Alkenes

Question Paper 4

Level	International A Level
Subject	Chemistry
Exam Board	CIE
Topic	Hydrocarbons
Sub-Topic	Alkenes
Paper Type	Theory
Booklet	Question Paper 4

Time Allowed: **69 minutes**

Score: **/57**

Percentage: **/100**

Grade Boundaries:

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

1 **(a)** By choosing the chlorides of **two** of the Group IV elements as examples, describe the trend in the reactions of these chlorides with water. Suggest an explanation for any differences, and write equations for any reactions that occur.

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.....[3]

(b) The standard enthalpy changes of formation of lead(II) chloride and lead(IV) chloride are given in the following table.

compound	$\Delta H_f^\ominus$ / kJ mol^{-1}
$PbCl_2(s)$	–359
$PbCl_4(l)$	–329

Use these data, and also bond energy data from the *Data Booklet*, to calculate the enthalpy changes for the following two reactions.

(i) $CCl_2(g) + Cl_2(g) \longrightarrow CCl_4(g)$

$\Delta H^\ominus$ = ... kJ mol^{-1}

(ii) $PbCl_2(s) + Cl_2(g) \longrightarrow PbCl_4(l)$

$\Delta H^\ominus$ = ... kJ mol^{-1}

(iii) Make use of your answers to parts **(i)** and **(ii)** to suggest how the relative stabilities of the two oxidation states vary down the Group.

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.....
[3]

[Total: 6]

2 Compounds containing the allyl group, $CH_2=CHCH_2-$, have pungent smells and are found in onions and garlic.
Allyl alcohol, $CH_2=CHCH_2OH$, is a colourless liquid which is soluble in water.

(a) Allyl alcohol behaves as an alkene and as a primary alcohol.

Give the structural formula of the organic compound formed when allyl alcohol is

(i) reacted with Br_2,

(ii) heated under reflux with an acidified solution of $Cr_2O_7^{2-}$ ions.

[2]

(b) When allyl alcohol is reacted with MnO_2 at room temperature, propenal, $CH_2=CHCHO$ is formed.

What type of reaction is this?

.....[1]

(c) Allyl alcohol may be converted into propanal, CH_3CH_2CHO, by using a ruthenium(IV) catalyst in water.

$$CH_2=CHCH_2OH \xrightarrow{\text{ruthenium(IV) catalyst}} CH_3CH_2CHO$$

The reactant and the product are isomers.
What form of isomerism do they display?

.....[1]

(d) Allyl alcohol can be converted into propanal in two steps **without** the use of a ruthenium(IV) catalyst.

$CH_2{=}CHCH_2OH \xrightarrow{\text{step I}} CH_3CH_2CH_2OH \xrightarrow{\text{step II}} CH_3CH_2CHO$

What reagents and conditions would be used for **each** step?

step I

reagent(s) .....

condition(s) .....

step II

reagent(s) .....

condition(s) .....[4]

(e) By considering your answers to **(b)** and **(d)**, suggest what is unusual about the single-step reaction in **(c)**.

.....

.....[1]

(f) Suggest the structural formula of the organic compound formed when allyl alcohol is

(i) reacted with cold, dilute MnO_4^- ions,

(ii) heated under reflux with acidified MnO_4^- ions.

[3]

[Total: 12]

3 A student obtained the following results when analysing an organic compound, **H**.

test		observation
test 1	relative molecular mass	72
test 2	% composition by mass	C, 66.7%; H, 11.1%; O, 22.2%
test 3	reactions with $Br_2(aq)$	Br_2 decolourised
test 4	reaction with Na(s)	$H_2(g)$ evolved
test 5	reaction with warm $Cr_2O_7^{2-}/H^+$	green colour observed

The student allowed test 5 to go to completion and then investigated the **product** of test 5 with the following result.

test 6	reaction with 2,4-dinitrophenylhydrazine	no reaction

(a) Calculate the molecular formula of **H**.

[2]

(b) What can be deduced about the nature of **H** by the following tests?

(i) test 3 .....

(ii) test 4 .....
[2]

(c) **(i)** What functional group would have given a positive result in test 6?

.....

(ii) What functional group is shown to be present in **H** by tests 5 and 6?

.....
[2]

(d) On testing a sample of **H**, the student found that it was not chiral.

H did, however, show *cis-trans* isomerism.

How does *cis-trans* isomerism arise in an organic molecule?

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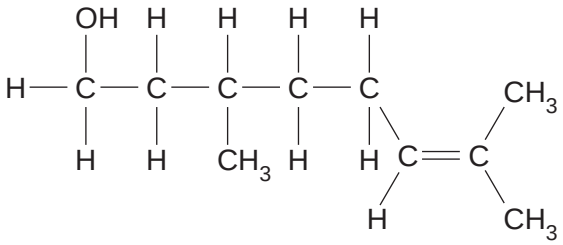
..... [2]

(e) Use all of the information above to draw labelled, displayed formulae of the stereoisomers of compound **H**.

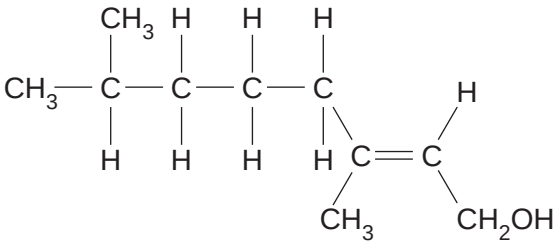
[2]

[Total: 10]

4 Some perfumes and scents of flowers and fruit contain compounds which are structural isomers. Two such examples are citronellol and geraniol.



citronellol



geraniol

(a) Confirm that citronellol and geraniol are isomers by calculating their molecular formula and their relative molecular mass, M_r.

(i) Molecular formula .....

(ii) M_r .....[2]

(b) Name two functional groups present in **both** molecules.

(i) .....

(ii) .....[3]

Citronellol and geraniol also show stereo isomerism.

(c) On the diagram of the structure of citronellol above, draw a circle around a chiral carbon atom. [1]

(d) **(i)** Draw the other *cis-trans* isomer of geraniol. [In parts **(d)** and **(f)** use R – to represent a part of the molecule.]

(ii) Explain why geraniol has no optical isomers.

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.....[2]

(e) State what you would expect to see if citronellol was reacted with aqueous bromine.

.....

.....[1]

(f) Draw structures of the organic products when geraniol reacts with each of the following reagents.

(i) an excess of $H^+ / Cr_2O_7^{2-}$ under reflux

(ii) ethanoic acid in the presence of an acidic catalyst

(iii) hydrogen bromide, HBr

[4]

[Total : 13]

5 **(a)** Draw a section of poly(propene), showing three repeat units.

[1]

(b) To what homologous series does poly(propene) belong?

.....[1]

(c) When a rupture (hernia) or a deep wound, e.g. as a result of a sports accident, is repaired by surgery, a mesh is inserted below the muscle tissue so that on healing the wound is less likely to reopen and the repair is stronger.

Poly(propene) is the recommended material for the mesh.

(i) Suggest **two** reasons why poly(propene) is used rather than a natural fibre such as cotton.

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(ii) Members of the homologous series you have given in **(b)** are considered to have two different kinds of reactions. Explain why neither of them can take place in a poly(propene) mesh inserted in living body tissues.

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.....[4]

[Total : 6]

6 **P**, **Q** and **R** are structural isomers with the molecular formula C_4H_8.

All three compounds readily decolourise bromine in the dark.

P and **Q** do not exhibit stereoisomerism but **R** exists as a pair of geometrical (cis-trans) isomers.

All three compounds react with hot concentrated, acidified potassium manganate(VII) to produce a variety of products as shown in the table.

compound	products
P	CO_2 and **S** (C_3H_6O)
Q	CO_2 and $CH_3CH_2CO_2H$
R	CH_3CO_2H only

S reacts with 2,4-dinitrophenylhydrazine reagent, 2,4-DNPH, to form an orange crystalline product but does not react with Fehling's reagent.

(a) Give the structural formulae of **P**, **Q**, **R** and **S**.

P ..... **Q** .....

R ..... **S** .....
[4]

(b) **(i)** Explain what is meant by the term *stereoisomerism*.

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..... [2]

(ii) Draw the **displayed** formulae of the geometrical isomers of **R** and name them both.

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

(c) State a reagent that could be used for the reduction of **S** and **name** the organic product of this reduction.

reagent ..... product ..... [2]

[Total: 10]