

Chem!stry

Name: ()

Class:

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Extra Practice – Essential Reactions in Organic Chemistry

• Part One: Alkanes

1. Combustion

Alkanes react with oxygen, undergoing complete combustion to form carbon dioxide and water. The reaction is useful because it is exothermic, releasing energy that can be used to power cars and generate electricity. Unfortunately, the carbon dioxide gas that is released contributes to climate change through global warming.

(a) Write the balanced chemical equation showing the complete combustion of ethane.

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(b) Write the balanced chemical equation showing the complete combustion of propane.

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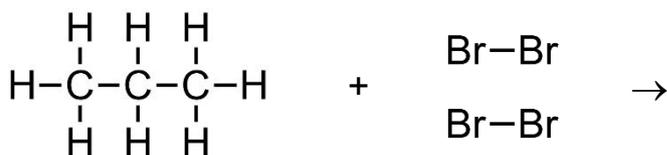
2. Substitution

Alkanes undergo substitution reactions with halogens (Group 17 non-metals) in the presence of ultraviolet light. The reaction produces a halogenoalkane and a hydrogen halide as the reaction products. If one mole of the alkane reacts with one mole of the halogen, then only one hydrogen atom is substituted. If one mole of the alkane reacts with two moles of the halogen, then two hydrogen atoms are substituted, and so on.

(a) Give the full structural formula and name of the organic product formed:

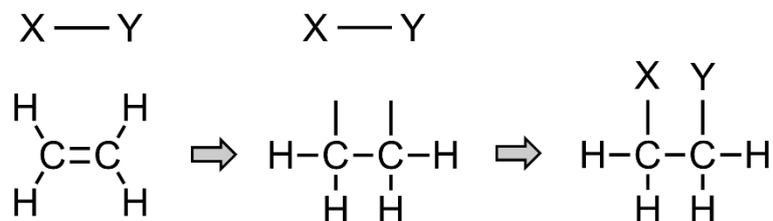


(b) Give the structural formulae and names of any two organic products that could be formed:



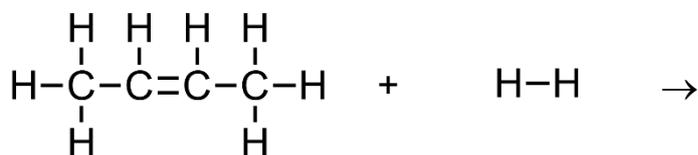
• Part Two: Addition Reactions of the Alkenes

Alkenes undergo addition reactions which usually involve the addition of a simple covalent molecule *across* the carbon-to-carbon double covalent bond.



1. Alkenes undergo addition reactions with hydrogen in the presence of a nickel catalyst to form alkanes.

- Give the full structural formula and name of the alkane formed:



2. Alkenes undergo addition reactions with water in the presence of an acid catalyst, such as H_3PO_4 , to form an alcohols.

- Give the full structural formulae and names of the two alcohols that could be formed:



3. Alkenes undergo addition reactions with bromine at room temperature and pressure to form bromoalkanes. This can be used as a qualitative test for unsaturation (*i.e.* the presence of a $C=C$ bond) because the colour of the reaction mixture changes from reddish-brown to colourless. Note: alkanes also react with halogens, but only in the presence of ultraviolet light.

- Give the full structural formula and name of the product formed:



4. Alkenes undergo addition reactions with hydrogen chloride at room temperature and pressure to form chloroalkanes.

- Give the full structural formulae and names of the two chloroalkanes that could be formed:



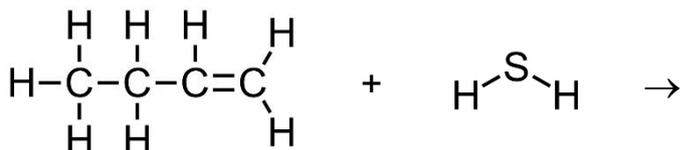
5. Alkenes undergo addition reactions with ammonia under conditions of high temperature and high pressure to form amines.

- Give the full structural formula and name of the amine formed:



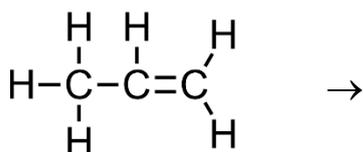
6. Alkenes undergo addition reactions with hydrogen sulfide under conditions of high temperature and high pressure in the presence of a catalyst to form thiols.

- Give the full structural formula and name of the thiol formed:



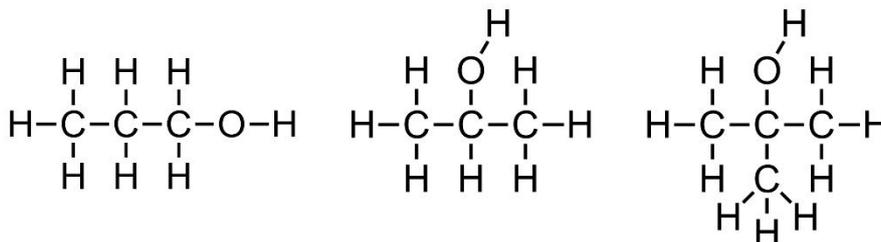
7. Alkenes undergo addition polymerisation to form plastics.

- Give the full structural formula and name of the addition polymer formed by propene.
- Show three repeating units.



• Part Three: Alcohols

Alcohols can be classified as being either *primary*, *secondary* or *tertiary* depending upon the number of carbon atoms directly bonded to the carbon attached to the hydroxyl group (C–O–H).

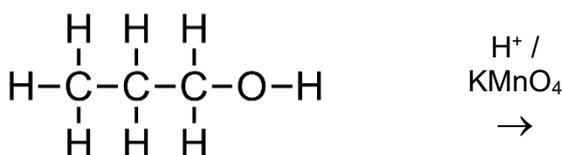


- propan-1-ol is a primary alcohol
- propan-2-ol is a secondary alcohol
- 2-methylpropan-2-ol is a tertiary alcohol

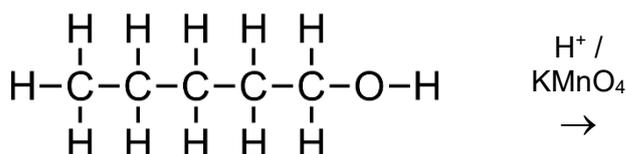
1. Oxidation

Primary alcohols can be oxidised to carboxylic acids when they are refluxed with acidified potassium manganate(VII).

(a) Give the full structural formula and name of the carboxylic acid formed:



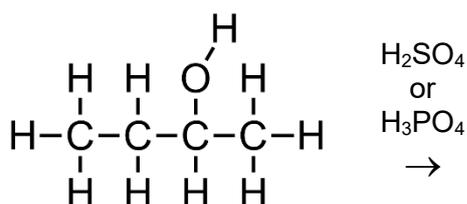
(b) Give the full structural formula and name of the carboxylic acid formed:



2. Dehydration

Alcohols can be dehydrated (a special kind of elimination reaction) to form alkenes when they are heated in the presence of an acid catalyst such as H_2SO_4 or H_3PO_4 .

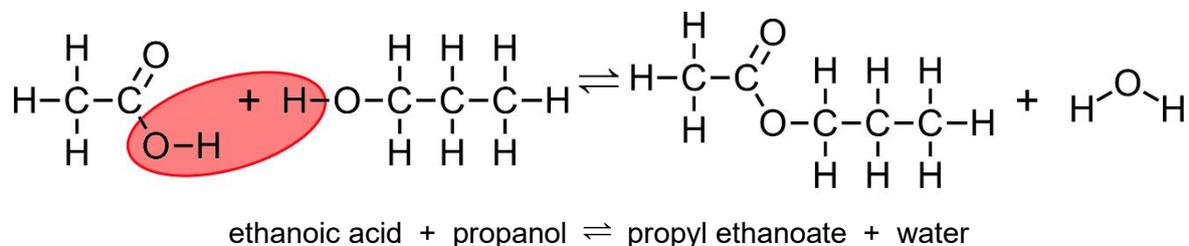
(a) Give the full structural formulae and names of the two alkenes that could be formed:



• Part Four: Carboxylic acids

1. Formation of Esters – Esterification

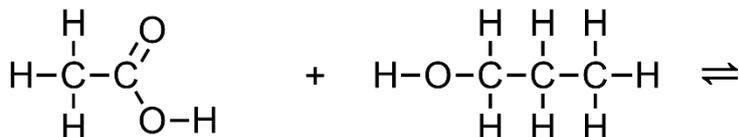
Carboxylic acids react with alcohols to form esters. Water is formed as a side-product, hence this type of reaction is often referred to as a *condensation reaction*. Note that the hydroxyl group from the carboxylic acid and hydrogen from the alcohol form the molecule of water, not the hydrogen from the acid as might be expected. Also note that the reaction is *reversible*.



To prepare the ester, the carboxylic acid and alcohol are heated together under reflux in the presence of sulfuric acid as the catalyst. The ester is then separated from the reaction mixture by distillation.

Esters have sweet and fruity flavours and aromas, hence they are widely used in the food and perfume industry.

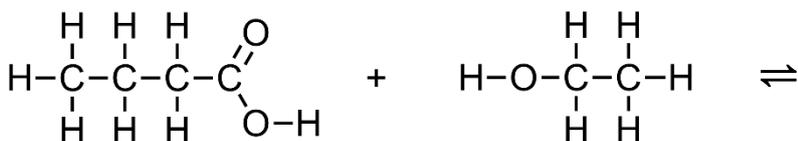
(a) Give the full structural formula and name of the ester that is formed:



(b) Give the full structural formula and name of the ester that is formed:



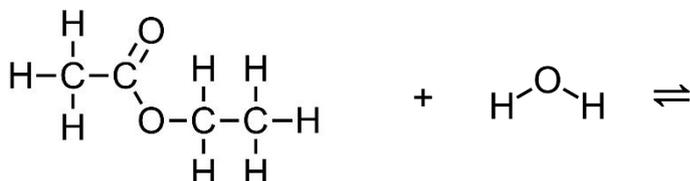
(c) Give the full structural formula and name of the ester that is formed:



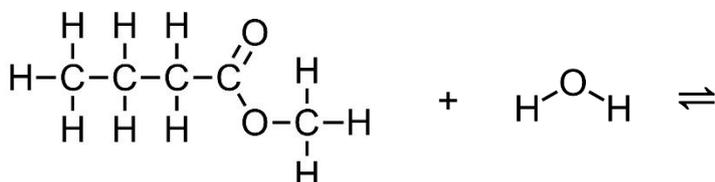
2. Ester Hydrolysis

Esters can be hydrolysed (broken down by the addition of water) into carboxylic acids and alcohols by refluxing in the presence of an acid catalyst, such as sulfuric acid or hydrochloric acid.

(a) Give the full structural formulae and names of the carboxylic acid and alcohol formed:



(b) Give the full structural formulae and names of the carboxylic acid and alcohol formed:



3. Formation of Amides

Amines are similar to alcohols, where the $-\text{OH}$ group is replaced by $-\text{NH}_2$. Carboxylic acids react with amines to form amides and water as the side-product.

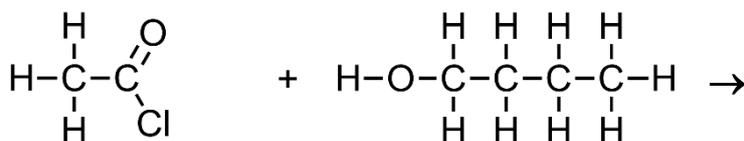
(a) Give the full structural formula and name of the amide that is formed:



4. Reactions of Acid Chlorides

Acid chlorides are similar to carboxylic acids, where the $-\text{OH}$ group is replaced by $-\text{Cl}$. Acid chlorides are often used because they are more reactive than carboxylic acids. Acid chlorides react with alcohols to form esters and hydrogen chloride as the side-product.

(a) Give the full structural formula and name of the ester that is formed:



- Scan the QR code for the answers to this assignment:



https://www.chemist.sg/organic_chem/worksheets/summary_of_reactions_ans.pdf