12 Alkanes
Answers to practice questions

Question number	Answer	Marks	Guidance
1	A saturated hydrocarbon contains only carbon and hydrogen atoms joined together by single covalent bonds.	B1	
2 (a)	Octane	B1	
2 (b)	2-methylbutane	B1	
2 (c)	2,2-dimethylbutane	B1	
3 (a)	Hexane is a straight chain alkane and will have higher boiling point. 3-Methylpentane is branched Hexane molecules have more surface points of contact is between molecules. The London forces between the molecules will be greater and so more energy is required to overcome the forces.	B1 B1	
3 (b)	2-Methyloctane is less branched than 2,2-dimethylheptane and will have the higher boiling point. 2-Methyloctane molecules have more surface points of contact is between molecules. The London forces will be greater and so more energy is required to overcome the forces.	B1 B1	
3 (c)	Hexane is a longer straight chain alkane than pentane and will have higher boiling point. Hexane molecules have a greater surface area and there will be more surface contact is between molecules. The London forces between the molecules will be greater and so more energy is required to overcome the forces.	B1 B1	
4 (a)	$CH_4 + Br_2 \rightarrow CH_3Br + HBr$	B1	
4 (b)	Conditions: UV radiation $Br_2 \rightarrow 2Br\bullet$ Homolytic fission	B1 B1 B1	
4 (c)	3 monochlorinated isomers can be formed	B1	
5 (a)	$C_9H_{20} + 14O_2 \rightarrow 9CO_2 + 10H_2O$	B1	
5 (b)	$C_9H_{20} + 9½O_2 \rightarrow 9CO + 10H_2O$	B1	
6 (a)	$C_4H_{10} + 6½O_2 \rightarrow 4CO_2 + 5H_2O$	B1	
6 (b)	$n(C_4H_{10}) = 1.45/58.0 = 0.0250$ mol	B1	

<table>
<tr><th>Question number</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>6 (c)</td><td>$n(O_2) = 6.5 \times 0.0250 = 0.1625$ mol

volume of $O_2 = 0.1625 \times 24.0 = 3.90\ dm^3$</td><td>B1

B1</td><td></td></tr>
<tr><td>6 (d)</td><td>$n(O_2) = 4 \times 0.0250 = 0.100$ mol

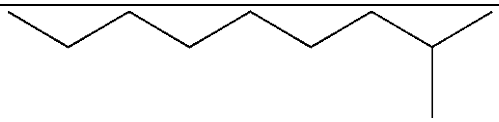
volume of $CO_2 = 0.100 \times 24.0 = 2.40\ dm^3$</td><td>B1

B1</td><td></td></tr>
<tr><td>7</td><td>As number of carbon atoms increases, the carbon chain length increases and there will be a greater surface area and there will be more surface contact is between molecules.

The London forces between the molecules will be greater

and so more energy is required to overcome the forces, increasing the boiling point.</td><td>B1

B1

B1</td><td></td></tr>
<tr><td>8 (i)</td><td>Decane</td><td>B1</td><td>DO NOT ALLOW deceane</td></tr>
<tr><td>8 (ii)</td><td>  </td><td>B1</td><td>Formula must be skeletal AND must not include any symbol, e.g. CH_3</td></tr>
<tr><td>8 (iii)</td><td>The molecules of straight chain alkane have more surface points of contact is between molecules.

The London forces (also known as “van der Waals’ forces“) between the molecules will be greater and so more energy is required to overcome the forces.</td><td>B1

B1</td><td>Both answers need to be comparisons
Assume ‘it’ refers to decane
IGNORE surface area
ALLOW straight chains can get closer together
OR branched chains cannot get as close to one another
IGNORE branched chain are more compact

ALLOW Decane has stronger van der Waals’ forces
OR branched chains have weaker van der Waals’ forces

More intermolecular forces is not sufficient</td></tr>
<tr><td>9 (a) (i)</td><td><table>
<tr><th>Step</th><th>Equation</th></tr>
<tr><td>Initiation</td><td>$Br_2 \rightarrow 2Br\bullet$</td></tr>
<tr><td>Propagation</td><td>$C_6H_{12} + Br\bullet \rightarrow C_6H_{11}\bullet + HBr$
$C_6H_{11}\bullet + Br_2 \rightarrow C_6H_{11}Br + Br\bullet$</td></tr>
<tr><td>Termination</td><td>$2C_6H_{11}\bullet \rightarrow C_{12}H_{22}$
$2Br\bullet \rightarrow Br_2$</td></tr>
</table></td><td>B1
B1

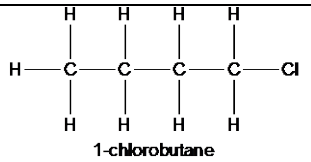
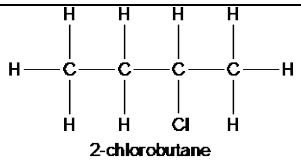
B1

B1</td><td>IGNORE state symbols

IGNORE dots

If an incorrect hydrocarbon with six C atoms is used:
DO NOT ALLOW any marks for the propagation steps but
ALLOW ECF for termination steps (i.e. 3 max)</td></tr>
</table>

Question number	Answer	Marks	Guidance
	$C_6H_{11}\bullet + Br\bullet \rightarrow C_6H_{11}Br$	B1	
9 (a) (ii)	The Br–Br covalent bond break with each bonded Br atom taking one of the shared pair of electrons from the bond to form two Br• radicals.	B1	**ALLOW** 'the breaking of a covalent bond' **ALLOW** the splitting of the bond in bromine **ALLOW** the breaking of a covalent bond where each atom keeps one of the bonding electrons **IGNORE** particle for atom **ALLOW** one electron goes to each product / species **DO NOT ALLOW** molecule or compound for atom **IGNORE** homolytic fission equations
9 (b) (i)	$C_6H_{12} + 2Br_2 \rightarrow C_6H_{10}Br_2 + 2HBr$	B1	**ALLOW** molecular formula only.
9 (b) (ii)	1.2-dibromocyclohexane	B1	Locant numbers **MUST** lowest possible e.g. **DO NOT ALLOW** 2,4-dibromocyclohexane etc. **IGNORE** structures
10 (a) (i)	UV radiation	B1	**ALLOW** high temperature **OR** 300 °C **IGNORE** light/radiation **DO NOT ALLOW** any catalyst
10 (a) (ii)	The mechanism is radical substitution The first step is initiation where I• and Br• radicals are formed using energy from the UV radiation. All bond breaking proceed by homolytic fission $IBr \rightarrow I\bullet + Br\bullet$ The next step is propagation where the products are formed in quantity via a chain reaction. $CH_4 + Br\bullet \rightarrow CH_3\bullet + HBr$ $CH_3\bullet + IBr \rightarrow CH_3I + Br\bullet$ One possible termination equation is: $CH_3\bullet + Br\bullet \rightarrow CH_3Br$	B1 B1 B1 B1 B1 B1 B1	**IGNORE** any state symbols in equations Radicals do **NOT** need a single dot **IGNORE** dots **DO NOT ALLOW** homolytical fission Heterolytic anywhere in the answer contradicts this mark **IGNORE** $I + CH_4 \rightarrow HI + CH_3$ **IGNORE** $CH_3 + IBr \rightarrow CH_3Br + I$ **DO NOT ALLOW** equations with H **OR** any other incorrect equation (i.e. not one of the four propagation steps shown) **ALLOW** any other suitable

Question number	Answer	Marks	Guidance
			termination steps **DO NOT ALLOW** termination steps with H **QWC** can only be given if marking points 2, 4 and 5 have been awarded
11 (a)	In homolytic fission, a covalent bond is breaks with each bonded atoms takes one of the shared pair of electrons from the bond.	B1	
11 (b)	$Cl\bullet + C_4H_9Cl \rightarrow C_4H_8Cl\bullet + HCl$ $C_4H_8Cl\bullet + Cl_2 \rightarrow C_4H_8Cl_2 + Cl\bullet$	B1 B1	**IGNORE** dots even if incorrect
11 (c)	$C_4H_{10} + 4½O_2 \rightarrow 4CO + 5H_2O$	B1	**ALLOW** any correct multiples for these equations eg $2C_4H_{10} + 9O_2 \rightarrow 8CO + 10\ H_2O$ **IGNORE** state symbols **ALLOW** equations for incomplete combustion that give CO_2 with CO and/or C eg $C_4H_{10} + 4O_2 \rightarrow 3CO + C + 5H_2O$
12 (a) (i)	Structural isomers are compounds with the same molecular formula but different structural formulae	B1	
12 (a) (ii)	Any from C_6H_{14}, C_7H_{16}, C_8H_{18}, C_9H_{20}, $C_{10}H_{22}$	B1	
12 (b) (i)	UV radiation	B1	
12 (b) (ii)	$C_4H_9Cl = 12 \times 4 + 1 \times 9 + 35.5 = 92.5$	B1	
12 (b) (iii)	 1-chlorobutane  2-chlorobutane 1 mark for each structure	B1 x 2	
13 (a)	C_nH_{2n+2}	B1	
13 (b) (i)	$C_8H_{18} + 8½O_2 \rightarrow 8CO + 9H_2O$	B1	
13 (b) (ii)	Incomplete combustion takes place when there is a limited supply of oxygen	B1	
13 (c)	$n(C_8H_{18}) = 22.8/114.0 = 0.200$ mol $n(O_2) = 8.5 \times 0.200 = 1.70$ mol	B1 B1	

Question number	Answer	Marks	Guidance
	volume of O_2 = 1.70 × 24.0 = 40.8 dm^3	B1	