

WJEC (Wales) Chemistry A-level

Topic 4.5 - Carboxylic Acids and their Derivatives

Flashcards

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Order the relative acidities of carboxylic acids, phenols and alcohols



Order the relative acidities of carboxylic acids, phenols, alcohols and water

In order of decreasing acidity: Carboxylic acids
Phenols
Water
Alcohols



Name the type of reaction carried out when an alcohol reacts to form a carboxylic acid



Name the type of reaction carried out when an alcohol reacts to form a carboxylic acid

Oxidation



What is the intermediate product formed during the oxidation of an alcohol to form a carboxylic acid?



What is the intermediate product formed during the oxidation of an alcohol to form a carboxylic acid?

The alcohol is oxidised to an aldehyde.

This is the intermediate product which then undergoes further oxidation to form a carboxylic acid.

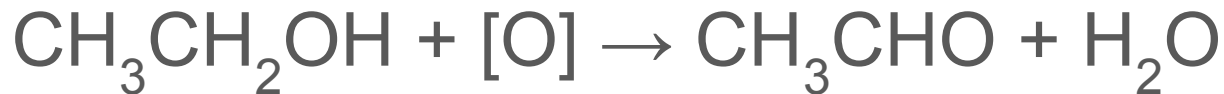


What is the chemical equation for the oxidation of ethanol to form ethanoic acid?



What is the chemical equation for the oxidation of ethanol to form ethanoic acid?

Two reactions take place consecutively:



What reaction conditions are required to ensure complete oxidation of the alcohol to the carboxylic acid?



What reaction conditions are required to ensure complete oxidation of the alcohol to the carboxylic acid?

Excess oxidising agent (acidified potassium dichromate(VI)) needs to be added to the alcohol and it must be heated under reflux.



What is the most common oxidising agent used for the oxidation of alcohols?



What is the most common oxidising agent used for the oxidation of alcohols?

Acidified potassium dichromate(VI)



What type of alcohol will produce carboxylic acids when oxidised?



What type of alcohol will produce carboxylic acids when oxidised?

Primary alcohols



What is the reducing agent used to reduce carboxylic acids to alcohols?



What is the reducing agent used to reduce carboxylic acids to alcohols?



Why is NaBH_4 used to reduce aldehydes and ketones but not carboxylic acids?



Why is NaBH_4 used to reduce aldehydes and ketones but not carboxylic acids?

NaBH_4 is a safer reducing agent than LiAlH_4 . It is preferred when reducing aldehydes and ketones but NaBH_4 cannot be used to reduce carboxylic acids because it is not reactive enough.



Give the chemical equation for the reduction of propanoic acid. What is the name of the product formed?



Give the chemical equation for the reduction of propanoic acid. What is the name of the product formed?



Name of product: Propan-1-ol



What reagents are required to oxidise methylbenzene to benzoic acid?



What reagents are required to oxidise methylbenzene to benzoic acid?

Alkaline potassium manganate(VII) is first added to the methylbenzene. Once a dark brown precipitate forms, the mixture is acidified with dilute sulfuric acid.



Methylbenzene forms benzoic acid under oxidation. What does propylbenzene form when it undergoes oxidation?



Methylbenzene forms benzoic acid under oxidation.
What does propylbenzene form when it undergoes oxidation?

Benzoic acid

Regardless of the length of the side chain, all side chains are oxidised to a -COOH group.



What is decarboxylation?



What is decarboxylation?

Decarboxylation is the process by which the -COOH functional group of a carboxylic acid or $\text{-COO}^-\text{Na}^+$ group of a carboxylate salt is removed from the molecule and replaced with a hydrogen atom.



What is a common reagent used for decarboxylation?



What is a common reagent used for decarboxylation?

Soda lime (contains NaOH)



What is the chemical equation for the reaction between sodium ethanoate and soda lime?



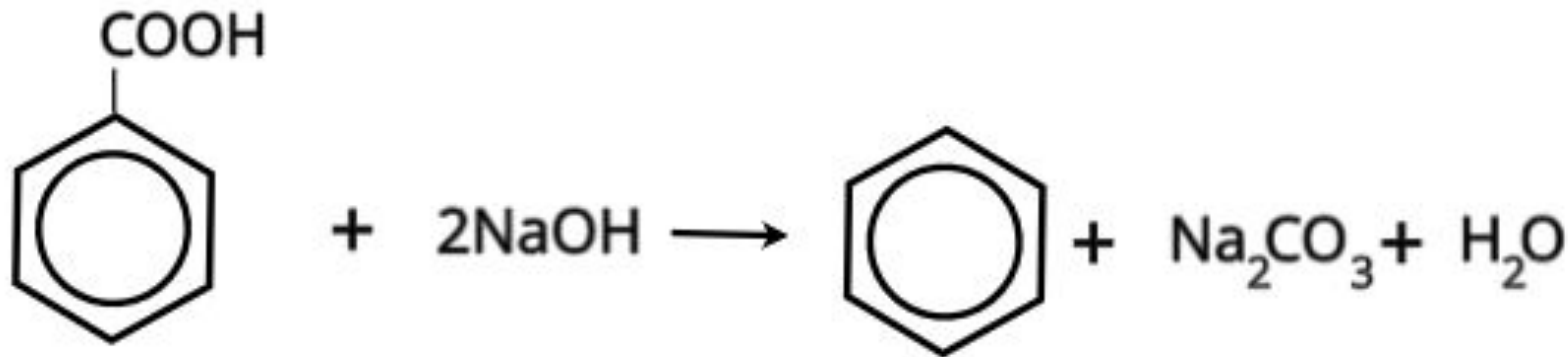
What is the chemical equation for the reaction between sodium ethanoate and soda lime?



What is the chemical equation for the reaction between benzoic acid and soda lime?



What is the chemical equation for the reaction between benzoic acid and soda lime?



What is formed when an alcohol reacts with a carboxylic acid?



What is formed when an alcohol reacts with a carboxylic acid?

An ester



What is the functional group of an ester?



What is the functional group of an ester?

-COO-



What condition and catalyst is required for an esterification reaction?



What condition and catalyst is required for an esterification reaction?

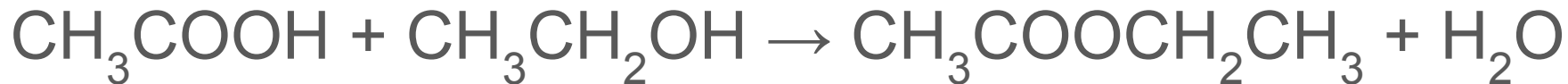
The alcohol and carboxylic acid must be heated in the presence of a strong acid catalyst, e.g. concentrated sulfuric acid.



Give the chemical equation for the reaction between ethanoic acid and ethanol



Give the chemical equation for the reaction between ethanoic acid and ethanol



Name the ester formed in the reaction between butanoic acid and propanol



Name the ester formed in the reaction between butanoic acid and propanol

Propyl butanoate



What are the identifying properties of esters?



What are the identifying properties of esters?

Esters are sweet smelling compounds which are often used in flavourings and perfumes. They have low boiling points and make good solvents for other polar molecules.



What is used as a catalyst in esterification reactions?



What is used as a catalyst in esterification reactions?

Concentrated sulfuric acid



Why is hydrogen chloride sometimes a preferred catalyst for esterification?



Why is hydrogen chloride sometimes a preferred catalyst for esterification?

Hydrogen chloride gives a better yield since no alkene side products are formed.



Give the three possible reagents which can be used to produce an acyl chloride from a carboxylic acid



Give the three possible reagents which can be used to produce an acyl chloride from a carboxylic acid

Phosphorus(V) chloride, PCl_5

Phosphorus(III) chloride, PCl_3

Sulfur dichloride oxide, SOCl_2 (thionyl chloride)



What is the chemical equation for the reaction between ethanoic acid and phosphorus(V) chloride?



What is the chemical equation for the reaction between ethanoic acid and phosphorus(V) chloride?



What is the chemical equation for the reaction between propanoic acid and phosphorus(III) chloride?



What is the chemical equation for the reaction between propanoic acid and phosphorus(III) chloride?



What is the chemical equation for the reaction between ethanoic acid and sulfur dichloride oxide?



What is the chemical equation for the reaction between ethanoic acid and sulfur dichloride oxide?



Why is SOCl_2 the preferred reagent when making acid chlorides?



Why is SOCl_2 the preferred reagent when making acid chlorides?

In the reaction with SOCl_2 , the byproducts are gaseous so it is easier to obtain the acid chloride. Isolation of the acid chloride is more difficult when using PCl_3 or PCl_5 .



Name the type of reaction in which esters and acid chlorides can react to form carboxylic acids



Name the type of reaction in which esters and acid chlorides can react to form carboxylic acids

Hydrolysis - a reaction in which a substance is split up by water.



What are the different setups required for acid hydrolysis of an ester and base hydrolysis of an ester?



What are the different setups required for acid hydrolysis of an ester and base hydrolysis of an ester?

Acid hydrolysis: The ester must be refluxed with a dilute acid, e.g. HCl or H_2SO_4 .

Base hydrolysis: The ester must be refluxed with a dilute alkali, e.g. NaOH.



Compare the products formed when ethyl ethanoate undergoes acid hydrolysis and base hydrolysis



Compare the products formed when ethyl ethanoate undergoes acid hydrolysis and base hydrolysis

Acid hydrolysis products:

Ethanoic acid, ethanol

Base hydrolysis products:

Ethanoate ion, ethanol



How does the hydrolysis of acid chlorides compare with the hydrolysis of esters?



How does the hydrolysis of acid chlorides compare with the hydrolysis of esters?

The hydrolysis of acid chlorides is much more rapid than the hydrolysis of esters.

Acid chlorides will react vigorously with cold water.



Give the chemical equation for the reaction of ethanoyl chloride with water



Give the chemical equation for the reaction of ethanoyl chloride with water



How is an amide made from a carboxylic acid?



How is an amide made from a carboxylic acid?

First, ammonium carbonate is added to an excess of the carboxylic acid until the ammonium salt is formed. Then, the ammonium salt is heated to undergo dehydration and produce an amide.



How is a nitrile made from an amide?



How is a nitrile made from an amide?

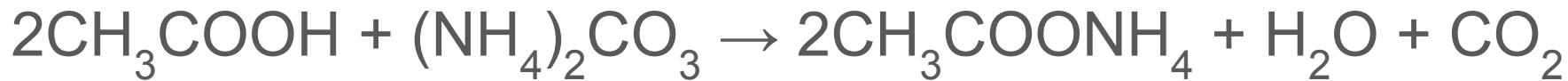
A nitrile is produced if an amide undergoes dehydration by heating it with phosphorus(V) oxide (P_4O_{10}).



What is the chemical equation for the formation of the ammonium salt when ethanoic acid reacts with ammonium carbonate?



What is the chemical equation for the formation of the ammonium salt when ethanoic acid reacts with ammonium carbonate?



Give the reactants and conditions required for the formation of a hydroxynitrile from an aldehyde/ketone



Give the reactants and conditions required for the formation of a hydroxynitrile from an aldehyde/ketone

Potassium or sodium cyanide is added to sulfuric acid to produce hydrogen cyanide.

Temperature of 20°C.



Why is hydrogen cyanide not added directly to an aldehyde/ketone for a nucleophilic addition reaction?



Why is hydrogen cyanide not added directly to an aldehyde/ketone for a nucleophilic addition reaction?

Hydrogen cyanide is a very poisonous gas.

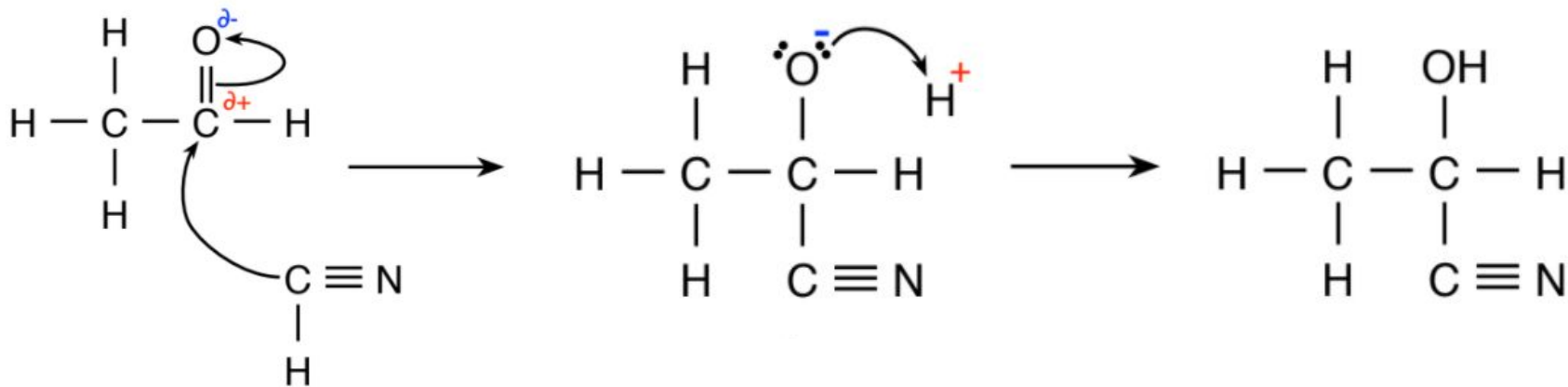


Draw and name the mechanism for the formation of 2-hydroxypropanenitrile from ethanal and hydrogen cyanide



Draw and name the mechanism for the formation of 2-hydroxypropanenitrile from ethanal and hydrogen cyanide

Nucleophilic addition



What is produced when a halogenoalkane reacts with ethanolic potassium cyanide?



What is produced when a halogenoalkane reacts with ethanolic potassium cyanide?

A nitrile



What is the IUPAC name for the product formed when 2-bromopropane reacts with ethanolic potassium cyanide?



What is the IUPAC name for the product formed when 2-bromopropane reacts with ethanolic potassium cyanide?

2-methylpropane



Describe the stages in the hydrolysis of nitriles



Describe the stages in the hydrolysis of nitriles

First nitriles react with water to produce amides. Then the amides undergo further hydrolysis and react with water to form either a carboxylic acid or a carboxylate salt, depending on the reaction conditions.



How do the reactants and products of base hydrolysis of nitriles compare to those of acid hydrolysis of nitriles?



How do the reactants and products of base hydrolysis of nitriles compare to those of acid hydrolysis of nitriles?

Hydrolysis	Reactants	Products
Acid	Dilute hydrochloric acid	Carboxylic acid and ammonium chloride (NH_4Cl)
Base	Dilute sodium hydroxide	Sodium carboxylate salt and ammonia (NH_3)



What is the reducing agent used in the reduction of nitriles to amines?



What is the reducing agent used in the reduction of nitriles to amines?



What is the chemical equation for the reduction of propanenitrile to propylamine?



What is the chemical equation for the reduction of propanenitrile to propylamine?

