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A' Level Chemistry
Year 2

Unit 13: Isomerism, Aldehydes, Ketones etc.

Summer Examination Revision Pack

The questions in this pack should be attempted **AFTER** completing all other revision.

Grade Accelerator
Recall Definitions
Drawing Diagrams
Using Equations
Drawing Graphs

Quizlet

Quizlet Classes
Flashcard Based
Games
Tests & Quizzes
Keyword Spell Checker

Condensed Notes
Keywords & Definitions
Key Concepts
Application
Key Skills

Online Forms
Take Time to Answer
Use Paper & Calculator
Work It Out
Review Missed Marks

Use the 3 Wave Process when completing these revision packs.

1. Complete the questions without assistance
(Can't answer a question? Leave it and move on)
2. Use your notes to fill any gaps after step 1
3. Use the mark scheme to fill in any remaining gaps.

1. Having gaps after step 1 is normal, that's why we are doing revision!
2. If your notes don't help during step 2, they are not good enough!
(Change your note taking method and try to understand the problem)
3. If you don't understand why the mark scheme answer is correct, **see Andy.**

STOP If you struggle with the questions in the pack, **STOP!** and complete some more revision.

STOP If you come to a complete dead-end, **STOP!** and speak to **Andy** asap.

0 4 The aldehyde $CH_3CH_2CH_2CH_2CHO$ reacts with KCN followed by dilute acid to form a racemic mixture of the two stereoisomers of $CH_3CH_2CH_2CH_2CH(OH)CN$

0 4 . 1 Give the IUPAC name of $CH_3CH_2CH_2CH_2CH(OH)CN$

[1 mark]

0 4 . 2 Describe how you would distinguish between separate samples of the two stereoisomers of $CH_3CH_2CH_2CH_2CH(OH)CN$

[2 marks]

0 4 . 3 Explain why the reaction produces a racemic mixture.

[3 marks]

Do not write outside the box

0 4 . 4 An isomer of $CH_3CH_2CH_2CH_2CHO$ reacts with KCN followed by dilute acid to form a compound that does not show stereoisomerism.

Draw the structure of the compound formed and justify why it does not show stereoisomerism.

[2 marks]

Structure

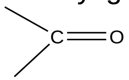
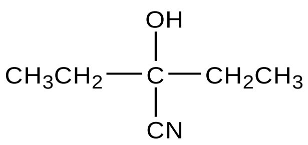
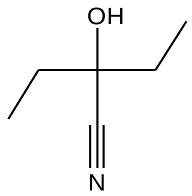
Justification

____

____

8

Turn over for the next question

Question	Answers	Mark	Additional Comments/Guidance
04.1	2-hydroxyhexanenitrile	1	
04.2	(Plane) polarised light Enantiomers would <u>rotate</u> light in opposite directions	1 1	not different alone
04.3	<u>planar</u> carbonyl group or <u>planar</u>  Attack from either side With <u>equal</u> probability OR produces <u>equal</u> amounts (of the two isomers/enantiomers)	1 1 1	Not planar molecule, not planar bond, not planar C=O
04.4	 Does not contain a chiral centre **OR** does not contain C attached to 4 different groups **OR** contains two identical/ethyl groups **OR** symmetrical (product)	1 1	Allow C_2H_5 or skeletal  M2 dependent on correct M1 (No structure = 0) If pentan-3-one drawn then allow symmetrical ketone for M2
Total		**8**	

Do not write outside the box

1 3 Aqueous $NaBH_4$ reduces aldehydes but does not reduce alkenes.

1 3 . 1 Show the first step of the mechanism of the reaction between $NaBH_4$ and 2-methylbutanal.
You should include two curly arrows.

Explain why $NaBH_4$ reduces 2-methylbutanal but has no reaction with 2-methylbut-1-ene.

[5 marks]

First step of mechanism

Explanation ______________________________

____

____

____

____

____

1 3 . 2 A student attempted to reduce a sample of 2-methylbutanal but added insufficient $NaBH_4$
The student confirmed that the reduction was incomplete by using a chemical test.

Give the reagent and observation for the chemical test.

[2 marks]

Reagent ______________________________

____

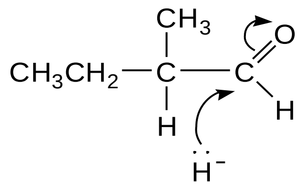
Observation ______________________________

____

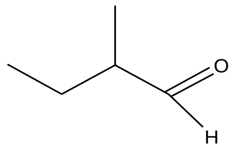
7

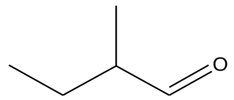
END OF QUESTIONS

<table>
<tr><th>Question</th><th colspan="2">Answers</th><th>Additional Comments/Guidelines</th><th>Mark</th></tr>
<tr><td>13.1</td><td colspan="2">M1 for structure of 2-methylbutanal

M2 for 2 curly arrows and lp on hydride, i.e.


Explanation:
M3 H⁻ ion / nucleophile is attracted to δ+ C
M4 electron rich C=C
M5 H⁻ ion / nucleophile is repelled by C=C
OR
C=C only attacked by/reacts with electrophiles</td><td>Allow C_2H_5 for CH_3CH_2



OR


Penalise M2 for wrong partial charges on C=O
Ignore product</td><td>1

1

1
1
1</td></tr>
<tr><td>13.2</td><td>Tollens' (reagent) OR
ammoniacal silver nitrate OR
description of making Tollens'

Silver mirror/ppt OR
black solid / precipitate / deposit</td><td>Fehling's/ Benedict's (solutions)

red solid / precipitate (allow orange or brown)</td><td>NOT dichromate
For Tollens' reagent:
for M1 ignore either $AgNO_3$ or $[Ag(NH_3)_2^+]$ or "the silver mirror test" on their own, or "Tolling's reagent", but mark on

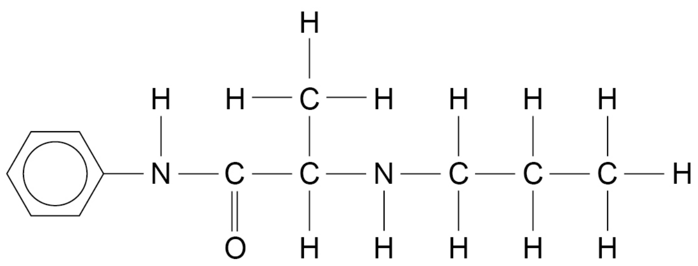
For Fehling's/Benedict's solution:
for M1 Ignore Cu^{2+}(aq) or $CuSO_4$ or "Fellings" on their own, but mark on</td><td>1

1</td></tr>
</table>

Do not write outside the box

0 2 Prilocaine is used as an anaesthetic in dentistry.
Figure 3 shows the structure of prilocaine.

Figure 3



0 2 . 1 Draw a circle around any chiral centre(s) in **Figure 3**.

[1 mark]

0 2 . 2 Identify the functional group(s) in the prilocaine molecule.

[1 mark]

Tick (✓) the box(es) corresponding to the functional group(s).

Amide	Amine	Ester	Ketone

0 2 . 3 Prilocaine is completely hydrolysed in the human body to give a mixture of products.

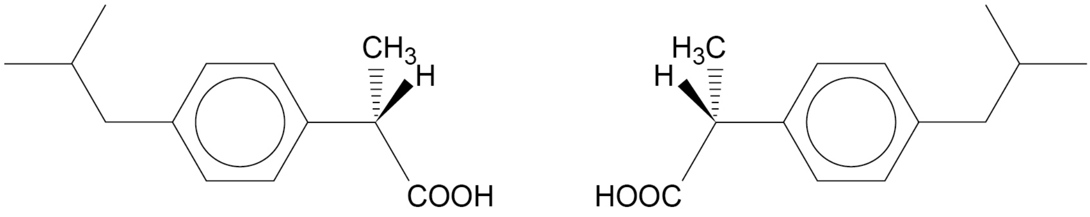
Draw the structures of the two organic products formed in the complete hydrolysis of prilocaine in acidic conditions.

[3 marks]

Do not write outside the box

0 2 . 4 **Figure 4** shows optical isomers **F** and **G**.

Figure 4



Isomer **F** Isomer **G**

Isomer **F** is the active compound in the medicine ibuprofen.

In the manufacture of ibuprofen both isomers **F** and **G** are formed. An enzyme is then used to bind to isomer **G** and catalyse its hydrolysis.

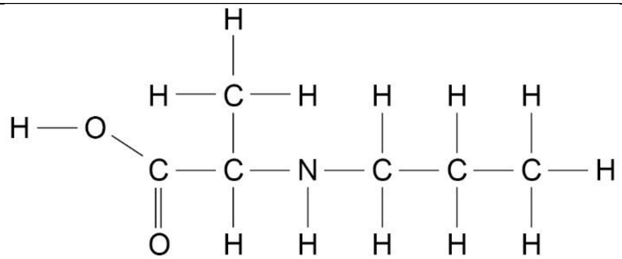
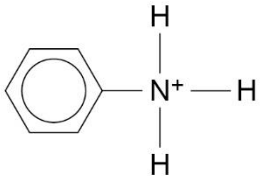
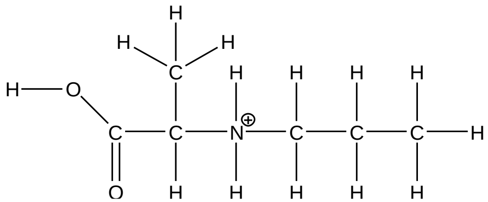
After the products of hydrolysis of **G** are removed, a pure sample of isomer **F** is collected.

Explain how a structural feature of this enzyme enables it to catalyse the hydrolysis of isomer **G** but not the hydrolysis of isomer **F**.

[2 marks]

7

Turn over for the next question

Question	Answers	Additional comments/Guidelines	Mark
02.1	One circled C atom only – The C attached to CH_3/C=O/ H and NH		1
02.2	Two ticks only for amine and amide		1
02.3	 	**M1** for choosing the correct bond to hydrolyse **M2** and **M3** for the correct structures of the products Allow protonated amino acid for M2  Allow $C_6H_5NH_3^+$ or + outside a square bracket	3

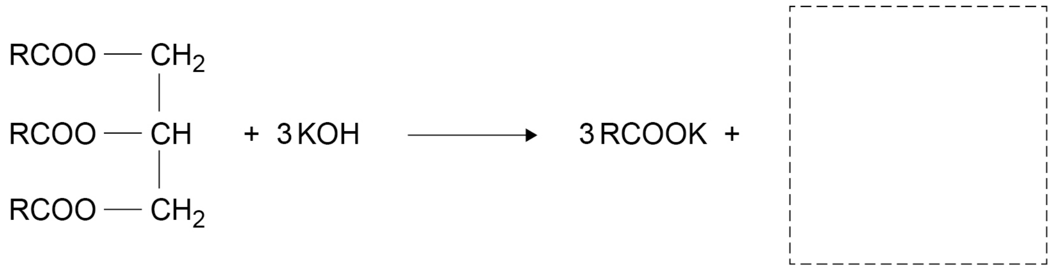
MARK SCHEME – A-LEVEL CHEMISTRY – 7405/2 – JUNE 2020

02.4	**M1** Enzyme has an <u>active site</u> **M2** The G-Enantiomer / Enzyme has the correct stereo chemistry / stereospecific Or The G-Enantiomer / Enzyme has the complementary shape	For M2 allow opposite argument for F-Enantiomer	1 1

Do not write outside the box

Answer **all** questions in the spaces provided.

0 1 Coconut oil contains a triester with three identical R groups.
This triester reacts with potassium hydroxide.



0 1 . 1 Complete the equation by drawing the structure of the other product of this reaction in the box.

Name the type of compound shown by the formula RCOOK

Give **one** use for this type of compound.

[3 marks]

Type of compound ____________________

Use ____________________

0 1 . 2 The triester in coconut oil has a relative molecular mass, M_r = 638.0
In the equation shown at the start of Question **01**, R represents an alkyl group that can be written as $CH_3(CH_2)_n$

Deduce the value of n in $CH_3(CH_2)_n$
Show your working.

[3 marks]

n ____________________

Do not write outside the box

0 1 . 3 A 1.450 g sample of coconut oil is heated with 0.421 g of KOH in aqueous ethanol until all of the triester is hydrolysed.
The mixture is cooled.
The remaining KOH is neutralised by exactly 15.65 cm^3 of 0.100 mol dm^{-3} HCl

Calculate the percentage by mass of the triester (M_r = 638.0) in the coconut oil.

[6 marks]

Percentage by mass ____________________

Do not write outside the box

0 1 . 4 Suggest why aqueous ethanol is a suitable solvent when heating the coconut oil with KOH.

Give a safety precaution used when heating the mixture.
Justify your choice.

[3 marks]

Reason ____

____

Safety precaution ____

____

Justification ____

____

15

Question	Answers	Additional Comments/Guidelines	Mark
01.1	$CH_2OHCH(OH)CH_2OH$		1
	(Potassium) Carboxylate salt	Allow fatty acid salt / salt Salt of a carboxylic acid	1
	Soap	Allow detergent / surfactant	1

Question	Answers	Additional Comments/Guidelines	Mark
01.2	638 = 173 + 3(15 + 14n) M_r ester fragment = 173		M1
	Show substract 638 – (M1 + 45)		M2
	Division of M2 by 42 n = 10	n must be an integer	M3

Question	Answers	Additional Comments/Guidelines	Mark
01.3	Amount HCl = 0.100 × 0.01565 = 1.565×10^{-3} mol Initial amount KOH = $\frac{0.421}{56.1}$ = 7.50×10^{-3} mol Amount KOH used = M2 – M1 = 5.939×10^{-3} mol Amount ester = $\frac{5.935 \times 10^{-3}}{3}$ = 1.980×10^{-3} mol (M3 / 3) Mass ester = (1.980×10^{-3}) × 638 = 1.263 g (M4 x 638) %age by mass = $\frac{1.263}{1.45}$ × 100 = 87.1 % ((M5 / 1.45) x 100)	Allow 87.0 to 87.1 Allow 2 sf Don’t allow M6 for an answer >100%	M1 M2 M3 M4 M5 M6

Question	Answers	Additional Comments/Guidelines	Mark
01.4	Allow to dissolve both oil and KOH	To act as a mutual solvent **OR** To ensure reactants are miscible	M1
	Precaution must be linked to heating e.g. Use a water bath for heating mixture	Allow electrical heater / mantle Allow sand bath	M2
	Prevents risk of fire / Ethanol is flammable	Allow KOH is corrosive/caustic/damages eyes if matches alternative precaution given	M3

Do not write outside the box

0 1 . 8 Name and outline the mechanism for the reaction of butanone with KCN followed by dilute acid.

[5 marks]

Name of mechanism ____________________

Outline of mechanism

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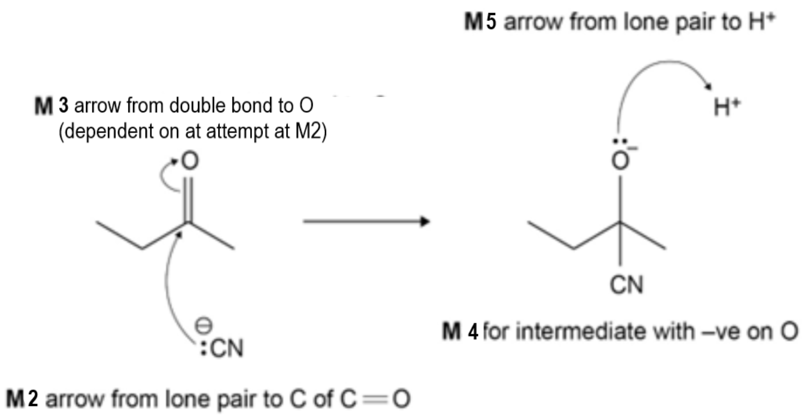
Turn over for the next question

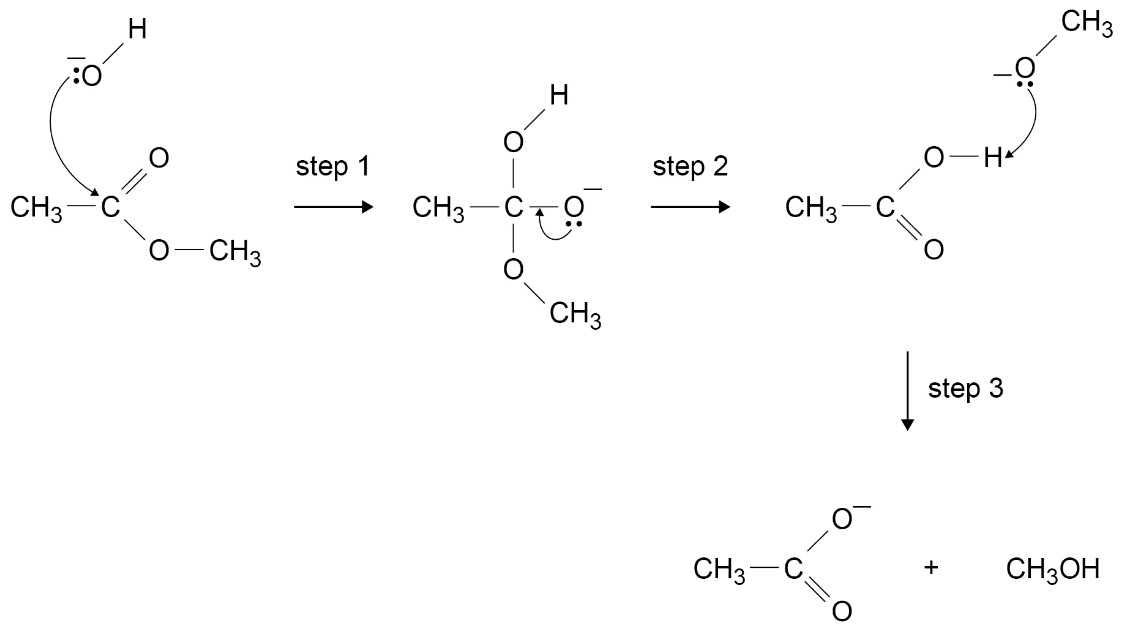
Question	Answers	Additional Comments/Guidelines	Mark
01.8	Nucleophilic Addition  	ALLOW negative charge anywhere on cyanide But attacking lone pair must be on C Do not award M3 without attempt of M2 Allow M2 for attack to a positive carbon following breaking of C=O Penalise covalent KCN in M2 M3 ignore partial charges unless wrong Penalise M3 for incorrect connection between CN and C NB Allow fully displayed or other structural formulae	M1 M2 M3 M4 M5 (1 x AO1, 4 x AO2)

Do not write outside the box

0 7 This question is about esters.

Figure 4 shows an incomplete mechanism for the reaction of an ester with aqueous sodium hydroxide.

Figure 4



0 7 . 1 Add **three** curly arrows to complete the mechanism in **Figure 4**.

[3 marks]

0 7 . 2 Name the type of reaction shown in **Figure 4**.

[1 mark]

____

0 7 . 3 Deduce the role of the CH_3O^- ion in step **3** shown in **Figure 4**.

[1 mark]

____

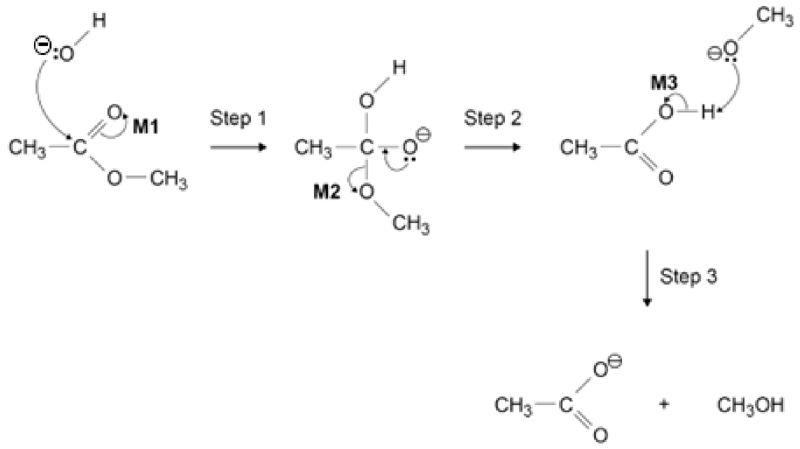
0 7 . 4 A triester in vegetable oil reacts with sodium hydroxide in a similar way.

Give a use for a product of this reaction.

[1 mark]

____

6

Question	Answers	Additional Comments/Guidelines	Mark
07.1		M1: Arrow from C=O bond to O M2 Arrow from correct C-O bond to O M3 Arrow from O-H bond to O	3 (3 x AO3)

Question	Answers	Additional Comments/Guidelines	Mark
07.2	(Alkaline/base) hydrolysis		1 (AO1)

Question	Answers	Additional Comments/Guidelines	Mark
07.3	Base	Allow proton acceptor Ignore ref to Bronsted Lowry	1 (AO1)

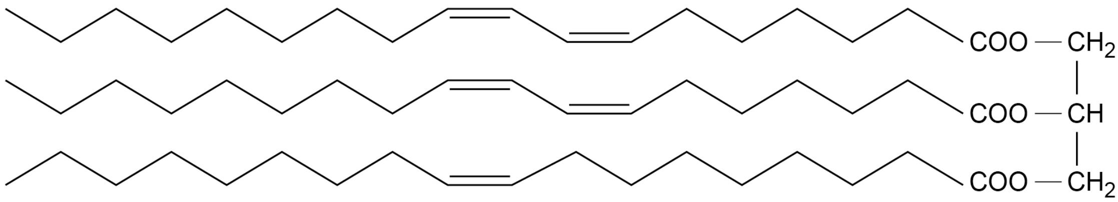
Question	Answers	Additional Comments/Guidelines	Mark
07.4	Soap only		1 (AO1)

Do not write outside the box

0 9 This question is about olive oil.

A sample of olive oil is mainly the unsaturated fat **Y** mixed with a small amount of inert impurity.

The structure of **Y** in the olive oil is shown.
Y has the molecular formula $C_{57}H_{100}O_6$ (M_r = 880).



The amount of **Y** is found by measuring how much bromine water is decolourised by a sample of oil, using this method.

- Transfer a weighed sample of oil to a 250 cm^3 volumetric flask and make up to the mark with an inert organic solvent.
- Titrate 25.0 cm^3 samples of the olive oil solution with 0.025 mol dm^{-3} $Br_2(aq)$.

0 9 . 1 A suitable target titre for the titration is 30.0 cm^3 of 0.025 mol dm^{-3} $Br_2(aq)$.

Justify why a much smaller target titre would **not** be appropriate.

Calculate the amount, in moles, of bromine in the target titre.

[2 marks]

Justification ______________________________

____

____

____

Amount of bromine ______________________ mol

Do not write outside the box

0 9 . 2 Calculate a suitable mass of olive oil to transfer to the volumetric flask using your answer to Question **09.1** and the structure of **Y**.
Assume that the olive oil contains 85% of **Y** by mass.

(If you were unable to calculate the amount of bromine in the target titre, you should assume it is 6.25×10^{-4} mol. This is **not** the correct amount.)

[5 marks]

Mass of olive oil ____________________ g

Question 9 continues on the next page

Turn over ►

The olive oil solution can be prepared using this method.

- Place a weighing bottle on a balance and record the mass, in g, to 2 decimal places.
- Add olive oil to the weighing bottle until a suitable mass has been added.
- Record the mass of the weighing bottle and olive oil.
- Pour the olive oil into a 250 cm^3 volumetric flask.
- Add organic solvent to the volumetric flask until it is made up to the mark.
- Place a stopper in the flask and invert the flask several times.

0 9 . 3 Suggest an extra step to ensure that the mass of olive oil in the solution is recorded accurately.

Justify your suggestion.

[2 marks]

Extra step ______________________________

____

____

Justification ______________________________

____

0 9 . 4 State the reason for inverting the flask several times.

[1 mark]

____

____

____

Do not write outside the box

0 9 . 5 A sample of the olive oil was dissolved in methanol and placed in a mass spectrometer. The sample was ionised using electrospray ionisation. Each molecule gained a hydrogen ion (H^+) during ionisation.
The spectrum showed a peak for an ion with $\frac{m}{z}$ = 345 formed from an impurity in the olive oil.
The ion with $\frac{m}{z}$ = 345 was formed from a compound with the empirical formula $C_5H_{10}O$

Deduce the molecular formula of this compound.

[2 marks]

Show your working.

Molecular formula ______________________________

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Turn over for the next question

Question	Answers	Additional Comments/Guidelines	Mark
09.1	Smaller titre will increase (%) uncertainty / error amount Br_2 = 0.025 × $^{30}/_{1000}$ = 7.5 × 10^{-4} mol	 Or 0.00075	1 1 (2 x AO3)

Question	Answers	Additional Comments/Guidelines	Mark
09.2	Ratio Y :bromine M1 1 : 5 M2 n Y in 25 cm^3 oil = $\frac{7.5 \times 10^{-4}}{5}$ = 1.5 × 10^{-4} If no ratio must state n Y for M2 M3 n Y in 250 cm^3 = M2 × 10 = (1.5 × 10^{-3}) M4 Mass = M3 × 880 = (1.32 g) M5 Total mass oil needed = M4 × $^{100}/_{85}$ = 1.55 g	Alternative calc using supplied answer n Y in 25 cm^3 oil = $\frac{6.25 \times 10^{-4}}{5}$ = 1.25 × 10^{-4} n Y in 250 cm^3 = 1.25 × 10^{-4} × 10 = (1.25 × 10^{-3}) Mass = 1.25 × 10^{-3} × 880 = (1.1 g) Total mass oil needed = 1.1 × $^{100}/_{85}$ = 1.29g If wrong ratio used treat as AE and mark ECF	M1 M2 M3 M4 M5 (3 x AO2, 2 x AO3)

Question	Answers	Additional Comments/Guidelines	Mark
09.3	Extra step: Weigh the bottle after oil transfer (and record the mass) Justification: Not all of the oil is transferred Or so that the mass of oil left in the bottle is accounted for Or find the exact mass of oil used	OR Rinse the bottle with solvent after transfer and add the washings (to the volumetric flask) To ensure all the oil is transferred M2 is dependent on M1	M1 M2 (2 x AO3)

Question	Answers	Additional Comments/Guidelines	Mark
09.4	To ensure the solution is homogeneous	Allow evenly mixed/ distributed OWTTE Uniform solution	1 (AO3)

Question	Answers	Additional Comments/Guidelines	Mark
09.5	M_r = 345 – 1 M_r ($C_5H_{10}O$) = 86 $^{M1}/_{86}$ = 4 Hence $C_{20}H_{40}O_4$	Must show workings in both M1 and M2	M1 M2 (2 x AO2)

Do not write outside the box

0 3 This question is about ketones.

0 3 . 1 Solution **X** reacts with liquid ketones to form a crystalline solid.

This reaction can be used to identify a ketone if the crystalline solid is separated, purified by recrystallisation, and the melting point determined.

Describe how the crystalline solid is separated and purified.

[5 marks]

Do not write outside the box

0 3 . 2 Propanone (CH_3COCH_3) reacts with the weak acid HCN to form a hydroxynitrile.

This hydroxynitrile is usually made by reaction of propanone with KCN followed by dilute acid, instead of with HCN

State the hazard associated with the use of KCN

Suggest a reason, other than safety, why KCN is used instead of HCN.

[2 marks]

Hazard ____________________

Why KCN is used ____________________

____

0 3 . 3 Outline the mechanism for the reaction of propanone with KCN followed by dilute acid.

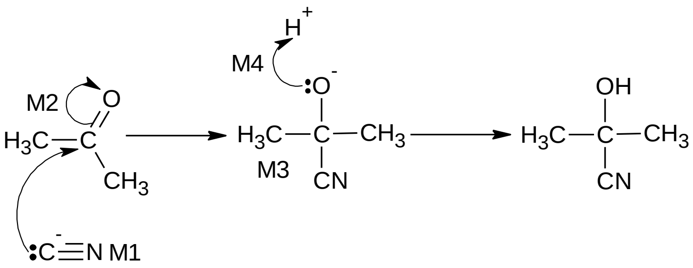
[4 marks]

11

Turn over for the next question

Question	Answers	Additional comments/Guidelines	Mark
3.1	filter / decant		1
	dissolve in minimum vol	**allow** small volume **allow** to make saturated solution	1
	of hot solvent	**not** warm **Ignore** hot filtration	1
	cool / leave (to crystallise) **AND** filter (under reduced pressure)		1
	Wash with cold solvent/water, and dry (with method)		1

Question	Answers	Additional comments/Guidelines	Mark
3.2	**M1** toxic / poisonous	**allow** can produce toxic fumes/gas / corrosive	1
	M2 HCN weak / $[CN^-]$ too low **ORA**	**allow** KCN dissociates to provide CN^-/nucleophile **allow** KCN dissociates better/more than HCN	1

Question	Answers	Additional comments/Guidelines	Mark
3.3			
	M1 cyanide ion with lone pair on C and negative charge and curly arrow from lone pair to C of C=O	**not** if K–CN bond shown breaking	1
	M2 Curly arrow from = to O	**not** if dipole incorrect	1
	M3 intermediate anion	new bond must be to C of CN	1
	M4 curly arrow from lone pair on O to H^+	**allow** curly arrow to H of HCN	1