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)

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)

(2)

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.

(1)

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

CH3-CH2-CH2	cl
cl	CH ₃ —CH—CH ₃
1-chloropropane	2-chloropropane

1-chloropropane and 2-chloropropane are

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

(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)

(1)

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)

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**.

CH₃CH₂CH₂COOH or HOCH₂CH=CHCH₂OH A B

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

(2)

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)

.....

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.

$$CH_2 = CHCH_2CH_3 \rightarrow$$
 (2)



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)

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).

(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)

Q11.

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

lodine monochloride is used in measuring unsaturation in organic compounds.

lodine 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)

Q12.

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

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, Br₂.
 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)
	Α	2	
5	В	3	
5	С	4	
1	D	8	

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

(1)

- A diffractedB reflected
- C refracted
- D rotated

Q13.

* This question is about polymers.

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



cyclohexene

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

(6)

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)
 •
 •

(1)

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?

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

(4)

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.



Н Br

Q17.

This question is about hydrocarbons.

Propene reacts with iodine monochloride, ICI, 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 ICI molecule, curly arrows and any relevant lone pairs of electrons.

(4)

Q18.

Ar yo an	ur r swe	er the nind er wit	e question with a cross in the box you think is correct \boxtimes . If you change about an answer, put a line through the box \boxtimes and then mark your new th a cross \boxtimes .	
Pr 2-0	opei chlo	ne ca ropro	an be converted into a mixture of 1-chloropropane and ppane, in which 2-chloropropane is the major product.	
(i)	Giv	e the	e reagent required for this reaction.	
				(1)
(ii)	W	hat is	the type and mechanism of the reaction in (i)?	
		A B C D	electrophilic addition nucleophilic addition electrophilic substitution nucleophilic substitution	(1)

(1)

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.



(2)

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.

but-2-ene-1,4-diol

butane-1,4-diol

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

..... (ii) This reaction is best described as (1) Δ Α hydrolysis oxidation B 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)

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.

		Step 1	\sim		
	but-2-en-1-ol	LiAlH₄ in dry ether	buta	n-1-ol	
			Step 2	KCN in aqueous ethanol	
	OH pentanoic acid	Step 3 heat under reflux with NaOH(aq)	\sim	CN	
(i) Li	AlH4 is a source of hydride id	ons, H⁻.			
G	ive a possible reason why Li	AlH₄ cannot be use	ed to reduc	ce alkenes.	(1)
	Give a suitable reagent and c	ondition for Step 1			(2)
(iii) S	Step 2 is incorrect because a bound.	lcohols can only b	e converte	d to nitriles via an interme	ediate
i 	dentify a suitable intermedia	te compound by na	ame or forr	nula.	(1)
(iv) \$	Step 3 involves the hydrolysis	s of a nitrile.			
aque I	Give the additional reagent the ous sodium hydroxide, to propertanoic acid.	nat should be adde oduce	d after hea	ating under reflux with	
					(1)

(3)

Q22.

This question is about alkenes.

Two reactions of ethene are shown.



Complete the table.

Reaction	Reagent and condition	Product
1	HBr at room temperature	
2		H H H—C—C—OH H H

Mark Scheme

Q1.

Question Number	Answer	Additional Guidance	Mark
(i)	An answer that makes refe to the following point: • 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: dipole for the following points: dipole for the following points: dipole for the following present on hydrogen chloride arrow from (1) C=C bond to H or to where bond will be and arrow from H-Cl bond to, or just beyond, Cl correct for the form intermediate arrow from (1) Ione pair on chloride ion to positive carbocation (to give form (to give form) (to g	Allow TE for use of Cl ₂ 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 scor M4	(4)

Q2.

Question Number	Answer	Additional Guidance	Mark
	An answer that makes reference to the following point:	Correct answers will include monomer, polymer or words describing bonding / joining / linking of the vinyl chloride Allow pvc for polyvinyl chloride throughout	(1)
	 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 	Allow many vinyl chloride molecules joined / bonded together to make polyvinyl chloride Allow vinyl chloride is the repeat unit in polyvinyl chloride	

Q3.

Question Number	Answer		Additional Guidance	Mark
	An answer that makes reference to two of the following points:			(2)
	recycling	(1)	Allow remoulding Allow made into other items / description of recycling	
	 incineration to release energy 	(1)	Allow for burning as a fuel Ignore just 'for incineration'	
	 as a feedstock for cracking 	(1)	Ignore just 'as a feedstock'	

Q4.

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

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

Question Number	Acceptable Answer	Additional Guidance	Mark
(iii)	 An answer which shows the following: 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 and curly arrow from H-Cl bond to Cl atom (1) 	Example of mechanism $c_{H_{3}} - \stackrel{H}{\underset{\delta^{-}}{\overset{\circ}{\underset{c}{\vdash}}}} \stackrel{c_{H_{3}}}{\underset{\delta^{-}}{\overset{\circ}{\underset{c}{\vdash}}}} \stackrel{e_{H_{3}}}{\underset{\epsilon^{-}}{\overset{\circ}{\underset{c}{\vdash}}}} \stackrel{H}{\underset{\epsilon^{-}}{\overset{\circ}{\underset{c}{\vdash}}}} \stackrel{H}{\underset{\epsilon^{-}}{\overset{\circ}{\underset{c}{\vdash}}}} \stackrel{H}{\underset{\epsilon^{-}}{\overset{\circ}{\underset{c}{\vdash}}}} \stackrel{H}{\underset{\epsilon^{-}}{\overset{H}{\underset{c}{\vdash}}}} \stackrel{H}{\underset{\epsilon^{-}}{\underset{\epsilon^{-}}{\overset{H}{\underset{c}{\vdash}}}} \stackrel{H}{\underset{\epsilon^{-}}{\underset{\epsilon^{-}}{\underset{\epsilon^{-}}{\underset{\epsilon^{-}}{\atop{\iota^{-}}{\atop{\iota^{-}}}}}}} \stackrel{H}{\underset{\epsilon^{-}}{\underset{\epsilon^{-}}{\underset{\epsilon^{-}}{\underset{\epsilon^{-}}{\underset{\epsilon^{-}}{\atop{\iota^{-}}}}}}} \stackrel{H}{\underset{\epsilon^{-}}{\underset{\epsilon^{-}}{\underset{\epsilon^{-}}{\underset{\epsilon^{-}}{\underset{\epsilon^{-}}{\underset{\epsilon^{-}}{\underset{\epsilon^{-}}{\underset{\epsilon^{-}}{\underset{\epsilon^{-}}}}}}}} \stackrel{H}{\underset{\epsilon^{-}}}{\underset{\epsilon^{-}}{\underset{\epsilon^{-}}{\underset{\epsilon^{-}}{\underset{\epsilon^{-}}}{\underset{\epsilon^{-}}{\underset{\epsilon^{-}}{\underset{\epsilon^{-}}{\underset{\epsilon^{-}}{\underset{\epsilon^{-}}}{\underset{\epsilon^{-}}{\underset{\epsilon^{-}}{\underset{\epsilon^{-}}{\underset{\epsilon^{-}}{\underset{\epsilon^{-}}}{\underset{\epsilon^{-}}{\underset{\epsilon^{-}}{\underset{\epsilon^{-}}}{\underset{\epsilon^{-}}{\underset{\epsilon^{-}}}{\underset{\epsilon^{-}}{\underset{\epsilon^{-}}}{\underset{\epsilon^{-}}}{\underset{\epsilon^{-}}{\underset{\epsilon^{-}}}{\underset{\epsilon^{-}}}{\underset{\epsilon^{-}}{\underset{\epsilon^{-}}}{\underset{\epsilon^{-}}{\underset{\epsilon^{-}}}}{\underset{\epsilon^{-}}}$	
	 intermediate with + charge shown on correct carbon (1) curly arrow from <u>lone pair</u> on chloride ion to correct 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	
	(1)		(4)

Q5.

Question Number	Answer	Additional Guidance	Mark
Number (i)	Answer 2 repeat units with extension bonds	Additional GuidanceExample of two repeat units H H H $-C$ $-C$ $-C$ $-C$ $-C$ $-C$ H H H $-C$ $-C$ $-C$ $-C$ $-C$ $-C$ H H H H $-C$ $-C$ H H H H $-C$ $-C$ H <td< td=""><td>Mark (1)</td></td<>	Mark (1)
		Ignore brackets / n Ignore connectivity of vertical CH2CH3 groups	

Question Number		Answer	Additional Guidance	Mark
(ii)	•	calculation of moles of but-1-ene (1)	$\frac{\text{Example of calculation}}{\text{moles of but-1-ene}} = \frac{70.0}{56.0} = 1.25$	(2)
	•	calculation of number of molecules of but-1-ene (1)	molecules of but-1-ene = 1.25 x 6.02 x10 ²³ = 7.525 x 10 ²³	
			TE on moles but-1-ene	
			Ignore SF except 1 SF	
			x10 ²³	
			Correct answer with no working scores (2)	

Q6.

Question Number	Answer		A	lditional Guidance	Mark
	A description that makes		Examples of reagen	ts and observations	(2)
	reference to		Reagent	Observation	
	two of the		bromine water	orange / yellow / brown solution	1
	following		Allow bromine	goes colourless	
	points:		(in an organic solvent)	Allow bromine water is decolourised	
	 reagent 	(1)	carboxylic acid and	characteristic smell (of an ester)	1
	 corresponding observation 	(1)	(concentrated) H ₂ SO ₄ / HCl / H ⁺		
			acidified potassium manganate(VII) / permanganate	purple to colourless / decolourised	2,5
			alkaline potassium manganate(VII)	purple to green	
			(neutral) potassium manganate(VII)	purple to brown ppt	
			acidified (potassium) dichromate((VI)) (ions)	orange to green	
			Allow names or fon given, both must be Ignore conditions e.	nulae for reagents but if both are correct g. heat	
			Do not award PC15	Na	
			If more than one test	t is given, penalise any incorrect	

Q7.	
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Question Number	Answer	Additional Guidance	
(i)	K	Example of mechanism: $\downarrow \qquad \qquad$	(3)
	 curly arrow from C=C to chlorine and curly arrow from Cl-Cl to 'bottom' chlorine atom(1) 	Ignore dipoles even if incorrect	
	 structure of carbocation intermediate and structure of final product (1) 	Allow correct structural/displayed formulae for intermediate and/or product	
	 chloride ion with lone pair and curly arrow from lone pair to C+ of carbocation (1) 	Allow TE on incorrect primary carbocation	

Question Number	Answer	Additional Guidance	Mark
(ii)	• 1,2-dichloro-2-methylbutane	Allow name shown on mechanism Ignore missing hyphens and commas Do not allow 2-methyl-1,2- dichlorobutane TE on structure in (a)(i) Allow correct name even if incorrect structure in (i)	(1)

Q8.

Question Number	Answer	Additional Guidance	Mark
	(CH ₂ =CHCH ₂ CH ₃ -) (1) $ \begin{array}{c} H & H & H & H \\ \hline \\ C & C & C & C \\ H & CH_2 & H & CH_2 \\ H & CH_2 & H & CH_2 \\ CH_3 & CH_3 & CH_3 \\ \end{array} $	Accept skeletal, structural or displayed formulae or combination of which is clear, e.gC ₂ H ₅ Brackets are not essential	(2)
		Ignore 'n' Ignore orientation of side chains Ignore bond length Ignore where bond goes to for the ethyl groups Penalise lack of 'end-	
	(1)	bonds' once only Award 1 mark max if only one repeat unit given for each polymer Ignore more than 2 repeat units	

Question Number	Acceptable Answer	Additional Guidance	Mark
	Br Br	accept displayed/structural/skeletal formulae	(4)
	Br Br	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	
	one mark for each structure	$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	
		Allow 2 marks for 4 different and correct monobromo isomers Allow 1 mark for 2/3 different and correct monobromo isomers Zero for 1 monobromoisomer 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	

Q10.

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

Question Number	Acceptable Answer	Additional Guidance	Mark
(ii)	 An explanation that makes reference to the following: (incineration produces) HCl/chlorinated molecules (1) which are corrosive/toxic /cause acid rain (1) 	M2 is dependent on M1 allow chlorine ignore carbon dioxide and its consequences allow adverse effect on ozone layer	(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
(iii)	An answer that makes reference to the following:	45 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	
	any appropriate precautions to deal with toxic vapours/use fume cupboard etc.	allow good ventilation required allow gas mask/respirator do not award just mask ignore gloves, lab coat	(1)

Q11.

Question Number	Answer	Additional Guidance	Mark
(i)	 diagram showing bond polarity using partial charges δ+ on iodine and δ- on chlorine 	Ι ^{δ+} _CΙ ^{δ-}	(1)

	Answer		Additional Guidance	Mark	
(ii)	 arrow from double bond to I^{δ+} and arrow from I-Cl bond to Cl^{δ-} intermediate secondary carbocation with positive charge on carbon in the 2 position 	(1)	$\begin{array}{c} H \\ H $	(3)	
	position		Do not award δ- instead of −		
	 arrow from lone pair on Cl⁻ to electron deficient carbon of carbocation 	(1)	If dipole is reversed in (i) award mark for arrow from lone pair on I ⁻ to electron deficient carbon of carbocation Ignore missing final product Allow M1 & M3 for minor product		

Q12.

Question Number	Answer	Additional Guidance	Mark
Question Number (i)	Answer • 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)	Additional Guidance Example of mechanism See below Penalise lack of dipole only once in M1 and M2 Award C* in intermediate on either C from the double bond Do not award M3 if four bonds are shown on carbocation Br atoms can be shown either upwards or downwards in final product Award (0) if just electrophilic substitution mechanism given.	Mark (4)
		If both electrophilic substitution and addition shown allow 2 max Penalise errors in structure of methyl cinnamate once only in either M3 or M4	



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

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

Q13.

Question Number	n Answer		Additional Guidance	Mark
*	This question assesses the stud coherent and logically structur and fully sustained reasoning. Marks are awarded for indicat the answer is structured and sh The following table shows how awarded for indicative contents	lent's ability to show a red answer with linkages ive content and for how nows lines of reasoning. w the marks should be	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	(6)
	Number of indicative N marking points seen in answer n	Vumber of marks warded for indicative marking points	reasoning scores 4 marks (3 marks for indicative content and 1 mark for partial structure	
	6	4	and some linkages and lines of	
	5-4	3	reasoning).	
	3-2	2	If there were no linkages	
	1	1	between the points, then the	
	0	0	same indicative marking points	
	The following table shows how awarded for structure and line	w the marks should be s of reasoning Number of marks awarded for structure of answer and sustained lines of reasoning	3 marks (3 marks for indicative content and zero marks for linkages).	
	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		

Indic:	ative content 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	Allow both polymerisations require a catalyst Allow both polymers are formed from a single type of
•	IP3 4-hydroxycyclohexanecarboxylic acid forms a condensation polymer / the polymer is formed by a condensation reaction	monomer Allow unsaturated monomer forms saturated polymer
•	IP4 no additional products from when cyclohexene polymerises, but water is also	



Q14.

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

Q15.

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

Q16.

Question Number	Answer	Additional Guidance	Mark
	 arrow from double bond to ∂+ H in HBr (1) 	Penalise lack of dipole only once in M1 or M2 Do not award M1 if arrow from C=C to C also shown	(4)
	 arrow from bond in HBr to Br²⁻ (1) 		
	 structure of carbocation (1) 		
	 arrow from lone pair on Br⁻ to C⁺ in carbocation and final products (1) 	Formation of 3-bromopropane can potentially score M1, M2 and M4 as a TE	
	· · · · · · · · · · · · · · · · · · ·	Br	\wedge

Q17.

Question Number	Answer	Additional Guidance	Mark
	 dipole on I- Cl and correct major product (1) 	Example of mechanism $\begin{array}{c} H \\ H \\ H \\ H \\ H \\ I \\ I \\ I \\ I \\ I \\$	(4)
	 curly arrow from C=C to I and curly arrow from I-Cl to, or just beyond, Cl (1) 	Do not award C ^{ō+} on intermediate Allow curly arrow from lone pair to C ^{ō+} if penalised in M3 Notes If minor product formed, M2, M3 (with I on other carbon atom) and M4 can score	
	 intermediate (1) lone pair on Cl⁻	If dipole shows Cl ⁵⁺ 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 ⁺	

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)	The only correct answer is A (electrophilic addition)	(1)
	B is not correct because the reaction involves attack by an electrophile	
	C is not correct because the reaction is an addition not a substitution	
	D is not correct because the reaction is an addition involving attack by an electrophile	

Q19.

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

Q20.

Question Number	Acceptable Answer	Additional Guidance	Mark
(i)	 Reagent: B is hydrogen / H₂ (gas) (1) 	mark independently	
	Condition: • nickel/ Ni (catalyst) (1)	allow any other suitable transition metal catalysts eg Pt, Pd ignore additional information	
		relating to the support for the catalyst ignore references to heating/pressure/UV	(2)

Question Number	Acceptable Answer	Mark
(ii)	The only correct answer is C	
	A is not correct because water is not involved	
	${\bf B}$ is not correct because there is no increase in number of oxygen atoms	
	D is not correct because no substitution has taken place	(1)

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: the hydride ion will not attack / will be repelled by regions of high electron density 	Allow the reduction by LiAlH4 is a nucleophilic addition / alkenes do not undergo nucleophilic reactions / H ⁻ is a nucleophile Allow alkenes react with H ⁺ / H ⁰⁺ / H• Allow the hydride ion will not attack a pi-bond / C=C Allow like charges repel Ignore hydride ions cannot reduce alkenes Ignore hydride ions can only reduce carbonyl compounds	(1)

Question Number	Answer	Additional Guidance	Mark	
(ii)	An answer that makes reference to the following points:	Mark independently	(2)	
	 hydrogen / H₂ (1) 	Ignore reference to temperature		
	 nickel / Ni or platinum / Pt / palladium / Pd (1) 			

Question Number	Answer	Additional Guidance		
(iii)	• 1-bromobutane / CH3CH2CH2CH2Br	If name and formula are given, both must be correct Allow Cl or I instead of Br Allow skeletal or displayed formulae	(1)	

Question Number	Answer	Additional Guidance	Mark
(iv)	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 Gui	dance	Mark
		Example of table			(3)
		Reaction	Reagent and condition	Product	
		1	(HBr at room temperature)	H H HCBr H H	
		2	steam / H₂O(g) and acid / H⁺	Н Н Н С С ОН Н Н Н	
	 product in Reaction 1 (1) 	Allow structur name for (1-)t	al / skeletal / n promoethane	nolecular formula /	
	 reagent in Reaction 2 (1) 	Allow water / Allow specific acid / sulfuric	H ₂ O and heat in acid e.g. (conce acid	stead of steam entrated) phosphoric	
	condition in Reaction 2 (1)	Ignore any spe Do not award than steam /	ecific temperatu acid if mention o water e.g. acidif	re and pressure of any reagent other fied dichromate	