Carboxylic Acids, Esters and Acylation Practice Test

Mr Cole Chemistry

Name ..... Class: .....

Start Time ..... End Time ..... Time Taken .....

Time allowed: 53 minutes

INSTRUCTIONS TO CANDIDATES

- This document is designed to be used as a practice test.
- Complete the test under exam conditions in one sitting.
- Optional: Before marking it, go through the paper with a set of notes and improve your answers.
- Mark the test using the mark scheme make corrections on the paper.
- Complete the table on the front page.
- Improve your notes so that they better reflect your weaknesses.
- Make a note of your strengths and weaknesses for future revision.

Success Criteria	**Questions in Paper**	**Mark**	**Out of**	**%**	**Rank Order**
Esterification	1a, 4a		1, 4		
Addition-Elimination Mechanism	1b		5		
Acid anhydrides	1c, 1d, 4b		1, 2, 3		
Analysis	1e		3		
Triesters	2, 4c		5, 3		
Practical techniques	3, 6a, 6c, 6d, 6e, 6h		2, 1, 1, 1, 1, 6		
Testing for acyl chlorides	5		2		
Calculations	6b, 6j		2, 3		
Hydrolysis of esters	6f		1		
Solubility	6g		2		
Total			49		

Q1.

(a) Write an equation for the formation of methyl propanoate, $CH_3CH_2COOCH_3$, from methanol and propanoic acid.

_____

(1)

(b) Name and outline a mechanism for the reaction between methanol and propanoyl chloride to form methyl propanoate.

Name of mechanism _____

Mechanism

(5)

(c) Propanoic anhydride could be used instead of propanoyl chloride in the preparation of methyl propanoate from methanol. Draw the structure of propanoic anhydride.

(1)

(d) (i) Give **one** advantage of the use of propanoyl chloride instead of propanoic acid in the laboratory preparation of methyl propanoate from methanol.

_____

_____

(ii) Give **one** advantage of the use of propanoic anhydride instead of propanoyl chloride in the industrial manufacture of methyl propanoate from methanol.

_____

_____

(2)

(e) An ester contains a benzene ring. The mass spectrum of this ester shows a molecular ion peak at *m/z* = 136.

(i) Deduce the molecular formula of this ester.

_____

_____

_____

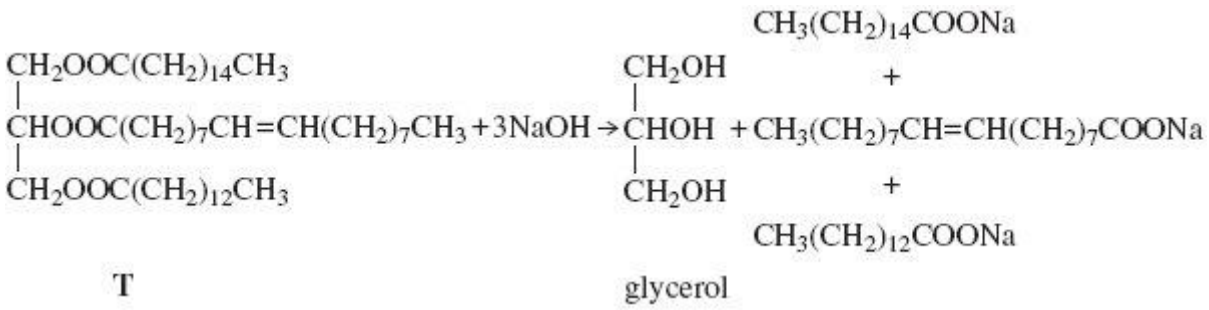
(ii) Draw **two** possible structures for this ester.

(3)

(Total 12 marks)

Q2.

The triester, **T**, shown below is found in palm oil. When **T** is heated with an excess of sodium hydroxide solution, the alcohol glycerol is formed together with a mixture of three other products as shown in the following equation.



T glycerol

(a) (i) Give the IUPAC name for glycerol.

_____

(1)

(ii) Give a use for the mixture of sodium salts formed in this reaction.

_____

(1)

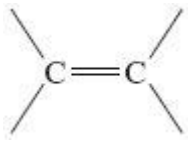
(b) When **T** is heated with an excess of methanol, glycerol is formed together with a mixture of methyl esters.

(i) Give a use for this mixture of methyl esters.

_____

(1)

(ii) One of the methyl esters in the mixture has the IUPAC name methyl (*Z*)-octadec-9-enoate. Draw **two** hydrogen atoms on the diagram below to illustrate the meaning of the letter *Z* in the name of this ester.



(1)

(iii) One of the other methyl esters in the mixture has the formula $CH_3(CH_2)_{12}COOCH_3$ Write an equation for the complete combustion of one molecule of this ester.

_____

(1)

(Total 5 marks)

Q3.

Describe briefly how you could measure the melting point of aspirin.

_____

_____

_____

_____

(Total 2 marks)

Q4.

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.

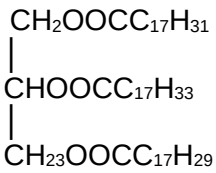
(4)

(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.

(3)

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



$CH_2OOCC_{17}H_{31}$
|
$CHOOCC_{17}H_{33}$
|
$CH_{23}OOCC_{17}H_{29}$

(3)

(Total 10 marks)

Q5.

Aldehydes can be prepared from acyl chlorides.

State how an aldehyde could be tested to show whether it is contaminated with traces of unreacted acyl chloride.
State what you would observe.

Test _____

Observation _____

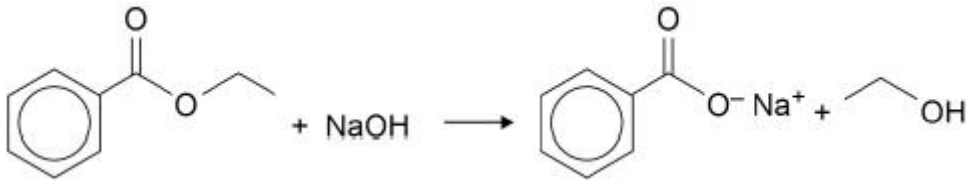
_____

(Total 2 marks)

Q6.

Benzoic acid can be prepared from ethyl benzoate.

Ethyl benzoate is first hydrolysed in alkaline conditions as shown:



A student used the following method.

Add 5.0 cm^3 of ethyl benzoate (density = 1.05 g cm^{-3}, M_r = 150) to 30.0 cm^3 of aqueous 2 mol dm^{-3} sodium hydroxide in a round-bottomed flask.

Add a few anti-bumping granules and attach a condenser to the flask. Heat the mixture under reflux for half an hour. Allow the mixture to cool to room temperature.

Pour 50.0 cm^3 of 2 mol dm^{-3} hydrochloric acid into the cooled mixture.

Filter off the precipitate of benzoic acid under reduced pressure.

(a) Suggest how the anti-bumping granules prevent bumping during reflux.

_____

_____

_____

(1)

(b) Show, by calculation, that an excess of sodium hydroxide is used in this reaction.

(2)

(c) Suggest why an excess of sodium hydroxide is used.

_____

_____

(1)

(d) Suggest why an electric heater is used rather than a Bunsen burner in this hydrolysis.

(1)

(e) State why reflux is used in this hydrolysis.

(1)

(f) Write an equation for the reaction between sodium benzoate and hydrochloric acid.

(1)

(g) Suggest why sodium benzoate is soluble in cold water but benzoic acid is insoluble in cold water.

(2)

(h) After the solid benzoic acid has been filtered off, it can be purified.

Describe the method that the student should use to purify the benzoic acid.

(6)

(i) In a similar experiment, another student used 0.040 mol of ethyl benzoate and obtained 5.12 g of benzoic acid.

Calculate the percentage yield of benzoic acid.

Suggest why the yield is not 100%.

Percentage yield _____ %

Suggestion _____

_____

_____

(3)

(Total 18 marks)