



9: Organic chemistry 2 – Topic questions

The questions in this document have been compiled from a number of past papers, as indicated in the table below.

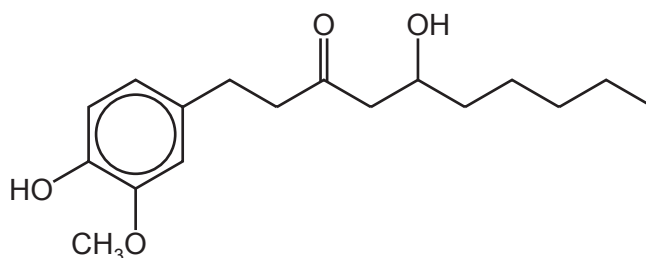
Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
8	2017	March	42
4	2017	June	41
7	2017	June	42

The mark scheme for each question is provided at the end of the document.

- 8 The root of the ginger plant contains compounds with medicinal and flavouring properties. Three of the more important compounds are gingerol, shogaol and zingerone.

(a) The structure of gingerol is shown. The $\text{CH}_3\text{O}-$ group in gingerol is unreactive.



gingerol

Gingerol reacts with acidified potassium dichromate(VI).

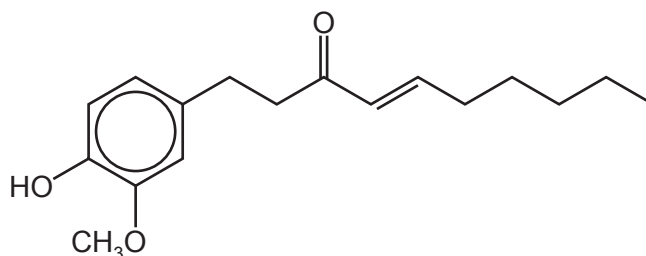
State the *type of reaction* and the functional group change which occurs during this reaction.

type of reaction

functional group change

from to [1]

(b) The structure of shogaol is shown.



shogaol

(i) State the *type of reaction* needed to convert gingerol into shogaol.

..... [1]

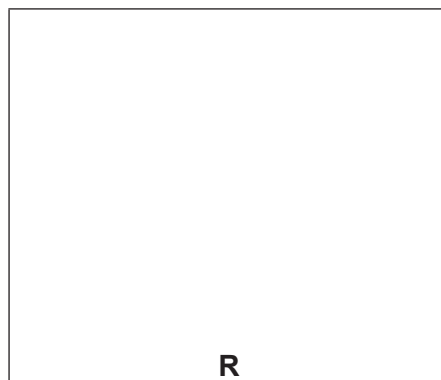
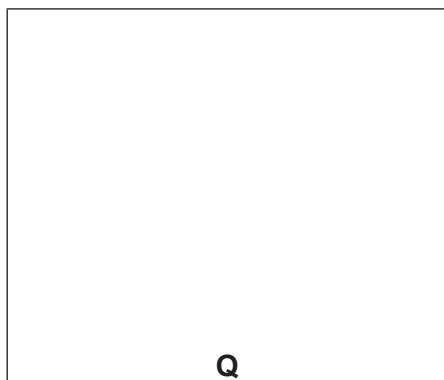
(ii) State the reagents and conditions needed to convert gingerol into shogaol.

reagents

conditions [1]

- (iii) Shogaol reacts with hot, concentrated acidified manganate(VII) ions to form two organic products, **Q** and **R**.

Draw the structures of **Q** and **R**.



[2]

- (c) Zingerone is formed from gingerol.

Some reactions of zingerone are shown.

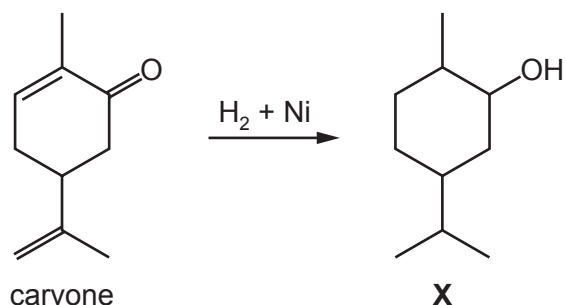
Complete the table to identify the functional groups in zingerone.

reagent and conditions	observation	functional group in zingerone indicated by the observation
benzenediazonium chloride, 5 °C, alkaline solution	red ppt.	
2,4-dinitrophenylhydrazine	orange ppt.	
warm with Tollens' reagent	no change	

[2]

[Total: 7]

- 4 Carvone occurs in spearmint and a stereoisomer of carvone occurs in caraway seeds. Treating either isomer with hydrogen over a nickel catalyst produces a mixture of isomers with the structural formula **X**.



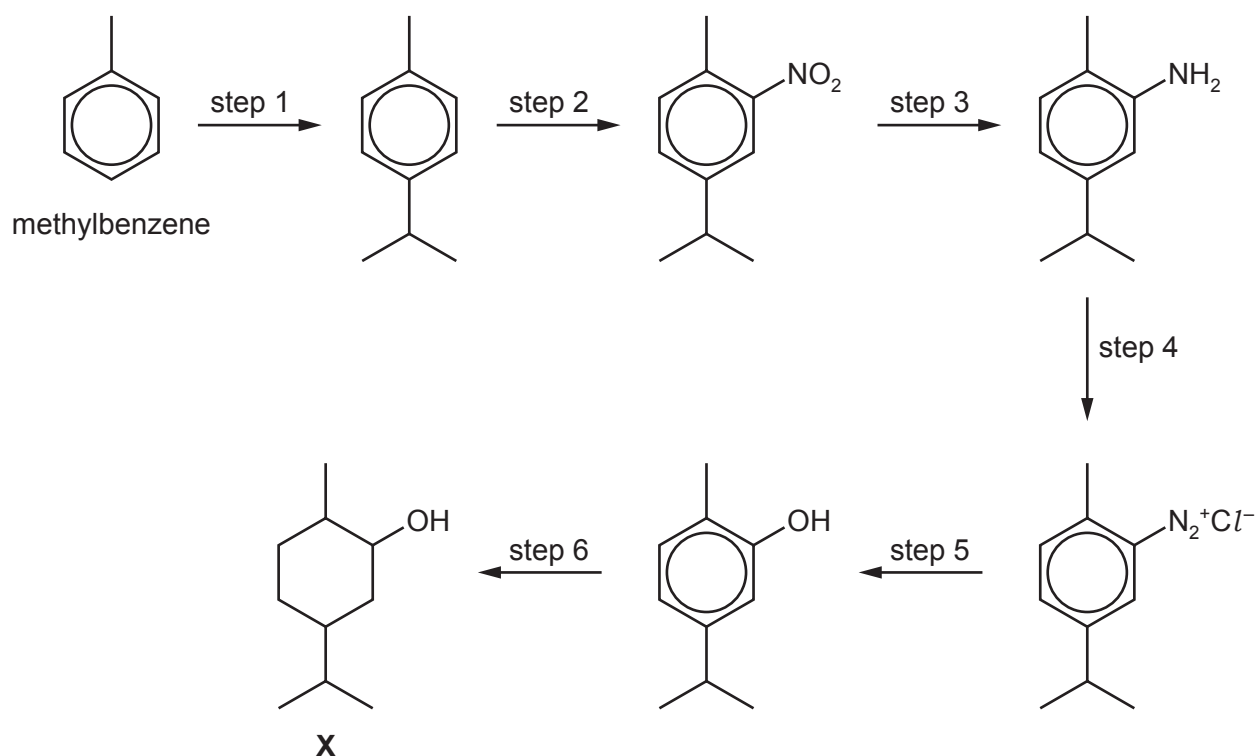
- (a) (i) State the type of stereoisomerism carvone can show. Explain your answer.

.....
 [1]

- (ii) Write an equation, using molecular formulae, for this conversion of carvone to **X**.

..... [2]

X can be synthesised from methylbenzene by the following route.



- (b) (i) Name the mechanism in step 1.

..... [1]

- (ii) What type of reaction is occurring in the following steps?

step 3

step 5 [2]

- (iii) Suggest reagents and conditions for each of the following steps.

step 1

step 2

step 3

step 4 [6]

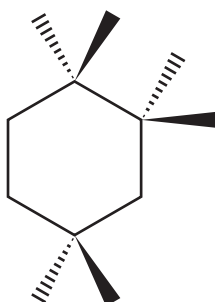
- (c) During step 6, hydrogen is added to the benzene ring to produce the cyclohexane ring in **X**. The six hydrogen atoms are all added to the **same side** of the benzene ring.

- (i) State the reagents and conditions needed for this reaction.

..... [1]

- (ii) Complete the part structure to show the structure of the isomer of **X** that would most likely be obtained during this reaction.

X



[2]

[Total: 15]

- 7 Compounds **W**, **X**, **Y** and **Z** are isomers of each other with the molecular formula C_8H_7ClO . All four isomers contain a benzene ring. Only **one** of the isomers contains a chiral centre. The results of six tests carried out on **W**, **X**, **Y** and **Z** are shown in the table.

test		observations with each isomer			
		W	X	Y	Z
1	add cold $AgNO_3(aq)$	white ppt. forms immediately	none	white ppt. forms very slowly	none
2	heat with $NaOH(aq)$, then add dilute $HNO_3 + AgNO_3(aq)$	white ppt.	none	white ppt.	none
3	add $NaOH(aq) + I_2(aq)$	none	pale yellow ppt.	none	none
4	warm with Fehling's solution	none	none	red ppt.	none
5	add cold, dilute, acidified $KMnO_4(aq)$	no change	no change	no change	decolourises
6	add $Br_2(aq)$	no change	no change	no change	decolourises and forms white ppt.

- (a) Use the experimental results in the table above to determine the group(s), in addition to the benzene ring, present in the four isomers **W**, **X**, **Y** and **Z**.

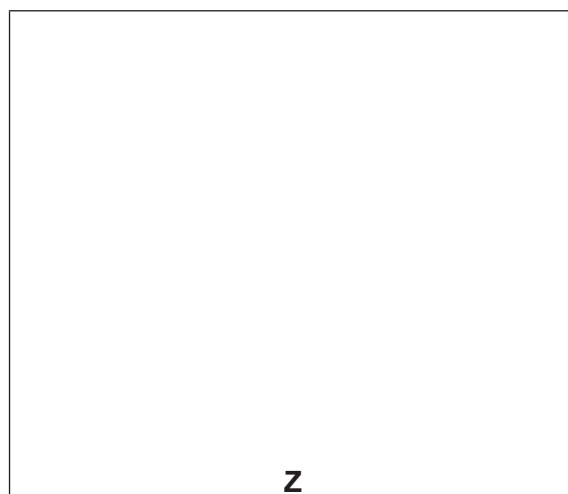
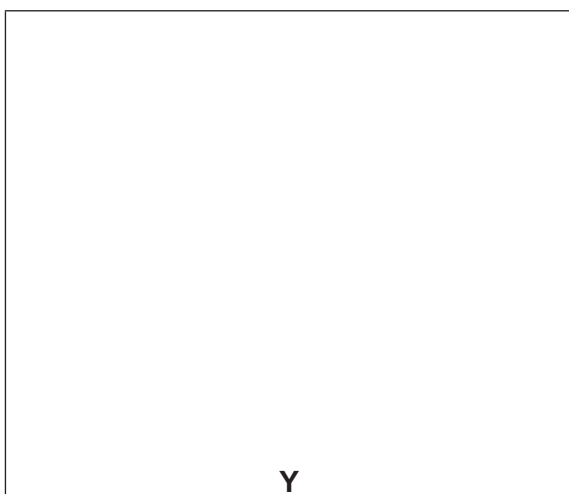
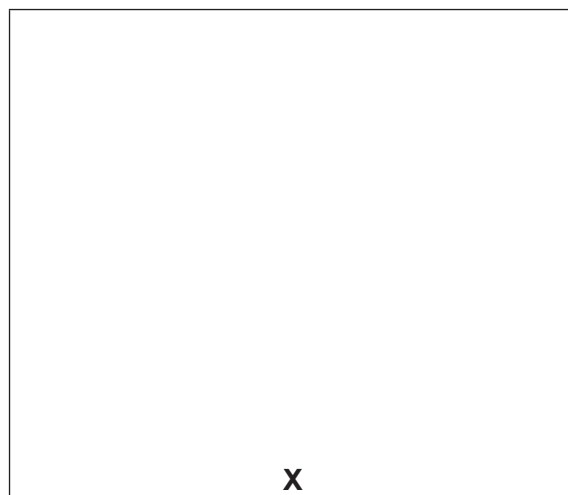
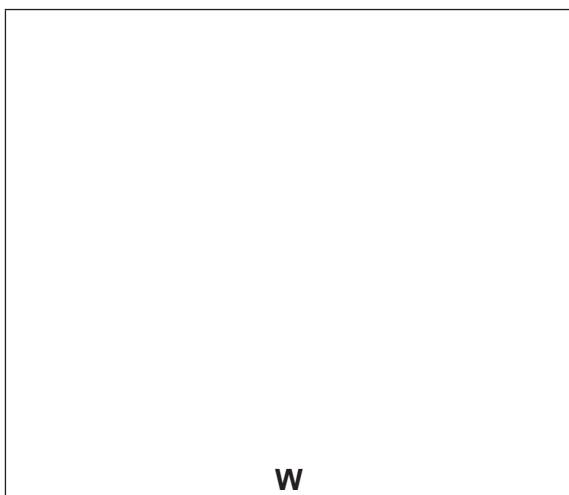
Complete the table below, identifying the group(s) present in each isomer.

group(s) in compound			
W	X	Y	Z
.....
.....
.....

[5]

(b) Isomers **W**, **X**, **Y** and **Z** all have the molecular formula C_8H_7ClO .

(i) Use the information in (a) to suggest a structure for each of these isomers and draw these in the boxes.

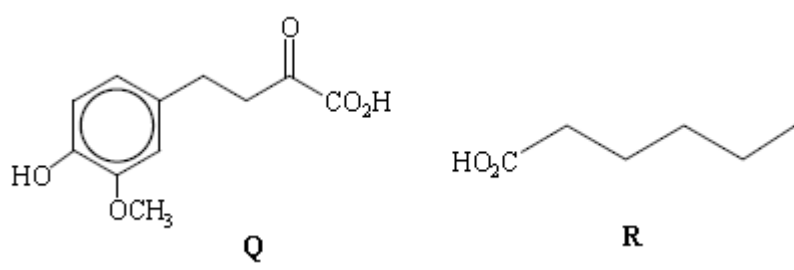


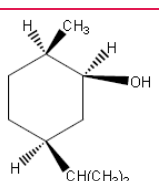
[4]

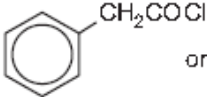
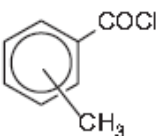
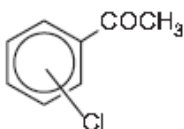
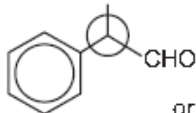
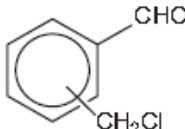
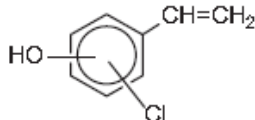
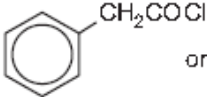
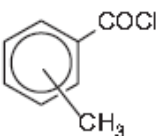
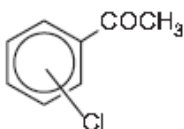
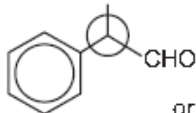
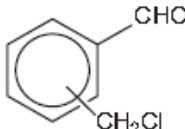
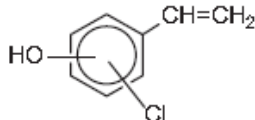
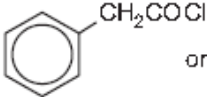
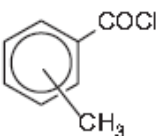
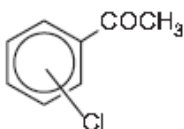
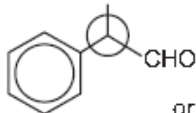
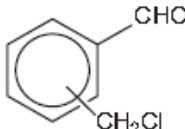
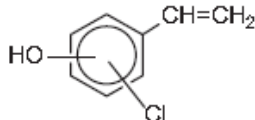
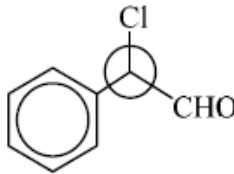
(ii) Draw a **circle** around the chiral centre in **one** of the above structures.

[1]

[Total: 10]

Question	Answer	Marks
8 (a)	oxidation of -OH / alcohol to C=O / ketone / carbonyl	1
8 (b) (i)	dehydration / elimination	1
8 (b) (ii)	heat with Al_2O_3 OR heat with H_3PO_4 / H_2SO_4	1
8 (b) (iii)	 <p style="text-align: center;">Q R</p>	2
8 (c)	phenol	1
	ketone	1
Total: 7		

Question	Answer	Marks
4 (a) (i)	optical, because it contains a / one chiral C-atom or chiral C-atoms or chiral atom / centre or C^* indicated or C with 4 different groups	1
4 (a) (ii)	$\text{C}_{10}\text{H}_{14}\text{O} + 3\text{H}_2 \rightarrow \square \text{C}_{10}\text{H}_{20}\text{O}$ correct formulae	1
	balancing	1
4 (b) (i)	electrophilic substitution	1
4 (b) (ii)	step 3 reduction	1
	step 5 substitution / hydrolysis	1
4 (b) (iii)	step 1 $(\text{CH}_3)_2\text{CHCl} + \text{AlCl}_3$ / AlBr_3 / FeCl_3 / FeBr_3	1 + 1
	step 2 $\text{HNO}_3 + \text{H}_2\text{SO}_4$ conc ($T < 55^\circ\text{C}$)	1
	step 3 $\text{Sn} + \text{HCl}$	1
	step 4 HNO_2 (or $\text{NaNO}_2 + \text{HCl}$) (at $T < 10^\circ\text{C}$)	1
	the two temperatures for steps 2 and 4	1
4 (c) (i)	$\text{H}_2 + \text{Pt}$ or $\text{H}_2 + \text{Ni}$ + heat or pressure	1
4 (c) (ii)	 <p>$(\text{CH}_3)_2\text{CH}$, CH_3 and OH on the correct ring atoms i.e. structure is correct</p>	1
	all Hs on the same side of the ring	1
Total: 15		

Question	Answer	Marks								
7 (a)	<table><tr><td>W</td><td>X</td><td>Y</td><td>Z</td></tr><tr><td>acyl chloride / COCl</td><td>methyl ketone / CH_3CO group aryl chloride</td><td>aldehyde / CHO chloro(alkane) RCl</td><td>Alkene / $\text{C}=\text{C}$ Phenol / $\text{C}_6\text{H}_5\text{OH}$ aryl chloride</td></tr></table> <p>0–1 [0]; 2 [1]; 3 [2]; 4 [3]; 5 [4]; 6–8 [5]</p>	W	X	Y	Z	acyl chloride / COCl	methyl ketone / CH_3CO group aryl chloride	aldehyde / CHO chloro(alkane) RCl	Alkene / $\text{C}=\text{C}$ Phenol / $\text{C}_6\text{H}_5\text{OH}$ aryl chloride	5
W	X	Y	Z							
acyl chloride / COCl	methyl ketone / CH_3CO group aryl chloride	aldehyde / CHO chloro(alkane) RCl	Alkene / $\text{C}=\text{C}$ Phenol / $\text{C}_6\text{H}_5\text{OH}$ aryl chloride							
7 (b) (i)	<table><tr><td><p>W  or </p><p>Cl</p></td><td><p>X </p></td></tr><tr><td><p>Y  or </p><p>or</p></td><td><p>Z </p></td></tr></table>	<p>W  or </p> <p>Cl</p>	<p>X </p>	<p>Y  or </p> <p>or</p>	<p>Z </p>	1 + 1 1 + 1				
<p>W  or </p> <p>Cl</p>	<p>X </p>									
<p>Y  or </p> <p>or</p>	<p>Z </p>									
7 (b) (ii)	<p>Y </p> <p>OR any chiral atom correctly labelled</p>	1								
Total: 10										

Notes about the mark scheme are available separately.