WM Test bank

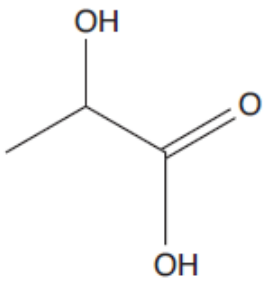
This PowerPoint contains all questions matched with their answers for the topic What's in a Medicine.

These Q's are from the old SPEC – so some may not be fully relevant, but, most are.

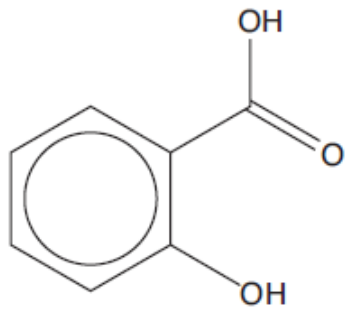
The Answers are directly underneath the Q's.

There will be crossover and you should ignore the codes that are not WM – questions like this test knowledge across all the units.

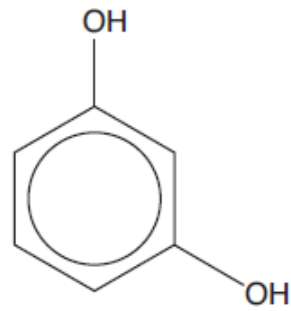
A chemical peel is a solution used to improve and smooth the texture of facial skin by removing its damaged outer layers. Jessener's Peel contains compounds **A**, **B** and **C**, whose structures are shown below.



A



B



C

WM7ii

Give the systematic name of compound **A**.

..... **[2]**

WM7ii

2-hydroxypropanoic acid ✓✓

2 mark independently

2-hydroxy ✓
DO NOT ALLOW hydroxyl

propanoic acid ✓
ALLOW if propan- and -oic are separated.

A student is provided with three solutions **P**, **Q** and **R**.

Each of these solutions contains one of the compounds **A**, **B** or **C** dissolved in water.

She performs two chemical tests on each solution **P**, **Q** and **R**. Her results are given in the table below.

test	P	Q	R
addition of neutral iron(III) chloride solution	purple solution	yellow-brown solution	purple solution
addition of sodium carbonate solution	no reaction	fizzing	fizzing

WM9

WM11i

WM11ii

Identify which compound, **A**, **B** or **C**, is present in each of the solutions **P**, **Q** and **R**.

P contains ..... **Q** contains ..... **R** contains ..... [1]

P = **C**
Q = **A** ✓
R = **B**

1

Give a reason for each of your answers in **(i)**.

P .....

.....

.....

Q .....

.....

.....

R .....

.....

..... [3]

WM9

WM11i

WM11ii

P = (**C**) does not fizz / does not react / with Na_2CO_3 **AND** so no –COOH group present / AW ✓

Q = no phenol group (in **A**), so $FeCl_3$ remains yellow / AW ✓

R = (**B** has) **both** phenol & carboxylic acid (COOH) (so will turn $FeCl_3$ purple and will fizz with Na_2CO_3) / AW ✓

The words in brackets are only needed if tests not discussed for P & Q.

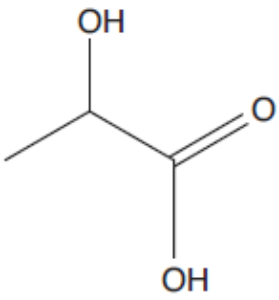
3

if answers to **(i)** are incorrect/no response award 1 mark for correct answers for having **both tests** for phenol and carboxylic acid:
ie:
purple solution = phenol
AND acids fizz with carbonate ✓

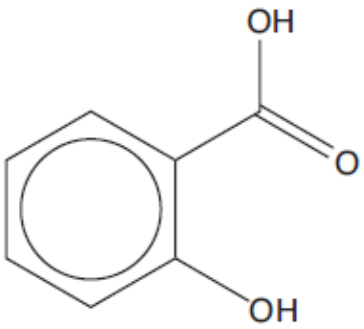
IGNORE P is **C** as it turns $FeCl_3$ purple

IGNORE Q is **A** as it fizzes & is therefore a carboxylic acid

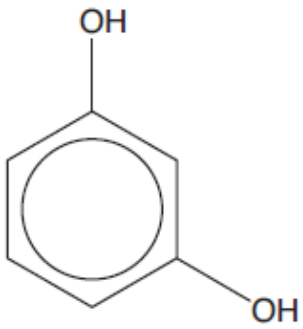
4



A

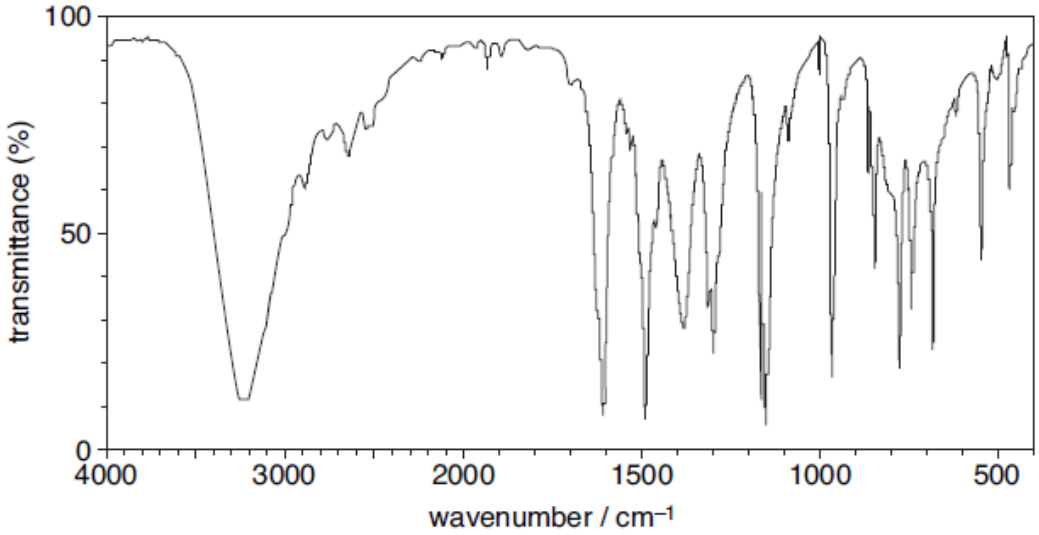


B



C

Compounds **A**, **B** and **C** can also be identified using infrared spectroscopy. The infrared spectrum of one of these compounds is shown below.



WM20i

Identify the compound and provide **two** pieces of evidence from the spectrum to support your answer.

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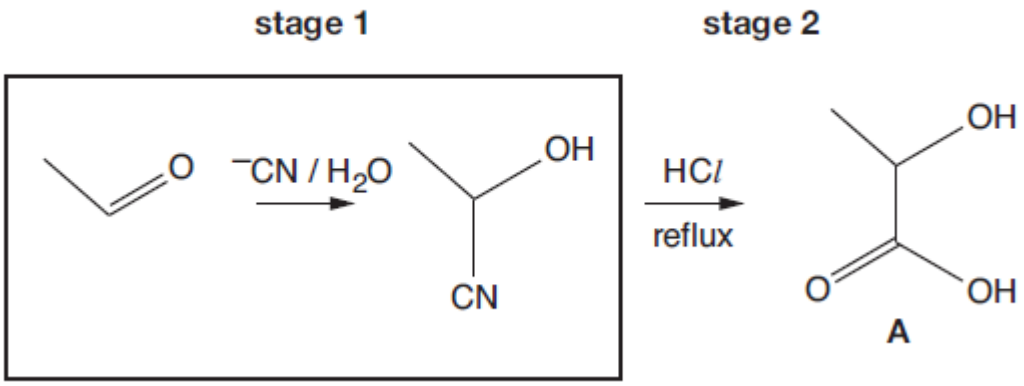
..... **[3]**

WM20i

C ✓ because: (broad) peak at around 3250 (cm^{-1}) indicates <u>alcohol or phenol</u> / OH / hydroxyl group ✓ no peak at 1700–1725 (cm^{-1}) so no <u>C=O</u> (in –COOH) present ✓	3	**IGNORE** any reference to carboxylic acid for the 3250 peak **ALLOW** a range around 3250 Peaks may be identified on the diagram **IGNORE** all other peaks

Compound **A** can be synthesised from ethanal in a two-stage reaction.



WM12iii
WM16ii

Identify, by underlining **two** words from the list below, the type of mechanism for the reaction in **stage 1**.

addition **condensation** **electrophilic** **elimination**

nucleophilic **radical** **substitution** **[2]**

WM12iii
WM16ii

nucleophilic addition ✓✓	**2**	nucleophilic ✓ addition ✓ mark independently

WM13

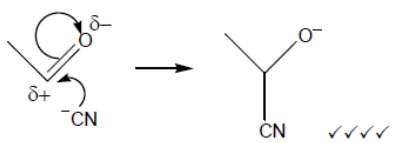
In the first step of **stage 1** the cyanide ion attacks the ethanal.

Draw the mechanism for this step using appropriate 'curly arrows' and bond polarities.

Draw the structure of the resultant ion.

[4]

WM13



4	'curly' arrow showing attack by ⁻CN at C=O **carbon** ✓ **DO NOT ALLOW** arrow starting from N of ⁻CN / single-headed arrows but give 1 mark if both are single headed but otherwise correct C=O bond polarised correctly ✓ curly arrow showing movement of double bond ✓ final structure correct **ALLOW** any correct structural formula not just skeletal ✓ O **MUST** be –ve **IGNORE** any further reaction showing O⁻ gaining H⁺

Many such reactions are used industrially for synthesising compounds.

Why is it important that these reactions have high atom economy?

WM16v

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.....

.....

..... **[2]**

WM16v

reduce / cut down on / less / little **waste** (products) ✓	**2**	
costs of are kept to a minimum / less energy used ✓		**ALLOW** cost effective

WM16iv

Compare the relative atom economies of the following reactions. No calculations are needed.

$CH_3CHO + HCN \rightarrow CH_3CH(OH)CN$ **reaction 1.1**

$CH_3CH(OH)CN + 2H_2O \rightarrow CH_3CH(OH)COOH + NH_3$ **reaction 1.2**

.....

.....

..... **[2]**

WM16iv

reaction 1.1 has a higher atom economy than reaction 1.2 ✓	**2**	**ALLOW** comparison of percentage atom economy *eg* reaction 1.1 has 100% economy, reaction 1.2 does not.
because it is an **addition** reaction / only one product is formed **whereas** in reaction 1.2 **hydrolysis** / condensation occurs / atoms are wasted / lost / two 'products' are formed / co-products are also formed / AW ✓		**IGNORE** any reference to substitution / elimination for reaction 1.2 / by-product

2 An aqueous solution of iron(III) chloride is sometimes used by coin collectors to identify the dates of badly worn 'nickel' coins. Nickel coins are made from an alloy of copper and nickel. The iron(III) chloride solution reacts with the surface of the coin highlighting the date.

Use appropriate data from the table below to describe and explain the reaction occurring between iron(III) chloride solution and the copper in the coin.

You should give an ionic equation for the reaction occurring. State symbols are not required.

half-reaction	$E^{\ominus}$/V
$Fe^{2+} + 2e^- \rightarrow Fe$	–0.44
$Cu^{2+} + 2e^- \rightarrow Cu$	+0.34
$Fe^{3+} + e^- \rightarrow Fe^{2+}$	+0.77

SS5i
SS2ii

.....

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.....

.....

ionic equation

→

[3]

SS5i
SS2ii

Fe^{3+} will oxidise Cu / ORA
OR
Cu loses electrons to form Cu^{2+} / ORA ✓

because **electrode potential of Fe^{3+} / (Fe^{2+}) is more positive** / ORA (involves the Copper half-cell)
OR
Uses E_{cell} calculation to show reaction is feasible✓

$Cu + 2Fe^{3+} \rightarrow Cu^{2+} + 2Fe^{2+}$ ✓

3

ALLOW Fe(III) and Cu(II)

DO NOT ALLOW electronegativity or higher / lower or larger / smaller

IGNORE state symbols

WM1i

Cytosine can behave as a base. Explain this by considering its chemical structure.

.....

.....

..... **[2]**

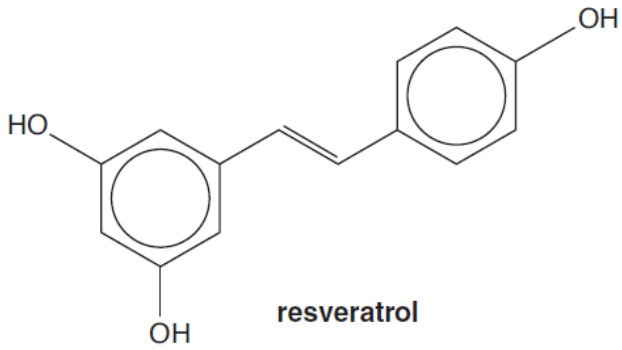
WM1i

lone pair (of electrons) on N / amine (group) ✓ accepts a proton / H^+ ✓	**2**

1

It is claimed that an ingredient of red wine, resveratrol, has the potential to become a 'wonder drug'. Research suggests that it kills cancer cells and protects the heart and brain.

The structure of resveratrol is shown below.



resveratrol

WM17

Give **two** successful outcomes of clinical trials that would be necessary before resveratrol could be marketed as an effective drug.

.....

..... **[2]**

WM17

Two marking points from: non-toxic AW ✓ no harmful/severe side effects AW ✓ it works (better than standard medicines) AW ✓	2	**ALLOW** it (compound OR dose) is safe **ALLOW** it is effective

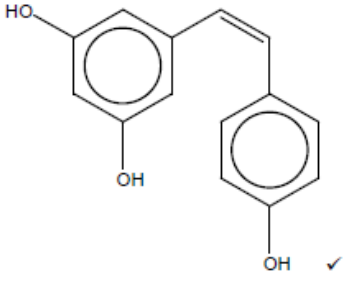
TL23v

Resveratrol is an *E* isomer.

Draw the structure of the *Z* isomer of resveratrol.

[1]

TL23v

 ✓	1	**ALLOW** structural or skeletal formula for CH=CH skeletal structure must be correct and angular not linear -**OH groups** must be in correct positions

Explain why resveratrol and its *Z* isomer show *E/Z* isomerism.

TL23iv

.....

.....

..... **[2]**

TL23iv

restricted rotation/twisting OR no free rotation/twisting about C=C bond ✓ two different groups on each carbon (of the C=C) ✓	2	DO NOT ALLOW 'double bond' alone ALLOW both groups can be either side of the C=C (*can be shown on a diagram)*

TL16i

Suggest why the two stereoisomers would be expected to have different activities in the body.

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.....

..... **[2]**

TL16i

they have different shapes ✓ one would fit (better) into/bind with <u>active site</u> (of enzyme) than the other AW OR only one will form the enzyme-substrate complex / they form enzyme-substrate complexes with different enzymes ✓	2	ALLOW the <u>active site</u> has a specific shape ALLOW they could fit into/bind with different <u>active sites/receptors</u>

MR12i

Resveratrol is a white solid that can be purified by recrystallisation.

What properties should a solvent have to achieve efficient recrystallisation?

.....

.....

..... **[2]**

MR12i

solvent should dissolve solute at higher temperatures AW ✓ solvent should dissolve (almost) no solute OR solute is insoluble at room/lower temperature AW ✓	2	ALLOW when warmed/heated ACCEPT much less soluble IGNORE any reference to crystallisation on evaporation ALLOW crystallises out at low temperatures

Explain why resveratrol reacts with aqueous sodium hydroxide and suggest why the products are soluble in water.

In your answer, you should make it clear how the solubility of a substance depends on its structure.

WM6iv
WM11i

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.....

..... **[4]**

WM6iv
WM11i

(resveratrol has) phenol/phenolic hydroxyl groups ✓

the –OH groups/phenols/resveratrol
are acids/are acidic/ is neutralised by NaOH/react with NaOH or hydroxide ions ✓

ions form ✓

QWC: ions / salts are soluble ✓

4	PLEASE ANNOTATE MARKS GIVEN WITH ✓
	IGNORE phenol groups/phenols are soluble in water
	ALLOW salt forms / formula(e) of ion(s)
	ALLOW ions/salts interact/hydrogen bond/ion-dipole with water molecules

SS2ii

Using the formula $C_{14}H_{12}O_3$ for resveratrol, write an equation for its reaction with an excess of hydroxide ions.

Show any relevant charges.

$C_{14}H_{12}O_3$ + →

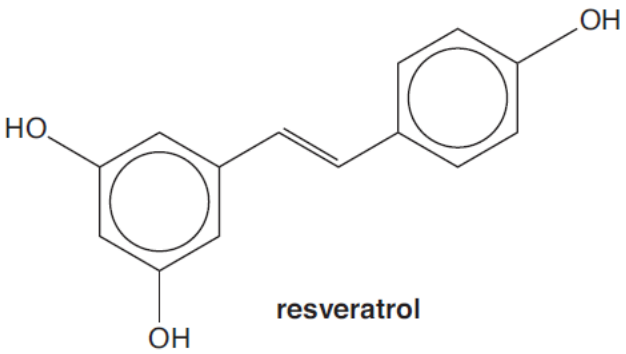
[2]

SS2ii

$C_{14}H_{12}O_3 + 3OH^- \rightarrow C_{14}H_9O_3^{3-} + 3H_2O$

acceptable anion (see Guidance) ✓
all correct as above equation ✓

2	**For first marking point:** **IGNORE** any positive metal cation anion must be $C_{14}H_9O_3^{3-}$ **ALLOW** $C_{14}H_9(O^-)_3$ or $C_{14}H_{10}O_3^{2-}$ or $C_{14}H_{11}O_3^-$



resveratrol

Mass spectrometry can be used to confirm the structure of resveratrol.

The molecular ion peak occurs at mass (*m/z*) 228. There is also a peak at mass 211 and another at mass 93.

WM19iv

Suggest a formula for the chemical species causing the peak in the mass spectrum at mass 93.

[2]

WM19iv

C_6H_5O / C_6H_4OH ✓ positive charge on molecule ✓	2	**ALLOW** use of phenyl ring in formula for C_6H_4OH with + charge on a ring carbon (*also* kekule formulae) If both ring and molecular formula given, **IGNORE** ring

WM19v

Suggest a formula for the group of atoms lost from the molecular ion to produce the chemical species causing the peak at mass 211.

[1]

WM19v

OH ✓	1	**DO NOT ALLOW** if charged **IGNORE** – before OH indicating a group of atoms

WM11iii

One mole of resveratrol was reacted with **one mole** of ethanoyl chloride.

Name the new functional group formed.

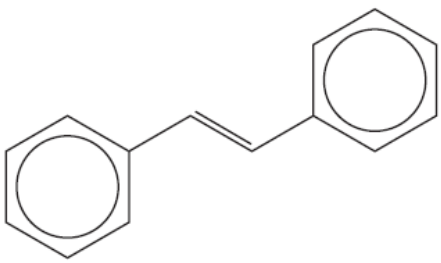
..... **[1]**

WM11iii

ester ✓	1	ALLOW 'esther'

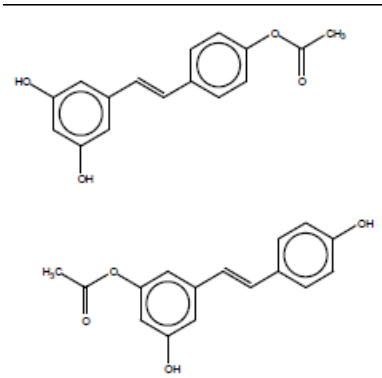
WM6vii

Complete the diagram below to show the formula of a possible organic product of this reaction. Show the structure of the new functional group.

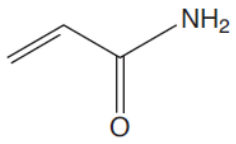


[3]

WM6vii

 ethanoyl ($CH_3C=O$) group correct ✓ phenyl ring attachment correct (via O– to a correct OH position)✓ the two unreacted OH groups in correct position ✓	3	If 2 or 3 correct –OH groups are ethanoylated then award 2 marks **ALLOW** skeletal formula for ethanoyl group **ethanoyl** group can be on either ring system if on the **left hand side** of the double bond it can be in either of the **two** possible positions

3 Compound **A**, $C_2H_3CONH_2$, is a suspected carcinogen. It has recently been shown to be formed in starchy foods when they are heated at high temperatures such as those involved in frying or roasting. The structure of compound **A** is shown below.



MR6ii

Name the functional groups in compound **A**.

.....

..... **[2]**

MR6ii

alkene / carbon-carbon double bond ✓ amide ✓	2	double bond alone does **NOT** score **DO NOT ALLOW** secondary amide alkene + amine + ketone(carbonyl) = 1 mark

Compound **A** can be broken down by hydrolysis in aqueous acid or alkali.

In the appropriate boxes below, complete the equations for the reaction of compound **A** with acid and with alkali.

SS2ii

$C_2H_3CONH_2 + H_2O + H^+ \rightarrow$

$C_2H_3CONH_2 + OH^- \rightarrow$

[4]

SS2ii

$C_2H_3CONH_2 + H_2O + H^+ \rightarrow C_2H_3COOH + NH_4^+$ ✓✓ $C_2H_3CONH_2 + OH^- \rightarrow C_2H_3COO^- + NH_3$ ✓✓	4	1 mark for each correct product **DO NOT ALLOW** NH_4OH H_2O as a product in 2nd equation means max of 3 marks

MR6i

MR7

Compound **A** can be catalytically reduced to compound **B**, $C_3H_7NH_2$.

Name compound **B**.

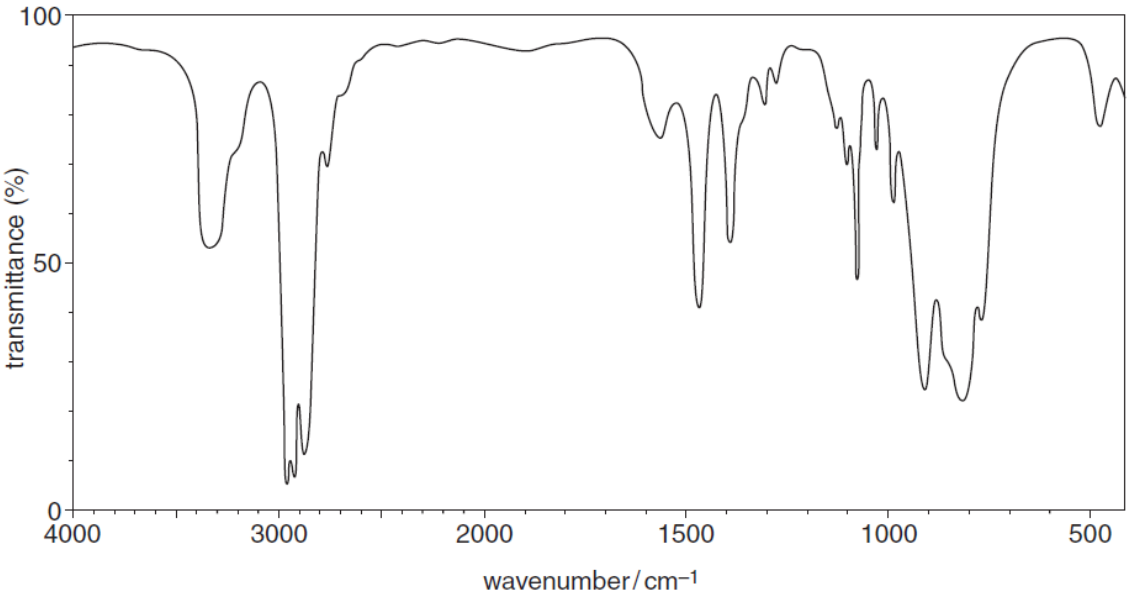
..... **[1]**

MR6i

MR7

Propylamine / 1-aminopropane ✓	1	**ALLOW** 1-propylamine **DO NOT ALLOW** aminopropane

A student attempted the reduction of compound **A**. The infrared spectrum of the product is shown below.



WM20i

The spectrum shows that the student was successful and that all compound **A** had been reduced.

Give **two** pieces of evidence to justify these conclusions.

.....

.....

.....

..... **[2]**

WM20i

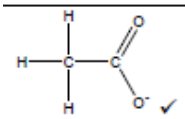
Any **two** *of the following* **three** *answers:* NO peak at about 1620-1680 cm^{-1} indicates NO C=C / alkene present ✓ NO peak at about 1630-1700 cm^{-1} indicates NO C=O / amide present ✓ NO peak at 3500 cm^{-1} indicates amide gone ✓	2	**ALLOW** correct wavenumbers without units **and** a single wavenumber value in the correct range **ALLOW** peak at 3300-3500 cm^{-1} indicates **amine** (indicates N-H bond alone is insufficient)

WM9

Draw the full structural formula of the carboxylate ion formed from ethanoic acid.

[1]

WM9



✓

1	**ALLOW** delocalised carboxylate ion **IGNORE** any added metal ions **ALLOW** $-CH_3$

MR5

Cross-linked poly(acrylic acid) does not dissolve when water is added.
Poly(acrylic) acid without cross-links eventually dissolves when sufficient water is added.

Suggest and explain a reason for this difference in properties.

.....

.....

.....

.....

..... **[2]**

MR5

crosslinks will prevent **chains moving apart** (sufficiently to dissolve) / held in position (so it does not dissolve) AW ✓ without crosslinks water will force polymer chains apart (and so polymer will dissolve) AW ✓	2	**ALLOW** without crosslinks water will form intermolecular bonds (hydrogen bonds) with chains/molecules/polymer/ COOH or OH groups

1

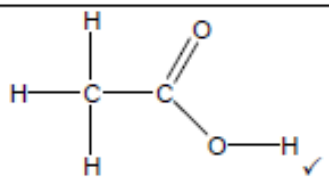
E300 is an antioxidant used in white wines. It prevents dissolved oxygen reacting with the ethanol to form an acid, **X**, which would produce a sour-tasting wine.

WM8iii

In the box below draw the **full** structural formula of the acid, **X**, responsible for the wine's sour taste.

[1]

WM8iii



1

DO NOT ALLOW missing Hs
ALLOW –OH group

WM8iii

A student attempted to oxidise ethanol to acid **X** in the laboratory.

(i) Give the chemical reagents and reaction conditions the student would need to use.

reagents .....

.....

conditions .....

..... **[3]**

WM8iii

acidified ✓
(potassium) dichromate / (sodium) dichromate / $Cr_2O_7^{2-}$ ✓

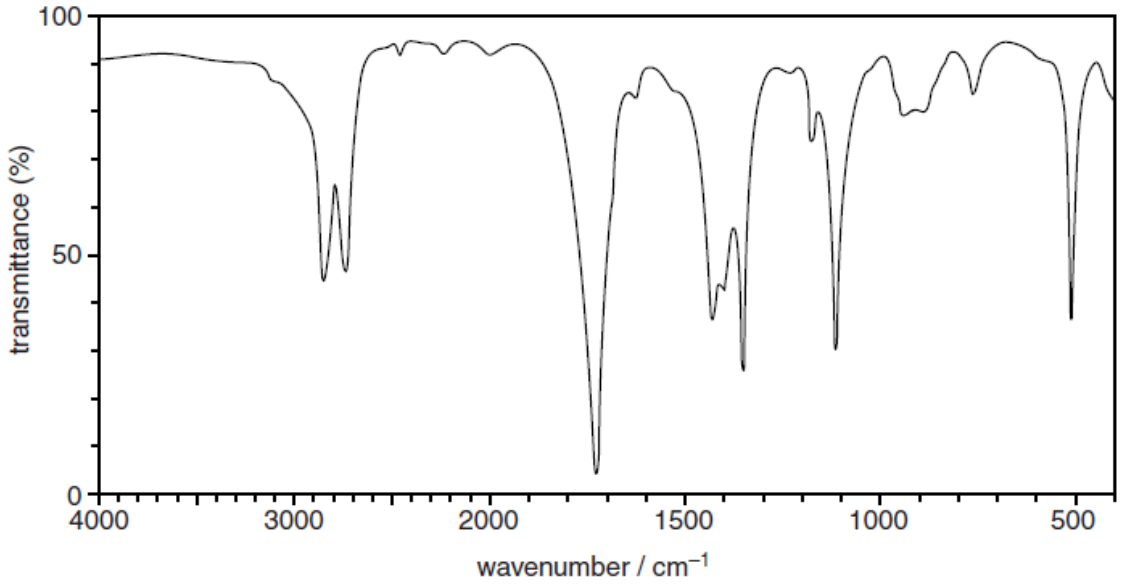
heat (under) reflux / reflux ✓

3

Any concentration of sulfuric acid / H_2SO_4
DO NOT ALLOW hydrochloric *or* nitric acids
IGNORE oxidation state of dichromate

DO NOT ALLOW heat alone
ALLOW heat with condenser

The infrared spectrum of the purified product the student actually obtained is shown below.



WM20i

Use the *Data Sheet* together with the spectrum on page 2 to identify the product made by the student. Give your reasoning.

reasoning .....

.....

.....

.....

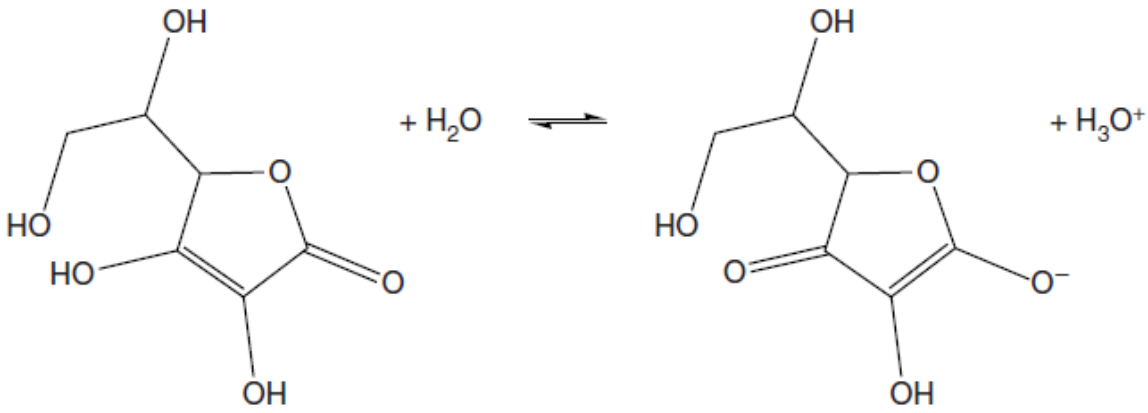
.....

name or formula of product ..... **[3]**

WM20i

(strong) peak/trough at about 1720–1740 (cm^{-1}) indicates C=O/carbonyl group ✓ no broad peak/trough at approx. 2500–3200 (cm^{-1}) so no –OH/hydroxyl (in –COOH) present OR no –OH/hydroxyl peak/trough at 2500–3200 *AW* ✓ ethanal / CH_3CHO ✓	3	C=O may be shown on the diagram of the spectrum by the correct peak/trough **ALLOW** specific frequency from within range **IGNORE** references to aldehyde or carboxylic acid for the 1720-1740 cm^{-1} peak **ALLOW** correct full structural and skeletal formulae **ALLOW** acetaldehyde

When E300 is added to water, an acid–base equilibrium is set up, as shown below.



E300

WM1i

Explain what is meant by the term *base* in the Brønsted–Lowry theory.

..... **[1]**

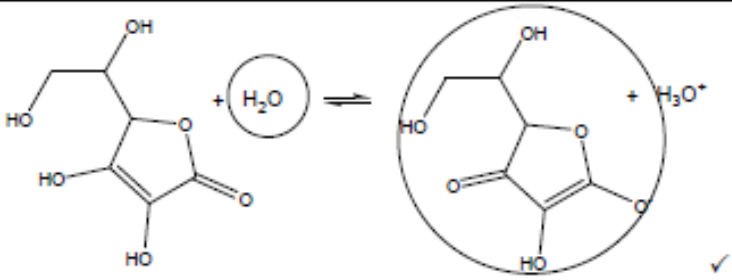
WM1i

a proton / H^+ acceptor ✓	1	

WM1ii

Circle **two** species in the equation above that are acting as bases. **[1]**

WM1ii

 ALLOW If only $-O^-$ is circled	1	both circles required
carbon dioxide / CO_2 ✓	2	

WM9

When a solution of E300 reacts with calcium carbonate, fizzing occurs and a solid product can be extracted from the resulting mixture.

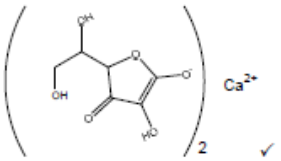
Identify the gas produced and suggest a formula for the solid product.

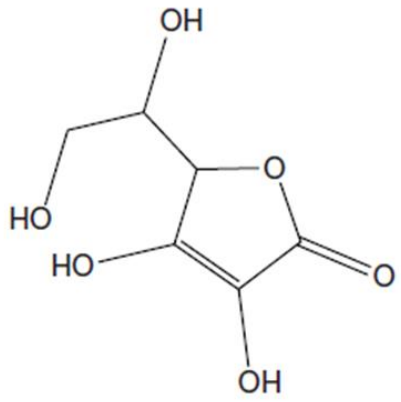
gas .....

formula of solid product:

[2]

WM9

carbon dioxide / CO_2 ✓  ✓	2	**ALLOW** $(C_6H_7O_6)_2Ca$ / $(C_6H_7O_6)^-{}_2Ca^{2+}$ **ALLOW** slight error in formula of ion *i.e.* number of H(6-8) and O(5-7) **ALLOW** with or without correct charges but not half and half



E300

WM11i

Both E300 and phenol, C_6H_5OH, are acidic in solution.

Describe the relative acidities of E300 and phenol. Give your reasoning.

.....

.....

.....

.....

..... **[2]**

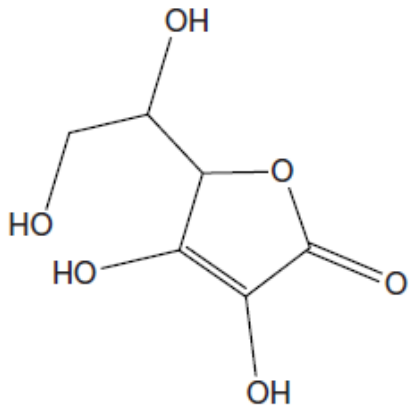
WM11i

E300 is a stronger acid (than phenol) ✓ it fizzes/reacts with a carbonate but phenols don't ✓	2	**ALLOW** E300 is more acidic/in solution has a lower pH **IGNORE** references to stability of ions and/or electron delocalisation

WM6i

A primary alcohol group in E300 reacts with $C_{17}H_{35}COOH$ to form another antioxidant.

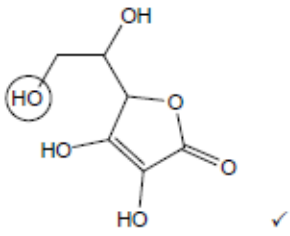
Circle a primary alcohol group on the structure of E300 below.



E300

[1]

WM6i



✓

	1	**ALLOW** if adjacent C is included in the circle

WM6vii

Draw the structural formula of the new functional group formed in this reaction.

[1]

WM6vii

–OOC ✓	1	**ALLOW** any correct ester structure **OR** full structural formula **ALLOW** $C_{17}H_{35}COO–$ **OR** –CO.O–C etc.

WM10

What else must be added to a mixture of E300 and $C_{17}H_{35}COOH$, to make the new antioxidant?

WM10

..... **[1]**

<u>concentrated</u> sulfuric/hydrochloric acid	1	**ACCEPT** correct formula for either acid

WM10

In addition to the antioxidant, another product is formed in this reaction.

Name this product.

..... **[1]**

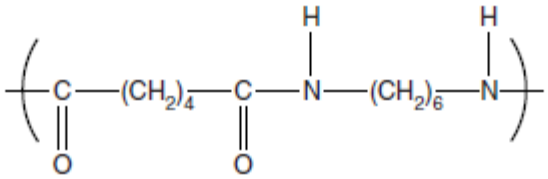
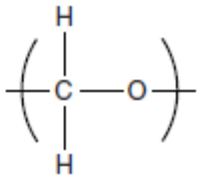
WM10

water ✓	1	**ALLOW** H_2O

2 Some nylons can be used to make moulded mechanical parts such as gear wheels. However for high performance engineering components, polyoxymethylene, POM, is often used instead.

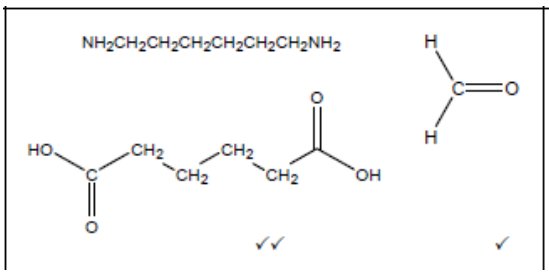
Complete the table below by drawing the correct formulae in the appropriate boxes.

MR9

polymer	nylon-6,6 (condensation polymer)	POM (addition polymer)
repeating unit		
formula(e) of monomer(s)		

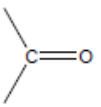
[3]

MR9



✓✓ ✓

3 **ALLOW** skeletal formulae or (eg) HOOC $(CH_2)_4$ COOH OR COOH $(CH_2)_4$ COOH
If structural formulae are drawn **DO NOT ALLOW** missing H atoms.
ALLOW CH_2O
REJECT



WM7vi

Name the functional group in POM.

..... [1]

WM7vi

ether ✓	1

WM13

Both polymers can be hydrolysed by *heating under reflux* with a suitable reagent. The monomers can then be obtained by *distillation*.

Describe and explain **one** difference between *heating under reflux* and *distillation*.

.....

.....

.....

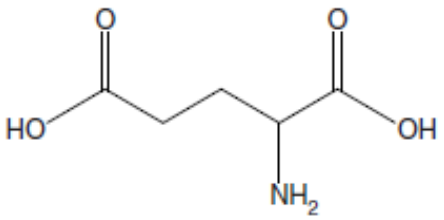
.....

..... [2]

WM13

in *heating under reflux* the condenser is vertical OR mixture is evaporated and condensed/liquefied and returned to mixture *AW* OR no material/reactants/products/chemicals/substance is lost from the mixture *AW* ✓ in *distillation* the condenser is slope downwards / horizontal /attached at the side OR mixture/chemicals/molecules are evaporated and condensed (or liquefied) and collected OR mixture/chemicals/molecules are separated ✓	2	**ALLOW** use of correct diagrams with condenser labelled **IGNORE** any reference to flammability

3 Glutamic acid is a naturally occurring amino acid. Derivatives of glutamic acid are used as flavour enhancers in many foods.



glutamic acid

WM7iii
MR7

Give the systematic name for glutamic acid.

..... **[2]**

WM7iii
MR7

2-aminopentan(e)dioic acid 2-amino ✓ pentan(e)dioic acid ✓	2	mark independently **IGNORE** dashes and commas; absence of 'e' before 'dioic'; 1,5 between 'pentan(e)' and 'dioic' **DO NOT ALLOW** dicarboxylic acid **DO NOT ALLOW** amine; other numbers between 'pentan(e)' and 'dioic' (2nd mark is lost)

WM9
WM1ii

Glutamic acid is a crystalline solid with a melting point of 199 °C. It reacts with both acids and alkalis in solution.

Explain why glutamic acid can react with both acids and alkalis in solution.

.....

.....

.....

..... **[2]**

WM9
WM1ii

acids will react with the amino/–NH_2 group *AW* ✓ alkalis/bases will react with the carboxyl/–COOH group *AW* ✓	2	**ALLOW** the amino/–NH_2 group can be protonated / is a proton/H^+ acceptor **ALLOW** the carboxyl/–COOH group can lose a proton/H^+ / is a proton/H^+ donor **ALLOW** hydroxyl/-OH group instead of –COOH group **IGNORE** any reference to acidic or basic.

Glutamic acid was used as the starting material to make the drug thalidomide. Thalidomide began to be prescribed as a sedative and painkiller for pregnant women around 1958. The drug was withdrawn from use in 1961 because it was linked to severe birth defects. Testing procedures for new drugs then became much stricter.

WM17

Suggest **two** possible reasons why thalidomide may have been used as a sedative in place of drugs that existed at that time.

.....

.....

..... **[2]**

WM17

two answers from the following: more effective / faster acting ✓ less expensive/cheaper (to manufacture) ✓ smaller dose required ✓ easier to formulate/administer *AW* ✓ fewer side-effects ✓ can treat other symptoms / wider application ✓	2	**DO NOT ALLOW** 'better' for 'more effective' **ALLOW** 'worked better than...'

WM17

Suggest **one** way that the testing of drugs today ensures that the thalidomide tragedy is unlikely to happen again.

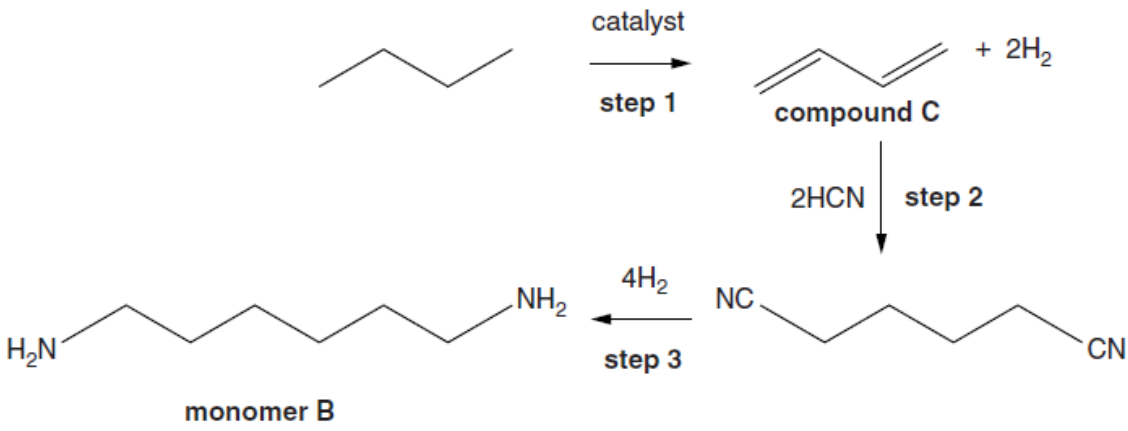
.....

..... **[1]**

WM17

one answer from the following: safety tests on drugs for use during pregnancy ✓ test to see if drug can pass through placenta *AW* ✓ longer period of testing / longer clinical trials ✓ testing on (pregnant) animals ✓	1	**ALLOW** optical isomers can now be separated

In the manufacture of PPA, monomer **B** can be made from butane by the following 3-step process.



For each step, name the type of reaction taking place by selecting a suitable word from the list below.

WM16ii

addition condensation elimination rearrangement substitution

step 1 .....

step 2 .....

step 3 .....

[3]

WM16ii

1. elimination ✓ 2. addition ✓ 3. addition ✓	3	**IGNORE** 'nucleophilic'

WM16v

How does the hydrogen produced by **step 1** help to reduce the cost of the overall process?

.....

..... **[1]**

WM16v

can be used in step 3 **AW** ✓	1	**NOT** step 2 **ALLOW** • can be sold • can be used as a source of energy • can be recycled

WM8iii

In some countries, compound **C** is synthesised by first converting ethanol into CH_3CHO.

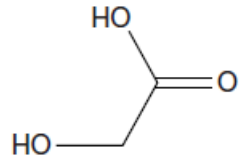
Give the reagents used in a laboratory to convert ethanol into CH_3CHO.

..... **[1]**

WM8iii

acidified dichromate ✓	1	**IGNORE** • metal cation • name of acid • wrong formulae if name given • oxidation state of 'dichromate' **ALLOW** H_2SO_4/H^+ and $Cr_2O_7^{2-}$ **DO NOT ALLOW** just dichromate

2 Glycolic acid is widely used in cosmetic skin-care products. It is an odourless and crystalline solid that is very soluble in water.



glycolic acid

WM1ii
WM1i

Describe and explain how part of the glycolic acid structure acts as an acid.

.....

.....

..... **[2]**

WM1ii
WM1i

–COOH / carboxyl / carboxylic acid group ✓ is a proton/H^+ donor / loses H^+ ✓	2	correct equation showing dissociation gains both marks **ALLOW** 'gives H^+' *Mark separately*

The concentration of glycolic acid in a skin-care product is important. Any product containing over 10.0 g of glycolic acid in 100 cm^3 solution is classed as a hazardous material.

'Acnegone' is a solution of glycolic acid.

A student carries out an acid–base titration using a standard solution of NaOH to find out how much glycolic acid is in the *Acnegone* solution.

The student dilutes 14.0 cm^3 of *Acnegone* with water to form 250 cm^3 of solution.

SS2ii
WM9

25.0 cm^3 of this solution reacts exactly with 16.0 cm^3 of 0.250 mol dm^{-3} aqueous NaOH.

Complete the equation for the reaction of glycolic acid with sodium hydroxide.

$CH_2OHCOOH$ + →

[1]

SS2ii
WM9

$CH_2OHCOOH$ + NaOH → $CH_2OHCOONa$ + H_2O ✓	1	**ALLOW** CH_2OHCOO^- Na^+, Na^+ CH_2OHCOO^- **OR** $Na(CH_2OHCOO)$ **IGNORE** state symbols **NOT** $CH_2OHNaCOO$

SS3

Calculate the mass of glycolic acid in 100 cm^3 of *Acnegone* and state whether *Acnegone* should be classed as a hazardous product. Give your answer to an **appropriate** number of significant figures.

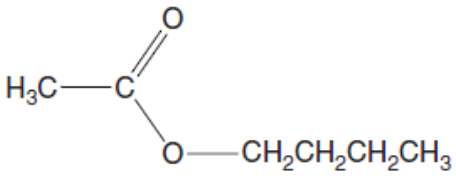
mass of glycolic acid = ... g in 100 cm^3

SS3

1. moles of NaOH used in titration = **16.00/1000** x **0.250** ✓ = 0.00400	6	*There are several possible routes through this question after point 2, the 'mole route' A, the 'mass route' B and the 'concentration route' C* **If final answer is incorrect please annotate with ticks where the marks are awarded**
2. moles of glycolic acid used in titration = answer from **1**, ***scaled by ratio in equation in 2bi*** ✓ 0.00400 **CHECK equation in 2(b)(i)**		2. **ALLOW** by implication if 0.004 used subsequently
3A. moles of glycolic acid in 250 cm^3 = (answer from **2**) x **10** ✓ = 0.0400 mol **OR** 3B. mass of glycolic in 25 cm^3 = (answer from **2**)x M_r of glycolic acid ✓ 0.304 g **OR** 3C. concentration of glycolic acid = (answer from **2**) **x 1000/25** ✓ 0.16 mol dm^{-3}		**The marks are awarded for the working out given in bold OR** the correctly calculated answer to that working (but no mark if calculated answer is shown and is wrong)
4. M_r of glycolic acid = **76.(0)** ✓		4. Award if 76 used correctly anywhere

5A. moles of glycolic acid in 100 cm^3 = (answer from **3A**) x 100/14 ✓ 0.286 mol **OR** 5Bi. mass of glycolic acid in 250 cm^3 = (answer from **3A**) x M_r of glycolic acid ✓ 3.04 g **OR** 5Bii. mass of glycolic in 250 cm^3 = (answer from **3B**) x **10** = ✓ 3.04 g **OR** 5C. concentration of undiluted glycolic acid = (answer from 3C) x **250/14** ✓ 2.86 mol dm^{-3}		**ALLOW** ecf for incorrect equation **AND** between each step **ALLOW** 'Acnegone' for 'glycolic acid' **ALLOW** answers in standard form *The following on the answer line with correct corresponding comment, score as follows, irrespective of working or lack of it:* 21.7 scores 6 1.22 scores 5 (error in 5C) 12.2 scores 5 (error in 6C) 2.17 scores 5 (error in 3A or 5Bii) 3.04 scores 5 (error in 6) *these to other sf* **OR** *with incorrect comment score one mark less* **If one of the answers above applies place correct number of ticks by answer**
6. mass of glycolic acid in 100 cm^3 undiluted = (answer from **5A**) x M_r of glycolic acid **OR** = (answer from **5B**) **x 100/14** **OR** = (answer from 5C /10) x M_r of glycolic acid = **21.7** (3 sf) **AND** correct comment ✓		

Carboxylic acids can be converted to esters. Esters, such as compound **D**, are often used in varnishes.



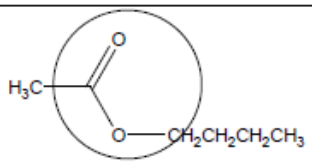
compound D

WM6vii

Name compound **D** and circle the ester group.

..... **[2]**

WM6vii



butyl ethanoate ✓
ester link correct ✓

2

IGNORE where the circle cuts the bond as long COO is included
ALLOW adjacent C atoms in circle

ALLOW butylethanoate without gap

WM10

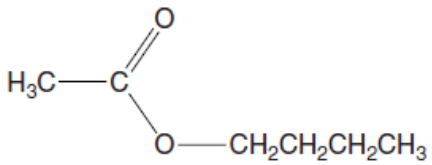
Name the compounds you would heat under reflux with ethanoic acid to form compound **D**.

.....

..... **[2]**

WM10

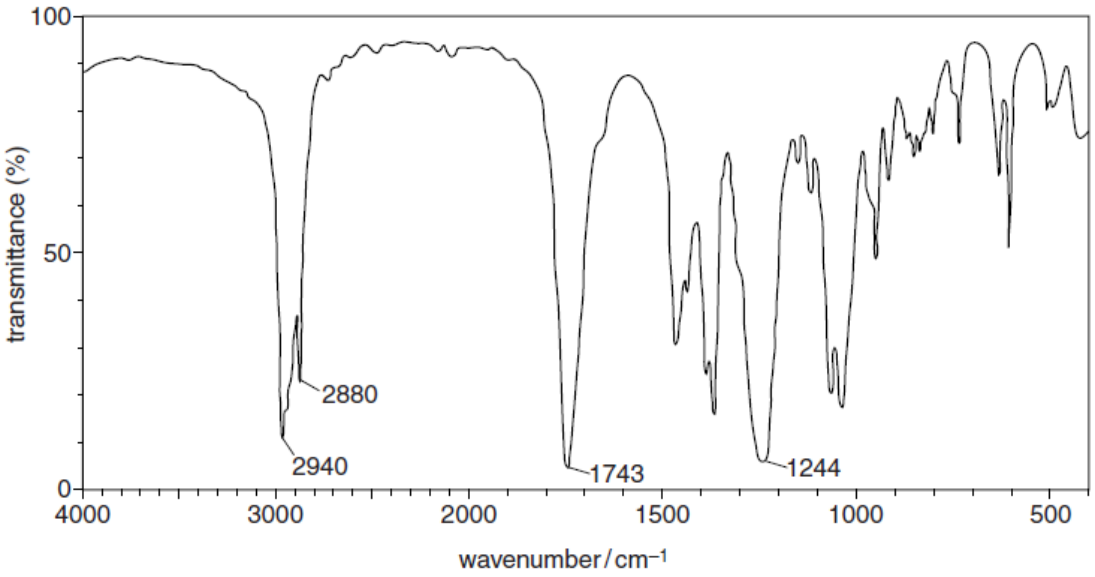
butan-1-ol ✓ concentrated sulfuric acid/hydrochloric acid ✓	2	**MUST HAVE** number 1 **DO NOT ALLOW ecf** for alcohol in 2(c)(i) **ALLOW** formula for acid **ONLY** **IGNORE** spelling of name for H_2SO_4 as long as it is clear



compound D

A student attempts to synthesise compound **D** from ethanoic acid. The student distils off the product and runs an infrared spectrum and a mass spectrum on it.

The infrared spectrum is shown below.



WM20i

Use the IR spectrum and your *Data sheet* to give **two** pieces of evidence to show that the product does not contain any starting materials.

.....

.....

.....

.....

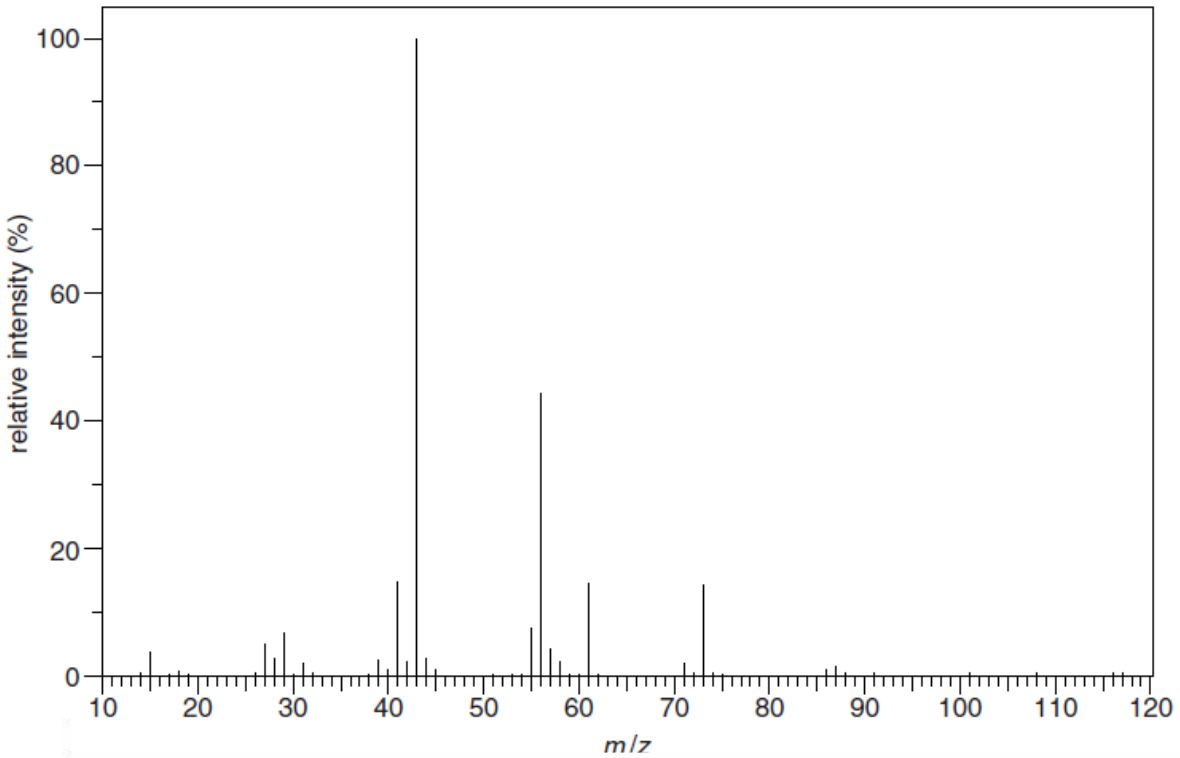
.....

..... **[2]**

WM20i

The answer requires a comment for a carboxylic acid AND an alcohol so award ONE mark from each section below: **CARBOXYLIC ACID** (strong) peak at 1743 (cm^{-1}) shows C=O in ester not acid **OR** no peak 1700 – 1725 (cm^{-1}) shows no C=O in acid **OR** no broad peak at 2500 – 3200 (cm^{-1}) shows no O–H in acid ✓ **ALCOHOL** no peak greater than 3000 / in range 3200 – 3600 (allow 3640) so no O–H in alcohol ✓	2	answers may be given on spectrum to score each point, **range**, **bond** and **group** in which it is found must be given **ALLOW** carboxyl or carboxylic acid or COOH or ethanoic acid (or formula) for **'acid'** FOR O–H **ALLOW** OH / hydroxyl FOR C=O **ALLOW** carbonyl **NOT** CO

The mass spectrum of the ester is shown below.



Suggest formulae for the following:

- the chemical species responsible for the peak at *m/z* 73,
- the species **lost** from the molecular ion to form this chemical species.

Write your answers in the table below the working space.

	Formula
Species which gives the peak at *m/z* 73	
Species lost from the molecular ion	

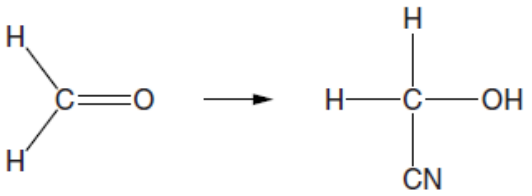
[3]

WM19iii

WM19v

peak at *m/z* 73: CH_3COOCH_2 / $C_3H_5O_2$ ✓ positive charge on any formula ✓ **species lost:** $CH_2CH_2CH_3$ / C_3H_7 (NO charge) ✓	3	**ALLOW** any correct structural or molecular formula for both answers **ALLOW** $C_4H_9O^+$ **IF** $C_4H_9O^+$ given above **THEN species lost must be** C_2H_3O / CH_3CO

Glycolic acid can be made from methanal. Methanal is first reacted with cyanide ions in aqueous solution to form a cyanohydrin.



WM12iii

Underline **two** of the following words which describe the mechanism of the reaction described above.

addition **condensation** **electrophilic** **elimination**

nucleophilic **radical** **substitution**

[2]

WM12iii

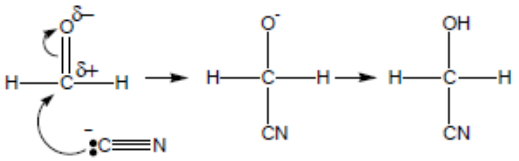
nucleophilic ✓ addition ✓	2

WM13

Describe the mechanism of the reaction using 'curly' arrows, bond polarities and relevant lone pairs of electrons.

[5]

WM13

H^+ or H_2O or HCN  HCHO with bond polarity correct ✓ CN^- with lone pair of electrons on C ✓ both curly arrows correct (lower one must be from C of CN) ✓ intermediate ion correct ✓ gain of H^+ from **water, HCN** or **direct** to form the cyanohydrin ✓	5	**ALLOW** CN^- without triple bond **ALLOW** –ve charge on N of CN^- **IGNORE** any arrow used to add H^+ etc to the intermediate

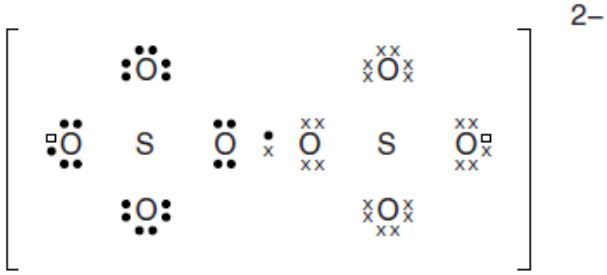
4 A common way of cleaning laboratory glassware is by dipping it in a bath containing acidified potassium dichromate(VI), often called chromic acid, which is a powerful oxidising agent. However, such use of compounds containing heavy metal ions is considered hazardous.

'Nochromix®' is a metal-free alternative to chromic acid. It consists of ammonium peroxodisulfate crystals. These are white crystals that are very soluble in water, forming a solution which can also act as a strong oxidising agent.

The diagram shows the arrangement of atoms in a peroxodisulfate ion, $S_2O_8^{2-}$.

WM2

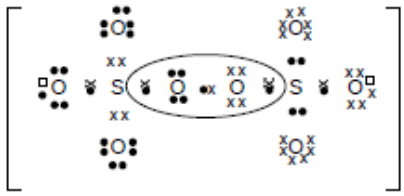
Complete the diagram to show a *'dot-and-cross'* representation of the peroxodisulfate ion.



▫ represents the extra electrons required to form the ion

[2]

WM2



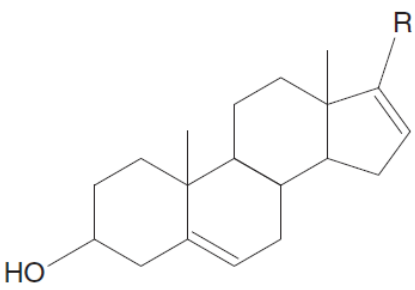
correct inside oval (around peroxy Os) ✓
rest correct ✓

2

ALLOW another symbol for S electrons

second mark depends on first

Abiraterone, $C_{24}H_{31}NO$, is a new drug under trial as a treatment for cancer of the prostate gland. The structure of abiraterone is shown below.



R is a ring structure with the molecular formula C_5H_4N

abiraterone

WM7vi

Name **two** functional groups present in the part of the abiraterone molecule shown.

.....

..... **[2]**

WM7vi

Alkene / carbon-carbon double bond / C=C ✓ alcohol / hydroxyl / hydroxy ✓	2	Double bond alone does **NOT** score. **ALLOW** secondary alcohol but not primary or tertiary. Do **NOT** allow hydroxide.

WM19ii

High-resolution mass spectrometry can be used to determine the molecular formula of a compound by measuring the mass:charge ratio of the M^+ peak.

Explain how the molecular formula of abiraterone can be determined from an accurate mass:charge ratio for the M^+ peak in its mass spectrum.

.....

.....

.....

.....

..... **[2]**

WM19ii

The **masses** of the different types of atom present are **not integers** / masses are measured relative to carbon-12 (12.00000) ✓ **OR** different compounds with the same whole number molecular mass will have **different M_r values** from high resolution spectra / AW ✓ **AND** Comparison of **M_r** with database / list of formulae/M_r values ✓	2	*mark independently* **ALLOW** high resolution MS gives accurate M_r to 4 decimal places **ALLOW** calculate molecular formula by using masses of atoms involved

WM19v

WM19iii

The M_r value of abiraterone is 349 to the nearest whole number. In the low-resolution mass spectrum of abiraterone there are also peaks at mass:charge ratios of 15 and 332.

Give the formulae of the species

- responsible for the peak at 15 .....
- lost from the molecular ion to form a fragment which causes the peak at 332.

..... **[2]**

WM19v

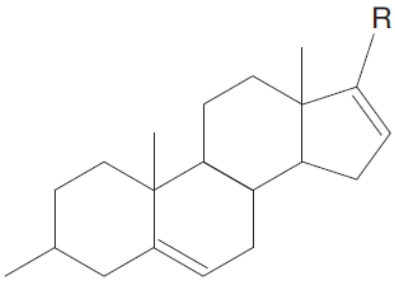
WM19iii

Peak: CH_3^+ ✓ species lost = OH ✓	2	**MUST** have correct charge for first mark **MUST** be neutral for the second mark

In treating cancers, abiraterone is used as its **ethanoate** ester.

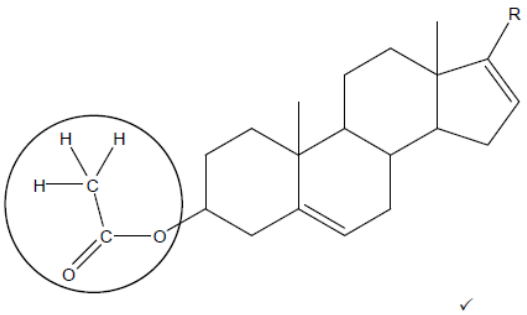
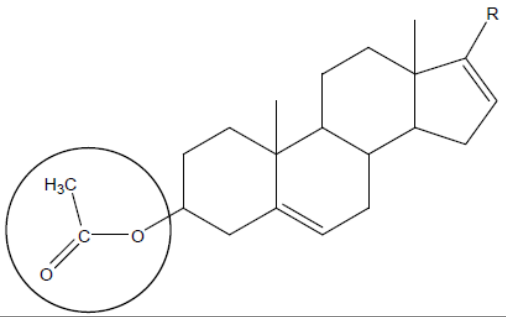
WM7

On the diagram below, draw the **full** structural formula of the *ethanoate* group in the correct position.



[1]

WM7

 ✓	1	**ALLOW** this, though not full structural! **DO NOT ALLOW** skeletal formula 

WM10

Name the two substances that must be heated under reflux with abiraterone to make its ethanoate ester.

.....

..... **[2]**

WM10

ethanoic acid ✓ concentrated sulfuric acid / concentrated hydrochloric acid ✓	2	*Mark separately* **IGNORE** conc./ dil. / aq. for ethanoic acid Moderately is CON for acid **ALLOW** correct formula. e.g. CH_3COOH and conc H_2SO_4

WM17

Clinical trials are carried out to determine the suitability of abiraterone as a drug.

Give **three** questions that **clinical trials** are designed to answer.

.....

.....

.....

.....

..... **[3]**

WM17

1. Is the drug safe (to be used in humans)? ✓ 2 Does it do the job it is designed to do? ✓ 3 Is it better than the standard treatment being used? ✓	3	*Alternative answers to the 3 answers on the left:* **IGNORE** incorrect answers, including 'is it toxic/harmful?', 'is it cost-effective?' 'can it be modified?' **NOTE** only one mark can be scored for each of the candidate's questions (e.g. 'effective and better' in one question only scores 1) 1. Are there any **side-effects**? / AW 1. What is the **safe-dose**? / AW 2. Is it **effective**? / does it work AW 3. Is it an **improvement** on other drugs? / AW 3. Can it be used to treat **other** symptoms/health problems / diseases? / AW **ALLOW** specific examples *e.g. can it be used to treat cancer?*

The concentration of an iron(II) ethanoate solution can be determined by a redox titration with cerium(IV) sulfate. A few drops of an indicator are added. The solution turns purple at the end point.

SS3

The equation for the reaction between Ce^{4+} and Fe^{2+} is given below.

$$Ce^{4+}(aq) + Fe^{2+}(aq) \longrightarrow Ce^{3+}(aq) + Fe^{3+}(aq)$$

The indicator solution used is made by dissolving 0.10 g of a compound **A** in 0.0050 mol dm^{-3} NaOH solution to make 100 cm^3 of indicator solution.

M_r of compound **A**, 213

Calculate the concentration of compound **A** in the indicator solution.
Give your answer to an **appropriate** number of significant figures.

concentration of **A** = ... mol dm^{-3} **[2]**

SS3

1. moles of A in 100 cm^3 = **0.1(0) / 213** (= 4.695 x 10^{-4}) ✓ 2. moles of A in 1000 cm^3 = 10 x 0.10 / 213 = **4.7 x 10^{-3}** / 0.0047✓ 2sf	2	*Remember that in calculations correct answer gets full mark with or without working* **ALLOW** 4.70 x 10^{-3} (3 sf)

The table below contains data obtained from the infrared spectrum of compound **A**.

Use your *Data sheet* to complete the table. **[2]**

WM20i

wavenumber / cm^{-1}	bond	location
3150		
1715		

WM20i

wavenumber / cm^{-1}	bond	location
3150	O-H	carboxylic acid
1715	C=O	ketone AND/OR carboxylic acid
	✓	✓

2

BOTH bonds correct ✓

BOTH locations correct ✓

WM9

Compound **A** is insoluble in water but soluble in alkaline solution.

Use this information and the information from **(ii)** to identify the functional group in compound **A** and so explain why **A** is soluble in an alkaline solution.

.....

.....

.....

..... **[2]**

WM9

1. COOH / carboxylic (acid) / carboxyl group ✓ (reacts with alkali) to form: 2. ions in solution / a soluble salt / salt that dissolves / soluble carboxylate (allow formula) ✓ **OR** 2. carboxylate/anion of carboxylic acid (allow formula) forms bonds with water	2	**IGNORE** references to intermolecular bonding

WM16v

Enzymes, such as the hydroxylases, are used commercially for the synthesis of compounds.

Give **two** ways that enzymes may increase the efficiency of an industrial process.

.....

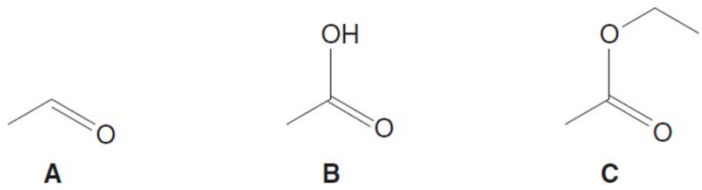
.....

..... **[2]**

WM16v

Any **two** from: **speeds up** reaction rate **reduces the number of steps** in a synthesis ✓ **improves the atom economy** AW ✓ **reduces the amount of energy/heat** required AW ✓ **easier separation** methods ✓ enzymes can be **reused/recycled** ✓ uses less toxic solvents/producing **less hazardous waste** no/fewer **organic solvents** used ✓ **reduces** use of more **toxic catalysts** ✓	2	**ALLOW** it is a one step process **ALLOW** lower temperature/pressure used/needed/required **IGNORE** renewed

Poor processing or storage of wine can lead to the build-up of certain compounds that can spoil the flavour and aroma of the wine. The structures of three such compounds are shown below.



A **B** **C**

WM7iv

Give the systematic name of compound **A**.

..... **[1]**

WM7iv

ethanal ✓	1	**DO NOT ALLOW** acetaldehyde

WM8iii

A student wanted to make a sample of compound **A** from ethanol in the laboratory.

Give the reagents that would be mixed with ethanol.

State how compound **A** could be obtained from the reaction mixture.

.....

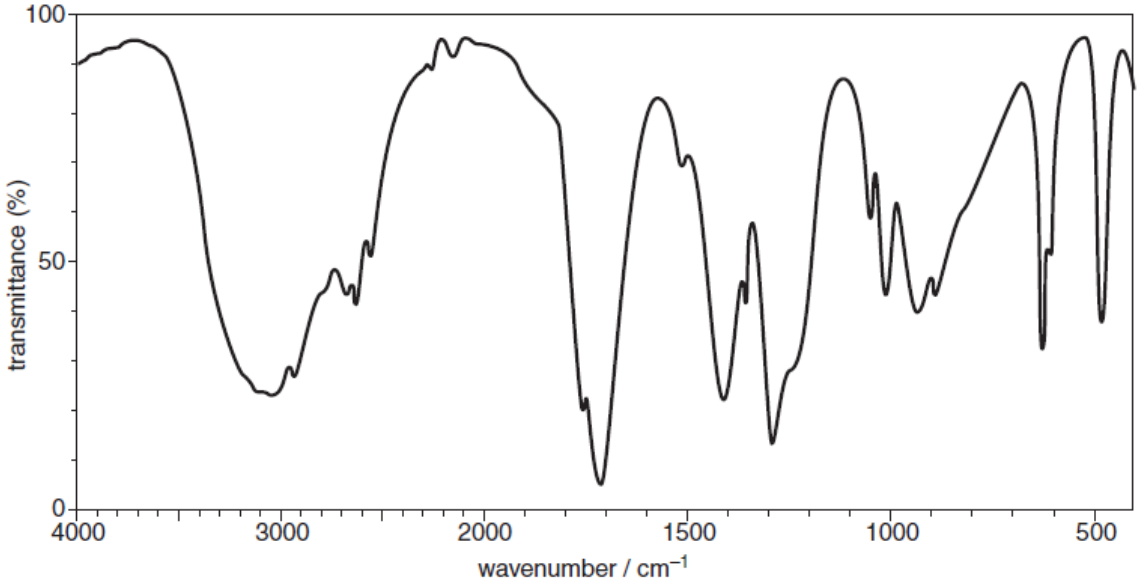
.....

..... **[3]**

WM8iii

acidified / H^+ ✓ dichromate / $Cr_2O_7^{2-}$ ✓ distil ✓	3	**IGNORE** any sodium/potassium ions in formula/name **ALLOW** only sulfuric acid / H_2SO_4 **IGNORE** fractional **ALLOW** distillation **DO NOT ALLOW** if reflux is also stated

The infrared spectrum of the purified product, shown below, indicates that the student was **not** successful in converting ethanol to compound **A**.



WM20i

Give reasons why the spectrum shows that the product was neither unreacted ethanol nor compound **A**.

Use the spectrum to identify the product.

reason product was **not** ethanol .....

.....

reason product was **not** compound **A** .....

.....

product is ..... **[3]**

WM20i

(strong) peak/trough at around 1720 (cm^{-1}) / *anywhere* in region **1700-1725 indicates** C=O (in carboxylic acid) (NOT PRESENT IN ETHANOL) ✓	3	**OR** no peak above 3200 (cm^{-1}) OR in region of 3600-3640 (cm^{-1}) for –OH in alcohol **DO NOT ALLOW** No peak/trough at 1050-1300 for C-O in alcohol (cm^{-1}) *since peaks are present in this region*
(broad) peak/trough at around 3100 (cm^{-1}) / *anywhere* in region **2500-3200 indicates** O-**H** (in carboxylic acid) (NOT PRESENT IN COMPOUND A) ✓		**ALLOW** no (strong) peak/trough at around 1720-1740 (cm^{-1}) for aldehyde group in compound A
ethanoic acid **OR** Compound B ✓		**DO NOT ALLOW** a carboxylic acid **ALLOW** labels on peaks in spectrum

WM13

Suggest and explain **one** reason why the student did not obtain compound **A**.

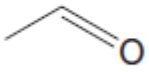
.....

.....

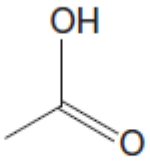
..... **[2]**

WM13

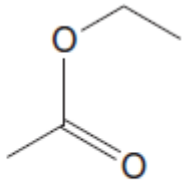
Any suggestion that indicates that reflux/excessive heating took place / distillation of ethanal as it was formed did not take place **OR** **excess** acidified dichromate was used / acidified dichromate was not added slowly to ethanol ✓ (ethanol/ethanal was) <u>oxidised</u> further ✓	2



A



B



C

WM6vii

Name the functional group in compound **C**.

..... **[1]**

WM6vii

ester ✓	1

WM10

When the reaction in **(ii)** is carried out in the laboratory, an additional compound is added to the mixture.

Name this compound and suggest **one** reason why it is used.

.....

.....

..... **[2]**

WM10

concentrated sulfuric acid **OR** H_2SO_4 ✓ act as catalyst **OR** speed up reaction rate **OR** absorb water ✓	**2**	**IGNORE** references to activation enthalpy

WM16v

Suggest **one** advantage of using enzymes over laboratory reagents to prepare organic compounds on an industrial scale.

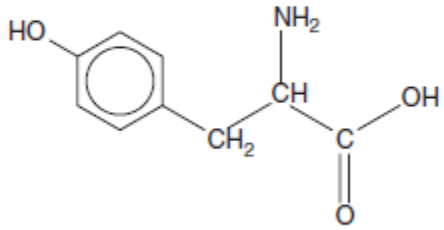
.....

..... **[1]**

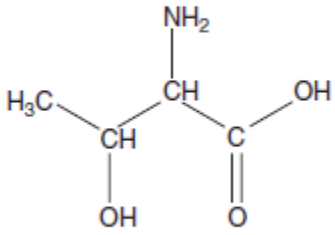
WM16v

reduces number of steps / increases atom economy **OR** could be cheaper **OR** could be faster **OR** reduces energy requirements **OR** can be carried out at low temperature **OR** can be reused ✓	**1**

3 Tyrosine and threonine are two amino acids used in the construction of proteins. Their 'R' groups both contain hydroxyl groups. Their structures are shown below.



tyrosine



threonine

WM11ii

State how the hydroxyl groups are different in tyrosine and threonine and give a chemical test to distinguish between them.

Describe what you would **see** in **each** case.

.....

.....

.....

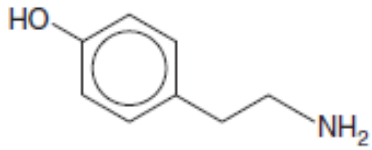
.....

..... **[4]**

WM11ii

Tyrosine: <u>phenol</u> ✓ Threonine: <u>alcohol</u> ✓ add (neutral) $FeCl_3$ / iron(III) chloride ✓ Tyrosine: turns purple/violet **AND** Threonine remains yellow /does not change colour ✓	4	**ALLOW** orange **BUT NOT** brown alone for colour of $FeCl_3$ **ALLOW** acidified dichromate ✓ – Threonine goes green **AND** Tyrosine remains orange / does not change colour ✓

In foodstuffs such as cheese, tyrosine decays into tyramine. Tyramine is possibly responsible for migraine-type headaches.



tyramine

Complete the table below to show the structures of the products formed when tyramine reacts with the named reagents.

reagent	product(s) formed
hydrochloric acid	
ethanoyl chloride	

[5]

MR13

MR11

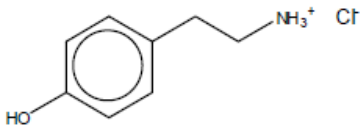
WM11iii

MR13

MR11

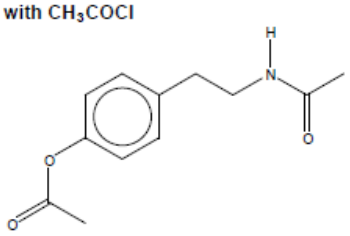
WM11iii

with HCl



1 mark for $-NH_3^+$ group correct ✓
1 mark for rest of ion correct ✓

with CH_3COCl



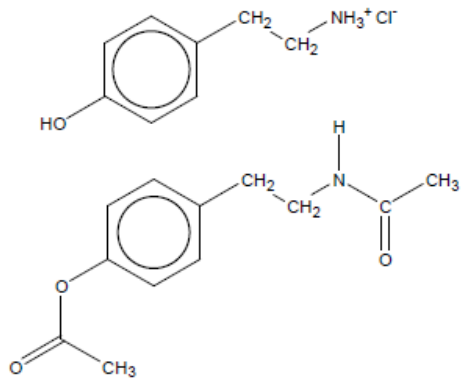
and HCl

1 mark for each acyl group ✓✓

1 mark for HCl (**IGNORE** number of HCls) ✓

5

ALLOW correct (full) structures but H's must be shown
ALLOW $-NH_3$+ve ion without Cl^-



WM11i

Although tyramine is not very soluble in water it will 'dissolve' if a little aqueous alkali is added to a mixture of tyramine and water.

Explain why tyramine is able to do this.

.....

.....

..... **[2]**

WM11i

phenols / phenol group / -OH group on tyramine will form ion / react with alkalis ✓ ionic substances / salts are (more) soluble in water **OR** ions interact / bond / with water (molecules) **OR** ions are attracted to water (molecules) ✓	**2**	**ALLOW** …… forms salts

Hydrated chromium(III) salts react with water to set up the equilibrium below.

$$[Cr(H_2O)_6]^{3+} + H_2O \rightleftharpoons [Cr(H_2O)_5OH]^{2+} + H_3O^+$$

WM1i

Explain why this is an example of an acid–base equilibrium.

WM1ii

Give the **two** chemical species that are acting as acids.

.....

.....

..... **[2]**

WM1i

WM1ii

transfer/exchange of proton OR a proton is lost/donated **AND** gained/accepted ✓	2	**ALLOW** H^+ for proton
$[Cr(H_2O)_6]^{3+}$ **AND** H_3O^+ ✓		**DO NOT ALLOW** 'Cr complex ion' without formula

MR7

Chromium(III) forms a complex ion with the bidentate ligand $H_2NCH_2CH_2NH_2$.

(i) Name the ligand $H_2NCH_2CH_2NH_2$.

..... **[1]**

MR7

1,2-diaminoethane ✓	1	**IGNORE** commas and dashes **ALLOW** ethylenediamine **BUT NOT** ethan(e)-1,2-diamine

WM2

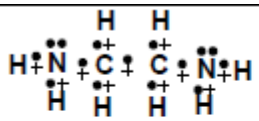
(ii) Draw a '*dot-and-cross*' diagram for $H_2NCH_2CH_2NH_2$.

[2]

WM2

SS24

SS23

 ALL bond pairs correct ✓ BOTH lone pairs correct ✓	2	**ALLOW** two crosses for lone pair

(iii) Use your answer to **(ii)** to explain why $H_2NCH_2CH_2NH_2$ is a *bidentate ligand*.

.....

.....

..... **[2]**

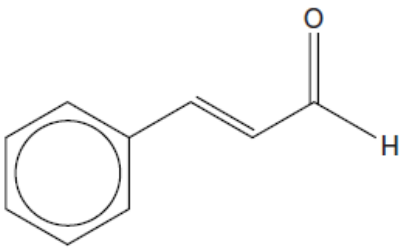
SS24

SS23

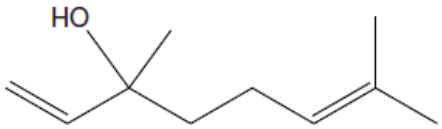
it can use/donate **two/both** lone pairs (of electrons) ✓ to form dative covalent/coordinate bonds (with metal cation) ✓	2	**ACCEPT** 'free' pair of electrons

Cinnamon oil is thought to have health benefits for people suffering from diabetes as it lowers blood-sugar levels. The oil does not mix with water and is a skin irritant.

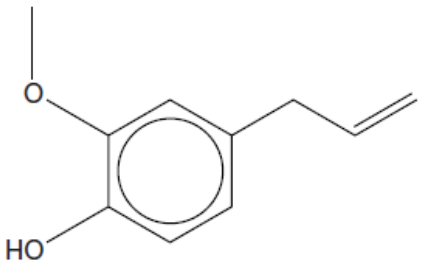
Three of the main constituents of the oil are cinnamaldehyde, linalool and eugenol. The structures of these compounds are shown below.



cinnamaldehyde



linalool



eugenol

WM17

Suggest **one** problem chemists must solve in deciding on a suitable dose of the oil for a diabetic patient.

.....

..... **[1]**

WM17

how to dissolve/administer/form a suspension of the oil OR find out dilution which is a non-irritant AW OR dose which is safe AW ✓	1	DO NOT ALLOW to find if it is more effective, cost ALLOW dose which does not irritate the skin

WM18i

Describe how thin-layer chromatography can be used to show that cinnamaldehyde, linalool and eugenol are present in cinnamon oil.

.....

.....

.....

.....

.....

.....

.....

..... **[5]**

WM18i

draw **pencil-line** near bottom of plate and place 1 **drop** (or similar word) **of mixture** (and a drop of each of the 3 compounds) on the line ✓ place plate in solvent, **line above solvent** level **AND** add **lid/cover** ✓ when solvent nears **top of plate**, **remove/dry** plate ✓ locate spots with **UV light/iodine** ✓ **compare** heights/position of spots from mixture with the 3 standard compounds OR **calculate** R_f values of spots and compare with those of the standards (may be named) ✓	5	**please annotate marks given with ticks** ALL marking points may be gained from labelled diagram(s) DO NOT ALLOW paper for plate BUT ecf for further use DO NOT ALLOW 'locating agent' alone

WM7vi

WM6iv

Name three functional groups present in **eugenol** other than a benzene ring.

1 .....

2 .....

3 ..... **[2]**

alkene / C = C ether phenol/hydroxy(l) ALL correct 2 marks ✓✓ ANY 2 correct 1 mark ✓	2	DO NOT ALLOW double bond, formulae DO NOT ALLOW alcohol

WM7vi

WM6iv

A student devised a test to distinguish between eugenol and linalool. The student made an aqueous suspension of each compound in a separate test-tube. Sodium hydroxide solution was added to each test-tube and the test-tubes were shaken. The suspension of eugenol and water formed a solution; the linalool in water remained cloudy.

WM11i

Explain the difference in behaviour when shaking the two suspensions with aqueous sodium hydroxide.

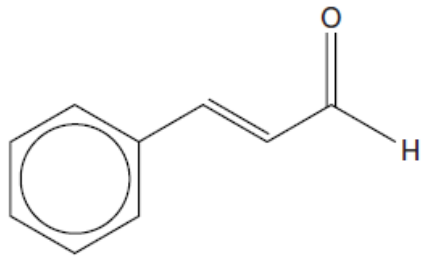
.....

.....

..... **[2]**

WM11i

Eugenol/phenol reacts with NaOH to form salt/soluble product ✓ alcohols do not react with NaOH **OR** no phenol group in linalool so no reaction ✓	2	**ALLOW** for 1st mark formula of ions forming salt eg $-O^- Na^+$ **DO NOT ALLOW** 'linalool does not react' without reference to a phenol or alcohol functional group



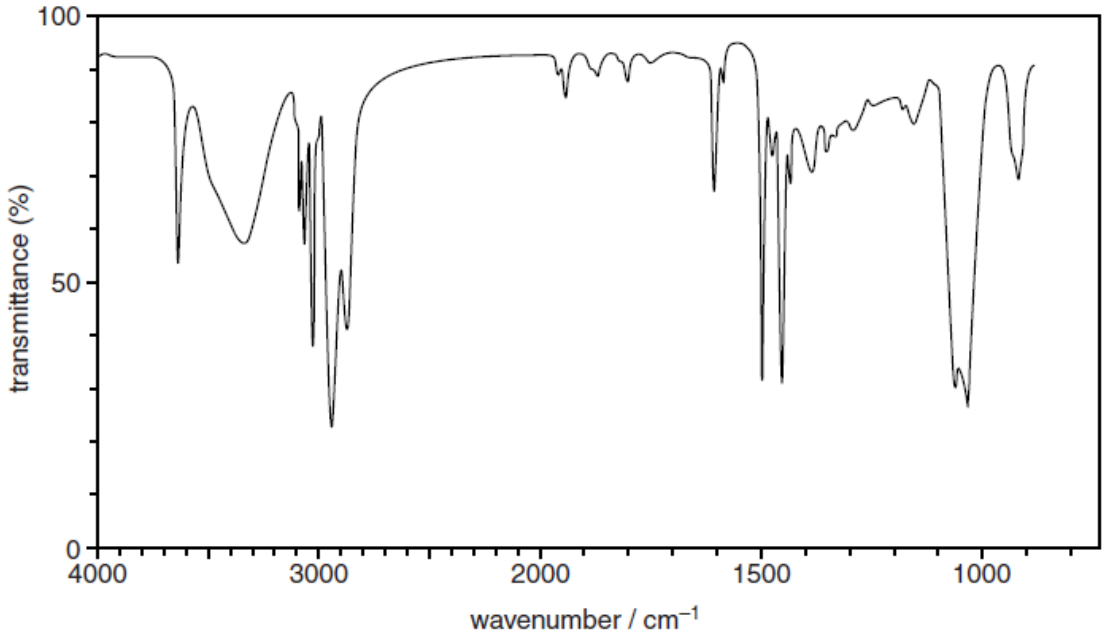
cinnamaldehyde

A student attempts to react cinnamaldehyde with hydrogen. If a reaction takes place, two products, **X** and **Y**, are possible:

- **X** is formed if just the C=C bond reacts
- **Y** is formed if the C=C reacts **and** the C=O is reduced to an alcohol.

The student's infrared spectrum of the product of the reaction is shown below.

Use the *Data Sheet* and the spectrum to work out what is produced in the reaction. On the next page, give your reasoning and draw the structure of the compound responsible for the spectrum.



WM20i

reasoning .....

.....

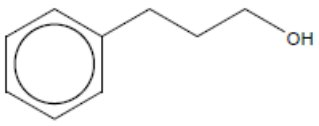
.....

.....

structure of compound responsible for the spectrum

[3]

WM20i

(peak at) 3200–3640 (cm^{-1}) indicates –OH (in alcohol) ✓ no (strong) peak at (about) 1720–1740 (cm^{-1}) so no C=O group (in aldehyde) ✓  ✓	3	may be shown on the diagram of the spectrum **ALLOW** any value or range of values for peak within the range may show $–CH_2–$ groups

WM12ii

Cinnamaldehyde can be converted to cinnamic acid.

Give the reagents and conditions that are used in the laboratory to convert an aldehyde into a carboxylic acid.

reagents .....

.....

conditions ..... [2]

WM12ii

acidified dichromate ✓ heat / reflux ✓	2	**ALLOW** any concentration of acid **ALLOW** formulae, sulfuric acid for acid, potassium or sodium salt

PR5i

Carbon monoxide is used as a reactant for the production of propanal, CH_3CH_2CHO, from ethene.

Name the homologous series to which propanal belongs.

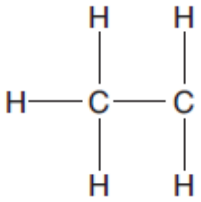
..... [1]

PR5i

aldehyde(s) ✓	1	ALLOW alkanal(s)

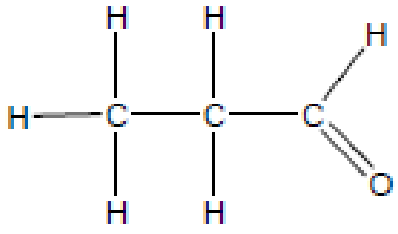
PR5i

Complete the diagram below to show the full structural formula for propanal.



[1]

PR5i



✓

1

4

PR1i

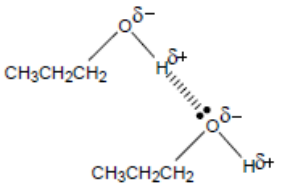
A student decided to make some propene from propan-1-ol.

Propan-1-ol is a liquid at room temperature, whilst propene is a gas. The strongest type of intermolecular bond between propan-1-ol molecules is hydrogen bonding.

Draw a diagram to show the hydrogen bonding between **two** propan-1-ol molecules. Include relevant lone pairs and partial charges in your diagram.

[4]

PR1i



hydrogen bond between correct atoms ✓ lone pair on relevant O in line with H bond ✓ partial charges shown, δ– on each O and δ+ on each H ✓ O–H–O straight ✓	4	Hydrogen bond can be shown in other forms, but not as a solid line. Second mark, but **NOT** third mark, can be scored if the hydrogen bond is between incorrect atoms.

PR2
ES7i
ES7ii

Propan-1-ol has a higher boiling point than propene. Explain this in terms of intermolecular bonding.

In your answer, you should make it clear how the steps you describe are linked to one another.

.....

.....

.....

.....

..... **[4]**

PR2
ES7i
ES7ii

*Any **three** from:* 1. intermolecular bond in propene is instantaneous dipole-induced dipole ✓ 2. hydrogen bonds / intermolecular bonds (in propan-1-ol) are stronger than those in propene (ORA) ✓ 3. intermolecular bonds must be broken for the liquid to boil ✓ 4. more <u>energy</u> is needed to break them (ORA) ✓ **AND** QWC - mark for connection of ideas: idea of linking strength of intermolecular bonds to amount of energy needed to break them ✓	4	**ALLOW** van der Waals' **DO NOT ALLOW** harder / easier **DO NOT ALLOW** 'higher temperature' for 'more energy'.