

Experiment No. 1: Identification of Cations

- I Practical Significance**
Ionization phenomenon, nature of solution and magnitude of ions plays a vital role in various chemical, catalysis processes, reactions and their products in industries. In chemical and allied engineering processes diploma engineers have to work with different solutions and respective cations and anions. They have to perform sample testing in the industries and also use the data produced from the sample testing. In this experiment students will find the magnitude and types of cations present in the given sample which help in sample testing in industries.
- II Relevant Program Outcomes (POs)**
PO1 Basic knowledge
PO3 Experiments and practice
PO4 Engineering tools
PO8 Individual and team work
PO9 Communication
PO10 Life-long learning
- III Relevant Course Outcomes**
d) Apply the catalysis process in industries.
- IV Practical Learning Outcome**
Identify cations in the given ionic solutions.
- V Practical Skills**
1. Handling glass wares.
2. Handling reagents.
3. Observation.
- VI Relevant Affective domain related Outcomes**
1. Follow safety practices.
2. Practice good housekeeping.
- VII Minimum Theoretical Background**
Dissolution of acids, bases and salts in water dissociate into two types of ions. Positively charged ions are called as cations formed by loss of electrons from the metallic atoms, while anions are formed by gain of electrons from non metallic radicals or group of non metals. Charges present on cations and anions represent the valency of the element, from ion is derived. Total number of charges present on cations are always equal to total number of charges present on anions hence whole solution is electrically neutral.
- VIII Circuit diagram / Experimental set-up / Work Situation**
(N.A.)

IX Resources required

Sr. No.	Resources	Specification	Quantity	Remark
1.	Test tube	15 ml	6 each	
2.	Test tube holder	Steel with wooden handle	1 each	
3.	Test tube stand	Wooden / Plastic	1 each	
4.	Chemicals	As per requirement		
5.	Beaker	100 ml	1 each	

X Procedure

- Clean the test tube thoroughly with water.
- Take 2-3 ml of given solution in test tube with the help of dropper.
- Add equal amount of relevant reagents according to qualitative analysis chart given below.

Table for qualitative analysis:

A. Identification of Cations

Sr. No.	Test	Observation	Inference
1.	O.S. + dil. HCl	White ppt.	I group present i.e. Pb^{2+} may be present.
		No ppt.	I group is absent
2.	O.S. + dil. HCl + H_2S gas	ppt. obtained	II Group Present
		1. Black ppt. of CuS	Cu^{2+} may be present
		2. Brown ppt. OF SnS	Sn^{2+} may be present
		3. Yellow ppt. of SnS_2	Sn^{4+} may be present
3.	O.S. + NH_4Cl (excess) + NH_4OH (till alkaline)	No ppt.	II group is absent
		ppt. obtained	III A Group present.
		1. White gelatinous ppt. of $Al(OH)_3$	Al^{3+} may be present.
		2. Dirty green ppt. of $Fe(OH)_2$	Fe^{2+} may be present
		3. Reddish brown ppt. of $Fe(OH)_3$	Fe^{3+} may be present
		4. Bluish green ppt. of $Cr(OH)_3$	Cr^{3+} may be present
4.	O.S. + NH_4Cl (excess) + NH_4OH (till alkaline) + H_2S gas	No ppt.	III A group is absent
		ppt. obtained	III B Group Present
		1. White ppt. ZnS	Zn^{2+} may be present
		2. Faint pink ppt. of MnS	Mn^{2+} may be present
		3. Black ppt. of NiS or CoS	Ni^{2+} or Co^{2+} may be present
5.	O.S. + NH_4Cl (excess) + Above Black ppt. obtained + Conc. HNO_3	No ppt.	III B group is absent
		Green solution	Ni^{2+} present
		Blue Solution	Co^{2+} present
5.	O.S. + NH_4Cl (excess) +	White ppt. of $CaCO_3$ or	IV group is present

Sr. No.	Test	Observation	Inference
	NH ₄ OH (till alkaline) + (NH ₄) ₂ CO ₃	BaCO ₃	i.e. Ba ²⁺ or Ca ²⁺ may be present
		No ppt.	IV group is absent
	O.S. + K ₂ CrO ₄	Yellow ppt.	Ba ²⁺ may be present
		No ppt.	Ca ²⁺ may be present
6.	O.S. + NH ₄ Cl (excess) + NH ₄ OH (till alkaline) + NaH ₂ PO ₄	White ppt.	V Group present i.e. Mg ²⁺ may be present
		No ppt.	V group is absent

If all the above groups are absent then proceed for detection of Na⁺, K⁺ and NH₄⁺

Sr. No.	Test	Observation	Inference
1.	O.S. + NaOH (Boil)	Smell of ammonia gas or turns moist red litmus blue	NH ₄ ⁺ May be present
		No smell of ammonia does not turns moist red litmus blue	Na ⁺ or K ⁺ may be present
2.	O.S. + Sodium cobaltinitrite [fresh solution]	Yellow ppt.	K ⁺ may be present
		No ppt.	Na ⁺ may be present

B. Confirmatory Test (C.T.) for cations

C.T. for GROUP I cations

C. T. for Pb²⁺

Sr. No.	Test	Observation	Inference
1.	O. S. + dil. H ₂ SO ₄	White ppt.	Pb ²⁺ confirmed
2.	O.S. + KI	Deep yellow ppt.	Pb ²⁺ confirmed
3.	O.S. + K ₂ CrO ₄	Yellow ppt.	Pb ²⁺ confirmed

C.T. For GROUP II cations

C.T. for Cu²⁺

Sr. No.	Test	Observation	Inference
1.	O.S. + K ₄ [Fe(CN) ₆]	Chocolate red ppt.	Cu ²⁺ Confirmed
2.	O.S. + KI	Brown ppt.	Cu ²⁺ Confirmed
3.	O.S. + NaOH	Blue ppt.	Cu ²⁺ Confirmed

C.T. for Sn²⁺

Sr. No.	Test	Observation	Inference
1.	O.S. + HgCl ₂	White ppt. turns gray	Sn ²⁺ confirmed

2.	O. S. + NaOH	White ppt. Soluble in excess of NaOH	Sn ²⁺ confirmed
3.	O.S.+Iodine solution	Decolourisation of iodine solution	Sn ²⁺ confirmed

C.T. for GROUP III A cations

C.T. for Al³⁺

Sr. No.	Test	Observation	Inference
1.	O. S.+ NaOH	White gelatinous ppt.	Al ³⁺ confirmed
2.	O.S.+ Ammonium acetate solution	No PPT. in cold but gives white gelatinous ppt. on boiling	Al ³⁺ confirmed
3.	3.O.S.+NaH ₂ PO ₄	white gelatinous ppt. soluble in dil. HCl	Al ³⁺ confirmed

C.T. for Fe²⁺ [Ferrous]

Sr. No.	Test	Observation	Inference
1.	O. S.+K ₃ [Fe(CN) ₆]	Deep Blue ppt.	Fe ²⁺ confirmed
2.	O.S.+ NaOH	Dirty green ppt.	Fe ²⁺ confirmed
3.	O.S.+ dil. H ₂ SO ₄ + 1% KMnO ₄ solution.	Pink colour of KMnO ₄ decolorizes	Fe ²⁺ confirmed

C.T. for Fe³⁺ [Ferric]

Sr. No.	Test	Observation	Inference
1.	O. S. + K ₄ [Fe(CN) ₆]	Deep Blue ppt.	Fe ³⁺ confirmed
2.	O.S. + NaOH	Reddish brown ppt.	Fe ³⁺ confirmed
3.	O.S. + Ammonium thiocyanate solution	Blood red ppt.	Fe ³⁺ confirmed

C.T. for Cr³⁺

Sr. No.	Test	Observation	Inference
1.	O. S.+ NaOH	Bluish Green ppt.	Cr ³⁺ confirmed
2.	O.S. + PbO ₂ + NaOH Boil collect supernatant solution in another test tube and add acetic acid	Yellow ppt.	Cr ³⁺ confirmed

C.T. for Group III (B) cations**C.T. for Zn^{2+}**

Sr. No.	Test	Observation	Inference
1.	O. S. + NaOH	White ppt. insoluble in dil. HCl	Zn^{2+} Confirmed
2.	O. S. + NaH_2PO_4	White ppt.	Zn^{2+} Confirmed
3.	O. S. + $K_4[Fe(CN)_6]$	White ppt.	Zn^{2+} Confirmed

C.T. for Mn^{2+}

Sr. No	Test	Observation	Inference
1.	O.S. + NaOH	White ppt. soluble in excess of NaOH	Mn^{2+} confirmed
2.	O.S. + NaOH + Br_2 water	Black ppt.	Mn^{2+} confirmed
3.	O.S. + $K_4[Fe(CN)_6]$	Pinkish white ppt. soluble in dil. HCl	Mn^{2+} confirmed

C.T. for Ni^{2+}

Sr. No	Test	Observation	Inference
1.	O.S. + NaOH + Br_2 water	Black ppt.	Ni^{2+} confirmed
2.	O.S. + NH_4OH	Pale green ppt. Soluble in excess giving blue solution	Ni^{2+} confirmed
3.	O.S. + Dimethyl glyoxime	Scarlet red ppt.	Ni^{2+} confirmed

C.T. for Co^{2+}

Sr. No	Test	Observation	Inference
1.	O.S. + NH_4OH	Blue ppt. turns Brown in Excess	Co^{2+} confirmed
2.	O.S. + Ammonium thiocyanate (NH_4CNS)	Black ppt.	Co^{2+} confirmed
3.	$K_4[Fe(CN)_6]$	Reddish ppt.	Co^{2+} confirmed

C.T. for Group IV cations
C.T. for Ba²⁺

Sr. No.	Test	Observation	Inference
1.	O.S. + K ₂ CrO ₄ (potassium chromate)	Yellow ppt.	Ba ²⁺ Confirmed
2.	O.S. + Ammonium oxalate	White ppt.	Ba ²⁺ Confirmed
3.	O.S. + dil. H ₂ SO ₄	White ppt.	Ba ²⁺ Confirmed

C.T. for Ca²⁺

Sr. No.	Test	Observation	Inference
1.	O.S. + K ₂ CrO ₄ (potassium chromate)	No ppt.	Ca ²⁺ confirmed
2.	O.S. + Ammonium oxalate	White ppt. insoluble in acetic acid	Ca ²⁺ confirmed
3.	O.S. + NH ₄ Cl (crystals) + K ₄ [Fe(CN) ₆]	White ppt.	Ca ²⁺ confirmed
4.	Flame Test	Brick Red colored flame	Ca ²⁺ Confirmed

C.T. for Group V cations

C.T. for Mg²⁺

Sr. No.	Test	Observation	Inference
1.	O.S. + NaOH	White ppt.	Mg ²⁺ confirmed
2.	O.S. + Hypoiodide solution	Reddish brown ppt.	Mg ²⁺ confirmed

C.T. for NH₄⁺

Sr. No.	Test	Observation	Inference
1.	O.S. + Nessler's reagent	Brown ppt.	NH ₄ ⁺ Confirmed
2.	O.S. + Picric acid (alcoholic)	Yellow crystalline ppt.	NH ₄ ⁺ Confirmed

C.T. for K⁺

Sr. No.	Test	Observation	Inference
1.	O.S. + Sodium cobaltinitrite Solution (freshly prepared)	Yellow ppt.	K ⁺ Confirmed
2.	O.S. + Picric acid (alcoholic)	Yellow ppt.	K ⁺ Confirmed

B. Confirmatory Test (C.T.) for cation... Na^+

Sr. No.	Test	Observation	Inference
1.	0.5 + Sodium cobalt nitrite solution	yellow ppt	Na^+ confirmed

A. Sample Solution 2

Sr. No.	Test	Observation	Inference
1)	0.5 + Sodium cobalt nitrite (fresh solution)	yellow ppt	K^+ may be present

B. Confirmatory Test (C.T.) for cation... K^+

Sr. No.	Test	Observation	Inference
1)	0.5 + Sodium cobalt nitrite	yellow ppt	K^+ confirmed
2)	0.5 + picric acid (acid holic)	yellow ppt	K^+ confirmed
3)	0.5 + perchloric acid	white ppt	K^+ confirmed

XVI Results

- Cation identified in sample solution 1 is Na^+ Sodium that can be obtained by dissolving sodium cobalt nitrite salt in water.
- Cation identified in sample solution 2 is K^+ that can be obtained by dissolving picric acid salt in water.

XVII Interpretation of results
 v group radical present in the given land solution.

XVIII Conclusions and Recommendations
 1. Na⁺ is an cation sample solution 1 contains Na⁺
 2. Na⁺ is an cation given sample solution
 contain k⁺ cation.

XIX Practical Related Questions

1. Solution 'A' gives black ppt. with dil. HCl and H₂S gas, which basic radical is present in given solution.
2. Describe identification procedure of Ba²⁺ or Ca²⁺ radical from given unknown solution.
3. Identify cation in solution 'X' if solution 'X' having pale green colouration and when mixed with sodium hydroxide gives dirty green color ppt.

XX References / Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1.	Inorganic qualitative analysis	Vogel	Publisher: Prentice Hall, 2013 ISBN 13: 9780582218666
2.	Experiments in general chemistry Principles and modern applications	Thomas G. Greco; Lyman H. Richard; Gerald S. Weiss	Pearson, 9 th edition ISBN-13:978-0131493919
.	Chemistry: Inorganic Qualitative Analysis in the Laboratory	Clyde Metz	Elsevier: ISBN: 978-0-12-503354-1

XXI Assessment Scheme

Process related assessment scheme

Sr. No.	Process related	Weightage(60%)
1	Process for detection of cation1	15%
2	Process for detection of cation2	15%
3	Confirmatory test for cation1	15%
4	Confirmatory test for cation2	15%

Product related assessment scheme

Sr. No.	Product related	Weightage(40%)
1.	Identification of cation1	10%
2.	Identification of cation2	10%
3.	Answer to sample questions	10%
4.	Submission of report in time	10%

Marks Obtained			Dated Signature of Teacher
Process Related (15)	Product Related (10)	Total (25)	
14	09	23	<i>[Signature]</i>

[Space to Write Answers]

Q.1 ——— ?

When solution A gives yellow ppt with sodium cobalt nitrite (fresh solution) then Na^+ basic radical is present in solution that Na^+ Basic radical.

Q2 ——— ?

When a original solution NaCl added cobalt nitrite fresh solution then yellow ppt that Na^+ sodium. It gives yellow ppt Na^+ is confirmed.

Q. 3 — ?

When sodium be gives yellow ppt go
for CT. test is $0.3 + \text{picric}$ it gives yellow
ppt K^+ .