

(c) **P** and **Q** ($\text{C}_3\text{H}_6\text{O}$) both form an orange precipitate when reacted with 2,4-DNPH. Only **Q** produces a yellow precipitate when reacted with alkaline aqueous iodine.

(i) Name **P** and **Q**.

P

Q

[2]

May/June 2017 9701/21 · Q4 (c)(i)

(c) The isomers **F** and **G**, $\text{C}_5\text{H}_{10}\text{O}$, both form an orange precipitate when reacted with 2,4-DNPH.

F is unbranched and reacts with alkaline aqueous iodine to produce a yellow precipitate.

G does not react with alkaline aqueous iodine. It contains a chiral centre and produces a silver mirror when warmed with Tollens' reagent.

(i) Name the yellow precipitate produced by the reaction between **F** and alkaline aqueous iodine.

..... [1]

May/June 2017 9701/22 · Q4 (c)(i)

- (a) Complete the table, identifying any observations for the reaction of each reagent with **P**, **Q** and **R**.

If no reaction occurs, write 'no reaction'.

reagent	observations with		
	P	Q	R
Na(s)			
2,4-DNPH	no reaction		
acidified K ₂ Cr ₂ O ₇ (aq)	no reaction		

[3]

- (b) **Q** is reduced by NaBH₄.

Write an equation for the reaction of **Q** with NaBH₄.

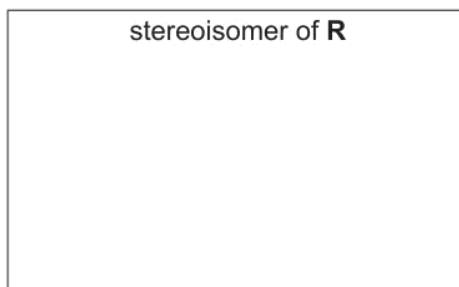
In your answer, use [H] to represent NaBH₄.

C₅H₁₀O + [1]

(c) **R** exists as a pair of stereoisomers.

Identify the type of stereoisomerism shown by **R** and draw the structure of the other stereoisomer.

type of stereoisomerism



[2]

March 2019 9701/22 · Q3 (a), (b), (c) (cont.)

(c) **X**, **Y** and **Z** are all isomers of $(\text{CH}_3)_3\text{CCHO}$.

A summary of some of the reactions and properties of **X**, **Y** and **Z** is shown in the table.

compound	observations with 2,4-DNPH	observations with Fehling's solution	principal absorptions in infra-red spectrum
X		no reaction	1715 cm^{-1}
Y		red precipitate	1730 cm^{-1}
Z	no reaction	no reaction	$3200\text{--}3600\text{ cm}^{-1}$ 1630 cm^{-1} 1050 cm^{-1}

(i) **X** and **Y** each contains a carbonyl group.

Complete the table with the expected observations for the reactions of **X** and **Y** with 2,4-DNPH. [1]

Oct/Nov 2019 9701/21 · Q4 (c)(i)

(iii) Give the observation you would make when 2,4-dinitrophenylhydrazine is added to **P**.

..... [1]

March 2020 9701/22 · Q3 (a)(iii)

- (ii) Only one of the students successfully prepares 2-hydroxybutanoic acid.

Identify which of **Q** or **R** is 2-hydroxybutanoic acid and explain the difference between reactions 2 and 3.

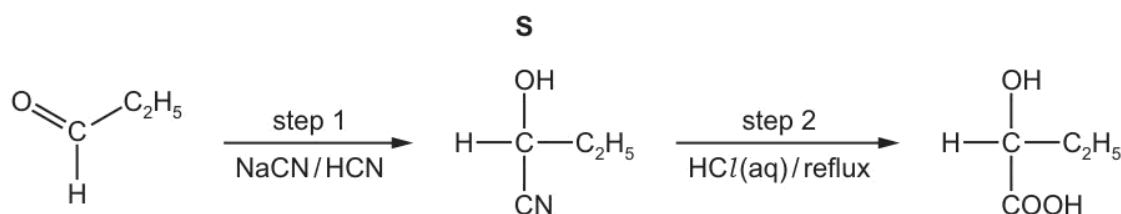
.....
.....
..... [2]

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[Turn over**10**

A third student prepares 2-hydroxybutanoic acid using propanal as the starting material. In step 1 the student reacts propanal with a mixture of NaCN and HCN.



- (iii) Draw the mechanism for the reaction of propanal with the mixture of NaCN and HCN to form **S**.

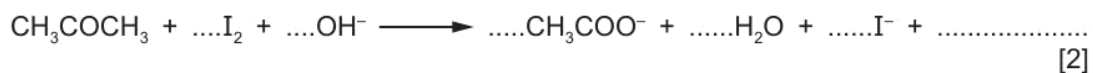
- Identify the ion that reacts with propanal.
- Draw the structure of the intermediate of the reaction.
- Include all charges, partial charges, lone pairs and curly arrows.



[4]

- (vi) Propanone reacts with excess alkaline aqueous iodine.

Complete and balance the equation for this reaction.



- (vii) State **one** observation that can be made in the reaction in (c)(vi).

..... [1]

[Total: 16]

15

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16

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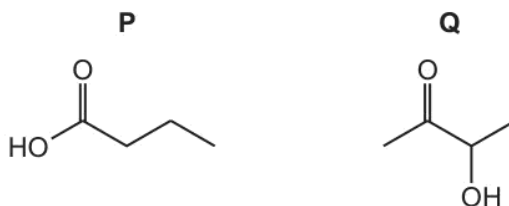
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Oct/Nov 2020 9701/21 · Q4 (c)(vi) (cont.)

(c) **P** and **Q** have the same molecular formula as **G**.



Complete the table with the expected observations for the reactions of **P** and **Q** with the named reagents.

reagent	result with P	result with Q
$\text{Br}_2(\text{aq})$		
2,4-dinitrophenylhydrazine		
aqueous sodium carbonate		

[3]

Oct/Nov 2020 9701/22 · Q4 (c)

- (b) Hydroxyethanal reacts separately with 2,4-dinitrophenylhydrazine (2,4-DNPH) and with Tollens' reagent.

State what you would observe in each reaction.

reaction with 2,4-DNPH

reaction with Tollens' reagent

[2]

March 2021 9701/22 · Q4 (b)

- (d) Alcohol **Y** reacts completely when warmed with acidified $\text{Cr}_2\text{O}_7^{2-}$ to form **Z**.

Z is distilled from the reaction mixture as soon as it is made.

Tollens' reagent is added to a sample of **Z** and warmed. A silver mirror forms.

- (i) Name the type of reaction that occurs when **Y** reacts to form **Z**.

..... [1]

- (ii) Identify with a tick (✓) the functional group(s) present in **Z**.

functional group	present in Z
aldehyde	
ketone	
carboxylic acid	

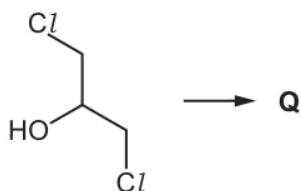
[1]

[Total: 12]

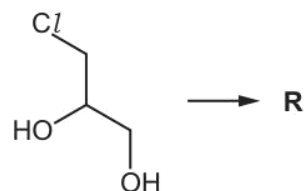
- (b) Separate samples of 1,3-dichloropropan-2-ol and 3-chloropropane-1,2-diol are heated with excess acidified $\text{Cr}_2\text{O}_7^{2-}$ until there is no further reaction.

In each reaction, a different organic product, **Q** or **R**, is made.

1,3-dichloropropan-2-ol



3-chloropropane-1,2-diol



Q and **R** are tested separately with 2,4-dinitrophenylhydrazine solution, 2,4-DNPH, and sodium carbonate solution, $\text{Na}_2\text{CO}_3(\text{aq})$.

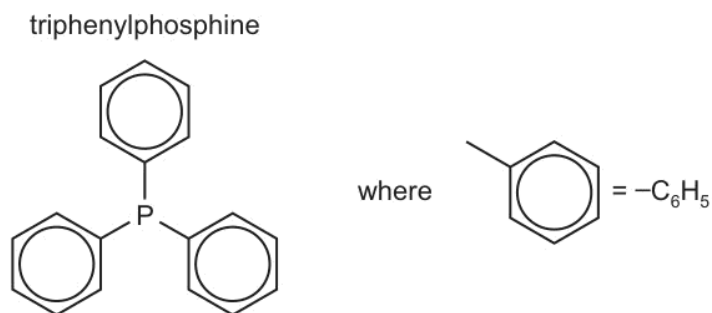
Complete the table to give any relevant observations.

If no reaction occurs, write 'no visible change'.

reagent	observation with Q	observation with R
2,4-DNPH		
$\text{Na}_2\text{CO}_3(\text{aq})$		

[4]

(c) Triphenylphosphine is used in a type of reaction known as a *Wittig reaction*.



(i) Give the empirical formula of triphenylphosphine.

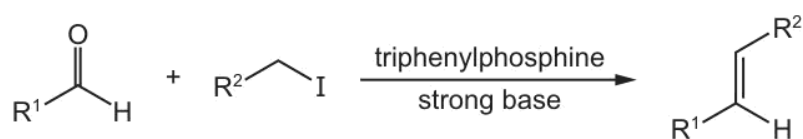
..... [1]

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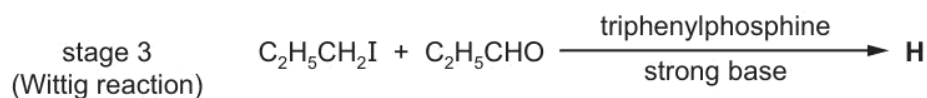
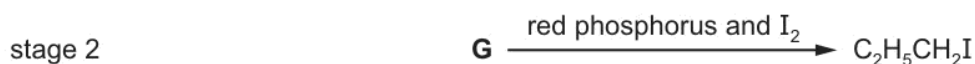
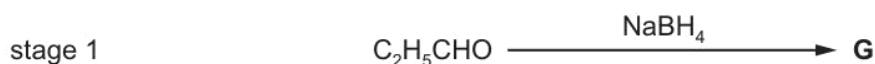
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In a Wittig reaction, an aldehyde reacts with a halogenoalkane to form an alkene. The conversion is shown in the following unbalanced equation.



Compound **H** can be made from propanal, $\text{C}_2\text{H}_5\text{CHO}$. Stage 3 in the reaction scheme is a Wittig reaction.



Oct/Nov 2021 9701/21 · Q3 (c)(i)

- (ii) State and explain how 2,4-dinitrophenylhydrazine (2,4-DNPH) can be used to detect the presence of **V** as a product of reaction 2.

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

Oct/Nov 2021 9701/22 · Q3 (d)(ii)

- (a) (i) Complete Table 4.1 to state what you would **observe** when **J** reacts with the reagents listed.

Table 4.1

reagent	observation with J
2,4-dinitrophenylhydrazine (2,4-DNPH)	
Tollens' reagent	
sodium metal	

[3]

March 2022 9701/22 · Q4 (a)(i), (b)(iv) (continued ·)

(iv) **K** can be made from propanone in the three-step synthesis shown in Fig. 4.3.

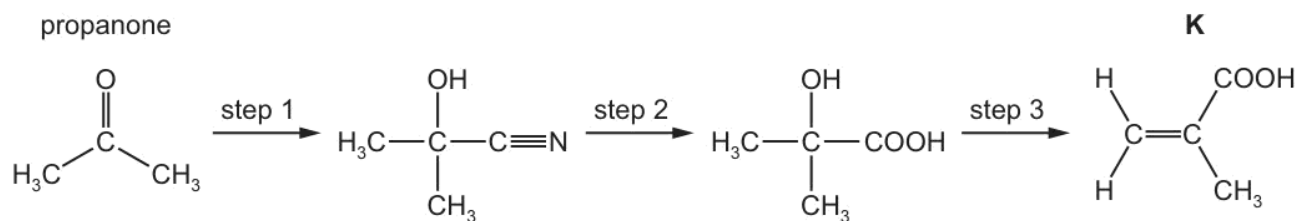


Fig. 4.3

Complete Table 4.3 to identify the reagent(s) used and the type of reaction in each step.

Table 4.3

step	reagent(s)	type of reaction
1		
2		
3	Al_2O_3	

[5]

[Total: 15]

(c) **W**, **X** and **Y** have the same molecular formula, $C_5H_{10}O$.

W, **X** and **Y** are added separately to different reagents. Observations for these reactions are described in Table 4.1.

Table 4.1

	+ 2,4-dinitrophenylhydrazine	+ alkaline $I_2(aq)$	+ Fehling's reagent and warm
W	orange precipitate seen	no change	orange-red precipitate seen
X	orange precipitate seen	yellow precipitate seen	no change
Y	orange precipitate seen		

(i) **W**, **X** and **Y** each contain a common functional group.

Name the functional group that is present in all three compounds.

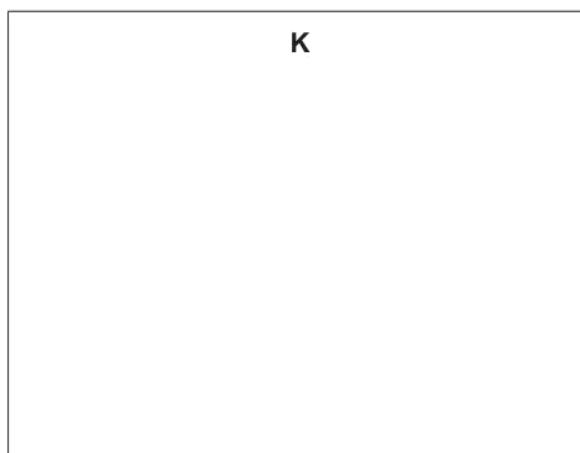
..... [1]

(c) **K** has molecular formula C_3H_6O .

When **K** is added to 2,4-dinitrophenylhydrazine, an orange precipitate forms.

When **K** is warmed with Tollens' reagent, a silver mirror forms.

Draw the displayed formula of **K**.



[2]

[Total: 16]

May/June 2022 9701/23 · Q3 (c)

(b) **A** and **B** are structural isomers with molecular formula $C_5H_{10}O$.

They are both straight-chained molecules with only one functional group.

Table 5.1 describes observations when separate samples of **A** and **B** are added to different reagents.

Table 5.1

reagent	A	B
2,4-dinitrophenylhydrazine (2,4-DNPH reagent)	orange precipitate appears	orange precipitate appears
Tollens' reagent	silver mirror appears	no reaction
alkaline $I_2(aq)$	no reaction	no reaction

(i) Name the functional group present in both **A** and **B**.

..... [1]

May/June 2023 9701/22 · Q5 (b)(i)

(iii) Complete Table 1.1 to show what is observed when compounds **Y** and **Z** react separately with the named reagents.

Table 1.1

reagent	observation with Y	observation with Z
$Na_2CO_3(aq)$	no reaction	
alkaline $I_2(aq)$		
2,4-dinitrophenylhydrazine (2,4-DNPH)		
Tollens' reagent		

[4]

March 2024 9701/22 · Q1 (d)(iii)

- (ii) **Q** contains **only** hydroxyl functional groups.

Complete Table 6.1 to show the observations that occur when 2,4-dinitrophenylhydrazine (2,4-DNPH reagent) is added to separate samples of **Y** and **Q**.

Table 6.1

	observation on addition of 2,4-DNPH reagent
Y	
Q	

[1]

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May/June 2024 9701/21 · Q6 (c)(ii)

- (iii) Write numbers in the boxes to balance the equation showing the reaction of propanone with NaClO .



[1]

Oct/Nov 2024 9701/21 · Q2 (c)(iii)

(a) Reaction 1 is a nucleophilic addition reaction.

(i) Complete Fig. 4.2 to show the mechanism for the formation of **A** from propanone.

Include charges, dipoles, lone pairs of electrons and curly arrows as appropriate.



Fig. 4.2

[3]

(b) Suggest the reagents and conditions for reaction 2.

..... [1]

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(ii) Name **C**.

..... [1]

(d) State what is observed in reaction 4.

..... [1]

(e) Explain why Fehling's reagent does **not** react with propanone.

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

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[Turn over

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Oct/Nov 2024 9701/21 · Q4 (a)(i), (b), (c)(ii), (d), (e) (cont.)

(iii) Complete Table 4.1 to state what is observed when **F** reacts with the reagents listed.

Table 4.1

reagent	observation with F
2,4-dinitrophenylhydrazine (2,4-DNPH reagent)	
Tollens' reagent	
alkaline I ₂ (aq)	

[3]





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Question 4 continues on page 14.





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(b) Suggest the reagents and conditions for reaction 2.

..... [1]

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(e) Explain why Fehling's reagent does **not** react with propanone.

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

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[Turn over]

- (a) State the functional group in ethanal, propanal and propanone.

..... [1]

- (b) State a reagent and the relevant observation that confirm that **F**, **G** and **H** have the same functional group.

reagent

observation [2]

- (c) Separate samples of **F**, **G** and **H** are each tested with Tollens' reagent and with alkaline $I_2(aq)$. The observations are shown in Table 6.1.

Table 6.1

	Tollens' reagent	alkaline $I_2(aq)$
F	no observable change	pale yellow precipitate
G	silver mirror	pale yellow precipitate
H	silver mirror	no precipitate

- (i) Use Table 6.1 to name the organic compounds in bottles **F**, **G** and **H**.

F =

G =

H = [2]

- (ii) Identify the yellow precipitate produced when alkaline $I_2(aq)$ is added to separate samples of **F** and **G**.

..... [1]

- (iii) Construct the ionic equation for the reaction of dichromate(VI) ions with methanal in acidic conditions.

..... [2]

- (iv) Methanal is a liquid at -30°C but carbon dioxide is a gas at this temperature. Explain why.

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

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4

[Turn over]

Oct/Nov 2025 9701/21 · Q1 (c)(iii), (c)(iv)

- (iii) Construct the ionic equation for the reaction of manganese(IV) oxide with methanal in acidic conditions.

..... [2]

[Total: 10]

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[Turn over]

4

Oct/Nov 2025 9701/22 · Q1 (c)(iii)

- (iv) Methanal is a liquid at -30°C but carbon dioxide is a gas at this temperature. Explain why.

.....

.....

.....

..... [2]

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4

[Turn over]

Oct/Nov 2025 9701/23 · Q1 (c)(iv)