

Chem!stry

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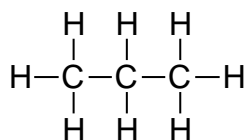
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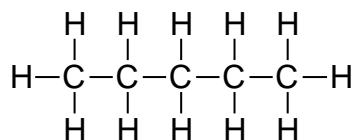
Essential Reactions in Organic Chemistry

Reactions of the Alkanes:

Alkanes are obtained by the fractional distillation of crude oil and are described as saturated hydrocarbons with the general formula C_nH_{2n+2} . Two examples are given below:



Propane
 C_3H_8



Pentane
 C_5H_{12}

Question 1.

a) Define the term *saturated*:

.....

b) Define the term *hydrocarbon*:

.....

• One of the most important uses of alkanes is as fuels. All alkanes burn *completely* in air to produce *carbon dioxide* and *water*.

Question 2.

a) What would you expect the *incomplete* combustion of an alkane to form? Why is this dangerous?

.....

b) Methane is the major component of natural gas which is used as a fuel for cooking. Write a balanced chemical equation to show the complete combustion of methane:

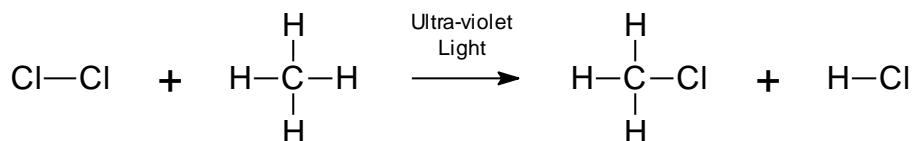
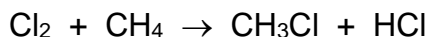
.....

c) 2,2,4-trimethylpentane is a major component of petrol. Write a balanced chemical equation to show the complete combustion of 2,2,5-trimethylpentane:

.....

- Alkanes undergo a *substitution reaction* with Group VII elements in the presence of ultra-violet light to form halogenoalkanes. An example is given below:

chlorine + methane → chloromethane + hydrogen chloride



Question 3.

- a) Write a word-equation and a balanced chemical equation for the reaction that takes place between bromine and ethane in the presence of ultra-violet light:

Word equation:

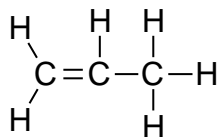
Balanced chemical equation:

- b) Give the full structural formulae and names of *two* compounds that could be formed when ethane reacts with *excess* bromine in the presence of ultra-violet light:

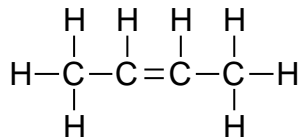
Structure formula of compound #1	Structure formula of compound #2
Name of compound:	Name of compound:

Reactions of the Alkenes:

Alkenes are obtained by the industrial scale cracking of alkanes and are described as *unsaturated* hydrocarbons with the general formula C_nH_{2n} . Two examples are given below:



Propene
 C_3H_6



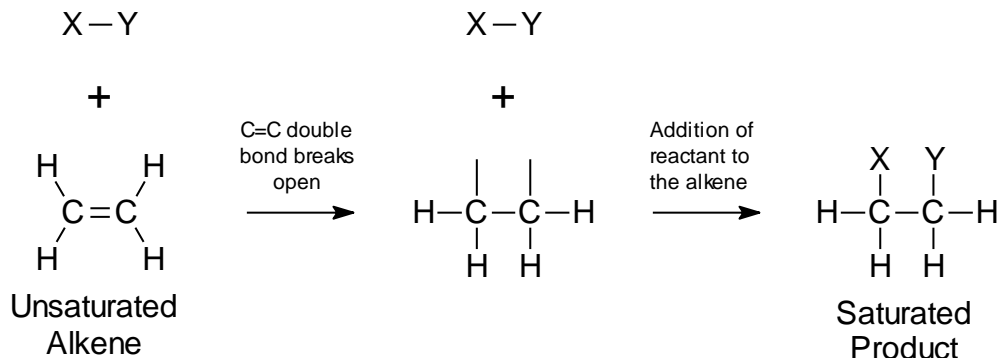
But-2-ene
 C_4H_8

Question 4:

What do you understand by the term *unsaturated*?

.....

The most common reaction of the alkenes is the addition of reactants across the carbon-to-carbon double covalent bond as outlined in the diagram shown below:



Question 5.

- a) In the presence of a platinum or nickel catalyst, hydrogen gas will react with an alkene to form an alkane. This process is called *catalytic hydrogenation*. Write a word equation and a balanced chemical equation for the reaction between propene and hydrogen and draw the structural formula of the reaction product in the space provided:

Word equation:

Balanced chemical equation:

Structural formula of product:

- b) Using a few drops of concentrated sulphuric acid as a catalyst, water will react with an alkene to form an alcohol. This process is called *hydration*. Write a word equation and a balanced chemical equation for the reaction between ethene and water and draw the structural formulae of the reaction product in the space provided:

Word equation:

Balanced chemical equation:

Structural formula of product:

- c) A Group VII element will react with an alkene at room temperature to form a halogenoalkane. *If the element bromine is used, then there is a very obvious colour change from orange to colourless which can be used as the qualitative test for an alkene.* Write a word equation and a balanced chemical equation for the reaction between but-1-ene and bromine and draw the structural formulae of the reaction product in the space provided:

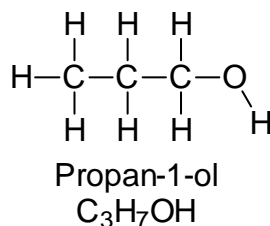
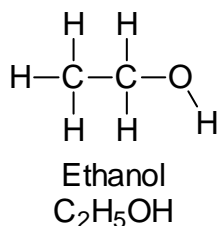
Word equation:

Balanced chemical equation:

Structural formula of product:

Reactions of the Alcohols:

Members of the homologous series of alcohols all contain the $-OH$ functional group. The general formula of an alcohol is $C_nH_{2n+1}OH$. Two examples are given below:



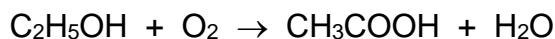
The most common alcohol is ethanol. Ethanol can be obtained by the fermentation of glucose in the presence of yeast, an enzyme in the yeast functioning as a catalyst for the reaction:

glucose \rightarrow ethanol + carbon dioxide



If ethanol is exposed to air for too long, it is oxidised by atmospheric oxygen to form ethanoic acid. This is why bottles of wine that are left open for too long taste like vinegar:

ethanol + oxygen \rightarrow ethanoic acid + water



Alcohols can be oxidised to carboxylic acids in the laboratory by refluxing with a suitable oxidising agent such as acidified potassium dichromate(VI) (changes colour from orange to green) or acidified potassium manganate(VII) (changes colour from purple to colourless).

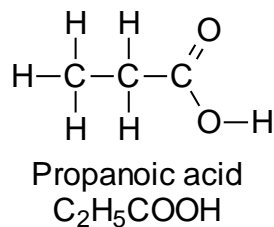
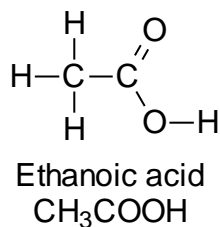
Question 6.

Give the full structural formula and name of the carboxylic acid that is formed when each of the following alcohols is oxidised:

Alcohol	Structural Formula of Carboxylic Acid
$\begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{H}-\text{C}-\text{C}-\text{O}-\text{H} \\ \quad \\ \text{H} \quad \text{H} \\ \text{Ethanol} \end{array}$	Name:
$\begin{array}{c} \text{H} \quad \text{H} \quad \text{H} \\ \quad \quad \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{O}-\text{H} \\ \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \\ \text{Propan-1-ol} \end{array}$	Name:
$\begin{array}{c} \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \\ \quad \quad \quad \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{C}-\text{O}-\text{H} \\ \quad \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \\ \text{Butan-1-ol} \end{array}$	Name:

Reactions of the Carboxylic Acids:

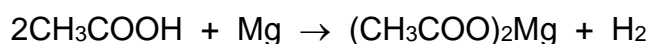
Members of the homologous series of carboxylic acids all contain the $-\text{COOH}$ functional group. The general formula of a carboxylic acid is $\text{C}_n\text{H}_{2n}\text{O}_2$. Two examples are given below:



Carboxylic acids are described as *weak acids* because they do not fully ionise when dissolved in water. Carboxylic acids demonstrate all the typical properties of acids.

- They react with metals to produce a salt and hydrogen:

ethanoic acid + magnesium \rightarrow magnesium ethanoate + hydrogen



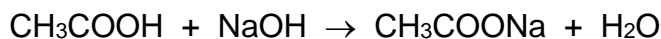
- They react with carbonates to produce a salt, water and carbon dioxide:

ethanoic acid + sodium carbonate → sodium ethanoate + water + carbon dioxide



- They react with bases to produce a salt and water:

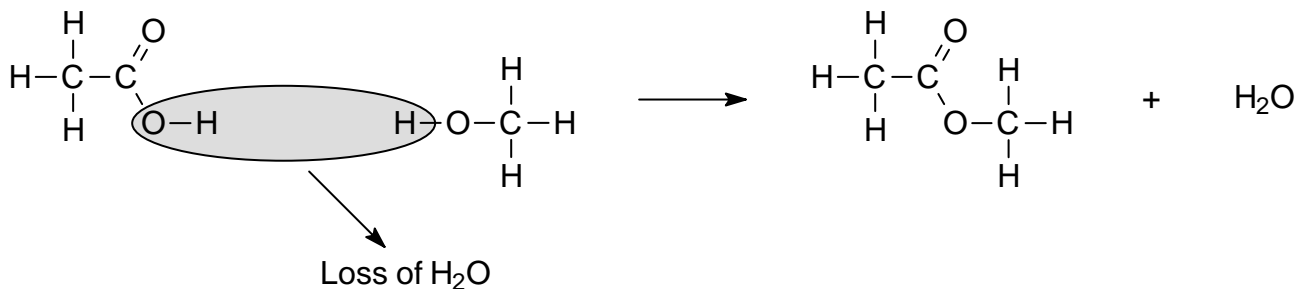
ethanoic acid + sodium hydroxide → sodium ethanoate + water



When an *alcohol* and *carboxylic acid* are warmed together in the presence of a mineral acid as catalyst (e.g. a few drops of concentrated sulphuric acid), an *ester* is formed as the main reaction product. Water is produced as the side-product. The reaction is known as an *esterification*.

To work out the structure of the ester formed when an alcohol and carboxylic acid react, draw the alcohol and carboxylic acid side-by-side with their functional groups facing each other. Circle and remove a molecule of water from between the two molecules and join together the remaining fragments.

for example:



The name of the ester is in two parts. The first part is taken from the name of the alcohol, and the second part is taken from the name of the carboxylic acid.

for example:

methanol + ethanoic acid → methyl ethanoate + water

ethanol + propanoic acid → ethyl propanoate + water

Esters have an attractive fruity aroma and are therefore used in the food and perfume industries.

Question 7.

For each of the following chemical reactions:

- Name the carboxylic acid.
- Name the alcohol.
- Give the full structural formula and name of the ester that is formed.

a)	$\begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}-\text{C} \\ \quad // \\ \text{H} \quad \text{O} \\ \quad \quad \\ \quad \quad \text{O}-\text{H} \end{array} + \begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{H}-\text{O}-\text{C}-\text{C}-\text{H} \\ \quad \\ \text{H} \quad \text{H} \end{array} \longrightarrow$ <p>Name of carboxylic acid:</p> <p>Name of alcohol:</p> <p>Name of ester:</p>
b)	$\begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{H}-\text{C}-\text{C}-\text{C} \\ \quad \quad // \\ \text{H} \quad \text{H} \quad \text{O} \\ \quad \quad \quad \\ \quad \quad \quad \text{O}-\text{H} \end{array} + \begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{H}-\text{O}-\text{C}-\text{C}-\text{H} \\ \quad \\ \text{H} \quad \text{H} \end{array} \longrightarrow$ <p>Name of carboxylic acid:</p> <p>Name of alcohol:</p> <p>Name of ester:</p>
c)	$\begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{H}-\text{C}-\text{C}-\text{C} \\ \quad \quad // \\ \text{H} \quad \text{H} \quad \text{O} \\ \quad \quad \quad \\ \quad \quad \quad \text{O}-\text{H} \end{array} + \begin{array}{c} \text{H} \\ \\ \text{H}-\text{O}-\text{C}-\text{H} \\ \\ \text{H} \end{array} \longrightarrow$ <p>Name of carboxylic acid:</p> <p>Name of alcohol:</p> <p>Name of ester:</p>

- Scan the QR code given below to view the answers to this assignment.



http://www.chemist.sg/organic_chem/worksheets/essential_reactions_ans.pdf