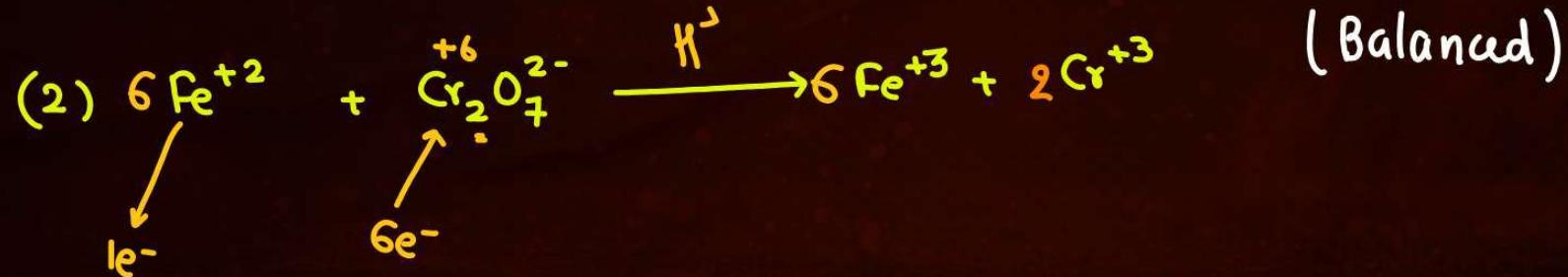
H₂O

(Q) Balance the rxn.



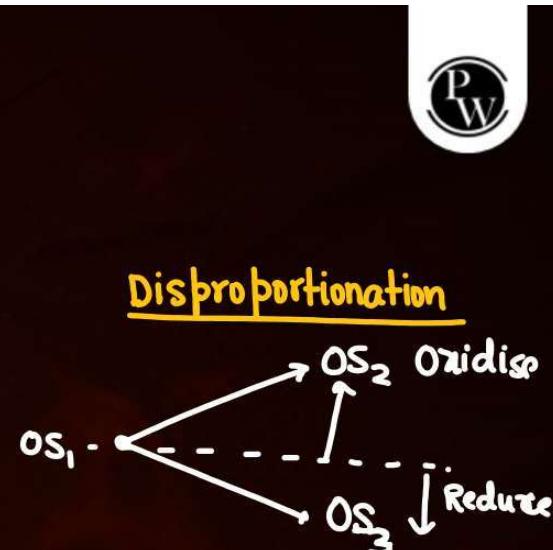
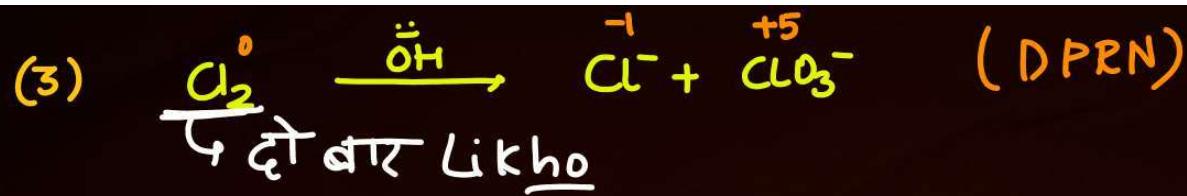
5e⁻

1e⁻



1e⁻

6e⁻



QUE


 LO^m

Match List - I with List - II.

| | List - I Reaction | | List - II Type of redox reaction |
|------------|---|-------|---|
| (A) | $\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{NO}_{(\text{g})}$ → (iv) | (I) | Decomposition |
| (B) | $\text{Pb}(\text{NO}_3)_2(\text{s}) \rightarrow 2\text{PbO}_{(\text{s})} + 4\text{NO}_{2(\text{g})} + \text{O}_{2(\text{g})}$ -(I) | (II) | Displacement |
| (C) | $2\text{Na}_{(\text{s})} + 2\text{H}_2\text{O}(\text{l}) \rightarrow 2\text{NaOH}_{(\text{aq})} + \text{H}_{2(\text{g})}$ → II | (III) | Disproportionation |
| (D) III | $2\text{NO}_{2(\text{g})}^{+\text{IV}} + 2^{-}\text{OH}(\text{aq.}) \rightarrow \text{NO}_{2(\text{aq.})}^{+\text{3}} + \text{NO}_{(\text{aq.})}^{-\text{3}}$ DPRN | (IV) | Combination |

Choose the correct answer from the options given below :

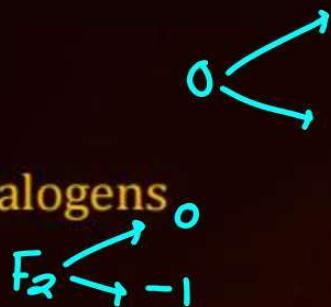
[2024 (06 Apr Shift 2)]

- A** (A)-(II), (B)-(III), (C)-(IV), (D)-(I)
- B** (A)-(III), (B)-(II), (C)-(I), (D)-(IV)
- C** (A)-(IV) (B)-(I), (C)-(II), (D)-(III)
- D** (A)-(I), (B)-(II), (C)-(III), (D)-(IV)

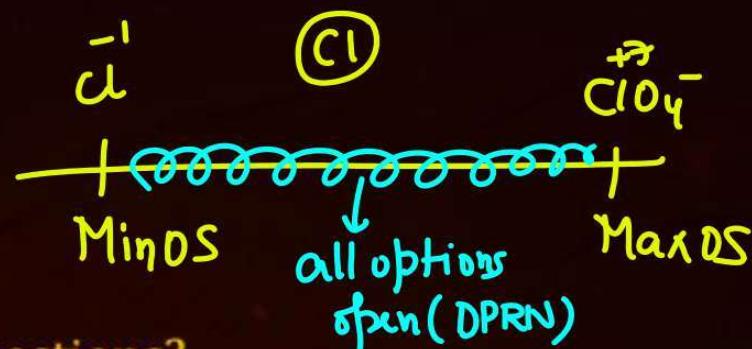
Ans. (C)

QUE

Among the following halogens
F₂, Cl₂, Br₂ and I₂



Which can undergo disproportionation reactions?



2024 (08 Apr Shift 1)

Kaise pehchane

Oxidising Agent → Max OS

Reducing Agent → Min OS

DPRN

- A F₂, Cl₂ and Br₂
- B F₂ and Cl₂
- C Only I₂
- D Cl₂, Br₂ and I₂

Ans.

QUE

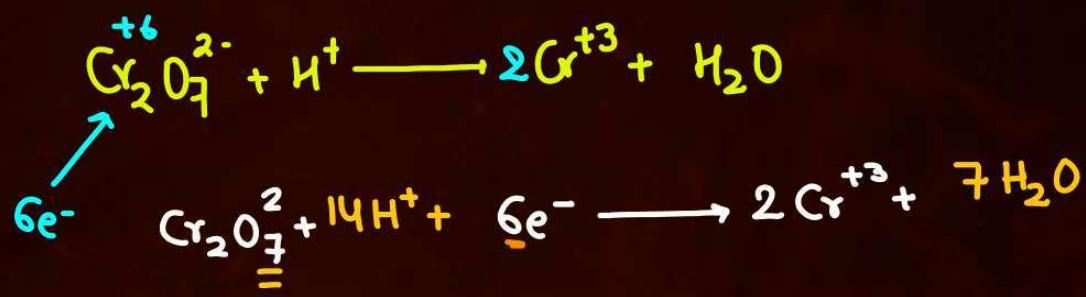
In acidic medium, $\text{K}_2\text{Cr}_2\text{O}_7$ shows oxidising action as represented in the half reaction



X, Y, Z and A are respectively are:

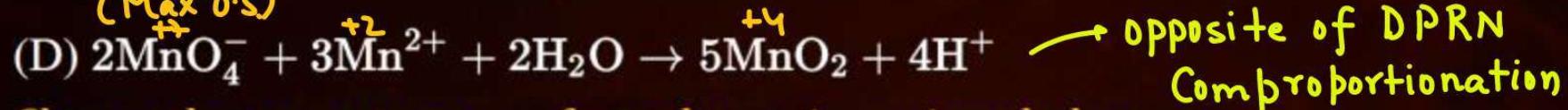
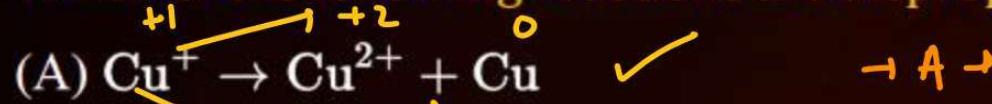
- A ~~8, 6, 4 and Cr_2O_3~~
- B ~~14, 7, 6 and Cr^{3+}~~
- C ~~8, 4, 6 and Cr_2O_3~~
- D ~~14, 6, 7 and Cr^{3+}~~

A [2024 (01 Feb Shift 1)]

**Ans.**

QUE

Which of the following reactions are disproportionation reactions?



Choose the correct answer from the options given below:

[2024 (01 Feb Shift 1)]

- A (A), (B)
- B (B), (C), (D)
- C (A), (B), (C)
- D (A), (D)

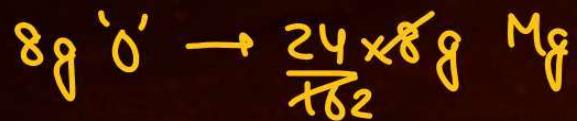
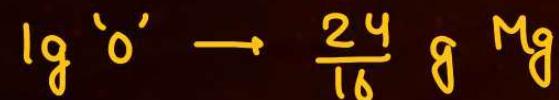
Ans. (A)

Equivalent Concept

Equivalent Mass : \rightarrow Amount of any substance that rxⁿ with either 1g 'H' or 8g 'O' or 35.5g 'Cl'.

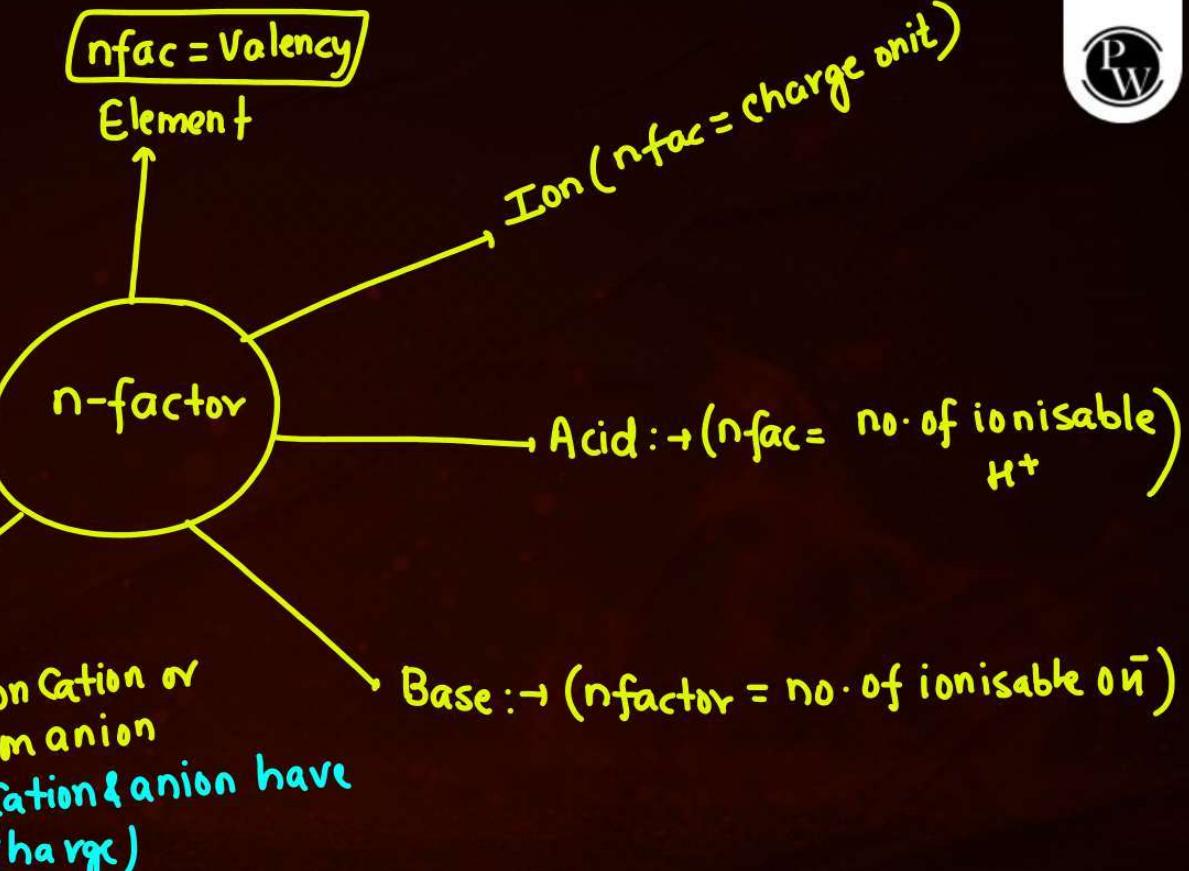
Find eq. mass of Mg in MgO ?

24g Mg reacts with 16g 'O'



$$= \underline{\underline{12\text{g}}}$$

$$\text{Equivalent Wt} = \frac{\text{Molar Mass}}{\text{n-factor}}$$



$$\begin{aligned} \text{nfac of A} &= b \\ \text{nfac of B} &= a \end{aligned}$$

Case I: $\text{Ca}^{+2}(\text{CO}_3)^{-2}$ nfac = Charge on Cation or Charge on Anion
(When Cation & Anion have Same charge)

Case II: nfactor = $|q_1 \times q_2|$

$$\text{no. of moles} = \frac{\text{Given wt}}{\text{Molar Mass}}$$

$$\text{no. of equivalents} = \frac{\text{Given wt}}{\text{Eq. wt}}$$

$$\text{Normality (N)} = \frac{\text{No. of eq}}{V_{\text{sol}}(\text{in L})}$$

$$N = \frac{n \text{ fac} \times \text{no. of mols}}{V_{\text{sol}}}$$

$$N = n \text{ fac} \times M$$

$$\text{Eq. wt} = \frac{\text{Molar Mass}}{n\text{-factor}}$$

$$\text{no. of eq} = \frac{\text{Given wt}}{\text{Molar Mass}} \times n \text{ fac.}$$

$$\boxed{\text{no. of eq} = n \text{ fac} \times \text{no. of mols}}$$

QUE

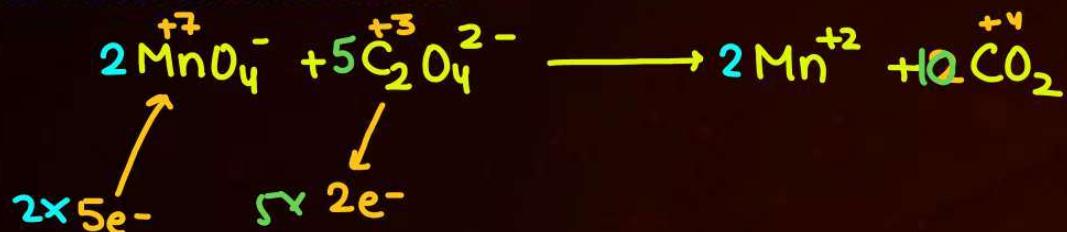
Eq. concept
(M)

Mole Concept
Balancing required



Only 2 mL of KMnO₄ solution of unknown molarity is required to reach the end point of a titration of 20 mL of oxalic acid (2M) in acidic medium. The molarity of KMnO₄ solution should be M.

[2024 (04 Apr Shift 1)]



$$\frac{n_{\text{MnO}_4^-}}{2} = \frac{n_{\text{C}_2\text{O}_4^{2-}}}{5}$$

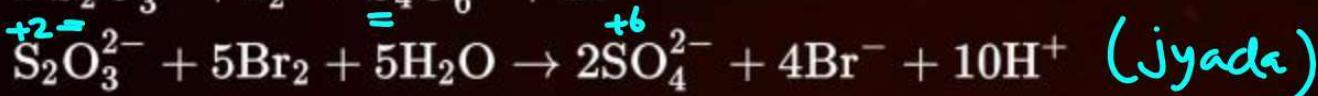
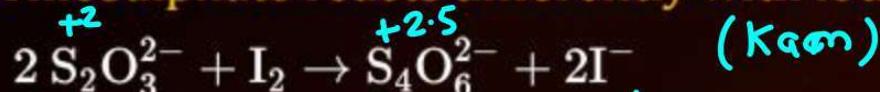
$$\frac{M \times 2}{2} = \frac{2 \times 20 \text{M}}{5} \quad \underline{\underline{M=8 \text{M}}}$$

$$\begin{aligned} M &\rightarrow \checkmark \\ V &\rightarrow \checkmark \\ M \times V &= \text{No. of mols} \end{aligned}$$

Ans.

QUEBr₂ I₂

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



Which of the following statement justifies the above dual behaviour of thiosulphate? ✓

A

Bromine is a stronger oxidant than iodine

[2024 (08 Apr Shift 1)]**B**

Thiosulphate undergoes oxidation by bromine and reduction by iodine in these reaction

C

Bromine is a weaker oxidant than iodine

D

Bromine undergoes oxidation and iodine undergoes reduction in these reactions

Ans.

Given below are two statements :

Statement (I) : Potassium hydrogen phthalate is a primary standard for standardisation of sodium hydroxide solution. (T)

Statement (II) : In this titration phenolphthalein can be used as indicator. ✓ (T)

In the light of the above statements, choose the most appropriate answer from the options given below:

[2024 (01 Feb Shift 1)]

- A** Both Statement I and Statement II are correct
- B** Statement I is correct but Statement II is incorrect
- C** Statement I is incorrect but Statement II is correct
- D** Both Statement I and Statement II are incorrect

Ans. (A)

QUE



Self reduce

Which of the following cannot function as an oxidising agent?

[2024 (27 Jan Shift 2)]

- A N^{3-} (min O.S) ✓
- B $\text{S}\overset{+6}{\text{O}}_4^{2-}$ ✓
- C $\text{Br}\overset{+5}{\text{O}}_3^-$ ✓
- D $\text{Mn}\overset{+7}{\text{O}}_4^-$ ✓

Ans.

KMnO_4 decomposes on heating at 513 K to form O_2 along with

[2024 (29 Jan Shift 1)]

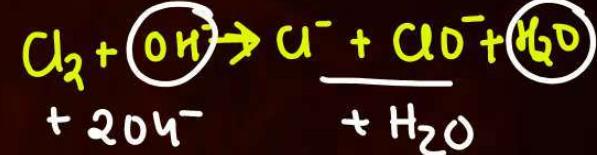
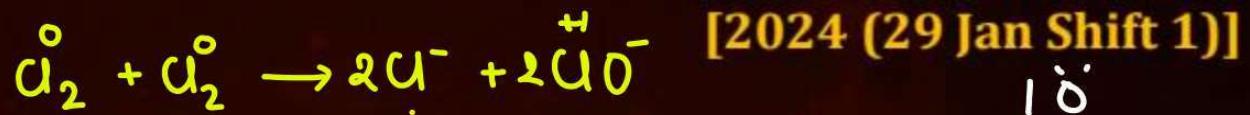
- A** MnO_2 & K_2O_2
- B** K_2MnO_4 & Mn
- C** Mn & KO_2
- D** K_2MnO_4 & MnO_2

Ans. (D)

Chlorine undergoes disproportionation in alkaline medium as shown below :



The values of a, b, c and d in a balanced redox reaction are respectively:



- A** 1, 2, 1 and 1
- B** 2, 2, 1 and 3
- C** 3, 4, 4 and 2
- D** 2, 4, 1 and 3

Ans.

QUE

If 50 mL of 0.5M oxalic acid is required to neutralize 25 mL of NaOH solution, the amount of NaOH in 50mL of given NaOH solution is _____ g.

50mL → 100 mmol
50 mmol

PW

[2024 (29 Jan Shift 2)]



25 mmol 50 mmol

NaOH (50mL)
→ pH (25 mL)

$$\text{NaOH} = 100 \text{ mmol}$$

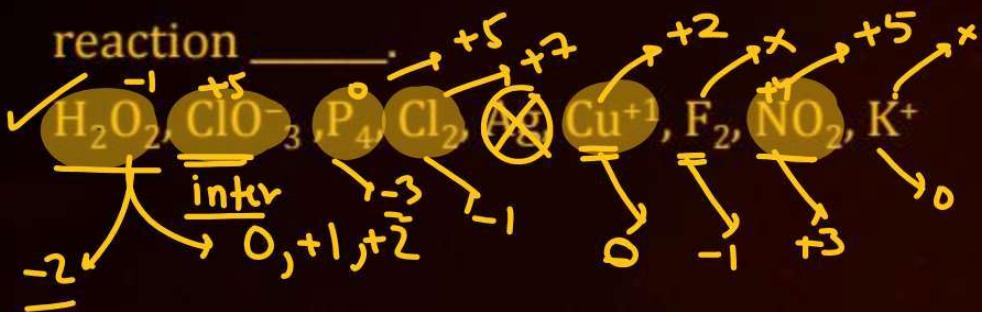
$$W_{\text{NaOH}} = \frac{100}{1000} \times 40 = 4 \text{ g}$$

Ans.

QUE



Total number of species from the following which can undergo disproportionation reaction _____.



[2024 (30 Jan Shift 2)]

6

Ans.

QUE



If the above equation is balanced with integer coefficients, the value of is _____

[2024 (30 Jan Shift 1)]

Ans. (8)

Strong reducing and oxidizing agents among the following , respectively, are

[2023 (06 Apr Shift 1)]

- A** Ce³⁺ and Ce⁴⁺
- B** Ce⁴⁺ and Tb⁴⁺
- C** Ce⁴⁺ and Ea²⁺
- D** Eu²⁺ and Ce⁴⁺

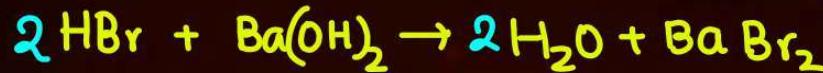
Ans. (D)

QUEP
W

V

The volume of 0.02 M aqueous HBr required to neutralize 10.0 mL of 0.01 M aqueous Ba(OH)₂ is (Assume complete neutralization)math

[2023 (06 Apr Shift 2)]



$$\underline{0.2\text{mmol}} \quad 0.1\text{mmol}$$

$$0.2\text{mmol} = M \times V(\text{mL})$$

$$0.2 = 0.02 \times V(\text{mL})$$

$$V_{\text{mL}} = \underline{\underline{10}}$$

$$\frac{n_{\text{Ba(OH)}_2}}{1} = \frac{n_{\text{HBr}}}{2}$$

- A 2.5 mL
- B 5.0 mL
- C 10.0 mL
- D 7.5 mL

Ans.

QUE



[2023 (08 Apr Shift 1)]

- A** 2
- B** 12
- C** 10
- D** 6

Ans. (C)

QUE



In alkaline medium, the reduction of permanganate anion involves a gain of _____ electrons.

[2023 (10 Apr Shift 2)]

Ans. (3)

QUE



KMnO_4 is titrated with ferrous ammonium sulphate hexahydrate in presence of dilute H_2SO_4 . Number of water molecules produced for molecules of KMnO_4 is _____.

[2023 (13 Apr Shift 1)]

Ans. (68)

QUE



See the following chemical reaction:



The sum of X, Y and Z is

[2023 (13 Apr Shift 2)]

Ans. (23)

Q.

5g of NaOH was dissolved in deionized water to prepare a 450 mL stock solution. What volume (in mL) of this solution would be required to prepare 500 mL of 0.1 M solution? [JEE Main 2023]



Q.

The number of electrons involved in the reduction of permanganate to manganese dioxide in acidic medium is:

[JEE Main 2023]



Q.



KMnO₄ Oxidises I⁻ in acidic and neutral/faintly alkaline solution,
respectively to:

[JEE Main 2023]

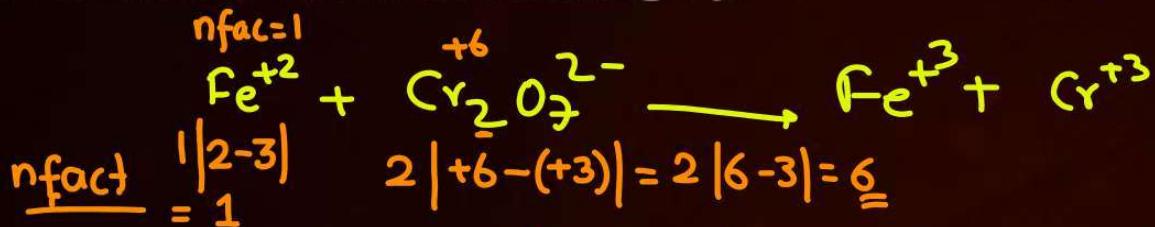
- A** I₂ and IO₃⁻
- B** IO₃⁻ and I₂
- C** IO₃⁻ and IO₃⁻
- D** I₂ and I₂

Question-3

$$N \times V = ?$$



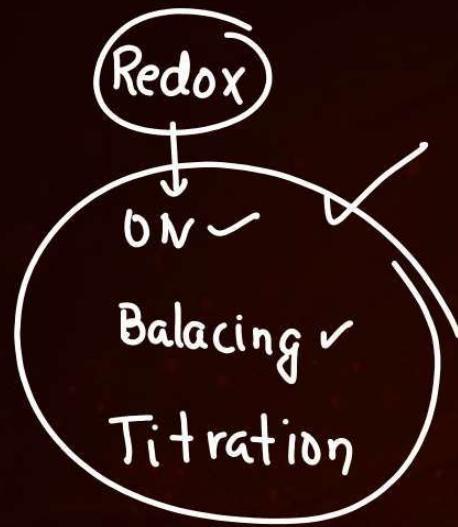
15 mL of aqueous solution of Fe^{2+} in acidic medium completely reacted with 20 mL of 0.03 N aqueous $\text{Cr}_2\text{O}_7^{2-}$. The Normality of the Fe^{2+} solution is 4 $\times 10^{-2}$ N (Round off to the Nearest Integer). [17 March 2021 Shift 1]



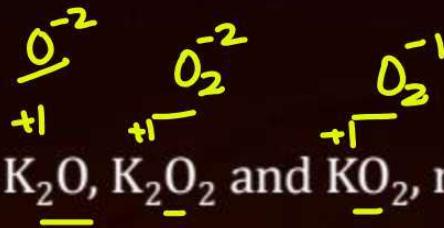
Redox: $n_{\text{fact}} = \frac{\text{no. of atom} | \text{OS}_1 - \text{OS}_2 |}{2}$

$$N_1 V_1 = N_2 V_2$$

$$\begin{aligned} \text{Fe}^{+2} &\rightarrow N_1 = ? \\ V_1 &= 15 \text{ mL} \\ (\text{Cr}_2\text{O}_7^{2-}) &\rightarrow N_2 = 0.03 \\ V_2 &= 20 \text{ mL} \\ N_1 \times 15 &= \frac{0.01}{0.03} \times 20 \\ &= 4 \times 10^{-2} \end{aligned}$$



Question-13



Oxidation number of potassium in $\underline{\text{K}_2\text{O}}$, $\underline{\text{K}_2\text{O}_2}$ and $\underline{\text{KO}_2}$, respectively, is:

[7 January 2020 Shift 1]

- (A) +2, +1 and +1/2
- (C) +1, +4 and +2

- (B) +1, +1 and +1
- (D) +1, +2 and +4

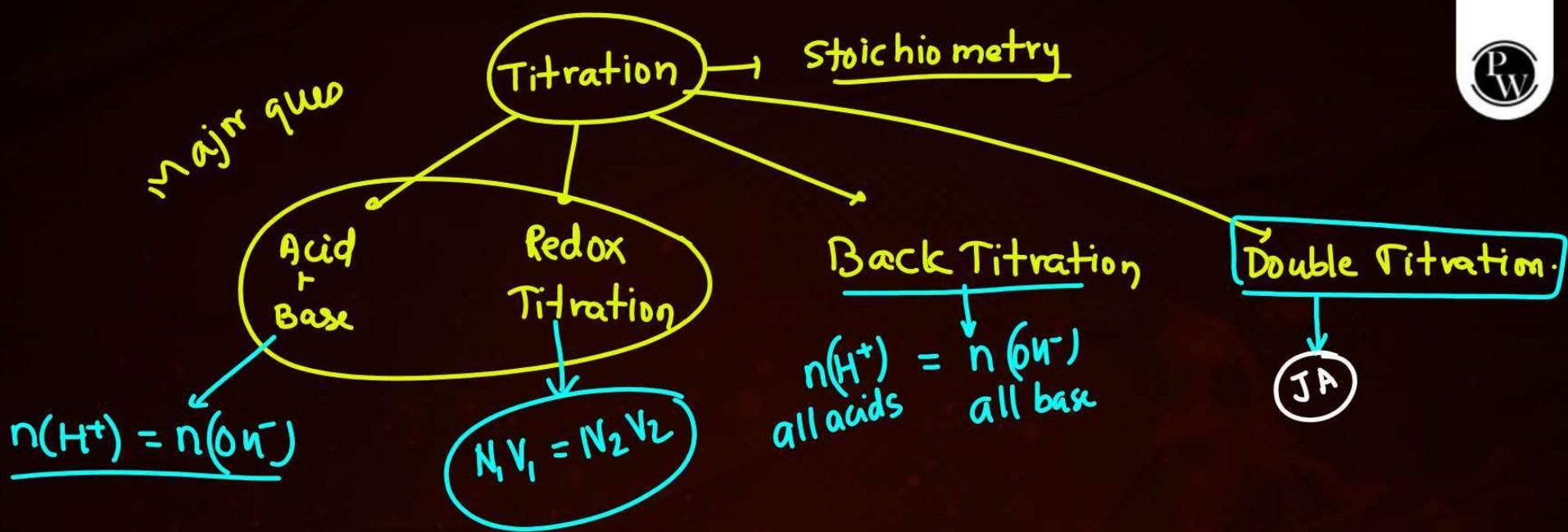
Question-18|



In the reaction of oxalate with permanganate in acidic medium, the number of electrons involved in producing one molecule of CO_2 is:

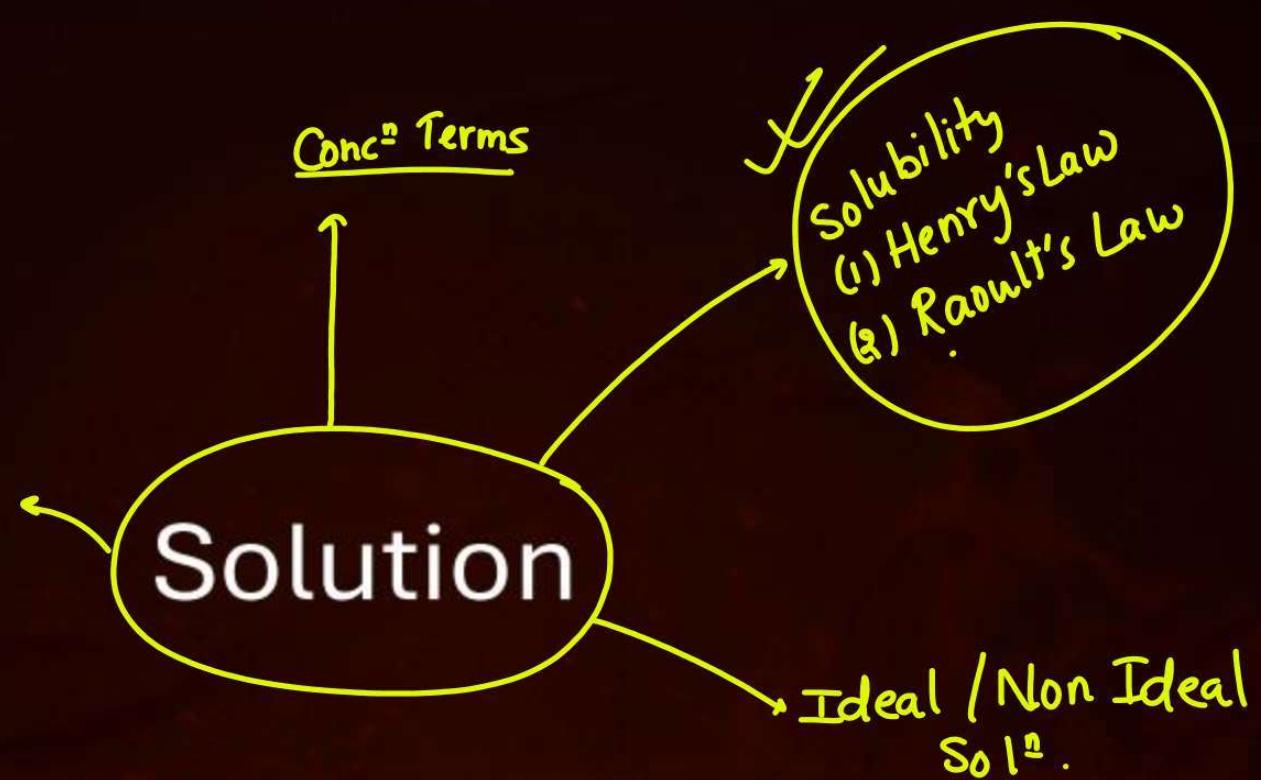
[10 January 2019 Shift 2]

- (A) 1
- (B) 10
- (C) 2
- (D) 5



Questions

Colligative
Property
&
Van't Hoff.



QUE



The quantity which changes with temperature is:

[27 Jan. 2024 (Shift 2)]

- A Molarity $\frac{n}{V}$
- B Mass percentage $\frac{\omega}{\omega} \times 100$
- C Molality $\frac{n}{\omega_{\text{solvent}}}$
- D Mole fraction $\frac{n}{n_T}$

Ans.

QUE

If a substance 'A' dissolves in solution of a mixture of 'B' and 'C' with their respective number of moles as n_A , n_B and n_C , mole fraction of C in the solution is:

A $\frac{n_C}{n_A \times n_B \times n_C}$

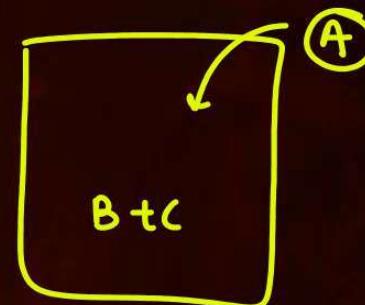
B $\frac{n_C}{n_A + n_B + n_C}$

C $\frac{n_C}{n_A - n_B - n_C}$

D $\frac{n_B}{n_A + n_B}$

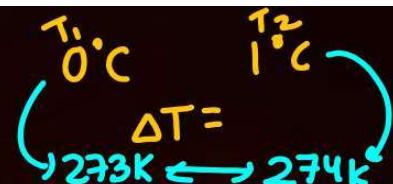
$$\frac{n_C}{n_A + n_B + n_C}$$

[3,0 Jan. 2024 (Shift 2)]

**Ans.**

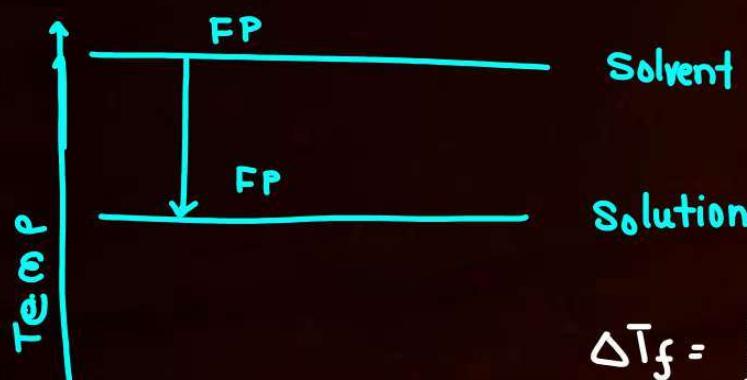
QUE

$$T_f^0 - T_f = \Delta T_f = i K_f m$$



Mass of ethylene glycol (antifreeze) to be added to 18.6 kg of water to protect the freezing point at -24°C is _____.kg (Molar mass in gmol^{-1} for ethylene glycol 62, K_f of water = $1.86 \text{ K kg mol}^{-1}$)

[01 Feb 2024 (Shift 2)]



$$\frac{\text{Depression in Freezing pt}}{i K_f m} = \Delta T_f = T_f^0 - T_f$$

(Note: T_f^0 is circled in yellow)

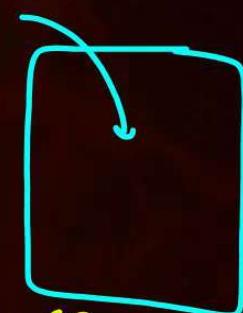
$$\Delta T_f = i K_f m$$

$$24 = 1 \times 1.86 \times \frac{n_{\text{solute}}}{18610}$$

$$n_{\text{solute}} = 240$$

$$\begin{aligned}
 W_{\text{solute}} &= n_{\text{solute}} \times 62 \\
 &= \frac{240 \times 62}{1000} \text{ gram} \\
 &= 240 \times 62 \quad \checkmark
 \end{aligned}$$

Ans.

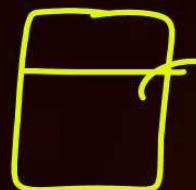


-24°C

QUE

$$(P_T)_{\text{Theo}} = P_A^{\circ} X_A + P_B^{\circ} X_B$$

A solution of two miscible liquids showing negative deviation from Raoult's law will have :

 $A+B$

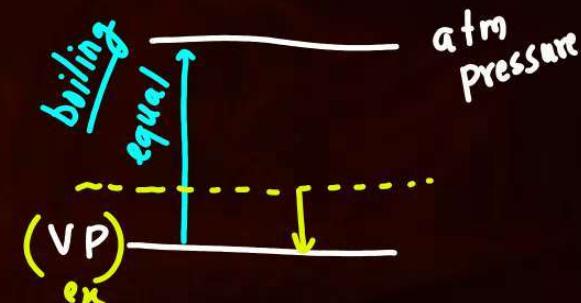
$$(P_T)_{\text{Theo}} > (P_T)_{\text{exp}}$$

[27 Jan. 2024 (Shift 1)]

\rightarrow negative deviation

Maximum boiling Azeo.

- A increased vapour pressure, increased boiling point
- B increased vapour pressure, decreased boiling point
- C decreased vapour pressure, decreased boiling point
- D decreased vapour pressure, increased boiling point

**Ans.**

Theory

+ve Deviation

$$(P_T)_{\text{exp}} > \underline{P_A^0 X_A + P_B^0 X_B}$$

- ① Vapour Pressure ↑
- ② boiling Pt ↓
- ③ Minimum boiling azeotrope

✓ A---A or B-----B > A---B

-ve deviation

$$\underline{(P_T)_{\text{exp}}} < P_A^0 X_A + P_B^0 X_B$$

- ④ Vapour Pressure ↓
- ⑤ Boiling Pt ↑
- ⑥ Maximum Boiling azeotrope

✓ A-----A or B-----B < A---B

QUE

A solution of H_2SO_4 is 31.4% H_2SO_4 by mass and has a density of 1.25 g/mL. The molarity of the H_2SO_4 solution is _____ M (nearest integer)

[Given molar mass of H_2SO_4 = 98 g mol⁻¹]

[29 Jan. 2024 (Shift 1)]

Ans. (4)

QUE

98

Molality of 0.8M H₂SO₄ solution (density 1.06 g cm⁻³) is _____ × 10⁻³m.

$$m = \frac{1000 M}{1000d - M(MM)_{\text{solute}}}$$

1.06 ↓ 0.8 ↑ 98

[29 Jan. 2024 (Shift 1)]**Ans.**

QUE



The osmotic pressure of a dilute solution is 7×10^5 Pa at 273 K. Osmotic pressure of the same solution at 283 K is _____ $\times 10^4 \text{ Nm}^{-2}$ [29 Jan. 2024 (Shift 1)]

$$\left. \begin{array}{l} \pi_1 \\ T_1 = 273 \text{ K} \end{array} \right| \quad \left. \begin{array}{l} \pi_2 \\ T_2 = 283 \text{ K} \end{array} \right.$$

$$\frac{\pi_1}{\pi_2} = \frac{iCRT_1}{iCRT_2}$$
$$\pi_2 = \frac{T_2 \times \pi_1}{T_1} = \frac{283}{273} \times 7 \times 10^5 \approx 73 \times 10^4$$

→ Best C.P. to find molar mass of solute

$\Pi = iCRT$
 $C = \text{Conc.}$
 $R = \text{Universal gas Const.}$
 $T = \text{Temp.}$

Ans.

QUE

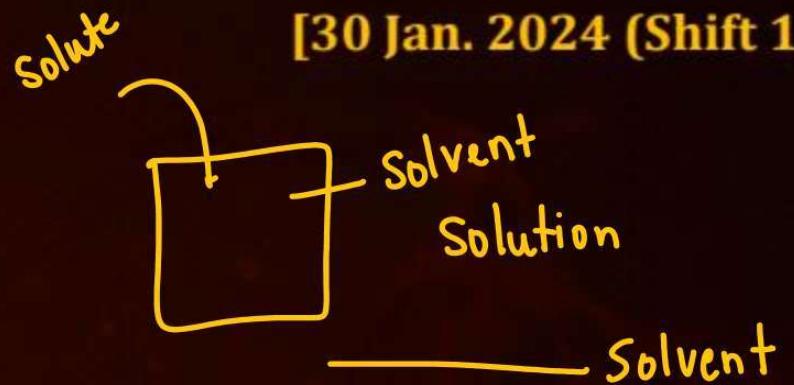
Depression in F.P



What happens to freezing point of benzene when small quantity of naphthalene is added to benzene?

- A Increases
- B Remains unchanged
- C First decreases and then increases
- D Decreases

[30 Jan. 2024 (Shift 1)]



Ans.

QUE

MxV



The mass of sodium acetate (CH_3COONa) required to prepare 250mL of 0.35M aqueous solution is _____ g. (Molar mass of CH_3COONa is 82.02 g mol^{-1})

n.w

[30 Jan. 2024 (Shift 1)]

Ans.

QUE

The solution from the following with highest depression in freezing point/lowest freezing point is

[30 Jan 2024 (Shift 2)]

$$\Delta T_f = i K_f m \quad \text{Solvent} \rightarrow \text{Const}$$

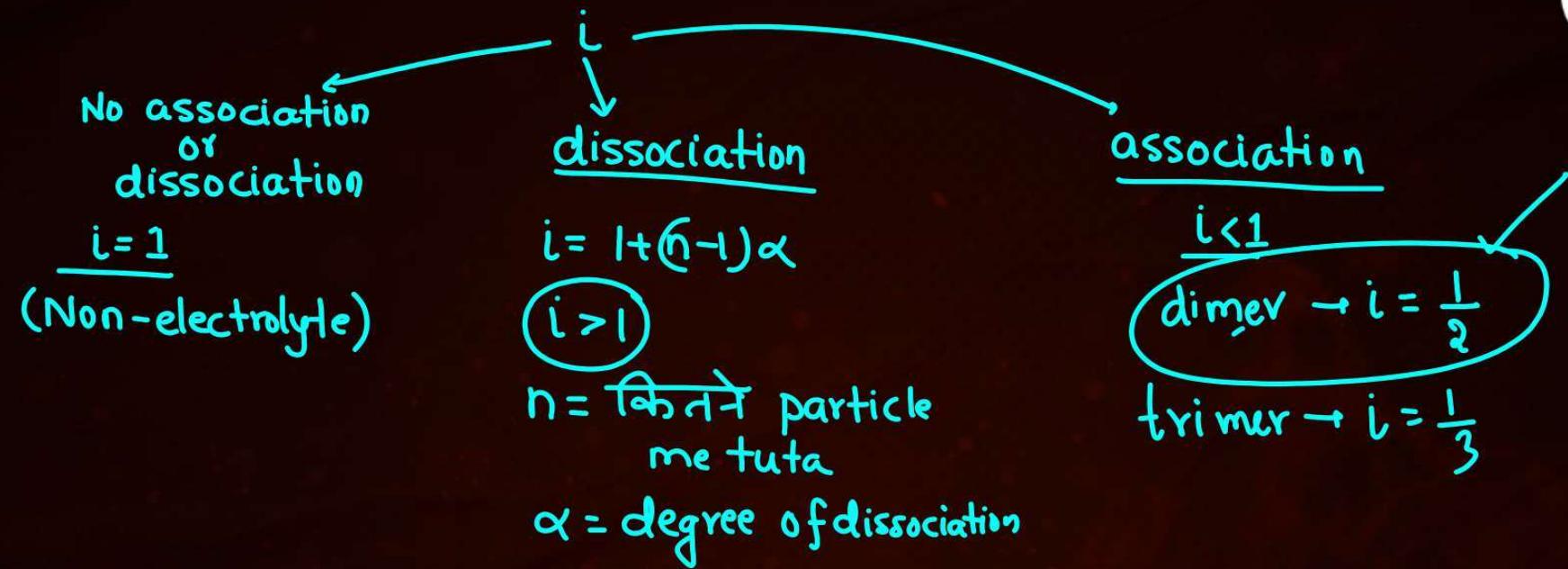
- A** 180 g of acetic acid dissolved in water
- B** 180 g of acetic acid dissolved in benzene
- C** 180 g of benzoic acid dissolved in benzene
- D** 180 g of glucose dissolved in water

$$\Delta T_f \propto i m \uparrow$$

$$\Delta T_f \uparrow$$

F.P. utna kam

Ans.



We have three aqueous solutions of NaCl labelled as ' A' , ' B ' and ' C ' with concentration 0.1 M, 0.01M & 0.001M, respectively. The value of van t' Haft factor (i) for these solutions will be in the order.

[01 Feb. 2024 (Shift 1)]

- A** $i_A < i_B < i_C$
- B** $i_A < i_C < i_B$
- C** $i_A = i_B = i_C$
- D** $i_A > i_B > i_C$

Ans. (A)

QUE

$$m = \frac{n_{\text{solute}}}{W_{H_2O}(\text{kg})}$$

$$i = 1$$

$$i K_b m = \frac{\Delta T_b}{2} = T_b - T_b^0$$

→ 0.1 Kg

2.5 g of a non-volatile, non-electrolyte is dissolved in 100 g of water at 25°C. The solution showed a boiling point elevation by 2° C. Assuming the solute concentration is negligible with respect to the solvent concentration the vapor pressure of the resulting aqueous solution is _____. mm of Hg (nearest integer)

[Given : Molal boiling point elevation constant of water (K_b) = 0.52 K.kgmol⁻¹, 1 atm pressure = 760 mm of Hg, molar mass of water = 18 g mol⁻¹]

$$\Delta T_b = i K_b m$$

$$2 = 1 \times 0.52 \times \frac{n_{\text{solute}}}{0.1}$$

$$n_{\text{solute}} = \frac{2 \times 0.1}{0.52}$$

[04 April 2024 (Shift 2)]

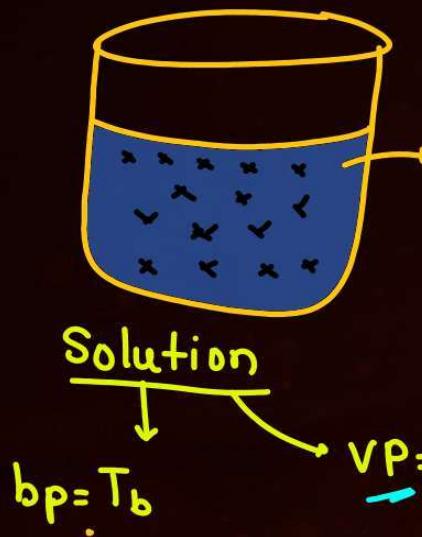
Ans.

$$\frac{P^o - P_s}{P^o} = \frac{i n}{i n + N}$$

$$i n + N = N$$

$$\frac{760 - P_s}{760} = \frac{0.2 \times 18}{0.52 \times 100}$$





$$\begin{aligned} bp &= T_b^0 \\ VP &= P^0 \end{aligned}$$

② Elevation in bp

$$T_b - T_b^0 = \Delta T_b = i K_b m$$

① RLVP

Relative lower of Vapour Pressure

$$\begin{aligned} RLVP &= \frac{P^0 - P_s}{P^0} = i X_{\text{solute}} \\ &= \frac{i n}{i n + N} \end{aligned}$$

n = no. of moles of solute

N = no. of moles of solvent

QUE



Given below are two statements:

Statement I: Gallium is used in the manufacturing of thermometers

Statement II: A thermometer containing gallium is useful for measuring the freezing point (256 K) of brine solution.

In the light of the above statements, choose the correct answer from the options given below :

[06 April. 2024 (Shift 1)]

- A** Both Statement I and Statement II are true
- B** Statement I is false but Statement II is true
- C** Both Statement I and Statement II are false
- D** Statement I is true but Statement II is false

Ans. (D)

QUE

Consider the dissociation of the weak acid HX as given below



[K_a : dissociation constant]

The osmotic pressure of 0.03M aqueous solution of HX at 300 K is ____ $\times 10^{-2}$ bar
(nearest integer)

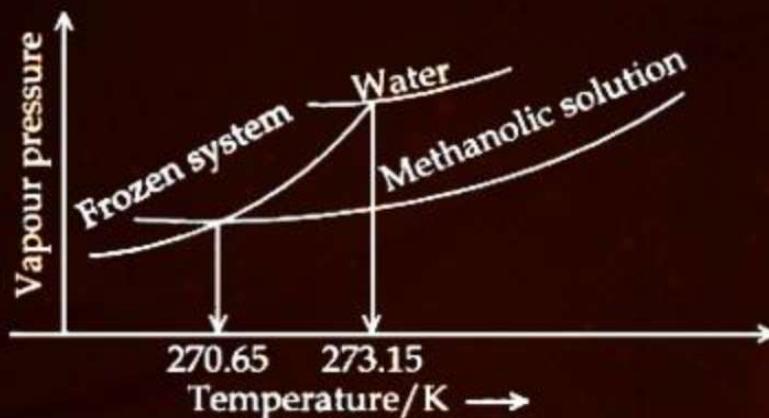
[Given : $R = 0.083 \text{ Lbarmol}^{-1} \text{ K}^{-1}$]

[06 April 2024 (Shift 1)]

Ans. (76)

QUE**PW**

When ' $x \times 10^{-2}$ mL methanol (molar mass = 32g; density = 0.792g/cm³) is added to 100 mL water (density = 1g /cm³) the following diagram is obtained.



$$X = \underline{\hspace{2cm}} \text{(nearest integer)}$$

[Given : Molal freezing point depression constant of water at 273.15 K is 1.86 K kg mol⁻¹]

Ans. (543)

QUE

$$\Delta T_b = i K_b m \quad i = 1 + (n-1)\alpha$$



A solution containing 10g of an electrolyte AB_2 in 100g of water boils at $100.52^\circ C$. the degree of ionization of the electrolyte (α) is 5 $\times 10^{-1}$. (nearest integer)
 $0.5 = 5 \times 10^{-1}$

[Given : Molar mass of AB_2 = 200 g mol $^{-1}$, K_b (molal boiling point elevation const. of water) = 0.52 K kg mol $^{-1}$, boiling point of water = $100^\circ C$; AB_2 ionizes as $AB_2 \rightarrow A^{2+} + 2B^-$]

$$\Delta T_b = 0.52$$

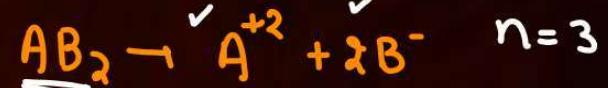
$$m_{H_2O} = 100\text{g} = 0.1\text{kg}$$

$$n_{AB_2} = \frac{10}{200} = \frac{1}{20}$$

$$0.52 = i \times 0.52 \times \frac{1}{20 \times 0.1}$$

$$i = 2$$

[08 April 2024 (Shift 2)]



$$i = 1 + (n-1) \alpha$$

$$2 = 1 + (3-1) \alpha$$

$$2 - 1 = 2 \alpha$$

$$2 \alpha = 1 \\ \alpha = \frac{1}{2} = 0.5$$

Ans.

QUE



A solution is prepared by adding 1 mole ethyl alcohol in 9 mole water. The mass percent of solute in the solution is _____(integer answer) (Given : Molar mass in gmol^{-1} Ethyl alcohol : 46 water : 18)

[08 April 2024 (Shift 2)]

Ans. (22)

QUE



Molality of an aqueous solution of urea is 4.44 m. Mole fraction of urea in solution is 2×10^{-3} . Value of x is - (Integer answer)

[08 April 2024 (Shift 2)]

Ans. (74)

QUE

$$A \quad P_A^{\circ} = 80$$

$$B \quad P_B^{\circ} = 24$$

The vapour pressure of pure benzene and methyl benzene at 27°C is given as 80 Torr and 24 Torr, respectively. The mole fraction of methyl benzene in vapour phase, in equilibrium with an equimolar mixture of those two liquids (ideal solution) at the same temperature is 23 $\times 10^{-2}$ (nearest integer)

[09 April 2024 (Shift 2)]
Raoult's

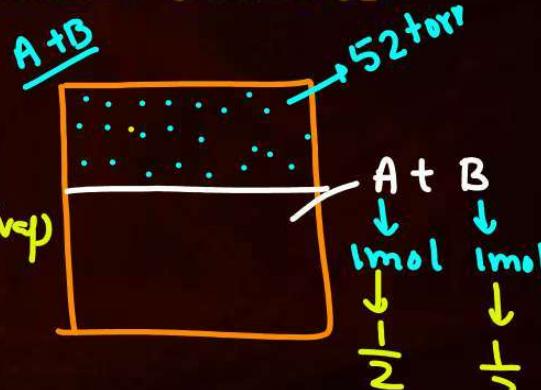
$$\begin{aligned} P_T &= P_A^{\circ} x_A + P_B^{\circ} x_B \\ &= 80 \times \frac{1}{2} + 24 \times \frac{1}{2} \\ &= 40 + 12 = 52 \end{aligned}$$

$$P_B = P_B^{\circ} x_B$$

Ans.
Dalton's Law of Partial Pressure

$$\begin{aligned} P_B &= P_T \times Y_B && (Y_B = \text{mole fraction in gas/vap phase}) \\ P_B^{\circ} x_B &= P_T \times Y_B \end{aligned}$$

$$\begin{aligned} Y_B &= \frac{P_B^{\circ} x_B}{P_T} = \frac{24 \times \frac{1}{2}}{52 \times \frac{1}{2}} = \frac{24}{104} \\ &= 0.2307 \\ &= 23.07 \times 10^{-2} \end{aligned}$$



QUE



Mass of Urea (NH_2CONH_2) required to be dissolved in 1000 g of water in order to reduce the vapour pressure of water by 25% is _____ g.

Given: Molar mass of N, C, O and H are 14, 12, 16 and 1 g mol^{-1} respectively. g.
(Nearest integer)

[2023 (06 Apr Shift 1)]

Ans. (1111)

Consider the following pairs of solution which will be isotonic at the same temperature.
The number of pairs of solutions is/ are ____ [2023 (06 Apr Shift 2)]

- A** 1 M aq. NaCl and 2 M aq. urea
- B** 1 M aq. CaCl_2 and 1.5 M aq. KCl
- C** 1.5 M aq. AlCl_3 and 2 M aq. Na_2SO_4
- D** 2.5 M aq. KCl and 1 M aq. $\text{Al}_2(\text{SO}_4)_3$

Ans. (D)

QUE

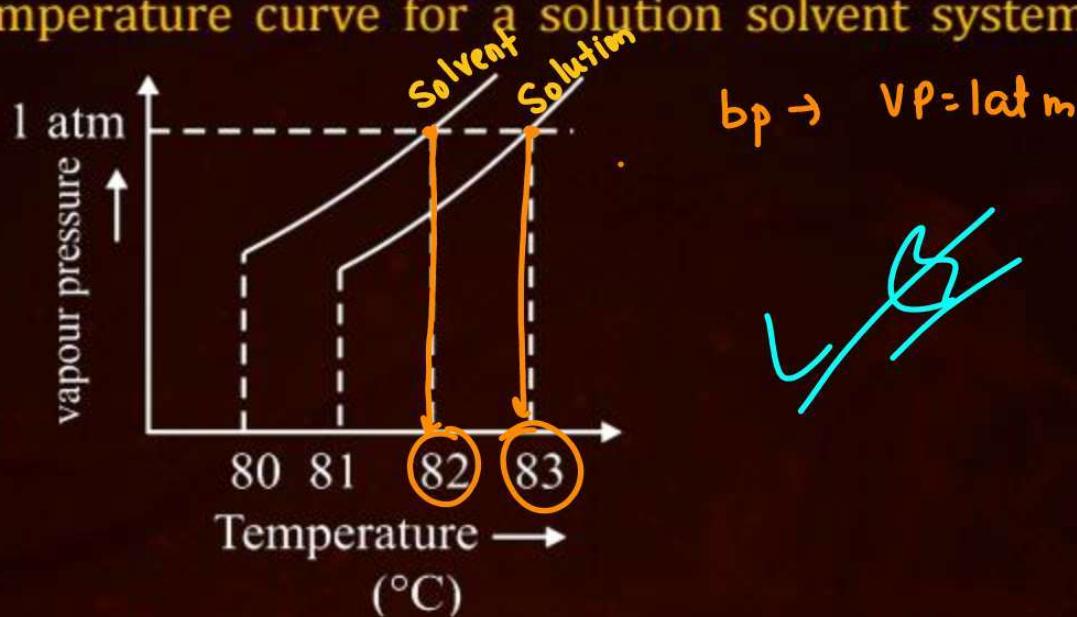


The vapour pressure vs. temperature curve for a solution solvent system is shown below.

$$\text{Solution} = 83$$

$$\Delta T_b =$$

(82)



The boiling point of the solvent is ____ °C.

[2023 (08 Apr Shift 1)]

Ans.

QUE



If the degree of dissociation of aqueous solution of weak monobasic acid is determined to be 0.3, then the observed freezing point will be _____% higher than the expected/theoretical freezing point. (Nearest integer).

[2023 (10 Apr Shift 1)]

Ans. (30)

QUE

An aqueous solution of volume 300 cm^3 contains 0.63 g of protein. The osmotic pressure of the solution at 300 K is 1.29 mbar . The molar mass of the protein is gmol^{-1} .

Given: $R = 0.083 \text{ L}_\text{bar} \text{ K}^{-1} \text{ mol}^{-1}$

[2023 (10 Apr Shift 2)]

Ans. (40535)

QUE



0.004 M K_2SO_4 solution is isotonic with 0.01 M glucose solution. Percentage dissociation of K_2SO_4 is (Nearest integer)

[2023 (10 Apr Shift 2)]

Ans. (75)

QUE



mole percent of MgCl_2 is dissociated in aqueous solution. The vapour pressure of 1.0 molal aqueous solution of MgCl_2 at 38°C is _____. mm Hg. (Nearest is integer)

Given: Vapour pressure of water at 38°C is 50 mm Hg

[2023 (12 Apr Shift 1)]

Ans. (48)

Match List I with List II.

[26 January - Shift 2]

| | List -I | | List -II |
|----|-------------------------------------|------|--|
| A. | Van't Hoff factor, i | I. | Cryoscopic constant |
| B. | k_f | II. | Isotonic solution |
| C. | Solution with same osmotic pressure | III. | <u>Normal molar mass</u> Abnormal molar mass |
| D | Azeotropes | IV. | Solution with same composition of vapour above it. |

Choose the correct answer from the options given below:

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

Ans. (A)

QUE



A solution containing 2 g of a non-volatile solute in 20 g of water boils at 373.52 K. The molecular mass of the solute is _____ gmol⁻¹. (Nearest integer)

Given, water boils at 373 K, K_b for water = 0.52 K kg mol⁻¹

$$\Delta T_b = 0.52$$

$$i K_b m = 0.52$$

~~$$1 \times 0.52 \times m = 0.52$$~~

$$\underline{m=1}$$

$$\frac{n_{\text{solute}}}{W_{H_2O}(\text{kg})} = 1$$

$$\cancel{\frac{1}{(MM)_{\text{solute}}}} = \frac{201}{100}$$

$$(MM)_{\text{solute}} = \underline{100}$$

[30 January - Shift 1]

NCERT → +ve deviation
- ve deviation

Ans.

QUE

The total pressure of a mixture of non-reacting gases X (0.6 g) and Y (0.45 g) in a vessel is 740 mm of Hg. The partial pressure of the gas X is _____ mm of Hg. (Nearest Integer)

(Given : molar mass X = 20 and Y = 45 g mol⁻¹)

[30 January - Shift 2]

Ans. (555)

Ideal

+ve (alcohol)

-ve (acid + H₂O)



Example :

dilute solutions ;

benzene + toluene ;

n-hexane + n-heptane ;

chlorobenzene + bromobenzene ;

ethyl bromide + ethyl iodide ;

n-butyl chloride + n-butyl bromide

CCl₄ + SiCl₄ ;

C₂H₄Br₂ + C₂H₄Cl₂

C₂H₅Br + C₂H₅Cl

Example :

acetone + ethanol ;

acetone + CS₂ ;

water + methanol ;

water + ethanol ;

CCl₄ + CHCl₃ ;

CCl₄ + toluene ;

acetone + benzene

CCl₄ + CH₃OH ;

cyclohexane + ethanol

Example :

acetone + aniline ;

acetone + chloroform ;

CH₃OH + CH₃COOH ;

H₂O + HNO₃ ;

water + HCl ;

acetic acid + pyridine ;

HNO₃ + CHCl₃

- Atomic
- Thermo
- Chemical
 Σb^m



Atomic Structure

Theories

- ① Dalton's Theory
- ② Plum Pudding Model
- ③ Rutherford Theory



Wave/Particle Nature

Q. No

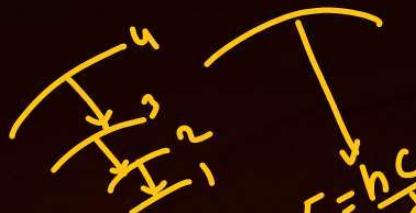
H- spectrum ✓
BBR ✓
Bohr Model

H- Spectrum

Emission spectrum

$$\bar{\nu} = \frac{1}{\lambda} = R_H \cdot Z^2 \left\{ \frac{1}{n_1^2} - \frac{1}{n_2^2} \right\}$$

| | | | |
|--------|----------|---|--------------|
| लाल | Lyman | 1 | 2, 3, 4, ... |
| बाल | Balmer | 2 | 3, 4, 5, ... |
| पाल | Paschen | 3 | 4, 5, 6, ... |
| भारत | Brackett | 4 | : |
| प्रैसी | Pfund | 5 | : |
| हम्फरी | Humphery | 6 | : |



UV Region

Visible Region

IR Region

$$E = \frac{hc}{\lambda}$$

(1) Find λ for

$\lambda_{\min} \rightarrow ① E_{\max}$

$\lambda_{\max} \rightarrow ② E_{\min}$ (nearest) $(n_1+1) \rightarrow n_1$

③ α line \rightarrow First $(n_1+1) \rightarrow n_1$

④ β line \rightarrow 2nd $(n_1+2) \rightarrow n_1$

$$\frac{1}{R_H} = 912 \text{ Å}$$

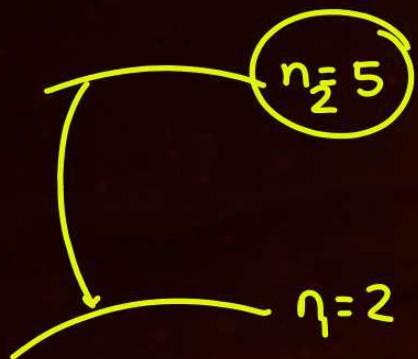
no. of spectral Lines

Kahan aaya Kahan aaya
} ↓

$$\text{max no. of spectral Line} = \frac{(n_2 - n_1)(n_2 - n_1 + 1)}{2}$$

no. of line in particular series $\Rightarrow (n_2 - n_1)$

(Q)



$$\text{Total spectral Line} : \frac{(5-2)(5-2+1)}{2} = \frac{3 \times 4}{2} = 6$$

$$\text{No. of lines in Visible region} = n_2 - n_1 = 5-2 = 3$$

Quantum Mechanical Model

Schrodinger's Wave Eqn.

HUP

$\Psi \rightarrow e^-$ wave func². ($e^- \longrightarrow$

$|\Psi| \rightarrow$ amplitude of e^- wave func² e^- 

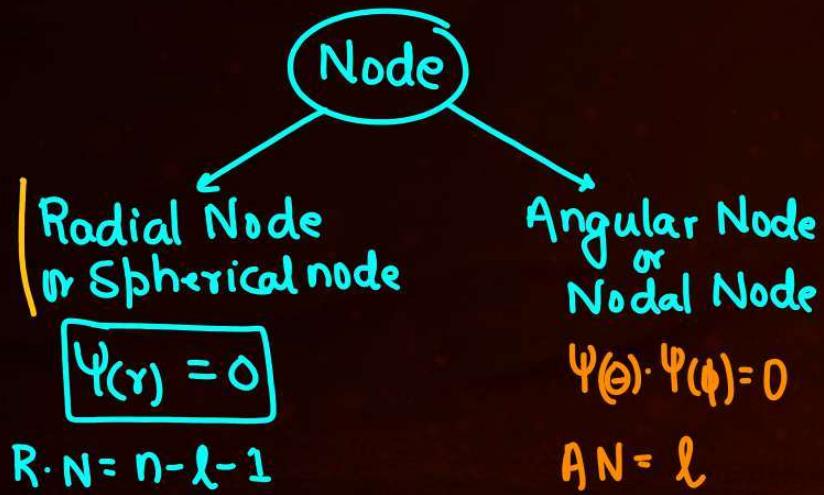
$|\Psi|^2 \rightarrow$ Probability of finding an e^- .

>95%
Orbital

almost zero
Node

$$|\psi|^2 = 0 \text{ (Node)}$$

$$\psi \rightarrow \begin{array}{l} \text{Radial Part } \Psi(r) / R(n) \\ \text{Angular Part } \Psi(\theta) \cdot \Psi(\phi) \end{array}$$



$$\begin{aligned} \text{Total Node} &= RN + AN \\ &= n - l - 1 + l \\ &= \underline{n - 1} \end{aligned}$$

$$\begin{array}{c} 6 \xrightarrow{l=2} RN = 6 - 2 - 1 = 3 \\ \hline 6d \xrightarrow{AN=l=2} AN = l = 2 \\ TN = 5 \end{array}$$

(Q. No.)

Principle Q. No

- ✓ Orbit (n)
- ✓ Energy of e^- .
- ✓ $n = 1, 2, 3, 4 \dots$
 K, L, M, N, \dots
- ✓ Max no. of e^- in an orbit $= 2n^2$

$$\text{Max no. of orbital in an orbit} = n^2$$

Azimuthal Q.No (l)

- ✓ Orientation (Shape of Subshell)
- ✓ Subshell.

✓ $l \rightarrow 0 \text{ to } n-1$

✓ l Subshell

0 s

1 p

2 d

3 f

⋮ ⋮

✓ Orbital angular momentum of $e^- = \sqrt{l(l+1)} \frac{\hbar}{2\pi}$

$$= \sqrt{l(l+1)} \frac{\hbar}{2\pi}$$

Magnetic Q.No (m)

- ✓ Orientation of orbitals.
- ✓ $m = -l \text{ to } +l$

$$\text{Total value} = 2l+1$$

$$\text{Total e}^- \text{ in a subshell} = 2(2l+1)$$

$$\begin{aligned} s &\rightarrow 2e^- \\ p &\rightarrow 6e^- \\ d &\rightarrow 10e^- \\ f &\rightarrow 14e^- \end{aligned}$$

④ Spin Q. No

Clockwise = $+\frac{1}{2}$, ↑ or ↑
 anti clockwise = $-\frac{1}{2}$, ↓ or ↓

$$\nearrow n = \text{no. of unpaired e}^-$$

$$\begin{aligned} h_s &= \text{spin only magnetic moment} \\ &= \sqrt{n(n+2)} \quad B \cdot \underline{M} \end{aligned}$$

$$\begin{aligned} \text{TSM} &\rightarrow \text{Total Spin Multiplicity} \\ &= \underline{n+l} \end{aligned}$$

Graphs

① $\Psi(r)$ v/s r

#RBI

For s-subshell

$$n=0, \Psi(n) > 0$$

$$n=\infty, \Psi(n) = 0$$

For other (p,d,f)

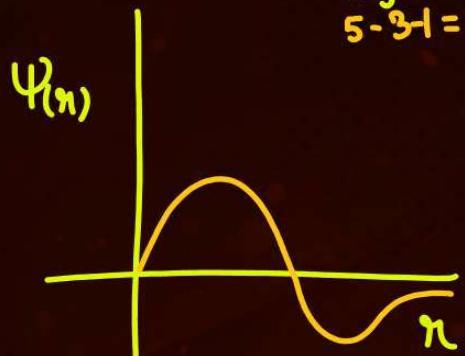
$$n=0, \Psi(n) = 0$$

$$n=\infty, \Psi(n) = 0$$

* Graph x-axis ko $n-l-1$ time cut/touch karega other than $r=0$ & $r=a$.

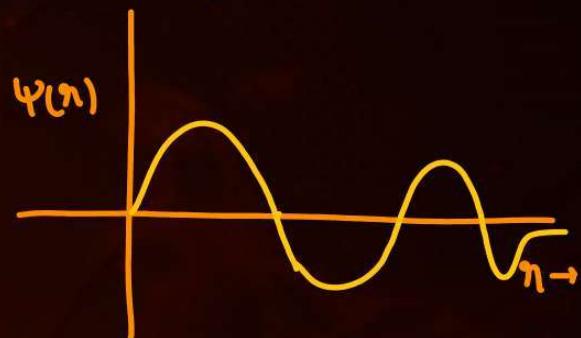
② $\Psi^2(r)$ v/s r

$$\frac{5f}{5-3-1} = 1$$



③ RPDF

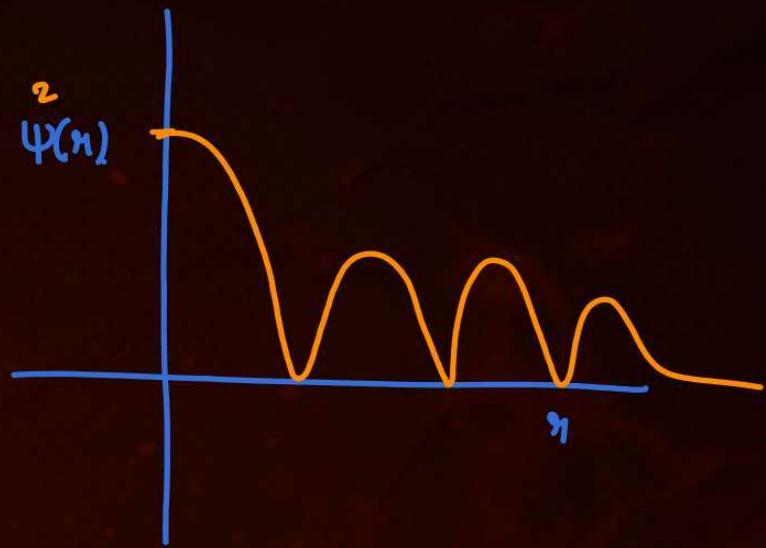
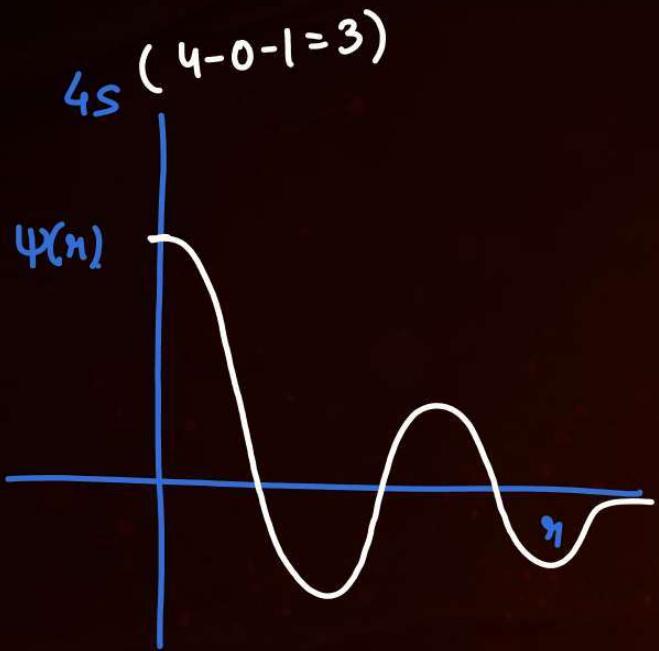
$$5p (5-1-1=3)$$

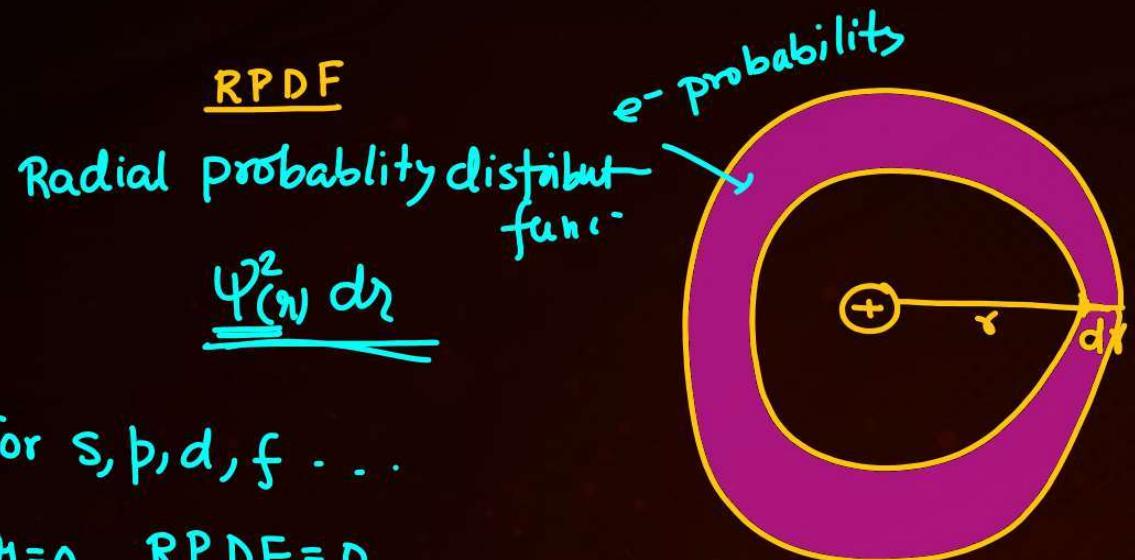


$\Psi^2(r)$ v/s r

Same as $\Psi(r)$ v/s r

bas -ve graph ka mirror image.

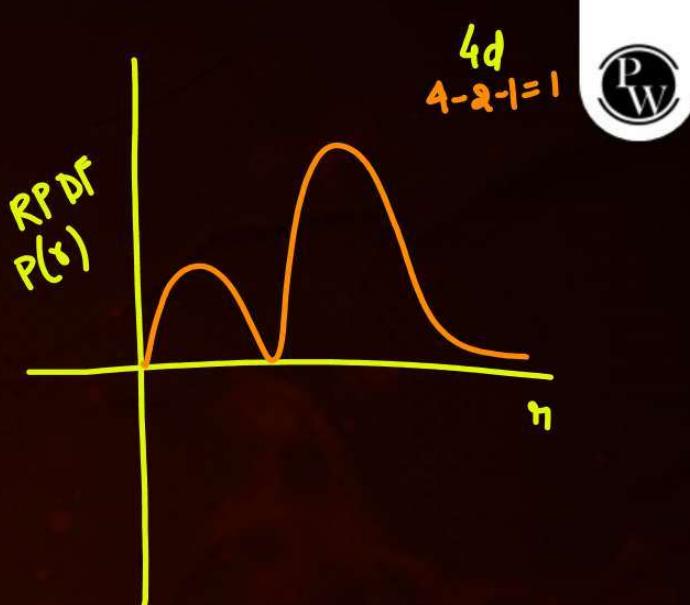




For s, p, d, f . . .

$$n=0, \text{ RPDF} = 0$$

$$n=\infty, \text{ RPDF} = 0$$



Rules for Writing e.c

① Aufbau Principle
(n+l) rule

② Hund's Rule

एक subshell के orbital को

③ Pauli's Exclusion Principle



Sawaal

Que



end (6sec)

The number of radial node/s for 3p orbital is:

[01 Feb 2024 (Shift 2)]

- A 1
- B 4
- C 2
- D 3

$$\begin{array}{c} \downarrow \\ n-l-1 \\ 3-1-1 = 1 \end{array}$$

Ans.

Que

$$\lambda \propto \frac{1}{p}$$

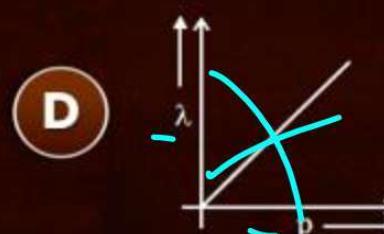
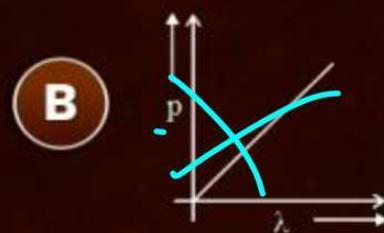
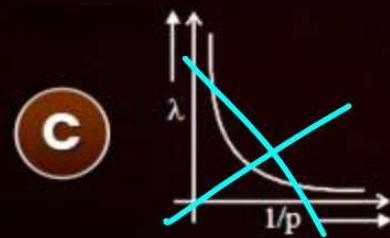
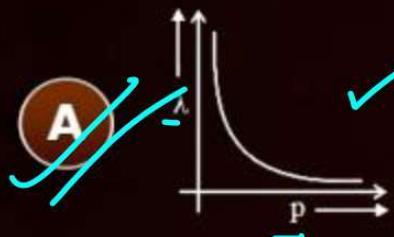
st line

$$\lambda = \frac{h}{p}$$

PW

According to the wave-particle duality of matter by de-Broglie. Which of the following graph plot presents most appropriate relationship between wavelength of electron (λ) and momentum of electron (p) ?

[01 Feb 2024 (Shift 1)]



Ans.

Which of the following electronic configuration would be associated with the highest magnetic moment?

$$\mu_B \text{ max} \rightarrow$$

no. of unpaired

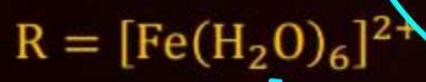
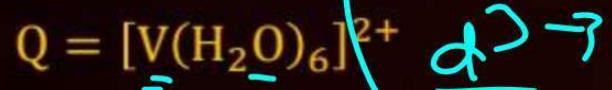
$e^- \rightarrow \text{mag}$

[27 Jan 2024 (Shift 1)]

- A [Ar]3 d⁷  ③
- B [Ar]3 d⁸  ②
- C [Ar]3 d³  ③
- D [Ar]3 d⁶  ④

Ans.

Consider the following complex ions



The correct order of the complex ions, according to their spin only magnetic moment values (in B.M.) is :

[27 Jan 2024 (Shift 1)]

- A** R < Q < P
- B** R < P < Q
- C** Q < R < P
- D** Q < P < R

Ans. (C)

Que

$$n^2 \times 16$$



The number of electrons present in all the completely filled subshells having $n = 4$ and $s = +\frac{1}{2}$ is (Where n = principal quantum number and s = spin quantum number)

$n=4$: 4s 4p 4d 4f

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | | | | | | |
| 1 | 1 | 1 | | | | |
| 1 | 1 | 1 | 1 | 1 | | |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 |

Total no.
of orbitals

[27 Jan 2024 (Shift 1)]

Ans.

The correct set of four quantum numbers for the valence electron of rubidium atom ($Z = 37$) is:

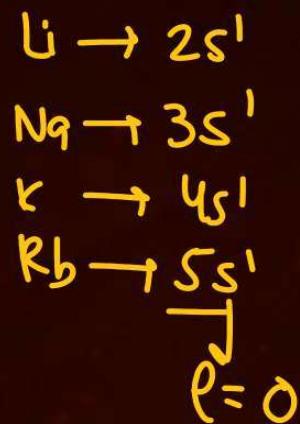
[29 Jan 2024 (Shift 1)]

A $\underline{5,0,0, +\frac{1}{2}}$

B $\underline{5,0,1, +\frac{1}{2}}$

C $\cancel{\underline{5,1,0, +\frac{1}{2}}}$

D $\cancel{\underline{5,1,1, +\frac{1}{2}}}$



Ans.

Match List I with List II

[29 Jan 2024 (Shift 2)]

| List I (Spectral Series for Hydrogen) | | List II (Spectral Region/Higher Energy State) | |
|--|--|--|-----------------|
| A. | Lyman | I. | Infrared region |
| B. | Balmer  | II. | UV region |
| C. | Paschen | III. | Infrared region |
| D. | Pfund | IV. | Visible region |

Choose the correct answer from the options given below :-

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

Ans. (C)

Given below are two statements:

Statement-I: The orbitals having same energy are called as degenerate orbitals. (T)

Statement-II: In hydrogen atom, $3p$ and $3d$ orbitals are not degenerate orbitals. (False.)

In the light of the above statements, choose the most appropriate answer from the

options given ✓ For single e- species

[30 Jan 2024 (Shift 1)]

energy is only dependent on Principle Q.No .

(H) (Is) $\langle (2s=2p) \rangle < \underbrace{(3s=3p=3d)}_{\text{ }} < \dots$

- A** Statement-I is true but Statement-II is false
- B** Both Statement-I and Statement-II are true.
- C** Both Statement-I and Statement-II are false
- D** Statement-I is false but Statement-II is true

Ans. (A)

Number of spectral lines obtained in He^+ spectra, when an electron makes transition from fifth excited state to first excited state will be

[30 Jan 2024 (Shift 2)]

$$\begin{array}{ccc} \overline{n_2=5} & & \overline{n_1=2} \\ \downarrow & & \downarrow \\ \text{Diagram showing a curved arrow from } n_2=5 \text{ to } n_1=2. & & \end{array}$$
$$\frac{(n_2 - n_1)(n_2 - n_1 + 1)}{2} = \cancel{5^2} \times \cancel{5} = 10$$

Ans.

The four quantum numbers for the electron in the outer most orbital of potassium (atomic no. 19) are

[31 Jan 2024 (Shift 2)]

A $n = 4, l = 2, m = -1, s = +\frac{1}{2}$

B $n = 4, l = 0, m = 0, s = +\frac{1}{2}$

C $n = 3, l = 0, m = 1, s = +\frac{1}{2}$

D $n = 2, l = 0, m = 0, s = +\frac{1}{2}$

Ans. (B)

Que

The de-Broglie's wavelength of an electron in the 4th orbit is $\frac{\lambda}{\pi a_0}$.

(a_0 = Bohr's radius)

$$\lambda = \frac{h}{p}$$

$$n=4 \\ r=r_4$$

$$n=4$$

$$\frac{\lambda}{\pi a_0}$$

2021
2022
2023

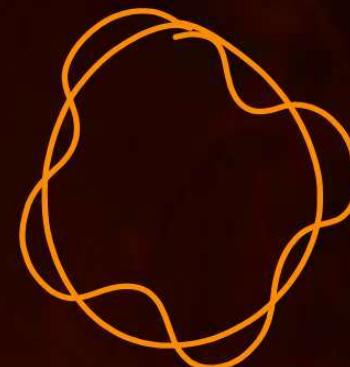
[04 Apr 2024 (Shift 1)]

$$2\pi r = n \lambda$$

$$2\pi r_4 = 4 \lambda$$

$$\lambda = \frac{2\pi r_4}{4}$$

$$= \frac{2\pi \cdot 4^2 \times a_0}{4}$$
$$= 8\pi a_0$$



$$r_4 = a_0 \cdot \frac{n^2}{1}$$

Ans.

Que



The maximum number of orbitals which can be identified with $n = 4$ and $m_l = 0$ is ____.

[04 Apr 2024 (Shift 2)]

Ans. (4)

Que



In an atom, total number of electrons having quantum numbers $n = 4$, $|m_l| = 1$ and $m_s = -\frac{1}{2}$ is

[05 Apr 2024 (Shift 2)]

Ans. (6)

Compare the energies of following sets of quantum numbers for multielectron system.

- (A) $n = 4, l = 1$ (B) $n = 4, l = 2$
(C) $n = 3, l = 1$ (D) $n = 3, l = 2$ (E) $n = 4, l = 0$

Choose the correct answer from the options given below :

[09 Apr 2024 (Shift 1)]

- A** (B) > (A) > (C) > (E) > (D)
- B** (E) < (C) < (D) < (A) < (B)
- C** (E) > (C) > (A) > (D) > (B)
- D** (C) < (E) < (D) < (A) < (B)

Ans. **(D)**

Match List I with List II

[09 Apr 2024 (Shift 2)]

| | List - I (Element) | | List - II (Electronic configuration) |
|----|--------------------|------|---|
| A. | N | I. | [Ar]3 d ¹⁰ 4 s ² 4p ⁵ AR |
| B. | S | II. | [Ne]3 s ² 3p ⁴ |
| C. | Br | III. | [He]2 s ² 2p ³ |
| D. | Kr | IV. | [Ar]3 d ¹⁰ 4 s ² 4p ⁶ |

Choose the correct answer from the options given below:

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

Ans. (A)

Q.

If wavelength of the first line of the Paschen series of hydrogen atom is 720 nm, then the wavelength of the second line of this series is ____ nm.
(Nearest)

[JEE Main 2023]



Q.

The radius of the 2nd orbit of Li²⁺ is x. The expected radius of the 3rd orbit of Be³⁺ is:

[JEE Main 2023]

- A** $\frac{9}{4}x$
- B** $\frac{4}{9}x$
- C** $\frac{27}{16}x$
- D** $\frac{16}{27}x$

Q.

The shortest wavelength of hydrogen atom in Lyman series is λ . The longest wavelength in Balmer series of He^+ is: [JEE Main 2023]

- A** $\frac{5}{9\lambda}$
- B** $\frac{9\lambda}{5}$
- C** $\frac{36\lambda}{5}$
- D** $\frac{5\lambda}{9}$

Q.



The wave function (ψ) of 2s is given by $\Psi_{2s} = \frac{1}{2\sqrt{2\pi}} \left(\frac{1}{a_0}\right)^{1/2} \left(2 - \frac{r}{a_0}\right) e^{-r/2a_0}$.

At $r = r_0$, radial node is formed. Thus, r_0 in terms of a_0 [JEE Main 2023]

- A $r_0 = a_0$
- B $r_0 = 4a_0$
- C $r_0 = a_0/2$
- D $r_0 = 2a_0$



$\Psi = 0 \rightarrow$ R polynomial function = 0
 $2 - \frac{r}{a_0} = 0$
 $\frac{r}{a_0} = 2$
 $r = 2a_0$

2 radial node
↓
Quadr

Q.



Which transition in the hydrogen spectrum would have the same wavelength as the Balmer type transition from $n = 4$ to $n = 2$ of He^+ spectrum

[JEE Main 2023]

- A** $n = 2$ to $n = 1$
- B** $n = 1$ to $n = 3$
- C** $n = 1$ to $n = 2$
- D** $n = 3$ to $n = 4$

$$\frac{1}{\lambda} = R_H \cdot (2)^2 \left\{ \frac{1}{2^2} - \frac{1}{4^2} \right\}$$

$$\frac{1}{\lambda} = R_H \cdot \left(\frac{1}{41} - \frac{1}{164} \right)$$

2 → 1

$$\frac{1}{\lambda} = R_H \left(\frac{1}{1^2} - \frac{1}{2^2} \right)$$

Q.

$(n+l)$ ↑ energy ↑



Arrange the following orbitals in decreasing order of energy?

- (A) $n = 3, l = 0, m = 0$ 3 (B) $n = 4, l = 0, m = 0$ 4
(C) $n = 3, l = 1, m = 0$ 3 (D) $n = 3, l = 2, m = 1$ 5

The correct option for the order is

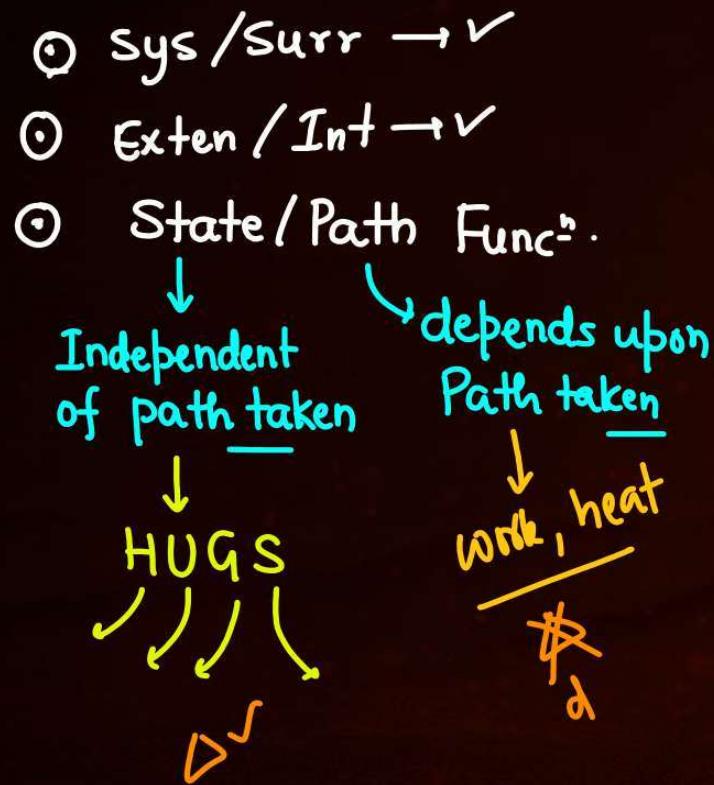
[JEE Main 2023]

- A B > D > C > A
- B D > B > C > A
- C ~~A > C > B > D~~
- D D > B > A > C



Thermodynamics

THDM

 $H \rightarrow$ Enthalpy $U \rightarrow$ Internal Energy $G \rightarrow$ Gibbs free enthalpy $S \rightarrow$ EntropySign Convention

Work done on the system = +ve

Work done by " " = - ve

Heat supplied to system = +ve

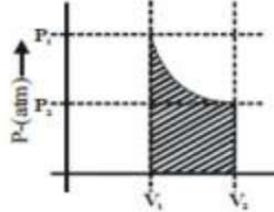
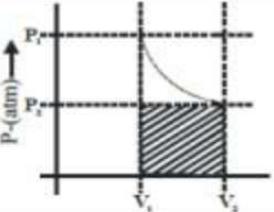
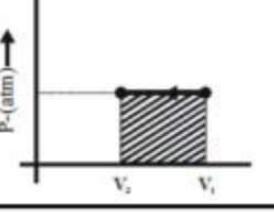
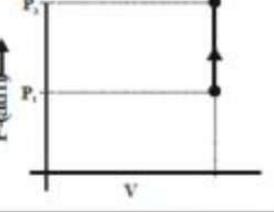
Heat given out by system = - ve

FLOT

$$\Delta U = q + w$$

↓ ↓
heat work done

Change
in internal
energy

| Process | Expression for w ✓ | Expression for q ✓ | ΔU ✓ | ΔH ✓ | Work on PV-graph |
|-------------------------|---|--|----------------------------|----------------------------|---|
| Reversible isothermal | $w = -nRT \ln \frac{V_2}{V_1}$ $= -nRT \ln \frac{P_1}{P_2}$ | $q = nRT \ln \left(\frac{V_2}{V_1} \right)$ $q = nRT \ln \left(\frac{P_1}{P_2} \right)$ | 0 process | 0 |  |
| Irreversible isothermal | $w = -P_{\text{ext}} (V_2 - V_1)$ $= -P_{\text{ext}} \left(\frac{nRT}{P_2} - \frac{nRT}{P_1} \right)$ | $q = P_{\text{ext}} (V_2 - V_1)$ | 0 | 0 |  |
| Isobaric process | $w = -P_{\text{ext}} (V_2 - V_1)$ $= -nR\Delta T$ | $q = \Delta H = nC_P \Delta T$ | $\Delta U = nC_V \Delta T$ | $\Delta H = nC_P \Delta T$ |  |
| Isochoric process | $w = 0$ | $q = \Delta U = nC_V \Delta T$ | $\Delta U = nC_V \Delta T$ | $\Delta H = nC_P \Delta T$ |  |

| | | | | | |
|--------------------------------|---|---|--------------------------------|--------------------------------|--|
| Reversible adiabatic process | $w = nC_V(T_2 - T_1)$ $= \frac{P_2 V_2 - P_1 V_1}{\gamma - 1}$ | $q = 0$ $PV^\gamma = \text{constant}$ $TV^{\gamma-1} = \text{constant}$ $TP^{1-\gamma/\gamma} = \text{constant}$ | $\Delta U = nC_V\Delta T$ - | $\Delta H = nC_P\Delta T$ - | |
| Irreversible adiabatic process | $w = nC_V(T_2 - T_1)$ $= \frac{P_2 V_2 - P_1 V_1}{\gamma - 1}$ | $q = 0$ $nC_v(T_2 - T_1) = -P_{\text{ext}} \left(\frac{nRT_2}{P_2} - \frac{nRT_1}{P_1} \right)$ | $\Delta U = nC_V\Delta T$ - | $\Delta H = nC_P\Delta T$ - | |
| Polytropic | $w = \frac{P_2 V_2 - P_1 V_1}{n-1}$ $w = \frac{R(T_2 - T_1)}{(n-1)}$ | $q = \int_{T_1}^{T_2} C_V dT$ $w = \frac{R(T_2 - T_1)}{(n-1)}$ | $\Delta U = nC_V\Delta T$ - | $\Delta H = nC_P\Delta T$ - | |
| Cyclic Process | Area enclosed in PV-diagram For clockwise -ive For anticlockwise +ive | $q = -w$ | 0 | 0 | |

FLOT in different Proces

① $\Delta T = 0$ (Isothermal)

$$\Delta U = 0$$

$$\Delta U = q + w$$

$$q = -w$$

$$w = -2 \cdot 303 \cdot nRT \cdot \log \frac{V_2}{V_1}$$

$$P_1 V_1 = P_2 V_2$$

$$\frac{V_2}{V_1} = \frac{P_1}{P_2}$$

$$C_V = \frac{R}{\gamma - 1}$$

② Iso baric

$$P = \text{Const.}$$

$$w = -P_{ext} (\Delta V)$$

$$q = q_P = nC_P \Delta T$$

$$\Delta U = q + w$$

④ Adiabatic

$$q = 0$$

$$\Delta U = w = nC_V \Delta T$$

③ Isochoric

$$V = \text{Const.}$$

$$w = 0$$

$$\Delta U = q_v = nC_V \Delta T$$

⑤ Cyclic Process

• Area under PV-Curve



• Find w for all process

• and add.

$$\Delta U = q + w$$

$$q = -w$$

① Free Expansion

expansion in vacuum

$$\boxed{P_{ext} = 0}$$
$$\omega = 0$$

① Isothermal Free expansion

$$\Delta U = 0$$

$$\omega = 0$$

$$q = 0$$

② Adiabatic Free Expansion

$$q = 0$$

$$\omega = 0$$

$$\Delta U = 0$$



C_T given
Find $q = C_T \Delta T$

$$C_T = \frac{q}{\Delta T}$$

Unit: $J K^{-1}$

Total Heat Capacity
(C_T)

Heat Capacity

C_V find q
 $q = n C_V \Delta T$
 C_P find q
 $q = n C_P \Delta T$

Molar Heat Capacity C_m

$$C_m = \frac{q}{n \Delta T}$$

Unit: $J K^{-1} mol^{-1}$

at Const Volume C_V Constant Pressure C_P

Specific Heat Capacity (s)

$$q = m s \Delta T$$

$$s = \frac{q}{m \Delta T}$$

- Unit: $J K^{-1} g^{-1}$

Que



$$\Delta V = 0 \\ q = -w$$

Three moles of an ideal gas are compressed isothermally from 60 L to 20 L using constant pressure of 5 atm. Heat exchange for the compression is - _____ Lit. atm.

[04 April 2024 (Shift 2)]

$$q = -w$$

$$= -(-P_{ex} \times \Delta V)$$

$$P_{ex} \rightarrow \text{const} = 5 (20-60)$$

irr.

$$w = \underline{-P_{ex} \Delta V} = -5 \times 40 \\ = -200 \text{ L-atm}$$

Ans. (

Que

$$P_{ext} = 1 \text{ atm}, V_i = V_i, T_i = 298 \text{ K}$$
$$V_f = 2V_i, P_i = 5 \text{ atm}$$

$$PV = nRT$$
$$V = \frac{nRT}{P}$$

$$T_2 = ?$$

An ideal gas $\bar{C}_V = \frac{5}{2}R$ is expanded adiabatically against a constant pressure of 1 atm until it doubles in volume. If the initial temperature and pressure is 298 K and 5 atm respectively then the final temperature is _____ K (nearest integer).

[\bar{C}_V is the molar heat capacity at constant volume]

[06 April 2024 (Shift 1)]

$$W = -P_{ext} \Delta V$$

$$W = nC_V \Delta T$$

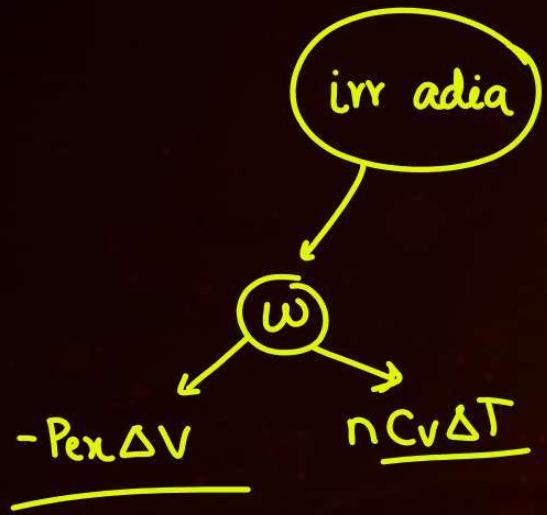
Rev. adiabatic $\rightarrow PV^\gamma = \text{Const}$.
not for irr. proc.

$$-P_{ext}(V_2 - V_1) = nC_V(T_2 - T_1)$$

$$-\frac{1}{5} \left(\frac{nRT_2}{P_2} - \frac{nRT_1}{P_1} \right) = \frac{1}{2} \times 5R \times (T_2 - T_1)$$

$$\frac{-T_2}{1} + \frac{T_1}{5} = \frac{5}{2} (T_2 - T_1)$$

Ans.



Que



The enthalpy of formation of ethane (C_2H_6) from ethylene by addition of hydrogen where the bond-energies of C – H, C – C, C = C, H – H are 414 kJ, 347 kJ, 615 kJ and 435 kJ respectively is kJ

[04 April 2024 (Shift 1)]

Ans. (125)

Que

$$Q = E = \frac{Pxt}{60 \times 100} = \underline{\underline{6000 \text{ J}}}$$

t

When a 60W electric heater is immersed in a gas for 100 s in a constant volume container with adiabatic walls, the temperature of the gas rises by 5°C. The heat capacity of the given gas is JK⁻¹ (Nearest integer)

$\Delta T = 5^\circ\text{C}$

[2023 (08 Apr Shift 1)]

$$C_T = \frac{Q}{\Delta T} = \frac{6000}{5} = C_T$$

$$C_T = \frac{6000}{5} = 1200$$

Ans.

Que



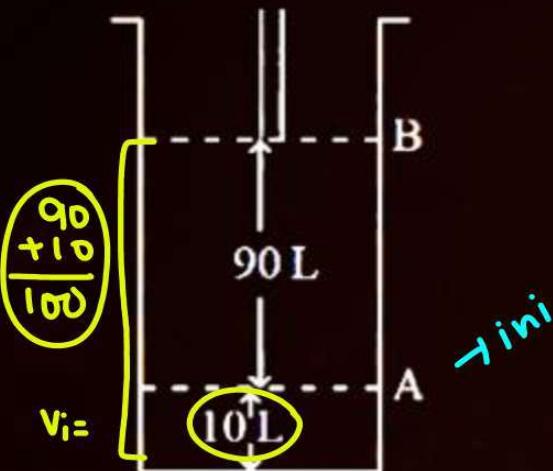
For the reaction at 298 K, $2 A + B \rightarrow C$ $\Delta H = 400 \text{ kJ mol}^{-1}$ and $\Delta S = 0.2 \text{ kJ mol}^{-1} \text{ K}^{-1}$ The reaction will become spontaneous above _____ K.

[06 April 2024 (Shift 2)]

Ans. (2000)

Que

PW



$$W = -2.303 nRT \log \frac{V_2}{V_1}$$

$$= -2.303 \times 1 \times 0.082 \times 291.15 \times$$

291

$$\log \frac{100 - 10}{10}$$

Consider the figure provided.

1 mol of an ideal gas is kept in a cylinder, fitted with a piston, at the position A, at 18°C . If the piston is moved to position B, keeping the temperature unchanged, then 'x' atm work is done in this reversible process.

Que



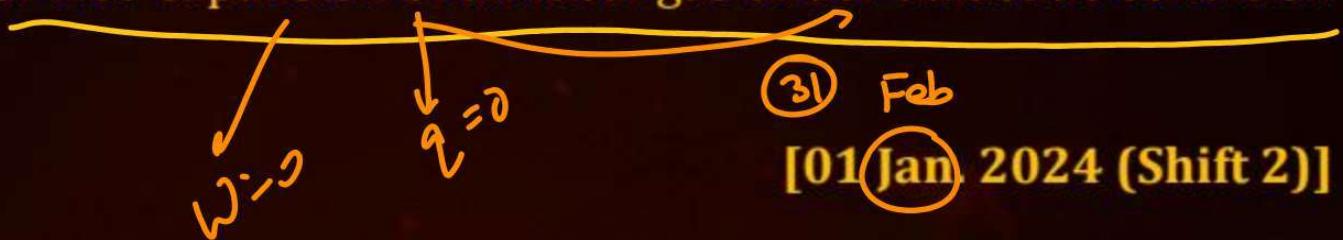
x = _____ L atm (nearest integer)

[Given : Absolute temperature = ${}^{\circ}\text{C} + 273.15$, R = 0.08206 L atm mol $^{-1}$ K $^{-1}$]

[08 April 2024 (Shift 2)]

Ans.

Choose the correct option for free expansion of an ideal gas under adiabatic condition from the following :



31 Feb

[01 Jan. 2024 (Shift 2)]

- A $q = 0, \Delta T \neq 0, w = 0$
- B $q = 0, \Delta T < 0, w < 0$
- C $q \neq 0, \Delta T = 0, w = 0$
- D $q = 0, \Delta T = 0, w = 0$

$$\Delta U = q + w$$

$$\Delta U = 0$$

$$\underline{\Delta T = 0}$$

ΔU = heat added at
Const volume

$$q_V = nC_V \Delta T$$

ΔH = heat added at
Constant pressure

$$q_P = nC_P \Delta T$$

Ans.

Chemical rxn:

$$\Delta H = \Delta U + \Delta n_g RT$$

Enthalpy

Δn_g = no. of mols of gas at product - reactant side

| | | |
|-----------------------------------|-----------------------|-----------------------|
| If $\Delta n_g = 0$ | $\Delta n_g > 0$ | $\Delta n_g < 0$ |
| $\Rightarrow \Delta H = \Delta U$ | $\Delta H > \Delta U$ | $\Delta H < \Delta U$ |

$$\begin{array}{c} \Delta n_g \\ \Delta H \end{array} \begin{array}{c} \square \\ \square \end{array} \begin{array}{c} 0 \\ \Delta U \end{array}$$

$$\Delta H = nC_P \Delta T$$

(for any process)

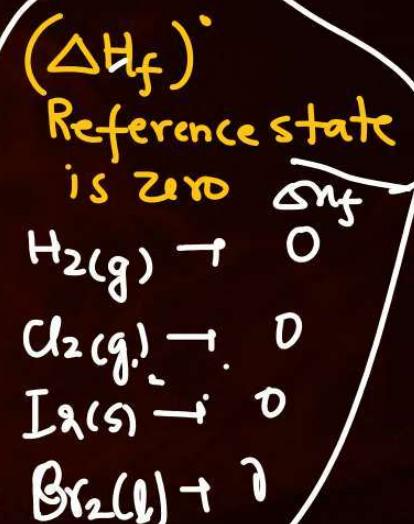
If enthalpy of reactants are given

$$\Delta H_r = \sum (m \cdot \Delta H)_{\text{product}} - \sum (m \cdot \Delta H)_{\text{Reactant}}$$

$m = \text{Stoichiometric coeff.}$

If $\Delta H_{\text{formation}}$ is given.

$$\Delta H_r = \sum (m \cdot \Delta H_f)_{\text{Product}} - \sum (m \cdot \Delta H_f)_{\text{Reactant}}$$



If ΔH of reagents are given in terms of $\Delta H_{\text{combust}}$ or $\Delta H_{\text{bond enthalpy}}$

$$\Delta H_r = \sum (m \cdot \Delta H)_{\text{Reactant}} - \sum (m \cdot \Delta H)_{\text{Product}}$$

Que

Physical state change

ΔU



$\Delta_{vap} H^\circ$ for water is + 40.79 kJ mol⁻¹ at 1 bar and 100°C. Change in internal energy for this vapourisation under same condition is kJmol⁻¹ (integer answer) (Given R = 8.3JK⁻¹ mol⁻¹)

$$\Delta H = \Delta U + \Delta n_g RT$$

$$\begin{aligned}\Delta U &= \underline{\Delta H} - \Delta n_g \underline{RT} & 2.5 \\ &= 40.79 - \frac{1 \times 8.3 \times 373}{1000} & 0.3\end{aligned}$$



$\Delta n_g = 1$

[08 April 2024 (Shift 2)]

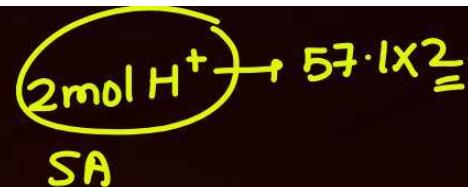
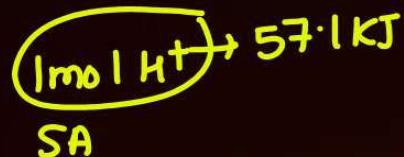
40.79

2.5

38.29

Ans. (38)

Que



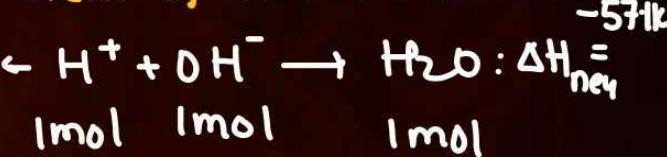
PW

When equal volume of 1M HCl and ~~1M H₂SO₄~~ and 1M H₂SO₄ are separately neutralized by excess volume of 1M NaOH solution x and y kJ of heat is liberated respectively. The value of y/x is _____.

$$\frac{y}{x} = \frac{2 \times 57.1}{57.1} = 2$$

[09 April 2024 (Shift 1)]

Heat of neutralisation.



Ans.

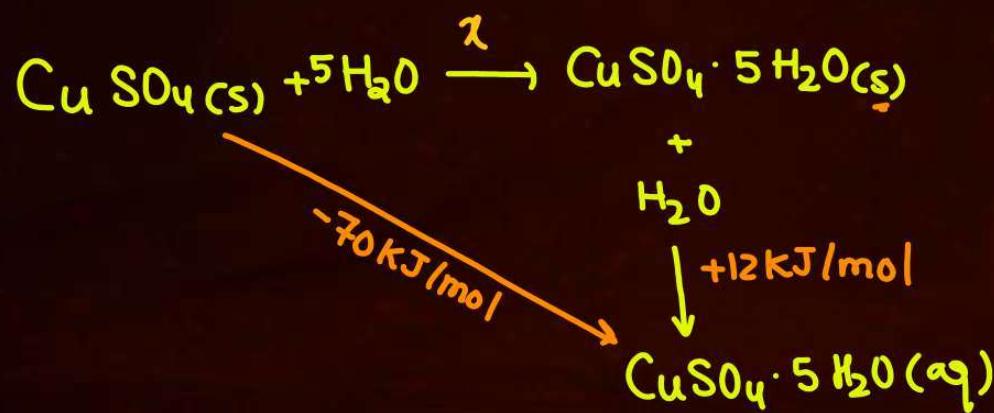
Que



The heat of solution of anhydrous CuSO_4 and $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ are -70 kJ mol^{-1} and $+12\text{ kJ mol}^{-1}$ respectively.

The heat of hydration of CuSO_4 to $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ is $-x\text{ kJ}$. The value of x is _____. (nearest integer)

$$\begin{aligned}\chi + 12 &= -70 \\ \underline{\underline{\chi = -82}}\end{aligned}$$



[09 April 2024 (Shift 1)]

Ans.

$S \rightarrow$ entropy
 \rightarrow State funcⁿ

Randomness of system.

Randomness \uparrow $S \uparrow$ $\Delta S > 0$

Randomness \downarrow $S \downarrow$ $\Delta S < 0$

$$ds = \frac{dq}{T}$$

(FLQT)

$$dU = dq + dw$$

$$dq = dU - dw$$

$$\downarrow \quad \quad \quad \downarrow$$

$$nC_v dT - P_{ext} dV$$

$$ds = \underline{dU - dw}$$

$$ds = \frac{nC_v dT + P dV}{T}$$

ΔS calculation

ΔS for reagents given
 \downarrow

$$\Delta S_{\text{reaxn}} = \sum m(\Delta S)_{\text{product}} - \sum m(\Delta S)_{\text{react}}$$

For any process

$$\Delta S = \frac{\Omega}{T}$$

$$\Delta S = \int \frac{ds}{T} = \int \frac{nC_V dT}{T} + \int \frac{PdV}{T}$$

$$\boxed{\Delta S = nC_V \ln \frac{T_2}{T_1} + nR \ln \frac{V_2}{V_1}}$$

$$PV = nRT$$

$$\frac{P}{T} = \frac{nR}{V}$$

Isothermal

$$T_2 = T_1$$

$$\Delta S = nR \ln \frac{V_2}{V_1}$$

adiabatic

$$q = 0$$

$$\Delta S = 0$$

Isobaric Process

$$\Delta S = nC_p \ln \frac{V_2}{V_1}$$

Isochoric

$$V_2 = V_1$$

$$\Delta S = nC_v \ln \frac{T_2}{T_1}$$

$\Delta G \rightarrow \text{Gibb free energy}$

↳ usefull work

$$\boxed{\Delta G = \Delta H - T\Delta S}$$

Spontaneous

$$\underline{\Delta G = -ve}$$

| ΔH | ΔS | ΔG |
|------------|------------|-----------------|
| +ve | -ve | +ve (non-spont) |
| -ve | +ve | -ve (spont) |
| +ve | +ve | $T > T_{eq}$ |
| -ve | -ve | $T < T_{eq}$ |

$T_{eq} \Rightarrow \Delta G = 0$

$$\boxed{T_{eq} = \frac{\Delta H}{\Delta S}}$$

Que



When $\Delta H_{\text{vap}} = 30 \text{ kJ/mol}$ and $\Delta S_{\text{vap}} = 75 \text{ J mol}^{-1} \text{ K}^{-1}$, then the temperature of vapor, at one atmosphere is _____ K.

eqb^n

$$T = \frac{\Delta H}{\Delta S} = \frac{30 \times 1000}{75} = \frac{300 \times 100}{75} = \underline{\underline{400}}$$

[09 April 2024 (Shift 2)]

Ans.

Que

eq^r

PW

For a certain reaction at 300K, K = 10, then ΔG° for the same reaction is _____ $\times 10^{-1}$ kJ mol $^{-1}$ (given R = 8.314 JK $^{-1}$ mol $^{-1}$)

$$\Delta G = \Delta G^\circ + RT \ln \phi$$

[01 Jan 2024 (Shift 2)]

Ans.

Que



$$1 \text{ dm}^3 = 10^{-3} \text{ m}^3$$

If three moles of an ideal gas at 300K expand isotherrnally from 30 dm^3 to 45dm^3 against a constant opposing pressure of 80kPa then the amount of heat transferred is 1200 J.

$$\begin{aligned}W &= -P_{\text{ext}} \Delta V \\&= -80 \times 10^3 \times (45 - 30) \times 10^{-3} \\&= -80 \times 15 \\&= -1200 \text{ J}\end{aligned}$$

[27 Jan 2024 (Shift 1)]

Ans.

Que

R-P

Consider the following data

Heat of combustion of $\text{H}_2(\text{g}) = -241.8 \text{ kJ mol}^{-1}$

Heat of combustion of $\text{C}(\text{s}) = -39.5 \text{ kJ mol}^{-1}$

Heat of combustion of $\text{C}_2\text{H}_5\text{OH(l)} = -1234.7 \text{ kJ mol}^{-1}$

The heat of formation of $\text{C}_2\text{H}_5\text{(l)}$ is (-) _____ kJ mol^{-1} (Nearest integer).



$$\Delta H_f = \sum m \cdot \Delta H_c^{\circ}_{\text{React}} - \sum (m \cdot \Delta H_c^{\circ})_{\text{prod}}$$

$$2 \times (-39.5) + 3(-241.8) - [-1234.7]$$

Ans. (278)

Simple
Mathematics

PW

Which of the following is not correct?

[29 Jan 2024 (Shift 1)]

- A ΔG is negative for a spontaneous reaction ✓
- B ΔG is positive for a spontaneous reaction X
- C ΔG is zero for a reversible reaction (True)
- D ΔG is positive for a non-spontaneous reaction (T)

Ans.

Que



Standard enthalpy of vapourisation for CCl_4 is 30.5 kJ mol^{-1} . Heat required for vapourisation of 284 g of CCl_4 at constant temperature is _____ kJ.

(Given molar mass in gmol^{-1} ; C = 12, Cl = 35.5)

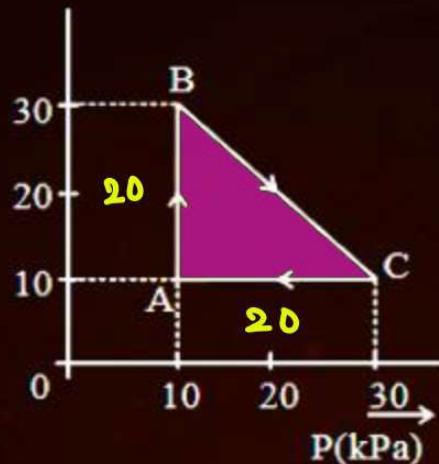
[29 Jan 2024 (Shift 2)]

Ans. (56)

Que



V
(dm³)



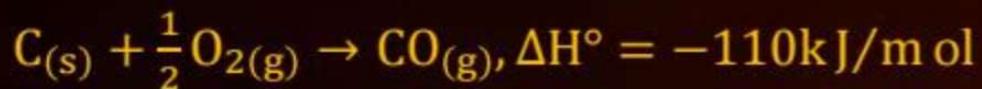
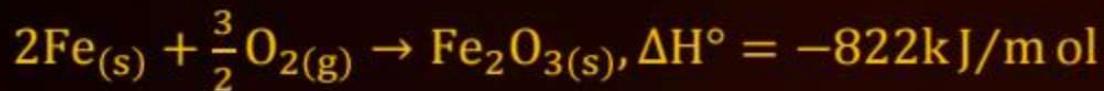
$$\frac{1}{2} \times 20 \times 20 \\ = 200$$

An ideal gas undergoes a cyclic transformation starting from the point and coming back to the same point by tracing the path A → B → C → A as shown in the diagram. The total work done in the process is _____ J.

[30 Jan 2024 (Shift 1)]

Ans.

Two reactions are given below:



Then enthalpy change for following reaction



[30 Jan 2024 (Shift 2)]

Ans. (492)

Que



The value of $\log K$ for the reaction $A \rightleftharpoons B$ at 298 K is _____. (Nearest integer)

Given : $\Delta H^\circ = - 54.07 \text{ kJ mol}^{-1}$

$\Delta S^\circ = 10 \text{ JK}^{-1} \text{ mol}^{-1}$

(Taken $2.303 \times 8.314 \times 298 = 5705$)

[2023 (06 Apr Shift 1)]

Ans. (10)

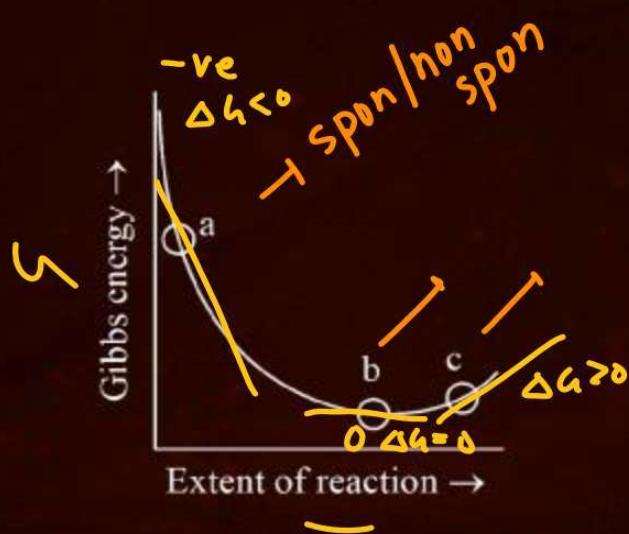
Que



Consider the graph of Gibbs free energy G vs extent of reaction. The number of statement/s from the following which are true with respect to points (a), (b) and (c) is ____.

[2023 (06 Apr Shift 1)]

- a → spontaneous
- b → equilibrium
- c → non-spontaneous



(2)

- A** Reaction is spontaneous at (a) and (c)
- B** Reaction is at equilibrium at point (b) and non-spontaneous at point (c)
- C** Reaction is spontaneous at (a) and non-spontaneous at (c)
- D** Reaction is non-spontaneous at (a) and (b)

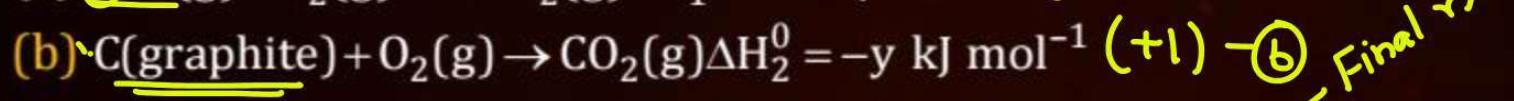
Ans. **(B)**
=

Que



→ #RBI

Given



The ΔH° for the reaction $\text{C(graphite)} + \frac{1}{2}\text{O}_2\text{(g)} \rightarrow \text{CO(g)}$ is

[2023 (10 Apr Shift 1)]

- A $\frac{2x-y}{2}$
- B $\frac{x+2y}{2}$
- C $\frac{x-2y}{2}$
- D $2y - x$

→
$$\begin{aligned} & -\frac{a}{2} + b \\ & -\frac{(-x)}{2} + -y \\ & \frac{x}{2} - y \\ & \underline{\frac{x-2y}{2}} \end{aligned}$$

Ans.

The number of endothermic process/es from the following is _____.

[2023 (10 Apr Shift 2)]

- A** $I_2(g) \rightarrow 2I(g)$
- B** $HCl(g) \rightarrow H(g) + Cl(g)$
- C** $H_2O(l) \rightarrow H_2O(g)$
- D** $C(s) + O_2(g) \rightarrow CO_2(g)$
- E** Dissolution of ammonium chloride in water

Ans. (D)

Que

Numerous



The total number of intensive properties from the following is.....

~~Volume, Molar heat capacity, molarity, E°_{Cell} , Gibbs free energy change, Molar mass,~~
~~Mole~~ → extensive

$$\text{Ans} = \underline{\underline{4}}$$

[2023 (11 Apr Shift 2)]

Ans.

One mole of an ideal gas at 350 K in a 2.0 L vessel of thermally conducting walls, which are in contact with the surroundings. It undergoes isothermal reversible expansion from 2.0 L to 3.0 L against a constant pressure of 4 atm. The change in entropy of the surroundings (ΔS) is _____ J K⁻¹ (Nearest integer)

Given: . R = 8.314 J K⁻¹ mol⁻¹

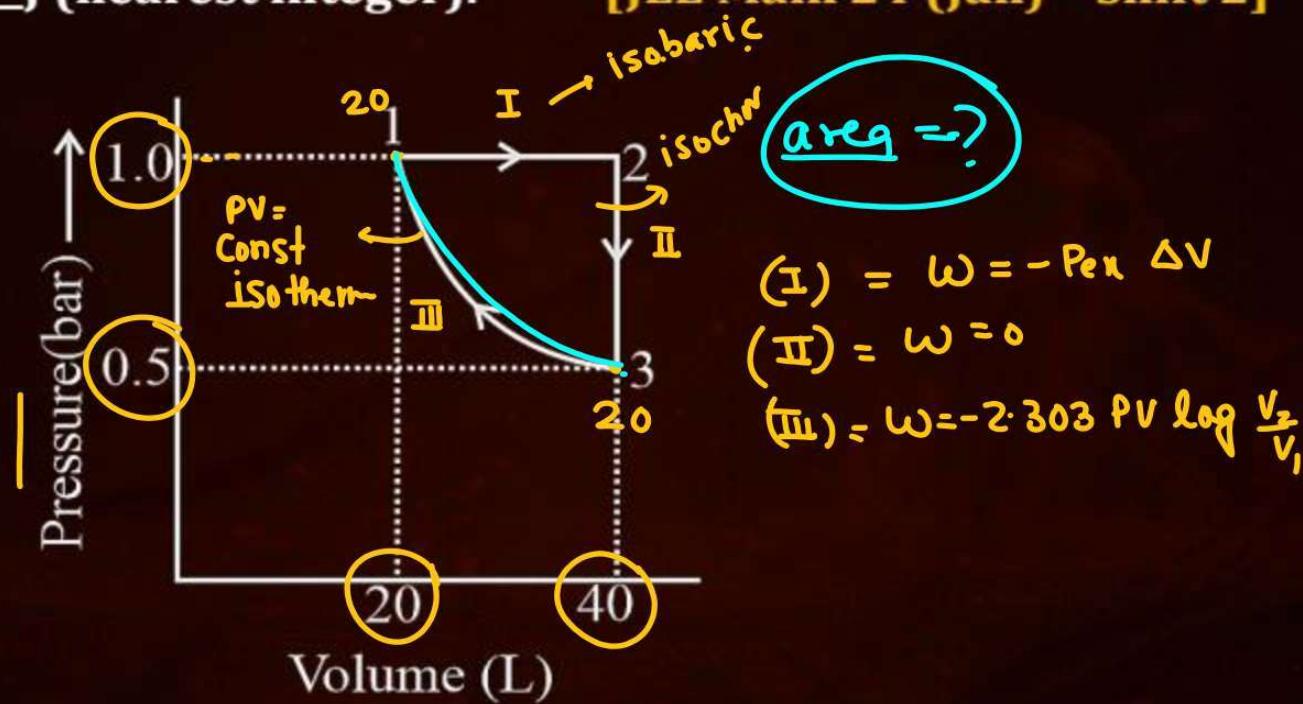
[2023 (12 Apr Shift 1)]

Ans. (3)

Q

One mole of an ideal monoatomic gas is subjected to changes as shown in the graph. The magnitude of the work done (by the system or on the system) is _____ J (nearest integer). [JEE Main 24 (Jan) - Shift 2]

$$nRT = PV$$

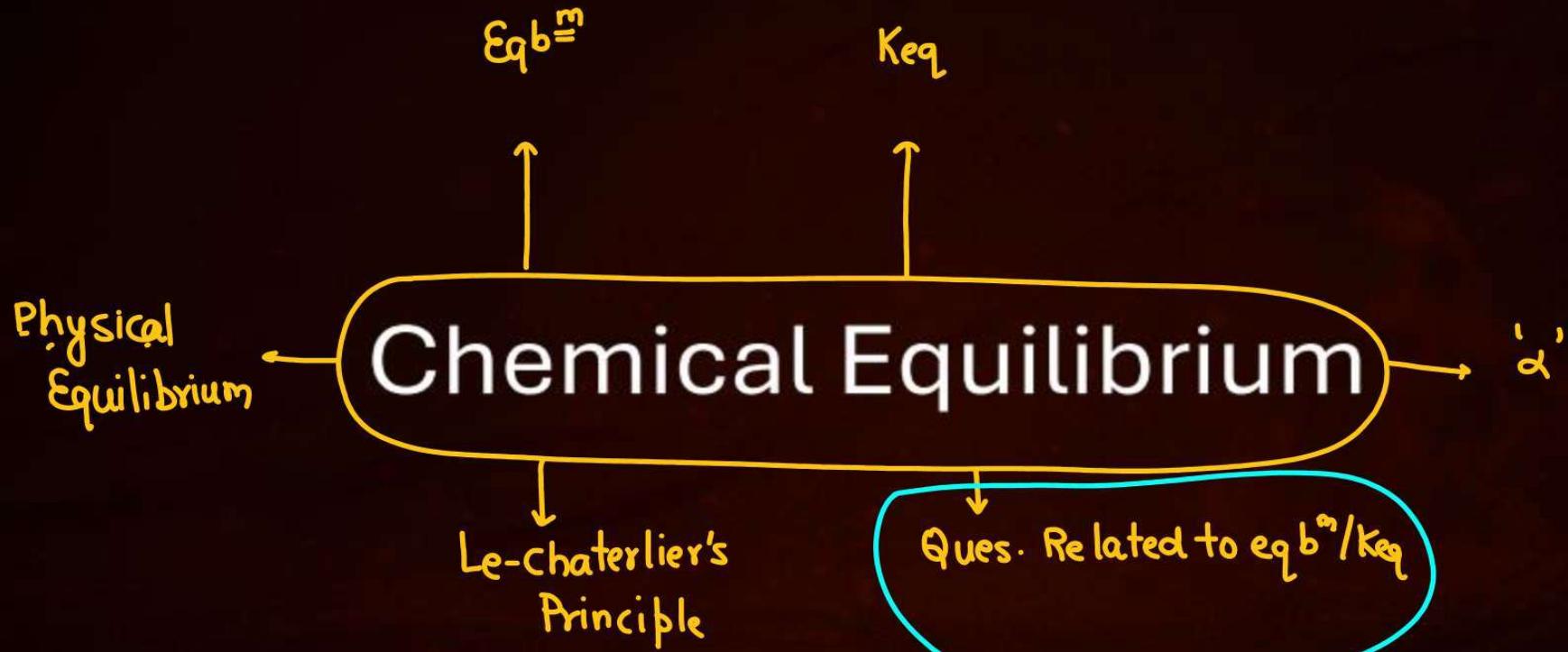


Enthalpies of formation of $\text{CCl}_4(\text{g})$, $\text{H}_2\text{O}(\text{g})$, $\text{CO}_2(\text{g})$ and $\text{HCl}(\text{g})$ are -105, -242, -394 and -92 kJ mol^{-1} respectively. The magnitude of enthalpy of the reaction given below is _____ kJ mol^{-1} (nearest integer)



[JEE Main 31 (Jan.) 2023, Shift 2]

$$\begin{aligned}\Delta H_f &= \sum m \cdot (\Delta H_f)_{\text{product}} - \sum m \cdot (\Delta H_f)_{\text{react}} \\ &= 4(-92) + (-394) - \underbrace{\left[2(-242) + (-105) \right]}_{\text{Reactants}}\end{aligned}$$



Le-Chaterlier's Principle

Equilibrium → Disturb → Reaction

(1) Change in conc²

(2) Change in Pressure / Volume

(3) Addition of Catalyst

(4) Addition of inert gas

(a) Constant Vol

(b) Constant Pressure

(5) Change in Temp. } $\rightarrow K_{eq}$ Change

K_{eq}
Change
nahi
hota
hai.

① Change in Conc^o

Reactant

Increase → Forward

Decrease → Backward

Product

Increase → Backward

Decrease → Forward.



- (I) Proceed forward
- (II) Proceeds backward
- (III) no change

② Change in Volume/ Pressure

✓ Jis rx⁻² me gas hogा wahi effected hogा.

✓ Pressure ↑ Volume ↓
[Gas] ↑

Best friend

$\Delta n_g > 0$: Backwards
 $\Delta n_g < 0$: Forward

✓ Pressure ↓ Volume ↑

[Gas] ↓

Face Book

$\Delta n_g > 0$: Forward

$\Delta n_g < 0$: Backward

If $\Delta n_g = 0$
Then no effect

→ Reels
Face Book

③ Addition of Catalyst

- ✓ No effect on equilibrium.
- ✓ Help r_{x^b} to attain eqb^m faster.
- ✓ Does not affect any ThDM property.

④ Addition of inert gas

(i) Constant Volume

→ Koi Fadak nahi Padta.

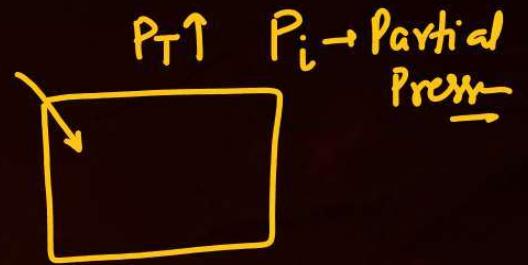
(ii) Constant Pressure

$V \uparrow$

$\Delta n_g = 0$: no effect

$\Delta n_g > 0$ forward

$\Delta n_g < 0$ backwards.



⑤ Change in Temp

Endothermic ($q \rightarrow \text{absorb}$)

$T \uparrow$ forward

$T \downarrow$ Backward

Exothermic

$T \uparrow$ Backward

$T \downarrow$ Forward

#Q.



Blood Red Ppt

For the given reaction choose the correct expression of K_c from the following -



$$K_c =$$

[31 Jan. 2024 (Shift 1)]

A $K_c = \frac{[\text{FeSCN}^{2+}]}{[\text{Fe}^{3+}][\text{SCN}^{-}]}$

B $K_c = \frac{[\text{Fe}^{3+}][\text{SCN}^{-}]}{[\text{FeSCN}^{2+}]}$

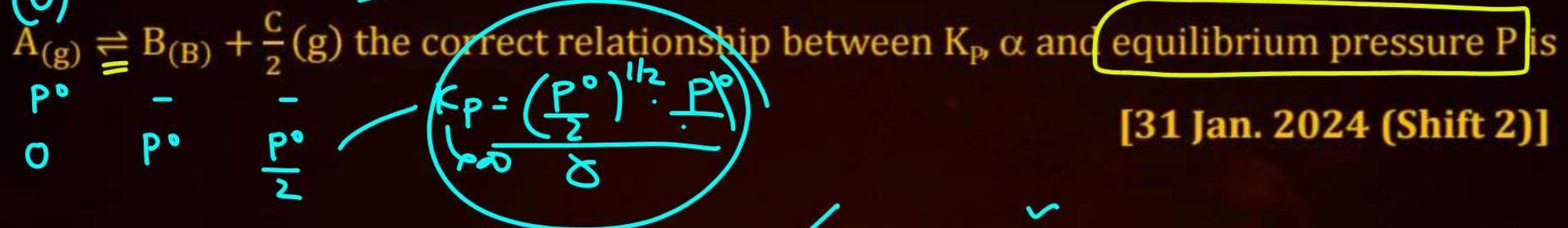
C $K_c = \frac{[\text{FeSCN}^{2+}]}{[\text{Fe}^{3+}]^2[\text{SCN}^{-}]^2}$

D $K_c = \frac{[\text{FeSCN}^{2+}]^2}{[\text{Fe}^{3+}][\text{SCN}^{-}]}$

Ans.

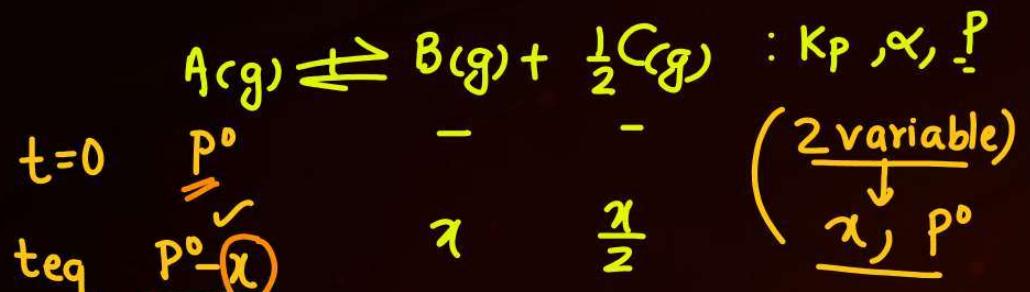
#Q.

(Q)



- A** $K_p = \frac{\alpha^{1/2} P^{1/2}}{(2+\alpha)^{1/2}}$
- B** $K_p = \frac{\alpha^{3/2} P^{1/2}}{(2+\alpha)^{1/2}(1-\alpha)}$
- C** $K_p = \frac{\alpha^{1/2} P^{3/2}}{(2+\alpha)^{3/2}}$
- D** $K_p = \frac{\alpha^{1/2} P^{1/2}}{(2+\alpha)^{3/2}}$

Ans.



$$(P_T)_{eq} = P^o - x + x + \frac{\alpha}{2}$$

$$P = P^o + \frac{\alpha}{2}$$

$$\alpha = \frac{x}{P^o}$$

$$x = \alpha P^o$$

$$P = P^o + \frac{\alpha P^o}{2}$$

$$P = P^o \left(1 + \frac{\alpha}{2} \right)$$

$$P^o = \frac{P}{\left(1 + \frac{\alpha}{2} \right)}$$

$$\begin{aligned} P_A &= P^o - \alpha P^o \\ &= P^o (1 - \alpha) \\ &= \frac{P}{\left(1 + \frac{\alpha}{2} \right)} (1 - \alpha) \end{aligned}$$

$$\begin{aligned} K_P &= \frac{(P_C)^{1/2} (P_B)}{P_A} = \frac{\alpha}{2} \left(\frac{P}{2 + \alpha} \right) \\ &= \frac{\alpha^{1/2} P^{1/2} \times \alpha P}{(2 + \alpha)^{1/2} \left(1 + \frac{\alpha}{2} \right)} = \frac{\alpha^{3/2} P^{1/2}}{(2 + \alpha)^{1/2} (1 - \alpha)} \end{aligned}$$

$$\begin{aligned} P_B &= \alpha \left(\frac{P}{1 + \frac{\alpha}{2}} \right) \\ \frac{x}{2} &= \frac{\alpha}{2} \left(\frac{P}{1 + \frac{\alpha}{2}} \right) \end{aligned}$$

#Q.



The following concentrations were observed at 500 K for the formation of NH_3 from N_2 and H_2 . At equilibrium : $[\text{N}_2] = 2 \times 10^{-2} \text{ M}$, $[\text{H}_2] = 3 \times 10^{-2} \text{ M}$ and $[\text{NH}_3] = 1.5 \times 10^{-2} \text{ M}$. Equilibrium constant for the reaction is ____.



[29 Jan 2024 (Shift 2)]

$$K_c = \frac{[\text{NH}_3]^2}{[\text{N}_2][\text{H}_2]^3} = \frac{1.5 \times 1.5 \times 10^{-4}}{2 \times 10^{-2} \times 3 \times 3 \times 3 \times 10^{-6}} \times 10^4$$

$$= \frac{1}{24} \times 10^4$$

$$= \frac{100 \times 10}{24}$$

Ans.

#Q.



For the reaction $\text{N}_2\text{O}_4(\text{g}) \rightleftharpoons 2\text{NO}_2(\text{g})$, $K_p = 0.492$ atm at 300 K. K_c for the reaction at same temperature is _____ $\times 10^{-2}$

(Given : $R = 0.082 \text{ L atm mol}^{-1} \text{ K}^{-1}$)

$$\Delta n_g = 2 - 1 = 1$$

$$K_p = K_c \cdot (RT)^{\Delta n_g}$$

$$K_c = \frac{K_p}{RT}$$

$$= \frac{0.492}{0.082 \times 300} = ②$$

[29 Jan 2024 (Shift 1)]

$$K_p = K_c \cdot (RT)^{\Delta n_g}$$

$$K_p = K_c$$

$$① \Delta n_g = 0 \quad (RT)^0 = 1$$

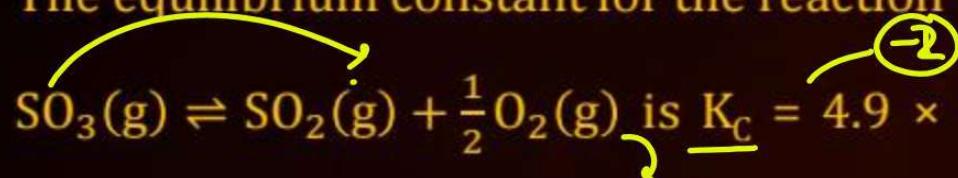
$$② T = \frac{1}{R} : T \approx 12.13 \text{ K}$$

Ans.

#Q.



The equilibrium constant for the reaction



-2

is $K_C = 4.9 \times 10^{-2}$. The value of K_C for the reaction given below is $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ is

[04 April. 2024 (Shift 2)]

- A** 4.9
- B** 49
- C** 41.6
- D** 416

$$\begin{aligned} K_C' &= \left(\frac{1}{K_C}\right)^2 \\ &= \left(\frac{1}{4.9 \times 10^{-2}}\right)^2 = \frac{10^4}{4.9 \times 4.9} \end{aligned}$$

Ans.

#Q.



The following reaction occurs in the Blast furnace where iron ore is reduced to iron metal

$$\text{Fe}_2\text{O}_3 + 3\text{CO}_{(g)} \rightleftharpoons \text{Fe}_{(l)} + 3\text{CO}_{2(g)}$$

Using the Le-chatelire's principle, predict which one of the following will not disturb the equilibrium.

[05 April. 2024 (Shift 1)]

- A Addition of CO_2
- B Removal of CO_2
- C ~~Addition of Fe_2O_3~~
- D Removal of CO

Ans.

#Q.



Daltons

At -20°C and 1 atm pressure a cylinder is filled with equal number of H_2 , I_2 and HI molecules for the reaction $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g})$, the K_p for the process is $x \times 10^{-1}$.

$$X = \underline{\hspace{2cm}}$$

$$\frac{1\text{mol}}{\sqrt{P}} + \frac{1\text{mol}}{\sqrt{P}} + \frac{1\text{mol}}{\sqrt{P}} = 1$$

[GIVEN : $r = 0.082 \text{ l atm K}^{-1} \text{ mol}^{-1}$]

$$P = \frac{1}{3}$$

[06 April 2024 (Shift 1)]

$$K_p = \frac{\left(\frac{1}{3}\right)^2}{\left(\frac{1}{3}\right)\left(\frac{1}{3}\right)} = \underline{\hspace{2cm}}$$

$$K_p = \frac{x \times 10^{-1}}{10 \times 10^{-1}} =$$

- (A) 0.01
- (B) 10
- (C) 10
- (D) 1

Ans. (B)

#Q.



The ratio $\frac{K_p}{K_c}$ for the reaction : $CO_{(g)} + \frac{1}{2}O_{2(g)} \rightleftharpoons CO_{2(g)}$ is

[06 April 2024 (Shift 2)]

A $\frac{1}{\sqrt{RT}}$

B $(RT)^{1/2}$

C RT

D 1

$$\Delta n_g = 1 - \left(\frac{1}{2} + 1\right)$$

$$= -\frac{1}{2}$$

$$K_p = K_c (RT)^{-1/2}$$

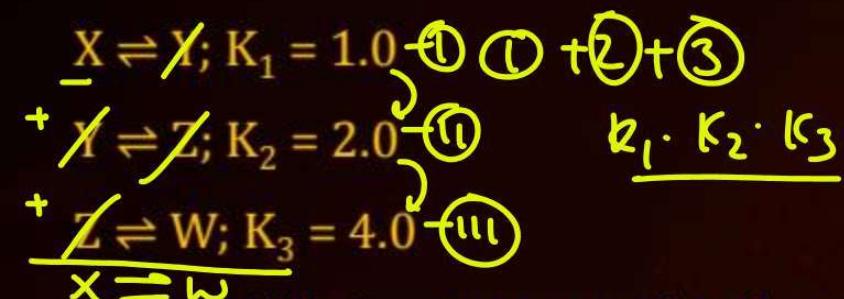
$$\frac{K_p}{K_c} = (RT)^{-1/2}$$

Ans.

#Q.

P
W

For the given hypothetical reactions, the equilibrium constants are as follows :



The equilibrium constant for the reaction $X \rightleftharpoons W$ is

[08 April 2024 (Shift 1)]

- A 6.0
- C 7.0

- B 12.0
- D 8.0

Ans.

#Q.

P
W

Orange
Yellow

The equilibrium $\text{Cr}_2\text{O}_7^{2-} \rightleftharpoons 2\text{CrO}_4^{2-}$ is shifted to the right in :

backwards

[08 April 2024 (Shift 2)]

- A an acidic medium
- B a basic medium ✓
- C a neutral medium
- D a weakly acidic medium

Ans. (B)

Q.



Water decomposes at 2300 K



The percent of water decomposing at 2300 K and 1 bar is ____ (Nearest Integer)

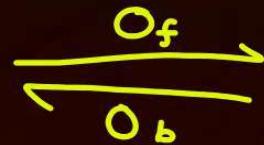
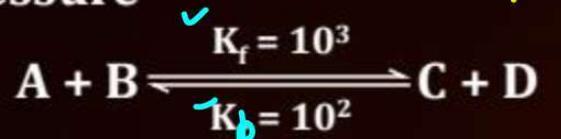
Equilibrium constant for the reaction is 2×10^{-3} at 2300 K

[JEE Main 2023]

Q.



Consider the following reaction approaching equilibrium at 27°C and 1 atm pressure



$$K_{eq} = \frac{K_f}{K_b}$$

6

The standard Gibb's energy change ($\Delta_r G^\circ$) at 27°C is (-) ____ kJ mol⁻¹.
(Nearest integer)

[JEE Main 2023]

$$K_{eq} = \frac{10^3}{10^2} = 10$$

$\Phi = Rx^n$ Quotient

$$\cancel{\Delta G}^\circ = \Delta G^\circ + RT \ln \Phi$$

At eqb

$$\Delta G = 0$$

$$\Phi = K_{eq}$$

$$\Delta G^\circ = -RT \ln K$$

$$= -RT \ln 10$$

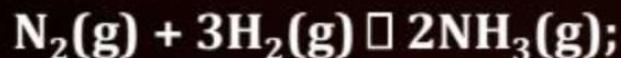
$$= -RT \times 2.303$$

$$= -\frac{8.314 \times 300 \times 2.303}{1000} \text{ kJ}$$

Q.



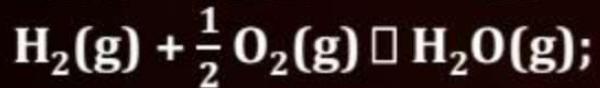
At 298 K



$$K_1 = 4 \times 10^5$$

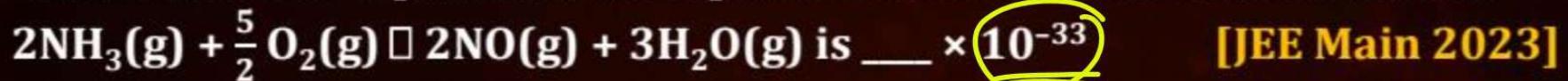


$$K_2 = 1.6 \times 10^2$$



$$K_3 = 1.0 \times 10^{-3}$$

Based on above equilibria, the equilibrium constant for the reaction,



25 min

8:10 min \rightarrow 8:35 min

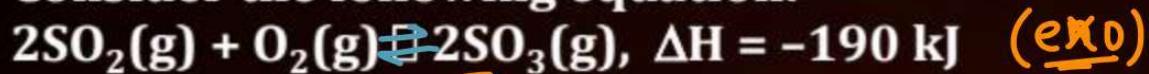
Q.

$$2-3 = -ve$$

3

2

Consider the following equation:



The number of factors which will increase the yield of SO_3 at equilibrium from the following is _____

[JEE Main 2023]

- (a) Increasing temperature
- (b) Increasing pressure
- (c) Adding more SO_2
- (d) Adding more O_2
- (e) Addition of catalyst

$P \uparrow$
 $\Delta n_g > 0 : B$
 $\Delta n_g < 0 : F$

Ans = 3

Q.

$$-1/2 \quad \frac{\cancel{K_p} \times 300}{\cancel{T}^{\circ\text{C}}} \times \frac{10^3}{4}$$

For reaction: $\text{SO}_2(\text{g}) + \frac{1}{2}\text{O}_2(\text{g}) \rightleftharpoons \text{SO}_3(\text{g})$; $K_p = 2 \times 10^{12}$ at 27°C and 1 atm pressure. The K_c for the same reaction is $\underline{\quad} \times 10^{13}$. (Nearest integer)
 (Given: $R = 0.082 \text{ L atm K}^{-1} \text{ mol}^{-1}$)

[JEE Main 2023]

$$K_p = K_c \cdot (RT)^{\Delta n_g}$$

$$K_c = \frac{K_p}{(RT)^{\Delta n_g}} = \frac{2 \times 10^{12}}{(0.082 \times 300)^{-1/2}} = \frac{2 \times 10^{12}}{(\sqrt{25})^{-1}}$$

$$\begin{aligned} &= \\ &= 10 \times 10^{12} \\ &= \underline{1 \times 10^{13}} \end{aligned}$$

- (1) Ionic
 (2) Electro
 (3) Chemical Kinetics

Q.



At 25°C, the enthalpy of the following processes are given:

- ✓ $\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{OH}(\text{g})$ $\Delta H^\circ = 78 \text{ kJ mol}^{-1}$ (+½)
- = $\text{H}_2(\text{g}) + \frac{1}{2}\text{O}_2(\text{g}) \rightarrow \text{H}_2\text{O}(\text{g})$ $\Delta H^\circ = -242 \text{ kJ mol}^{-1}$ (-1)
- ' $\text{H}_2(\text{g}) \rightarrow 2\text{H}(\text{g})$ $\Delta H^\circ = 436 \text{ kJ mol}^{-1}$ (½)
- $\frac{1}{2}\text{O}_2(\text{g}) \rightarrow \text{O}(\text{g})$ $\Delta H^\circ = -249 \text{ kJ mol}^{-1}$

What would be the value of X for the following reaction? ___(Nearest Integer.)

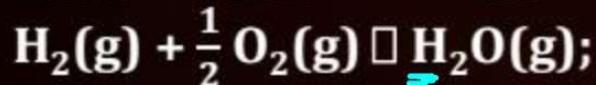


$$= \frac{78}{2} + (+242) + \frac{436}{2}$$

-

Q.

At 298 K

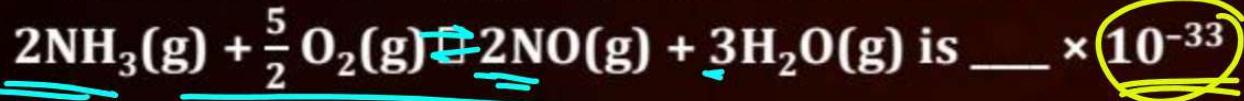


$$K_1 = 4 \times 10^5 \quad (-1)$$

$$K_2 = 1.6 \times 10^2 \quad +1$$

$$K_3 = 1.0 \times 10^{-3} \quad +3$$

Based on above equilibria, the equilibrium constant for the reaction,



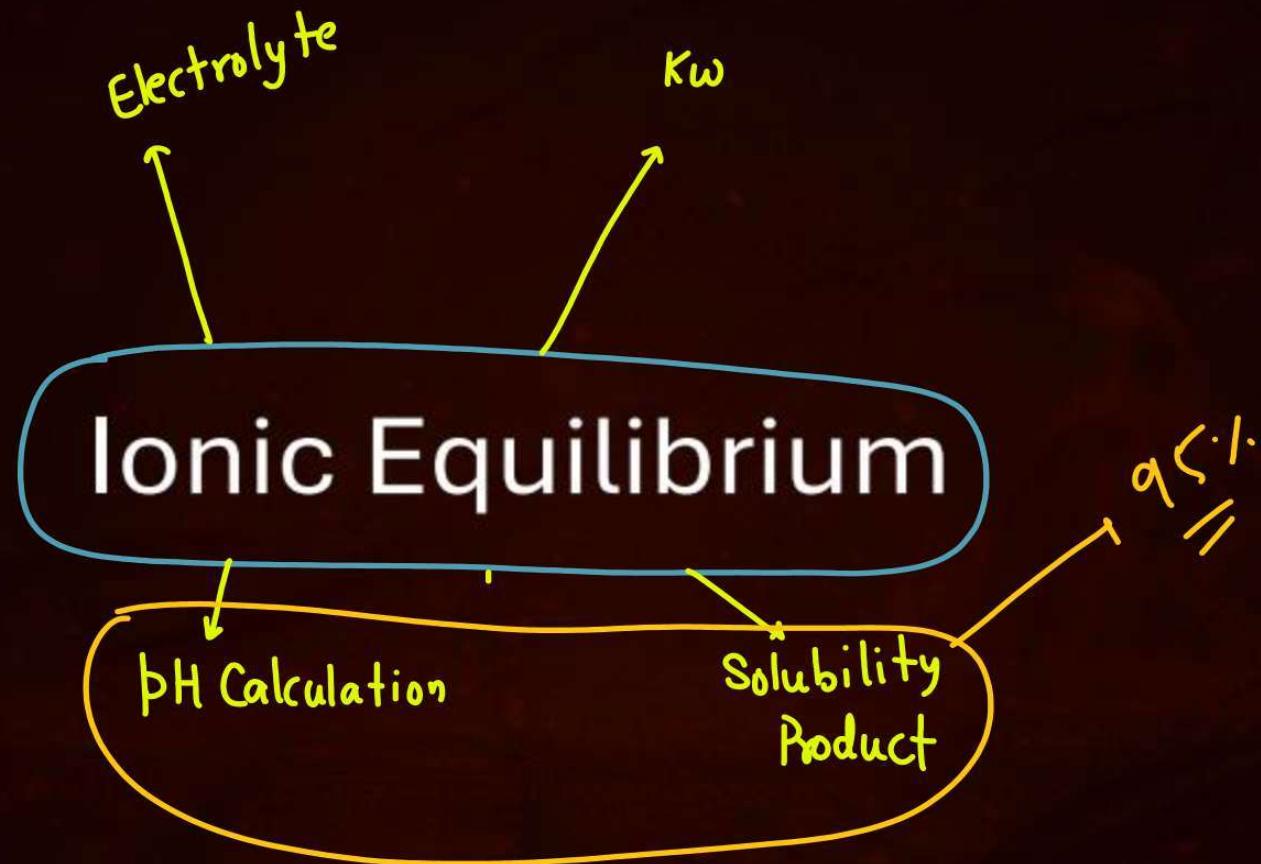
[JEE Main 2023]

$$\begin{aligned}
 & -I + II + III \\
 & \frac{K_2 \cdot K_3^3 \cdot 10^4}{K_1} = \frac{1.6 \times 10^2 \times (10^{-3})^3}{4 \times 10^5} \\
 & = 0.4 \times 10^{-7.5} \\
 & = 0.4 \times 10^{-12}
 \end{aligned}$$

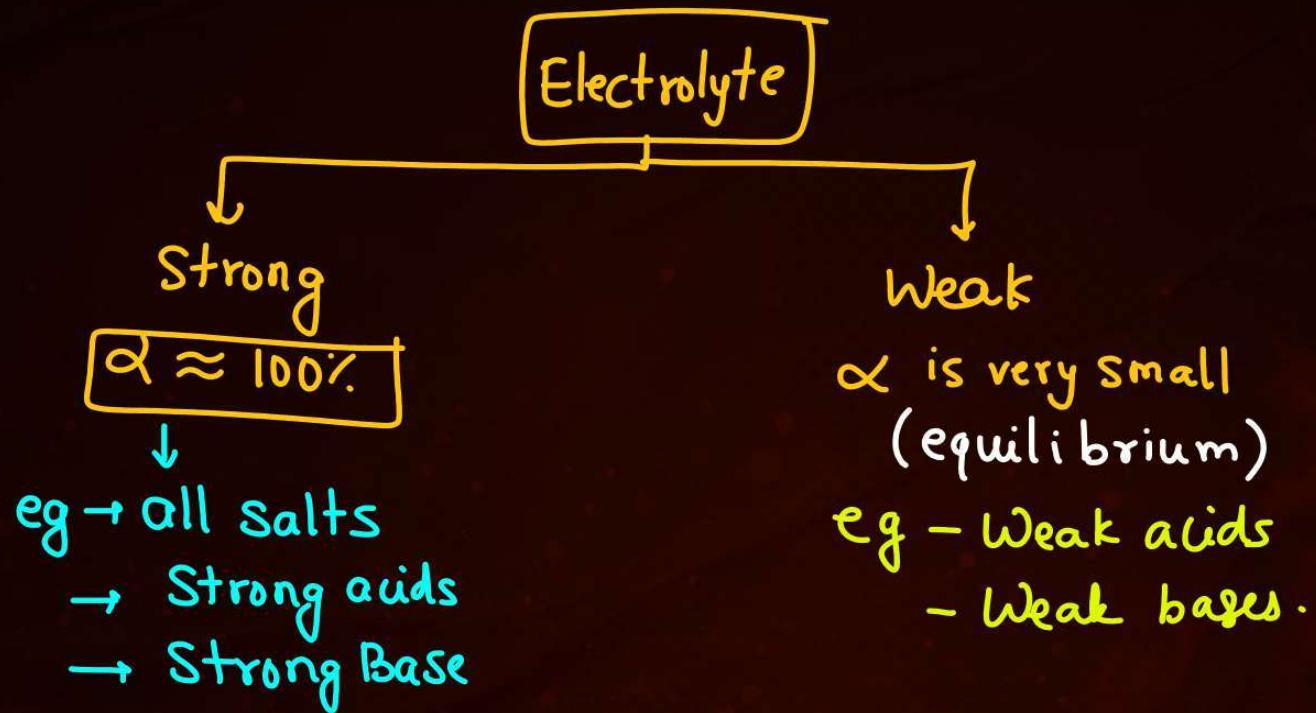
25 min

8:10 min \rightarrow 8:35 min

Th



PW



Dissociation Constant for water

H₂O is very weak electrolyte.



✓ $K_w = [\text{H}^+] [\text{OH}^-]$

$$pK_w = -\log K_w = -\log [\text{H}^+] - \log [\text{OH}^-]$$

$pK_w = pH + pOH$

Neutral
 $pH = 7 = pOH$

at 25°

$$pK_w = 14$$

pH Scale = 0 to 14

Neutral pH = 7

$$pH = pOH = 7$$

$$T = 25^\circ\text{C}$$

$$pK_w = 12$$

pH = 0 to 12

Scale

Neutral pH = 7

-log (anything) = p(that thing)

-log (x_iy_i) = p(x_iy_i)

-log K_w = pK_w

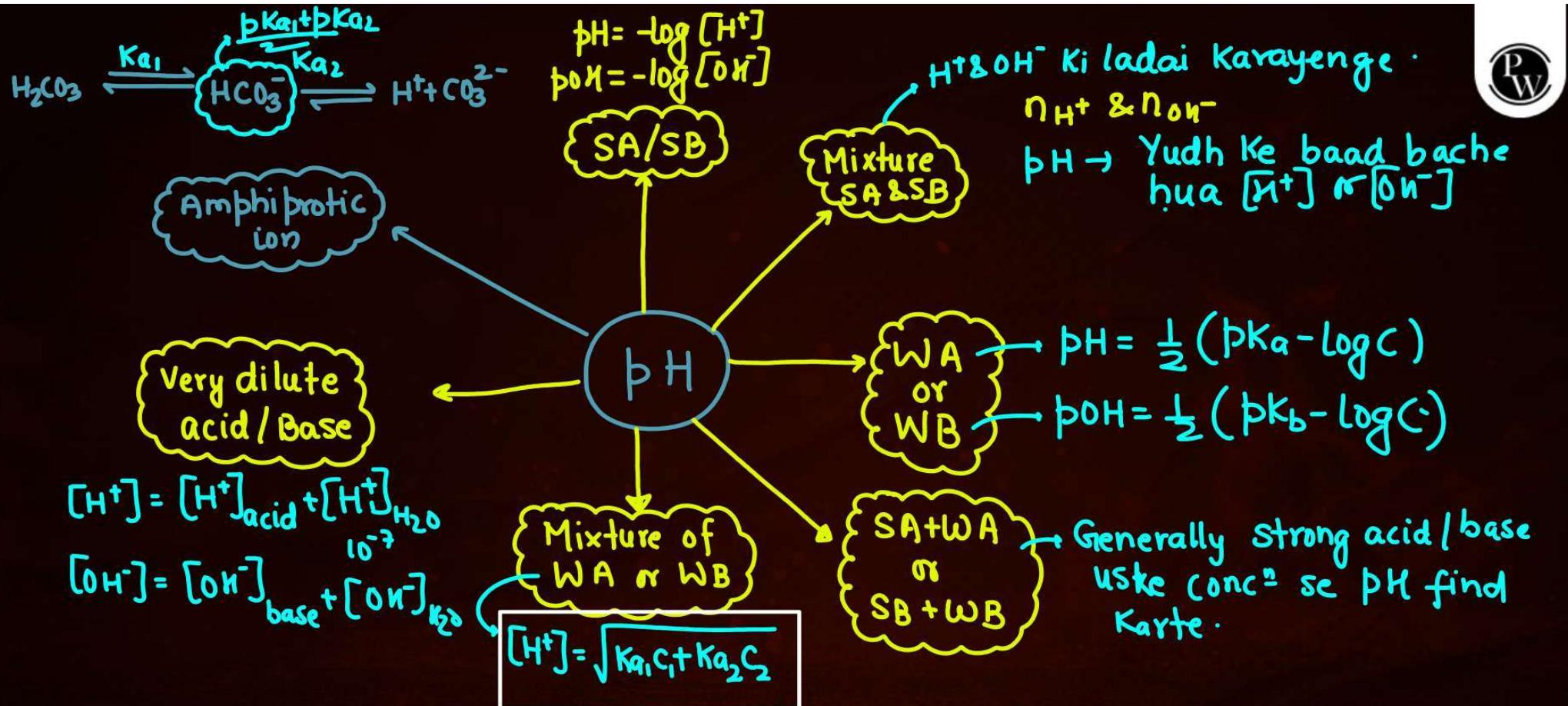
-log [H⁺] = pH

-log K_a = pK_a

-log W = PW

✓ Ostwald Law of Dilution

“ Jaise jaise dilution \uparrow conc $^2 \downarrow$ \Rightarrow weak electrolyte ka $\alpha \uparrow$ aur weak electrolyte strong banane ki taraf move karega.



#RBI

Salt hydrolysis

Weak part Ka hydrolysis hota hai.



Sabka pH

| | Salt | pH | Hydrolysis | |
|-----|------------------------|--|-----------------------|--------------------------|
| (1) | SA + SB | 7 | xx < | |
| (2) | <u>SA</u> + w <u>B</u> | 7 - $\frac{1}{2}(\text{pK}_b + \log C)$ | Cationic Part | (NH ₄ Cl etc) |
| (3) | w <u>A</u> + <u>SB</u> | 7 + $\frac{1}{2}(\text{pK}_a + \log C)$ | Anionic Part : | |
| (4) | <u>WA</u> + w <u>B</u> | 7 + $\frac{1}{2}(\text{pK}_a - \text{pK}_b)$ | Both Cation & Anionic | |

Buffer

① Simple
 ✓ $WA, WB \& Salt of WA \& WB$

 $pK_a \rightarrow$ ② Mixed

(a) Acidic Buffer

$WA + Salt$
 (Conjugate base)

✓
 $pK \pm 1$

$$pH = pK_a + \log \frac{[\text{Salt}]}{[\text{Acid}]}$$

(b) Basic Buffer

$WB + Salt$
 (Conjugate acid)

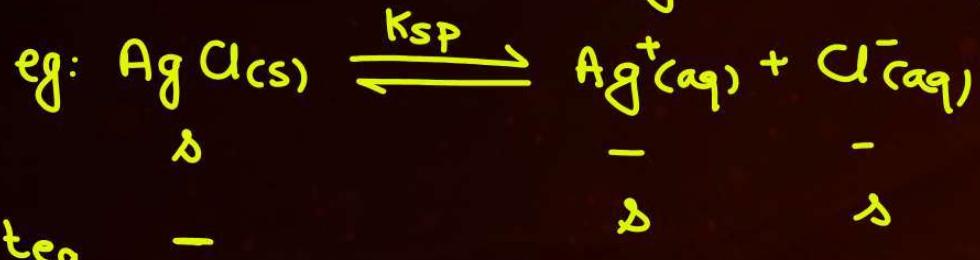
$$pOH = pK_b + \log \frac{[\text{Salt}]}{[\text{Base}]}$$

Solubility product

✓ Sparing Soluble Salt

e.g. → AgCl , AgBr , AgI , Ag_2CrO_4 etc

Jitna dissolve hoga utna tutega.



$$K_{sp} = [\text{Ag}^+] [\text{Cl}^-]$$

$$= \delta^2$$

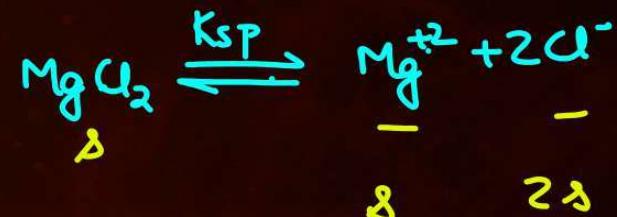
$$K_{sp} = \delta^2$$



| | | | |
|----------|----------|-----------|-----------|
| δ | - | - | - |
| - | δ | 3δ | 3δ |

$$K_{sp} = [\text{Al}^{+3}] [\text{OH}^-]^3$$

$$= \delta^1 (3\delta)^3 = 27\delta^4$$



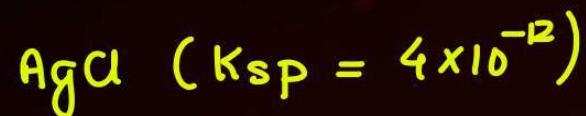
$$K_{sp} = \delta (\text{Z}\delta)^2$$

$$= 4\delta^3$$

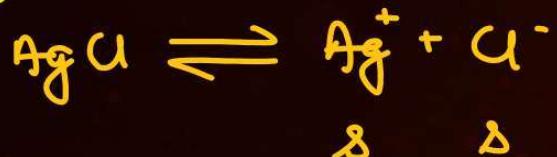
- (1) δ given find K_{sp}
- (2) K_{sp} given find solubility
- ✓ (3) Solubility in presence of Common ion
- ✓ (4) Simultaneous solubility
- ✓ (5) Condition for precipitation.
- } Simple

Solubility in presence of Common ion

$$s \sim \cancel{1} \times 10^{-1}$$



$$s(\text{AgCl}) = ?$$



AgCl
in NH_3

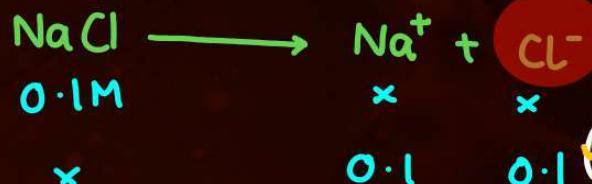
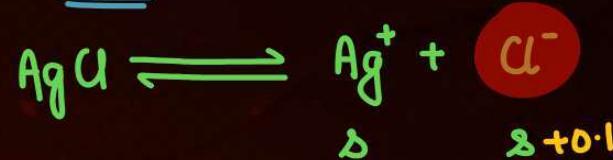
Infinitely
Soluble

$$K_{\text{sp}} = s^2$$

$$s = \sqrt{4 \times 10^{-12}}$$

$$= \underline{\underline{2 \times 10^{-6}}}$$

in 0.1M NaCl



$$K_{\text{sp}} = [\text{Ag}^+] [\text{Cl}^-]$$

$$= s (s + 0.1)$$

$$s = \frac{K_{\text{sp}}}{10^{-1}} = \frac{4 \times 10^{-12}}{10^{-1}} = 4 \times 10^{-11}$$

$\underline{\underline{[\text{Cl}^-]}}$

Product
Backward

- (a) Only 1
- (b) Only 2
- (c) both 1 & 2

Simultaneous solubility

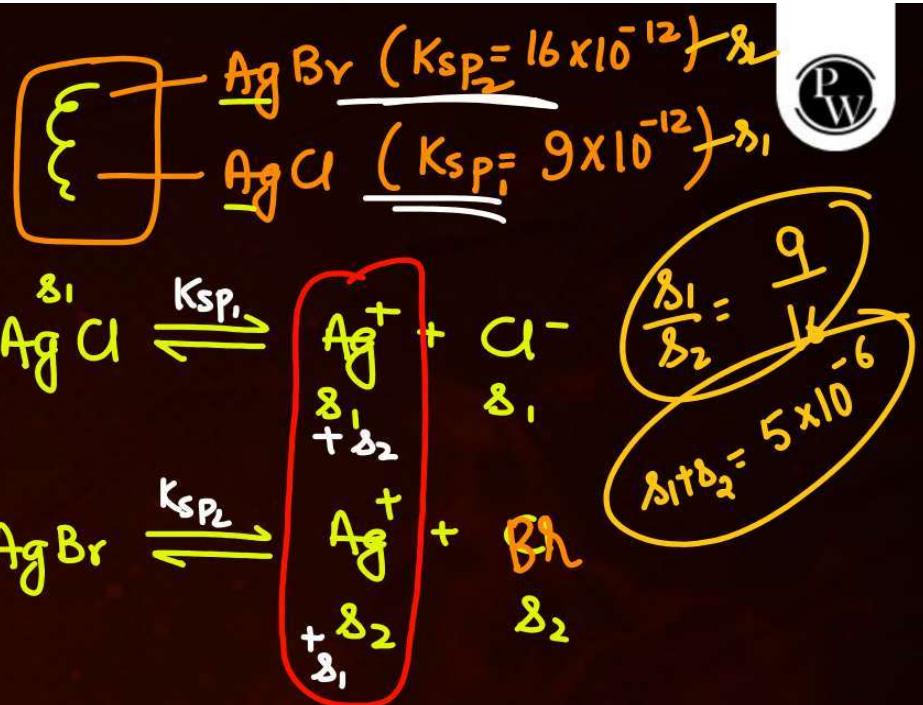
2 sparingly soluble
Salt
सूक्ष्म कोनल इन

$$\text{Equ? } \frac{K_{SP_1}}{K_{SP_2}} = \frac{[\text{Ag}^+][\text{Cl}^-]}{[\text{Ag}^+][\text{Br}^-]} = \frac{\delta_1}{\delta_2} \quad \textcircled{1}$$

$$K_{SP_1} + K_{SP_2} = (\delta_1 + \delta_2) \delta_1 + (\delta_1 + \delta_2) \delta_2 \\ = (\delta_1 + \delta_2)(\delta_1 + \delta_2)$$

$$(\delta_1 + \delta_2)^2 = K_{SP_1} + K_{SP_2}$$

$$\delta_1 + \delta_2 = \sqrt{K_{SP_1} + K_{SP_2}}$$



Condition for ppt

(Q_f) Ionic product = $K_{sp} \Rightarrow$ Saturated

Ionic Product $> K_{sp} \Rightarrow$ ppt banega

Ionic Product $< K_{sp} \Rightarrow$ Unsaturated sol.

Given below are two statements :

Statement I : On passing $\text{HCl}_{(\text{g})}$ through a saturated solution of BaCl_2 , at room temperature white turbidity appears.

Statement II : When HCl gas is passed through a saturated solution of NaCl, sodium chloride is precipitated due to common ion effect.

In the light of the above statements, choose the most appropriate answer from the options given below :

[05 April 2024 (Shift 2)]

- A** Both Statement I and Statement II are correct
- B** Statement I is correct but Statement II is incorrect
- C** Both Statement I and Statement II are incorrect
- D** Statement I is incorrect but Statement II is correct

Ans. (B)

Que

Given below are two statements :

Statement (I) : A Buffer solution is the mixture of a salt and an acid or a base mixed in any particular quantities. (F) X

Statement (II) : Blood is naturally occurring buffer solution whose pH is maintained by H_2CO_3 / HCO_3^- concentrations. (T) ✓

In the light of the above statements, choose the correct answer from the options given below :

[08 April 2024 (Shift 2)]

- A** Statement I is true but Statement II is false
- B** Both Statement I and Statement II are true
- C** Statement I is false but Statement II is true
- D** Both Statement I and Statement II are false

Ans. (C)

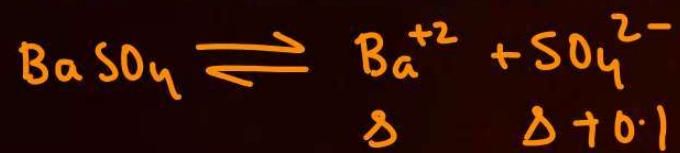
Que



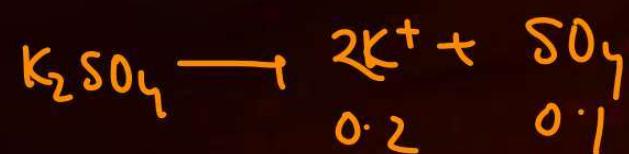
The solubility product of BaSO_4 is 1×10^{-10} at 298 K: the solubility of BaSO_4 in 0.1M K_2SO_4 (aq) solution $\underline{\underline{233}} \times 10^{-9} \text{ g L}^{-1}$ (nearest integer)

Given molar mass of BaSO_4 in 233 g mol^{-1}

$$\begin{aligned}s &= 10^{-9} \text{ mol/L} \\ &= 10^{-9} \times \underline{\underline{233}} \text{ g L}^{-1}\end{aligned}$$



$s(10^{-10}) = 10^{-10}$ [08 April 2023 (Shift 2)]



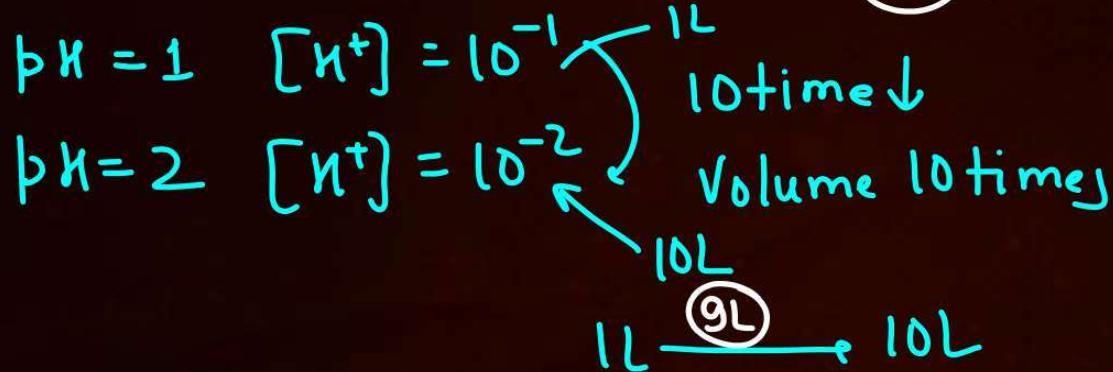
$$s = \frac{10^{-10}}{10^{-1}} = 10^{-9}$$

Ans.

Que



An analyst wants to convert 1 L HCl of pH = 1 to a solution of HCl of pH = 2. The volume of water needed to do this dilution is 9000 mL (Nearest integer)



[12 April 2023 (Shift 1)]

Ans.

Que



25. 0 mL of 0. 050 M $\text{Ba}(\text{NO}_3)_2$ is mixed with 25. 0 mL of 0. 020 M NaF . K_{sp} of BaF_2 is 0.5×10^{-6} 298K. The ratio of $[\text{Ba}^{2+}] [\text{F}^{-}]^2$ and K_{sp} is _____.

M·ω

[13 April 2023 (Shift 1)]

Ans.

Que

20 mL of 0.1M NaOH is added to 50 mL of 0.1 M acetic acid solution. The pH of the resulting solution is $\times 10^{-2}$ (Nearest integer) Given :

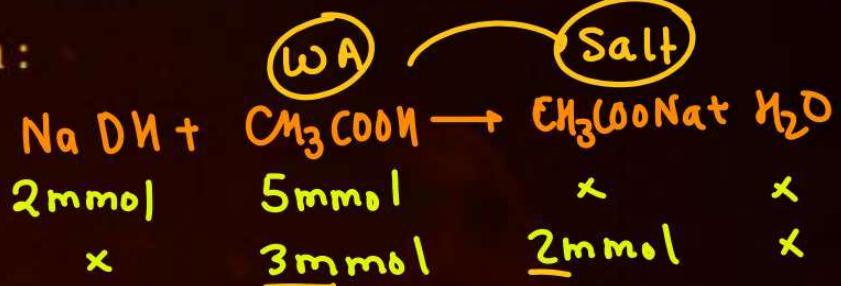
$$\text{pKa} (\text{CH}_3\text{COOH}) = \underline{4.76}$$

$$\log 2 = 0.30$$

$$\log 3 = 0.48$$

$$\begin{aligned}\text{pH} &= \text{pKa} + \log \frac{\text{Salt}^-}{\text{Acid}^-} \\ &= 4.76 + \log \frac{2 \text{ mmol}}{3 \text{ mmol}} \\ &= 4.76 + \log 2 - \log 3\end{aligned}$$

Buffer



[13 April 2024 (Shift 2)]

Ans.

Which of the following statement(s) is/are correct?

- A. The pH of 1×10^{-8} M HCl solution is 8
- B. The conjugate base of H_2PO_4^- is HPO_4^{2-}
- C. K_w increases with increase in temperature.
- D. When a solution of a weak monoprotic acid is titrated against a strong base at half neutralisation point, $\text{pH} = \frac{1}{2}\text{pK}_a$ Choose the correct answer from the options given below:

[15 April 2024 (Shift 1)]

- A** (B), (C)
- B** (A), (D)
- C** (A), (B), (C)
- D** (B), (C), (D)

Ans. (A)

$$\frac{N_{\text{NH}_3} + N_{\text{Cl}}}{N_{\text{NH}_3}} = 7 - \frac{1}{2}(\text{p}K_D + \log C)$$



The pH of a 0.02M NH_4Cl solution will be

[given $K_b(\text{NH}_4\text{OH}) = 10^{-5}$ and $\log 2 = 0.301$]

[10 April 2019 Shift 2]

- (A) 2.65
 (C) 4.65

(B) 4.35

(D) 5.35

$$7 - \frac{1}{2}(5 + \log 2 \times 10^{-2})$$

$$7 - \frac{1}{2}(5 - 2 + 0.3)$$

$$7 - \frac{1}{2}(3.3)$$

$$\underline{7 - 1.65}$$

$pK \pm 1$

Electrical energy.

Galvanic Cell

Electrolytic Cell

Chemical rx²
(non-spontaneous)

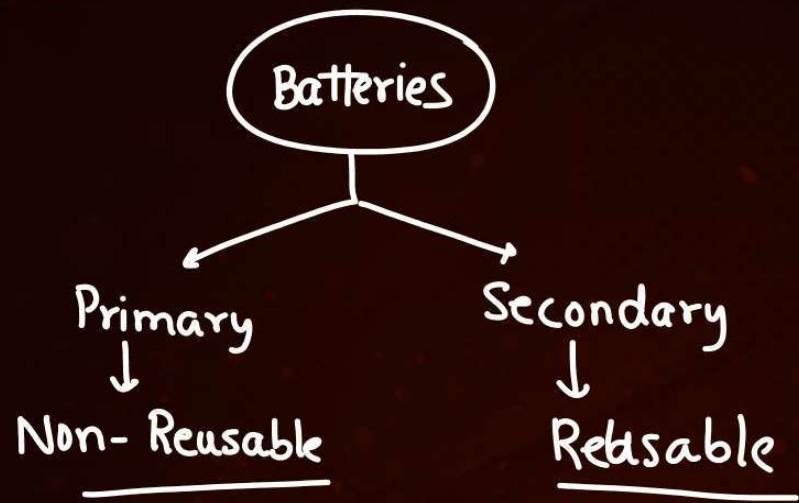
Electrochemistry

Conductance

Batteries

Faraday's Law

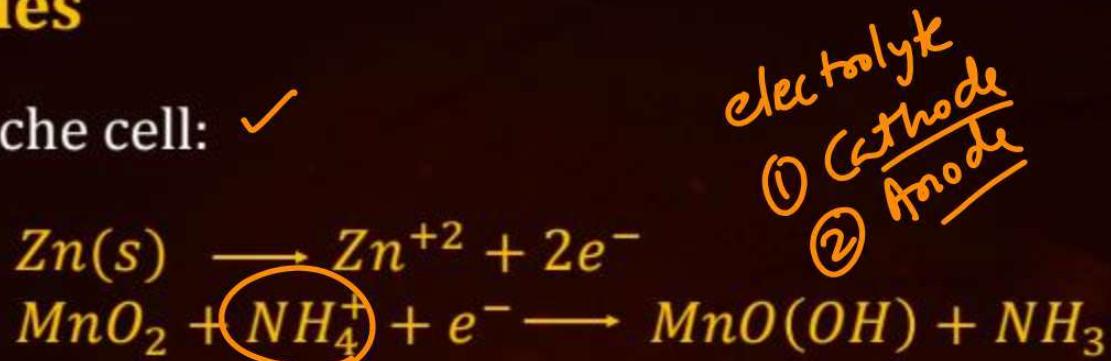
PW



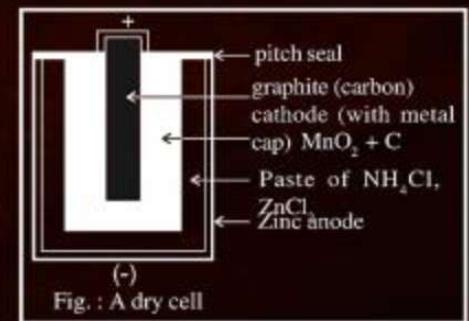
Primary Batteries

Dry cell or Laclanche cell: ✓

- ✓ Anode
- ✓ Cathode



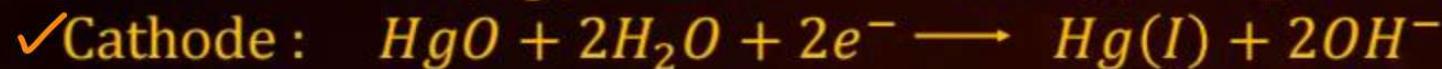
The cell has a potential of nearly 1.5 V



Mercury cell : \rightarrow Clock



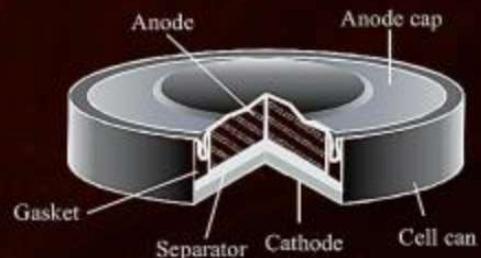
The electrolyte is a paste of KOH and ZnO.



The overall reaction is represented by



The cell potential is approximately 1.35 V and remains constant during its life as the overall reaction does not involve any ion in solution whose concentration can change during its life time.



Commonly used mercury cell.
The reducing agent is zinc and
the oxidising agent is mercury
(II) oxide.

Secondary Batteries.

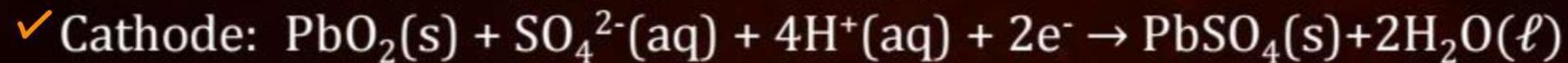
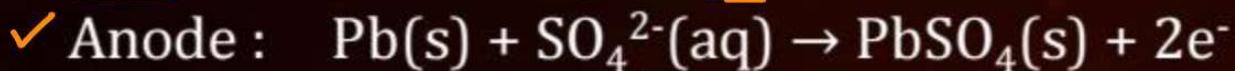
① Ni-Cd Battery

② Pd - Storage

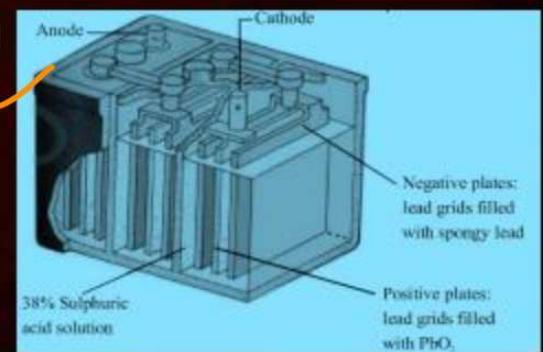
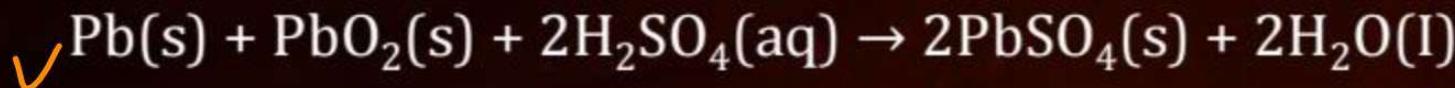
Lead storage cell:

It consists of a lead anode and a grid of lead packed with lead dioxide (PbO_2) as cathode.

A 38% solution of sulphuric acid is used as an electrolyte.



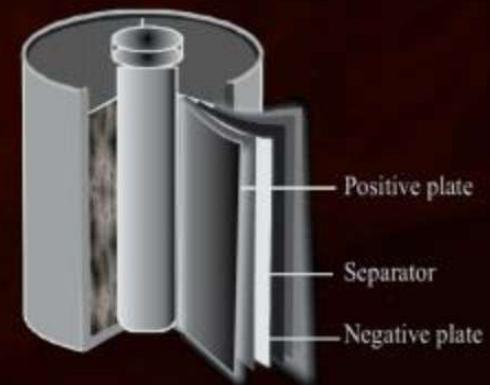
i.e., overall cell reaction consisting of cathode and anode reactions is:



The Lead storage battery

Nickel-cadmium cell:

Nickel-cadmium cell which has longer life than the lead storage cell but expensive to manufacture. We shall not go into details of working of the cell and electrode reactions during charging and discharging. The overall reaction during discharge is:



A rechargeable nickel-cadmium cell in a jelly roll arrangement and separated by a layer soaked in moist sodium or potassium hydroxide

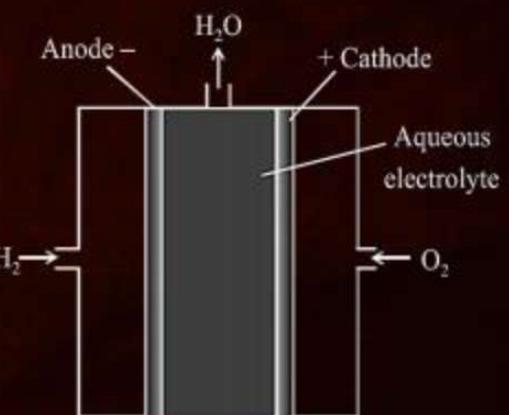
FUEL CELLS



Over all reaction being:



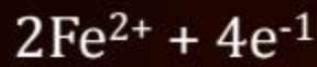
The cell runs continuously as long as the reactions are supplied fuel cell produce electricity with an efficiency of about 70% compared to thermal plants whose efficiency is about 40%.



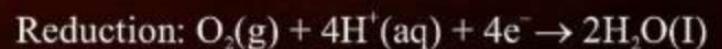
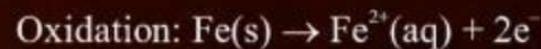
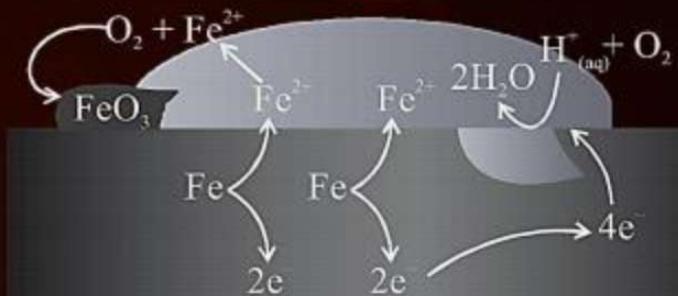
Fuel cell using H₂ and O₂ produces electricity

CORROSION :

Anode : $2\text{Fe(s)} \rightarrow 2\text{Fe}^{2+} + 4\text{e}^-$



$$E_{(\text{Fe}^{2+}/\text{Fe})}^\ominus = -0.44 \text{ V}$$



Atmospheric

Corrosion of iron in atmosphere

Que

$$[H^+] = 10^{-\theta}$$

What pressure (bar) of H_2 would be required to make emf of hydrogen electrode zero in pure water at $25^\circ C$?

PW

- A 10^{-7}
- B 0.5
- C 1
- D 10^{-14}



$$E_{cell}^{\circ} = E_{cell}^{\circ} - \frac{0.059}{2} \log \frac{[H^+]^2}{P_{H_2}}$$

$$0 = -\frac{0.059}{2} \log \frac{[H^+]}{P_{H_2}}$$

$$\log \frac{[H^+]^2}{P_{H_2}} = 0$$

[2024 (04 Apr Shift 1)]

$$\frac{[H^+]^2}{P_{H_2}} = 1$$

$$P_{H_2} = [H^+]^2 = (10^{-\theta})^2$$

Ans.

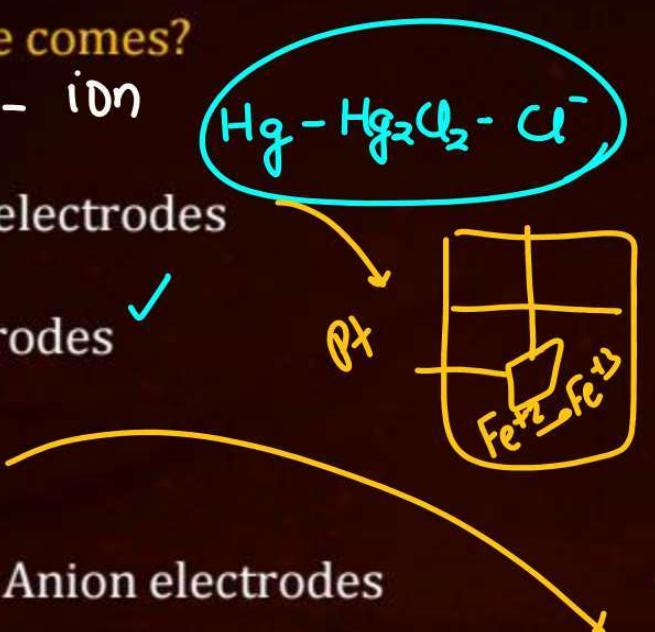
Que



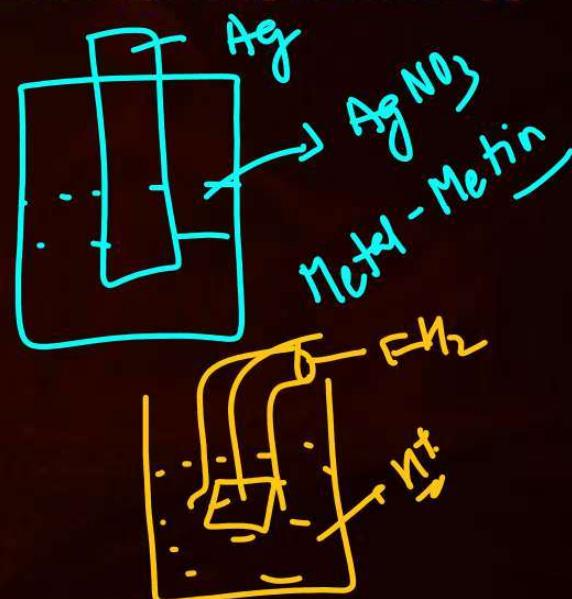
One of the commonly used electrode is calomel electrode. Under which of the following categories, calomel electrode comes?

Metal - insoluble salt - ion

- A Oxidation - Reduction electrodes
- B Metal ion - Metal electrodes
- C Gas - Ion electrodes
- D Metal - Insoluble Salt - Anion electrodes



[2024 (04 Apr Shift 1)]



Ans.

Que



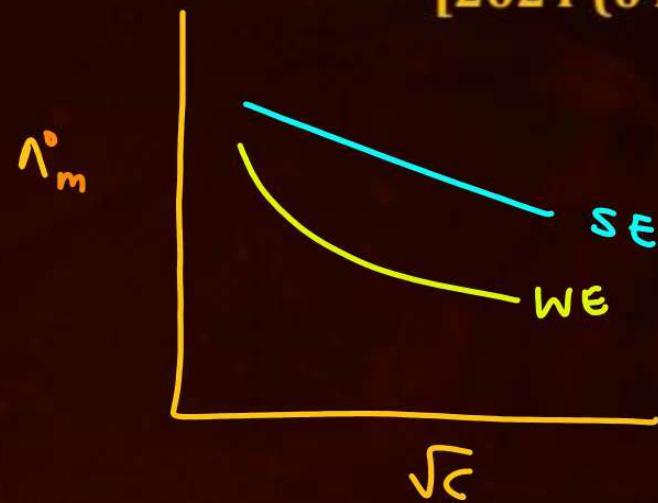
For a strong electrolyte, a plot of molar conductivity against $(\text{concentration})^{1/2}$ is a straight line, with a negative slope, the correct unit for the slope is

$$\text{Scm}^2 \text{ mol}^{-1}$$

- A $\text{Scm}^2 \text{ mol}^{-3/2} \text{ L}^{-1/2}$
- B $\text{Scm}^2 \text{ mol}^{-3/2} \text{ L}^{1/2}$
- C $\text{Scm}^2 \text{ mol}^{-3/2} \text{ L}$
- D $\text{Scm}^2 \text{ mol}^{-1} \text{ L}^{1/2}$

$$\underline{\Lambda_m^\circ = A - B\sqrt{C}}$$
$$B = \frac{\Lambda_m^\circ}{\sqrt{C}}$$

[2024 (04 Apr Shift 2)]



Ans.

Fuel cell, using hydrogen and oxygen as fuels,

- A. has been used in spaceship ✓
- B. ~~has as efficiency of 40% to produce electricity~~
- C. uses aluminum as catalysts → Thermal power plant
- D. is eco-friendly ✓
- E. is actually a type of Galvanic cell only ✓

Choose the correct answer from the options given below:

[2024 (04 Apr Shift 2)]

- A A, B, D, E only
- B A, D, E only
- C A, ~~B~~ D only
- D A, ~~B~~ C only

Ans. (B)

Que



Λ_m°



Molar ionic conductivities of divalent cation and anion are $57 \text{ S cm}^2 \text{ mol}^{-1}$ and $73 \text{ S cm}^2 \text{ mol}^{-1}$ respectively.



The molar conductivity of solution of an electrolyte with the above cation and anion will be :



[2024 (05 Apr Shift 1)]

- A $18 \cancel{\alpha} \text{ S cm}^2 \text{ mol}^{-1}$
- B $260 \cancel{\alpha} \text{ S cm}^2 \text{ mol}^{-1}$
- C $130 \cancel{\alpha} \text{ S cm}^2 \text{ mol}^{-1}$
- D $65 \cancel{\alpha} \text{ S cm}^2 \text{ mol}^{-1}$

Ans.

Que



1 Coulomb → electrochemical equivalent

The quantity of silver deposited when one coulomb charge is passed through AgNO₃ solution :

1 mol
1 Farad + 1 chemical equivalent

[2024 (05 Apr Shift 2)]

- A** 1 g of silver
- B** 1 electrochemical equivalent of silver
- C** 1 chemical equivalent of silver
- D** 0.1 g atom of silver

Ans.

Que

For the electro chemical cell
If $E_{(M^{2+}/M)}^{\circ}$ = 0.46 V and $E_{(X/X^{2-})}^{\circ}$ = 0.34 V.

Which of the following is correct?

$$E_{\text{cell}}^{\circ} = +0.12 \text{ V}$$

$$E_{X^{2-}/X}^{\circ} = -0.34 \text{ V}$$

- A $M + X \rightarrow M^{2+} + X^{2-}$ is a spontaneous reaction

B $E_{\text{cell}}^{\circ} > 0.80 \text{ V}$

C $E_{\text{cell}}^{\circ} = 0.80 \text{ V}$

- D $M^{2+} + X^{2-} \rightarrow M + X$ is a spontaneous reaction

Ans.

Spontaneous

$$\Delta G^{\circ} = -nFE_{\text{cell}}^{\circ}$$

J / 96500

[2024 (05 Apr Shift 2)]

SRP ↑
Cathode

SOP + SRP
Anode Cathode

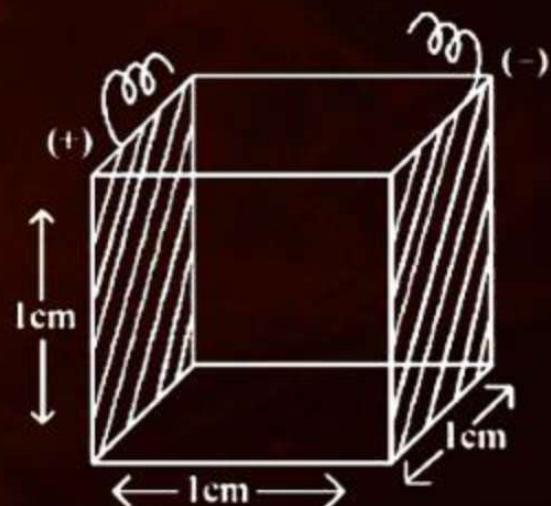


A conductivity cell with two electrodes (dark side) are half filled with infinitely dilute aqueous solution of a weak electrolyte. If volume is doubled by adding more water at constant temperature, the molar conductivity of the cell will -

[2024 (06 Apr Shift 1)]

- A** decrease sharply
- B** increase sharply
- C** remain same or can not be measured accurately
- D** depend upon type of electrolyte

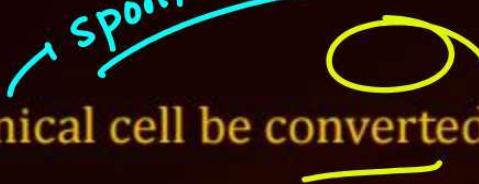
Ans. (C)



Que



spontaneous



non spont.

How can an electrochemical cell be converted into an electrolytic cell?

[2024 (06 Apr Shift 2)]

- A** Applying an external opposite potential lower than E° cell.
- B** Reversing the flow of ions in salt bridge.
- C** Applying an external opposite potential greater than E° cell-
- D** Exchanging the electrodes at anode and cathode.

Bacha → Padhar

Ans.

Que

$$\downarrow E_{\text{cell}} = E_{\text{cell}}^{\circ} - \frac{0.059}{2} \log \frac{[\text{Tl}^+]}{[\text{Cu}^{2+}]}$$



The emf of cell $\text{I} \left| \text{Tl}^+ \right| \text{Cu}^{2+} \right| \text{Cu}$ is 0.83 V at 298 K. It could be increased by:

[2024 (08 Apr Shift 2)]

A decreasing concentration of both Tl^+ and Cu^{2+} ions $2\text{Tl} \rightarrow 2\text{Tl}^+ \cancel{+}$

B increasing concentration of Cu^{2+} ions $\cancel{2e^- + Cu^{+2} \rightarrow Cu}$

C increasing concentration of Tl^+ ions $\cancel{Q = \frac{[\text{Tl}^+]^2}{[\text{Cu}^{+2}]}}$

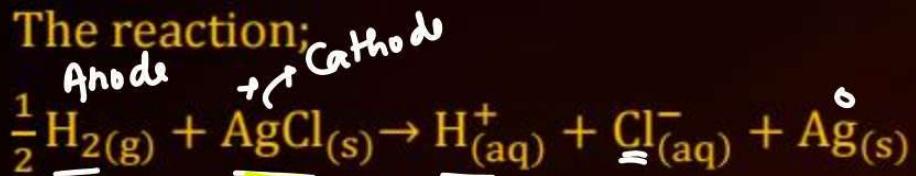
D increasing concentration of both Tl^+ and Cu^{2+} ions $\cancel{2\text{Tl} + Cu^{+2} \rightarrow 2\text{Tl}^+ + Cu}$

Ans.

Que

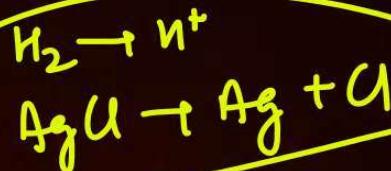


The reaction:



occurs in which of the following galvanic cell:

Anode || Cathode



[2024 (08 Apr Shift 2)]

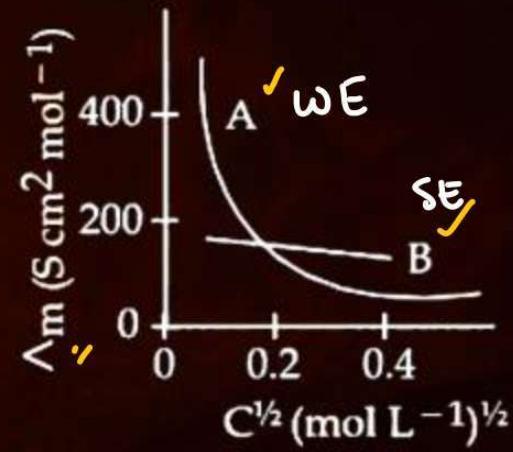
- A $\text{Ag} | \text{AgCl}_{(\text{s})} | \text{KCl}_{(\text{soln.})} | \text{AgNO}_3_{(\text{aq.})} | \text{Ag}$
- B $\text{Pt} | \text{H}_2(\text{g}) | \text{HCl}_{(\text{soln.})} | \text{AgCl}_{(\text{s})} | \text{Ag}$ ✓
- C $\text{Pt} | \text{H}_2(\text{g}) | \text{KCl}_{(\text{soln.})} | \text{AgCl}_{(\text{s})} | \text{Ag}$ ▼
- D $\text{Pt} | \text{H}_2(\text{g}) | \text{HCl}_{(\text{soln.})} | \text{AgNO}_3_{(\text{aq.})} | \text{Ag}$

Ans.

The molar conductivity for electrolytes A and B are plotted against $C^{1/2}$ as shown below. Electrolytes A and B respectively are:

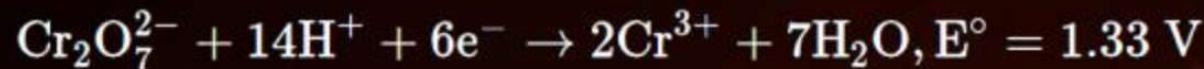
[2024 (09 Apr Shift 1)]

- A: strong electrolyte ; B: weak electrolyte
- B: A: weak electrolyte ; B: weak electrolyte
- C: A: weak electrolyte ; B: strong electrolyte
- D: A: strong electrolyte ; B: strong electrolyte



Ans.

The standard reduction potentials at for the following half cells are given below :



Consider the given electrochemical reactions,

The number of metal(s) which will be oxidized be $\text{Cr}_2\text{O}_7^{2-}$, in aqueous solution is _____

[2024 (09 Apr Shift 1)]

Ans. (C)

Which out of the following is a correct equation to show change in molar conductivity with respect to concentration for a weak electrolyte, if the symbols carry their usual meaning : [2024 (09 Apr Shift 2)]

- A** $\Lambda_m - \Lambda_m^0 + AC^{\frac{1}{2}} = 0$
- B** $\Lambda_m^2 C - K_a \Lambda_m^{\circ 2} + K_a \Lambda_m \Lambda_m^{\circ} = 0$
- C** $\Lambda_m^2 C + K_a \Lambda_m^{\circ 2} - K_a \Lambda_m \Lambda_m^{\circ} = 0$
- D** $\Lambda_m - \Lambda_m^{\circ} - AC^{\frac{1}{2}} = 0$

Ans. (B)

Match List I with List II

[2024 (09 Apr Shift 2)]

| | List - I (Cell) | | List - II (Use/Property/Reaction) |
|----|-----------------|------|--|
| A. | Leclanche cell | I. | Converts energy of combustion into electrical energy |
| B. | Ni – Cd cell | II. | Does not involve any ion in solution and is used in hearing aids |
| C. | Fuel cell | III. | Rechargeable |
| D. | Mercury cell | IV. | Reaction at anode $\text{Zn} \rightarrow \text{Zn}^{2+} + 2\text{e}^-$ |

Choose the correct answer from the options given below:

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

Ans. (D)

Que



The Potential for the given half cell at 298 K is

$$(-) \dots \times 10^{-2} \text{ V}$$



$$[\text{H}^+] = 1\text{M}, P_{\text{H}_2} = 2 \text{ atm}$$

(Given : $2.303RT / F = 0.06\text{V}$, $\log 2 = 0.3$)

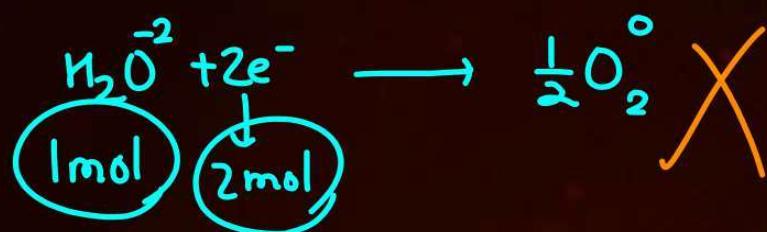
[2024 (01 Feb Shift 1)]

Ans. (A)

Que



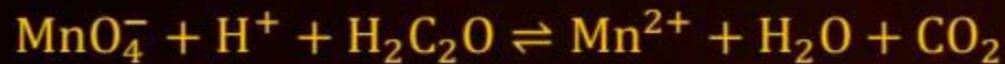
The amount of electricity in Coulomb required for the oxidation of 1 mol of H_2O to O_2 is
_____ $\times 10^5 \text{ C}$.



[2024 (01 Feb Shift 2)]

Ans. (B)

Consider the following redox reaction :



The standard reduction potentials are given as below (E_{red}°)

$$E_{\text{MnO}_4^-/\text{Mn}^{2+}}^\circ = +1.51\text{V}$$

$$E_{\text{CO}_2/\text{H}_2\text{C}_2\text{O}_4}^\circ = -0.49\text{V}$$

If the equilibrium constant of the above reaction is given as $K_{\text{eq}} = 10^x$, then the value of $x = \underline{\hspace{2cm}}$ (nearest integer)

[2024 (01 Feb Shift 2)]

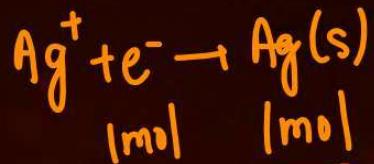
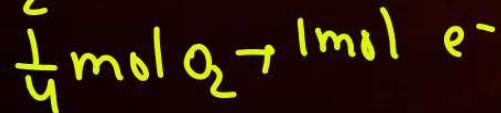
Ans. (339)

Que



The mass of silver (Molar mass of Ag : 108 g mol^{-1}) displaced by a quantity of electricity which displaces 5600 ml of O_2 at S.T.P. will be $\frac{108}{5.6}$ g.

$$\text{No}_2 = \frac{5.6}{22.4} = \frac{1}{4} \text{ mol}$$



[2024 (27 Jan Shift 1)]

1 Farad = $\frac{1\text{ mol e}^-}{1\text{ mol}}$

Ans.

Which of the following statements is not correct about rusting of iron?

[2024 (27 Jan Shift 2)]

- A** Coating of iron surface by tin prevents rusting, even if the tin coating is peeling off.
- B** When pH lies above 9 or 10 , rusting of iron does not take place.
- C** Dissolved acidic SO_2 , NO_2 oxides in water act as catalyst in the process of rusting.
- D** Rusting of iron is envisaged as setting up of electrochemical cell on the surface of iron object

Ans. (A)

Que



The hydrogen electrode is dipped in a solution of pH = 3 at 25°C The potential of the electrode will be - _____ $\times 10^{-2}$ V

$$\left(\frac{2.303RT}{F} = 0.059V \right)$$

[2024 (27 Jan Shift 2)]

Ans. (18)

Que



The mass of zinc produced by the electrolysis of zinc sulphate solution with a steady current of 0.015 A for 15 minutes is _____ $\times 10^{-4}$ g.

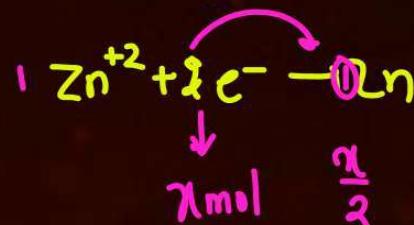
(Atomic mass of zinc = 65.4 amu)

$$i = 0.015 \text{ A}$$

$$t = 15 \text{ min} = 15 \times 60 \text{ sec}$$

$$Q = it = \frac{0.015 \times 15 \times 60}{96500} \text{ C}$$

$$\mu = \frac{225 \times 60 \times 10^{-3}}{96500} \cdot \frac{\text{Faraad}}{\text{mol}}$$



[2024 (29 Jan Shift 1)]

$$\frac{225 \times 60 \times 10^{-3} \times 65.4}{96500 \times 2} = \boxed{0.0225}$$

Ans.

Que



A constant current was passed through a solution of AuCl_4^- ion between gold electrodes. After a period of 10.0 minutes, the increase in mass of cathode was 1.314g. The total charge passed through the solution is _____ $\times 10^{-2}$ F.
(Given atomic mass of Au = 197)

[2024 (29 Jan Shift 1)]

Ans. (2)

Reduction potential of ions are given below:

$$E^\circ = 1.19V \quad E^\circ = 1.65V \quad E^\circ = 1.74V$$

[2024 (30 Jan Shift 2)]

The correct order of their oxidising power is:

- A** $\text{ClO}_4^- > \text{IO}_4^- > \text{BrO}_4^-$
- B** $\text{BrO}_4^- > \text{IO}_4^- > \text{ClO}_4^-$
- C** $\text{BrO}_4^- > \text{ClO}_4^- > \text{IO}_4^-$
- D** $\text{IO}_4^- > \text{BrO}_4^- > \text{ClO}_4^-$

Ans. (B)

The metals that are employed in the battery industries are

- A. Fe B. Mn C. Ni D. Cr E. Cd

Choose the correct answer from the options given below:

[2024 (31 Jan Shift 1)]

- A** B, C and E only
- B** A, B, C, D and E
- C** A, B, C and D only
- D** B, D and E only

Ans. (A)

Identify the factor from the following that does not affect electrolytic conductance of a solution.

[2024 (31 Jan Shift 1)]

- A** The nature of the electrolyte added.
- B** The nature of the electrode used.
- C** Concentration of the electrolyte.
- D** The nature of solvent used.

Ans. (B)

Que

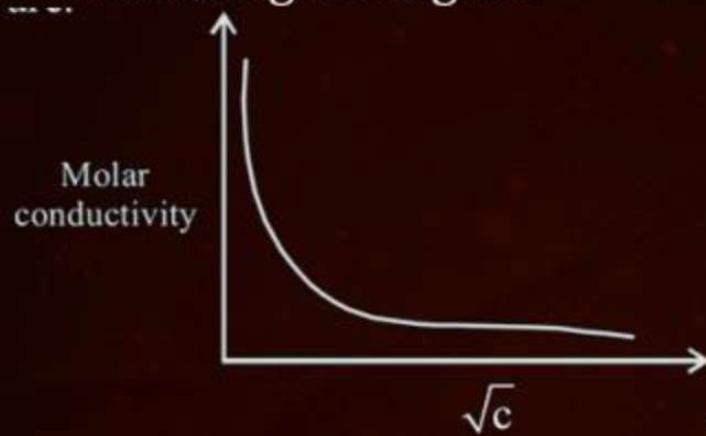


One Faraday of electricity liberates $x \times 10^{-1+}$ gram atom of copper sulphate, is _____. [2024 (31 Jan Shift 1)]

Ans. (5)

Question-18|

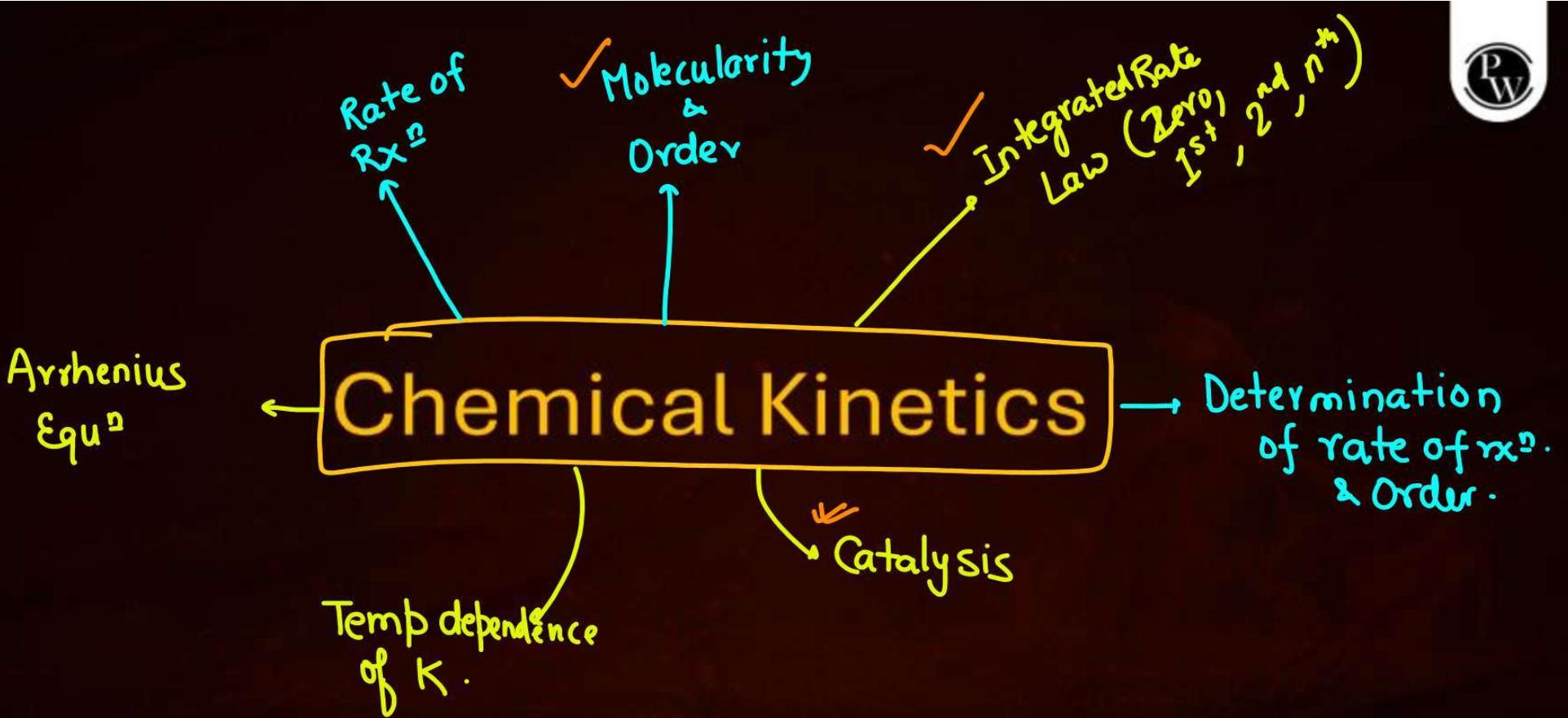
The variation of molar conductivity with concentration of an electrolyte (X) in aqueous solution is shown in the given figure.



The electrolyte X is :

[5 September 2020 Shift 2]

- (A) HCl
- (B) NaCl
- (C) KNO₃
- (D) CH₃COOH





Order and Molecularity

Elementary Rx → Order ✓
Molecularity ✓

Complex → Order ✓
(RDS)

Molecularity
not defined.

Comparision between molecularity and order of reaction

| Molecularity of Reaction | | Order of Reaction | |
|--------------------------|---|-------------------|--|
| 1 | It is defined as the no. of molecules of reactant taking part in a chemical reaction. ✓ $\text{NH}_4\text{NO}_2 \rightarrow \text{N}_2 + 2\text{H}_2\text{O}$, molecularity = 1 ✓ | 1 | It is defined as the sum of the power of concentration terms that appear in rate law. $\text{NH}_4\text{NO}_2 \rightarrow \text{N}_2 + 2\text{H}_2\text{O}$. Rate = <u>$k[\text{NH}_4\text{NO}_2]$</u> , order = 1 |
| 2 | It is always a whole number. ✓ It can neither be zero nor fractional. ✓ | 2 | It may be zero, fractional or integer. ✓ |
| 3 | It is derived from RDS in the mechanism of reaction ✓ | 3 | It is derived from rate expression. ✓ |
| 4 | It is theoretical value. ✓ | 4 | It is experimental value. ✓ |
| 5 | Reactions with molecularity > 3 are rare. ✓ | 5 | Reactions with order of reaction > 4 are also rare. ✓ |
| 6 | Molecularity is independent of pressure and temperature. ✓ | 6 | Order of reaction may depend upon pressure and temperature. ✓ |

Rate Law

$$r = k [A]^x [B]^y$$

order = $x+y$

| | Zero order | First order | Second order | n^{th} order |
|-----------------------|---|---|--|--|
| Differential Rate law | $\checkmark -\frac{d[A]}{dt} = k[A]^0$ | $-\frac{d[A]}{dt} = k[A] \checkmark$ | $-\frac{d[A]}{dt} = k[A]^2 \checkmark$ | $-\frac{d[A]}{dt} = k[A]^n \cancel{}$ |
| Integrated Rate law | $\checkmark [A]_t = [A]_0 - kt$ Time Initial Pch | $\ln[A]_t = -kt + \ln[A]_0$ $\ln \frac{A_0}{A_t} = kt$ | $\frac{1}{[A]_t} = kt + \frac{1}{[A]_0}$ | $\frac{1}{[A_t]^{n-1}} - \frac{1}{[A_0]^{n-1}} = (n-1) kt$ |
| Linear graph | $[A]_t$ v/s <u>t</u> | $\ln[A]$ v/s <u>t</u> ✓ | $\frac{1}{[A]}$ v/s <u>t</u> ✓ | $\frac{1}{[A_t]^{n-1}}$ v/s <u>t</u> |
| Half-life | $t_{1/2} = \frac{[A]_0}{2k}$ (depends on <u>$[A]_0$</u>) | $t_{1/2} = \frac{0.693}{k} \checkmark$ (independent of <u>$[A]_0$</u>) | $t_{1/2} = \frac{1}{k[A]_0} \checkmark$ (depends on <u>$[A]_0$</u>) | $t_{1/2} \propto \frac{1}{[A_0]^{n-1}}$ |

Determination of Order

① Initial rate method ✓

② Half life method

$$T_{1/2} \propto [A_0]^{1-n} \quad (n = \text{order})$$

③ Unit of Rate Constant

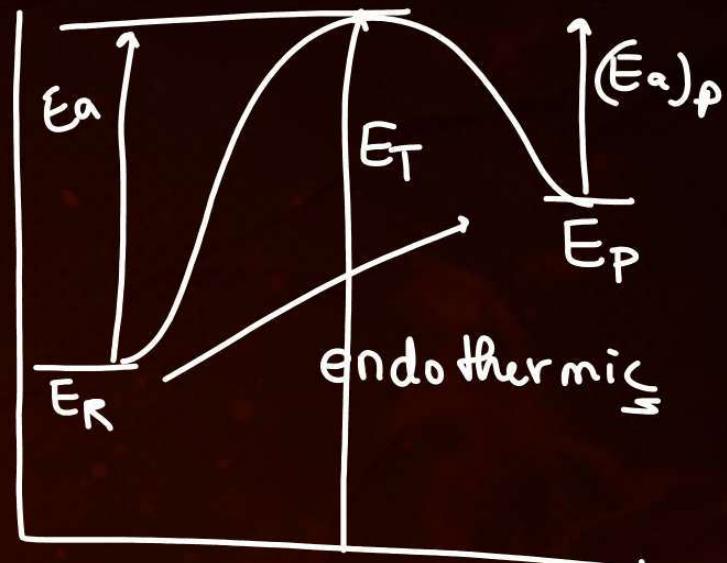
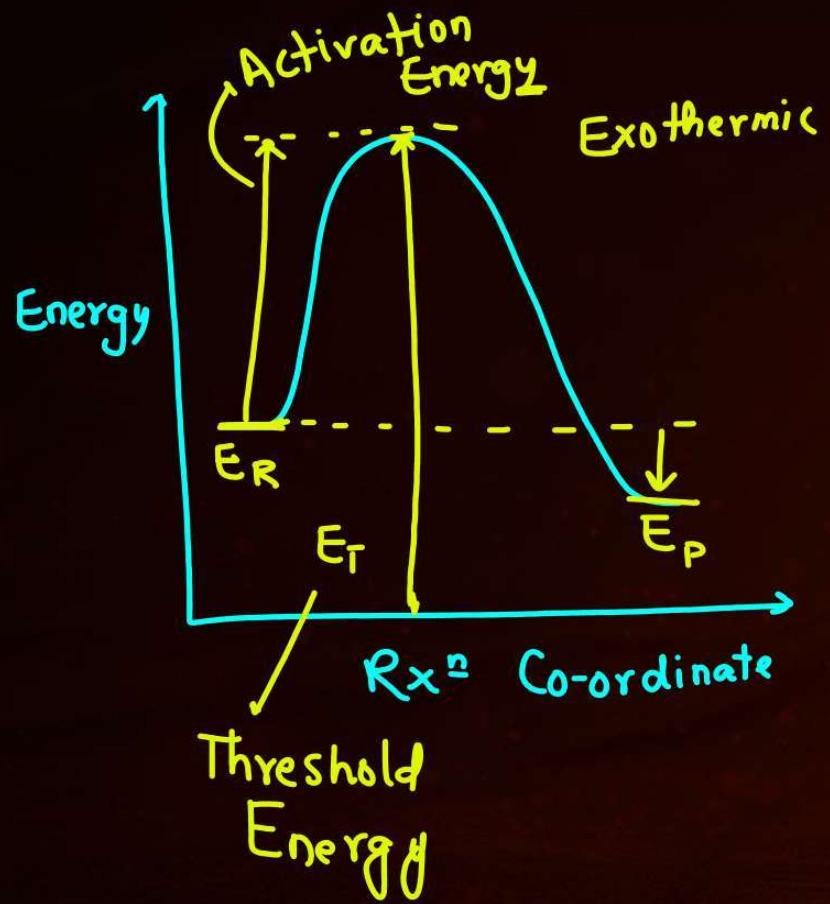
$$[K] = M^{1-n} s^{-1}$$

④ Graph

$$\gamma = K [\text{Conc}]^n$$

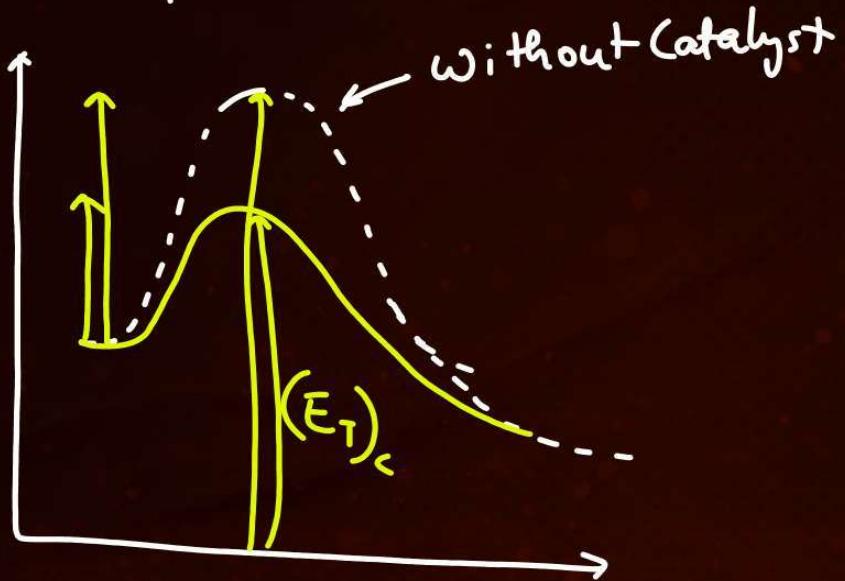
$$\frac{M s^{-1}}{[M]^n} = M^{1-n} s^{-1}$$

Order = $1-n = -2$
 $n = +3$



Catalyst

alternate path with lower E_a .



Temp Dependence of Rate Const. (K)



① Temp Coeff

✓ every 10°C rise in Temp ROR doubles.

$$\gamma = 4 \quad (T = 10^{\circ}\text{C})$$

$$\gamma' = ?(64) \quad \downarrow T = 50^{\circ}\text{C}$$

$$\begin{array}{cccccc} 10 & \longrightarrow & 20 & \longrightarrow & 30 & \longrightarrow \\ 4 & & 8 & & 16 & \\ & & & & & 32 \\ & & & & & 64 \end{array}$$

② Arrhenius Equⁿ

$$K = A \cdot e^{-E_a/RT}$$

↳ no. of particles undergoing
effective collision.

$$T_1 \rightarrow K_1$$

$$T_2 \rightarrow K_2$$

$$\ln \frac{K_2}{K_1} = \frac{E_a}{R} \left(\frac{1}{T_1} - \frac{1}{T_2} \right)$$

Que



During Kinetic study of reaction $2A + B \rightarrow C + D$, the following results were obtained

A [M] B [M] initial rate of formation of D

| | | | |
|-----|-----|-----|-----------------------|
| I | 0.1 | 0.1 | 6.0×10^{-3} |
| II | 0.3 | 0.2 | 7.20×10^{-2} |
| III | 0.3 | 0.4 | 2.88×10^{-1} |
| IV | 0.4 | 0.1 | 2.40×10^{-2} |

$$\frac{7.2}{6.0} \times \frac{2}{1} = 2.4$$

Based on above data, overall order of the reaction is $1+2=3$

[2024 (05 Apr Shift 1)]

Ans.

Que

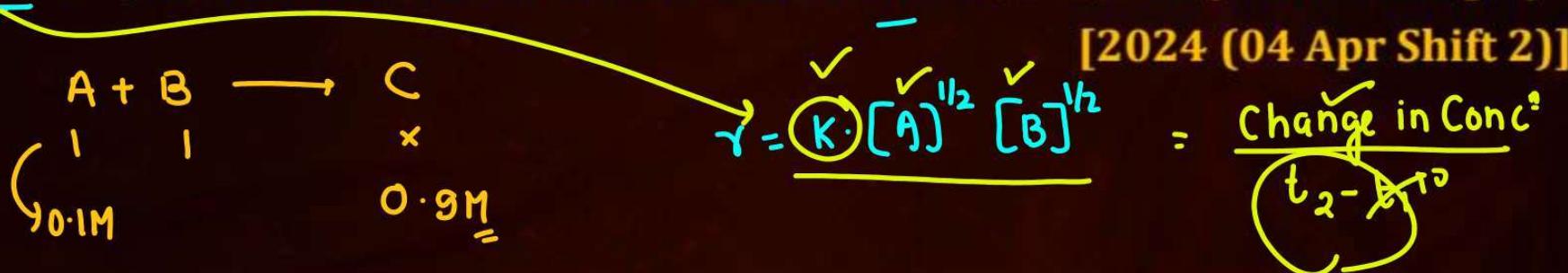
$$1M \longrightarrow 0.9M$$



Consider the following reaction, the rate expression of which is given below $A + B \rightarrow C$

$$\text{rate} = k [A]^{1/2} [B]^{1/2}$$

The reaction is initiated by taking $1M$ concentration of each. If the rate constant (k) is $4.6 \times 10^{-2} \text{ s}^{-1}$, then the time taken for it to become $0.1M$ is ____ sec. (nearest integer)



Ans.

Que



Time required for 99.9% completion of a first order reaction is _____ times the time required for completion of 99% reaction. (nearest integer)

$$\begin{aligned} t=0 & \xrightarrow{A} B \\ t_{99\%} & = \frac{100}{100-99} = 1 \\ t_{99.9\%} & = 0.1 \end{aligned}$$

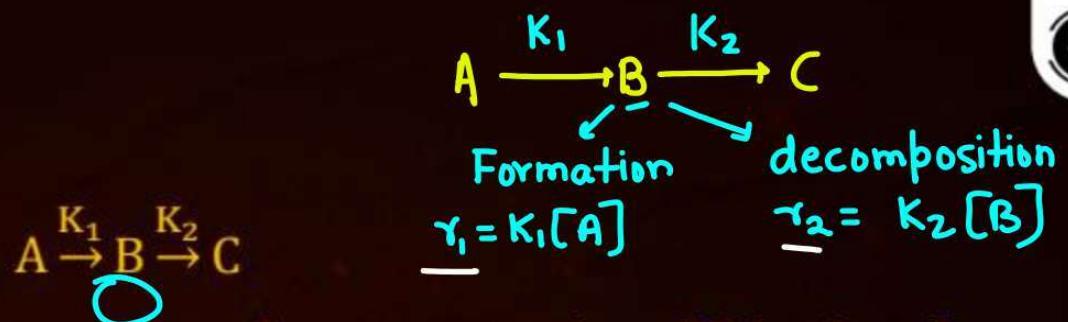
$$\begin{aligned} \frac{k t_{99}}{k t_{99.9}} &= \frac{\ln \frac{100}{1}}{\ln \frac{100}{0.1}} = \frac{2 \ln 10}{3 \ln 10} \\ \frac{k t_{99}}{k t_{99.9}} &= \frac{2 \ln 10}{3 \ln 10} \end{aligned}$$

[2024 (05 Apr Shift 2)]

Ans.

Que

For a reaction



If the rate of formation of B is set to be zero then the concentration of B is given by :

[2024 (08 Apr Shift 2)]

- A** $(K_1 + K_2) [A]$
- B** $(K_1/K_2) [A]$
- C** $(K_1 - K_2) [A]$
- D** $K_1 K_2 [A]$

$$\text{Net formation} = r_1 - r_2$$

$$0 = K_1[A] - K_2[B]$$

$$K_2[B] = K_1[A]$$

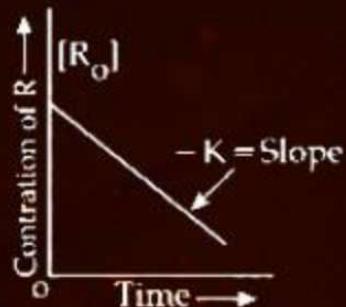
$$[B] = \frac{K_1}{K_2} [A]$$

Ans.

Given below are two statements :

Statement I: The rate law for the reaction $A + B \rightarrow C$ is rate (r) = $k [A]^2(B)$. When the concentration of both A and B is doubled, the reaction rate is increased "x" times.

Statement II :



The figure is showing "the variation in concentration against time plot" for a "y" order reaction.

The Value of $x + y$ is _____.

[2024 (09 Apr Shift 1)]

Ans. (8)

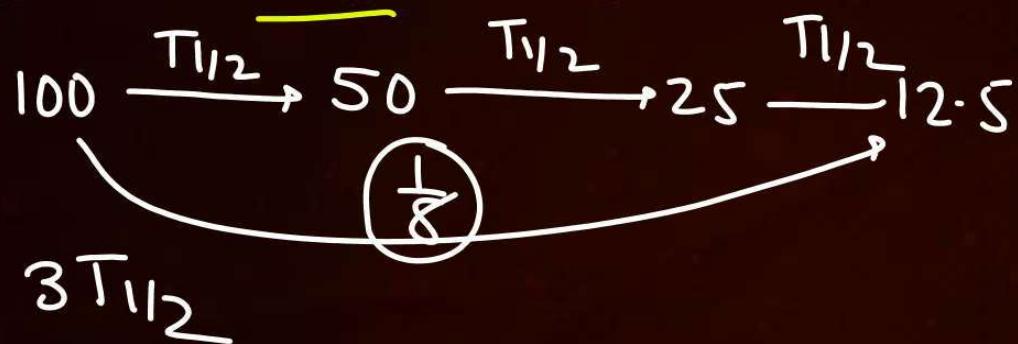
Que

PW

The ratio of $\frac{^{14}\text{C}}{^{12}\text{C}}$ in a piece of wood is $\frac{1}{8}$ part that of atmosphere. If half life of ^{14}C is 5730 years, the age of wood sample is _____ years.

X3

[2024 (01 Feb Shift 1)]



Ans. 0

Que



For a reaction taking place in three steps at same temperature, overall rate constant

$K = \frac{K_1 K_2}{K_3}$ If Ea_1, Ea_2 and Ea_3 are 40,50 and 60 kJ/ mol respectively, the overall Ea is
 $\underline{\underline{30}}$ kJ/ mol.

$$\frac{k_1 \times k_2}{k_3} \rightarrow Ea_1 + Ea_2 - Ea_3$$
$$= 40 + 50 - 60$$
$$= \underline{\underline{30}}$$

[2024 (29 Jan Shift 1)]

Ans.

Que



The rate of first order reaction is $0.04 \text{ mol L}^{-1} \text{ s}^{-1}$ at 10 minutes and $0.03 \text{ mol L}^{-1} \text{ s}^{-1}$. at 20 minutes after initiation. Half life of the reaction is _____ minutes. (Given $\log 2 = 0.3010$, $\log 3 = 0.4771$)

[2024 (30 Jan Shift 1)]

Ans. (24)

Que



NO₂ required for a reaction is produced by decomposition of N₂O₅ in CCl₄ as as by equation $2\text{N}_2\text{O}_5(\text{g}) \rightarrow 4\text{NO}_2(\text{g}) + \text{O}_2(\text{g})$

The initial concentration of N₂O₅ is 3 mol L⁻¹ and it is 2.75 mol L⁻¹ after 30 minutes.

The rate of formation of NO₂ is $x \times 10^{-3}$ mol L⁻¹ min, value of is _____.

[2024 (30 Jan Shift 2)]

Ans. (17)

Que



Integrated rate law equation for a first order gas phase reaction is given by (where P_i is initial pressure and P_t is total pressure at time t)

[2024 (31 Jan Shift 1)]

- A** $k = \frac{2.303}{t} \times \log \frac{P_i}{(2P_i - P_t)}$
- B** $k = \frac{2.303}{t} \times \log \frac{2P_i}{(2P_i - P_t)}$
- C** $k = \frac{2.303}{t} \times \log \frac{(2P_i - P_t)}{(P_i)}$
- D** $k = \frac{2.303}{t} \times \log \frac{P_i}{(2P_i - P_t)}$

Ans. (A)

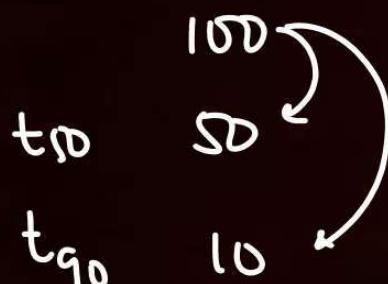
Que

First order

$r = k[A]$ for a reaction, 50 % of A is decomposed in 120 minutes. The time taken for 90% decomposition of A is _____ minutes.

PW

[2024 (31 Jan Shift 2)]



$$k \times 120 = \ln 2$$

$$k \times t_{90} = \ln 10$$

$$t_{90} = \frac{120 \times 2.303 \log 10}{2.303 \times 0.3}$$
$$= \frac{120}{0.3}$$

Ans.

The results given in the below table were obtained during kinetic studies of the following reaction: $2A + B \rightarrow C + D$

| Experiment | [A]/ molL ⁻¹ | [B]/ molL ⁻¹ | Initial rate/ molL ⁻¹ min ⁻¹ |
|------------|-------------------------|-------------------------|--|
| I | 0.1 | 0.1 | 6.00×10^{-3} |
| II | 0.1 | 0.2 | 2.40×10^{-2} |
| III | 0.2 | 0.1 | 1.20×10^{-2} |
| IV | X | 0.2 | 7.20×10^{-2} |
| V | 0.3 | Y | 2.88×10^{-1} |

[02 Sep 2020 Shift 2]

X and Y in the given table are respectively:

- (A) 0.4, 0.4
- (C) 0.3, 0.4

- (B) 0.4, 0.3
- (D) 0.3, 0.3

If 75% of a first order reaction was completed in 90 minutes,
60% of the same reaction would be completed in approximately
(in minutes) _____.

[04 Sep 2022 Shift1]