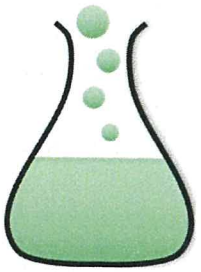
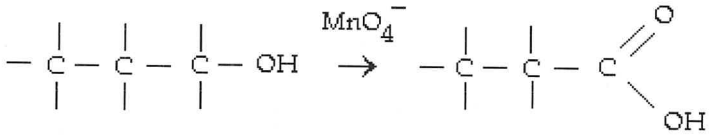
3A ORGANIC REACTIONS



ALCOHOL OXIDATION

* 1° are oxidized to either aldehydes or carboxylic acids, depending on the strength of oxidiser, while 2° produce ketones. 3° alcohols are **unreactive** with laboratory oxidisers such as dichromate and permanganate but can of course be combusted in oxygen given suitable ***activation energy***.

* With 1° alcohol oxidation mild oxidizers such as $Cr_2O_7^{2-}$ may produce an intermediate aldehyde.



➲ Under extreme oxidation, such as in ***COMBUSTION,*** all organic compounds will be oxidised through to CO_2 and H_2O!

1st Principles:

$C_3H_8O \rightarrow C_3H_6O_2$
$C_3H_8O + H_2O \rightarrow C_3H_6O_2$
$C_3H_8O + H_2O \rightarrow C_3H_6O_2 + 4H^+$
$C_3H_8O + H_2O \rightarrow C_3H_6O_2 + 4H^+ + 4e^-$

Semi-Structure:

$\Rightarrow \quad 5(CH_3CH_2CH_2OH + H_2O \rightarrow CH_3CH_2COOH + 4H^+ + 4e^-)$

$\Rightarrow \quad 4(MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{+2} + 4H_2O)$

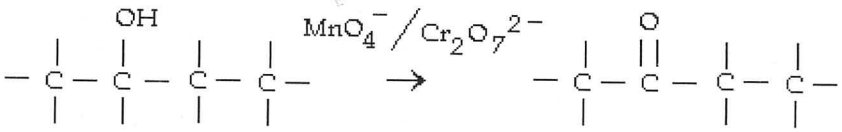
Add Inorganic Reduction half equation for the particular Oxidising Agent

12 11

$5CH_3CH_2OH + 4MnO_4^- + \cancel{32}H^+ + \cancel{5H_2O} \rightarrow 5CH_3CH_2COOH + 4Mn^{+2} + \cancel{20H^+} + \cancel{16}H_2O$

$5CH_3CH_2OH + 4MnO_4^- + 12H^+ \rightarrow 5CH_3CH_2COOH + 4Mn^{+2} + 11H_2O$

$\Rightarrow$ **$5CH_3CH_2CH_2OH_{(l)} + 4MnO_4^-{}_{(aq)} + 12H^+_{(aq)} \rightarrow 5CH_3CH_2COOH_{(aq)} + 4Mn^{+2}_{(aq)} + 11H_2O_{(l)}$**



1st Principles:

$C_4H_{10}O \rightarrow C_4H_8O$
$C_4H_{10}O \rightarrow C_4H_8O + 2H^+$
$C_4H_{10}O \rightarrow C_4H_8O + 2H^+ + 2e^-$

Semi-Structure:

$\Rightarrow \quad 3(CH_3CHOHCH_2CH_3 \rightarrow CH_3COCH_2CH_3 + 2H^+ + 2e^-)$

$\Rightarrow \quad Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$

Add Inorganic Reduction half equation for the particular Oxidising Agent

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$3CH_3CHOHCH_2CH_3 + Cr_2O_7^{2-} + \cancel{14}H^+ \rightarrow 3CH_3COCH_2CH_3 + 2Cr^{3+} + \cancel{6H^+} + 7H_2O$

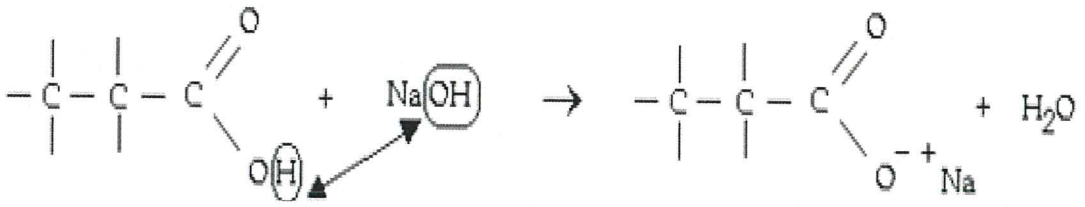
$3CH_3CHOHCH_2CH_3 + Cr_2O_7^{2-} + 8H^+ \rightarrow 3CH_3COCH_2CH_3 + 2Cr^{3+} + 7H_2O$

$\Rightarrow$ **$3CH_3CHOHCH_2CH_3{}_{(l)} + Cr_2O_7^{2-}{}_{(aq)} + 8H^+_{(aq)} \rightarrow 3CH_3COCH_2CH_3{}_{(l)} + 2Cr^{3+}{}_{(aq)} + 7H_2O_{(l)}$**

NB: ***Aldehydes will be oxidised to the carboxylic acid irrespective of the oxidising agent!***

CARBOXYLIC ACID NEUTRALISATION

* As with all acids an organic acid can be neutralised by base to leave a **salt** and **water**. Despite the "weak" nature of many organic acids, they neutralise base just as effectively as a "strong" acid. The base assists in removal of the acid proton, it does not have to simply ionise itself!

TM 

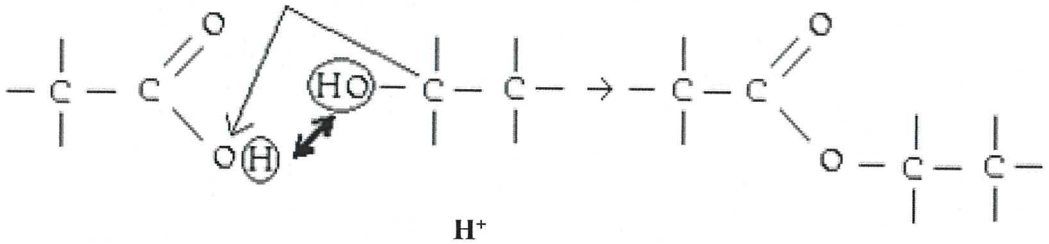
⇒ $\underline{CH_3CH_2COOH_{(aq)} + OH^-_{(aq)} \rightarrow CH_3CH_2COO^-_{(aq)} + H_2O_{(l)}}$

(Propanoate ion)

* NB. Spectator ion omitted (Na^+). Being a weak acid the molecular species is the most abundant chemical species so you should not cancel the acid to H^+!

ESTERIFICATION

* In the presence of an **acid catalyst ALCOHOLS** and **CARBOXYLIC ACIDS** can combine to form esters. These esters have a fruity smell.



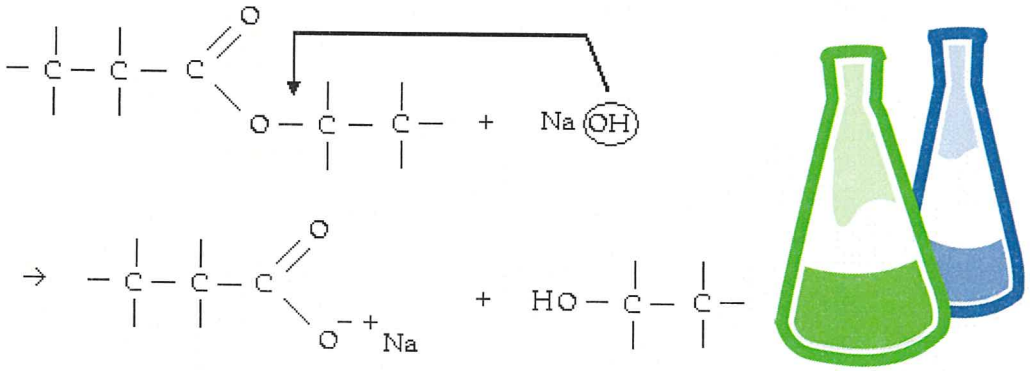
H^+

⇒ $\underline{CH_3COOH_{(l)} + CH_3CH_2OH_{(l)} \rightarrow CH_3COOCH_2CH_{3\,(l)} + H_2O_{(l)}}$

(Ethyl Ethanoate)

REVERSE ESTERIFICATION- Base + Ester

* As esterification is an **acid catalysed** process it can be reversed by the addition of a base to an ester.

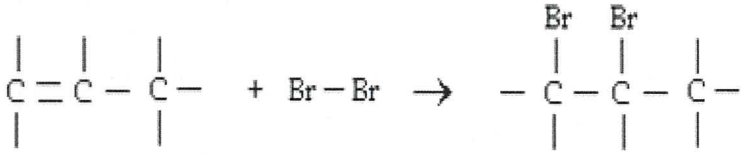


⇒ $CH_3CH_2COOCH_2CH_{3\,(l)} + NaOH_{(aq)} \rightarrow CH_3CH_2COONa_{(aq)} + CH_3CH_2OH_{(l)}$

⇒ $\underline{CH_3CH_2COOCH_2CH_{3\,(l)} + OH^-_{(aq)} \rightarrow CH_3CH_2COO^-_{(aq)} + CH_3CH_2OH_{(l)}}$

ADDITION

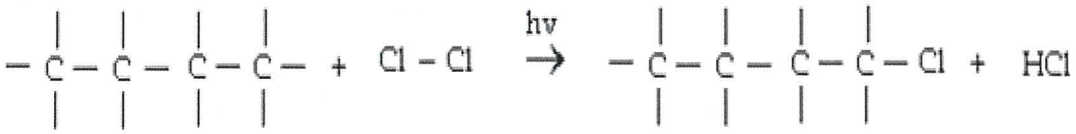
* Hydrocarbons with **UNSATURATED** parts (double or triple bonds) can be ***added*** onto producing saturated molecules:



⇒ $\underline{CH_2CHCH_{3\,(g)} + Br_{2\,(l)} \rightarrow CH_2BrCHBr\,CH_{3\,(l)}}$

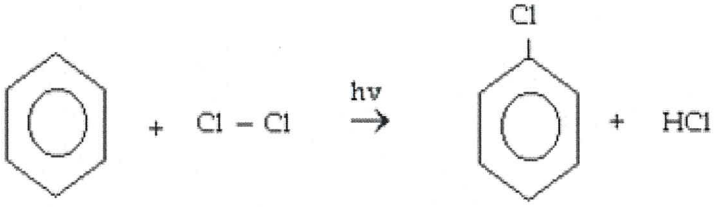
SUBSTITUTION

* **SATURATED** hydrocarbons (alkanes) or aromatic compounds (benzene) cannot undergo addition, only the interchange or ***substitution*** of parts of their structure:



⇒ $\underline{CH_3CH_2CH_2CH_{3\,(g)} + Cl_{2\,(g)} \xrightarrow{hv} CH_3CH_2CH_2CH_2Cl_{(l)} + HCl_{(g)}}$

OR



⇒ $\underline{C_6H_{6\,(l)} + Cl_2 \xrightarrow{hv} C_6H_5Cl_{\,(l)} + HCl}$

COMBUSTION

* All Hydrocarbons and carbohydrates will burn to produce carbon dioxide and water.

⇒ $\underline{2CH_3CH_2CH_2CH_{3\,(g)} + 13\,O_{2\,(g)} \rightarrow 8\,CO_{2\,(g)} + 10\,H_2O_{\,(g)}}$