Chem QA & Reactions Appendix

Chang Si Yuan

August 11, 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

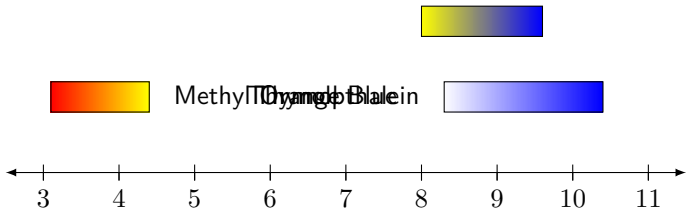
1.1.1 Table of Solubilities

<table>
<tr><td></td><td>Group 1,
NH_4^+</td><td>Hg^+,
Ag^+</td><td>Pb^{2+}</td><td>Ba^{2+},
Ca^{2+}</td><td>Else</td></tr>
<tr><td>NO_3^-</td><td colspan="5">1. All nitrates are soluble</td></tr>
<tr><td>X^-</td><td rowspan="3">2. All Group 1
and ammoniums
are soluble</td><td colspan="3">3. Halides of Hg, Ag and Pb are insoluble</td><td></td></tr>
<tr><td>SO_4^{2-}</td><td></td><td colspan="2">4. Sulfates of Pb, Ba and Ca are insoluble</td><td></td></tr>
<tr><td>OH^-, CO_3^{2-}, PO_4^{2-}, S_2^-</td><td colspan="4">5. Most other salts are insoluble</td></tr>
</table>

1.1.2 K_{sp} Comparison

1.2 Acid/Base Reactions

1.2.1 Acid/Base Titration Indicators



1.3 Redox Reactions and Reagents

$KMnO_4$ is a strong oxidizing agent which will turn from purple to colorless Mn^{2+}. Brown ppt of MnO_2 forms when insufficient acid is present.

$K_2Cr_2O_7$ is a strong oxidizing agent which will turn from orange to green Cr^{3+}.

KI is a reducing agent which may turn from colorless to brown I_2, possibly reducing Fe^{3+} to form brown solution and reducing Cu^{2+} to form cream ppt of CuI. Use starch solution to tell if I_2 is present in small concentrations, alternatively use (starchy) waste paper.

O_2 in air can oxidize:

- green Fe^{2+} solution to brown Fe^{3+} solution
- green $Fe(OH)_2$ ppt to brown $Fe(OH)_3$ ppt
- off-white $Mn(OH)_2$ ppt to brown MnO_2 ppt; and
- white $BaSO_3$ ppt soluble in acid to white $BaSO_4$ ppt insoluble in acid.

H_2O_2 can either act as a reducing agent to form H_2O, oxidizing agent (vs Fe^{2+}) to form 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

O_2 relights a glowing splint.

H_2 extinguishes a lit splint with a 'pop' sound.

CO_2 forms white ppt of $Ca(OH)_2$ when bubbled into limewater $Ca(CO_3)(aq)$.

SO_2 decolorizes acidified purple $KMnO_4$ filter paper.

NO_2 is a brown, pungent gas which (oxidizes?) $FeSO_4$ solution, turning green solution brown.

NH_3 is a pungent gas which turns moist red litmus paper blue.

2.2 Tests and Reactions for Inorganic Compounds, by Identity

2.2.1 Anions

NO_3^- produces NH_3 when heated in NaOH with Al(s).

NO_2^- produces NH_3 when heated in NaOH with Al(s) and produces NO_2 when reacted with HCl.

CO_3^{2-} shows effervescence when reacted with acid to give CO_2.

SO_4^{2-} produces a white ppt of $BaSO_4$, insoluble in acid.

SO_3^{2-} produces a white ppt of $BaSO_3$, which dissolves in acid to produce SO_2.

2.2.2 Halide Anions

I^- produces yellow ppt with $AgNO_3$, insoluble in NH_3(aq).

Br^- produces cream ppt with $AgNO_3$, insoluble in NH_3(aq).

Cl^- produces white ppt with $AgNO_3$, soluble in NH_3(aq) due to the formation of the diamminesilver complex.

2.2.3 Cations

	Soln	NaOH	NH_3(aq)
White ppts			
Ba^{2+}	-	-	-
Ca^{2+}	-	White	-
Zn^{2+}	-	White, soluble	White, soluble
Al^{3+}	-	White, soluble	White
Mg^{2+}	-	White	White
Colored ppts			
Cu^{2+}	Blue	Blue	Blue, soluble to deep blue
Cr^{3+}	Green	Green, soluble to green	Green
Fe^{2+}	Pale Green	Dirty Green	Dirty Green
Fe^{3+}	Brown	Brown	Brown
Mn^{2+}	-	Off-white	Off-white

$CuCO_3$ can be green or blue depending on its concentration.

Fe^{2+} and Fe^{3+} react with $Fe(CN_6)^{3-}$ to form a deep blue ppt of $Fe_4[Fe(CN_6)]_3$ (turnbull's ppt).

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

2.3 Tests for Inorganic Compounds, by Reactants and Conditions

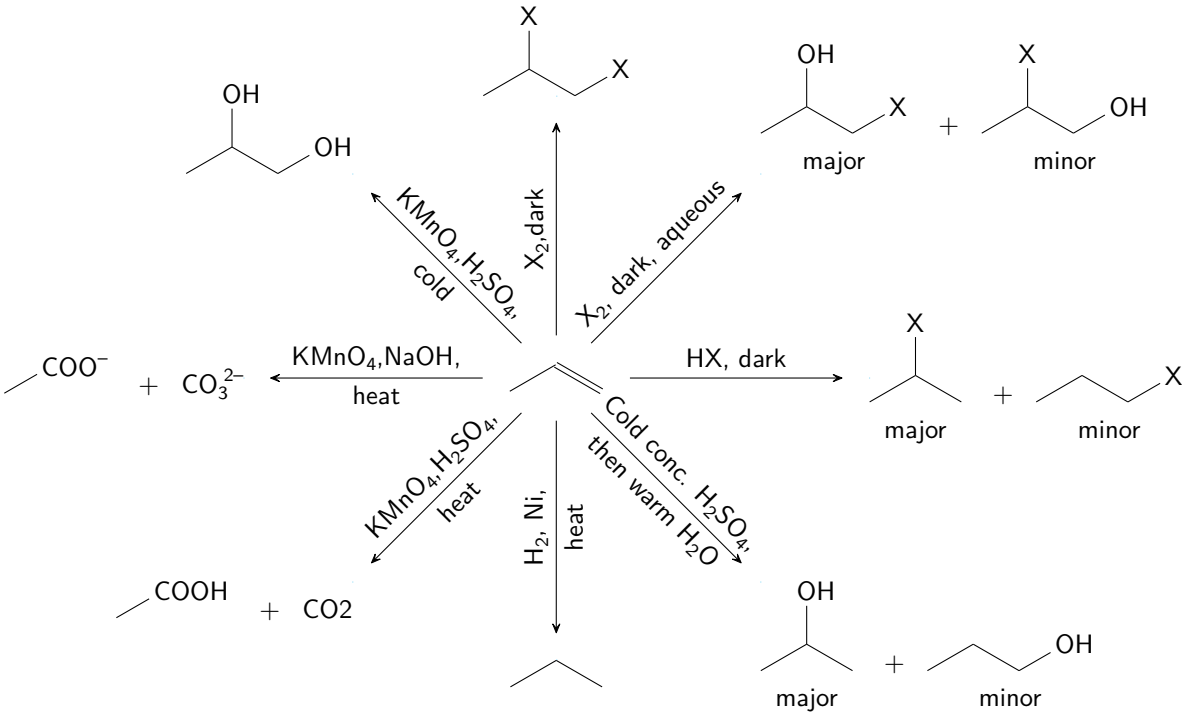
3 Common Organic Reactions

3.1 Organic Reactions, by Reacting Species

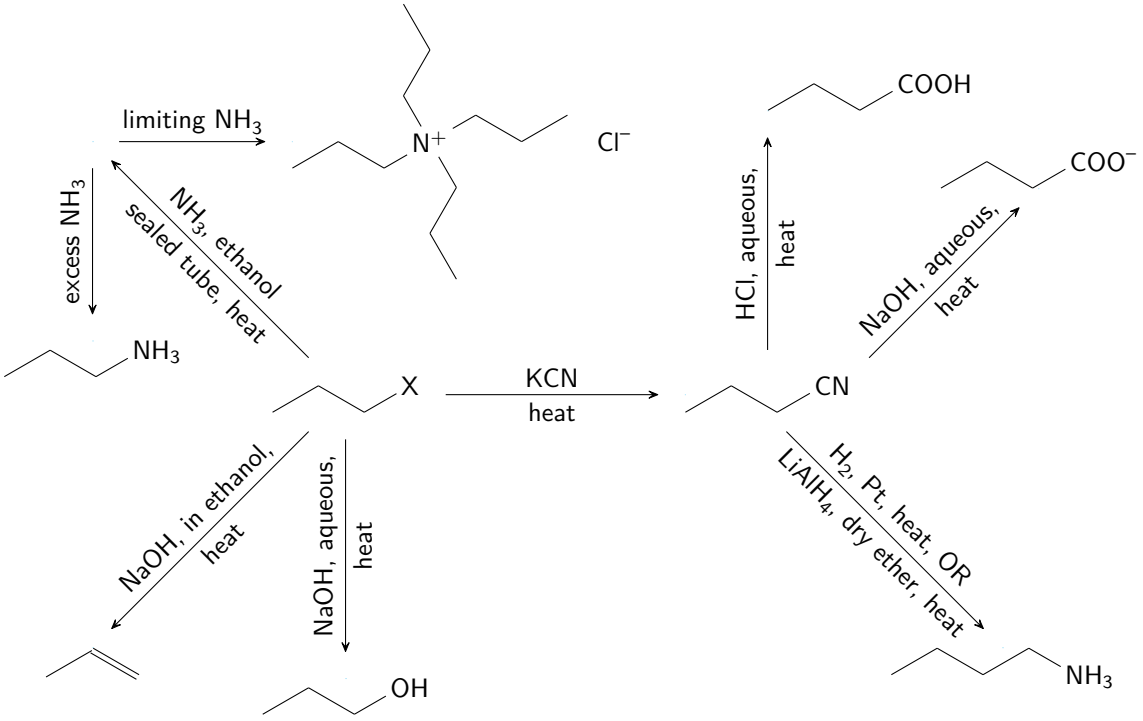
3.1.1 Alkanes

$$CH_3-CH_3 \xrightarrow{X_2,\text{UV light}} CH_3-CH_2Cl + \text{trace}$$

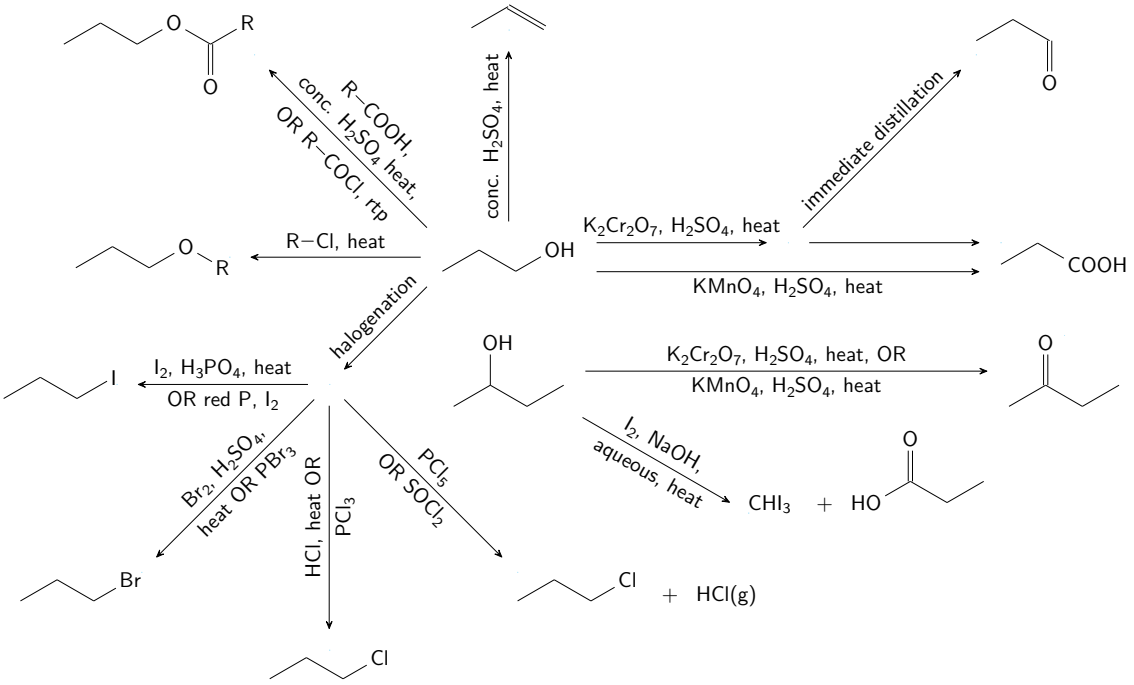
3.1.2 Alkenes



3.1.3 Halogenoalkanes



3.1.4 Hydroxy Compounds



3.1.5 Carbonyl Compounds