



A LEVEL CHEMISTRY

TOPIC 17 – CARBOXYLIC ACIDS, AMINES, ESTERS AND ACYLATION

ASSESSED HOMEWORK

Answer all questions

Max 80 marks

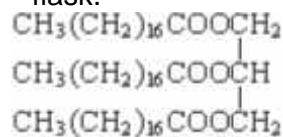
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SECTION A

1. A naturally-occurring triester, shown below, was heated under reflux with an excess of aqueous sodium hydroxide and the mixture produced was then distilled. One of the products distilled off and the other was left in the distillation flask.



- (i) Draw the structure of the product distilled off and give its name.

Structure

Name

- (ii) Give the formula of the product left in the distillation flask and give a use for it.

Formula

Use

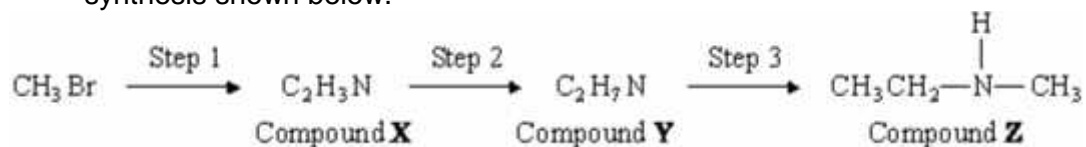
(4)
(Total 4 marks)



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2. Compound **Z** can be formed via compounds **X** and **Y** in the three step synthesis shown below.



Identify compounds **X** and **Y** and give reagents and conditions for Steps 1 and 2.

State the **type** of compound of which **Z** is an example.

Compound **Z** reacts with a large excess of bromomethane to form a solid product. Draw the structure of this product and name the type of mechanism for this reaction.

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(Total 9 marks)

3. Outline a mechanism for the reaction of CH_3OH with $\text{CH}_3\text{CH}_2\text{COCl}$ and name the organic product.

Mechanism

Name of organic product

(5)
(Total 5 marks)

4. A student prepared a sample of aspirin (melting point 135°C) in the laboratory and attempted to purify it by recrystallisation. To check the purity



of the aspirin the student determined its melting point.

- (a) State **two** observations, during this melting point determination, that would indicate that the sample is **not** pure.

Observation

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Observation

2

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(2)

- (b) Suggest why a pure sample of aspirin may sometimes appear to melt at a temperature different from 135 °C.

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(1)

(Total 3 marks)

5. Butenedioic acid, HOOCCH=CHCOOH, occurs as two stereoisomers. One of the isomers readily forms the acid anhydride C₄H₂O₃ when warmed.

(a) Draw the structures of the two isomers of butenedioic acid and name the type of isomerism shown.

Use the structures of the two isomeric acids to suggest why only one of them readily forms an acid anhydride when warmed. Draw the structure of the acid anhydride formed.

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(6)

(b) Write an equation for a reaction which occurs when butenedioic acid is treated with an excess of aqueous sodium hydroxide.

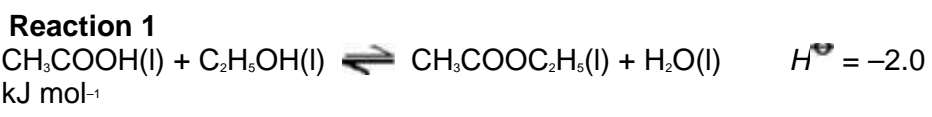
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(2)
(Total 8 marks)

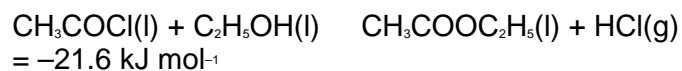
6. Ethyl ethanoate can be prepared by the reactions shown below.



Reaction 2



Δ



H^+

Give one advantage and one disadvantage of preparing ethyl ethanoate by **Reaction 1** rather than by **Reaction 2**.

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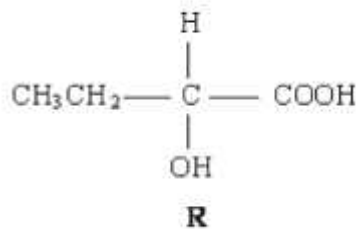
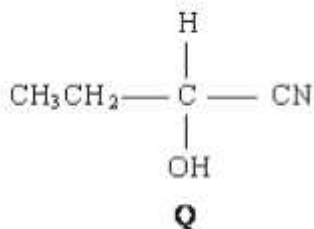
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(2)
(Total 2 marks)

7. Consider the compounds below:



- (a) 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.

(2)

- (b) Draw the structure of the main organic product formed in each case when **R** reacts separately with methanol in the presence of a few drops of concentrated sulphuric acid



(1)
(Total 3 marks)

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8. (a) Name and outline a mechanism for the reaction between propanoyl chloride, $\text{CH}_3\text{CH}_2\text{COCl}$, and methylamine, CH_3NH_2 . Draw the structure of the organic product.

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(6)

- (b) Write an equation for the reaction of propanoyl chloride with water. An excess of water is added to 1.48 g of propanoyl chloride. Aqueous sodium hydroxide is then added from a burette to the resulting solution. Calculate the volume of 0.42 mol dm^{-3} aqueous sodium hydroxide needed to react exactly with the mixture formed.

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(5)
(Total 11 marks)

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9. Esters have many important commercial uses such as solvents and artificial flavourings in foods.

Esters can be prepared in several ways including the reactions of alcohols with carboxylic acids, acid anhydrides, acyl chlorides and other esters.

- (a) Ethyl butanoate is used as a pineapple flavouring in sweets and cakes.

Write an equation for the preparation of ethyl butanoate from an acid and an alcohol.

Give a catalyst used for the reaction.

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(4)

- (b) Butyl ethanoate is used as a solvent in the pharmaceutical industry.

Write an equation for the preparation of butyl ethanoate from an acid anhydride and an alcohol.

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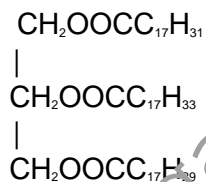
(3)

- (c) Name and outline a mechanism for the reaction of CH_3COCl with CH_3OH to form an ester.

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(5)

- (d) The ester shown below occurs in vegetable oils. Write an equation to show the formation of biodiesel from this ester.



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(3)
(Total 15 marks)

10. (a) Name and outline a mechanism for the formation of butylamine, $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{NH}_2$, by the reaction of ammonia with 1-bromobutane, $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Br}$.

Name of
mechanism

Mechanism

(5)



- (b) Butylamine can also be prepared in a two-step synthesis starting from 1-bromopropane, $\text{CH}_3\text{CH}_2\text{CH}_2\text{Br}$. Write an equation for each of the two steps in this synthesis.

Step 1

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Step 2

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(3)

- (c) Explain why butylamine is a stronger base than ammonia

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(2)

- (d) Draw the structure of a tertiary amine which is an isomer of butylamine.

(1)

(Total 11 marks)

11. Samples of 1-chloropropane and ethanoyl chloride can be distinguished by the addition of an aqueous solution of silver nitrate. State what you would observe with each sample.

Observation with 1-chloropropane

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Observation with ethanoyl chloride.

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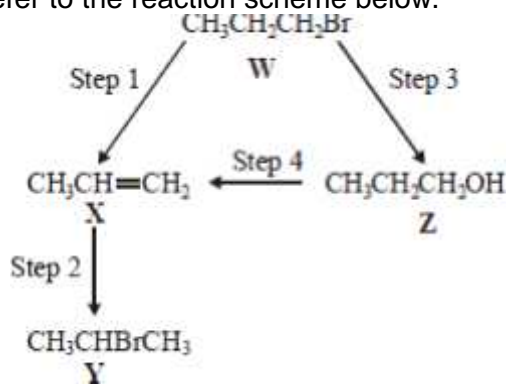
(Total 2 marks)

12. In which one of the following mixtures does a redox reaction occur?

- A ethanal and Tollens' reagent
- B ethanoyl chloride and ethanol
- C ethanal and hydrogen cyanide
- D ethanoic acid and sodium hydroxide

(Total 1 mark)

13. For this question refer to the reaction scheme below.



Which one of the following statements is **not** correct?

- A Reaction of **W** with sodium cyanide followed by hydrolysis of the resulting product gives propanoic acid.
- B Mild oxidation of **Z** produces a compound that reacts with Tollens' reagent, forming a silver mirror.



- C** Z reacts with ethanoic acid to produce the ester propyl ethanoate.
- D** W undergoes addition polymerisation to form poly(propene). **(Total 1 mark)**

14. An excess of methanol was mixed with 12 g of ethanoic acid and an acid catalyst. At equilibrium the mixture contained 8 g of methyl ethanoate. The percentage yield of ester present was

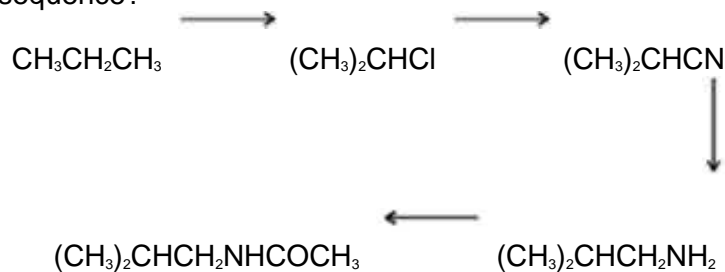
- A** 11
- B** 20
- C** 54
- D** 67

(Total 1 mark)

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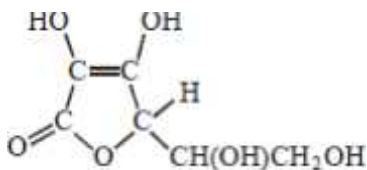
15. Which one of the following types of reaction mechanism is **not** involved in the above sequence?



- A free-radical substitution
 B nucleophilic substitution
 C elimination
 D nucleophilic addition-elimination

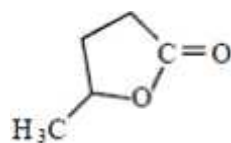
(Total 1 mark)

16. Which one of the following is **not** a correct statement about vitamin C, shown below?



- A It is a cyclic ester.
 B It can form a carboxylic acid on oxidation.
 C It decolourises a solution of bromine in water.
 D It is a planar molecule.

(Total 1 mark)



17. Acid hydrolysis of _____ produces

- A $\text{CH}_3\text{CH}(\text{OH})\text{CH}_2\text{CH}_2\text{COOH}$

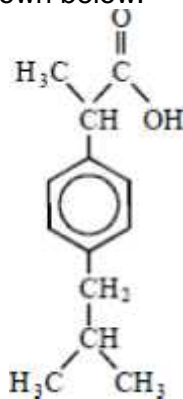


- B** $\text{CH}_2(\text{OH})\text{CH}_2\text{CH}_2\text{CH}_2\text{COOH}$
- C** $\text{CH}_3\text{CH}(\text{OH})\text{CH}_2\text{CH}_2\text{OCHO}$
- D** $\text{CH}_2(\text{OH})\text{CH}_2\text{CH}_2\text{CH}_2\text{OCHO}$

(Total 1 mark)

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18. Ibuprofen is a drug used as an alternative to aspirin for the relief of pain, fever and inflammation.
The structure of ibuprofen is shown below.



Which one of the following statements is **not** correct?

- A It has optical isomers.
- B It liberates carbon dioxide with sodium carbonate solution.
- C It undergoes esterification with ethanol.
- D It undergoes oxidation with acidified potassium dichromate(VI).

(Total 1 mark)