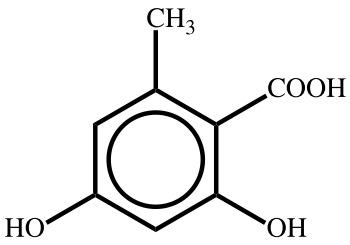
Ethanoyl chloride

A Level

Part A Orsellinic acid

Orsellinic acid occurs in lichens.

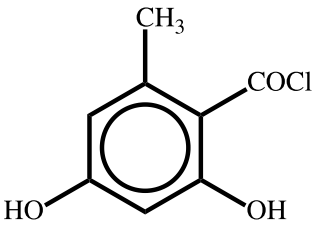


orsellinic acid

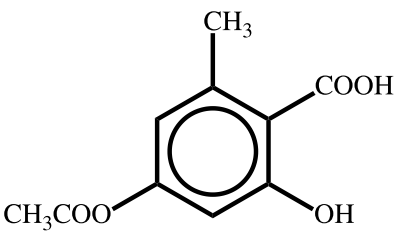
Figure 1: Structure of orsellinic acid

Which of the following formulae represents the product of its reaction with 2 equivalents of ethanoyl chloride (CH_3COCl)?

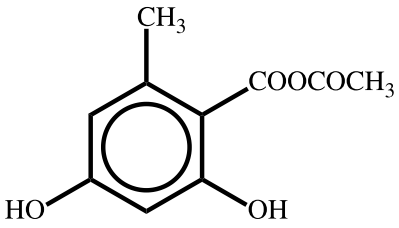
A



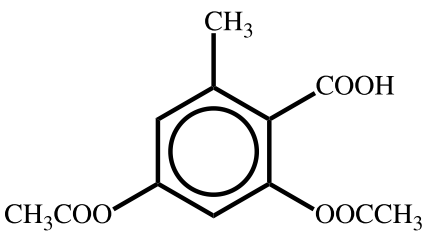
B



C



D



E

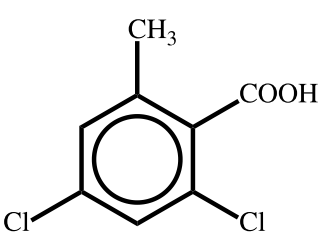


Figure 2: Possible products of reaction of orsellinic acid with ethanoyl chloride

- A
- B
- C

- D
- E

Part B Reaction with glucose

Glucose can be represented by the formula $\mathrm{CH_2OH(CHOH)_4CHO}$.

How many moles of ethanoyl chloride would react with one mole of glucose?

- 1
- 2
- 3
- 4
- 5
- 6

Part A adapted with permission from UCLES, A-Level Chemistry, June 1990, Paper 1, Question 29;
Part B adapted with permission from UCLES, A-Level Chemistry, November 1995, Paper 4, Question 27

Haloalkane reactions

A Level

Part A With sodium hydroxide

Which compounds may be prepared from $C_6H_5CHBrCH_3$ by the action of sodium hydroxide under different conditions?

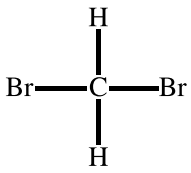
1 $C_6H_5CO_2Na$
2 $C_6H_5CH(OH)CH_3$
3 $C_6H_5CH{=}CH_2$

- **1**, **2** and **3** are correct
- **1** and **2** only are correct
- **2** and **3** only are correct
- **1** only is correct
- **3** only is correct

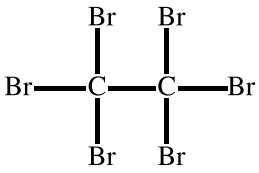
Part B Elimination

Which compound could undergo an elimination reaction when treated with hot ethanolic potassium hydroxide?

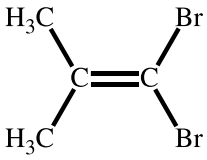
A



B



C



D

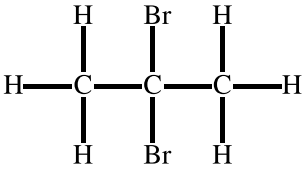


Figure 1: Possible candidates for elimination reactions with hot ethanolic potassium hydroxide

- A
- B
- C
- D

Part A adapted with permission from UCLES, A-Level Chemistry, November 1999, Paper 3, Question 37;
Part B adapted with permission from UCLES, A-Level Chemistry, June 1997, Paper 3, Question 24

Haloalkane Synthesis

A Level

Part A DBCP synthesis

1,2-Dibromo-3-chloropropane (DBCP) has been used in the control of earthworms in agricultural land. Which of the following would be the best synthesis of this compound?

- $CH_2{=}CHCHBrCl + HBr \longrightarrow DBCP$
- $CH_2{=}CHCHBr_2 + HCl \longrightarrow DBCP$
- $CH_3CH_2CH_2Cl + 2\,Br_2 \longrightarrow DBCP + 2\,HBr$
- $CH_2{=}CHCH_2Cl + Br_2 \longrightarrow DBCP$
- $CH_3CHBrCH_2Br + Cl_2 \longrightarrow DBCP + HCl$

Part B Chloroethane synthesis

Which of the following pairs of reagents **cannot** be used to prepare CH_3CH_2Cl?

- $CH_2{=}CHCl + H_2$
- $CH_3CH_3 + Cl_2$
- $CH_3CH_2OH + Cl_2$
- $CH_2{=}CH_2 + HCl$
- $CH_3CH_2OH + HCl$

Part A adapted with permission from UCLES, A-Level Chemistry, November 1989, Paper 3, Question 25;
Part B adapted with permission from UCLES, A-Level Chemistry, November 1989, Paper 3, Question 28

Monomers and polymers

A Level

Part A Nappies

The absorbent material in babies' disposable nappies is made from the polymer

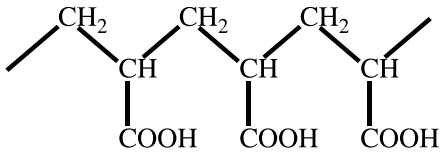


Figure 1: Structure of the polymer in disposable nappies

From which monomer could this polymer be obtained?

- $H_2C{=}CHCOOH$
- $HOOCCH{=}CHCOOH$
- $HOCH_2CH_2COOH$
- $ClCH_2CH_2COOH$

Part B Adhesive tape

The sticky substance of adhesive tape can be a poly(acrylate) made from an 'acrylic ester' such as that shown.

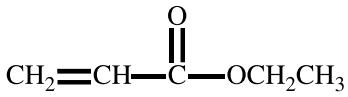
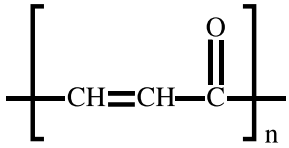


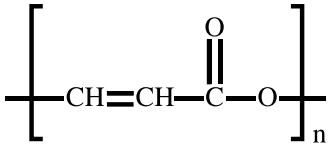
Figure 2: Structure of an acrylic ester

What is the structure of the poly(acrylate) made from this monomer?

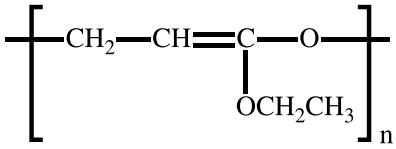
A



B



C



D

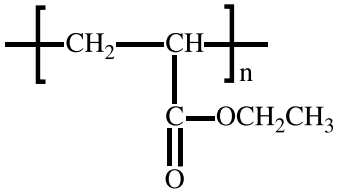


Figure 3: Possible monomers for poly(acrylate)

- A
- B
- C
- D

Part A adapted with permission from UCLES, A-Level Chemistry, November 1997, Paper 3, Question 30;
Part B adapted with permission from UCLES, A-Level Chemistry, November 1998, Paper 3, Question 30

More esters

A Level

Part A Sun cream

A sun protection cream contains the following ester as its active ingredient.

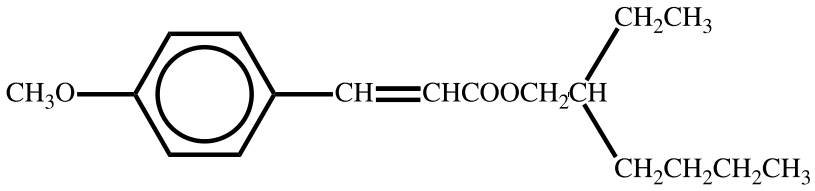
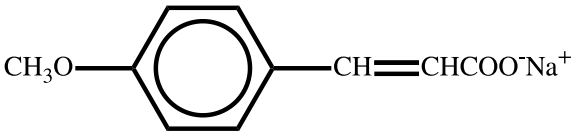


Figure 1: Active ingredient in sun cream

What are the products of its hydrolysis by aqueous sodium hydroxide?

1 $CH_3CH_2CH_2CH_2CH(CH_2CH_3)CH_2OH$

2



3

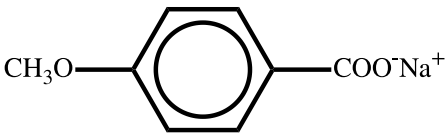
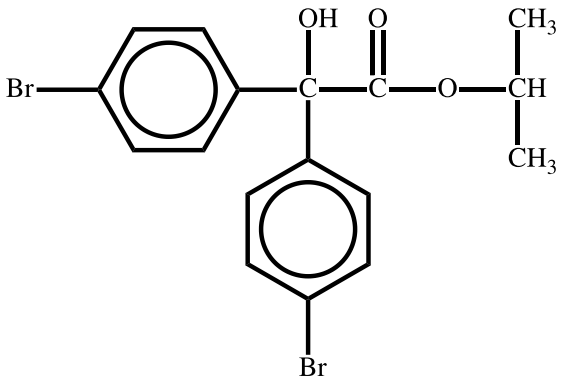


Figure 2: Possible hydrolysis products of active ingredient in sun cream

- **1**, **2** and **3** are correct
- **1** and **2** only are correct
- **2** and **3** only are correct
- **1** only is correct
- **3** only is correct

Part B Acarol

Acarol is sold as an insecticide for use on fruit and vegetables.



Acarol

Figure 3: Structure of *Acarol*

The final stage in its manufacture is an esterification.

Which alcohol is used to form the ester?

- propan-1-ol
- propan-2-ol
- di(4-bromophenyl)methanol
- methanol

Part A adapted with permission from OCR, A-Level Chemistry, November 1999, Paper 3, Question 39;
Part B adapted with permission from UCLES, A-Level Chemistry, June 1997, Paper 3, Question 27

Mystery compound

Further A

A liquid **E**, $\mathrm{C_8H_{14}O_4}$, was immiscible with water but slowly dissolved when boiled with aqueous sodium hydroxide. Distillation of the resulting solution gave another liquid **F**, $\mathrm{C_3H_8O}$. Oxidation of **F** with acidified potassium dichromate (VI) gave a substance **G** which did not react with sodium carbonate or with Tollens' reagent.

The solution remaining after the distillation of **F** was acidified and, on evaporation, yielded a solid **H**, $\mathrm{C_2H_2O_4}$. An aqueous solution of **H** has a pH of 2. It was found that $0.225\,\mathrm{g}$ of **H** was neutralised by $20\,\mathrm{cm^3}$ of $0.25\,\mathrm{mol\ dm^{-3}}$ sodium hydroxide.

Deduce the identity of substances **E** to **H**.

Use the structure editor to generate a SMILES string for each substance.

In the editor, after drawing your structure, click on the round, yellow smiley face to generate a SMILES string. Copy the SMILES string and paste it in the answer box.

Using the structure editor

Part A **E**

What is compound **E**?

Part B **F**

What is compound **F**?

Part C **G**

What is compound **G**?

Part D H

What is compound **H**?

Adapted with permission from UCLES, A-Level Chemistry, November 1991, Special paper, Question 9.

Oxidation and reduction

A Level

Part A Oxidation and reduction

Compounds **P** and **Q** have the following formulae:

$HOCH_2CH(OH)CHO$	$HOCH_2COCH_2OH$
P	**Q**

Which of the following statements apply to these compounds?

1. **P** can be directly oxidised to **Q**.
2. **P** and **Q** can both be reduced to $HOCH_2CH(OH)CH_2OH$.
3. Both **P** and **Q** react with ethanoyl chloride to form esters.

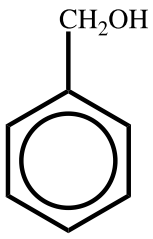
- **1**, **2** and **3** are correct
- **1** and **2** only are correct
- **2** and **3** only are correct
- **1** only is correct
- **3** only is correct

Part B Alcohols resistant to oxidation

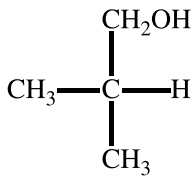
Many alcohols are oxidised by warming with acidified potassium dichromate(VI).

Which alcohol resists this oxidation?

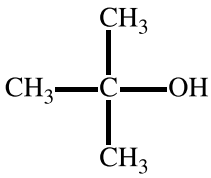
A



B



C



D

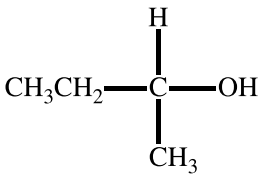


Figure 1: Possible alcohols resisting oxidation by acidified potassium dichromate(VI)

- A
- B
- C
- D

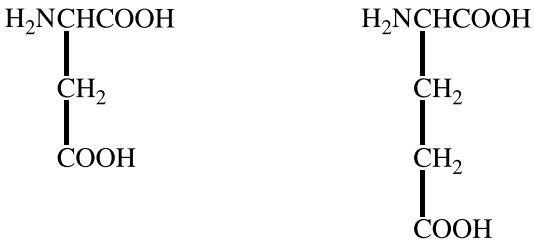
Part A adapted with permission from UCLES, A-Level Chemistry, June 1997, Paper 3, Question 40;
Part B adapted with permission from UCLES, A-Level Chemistry, June 1999, Paper 3, Question 25

Peptides

A Level

Part A Amide linkages

The amino acids aspartic acid and glutamic acid can react with each other to form amide linkages.



aspartic acid glutamic acid

Figure 1: Structures of aspartic acid and glutamic acid

What is the maximum number of different compounds, each containing one amide linkage, that can be formed from one molecule of aspartic acid and one molecule of glutamic acid?

- 1
- 2
- 4
- 6

Part B Hydrolysis of insulin

Partial hydrolysis of insulin, the hormone essential for carbohydrate metabolism, gives the following tripeptide.

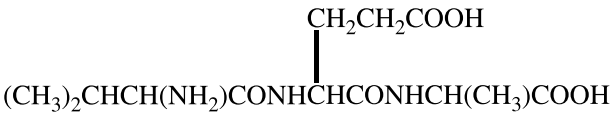
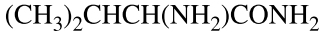


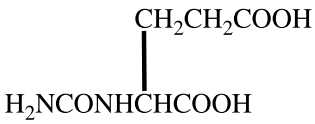
Figure 2: Tripeptide after partial hydrolysis of insulin

Which compound could be obtained by further hydrolysis of this tripeptide?

[Depending on the pH of the final solution, carboxylic acid groups may be deprotonated to form $-\mathrm{COO}^-$ and amines may be protonated to form $-\mathrm{NH_3}^+$. At pH values near neutral they may form zwitterions containing both $-\mathrm{COO}^-$ and $-\mathrm{NH_3}^+$ in the same molecule.]

A 

B 

C 

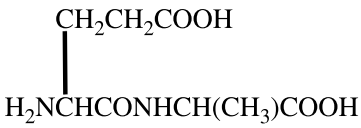
D 

Figure 3: Possible products of further hydrolysis of insulin

- A
- B
- C
- D

Part A adapted with permission from UCLES, A-Level Chemistry, November 1998, Paper 3, Question 28;
Part B adapted with permission from UCLES, A-Level Chemistry, June 1999, Paper 3, Question 29

Poly(ethenol)

A Level

Poly(ethenol) is a plastic material which can be made by replacing the ester groups in poly(ethenyl ethanoate) by the following route:

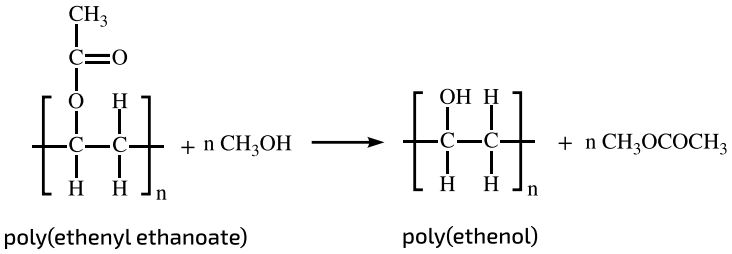


Figure 1: Conversion of poly(ethenyl ethanoate) to poly(ethenol)

When almost all the ester groups have been replaced, the resulting polymer is soluble in water. This makes its disposal very straightforward.

Part A Monomer

Draw the full structural formula for the monomer ethenyl ethanoate using the structure editor and enter the SMILES string below.

In the editor, after drawing your structure, click on the round, yellow smiley face to generate a SMILES string. Copy the SMILES string and paste it in the answer box.

Using the structure editor

Part B Polymerisation type

What type of polymerisation would be involved in making poly(ethenyl ethanoate) from ethenyl ethanoate?

Part C Homologous series

Poly(ethenol) cannot be made directly since the monomer does not exist as a stable compound. Ethenol, $CH_2{=}CH(OH)$, is an unstable form of ethanal, CH_3CHO.

Name the homologous series to which ethanal belongs.

Part D Enthalpy change

Using bond energy terms, calculate ΔH for the conversion of ethenol to ethanal.

Bond energies / $kJ\ mol^{-1}$:

$E(C{-}C) = 347;\ E(C{-}H) = 413;\ E(C{-}O) = 358;$

$E(C{=}C) = 612;\ E(C{=}O) = 736;\ E(O{-}H) = 464$

Part E Intermolecular forces

In addition to induced dipole forces what other intermolecular forces exist between chains of poly(ethenol)?

Adapted with permission from OCSEB, A-Level Chemistry (Salters), June 1995, Paper 1, Question 2.

Reactions classification

A Level

Many organic reactions can be classified as either addition, substitution, elimination, oxidation or reduction reactions. Their mechanisms can also be classified as either nucleophilic addition or substitution, electrophilic addition or substitution, or free-radical substitution.

(i) $CH_3CH{=}CH_2 \longrightarrow CH_3CHBrCH_3$

(ii) $CH_3CH_2CH_3 \longrightarrow CH_3CHBrCH_3$

(iii) $CH_3CHBrCH_3 \longrightarrow CH_3CH(OH)CH_3$

(iv) $CH_3COCH_3 \longrightarrow CH_3CH(OH)CH_3$

Classify the above reactions by **reaction type** and **mechanism**.

Part A Reaction (i)

$$CH_3CH{=}CH_2 \longrightarrow CH_3CHBrCH_3$$

Reaction type is . Mechanism is .

Items:

nucleophilic | substitution | oxidation | reduction | free-radical | addition | elimination | electrophilic

Part B Reaction (ii)

$$CH_3CH_2CH_3 \longrightarrow CH_3CHBrCH_3$$

Reaction type is . Mechanism is .

Items:

free-radical | reduction | electrophilic | oxidation | elimination | nucleophilic | addition | substitution

Part C Reaction (iii)

$$CH_3CHBrCH_3 \longrightarrow CH_3CH(OH)CH_3$$

Reaction type is . Mechanism is .

Items:

elimination | reduction | substitution | nucleophilic | oxidation | electrophilic | addition | free-radical

---

Part D Reaction (iv)

$$CH_3COCH_3 \longrightarrow CH_3CH(OH)CH_3$$

Reaction type is . Mechanism is .

Items:

oxidation | nucleophilic | electrophilic | substitution | free-radical | reduction | addition | elimination

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Adapted with permission from UCLES, A-Level Chemistry, June 1995, Paper 1, Question 8.