

# Chem QA & Reactions Appendix

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August 9, 2017

(ver 0.3.1)

A catalog of reactions to be understood and recalled for the GCE "A"-level Chemistry Paper, including Organic and Inorganic Qualitative Analysis for both the theory and practical papers.

These notes are meant for free, public use, but at the reader's own risk.

Good luck with your exams.

# 1 Common Inorganic Reactions

## 1.1 Precipitate Solubility

### 1.1.1 Table of Solubilities

	Group 1, $\text{NH}_4^+$	$\text{Hg}^+$ , $\text{Ag}^+$	blue $\text{Pb}^{2+}$	$\text{Ba}^{2+}$ , $\text{Ca}^{2+}$	Else
$\text{NO}_3^-$	1. All nitrates are soluble				
$\text{X}^-$	3. Halides of $\text{Hg}$ , $\text{Ag}$ and $\text{Pb}$ are insoluble				
$\text{SO}_4^{2-}$	4. Sulfates of $\text{Pb}$ , $\text{Ba}$ and $\text{Ca}$ are insoluble				
$\text{OH}^-$ , $\text{CO}_3^{2-}$ , $\text{PO}_4^{2-}$ , $\text{S}_2^-$	5. Most other salts are insoluble				

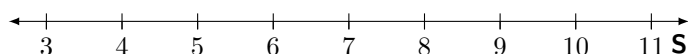
### 1.1.2 $K_{sp}$ Comparison

## 1.2 Acid/Base Reactions

### 1.2.1 Acid/Base Titration Indicators



Methyl Orange



## 1.3 Redox Reactions and Reagents

$\text{KMnO}_4$  is a strong oxidizing agent which will turn from purple to colorless  $\text{Mn}^{2+}$ . Brown ppt of  $\text{MnO}_2$  forms when insufficient acid is present.

$\text{K}_2\text{Cr}_2\text{O}_7$  is a strong oxidizing agent which will turn from orange to green  $\text{Cr}^{3+}$ .

$\text{KI}$  is a reducing agent which may turn from colorless to brown  $\text{I}_2$ , possibly reducing  $\text{Fe}^{3+}$  to form brown solution and reducing  $\text{Cu}^{2+}$  to form cream ppt of  $\text{CuI}$ . Use starch solution to tell if  $\text{I}_2$  is present in small concentrations, alternatively use (starchy) waste paper.

$\text{O}_2$  in air can oxidize:

- green  $\text{Fe}^{2+}$  solution to brown  $\text{Fe}^{3+}$  solution
- green  $\text{Fe}(\text{OH})_2$  ppt to brown  $\text{Fe}(\text{OH})_3$  ppt
- off-white  $\text{Mn}(\text{OH})_2$  ppt to brown  $\text{MnO}_2$  ppt; and
- white  $\text{BaSO}_3$  ppt soluble in acid to white  $\text{BaSO}_4$  ppt insoluble in acid.

$\text{H}_2\text{O}_2$  can either act as a reducing agent to form  $\text{H}_2\text{O}$ , oxidizing agent (vs  $\text{Fe}^{2+}$ ) to form  $\text{O}_2$  or spontaneously decompose to form both, especially in presence of a transition metal catalyst.

# 2 Tests for Inorganic Compounds

## 2.1 Tests for Gases

$\text{O}_2$  relights a glowing splint.

$\text{H}_2$  extinguishes a lit splint with a 'pop' sound.

$\text{CO}_2$  forms white ppt of  $\text{Ca}(\text{OH})_2$  when bubbled into lime-water  $\text{Ca}(\text{CO}_3)(\text{aq})$ .

$\text{SO}_2$  decolorizes acidified purple  $\text{KMnO}_4$  filter paper.

$\text{NO}_2$  is a brown, pungent gas which (oxidizes?)  $\text{FeSO}_4$  solution, turning green solution brown.

$\text{NH}_3$  is a pungent gas which turns moist red litmus paper

## 2.2 Tests for Inorganic

$\text{NO}_3^-$  produces  $\text{NH}_3$  when heated in  $\text{NaOH}$  with  $\text{Al}(\text{s})$ .

$\text{NO}_2^-$  produces  $\text{NH}_3$  when heated in  $\text{NaOH}$  with  $\text{Al}(\text{s})$  and produces  $\text{NO}_2$  when reacted with  $\text{HCl}$ .

$\text{CO}_3^{2-}$  shows effervescence when reacted with acid to give  $\text{CO}_2$ .

$\text{SO}_4^{2-}$  produces a white ppt of  $\text{BaSO}_4$ , insoluble in acid.

$\text{SO}_3^{2-}$  produces a white ppt of  $\text{BaSO}_3$ , which dissolves in acid to produce  $\text{SO}_2$ .

### 2.2.2 Halide Anions

$\text{I}^-$  produces yellow ppt with  $\text{AgNO}_3$ , insoluble in  $\text{NH}_3(\text{aq})$ .

$\text{Br}^-$  produces cream ppt with  $\text{AgNO}_3$ , insoluble in  $\text{NH}_3(\text{aq})$ .

$\text{Cl}^-$  produces white ppt with  $\text{AgNO}_3$ , soluble in  $\text{NH}_3(\text{aq})$  due to the formation of the diamminesilver complex.

### 2.2.3 Cations

	Soln	$\text{NaOH}$
White ppts		
$\text{Ba}^{2+}$	-	-
$\text{Ca}^{2+}$	-	White
$\text{Zn}^{2+}$	-	White, soluble
$\text{Al}^{3+}$	-	White, soluble
$\text{Mg}^{2+}$	-	White
Colored ppts		
$\text{Cu}^{2+}$	Blue	Blue
$\text{Cr}^{3+}$	Green	Green, soluble to green
$\text{Fe}^{2+}$	Pale Green	Dirty Green
$\text{Fe}^{3+}$	Brown	Brown
$\text{Mn}^{2+}$	-	Off-white

$\text{CuCO}_3$  can be green or blue depending on its concentration.

$\text{Fe}^{2+}$  and  $\text{Fe}^{3+}$  react with  $\text{Fe}(\text{CN})_6^{3-}$  to form a deep blue ppt of  $\text{Fe}_4[\text{Fe}(\text{CN})_6]_3$  (turnbull's ppt).

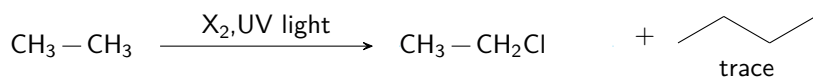
$\text{Fe}^{3+}$  reacts with  $\text{SCN}^-$  to form a blood red coloration.

## 2.3 Tests for Inorganic Compounds, by Reagents and Conditions

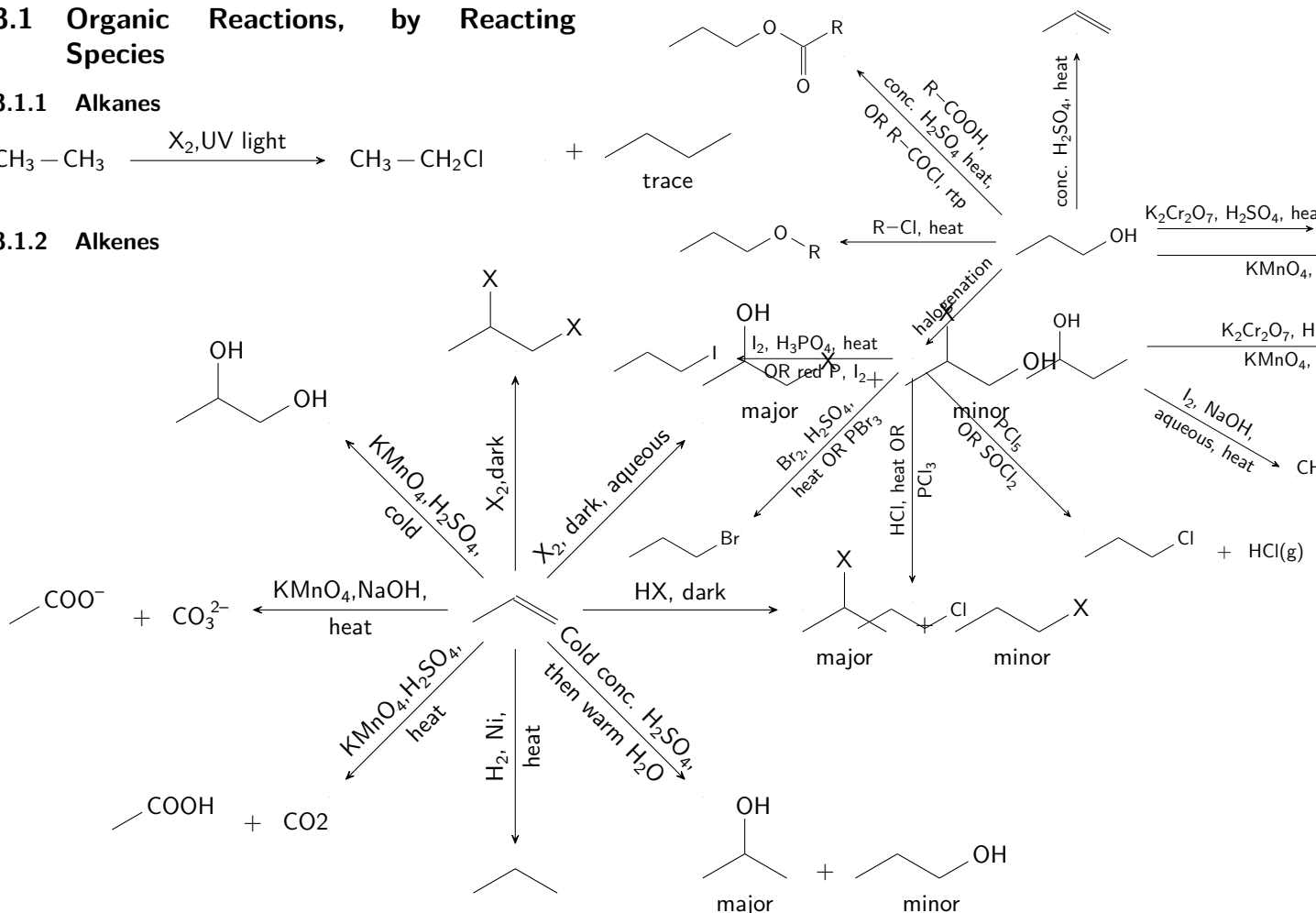
## 3 Common Organic Reactions

### 3.1 Organic Reactions, by Reacting Species

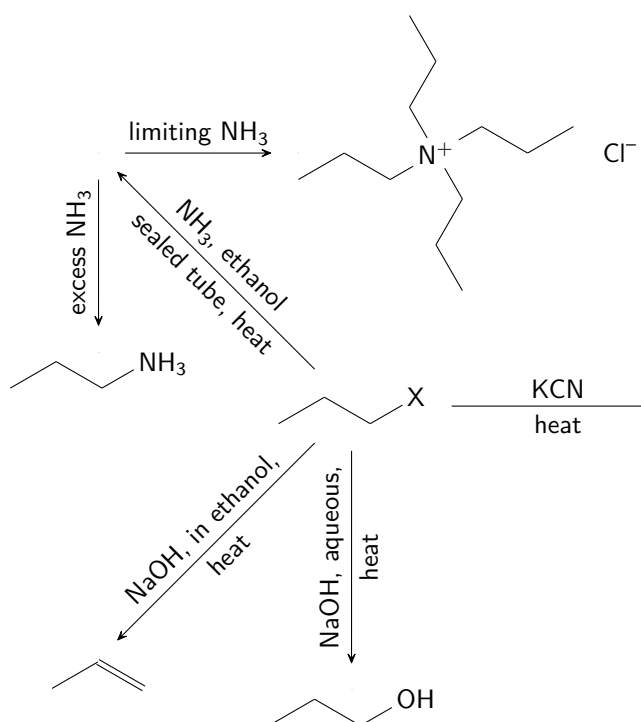
#### 3.1.1 Alkanes



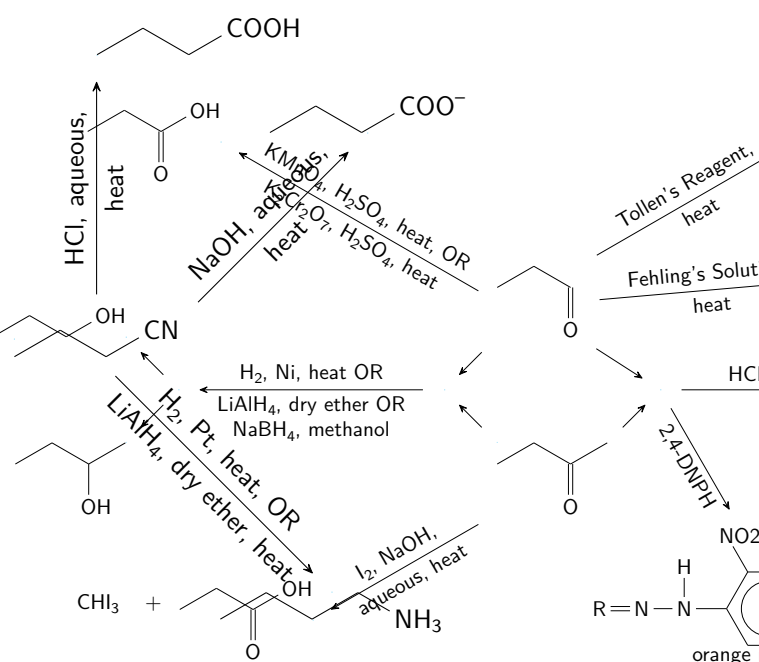
#### 3.1.2 Alkenes



#### 3.1.3 Halogenoalkanes



#### 3.1.5 Carbonyl Compounds



- 3.1.6 Carboxylic Acids
- 3.1.7 Nitrogen Compounds
- 3.1.8 Arenes
- 3.1.9 Phenols
- 3.1.10 Other Aromatic Species
- 3.2 Organic Reactions, by Reagents and Conditions
  - 3.2.1 Acid Reactions
  - 3.2.2 Base Reactions
  - 3.2.3 Reduction
  - 3.2.4 Oxidation
  - 3.2.5 With Cyanides
  - 3.2.6 With Halogens

## **4 Tests for Organic Compounds**

- 4.1 Tests to Identify Species
- 4.2 Tests to Differentiate between Species