

# General principles of a qualitative chemical analysis. Identification of inorganic cations

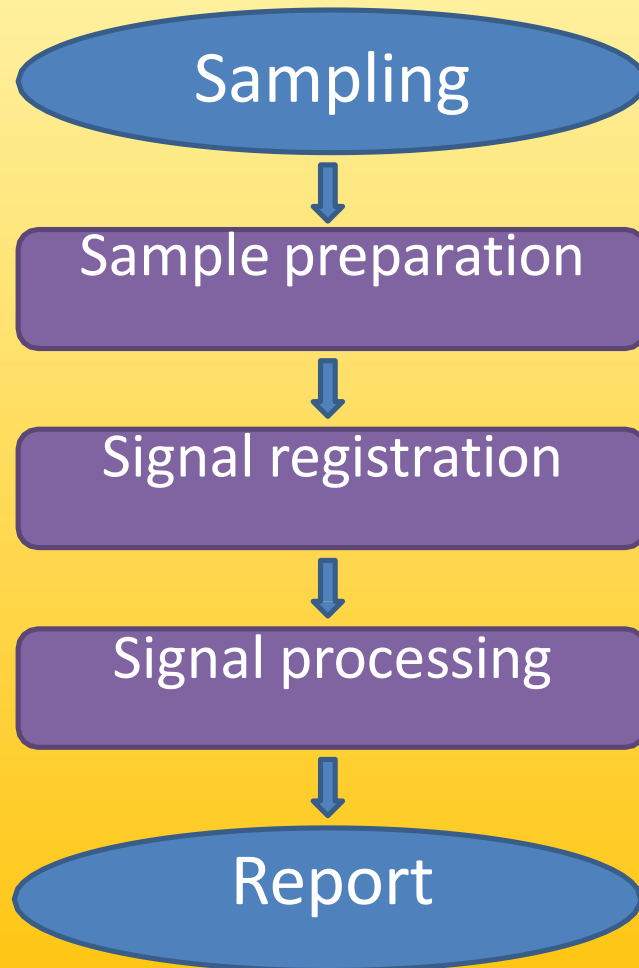
# Questions

- What is the goal of chemical analysis?
- What signals are used for quantitative analysis?
- What signals are used for qualitative analysis?
- Do you know any examples of qualitative analysis?

# Signals for qualitative analysis

- Color and smell (solution, precipitate, flame)
- Boiling and melting points
- Formation of a precipitate with a reagent
- Refraction index
- Spectra (light absorption and emission, mass spectra)

# General procedure of analysis



# Qualitative analysis

## Chemical

Precipitation (+ color)  
Burning (+color)  
Formation of a colored product  
Voltammetry

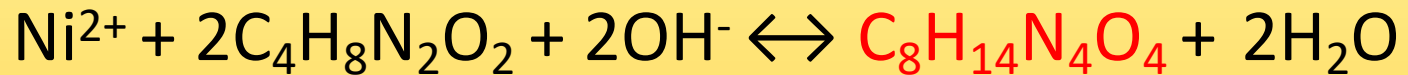
## Physical

UV-Vis spectroscopy  
IR spectroscopy  
NMR spectroscopy  
Chromatography  
Electrophoresis  
Mass spectrometry

## Biochemical

Biosensors  
Bioassays

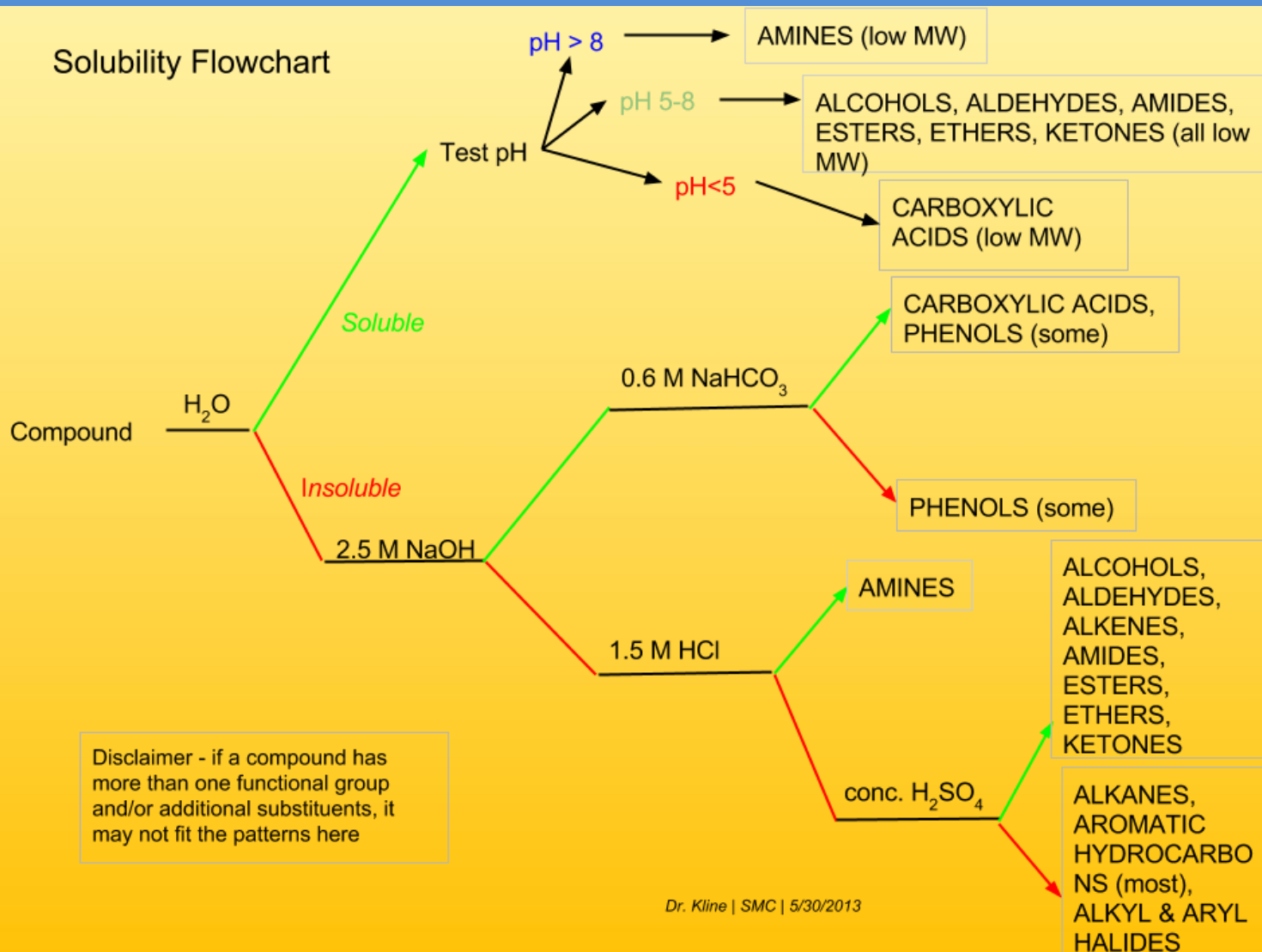
# Examples of qualitative analysis



# FLAME TEST COLOURS

 LITHIUM $\text{Li}^+$	 SODIUM $\text{Na}^+$	 POTASSIUM $\text{K}^+$	 RUBIDIUM $\text{Rb}^+$	 CAESIUM $\text{Cs}^+$	 CALCIUM $\text{Ca}^{2+}$
 STRONTIUM $\text{Sr}^{2+}$	 BARIUM $\text{Ba}^{2+}$	 RADIUM $\text{Ra}^{2+}$	 COPPER $\text{Cu}^{2+}$	 IRON $\text{Fe}^{2+}/\text{Fe}^{3+}$	 BORON $\text{B}^{3+}$
 INDIUM $\text{In}^{3+}$	 LEAD $\text{Pb}^{2+}$	 ARSENIC $\text{As}^{3+}$	 ANTIMONY $\text{Sb}^{3+}/\text{Sb}^{5+}$	 SELENIUM $\text{Se}^{2+}/\text{Se}^{4+}$	 ZINC $\text{Zn}^{2+}$

# Qualitative analysis by solubility





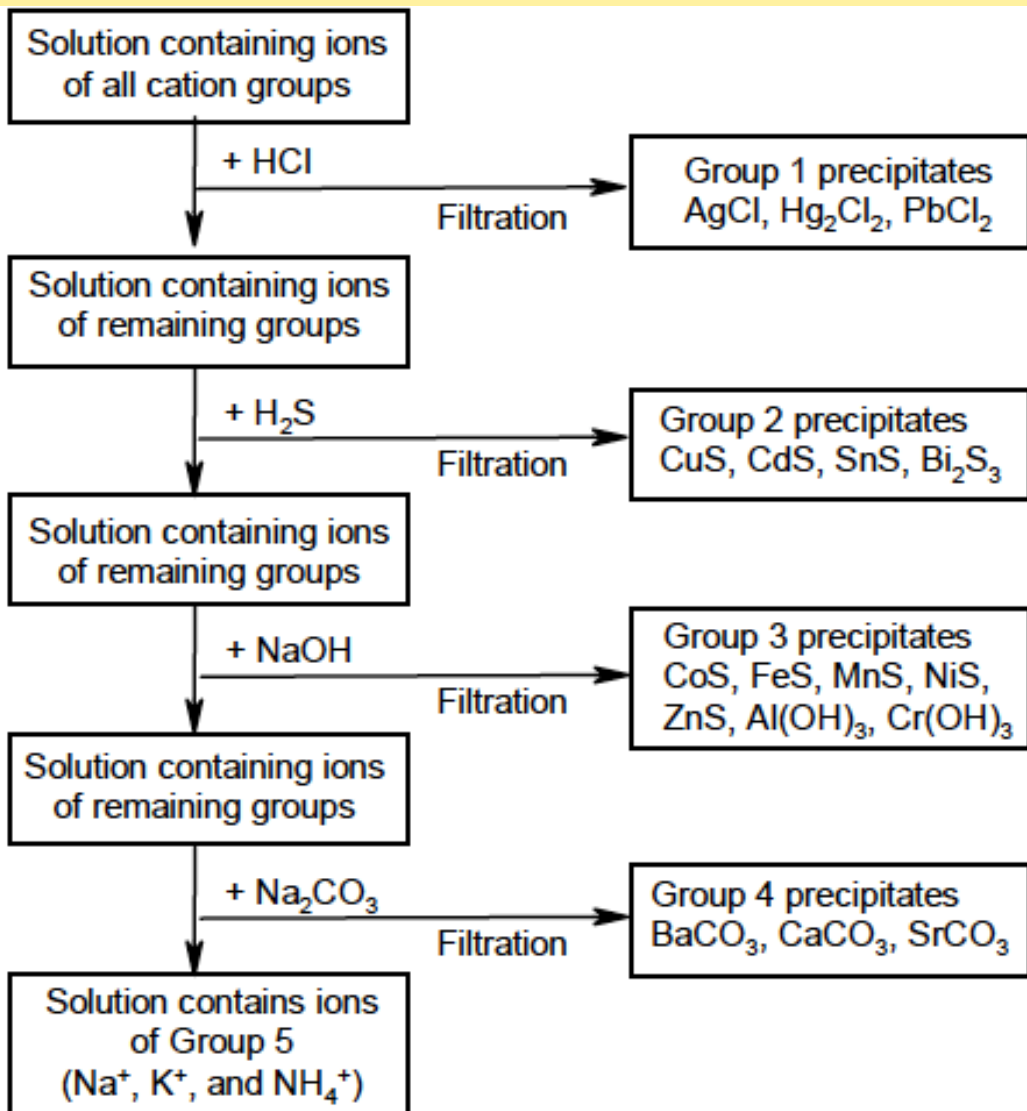
# Identification of cations

- Acid-base
- Sulfide
- Ammonia-phosphate

# Sulfide classification

Group No. Rus (Eng)	Cations	Reagent
I (or V)	$K^+$ , $Na^+$ , $NH_4^+$ , $Mg^{2+}$	No
II (or IV)	$Ba^{2+}$ , $Ca^{2+}$ , $Sr^{2+}$	$(NH_4)_2CO_3$
III	$Al^{3+}$ , $Cr^{3+}$ , $Fe^{3+}$ , $Fe^{2+}$ , $Ni^{2+}$ , $Co^{2+}$ , $Mn^{2+}$ , $Zn^{2+}$	$(NH_4)_2S$
IV (or II)	I: $Cu^{2+}$ , $Cd^{2+}$ , $Hg^{2+}$ , $Bi^{3+}$ II: $As^{3+}$ , $Sn^{2+}$ , $Sn^{4+}$ , $Sb^{3+}$ , $AsO_4^{3-}$ , $SbO_4^{3-}$	$H_2S$
V (or I)	$Ag^+$ , $Pb^{2+}$ , $Hg_2^{2+}$	HCl

# Flow chart



# Acid-base classification

Group No.	Cations	Reagent
I	$K^+, Na^+, NH_4^+$	No
II	$Ag^+, Pb^{2+}, Hg_2^{2+}$	HCl
III	$Ba^{2+}, Ca^{2+}, Sr^{2+}$	$H_2SO_4$
IV	$Al^{3+}, Cr^{3+}, Zn^{2+}, As^{3+}, As^{5+}$	$NaOH + H_2O_2$
V	$Mg^{2+}, Sb^{3+}, Mg^{2+}, Sb^{5+}, Bi^{3+},$ $Mn^{2+}, Fe^{3+}, Fe^{2+}$	$NaOH$ or $NH_4OH$ (conc.)
VI	$Cu^{2+}, Cd^{2+}, Hg^{2+}, Ni^{2+}, Co^{2+}$	$NH_3$ (conc.)

# Video

- <https://www.youtube.com/watch?v=AWEr80mXj8Y>