

Edexcel Chemistry A-level - Alkenes

Questions

Q1.

Chloroalkanes can be formed from both alkenes and alkanes.

Ethene can be converted into chloroethane.

(i) Identify, by name or formula, the reagent for this conversion.

(1)

.....

(ii) Draw the mechanism for the conversion of ethene into chloroethane.

Include curly arrows, and any relevant lone pairs and dipoles.

(4)

(Total for question = 5 marks)

Edexcel Chemistry A-level - Alkenes

Q2.

Plastic products often have a symbol on them. Two of the symbols are shown.



The V on the symbol with the number 3 stands for vinyl or vinyl chloride.

The V is sometimes replaced by PVC, standing for polyvinyl chloride.

State the link between vinyl chloride and polyvinyl chloride.

(1)

.....

.....

.....

(Total for question = 1 mark)

Edexcel Chemistry A-level - Alkenes

Q3.

Plastic products often have a symbol on them. Two of the symbols are shown.



The symbols are used to sort the plastic products into groups of specific types of plastic when they are thrown away.

Some plastic products can be cleaned and used again.

Give two other uses of waste plastic.

(2)

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(Total for question = 2 marks)

Edexcel Chemistry A-level - Alkenes

Q4.

This question concerns alkenes and some halogen compounds.

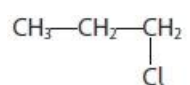
The alkene, propene, reacts with hydrogen chloride.

(i) This reaction is best described as

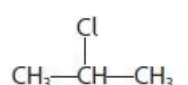
- A electrophilic substitution
- B electrophilic addition
- C nucleophilic substitution
- D nucleophilic addition

(1)

(ii) The reaction of propene with hydrogen chloride can produce two isomeric products:



1-chloropropane



2-chloropropane

1-chloropropane and 2-chloropropane are

- A *cis-trans* isomers
- B *E/Z* isomers
- C structural isomers
- D stereoisomers

(1)

(iii) Draw the mechanism for the reaction of propene with hydrogen chloride to produce 2-chloropropane. Include curly arrows, and any relevant dipoles and lone pairs.

(4)

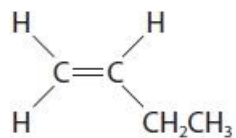
(Total for question = 6 marks)

Edexcel Chemistry A-level - Alkenes

Q5.

This question is about alkenes.

But-1-ene has the structure



- (i) Draw the structure of the polymer formed when but-1-ene polymerises.
Include **two** repeat units.

(1)

- (ii) Calculate the number of molecules in 70.0 g of but-1-ene.
[Avogadro constant = $6.02 \times 10^{23} \text{ mol}^{-1}$]

(2)

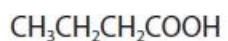
(Total for question = 3 marks)

Edexcel Chemistry A-level - Alkenes

Q6.

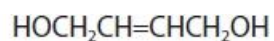
Analysis shows that a compound has the molecular formula $C_4H_8O_2$.

A student suggests that the compound could be either **A** or **B**.



A

or



B

Deduce a **chemical** test which would give a positive result for **B** but **not** for **A**.
Include the reagent and observation.

(2)

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(Total for question = 2 marks)

Edexcel Chemistry A-level - Alkenes

Q7.

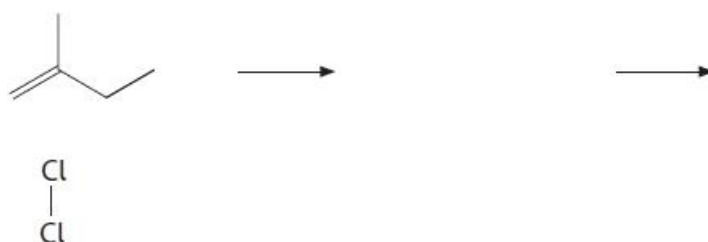
This is a question about dihalogenoalkanes.

Dihalogenoalkanes are formed when alkenes react with halogens.

(i) Complete the mechanism for the production of a dihalogenoalkane from 2-methylbut-1-ene and chlorine.

Include curly arrows and any relevant lone pairs.

(3)



(ii) Give the name of the dihalogenoalkane produced.

(1)

.....

(Total for question = 4 marks)

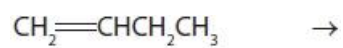
Edexcel Chemistry A-level - Alkenes

Q8.

This is a question about polymerisation.

But-1-ene and cyclohexene both form addition polymers.

Draw a section of each polymer, showing **two** repeat units.



(2)



(Total for question = 2 marks)

Edexcel Chemistry A-level - Alkenes

Q9.

2-methylbuta-1,3-diene can react with hydrogen bromide.

When 2-methylbuta-1,3-diene reacts with **excess** hydrogen bromide, several isomeric products are possible. Give the structures of **four** isomeric products.

(4)

(Total for question = 4 marks)

Edexcel Chemistry A-level - Alkenes

Q10.

This question concerns alkenes and some halogen compounds.

The halogenoalkane chloroethene is used to make the important polymer poly(chloroethene), PVC.

(i) Draw a **displayed** formula of two repeat units of poly(chloroethene).

(1)

(ii) Some polymers are disposed of by incineration. Ignoring any economic considerations, explain why incineration is **not** a suitable method for the disposal of poly(chloroethene).

(2)

.....

.....

.....

.....

.....

.....

(iii) Chloroethene has a boiling temperature of 260 K and is known to be carcinogenic. Use these facts to state **one** precaution that chemists should take when using this compound.

(1)

.....

.....

(Total for question = 4 marks)

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Q11.

This question concerns iodine monochloride, ICl, a red-brown solid which melts at 27 °C to form a red-brown liquid.

Iodine monochloride is used in measuring unsaturation in organic compounds.

Iodine monochloride is a polar molecule which adds rapidly to double bonds in a similar way to hydrogen chloride. This reaction can be used to determine the degree of unsaturation in oils.

(i) Add the dipole to a molecule of iodine monochloride.

(1)



(ii) Draw the mechanism for the addition of iodine monochloride to propene.

You should include all curly arrows and relevant lone pairs and dipoles.

(3)

(Total for question = 4 marks)

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Q12.

Answer the questions with a cross in the boxes you think are correct . If you change your mind about an answer, put a line through the box and then mark your new answer with a cross .

Methyl cinnamate, $C_{10}H_{10}O_2$, is a white crystalline solid used in the perfume industry.

Methyl cinnamate undergoes an addition reaction in the dark with bromine.

- (i) Draw the mechanism for the reaction between methyl cinnamate and bromine, Br_2 .
Include curly arrows, and relevant lone pairs and dipoles.

(4)

- (ii) Deduce the number of optical isomers of the addition product that can exist.

(1)

- A 2
 B 3
 C 4
 D 8

- (iii) When plane-polarised light is passed through an optical isomer, the plane of polarisation is

(1)

- A diffracted
 B reflected
 C refracted
 D rotated

(Total for question = 6 marks)

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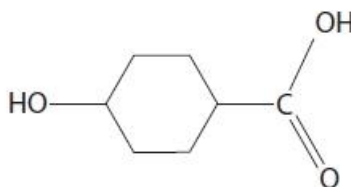
Q13.

* This question is about polymers.

Compare and contrast how each of these monomers forms a polymer.



cyclohexene



4-hydroxycyclohexanecarboxylic acid

Include equations, showing the formation of a single repeat unit for each polymer.

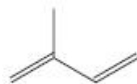
(6)

(Total for question = 6 marks)

Edexcel Chemistry A-level - Alkenes

Q14.

Some plants are able to make terpenes by linking together several molecules of 2-methylbuta-1,3-diene, also known as isoprene. The skeletal formula of 2-methylbuta-1,3-diene is



Predict the number of isoprene molecules that would be needed to make a single geraniol molecule. Justify your answer.

(2)

.....

.....

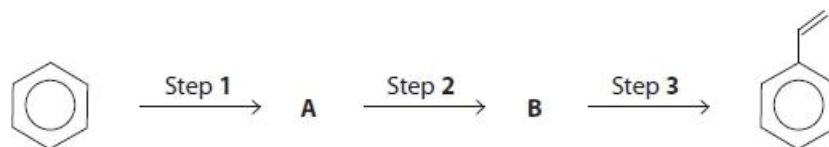
.....

(Total for question = 2 marks)

Edexcel Chemistry A-level - Alkenes

Q15.

Phenylethene, commonly known as styrene, is an important substance in the production of polystyrene which is used for some types of plastic packaging. Phenylethene can be made from benzene in a three-step synthesis.



Which reagent could produce a diol from phenylethene?

(1)

- A acidified potassium dichromate(VI)
- B acidified potassium manganate(VII)
- C aqueous sodium hydroxide
- D steam

(Total for question = 1 mark)

Edexcel Chemistry A-level - Alkenes

Q16.

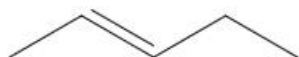
This question is about alkenes with the molecular formula C_5H_{10} .

Pent-2-ene reacts with hydrogen bromide, HBr, to form two bromoalkanes.

Complete the diagram to show the mechanism for the formation of 2-bromopentane in this reaction.

Include curly arrows, and relevant lone pairs and dipoles.

(4)



(Total for question = 4 marks)

Edexcel Chemistry A-level - Alkenes

Q17.

This question is about hydrocarbons.

Propene reacts with iodine monochloride, ICl, by an electrophilic addition mechanism.

Draw the mechanism for the reaction between propene and iodine monochloride to form the **major** product.

Include the dipole on the ICl molecule, curly arrows and any relevant lone pairs of electrons.

(4)

(Total for question = 4 marks)

Edexcel Chemistry A-level - Alkenes

Q18.

Answer the question with a cross in the box you think is correct . If you change your mind about an answer, put a line through the box and then mark your new answer with a cross .

Propene can be converted into a mixture of 1-chloropropane and 2-chloropropane, in which 2-chloropropane is the major product.

(i) Give the reagent required for this reaction.

(1)

.....

(ii) What is the type and mechanism of the reaction in (i)?

(1)

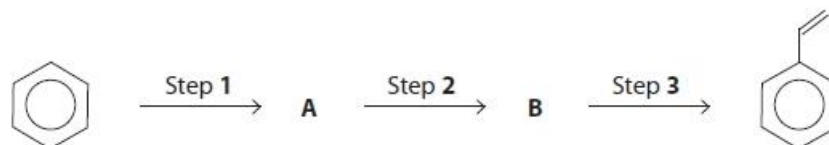
- A** electrophilic addition
- B** nucleophilic addition
- C** electrophilic substitution
- D** nucleophilic substitution

(Total for question = 2 marks)

Edexcel Chemistry A-level - Alkenes

Q19.

Phenylethene, commonly known as styrene, is an important substance in the production of polystyrene which is used for some types of plastic packaging. Phenylethene can be made from benzene in a three-step synthesis.



Draw a section of the polymer, polystyrene, showing **two** repeat units.

(1)



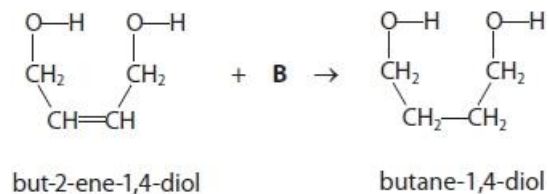
(Total for question = 1 mark)

Edexcel Chemistry A-level - Alkenes

Q20.

This question is about the synthesis and reactions of butane-1,4-diol.

Butane-1,4-diol can be synthesised from but-2-ene-1,4-diol, by reaction with a reagent, **B**.



(i) Identify reagent **B** and state suitable conditions for this reaction.

(2)

.....
.....

(ii) This reaction is best described as

(1)

- A** hydrolysis
- B** oxidation
- C** reduction
- D** substitution

(iii) Name **one** other commercially important product that can be manufactured by this type of reaction with the alkene group.

(1)

.....

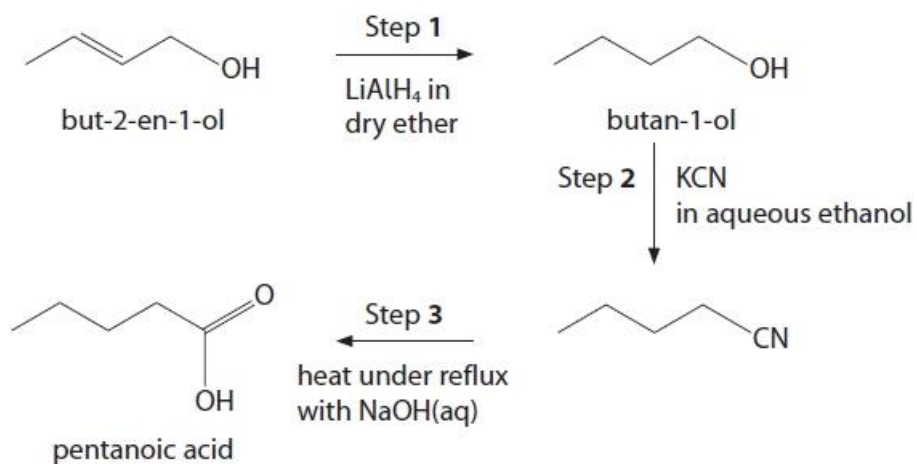
(Total for question = 4 marks)

Edexcel Chemistry A-level - Alkenes

Q21.

This question is about the synthesis of organic compounds.

A student suggested the following plan for the synthesis of pentanoic acid from but-2-en-1-ol.



(i) LiAlH_4 is a source of hydride ions, H^- .

Give a possible reason why LiAlH_4 cannot be used to reduce alkenes.

(1)

.....
.....
.....

(ii) Give a suitable reagent and condition for Step 1.

(2)

.....

(iii) Step 2 is incorrect because alcohols can only be converted to nitriles via an intermediate compound.

Identify a suitable intermediate compound by name or formula.

(1)

.....

(iv) Step 3 involves the hydrolysis of a nitrile.

Give the additional reagent that should be added after heating under reflux with aqueous sodium hydroxide, to produce pentanoic acid.

(1)

.....

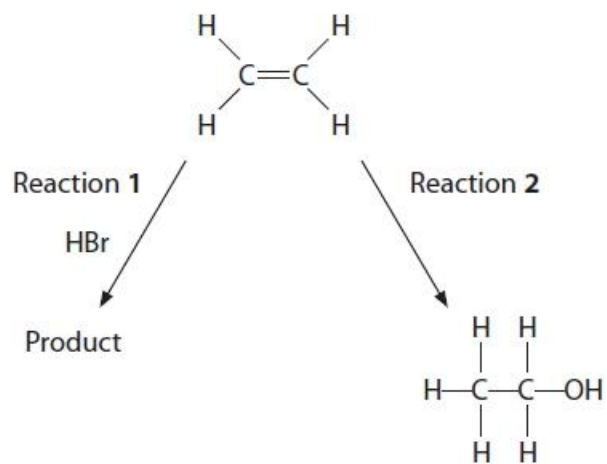
(Total for question = 5 marks)

Edexcel Chemistry A-level - Alkenes

Q22.

This question is about alkenes.

Two reactions of ethene are shown.



Complete the table.

(3)

Reaction	Reagent and condition	Product
1	HBr at room temperature	
2		

(Total for question = 3 marks)

Mark Scheme

Q1.

Question Number	Answer	Additional Guidance	Mark
(i)	An answer that makes reference to the following point: <ul style="list-style-type: none"> HCl(g) / hydrogen chloride (gas) 	Do not award hydrochloric acid / HCl(aq) / chlorine / Cl ₂ / Cl If name and formula are both given, both must be correct	(1)
Question Number	Answer	Additional Guidance	Mark
(ii)	An answer that makes reference to the following points: <ul style="list-style-type: none"> dipole present on hydrogen chloride (1) arrow from C=C bond to H or to where bond will be and arrow from H-Cl bond to, or just beyond, Cl (1) correct carbocation intermediate (1) arrow from lone pair on chloride ion to positive carbon in carbocation (to give correct product) (1) 	<p>Allow TE for use of Cl₂ in (a)(i), but max (3) if chloroethane is formed as the product Use of the wrong alkene (e.g. propene) or the wrong hydrogen halide (e.g. HBr) cannot score M4</p>	(4)

Edexcel Chemistry A-level - Alkenes

Q2.

Question Number	Answer	Additional Guidance	Mark
	<p>An answer that makes reference to the following point:</p> <ul style="list-style-type: none"> Vinyl chloride is the monomer from which (the polymer) polyvinyl chloride is made Or the polymer polyvinyl chloride is made from the (monomer) vinyl chloride 	<p>Correct answers will include monomer, polymer or words describing bonding / joining / linking of the vinyl chloride Allow pvc for polyvinyl chloride throughout</p> <p>Allow many vinyl chloride molecules joined / bonded together to make polyvinyl chloride Allow vinyl chloride is the repeat unit in polyvinyl chloride</p>	(1)

Q3.

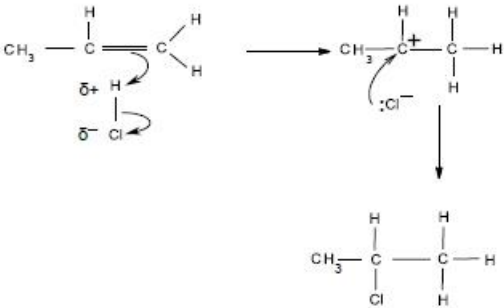
Question Number	Answer	Additional Guidance	Mark
	<p>An answer that makes reference to two of the following points:</p> <ul style="list-style-type: none"> recycling (1) incineration to release energy (1) as a feedstock for cracking (1) 	<p>Allow remoulding Allow made into other items / description of recycling</p> <p>Allow for burning as a fuel Ignore just 'for incineration'</p> <p>Ignore just 'as a feedstock'</p>	(2)

Edexcel Chemistry A-level - Alkenes

Q4.

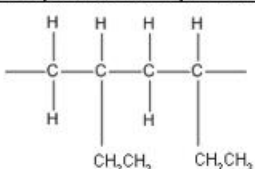
Question Number	Acceptable Answer	Mark
(i)	<p>The only correct answer is B</p> <p><i>A is not correct because reaction is not substitution</i></p> <p><i>C is not correct because reaction is not substitution, nor nucleophilic</i></p> <p><i>D is not correct because reaction is not nucleophilic</i></p>	(1)

Question Number	Acceptable Answer	Mark
(ii)	<p>The only correct answer is C</p> <p><i>A is not correct because no C=C present</i></p> <p><i>B is not correct because no C=C present</i></p> <p><i>D is not correct because these are not stereoisomers</i></p>	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
(iii)	<p>An answer which shows the following:</p> <ul style="list-style-type: none"> curly arrow from double bond to H atom of HCl/space between double bond and H atom of HCl (1) correct dipole on HCl molecule <u>and</u> curly arrow from H-Cl bond to Cl atom (1) intermediate with + charge shown on correct carbon (1) curly arrow from <u>lone pair</u> on chloride ion to correct carbon (1) 	<p><u>Example of mechanism</u></p>  <p>incorrectly drawn starting molecule loses M1, e.g. missing H or pentavalent carbon. incorrect starting molecule, e.g. butene will lose M3. if product is 1-chloropropane M3 only is lost. Other errors in end product lose M4 use of HBr in place of HCl loses M2 only use of H⁺ and Cl⁻ loses M1 and M2</p>	(4)

Edexcel Chemistry A-level - Alkenes

Q5.

Question Number	Answer	Additional Guidance	Mark
(i)	<ul style="list-style-type: none"> 2 repeat units with extension bonds 	<p><u>Example of two repeat units</u></p>  <p>The extension bonds can be solid / dotted / dashed</p> <p>Allow C₂H₅ for the side chains</p> <p>Allow ethyl groups on carbon atoms: 1 and 3, 2 and 4, 1 and 4 or 2 and 3</p> <p>Allow skeletal formula / any combination of structural or displayed formulae</p> <p>Ignore brackets / n</p> <p>Ignore connectivity of vertical CH₂CH₃ groups</p>	(1)

Question Number	Answer	Additional Guidance	Mark
(ii)	<ul style="list-style-type: none"> calculation of moles of but-1-ene (1) calculation of number of molecules of but-1-ene (1) 	<p><u>Example of calculation</u></p> $\text{moles of but-1-ene} = \frac{70.0}{56.0} = 1.25 \text{ (mol)}$ $\text{molecules of but-1-ene} = 1.25 \times 6.02 \times 10^{23} = 7.525 \times 10^{23}$ <p>TE on moles but-1-ene Ignore SF except 1 SF Do not award M2 for mass x 6.02 x 10²³</p> <p>Correct answer with no working scores (2)</p>	(2)

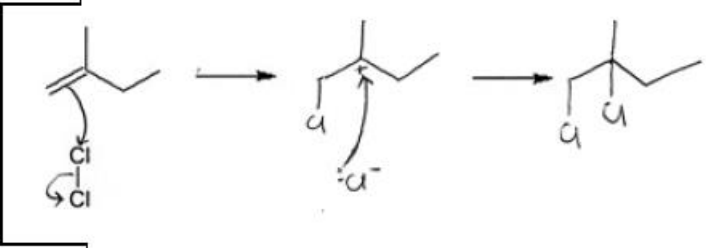
Edexcel Chemistry A-level - Alkenes

Q6.

Question Number	Answer	Additional Guidance	Mark														
	<p>A description that makes reference to two of the following points:</p> <ul style="list-style-type: none"> • reagent (1) • corresponding observation (1) 	<p><u>Examples of reagents and observations</u></p> <table border="1"> <thead> <tr> <th>Reagent</th> <th>Observation</th> </tr> </thead> <tbody> <tr> <td>bromine water Allow bromine (in an organic solvent)</td> <td>orange / yellow / brown solution goes colourless Allow bromine water is decolourised</td> </tr> <tr> <td>carboxylic acid and (concentrated) $H_2SO_4 / HCl / H^+$</td> <td>characteristic smell (of an ester)</td> </tr> <tr> <td>acidified potassium manganate(VII) / permanganate</td> <td>purple to colourless / decolourised</td> </tr> <tr> <td>alkaline potassium manganate(VII)</td> <td>purple to green</td> </tr> <tr> <td>(neutral) potassium manganate(VII)</td> <td>purple to brown ppt</td> </tr> <tr> <td>acidified (potassium) dichromate(VI) (ions)</td> <td>orange to green</td> </tr> </tbody> </table> <p>Allow names or formulae for reagents but if both are given, both must be correct</p> <p>Ignore conditions e.g. heat</p> <p>Do not award PCl_5 / Na</p> <p>If more than one test is given, penalise any incorrect tests</p>	Reagent	Observation	bromine water Allow bromine (in an organic solvent)	orange / yellow / brown solution goes colourless Allow bromine water is decolourised	carboxylic acid and (concentrated) $H_2SO_4 / HCl / H^+$	characteristic smell (of an ester)	acidified potassium manganate(VII) / permanganate	purple to colourless / decolourised	alkaline potassium manganate(VII)	purple to green	(neutral) potassium manganate(VII)	purple to brown ppt	acidified (potassium) dichromate(VI) (ions)	orange to green	(2)
Reagent	Observation																
bromine water Allow bromine (in an organic solvent)	orange / yellow / brown solution goes colourless Allow bromine water is decolourised																
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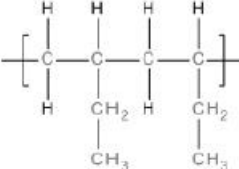
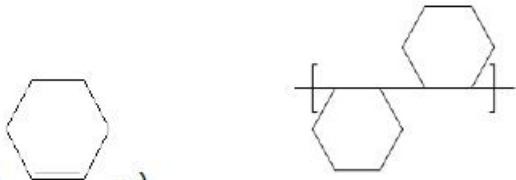
Q7.

Question Number	Answer	Additional Guidance	Mark
(i)	<ul style="list-style-type: none"> • curly arrow from C=C to chlorine and curly arrow from Cl-Cl to 'bottom' chlorine atom (1) • structure of carbocation intermediate and structure of final product (1) • chloride ion with lone pair and curly arrow from lone pair to C⁺ of carbocation (1) 	<p>Example of mechanism:</p>  <p>Ignore dipoles even if incorrect</p> <p>Allow correct structural/displayed formulae for intermediate and/or product</p> <p>Allow TE on incorrect primary carbocation</p>	(3)

Edexcel Chemistry A-level - Alkenes

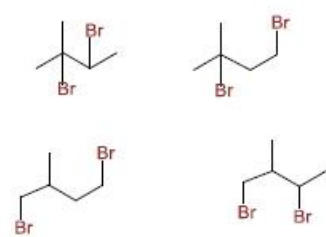
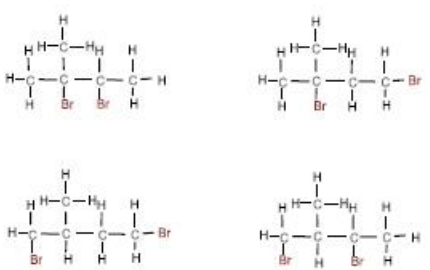
Question Number	Answer	Additional Guidance	Mark
(ii)	<ul style="list-style-type: none"> 1,2-dichloro-2-methylbutane 	<p>Allow name shown on mechanism</p> <p>Ignore missing hyphens and commas</p> <p>Do not allow 2-methyl-1,2-dichlorobutane</p> <p>TE on structure in (a)(i)</p> <p>Allow correct name even if incorrect structure in (i)</p>	(1)

Q8.

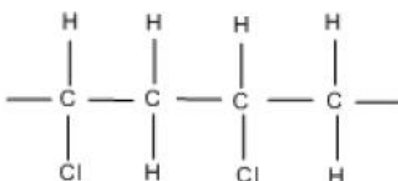
Question Number	Answer	Additional Guidance	Mark
	<p>(CH₂=CHCH₂CH₃-)</p> <p>(1)</p>  <p>(1)</p> 	<p>Accept skeletal, structural or displayed formulae or combination of which is clear, e.g. -C₂H₅</p> <p>Brackets are not essential</p> <p>Ignore 'n'</p> <p>Ignore orientation of side chains</p> <p>Ignore bond length</p> <p>Ignore where bond goes to for the ethyl groups</p> <p>Penalise lack of 'end-bonds' once only</p> <p>Award 1 mark max if only one repeat unit given for each polymer</p> <p>Ignore more than 2 repeat units</p>	(2)

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Q9.

Question Number	Acceptable Answer	Additional Guidance	Mark
	 <p>one mark for each structure</p>	<p>accept displayed/structural/skeletal formulae</p>  <p>Allow 2 marks for 4 different and correct monobromo isomers Allow 1 mark for 2/3 different and correct monobromo isomers Zero for 1 monobromo isomer accept correct enantiomers (provided both C=C bond react) Deduct one mark only for use of HCl Deduct one mark for (any number of) missing hydrogens</p>	(4)

Q10.

Question Number	Acceptable Answer	Additional Guidance	Mark
(i)		<p>must show two repeat units fully displayed</p> <p>allow head to head, head to tail, tail to tail, syndiotactic and isotactic structures</p> <p>do not award any other type of formula</p> <p>ignore brackets and n</p>	(1)

Edexcel Chemistry A-level - Alkenes

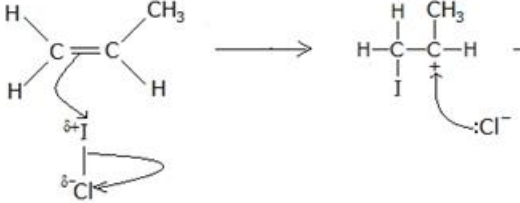
Question Number	Acceptable Answer	Additional Guidance	Mark
(ii)	<p>An explanation that makes reference to the following:</p> <ul style="list-style-type: none"> (incineration produces) HCl/chlorinated molecules (1) which are corrosive/toxic /cause acid rain (1) 	<p>M2 is dependent on M1</p> <p>allow chlorine ignore carbon dioxide and its consequences</p> <p>allow adverse effect on ozone layer</p>	(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
(iii)	<p>An answer that makes reference to the following:</p> <p>any appropriate precautions to deal with toxic vapours/use fume cupboard etc.</p>	<p>allow good ventilation required allow gas mask/respirator do not award just mask ignore gloves, lab coat</p>	(1)

Q11.

Question Number	Answer	Additional Guidance	Mark
(i)	<ul style="list-style-type: none"> diagram showing bond polarity using partial charges $\delta+$ on iodine and $\delta-$ on chlorine 	$\overset{\delta+}{\text{I}} - \overset{\delta-}{\text{Cl}}$	(1)

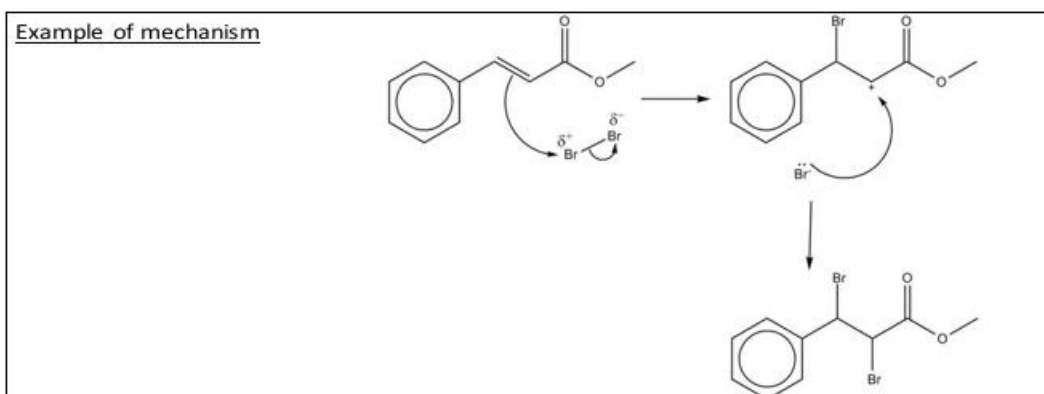
Edexcel Chemistry A-level - Alkenes

	Answer	Additional Guidance	Mark
(ii)	<ul style="list-style-type: none"> <li data-bbox="395 465 624 607">• arrow from double bond to Iδ^+ and arrow from I-Cl bond to Clδ^- <li data-bbox="395 674 624 898">• intermediate secondary carbocation with positive charge on carbon in the 2 position <li data-bbox="395 987 624 1180">• arrow from lone pair on Cl$^-$ to electron deficient carbon of carbocation 	<div style="text-align: center;">  </div> <p data-bbox="719 472 1267 528">Award M1 if dipoles are reversed in (b)(i) and arrow to Clδ^+</p> <p data-bbox="719 533 1254 645">Arrows should come from, or very close to, bonds and go to, or very close to, atoms. Allow arrow to I with no δ^+ if given correctly in (i)</p> <p data-bbox="719 674 1254 786">Mark is for secondary carbocation so TE from (b)(i) for carbocation from addition of Cl first in M1 Do not award δ^+ instead of +</p> <p data-bbox="719 931 1059 958">Do not award δ^- instead of -</p> <p data-bbox="719 987 1214 1070">If dipole is reversed in (i) award mark for arrow from lone pair on I$^-$ to electron deficient carbon of carbocation</p> <p data-bbox="719 1099 1114 1155">Ignore missing final product Allow M1 & M3 for minor product</p>	(3)

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Q12.

Question Number	Answer	Additional Guidance	Mark
(i)	<ul style="list-style-type: none"> • M1 arrow from double bond to (δ^+)Br in Br₂ (1) • M2 arrow from bond in Br₂ to Brδ^- (1) • M3 structure of carbocation (1) • M4 arrow from lone pair on Br$^-$ to C$^+$ in carbocation and final product (1) 	<p><u>Example of mechanism</u> See below</p> <p>Penalise lack of dipole only once in M1 and M2</p> <p>Award C$^+$ in intermediate on either C from the double bond</p> <p>Do not award M3 if four bonds are shown on carbocation</p> <p>Br atoms can be shown either upwards or downwards in final product</p> <p>Award (0) if just electrophilic substitution mechanism given.</p> <p>If both electrophilic substitution and addition shown allow 2 max</p> <p>Penalise errors in structure of methyl cinnamate once only in either M3 or M4</p>	(4)



Question Number	Answer	Mark
(ii)	<p>The only correct answer is C (4)</p> <p>A is not correct because 2 chiral centres form in reaction, so 4 possible combinations of +/- forms</p> <p>B is not correct because 2 chiral centres form in reaction, so 4 possible combinations of +/- forms</p> <p>D is not correct because 2 chiral centres form in reaction, so 4 possible combinations of +/- forms</p>	(1)

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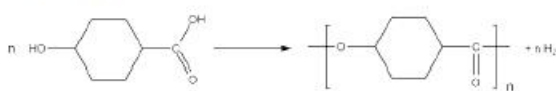

Question Number	Answer	Mark
(iii)	<p>The only correct answer is D (rotated)</p> <p><i>A is not correct because diffracted is the wrong term</i></p> <p><i>B is not correct because reflected is the wrong term</i></p> <p><i>C is not correct because refracted is the wrong term</i></p>	(1)

Q13.

Question Number	Answer	Additional Guidance	Mark																				
*	<p>This question assesses the student's ability to show a coherent and logically structured answer with linkages and fully sustained reasoning.</p> <p>Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning.</p> <p>The following table shows how the marks should be awarded for indicative content.</p> <table border="1"> <thead> <tr> <th>Number of indicative marking points seen in answer</th> <th>Number of marks awarded for indicative marking points</th> </tr> </thead> <tbody> <tr> <td>6</td> <td>4</td> </tr> <tr> <td>5-4</td> <td>3</td> </tr> <tr> <td>3-2</td> <td>2</td> </tr> <tr> <td>1</td> <td>1</td> </tr> <tr> <td>0</td> <td>0</td> </tr> </tbody> </table> <p>The following table shows how the marks should be awarded for structure and lines of reasoning</p> <table border="1"> <thead> <tr> <th></th> <th>Number of marks awarded for structure of answer and sustained lines of reasoning</th> </tr> </thead> <tbody> <tr> <td>Answer shows a coherent logical structure with linkages and fully sustained lines of reasoning demonstrated throughout</td> <td>2</td> </tr> <tr> <td>Answer is partially structured with some linkages and lines of reasoning</td> <td>1</td> </tr> <tr> <td>Answer has no linkages between points and is unstructured</td> <td>0</td> </tr> </tbody> </table>	Number of indicative marking points seen in answer	Number of marks awarded for indicative marking points	6	4	5-4	3	3-2	2	1	1	0	0		Number of marks awarded for structure of answer and sustained lines of reasoning	Answer shows a coherent logical structure with linkages and fully sustained lines of reasoning demonstrated throughout	2	Answer is partially structured with some linkages and lines of reasoning	1	Answer has no linkages between points and is unstructured	0	<p>Guidance on how the mark scheme should be applied: The mark for indicative content should be added to the mark for lines of reasoning. For example, a response with four indicative marking points that is partially structured with some linkages and lines of reasoning scores 4 marks (3 marks for indicative content and 1 mark for partial structure and some linkages and lines of reasoning).</p> <p>If there were no linkages between the points, then the same indicative marking points would yield an overall score of 3 marks (3 marks for indicative content and zero marks for linkages).</p>	(6)
Number of indicative marking points seen in answer	Number of marks awarded for indicative marking points																						
6	4																						
5-4	3																						
3-2	2																						
1	1																						
0	0																						
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Answer has no linkages between points and is unstructured	0																						

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	<p>Indicative content</p> <ul style="list-style-type: none"> • IP1 in both cases many monomers join (by covalent bonds to form polymers) • IP2 cyclohexene forms an addition polymer / the polymer is formed by an addition reaction • IP3 4-hydroxycyclohexanecarboxylic acid forms a condensation polymer / the polymer is formed by a condensation reaction • IP4 no additional products from when cyclohexene polymerises, but water is also 	<p>Allow both polymerisations require a catalyst Allow both polymers are formed from a single type of monomer</p> <p>Allow unsaturated monomer forms saturated polymer</p>	
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	<p>formed when 4-hydroxycyclohexanecarboxylic acid polymerises</p> <ul style="list-style-type: none"> • IP5 • IP6  	<p>Allow 'only 1 product in addition but two products in condensation' Allow only one functional group is needed for addition polymerisation but two different functional groups are needed for condensation polymerisation Allow cyclohexene polymerisation has 100% atom economy, 4-hydroxycyclohexanecarboxylic polymerisation has less than 100% atom economy</p> <p>Ignore omitted or misplaced n in IP5 and IP6</p> <p>Allow 1 IP for IP5 and IP6 if both correct repeat units shown</p> <p>Allow 2 oxygen atoms on RHS and none on LHS for IP6 repeat unit</p>	
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Q14.

Question Number	Acceptable Answer	Additional Guidance	Mark
	<p>2 (1)</p> <p>number of C atoms in geraniol = 10, C atoms in isoprene = 5, (10/5 = 2) (1)</p>	<p>Note: this must be a whole number</p> <p>Allow answers using C chain length ie isoprene = 4, geraniol = 8</p> <p>Ignore number of hydrogens in both isoprene and geraniol</p> <p>Do not award answers using M_r</p>	(2)

Q15.

Question Number	Acceptable Answer	Mark
	<p>The only correct answer is B</p> <p><i>A is incorrect because this is an oxidising agent for alcohols not alkenes</i></p> <p><i>C is incorrect because this would not react</i></p> <p><i>D is incorrect because this would only produce an alcohol</i></p>	(1)

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Q16.

Question Number	Answer	Additional Guidance	Mark
	<ul style="list-style-type: none"> • arrow from double bond to δ^+ H in HBr (1) • arrow from bond in HBr to $\text{Br}^{\delta-}$ (1) • structure of carbocation (1) • arrow from lone pair on Br^- to C^+ in carbocation and final products (1) 	<p>Penalise lack of dipole only once in M1 or M2 Do not award M1 if arrow from C=C to C also shown</p> <p>Formation of 3-bromopropane can potentially score M1, M2 and M4 as a TE</p>	(4)

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Q17.

Question Number	Answer	Additional Guidance	Mark
	<ul style="list-style-type: none"> dipole on I-Cl and correct major product (1) curly arrow from C=C to I and curly arrow from I-Cl to, or just beyond, Cl (1) intermediate (1) lone pair on Cl⁻ and curly arrow from lone pair to C⁺ (1) 	<p>Example of mechanism</p> <p>Do not award C^{δ+} on intermediate</p> <p>Allow curly arrow from lone pair to C^{δ+} if penalised in M3</p> <p>Notes If minor product formed, M2, M3 (with I on other carbon atom) and M4 can score</p> <p>If dipole shows Cl^{δ+} or no dipole shown and Cl joining first, M2 can score for curly arrow from C=C to Cl and curly arrow from Cl-I to, or just beyond, I and M4 can score for lone pair on I⁻ and curly arrow from lone pair to C⁺</p>	(4)

Q18.

Question Number	Acceptable Answer	Additional Guidance	Mark
(i)	• hydrogen chloride / HCl((g)) / H-Cl	Do not award hydrochloric acid / HCl(aq)	(1)

Question Number	Answer	Mark
(ii)	<p>The only correct answer is A (electrophilic addition)</p> <p>B is not correct because the reaction involves attack by an electrophile</p> <p>C is not correct because the reaction is an addition not a substitution</p> <p>D is not correct because the reaction is an addition involving attack by an electrophile</p>	(1)

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Q19.

Question Number	Acceptable Answer	Additional Guidance	Mark
		<p>Accept skeletal, structural or displayed formulae Accept any orientation of benzene ring</p> <p>Ignore brackets Ignore 'n' / '2n' / 'n/2' Allow syndiotactic and atactic forms Allow more than two units, as long as all correct.</p> <p>Neither of these diagrams scores Both have missing CH₂</p>	(1)

Q20.

Question Number	Acceptable Answer	Additional Guidance	Mark
(i)	<p>Reagent:</p> <ul style="list-style-type: none"> B is hydrogen / H₂ (gas) (1) <p>Condition:</p> <ul style="list-style-type: none"> nickel/ Ni (catalyst) (1) 	<p>mark independently</p> <p>allow any other suitable transition metal catalysts eg Pt, Pd</p> <p>ignore additional information relating to the support for the catalyst</p> <p>ignore references to heating/pressure/UV</p>	(2)

Question Number	Acceptable Answer	Mark
(ii)	<p>The only correct answer is C</p> <p>A is not correct because water is not involved</p> <p>B is not correct because there is no increase in number of oxygen atoms</p> <p>D is not correct because no substitution has taken place</p>	(1)

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Question Number	Acceptable Answer	Additional Guidance	Mark
(iii)	margarine	allow <u>liquid</u> coal allow butter substitute do not award just butter	(1)

Q21.

Question Number	Answer	Additional Guidance	Mark
(i)	An answer that makes reference to the following point: <ul style="list-style-type: none"> the hydride ion will not attack / will be repelled by regions of high electron density 	<p>Allow the reduction by LiAlH_4 is a nucleophilic addition / alkenes do not undergo nucleophilic reactions / H^- is a nucleophile</p> <p>Allow alkenes react with H^+ / $\text{H}^{\delta+}$ / $\text{H}\cdot$</p> <p>Allow the hydride ion will not attack a pi-bond / $\text{C}=\text{C}$</p> <p>Allow like charges repel</p> <p>Ignore hydride ions cannot reduce alkenes</p> <p>Ignore hydride ions can only reduce carbonyl compounds</p>	(1)

Question Number	Answer	Additional Guidance	Mark
(ii)	An answer that makes reference to the following points: <ul style="list-style-type: none"> hydrogen / H_2 (1) nickel / Ni or platinum / Pt / palladium / Pd (1) 	<p>Mark independently</p> <p>Ignore reference to temperature</p>	(2)

Question Number	Answer	Additional Guidance	Mark
(iii)	<ul style="list-style-type: none"> 1-bromobutane / $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Br}$ 	<p>If name and formula are given, both must be correct</p> <p>Allow Cl or I instead of Br</p> <p>Allow skeletal or displayed formulae</p>	(1)

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Question Number	Answer	Additional Guidance	Mark
(iv)	<ul style="list-style-type: none"> hydrochloric acid / HCl / H⁺ 	Allow any (dilute) strong acid Ignore concentration of acid Do not award any weak acid	(1)

Q22.

Question Number	Answer	Additional Guidance	Mark									
	<ul style="list-style-type: none"> product in Reaction 1 (1) reagent in Reaction 2 (1) condition in Reaction 2 (1) 	<p>Example of table</p> <table border="1"> <thead> <tr> <th>Reaction</th> <th>Reagent and condition</th> <th>Product</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>(HBr at room temperature)</td> <td> $\begin{array}{c} \text{H} & \text{H} \\ & \\ \text{H}-\text{C} & -\text{C}-\text{Br} \\ & \\ \text{H} & \text{H} \end{array}$ </td> </tr> <tr> <td>2</td> <td>steam / H₂O(g) and acid / H⁺</td> <td> $\left(\begin{array}{c} \text{H} & \text{H} \\ & \\ \text{H}-\text{C} & -\text{C}-\text{OH} \\ & \\ \text{H} & \text{H} \end{array} \right)$ </td> </tr> </tbody> </table> <p>Allow structural / skeletal / molecular formula / name for (1-)bromoethane</p> <p>Allow water / H₂O and heat instead of steam</p> <p>Allow specific acid e.g. (concentrated) phosphoric acid / sulfuric acid</p> <p>Ignore any specific temperature and pressure</p> <p>Do not award acid if mention of any reagent other than steam / water e.g. acidified dichromate</p>	Reaction	Reagent and condition	Product	1	(HBr at room temperature)	$\begin{array}{c} \text{H} & \text{H} \\ & \\ \text{H}-\text{C} & -\text{C}-\text{Br} \\ & \\ \text{H} & \text{H} \end{array}$	2	steam / H ₂ O(g) and acid / H ⁺	$\left(\begin{array}{c} \text{H} & \text{H} \\ & \\ \text{H}-\text{C} & -\text{C}-\text{OH} \\ & \\ \text{H} & \text{H} \end{array} \right)$	(3)
Reaction	Reagent and condition	Product										
1	(HBr at room temperature)	$\begin{array}{c} \text{H} & \text{H} \\ & \\ \text{H}-\text{C} & -\text{C}-\text{Br} \\ & \\ \text{H} & \text{H} \end{array}$										
2	steam / H ₂ O(g) and acid / H ⁺	$\left(\begin{array}{c} \text{H} & \text{H} \\ & \\ \text{H}-\text{C} & -\text{C}-\text{OH} \\ & \\ \text{H} & \text{H} \end{array} \right)$										