Higher Chemistry: Unit 2 – Nature's Chemistry

Mid Unit Summary

WELL DONE!

By now you have completed the following topics in Nature's Chemistry:

A. Systematic Carbon Chemistry
B. Alcohols and Oxidation
C. Esters, Fats and Oils

Now it's time for a summary of what you have learned so far and to check your understanding.

Success Criteria

You will have been successful in this lesson if you:

1. Read the summaries below (there is no need to copy/print these)
2. Watch the links provided
3. Complete the revision questions below (answers will be given on Wednesday)
4. Complete the summary quiz (on MS forms – link at the end of this document)

MS Teams will be monitored throughout the week by a chemistry teacher. If you need help or clarification with either the task or the content of the lesson, just ask.

Links to Prior Knowledge

You may wish to revise the following to help you understand this summary:

- Nature's Chemistry lessons so far

You may wish to have a data booklet for this lesson. Download or print a copy of the Higher Chemistry Data Booklet from MS Teams or from the SQA website - https://www.sqa.org.uk/sqa/files_ccc/ChemistryDataBooklet_NewH_AH-Sep2016.pdf

Read through the following summary notes – you do not need to copy these, as you already have notes on these topics.

Part A – Systematic Carbon Chemistry

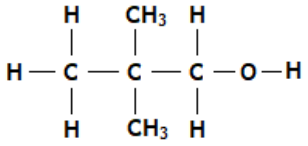
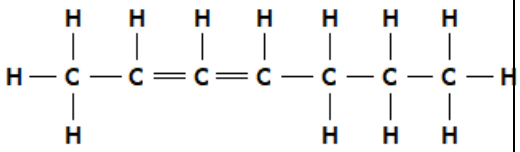
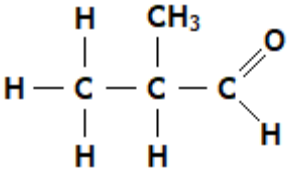
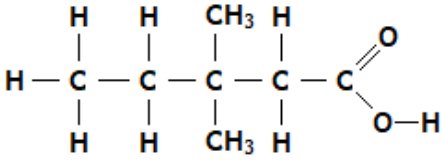
1. Homologous Series

You should now be able to name and draw full and shortened formula for the following homologous series.

Alkanes	Alcohols	Carboxylic acids
Alkenes	Aldehydes	Esters
Cycloalkanes	Ketones	

2. Systematic Naming of Carbon Compounds

Below are some examples of molecules along with their systematic names:

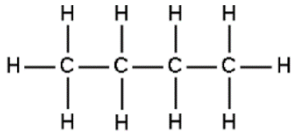
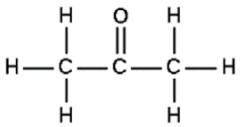
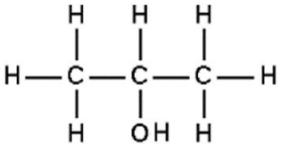
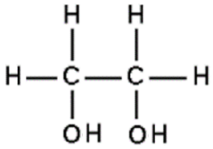
Name	Molecular formula	Extended structural formula	Shortened structural formula
2,2-dimethylpropan-1-ol	$C_5H_{11}OH$		$CH_3C(CH_3)_2CH_2OH$
hept-2,3-diene	C_7H_{12}		$CH_3CHCHCHCH_2CH_2CH_3$
methylpropanal	C_4H_8O		$CH_3CH(CH_3)CHO$
3,3-dimethylpentanoic acid	$C_6H_{13}COOH$		$CH_3CH_2C(CH_3)_2CH_2COOH$

3. Physical Properties of Carbon Compounds

Physical properties of carbon compounds are affected by the type and strength of intermolecular forces (Van der Waals forces). See unit 1 notes for more information on Van der Waals forces.

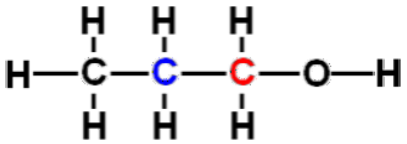
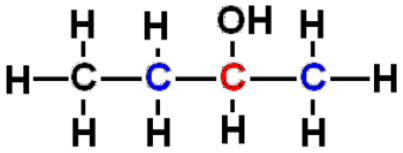
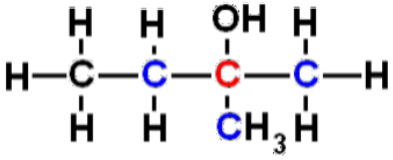
For organic molecules, the functional group often determines the polarity of the molecule and therefore affects the following properties:

A. **Melting and Boiling Points**
B. **Viscosity**
C. **Solubility in water**

Polarity of molecule	Molecular structure	Boiling Point (°C)	Relative viscosity	Solubility in water
butane *(non-polar)*		-1	Least viscous	insoluble
propanone *(polar)*		56		soluble
propan-2-ol *(polar & contains O-H)*		82		soluble
Ethan-1,2-diol *(polar & contains 2xO-H)*		197	Most viscous	soluble

Part B – Alcohols and Oxidation

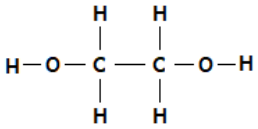
Types of Alcohols

Primary Eg propan-1-ol	carbon bonded to –OH group is attached to **1 other carbon atom.**	
Secondary Eg butan-2-ol	carbon bonded to –OH group is attached to **2 other carbon atoms**	
Tertiary Eg 2-methylbutan-2-ol	carbon bonded to –OH group is attached to **3 other carbon atoms**	

Diols and Triols

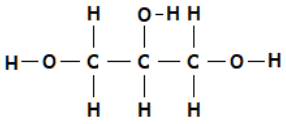
Alcohols with two hydroxyl groups are called **DIOLS**.

Eg ethan-1,2-diol



Alcohols with three hydroxyl groups are called **TRIOLS**.

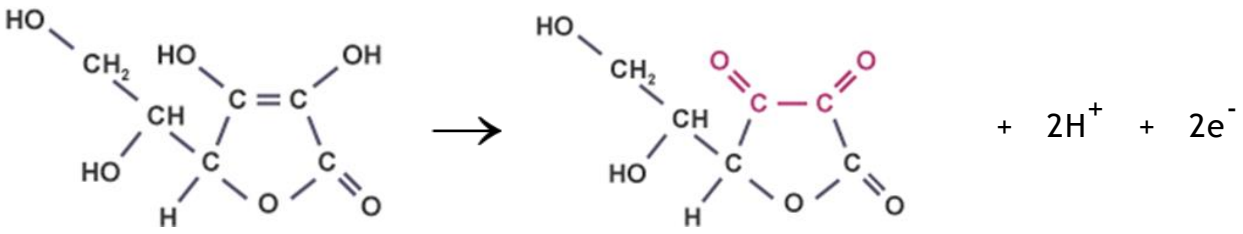
Eg propan-1,2,3-triol



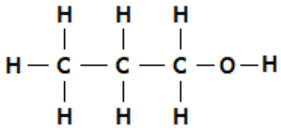
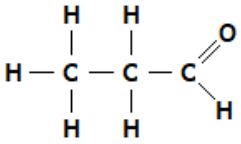
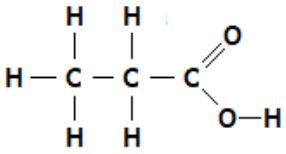
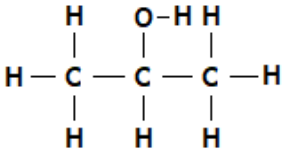
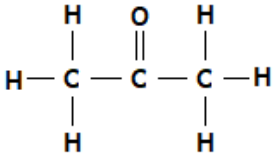
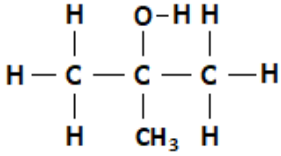
Antioxidants

- molecules that **prevent unwanted oxidation** reactions occurring
- substances that are **easily oxidised**, and oxidise in place of the compounds they have been added to protect

Example: oxidation of vitamin C



SUMMARY OF OXIDATION REACTIONS

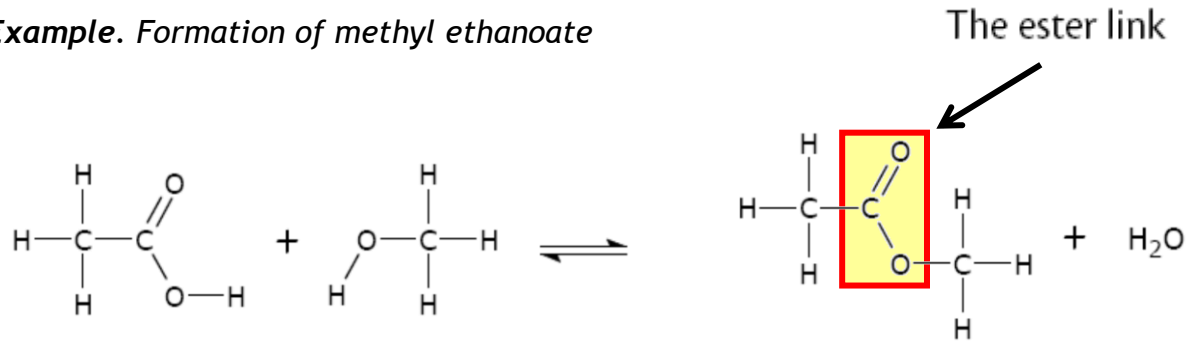
Starting Alcohol	Oxidising Agent	Product of Oxidation	Oxidising Agent	Product of Further Oxidation
Primary alcohol  propan-1-ol	hot copper oxide (black to red/brown)	Aldehyde  propanal	acidified dichromate solution (orange to green)	Carboxylic acid  propanoic acid
Secondary alcohol  propan-2-ol	acidified dichromate solution (orange to green)	Ketone  propanone	Fehling's solution (blue to brick red)	NO REACTION
Tertiary alcohol  methylpropan-2-ol		NO REACTION	Tollens' Reagent (silver mirror appears)	

Part C – Esters, Fats and Oils

Formation of Esters

A condensation reaction is a reaction in which two small molecules join to make a larger molecule with the elimination of a small molecule (usually water).

***Example**. Formation of methyl ethanoate*

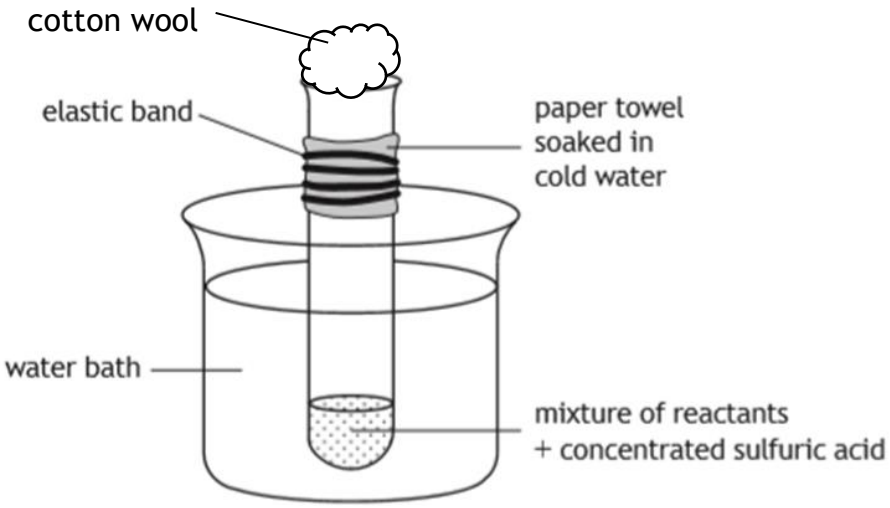


ethanoic acid	+	methanol	⇌	methyl ethanoate	+	water
CH_3COOH	+	CH_3OH	⇌	CH_3COOCH_3	+	H_2O

The reverse of condensation is hydrolysis. A hydrolysis reaction is the breaking down of a larger molecule into smaller molecules using water.

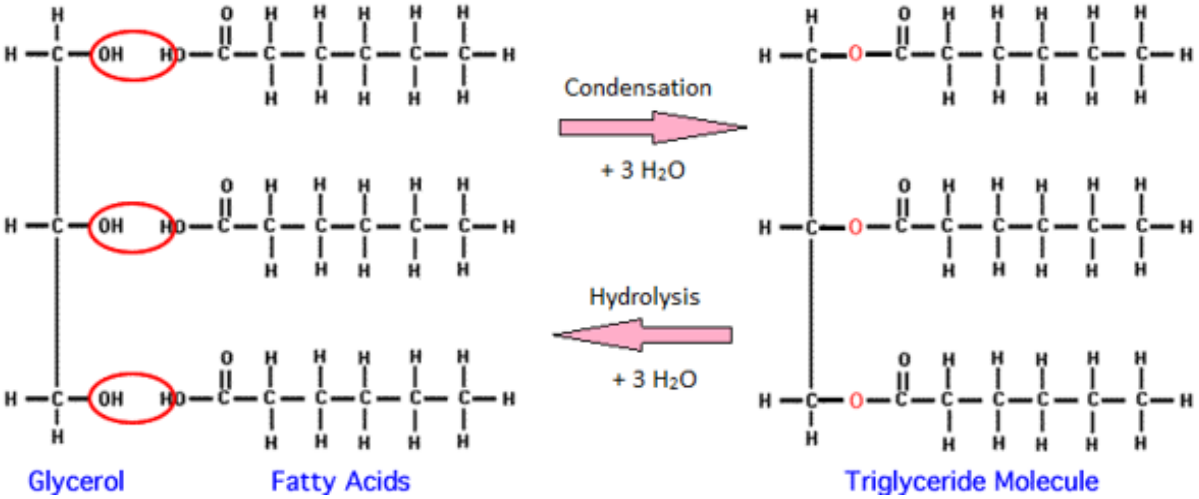
Making Esters in the Laboratory

Esters can be made in the laboratory using the following apparatus:

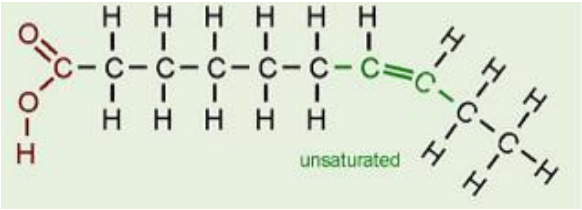
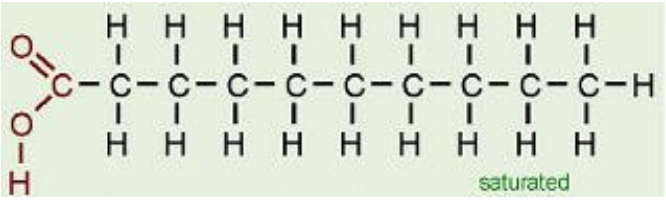
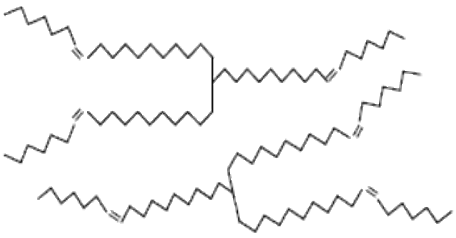
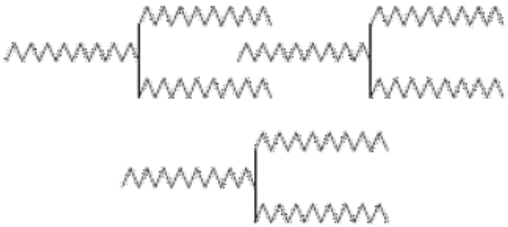


Edible Fats and Oils

Formation of fats and oils



Melting Point Difference Between Fats and Oils

OILS are liquids at room temperature because oils contain more unsaturated fatty acids than fats.	**FATS** are solid at room temperature because fats are made from mostly saturated fatty acids.
	
 oil molecules (not able to pack closely) weaker LDFs	 Fat molecules (close packing)

WATCH - YOUTUBE: Miss Adam's Chemistry:
https://www.youtube.com/playlist?list=PLpeedPxQgHa3F1wG3qloJtW8s61w6PtDO

The first 4 videos on this playlist will take you through everything you should know by now in Nature's chemistry

Further Reading

To learn more about this part of Nature's Chemistry, try the following online resources:

BBC Bitesize: https://www.bbc.co.uk/bitesize/topics/zybg87h

Go to any of the first four topics and try the end of topic tests

Scholar: Log in through GLOW

Higher Chemistry → Nature's chemistry → Topics 1.5

Try any of the activities and try any of the end of topic tests

Evans2 chem web: https://www.evans2chemweb.co.uk/login/index.php#

Username: snhs password: giffnock

Select any teacher → revision material → CfE Higher → Unit 2: Nature's Chemistry

Revision Questions and Summary Quiz

You should now try the written questions below, then the multiple choice questions in the Nature's Chemistry Mid Unit **Summary Quiz (link at the end of this document)**

(You will need to be signed into GLOW to access this)

Revision Questions for Mid Unit Nature's Chemistry

1. The table shows the boiling points of some alcohols.

Alcohol	Boiling point/°C
$CH_3CH_2CH_2CH_2OH$	118
$CH_3CH_2CH(OH)CH_3$	98
$CH_3CH(CH_3)CH_2OH$	108
$CH_3CH_2CH_2CH_2CH_2OH$	137
$CH_3CH_2CH_2CH(OH)CH_3$	119
$CH_3CH_2CH(CH_3)CH_2OH$	128
$CH_3CH_2C(OH)(CH_3)CH_3$	101
$CH_3CH_2CH_2CH_2CH_2CH_2OH$	159
$CH_3CH_2CH_2CH(CH_3)CH_2OH$	149
$CH_3CH_2CH_2C(OH)(CH_3)CH_3$	121

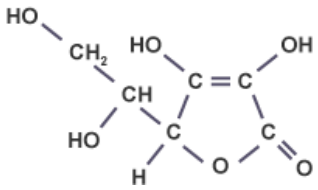
(a) How many alcohols in the table would oxidise to produce ketones? **(1)**

(b) Using information from the table, describe **two** ways in which differences in the structures affect boiling point of isomeric alcohols. **(2)**

(c) Predict a boiling point for hexan-2-ol, in °C. **(1)**

(d) Name the alcohol which has a boiling point of 108°C. **(1)**

2. Vitamin C, $C_6H_8O_6$ is a common antioxidant present in many fruits.



(a) Describe what it meant by the term "antioxidant" **(1)**

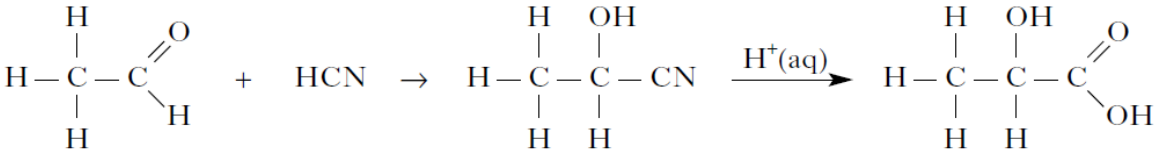
(b) Based on its structure, explain why Vitamin C is soluble in water **(1)**

(c) Copy and complete the ion-electron equation for the oxidation of vitamin C.

$C_6H_8O_6\ (aq) \rightarrow C_6H_6O_6\ (aq)$ **(1)**

3. A huge range of synthetic organic compounds can be made in the laboratory by "building up" molecules to obtain the desired product.

Hydrogen cyanide offers a route to increasing the chain length of a molecule. If ethanal is reacted with hydrogen cyanide and the product hydrolysed with acid, lactic acid is formed.



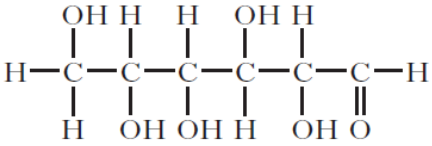
ethanal lactic acid

(a) Draw a structural formula for the acid produced when propanone is used instead of ethanal in the above reaction sequence. **(1)**

(b) In a separate reaction, ethanol can undergo a reduction reaction. Name and draw the molecule produced when ethanal undergoes a reduction reaction. **(1)**

4. Bread is made from a variety of ingredients, the main one being flour.

Baking bread causes some of the starch in the flour to hydrolyse, producing sugars such as glucose and maltose.



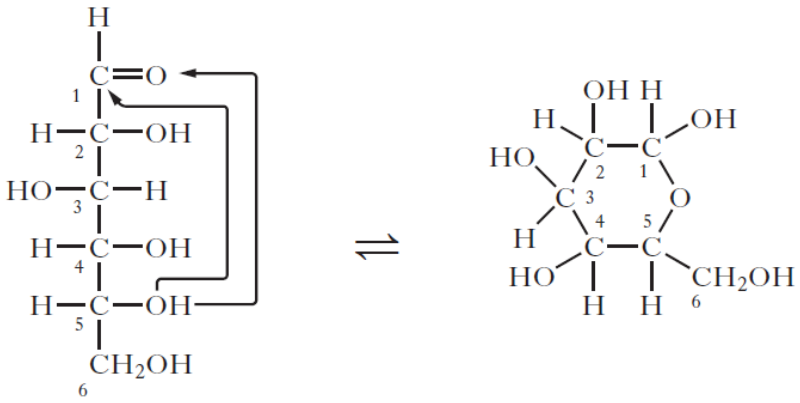
glucose

(a) One test for glucose involves Fehling's solution (Benedict's solution).
What part of the glucose molecule reacts with Fehling's solution? **(1)**

(b) What would be observed if glucose was gently heated with Tollens' reagent? **(1)**

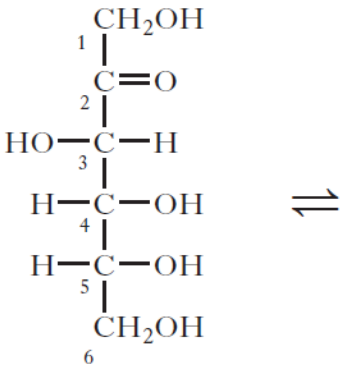
(c) In solution, sugar molecules exist in an equilibrium of straight-chain and ring forms.

To change from the straight-chain form to the ring form, the oxygen of the hydroxyl on carbon number 5 joins to the carbonyl carbon. This is shown below for glucose.



glucose

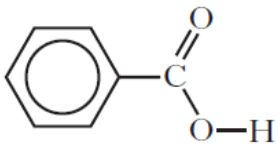
Draw the structure of a ring form for fructose.



fructose

(1)

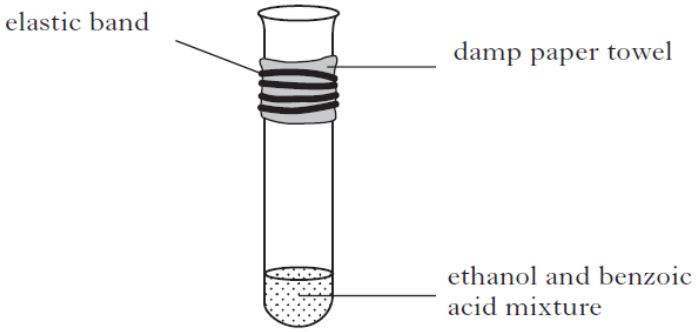
5. Benzoic acid, C_6H_5COOH, is an important feedstock in the manufacture of chemicals used in the food industry.



benzoic acid

The ester ethyl benzoate is used as food flavouring.

Ethyl benzoate can be prepared in the laboratory by an esterification reaction. A mixture of ethanol and benzoic acid is heated, with a few drops of concentrated sulfuric acid added to catalyse the reaction.

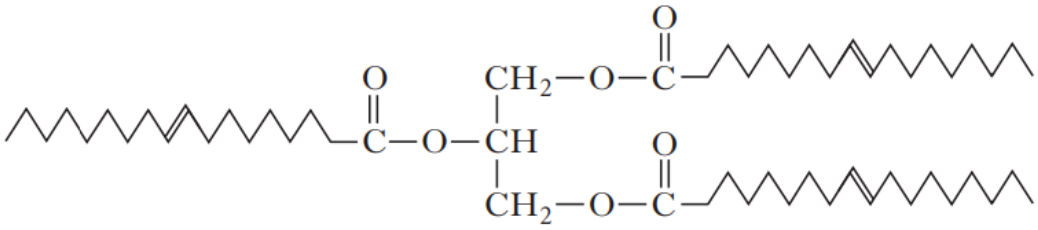


(a) Suggest a suitable method for heating the reaction mixture. **(1)**

(b) During esterification the reactant molecules join by eliminating a small molecule. What name is given to this type of chemical reaction? **(1)**

(c) Draw a structural formula for ethyl benzoate. **(1)**

6. The structure of a molecule found in olive oil can be represented as shown.



(a) Name the alcohol that would be produced on hydrolysis of the molecule above. **(1)**

(b) After hydrolysis, the fatty acids in the olive oil can react with sodium hydroxide solution to produce sodium salts of fatty acids. Name the type of reaction taking place. **(1)**

(c) In what way does the structure of a fat molecule differ from that of an oil molecule? **(1)**

(d) Over time, open containers of olive oil develop a rancid flavour.
What substance is reacting with the oil to cause these unwanted changes to take place? **(1)**

TOTAL= 20

Answers will be given on Wednesday

Summary Quiz

You should now complete the Nature's Chemistry Mid Unit **Summary Quiz** (25 marks)

(You will need to be signed into GLOW to access this)