Edexcel Chemistry A-level

Topic 17 - Organic Chemistry II

Flashcards

What property must a carbon atom have for the molecule to display optical isomerism about that carbon atom?

What property must a carbon atom have for the molecule to display optical isomerism about that carbon atom?

4 different substituents attached to one carbon atom

What are the similarities and differences between two optical isomers?

What are the similarities and differences between two optical isomers?

Same atoms and bonds, but they are non-superimposable mirror images of one another. NOT IDENTICAL in chemical properties necessarily.

Differ in the way they rotate plane polarised light - rotate plane of polarisation by the same angle but in different directions.

What word is used to describe optically active molecules?

What word is used to describe optically active molecules?

chiral

What are the pair of isomers called?

What are the pair of isomers called?

Enantiomers

What is the chiral centre?

What is the chiral centre?

The carbon that has four different substituents attached to it

How is the chiral centre denoted?

How is the chiral centre denoted?

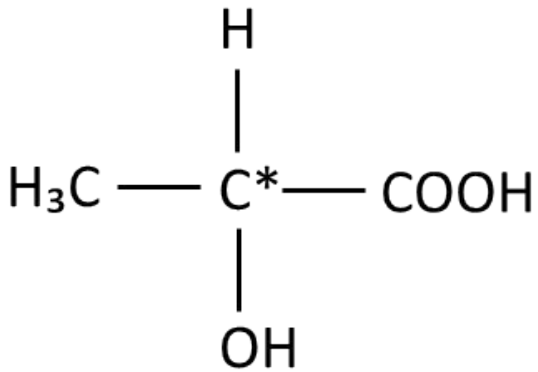
C* (star on C)

Give two examples of chiral molecules. Draw one of them (both enantiomers).

Give two examples of chiral molecules. Draw one of them (both enantiomers).

All alpha amino acids, except glycine.

Lactic acid / 2-hydroxypropanoic acid



How is light polarised?

How is light polarised?

By passing it through a polaroid filter, so oscillations are only in one plane.

What effect does the racemic mixture have on plane polarised light?

What effect does the racemic mixture have on plane polarised light?

None, as the rotation by each enantiomer cancels out to nothing

What effect does the + isomer have on plane polarised light?

What effect does the + isomer have on plane polarised light?

Rotates plane of polarisation by x^0 clockwise

What effect does the - isomer have on plane polarised light?

What effect does the - isomer have on plane polarised light?

Rotates plane of polarisation by x^{o} anti clockwise (same angle, opposite direction)

What is the structure of a polarimeter?

What is the structure of a polarimeter?

Light source (unpolarised light) → polarising filter (polarised light) → polarised light passes through compartment containing sample → detector determines the angle of rotation of the plane polarised light

What are polarimeters used for?

What are polarimeters used for?

To identify which enantiomer is present, the purity of the sample, the concentration of the sample etc.

Why is the $CH_3CH(OH)CN$ molecule formed chiral?

Why is the $CH_3CH(OH)CN$ molecule formed chiral?

H, CH_3, OH and CN groups attached to the central chiral carbon atom - 4 substituents

How does this second stage affect the chirality?

How does this second stage affect the chirality?

Does not affect it - still racemic as chirality not affected by this stage.

Are racemic mixtures formed in nature? Why?

Are racemic mixtures formed in nature? Why?

Not often, as enzyme mechanisms are 3D so only form one enantiomer

Why is optical isomerism a problem for the drug industry?

Why is optical isomerism a problem for the drug industry?

Sometimes, only one enantiomer is effective due to enzyme's active site/cell receptors being 3D.

What are the options to resolve the issue of only one enantiomer being effective?

What are the options to resolve the issue of only one enantiomer being effective?

1. Separate enantiomers - difficult and expensive as have very similar properties
2. Sell racemate - wasteful as half is inactive
3. Design alternative synthesis to only produce one enantiomer.

Examples of optically active drugs?

Examples of optically active drugs?

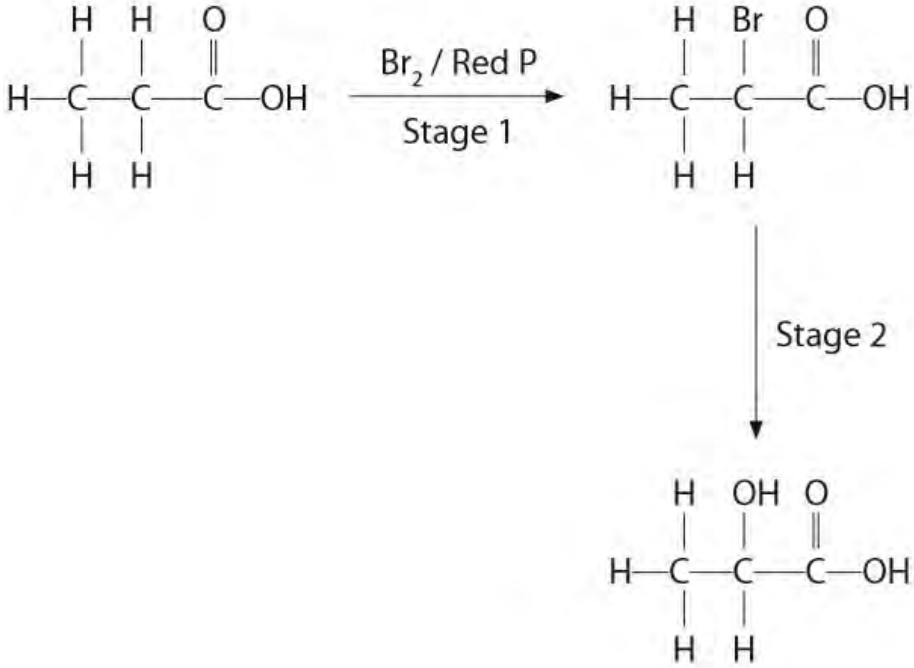
Ibuprofen, Thalidomide

Why is ibuprofen able to be sold as a racemate, even though the + isomer is needed to treat inflammation?

Why is ibuprofen able to be sold as a racemate, even though the + isomer is needed to treat inflammation?

Sold as 50% racemate.

But body converts 60% of R- isomer to S+ isomer → end up with 80% S+ isomer



(ii) When an optically active isomer of 2-bromopropanoic acid is used in Stage 2, the resulting 2-hydroxypropanoic acid is also optically active. State and explain what this indicates about the mechanism of the first reaction in Stage 2.

Answer

A racemic mixture is not formed

OR

More of one enantiomer /(optical) isomer is formed

OR

Only one enantiomer /(optical) isomer is formed

(1)

Second mark (Stand alone)

(Some of the) reaction is S_N2 **(1)**

Third mark (Stand alone)
Nucleophile / OH^- only attacks from one side of the molecule / from the opposite side to leaving group

(1)

ALLOW
Use of 'intermediate' for 'transition state' in description of S_N2

What is the carbonyl group?

What is the carbonyl group?

C=O

What is the functional group and general formula for an aldehyde?

What is the functional group and general formula for an aldehyde?

RCHO (C double bonded to O, single bond to H and R)

What is the functional group for a ketone?

What is the functional group for a ketone?

RCOR’ (C double bonded to O)

How do you name aldehydes?

How do you name aldehydes?

-al suffix (C=O is on the end of a chain)

How do you name ketones?

How do you name ketones?

-one suffix (designate number for which carbon C=O is on)

What kind of intermolecular forces do molecules with the carbonyl group have? Why?

What kind of intermolecular forces do molecules with the carbonyl group have? Why?

Permanent dipole-dipole due to the polar C=O bond (O is delta -) not hydrogen bonds.

How soluble are they in water? What influences solubility?

How soluble are they in water? What influences solubility?

Yes - form hydrogen bonds between water molecules and oxygen of C=O. As C chain length increases, solubility decreases.

Which bond in carbonyl compounds is usually involved in reactions? Why?

Which bond in carbonyl compounds is usually involved in reactions? Why?

C=O, due to the polarity of the bond (large difference in electronegativity between C and O)

What is the strongest bond in carbonyl compounds?

What is the strongest bond in carbonyl compounds?

C=O

Draw a mechanism for the nucleophilic addition of a carbonyl compound, using :Nu^- to represent the nucleophile.

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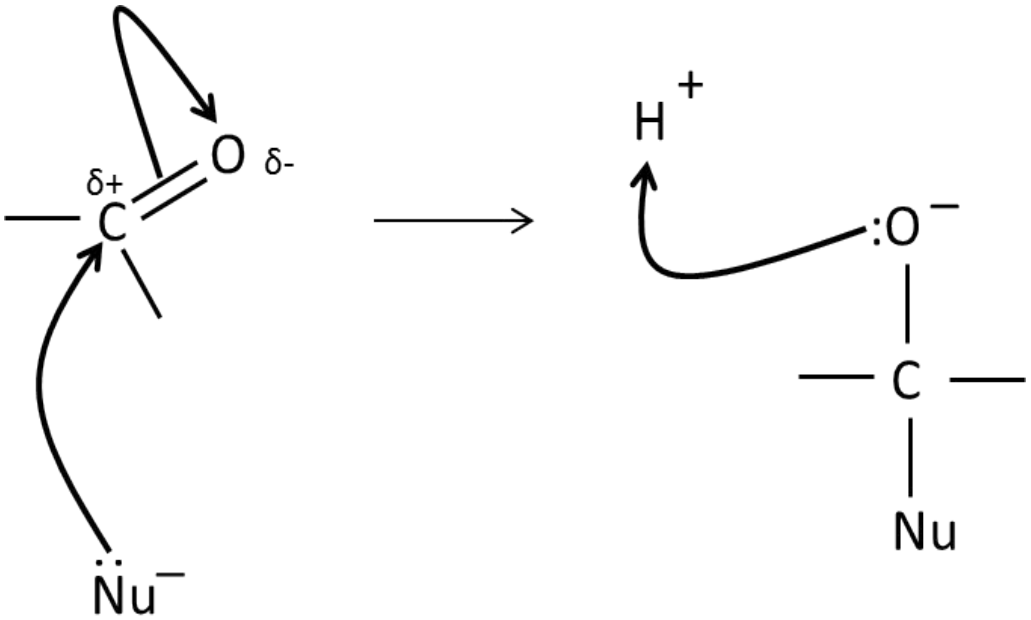

Draw a mechanism for the nucleophilic addition of HCN to a carbonyl compound.

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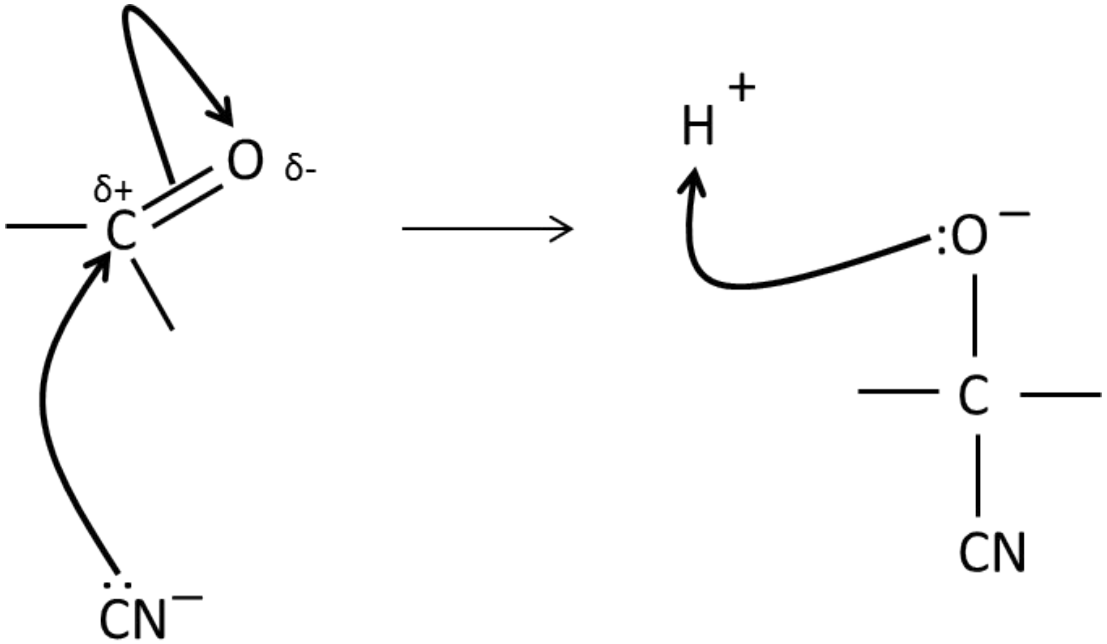


Why is the addition of HCN important?

Why is the addition of HCN important?

Increases the length of the carbon chain by one carbon atom - very useful

Will the product of HCN added to a carbonyl compound have optical isomers? Why?

Will the product of HCN added to a carbonyl compound have optical isomers? Why?

Yes they will. In the aldehyde/ketone, the carbonyl carbon is planar, so the $:CN^-$ can attack from either above or below, forming two enantiomers.

What is the name of the product when HCN is added to a carbonyl compound?

What is the name of the product when HCN is added to a carbonyl compound?

Hydroxynitriles (have OH and CN groups)

What is Fehling's solution? What colour is it?

What is Fehling's solution? What colour is it?

Copper complex ions, blue

What happens when an aldehyde is added to Fehling's solution?

What happens when an aldehyde is added to Fehling's solution?

Reduced to Cu^{+} ions → colour change to brick red ppt

What happens when a ketone is added to Fehling's solution?

What happens when a ketone is added to Fehling's solution?

No visible change → stays blue

What is in Tollens' reagent?

What is in Tollens' reagent?

Silver complex ions, colourless solution

What happens when an aldehyde is added to Tollen's reagent?

What happens when an aldehyde is added to Tollen's reagent?

Silver mirror forms as Ag^+ reduced to Ag (s)

What happens when a ketone is added to Tollen's reagent?

What happens when a ketone is added to Tollen's reagent?

No visible change

What is a qualitative test for the presence of a carbonyl group and how you identify the carbonyl compound?

What is a qualitative test for the presence of a carbonyl group and how you identify the carbonyl compound?

2,4-DNP reacts with both aldehydes and ketones to form an orange precipitate. To identify the compound take the melting point of orange crystals product from 2,4-DNP and compare melting point with known values in database.

Write a reaction of propanone with iodine in the presence of alkali

Write a reaction of propanone with iodine in the presence of alkali

$$CH_3COCH_3 + 3I_2 + 4NaOH \rightarrow CHI_3 + CH_3COONa + 3NaI + 3H_2O$$

What is another oxidising agent for alcohols and aldehydes? What change in colour does this undergo?

What is another oxidising agent for alcohols and aldehydes? What change in colour does this undergo?

Acidified potassium dichromate (VI) - H_2SO_4 and $K_2Cr_2O_7$. Colour change from orange to green.

What is a reducing agent for aldehydes and ketones? What ions does this release in solution?

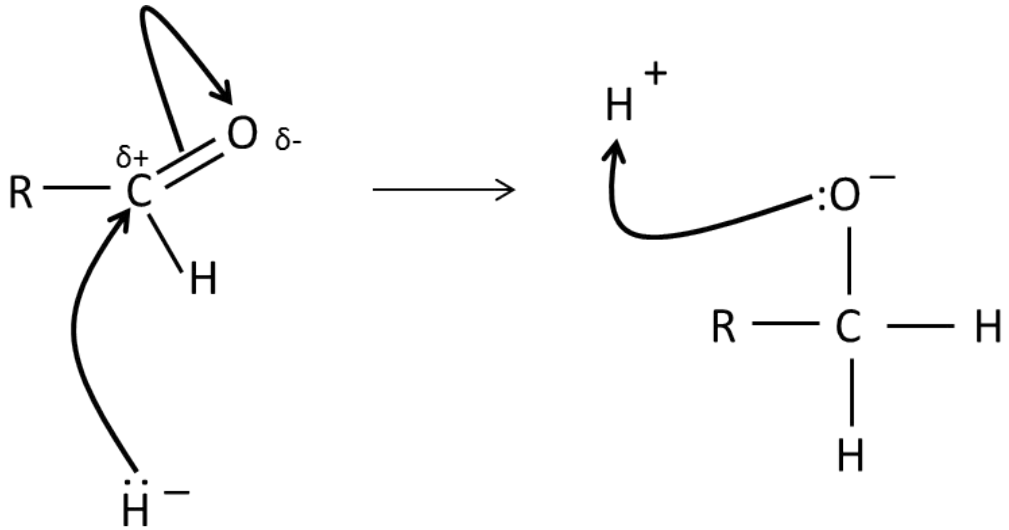
What is a reducing agent for aldehydes and ketones? What ions does this release in solution?

$NaBH_4$ (sodium tetrahydridoborate (III)) or lithium tetrahydridoaluminate , releases an H^- ion

Draw and name a mechanism for the reduction of an aldehyde.

Draw and name a mechanism for the reduction of an aldehyde.

Nucleophilic addition



Write an equation for the reduction of pentan-2-one and for 3-methylbutanal

Write an equation for the reduction of pentan-2-one and for 3-methylbutanal

$CH_3COCH_2CH_2CH_3 + 2[H] \rightarrow CH_3CH(OH)CH_2CH_2CH_3$

$CH_3CH_2CH_2(CH_3)CHO + 2[H] \rightarrow CH_3CH_2CH_2(CH_3)CH_2OH$

What is a carboxylic acid? Functional group?

What is a carboxylic acid? Functional group?

-COOH (C=O and C-OH)

How do you name carboxylic acids?

How do you name carboxylic acids?

-oic acid

Are carboxylic acids soluble in water? Why? What influences their solubility

Are carboxylic acids soluble in water? Why? What influences their solubility

Yes. Acid group can form hydrogen bonds with water molecules

What are the intermolecular forces in carboxylic acids?

What are the intermolecular forces in carboxylic acids?

Hydrogen bonds in solid state - very strong.

What are the 3 ways to prepare carboxylic acid?

What are the 3 ways to prepare carboxylic acid?

Oxidation of alcohols or aldehydes and the hydrolysis of nitriles

Write an equation of the reaction between propanoic acid and lithium tetrahydridoaluminate

Write an equation of the reaction between ethanoic acid and lithium tetrahydridoaluminate

$$CH_3CH_2COOH + 4[H] \rightarrow CH_3CH_2CH_2OH + H_2O$$

Write an equation of the reaction between ethanoic acid and phosphorus(V) chloride

Write an equation of the reaction between ethanoic acid and phosphorus(V) chloride

$$CH_3CH_2COOH + PCl_5 \rightarrow CH_3CH_2COCl + POCl_3 + HCl$$

What are esters and what are they formed from? Give the functional group, general formula?

What are esters (what are they formed from)?

Functional group, general formula?

Formed from carboxylic acids and alcohols.

RCOOR’ (C=O, C-O-C)

Write an equation for the reaction of ethanoic acid with propan-1-ol

Write an equation for the reaction of ethanoic acid with propan-1-ol

$$CH_3COOH + CH_3CH_2CH_2OH \rightarrow CH_3COOCH_2CH_2CH_3 + H_2O$$

How do you name esters?

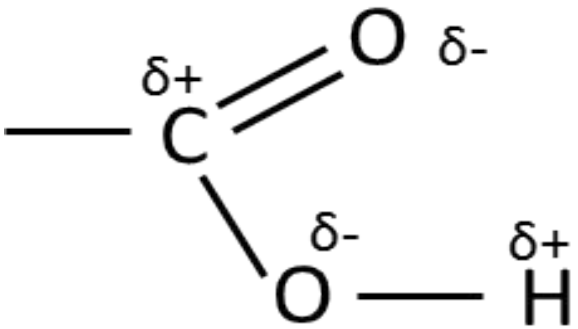
How do you name esters?

Start with the group that has replaced the hydrogen, then acid part e.g. propyl (from alcohol) ethanoate (from carboxylic acid).

In what way is the carboxylic acid group polarised? (Diagram)

In what way is the carboxylic acid group polarised?

(Diagram)



Write an equation for the equilibrium formed by a ethanoic acid in solution

Write an equation for the equilibrium formed by a ethanoic acid in solution

$$CH_3COOH\ (aq) \rightleftharpoons CH_3COO^-\ (aq) + H^+\ (aq)$$

What happens to the negative charge on the ethanoate ion in terms of electrons?

What happens to the negative charge on the ethanoate ion in terms of electrons?

Electrons delocalise so the negative charge is shared across the whole of the carboxylate group

How could you distinguish carboxylic acids from other -OH containing compounds?

How could you distinguish carboxylic acids from other -OH containing compounds?

Add $NaHCO_3$, acids will produce sodium salt, water and carbon dioxide.

Write an equation for the reaction of ethanoic acid with NaOH

Write an equation for the reaction of ethanoic acid with NaOH

$$CH_3COOH + NaOH \rightarrow H_2O + CH_3COO^-Na^+$$

Write an equation for the reaction of ethanoic acid with Na_2CO_3.

Write an equation for the reaction of ethanoic acid with Na_2CO_3.

$$2CH_3COOH + Na_2CO_3 \rightarrow 2CH_3COO^-Na^+ + H_2O + CO_2$$

What catalyst is needed for the formation of esters from alcohols and carboxylic acids?

What catalyst is needed for the formation of esters from alcohols and carboxylic acids?

Concentrated strong acid e.g. H_2SO_4

What catalyst is needed for the hydrolysis of esters?

What catalyst is needed for the hydrolysis of esters?

Dilute strong acid e.g. H_2SO_4

What is an alternative method of hydrolysis?

What is an alternative method of hydrolysis?

Base hydrolysis

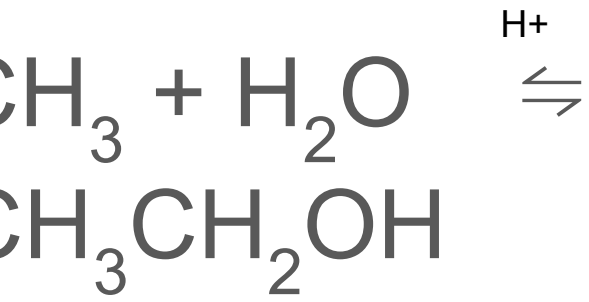
What are the advantages of base hydrolysis?

What are the advantages of base hydrolysis?

Reaction goes to completion due to neutralisation by base - more product in the mixture than acid catalysed hydrolysis.

Write an equation for the acid hydrolysis of ethyl propanoate including conditions

Write an equation for the acid hydrolysis of ethyl propanoate



Dilute acid and heat under reflux

Write an equation for the base hydrolysis of ethyl propanoate including conditions

Write an equation for the base hydrolysis of ethyl propanoate

$$CH_3CH_2CO_2CH_2CH_3 + NaOH \rightarrow CH_3CH_2CO_2^- Na^+ + CH_3CH_2OH$$

Heat under reflux

What does transesterification mean?

What does transesterification mean?

Converting one type of ester to another

What are carboxylic acid derivatives?

What are carboxylic acid derivatives?

Molecules that have the acyl group as part of their structure, formed from carboxylic acids

Name two acid derivatives and give their functional groups

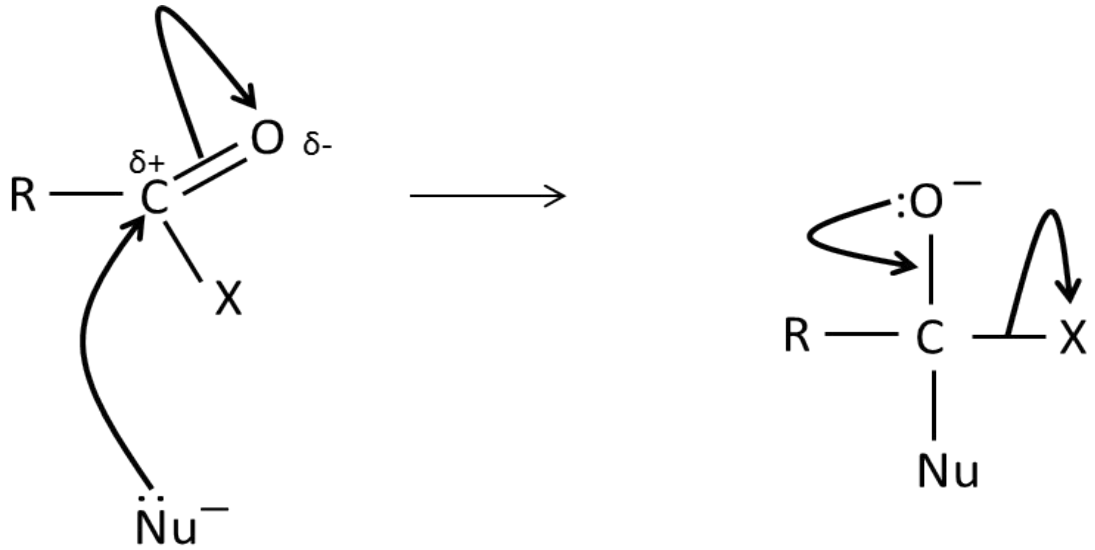
Name two acid derivatives and give their functional groups

Acyl chlorides: RCOCl

Acid anhydrides: RCOOCR / $(RCO)_2O$

Draw the mechanism for the acylation of a nucleophile by an acid derivative.

Draw the mechanism for the acylation of a nucleophile by an acid derivative.



If the nucleophile is ammonia for the acylation of acyl chlorides, what are the products of the reaction?

If the nucleophile is ammonia for the acylation of acyl chlorides or acid anhydrides, what are the products of the reaction?

An amide

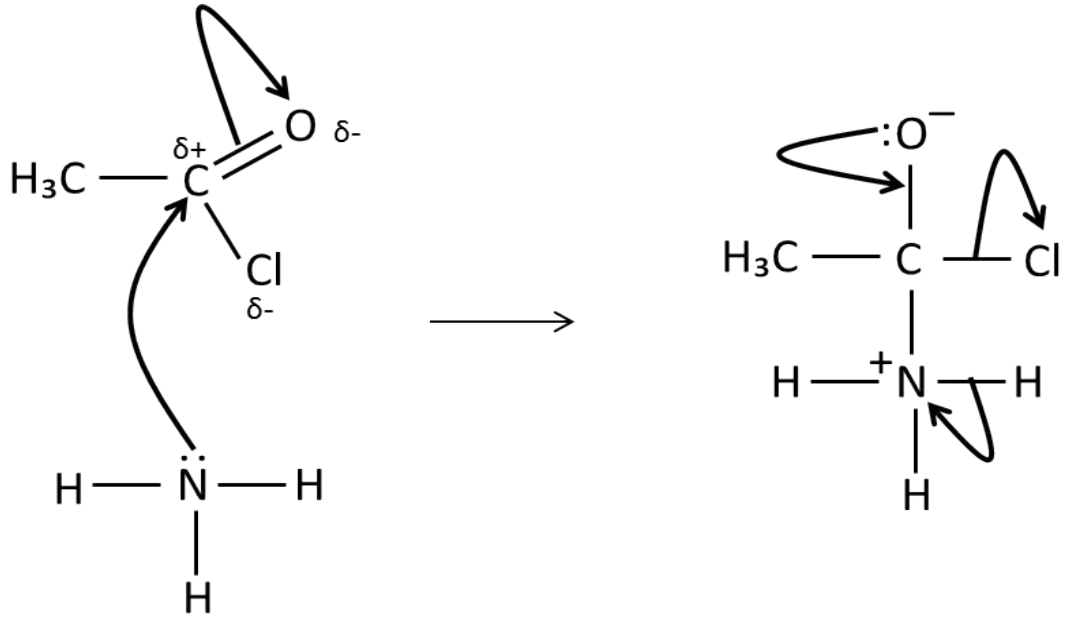
Write an equation for the reaction of ethanoyl chloride and ammonia

Write an equation for the reaction of ethanoyl chloride and ammonia

$$CH_3COCl + 2NH_3 \rightarrow CH_3CONH_2 + NH_4Cl$$

Draw the mechanism for the reaction of ethanoyl chloride and ammonia

Draw the mechanism for the reaction of ethanoyl chloride and ammonia



If the nucleophile is a primary amine, what are the products of the acylation of acyl chlorides?

If the nucleophile is a primary amine, what are the products of the acylation of acyl chlorides or acid anhydrides?

N-substituted amide

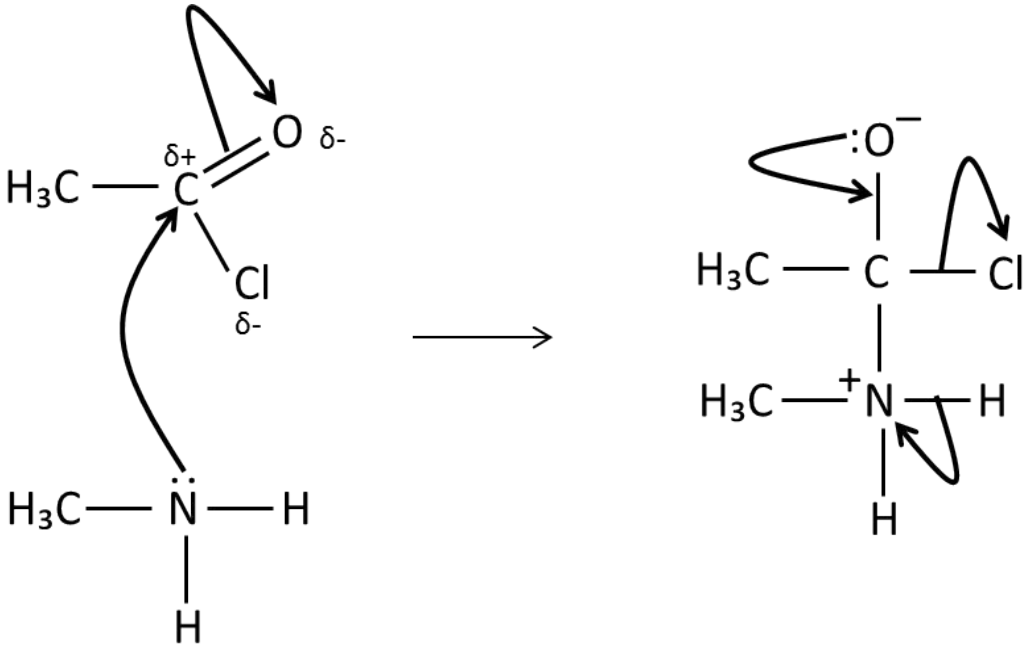
Write an equation for the reaction of ethanoyl chloride and methylamine

Write an equation for the reaction of ethanoyl chloride and methylamine

$$CH_3COCl + CH_3NH_2 \rightarrow CH_3CONHCH_3 + CH_3NH_3Cl$$

Draw the mechanism for the reaction of ethanoyl chloride and methylamine.

Draw the mechanism for the reaction of ethanoyl chloride and methylamine.



If the nucleophile is an alcohol, what are the products of the acylation of acyl chlorides?

If the nucleophile is an alcohol, what are the products of the acylation of acyl chlorides or acid anhydrides?

An ester

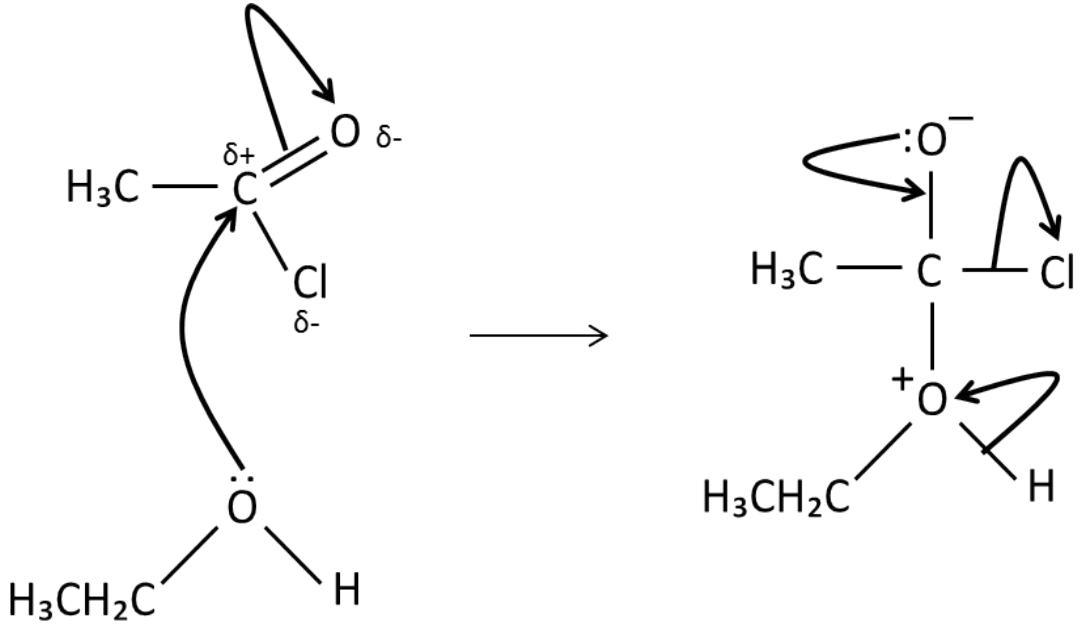
Write an equation for the reaction of ethanoyl chloride and ethanol

Write an equation for the reaction of ethanoyl chloride and ethanol

$$CH_3COCl + CH_3CH_2OH \rightarrow CH_3COOCH_2CH_3 + HCl$$

Draw the mechanism for the reaction of ethanoyl chloride and ethanol

Draw the mechanism for the reaction of ethanoyl chloride and ethanol



If the nucleophile is water, what are the products of the acylation of acyl chlorides

If the nucleophile is water, what are the products of the acylation of acyl chlorides or acid anhydrides?

Carboxylic acid (hydrolyses ester linkage)

What is the name of this reaction (the acylation of acyl chlorides/ with water as a nucleophile)?

What is the name of this reaction (the acylation of acyl chlorides/acid anhydrides with water as a nucleophile)?

hydrolysis

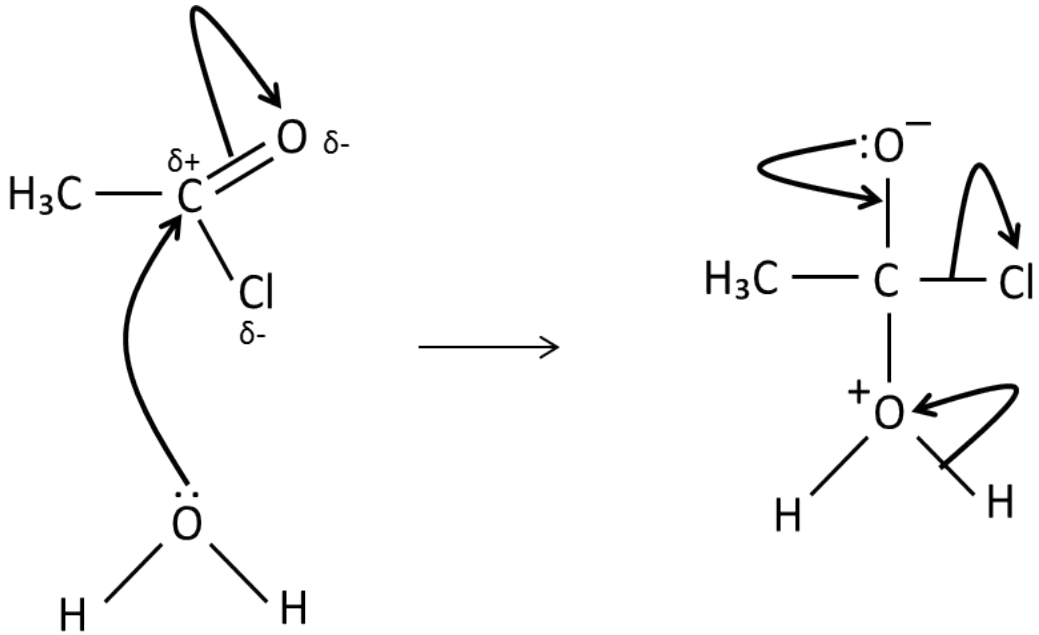
Write an equation for the reaction of ethanoyl chloride and water.

Write an equation for the reaction of ethanoyl chloride and water.

$$CH_3COCl + H_2O \rightarrow CH_3COOH + HCl$$

Draw the mechanism for the reaction of ethanoyl chloride and water.

Draw the mechanism for the reaction of ethanoyl chloride and water.



What is a commercially important acylation reaction?

What is a commercially important acylation reaction?

The manufacture of aspirin

What is condensation?

What is condensation?

Small molecule eliminated (usually H_2O) to form a larger molecule

How many monomers are condensation polymers usually formed from?

How many monomers are condensation polymers usually formed from?

two

What properties do these monomers forming condensation polymers have?

What properties do these monomers forming condensation polymers have?

Each has two functional groups

Examples of condensation polymers?

Examples of condensation polymers?

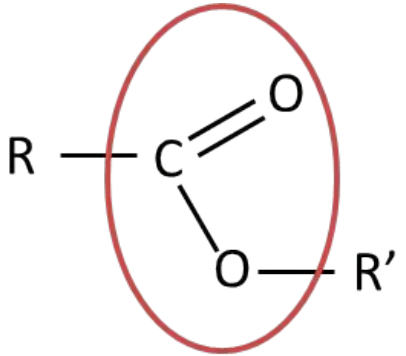
Polyesters

Polyamides

Polypeptides

What is the linkage in a polyester?

What is the linkage in a polyester?



What molecule is eliminated in formation of a polyester?

What molecule is eliminated in formation of a polyester?

H_2O

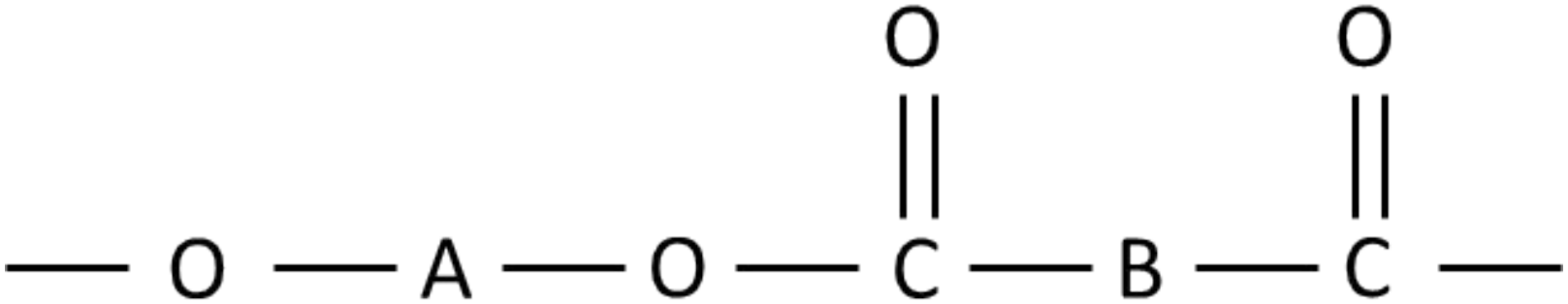
What are the two monomers which form a polyester (generic names and structures)?

What are the two monomers which form a polyester (generic names and structures)?

Diol and dicarboxylic acid or a molecule with both alcohol and a carboxylic acid functional groups

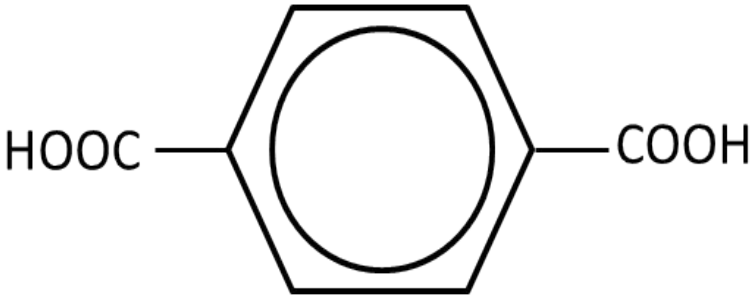
Draw a generic repeating unit for a polyester

Draw a generic repeating unit for a polyester

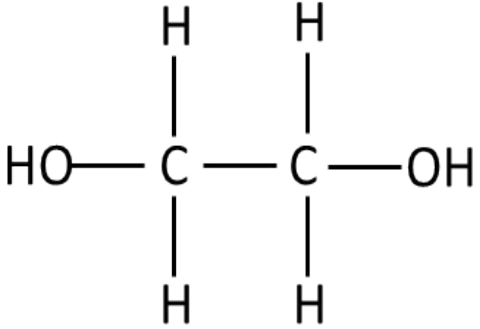


Which monomers is Terylene made from?

Which monomers is Terylene made from?



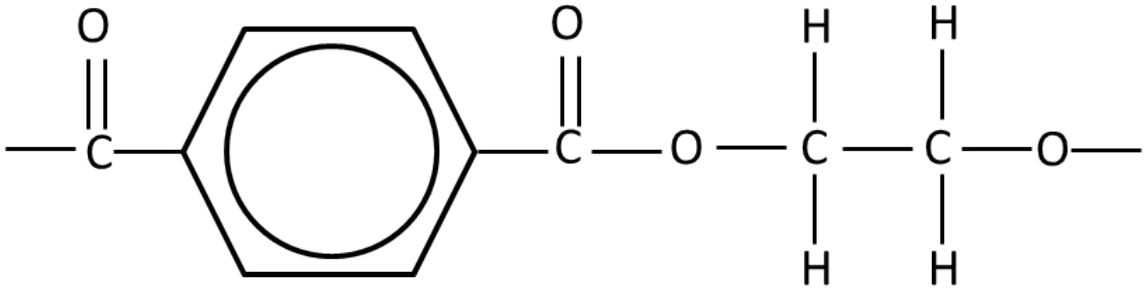
Benzene-1,4-dicarboxylic acid



Ethane-1,2-diol

Draw the repeating unit of Terylene

Draw the repeating unit of Terylene



What is Terylene used for?

What is Terylene used for?

As a fibre for making clothes

Why can condensation polymers be broken down?

Why can condensation polymers be broken down?

They have polar bonds

How are condensation polymers broken down?

How are condensation polymers broken down?

Hydrolysis (opposite of condensation)

What is the difference between addition and condensation polymerisation?

What is the difference between addition and condensation polymerisation?

Condensation makes the polymer and eliminates a small molecule; addition polymerisation breaks C=C to form only one product (just the polymer).

Why do polyesters not show hydrogen bonding?

Why do polyesters not show hydrogen bonding?

All O-H bonds are removed during polymerisation