Alkanes: Formulae, Reactions & Structure

Mark Scheme 1

Level	International A Level
Subject	Chemistry
Exam Board	Edexcel
Topic	The Core Principles of Chemistry
Sub Topic	Alkanes: Formulae, Reactions & Structure
Booklet	Mark Scheme 1

Time Allowed: **59 minutes**

Score: **/49**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

Question Number	Correct Answer	Reject	Mark
1(a)	A		1
	Incorrect Answers: B – Two groups attached to one of the carbons in the double bond are the same C - Two groups attached to one of the carbons in the double bond are the same D- T groups attached to one of the carbons in the double bond are the same		

Question Number	Correct Answer	Reject	Mark
1(b)	D		1
	Incorrect Answers: A – The major product is 3-bromohexane B - The major product is 3-bromo-3-methylpentane C- Th major product is 2-bromo-2-methylpentane		

Question Number	Correct Answer	Reject	Mark
1(c)	B		1
	Incorrect Answers: A – There are 12 hydrogen atoms C - There are 12 hydrogen atoms D- There re 12 hydrogen atoms		

Question Number	Correct Answer	Reject	Mark
2	C		1
	Incorrect Answers: A – The longest consecutive chain is 7 not 5 B - The longest consecutive chain is 7 not 5 D- T numbering of the longest chain is wrong		

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

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

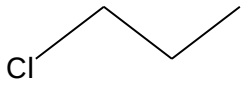
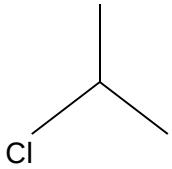
Question Number	Correct Answer	Reject	Mark
5(a)	B		

Question Number	Correct Answer	Reject	Mark
5(b)	C		1

Question Number	Correct Answer	Reject	Mark
5(c)	A		1

Question Number	Correct Answer	Reject	Mark
6	D		1

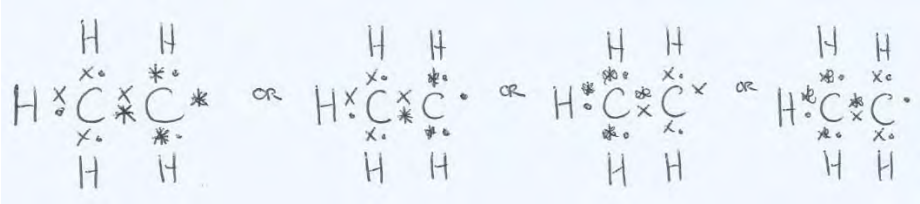
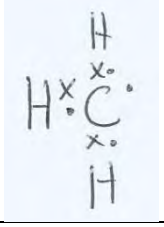
Question Number	Acceptable Answers	Reject	Mark
7(a)	$CH_4 + Br_2 \rightarrow CH_3Br + HBr$ IGNORE State symbols even if incorrect Reference to uv light	C_2H_6	1

Question Number	Acceptable Answers	Reject	Mark
7(b)	The names must correspond to the formulae but there is no TE on incorrect formulae  (1) Name: 1-chloropropane (1)  (1) Name: 2-chloropropane (1) IGNORE bond angles, bond lengths, bond orientations, punctuation		4

Question Number	Acceptable Answers	Reject	Mark
7(c)(i)	(Ethane) has no electron-rich area/no electron-dense area/ has no delta negative centre/no δ− (for the electrophile to react with) IGNORE No double bonds / no ∏ bonds but this can be credited in (c)(ii) Has maximum number of hydrogen atoms	Charge density/ No lone pair	1

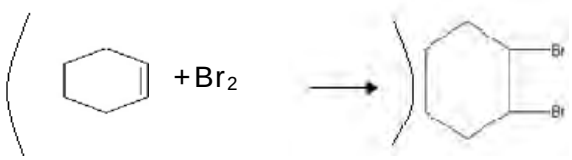
Question Number	Acceptable Answers	Reject	Mark
7(c)(ii)	(Ethane) has no multiple bonds/ has no double bond / has no π bond / has only single / has only σ bonds ALLOW Ethane is saturated NOTE This may be explained in the answer to (c)(i) IGNORE Ethane is an alkane	Incorrect chemistry, e. donates protons	1

Question Number	Acceptable Answers	Reject	Mark
7(c)(iii)	(Equation) $Cl_2 \rightarrow 2Cl\bullet$ (1) IGNORE curly arrows even if incorrect (Name of reaction step) Initiation (1) IGNORE Free radical substitution/Homolytic fission Mark independently		2

Question Number	Acceptable Answers	Reject	Mark
7(c)(iv)	Carbon with only two hydrogens has single electron (1) Dot and cross of C–C and all C–H bonds correct (1) Example:  ALLOW One mark for ethane dot and cross diagram One mark for methyl free radical, example 	Missing H's	2

Question Number	Acceptable Answers	Reject	Mark
7(c)(v)	Increase the proportion of chlorine/ Use excess / more chlorine ALLOW decrease proportion of ethane OR Use less ethane Ignore references to temperature, pressure and uv light	Chloride Cl	1

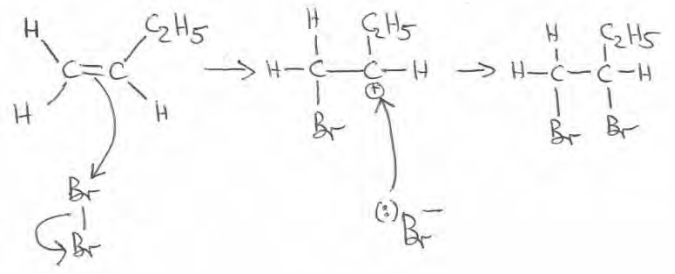
(Total for Question 7 = 12 marks)

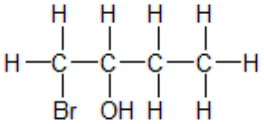
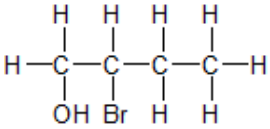
Question Number	Acceptable Answers	Reject	Mark
8(a)(i)	 IGNORE bond angles, bond lengths, bond orientations	+ 2	1

Question Number	Acceptable Answers	Reject	Mark
8(a)(ii)	From red-brown / red / brown to colourless	Clear/white Orange/yellow/ Orange-brown	1

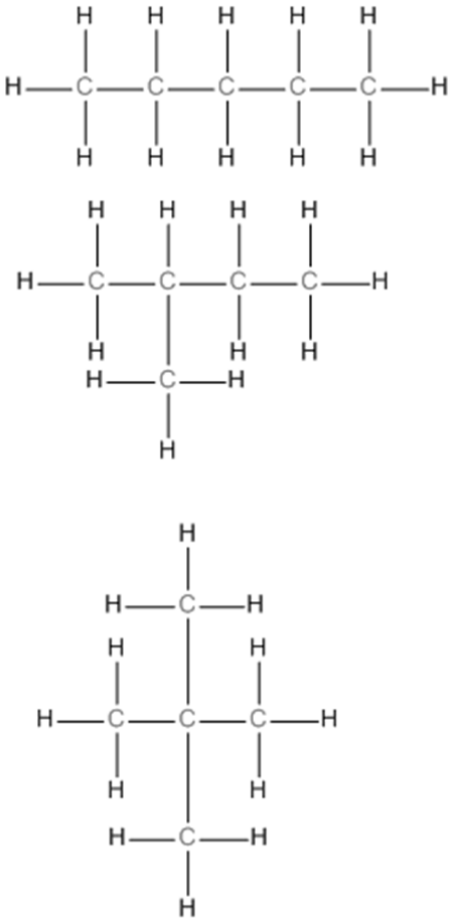
Question Number	Acceptable Answers	Reject	Mark
8(b)(i)	(Bonds broken =) 612 + 193 = (+)805 (Bonds made=) 347 + (290x2)=(-) 927 (1) Enthalpy of reaction =(805 — 927=) —122 (kJ mol^{-1}) Correct answer with no working scores two marks ALLOW (All bonds broken=)+4803 (All bonds made =)-4925 (1) Enthalpy of reaction = (+4803 – 4925=) -122 (kJ mol^{-1}) (1) Award one mark for (+) 122 (kJ mol^{-1}) Award one mark for a correct subtraction using one of the correct values above, example 4538 – 4925 = –387 (kJ mol^{-1})		2

Question Number	Acceptable Answers	Reject	Mark
8(b)(ii)	Bond enthalpies are for gaseous compounds **and** bromine is a liquid / 1,2 dibromobutane is a liquid IGNORE Reference to just ‘different states’		1

Question Number	Acceptable Answers	Reject	Mark
8(b)(iii)	Mechanism drawn similar to  **Marking point 1** Curly arrow from double bond to Br **and** curly arrow from Br-Br bond to the Br (dipoles not required) (1) **Marking point 2** Correct carbocation structure (1) **Marking point 3** Curly arrow from anywhere on the bromide ion (including the minus sign) towards the carbocation **and** the correct product ALLOW TE on primary carbocation (1) Note the bromide ion must have a full negative charge but the lone pair of electrons need not be shown	Incorrect dipole $^{\delta-}$Br	3

Question Number	Acceptable Answers	Reject	Mark
8(b)(iv)	1-bromobutan-2-ol / $CH_3CH_2CHOHCH_2Br$/  ALLOW 2-bromobutan-1-ol / $CH_3CH_2CHBrCH_2OH$/  ALLOW 2-bromo-1-butanol ALLOW skeletal or structural formulae Penalise contradictory names/formulae	Missing H's	1

TOTAL FOR QUESTION 8 = 9 MARKS

Question Number	Acceptable Answers	Reject	Mark
9(a)	 All 3 correct **(2)** Any 2 correct **(1)** ALLOW CH_3 groups If no other marks are scored, ALLOW 3 correct isomers as structural, skeletal or any other combination of formulae except molecular for **(1)** mark IGNORE bond angles and bond lengths IGNORE structural or skeletal formulae in addition to displayed formulae / names, even if incorrect If 4 or more isomers drawn, max 1	Missing H once only Only structural or skeletal formulae once only	**2**

Question Number	Acceptable Answers	Reject	Mark
9(b)(i)	(Free) radical **(1)** Substitution **(1)** IGNORE homolytic fission/ initiation / propagation /termination	Heterolytic /electrophilic /nucleophilic	**2**

Question Number	Acceptable Answers	Reject	Mark
9(b)(ii)	$C_5H_{12} + Cl\bullet \rightarrow C_5H_{11}\bullet + HCl$ **(1)** $C_5H_{11}\bullet + Cl_2 \rightarrow C_5H_{11}Cl + Cl\bullet$ **(1)** ALLOW equations in either order / displayed formulae / structural formulae NO TE on incorrect free radical IGNORE size and position of dot / any type of curly arrows	Missing dots once only in (b)(ii) and (b)(iii) Additional incorrect equations once only Formation of H• scores **(0)** overall	**2**

Question Number	Acceptable Answers	Reject	Mark
9(b)(iii)	Any one from $Cl\bullet + Cl\bullet \rightarrow Cl_2$ $Cl\bullet + C_5H_{11}\bullet \rightarrow C_5H_{11}Cl$ $C_5H_{11}\bullet + C_5H_{11}\bullet \rightarrow C_{10}H_{22}$ IGNORE any type of curly arrows	Additional incorrect equation	**1**

Question Number	Acceptable Answers	Reject	Mark
9(c)(i)	Correct answer with or without working scores the mark 100.0 x 4.18 x 14.5 (**=** 6061 J) **=** 6.061/6.06/6.1 (kJ) ALLOW 6061 **J** IGNORE sign (+/-) / kJ mol^{-1}	6 / 6061 (kJ)	**1**

Question Number	Acceptable Answers	Mark
9(c)(ii)	Correct answer with or without working scores the mark number of moles = $\frac{0.144}{72}$ = 0.002 / $2x10^{-3}$ ALLOW correct working with no answer written	**1**

Question Number	Acceptable Answers	Reject	Mark
9(c)(iii)	Correct answer with or without working scores both marks enthalpy change of combustion = $\frac{\text{answer to (c)(i)}}{\text{answer to (c)(ii)}}$ = −3030.5/−3031 kJ mol^{-1} Or −3030500/−3.0305 x 10^6/−3031000/−3.031 x 10^6 J mol^{-1} Correct number **(1)** Correct sign and units consistent with number **(1)** Mark independently ALLOW −3030/−3050 kJ mol^{-1} and equivalent answers in J mol^{-1} score both marks ALLOW units as kJ/mol or $\frac{\text{kJ}}{\text{mol}}$ or J/mol or $\frac{\text{J}}{\text{mol}}$ IGNORE SF except 1SF ALLOW TE from (c)(i) and (c)(ii)	Incorrect unit e.g. kJ/mol^{-1} or kJ mol^{-}	**2**

Question Number	Acceptable Answers	Reject	Mark
9(c)(iv)	**First mark** Incomplete combustion ALLOW incomplete reaction **(1)** IGNORE not enough oxygen / not all the fuel has reacted **Second mark** Evaporation of the alkane / fuel / reactant / compound ALLOW alkane is volatile / heat capacity of/heat absorbed by container/apparatus was not included **(1)** IGNORE Heat loss to the surroundings / Not measured at standard conditions / Mention of heat capacity/density of water / Evaporation of water / Error in thermometer/balance / Alkane is impure If average bond enthalpies is mentioned, max (1)		**2**

Question Number	Acceptable Answers	Reject	Mark
9(c)(v)	The experimental errors are greater than the differences in the Data Book values OR The experimental value is much lower than all the Data Book values/ the Data Book values are all much more exothermic than the experimental value ALLOW The three Data Book values are (too) close together IGNORE Answer to (c)(iii)/ experimental value is very different to the Data Book values	Average bond enthalpies	**1**

Question Number	Acceptable Answers	Reject	Mark
9(d)	$C_5H_{12}(l) + 8O_2(g) \rightarrow 5CO_2(g) + 6H_2O(l)$  $5C(s, graphite) + 6H_2(g) + 8O_2(g)$ **Cycle** 2 marks $5C(s, graphite) + 6H_2(g) + 8O_2(g)$ **OR** $5C(s) + 6H_2(g) + 8O_2(g)$ Correct species, multiples and all state symbols needed **(1)** Both arrows upwards ALLOW two arrows from elements to products of combustion /downward arrows provided they are labelled with correct value or symbol **(1)** IGNORE additional curved arrows as part of working **Calculation** 2 marks Mark independently of arrows on cycle Correct answer with or without working scores both marks $\Delta H_c = (5x-393.5) + (6x-285.8) -(-173.2)$ **(1)** $= -3509.1/-3509$ (kJ mol^{-1}) **(1)** IGNORE kJ as unit ALLOW TE from incorrect multiple of C and H_2	Other incorrect unit	**4**

(Total for Question 9 = 18 marks)