

AQA A2 CHEMISTRY

TOPIC 4.4

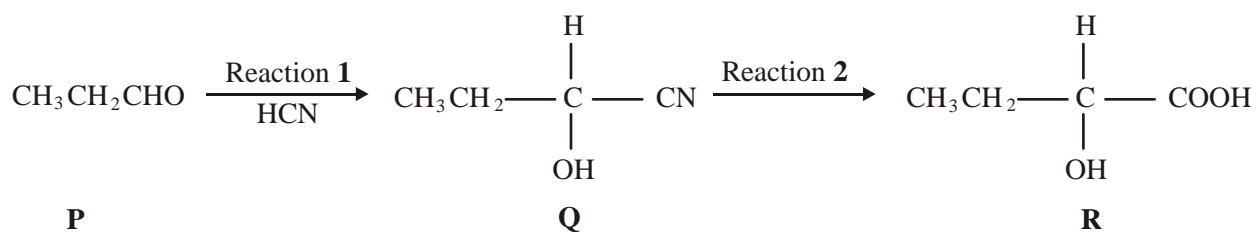
NOMENCLATURE AND ISOMERISM IN ORGANIC CHEMISTRY

TOPIC 4.5

COMPOUNDS CONTAINING THE CARBONYL GROUP

BOOKLET OF PAST EXAMINATION QUESTIONS

1. Consider the sequence of reactions below.



- (a) Name and outline a mechanism for Reaction 1.

Name of mechanism

Mechanism

(5)

- (b) (i) Name compound **Q**

.....

- (ii) The molecular formula of **Q** is $\text{C}_4\text{H}_7\text{NO}$. Draw the structure of the isomer of **Q** which shows geometrical isomerism and is formed by the reaction of ammonia with an acyl chloride.

(3)

(c) Draw the structure of the main organic product formed in each case when **R** reacts separately with the following substances:

(i) methanol in the presence of a few drops of concentrated sulphuric acid;

(ii) acidified potassium dichromate(VI);

(iii) concentrated sulphuric acid in an elimination reaction.

(3)
(Total 11 marks)

2. Alcohol **X** has the structure $(\text{CH}_3)_2\text{C}(\text{OH})\text{CH}(\text{CH}_3)_2$

(a) (i) Name alcohol **X**.

.....

(ii) Name and outline the mechanism for the reaction occurring when alcohol **X** is converted into 2,3-dimethylbut-2-ene in the presence of a strong acid.

Name of mechanism.....

Mechanism

(iii) Give the structure of, and name an isomer of 2,3-dimethylbut-2-ene which is also formed in the reaction. Explain why two products are obtained.

Structure

Name of isomer.....

Explanation

.....

.....

(10)

- (b) (i) Write an equation for the reaction between alcohol **X** and ethanoyl chloride. Name and outline a mechanism for this reaction, using ROH to represent the alcohol in the mechanism.

Equation

Name of mechanism.....

Mechanism

- (ii) Give an alternative method for obtaining the organic reaction product in part (b) (i), starting from alcohol **X**, other than using ethanoic anhydride.

State the type of reaction, the reagent(s) used and the reaction conditions.

Type of reaction

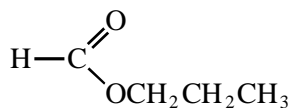
Reagent(s).....

Conditions.....

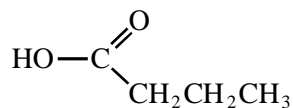
(9)

(Total 19 marks)

3. (a) Consider the following pair of isomers.



C



D

- (i) Name compound **C**.
.....
- (ii) Identify a reagent which could be used in a test-tube reaction to distinguish between **C** and **D**. In each case, state what you would observe.

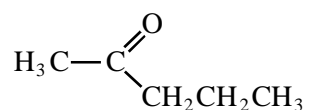
Reagent

Observation with C

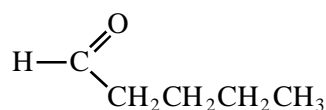
Observation with D.....

(4)

- (b) Consider the following pair of isomers.



E



F

- (i) Name compound **E**.

.....

- (ii) Identify a reagent which could be used in a test-tube reaction to distinguish between **E** and **F**. In each case, state what you would observe.

Reagent

Observation with E

Observation with F

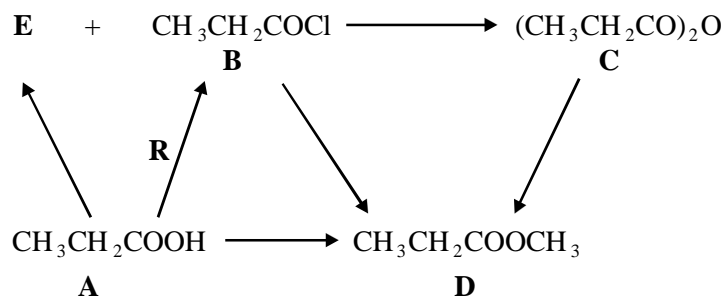
(4)

- (c) Draw the structure of the chain isomer of **F** which shows optical isomerism.

(1)

(Total 9 marks)

4. This question is about compounds **A**, **B**, **C**, **D** and **E** and their interconversions. Some of these are shown in the diagram below.



- (a) (i) Give the names of compounds **B** and **C**.

Name of compound **B**

Name of compound **C**

(2)

- (ii) Describe one observation that would be made when compound **B** reacts with water.

.....

.....

(1)

- (iii) Draw the graphical formula of the organic product formed when compound **B** reacts with ammonia.

(1)

- (iv) When compound **C** is heated in water, it is hydrolysed to a carboxylic acid. Write the equation for the reaction that occurs

.....

(1)

(b) Compounds **A**, **B** and **C** will each react with the same alcohol to form compound **D**.

(i) Give the name of the alcohol and the name of compound **D**.

Name of alcohol

Name of compound D

(2)

(ii) State the appropriate reaction conditions for the formation of compound **D** from each of the compounds **A**, **B** and **C**.

Condition(s) for A

Condition(s) for B

Condition(s) for C

(4)

(Total 11 marks)

5. (a) (i) Write an equation for the reaction of butan-2-ol with ethanoic acid, showing clearly the structure of the organic product.

(ii) Name the type of organic compound formed in part (a)(i) and suggest a use for this compound.

Type of compound.....

Use.....

(iii) Give a homogeneous catalyst for the reaction in part (a)(i) and state the meaning of the term *homogeneous*.

Catalyst.....

Meaning of homogeneous.....

.....

(6)

(b) Write an equation for the complete combustion of butan-2-ol in an excess of oxygen.

.....

(1)

(c) But-1-ene and other products can be made by the dehydration of butan-2-ol.

(i) Outline a mechanism for the dehydration of butan-2-ol into but-1-ene.

(ii) Explain why but-1-ene does not show geometrical isomerism.

.....
.....

(iii) An alternative dehydration of butan-2-ol produces geometrical isomers.
Draw the structure of one of these geometrical isomers and give its full name.

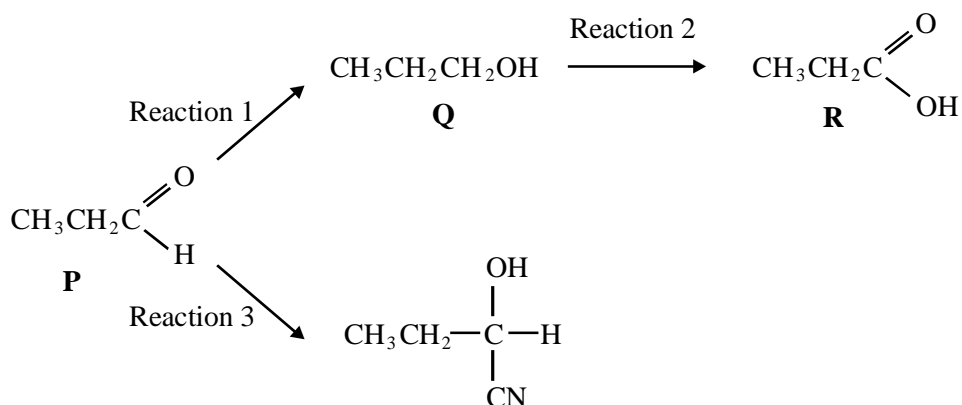
Structure of geometrical isomer

Name.....

(7)

(Total 14 marks)

6. Consider the following reaction scheme.



(a) Give the reagent(s) for Reaction 1 and name the type of reaction involved.

Reagent(s).....

Type of reaction.....

(2)

- (b) (i) Give the reagent(s) and conditions for Reaction 2.

Reagent(s).....

Conditions.....

- (ii) Write an equation for this reaction using the symbol [O] to represent the oxidising agent.

(4)

- (c) Give the reagent(s) and name the mechanism involved in Reaction 3.

Reagent(s).....

Name of mechanism.....

(2)

- (d) Reaction 3 produces a mixture of two stereoisomers.

- (i) What is the relationship between these two isomers?

.....

.....

- (ii) How can separate samples of these isomers be distinguished?

.....

.....

(3)

- (e) (i) Draw the structure and state the name of the organic product formed when **Q** reacts with **R**.

Structure

Name

- (ii) Draw the structure of an isomer of **R** which forms ethanol on hydrolysis.

(3)

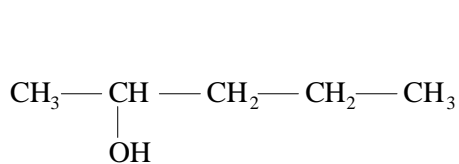
- (f) Write an equation for the complete combustion of **P**.

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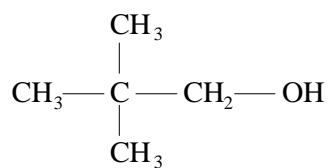
(2)

(Total 16 marks)

7. (a) The structures of two alcohols of formula $C_5H_{11}OH$ are shown below.



pentan-2-ol



2,2-dimethylpropan-1-ol

- (i) A third alcohol of formula $C_5H_{11}OH$ is tertiary. Draw the graphical formula and give the name of this alcohol.

Graphical formula

Name.....

(2)

- (ii) Draw the graphical formulae of **two** alkenes formed when pentan-2-ol is heated with concentrated sulphuric acid.

(2)

- (iii) State the type of reaction taking place in (a)(ii).

.....

(1)

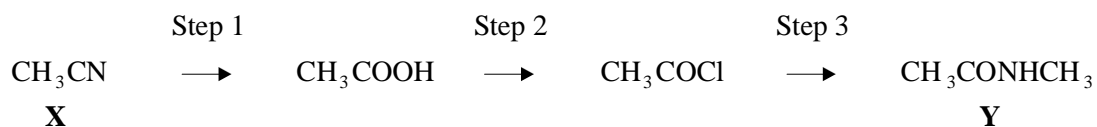
- (iv) Explain why the type of reaction taking place in (a)(ii) does not occur when 2,2-dimethylpropan-1-ol is heated with concentrated sulphuric acid.

.....

.....

(1)

(b) Compound **X** is converted into compound **Y** by the reactions outlined below.



(i) Give the name of compound **X**.

..... (1)

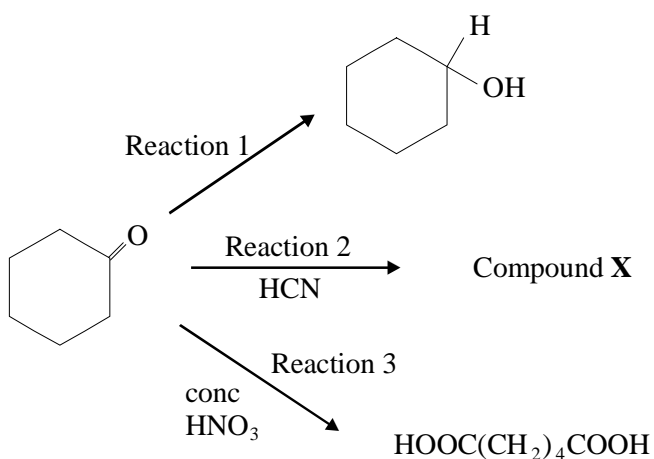
(ii) State the type of reaction taking place in Step 1.

..... (1)

(iii) Write an equation for the reaction taking place in Step 3.

..... (2)
(Total 10 marks)

8. Consider the following three reactions of cyclohexanone, $C_6H_{10}O$.



- (a) Give a suitable reagent for Reaction 1.

.....

(1)

- (b) Name the type of reaction and outline a mechanism for Reaction 2.

Type of reaction

Mechanism

(5)

- (c) (i) Name the organic product of Reaction 3.

.....

- (ii) Calculate the maximum mass of this organic product that could be formed if 2.40 g of cyclohexanone were allowed to react in Reaction 3.

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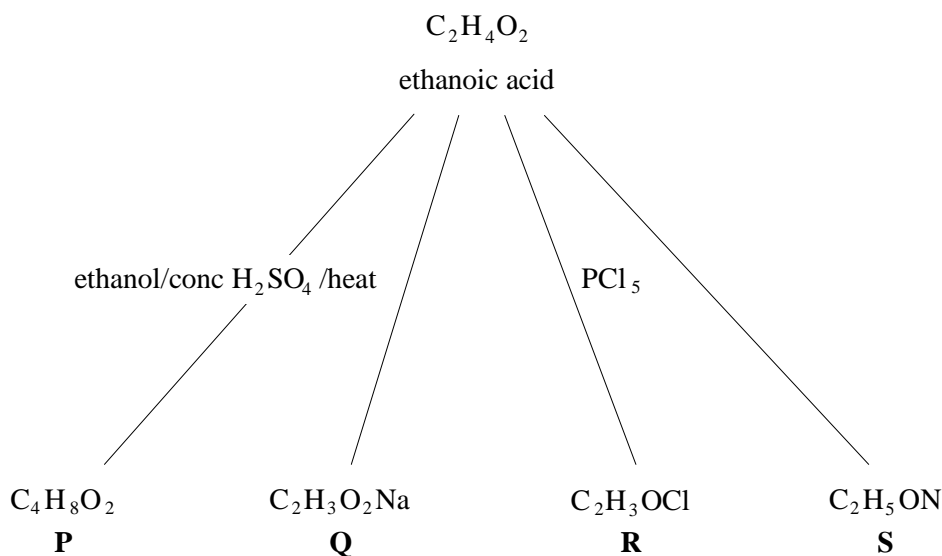
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(4)

(Total 10 marks)

9. The molecular formulae of some compounds that can be prepared from ethanoic acid are given in the scheme below.



- (a) (i) Give the name and graphical formula of **P**.

Name.....

Graphical formula

(2)

- (ii) Give the name of the type of reaction which occurs when **P** is formed from ethanoic acid.

.....

(1)

- (b) Ethanoic acid can be obtained from **P**.

- (i) Give the name of the reagent(s) and state the conditions required.

.....

.....

(2)

- (ii) Write a balanced equation for the reaction

.....

(1)

- (c) (i) State the reagent and reaction conditions that could be used for converting ethanoic acid into **Q**.

.....
.....

(2)

- (ii) Give the name and graphical formula of the organic product of the reaction between anhydrous samples of **Q** and **R**.

Name.....

Graphical formula

(2)

- (iii) State how the product formed in (c)(ii) could be converted into ethanoic acid and write an equation for the reaction.

.....
.....

(2)

- (d) (i) Give the name and graphical formula of the amide **S**.

Name.....

Graphical formula.....

(2)

- (ii) State the reagent(s) and reaction conditions that could be used for converting ethanoic acid into **S**.

.....
.....

(2)

- (iii) Write a balanced equation for the reaction between **S** and aqueous hydrochloric acid.

.....

(1)

(Total 17 marks)

10. (a) Addition reactions to both alkenes and carbonyl compounds can result in the formation of isomeric compounds.

- (i) Choose an alkene with molecular formula C_4H_8 which reacts with HBr to form two structural isomers. Give the structures of these two isomers and name the type of structural isomerism shown.

Outline a mechanism for the formation of the major product.

- (ii) Using HCN and a suitable carbonyl compound with molecular formula C_3H_6O , outline a mechanism for an addition reaction in which two isomers are produced. Give the structures of the two isomers formed and state the type of isomerism shown.

(14)

- (b) Explain why ethanoyl chloride reacts readily with nucleophiles.
Write an equation for one nucleophilic addition–elimination reaction of ethanoyl chloride.
(A mechanism is not required.)

(4)

(Total 18 marks)