

Alcohols

Question Paper 2

Level	International A Level
Subject	Chemistry
Exam Board	Edexcel
Topic	Application of Core Principles of Chemistry
Sub Topic	Alcohols
Booklet	Question Paper 2

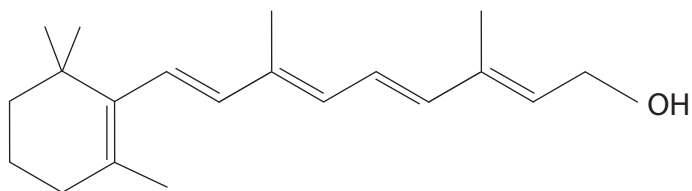
Time Allowed: 54 minutes
Score: /45
Percentage: /100

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	77.5%	70%	62.5%	57.5%	45%	<45%

1 In the human body, one chemical can have a number of different effects.

An example is retinol, one of the substances in vitamin A.
The structure of retinol is shown below.



Retinol can be converted into retinal and a form of this is combined with an opsin molecule in the retina of the eye to make the light-sensitive pigment rhodopsin. When light enters the eye, the shape of the retinal molecule is changed, which results in it separating from the opsin molecule. The outcome of this separation is that we 'see' light.

Retinol can also be converted to retinoic acid, which is important in the body for the correct maintenance of mucous membranes. Failure to produce retinoic acid can lead to a condition known as 'dry eye', or xerophthalmia, which can result in blindness.

The functions of this vitamin, and other nutrient molecules, illustrate the need for a healthy, balanced diet.

(a) Retinol has an alcohol functional group. Classify the type of alcohol group in retinol and explain the meaning of the term 'functional group'.

(2)

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(b) Give the molecular formula of retinol.

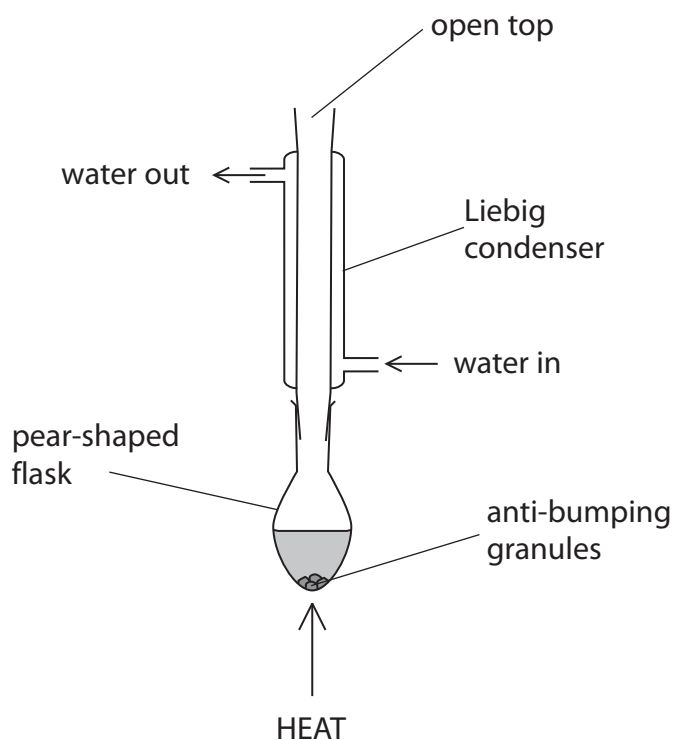
(2)

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(c) Retinol can be oxidized to the aldehyde, retinal.

*(i) To illustrate the conversion of an alcohol to an aldehyde in the laboratory, a student suggested using the following apparatus and an excess of an oxidizing agent. Explain why this proposed method would have been unsuitable for the production of an aldehyde and explain what modifications are necessary for successful conversion. A new diagram is not required.

(3)



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(ii) The oxidizing agent suggested was sodium dichromate, $\text{Na}_2\text{Cr}_2\text{O}_7$, in acidic solution. Complete the ionic half-equation below. Give the oxidation numbers of the chromium in the chromium species and state their colours.

(5)



Oxidation
Number

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Colour

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*(iii) Describe **two** features on the infrared spectrum which could be used to determine whether the retinol has been completely converted to retinal.

Select some of the following infrared data to support your answer.

(2)

O—H stretching in alcohols (variable, broad) at	3750 – 3200 cm ⁻¹
O—H stretching in carboxylic acids (weak) at	3300 – 2500 cm ⁻¹
C=O stretching in aldehydes (strong) at	1740 – 1720 cm ⁻¹
C=O stretching in ketones (strong) at	1700 – 1680 cm ⁻¹
C=O stretching in carboxylic acids, alkyl (strong) at	1725 – ⁻¹
C—H stretching in aldehydes (weak) at	2900 – 2820 cm ⁻¹
C—H stretching in aldehydes (weak) at	2775 – 2700 cm ⁻¹

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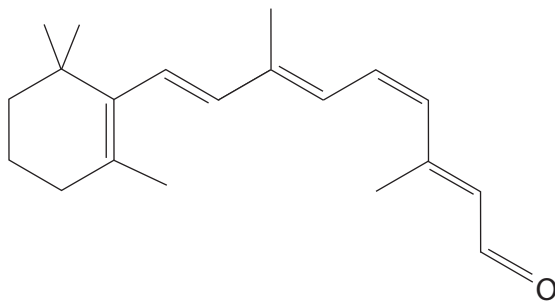
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- (iv) The structure of the retinal molecule that combines with opsin in the human body differs from the structure expected from the oxidation of retinol.

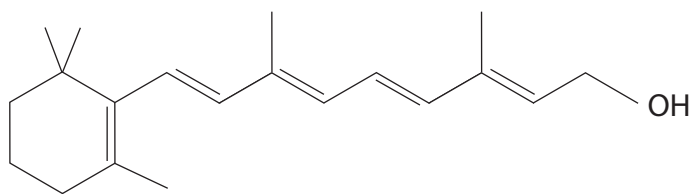
The structures of retinal and retinol are shown below.

(1)

Retinal



Retinol



As well as an oxidation, a structural change has occurred within the molecule. Circle only the part of the **retinal** molecule where this change has occurred.

- (v) The bond angle around each carbon atom in a carbon-carbon double bond is about 120° . Explain the reason for this bond angle and state the name of the shape around each carbon atom.

(3)

Reason

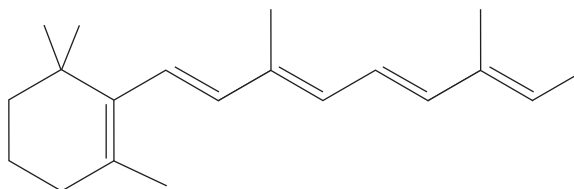
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Shape

(d) Complete the diagram below to show the skeletal formula of retinoic acid.

(1)



*(e) Retinoic acid and retinol both have OH groups. Suggest **one** chemical reagent that you could use to test for the presence of an OH group which would work for both compounds. You may assume that both organic compounds are dissolved in suitable solvents.

Give the positive observation for the test and state **one** necessary experimental precaution that you would make to reduce the risk from carrying out this test.

(3)

Reagent

Observation

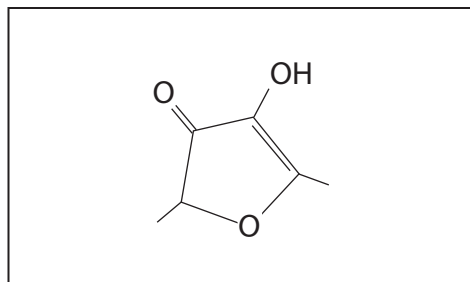
Precaution

(Total for Question 1 = 22 marks)

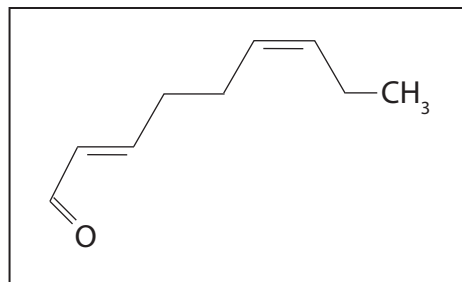
- 2 The sensation of flavour arises from a combination of both taste, detected by chemical receptors on the tongue, and smell, detected by chemical receptors in the nose.

Some chemicals are commonly called after one particular flavour or aroma, such as:

'strawberry furanone'



'cucumber aldehyde'



However, a flavour such as strawberry is not created from just one chemical but can be from a mixture containing many different chemicals, all of which can interact with various receptors in the mouth and the nose. For example, one strawberry milkshake product contains 59 different ingredients in order to achieve the required strawberry flavour.

In order to detect the different chemical components of a particular flavour, a number of chemical techniques can be employed. One such technique is GCMS, Gas Chromatography Mass Spectrometry. The volatile chemicals are first separated by gas chromatography and then detected and analysed by mass spectrometry.

The flavour of various chemicals and their mixtures can be altered by the ways in which they are processed or cooked. For example, the Maillard reaction is promoted by heating and is responsible for the browning of bread and results in the formation of toast, which has a different flavour to the uncooked bread.

- (a) Give the molecular formula of the 'strawberry furanone'.

(1)

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- (b) Name **one** functional group, other than ketone, present in the 'strawberry furanone' molecule.

(1)

(c) The presence of an OH group can be detected by the use of sodium or by the use of phosphorus(V) chloride, PCl_5 .

Using the formula R-OH, complete the balanced equations for both of these reactions and give one observation for each of them. State symbols are not required.

(i) The reaction with sodium

(2)

Equation +

Observation

(ii) The reaction with phosphorus(V) chloride

(2)

Equation +

Observation

(iii) In each reaction a hazardous gas is produced. By considering the hazards associated with each of these gases, suggest which poses the greater risk. Justify your answer.

(2)

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(d) The 'cucumber aldehyde' can be formed from the oxidation of the corresponding alcohol.

(i) Identify by names or formulae, the two reagents that could be used together to oxidize an alcohol to an aldehyde. State the essential reaction condition.

(3)

Reagents for oxidation

Condition.....

*(ii) Infrared spectroscopy can be used to distinguish different functional groups, such as alcohols and aldehydes.

State how this analytical technique is used to do this and explain the effect of the radiation on the molecule.

Specific values and experimental details are not required.

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- *(e) Differences in volatility can be exploited to achieve the separation of molecules. Alkanes have a higher volatility than the corresponding alcohol and so can be effectively separated on this basis.

Explain how the intermolecular forces present in alkanes arise and how the predominant intermolecular force in alcohols is formed, and then why alkanes have a higher volatility.

(7)

Intermolecular forces in alkanes

How they arise

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Predominant intermolecular forces in alcohols

How they arise

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Why alkanes have a higher volatility

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- (f) Explain how it is possible to distinguish between individual chemicals using their mass spectra.

(1)

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(g) The browning of apples, which can occur when they are bruised, is due to the action of enzymes which create brown polymers. However, this does not affect the aroma of the apples. Suggest why this is so.

(1)

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(Total for Question 2 = 23 marks)
