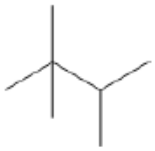
Introduction to Organic Chemistry - Mark Scheme

Q1.

Question number	Answer	Additional guidance	Mark
(a)(i)	An answer that makes reference to the following: • Heptane / petrol containing heptane: burns less efficiently / smoothly (than branched chains / cycloalkanes) **or** does not combust efficiently **or** causes pre-ignition / knocking	Allow burns for combusts and vice versa Allow reverse argument e.g. petrol burns more efficiently with no / small amount of heptane Allow the octane number would be low / zero Ignore: It does not ignite / burn easily It is difficult / harder to combust Just 'less efficient' without reference to combustion Incomplete combustion Amount of CO_2 produced Causes auto-ignition References to toxicity and flammability	(1)

Question Number	Answer	Additional guidance	Mark
(a)(ii)	• 	Ignore bond lengths and bond angles Ignore structural or displayed formulae as working Ignore skeletal formula with any CH_3 groups specified	(1)

Question number	Answer	Additional guidance	Mark
(a)(iii)	• correct equation	Example of equation: $C_7H_{16} \rightarrow C_7H_{14} + H_2$ Allow multiples Ignore any other type of formulae	(1)

Question number	Answer	Additional guidance	Mark
(a)(iv)	An explanation that makes reference to the following points: • (oxides of nitrogen / these compounds) dissolve in / react with / combine with / mix with water **(1)** • (to form nitric / nitrous) acid(s) / acidic solution / acid rain **(1)**	Ignore any reference to oxides of sulfur / sulfur dioxide / sulfuric acid in answer Allow moisture / rain / clouds for water Ignore react with air / oxygen Allow decreases pH of solution / rain	**(2)**

Question number	Answer	Additional guidance	Mark
(b)(i)	• Initiation (step / reaction)	Allow initiating (step) Ignore free radical / homolytic / chain / initial (step) Do not award heterolytic	**(1)**

Question number	Answer	Additional guidance	Mark
(b)(ii)	• $C_7H_{16} + Cl\bullet \rightarrow C_7H_{15}\bullet + HCl$ **(1)** • $C_7H_{15}\bullet + Cl_2 \rightarrow C_7H_{15}Cl + Cl\bullet$ **(1)**	Allow propagation steps in either order Allow • anywhere on correct species Ignore curly arrows, even if incorrect Do not award • on species that are not radicals Penalise omission of • or incorrect number of hydrogens in heptane once only in b(ii), b(iii) and b(iv)	**(2)**

Question number	Answer	Additional guidance	Mark
(b)(iii)	• $C_7H_{15}\bullet + C_7H_{15}\bullet \rightarrow C_{14}H_{30}$	TE on alkyl radical in (b)(ii) Do not award product written as $2C_7H_{15}$ / $C_7H_{15}C_7H_{15}$	**(1)**

Question number	Answer	Additional guidance	Mark
(b)(iv)	An explanation that makes reference to the following points: • chlorine(free) radical / atom / Cl• removes another hydrogen (atom in the product / chloroheptane) **(1)** • (this free) radical reacts with another chlorine molecule / Cl_2 (to form dichloroheptane) **or** (this free) radical reacts with a chlorine radical / atom / Cl• (to form dichloroheptane) **(1)**	TE on alkyl radical in (b)(ii) Allow $C_7H_{15}Cl + Cl• \rightarrow C_7H_{14}Cl• + HCl$ Ignore Cl• substitutes a H atom Allow $C_7H_{14}Cl• + Cl_2 \rightarrow C_7H_{14}Cl_2 + Cl•$ **or** $C_7H_{14}Cl• + Cl• \rightarrow C_7H_{14}Cl_2$ Ignore just 'further substitution' Ignore $C_7H_{16} + 2Cl_2 \rightarrow C_7H_{14}Cl_2 + 2HCl$ Any answer that shows 2Cl substituted in one step	**(2)**

Q2.

Question number	Answer	Mark
	The only correct answer is A (accepts a pair of electrons) ***B*** *is incorrect because electrophiles never have a negative charge* ***C*** *is incorrect because not all electrophiles have a positive charge* ***D*** *is incorrect because nucleophiles donate a pair of electrons*	**(1)**

Q3.

Question number	Answer	Mark
	The only correct answer is D (general formula) ***A*** *is incorrect because boiling temperature increases as the number of carbon atoms increases* ***B*** *is incorrect because density increases as the number of carbon atoms increases* ***C*** *is incorrect because the alkanes have different empirical formulae*	**(1)**

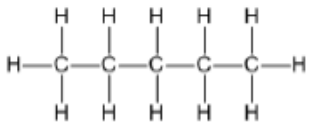
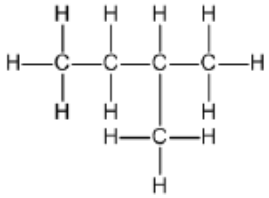
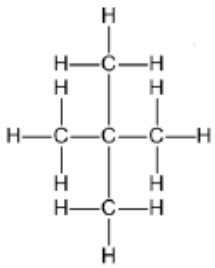
Q4.

Question number	Answer	Mark
	B (C_4H_7Cl)	1

Q5.

Question number	Answer	Mark
	A π, heterolytic	1

Q6.

Question number	Answer	Additional guidance	Mark
(a)	•  (1) •  (1) •  (1)	Allow CH_3 in branches Allow 2 marks for 3 correct structural or skeletal formulae or any combination of these	3

Question number	Answer	Additional guidance	Mark
(b)	• 2,4-dimethylhexane	Ignore punctuation errors	1

Question number	Answer	Additional guidance	Mark
(c)	• molecular formula: C_5H_{12} (1) • boiling temperature 25 - 40 °C (1)	Allow any temperature or range within the given range	2

Question number	Answer	Additional guidance	Mark
(d)(i)	• $C_3H_8 + 3½O_2 \rightarrow C + CO + CO_2 + 4H_2O$	Allow multiples Ignore state symbols, even if incorrect	1

Question number	Answer	Additional guidance	Mark
(d)(ii)	An explanation that makes reference to the following points: • (carbon monoxide) reacts with haemoglobin (in the blood) (1) • preventing it from carrying oxygen (around the body). (1)	Allow forms carboxyhaemoglobin	2

Question number	Answer	Additional guidance	Mark
(e)(i)	• $C_3H_8 + Cl\bullet \rightarrow C_3H_7\bullet + HCl$ (1) • $C_3H_7\bullet + Cl_2 \rightarrow C_3H_7Cl + Cl\bullet$ (1)	Allow equations in either order Penalise missing • once only	2

Question number	Answer	Additional guidance	Mark
(e)(ii)	• the products are 1-chloropropane and 2-chloropropane	Allow any unambiguous formulae Ignore molecular formulae	1

Question number	Answer	Additional guidance	Mark
(e)(iii)	• the chlorine free radical can remove a hydrogen from either the end carbon atoms or the central carbon atom		1

Question number	Answer	Additional guidance	Mark
(e)(iv)	• two propyl (free) radicals react together or • $C_3H_7\bullet + C_3H_7\bullet \rightarrow C_6H_{14}$	Ignore just '(two free) radicals react together' Do not allow molecules/ions	1

Question number	Answer	Additional guidance	Mark
(e)(v)	• structure (1) • corresponding name (1)	Examples of structures and names: $CH_3CH_2CHCl_2$ 1,1-dichloropropane $CH_3CHClCH_2Cl$ 1,2-dichloropropane $CH_3CCl_2CH_3$ 2,2-dichloropropane $CH_2ClCH_2CH_2Cl$ 1,3-dichloropropane Allow displayed, structural or skeletal formulae or any combination of these	2

Q7.

Question number	Answer	Mark
	The only correct answer is A (*E*-2-chlorobut-2-ene) ***B*** *is incorrect because the two highest priority groups are opposite to each other* ***C*** *is incorrect because chlorine is on the second carbon atom* ***D*** *is incorrect because chlorine is on the second carbon atom and the two highest priority groups are opposite to each other*	**(1)**

Q8.

Question number	Answer	Mark
	A E-5-methylhex-2-ene	1