

# Study Notes: Analytical Chemistry - Qualitative Analysis

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## 1. Introduction to Qualitative Analysis

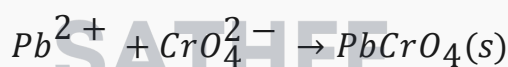
Qualitative analysis is a branch of analytical chemistry that identifies the presence of specific ions or functional groups in a sample. It is typically used to determine the chemical composition of a substance without quantifying the amount.

## 2. Confirmatory Tests for Different Groups of Cations

### 2.1 Group I Cations ( $Pb^{2+}$ , $Cu^{2+}$ )

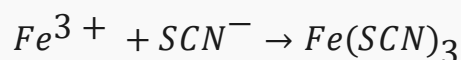
#### 2.1.1 Potassium Chromate Test

- **Procedure:** Add potassium chromate solution to the sample.
- **Observation:** A **yellow precipitate** of  $PbCrO_4$  forms if  $Pb^{2+}$  is present.
- **Reaction:**



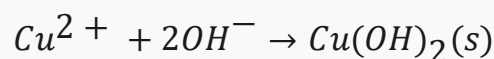
#### 2.1.2 Potassium Thiocyanate Test

- **Procedure:** Add potassium thiocyanate solution to the sample.
- **Observation:** A **blood-red color** forms due to the formation of  $Fe(SCN)_3$ .
- **Reaction:**



#### 2.1.3 Ammonia Test

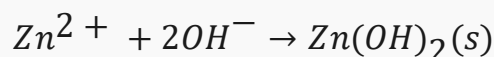
- **Procedure:** Add ammonia solution to the sample.
- **Observation:** A **blue precipitate** of  $Cu(OH)_2$  forms if  $Cu^{2+}$  is present.
- **Reaction:**



## 2.2 Group II Cations ( $\text{Zn}^{2+}$ , $\text{Ni}^{2+}$ )

### 2.2.1 Sodium Hydroxide Test

- **Procedure:** Add sodium hydroxide solution to the sample.
- **Observation:** A **white precipitate** of  $\text{Zn}(\text{OH})_2$  forms if  $\text{Zn}^{2+}$  is present.
- **Reaction:**



### 2.2.2 Ammonia Test

- **Procedure:** Add ammonia solution to the sample.
- **Observation:** A **blue precipitate** of  $\text{Ni}(\text{OH})_2$  forms if  $\text{Ni}^{2+}$  is present.
- **Reaction:**



## 2.3 Group III Cations ( $\text{Mg}^{2+}$ )

### 2.3.1 Phenolphthalein Test

- **Procedure:** Add phenolphthalein solution to the sample.
- **Observation:** A **pink color** forms due to the formation of  $\text{Mg}(\text{phen})_2$ .
- **Reaction:**

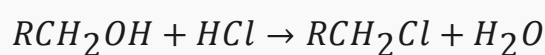


## 3. Tests for Specific Functional Groups

### 3.1 Alcohol Test

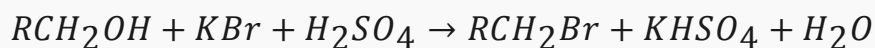
#### 3.1.1 Lucas Test

- **Procedure:** Add Lucas reagent (concentrated HCl and  $\text{ZnCl}_2$ ) to the sample.
- **Observation:** A **cloudy or turbid solution** indicates the presence of **alcohols**.
- **Reaction:**

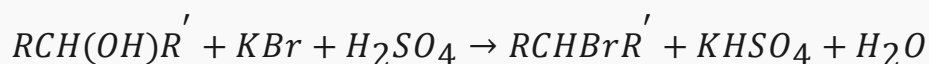


## 3.1.2 Victor Meyer Test

- **Procedure:** Add Victor Meyer reagent (KBr, H<sub>2</sub>SO<sub>4</sub>) to the sample.
- **Observation:** A **red color** forms if the alcohol is **primary**, **violet** if **secondary**, and **no color** if **tertiary**.
- **Reactions:**
- **Primary:**



- **Secondary:**



## 3.2 Aldehyde Test

### 3.2.1 Tollens' Test

- **Procedure:** Add Tollens' reagent (AgNO<sub>3</sub> in NH<sub>3</sub>) to the sample.
- **Observation:** A **silver mirror** forms if the compound is an **aldehyde**.
- **Reaction:**



## 3.3 Ketone Test

### 3.3.1 Iodoform Test

- **Procedure:** Add iodine and NaOH to the sample.
- **Observation:** A **yellow precipitate** of CHI<sub>3</sub> forms if the compound is a **methyl ketone**.
- **Reaction:**



## 4. Summary of Key Tests and Observations

Test	Cation/Group	Reagent	Observation	Result
Potassium Chromate	$Pb^{2+}$	$K_2CrO_4$	Yellow precipitate	Presence of $Pb^{2+}$
Potassium Thiocyanate	$Fe^{3+}$	KSCN	Blood-red color	Presence of $Fe^{3+}$
Sodium Hydroxide	$Zn^{2+}$	NaOH	White precipitate	Presence of $Zn^{2+}$
Ammonia	$Ni^{2+}$	$NH_3$	Blue precipitate	Presence of $Ni^{2+}$
Phenolphthalein	$Mg^{2+}$	Phenolphthalein	Pink color	Presence of $Mg^{2+}$
Lucas Test	Alcohol	HCl, $ZnCl_2$	Cloudy or turbid solution	Presence of alcohol
Tollens' Test	Aldehyde	$AgNO_3$ in $NH_3$	Silver mirror	Presence of aldehyde
Iodoform Test	Methyl Ketone	$I_2$ , NaOH	Yellow precipitate	Presence of methyl ketone

## 5. Conclusion

Qualitative analysis is a fundamental technique in analytical chemistry that allows for the identification of specific ions and functional groups in a sample. The methods described above provide a structured approach to determining the composition of unknown substances, using a combination of chemical reagents and observable changes. Each test is designed to detect specific ions or functional groups, making it a powerful tool for both educational and practical applications.