

**Q8.**

Avgas is an aviation fuel used in the internal combustion engines of helicopters. It consists of a large number of hydrocarbons, including a high proportion of hexane, which can exist as several isomers.

- (a) Draw the skeletal formulae of **two** branched isomers of hexane.

(1)

- (b) State the type of isomerism shown by these branched isomers.

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(1)

- (c) Safety signs on the fuselage of the helicopter state that the air inlets to the engine need to be cleaned out regularly.

Write an equation for the combustion of hexane that would happen in the helicopter engine if the air inlets were partially blocked with debris.

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(2)

- (d) Suggest how this partial blockage might affect the performance of the helicopter engine.

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(1)

**(Total 5 marks)**

**Q9.**

The outer layers of some golf balls are made from a polymer called polyisoprene.

The isoprene monomer is a non-cyclic branched hydrocarbon that contains 88.2 % carbon by mass.

The empirical formula of isoprene is the same as its molecular formula.

- (a) Deduce the molecular formula of isoprene and suggest a possible structure.

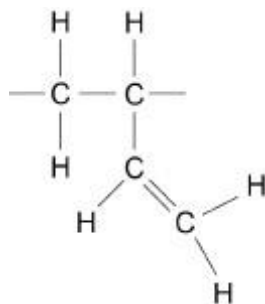
Molecular formula \_\_\_\_\_

Structure

(4)



- (b) The insides of some golf balls are made from a mixture of three other polymers. The repeating unit for one of these polymers is shown.



Draw the skeletal formula of the monomer used to make this polymer.

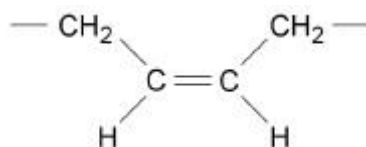
Give the IUPAC name of the monomer.

Skeletal formula of monomer

IUPAC name \_\_\_\_\_

(2)

- (c) A second polymer in the mixture has a repeating unit with the structure shown.



The third polymer in the mixture is a stereoisomer of this polymer.

Draw the structure of the repeating unit of the third polymer.

Give a reason why this type of stereoisomerism arises.

Repeating unit



Reason \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**(2)**

- (d) Golf balls recovered from lakes and ponds can be used again even after being in water for several years.

Explain why these golf balls do not biodegrade.

\_\_\_\_\_

\_\_\_\_\_

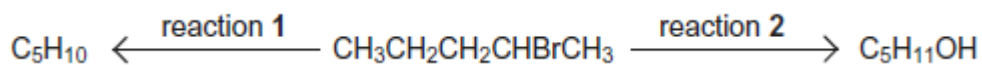
\_\_\_\_\_

**(1)**

**(Total 9 marks)**

**Q10.**

Two reactions of 2-bromopentane, (CH<sub>3</sub>CH<sub>2</sub>CH<sub>2</sub>CHBrCH<sub>3</sub>) are shown.



The C<sub>5</sub>H<sub>10</sub> formed in reaction 1 exists as a mixture of three isomers, one of which is pent-1-ene. Two of the isomers are a pair of stereoisomers. All three isomers decolourise bromine.

- (a) The same reagent is used in both reactions. The product is determined by the choice of conditions.

State the reagent and the conditions for each of reaction 1 and reaction 2.

State the role of the reagent in each reaction.

Name and outline the mechanism of reaction 1 for the formation of pent-1-ene.

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(8)



- (b) All three isomers of  $C_5H_{10}$  contain the same functional group.

Draw the displayed formula of pent-1-ene.

Draw the structures of the pair of stereoisomers and give their full IUPAC names.

Explain the origin of the stereoisomerism shown.

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(5)











(Total 10 marks)

**Q13.**

This question is about isomers with the molecular formula  $C_5H_{10}O$

- (a) Draw the skeletal formula of a branched chain aldehyde with molecular formula  $C_5H_{10}O$  that is optically active.

(1)

- (b) Describe how you distinguish between separate samples of the two enantiomers of the branched chain aldehyde  $C_5H_{10}O$

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(2)

- (c) Draw the *E* and *Z* forms of a structural isomer of  $C_5H_{10}O$  that shows **both** optical and geometric isomerism.

<i>E</i> isomer	<i>Z</i> isomer

(2)

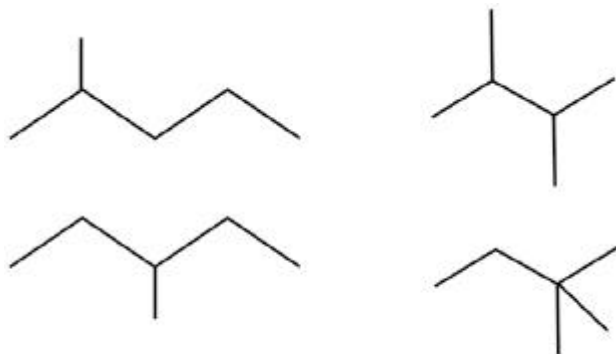




## Mark Scheme

### Q8.

- (a) Any two of these isomers



1

- (b) Chain isomerism

*Mark consequential to part (a)*

1

- (c)  $C_6H_{14} + 6.5O_2 \rightarrow 6CO + 7H_2O$

*M1 Product is CO or C*

*M2 Balanced equation*

1

**OR**



*Allow equations containing  $CO_2$  as long as either C, CO or both are also present*

1

- (d) Less energy given out by the fuel / engine is less powerful / less efficient / needs to burn more fuel to get the same energy / increased costs due to need to use more fuel

*Do **not** allow answers linked to CO poisoning or incomplete combustion*

1

[5]

### Q9.

- (a)

	C	H
%mass	88.2	11.8
mol	$\frac{88.2}{12}$	$\frac{11.8}{1}$
	= 7.35	= 11.8



÷ smaller	$\frac{7.35}{7.35}$	$\frac{11.8}{7.35}$
	= 1	= 1.61
x5	= 5	= 8

Empirical formula = molecular formula  $C_5H_8$

**M1** for amounts 7.35 and 11.8

1

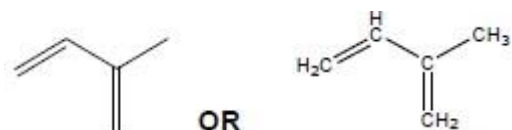
**M2** for process dividing **M1** by smaller

1

**M3** for answer  $C_5H_8$  only

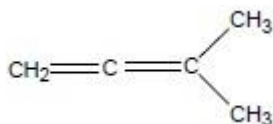
1

**M4** (must be branched)



OR

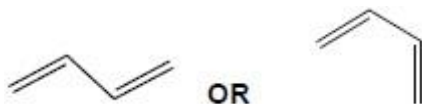
Allow alternatives



$HC\equiv CCH(CH_3)_2$

1

(b)



OR

**Must be skeletal**

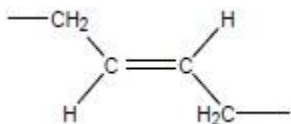
1

Buta-1,3-diene

**M2** can only be this and is independent of **M1**

1

(c)



Must show trailing bonds

Ignore brackets and n

Allow skeletal – with brackets



Must be E 'trans'

1



Mark independently

Restricted rotation about the C=C or double bond

*Allow lack of rotation/no rotation/limited rotation about the C=C or double bond*

*Ignore different groups on each carbon of the C=C double bond*

1

(d) Carbon Carbon bonds are non polar or (too) strong or not attacked by nucleophiles  
Or

Carbon Carbon bonds cannot be hydrolysed

*Allow carbon chains.....*

*OR*

*Bonds between repeating units.....*

*Ignore C-H bonds*

1

[9]

### Q10.

(a) NaOH/KOH

**IGNORE** OH-

**NOT** M1 if any mention of acidified/H+ in reagents or conditions

1

Reaction 1 = ethanolic/alcoholic **AND** reaction 2 = aqueous

**IGNORE** temp

**NOT** ethanoic

1

rxn 1 = base/proton acceptor

1

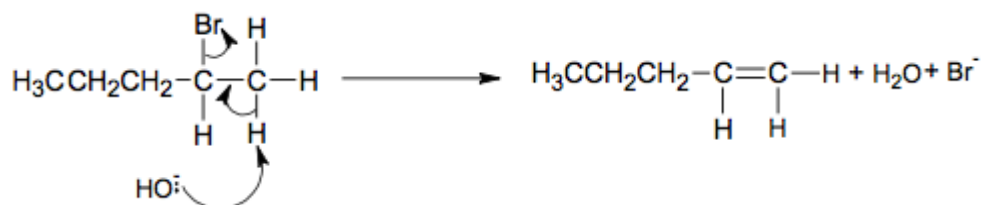
rxn 2 = nucleophile/lone pair donor/electron pair donor

1

(Base) Elimination

**NOT** nucleophilic

1



**M6** must show an arrow from the lone pair on the oxygen of a negatively charged hydroxide ion to a correct H atom

**M7** must show an arrow from a correct C-H bond on C adjacent to the C of the C-Br bond to a correct C-C bond. Only award if an arrow is shown attacking the H atom of a correct adjacent C-H



bond in **M6**

**M8** is independent provided it is from their original molecule and shows curly arrow from C-Br to Br

**ALLOW** correct E1 mechanism

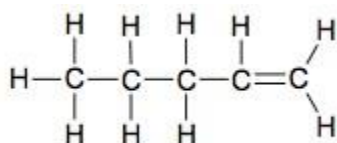
**IGNORE** incorrect inorganic products

If forming pent-2-ene can award M8 only even if arrows in mechanism correct

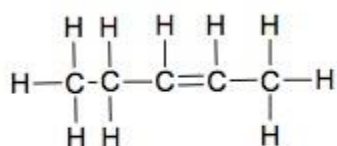
If C chain length or halogen wrong in reactant or product max 2/3

1  
1  
1

(b)

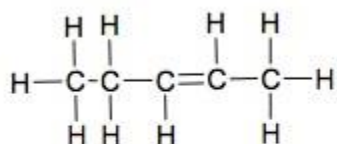


1



Z-pent-2-ene

1



E-pent-2-ene

1

If no M2 and M3 **ALLOW** 1 mark if both structures **OR** both names correct

**NOT** cis and trans

No free rotation around C=C

**ALLOW** no rotation of C=C

1

2 different atoms/groups on each of the C=C Cs owtte

**IGNORE** 'functional'

1

(c) Same volume/amount of AgNO<sub>3</sub>(aq) added to same volume/amount/no. of drops of haloalkane (in beaker/flask) in each experiment

Both volume references needed

**IGNORE** inappropriate volumes

1



Same temp **OR** same [AgNO<sub>3</sub>] each time

1

record time to measure sensible observation about the amount of AgCl ppt

*e.g. first appearance of ppt / ppt obscures mark / reading on a colorimeter*

**IGNORE** colour of ppt

**ALLOW** silver mirror

**NOT** reference to same time if describing method based on timing how long (for ppt to form)

**ALLOW** gravimetric method based on same time for each experiment

1

Rate = amount/time **OR** proportional to 1/time **OR** reference to shorter time = higher rate/longer time = lower rate

**ALLOW** greater mass = higher rate if gravimetric method

1

[17]

### Q11.

(a) **X** (O–H) (alcohols)

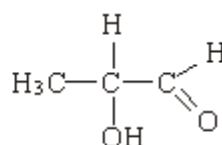
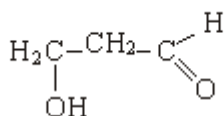
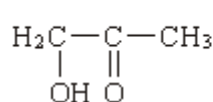
*penalise acid or missing "alcohol"*

1

**Y** C=O

*allow carbonyl*

1

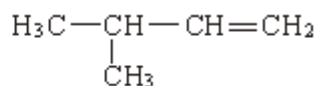
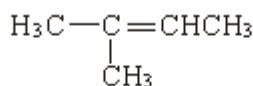
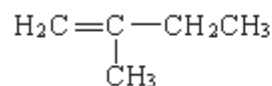


**A**

*NOT acid*

4

(b)

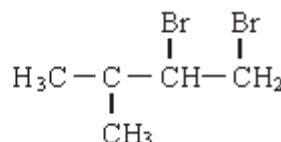
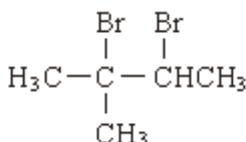
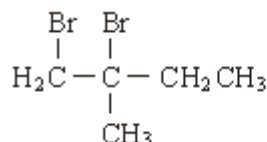


*Allow conseq dibromocompounds following incorrect unbranched alkenes*

*NOT allow dibromocompound consequent on a duplicate alkene*

*NOT allow monobromocompounds if HBr added*

3



3



6:3:1 either next to correct structure or to none	1
Allow a mark for identifying correct dibromocompound with three peaks even if integration ratio is wrong	1
if 6:3:1 missing or wrong, no marks for splitting	
Only award a mark for splitting if it is clear which integration number it refers to	
6 singlet or drawn	1
3 doublet or drawn	1
1 quartet/quadruplet or drawn	1
	(max 10 marks)

[16]

**Q12.**

- (a) M1:  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$ ; 1
- M2:  $\text{CH}_3\text{CH}(\text{OH})\text{CH}_2\text{CH}_3$ ;  
*(penalise incorrect alcohols in part (a), but mark consequentially in part (b) and in part (c), if relevant)*  
*(if three alcohols drawn, award MAX. 1 mark)* 1
- (b) M1, M2 and M3: Correct structures for butanal, butanone and butanoic acid;  
*(award these structure marks wherever the structures appear, but insist that the C=O is shown in each structure and additionally, the C-O in the carboxylic acid)* 3
- M4: balanced equation for the reaction of butan-1-ol with [O] to produce butanal and water; 1
- M5: balanced equation for the reaction of butan-1-ol with [O] to produce butanoic acid and water
- OR
- balanced equation for the reaction of butanal with [O] to produce butanoic acid; 1
- M6: balanced equation for the reaction of butan-2-ol with [O] to produce butanone and water;  
*(Credit condensed structures or molecular formulas in each)*



equation, provided it is obvious to which reaction the equation refers) (Insist that whatever formula is used in each equation that it is a conventional representation of the compound; for example penalise  $\text{CH}_3\text{CH}_2\text{CH}_2\text{COH}$  for butanal)

1

- (c) M1: Correct structure for 2-methylpropan-2-ol;  
M2: 2-methylpropan-2-ol

1

OR

methylpropan-2-ol;

(penalise on every occasion in parts (a) and (c), structures for the alcohols that are presented with the alcohol functional group as C-H-O)

1

[10]

## Q13.

(a)



1

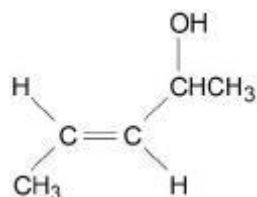
- (b) Use Plane polarised light

M1

rotates (the plane of) in opposite directions

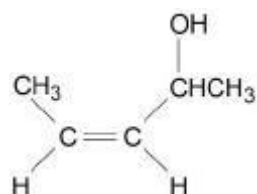
M2

(c)



Must be E isomer

M1

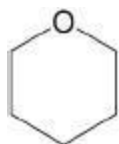


Must be Z isomer

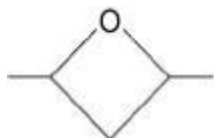
Allow 1 mark out of 2 for 2 correct structures but shown in the wrong boxes

M2

(d)



M1



M2

[7]

## Q14.

This question is marked using levels of response. Refer to the Mark Scheme Instructions for Examiners for guidance on how to mark this question.	
<b>Level 3</b> <b>5-6</b> <b>marks</b>	<b>All stages are covered and each stage is generally correct and virtually complete.</b> (6 v 5) Answer is well structured, with no repetition or irrelevant points, and covers all aspects of the question. Accurate and clear expression of ideas with no errors in use of technical terms.
<b>Level 2</b> <b>3-4</b> <b>marks</b>	<b>All stages are covered but stage(s) may be incomplete or may contain inaccuracies OR two stages are covered and are generally correct and virtually complete</b> (4 v 3) Answer has some structure and covers most aspects of the question. Ideas are expressed with reasonable clarity with, perhaps, some repetition or some irrelevant points. If any, only minor errors in use of technical terms.
<b>Level 1</b> <b>1-2</b> <b>marks</b>	<b>Two stages are covered but stage(s) may be incomplete or may contain inaccuracies OR only one stage is covered but is generally correct and virtually complete</b> (2 v 1) Answer includes statements which are presented in a logical order and/or linked.
<b>0</b> <b>marks</b>	Insufficient correct chemistry to warrant a mark.

Indicative chemistry

**Stage 1**

Difference between structural &amp; stereoisomers

1a structural isomers = molecules with same molecular formula but different structure

1b stereoisomers = molecules with same structural formula but different arrangement of atoms in space

**Stage 2**

Stereoisomers

2a lack of rotation around C=C



2b structures of *E*- and *Z*-but-2-ene  
2c correct identity of *E* and *Z* isomers

### Stage 3

Structural isomers

3a different C chain, e.g. methylpropene & but-1-ene / but-2-ene

3b different position of functional group e.g. but-1-ene & but-2-ene

3c different functional group, e.g. cyclobutane & but-1-ene / but-2-ene / methylpropene

[6]