

# Australian Islamic College 2019

## ATAR Chemistry Units 3 and 4

### Task 11 (Weighting: 5%)

#### Esters Validation Test

Test Time: 45 minutes

Please do not turn this page until instructed to do so.

First Name	Surname
<b>ANSWERS</b>	

Teacher

Mark / 42	Percentage

Equipment allowed: Pens, pencils, erasers, whiteout, correction tape, rulers and non-programmable calculators permitted by the Schools Curriculum and Standards Authority.

## **Special conditions:**

2 marks will be deducted for failing to write your full name on this test paper.

**Teacher help:** Your teacher can only help you during your test in one situation.

If you believe there is a mistake in a question show your teacher and your teacher will tell you if there is a mistake in the question and if appropriate, how to fix that mistake.

**Spelling of Science words** must be correct. Science words with more than one letter wrong (wrong letter and/or wrong place) will be marked wrong.

**Equations** must be written balanced and with correct state symbols or they will be marked wrong.

Questions must be answered in this booklet.

Total marks: 42

**PART ONE: MULTIPLE CHOICE QUESTIONS**

**(3 MARKS)**

**Circle the correct answer on this page.**

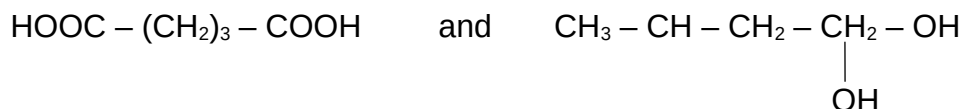
1. A food chemist wishes to create the odour of pineapples for a product. An ester with this odour has the formula:  $\text{CH}_3\text{CH}_2\text{OOCCH}_2\text{CH}_3$ . Which of the following pairs of reactants with the aid of a suitable catalyst would produce this ester?

- a.  $\text{CH}_3\text{CH}_2\text{COOH}$  and  $\text{CH}_3\text{COOH}$
- b.  $\text{CH}_3\text{COOH}$  and  $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$
- c.  **$\text{CH}_3\text{CH}_2\text{COOH}$  and  $\text{CH}_3\text{CH}_2\text{OH}$**
- d.  $\text{CH}_3\text{CH}_2\text{OH}$  and  $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$

2. An organic substance has an empirical formula of  $\text{C}_3\text{H}_6\text{O}_2$ . Which of the following is NOT a possible identity of the substance?

- a. Propanoic acid
- b. Ethyl methanoate
- c. **Methyl methanoate**
- d. Methyl ethanoate

3. The following two organic substances were reacted together under favourable conditions and a new product was formed.



Which one of the following could be produced from this reaction?

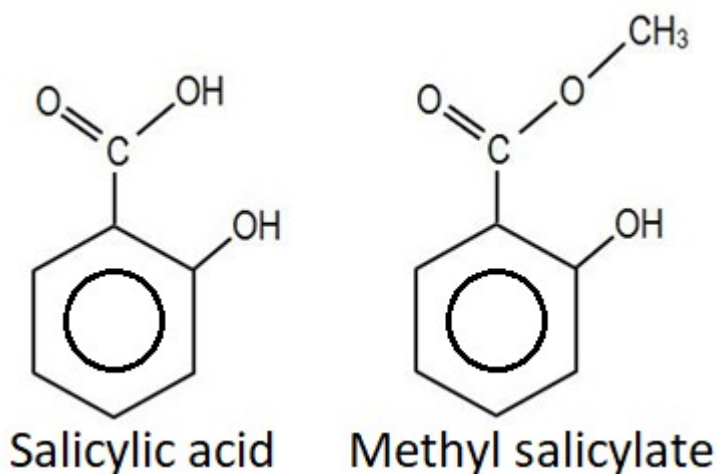
- a. A protein
- b. A fatty acid
- c. A soap
- d. **A polyester**

**END OF MULTIPLE CHOICE SECTION**

## PART TWO: SHORT ANSWER QUESTIONS

(39 marks)

1. These two molecules are salicylic acid (left) and methyl salicylate (right).



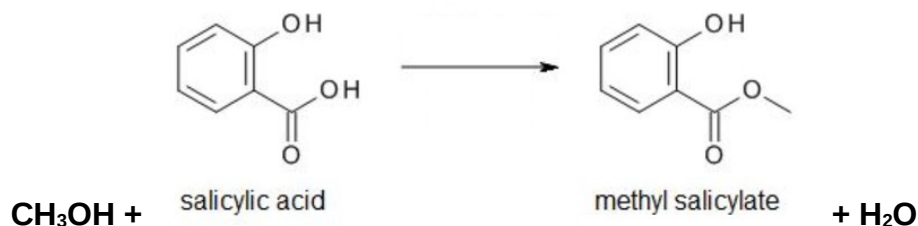
- a. Which molecule is likely to have the greatest dispersion forces? Justify your answer. (1 mark for both correct molecule and correct explanation; no part marks). (1 mark)

**Methyl salicylate, because it has more electrons/a larger molar mass.**  
**No half marks.**

- b. Salicylic acid is a solid at room temperature whereas methyl salicylate is a liquid. Explain this in terms of intermolecular forces. (2 marks)

**(Although both substances have hydrogen bonding between molecules) salicylic acid has a greater potential for hydrogen bonding (1) because of the extra hydroxyl group (1).**

- c. Draw structural formulae to show the esterification reaction that produced methyl salicylate. State symbols, reaction conditions and the catalyst do not need to be specified at this point. Hydrogen atoms bonded to carbon atoms do not need to be drawn.



**1 mark off for every mistake.**

- d. Name the other reactant, other than salicylic acid, in the esterification reaction that produces methyl salicylate.

(1 mark)

**Methanol**

- e. Concentrated sulfuric acid is added to the reaction when an ester is made. List two functions served by the presence of the concentrated sulfuric acid.

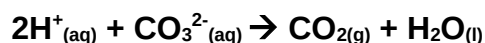
(2 marks)

**It acts as a catalyst (1).**

**It produces heat when it reacts with the water in the aqueous solution / various reactants, which increases reaction rate (1).**

2. On the video, concentrated sulfuric acid was removed by reaction with dilute sodium carbonate solution. Write the ionic equation for this reaction.

(1 mark)



**No marks if any mistakes.**

3. List two safety precautions that were seen being used in the video while esters were being synthesised. For each, describe the/a safety hazard that requires the use of that safety precaution.

(2 marks)

**Odours were tested by wafting because esters are toxic.**

**Reaction mixture was heated in a water bath rather than directly over the Bunsen burner because ethanol is flammable.**

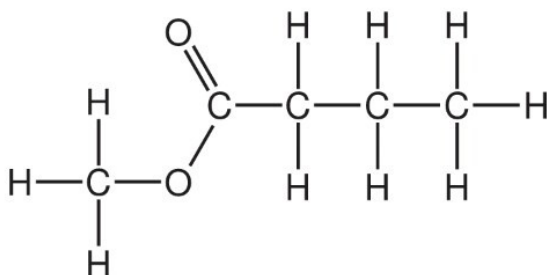
**Other answers may be acceptable, at the teacher's discretion.**

**Safety glasses etc were worn to protect against hot liquids etc.**

**Any 2, including both safety precaution and corresponding safety hazard, 1 mark each. No part marks.**

4. Draw a full structural formula, including all bonds and all hydrogen atoms, for the ester that forms from the reaction between methanol and butanoic acid. Also name this ester.

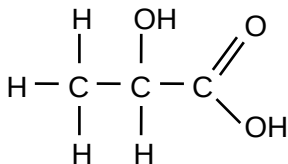
(2 marks)



methyl butanoate

**1 mark for structure, 1 mark for name. No part marks.**

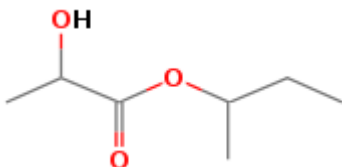
5. Lactic acid was first isolated from a sample of milk in 1780. It is often known as 'milk acid' due to its association with this substance. It is also produced in the human body during exercise, and can be used in medicine as a component of a solution to replace fluids after blood loss or surgery. Lactic acid is a weak, monoprotic acid with the following structure;



When lactic acid is mixed with butan-2-ol, in the presence of an appropriate catalyst and heat, an esterification reaction takes place.

- a. Draw the structure of the ester formed in this reaction.

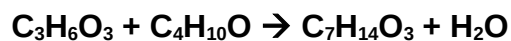
(1 mark)



No part marks

- b. Write a molecular equation for the esterification reaction taking place.

(1 mark)



No part marks

c. What would be the most noticeable observation for this reaction?

(1 mark)

**Formation of a pleasant (or fruity) odour.**

6. Stearic acid (IUPAC name octadecanoic acid) is a fatty acid (a long chain carboxylic acid) with the condensed structural formula  $\text{CH}_3(\text{CH}_2)_{16}\text{COOH}$ . Three molecules of stearic acid can be reacted with one molecule of another substance to make a triglyceride called stearin.

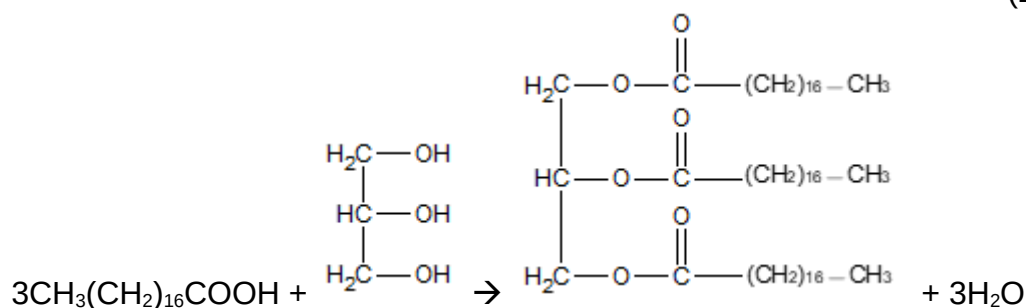
- a. Name the other substance referred to above, that will react with three molecules of stearic acid to make stearin.

(1 mark)

**Glycerol / Propane-1,2,3-triol.**

- b. Use condensed structural formulae to show the formation of stearin from three molecules of stearic acid and one molecule of another substance. Be sure to show all reactant/s and all product/s.

(2 marks)



**1 mark off per mistake, including mistakes in balancing. No follow-on marks.**

- c. What functional group/s are present in each of these?

(2 marks)

- i. Stearic acid

**Carboxylate (accept carboxylic acid) (1)**

- ii. Tristearin

**Ester (1)**

- d. Describe the differences in the intermolecular forces that are present in stearic acid and tristearin. Also describe the reasons for these differences by referring to specific structures within the molecules.

(5 marks)

**(Both have dispersion forces but) the dispersion forces are greater in tristearin than stearic acid (1) because tristearin has more electrons / has a larger molar mass than stearic acid (1).**

**Stearic acid has hydrogen bonding (and dipole-dipole forces) between molecules (1) due to the carboxylate group / OH group (1) whereas Tristearin has dipole-dipole forces (but not hydrogen bonding) (1) due to the polar C-O bonds (1).**

**Stearic acid therefore has stronger intermolecular forces (1).**

**Any 5.**

- e. Tristearin can be reacted with another substance to make soap.

- i. Name a substance that will react with tristearin to make soap.

(1 mark)

**Sodium hydroxide or potassium hydroxide (accept NaOH or KOH)**

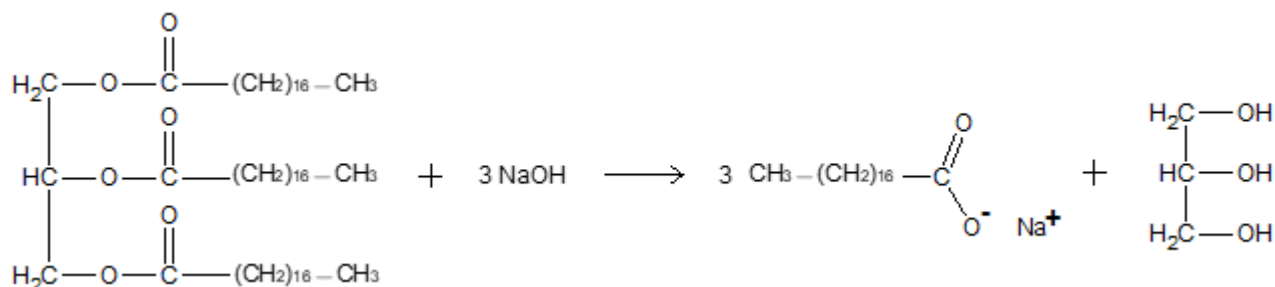
- ii. Name the type of reaction that will produce soap from tristearin.

(1 mark)

**Saponification. More than one letter wrong = no mark.**

- f. Use condensed structural formulae to show the reaction that produces soap from tristearin. Balance the equation.

(2 marks)



**1 mark off per mistake. No follow-on marks.**

- g. Write a suitable reaction that demonstrates why a soap made from tristearin cannot be used in hard water. Balance the equation.

(2 marks)



**1 mark off per mistake, including state symbols and balancing.**

**No follow-on marks.**

**OK to use  $\text{Mg}^{2+}$  in place of  $\text{Ca}^{2+}$ .**



- h. One advantage of detergents over soaps is that they can be used in hard water.  
List two other differences between soaps and detergents.

(2 marks)

**Detergents are made from petroleum products (and sulfuric acid) whereas soaps are made from animal fat or vegetable oil (1).**

**Detergents can be made more cheaply than soaps (1).**

**Detergents have a stronger cleaning action than soaps (1).**

**Other answers may be correct, at the teacher's discretion.**

- i. Describe how the shape of a soap molecule allows it to clean grease off a dirty plate.

(5 marks)

**A soap molecule is**

- **A long molecule (1)**
- **consisting of a polar (1) head/region containing a carboxyl group/ion (1) that is hydrophilic / attracted to / binds to water due to hydrogen bonding (1) and**
- **a hydrocarbon chain (1) that is hydrophobic / attracted to (non-polar) grease by dispersion forces (1).**
- **The molecule forms a 'bridge' between water and 'grease' / allows grease to dissolve in water (1).**
- **Soap molecules surround a grease particle, forming a micelle.**

**Any 5 points, 1 mark each.**

**END OF TEST**

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