Alkenes

Question Paper 6

Level	International A Level
Subject	Chemistry
Exam Board	CIE
Topic	Hydrocarbons
Sub-Topic	Alkenes
Paper Type	Theory
Booklet	Question Paper 6

Time Allowed: **70 minutes**

Score: **/58**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	777.5%	70%	62.5%	57.5%	45%	<45%

1 **(a)** Complete the electronic structures of the Cr^{3+} and Mn^{2+} ions.

Cr^{3+} $1s^2 2s^2 2p^6$ .....

Mn^{2+} $1s^2 2s^2 2p^6$ .....

[2]

(b) **(i)** Describe what observations you would make when dilute $KMnO_4(aq)$ is added slowly and with shaking to an acidified solution of $FeSO_4(aq)$ until the $KMnO_4$ is in a large excess.

.....

.....

.....

.....

.....

.....

(ii) Construct an ionic equation for the reaction that occurs.

.....

[4]

(c) By selecting relevant $E^{\ominus}$ data from the *Data Booklet* explain why acidified solutions of $Fe^{2+}(aq)$ are relatively stable to oxidation by air, whereas a freshly prepared precipitate of $Fe(OH)_2$ is readily oxidised to $Fe(OH)_3$ under alkaline conditions.

relevant $E^{\ominus}$ values and half equations

.....

.....

.....

.....

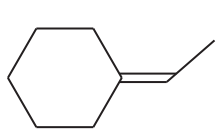
explanation

.....

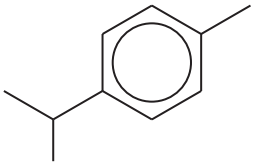
.....

[4]

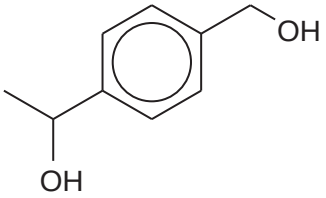
(d) Predict the organic products of the following reactions and draw their structures in the boxes below. You may use structural or skeletal formulae as you wish.



hot conc. $MnO_4^- + H^+$



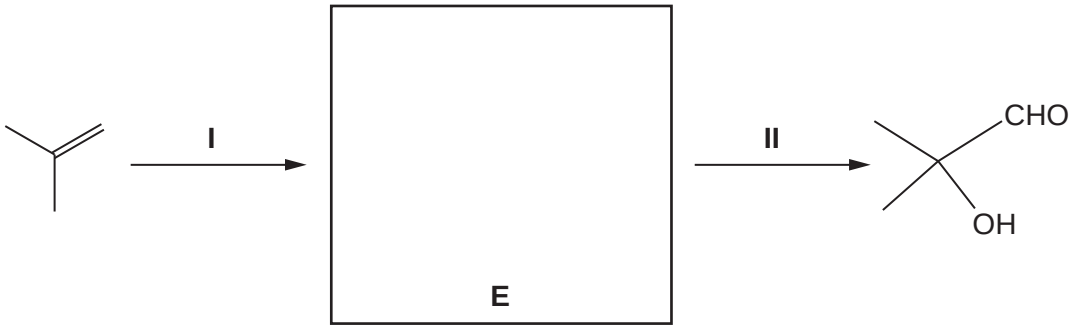
hot conc. $MnO_4^- + H^+$



hot $Cr_2O_7^{2-} + H^+$

[4]

(e) $KMnO_4$ and $K_2Cr_2O_7$ are the reagents that can be used to carry out the following transformation.



(i) Draw the structure of intermediate **E** in the box above.

(ii) Suggest reagents and conditions for the following.

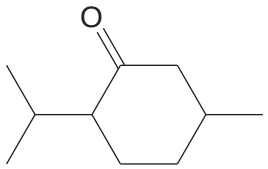
reaction **I** .....

reaction **II** .....

[3]

[Total: 17]

2 Menthone, $C_{10}H_{18}O$, is a cyclic ketone that occurs in oil of peppermint.



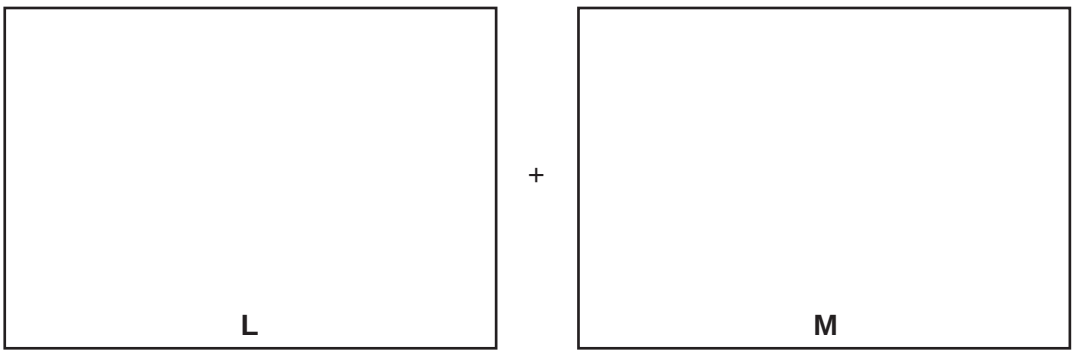
menthone

(a) Use asterisks (*) on the formula above to identify any chiral centres in the molecule of menthone. [2]

(b) Menthone can be reduced to menthol, which can be dehydrated to a mixture of two alkenes, **L** and **M**.

menthone **menthol**

step 2



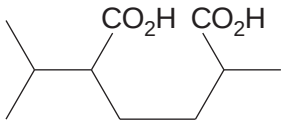
(i) Suggest reagents for

step 1, ...

step 2. .....

(ii) Suggest structures for **L** and **M** and draw them in the boxes above. [4]

(c) When heated with concentrated, acidified $KMnO_4$(aq), one of the two alkenes **L** or **M** produces the dicarboxylic acid **N**.



N

(i) Give the letter of the alkene that produced **N** by this reaction.

.....

(ii) Suggest the structure of the product, **P**, of the reaction between the other alkene you have drawn and hot concentrated acidified $KMnO_4$.

P

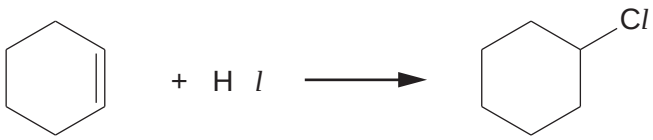
(iii) Suggest **one** chemical test that would enable you to distinguish between **N** and **P**.

reagent(s).....

observation.....

[3]

(d) Chlorocyclohexane can be prepared by bubbling HCl(g) through a solution of cyclohexene.

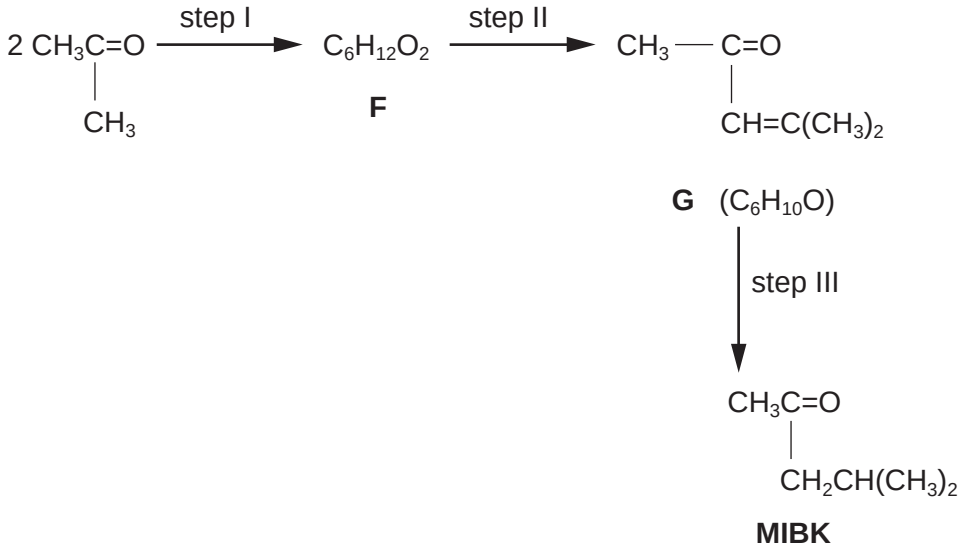


Suggest the mechanism of this 2-stage reaction by means of a diagram. Include all whole or partial charges, and represent the movements of electron pairs by curly arrows.

[3]

[Total: 12]

3 Propanone, CH_3COCH_3, an important industrial solvent, can be converted into another industrially important solvent, MIBK, by the following sequence.



(a) When **F** is formed in step I no other compound is produced.
Suggest a structural formula for **F**, which contains one –OH group.

[1]

(b) Compound **G** has two functional groups.

Name **one** functional group present in **G** and show how you would identify it. Put your answers in the table.

functional group in **G**	reagent used in test	what would be seen

[3]

(c) **G** is formed from **F** in step II.
Use your answers to **(a)** and **(b)** to suggest

(i) what type of reaction occurs in step II,

.....

(ii) a reagent for step II.

..... [2]

(d) The production of MIBK from **G** in step III involves the hydrogenation of the >C=C< group and is carried out catalytically. A mixture of compounds is formed because the >C=O group is also reduced.

What reagent(s) and solvent are normally used in a laboratory to reduce a >C=O group without reducing a >C=C< group present in the same molecule?

reagent(s) .....

solvent ..... [2]

G has a number of structural isomers.

(e) Draw the displayed formulae of a pair of structural isomers of **G** which contain the $CH_3CO–$ group and which exhibit *cis-trans* isomerism.

Label each structure *cis* or *trans* and give your reasoning.

[3]

[Total: 11]

4 The structural formulae of six different compounds, **A – F**, are given below.
Each compound contains four carbon atoms in its molecule.

$CH_3CH=CHCH_3$	$CH_3CH_2COCH_3$	$CH_2=CHCH_2CH_3$
A	**B**	**C**
$CH_3CH_2CH(OH)CH_3$	$HOCH_2CH_2CH_2CH_2OH$	$CH_3CH_2OCH_2CH_3$
D	**E**	**F**

(a) (i) What is the empirical formula of compound **E**? ……

(ii) Draw the skeletal formula of compound **D**.

(iii) Structural formulae do not show all of the isomers that may exist for a given molecular formula. Which **two** compounds **each** show **different** types of isomerism and what type of isomerism does each compound show? Identify each compound by its letter.

compound	type of isomerism

[4]

Compound **D** may be converted into compound **C**.

(b) (i) What type of reaction is this?

……

(ii) What reagent would you use for this reaction?

……

(iii) What is formed when compound **E** undergoes the same reaction using an excess of the same reagent?

…… [3]

Compound **A** may be converted into compound **B** in a two-stage reaction.

$$CH_3CH{=}CHCH_3 \xrightarrow{\text{stage I}} \text{intermediate} \xrightarrow{\text{stage II}} CH_3CH_2COCH_3$$

(c) **(i)** What is the structural formula of the intermediate compound formed in this sequence?

(ii) Outline how stage I may be carried out to give this intermediate compound.

.....

.....

.....

(iii) What reagent would be used for stage II?

…… [4]

(d) Compounds **D** and **F** are isomers.

What type of isomerism do they show?

…… [1]

[Total: 12]

5 **(a)** The viscosity of engine oil can be improved by the addition of certain medium chain-length polymers.

A portion of the chain of one such polymer is shown below.

$$–CH_2CH(CH_2CH_2CH_3)CH_2CH(CH_2CH_2CH_3)CH_2–$$

On average, the molecules of the medium-chain polymer contain 40 carbon atoms.

(i) Suggest the structure of the monomer.

.....

(ii) How many monomer units are incorporated into the average molecule of the polymer?

.....

[2]

(b) Used car engine oil can be recycled for use as a fuel by the processes of distillation and cracking.

(i) Assuming a typical molecule of engine oil has the formula $C_{40}H_{82}$, suggest an equation for a cracking reaction that could produce diesel fuel with the formula $C_{16}H_{34}$ and other hydrocarbons only.

.....

(ii) What conditions are needed for this cracking reaction?

.....

(iii) Considering only the bonds broken and the bonds formed during the reaction, use the *Data Booklet* to calculate the enthalpy change for the reaction you wrote in **(b)(i)**.

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.....

(iv) Comment on how the conditions you described in **(b)(ii)** relate to the enthalpy change you calculated in **(b)(iii)**.

.....

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[4]

[Total: 6]