

Question number	Answer	Marks	Guidance
1 (a)	<ul style="list-style-type: none"> • (Same) General formula /allow a named homologous series with its general formula • Chemically similar/same (chemical) reactions • Same functional group • Trend in physical properties/ e.g., including boiling point as M_r increases • (Molecules) increase by $\text{CH}_2/M_r = 14$ 	2	Any two points
1 (b)	<u>Fractional</u> distillation/ fractionation/ chromatography	1	Allow GLC
1 (c)	<p>(Molecules/compounds/substances) with the same <u>molecular</u> formula / same number and type of atoms</p> <p>but different structural formula/ different displayed formula/ different arrangement of atoms/different structures</p> <p><u>2,4-dimethylhexane</u></p> <p>C_4H_9</p>	<p>1</p> <p>1</p> <p>1</p> <p>1</p>	<p>Allow alkanes with same molecular formula</p> <p>Allow same chemical formula in $M1 = 0$ but can allow $M2$</p> <p>Not different positions in space</p> <p>$M2$ dependent on $M1$</p> <p>Ignore the absence of dash and/or commas</p>
1 (d)	<p>less surface contact / less surface area/ less polarisable molecule</p> <p>so fewer/weaker/less <u>Van der Waals"/vdw forces</u></p>	<p>1</p> <p>1</p>	<p>Allow more spherical or fewer points of contact</p> <p>Not smaller molecule/ not more compact molecule/ not shorter chain</p> <p>Allow converse arguments</p> <p>Must be comparative answer, i.e., not just few VDW forces</p> <p>QoL</p> <p>Assume "it" refers to the branched isomer</p>
2 (a)	$\text{C}_{16}\text{H}_{34} + 24.5\text{O}_2 \rightarrow 16\text{CO}_2 + 17\text{H}_2\text{O}$	1	Allow multiples Ignore state symbols in equation
2 (b)	Solidifies /freezes /goes viscous /waxing occurs	1	Allow does not vaporise/ less volatile Lack of Oxygen = 0 Apply list principle
2 (c) (i)	$\text{N}_2 + \text{O}_2 \rightarrow 2\text{NO}$ Spark/ (very) high temp/ $2500\text{ }^\circ\text{C} - 4000\text{ }^\circ\text{C}$	1	Allow multiples/ Ignore state symbols in equation Ignore pressure/catalyst/low % of

		1	oxygen Not just heat/hot Apply list principle, e.g., if high temp $150^\circ\text{C} = 0$
2 (c) (ii)	$2\text{CO} + 2\text{NO} \rightarrow 2\text{CO}_2 + \text{N}_2$ OR $\text{C}_8\text{H}_{18} + 25\text{NO} \rightarrow 8\text{CO}_2 + 12.5\text{N}_2 + 9\text{H}_2\text{O}$ OR $\text{C} + 2\text{NO} \rightarrow \text{CO}_2 + \text{N}_2$ OR $2\text{NO} \rightarrow \text{N}_2 + \text{O}_2$	1	Allow multiples/ Ignore state symbols in equation Allow other alkane reacting with NO in correctly balanced equation
	Pt/ Pd/ Rh/ Ir	1	Penalise contradiction of name and symbol
2 (c) (iii)	$4\text{NO}_2 + 2\text{H}_2\text{O} + \text{O}_2 \rightarrow 4\text{HNO}_3$	1	Allow multiples/ Ignore state symbols in equation
2 (d) (i)	High temp/ anywhere in range $400^\circ\text{C} - 900^\circ\text{C}$ / anywhere in range $670\text{--}1200\text{ K}$ / high pressure/ anywhere in range 5000 kPa up to 8000 kPa /	1	Not catalyst/heat
2 (d) (ii)	$\text{C}_{16}\text{H}_{34} \rightarrow \text{C}_6\text{H}_{14} + 2\text{C}_4\text{H}_8 + \text{C}_2\text{H}_4$ Or $\text{C}_{16}\text{H}_{34} \rightarrow \text{C}_6\text{H}_{14} + \text{C}_4\text{H}_8 + 3\text{C}_2\text{H}_4$	1	Do not allow multiples Ignore state symbols in equation
2 (d) (iii)	Polymers/ plastics/ named polymer	1	Allow polyesters or polyamides Ignore object made from polymer
3 (a) (i)	Crude oil / oil / petroleum	1	Do not allow "petrol"
3 (a) (ii)	Fractional distillation / fractionation / fractionating	1	Not distillation alone
3 (b) (i)	5	1	Allow five / V
3 (b) (ii)	Chain (isomerism)	1	Allow branched chain / chain branched / side chain (isomerism) Ignore position (isomerism) Do not allow straight chain / geometric / branched / function
3 (c) (i)	$\text{C}_{12}\text{H}_{26} / \text{H}_{26}\text{C}_{12}$	1	Only
3 (c) (ii)	<u>Thermal cracking</u>	1	If not thermal cracking, CE = 0/2 If blank mark on Allow 'high heat' for 'high temperature' Not 'heat' alone
	High temperature	1	

	(400 °C ≤ T ≤ 900 °C) or (650 K ≤ T ≤ 1200 K) and High pressure (≥ 10 atm, ≥ 1 MPa, ≥1000 kPa)		If no T, units must be 650 - 900
3 (c) (iii)	To produce substances which are (more) in demand / produce products with a high value / products worth more	1	Ignore 'to make more useful substances'
3 (d) (i)	Corrosive or diagram to show this hazard symbol	1	Ignore irritant, acidic, toxic, harmful
3 (d) (ii)	120.5 / (86 + 71) × 100 =76.75% or 76.8%	1	Allow answers > 3 sig figs
3 (e)	2,2-dichloro-3-methylpentane C ₃ H ₆ Cl	1 1	Ignore punctuation Any order
4 (a) (i)	C ₈ H ₁₈ + 8½O ₂ → 8CO + 9H ₂ O	1	Accept multiples
4 (a) (ii)	Not enough oxygen or air (available for complete combustion) /lack of oxygen or air / too much octane	1	Ignore poor ventilation, low temp, poor mixing, incomplete combustion
4 (b) (i)	2CO + 2NO → 2CO ₂ + N ₂	1	Allow multiples
4 (b) (ii)	Pt / Pd / Rh / Ir or names Big(ger) surface area / increased reaction rate / removes more of the gases / ensures complete reaction	1 1	Apply list principle Allow (ceramic) withstands high temperatures
4 (c) (i)	Acid rain	1	Allow consequence of acid rain Ignore greenhouse gas / global warming / ozone
4 (c) (ii)	CaO/ lime / CaCO ₃ /limestone Neutralises the gas or words to that effect/it is basic/ SO ₂ is acidic	1 1	Allow chemical names Allow 'reacts with it' or 'it is alkaline' Ignore 'absorb'
5 (a)	Initiation Cl ₂ → 2Cl• First propagation Cl• + CH ₃ Cl → •CH ₂ Cl + HCl Second propagation Cl ₂ + •CH ₂ Cl → CH ₂ Cl ₂ + Cl•	4	Penalise absence of dot once only. Credit the dot anywhere on the radical. Penalise C ₂ H ₄ Cl ₂

	Termination (must make 1,2-dichloroethane) $2 \cdot \text{CH}_2\text{Cl} \rightarrow \text{CH}_2\text{ClCH}_2\text{Cl}$		
5 (b) (i)	(chlorine free) radical	1	Ignore formula
5 (b) (ii)	M1 $\text{Cl}\cdot + \text{O}_3 \rightarrow \text{ClO}\cdot + \text{O}_2$ M2 $\text{ClO}\cdot + \text{O}_3 \rightarrow \text{Cl}\cdot + 2\text{O}_2$	2	M1 and M2 could be in either order. Credit the dot anywhere on the radical. Penalise absence of dot once only. Individual multiples acceptable but both need to be doubled if two marks are to be awarded.