Mark Scheme

Q1.

Question Number	Correct Answer	Reject	Mark
	B		**1**

Q2.

Question Number	Correct Answer	Reject	Mark
	B		**1**

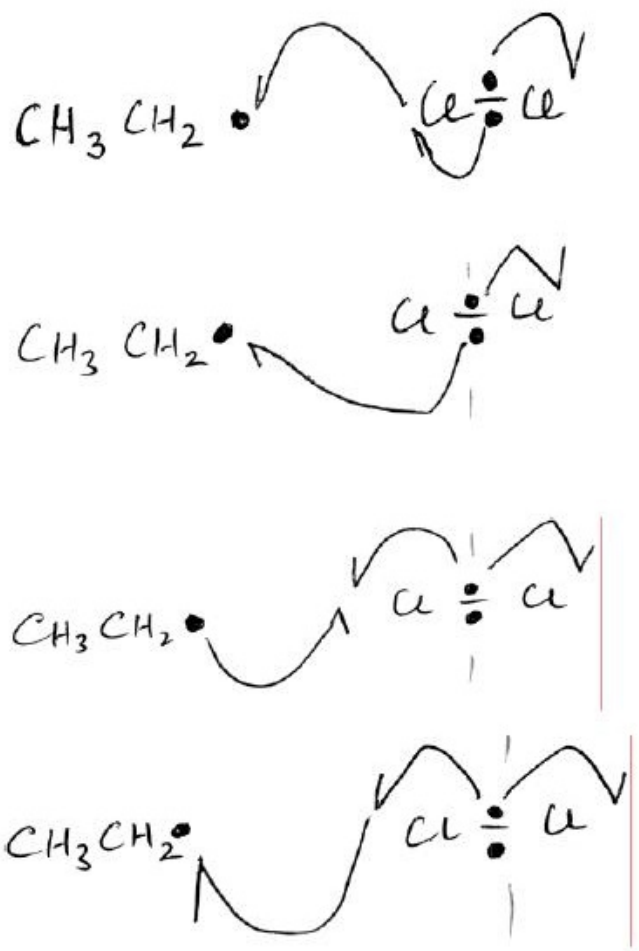
Q3.

Question Number	Acceptable Answers	Reject	Mark
(a)	$C_2H_6(g) + 3\frac{1}{2}O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l)$ Formulae and states **(1)** Balancing of correct entities **(1)**	Multiples	**2**

Question Number	Acceptable Answers	Reject	Mark
(b)	Notice the first mark is for the equation and there are 3 separate additional marks for the calculation H H H H | | | | H-C-C-H + Cl-Cl → H-C-C-Cl + H-Cl | | | | H H H H **(1)** Check all bonds displayed especially Cl-Cl and H-Cl **Calculation marks:** +413 + 243 **(1)** (−)(346 + 432) **(1)** OR 656 **(1)** (−) 778 **(1)** = −122 (kJ mol^{-1}) **(1)** Fully correct answer to calculation with no working **(3)** Extra 5x413 and 347 may be included on both sides, giving 3068 and (-)3190 Allow other same values(s) missing from both sides Bonds breaking **(1)** Bonds making **(1)** [Bonds breaking - bonds making] to give correct answer **with sign** **(1)**	Incorrect / no sign and / or incorrect units Incorrect units loses this mark	**4**

Question Number	Acceptable Answers	Reject	Mark
(c)(i)	Initiation **(1)** Allow homolysis / atomization / homolytic (fission) Ignore any reference to free radical substitution UV / (sun)light **(1)** Ignore reference to high temperature	Free radical substitution alone Photolysis	**2**

Question Number	Acceptable Answers	Reject	Mark
(c)(ii)	$CH_3CH_2\bullet$ + Cl-Cl → CH_3CH_2Cl + Cl• OR $CH_3CH_2\bullet$ + Cl-Cl → C_2H_5Cl + Cl• Both products correct including dot (1) Two half headed arrows showing homolytic breaking of Cl-Cl bond **(1)** Half headed arrow from radical to pair with a Cl arrow OR One arrow from chlorine bond clearly to ethyl radical **(1)** Arrows must be single-headed		**3**



The two dots in the covalent bond do not have to be shown

Question Number	Acceptable Answers	Reject	Mark
(c)(iii)	$Cl\bullet + Cl\bullet \rightarrow Cl_2$ **(1)** $\bullet CH_2CH_3 + \bullet CH_2CH_3 \rightarrow CH_3CH_2CH_2CH_3$ / C_4H_{10} **(1)** $\bullet CH_2CH_3 + Cl\bullet \rightarrow CH_3CH_2Cl$ **(1)** Penalise missing dots once Allow $\bullet C_2H_5$ for $\bullet CH_2CH_3$ Di and tri substitution steps	C_4H_{12} $CH_3CH_2CH_3CH_2$	**2**

Question Number	Acceptable Answers	Reject	Mark
(d)	$C_2H_6 \rightarrow C_2H_4 + H_2$ Allow $\mathbf{2}C_2H_6 \rightarrow C_2H_4 + \mathbf{2}CH_4$		**1**

Question Number	Acceptable Answers	Reject	Mark
(e)	Any two from: (It) produces (more) petrol / gasoline / diesel / jet fuel / LPG / liquid petroleum gas / fuel **(1)** Short chain alkanes / lighter fractions are more useful products **(1)** Demand is greater for shorter chain alkanes / lighter fractions / smaller molecules OR converts surplus of low demand fractions **(1)** It produces ethane / short chain alkenes for making poly(ethene) / ethane-1,2-diol / ethanol / plastics / polymers **(1)** Smaller alkanes give less pollution/burn more efficiently **(1)** Recycles waste products **(1)** As a source of hydrogen **(1)** **NB** examiners need to look carefully at the vowel in the middle of alk**a**ne / alk**e**ne / eth**a**ne / eth**e**ne if not clear do not give BOD	Points based on atom economy / renewable fuels alone Easier to transport / store Short chain alkenes / ethene more useful alone Recycles alone	2

Q4.

Question Number	Correct Answer	Mark
	B	1

Q5.

Question Number	Correct Answer	Reject	Mark
	C		**1**

Q6.

Question Number	Correct Answer	Reject	Mark
	A		1

Q7.

Question Number	Correct Answer	Mark
	C	**1**

Q8.

Question Number	Correct Answer	Mark
	C	**1**

Q9.

Question Number	Correct Answer	Reject	Mark
	D		**1**

Q10.

Question Number	Acceptable Answers	Reject	Mark
(a)	C_nH_{2n+2}		**1**

Question Number	Acceptable Answers	Reject	Mark
(b)(i)	Cracking		**1**

Question Number	Acceptable Answers	Reject	Mark
(b)(ii)	Reforming / dehydrogenation		**1**

Question Number	Acceptable Answers	Reject	Mark
(c)	Skeletal		**1**

Question Number	Acceptable Answers	Reject	Mark
(d)(i)	C_9H_{20}	Structural / displayed formulae	**1**

Question Number	Acceptable Answers	Reject	Mark
(d)(ii)	3-ethyl-4-methylhexane *ALLOW* methyl before ethyl 4-methyl-3-ethylhexane 3-methyl-4-ethylhexane 4-ethyl-3-methylhexane 3,4-ethylmethylhexane *IGNORE* incorrect "punctuation"		**1**

Question Number	Acceptable Answers	Reject	Mark
(e)(i)	**Enthalpy change Step A:** $\bar{E}$(C-H) + - $\bar{E}$ (H-Cl) = + 413 + (-432) = - 19 (kJ mol^{-1}) **(1)** Correct answer with no working **(1)** **Enthalpy change Step B:** $\bar{E}$(C-H) + - $\bar{E}$ (C-Cl) = + 413 + (-346) = (+) 67 (kJ mol^{-1}) **(1)** Correct answer with no working **(1)** *NOTE* Both values correct scores **(3)** One of the two values correct scores **(2)** *NOTE* Neither value is correct, but a clear statement that ΔH = bonds broken + bonds made scores **(1)**	(+)19 scores **(0)** for this mark -67 scores **(0)** for this mark	**3**

Question Number	Acceptable Answers	Reject	Mark
(e)(ii)	Step A as (ΔH) is **negative/exothermic** (compared with a positive/endothermic value for Step B) OR Step A as it is the more energetically favourable **Mark CQ on the energy changes in (e)(i)** e.g if +19 and -67 given in (e)(i), Step B will be justified for the CQ mark; e.g. if both values endothermic, selects the less endothermic value OR if both values exothermic, selects the more exothermic value *IGNORE* statements such as "no harmful by-products" etc.		**1**

Question Number	Acceptable Answers	Reject	Mark
(f)	Volume of bromomethane = $\frac{5}{1\,000\,000} \times 2.5 \times 10^5$ = 1.25 (dm^3) Correct answer with no working scores the mark		**1**