Question Number	Acceptable Answers	Reject	Mark
1(a)	C_nH_{2n} ALLOW any letter for n	C_2H_{2n} C_nH_{2n+2}	1

Question Number	Acceptable Answers	Reject	Mark
1(b)	Either one of the following options: $CH_2CH_2 + Br_2 \rightarrow CH_2BrCH_2Br$ 1,2-dibromoethane OR $CH_3CHCH_2 + Br_2 \rightarrow CH_3CHBrCH_2Br$ 1,2-dibromopropane **Marking Point 1** Correct reactant – ethene or propene (1) **Marking Point 2** Correct product from the number of carbon atoms in the reactant (1) **Marking Point 3** Correct name from the number of carbon atoms in the reactant (1) IGNORE punctuation on product ALLOW displayed/ skeletal formulae Penalise molecular formula of product only No TE on name if product incorrect		3

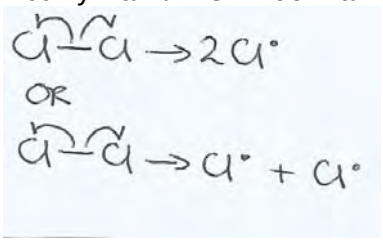
Question Number	Acceptable Answers	Reject	Mark
1(c)(i)	(Error 1) the dipole on the chlorine molecule should be the other way round (1) (Error 2) the arrow should be going from the double bond (to the chlorine)/electrons move from the double bond to the chlorine (1) (Error 3) the chlorine should have a **negative** charge (and a lone pair) (1)	Chlorine molecule	3

Question Number	Acceptable Answers	Reject	Mark
1(c)(ii)	Because **tertiary** carbocation is more stable (than a primary carbocation) OR the positive carbon has more **positively-inductive**/ **electron-releasing** alkyl groups (to help stabilization than the other carbon of the double bond) IGNORE references to carbon only having three bonds or being electron deficient	Just Secondary carbocation	1

Question Number	Acceptable Answers	Reject	Mark
1(d)	 OR  (1)  (1)		2

Question Number	Acceptable Answers	Reject	Mark
1(e)	Same molecular formula/same number of atoms/same amount of each element but different (Structural) arrangement (of atoms)/ structure/ structural formulae/ displayed formulae/ skeletal formulae	 'in space'	1

Question Number	Acceptable Answers	Reject	Mark
1(f)(i)	Ultraviolet (radiation)/ UV (radiation) / (Sun) light	High temperature	1

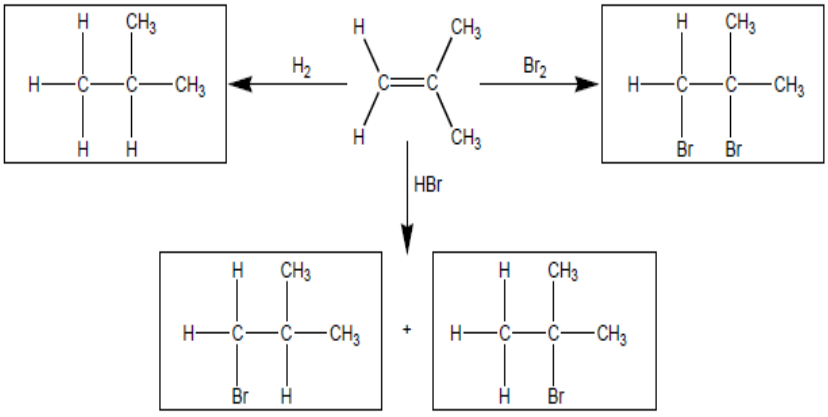
Question Number	Acceptable Answers	Reject	Mark
1(f)(ii)	Cl-Cl →2Cl● OR Cl-Cl →Cl● + Cl● (1) Correct use of curly half / 'fish-hook' arrows (1)  Curly half arrows can start from anywhere on the bond and extend beyond the Cl The half arrows can be above or below the bond or a combination of the two.		2

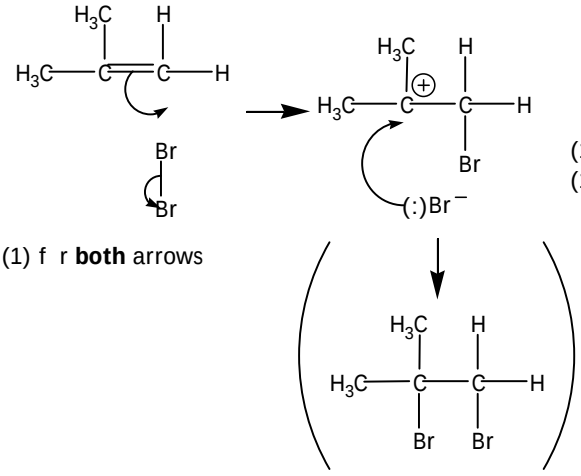
Question Number	Acceptable Answers	Reject	Mark
1(f)(iii)	(First propagation step) $C_4H_8 + Cl\bullet \rightarrow HCl + C_4H_7\bullet$ (1) (Second propagation step) $C_4H_7\bullet + Cl_2 \rightarrow C_4H_7Cl + Cl\bullet$ (1) The position of ● is not essential Penalise lack of ● once only	Reference to H/ H● scores (0)	2

Question Number	Acceptable Answers	Reject	Mark
1(f)(iv)	Homolytic/ homolytic fission/ homolytic bond fission		1

Question Number	Acceptable Answers	Reject	Mark
1(f)(v)	**arking point 1** **Two** free radicals are combining/reacting with each other/suitable termination equation (1) **Marking point 2** The product is a stable species/No free radicals produced/ The product is not a free radical/ Concentration of free radicals decreases / lowers the number of radicals (1)		2

Question Number	Acceptable Answers	Reject	Mark
1(g)	Further substitution/polysubstitution can occur OR Other products such as $C_4H_6Cl_2$/ $C_4H_5Cl_3$ **COMMENT:** ALLOW Forms C_4Cl_8		1

Question Number	Acceptable Answers	Reject	Mark
2(a)	 **(1)** for each correct product ALLOW correct displayed / skeletal / semi-skeletal / structural / semi-structural formula in each case ALLOW any order of symbols after or before each carbon ALLOW brackets or no brackets around Br/ CH_3 for example $CH_2BrCH_3CBrCH_3$		**4**

Question Number	Acceptable Answers	Reject	Mark
2(b)	 (1) f r carbocation (1) for arrow (1) f r **both** arrows **First mark** **Double-headed** arrow from alkene must start from somewhere on C=C bond Partial charge on Br_2 molecule must be correct if shown **Second mark** is for either correct primary or secondary carbocation and is a standalone mark **Third mark** **Double-headed** arrow from bromide ion can start from the minus sign, a lone pair on Br^-, or from the Br and can go to the C or the + sign on the intermediate The **negative charge** must be present on the **bromide ion** The final product, if shown, must be correct to gain third mark Mechanisms with other electrophiles (e.g. HBr, BrOH) can score 2nd and 3rd marks	Single-headed arrow Bromine / bromide free radicals Single-headed arrow (Penalise again)	**3**

Question Number	Acceptable Answers	Reject	Mark
2(c)	**First mark is for calculating the theoretical maximum mass of ethene from 9.2 g ethanol:-** (46 g C_2H_5OH gives 28 g C_2H_4 so 9.2 g C_2H_5OH gives maximum mass of) **5.6 g** C_2H_4 **(1)** **Second mark is for calculating the percentage yield from candidate's theoretical maximum mass:-** (4.2/5.6 x 100% =) **75** (%) IGNORE s.f. except 1 s.f. OR **First mark** Amount of ethene = 4.2/28 = 0.15 (mol) and amount of ethanol = 9.2/46 = 0.20 (mol) **(1)** **Second mark** % yield = 0.15/0.20 = 75 % **(1)** **NOTE** Correct answer with no working scores **(2)** % yield TE on candidate's theoretical mass / moles only if % yield ‹100% If molar masses are reversed, award one mark for 27.8%	**(0)** for $\frac{4.2}{9.2}$ x 100%	**2**

Question Number	Acceptable Answers	Reject	Mark
3 (a)(i)	**Crude** oil / petroleum / coal	Oil on its own / Natural gas / fossil fuels / any named fraction of crude oil	**1**

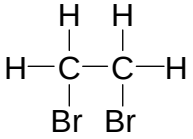
Question Number	Acceptable Answers	Reject	Mark
3 (a)(ii)	use of high temperatures / heat (in the absence of air) / thermal decomposition / catalysts **(1)** Either to break large molecules / to form smaller molecules / to break bonds in **large** molecules / to break carbon-carbon bonds **(1)** OR producing alkenes / producing carbon-carbon double bonds **(1)**		**2**

<table>
<tr><th>Question Number</th><th>Acceptable Answers</th><th>Reject</th><th>Mark</th></tr>
<tr><td>3 (a)(iii)</td><td>Risks (2)
Amendments (2)

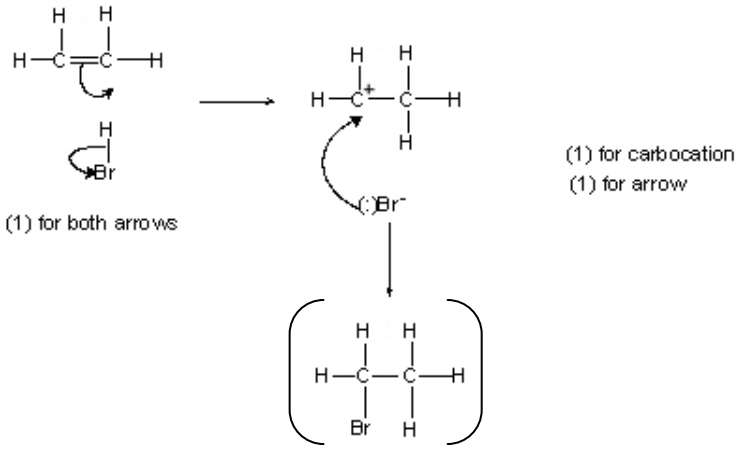
<table><tr><th>Risk</th><th>Amendment</th></tr><tr><td>exposure to harmful / toxic fumes</td><td>Set up in fume cupboard</td></tr><tr><td>Escape of flammable / harmful / toxic reactants or products from ill fitting bung</td><td>Correct fitting of bung</td></tr><tr><td>Escape of flammable / harmful /toxic reactants or products from poorly positioned delivery tube</td><td>Placement of delivery tube below mouth of test tube / use a longer delivery tube</td></tr><tr><td>suck back</td><td>Attach Bunsen valve / remove delivery tube from water before stopping heating etc</td></tr></table>
Mark all 4 points independently
If escaping gases linked to 2 amendments but no risk mentioned then allow 1 for risk</td><td>Dangerous

collect in syringe</td><td>4</td></tr>
</table>

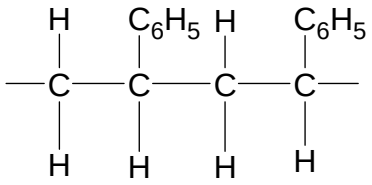
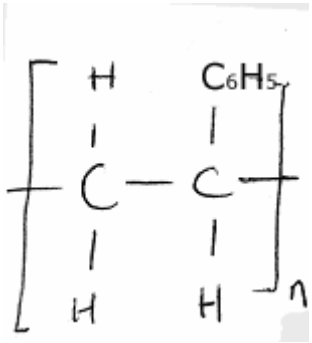
Question Number	Acceptable Answers	Reject	Mark
3 (b)(i)	Reagent – Hydrogen/H_2 **(1)** Catalyst – Nickel/Ni/palladium/Pd/platinum/Pt **(1)** Mark independently		**2**

Question Number	Acceptable Answers	Reject	Mark
3 (b)(ii)	1,2 – dibromoethane **(1)** ignore punctuation  **(1)** Mark independently Allow CH_2BrCH_2Br	1,2 - bromoethane dibromoethane Skeletal formula $C_2H_4Br_2$	**2**

Question Number	Acceptable Answers	Reject	Mark
3 (b)(iii)	From purple / pink → colourless	clear	**1**

Question Number	Acceptable Answers	Reject	Mark
3 (c)(i)	 arrow from bromide ion can start from any part of the bromide ion and can go towards the C or the + sign on the intermediate bromide ion must show negative charge allow 2 max for addition of Br_2 and any other electrophilic additions half headed arrows used throughout penalise only once	∂- on bromide ion for third mark	**3**

Question Number	Acceptable Answers	Reject	Mark
3 (c)(ii)	Bromine / bromide / hydrogen could add to either carbon (in the double bond) / bromide / bromine could add to either primary or secondary carbocation / (propene is unsymmetrical) so could form 1-bromopropane and / or 2-bromopropane. Allow correct structural or displayed formulae.	bromine could add to any of the three carbons	**1**

Question Number	Acceptable Answers	Reject	Mark
3 (d)	 position of hydrogen atoms and phenyl groups **(1)** Allow phenyl groups on 2nd and 3rd carbon OR 1st and 4th OR 1st and 3rd carbon carbon single bonds and continuation bonds **(1)** second mark not awarded for incorrect monomer  **(1)** max with or without square brackets and n or numbers Do not penalise H from phenyl groups attaching to carbon chains Ignore extra square brackets, numbers and 'n' provided 2 monomer units shown		**2**

Question Number	Acceptable Answers	Reject	Mark
3 (e)(i)	Any two (raw material for) paper cup requires cutting down trees **(1)** polystyrene cup uses less energy (280 kWh rather than 980 kWh) to produce so less CO_2 released / less fossil fuels **(1)** polystyrene cup releases less sulfur based compounds into air so less chance of forming acid rain / less chance of damaging buildings / acidifying lakes (produces 3.5 kg rather than 11 kg) **(1)** polystyrene cup releases no chlorine compounds which damages ozone layer / poisonous (produce 0 kg rather than 0.4 kg) **(1)** 2 pieces of data chosen with no explanation allow 1 mark Ignore comments regarding water		**2**

Question Number	Acceptable Answers	Reject	Mark
3 (e)(ii)	2 additional factors e.g ease of recyclability whether cup is easy to reuse space taken up in landfill type and amount of gases formed if incinerated useful heat obtained if incinerated biodegradeability / how long they take to decompose management of gases produced during decomposition durability / how long the cup lasts method of disposal Ignore comments regarding atom economy Ignore comments regarding acid rain / ozone layer / greenhouse gases unless linked to gases produced during disposal		**2**