test for 1° / 2° alcohol + aldehyde (oxidation)

1. The functional group in an organic compound, **W**, was identified by carrying out two chemical tests. The results of the tests are shown below.

test for C=O bond. (aldehyde or ketone)

Heating with acidified sodium dichromate(VI)(aq)	**Addition of 2,4-dinitrophenylhydrazine(aq)**
orange solution turns green	yellow/orange precipitate formed

Which compound could be **W**?

A $CH_3CH_2CH_2OH$

B CH_3COCH_3

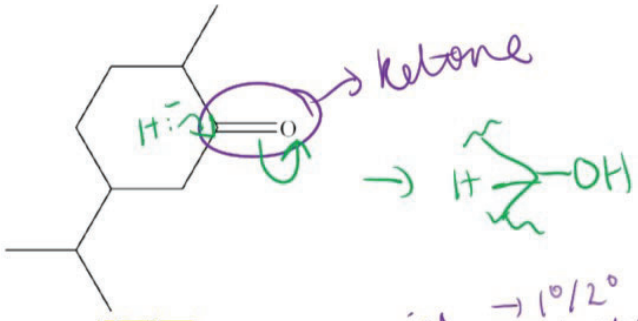
C $CH_3CH(OH)CH_3$

D CH_3CH_2CHO (aldehyde)

Your answer **D**

[1]

2. Carbonyl compounds have distinctive smells.
Menthone smells of peppermint.



Menthone

Menthone is reacted in a two-step synthesis shown below.

Step 1: A sample of menthone is added to hot acidified aqueous dichromate(VI) ions.

Step 2: The resulting mixture from **Step 1** is added to $NaBH_4$ in water.

What happens to the smell of the reaction mixture during the process?

	Step 1	Step 2
A	Smell of peppermint remains	Smell of peppermint is lost
B	Smell of peppermint is lost	Smell of peppermint returns
C	Smell of peppermint remains	Smell of peppermint remains
D	Smell of peppermint is lost	Smell of peppermint does not return

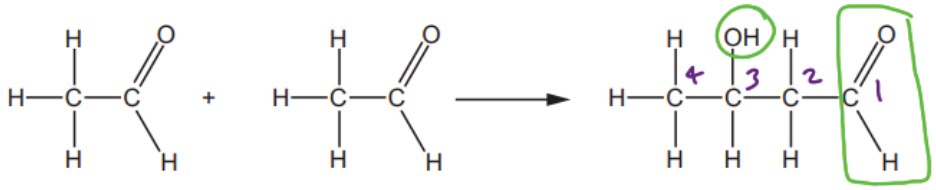
Your answer A

[1]

3. This question is about organic reactions.

(a) Compound **A** is formed when ethanal is mixed with OH^-(aq) ions, which act as a catalyst.

The balanced equation is shown in **reaction 6.1** below.



Reaction 6.1

Compound **A**

(i) Give the systematic name for compound **A**.

3-hydroxybutanal ..... **[1]**

(ii) What type of reaction has taken place?

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

(iii) **Reaction 6.1** takes place in two steps. OH^- ions act as a catalyst.

In **step 1**, ethanal reacts with OH^- ions to set up an acid–base equilibrium.
In **step 2**, compound **A** is formed.

- Complete the equilibrium for **step 1** and label the conjugate acid–base pairs as: **A1**, **B1** and **A2**, **B2**.

CH_3CHO + OH^- $\rightleftharpoons$ CH_3CO^- + H_2O

A1 B2 B1 A2

acids are proton donors

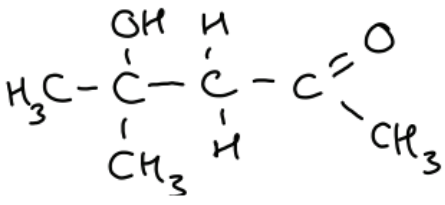
- Suggest the equation for **step 2**.

$CH_3CHO + {}^-CH_2CHO + H_2O \rightarrow CH_3CHOHCH_2CHO + OH^-$

[3]

(iv) A similar reaction takes place when propanone, $(CH_3)_2CO$, is mixed with OH^-(aq) ions.

Draw the structure of the organic product of this reaction.



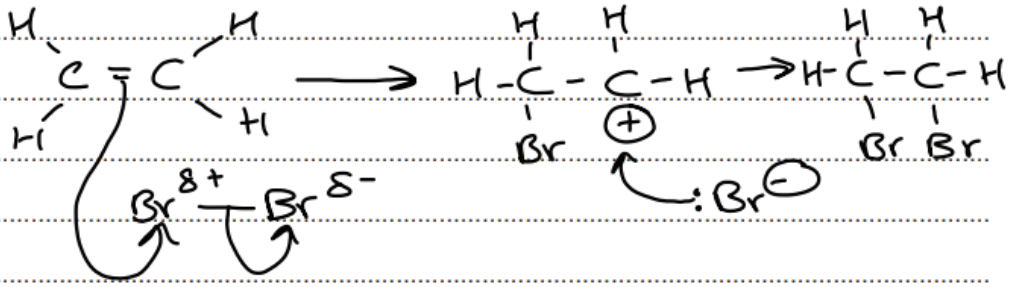
[1]

(b)* Many organic reactions use electrophiles as reagents.

Explain the role of electrophiles in organic chemistry.

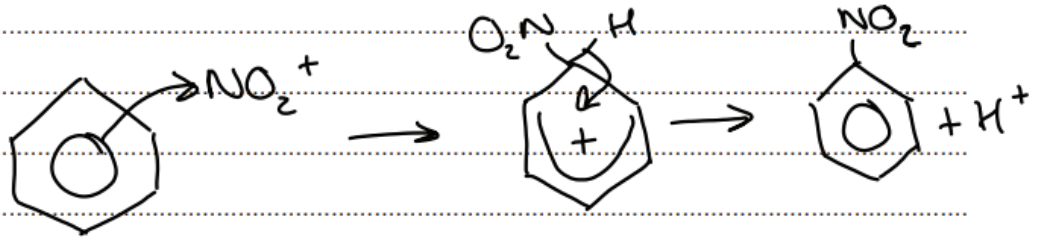
Your answer should include **one** reaction of an aliphatic compound and **one** reaction of an aromatic compound, including relevant mechanisms. **[6]**

electrophilic addition:



electrophilic substitution:

$H_2SO_4 + HNO_3 \rightarrow NO_2^+ + H_2O + HSO_4^-$



$H^+ + HSO_4^- \rightarrow H_2SO_4$

Additional answer space if required.

electrophiles act as electron pair acceptors.

4. A carbonyl compound is reacted with $NaBH_4$.

C=O

reducing agent
C=O → C-OH

Which compound(s) could be formed?

1 2-Methylpentan-2-ol

2 2-Methylpentan-1-ol

3 3-Methylpentan-2-ol

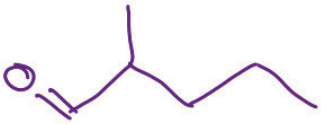
this is the organic compound that would reduce to form (1) but this compound doesn't exist

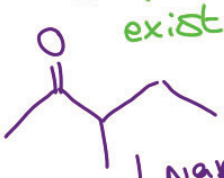
A 1, 2 and 3

B Only 1 and 2

C Only 2 and 3

D Only 1



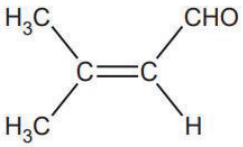


Your answer C HO

[1]

5. This question is about unsaturated aldehydes and alcohols.

(a) 3-Methylbut-2-enal, shown below, is used as a food flavouring.



3-methylbut-2-enal

Electrophilic addition

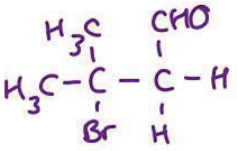
3-Methylbut-2-enal is reacted with hydrogen bromide, forming a mixture of two organic products.

One of the organic products forms in a much greater quantity than the other organic product.

(i) Outline the reaction mechanism for the formation of **one** of the organic products.

Include curly arrows and relevant dipoles.

major



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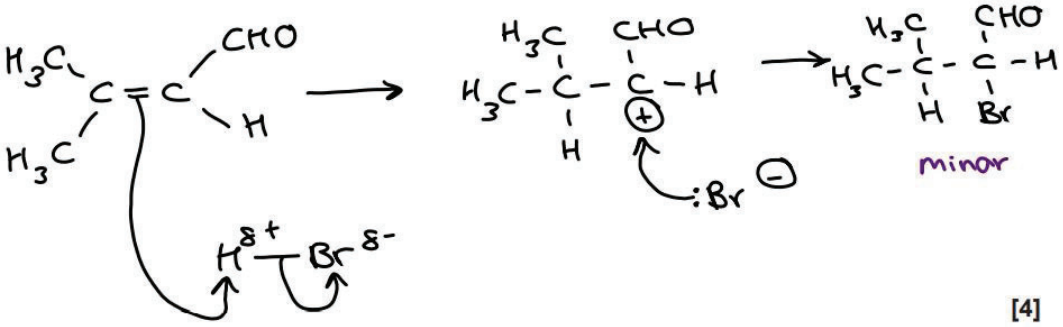


minor

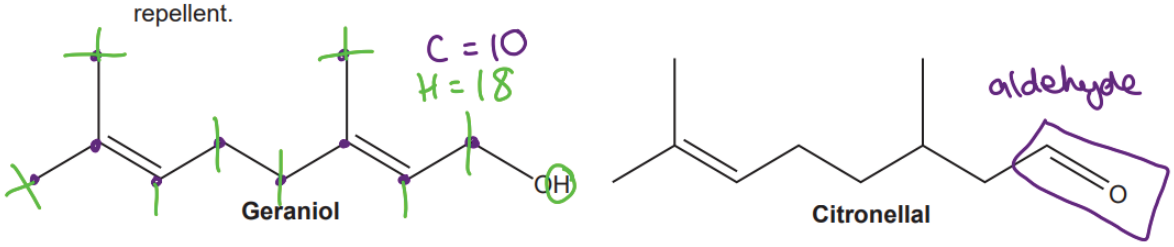
[4]

(ii) Explain why one of the organic products forms in a much greater quantity than the other organic product.

reaction goes via the most stable carbocation intermidiate. One product has a 2° carbocation intermidiate (minor) and the other has a 3° carbocation intermidiate (major). **[2]**

14

(b) Geraniol and citronellal, shown below, are isomers present in 'citronella oil', used as an insect repellent.



- Geraniol and citronellal are structural isomers of each other.
- They also show stereoisomerism.

(i) Describe how the observations from a chemical test would distinguish between geraniol and citronellal.

tollens reagent (test for aldehydes) will produce a silver mirror with citronellal

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

(ii) What is the molecular formula of geraniol?

$C_{10}H_{18}O$ ..... **[1]**

(iii) Explain why geraniol and citronellal are structural isomers of each other.

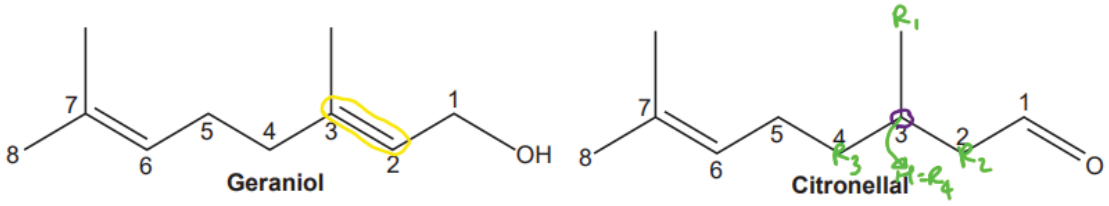
same molecular formula and a different structural formula

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

(iv) Explain the term **stereoisomerism**.

same structural formula but a different spatial arrangement of atoms ..... **[1]**

(v) The structures of geraniol and citronellal are repeated below with the carbon atoms numbered.



Explain the types of stereoisomerism shown by geraniol and citronellal.

In your answer,
- refer to the numbered carbon atoms in the structures above
- draw diagrams clearly showing any stereoisomers.

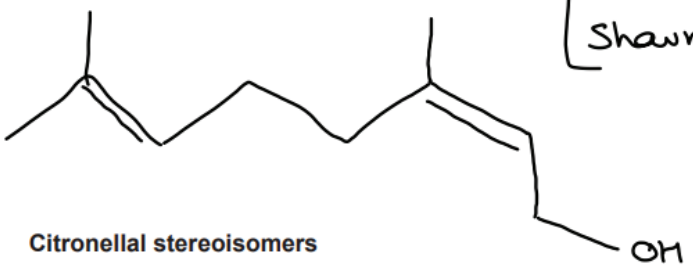
Geraniol has E-Z stereoisomerism about the C=C on carbons 2 and 3

Citronellal has optical isomerism because at the Chiral Carbon about carbon 3

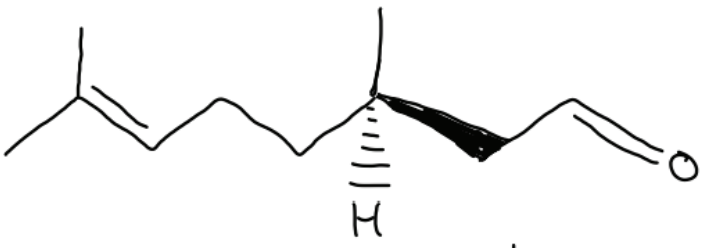
Geraniol stereoisomers

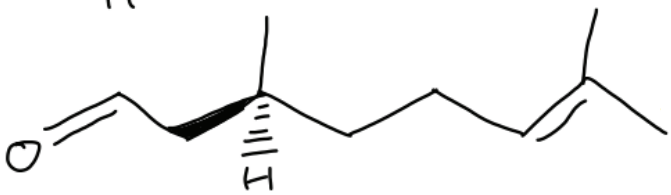
Z stereoisomer

[E stereoisomerism shown in Q]



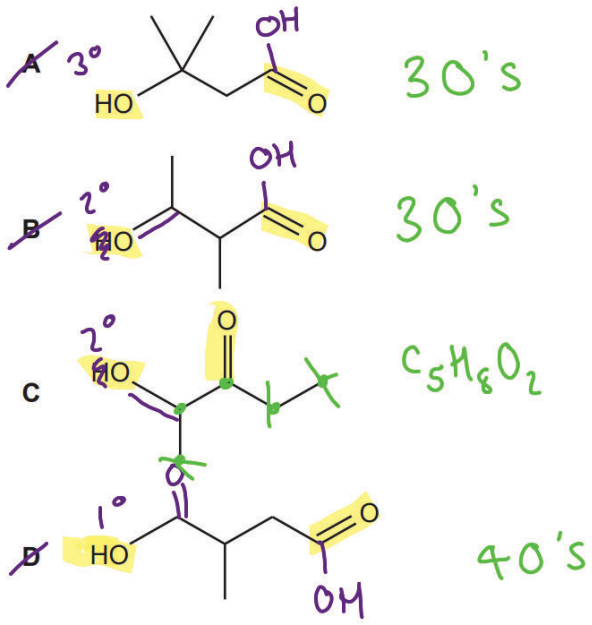
Citronellal stereoisomers





[4]

6. Which compound can be refluxed with acidified potassium dichromate(VI) to form an organic product with molecular formula $C_5H_8O_2$?

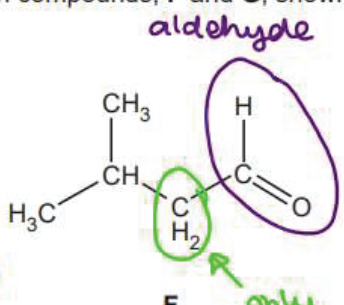


Your answer C

[1]

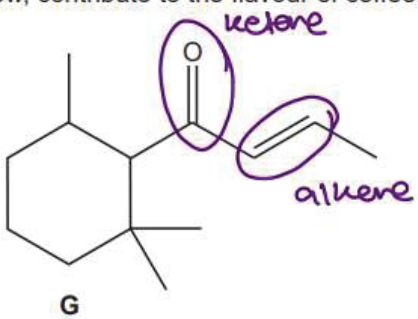
7. The carbonyl compounds, **F** and **G**, shown below, contribute to the flavour of coffee.

C_4H_8O
$+ C_{20}H_{40}$
($CH_2 \times 20$)



F

only bit of compound that changes



G

(a) Compound **F** is a member of a homologous series.

(i) Explain the term homologous series.

Same functional group / similar chemical properties / reactions each successive / subsequent member differs by CH_2

[2]

(ii) Predict the molecular formula for the member of this homologous series containing 24 carbon atoms.

$C_{24}H_{48}O$ [1]

(b) Describe suitable chemical tests, with observations, that would confirm the presence of the functional groups in **F** and **G**.

F/aldehyde tollen's reagent, silver mirror

test for aldehyde

G/alkene Br_2 goes colourless

test for alkene — tests for C=O group

G/ketone 2,4 DNP orange ppt.

tollen's reagent no silver mirror

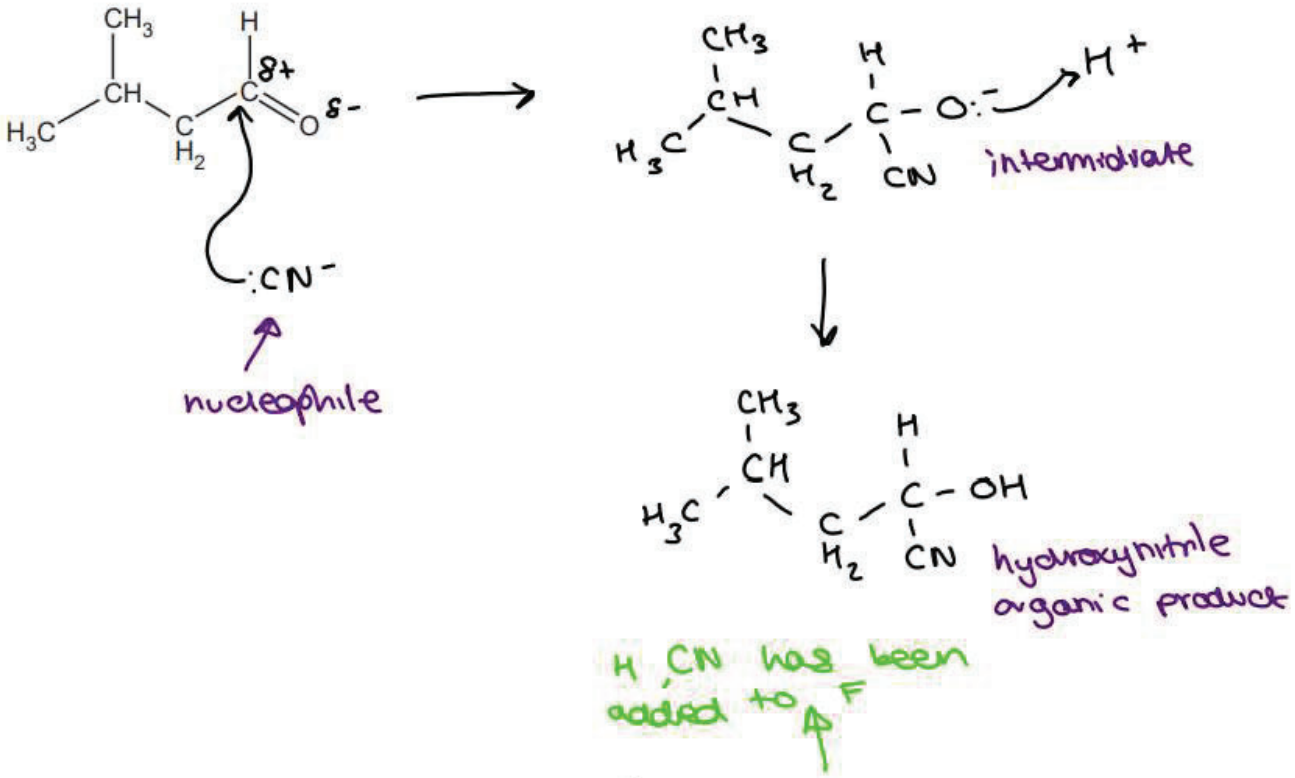
need to confirm that C=O is a ketone not an aldehyde

[4]

(c) Compound **F** reacts with HCN using NaCN(aq) and H^+(aq).

(i) Outline the mechanism for the reaction of **F** with NaCN(aq) and H^+(aq) and state the name of the mechanism. The structure of **F** has been provided.

Include relevant dipoles, lone pairs and the structure of the organic product.



Name of mechanism: nucleophilic addition [5]

(ii) Explain why the mechanism in **(c)(i)** involves heterolytic fission.

Heterolytic: one atom receives 2 electrons

Fission: breaking of a covalent bond

[2]