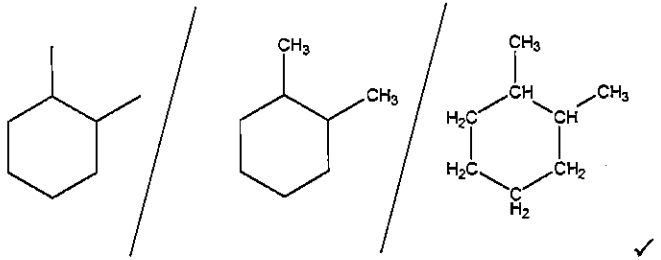
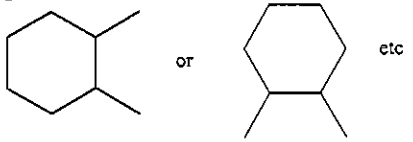
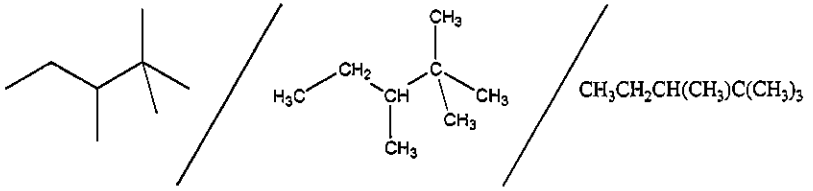
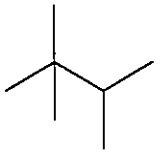
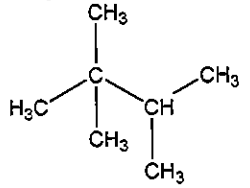
2812 Chains and Rings

Question			Expected Answers	Marks	Additional Guidance
1	(a)		compound/molecule that contains carbon & hydrogen **only** ✓	1	**allow** hydrocarbons contain carbon & hydrogen **only** **allow** molecules that contain carbon & hydrogen **only**
	(b)		$C_{14}H_{30} \longrightarrow C_8H_{18} + C_6H_{12}$ ✓	1	**allow** $CH_3(CH_2)_{12}CH_3 \longrightarrow CH_3(CH_2)_6CH_3 + C_6H_{12}$ **allow** any isomer of C_6H_{12} or any combination of alkenes that add up to C_6H_{12}.
	(c)	(i)	 ✓	1	**allow** different orientations as long as the two methyl groups are on adjacent Cs 
		(ii)	hydrogen/H_2 ✓	1	no other correct response
	(d)	(i)	 ✓	1	**allow** any unambiguous form of 2,2,3-trimethylpentane

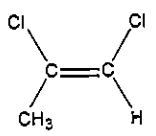
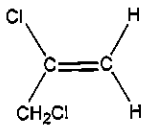
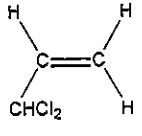
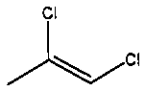
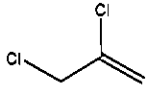
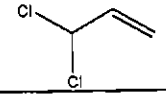
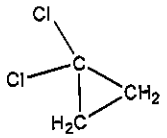
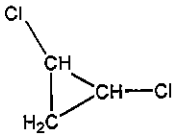
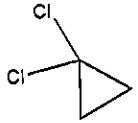
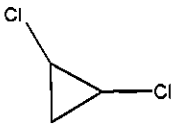
Question			Expected Answers	Marks	Additional Guidance
		(ii)	$C_8H_{18} + 12½O_2 \longrightarrow 8CO_2 + 9H_2O$ ✓✓ 1 mark if all formulae are correct both marks if correctly balanced	2	**allow** $2C_8H_{18} + 25O_2 \longrightarrow 16CO_2 + 18H_2O$ **allow** structural, displayed or skeletal formula of C_8H_{18}.
	(e)	(i)	(feedstock is obtained) from plants ✓ which can be re-grown ✓	2	**allow** made from sugar cane/beet/biomass *for 1 mark* **not allow** just sugar **allow** made from sugar because it can be re-grown *for 2 marks* **not allow** just fermentation **allow** fermentation from/of plants *for first marking point*
		(ii)	CO_2 used in photosynthesis is balanced by CO_2 released in combustion / it is carbon neutral ✓	1	**not allow** does not produce greenhouse gases **allow** doesn't emit any oxides of nitrogen/sulphur **not allow** doesn't produce toxic gases/acid rain If two statements are made and one is incorrect the mark is lost e.g. is carbon neutral and does not produce greenhouse gases *this gets ✗ con*
			Total	**10**	

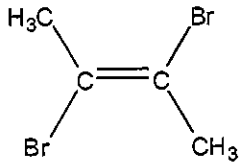
Question			Expected Answers	Marks	Additional Guidance
3	a	(i)	F ✓	1	no other acceptable answer
		(ii)	van der Waals ✓	1	**allow** vdW/vdw **ignore** spelling of van der Waals **not allow** intermolecular forces/ dipole-dipole/H-bonds
		(iii)	2,2,3-trimethylbutane/  ✓	1	**allow** either name or any unambiguous formula  $(CH_3)_3CCH(CH_3)_2$
	b	(i)	(particle/atom/molecule that) contains an unpaired/single electron ✓	1	**allow** .... contains an unpaired electron/has a single unpaired electron **do not allow** a *free* electron **do not allow** an ion with an unpaired/single electron
		(ii)	$Cl_2 \longrightarrow 2Cl^{\bullet}$ ✓	1	**allow** $Cl_2 \longrightarrow Cl^{\bullet} + Cl^{\bullet}$ / $\frac{1}{2}Cl_2 \longrightarrow Cl^{\bullet}$
		(iii)	homolytic (fission)/ ✓	1	**allow** homolysis/ homolytic cleavage
		(iv)	$C_7H_{16} + Cl^{\bullet} \longrightarrow {}^{\bullet}C_7H_{15} + HCl$ ✓ $^{\bullet}C_7H_{15} + Cl_2 \longrightarrow C_7H_{15}Cl + Cl^{\bullet}$ ✓	2	**allow** $C_7H_{15}^{\bullet}$ no other alternatives
		(v)	$^{\bullet}C_7H_{15} + {}^{\bullet}C_7H_{15} \longrightarrow C_{14}H_{30}$ or $C_7H_{15}C_7H_{15}$ ✓	1	allow $2{}^{\bullet}C_7H_{15} \longrightarrow C_{14}H_{30}$ or $C_7H_{15}C_7H_{15}$ ✓

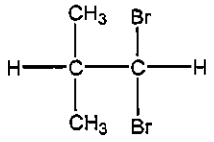
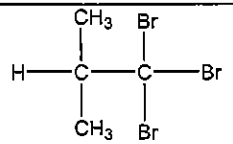
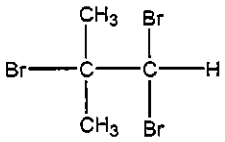
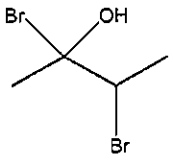
	c	(i)	compound **E** has **6** isomers ✓	1	no other acceptable answer
		(ii)	compound **G** has **3** isomers ✓	1	no other acceptable answer
				11	

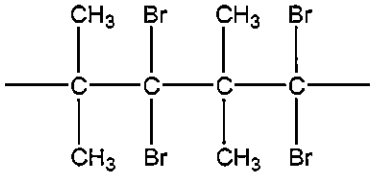
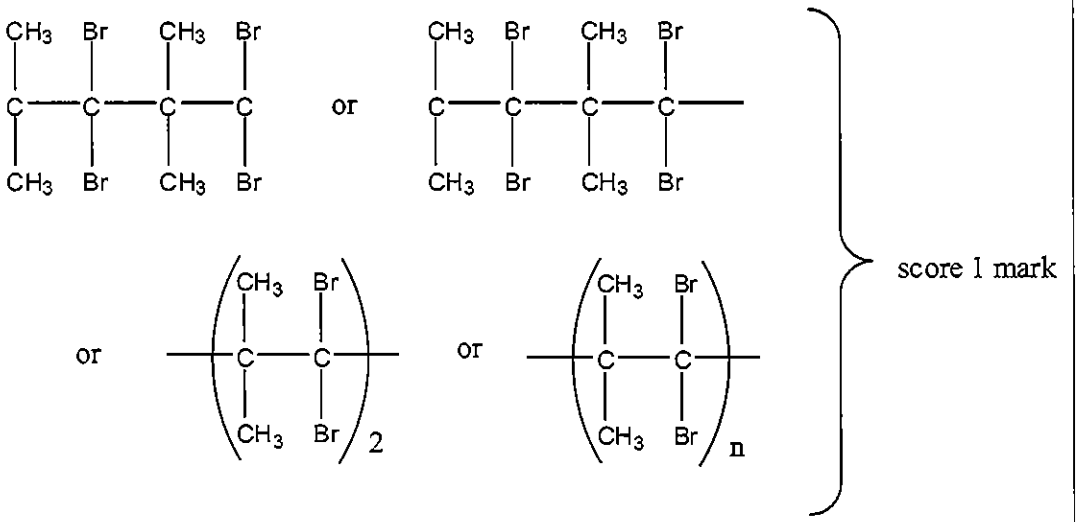
Question	Expected Answers	Marks	Additional Guidance
5 (a)	alkanes are non-polar ✓ nucleophiles/electrophiles are **attracted** to polar substances ✓ C–H bonds are strong ✓ allow max of 2 from 3	2	**allow** C–H bonds have little/no polarity/no dipoles **allow** no regions of high or low electron density **allow** nucleophiles/electrophiles/reagents are **not** attracted to non-polar substances **not allow** attacks/reacts as an alternative to attracts **allow** bonds in alkanes are strong
(b)	Free radical substitution ✓ balanced equation $C_5H_{12} + Br_2 \rightarrow C_5H_{11}Br + HBr$ ✓ mechanism $Br_2 \longrightarrow 2Br\bullet$ ✓ $Br\bullet + C_5H_{12} \longrightarrow HBr + \bullet C_5H_{11}$ ✓ $\bullet C_5H_{11} + Br_2 \longrightarrow C_5H_{11}Br + Br\bullet$ ✓ any two free radicals to show termination step ✓ conditions: uv ✓ bond fission: homolytic fission ✓ mixed products due to: • multiple substitution of H (in C_5H_{12}) • several isomers of $C_5H_{11}Br$ • different products could be formed in termination step* any two from three ✓✓	10	if a different alkane is used **do not allow** mark for either propagation step but the rest can be marked ecf If error in first propagation step ecf can be awarded for second propagation step **allow** any one of: $2Br\bullet \longrightarrow Br_2$ $Br\bullet + \bullet C_5H_{11} \longrightarrow C_5H_{11}Br$ $\bullet C_5H_{11} + \bullet C_5H_{11} \longrightarrow C_{10}H_{22}$ If H• formed in propagation allow ecf for a termination equation using the H• **allow** sunlight/high temperature **allow** homolysis/homolytic cleavage **do not allow** free radicals are very reactive/difficult to control * must be stated not just assumed if they write more than one termination step.

Question	Expected Answers	Marks	Additional Guidance
QWC	Well structured answer and uses all three of initiation, propagation and termination correctly✓	1	
	Total	13	

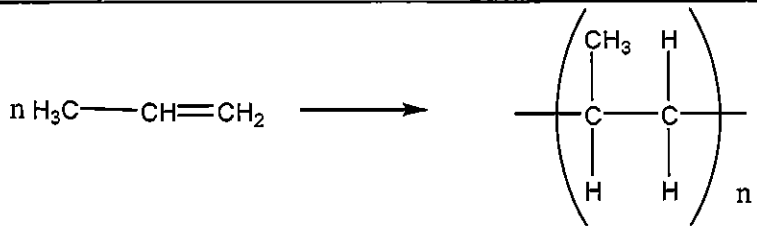
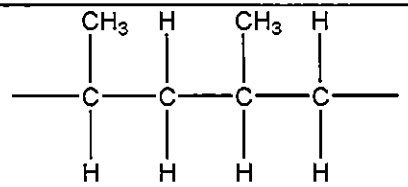
Question			Expected Answers	Marks	Additional Guidance
2	a	(i)	same molecular formula ✓ different structure/structural formula/ displayed formula ✓	2	**allow** same molecular formula, different arrangement of atoms same molecular formula different arrangement in space – scores 1 mark same formula, different structure – scores 1 mark **not allow** same atoms different structure etc
		(ii)	 (1,2-dichloro-)  (2,3-dichloro-)  (3,3-dichloro-)	3	**allow** correct structural formulae such as $CH_3C(Cl)CHCl$, $CH_2ClC(Cl)CH_2$, $CHCl_2CHCH_2$ **allow** correct skeletal formulae   
		(iii)	1,1-dichloropropene ✓	1	**allow** 1,1-dichloroprop-1-ene **do not allow** 1,1-chloroprop(-1-)ene/1-dichloroprop(-1-)ene/dichloroprop(-1-)ene **ignore** commas/hypens **allow** 11dichloroprop1ene
		(iv)	 or  ✓	1	**allow**  or  **do not allow** names
	b		because they have (C=C) double bond which restricts rotation ✓ and each C in the C=C is bonded to (two) different groups or atoms ✓	2	
				9	

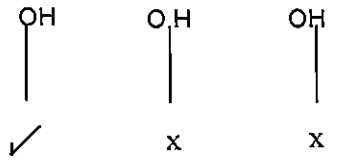
Question			Expected Answers	Marks	Additional Guidance
2	(a)	i	1,1-dibromomethylpropene✓	1	**allow** 1,1-dibromo-2-methylpropene **allow** 2-methyl-1,1-dibromopropene **allow** methyl-1,1-dibromopropene **also allow** any of the above with prop-1-ene
		ii	M_r = 213.8 ✓ % = (159.8/213.8) x 100 = 74.7 ✓	2	**not allow** M_r = 214 for first mark **allow** any of: % = 75/74.74 or any correct rounding up to and including the calculator value of 74.74275023 **allow** **ecf** for correct rounding of 74.76635514 if used M_r 214 **ecf** for correctly calculating percentage from incorrect M_r 37.4% scores 1 mark
		(iii)	any dibromobut-1-ene any dibromobut-2-ene (except 2,3-dibromobut-2-ene) any dibromomethylpropene (except 1,1-dibromomethylpropene) any dibromocyclobutane any dibromomethylcyclopropane ✓	1	see page 10 at end of question for skeletal formulae of acceptable isomers Most common **incorrect** response is *trans*-2,3-dibromobut-2-ene 
	(b)	i	decolourised ✓	1	**not allow** goes clear / discoloured **allow** turns colourless/orange colour disappears **ignore** "clear" if "decolourises and goes clear" i.e. not 'CON'
		ii	electrophilic addition ✓	1	
		iii	molecular formula = $C_4H_6Br_4$ ✓ empirical formula = $C_2H_3Br_2$ ✓	2	**allow** ecf from molecular formula $C_xH_yBr_z$

Question			Expected Answers	Marks	Additional Guidance
	(c)		 ✓ Ni/Pt ✓	2	Ignore bond linkage
	(d)	i	**B** is symmetrical ✓	1	**allow** **A** isn't symmetrical **ignore** A is asymmetric
		ii	 ✓  ✓	2	Ignore bond linkage
	e)	i	 ✓	1	**Do not allow** bond linkage to H in the OH, bond must **clearly** go to the O
		ii	reagent: steam/$H_2O_{(g)}$ ✓ conditions: phosphoric acid ✓	2	**allow** H_2O but only if temp is quoted above 100°C **allow** sulphuric acid **not allow** acid catalyst **allow** reagent: phosphoric acid ✓ **allow** conditions: steam ✓ mention of alkali ✗ *con* acid mark

Question	Expected Answers	Marks	Additional Guidance
(f)	 backbone of 4 carbon atoms with "two end bonds" ✓ 4 CH_3s and 4 Brs attached ✓	2	 score 1 mark **allow** more than two repeat units **ignore** CH_3 bond linkage
	Total	18	

Question			Expected Answers	Marks	Additional Guidance
5	a		Crude oil can be separated by fractional distillation because the compounds/fractions have different boiling points ✓ (AW) fractionation produces insufficient quantities of the 'petrol' fraction ✓ (AW) **balanced equation** to illustrate cracking ✓ alkenes which are used to produce alcohols or polymers✓ (AW) **balanced equation** to illustrate isomerisation ✓ **balanced equation** to illustrate reforming to obtain cycloalkanes (and arenes) ✓and H_2 ✓ which promote more efficient combustion/ better fuels/increases octane number/reduces knocking/ reduces pre-ignition ✓ * (AW) (*credited once)	8	**allow** different volatilities/ condenses at different temperatures **not allow** more demand **allow** alternate wording (AW) throughout 4 marks for equations – if equations not linked to process, **allow** max of 3 out of 4 **do not allow** just "*more useful*" can award two marks for balanced equation for reforming if both a cyclic compound and H_2 shown. 1 mark if H_2 absent but cyclic compound structure shown **not allow** word equations
			• ethanol is renewable ✓ • obtained from plants/ named plant ✓ • equation for fermentation $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$ ✓ • oil-based fuels are finite/take millions of years to form ✓	4	**not allow** obtained from sugar **not allow** oil is non-renewable **allow** an alternative argument based on carbon emission • ethanol is carbon neutral ✓ • obtained from plants which photosynthesise✓ • oil based fuels are **net** carbon emitters ✓
			$C_2H_5OH + 3O_2 \longrightarrow 2CO_2 + 3H_2O$ ✓	1	**allow** CH_3CH_2OH **not allow** C_2H_6O

QWC			Correctly uses, and spells correctly, at least **three** of: boiling point efficient, renewable additive, finite octane number/rating, fermentation knocking, fossil pre-ignition, carbon neutral cycloalkanes, van der Waals, cyclic , intermolecular arene biofuel volatility, viscosity	1	
	b	**(i)**	 ✓	1	**allow** n $C_3H_6 \longrightarrow (C_3H_6)_n$
		(ii)		1	**allow** bracket around the two repeat units with or without the following "n"
	c	**(i)**	reagent: H_2O ✓ conditions: temperature > 100°C and a H^+ catalyst ✓	2	**allow** steam and H^+ for both marks **allow** hot aqueous acid for both marks conditions mark is dependent on correct reagent **allow** H_2SO_4/H_3PO_4 **ignore** any reference to pressure

		(ii)	propan-1-ol ✓ and propan-2-ol ✓	2	**allow** any unambiguous formula **not allow** C_3H_7OH or propanol **do not allow** bond linkage must be correct. The bond must clearly go to the O  **do not allow** if Hs are not shown
				20	