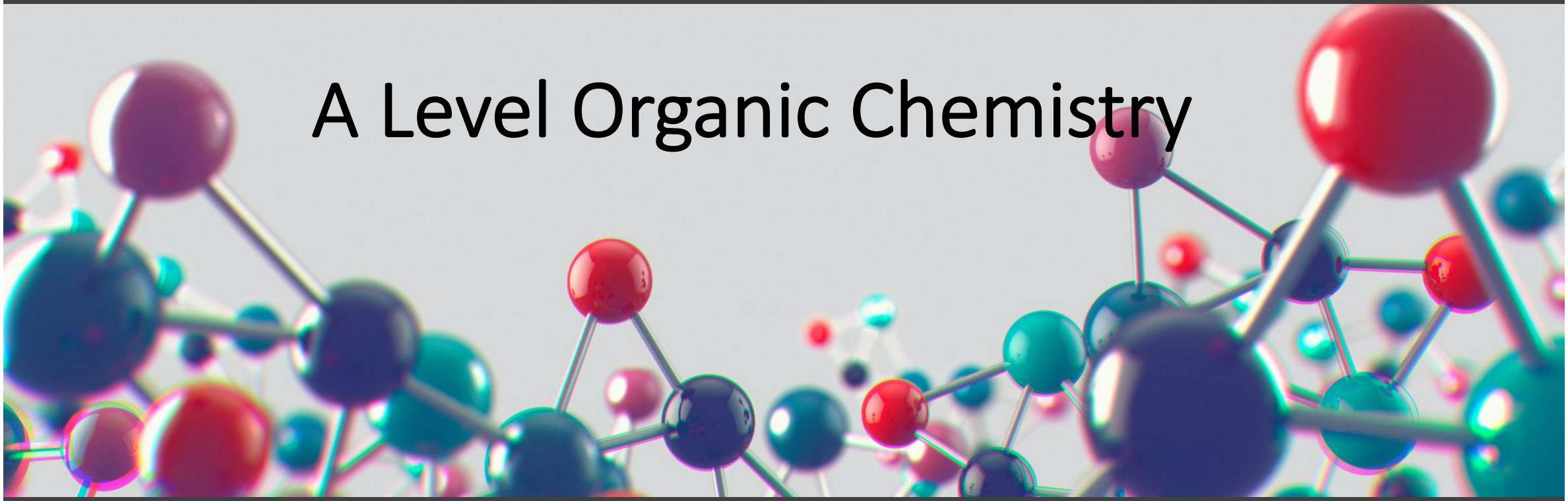


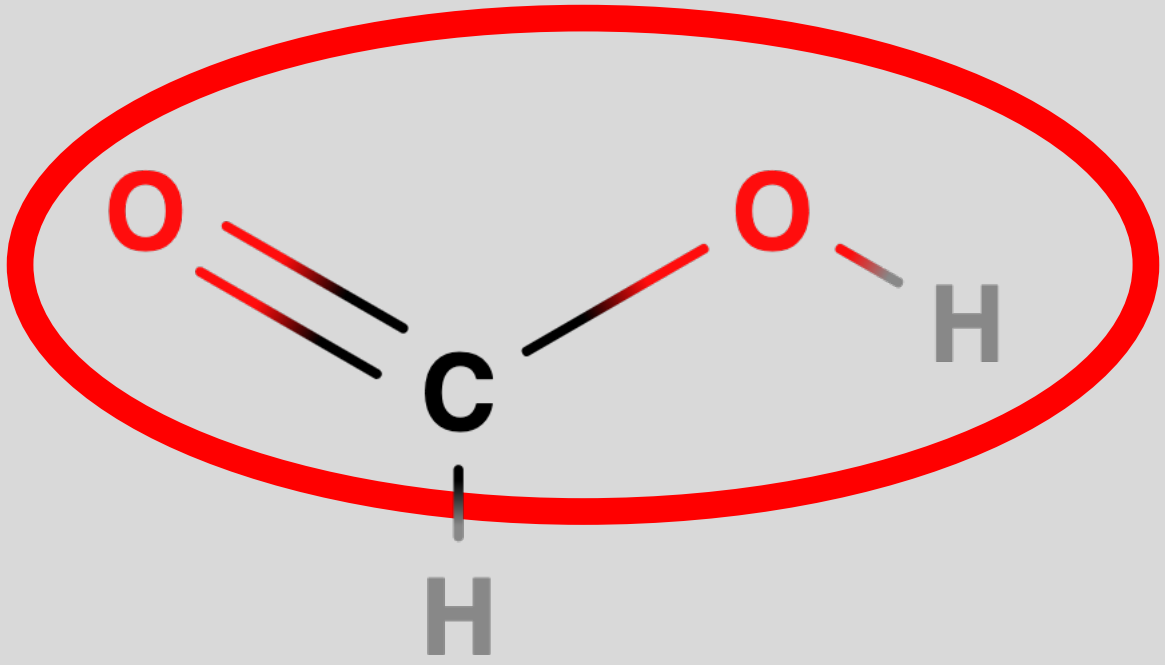
A Level Organic Chemistry

Carboxylic Acids and Esters

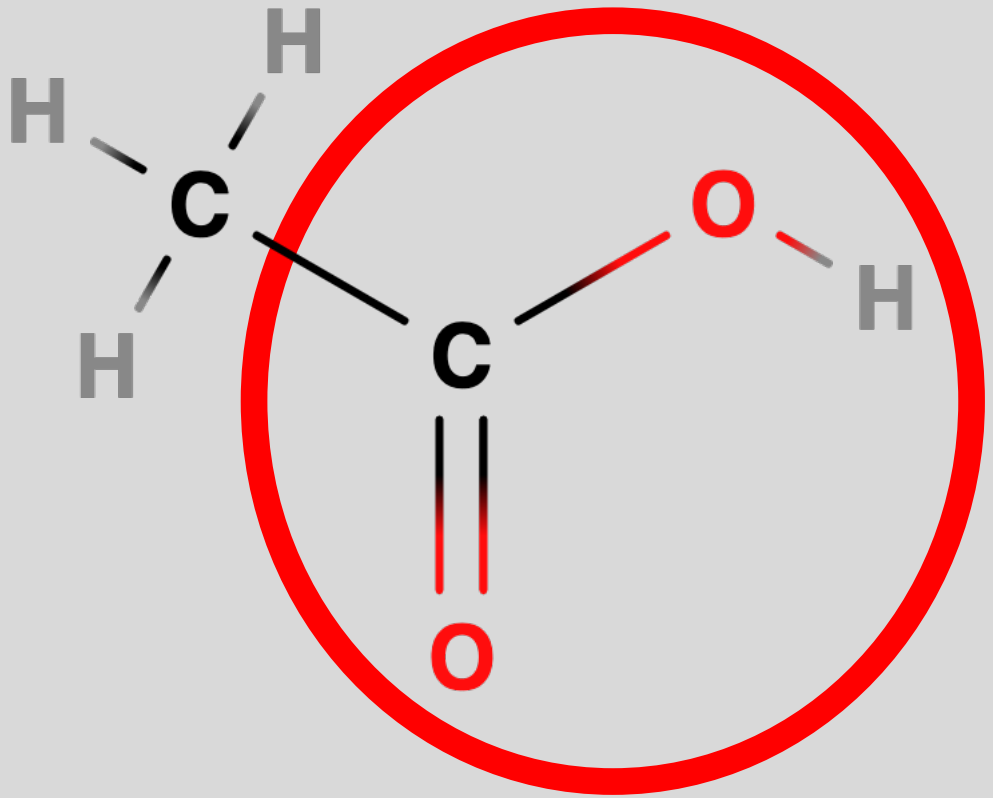
Download slides at ChemistryTuition.Net

Carboxylic Acids

Methanoic Acid

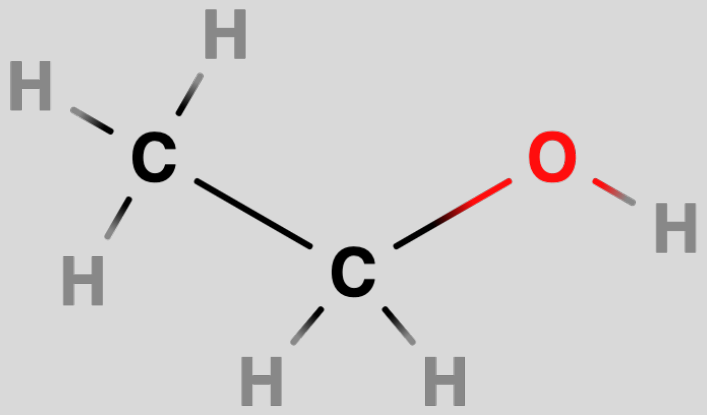


Ethanoic Acid



Synthesis of Carboxylic Acids

Primary Alcohol

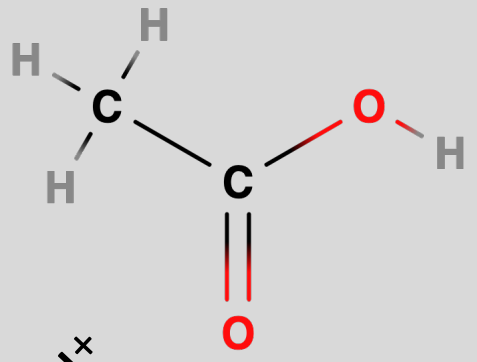


+ 2[O]

$K_2Cr_2O_7/H^+$

Reflux

Carboxylic Acid



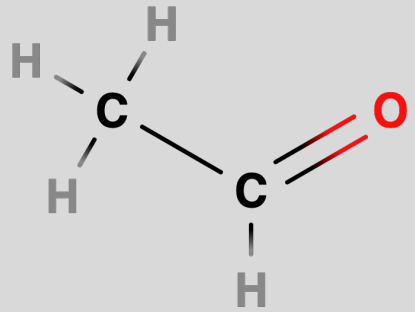
+ H_2O

+ [O]

$K_2Cr_2O_7/H^+$

Distil

Aldehyde



+ H_2O

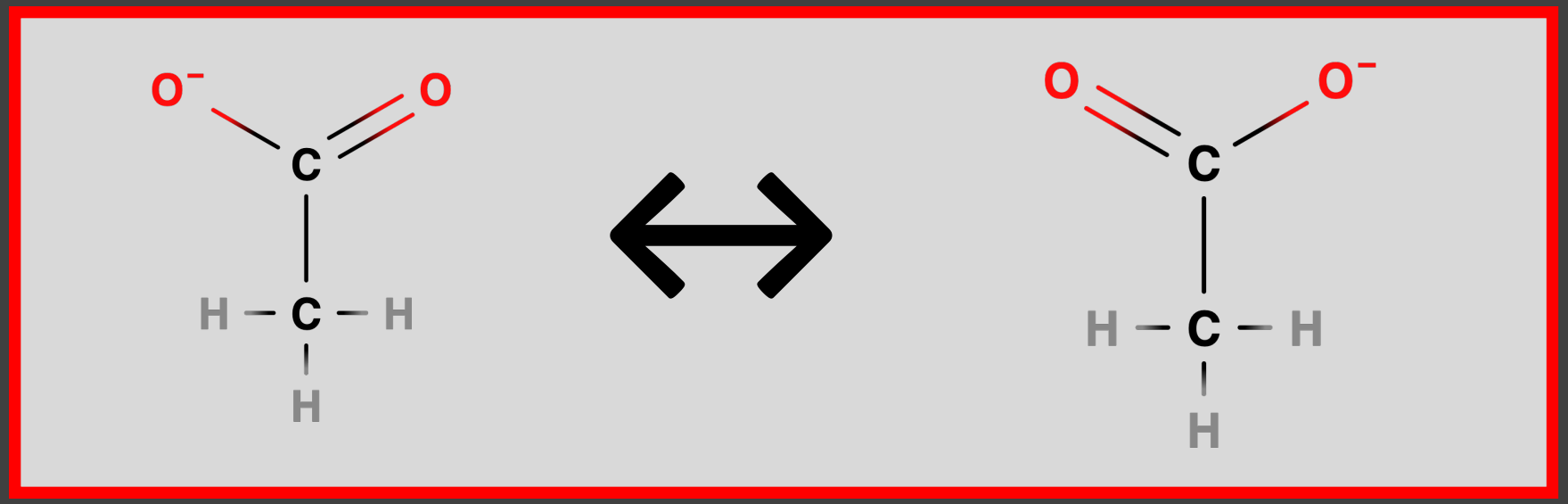
+ [O]

$K_2Cr_2O_7/H^+$

Reflux

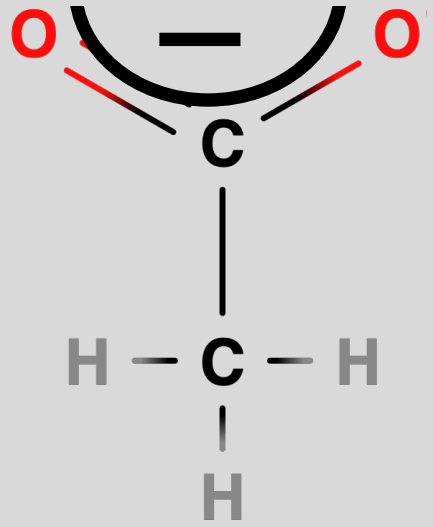
Carboxylic Acids are weak acids

$$CH_3COOH_{(aq)} \rightleftharpoons CH_3COO^-_{(aq)} + H^+_{(aq)}$$

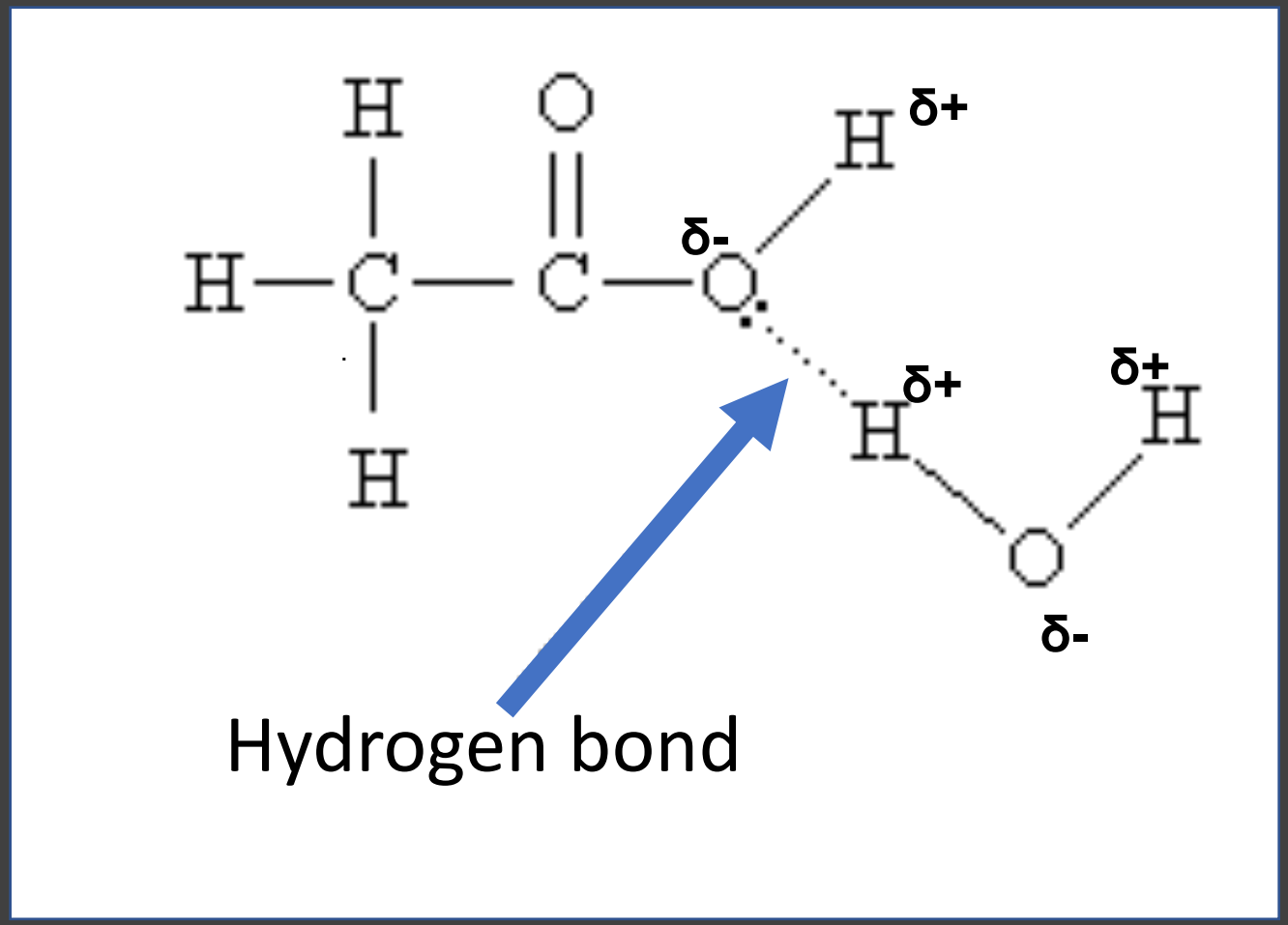


$$CH_3COOH_{(aq)} \rightleftharpoons CH_3COO^-_{(aq)} + H^+_{(aq)}$$

This means that there is only half a negative charge on each oxygen atom. This makes it relatively easy for the H^+ ion to escape from the oxygen atom to which it was attached.



Short chain carboxylic acids are soluble in water:



The carboxylic acid group is hydrophilic and can hydrogen bond to water. This results in a dipole-dipole interaction between the two molecules. However, as the hydrophobic carbon chain becomes longer the solubility of the acid drops rapidly.

Carboxylic Acid reacting like…..acids

Alkalis $CH_3COOH + NaOH \rightarrow CH_3COO^-Na^+ + H_2O$

Ethanoic Acid — Sodium ethanoate

Metals $2HCOOH + Zn \rightarrow (HCOO^-)_2Zn^{2+} + H_2$

Methanoic Acid — Zinc methanoate

Metal Carbonates

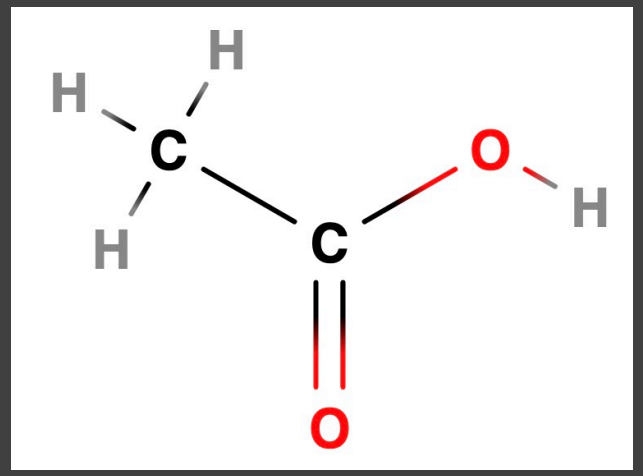
$2CH_3CH_2COOH + Na_2CO_3 \rightarrow 2CH_3CH_2COO^-Na^+ + H_2O + CO_2$

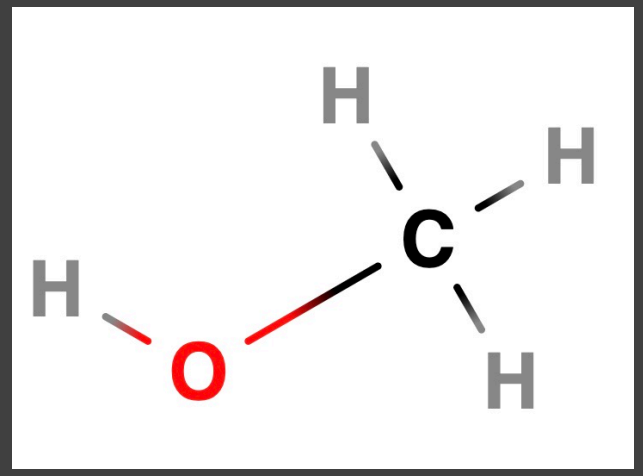
Propanoic Acid — Sodium propanoate

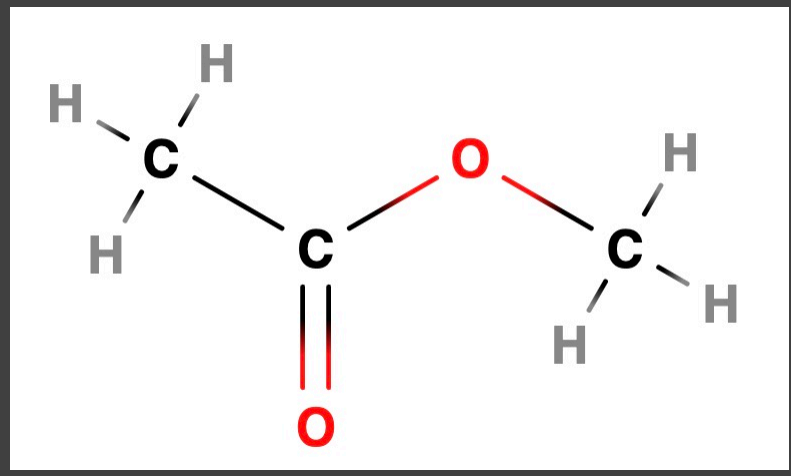
Esters

Carboxylic Acid + Alcohol $\overset{\text{conc } H_2SO_4}{\underset{\text{Reflux}}{\rightleftharpoons}}$ Ester + Water

Ethanoic Acid + Methanol $\rightleftharpoons$ Methyl ethanoate + Water



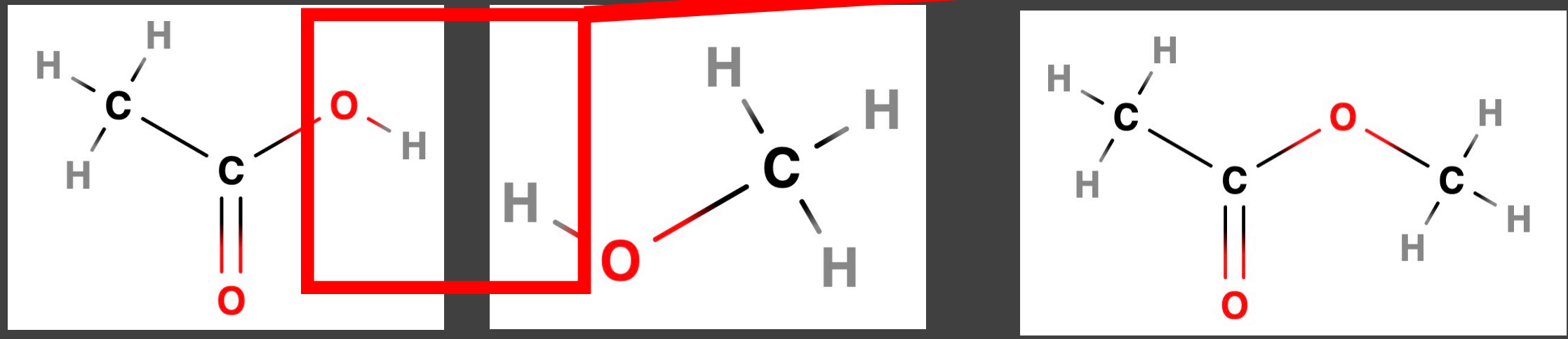




Esters

Carboxylic Acid + Alcohol $\overset{\text{conc } H_2SO_4}{\underset{\text{Reflux}}{\rightleftharpoons}}$ Ester + Water

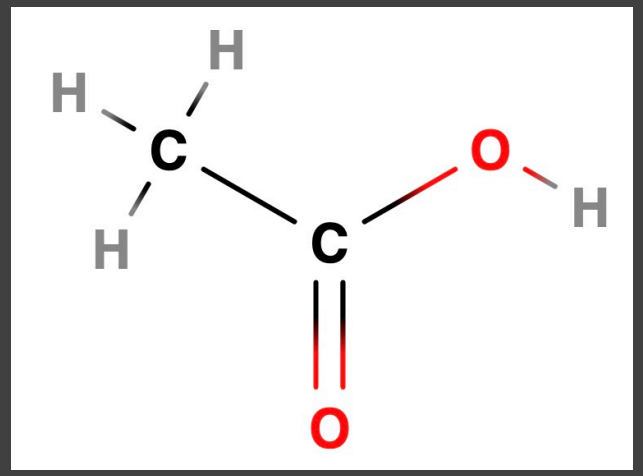
Ethanoic Acid + Methanol $\rightleftharpoons$ Methyl ethanoate + Water

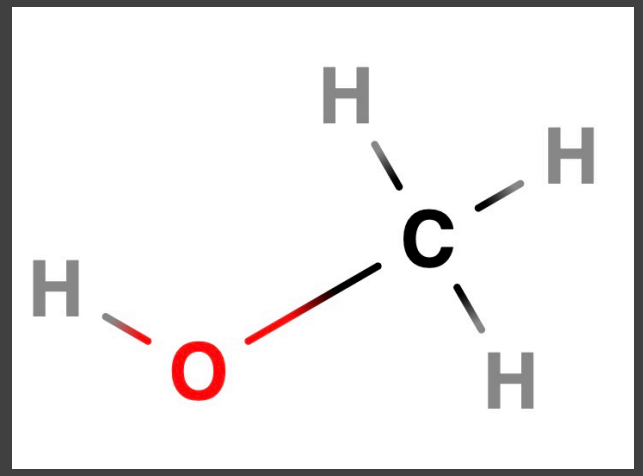


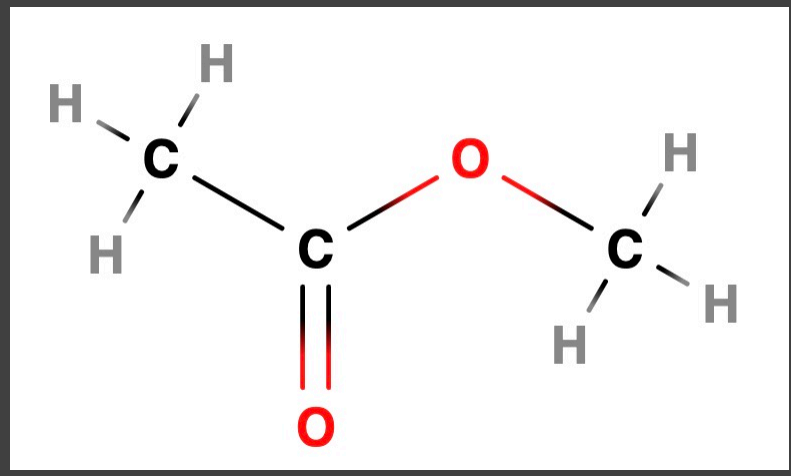
Esters

Carboxylic Acid + Alcohol $\overset{\text{conc } H_2SO_4}{\underset{\text{Reflux}}{\rightleftharpoons}}$ Ester + Water

Ethanoic Acid + Methanol $\rightleftharpoons$ Methyl ethanoate + Water



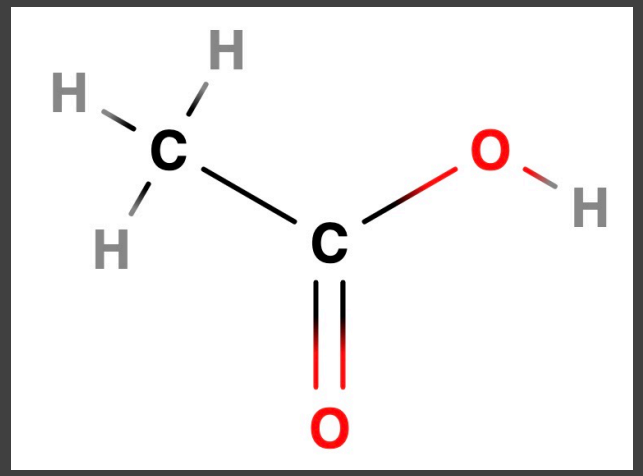


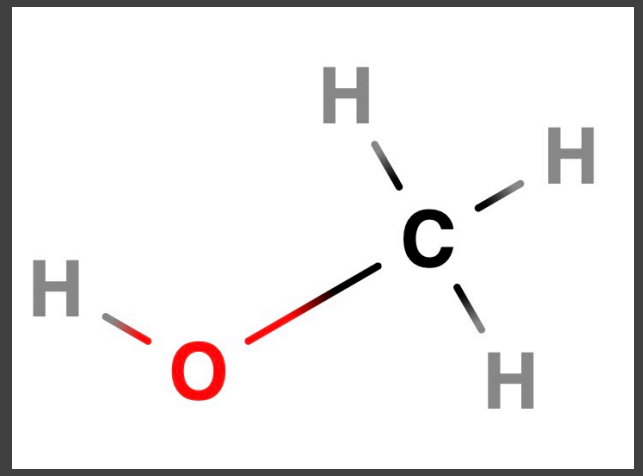


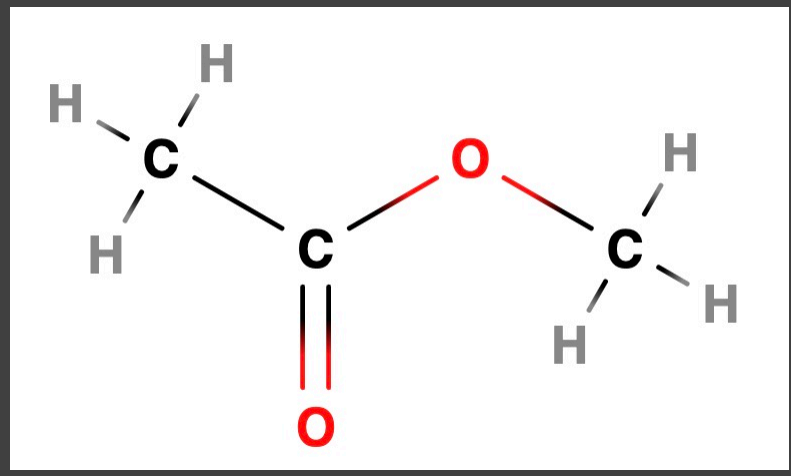
Esters

Carboxylic Acid + Alcohol $\overset{\text{conc } H_2SO_4}{\underset{\text{Reflux}}{\rightleftharpoons}}$ Ester + Water

Ethanoic Acid + Methanol ⇌ Methyl ethanoate + Water



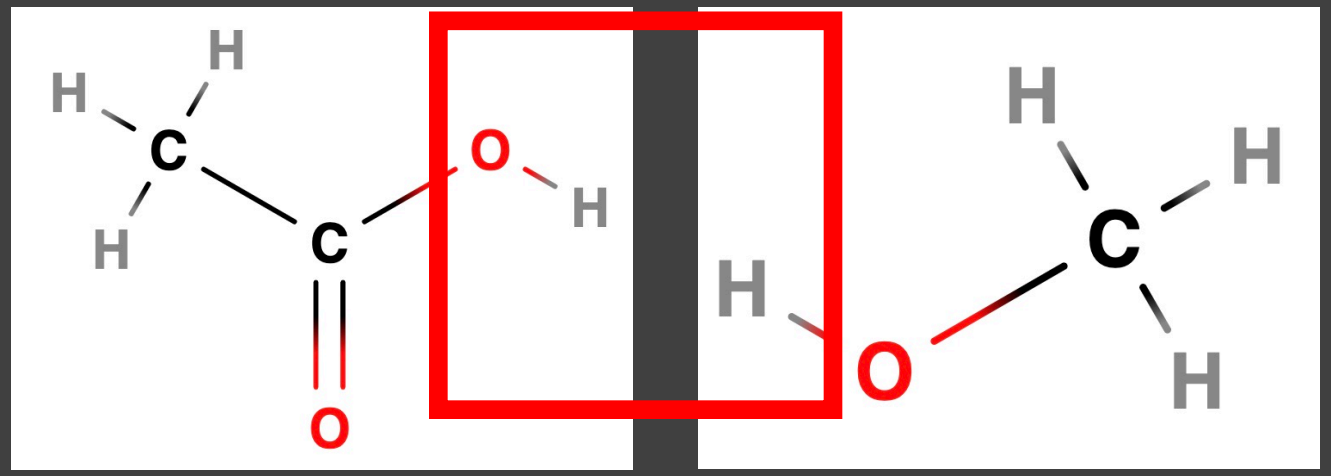


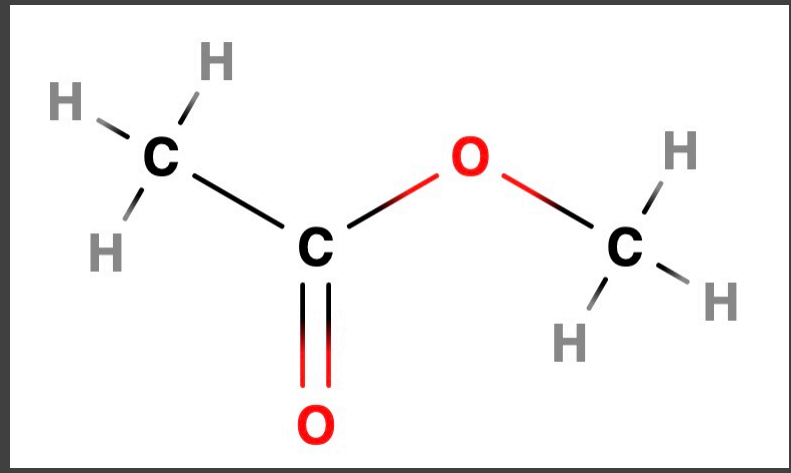


Esters

Carboxylic Acid + Alcohol $\overset{\text{conc } H_2SO_4}{\underset{\text{Reflux}}{\rightleftharpoons}}$ Ester + Water

Ethanoic Acid + Methanol $\rightleftharpoons$ Methyl ethanoate + Water

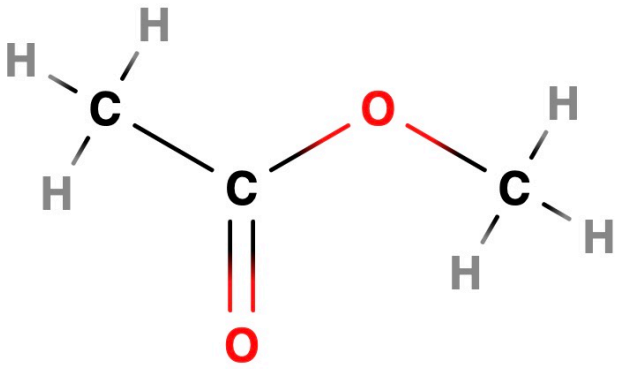




Hydrolysis of Esters

The ester bond may be hydrolysed (broken using water) by refluxing with $HCl_{(aq)}$(equlibrium reaction) or by warming with $NaOH_{(aq)}$ (not in equilibrium)

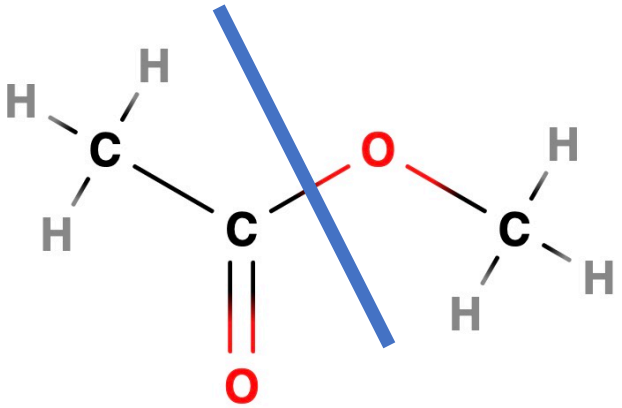
Hydrolysis of Esters using $HCl_{(aq)}$



$+ H_2O$ $\rightleftharpoons$

Reflux/
$HCl_{(aq)}$

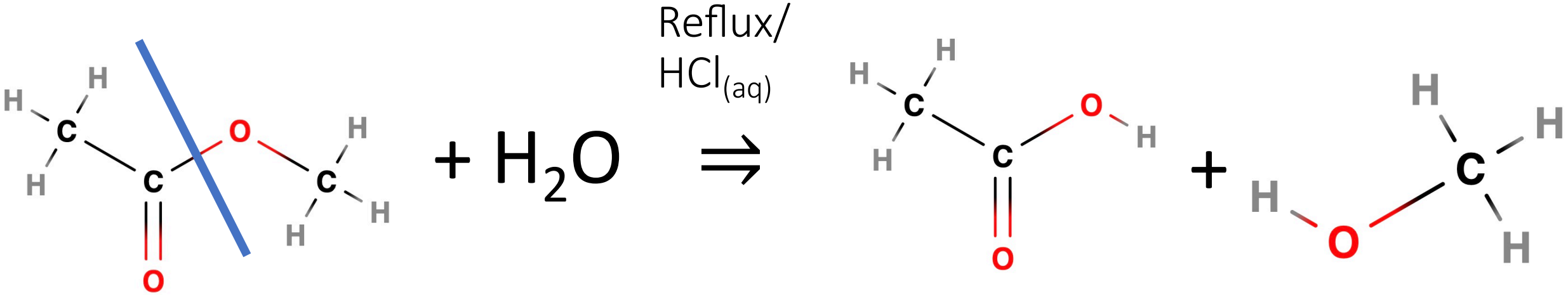
Hydrolysis of Esters using $HCl_{(aq)}$



+ H_2O $\rightleftharpoons$

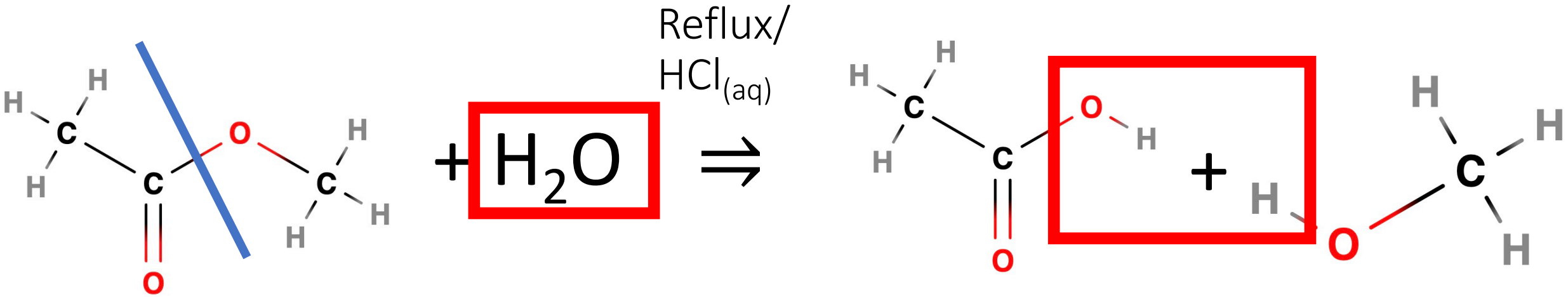
Reflux/
$HCl_{(aq)}$

Hydrolysis of Esters using $HCl_{(aq)}$



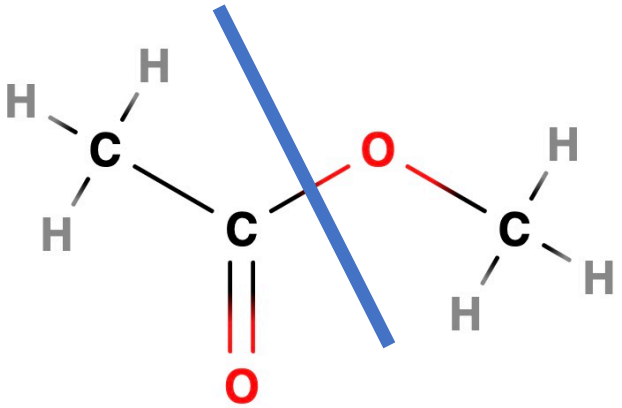
Methyl ethanoate + Water ⇌ Ethanoic Acid + Methanol

Hydrolysis of Esters using $HCl_{(aq)}$



Methyl ethanoate + Water ⇌ Ethanoic Acid + Methanol

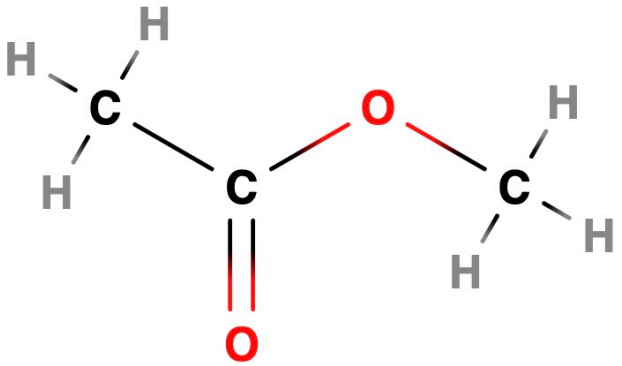
Hydrolysis of Esters using $NaOH_{(aq)}$



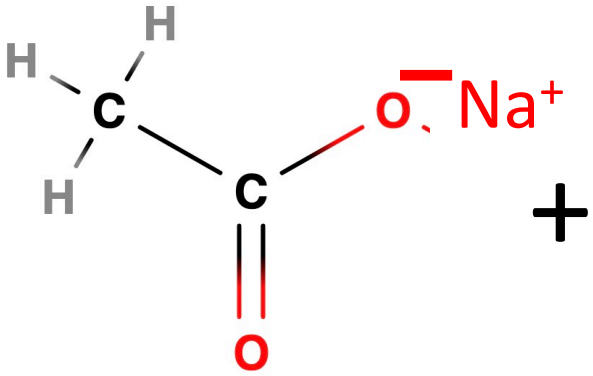
Warm

$+ NaOH_{(aq)} \rightarrow$

Hydrolysis of Esters using $NaOH_{(aq)}$



+ $NaOH_{(aq)}$ Warm →



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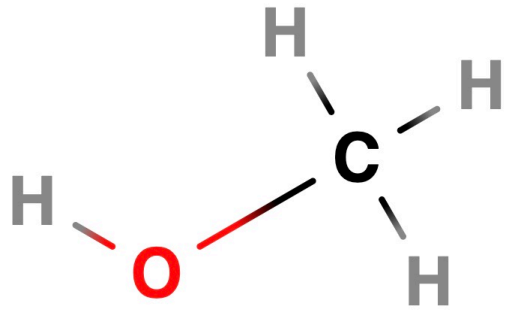
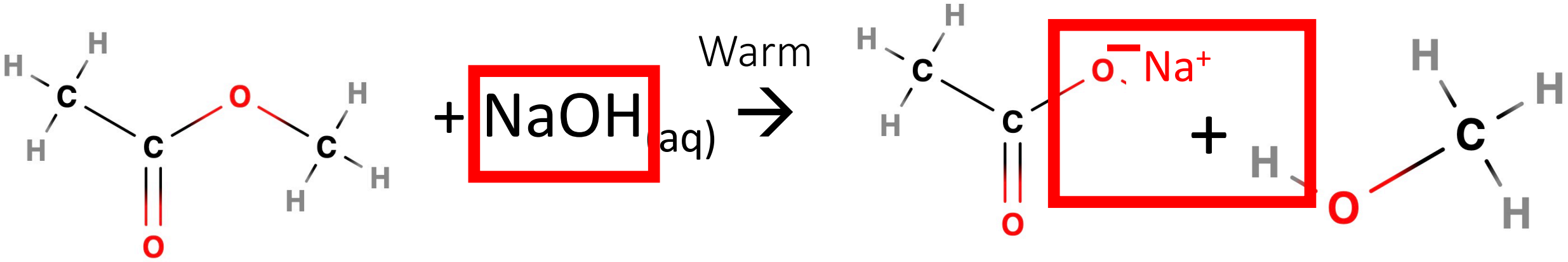
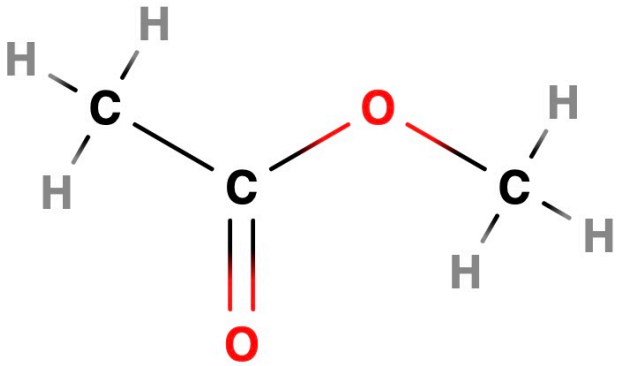


Hydrolysis of Esters using $NaOH_{(aq)}$

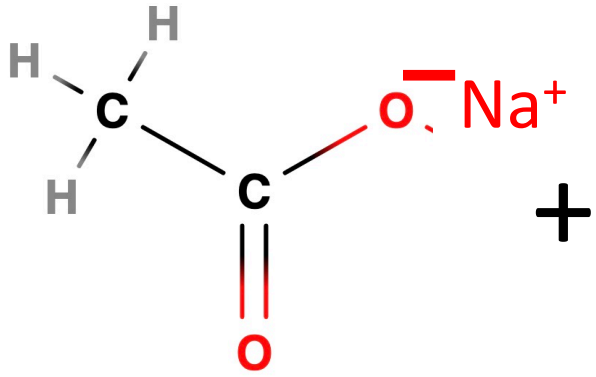


Methyl ethanoate + Sodium Hydroxide → Sodium Ethanoate + Methanol

Hydrolysis of Esters using $NaOH_{(aq)}$



+ $NaOH_{(aq)}$ Warm →



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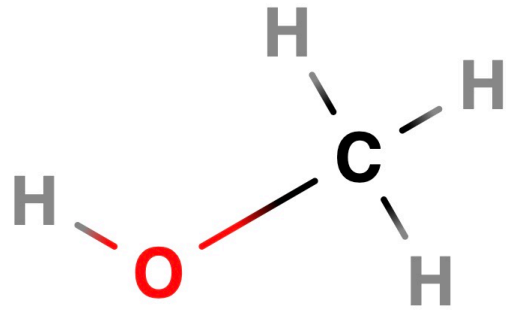
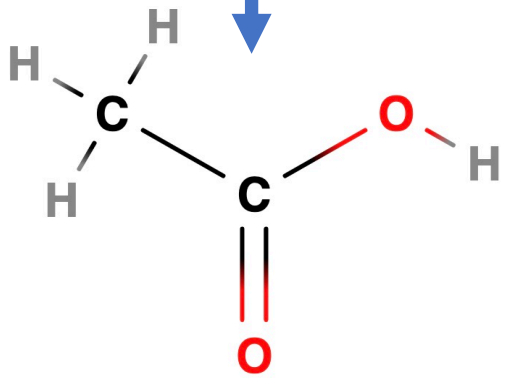


+ $HCl_{(aq)}$



Summary of hydrolysis

Using $HCl_{(aq)}$ – reversible which reduces yield. Only one step. Water is in the equation

Methyl ethanoate + Water ⇌ Ethanoic Acid + Methanol

Using $NaOH_{(aq)}$ – not reversible which increases yield of alcohol and carboxylate salt . Two steps required to produce the carboxylic acid which reduces the overall yield. NaOH is in the equation.

Methyl ethanoate + Sodium Hydroxide → Sodium Ethanoate + Methanol