ULTIMATE KCET

CRASH COURSE 2026

Chemistry | **Lecture - 01**

Structure of atom

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Recap *of previous lecture*

①

Thermodynamics ✓
Chemica bonding and

MOT

Topics to be covered

① Chemical bonding continuation

② Structure of atom

③ Practical chemistry

Solution

Year			Number of questions
2025	**Boiling point+ Vant hoff concepts , Solubility curve, Boiling point calculation Henry's constant - 04**		
2024	Relative lowering of vapour pressure, Raoult's law based questions		3
2023	Osmosis, Freezing point concept		2
2022	Osmotic pressure(2), Mole fraction, Solubility of gas ,Molal elevation constant,		5
2021	Henry's law – calculating moles , Henry's law constant based statement type , K_H–Solubility, Raoult's law – Giving total pressure calculating		4
2020	Abnormal molar mass		1
2019	Abnormal molar mass ,Raoult's law based –ve/+ve deviation of solvents, Relative lowering of vapour pressure,		3
2018	Van't half factor – i value based question.		1
2017	Van't half factor definition ,Osmosis, Van't half factor – i value based question.		3
2016	Van't half factor, Osmotic pressure definition, List of colligative property		3

Electrochemistry

Year	**Topic**		**Number of questions**
2025	**Galvanic cell statement type, electronic conductance statement type, Faraday’s law - 03**		
2024	Faraday's first law – 02, Debye Onsager equation		03
2023	pH calculations, product of electrolysis – Brine solution , Nernst equation,		03
2022	Gibbs free energy and spontaneity, Molar conductance (02), Catalyst used in Fuel cell, Nernst equation		04
2021	Nernst equation, cell constant, equilibrium constant		03
2020	Debye Onsager equation, Equilibrium constant, Product of electrolysis – NaF		04
2019	Displacement reaction, Emf calculations, Product of electrolysis, Faradays first law of electrolysis		04
2018	Molar conductance/specific conductance, Conductor/Non conductor		03
2017	Product of electrolysis of Aq NaCl		01
2016	Galvanic cell – Oxidation/reduction Vs anode/cathode, secondary cell, Faraday's law of electrolysis		03

Chemical kinetics

Year	Topic	Number of question
2025	catalyst + Half-life + Activation energy +The rate of reaction	**4**
2024	Identifying concentration using rate law, Arrhenius equation representation	2
2023	Arrhenius equation (np),rate constant unit, Half life and order of the reaction	3
2022	Nth order and half life of a reaction, unit based on rate expression , First order reaction (np),	3
2021	order of the reaction statement based question, $t_{99.99\%}$ completion , Rate expression [np],	3
2020	Collision frequency, Calculation on rate, $\mathbf{t_{60\%} = t_{93.6\%}}$ **?**	**3**
2019	Calculation on Rate of a reaction, Statement based question wrt to Arrhenius equation, Unit of rate based on order,	3
2018	Rate constant of pseudo first order reaction Calculation on rate	3

D and f block elements

Year	**Topic**	**No of questions –**
2025	**Colourless ion, redox reaction of Permanganate ion+ Oxidation of lanthanoid series + Electronic configuration**	**04**
2024	Reaction between SO_2 and $KMnO_4$, Color of lanthanoids, Mischmetal composition, Based on unpaired electrons in d orbital – 01, statement based question on lanthanoids	05
2023	Electronic configuration 3d, melting point of 3d	02
2022	Oxidation state and oxidizing agent/Reducing agent, Magnetic moment, Radioactive lanthanoid	03
2021	Physical properties/trends, Electronic configuration, coloured compound,	03
2020	d and f block elements – chemical reaction based, paramagnetic behaviour, Stability of Cu^{+2}/Cu^{+1}, metal reaction with H_2	04
2019	Physical properties based statement type of question, Chromyl chloride test, lanthanoid definition	03
2018	Amphoteric oxide, Common oxidation state, electronic configuration V/s atomic number	03

Coordination compounds

Year	Topic	No of questions
2025	**Ambidentate lignad + VBT theory + IUPAC based + Coordination number**	**04**
2024	Werner's theory +Ionisation isomerism+ Statement based question on complex	3
2023	IUPAC based question + Maximum unpaired electron - d^n	2
2022	CFSE comparison for octahedral and tetrahedral + Calculation of ions on ioisation of coorindation compounds	2
2021	Spectrochemical series based questions – wavelengths absorbed + Homoleptic complex + IUPAC name + Crystal field splitting in octahedral complex	4
2020	Coordination number + Number of streoisomerism + IUPAC name	3
2019	IUPAC name + nature of ligand [choose the strong ligand] +	2
2018	IUPAC name + Structural isomerism	2
2017	Coordination number and oxidation state + Nature of metal and ligand bond + Geometrical isomerism of M_{abcd}+	3
2016	Strength of ligand + IUPAC name + Ligand nature	3
2015	Question on Mohr salt+ Geometrical isomerism	2
2014	Statement based questions	1

Haloalkanes and Haloarenes

Year 2025	Topics Classification + wurts reaction +	Number of Questions
2024	Sequence based question, S_N^1 V/s S_N^2 solvent based , wurts reaction, DDT – Common name	04
2023	Organometallic compound	01
2022	Solvolysis of haloalkanes and haloarenes, Free radical reaction of alkenes,	02
2021	Order of reactivity – Sn1/Sn2,addition /Nucleophilic reaction of HBr[in excess] to 2-propenol	02
2020	Order of Reactivity towards Sn1/Sn2, Chlorination of benzene	02
2019	The bond length of C-X, wurts reaction	02
2018	Why tertiary RX do not undergo Sn2, Physical properties of RX, Wurtz reaction	03
2017	Homolytic bond fission, Chlorination of toluene	02
2016	Reactivity order of RX, IUPAC name of the halogen compound	02

Alcohols, phenols and ethers

Year	Topics	Number of Questions
2025	Phenol + alcohol – distinguishing , Bromination of reaction, Acidity of phenol, ether + HI	04
2024	Oxidation of alcohol – 02 , PCC .	3
2023	Heating phenylmethyl Ether, Nitration of phenol, Diazotisation of aliphatic compounds giving alcohol (sequence based questions), Optical isomers characteristics, Aspirin preparation	4
2022	Anisole+HI reaction, Heating ethanol at high temp , question on Meta cresol and its bromination reaction, Kolbe's reaction.	4
2021	Question on Meta cresol and its bromination reaction, sequence based question – giving optical active alcohol , Iodoform reaction .	3
2020	Ether, reagents based question, Boiling point of different compounds .	3
2019	Testing acidic nature of alcohol, Reagents based question.	2
2018	dehydration of 3^0 alcohol ,Acidic strength of phenol ,Test to distinguish phenol ,Intramolecular hydrogen bonding in phenol .	4
2017	Reagent based question, Acidic nature of phenol.	2
2016	Oxidation of alcohol, Acidic nature of phenol.	2

Aldehydes, ketones and carboxylic acids

Year	Topics	Number of Questions
2025	Etard reaction + DiBAL reduction of ester + Acidic strength + Acidic hydrohen	04
2024	Functional isomers, decarboxylation reaction	02
2023	RCHO+ RMgBR + conc H_2SO_4 +B_2H_6 - Functional isomers	02
2022	Reagent to oxidise primary alcohols to aldehydes, IUPAC name, Aldehydes + alcohols = reactionn , Aldehyde preparation HVZ reaction	04
2021	Iodoform test, reaction of acetone undergoing aldol condensation reaction, Choosing reducing reagents which reduced carboxylic acids to alcohol, Sequence based reaction,	03
2020	Aldol condensation reaction,	02
2019	HVZ reaction, Rosenmund reduction reaction + Cannizaro reaction	02
2018	Haloform reaction, Cumene process – acetone , Wolf kishner reduction reaction, Étard reaction	04
2017	Decarboxylation reaction, Cannizaro reaction , Solubility of carboxylic acids, Reagent to reduce ketones	04
2016	Cannizaro reaction, sequence based reaction,	02

Amines

Year	Topic	No. of Questions
2025	**Aniline v/s N-methyl aniline differentiating reagents + Methods of preparation + Benzene diazonium chloride and reagents**	**03**
2024	Coupling reaction	1
2023	Why aniline does not undergo Friedel Craft's reaction, Reagents in the conversion of aniline to nitrobenzene	2
2022	Carbylamine reaction, About secondary amine	2
2021	The method by which aniline can not be prepared , Product name in ammonolysis, IUPAC name of the compound	3
2020	Conversion from Nitrobenzene to Meta bromo aniline, Hinsberg's reagent	2
2019	Solubility of amines, Nitration of aniline	2
2018	Coupling reaction – Yellow dye	1
2017	Increasing order of basic nature of amines in aqueous solutions	1

Biomolecules

Year	Topics	Number of Questions
2025	Glycosidic linkage+Example based for [amino acids+ hormones+Vitamins+carbohydrates] + Glucose reaction	03
2024	Anomers and Nucleotides, hormones – 2 qsn	04
2023	Receptors position in cell, Sucrose hydrolysis, Thyroxine V/s amino acids, Vitamins V/s deficiency	04
2022	Drug controller general of India	01
2021	Complementary base pair	01
2020	Glycosidic bond, Hypothyroidism V/s Thyroxine, Fat soluble vitamin	03
2019	Phosphodiester bond, water insoluble bio compound,	02
2018	Glycosidic bond , anomers, Base which is present in DNA	03
2017	Hormones, Glycosidic bond , Vitamins	03
2016	Fehling solution test , Complementary base pair	02

Some basic concepts of chemistry

- Homogeneous mixture – 2024
- Mole – **empirical formula, molecular formula** – 2021,2016,2015,2013
- Mole redox reaction – 2020
- Mole/limiting reagent – 2018
- Mole/molecules – 2017,2015
- Mole/faraday's law - 2017
- Mole/electrons - 2012
- Mole/Volumetric analysis – 2012,2011,2009,2009,2007
- **%composition** – 2020,2014,2010

Structure of atom

- Heisenberg uncertainty principle , Calculation on maximum number of orbital - 2025
- Bohr radius – 2024
- Quantum numbers – **2021,2020,2018,2017,2016,2014,2015,2012,2012,2010,2009,2008**

  Electron, proton, Neutron – 2023
- Hydrogen spectrum – 2010
- de-Broglie wavelength – 2019,2009
- Bohr orbit and Bohr energy calculations - 2016

Classification of elements and periodicity in properties

- Discovery of New elements – Oganesson – 2024
- Identify metalloid - 2024
- Ionisation enthalpy2023,2022,2021,2015,2014,2012,2011,2006
- Amphoteric oxide – 2023,2022, 2017
- Trends – electronegativity, atomic radius, density, electron gain enthalpy – 2022,2017,2018
- Isoelectronic species - 2013

Chemical bonding and molecular structure

- Bond order and nature of bond by giving EC - 2025
- Isoelectronic species - 2024
- Bond order and Bond length (MOT), electronic configuration according to MOT – 2023,2022,2016,2015,2014,
- Nature of bond – 2021,2017,
- Type of hybridisation and geometry/shape –
- 2020,2018,2016,2015,2015,2014,2013
- Lone pair/Bond pair calculation – 2019,2017
- Dipole moment – 2019
- Chemical bonding general question – 2021,2007,2006

Thermodynamics

- Pressure – volume work, Enthalpy V/s Internal energy , Entropy based – statement type of question
- Enthalpy of reaction – based on activation energy of forward and backward reaction and Hess's law - 2024
- Enthalpy of solution -**2023**
- Pressure-volume work - **2022**
- Entropy/statement type of questions – 2020,2017,2013,2007,2008,2019
- Heat of formation – 2015
- Heat of combustion – 2014
- Entropy/Gibb's energy - 2014

- **Chemical Equilibrium**
- Le Chatelier’s principle, Physical equilibrium, calculation on equilibrium mixture - 2025
- **Solubility product and common ion effect – 2024**
- Calculation on K_c – 2023,2022,2017,2016,
- Calculation on equilibrium concentration –
- $K_p = K_c(RT)$
- Statement type of question – Qc/K_c - 2017
- Factors affecting equilibrium constant – 2021
- **Iomic Equilibrium**
- pH calculation based on pKa and pKb values – 2023,
- Concluding highest pH – 2022,2013
- Concluding Stronger acids – based on Ka/pKa values – 2021,2019
- Deciding conjugate base – 2020,2013

Redox reactions

- Types of reactions, Redox titration of $KMnO_4$/ FAS – 2025

- Deciding reducing agent in a chemical equation – 2023,2013
- Oxidation state calculation – 2023,2022,2020,2019,2011,2010,2008
- 2007,2006
- Definition of oxidation – 2021,2017
- Calculating coefficient in ionic equation – 2018,

Some basic principles and techniques – Organic chemistry

- Sodium fusion extract (02) - 2025
- IUPAC nomenclature – 2023,2022,2016,2014,2013,2011
- Isomerism – Functional isomerism – 2023,2020,2013,2007
- Electrophile based question on nitration of benzene – 2016
- Carbocation intermediate question – 2014
- Electronic effect – 2013,2012,2009
- Nucleophilicity - 2011

Hydrocarbon

- Aromatic/Non aromatic compound + IUPAC + Chain isomerism - 2025
- Reagents for Elimination based Qsn – 2024
- Nomenclature – 2023
- Aromaticity – 2023
- Acidic behaviour comparison – 2021 [benzene, ethyne, n-hexane]
- Preparation of hydrocarbon from RMgX ,primary amine/Methanol/H_20 - 2015 2020
- Hydrogenation of benzene – 2014
- Reagents based question
- Chemical properties of hydrocarbon

Table: Shape of molecule containing bond pair and lone pair

Molecule type	No. of bonding pair	No. of lone pair	Geometry	✓ Shape lonepair.	Examples
AB_2	sp 2	0	Linear	Linear	$BeCl_2$, $HgCl_2$
AB_3	sp3 3	0	Trigonal planar	Trigonal planar	BF_3
AB_2E	sp^3 2	1	Trigonal planar	Bent	SO_2, O_3
AB_4	4	0	Tetrahedral	Tetrahedral	CH4, NH_4^+
AB_3E	3	1	Tetrahedral	Trigonal pyramidal	NH_3
AB_2E_2	2	2	Tetrahedral	Bent	H_2O
AB_5	5	0	Trigonal bi-pyramidal	Trigonal bi-pyramidal	PCl_5
AB_4E	4	1	Trigonal bi-pyramidal	See-saw	SF_4

AB_3E_2	3	2	Trigonal bi-pyramidal	T-shape	ClF_3
AB_6	6	0	Octahedral	Octahedral	SF_6
AB_5E	5	1	Octahedral	Square pyramidal	BrF_5
AB_4E_2	4	2	Octahedral	Square planar	XeF_4

Fajans rules : Covalent character of ionic bond

$LiCl \longrightarrow \underbrace{Li^{\oplus} \quad Cl^{\ominus}}_{\text{covalent}}$

- ➢ The smaller the **size** of the cation and the larger the size of the anion, the greater the covalent character of an ionic bond.
- ➢ The greater the **charge** on the cation, the greater the covalent character of the ionic bond.

Mg^{2+}, Al^{3+}, ⊖ Cl

- ➢ For cations of the same size and charge, Most of the d block elements polarizes [pulling the electronic charge toward itself] than S – block elements.
- ➢ The charge/size ratio of a cation determines its polarizing power

QUESTION

According to Fajan's rule, covalent bond is favoured by

A Large cation and small anion

B Large cation and large anion

[✓ **C**] Small cation and large anion

D Small cation and small anion

Li
Na
K ↓

Small cation
large anion.

QUESTION

Polarizing power of Cd^{2+} on the anions is stronger than that of Ca^{2+} ion. This is because

A atomic number of Cd is greater than that of Ca

B atomic mass of Cd is greater than that of Ca

C Size of Cd^{2+} ion is larger than that of Ca^{2+} ion

D Ca^{2+} ion has noble gas configuration while Cd^{2+} ion has pseudo noble gas configuration with 18 electrons in its outer shell.

QUESTION

Which of the following pairs will form the most stable ionic bond ?

A $\overset{+1}{\text{Na}}$ and $\overset{-1}{\text{Cl}}$

B $\overset{+2}{\text{Mg}}$ and $\overset{-1}{\text{F}}$

C $\overset{+1}{\text{Li}}$ and $\overset{-1}{\text{F}}$

D $\overset{+1}{\text{Na}}$ and $\overset{-1}{\text{F}}$

Mg–F

↳ ionic bond

→ very strong

Lattice energy

/ ionic bond / electro static force of attraction

→ +ve & -ve → charge is high

→ +ve & -ve ion → size is small

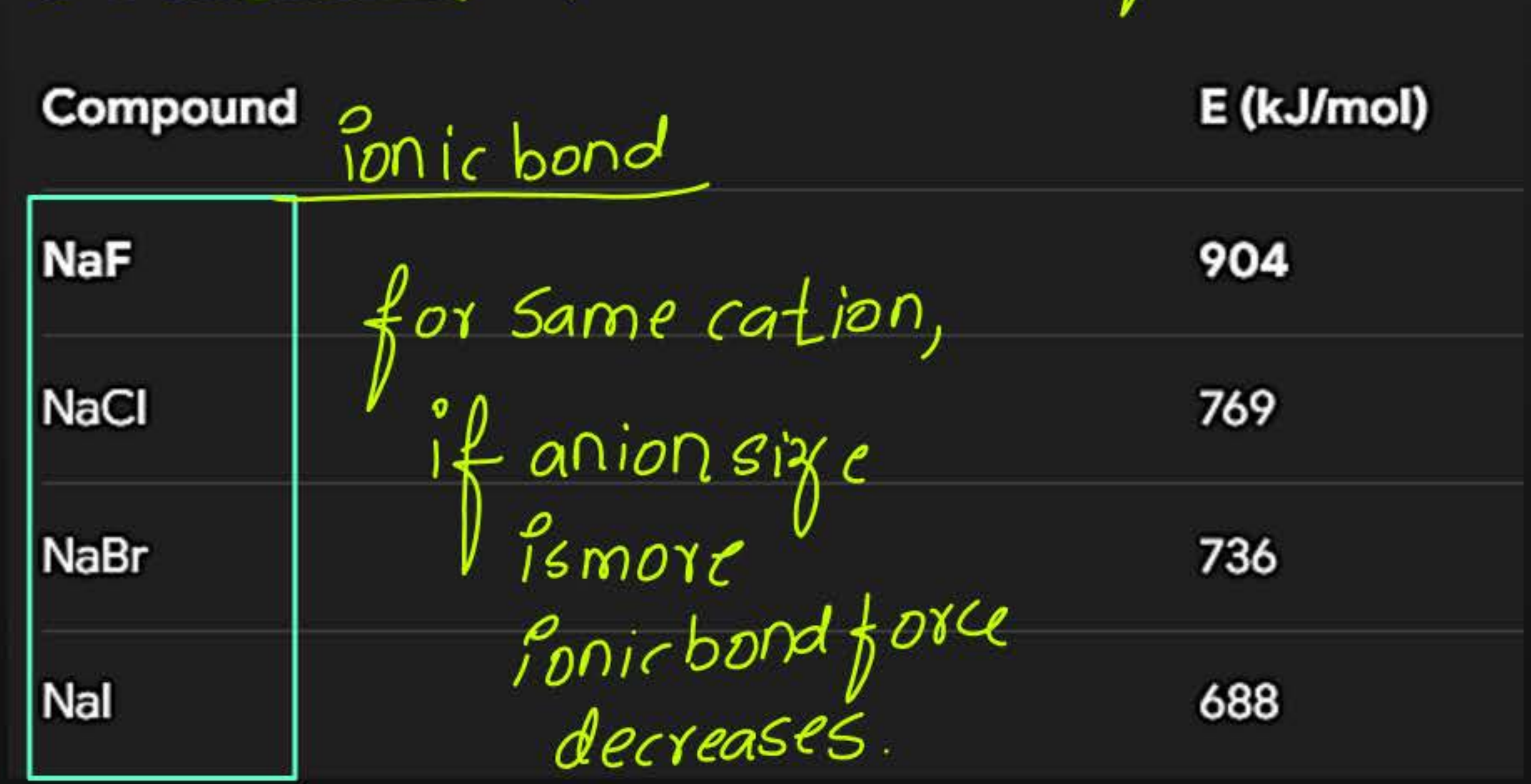
MgF_2 is –2922.5 kJ/mol.

(LiF) is –1022 kJ mol^{-1}.

(NaF) is -904 kJ mol^{-1}.

NaCI: –787 kJ/mol.

Lattice Energies (E) / Ionic bond force



Compound	E (kJ/mol)
NaF	904
NaCl	769
NaBr	736
NaI	688

ionic bond

for same cation,
if anion size
is more
ionic bond force
decreases.

Dipole moment

→ To Measure how much & in which direction change separation has taken place.

- **Dipole moment (μ) = charge (Q) × distance of separation (r)**
- Dipole moment is usually expressed in **Debye units (D)**
- Sometime it is also expressed in **coulomb meter**[1 D = 3.33564 × 10^{-30} CM] C m]
- dipole moment is a **vector quantity**

  dipole moment is represented by the **crossed arrow** ;This arrow symbolizes the direction of the shift of electron density in the molecule
- The cross is on positive end and arrow head is on negative end of the molecule

δ+

δ+ δ-

Na → F

q × Q

F ← B → F, F

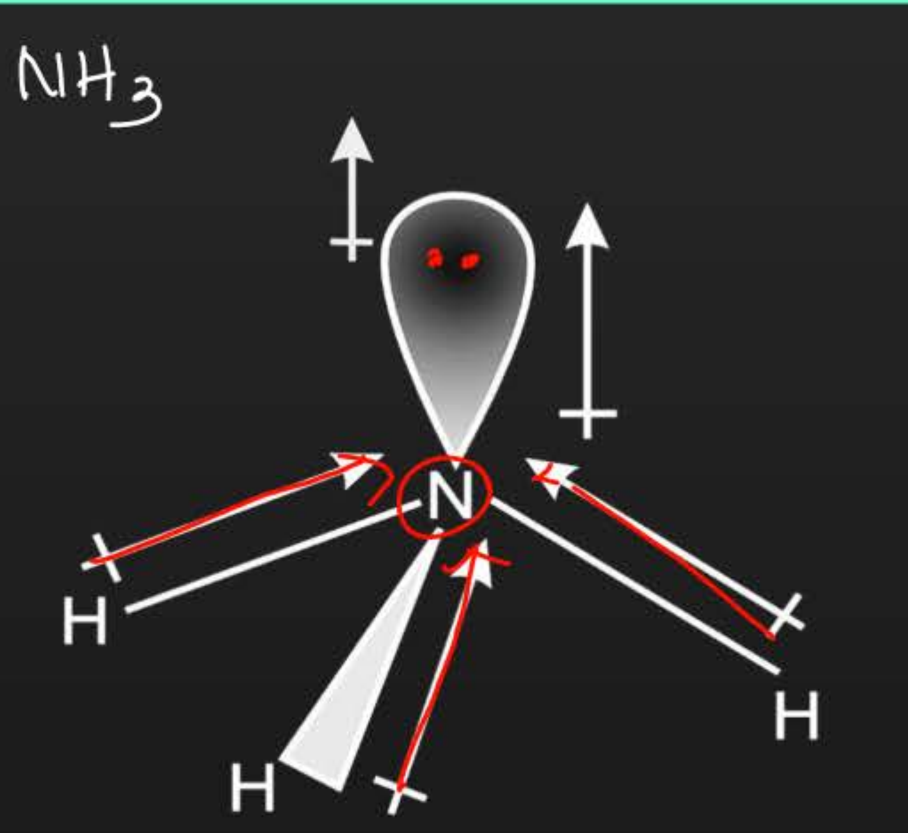
μ=0

$\underset{\mu}{NH_3} > NF_3$

Dipole moment in NH_3:
In NH_3 the orbital dipole due to lone pair is in the same direction as the resultant dipole moment of the N – H bonds

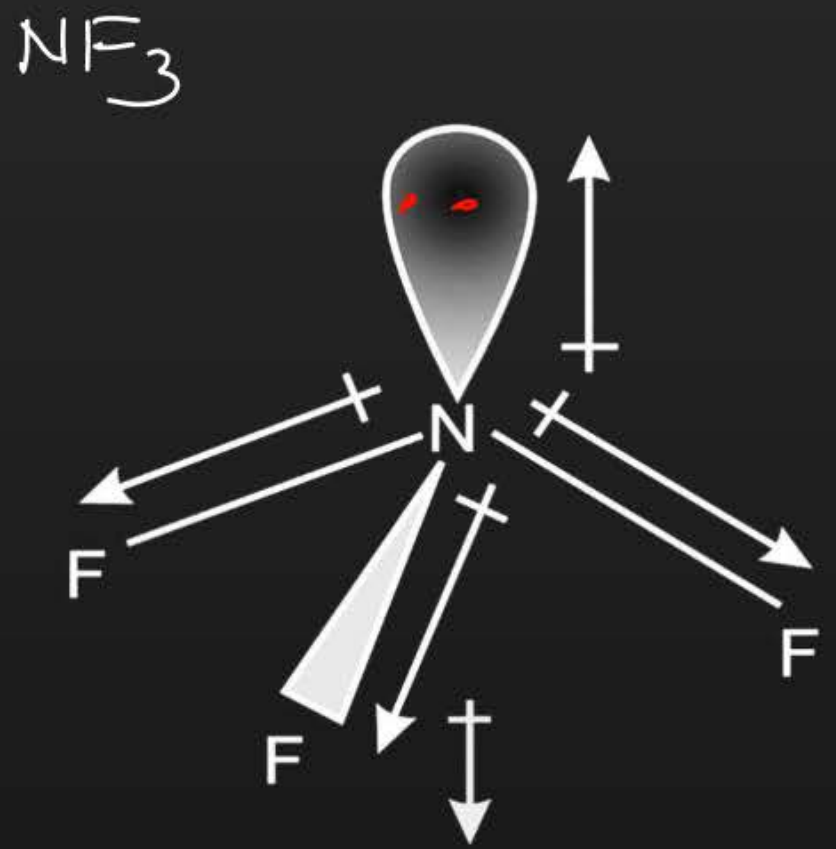
Dipole moment in NF_3: In NF_3 the orbital dipole is in the direction opposite to the resultant dipole moment of the three N–F bonds

NH_3



Resultant dipole moment in $NH_3 = 4.90 \times 10^{-30}$ C m

NF_3



Resultant dipole moment in $NF_3 = 0.80 \times 10^{-30}$ C m

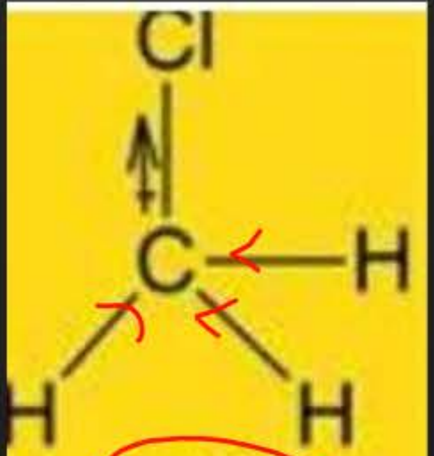
NEET

CH_3Cl
$\mu \neq 0$

$CHCl_3$
$\mu \neq 0$

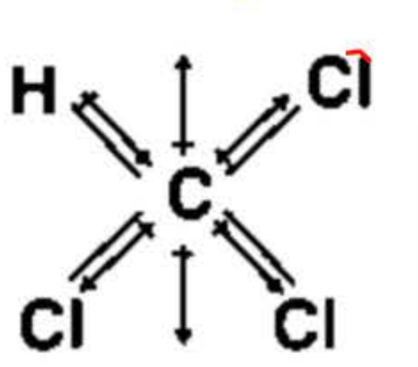
CH_2Cl_2
$\mu \neq 0$

CCl_4 ⟶ Non polar Molecule.
$\mu = 0$

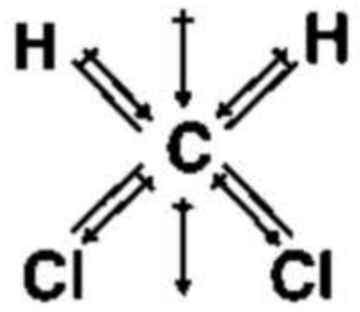


μ = 1.86 D

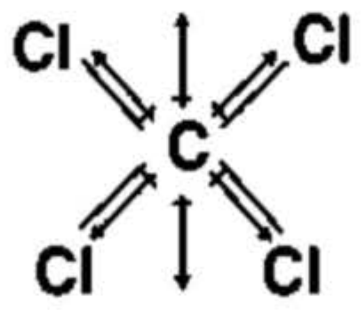
Methyl Chloride



(ii)
Chloroform
($CHCl_3$)
μ = 1.08D



(i)
Dichlormethane
(CH_2Cl_2)
μ = 1.60D



(iii)
Carbon tetrachloride
(CCl_4)
μ = 0D

$CH_3Cl > CH_2Cl > CHCl_3 > CCl_4$

↓ μ = Max

↓ $\mu = 0$

Nonpolar molecule

$\mu = 0$

Charge separation = $\mu = 0$

Dipole moment in decreasing order

→ CO_2

→ BF_3

→ CCl_4

→ $BeCl_2$

→ BCl_3

CH_3Cl $\mu \neq 0$

H_2O

NH_3

NF_3

$CHCl_3$

CH_2Cl_2

QUESTION

The dipole moment is minimum in

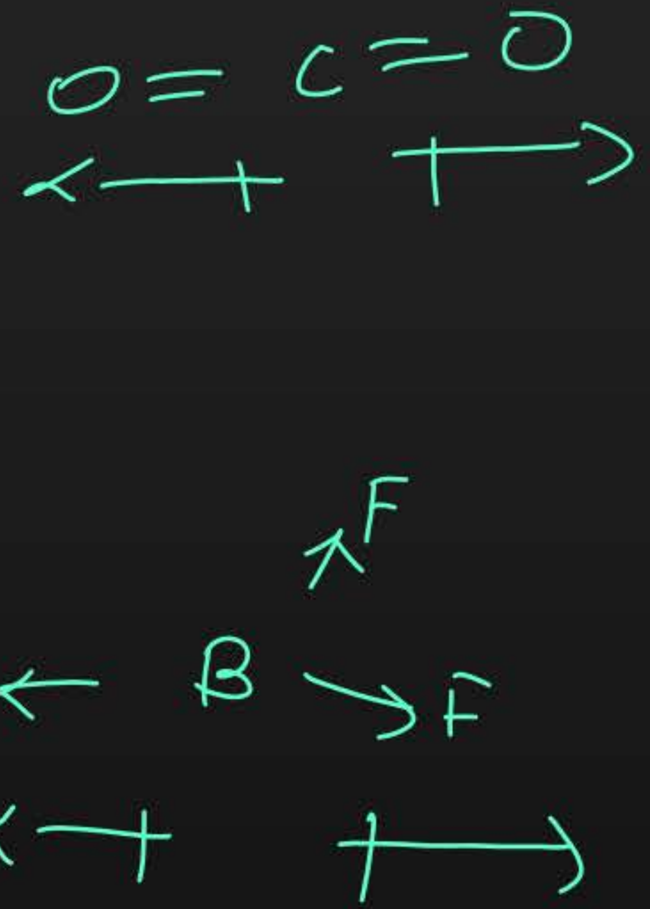
polar molecule.

A NH_3 $\mu \neq 0$

B NF_3 $\mu \neq 0$

C SO_2 $\mu \neq 0$

D BF_3 $\boxed{\mu = 0}$



Dipole moment
- → Electronegativity
- → direction
- → Shape of the molecule.

QUESTION

Which of the following is the correct order of dipole moment?

A $NH_3 < BF_3 < NF_3 < H_2O$ ✗

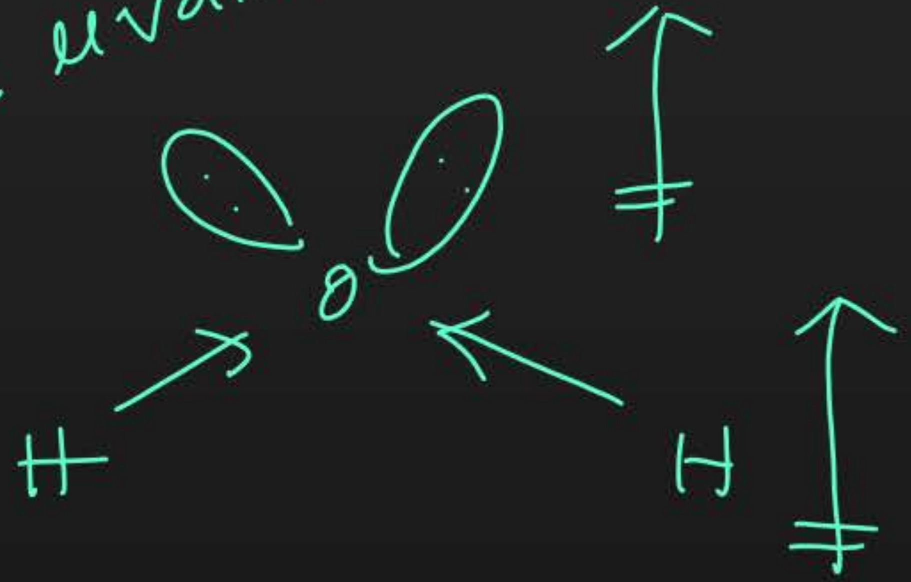
$\mu = 0$ Minim Max

B $BF_3 < \underbrace{NF_3 < NH_3}_{} < \boxed{H_2O}$ → highest μ value

$\mu = 0$

C $BF_3 < NH_3 < NF_3 < \boxed{H_2O}$

D $H_2O < NF_3 < NH_3 < BF_3$ ✗



QUESTION

Predict the correct order among the following.

A lone pair-lone pair > bond pair-bond pair > lone pair-bond pair

B bond pair-bond pair > lone pair-bond pair > lone pair-lone pair

C lone pair-bond pair > bond pair-bond pair > lone pair-lone pair

[✓ **D**] lone pair-lone pair > lone pair-bond pair > bond pair-bond pair

QUESTION

Which of the following would have a permanent dipole moment?

$\mu \neq 0$

A BF_3 ✗

B SiF_4

C SF_4

D XeF_4

$SiF_4 = n = \frac{1}{2}[V + M - C + A]$

$= \frac{1}{2}[4+4] = 8/2 = 4 \rightarrow sp^3$

lonepair $\Rightarrow n - M - D$

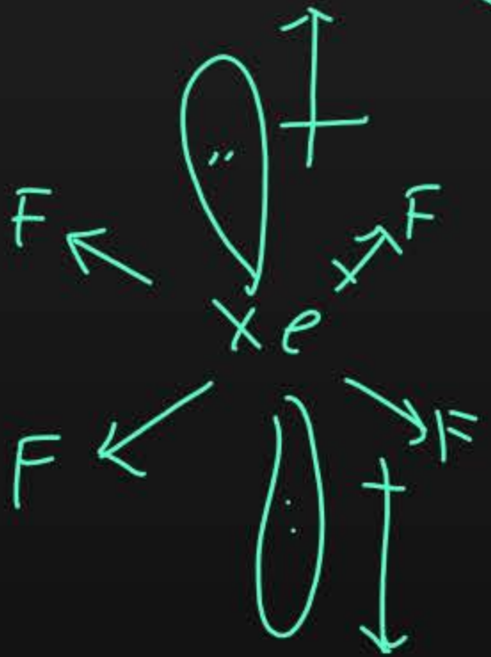
$= 4 - 4 = 0$

$XeF_4 \rightarrow n = \frac{1}{2}[8+4] = 12/2 = 6$

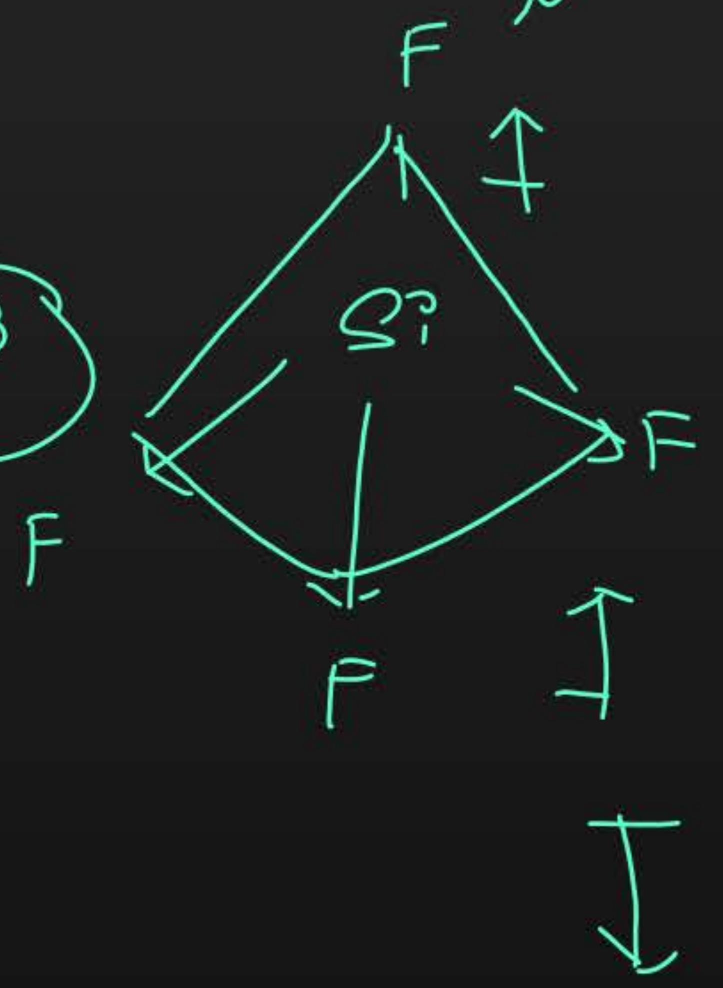
$\mu = 0$

$lp = n - M - D$

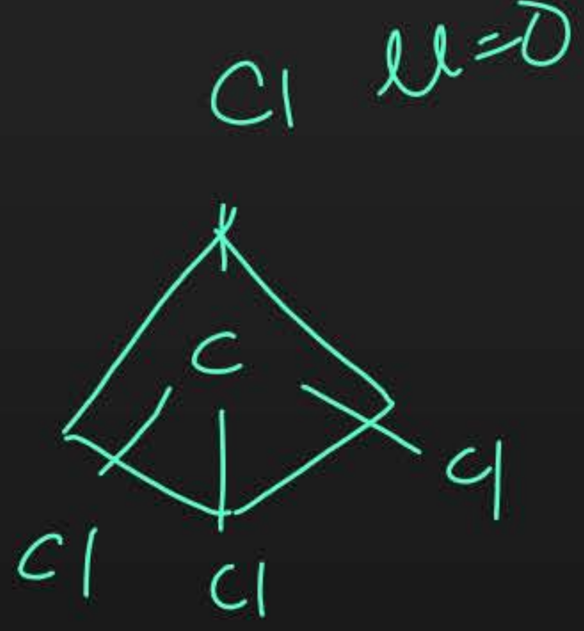
$= 6 - 4 = 2$



$\mu = 0$



$\mu = 0$



QUESTION

Match the xenon compounds in column I with its structure in column II and assign the correct code :

	Column I		Column II
A.	XeF4	(i)	Pyramidal
B.	XeF	(ii)	Square planar
C.	XeOF4	(iii)	Distorted octahedral
D.	XeO3	(iv)	Square pyramidal

Codes

	A	B	C	D
A	(ii)	(iii)	(iv)	(i)
B	(iii)	(ii)	(i)	(iv)
B	(iii)	(iv)	(i)	(ii)
D	(i)	(ii)	(iii)	(iv)

QUESTION

Amongst the following which one will have maximum lone pair-lone pair’ electron repulsion?

- A IF_5
- B SF_5
- C XeF_5
- D CIF_5

QUESTION

$O_2 \rightarrow$ paramagnetic $\boxed{O=O} \longrightarrow 2$.

$N \equiv N$ $\quad$ $Cl-Cl$

$H-H$

Consider the ions/molecule $O_2^+, O_2, O_2^-, O_2^{2-}$ For increasing $\boxed{\text{bond order}}$ the correct option is

Bond order $\propto \frac{1}{\text{Bond length}}$.

zero

He ✗ He

(A) $\overset{2}{O}{}_2^{+} < O_2^- < O_2 < O_2^+$ ✗

(B) $\overset{2}{O}{}_2^{-} < O_2^{\cancel{2}-} < O_2 < O_2^+$

$\underline{1}$ $\quad 1.5 \quad 2 \quad 2.5$

(C) $O_2^- < O_2^{2-} < O_2^+ < O_2$ ✗

(D) $O_2^- < O_2^+ < O_2^{2-} < O_2$ ✗

✓

$$\text{Bond order} = \frac{1}{2}\left[\begin{matrix}\text{No. of} \\ e^{\ominus} \\ \text{BMO}\end{matrix} - \begin{matrix}\text{No. of } e^{\ominus} \\ \text{in} \\ \text{ABMO}\end{matrix}\right]$$

$_8O + O = O_2 = 16e^{\ominus}$

$\sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \sigma 2p_z^2$

$\overset{1+1}{\pi 2p_x} = \overset{1+1}{\pi 2p_y}$ $\quad$ $\overset{①}{\pi^* 2p_x} = \overset{①}{\pi 2p_y}$

$\frac{1}{2}[10-6] = 4/2 = 2$

$O=O$

2−	⊖		⊕	2+
O_2	O_2	O_2	O_2	O_2
↓	↓	↓	↓	↓
1	1.5	2	2.5	3

QUESTION

Which molecule has the highest bond order?

A N_2

B Li_2

C He_2

D O_2

K=1
L=2
M=3
N=4

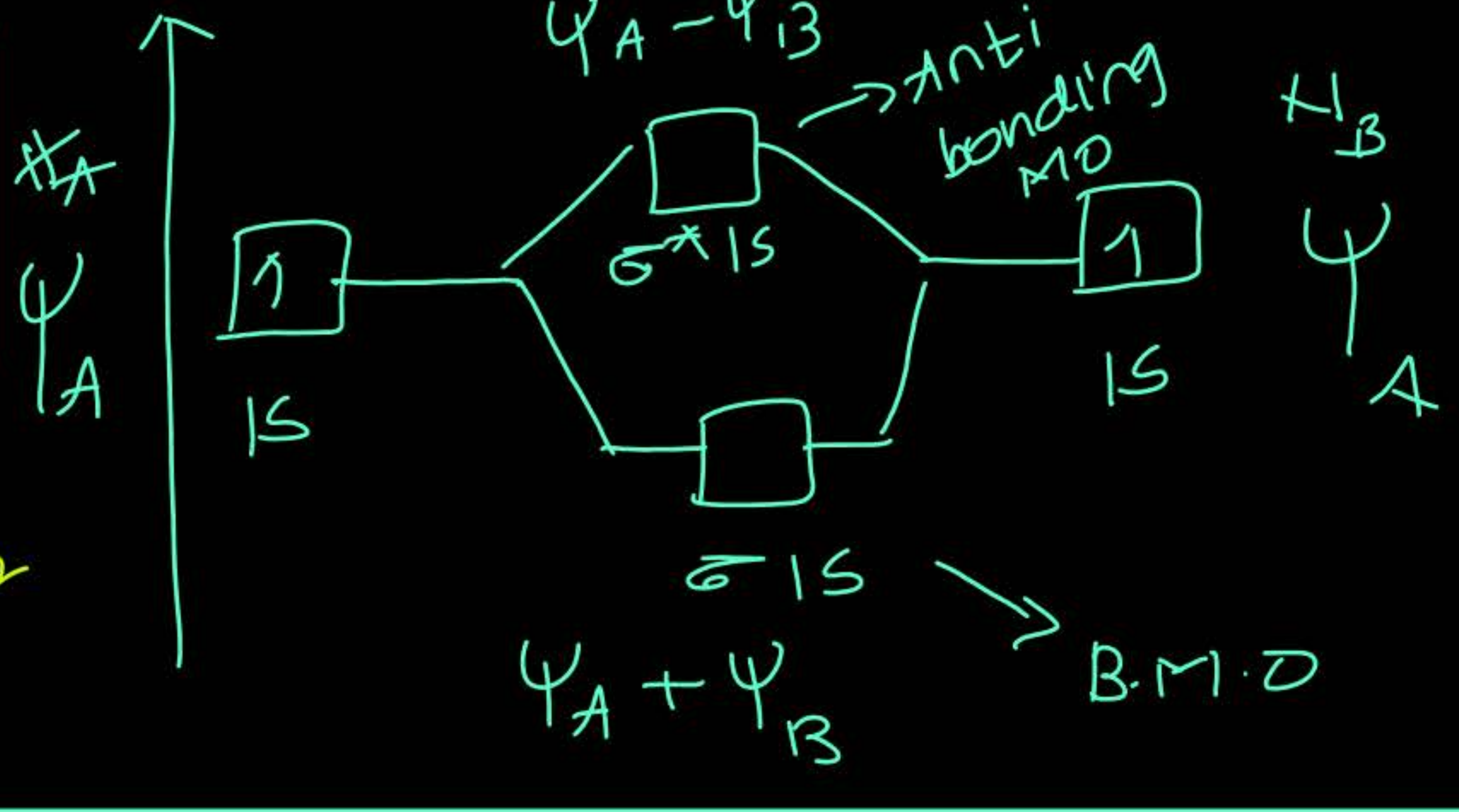
Molecular orbital theory

Molecular orbital

Bonding molecular orbitals

Antibonding molecular orbitals

$2P_x P_y P_z$



Atomic no = 7 or lesser than 7. →

$\sigma 1s, \sigma^* 1s, \sigma 2s, \sigma^* 2s, \pi 2P_x = \pi 2P_y, \sigma 2P_z$
$(\pi^* 2P_x = \pi^* 2P_y)$ $\sigma^* 2P_z$

Atomic no is 8 or greater than 8 →

$\sigma 1s, \sigma^* 1s, \sigma 2s, \sigma^* 2s, \sigma 2P_z, \pi 2P_x = \pi 2P_y$
$\pi^* 2P_x = \pi^* 2P_y, \sigma^* 2P_z$

QUESTION

According to molecular orbital theory, which of the following statement about the magnetic character and bond order is correct regarding O_2^+

MOT

- **A** Paramagnetic and Bond order $<O_2$
- **B** Paramagnetic and Bond order $> O_2$
- **C** Diamagnetic and Bond order $<O_2$
- **D** Diamagnetic and Bond order $> 0_2$

Question

Which of the following statement is incorrect?

MOT

- **A** Bond length of O_2 > Bond length of O_2^{2+}
- **B** Bond length of O_2^{+} < Bond order of O_2^{2-}
- **C** Bond length of O_2^{-} > Bond length of O_2^{2-}
- **D** Bond order of O_2 > Bond order of O_2^{2-}

Question

In oxygen and carbon molecule the bonding is

A $O_2 : 2\sigma, O\pi; C_2 : 0\sigma 2\pi$

B $O_2 : 1\sigma, 1\pi; C_2 : 0\sigma 2\pi$

C $O_2 : 0\sigma, 2\pi; C_2 : 2\sigma 0\pi$ ×

D $O_2 : 1\sigma, 1\pi; C_2 : 1\sigma 1\pi$ ×

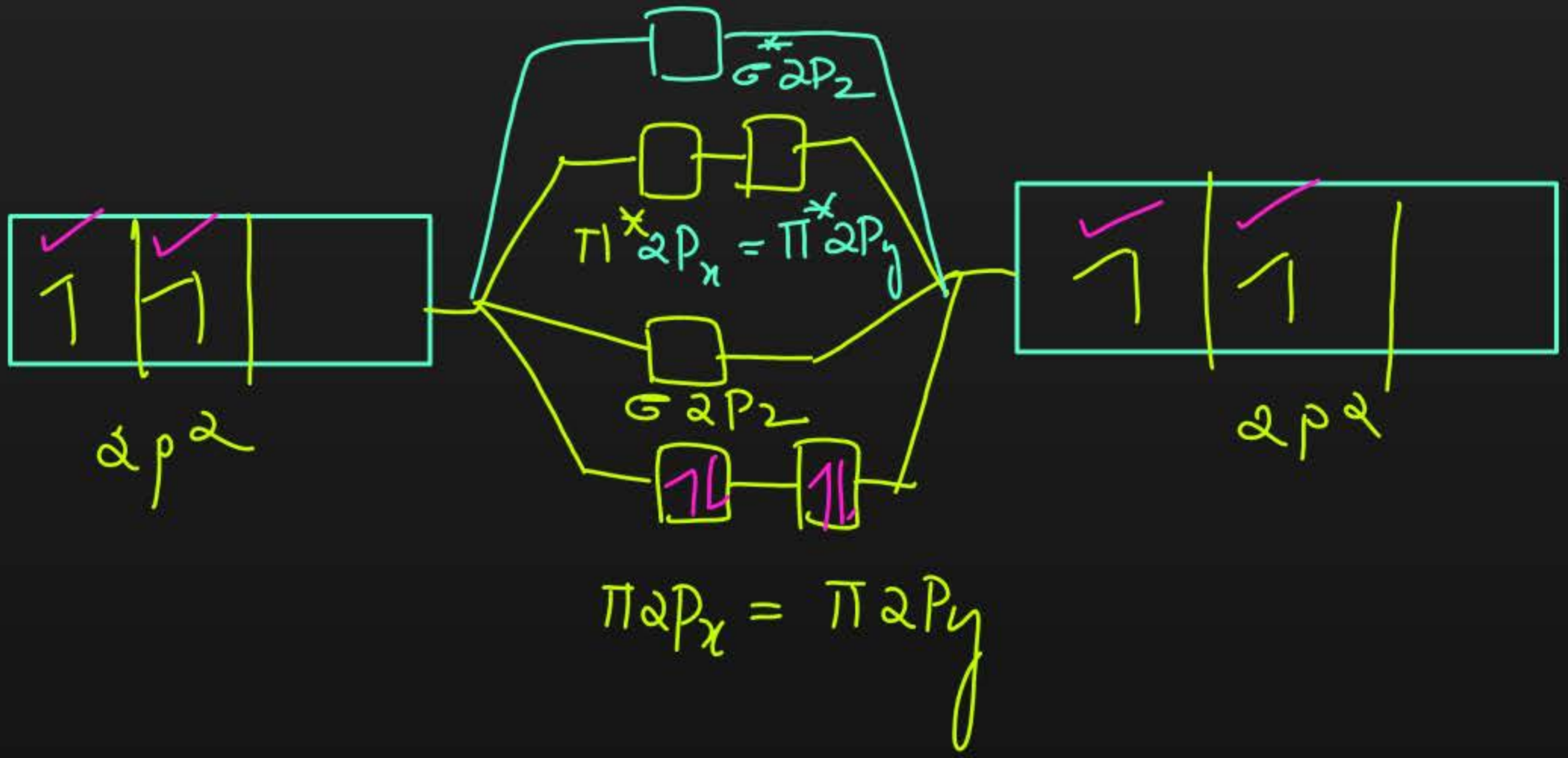
$_6C$

$1s^2, 2s^2, 2p^2$

$\boxed{C_2}$

C

$1s^2, 2s^2, 2p^2$



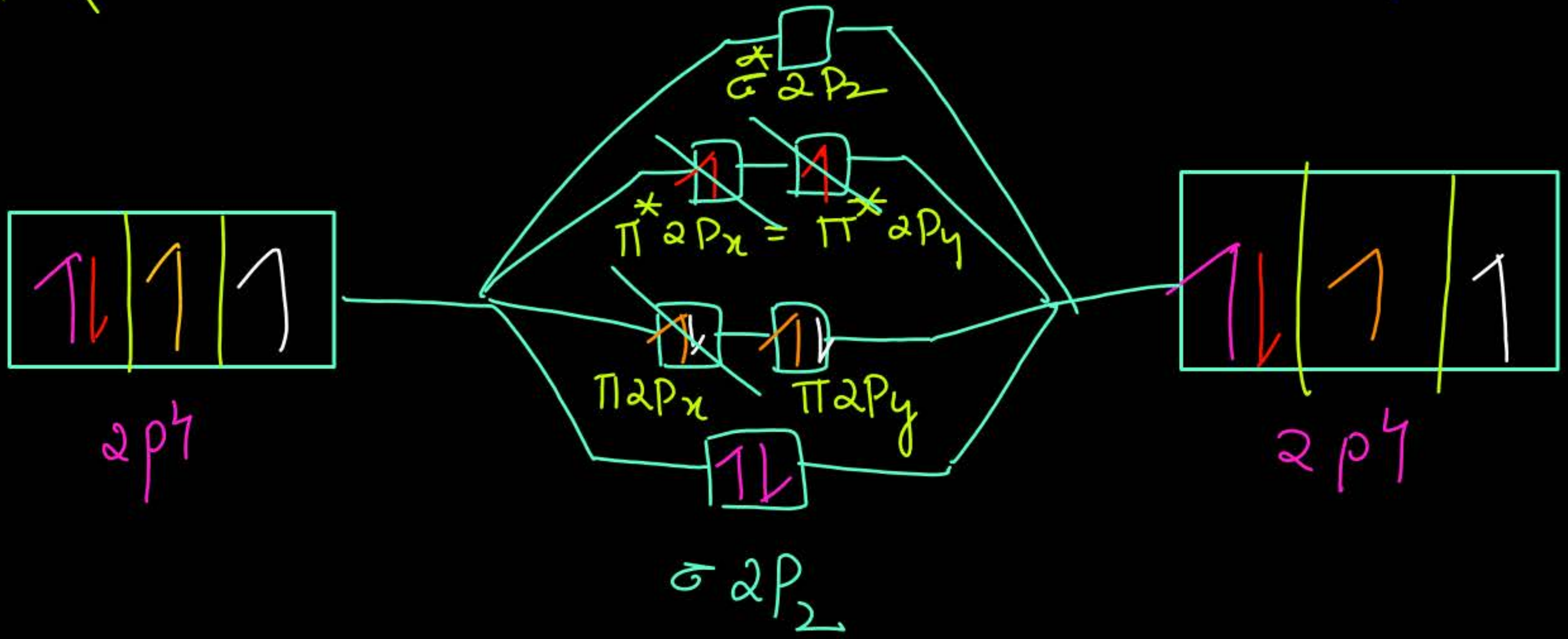
$_8O$

O_2 .

O_2; 1σ bond
1π bond .

$_8O$
~~$1s^2$~~, ~~$2s^2$~~, $2p^4$

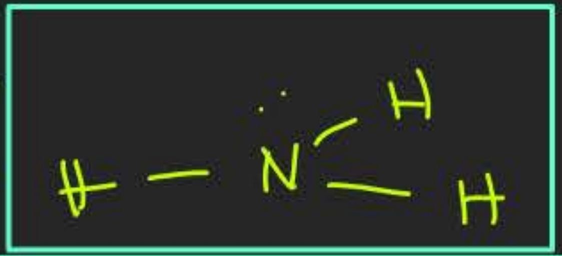
O
~~$1s^2$~~, ~~$2s^2$~~, $2p^4$



QUESTION

−33.4°C
B.P

gaseous ←

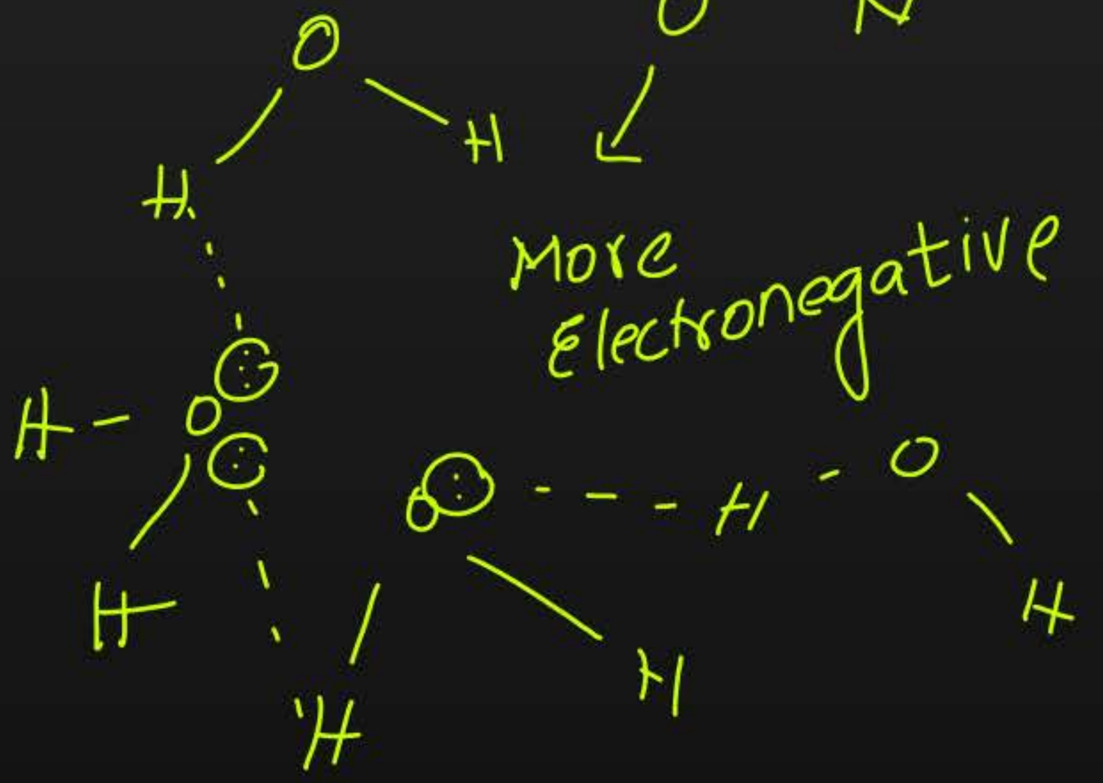


,

H − F → 19.5°C.
B.P

Hydrogen bonds are formed in many compounds e.g., H_2O, HF, NH_3. The boiling point of such compounds depends to an extent on the strength of hydrogen bond and the number of hydrogen bonds. The correct decreasing order of the boiling points of above compounds is

- **A** $HF > H_2O > NH_3$
  100°C 19.5°C −33.4°C.
- [✓ **B**] $H_2O > HF > NH_3$
- **C** $NH_3 > HF > H_2O$
- **D** $NH_3 > H_2O > HF$

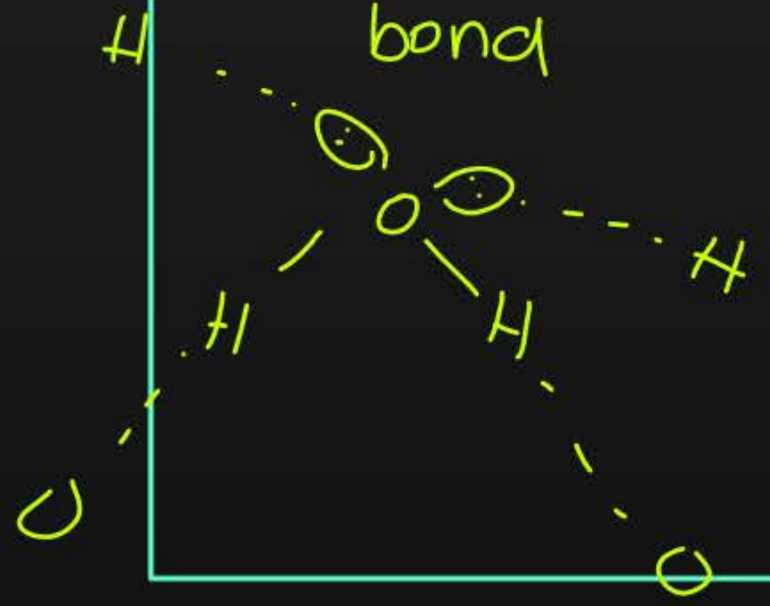


O N F

More Electronegative

→ Electronegativity

→ No. of hydrogen bond



Structure of atom.

Subatomic particles.

Mass of $e^{\ominus}$ $\longrightarrow$ 9.1×10^{-31} kg or 9.1×10^{-28} g.

Mass of proton $\longrightarrow$ 1.672×10^{-27} kg or 1.672×10^{-24} g

Mass of Neutron $\longrightarrow$ 1.675×10^{-27} kg or 1.675×10^{-24} g.

$$\frac{\text{Charge}}{\text{Mass}} = \frac{e}{\textcircled{M}} \text{ ratio} \rightarrow e^{\ominus} > p > n > \alpha \text{ particle}$$

small

$$\rightarrow \boxed{c = \nu \times \lambda}$$

$$\rightarrow \boxed{\lambda = \frac{c}{\nu}}$$

$$\underset{\text{wavenumber}}{\bar{\nu}} = \frac{1}{\lambda}$$

$\rightarrow E = h\nu$ $\qquad h = 6.6\times10^{-34}$ J S

$\rightarrow E = h\dfrac{c}{\lambda}$ $\qquad h = 6.6\times10^{-34}$ kg m^{2} s^{-1}

$\rightarrow \bar{\nu} = \dfrac{1}{\lambda} = RZ^{2}\left[\dfrac{1}{n_1^{2}} - \dfrac{1}{n_2^{2}}\right]$

Z = atomic no, for H = $\underline{1}$

alpha particle

$$\boxed{{}^{\textcircled{4}}_{2}\text{He}^{\textcircled{2+}}}$$

↓

doubly Charged Helium Particles.

$\textcircled{\text{He}}$

1s2.

Infra red
Pfund $n_1 = 5$
Brackett $n_1 = 4$
paschen $n_1 = 3$

Visible
Balmer $n_1 = 2$

UV
lyman $n_1 = 1$

Hydrogen spectra.

EMR radiation

Gamma rays, x rays, UV rays, visible, infrared, Micro wave, radio wave

$E \uparrow$ energy of / frequency radiation ↓ses

$\lambda \downarrow$ $\xrightarrow{\hspace{2cm}}$ wavelength decreases.

$E = h\nu$

$E = h$

$$\bar{\nu} = \frac{1}{\lambda} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] \rightarrow$$

$R = 109677\ cm^{-1}$
$= 1.09677 \times 10^{7}\ m^{-1}$.
↳ Rydberg constant.

Bohr model

$$E = -13.6\,\frac{Z^2}{n^2}\ eV$$

$$E_n = -\frac{R_H \times Z^2}{n^2}$$

$$E_n = \frac{-2\times10^{-18}\,Z^2}{n^2}\ J\,atom^{-1}$$

Infrared
- Pfund $n_1 = 5$
- Brackett $n_1 = 4$
- paschen $n_1 = 3$

Visible
- Balmer $n_1 = 2$

UV
- Lyman $n_1 = 1$

Hydrogen spectra.

$$\bar{\nu} = \frac{1}{\lambda} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] \rightarrow \text{Bohr model}$$

$R = 109677\ \text{cm}^{-1}$

$= 1.09677 \times 10^{7}\ \text{m}^{-1}$.

↳ Rydberg constant.

EMR radiation

Gamma rays, x rays, UV rays, visible, infrared, Micro wave, radio wave

E ↑ λ ↓

$\xrightarrow[\text{wavelength decreases.}]{\text{energy of / frequency radiation} \downarrow \text{ses}}$

$E = h\nu$

$E = h$ angular momentum of e^- in bohr orbit ↓

$_3Li^{2+}$, $_2He^+$, $_4Be^{3+}$

Bohr model

$$E_n = -13.6 \frac{Z^2}{n^2}\ \text{eV}$$

$$mvr = n\frac{h}{2\pi}$$

$$E_n = -\frac{R_H \times Z^2}{n^2}$$

$$\boxed{E = -13.6\ \text{eV}, -2\times10^{-18}\ \text{J/atom}}$$

$$E_n = -2\times10^{-18} \times \frac{Z^2}{n^2}\ \text{J/atom}$$

$$\boxed{r_n = \frac{a_0 \times n^2}{Z}}$$

$a_0 = 52.9\ \text{pm}$
$= 0.53\ \text{Å}$.

H = Z = 1
n = 1

radius of first bohr orbit $r_n = 52.9\ \text{pm} \times (1)^2$
$= 0.53\ \text{Å}$.

$h\nu = h\nu^0 + \frac{1}{2}mv^2$

$W = h\nu^0 \longrightarrow$ work function.

$\lambda = \frac{h}{P} = \frac{h}{m \times V}$

$h = 6.6 \times 10^{-34}\ kg\ m^2 s^{-1}$

$m = kg,\ V = \text{~~}\ m s^{-1}$

$\Delta x . \Delta P \geq \frac{h}{4\pi}$

$\Delta x \cdot \Delta V \geq \frac{h}{m_e . 4\pi}$

position ↓ ↓ velocity

$mg = 10^{-3} g$

$1g \longrightarrow 10^{-3} kg$

$1 Mg = 10^{-6} kg$.

Quantum no

$n \rightarrow K, L, M, N \longrightarrow$ Max $e^{\ominus}$ $\hookrightarrow 2n^2$

$\downarrow, \downarrow, \downarrow, \downarrow$

$1 \quad 2 \quad 3 \quad 4$

size energy

$K \rightarrow 2n^2 \longrightarrow 2(1)^2 = 2e^{\ominus}$

$L = 2(n^2) = 2(2)^2 = 4e^{\ominus}$

$M = 2(n^2) = 2(3)^2 = 18e^{\ominus}$

$N = 2(n^2) = 2(4)^2 = 32e^{\ominus}$

Maximum no. of subshell

$K \rightarrow n^2 = 1S$ sub

$L \rightarrow n^2 = 2^2 = 4$ shell $2s, 2P_x 2P_y 2P_z$

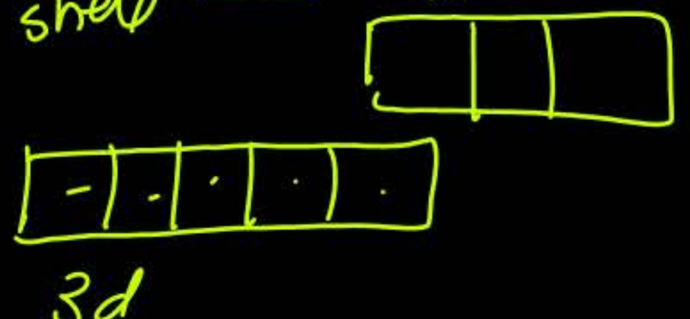
$M \rightarrow n^2 = 3^2 = 9$ sub shell, $\boxed{3S}$ $3P_x, 3P_y 3P_z$

$N = n^2 = 4^2 = 16$

$4s, 4P, 4d, 4f$

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

$1 \quad 3 \quad 5 \quad 7$

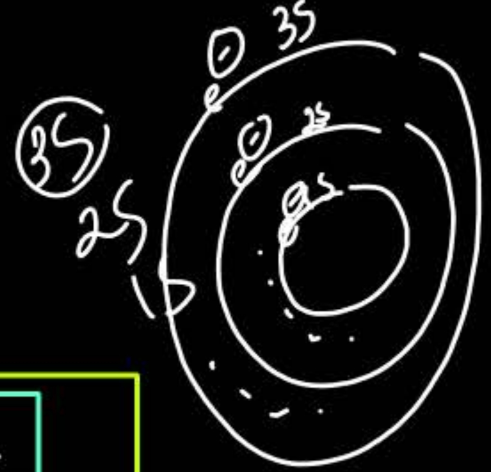


→ Principal Q. NO. → n → 1, 2, 3, 4, 5, 6, 7 ..... ∞

→ Azimathal Q. NO → l → 0, ... $(n-1)$

→ Magnetic Q. NO → m_l → $(2l+1)$

→ Spin Q. NO. → m_s → $+1/2$ or $-1/2$



3d $3-2-1=0$

$n=3$

$l=0, 1, 2$

$l = s = 0$
$p = 1$
$d = 2$
$f = 3$

$m_l = (2l+1)$

$(2(0)+1) = S = \square$

$m_l = (2(1)+1) = 3$ $\square\square\square$

P_x P_y P_z

$m_l = (2(2)+1) = 5$

$\square\square\square\square\square$

d_{xy} d_{yz} d_{xz} $d_{x^2-y^2}$ d_{z^2}

4s

$n=4$

$l=0$

$m_l=0$

$m_s = +1/2 \; -1/2$

Radial node → $\boxed{n-l-1}$

Angular node → $\boxed{(l)}$

3d → 2

Total node → $\boxed{n-1}$

$3d = 3-1 = 2$

e^- presence

The variation of ψ^2 as a function of r for 1s and 2s orbitals is given.

It may be noted that for 1s orbital the probability density is maximum at the nucleus and it decreases sharply as we move.

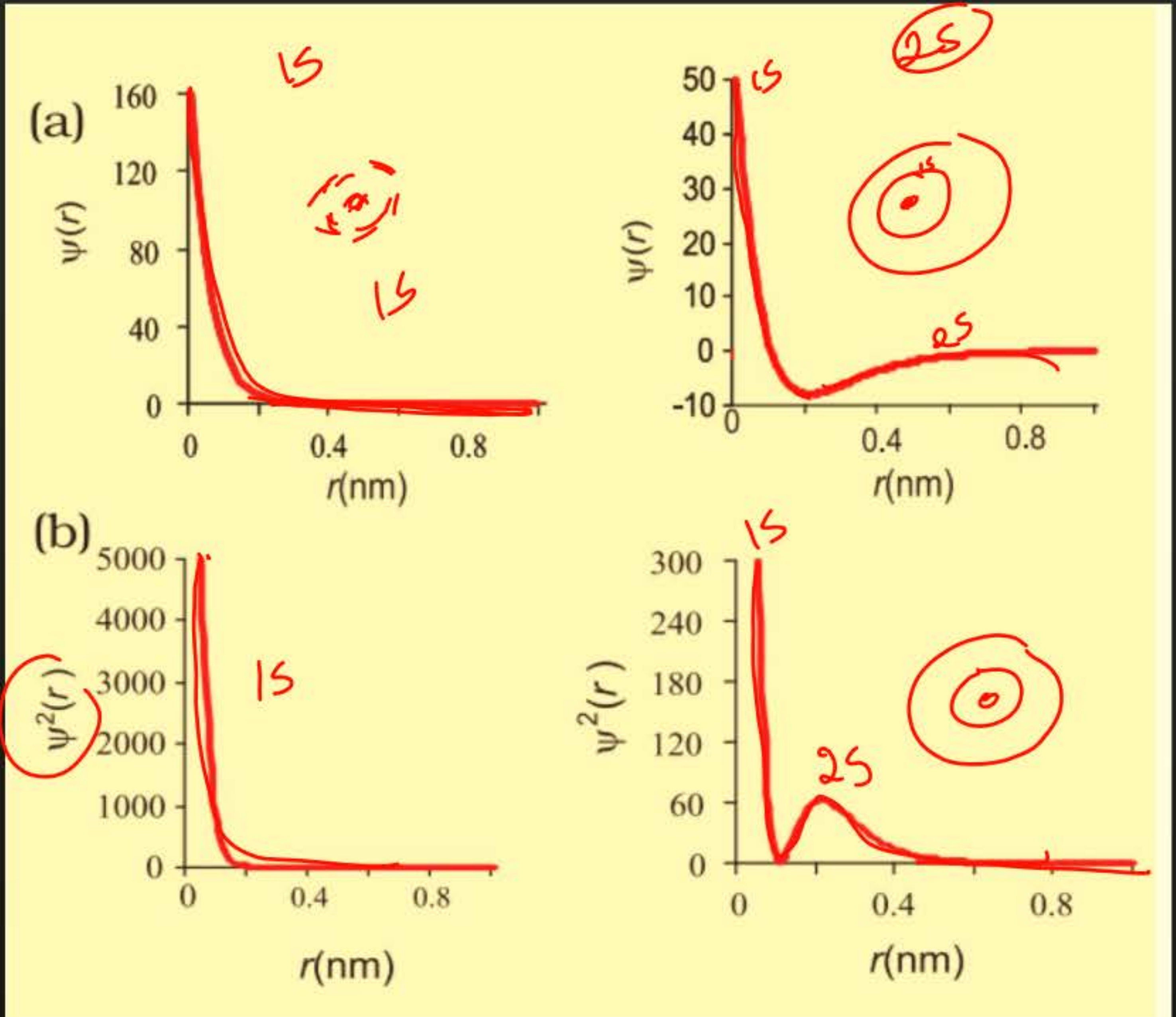
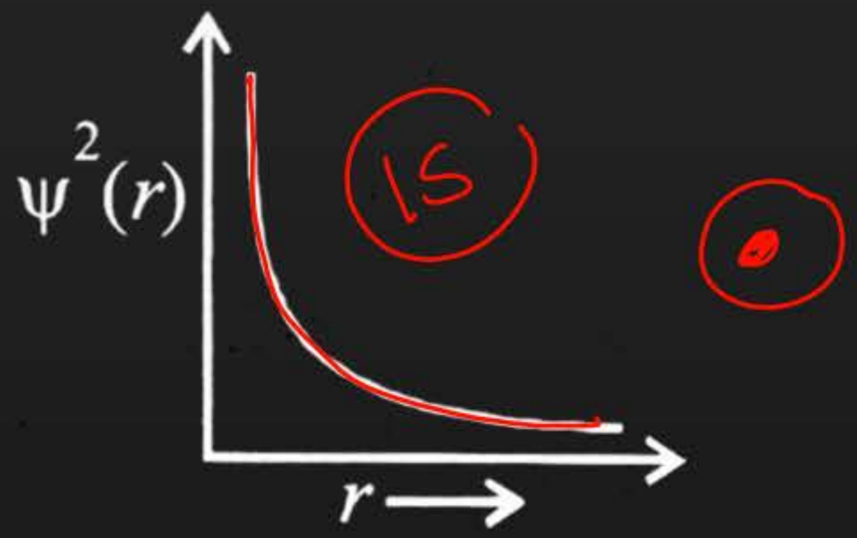


Fig. 2.12 *The plots of (a) the orbital wave function $\psi(r)$; (b) the variation of probability density $\psi^2(r)$ as a function of distance r of the electron from the nucleus for 1s and 2s orbitals.*

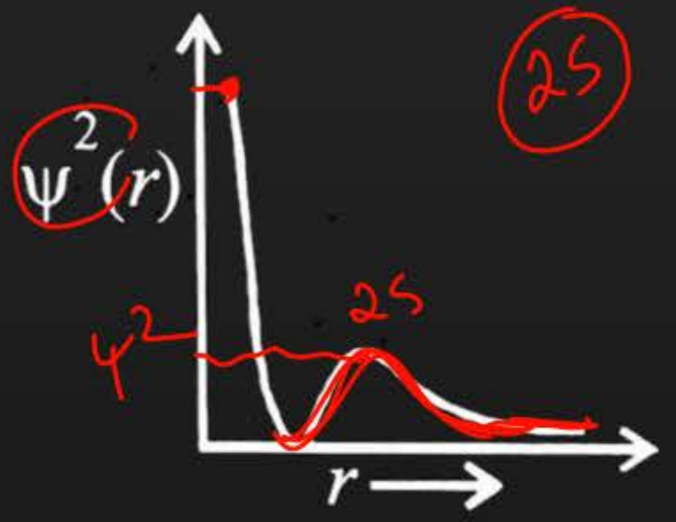
QUESTION

Which of the following is the correct plot for the probability density $\psi^2(r)$ as a function of distance 'r' of the electron form the nucleus for 2s orbital?

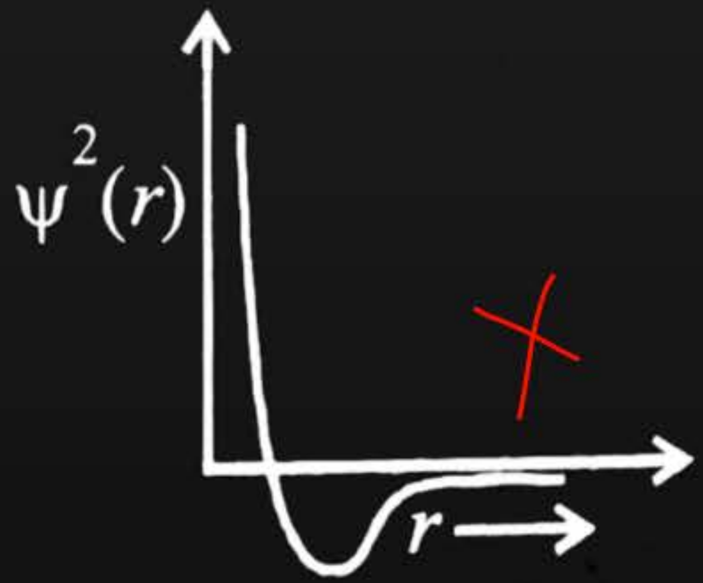
A



~~B~~



C



D

QUESTION

$1 cm = 10^{-2} m$

$1 A^{o} = 10^{-10} m.$

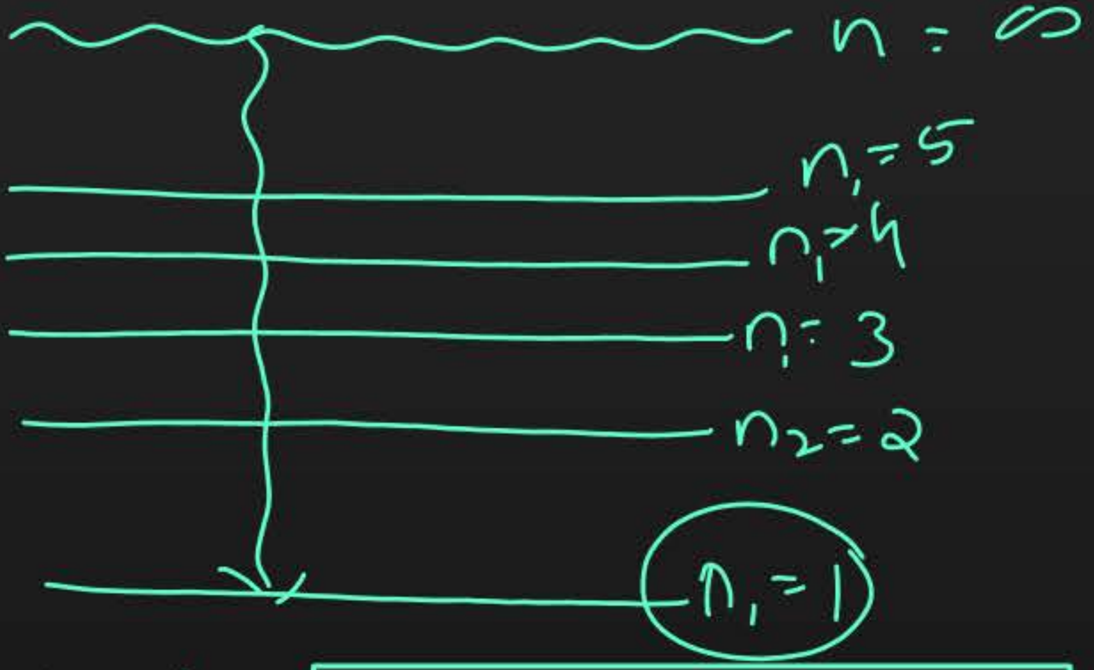
The shortest wavelength of the line in hydrogen atomic spectrum of Lyman series when $R_H = 109678\ cm^{-1}$ is

A 1002.7 Å

B 1215.67 Å

C 1127.30 Å

D 911.7 Å



$E = h\nu$

$\boxed{E} = h\frac{c}{\lambda}$

should be Max

shortest

$1 m = 100 cm$

$1 cm = 10^{-2} m.$

$1 A^{o} = 1 \times 10^{-10} m$

$n_1 = 1$

$n_2 = \infty$

$$\bar{\nu} = \frac{1}{\lambda} = 109677\left[\frac{1}{1^2} - \frac{1}{0}\right]$$

$$\bar{\nu} = \frac{1}{\lambda} = 109677\ cm^{-1}$$

$$\lambda = \frac{1}{109677} = 9.11 \times 10^{-6} cm$$

$1 A^{o} = 1 \times 10^{-10} m$

$? = 9.11 \times 10^{-6} \times 10^{-2} m$

QUESTION

According to Bohr's theory, the electronic energy of H-atom in Bohr's orbit is given by

A $E_n = -\frac{2.18 \times 10^{-19} \times Z}{2n^2} J$

2.18

~~B~~ $E_n = -\frac{2.179 \times 10^{-18} \times Z^2}{n^2} J$ /atom.

C $E_n = -\frac{21.79 \times 10^{-18} \times Z}{2n^2} J$

D $E_n = -\frac{21.8 \times 10^{-21} \times Z^2}{n^2} J$

$\underline{2 \times 10^{-18}}$

2.18×10^{-18}

QUESTION

The number of protons, neutrons and electrons in the ion respectively are [2023]

- **A** 16, 18, 16
- **B** 16, 16, 18
- **C** 18, 16, 16
- **D** 16, 16, 16

QUESTION

The number of angular and radial nodes in 3p-orbital respectively are [2021]

A 3, 1

[✓ B] 1, 1

C 2, 1

D 2, 3

$p = \underline{1}$

$3p$

radial node $= n - l - \underline{1}$

$= 3 - 1 - 1$

$= 3 - 2$

$= \underline{1}$

angular node $= 3p$

$\hookrightarrow \underline{1}$

$99.99 = 10^2$

QUESTION

Two particle A and B are in motion. If the wavelength associated with 'A' is 33.33 nm, the wavelength associated with ' B' whose momentum is 1/3rd of ' A' is [2019]

- **A** 1.0×10^{-8} m
- **B** 2.5×10^{-8} m
- **C** 125×10^{-7} m
- [✓ **D**] 1.0×10^{-7} m

$\lambda_A = \frac{h}{P_A}$ $\lambda_B = \frac{h}{P_B}$

$$\frac{\lambda_A}{\lambda_B} = \frac{P_B}{P_A}$$

$P_B = \frac{1}{3}^{rd} P_A$

$$\frac{33.33 \times 10^{-9} m}{\lambda_B} = \frac{1\,\cancel{P_A}}{3\,\cancel{P_A}}$$

$\therefore \lambda_B = 99.99 \times 10^{-9}$ m.

$= 0.99 \times 10^{2} \times 10^{-9}$ m

$= 0.9 \times 10^{-7}$ m

$= 1 \times 10^{-7}$ m.

QUESTION

The orbital nearest to the nucleus is [2018]

A 4f

B 5d

C 4s

D 7p

QUESTION

The correct set of quantum number for the unpaired electrons of chlorine atom is [2017]

- **A** $2, 1, -1, +\frac{1}{2}$
- **B** $2, 0, 0, +\frac{1}{2}$
- **C** $3, 1, 1, \pm\frac{1}{2}$
- **D** $3, 0, 0, \pm\frac{1}{2}$

QUESTION

Consider the following sets of quantum numbers. Which of the following setting is not permissible arrangement of electrons in an atom? [2016]

	n	l	m	s
(A)	4	0	0	$-\frac{1}{2}$
(B)	5	3	0	$+\frac{1}{2}$
(C)	3	2	–2	$-\frac{1}{2}$
(D)	3	2	–3	$+\frac{1}{2}$

QUESTION

The energy of electron in the nth Bohr orbit of H-atom is [2016]

A $-\frac{13.6}{n^2}$ ev

B $-\frac{13.6}{n}$ ev

C $-\frac{13.6}{n^4}$ ev

D $-\frac{13.6}{n^3}$ ev

QUESTION

The two electrons have the following set of quantum numbers, P = 3, 2, –2, + 1/2, Q = 3, 0, 0, + 1/2 Which of the following statement is true? [2015]

- **A** P and Q have same energy.
- **B** P has greater energy than Q.
- **C** P has lesser energy than Q.
- **D** P and Q represent same electron.

QUESTION

The statement that is not correct is [2014]

Azimathal Q. ×10.

A angular quantum number signifies the shape of the orbital. ✓ (l) →

B energies of stationary states in hydrogen like atoms is inversely proportional to the square of the principal quantum number. ✓

$E = \frac{-R_H \cdot 2^2}{n^2}$

~~**C**~~ total number of nodes for 3s-orbital is three. ✗ → n-1

$3s = 3 - 1$

$= 2$

D the radius of the first orbit of He^+ is half that of the first orbit of hydrogen atom. ✓

$r_{He} = \frac{0.53 A^\circ \times n^2}{Z} = \frac{0.53 \times 1}{2}$

$r_n = \frac{0.53 \times 1^2}{1}$

$r_H \nearrow$

QUESTION

Impossible orbital among the following is [2012]

- A 3f
- B 2p
- C 4d
- D 2s

QUESTION

The correct set of four quantum numbers for the outermost electron of sodium (Z = 11) is [2012]

(A) $3, 1, 1, \frac{1}{2}$

(B) $3, 2, 1, \frac{1}{2}$

(C) $3, 0, 0, \frac{1}{2}$

(D) $3, 1, 0, \frac{1}{2}$

QUESTION

n+l rule

$4s = 4+0 = 4$

high energy $3d = 3+2 = 5$

Which one of the following set of quantum numbers represent the highest energy level in an atom? [2012]

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

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

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

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

n+l

$3d \rightarrow 3+2 = 5$

$\boxed{4p} \rightarrow 4+1 = 5$

$n=4 \rightarrow$ high energy

QUESTION

If the energies of the two photons in the ratio of 3 : 2, the wavelength will be in the ratio of [2012]

A $2:3$

B $9:4$

C $3:2$

D $1:2$

QUESTION

The wave number of the spectral line in the emission spectrum of hydrogen will be equal to $\frac{8}{9}$ times the Rydberg's constant if the electron jumps from

[2010]

A n = 3 to n = 1

B n = 10 to n = 1

C n = 9 to n = 1

D n = 2 to n = 1

QUESTION

The set of quantum numbers for the outermost electron of copper in its ground state is [2010]

A $4, 1, 1, +\frac{1}{2}$

B $3, 2, 2, +\frac{1}{2}$

[✓ **C**] $4, 0, 0, +\frac{1}{2}$

D $4, 2, 2, +\frac{1}{2}$

$_{29}Cu \longrightarrow [Ar)\, 3d^{10}\, \boxed{4s^1}$

$\boxed{4s^1}$ ($4 \rightarrow n$, $s \rightarrow l$)

$\longrightarrow n = 4$

$\longrightarrow l = 0$

$\longrightarrow m_l = 0$

$\longrightarrow e^{\ominus} = +1/2$ or $-1/2$

QUESTION

The correct set of four quantum numbers for outermost electron of potassium (Z = 19) is [2009]

A $4, 1, 0, \frac{1}{2}$

B $3, 1, 0, \frac{1}{2}$

C $4, 0, 0, \frac{1}{2}$

D $3, 0, 0, \frac{1}{2}$

QUESTION

A body of mass x kg is moving with a velocity of 100 ms^{-1}. Its de-Broglie wavelength is 6.62×10^{-35} m Hence, x is ($h = 6.62 \times 10^{-34}$ Js) [2009]

- A 0.1 kg
- B 0.25 kg
- C 0.15 kg
- D 0.2 kg

QUESTION

When the azimuthal quantum number has the value of 2, the number of orbitals possible are [2008]

- A 7
- B 5
- C 3
- D 0

QUESTION

A body of mass 10 mg is moving with a velocity of 100 ms^{-1}. The wavelength of de-Broglie wave associated with it would be($h = 6.63 \times 10^{-34}$ Js) [2009]

- **A** 6.63×10^{-35} m
- **B** 6.63×10^{-34} m
- **C** 6.63×10^{-31} m ✓
- **D** 6.63×10^{-37} m

$m = 10 \times 10^{-3} g \longrightarrow 10 \times 10^{-6} kg$

$v = 100 m s^{-1}$

$$\lambda = \frac{6.6 \times 10^{-34} \, kg \, m^2 s^{-1}}{10 \times 10^{-6} \, \cancel{kg} \times 100 \, \cancel{m s^{-1}}}$$

$$\lambda = \frac{6.6 \times 10^{-34}}{10^{-3}} = \boxed{6.6 \times 10^{-31} m}$$

Chemistry practicals.

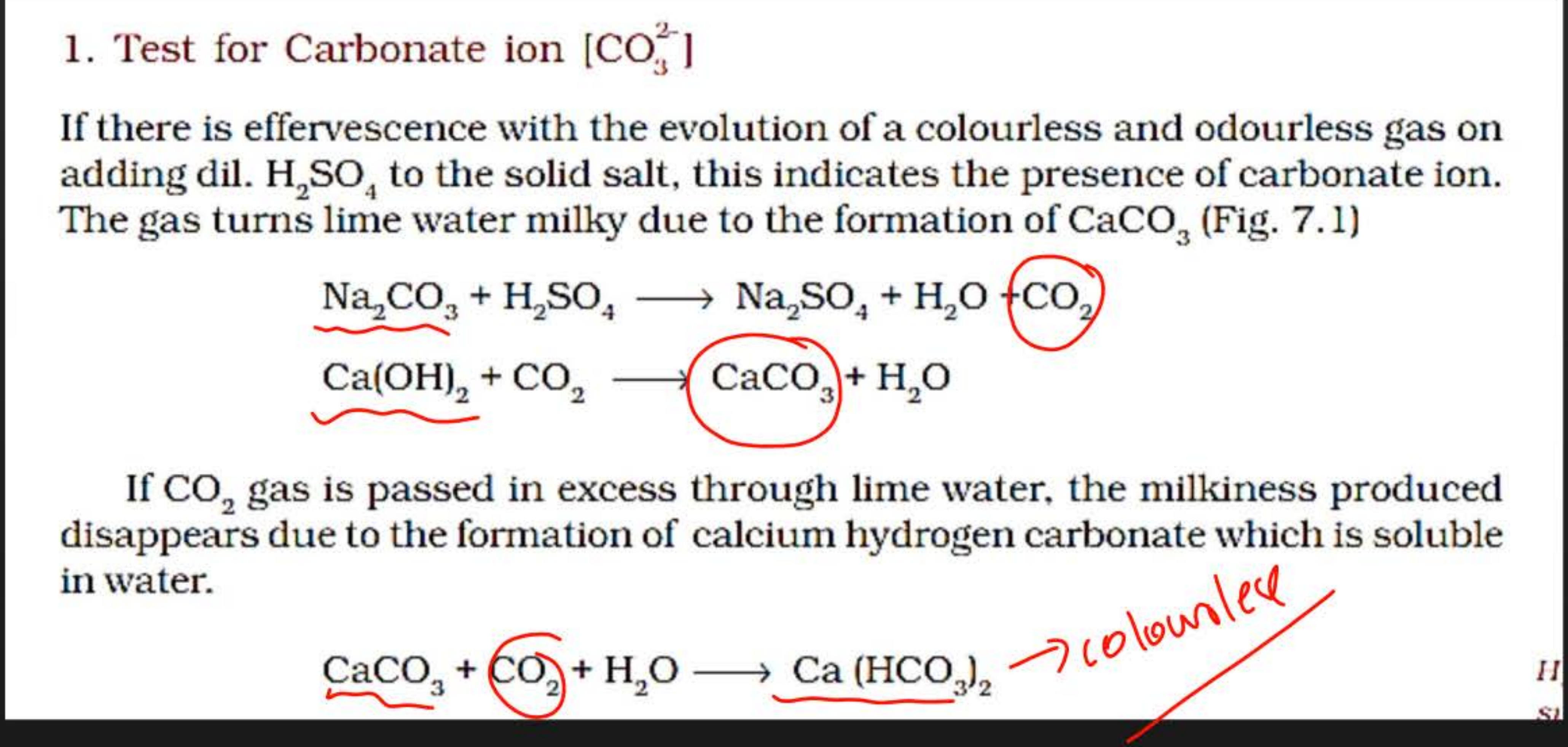
Synopsis. & types of Qustion asked.

→ 02 Question

- Chemical principles involved in the qualitative salt analysis:

Cations – Al^{3+}, Zn^{2+}, Ca^{2+}, Ba^{2+}, Mg^{2+}, NH_4^+

Anions- CO_3^{2-}, SO_4^{2-}, NO_3^-, Cl^-, Br^- (Insoluble salts excluded).



1. Test for Carbonate ion [CO_3^{2-}]

If there is effervescence with the evolution of a colourless and odourless gas on adding dil. H_2SO_4 to the solid salt, this indicates the presence of carbonate ion. The gas turns lime water milky due to the formation of $CaCO_3$ (Fig. 7.1)

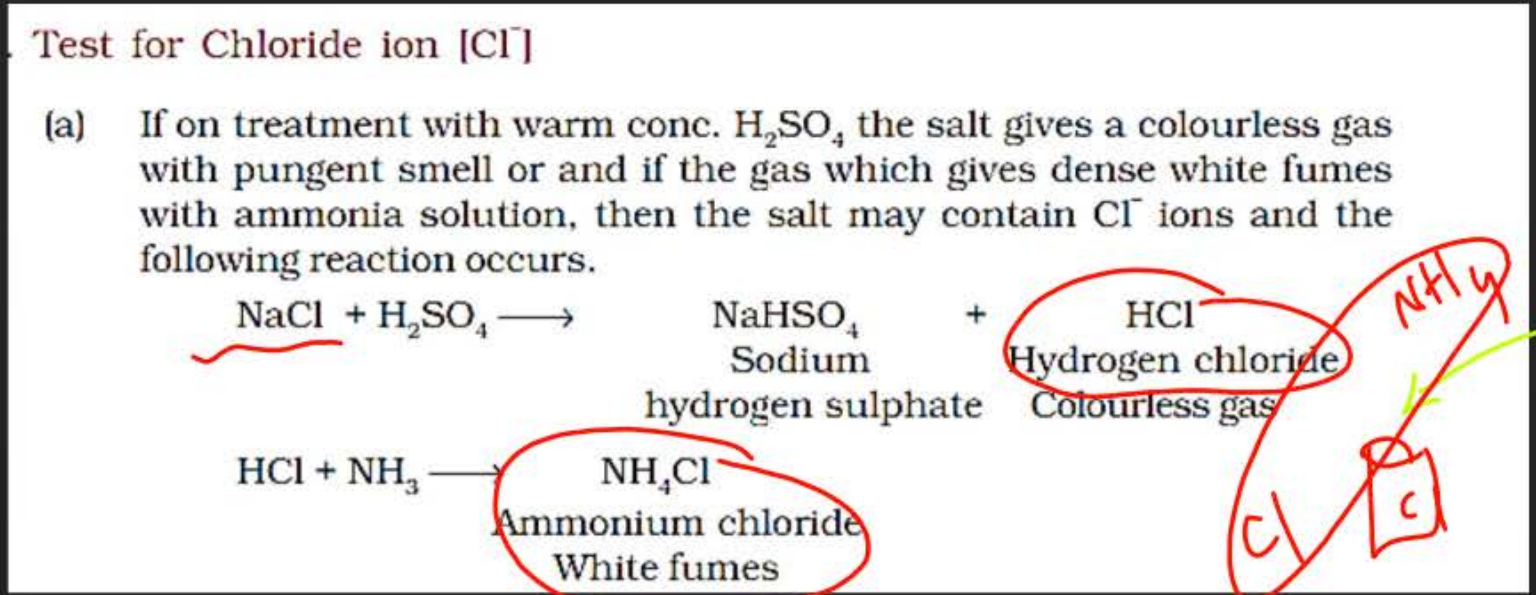
$$Na_2CO_3 + H_2SO_4 \longrightarrow Na_2SO_4 + H_2O + CO_2$$

$$Ca(OH)_2 + CO_2 \longrightarrow CaCO_3 + H_2O$$

If CO_2 gas is passed in excess through lime water, the milkiness produced disappears due to the formation of calcium hydrogen carbonate which is soluble in water.

$$CaCO_3 + CO_2 + H_2O \longrightarrow Ca(HCO_3)_2$$

→ colourless



Test for Chloride ion [Cl$^-$]

(a) If on treatment with warm conc. H_2SO_4 the salt gives a colourless gas with pungent smell or and if the gas which gives dense white fumes with ammonia solution, then the salt may contain Cl$^-$ ions and the following reaction occurs.

$$\underset{}{NaCl} + H_2SO_4 \longrightarrow \underset{\text{Sodium hydrogen sulphate}}{NaHSO_4} + \underset{\substack{\text{Hydrogen chloride}\\ \text{Colourless gas}}}{HCl}$$

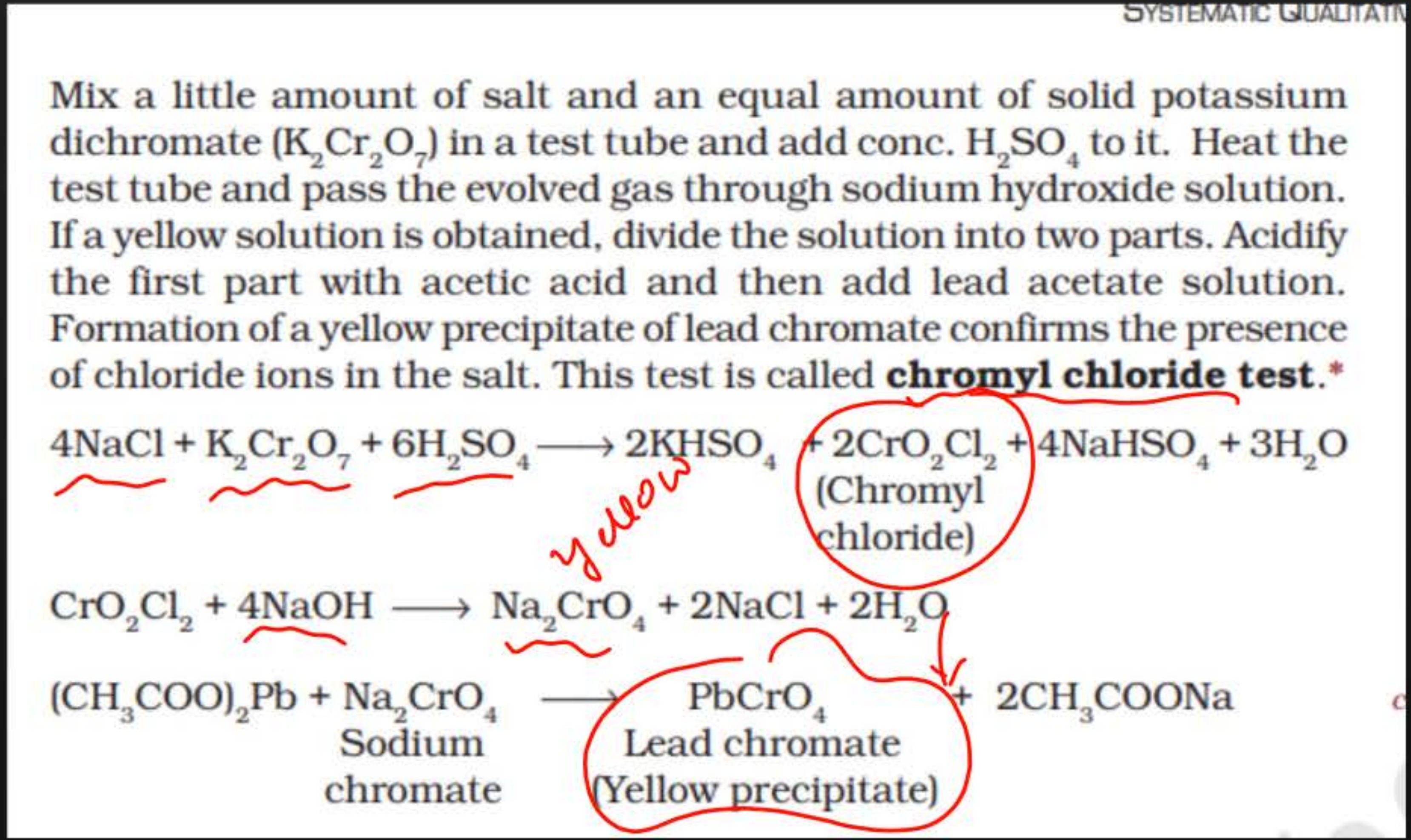
$$HCl + NH_3 \longrightarrow \underset{\substack{\text{Ammonium chloride}\\ \text{White fumes}}}{NH_4Cl}$$

NH4

Cl

c

→NH4OH



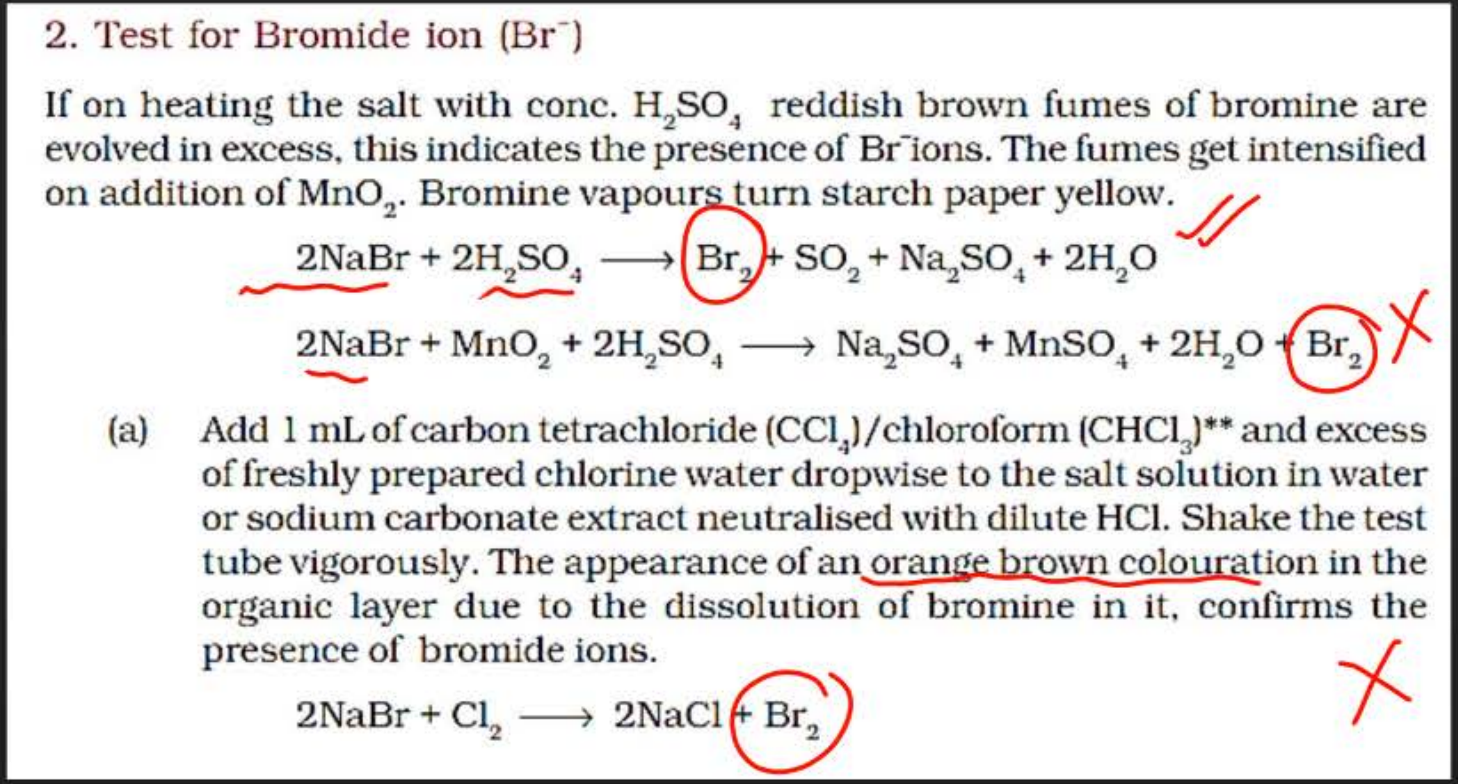
Mix a little amount of salt and an equal amount of solid potassium dichromate ($K_2Cr_2O_7$) in a test tube and add conc. H_2SO_4 to it. Heat the test tube and pass the evolved gas through sodium hydroxide solution. If a yellow solution is obtained, divide the solution into two parts. Acidify the first part with acetic acid and then add lead acetate solution. Formation of a yellow precipitate of lead chromate confirms the presence of chloride ions in the salt. This test is called **chromyl chloride test**.*

$$4NaCl + K_2Cr_2O_7 + 6H_2SO_4 \longrightarrow 2KHSO_4 + \underset{\text{(Chromyl chloride)}}{2CrO_2Cl_2} + 4NaHSO_4 + 3H_2O$$

yellow

$$CrO_2Cl_2 + 4NaOH \longrightarrow Na_2CrO_4 + 2NaCl + 2H_2O$$

$$(CH_3COO)_2Pb + \underset{\text{Sodium chromate}}{Na_2CrO_4} \longrightarrow \underset{\substack{\text{Lead chromate}\\ \text{(Yellow precipitate)}}}{PbCrO_4} + 2CH_3COONa$$



2. Test for Bromide ion (Br^-)

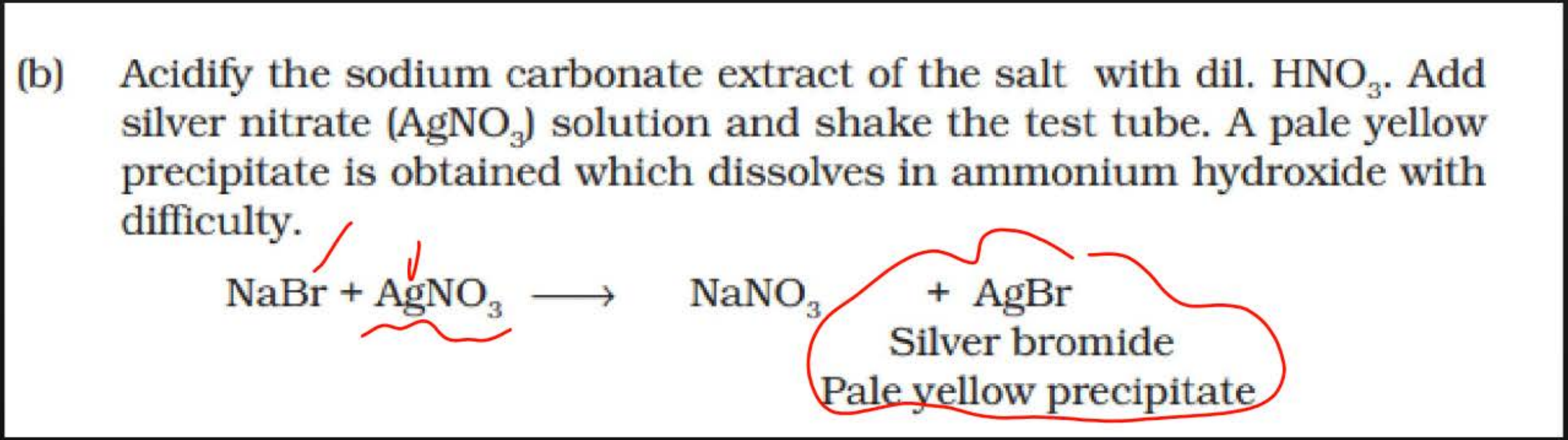
If on heating the salt with conc. H_2SO_4 reddish brown fumes of bromine are evolved in excess, this indicates the presence of Br^- ions. The fumes get intensified on addition of MnO_2. Bromine vapours turn starch paper yellow.

$$2NaBr + 2H_2SO_4 \longrightarrow Br_2 + SO_2 + Na_2SO_4 + 2H_2O$$

$$2NaBr + MnO_2 + 2H_2SO_4 \longrightarrow Na_2SO_4 + MnSO_4 + 2H_2O + Br_2$$

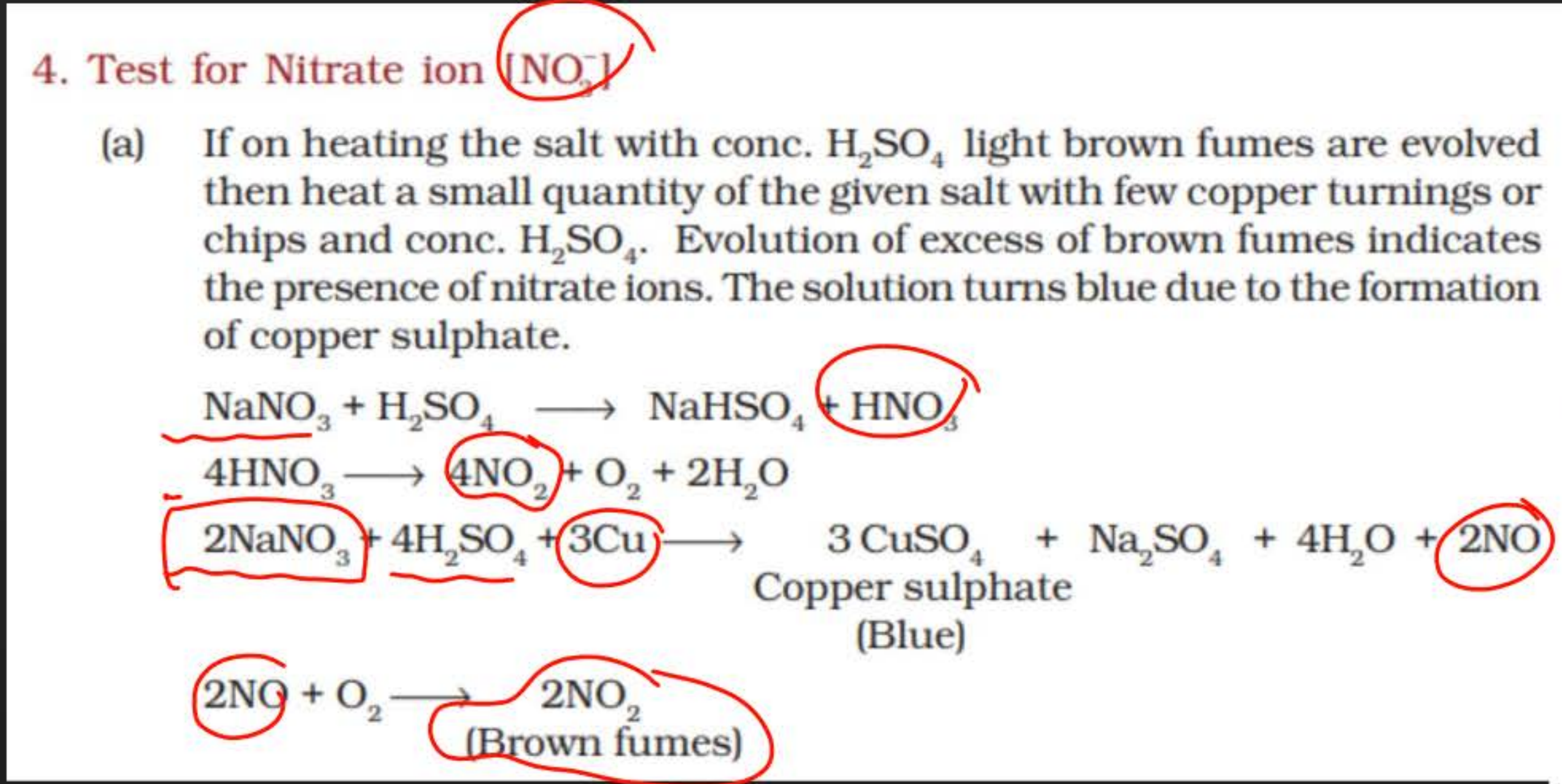
(a) Add 1 mL of carbon tetrachloride (CCl_4)/chloroform ($CHCl_3$)** and excess of freshly prepared chlorine water dropwise to the salt solution in water or sodium carbonate extract neutralised with dilute HCl. Shake the test tube vigorously. The appearance of an orange brown colouration in the organic layer due to the dissolution of bromine in it, confirms the presence of bromide ions.

$$2NaBr + Cl_2 \longrightarrow 2NaCl + Br_2$$



(b) Acidify the sodium carbonate extract of the salt with dil. HNO_3. Add silver nitrate ($AgNO_3$) solution and shake the test tube. A pale yellow precipitate is obtained which dissolves in ammonium hydroxide with difficulty.

$$NaBr + AgNO_3 \longrightarrow NaNO_3 + \underset{\substack{\text{Silver bromide} \\ \text{Pale yellow precipitate}}}{AgBr}$$



4. Test for Nitrate ion [NO_3^-]

(a) If on heating the salt with conc. H_2SO_4 light brown fumes are evolved then heat a small quantity of the given salt with few copper turnings or chips and conc. H_2SO_4. Evolution of excess of brown fumes indicates the presence of nitrate ions. The solution turns blue due to the formation of copper sulphate.

$$NaNO_3 + H_2SO_4 \longrightarrow NaHSO_4 + HNO_3$$

$$4HNO_3 \longrightarrow 4NO_2 + O_2 + 2H_2O$$

$$2NaNO_3 + 4H_2SO_4 + 3Cu \longrightarrow \underset{\substack{\text{Copper sulphate} \\ \text{(Blue)}}}{3\,CuSO_4} + Na_2SO_4 + 4H_2O + 2NO$$

$$2NO + O_2 \longrightarrow \underset{\text{(Brown fumes)}}{2NO_2}$$

Take 1 mL of an aqueous solution of the salt and add 2 mL conc. H_2SO_4 slowly. Mix the solutions thoroughly and cool the test tube under the tap. Now, add freshly prepared ferrous sulphate solution along the sides of the test tube dropwise so that it forms a layer on the top of the liquid already present in the test tube. A dark brown ring is formed at the junction of the two solutions due to the formation of nitroso ferrous sulphate (Fig. 7.2). Alternatively first ferrous sulphate is added and then concentrated sulphuric acid is added.

Oxc

Fig. 7.2 : Formation of brown ring

$$NaNO_3 + H_2SO_4 \longrightarrow Na\,HSO_4 + HNO_3$$

$$6\,FeSO_4 + 3H_2SO_4 + 2HNO_3 \longrightarrow 3Fe_2(SO_4)_3 + 4H_2O + 2NO$$

$$FeSO_4 + NO \longrightarrow \underset{\substack{\text{Nitroso ferrous sulphate} \\ \text{(Brown)}}}{[Fe(NO)]SO_4}$$

✓✓

1. Test of Sulphate ions [SO_4^{2-}]

(a) Aqueous solution or sodium carbonate extract of the salt acidified with acetic acid on addition of barium chloride gives a white precipitate of barium sulphate insoluble in conc. HCl or conc. HNO_3.

$$Na_2SO_4 + BaCl_2 \longrightarrow \underset{\text{(White precipitate)}}{\underset{\text{Barium sulphate}}{BaSO_4}} \downarrow + 2NaCl$$

PbS

PbSO4

(b) Sulphate ions give white precipitate of lead sulphate when aqueous solution or sodium carbonate extract neutralised with acetic acid is treated with lead acetate solution.

$$Na_2SO_4 + \underline{(CH_3COO)_2Pb} \longrightarrow \underset{\text{(White precipitate)}}{\underset{\text{Lead sulphate}}{PbSO_4}} \downarrow + 2CH_3COONa$$

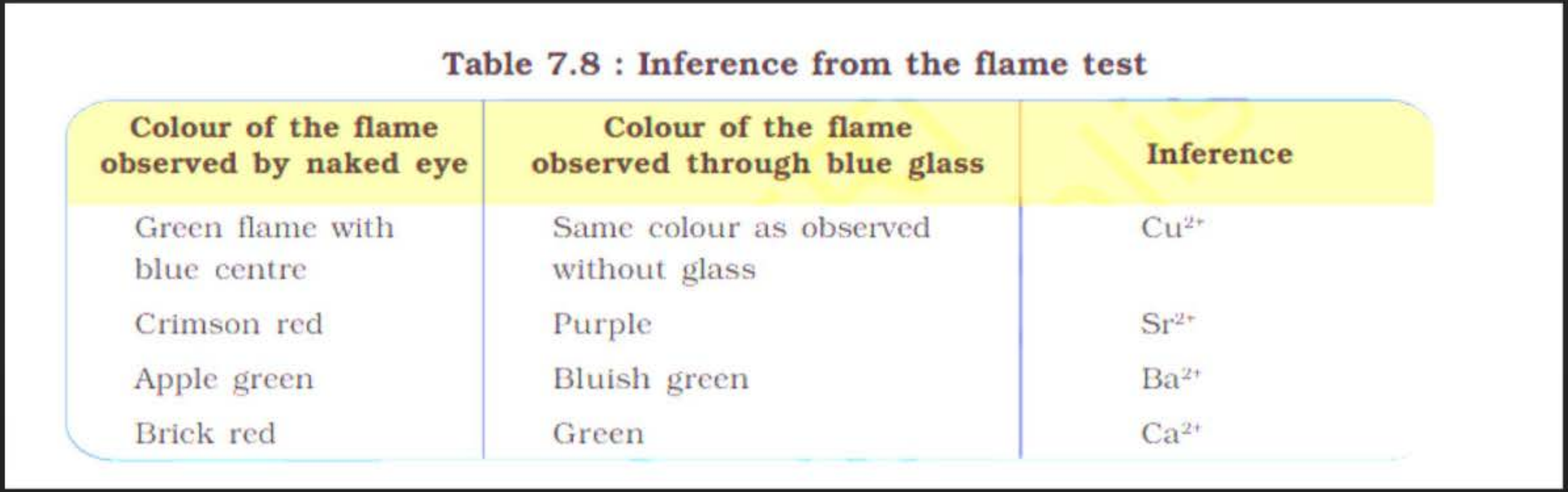
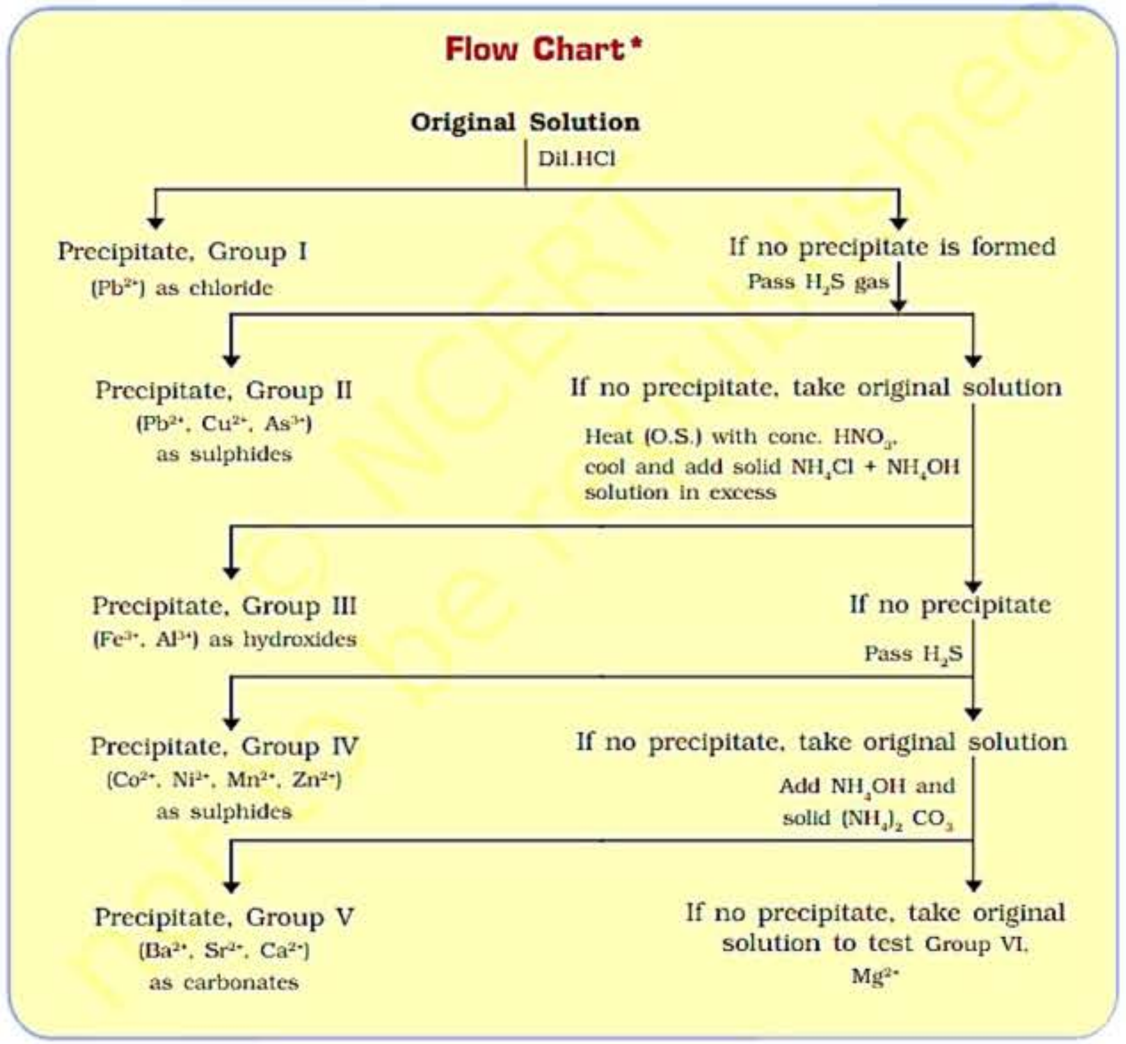


Table 7.8 : Inference from the flame test

Colour of the flame observed by naked eye	Colour of the flame observed through blue glass	Inference
Green flame with blue centre	Same colour as observed without glass	Cu^{2+}
Crimson red	Purple	Sr^{2+}
Apple green	Bluish green	Ba^{2+}
Brick red	Green	Ca^{2+}



Flow Chart*

Original Solution

Dil.HCl

Precipitate, Group I
(Pb^{2+}) as chloride

If no precipitate is formed
Pass H_2S gas

Precipitate, Group II
$(Pb^{2+}, Cu^{2+}, As^{3+})$
as sulphides

If no precipitate, take original solution
Heat (O.S.) with conc. HNO_3, cool and add solid $NH_4Cl + NH_4OH$ solution in excess

Precipitate, Group III
(Fe^{3+}, Al^{3+}) as hydroxides

If no precipitate
Pass H_2S

Precipitate, Group IV
$(Co^{2+}, Ni^{2+}, Mn^{2+}, Zn^{2+})$
as sulphides

If no precipitate, take original solution
Add NH_4OH and solid $(NH_4)_2CO_3$

Precipitate, Group V
$(Ba^{2+}, Sr^{2+}, Ca^{2+})$
as carbonates

If no precipitate, take original solution to test Group VI, Mg^{2+}

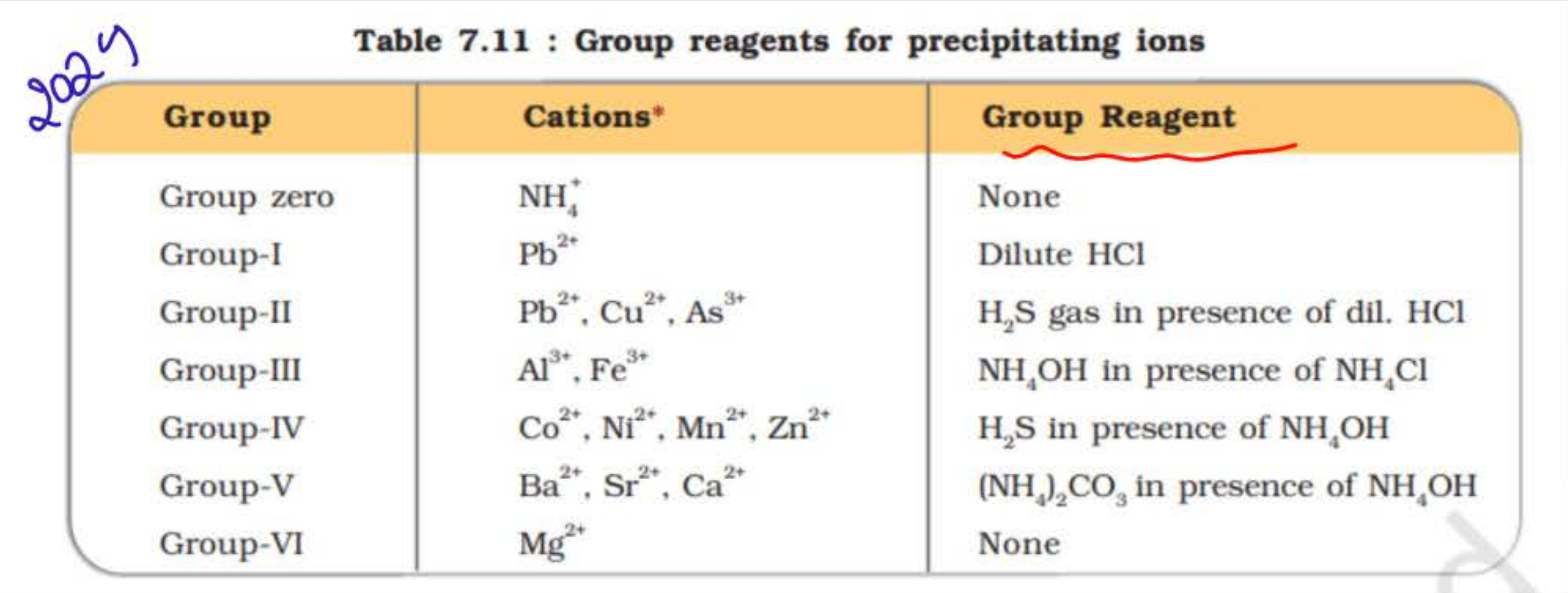


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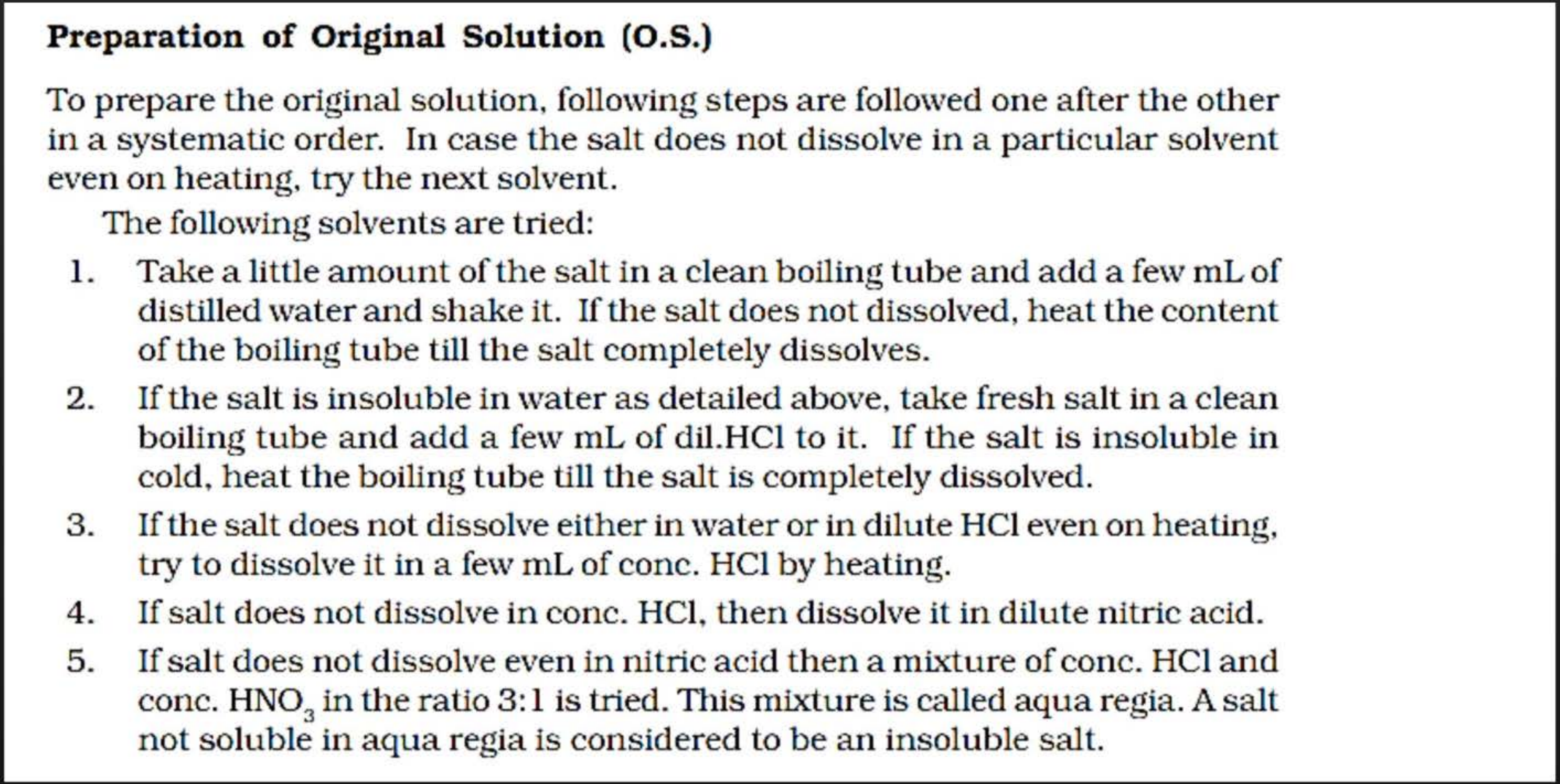
Table 7.11 : Group reagents for precipitating ions

Group	Cations*	Group Reagent
Group zero	NH_4^+	None
Group-I	Pb^{2+}	Dilute HCl
Group-II	$Pb^{2+}, Cu^{2+}, As^{3+}$	H_2S gas in presence of dil. HCl
Group-III	Al^{3+}, Fe^{3+}	NH_4OH in presence of NH_4Cl
Group-IV	$Co^{2+}, Ni^{2+}, Mn^{2+}, Zn^{2+}$	H_2S in presence of NH_4OH
Group-V	$Ba^{2+}, Sr^{2+}, Ca^{2+}$	$(NH_4)_2CO_3$ in presence of NH_4OH
Group-VI	Mg^{2+}	None



Preparation of Original Solution (O.S.)

To prepare the original solution, following steps are followed one after the other in a systematic order. In case the salt does not dissolve in a particular solvent even on heating, try the next solvent.

The following solvents are tried:

1. Take a little amount of the salt in a clean boiling tube and add a few mL of distilled water and shake it. If the salt does not dissolved, heat the content of the boiling tube till the salt completely dissolves.
2. If the salt is insoluble in water as detailed above, take fresh salt in a clean boiling tube and add a few mL of dil.HCl to it. If the salt is insoluble in cold, heat the boiling tube till the salt is completely dissolved.
3. If the salt does not dissolve either in water or in dilute HCl even on heating, try to dissolve it in a few mL of conc. HCl by heating.
4. If salt does not dissolve in conc. HCl, then dissolve it in dilute nitric acid.
5. If salt does not dissolve even in nitric acid then a mixture of conc. HCl and conc. HNO_3 in the ratio 3:1 is tried. This mixture is called aqua regia. A salt not soluble in aqua regia is considered to be an insoluble salt.

Group Analysis

(I) Analysis of Group-zero cation (NH_4^+ ion)

(a) Take 0.1 g of salt in a test tube and add 1-2 mL of NaOH solution to it and heat. If there is a smell of ammonia, this indicates the presence of ammonium ions. Bring a glass rod dipped in hydrochloric acid near the mouth of the test tube. White fumes are observed.

(b) Pass the gas through Nessler's reagent. Brown precipitate is obtained.

Chemistry of Confirmatory Tests for NH_4^+ ion

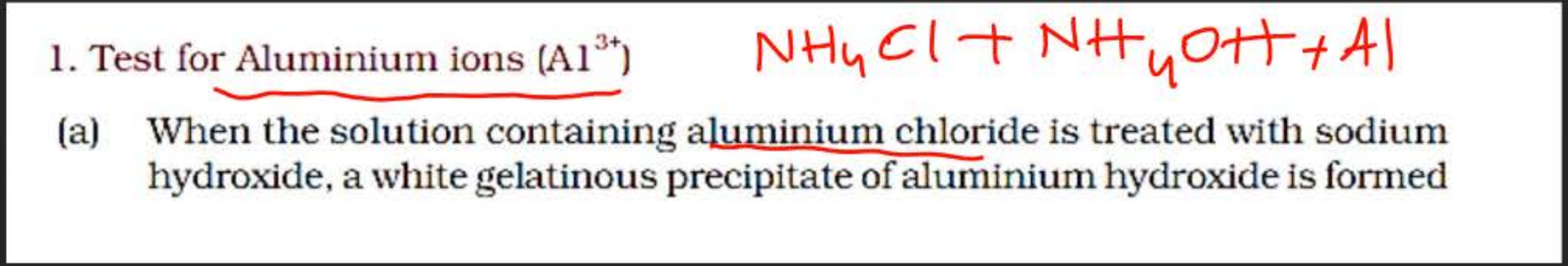
(a) Ammonia gas evolved by the action of sodium hydroxide on ammonium salts reacts with hydrochloric acid to give ammonium chloride, which is visible as dense white fume.

$$\underline{(NH_4)_2SO_4} + \underline{2NaOH} \longrightarrow Na_2SO_4 + \boxed{2NH_3} + 2H_2O$$

$$NH_3 + HCl \rightarrow NH_4Cl$$

Chemistry of confirmatory tests of Group-III cations

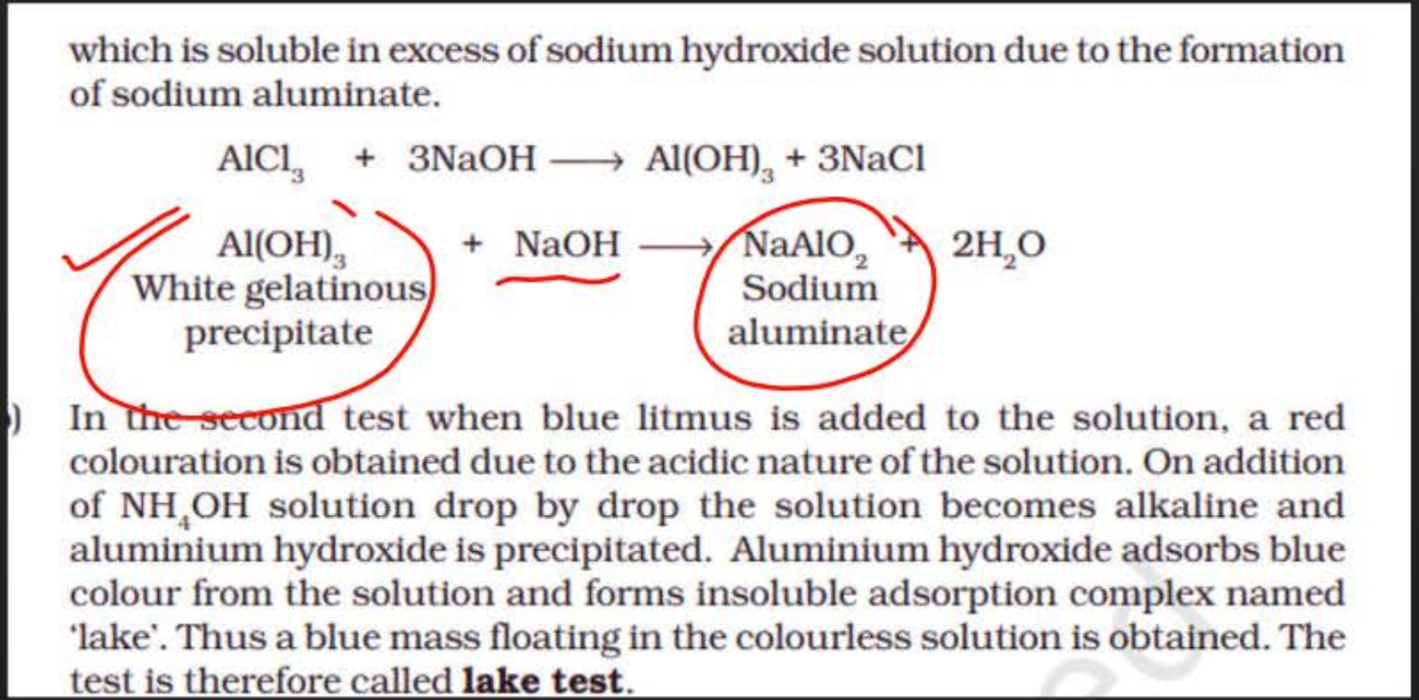
$AlCl_3 + NH_4Cl + NH_4OH \longrightarrow$



1. Test for Aluminium ions (Al^{3+})

$NH_4Cl + NH_4OH + Al$

(a) When the solution containing aluminium chloride is treated with sodium hydroxide, a white gelatinous precipitate of aluminium hydroxide is formed



which is soluble in excess of sodium hydroxide solution due to the formation of sodium aluminate.

$$AlCl_3 + 3NaOH \longrightarrow Al(OH)_3 + 3NaCl$$

$$\underset{\text{White gelatinous precipitate}}{Al(OH)_3} + NaOH \longrightarrow \underset{\text{Sodium aluminate}}{NaAlO_2} + 2H_2O$$

In the second test when blue litmus is added to the solution, a red colouration is obtained due to the acidic nature of the solution. On addition of NH_4OH solution drop by drop the solution becomes alkaline and aluminium hydroxide is precipitated. Aluminium hydroxide adsorbs blue colour from the solution and forms insoluble adsorption complex named 'lake'. Thus a blue mass floating in the colourless solution is obtained. The test is therefore called **lake test**.

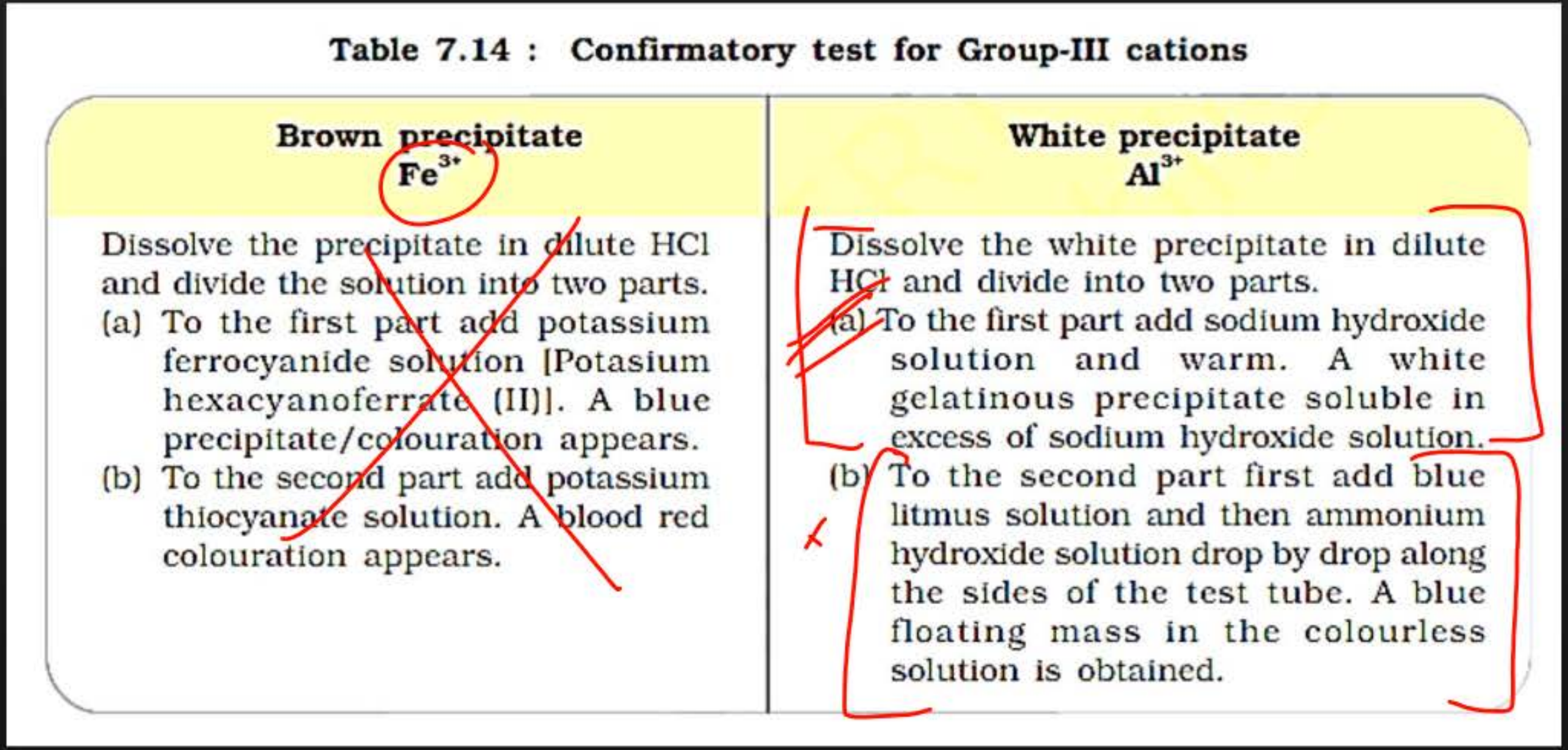
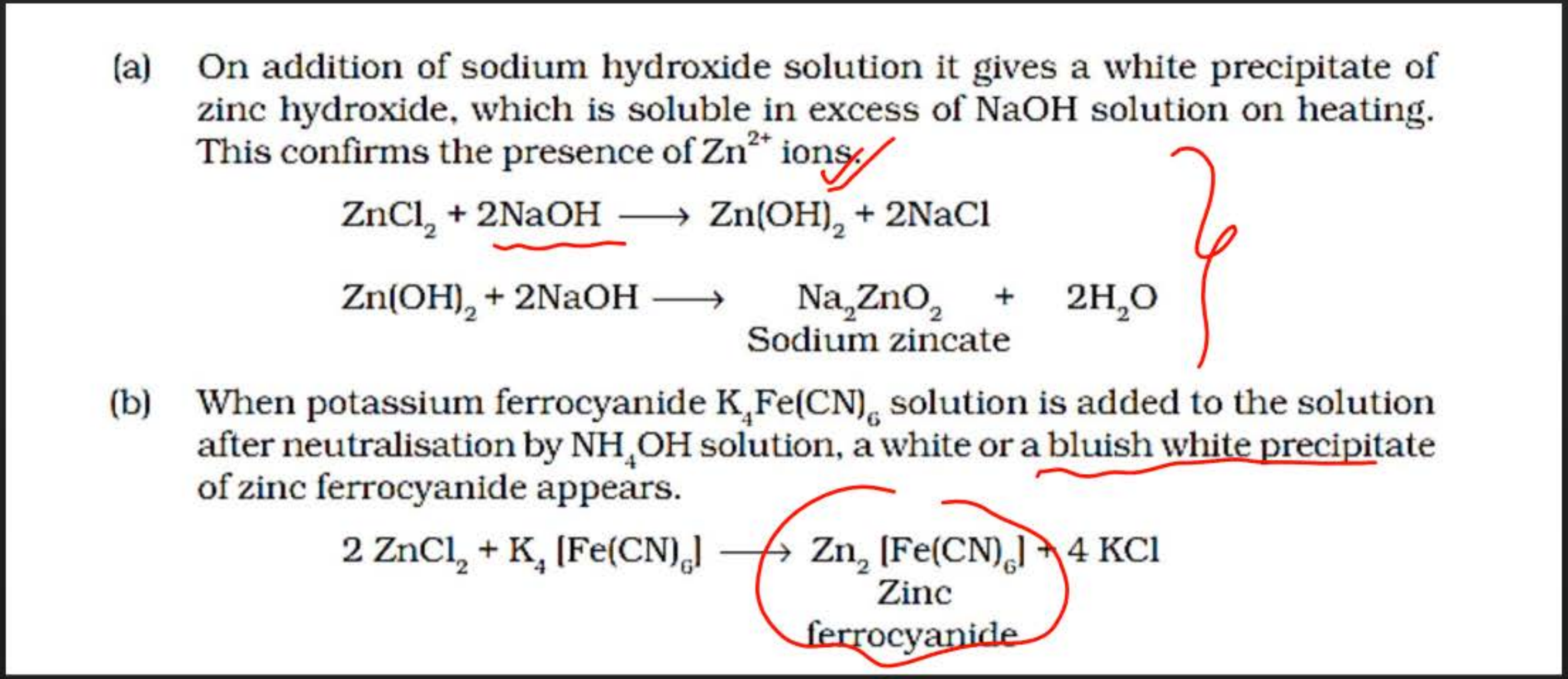


Table 7.14 : Confirmatory test for Group-III cations

Brown precipitate Fe^{3+}	**White precipitate Al^{3+}**
Dissolve the precipitate in dilute HCl and divide the solution into two parts. (a) To the first part add potassium ferrocyanide solution [Potasium hexacyanoferrate (II)]. A blue precipitate/colouration appears. (b) To the second part add potassium thiocyanate solution. A blood red colouration appears.	Dissolve the white precipitate in dilute HCl and divide into two parts. (a) To the first part add sodium hydroxide solution and warm. A white gelatinous precipitate soluble in excess of sodium hydroxide solution. (b) To the second part first add blue litmus solution and then ammonium hydroxide solution drop by drop along the sides of the test tube. A blue floating mass in the colourless solution is obtained.



(a) On addition of sodium hydroxide solution it gives a white precipitate of zinc hydroxide, which is soluble in excess of NaOH solution on heating. This confirms the presence of Zn^{2+} ions.

$$ZnCl_2 + 2NaOH \longrightarrow Zn(OH)_2 + 2NaCl$$

$$Zn(OH)_2 + 2NaOH \longrightarrow \underset{\text{Sodium zincate}}{Na_2ZnO_2} + 2H_2O$$

(b) When potassium ferrocyanide $K_4Fe(CN)_6$ solution is added to the solution after neutralisation by NH_4OH solution, a white or a bluish white precipitate of zinc ferrocyanide appears.

$$2\,ZnCl_2 + K_4\,[Fe(CN)_6] \longrightarrow \underset{\text{Zinc ferrocyanide}}{Zn_2\,[Fe(CN)_6]} + 4\,KCl$$

(VI) Analysis of Group–V cations

If group-IV is absent then take original solution and add a small amount of solid NH_4Cl and an excess of NH_4OH solution followed by solid ammonium carbonate $(NH_4)_2CO_3$. If a white precipitate appears, this indicates the presence of group–V cations.

Dissolve the white precipitate by boiling with dilute acetic acid and divide the solution into three parts one each for Ba^{2+}, Sr^{2+} and Ca^{2+} ions. **Preserve a small amount of the precipitate for flame test**. Summary of confirmatory tests is given in Table 7.16.

Table 7.16 : Confirmatory test for Group–V cations

$CaCO_3$

$BaCO_3$

Dissolve the precipitate by boiling with dilute acetic acid and divide the solution into three parts one each for Ba^{2+}, Sr^{2+} and Ca^{2+} ions		
Ba^{2+} ions ✓	**Sr^{2+} ions**	**Ca^{2+} ions** ✓
(a) To the first part add potassium chromate solution. A yellow precipitate appears. (b) Perform the flame test with the preserved precipitate. A grassy green flame is obtained.	(a) If barium is absent, take second part of the solution and add ammonium sulphate solution. Heat and scratch the sides of the test tube with a glass rod and cool. A white precipitate is formed. (b) Perform the flame test with the preserved precipitate. A crimson-red flame confirms the presence of Sr^{2+} ions.	(a) If both barium and strontium are absent, take the third part of the solution. Add ammonium oxalate solution and shake well. A white precipitate of calcium oxalate is obtained. (b) Perform the flame test with the preserved precipitate. A brick red flame, which looks greenish-yellow through blue glass, confirms the presence of Ca^{2+} ions.

1. Test for Barium ion (Ba^{2+})

(a) Potassium chromate (K_2CrO_4) solution gives a yellow precipitate of barium chromate when the solution of fifth group precipitate in acetic acid is treated with it.

$$BaCO_3 + 2CH_3COOH \longrightarrow (CH_3COO)_2Ba + H_2O + CO_2$$

$$(CH_3COO)_2Ba + \boxed{K_2CrO_4} \longrightarrow \underset{\substack{\text{Barium chromate}\\\text{(yellow precipitate)}}}{BaCrO_4} + 2CH_3COOK$$

2. Test for Strontium ion (Sr^{2+})

(a) Solution of V group precipitate in acetic acid gives a white precipitate of strontium sulphate with ammonium sulphate, $(NH_4)_2SO_4$, solution on heating and scratching the sides of the test tube with a glass rod.

$$SrCO_3 + 2CH_3COOH \longrightarrow (CH_3COO)_2Sr + H_2O + CO_2$$

$$(CH_3COO)_2Sr + (NH_4)_2SO_4 \longrightarrow \underset{\substack{\text{Strontium}\\\text{sulphate}\\\text{(White precipitate)}}}{SrSO_4} + 2CH_3COONH_4$$

(b) **Flame test –** Perform the flame test as given in the case of Ba^{2+}. A crimson red flame confirms the presence of Sr^{2+} ions.

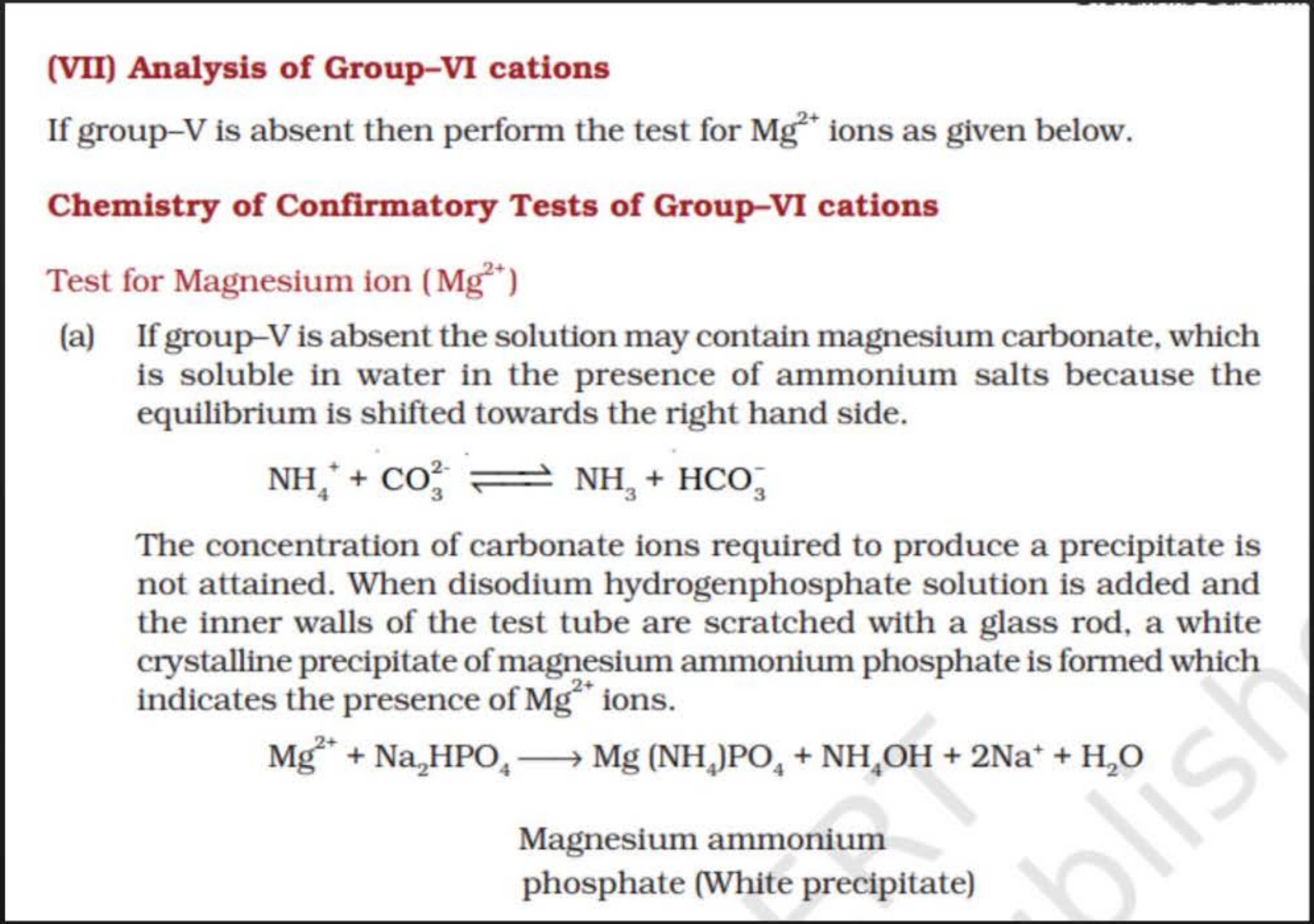
3. Test for Calcium ion (Ca^{2+})

(a) Solution of the fifth group precipitate in acetic acid gives a white precipitate with ammonium oxalate solution.

$$CaCO_3 + 2CH_3COOH \longrightarrow (CH_3COO)_2Ca + H_2O + CO_2$$

$$(CH_3COO)_2Ca + \boxed{\underset{\substack{\text{Ammonium}\\\text{oxalate}}}{(NH_4)_2C_2O_4}} \longrightarrow \underset{\substack{\text{Calcium oxalate}\\\text{(White precipitate)}}}{(COO)_2Ca} + 2CH_3COONH_4$$

(b) **Flame test –** Perform the flame test as mentioned above. Calcium imparts brick red colour to the flame which looks greenish-yellow through blue glass.



(VII) Analysis of Group–VI cations

If group–V is absent then perform the test for Mg^{2+} ions as given below.

Chemistry of Confirmatory Tests of Group–VI cations

Test for Magnesium ion (Mg^{2+})

(a) If group–V is absent the solution may contain magnesium carbonate, which is soluble in water in the presence of ammonium salts because the equilibrium is shifted towards the right hand side.

$$NH_4^+ + CO_3^{2-} \rightleftharpoons NH_3 + HCO_3^-$$

The concentration of carbonate ions required to produce a precipitate is not attained. When disodium hydrogenphosphate solution is added and the inner walls of the test tube are scratched with a glass rod, a white crystalline precipitate of magnesium ammonium phosphate is formed which indicates the presence of Mg^{2+} ions.

$$Mg^{2+} + Na_2HPO_4 \longrightarrow Mg\,(NH_4)PO_4 + NH_4OH + 2Na^+ + H_2O$$

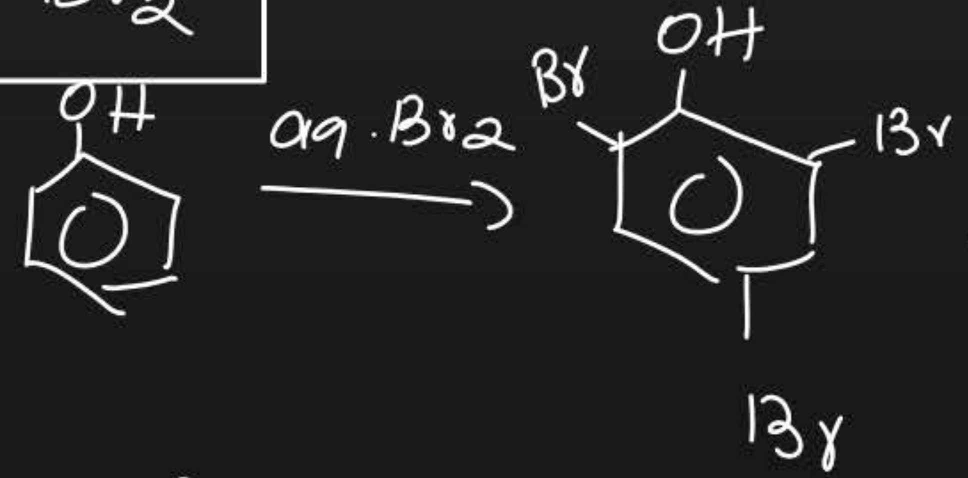
Magnesium ammonium
phosphate (White precipitate)

- Detection of the following functional groups; hydroxyl (alcoholic and phenolic), carbonyl (aldehyde and ketones) carboxyl, and amino groups in organic compounds.

phenol + alcohol

* → $FeCl_3$ → coloured complex → phenol
→ alcohol → do not answer

* $\boxed{aq \cdot Br_2}$



2,4,6-tribromo phenol white ppt

aq. Br_2 → No reaction with alcohol.

Aldehyde + ketones

Alldehyde → Tollen's reagent
ketone → No response

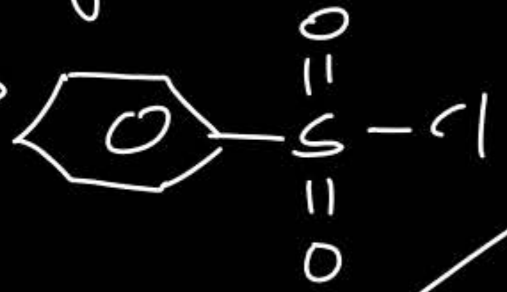
do not answer — Aromatic aldehyde
+ aliphatic aldehyde
Felhing solution test
→ Felhing's solution
ketone → No response to Felhing solution.

Aminogroups → separation

Carbylamine → only 1° aliphatic or aromatic amines

$[CHCl_3 + KOH]$ → RNC

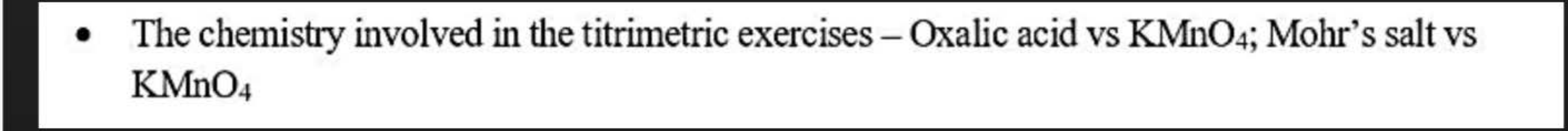
Hinsberg reagent

→ 
→ only for 1° & 2° amine

do not answer for 3° amine

1° amine → soluble in alkali

2° amine → insoluble in alkali.



- The chemistry involved in the titrimetric exercises – Oxalic acid vs $KMnO_4$; Mohr's salt vs $KMnO_4$

Aim

acid $\rightarrow H_2SO_4$

To determine the concentration/molarity of $KMnO_4$ solution by titrating it against a 0.1 M standard solution of oxalic acid.

Theory

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

$$2KMnO_4 + 16HCl \longrightarrow 2KCl + 2MnCl_2 + 5Cl_2 + 8H_2O$$

$Cl^{\ominus}$

$$MnO_4^{\ominus} + C_2O_4^{2-} + HCl \longrightarrow Mn^{2+} + Cl_2\uparrow$$

Titration of potassium permanganate solution against standard oxalic acid solution

Sl. No.	Volume of Oxalic acid in mL	Burette readings		Volume (V) of $KMnO_4$ used $V = (y–x)$ mL
		Initial (x)	Final (y)	

Calculations

(i) The strength of the unknown solution in terms of molarity may be determined by the following equation. $a_1M_1V_1 = a_2M_2V_2$

Oxalic acid		KMnO$_4$
$2M_1\,V_1$	$=$	$5M_2V_2$

$$M_2 = \frac{2}{5}\frac{M_1V_1}{V_2}$$

$5e^{\ominus}$

$$2MnO_4^{\ominus} + 5C_2O_4^{2-} + H^{\oplus} \longrightarrow Mn^{2+} + CO_2 + H_2O$$

$2e^{\ominus}$

Strength of the solution is given by the following equation:

$$\boxed{\text{Strength} = \text{Molarity} \times \text{Molar mass}}$$

$M_2 \times KMnO_4$

Result

(i) Molarity of $KMnO_4$ solution is ______.

(ii) Strength of $KMnO_4$ solution is ______.

Aim

To determine the concentration/molarity of $KMnO_4$ solution by titrating it against standard solution of ferrous ammonium sulphate.

Theory

Like oxalic acid, ferrous ammonium sulphate also acts as a reducing agent in the titration against potassium permanganate. The reaction which takes place is given below :

$1e^{\ominus}$

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

$5e^{\ominus}$

Titration of potassium permanganate solution against standard ferrous ammonium sulphate solution

Sl. No.	Volume of ferrous ammonium sulphate solution used for each titration in mL	Burette Readings		Volume (V) of $KMnO_4$ used $V = (y–x)$ mL
		Initial (x)	Final (y)	

Calculations

The strength of unknown solution in terms of molarity may be determined by the following equation : $\boxed{a_1M_1V_1 = a_2M_2V_2}$

$KMnO_4$ Fe^{2+}

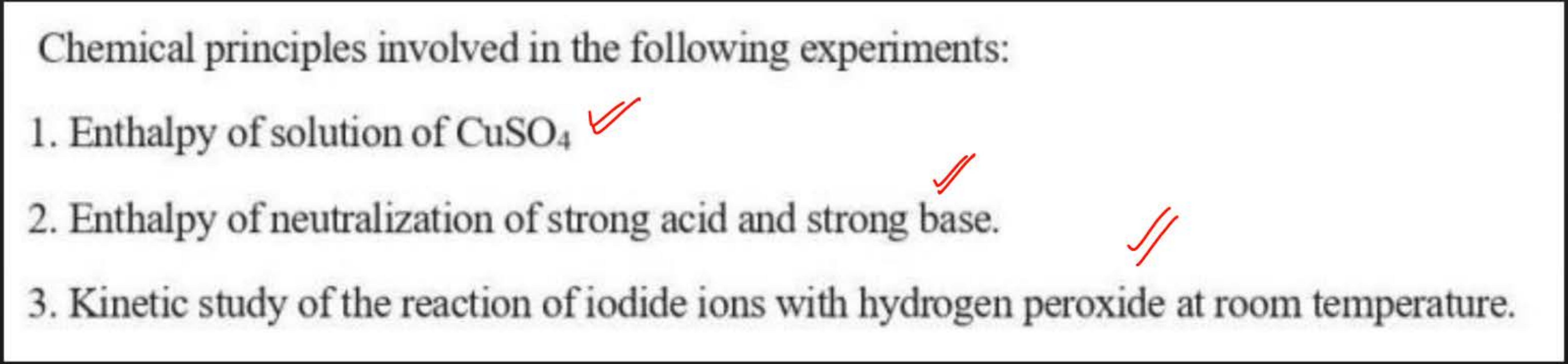
$5 \times M_1V_1$ $1 \times M_2 \times V_2$

Strength can be calculated by the formula given below :

Strength = Molarity × Molar mass

Result

The strength of the given potassium permanganate solution is ____ g/L.

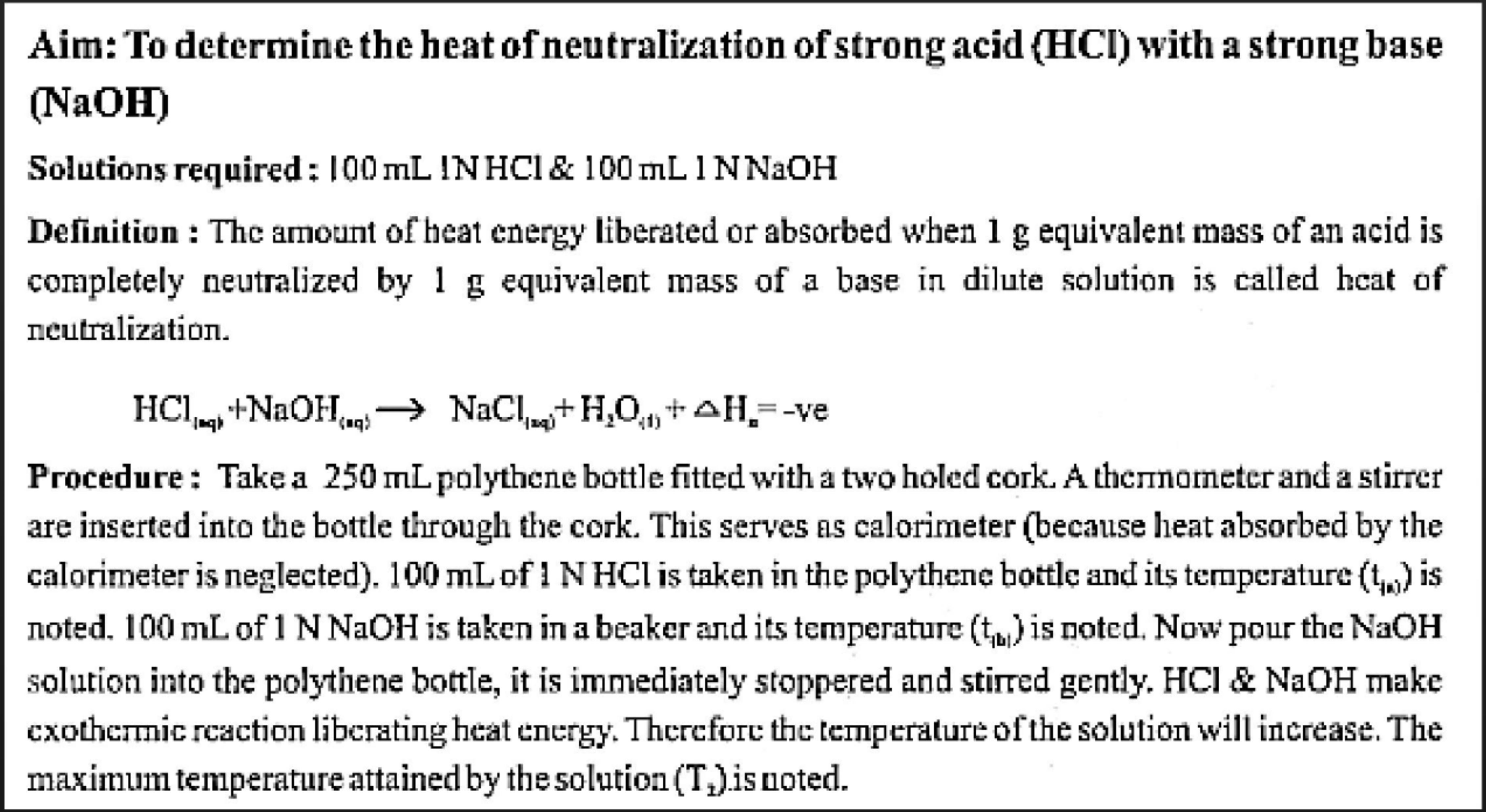


Chemical principles involved in the following experiments:

1. Enthalpy of solution of $CuSO_4$ ✓

2. Enthalpy of neutralization of strong acid and strong base. ✓

3. Kinetic study of the reaction of iodide ions with hydrogen peroxide at room temperature. ✓



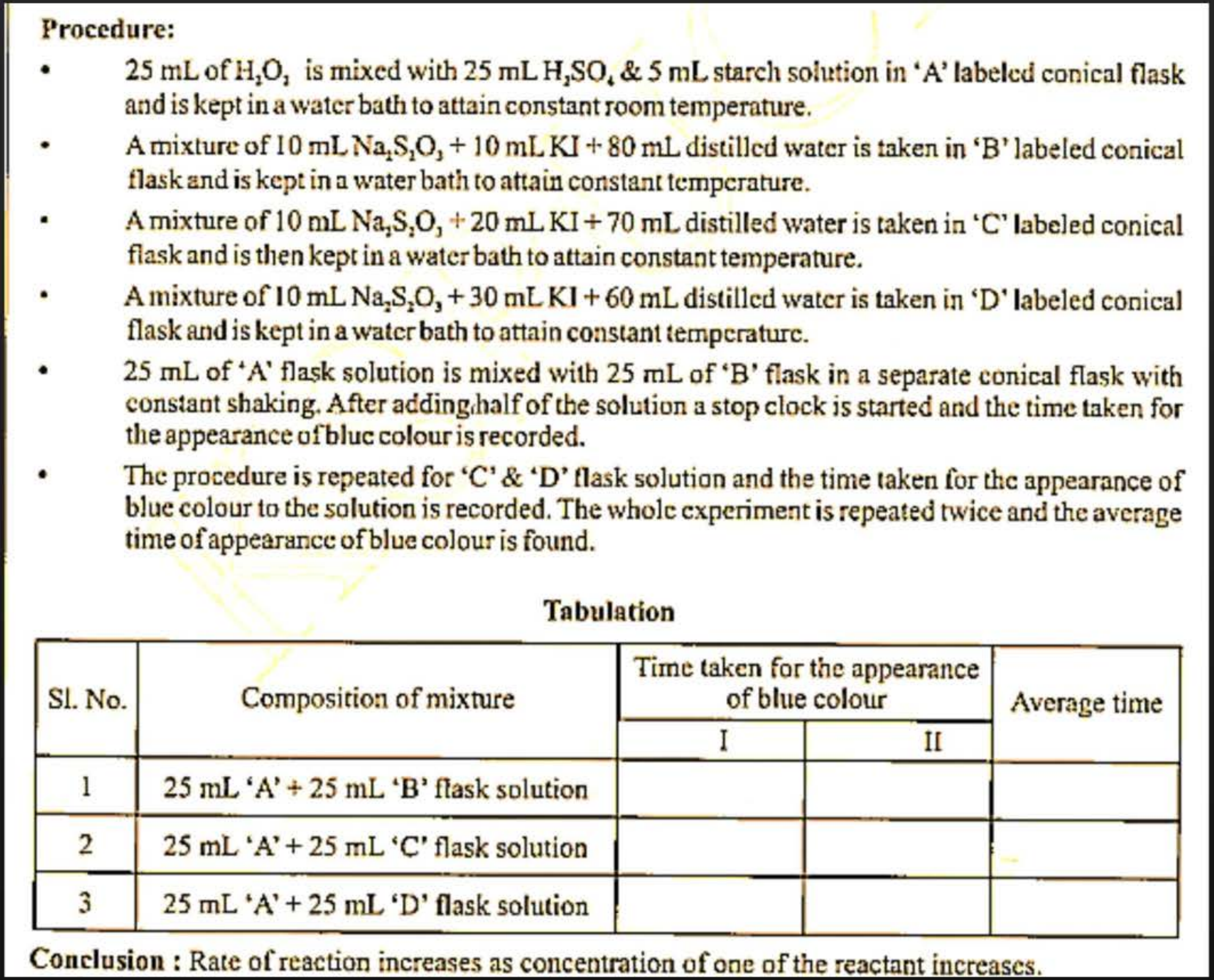
Aim: To determine the heat of neutralization of strong acid (HCl) with a strong base (NaOH)

Solutions required : 100 mL 1N HCl & 100 mL 1 N NaOH

Definition : The amount of heat energy liberated or absorbed when 1 g equivalent mass of an acid is completely neutralized by 1 g equivalent mass of a base in dilute solution is called heat of neutralization.

$$HCl_{(aq)} + NaOH_{(aq)} \longrightarrow NaCl_{(aq)} + H_2O_{(l)} + \Delta H_n = \text{-ve}$$

Procedure : Take a 250 mL polythene bottle fitted with a two holed cork. A thermometer and a stirrer are inserted into the bottle through the cork. This serves as calorimeter (because heat absorbed by the calorimeter is neglected). 100 mL of 1 N HCl is taken in the polythene bottle and its temperature ($t_{(a)}$) is noted. 100 mL of 1 N NaOH is taken in a beaker and its temperature ($t_{(b)}$) is noted. Now pour the NaOH solution into the polythene bottle, it is immediately stoppered and stirred gently. HCl & NaOH make exothermic reaction liberating heat energy. Therefore the temperature of the solution will increase. The maximum temperature attained by the solution (T_1).is noted.



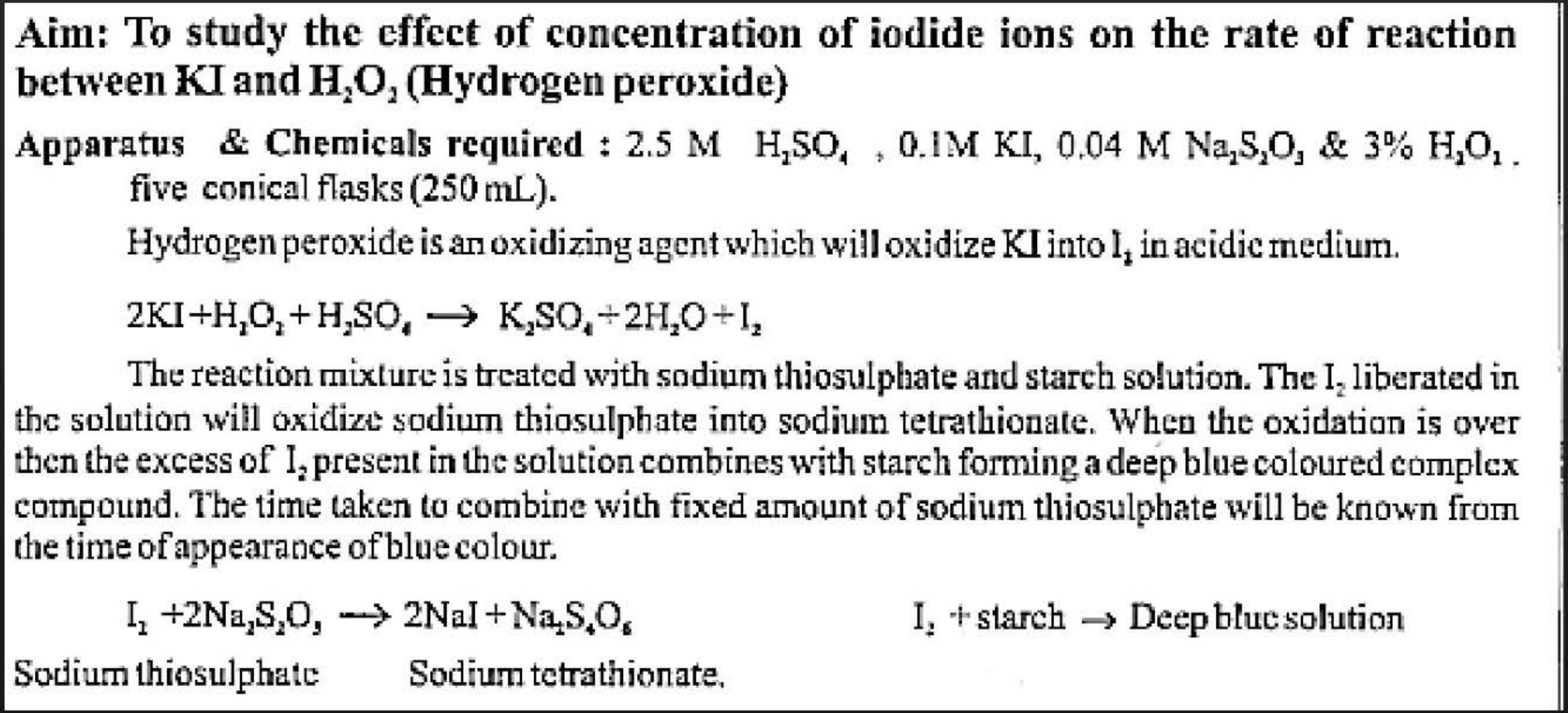
Procedure:

- 25 mL of H_2O_2 is mixed with 25 mL H_2SO_4 & 5 mL starch solution in 'A' labeled conical flask and is kept in a water bath to attain constant room temperature.
- A mixture of 10 mL $Na_2S_2O_3$ + 10 mL KI + 80 mL distilled water is taken in 'B' labeled conical flask and is kept in a water bath to attain constant temperature.
- A mixture of 10 mL $Na_2S_2O_3$ + 20 mL KI + 70 mL distilled water is taken in 'C' labeled conical flask and is then kept in a water bath to attain constant temperature.
- A mixture of 10 mL $Na_2S_2O_3$ + 30 mL KI + 60 mL distilled water is taken in 'D' labeled conical flask and is kept in a water bath to attain constant temperature.
- 25 mL of 'A' flask solution is mixed with 25 mL of 'B' flask in a separate conical flask with constant shaking. After adding half of the solution a stop clock is started and the time taken for the appearance of blue colour is recorded.
- The procedure is repeated for 'C' & 'D' flask solution and the time taken for the appearance of blue colour to the solution is recorded. The whole experiment is repeated twice and the average time of appearance of blue colour is found.

Tabulation

Sl. No.	Composition of mixture	Time taken for the appearance of blue colour		Average time
		I	II	
1	25 mL 'A' + 25 mL 'B' flask solution			
2	25 mL 'A' + 25 mL 'C' flask solution			
3	25 mL 'A' + 25 mL 'D' flask solution			

Conclusion : Rate of reaction increases as concentration of one of the reactant increases.



Aim: To study the effect of concentration of iodide ions on the rate of reaction between KI and H_2O_2 (Hydrogen peroxide)

Apparatus & Chemicals required : 2.5 M H_2SO_4 , 0.1M KI, 0.04 M $Na_2S_2O_3$ & 3% H_2O_2 . five conical flasks (250 mL).

Hydrogen peroxide is an oxidizing agent which will oxidize KI into I_2 in acidic medium.

$$2KI + H_2O_2 + H_2SO_4 \longrightarrow K_2SO_4 + 2H_2O + I_2$$

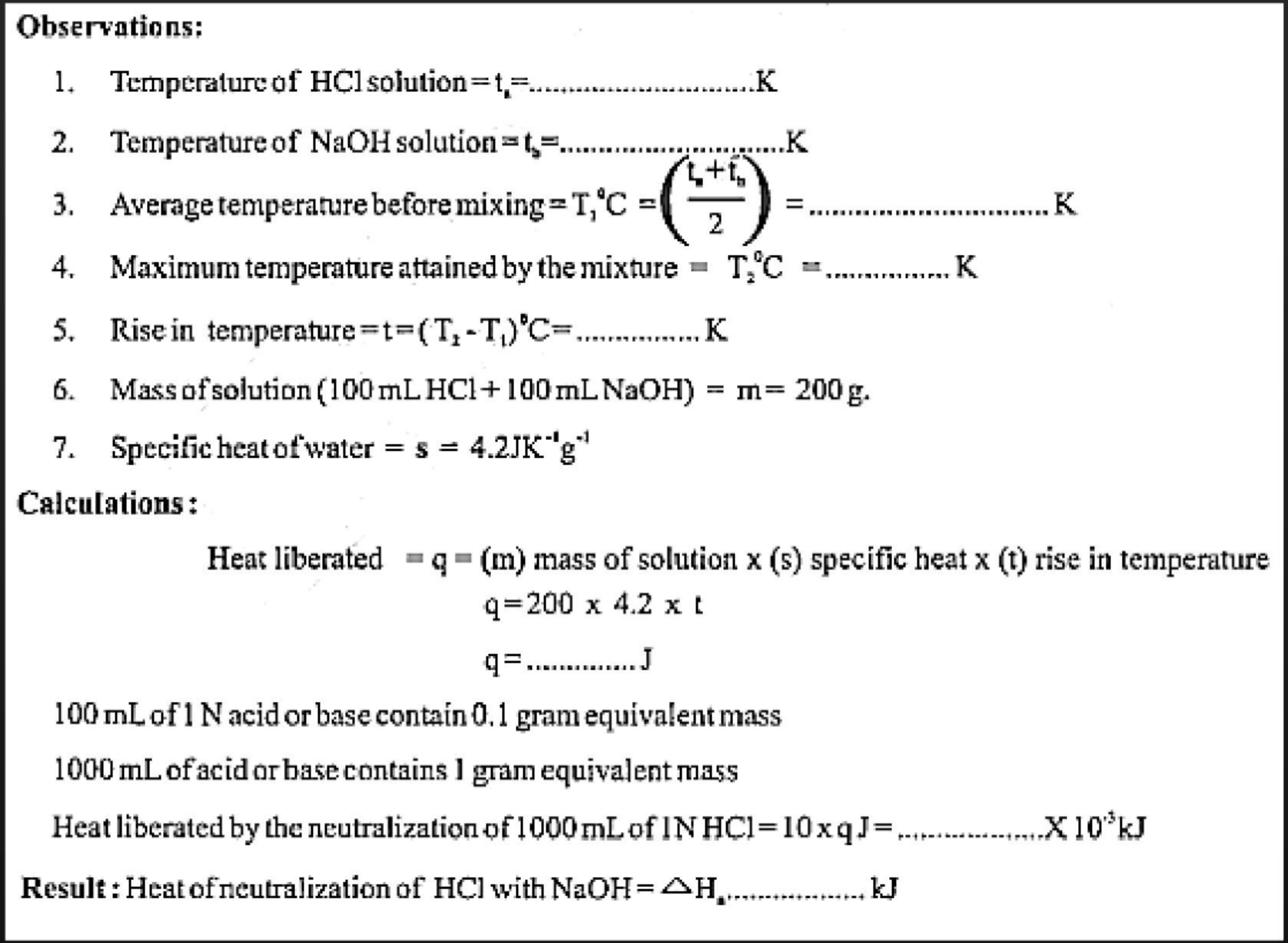
The reaction mixture is treated with sodium thiosulphate and starch solution. The I_2 liberated in the solution will oxidize sodium thiosulphate into sodium tetrathionate. When the oxidation is over then the excess of I_2 present in the solution combines with starch forming a deep blue coloured complex compound. The time taken to combine with fixed amount of sodium thiosulphate will be known from the time of appearance of blue colour.

$$\underset{\text{Sodium thiosulphate}}{I_2 + 2Na_2S_2O_3} \longrightarrow 2NaI + \underset{\text{Sodium tetrathionate.}}{Na_2S_4O_6}$$

I_2 + starch → Deep blue solution

$Rate = k[H_2O_2]^{1}[I]^{0}$ 1

Overall rate = 2



Observations:

1. Temperature of HCl solution = t_a=............................K
2. Temperature of NaOH solution = t_b=............................K
3. Average temperature before mixing = $T_1{}^{\circ}C = \left(\frac{t_a+t_b}{2}\right)$ = ...K
4. Maximum temperature attained by the mixture = $T_2{}^{\circ}C$ = ... K
5. Rise in temperature = $t = (T_2 - T_1)^{\circ}C$= .... K
6. Mass of solution (100 mL HCl + 100 mL NaOH) = m = 200 g.
7. Specific heat of water = s = $4.2 JK^{-1}g^{-1}$

Calculations:

Heat liberated = q = (m) mass of solution x (s) specific heat x (t) rise in temperature

$q = 200 \times 4.2 \times t$

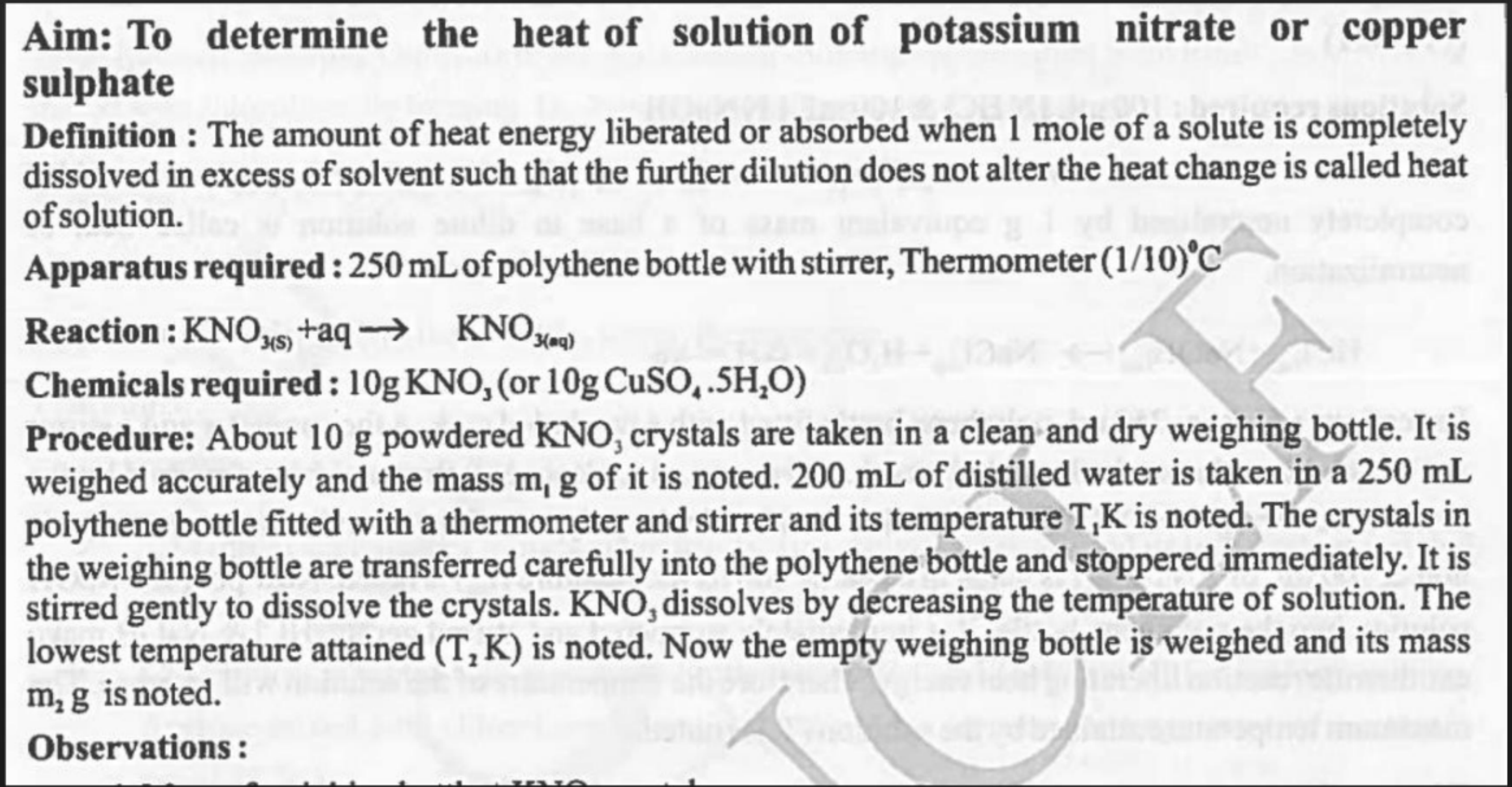
q = ... J

100 mL of 1 N acid or base contain 0.1 gram equivalent mass

1000 mL of acid or base contains 1 gram equivalent mass

Heat liberated by the neutralization of 1000 mL of 1N HCl = 10 x q J = ...X 10^{-3} kJ

Result: Heat of neutralization of HCl with NaOH = $\triangle H_n$.................. kJ



Aim: To determine the heat of solution of potassium nitrate or copper sulphate

Definition : The amount of heat energy liberated or absorbed when 1 mole of a solute is completely dissolved in excess of solvent such that the further dilution does not alter the heat change is called heat of solution.

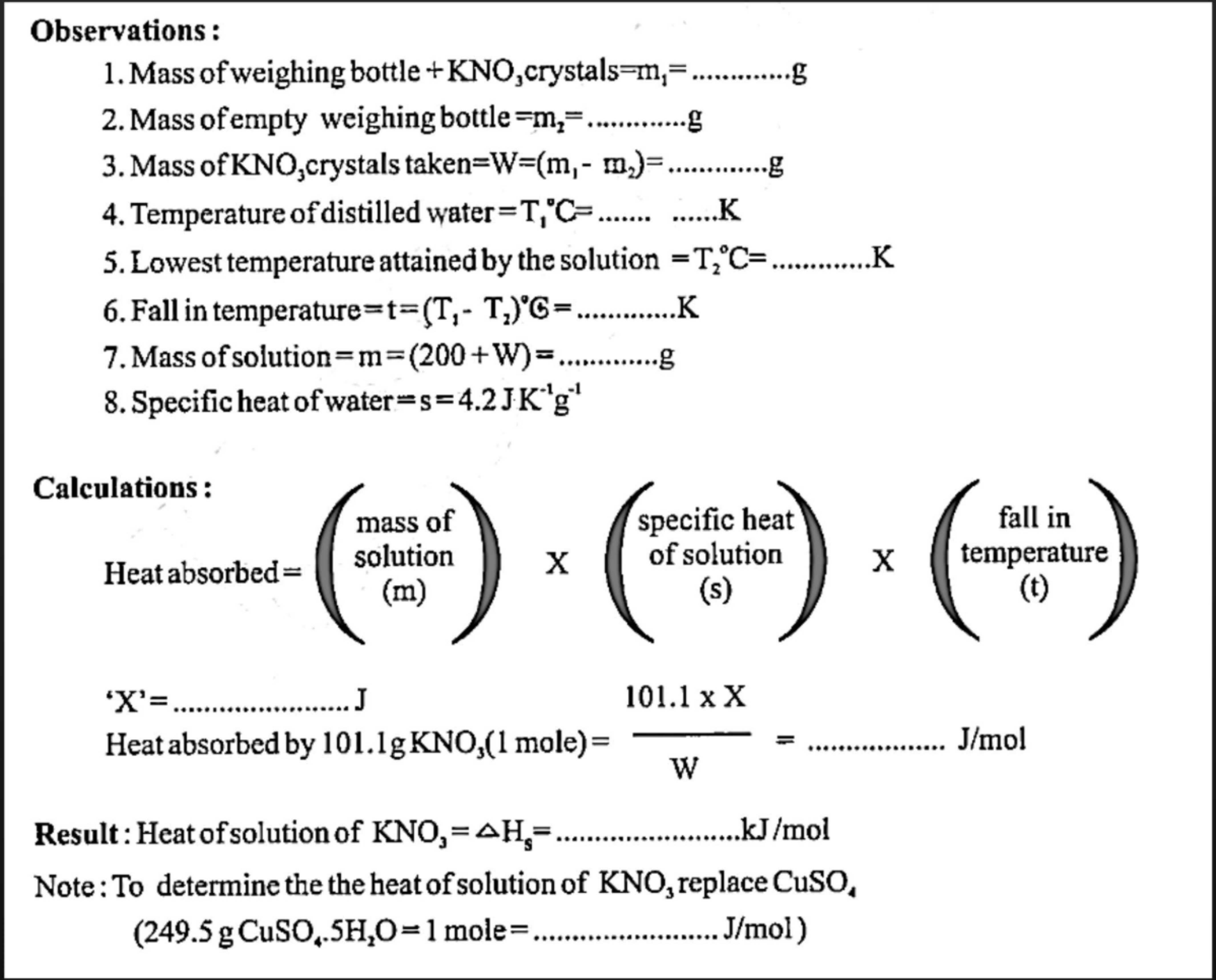
Apparatus required : 250 mL of polythene bottle with stirrer, Thermometer (1/10)°C

Reaction : $KNO_{3(S)} + aq \longrightarrow KNO_{3(aq)}$

Chemicals required : 10g KNO_3 (or 10g $CuSO_4.5H_2O$)

Procedure: About 10 g powdered KNO_3 crystals are taken in a clean and dry weighing bottle. It is weighed accurately and the mass m_1 g of it is noted. 200 mL of distilled water is taken in a 250 mL polythene bottle fitted with a thermometer and stirrer and its temperature T_1K is noted. The crystals in the weighing bottle are transferred carefully into the polythene bottle and stoppered immediately. It is stirred gently to dissolve the crystals. KNO_3 dissolves by decreasing the temperature of solution. The lowest temperature attained (T_2 K) is noted. Now the empty weighing bottle is weighed and its mass m_2 g is noted.

Observations :



Observations :

1. Mass of weighing bottle + KNO_3 crystals = m_1 = ...g
2. Mass of empty weighing bottle = m_2 = ...g
3. Mass of KNO_3 crystals taken = W = $(m_1 - m_2)$ = ...g
4. Temperature of distilled water = T_1°C = ...K
5. Lowest temperature attained by the solution = T_2°C = ...K
6. Fall in temperature = t = $(T_1 - T_2)$°C = ...K
7. Mass of solution = m = (200 + W) = ...g
8. Specific heat of water = s = 4.2 $J\,K^{-1}g^{-1}$

Calculations :

$$\text{Heat absorbed} = \left(\begin{array}{c}\text{mass of}\\ \text{solution}\\ (m)\end{array}\right) \text{X} \left(\begin{array}{c}\text{specific heat}\\ \text{of solution}\\ (s)\end{array}\right) \text{X} \left(\begin{array}{c}\text{fall in}\\ \text{temperature}\\ (t)\end{array}\right)$$

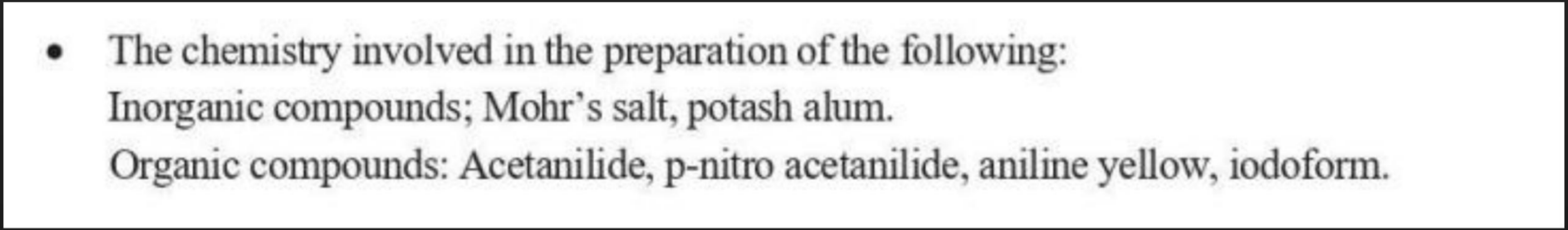
'X' = ... J

Heat absorbed by 101.1g KNO_3(1 mole) = $\dfrac{101.1 \text{ x } X}{W}$ = ... J/mol

Result : Heat of solution of $KNO_3 = \Delta H_s$ = ...kJ/mol

Note : To determine the the heat of solution of KNO_3 replace $CuSO_4$

(249.5 g $CuSO_4.5H_2O$ = 1 mole = ... J/mol)



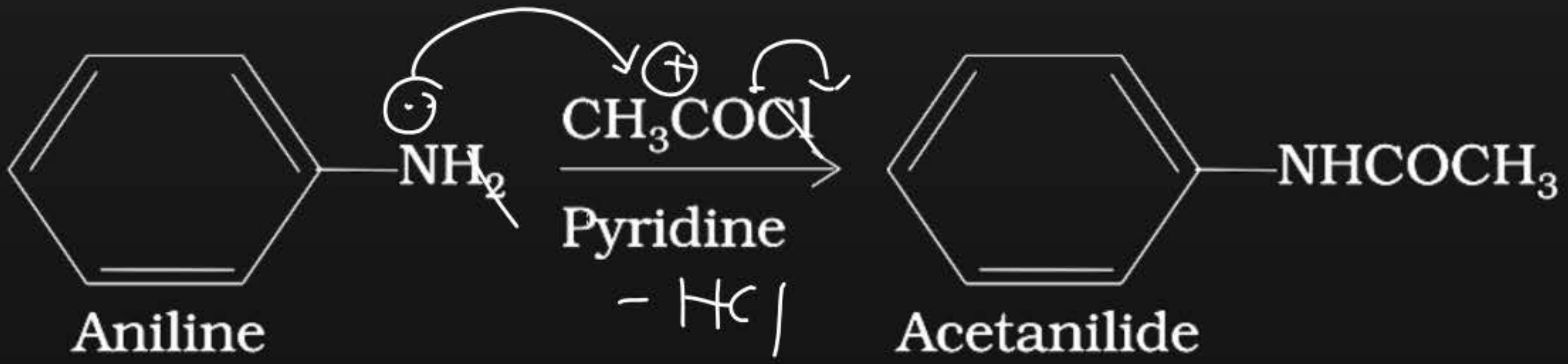
- The chemistry involved in the preparation of the following:
  Inorganic compounds; Mohr's salt, potash alum.
  Organic compounds: Acetanilide, p-nitro acetanilide, aniline yellow, iodoform.

Aim

To prepare acetanilide.

Theory

The replacement of one hydrogen atom of the — NH_2 group of aniline by CH_3CO– group in the presence of glacial acetic acid. Gives acetanilide. In the laboratory, acetylation is usually carried out with acetic anhydride. Acetyl chloride may also be used for the purpose of acetylation if acetic anhydride is not available. Acetylation with CH_3COCl is usually carried out in the presence of pyridine.



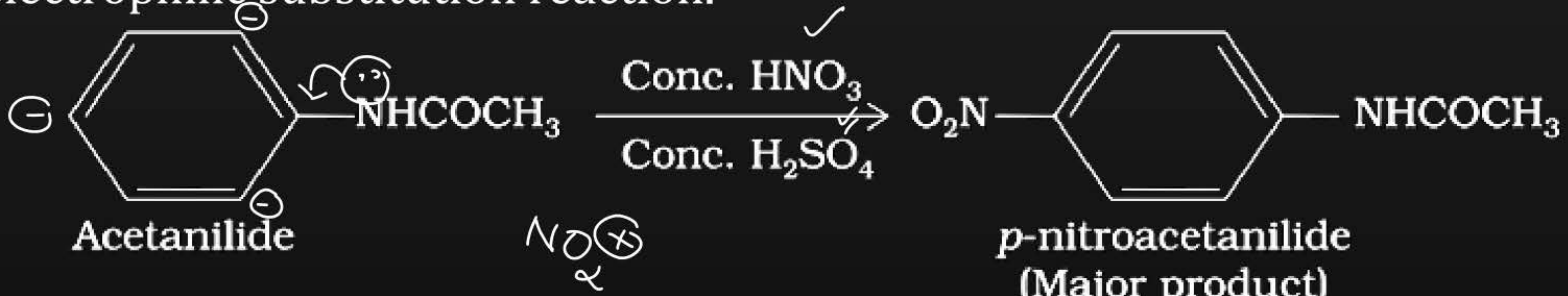
To prepare p-nitroacetanilide.

Theory

p-Nitroacetanilide is prepared by the nitration of acetanilide by using a mixture of conc. nitric acid and conc. sulphuric acid as nitrating reagent. The mixture of the two acids releases nitronium ion (NO_2^+), which acts as an electrophile in the reaction.

$$HNO_3 + 2H_2SO_4 \rightarrow NO_2^+ + H_3O^+ + 2HSO_4^-$$

Nitronium ion attacks the benzene ring containing anilide group, mainly at the para position to give p-nitroacetanilide as a major product. This is an example of aromatic electrophilic substitution reaction.



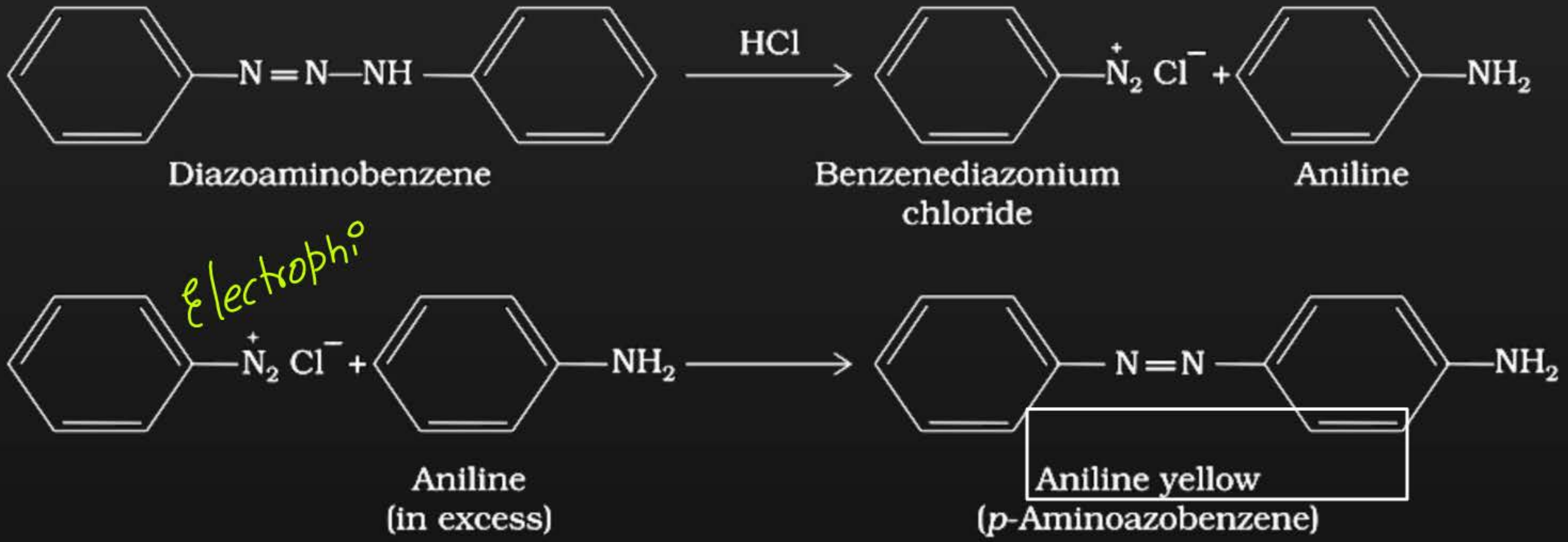
Acetanilide

p-nitroacetanilide
(Major product)

To prepare aniline yellow (p-amino-azobenzene).

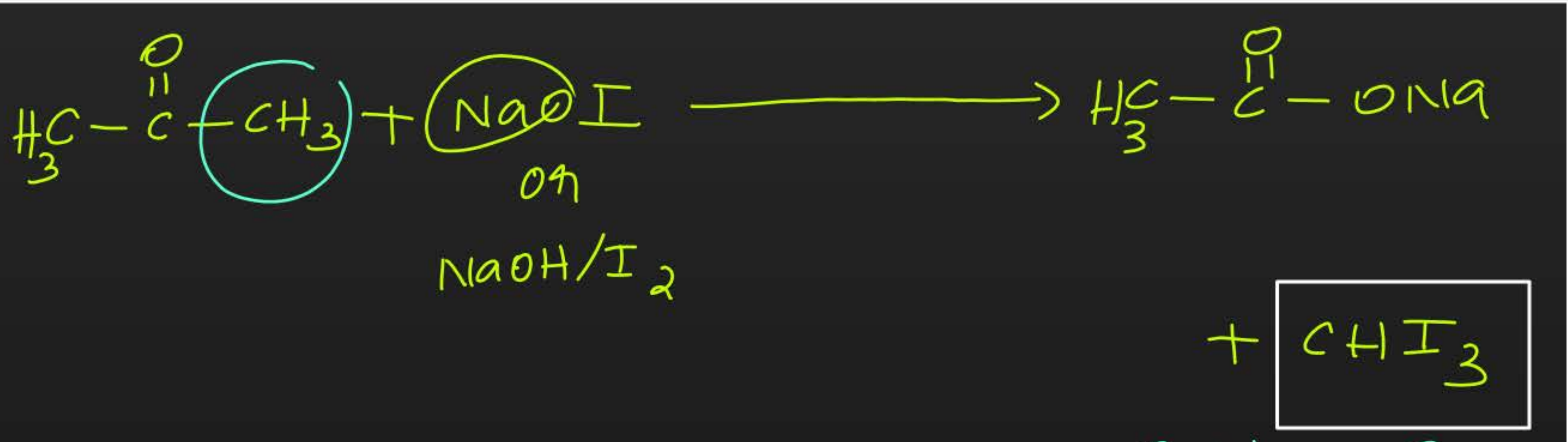
Theory

p-aminoazobenzene can be prepared in a good yield by rearrangement reaction of diazoaminobenzene with a small quantity of aniline hydrochloride in the presence of aniline as solvent. The chemistry of this conversion is as follows:



The above reaction is carried out only in weekly acidic conditions.

Iodoform preparation:



$$H_3C-\overset{O}{\overset{\|}{C}}-CH_3 + NaOI \longrightarrow H_3C-\overset{O}{\overset{\|}{C}}-ONa + \boxed{CHI_3}$$

or

$NaOH/I_2$

iodoform is formed → yellow.

Aim

To prepare double salts: ferrous ammonium sulphate (Mohr's salt) and potash alum.

When a mixture containing equimolar proportions of potassium sulphate and aluminium sulphate or ferrous sulphate and ammonium sulphate is crystallised from its solution, a double salt is formed. The formation of double salt may be shown as follows:

$2K^{\oplus}\ SO_4^{2-}\quad 2Al^{3+}\quad 3SO_4^{2-}$

$$K_2SO_4 + Al_2(SO_4)_3 + 24H_2O \longrightarrow K_2SO_4 \cdot Al_2(SO_4)_3 \cdot 24H_2O \text{ or } 2KAl(SO_4)_2 \cdot 12H_2O$$

(Potash alum)

$$FeSO_4 + (NH_4)_2SO_4 + 6H_2O \longrightarrow FeSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$$

Ferrous ammonium sulphate (Mohr's salt)

Fe^{2+} and Al^{3+} ions undergo hydrolysis, therefore, while preparing aqueous solutions of ferrous sulphate and aluminium sulphate in water, 2 – 3 mL dilute sulphuric acid is added to prevent the hydrolysis of these salts.

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