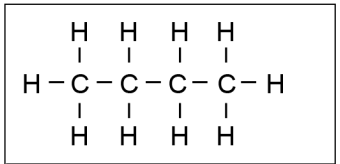
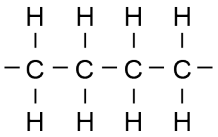
Assessment schedule – 2022

Chemistry: Demonstrate understanding of aspects of carbon chemistry (90932)

Evidence Statement

Q	Evidence	Achievement	Merit	Excellence
ONE (a)(i)	 butane	• Structure correct.		
(ii)	Type of bonding found in propane and butane is **covalent bonding**. This is because propane and butane are made up of the non-metal atoms /C and H, which share electrons. Non-metal atoms share their valence electrons to gain full outer shells, resulting in stable bonds.	• Covalent.	• Explains that the non-metal atoms / C and H, share electrons to gain a full outer shell / become stable.	
(b)(i)	Carbon monoxide is a colourless, odourless gas (denser than air).	• Both properties correct.		
(ii)	Word equation: propane + oxygen → carbon monoxide + water Balanced symbol equation: $C_3H_8 + 3.5O_2 \rightarrow 3CO + 4H_2O$ $(2C_3H_8 + 7O_2 \rightarrow 6CO + 8H_2O)$	• Valid word equation.		
(iii)	Complete combustion occurs in plentiful oxygen (air), and produces carbon dioxide and water, HOWEVER/ WHEREAS Incomplete combustion occurs when the oxygen (air) supply is limited, and produces carbon / carbon monoxide and water. Complete combustion burns with a clean blue / colourless flame, while incomplete combustion burns with an orange flame, because produces soot / black solid (carbon). Equation for complete combustion: $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$	• Products of complete combustion identified. • Valid observation for complete and incomplete combustion.	• Link availability of oxygen in incomplete and complete combustion to the products AND flame colour • One correct equation with one minor error in balancing.	• Compares availability of oxygen and makes links to flame colour and products for incomplete and complete combustion. • BOTH correctly balanced equation for complete combustion.

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; no relevant evidence.	1a	2a	3a	4a	2m	3m	1e + 1m	2e

Q	Evidence	Achievement	Merit	Excellence
TWO (a)(i)	A hydrocarbon is a (organic) molecule containing C and H atoms (joined together by covalent bonds).	• Correct statement.		
(ii)	Crude oil consists of a mixture of hydrocarbon molecules of different sizes, which must be distilled to separate into useful fractions, since the fractions of bitumen and petrol have different uses. Hydrocarbons of different molecular masses have different boiling points. For example petrol collects between 25 °C and 60 °C, whereas bitumen collects above 350 °C, as it has a longer carbon chain. The smaller molecules have a smaller mass and therefore weaker forces between molecules and hence lower boiling points. *(Note: candidates can use the intermolecular forces correctly but this is beyond the scope of the standard.)*	• Describes crude oil as a mixture of different length / size hydrocarbons.		
	When the heated crude oil vapour enters the tower, the smaller hydrocarbons in petrol with the lower boiling points condense into liquids higher up in the tower where it is cooler, or remain as gases, and exit near the top of the tower as a fraction of petrol. The larger, heavier hydrocarbons in bitumen drain as a liquid from the bottom of the tower.	• Recognises the separation of the (lighter and heavier) fractions depend on differences in the boiling points. OR Smaller hydrocarbons have a low boiling point. OR Top of the tower is cooler / bottom of tower is hotter.	• Links the size / length of chain of the hydrocarbon to where the fraction collects in the tower OR to its boiling point for both bitumen and petrol.	• Comprehensively links the size / length of chain of the hydrocarbon to the size of the forces between the molecules, the boiling point, temp gradient and where the fraction is collected in the tower using the data given for both bitumen and petrol.
(b)(i)	Polythene: 	• Draws at least two repeating units (includes bonds/ wiggles on ends)		
(ii)	Ethene has a (reactive) double covalent bond between two carbon atoms. Under high temperatures, high pressure, and catalytic conditions the double bond can be broken, resulting in a single covalent bond and a spare single bond that can covalently bond to the next monomer to form a long chain /polymer. Whereas ethane has only an (unreactive) single bond so ethane does not undergo polymerisation.	• Polymerisation is described. OR Ethane no double bond/ ethene has double bond that can break	• Correctly explains requirements for a double bond between carbon atoms AND monomers joining together to form a chain.	• Correctly explains the requirements for a carbon double bond in polymerisation including required conditions, and lack of alkane reaction.

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; no relevant evidence.	1a	2a	3a	4a	1m + 2a	2m	2e with minor error	2e

Q	Evidence	Achievement	Merit	Excellence
THREE (a)(i)	<table><tr><td>Ethane</td><td>Gas</td></tr><tr><td>Propane</td><td>Gas</td></tr><tr><td>Butane</td><td>Gas</td></tr></table>	• States correct.		
(ii)	The boiling point of a chemical is the temperature at which the chemical changes from the liquid state to the gaseous state. Describe the trend: As the number of carbon atoms increases in the alkane family, the boiling point increases. Explain the trend: As the number of carbon atoms increases/ the molecules also increase in size, resulting in a larger / stronger attractive force between the molecules. This results in more heat energy being required to separate the molecules to allow them to become gases. This can be seen from the data in the table as the boiling points of the molecules increase as the carbon chain length increases down the table from one carbon (methane) to five carbons (pentane).	• Defines the term boiling point as the temperature at which a liquid becomes a gas. • States that the boiling points increase as the number of carbon atoms increases.	• Explains that more heat energy is required to separate the molecules the larger they get. • Explains that as the number of carbon atoms increases, the larger / stronger the attractive force between molecules.	• Links the number of C atoms / size of molecule to the relative strength of the forces between the molecules given, the energy required to separate the molecules, and the boiling points provided in the table.
(b)	Add water to a sample of both solutions in a test tube. In one test tube, two immiscible/ separate layers will form, as hexane is insoluble in water. Hexane is an alkane and is not soluble in water, as there are insufficient attractions between hexane and water. Ethanol is an alcohol that is soluble in water as the attractive forces between the water and ethanol molecules are similar/ great enough, forming one layer.	• Recognises hexane can be identified by the formation of two immiscible layers. • States that ethanol is soluble in water.	• Links solubility of ethanol OR insolubility of hexane to attractions with water.	• Links solubility of BOTH ethanol and hexane to attractions with water.

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; no relevant evidence.	1a	2a	3a	4a	2m	3m	2e with minor error	2e

Cut Scores

Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
0 – 8	9 – 14	15 – 18	19 – 24