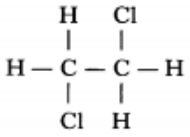
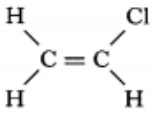
AH Exercise 2.2

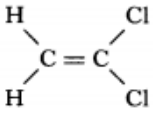
Stereochemistry

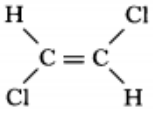
2006 AH MC36 (78%) and 2007 AH MC29 (81%)

36. Which of the following compounds has a geometric isomer?

A 

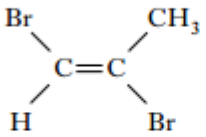
B 

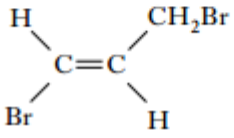
C 

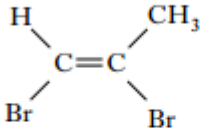
D 

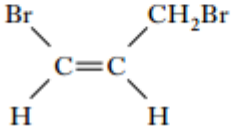
2011 AH MC37 (64%)

37. Which of the following is the geometric isomer of *trans*-1,2-dibromopropene?

A 

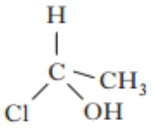
B 

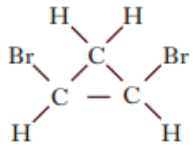
C 

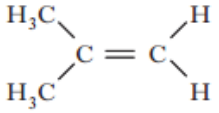
D 

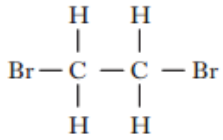
2012 AH MC36 (50%)

36. Which of the following has a geometric isomer?

A 

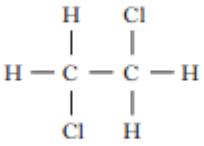
B 

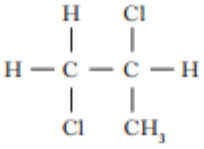
C 

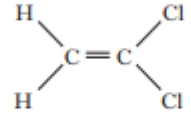
D 

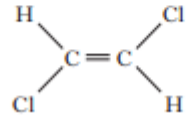
2014 AH MC35 (%) and 2014 revAH MC16 (88%)

35. Which of the following compounds has a geometric isomer?

A 

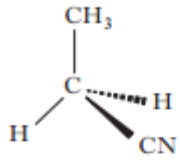
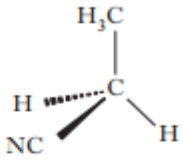
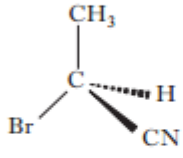
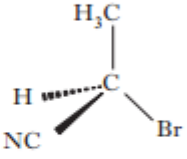
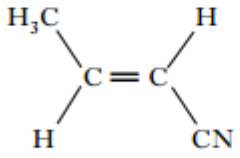
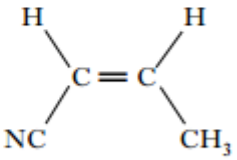
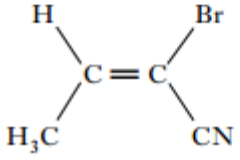
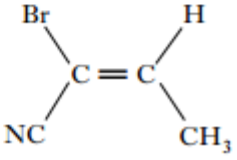
B 

C 

D 

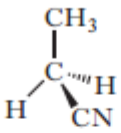
2009 AH MC38 (71%)

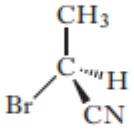
38. Which line in the table shows a pair of optical isomers?

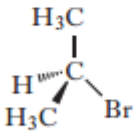
A		
B		
C		
D		

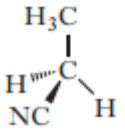
2015 AH MC37 (%) and 2015 revAH MC12 (83%)

37. Which of the following compounds will have an optical isomer?

A 

B 

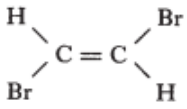
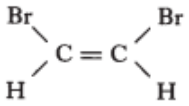
C 

D 

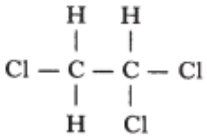
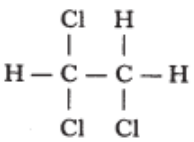
2004 AH MC40 (64%)

40. Which of the following represent the same chemical substance?

A $CH_2=CH-CH_2-CH_3$ and $CH_3-CH=CH-CH_3$

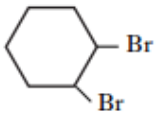
B  and 

C $CH_3-CH_2-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CH_3$ and $CH_3-\underset{\displaystyle CH_3}{\underset{|}{\overset{\displaystyle CH_3}{\overset{|}{C}}}}-CH_3$

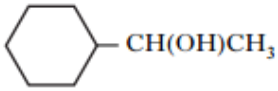
D  and 

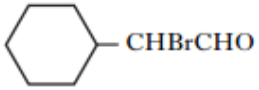
2008 AH MC36 (69%)

36. Which of the following molecules does **not** exhibit optical isomerism?

A 

B 

C 

D 

2014 AH MC36 (%) and 2014 revAH MC17 (66%)

36. Mandelic acid has two optical isomers **X** and **Y**. The table shows the rotation of plane polarised light caused by various solutions of **X** and **Y**.

Volume of 0·1 mol l^{-1} **X**/cm^3	Volume of 0·1 mol l^{-1} **Y**/cm^3	Volume of water/cm^3	Observed rotation/°
100	0	0	+158
50	0	50	+79
50	50	0	0
0	100	0	–158

What would be the observed rotation for a solution containing 25 cm^3 0·1 mol l^{-1} **X** and 75 cm^3 of 0·1 mol l^{-1} **Y**?

A –79°

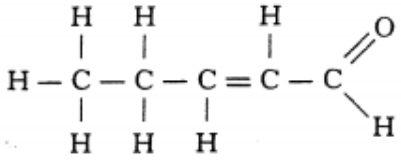
B –39·5°

C +39·5°

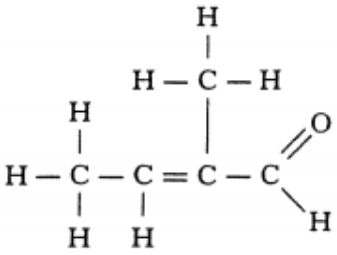
D +79°

2001 AH L10a+b

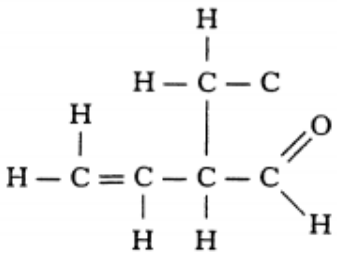
10. An unsaturated aldehyde has the molecular formula C_5H_8O. The formulae of three of its structural isomers are drawn below.



A



B



C

(*a*) Which one of the above compounds does **not** exhibit **geometric isomerism**? **1**

(*b*) One of the above compounds exhibits **optical isomerism**.
Copy its structural formula and circle the chiral (asymmetric) carbon atom. **1**

2002 AH L4a

4. Difluoromethanimine, FN = CHF, can exist in two isomeric forms.

When a sample of the *trans*-isomer was dissolved in an organic solvent at 22 °C it was slowly converted into the *cis*-isomer. After 7 days, 95% of the *trans*-isomer had been converted and no further conversion occurred thereafter.

(*a*) Draw the full structural formula of *trans*-difluoromethanimine. **1**

2002 AH L11c

11. A monocarboxylic acid, **X**, has an empirical formula of CH_2O. When 10·0 cm^3 of an aqueous solution of **X**, containing 7·85 $g\,l^{-1}$, was titrated against 0·049 $mol\,l^{-1}$ sodium hydroxide the titre volume was 17·8 cm^3.

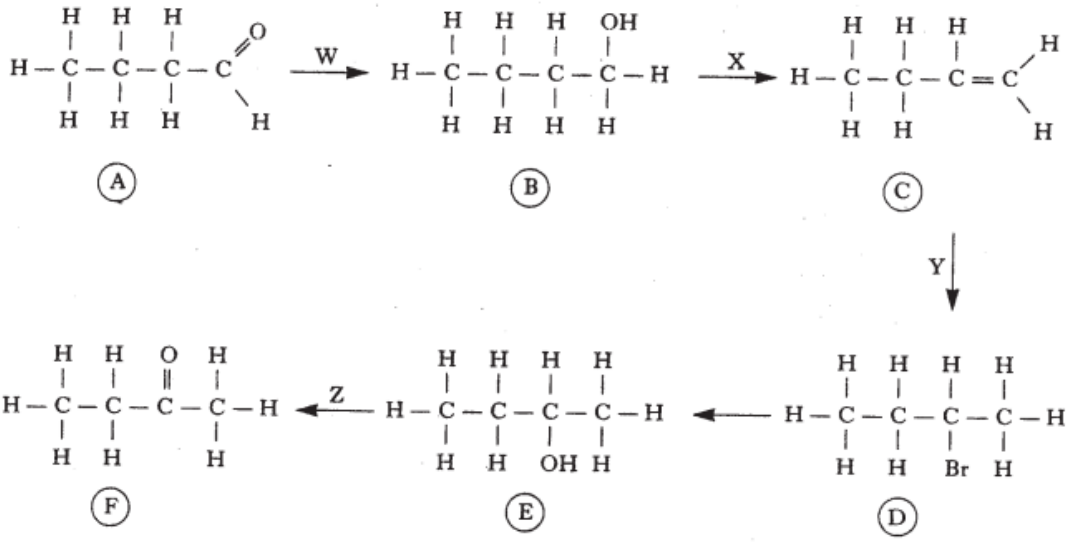
(*c*) **X** contains an asymmetric carbon atom.

(i) Deduce the structural formula of **X**. **1**

(ii) Plane-polarised light is **not** rotated when passed through an aqueous solution of **X**.
Suggest a reason for this. **1**

2003 AH L5e

5. A student designed the following reaction sequence.

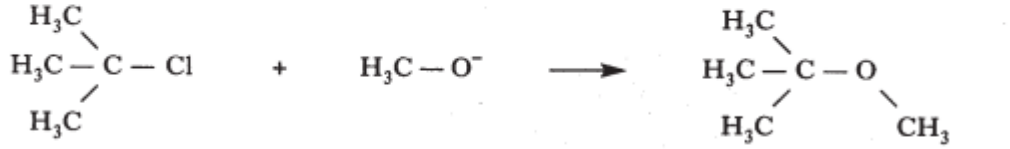


(*e*) (i) Why does (C) not have geometric isomers despite the presence of a carbon to carbon double bond? **1**

(ii) Which of the compounds (A) – (F) have optical isomers? **2**

2004 AH L10d

10. 2-Methoxy-2-methylpropane is a compound added to unleaded petrol as a "knock inhibitor". It can be synthesised by the reaction of methoxide ions with 2-chloro-2-methylpropane.

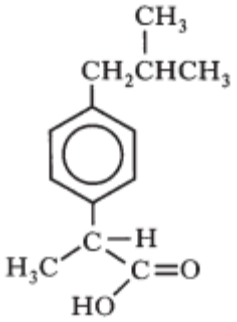


2-chloro-2-methylpropane methoxide ion 2-methoxy-2-methylpropane

(*d*) 2-Methoxy-2-methylpropane does not display optical isomerism. Draw the structural formula of an isomer of this compound which does display optical isomerism. **1**

2005 AH L10c

10. Ibuprofen is an anti-inflammatory agent which can be synthesised from benzene as shown below.

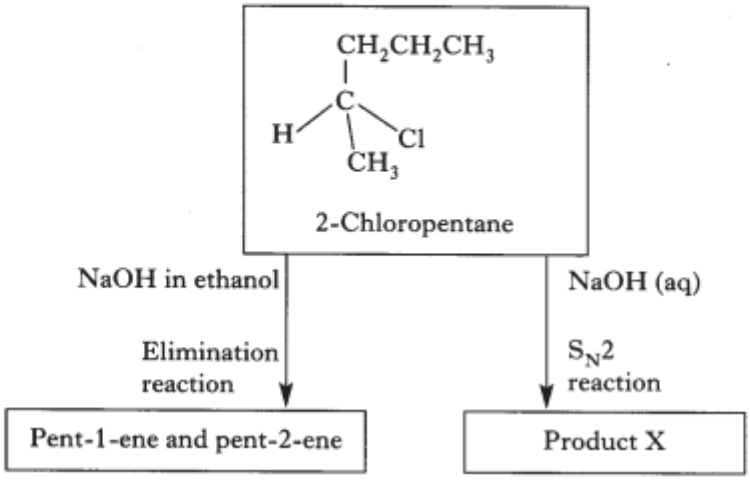


ibuprofen

(*c*) Copy the structure of ibuprofen and circle a chiral carbon atom. **1**

2005 AH L11b

11. In the reaction sequence shown below, 2-chloropentane reacts with sodium hydroxide in different ways depending on the solvent used.



(*b*) One of the alkenes formed in the elimination reaction is present as two **geometric** isomers. Draw the structures of both geometric isomers and name each one. **2**

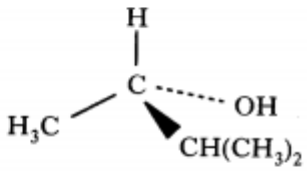
2006 AH L9b+c

9. Mixtures of the isomers of the alcohol, $C_5H_{11}OH$, are used as solvents for resins and oily materials.

The shortened structural formulae for four of these isomers are shown in the table.

Isomer	Shortened structural formula
A	$(CH_3)(C_2H_5)CHCH_2OH$
B	$(CH_3)_3CCH_2OH$
C	$(CH_3)_2(C_2H_5)COH$
D	$(C_2H_5)_2CHOH$

(*b*) Another isomer of $C_5H_{11}OH$ displays optical isomerism.
One of its optical isomers is shown below.

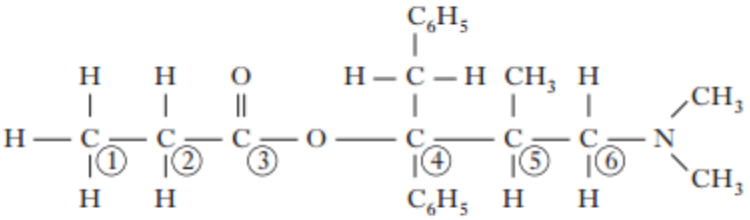


Draw a diagram representing the other optical isomer. **1**

(*c*) One of the four isomers, A to D, in the table above, is also optically active.
Draw a similar diagram to that shown in part (*b*) to represent one of its optical isomers. **1**

2007 AH L11a

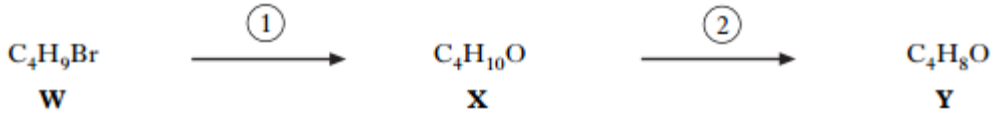
11. Propoxyphene is a pain-killing drug. Its structure is shown below.



(*a*) There are two chiral carbons in propoxyphene.
Referring to the structure above, identify both chiral carbons. **1**

2009 AH L9d

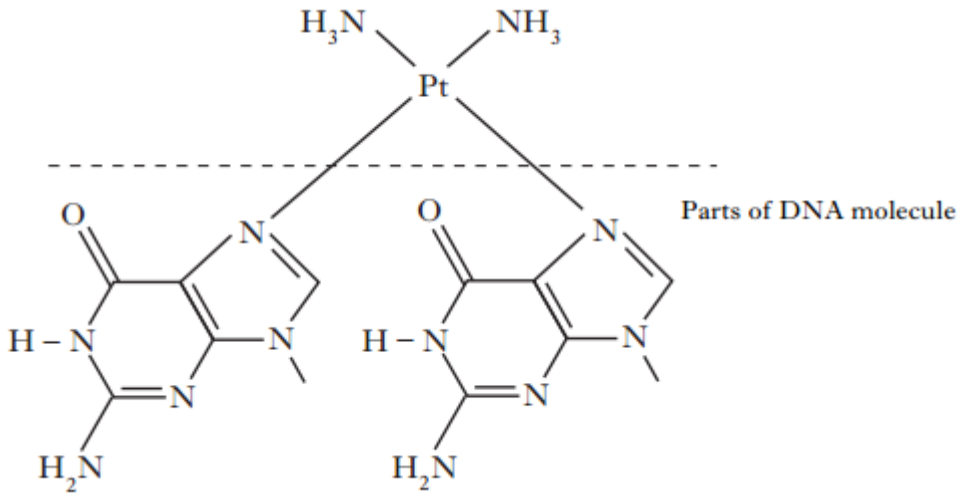
9. Compound **W** reacts in two steps to form compound **Y**.



(*d*) Dehydration of compound **X** produces three unsaturated isomers of molecular formula C_4H_8. Two of these are **geometric** isomers.
Draw the structures of both **geometric** isomers and name each one. **2**

2008 AH L4b

4. *cis*-Platin is a highly successful anti-cancer drug. The formula for *cis*-platin is $[Pt(NH_3)_2Cl_2]$.



(*b*) Draw a possible structure for the geometric isomer of *cis*-platin. **1**

2010 AH L11a

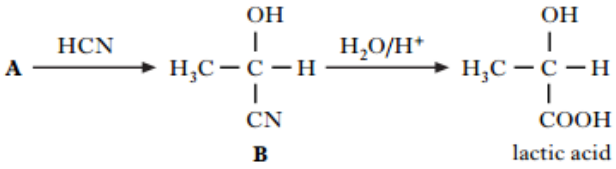
11. Consider the following reaction scheme.

(A) but-2-ene ⟶ (B) $CH_3CHBrCH_2CH_3$

(*a*) Explain why but-2-ene exhibits geometric isomerism yet its structural isomer but-1-ene does not. **1**

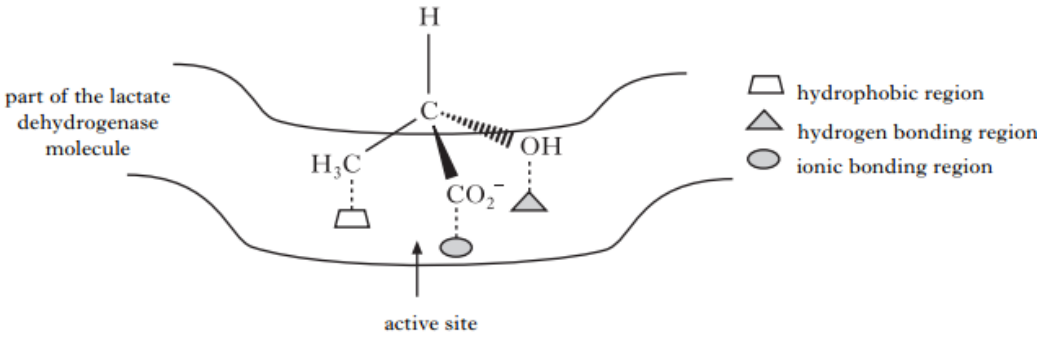
2010 AH L12d

12. Consider the following reaction sequence.



(*d*) Lactic acid in the form of lactate ions is dehydrogenated in the liver by the enzyme, lactate dehydrogenase.

The diagram shows how one of the optical isomers of the lactate ion binds to an active site of lactate dehydrogenase.



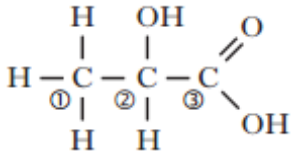
(i) Which type of intermolecular force is involved when the methyl group of the lactate ion binds to the hydrophobic region of the active site? **1**

(ii) Draw a structure for the other optical isomer of the lactate ion. **1**

(iii) Explain why this other optical isomer of the lactate ion cannot bind as efficiently to the active site of lactate dehydrogenase. **1**

2011 AH L14b

14. The structure of lactic acid is



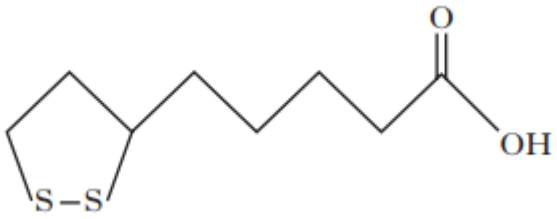
(*b*) Lactic acid contains an asymmetric carbon atom.

Identify, and **explain**, which one of the numbered carbon atoms is asymmetric. **1**

2012 AH L12b

12.

Lipoic acid has recently been used as a food supplement. The skeletal structural formula of lipoic acid is shown below.

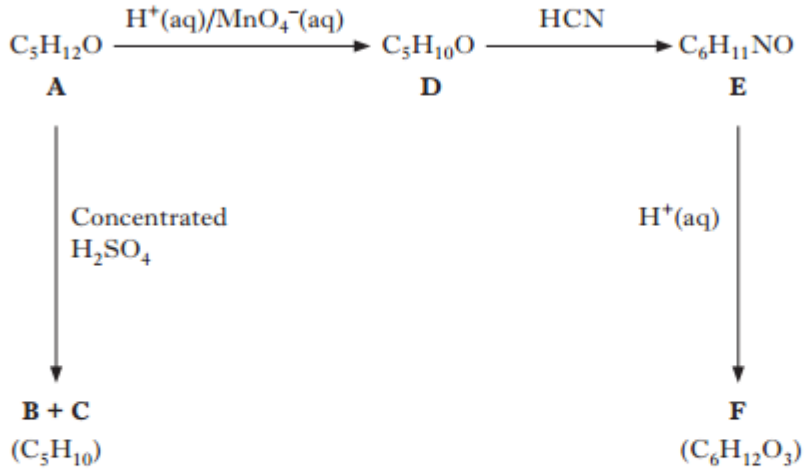


(*b*) (i) Lipoic acid is optically active. Copy the skeletal structural formula of lipoic acid and circle the carbon atom responsible for the optical activity of lipoic acid. **1**

(ii) Why does this carbon atom make lipoic acid optically active? **1**

2013 AH L13a

13. The diagram below shows a reaction sequence starting from compound **A** which is pentan-2-ol ($C_5H_{12}O$).



Compound **B** can exist as two geometric isomers.

Compound **C** is pent-1-ene.

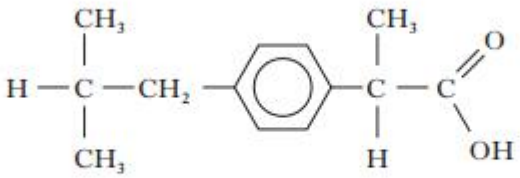
Compound **D** is the oxidation product of compound **A**.

(*a*) Name **and** draw the structural formulae for the two geometric isomers of compound **B**. **2**

2014 AH L8a and 2014 revAH L9a

8. Ibuprofen is one of the most commonly used non-steroidal anti-inflammatory drugs (NSAIDs).

The structure of ibuprofen is shown.



ibuprofen

(*a*) Copy the relevant part of the structure of ibuprofen and circle the carbon which makes ibuprofen chiral. **1**

2014 AH L10d and 2014 revAH L11d

10. The results of experiments on the alkaline hydrolysis of 2-iodobutane, $CH_3CHIC_2H_5$, are shown in the table below.

The equation for the hydrolysis is

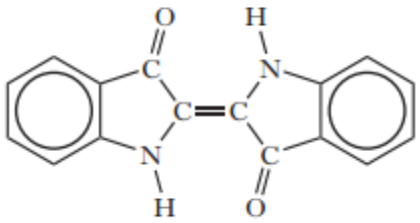
$$CH_3CHIC_2H_5(\ell) + OH^-(aq) \rightarrow CH_3CH(OH)C_2H_5(\ell) + I^-(aq)$$

(*d*) If the sample of 2-iodobutane contained molecules of only one optical isomer, the product would have no effect on plane-polarised light.

Explain this in terms of the mechanism. **1**

2015 AH L9b and 2015 revAH L9c

9. The blue colour of denim jeans comes from a dye known as indigo.



indigo

(*b*) Draw a structural formula for the geometric isomer of indigo. **1**

2015 AH L10f and 2015 revAH L10f

10. There are four isomers with the molecular formula C_4H_9Cl. Structural formulae for three of these isomers are

$CH_3CHClCH_2CH_3$ $(CH_3)_2CHCH_2Cl$ $(CH_3)_3CCl$

A **B** **C**

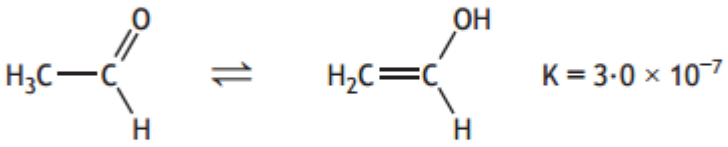
(*f*) Separate solutions of isomers **A** and **B** were analysed using plane polarised light. Neither solution showed optical rotation.

For **each isomer** explain why no optical rotation occurred. **2**

2016 AH L7b(i)+7b(ii)

7. Aldehydes and ketones can exist in two forms, a keto form and an enol form.

For example, the aldehyde ethanal exists in equilibrium with its enol form, ethenol.

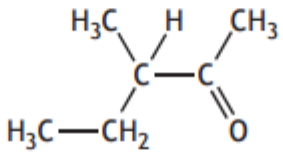


ethanal (keto form) ethenol (enol form)

These two different molecules are known as tautomers.

(b) 3-Methylpentan-2-one is optically active and exists in equilibrium with its enol tautomer.

(i) Circle the chiral centre on 3-methylpentan-2-one. **1**



(ii) Suggest why the optical activity of 3-methylpentan-2-one decreases over time. **1**