

CAIE Chemistry A-level

Topic 36 - Organic Synthesis

(A level only)

Flashcards

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List the typical reactions of alkanes



List the typical reactions of alkanes

- Combustion.
- Free-radical substitution with Br_2 or Cl_2 to form halogenoalkanes.
- Cracking to form short chain alkenes and alkanes.



List the typical reactions of alkenes



List the typical reactions of alkenes

- Electrophilic addition: steam (forms alcohols), hydrogen halides (forms halogenoalkanes), halogens (forms di-halogenoalkanes) and hydrogen (forms alkanes).
- Oxidation with $\text{H}^+/\text{MnO}_4^-$ to form diols.
- Addition polymerisation to form polymers.
- Combustion.



List the typical reactions of halogenoalkanes



List the typical reactions of halogenoalkanes

- Nucleophilic substitution: hydrolysis (forms alcohols), reaction with ethanolic cyanide (forms nitriles) and reaction with ammonia (forms primary amines).
- Elimination of hydrogen halide using ethanolic hydroxide ions (forms alkenes).



List the typical reactions of alcohols



List the typical reactions of alcohols

- Combustion.
- Substitution with hydrogen halides, sulfur dichloride oxide or phosphorus(III) halides (forms halogenoalkanes).
- Oxidation with $\text{H}^+/\text{Cr}_2\text{O}_7^{2-}$ (forms carboxylic acids).
- Dehydration using an acid catalyst (forms alkenes).
- Esterification with carboxylic acid or acyl chloride.



What is produced when ethanol reacts with sodium?



What is produced when ethanol reacts with sodium?

Sodium ethoxide and hydrogen gas.



List the typical reactions of aldehydes



List the typical reactions of aldehydes

- Oxidation with $\text{H}^+/\text{Cr}_2\text{O}_7^{2-}$ (forms carboxylic acids).
- Reduction with NaBH_4 or LiAlH_4 (forms primary alcohols).
- Nucleophilic addition with HCN (forms hydroxynitriles).



List the typical reactions of ketones



List the typical reactions of ketones

- Reduction with NaBH_4 or LiAlH_4 (forms secondary alcohols).
- Nucleophilic addition with HCN (forms hydroxynitriles).



List the typical reactions of carboxylic acids



List the typical reactions of carboxylic acids

- Reaction with metals, alkalis or carbonates (forms a salt and an inorganic product).
- Esterification with alcohols.
- Reduction with LiAlH_4 (forms primary alcohols).
- Reaction with SOCl_2 (forms acyl chlorides, sulfur dioxide and hydrochloric acid).
- Reaction with phosphorus(V) chloride or phosphorus(III) chloride (forms acyl chlorides).



What is produced when methanoic acid is oxidised using Fehling's or Tollens' reagent?



What is produced when methanoic acid is oxidised using Fehling's or Tollens' reagent?

Carbon dioxide and water



What is produced when ethanedioic acid is oxidised using acidified potassium manganate(VII)?



What is produced when ethanedioic acid is oxidised using acidified potassium manganate(VII)?

Carbon dioxide and water



List the typical reactions of esters



List the typical reactions of esters

- Acid hydrolysis (forms a carboxylic acid and an alcohol).
- Alkaline hydrolysis (forms a carboxylate salt and an alcohol).



List the typical reactions of amines



List the typical reactions of amines

- Reactions with acids to form a salt.
- Reactions with carboxylic acids or acyl chlorides to form amides.



List the typical reactions of nitriles



List the typical reactions of nitriles

- Acid hydrolysis (forms a carboxylic acid and a salt).
- Alkaline hydrolysis (forms a carboxylate salt and ammonia).
- Reduction with LiAlH_4 to form an amine.



List the typical reactions of arenes



List the typical reactions of arenes

- Electrophilic substitution: with a halogen (forms chlorobenzene with Cl_2 or bromobenzene with Br_2), with nitric acid (forms nitrobenzene).
- Friedel-Crafts acylation and alkylation.
- Oxidation of a side chain (forms benzoic acid).
- Hydrogenation (forms cyclohexane).



List the typical reactions of phenol



List the typical reactions of phenol

- Reactions with strong bases (not acidic enough to react with carbonates).
- Reaction with sodium (forms sodium phenoxide and hydrogen gas).
- Reaction with diazonium salts (forms azo compounds).
- Electrophilic substitution: nitric acid (forms nitrophenol), bromine (forms bromophenol).



List the typical reactions of acyl chlorides



List the typical reactions of acyl chlorides

- Hydrolysis with water (forms carboxylic acids and HCl).
- Hydrolysis with sodium hydroxide (forms a carboxylate salt and water).
- Esterification with alcohols or phenol.
- Reaction with ammonia (forms an amide and HCl).
- Reaction with primary amine (forms an n-substituted amide).



List the typical reactions of amides



List the typical reactions of amides

- Acid hydrolysis (forms a carboxylic acid and ammonium ions).
- Alkaline hydrolysis (forms a carboxylate salt and ammonia or an amine).
- Reduction using LiAlH_4 (forms a primary amine).



Describe the chemical test for an alkene



Describe the chemical test for an alkene

Add bromine water. If a $C=C$ bond is present, the orange solution will decolourise to form a colourless solution.



Describe the chemical test for a halogenoalkane



Describe the chemical test for a halogenoalkane

React with $\text{AgNO}_3(\text{aq})$ and test the solubility of the precipitate in $\text{NH}_3(\text{aq})$.

AgCl - white ppt, soluble in dilute NH_3 .

AgBr - cream ppt, soluble in concentrated NH_3 .

AgI - yellow ppt, insoluble in NH_3 .



Describe the chemical test for an alcohol



Describe the chemical test for an alcohol

React with $\text{H}^+/\text{Cr}_2\text{O}_7^{2-}$. If a primary or secondary alcohol is present, the colour will change from orange to green. There will be no colour change for tertiary alcohols.



Describe the chemical tests for an aldehyde



Describe the chemical tests for an aldehyde

- React with 2,4-DNPH. Yellow-orange precipitate forms in the presence of a carbonyl.
- React with Tollens' reagent. Silver mirror is produced if an aldehyde is present.
- React with Fehling's solution. Blue solution forms a brick red precipitate if an aldehyde is present.
- React with $\text{H}^+/\text{Cr}_2\text{O}_7^{2-}$. Orange solution turns green.



Describe the chemical test for a ketone



Describe the chemical test for a ketone

React with 2,4-DNPH. A yellow-orange precipitate forms in the presence of a carbonyl.



Describe the chemical test for a
carboxylic acid



Describe the chemical test for a carboxylic acid

React with a carbonate. If a carboxylic acid is present, CO_2 will be produced and so the solution will effervesce.



How can ethanoic acid be formed from chloroethane? Include any conditions and intermediates

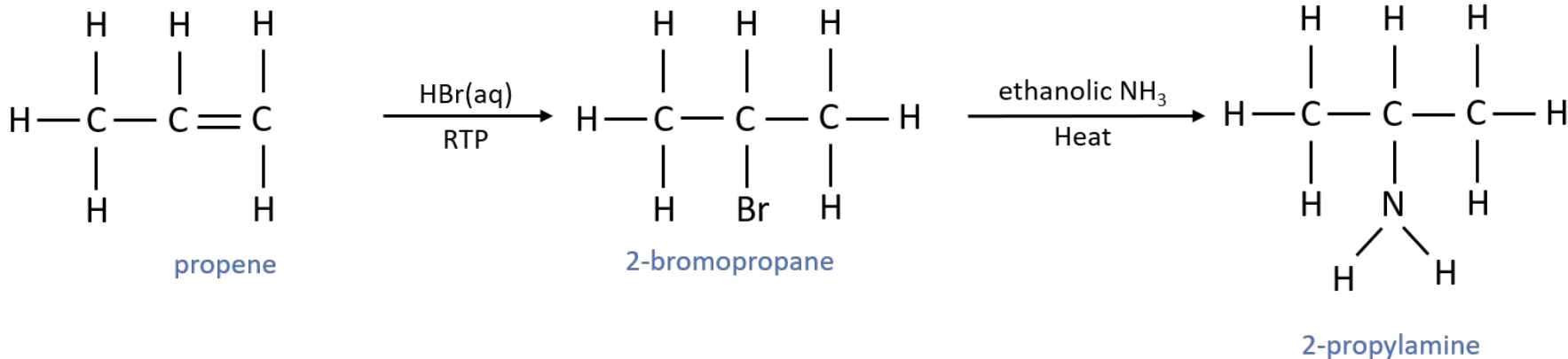


How can 2-propylamine be formed from propene? Include any conditions and intermediates



How can 2-propylamine be formed from propene?

Include any conditions and intermediates



What factors might be considered when analysing a synthetic route?



What factors might be considered when analysing a synthetic route?

- Type of reaction
- Reagents
- Atom economy
- By-products
- Conditions



What type of reaction is favoured when deciding which synthetic route to use?



What type of reaction is favoured when deciding which synthetic route to use?

Addition reactions are much more sustainable than substitution or elimination reactions as they have no waste products.



A synthetic route is chosen to produce an organic compound. In terms of reagents, why might this route be favoured?



A synthetic route is chosen to produce an organic compound. In terms of reagents, why might this route be favoured?

- The reagents might be renewable.
- The reagents may have few safety concerns.



How are by-products linked to the selection of a particular synthetic route?



How are by-products linked to the selection of a particular synthetic route?

A synthetic route with less harmful by-products is preferred as there would be fewer safety and environmental concerns. The process is more sustainable if the by-products can be used in another industry.



What conditions are favoured for a synthetic route?



What conditions are favoured for a synthetic route?

Conditions that are energy efficient and safe whilst also increasing the rate of reaction.

