OCR GCSE GATEWAY CHEMISTRY A · J248

CHEMISTRY



MARK SCHEME

C6.2 ORGANIC CHEMISTRY

SCORE	PERCENTAGE
/194	%

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Question			Answer/Indicative content	Marks	Guidance
1			A	1	
			Total	**1**	
2			D	1	
			Total	**1**	
3			C	1	
			Total	**1**	
4			C	1	
			Total	**1**	
5			C	1	
			Total	**1**	
6	a		Tall column with condensers coming off at different heights (1) Column heated at the bottom so hot at the bottom and cool at the top (1) Substances with high boiling points condense at the bottom (1) Substances with low boiling points condense at the top (1)	4	
	b		$C_{15}H_{32} \rightarrow 2C_6H_{12} + C_3H_8$ (1)	1	**ALLOW** any correct multiple
			Total	**5**	
7			C	1	
			Total	**1**	
8			C	1	
			Total	**1**	
9			B	1	
			Total	**1**	
10			D	1	
			Total	**1**	
11			C	1	

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Question			Answer/Indicative content	Marks	Guidance
			Total	1	
12	a		Fractions have different boiling points (1) Idea that larger molecules have stronger intermolecular forces (1)	2	Answer must be **comparative** ALLOW ORA
	b		Has a carbon-carbon double bond (1)	1	ALLOW has C=C ALLOW answer indicated on the displayed formula Has a double bond is not sufficient
			Total	3	

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Question			Answer/Indicative content	Marks	Guidance
13			hydrophilic end bonds to water molecule (1) hydrophobic end bonds to oil molecule (1)	2	**allow** attracted to / sticks into / joins to or forms intermolecular forces with as alternative to bonding **allow** head bonds to water molecule and tail bonds to oil molecule for two marks **allow** one mark for water molecules surround the hydrophilic end **and** oil molecules surround the hydrophobic end **allow** one mark for one end is bonded to water and the other to oil **allow** one mark for hydrophilic end stays in or likes water **and** hydrophobic stays in or likes oil **not** hydrophobic is bonded to water and hydrophilic is bonded to oil **Examiner's Comments** This question was about foods and food additives. Many candidates were able to describe how an emulsifier stops oil and water from separating. The candidates needed to refer to protein.
			Total	2	

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Question			Answer/Indicative content	Marks	Guidance
14			[Level 3] Answer describes how an ester is made in a laboratory, including that the reactants must be mixed or heated together **AND** applies knowledge of safety and risk assessment to give at least two safety precautions used in the preparation of an ester, one involving the problems of heating a flammable liquid. Quality of written communication does not impede communication of science at this level. **(5–6 marks)** [Level 2] Candidates recall the names of both reactants **AND** applies knowledge of safety and risk assessment to give two safety precautions used in the preparation of an ester. Quality of written communication partly impedes communication of science at this level. **(3–4 marks)** [Level 1] Candidates recall the name of one reactant used to make an ester **OR** applies knowledge of safety and risk assessment to give at least one safety precaution used in the preparation of an ester. Quality of written communication impedes communication of science at this level. **(1–2 marks)** [Level 0] Insufficient or irrelevant science such as repeating the question. Answer not worthy of credit. **(0 marks)**	6	This question is targeted up to grade C Indicative scientific points may include: • safety precautions include use of safety glasses, gloves, safety screen, fire extinguisher, water bath, laboratory coats etc • reagents are heated together in a beaker or in a test tube in a water bath • reagents are heated together • the reagents are mixed together • alcohols react with acids to make ester • higher level answers may refer to methods that use refluxing and distillation • sulfuric acid added as a catalyst to the reaction mixture • reaction mixture is added to sodium carbonate solution Use the L1, L2, L3 annotations in scoris. Do not use ticks. Examiner's Comments Candidates often found this question about the preparation of esters challenging. Many candidates knew the word equation, or the reactants, but some confused the acid with a mineral acid and the experiment with neutralisation by titration. A considerable number of candidates did not refer to making an ester at all. A common misconception was to describe the safety precautions associated with the use of perfumes rather than during the preparation of an ester.
			Total	6	

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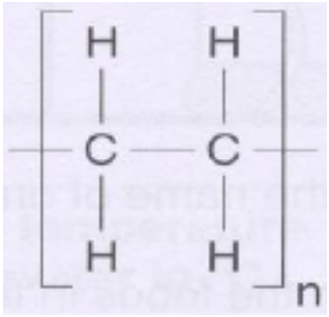
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Question			Answer/Indicative content	Marks	Guidance
15	a		contains a double bond (between carbon atoms) (1)	1	**not** double bond between carbon molecules **ignore** does not have the maximum amount of hydrogen atoms **Examiner's Comments** This question focused on the chemistry of ethene. Many candidates recognised the importance of the double bond.
	b	i	addition reaction (1)	1	**allow** bromination **Examiner's Comments** Were challenging and only a small proportion of the candidates described the addition reaction and named the compound type correctly.
		ii	a dibromocompound (1)	1	**allow** saturated / halogenocompound **Examiner's Comments** Were challenging and only a small proportion of the candidates described the addition reaction and named the compound type correctly.

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Question			Answer/Indicative content	Marks	Guidance
	c		 correct repeat unit drawn with open bonds at both ends (1) correct use of brackets and n (1)	2	second mark is dependent on first mark **allow** multiples of this structure eg ?($CH_2CH_2CH_2CH_2$-)$_n$. for two marks **allow** one mark for a section of the polymer that has at least two repeat units with open ends at both ends Examiner's Comments Many candidates correctly drew the displayed formula of poly(ethene). Common errors were drawing a double bond between the carbon bonds or omitting the open bonds at one or both ends of the monomer unit.
			Total	5	

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Question			Answer/Indicative content	Marks	Guidance
16	a		bitumen (1)	1	**allow** phonetic spelling **Examiner's Comments** Many candidates could interpret the data in the table.
	b	i	C_4H_{10} (1)	1	**not** C4H10 / C^4H^{10} **allow** $H_{10}C_4$ **Examiner's Comments** Candidates were often able to write the molecular formula and only a small proportion of the candidates used superscripts rather than subscripts.
		ii	propane and butane contain carbon and hydrogen (atoms) (1) only (1) has (carbon to carbon) single bonds **only** / contains single (covalent) bonds **only** (1)	3	**not** is a mixture of carbon and hydrogen (only) **not** contains carbon and hydrogen molecules Only must be linked to first marking point and is not independent **allow** has no (carbon to carbon) double bonds (1) **allow** they are saturated compounds (1) **allow** has general formula C_nH_{2n+2} (1) **ignore** has the maximum amount of hydrogen atoms **Examiner's Comments** Candidates were often able to write the molecular formula. Many candidates could explain why propane and butane are hydrocarbons but were often not able to explain why these hydrocarbons are alkanes. A common misconception was that the molecules had single bonds between molecules rather than between the carbon atoms. Other candidates gave imprecise answers and did not refer to the molecules only having single bonds.
			Total	5	

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Question			Answer/Indicative content	Marks	Guidance
17			idea that thermochromic paints change colour when heated or cooled / the paint is a different colour when hot or cold / the paint is a different colour at different temperatures (1) the colour of the paint or pigment will show when the milk is at the right temperature (to drink) (1)	2	**allow** so you can see if the milk is warm or cold (1) **allow** idea that the milk is safe for the baby to drink (1) **Examiner's Comments** A number of candidates could recall that thermochromic pigments change colour with temperature. Fewer recognised that this would show when the milk was at the correct temperature. The most common misconception was that thermochromic pigments insulated the bottle.
			Total	**4**	
18			poly(ethene) (1)	1	**allow** polythene (1) **allow** polyethene (1) **Examiner's Comments** About half of all candidates correctly named polyethene. ‘Nylon’, ‘polystyrene’ and ‘polyethane’ were the most common incorrect responses.
			Total	**1**	

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Question			Answer/Indicative content	Marks	Guidance
19			octane + oxygen ? carbon dioxide + water (1)	1	**allow** = instead of ? **not** and or & for + **allow** mix of formulae and words but equation does not have to be balanced e.g. C_8H_{18} + O_2 ? carbon dioxide + H_2O (1) **Examiner's Comments** Candidates can now construct word equations well. The most common errors were to write water rather than oxygen or to attempt to write a symbol equation. The correct formulae will score the mark but this was a rare occurrence.
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
20	a		bitumen (1) (bitumen) has the highest boiling point (range) (1)	2	**allow** phonetic spelling this mark is **dependent** on the correct fraction being chosen **allow** hottest boiling point (1) **allow** needs the highest temperature to be boiled (1) **allow** its boiling point is above 350oC (1) **allow** it's the highest temperature at the bottom (1) **ignore** it's the hottest **Examiner's Comments** Most candidates scored 1 mark, usually for the idea that non-renewable fuels are finite. Fewer gained the second mark for taking a long time to form. The main error was candidates who stated 'it can't be used again'.
	b	i	14 (1)	1	**Examiner's Comments** Was well answered by most candidates.
		ii	propane and butane contain carbon and hydrogen (atoms) (1) only (1) has (carbon to carbon) single bonds **only** / contains single (covalent) bonds **only** (1)	3	**not** is a mixture of carbon and hydrogen (only) **not** contains carbon and hydrogen molecules Only must be linked to first marking point and is not independent **allow** has no (carbon to carbon) double bonds (1) **allow** they are saturated compounds (1) **allow** has general formula C_nH_{2n+2} (1) **Examiner's Comments** Differentiated well. Most candidates stated that hydrocarbons contain carbon and hydrogen for 1 mark. The addition of 'only' gained the second mark. The third mark was the most challenging, with candidates needing to state that alkanes contain single bonds **only**.

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Question			Answer/Indicative content	Marks	Guidance
			Total	6	
21	a		formula **C** (1) because it contains (a) carbon to carbon double bond(s) (1)	2	**allow** contains C=C (double bonds) (1) must be clear it is a carbon-carbon double bond and not a carbon-oxygen double bond **ignore** carbon double bond / double carbon bond Examiner's Comments Almost half of candidates could identify formula **C** as unsaturated. Far fewer could explain their selection by talking about carbon to carbon double bonds. Many just stated '**C** has double bonds without realising there were carbon to oxygen double bonds in all the molecules. Statements such as carbon double bond or double carbon bond were insufficient to score the second mark.
	b		mixture of two liquids (1) that (normally) do not mix or are immiscible (1)	2	**allow** a colloid (1) **allow** oil and water (1) Examiner's Comments About a quarter of candidates scored 1 mark on this question usually for mentioning oil and water. Answers frequently described the role of emulsifiers rather than an emulsion.
			Total	4	

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Question			Answer/Indicative content	Marks	Guidance
22	a		hydrogen (1)	1	**allow** H or H_2 (1) **not** hydrogen and oxygen or hydrogen / oxygen Examiner's Comments Only about a quarter of candidates correctly stated hydrogen from the diagram. 'Coal' and 'petrol' were commonly stated.
	b		$2H_2 + O_2$? $2H_2O$ correct formulae (1) balancing (1) balancing mark is conditional on correct formulae	2	**allow** any correct multiple e.g. $4H_2 + 2O_2$? $4H_2O$ (2) **allow** = or ? for arrow **not** 'and' or & for + **allow** one mark for correct balanced equation with minor errors in case, subscript and superscript e.g. $2h_2 + O^2$? $2H_2o$ Examiner's Comments The equation was generally well answered with stronger candidates scoring both marks for a fully correct equation and others 1 mark for the correct formulae for reactants and product. Weaker candidates often wrote H_2O_2 rather than H_2O.
	c		idea that water is the only product (and is non polluting) (1)	1	**allow** does not make carbon dioxide / does not make greenhouse gases (1) **allow** water and **unused** hydrogen and oxygen (1) Examiner's Comments Only better candidates scored this mark. They recognised that water was the product. Weaker candidates thought that hydrogen or oxygen were the products and failed to score.

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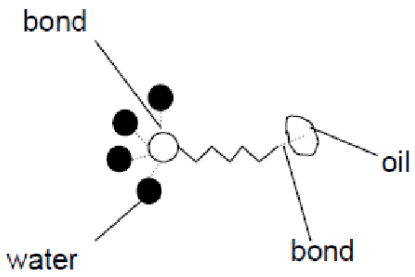
Question			Answer/Indicative content	Marks	Guidance
	d		provides water that astronauts can use / light / lightweight / low density / compact / no moving parts (1)	1	**allow** idea that makes a usable product i.e. water (for astronauts) / can be used as drinking water **ignore** efficient / reliable Examiner's Comments The most common answers were that the astronauts could drink the water and that the fuel cell was compact. Answers such as 'efficient' or 'reliable' were insufficient to score.
			Total	5	

Question			Answer/Indicative content	Marks	Guidance
23	a		formula **C** (1) because it contains (a) carbon to carbon double bond(s) (1)	2	 **allow** contains C=C (double bonds) (1) must be clear it is a carbon-carbon double bond and not a carbon-oxygen double bond **ignore** carbon double bond / double carbon bond ?Examiner's Comments?? Many candidates recognised that fat **C** was unsaturated however not all were able to explain precisely why this was so. Answers had to refer to the presence of carbon-carbon double bonds not just double bonds since the molecule also contained a carbon-oxygen double bond.
	b		**any two from:** saponification involves reacting (a fat or oil) with sodium hydroxide (1) soap is made (1) glycerol is made (1) it is a hydrolysis reaction (1)	2	 **allow** caustic soda / potassium hydroxide instead of sodium hydroxide **allow** propane-1, 2, 3-triol instead of glycerol **allow** marks to be awarded from a word equation even if equation is incorrect e.g. fat or oil + sodium hydroxide ? soap + glycerol (2) **allow** correct products from **A**, **B** or **C** if specified e.g. saponification of **A** gives methanol and soap **ignore** reference to enzymes ?Examiner's Comments?? The best answers gave a word equation to describe saponification. Some other candidates were able to list the products made by saponification. A significant proportion of candidates left this question blank.

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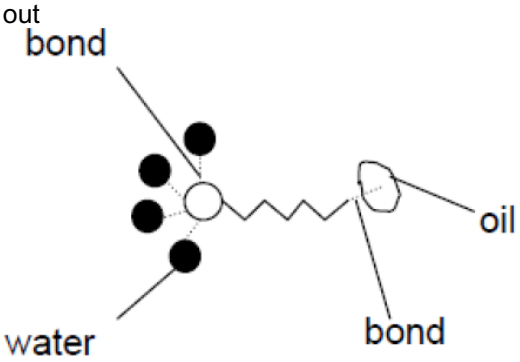
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Question			Answer/Indicative content	Marks	Guidance
	c		any two from: hydrophobic tail (1) (hydrophobic end) attracted to fat or oil / bonds to fat or oil / intermolecular attraction with fat or oil (1) (hydrophilic) head attracted to water / intermolecular attraction with water (1) idea that **tail** lifts off grease (1) idea that detergent molecules surround grease **and** so prevent it returning to clothes (1)	2	**marks may be awarded from a labelled diagram** **allow** stain = oil or fat in the context of the question **allow** hydrophobic end or hydrophobic head (1) **allow** attached to / sticks to / binds to dissolved in or goes into **not** sufficient **allow** hydrophilic end bonds with water / attached to water / sticks to water / binds to water (1) dissolved in or goes into **not** sufficient  ?Examiner's Comments?? Good answers gave labelled diagrams showing how a detergent could remove an oil stain. Candidates could often label the hydrophobic end of the detergent molecule but sometimes in their explanations they confused the tail with the head of the detergent. Most candidates referred to the hydrophilic head bonding with water molecules and the hydrophobic tail bonding with molecule of fat. Centres should advise candidates to ensure that diagrams are fully labelled to ensure full credit can be given.
			Total	6	

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Question			Answer/Indicative content	Marks	Guidance
24			any three from detergent has a hydrophilic (head) (1) idea that detergent is bonded to water molecules (1) hydrophobic end bonds with grease (1) idea that hydrophobic or tail lifts off grease (1)	3	USE TICKS FOR THIS QUESTION marks may be awarded for a labelled diagram **allow** idea of hydrophilic end or hydrophilic part (1) **allow** hydrophilic (end) is bonded to water / hydrophilic (end) is attracted to water (molecules) (2) water surrounds the hydrophilic end is **not** sufficient **allow** hydrophobic (end) is attracted to grease (molecules) grease surrounds the hydrophobic end is **not** sufficient for MP2 and MP3 **allow** attached to, clings to, connected, stick on or stick to instead of bonded, but **do not allow** stick into or stick out  **Examiner's Comments** The best answers to this question included a labelled diagram although many of the diagrams did not include the idea that the hydrophobic tail was attracted to oil and the hydrophilic head was attracted to water. The term hydrophilic was well known and used in the correct context.
			Total	3	

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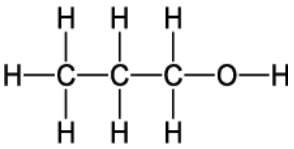
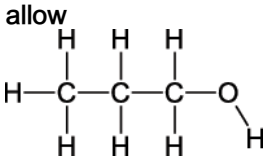
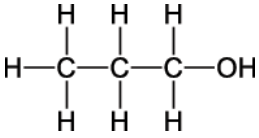
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Question			Answer/Indicative content	Marks	Guidance
25			idea that fuel cells contain poisonous catalysts (which need to be disposed of) (1) (idea of pollution) from the **burning** of fossil fuels associated with fuel cell production or manufacture of raw materials (1)	2	**allow** catalyst could be pollutants (when disposed of) / contain harmful catalysts **ignore** dangerous catalysts **allow** makes waste when they are thrown away **allow** mining for some of the materials used in a fuel cell (will cause pollution) ?Examiner's Comments?? The most common answer referred to the poisonous catalyst although many candidates gave vague answers relating to manufacture and/or disposal.
			Total	2	
26			test - add bromine (water) (1) result - idea that bromine water loses its colour (1) – this mark is dependent on the correct reagent or a near miss e.g. bromide	2	**allow** Br_2 (1) **allow** decolourised / loses its colour / goes colourless (1) **not** goes clear / discoloured **ignore** initial colour of bromine Examiner's Comments A significant proportion of the candidates misinterpreted this question and described how to test for a fat rather than how to test for unsaturation. Those candidates that did chose bromine often gave the correct result for an unsaturated fat and the number of candidates using clear rather than colourless has reduced from previous sessions.
			Total	2	

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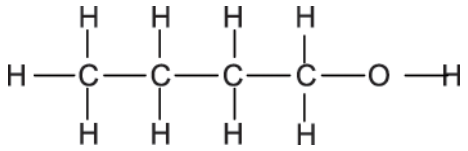
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Question			Answer/Indicative content	Marks	Guidance
27	a		$C_6H_{12}O_6$? $2CO_2 + 2C_2H_5OH$ formulae (1) balancing – dependent on correct formulae (1)	2	**allow** C_2H_6O as formula for ethanol **allow** any correct multiple e.g. $2C_6H_{12}O_6$? $4CO_2 + 4C_2H_5OH$ **allow** = or ? for arrow **not** "and" or & for + **allow** one mark for correct balanced equation with minor errors of case, subscript or superscript e.g. $C^6H^{12}O^6$? $2Co_2 + 2C_2H_5OH$ **Examiner's Comments** Many candidates could construct the balanced equation. Only a small proportion of the candidates changed the formulae of either the reactant or the product.
	b	i	i C_3H_7OH / C_3H_8O (1)	1	**Examiner's Comments** Many candidates could use the general formula to calculate the formula for propanol.
		ii	 (1)	1	**allow**  **allow**  (1) **allow** displayed formula for propan-2-ol **Examiner's Comments** Candidates often drew a correct displayed formula. The mark scheme allowed candidates to write the –O—H group as –OH but Centres should advise candidates that a proper displayed formula shows all of the bonds. Some candidates included pentavalent carbon atoms and others had oxygen atoms with a double bond. Another misconception was to have the –OH bond in the wrong order having C—H—O.

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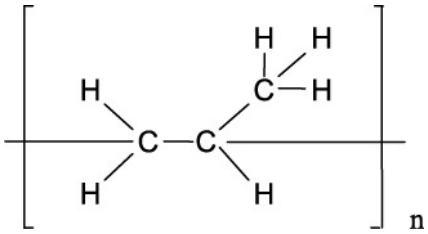
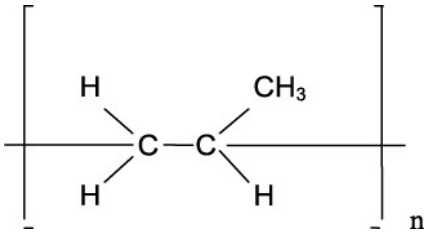
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Question			Answer/Indicative content	Marks	Guidance
			Total	4	
28		i	C_3H_7OH (1)	1	**allow** C_3H_8O allow any order of atoms **Examiner's Comments** Candidates could use the general formula to calculate that the formula of propanol is C_3H_7OH.
		ii	correct displayed formula (1) 	1	**allow** displayed formula for methylpropan — 1 — ol or methylpropan — 2 — ol or butan-2-ol **allow** OH in displayed formula with no bond between O and H **Examiner's Comments** Some candidates could draw the displayed formula for butanol. Almost all displayed formula drawn were of the straight chain primary alcohol.
			Total	2	

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Question			Answer/Indicative content	Marks	Guidance
29	a		correct atoms and bonds without the double bond (1) brackets and n (1)	2	**second marking point is dependent on the first** **allow** more than 1 repeat unit  **allow** round brackets **allow**  **Examiner's Comments** Many candidates drew the displayed formula for poly(ethene), rather than for poly(propene). To score the marks candidates needed to draw the basic covalent structure of the polymer, including the correct use of brackets and 'n' to indicate many repeat units. Credit was also given to candidates who drew 2 or more repeat units. Candidates need to ensure that they include the bonds at the side in the polymer structure to gain credit. Structures containing double bonds or only 3 bonds on carbon atoms did not gain marks.

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Question			Answer/Indicative content	Marks	Guidance
	b		Level 3 Two properties needed by the plastic are explained AND the flexibility of poly(propene) is explained in terms of the structure and bonding. Quality of communication does not impede communication of science at this level. (5–6 marks) Level 2 The flexibility of poly(propene) is explained in terms of the structure and bonding OR two properties needed by the plastic are explained OR one property of the plastic is explained and an attempt to explain why poly(propene) is flexible. Quality of written communication partly impedes communication of the science at this level. (3 - 4 marks) Level 1 One property needed by the plastic is explained OR an attempt to explain why poly(propene) is flexible. Quality of communication impedes communication of the science at this level. (1 - 2 marks) Level 0 Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	6	This question is targeted at grades up to A* Indicative scientific points for level 3 may include: • Poly(propene) molecules are attracted to one another by weak intermolecular forces or bonds that are easy to overcome • Poly(propene) molecules need very little energy to be separated • Poly(propene) molecules can slide over each other • Poly(propene) has atoms held together by strong covalent bonds Indicative scientific points for all levels may include: • Non-biodegradable so the plastic does not rot or decay • Insoluble in water or waterproof so that the sandwich box can be washed clean / so it will not dissolve / so moist foods can be stored • Non-toxic material so it will not contaminate the food or make the food dangerous to eat • Non-reactive or inert so will not react with chemicals in the food • Non-permeable so water doesn't reach the food ignore references to can be coloured / is strong / tough / durable / light or lightweight / ard / easily moulded / insulator / does not melt (in hot water) Use the L1, L2, L3 annotations in Scoris; do not use ticks Examiner's Comments This 6 mark question was targeted at all grades up to, and including, grade A* and discriminated well. At level 3 (5-6 marks)

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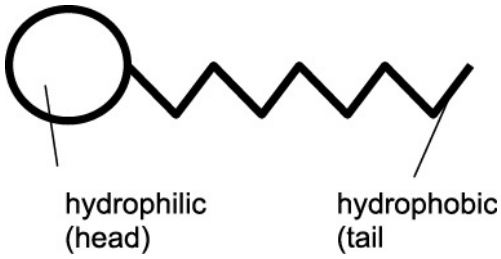
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Question			Answer/Indicative content	Marks	Guidance
					all aspects of the question needed to be addressed and candidates were required to explain why poly(propene) is flexible and suggest and explain two other properties needed by a plastic used to make a lunchbox. When candidates did not gain full credit it was usually because they gave properties of the plastic which were not relevant or did not fully explain the flexibility of poly(propene) in terms of weak intermolecular forces that are easy to overcome, allowing the polymer chains to slide over each other.
			Total	8	
30			$CH_4 + 2O_2$? $CO_2 + 2H_2O$ correct reactants and products (1) balancing – dependent on correct reactants and products (1)	2	**allow** any correct multiple, including fractions **allow** = / ? instead of ? **not** and / & balancing mark is dependent on the correct formulae but **allow** 1 mark for a balanced equation with minor errors in subscripts / formulae e.g. CH4 + 2O2 ? CO2 + 2H2o **Examiner's Comments** This question required candidates to write a balanced symbol equation for the complete combustion of methane in oxygen. One mark was awarded for the correct reactants and products and 1 mark for the correct balancing. The balancing mark was dependent on the correct formulae, but 1 mark was allowed for a balanced equation with a minor error in subscripts or formulae. When candidates did not gain marks it was often because they wrote an incorrect formula for water, e.g. H_2, or failed to balance the oxygen atoms on the left hand side of the equation.
			Total	2	

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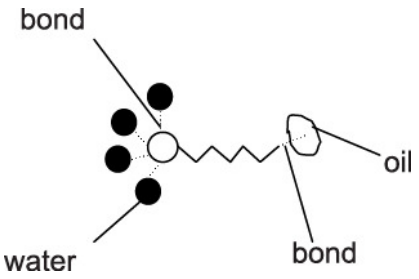
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Question			Answer/Indicative content	Marks	Guidance
31		i	hydrophilic (head) **and** hydrophobic (tail) (1)	1	 **allow** polar (head) and non-polar (tail) (1) **allow** ionic (head) and hydrocarbon (tail) (1) **ignore** water loving and water hating **Examiner's Comments** Most candidates correctly labelled the hydrophilic head and the hydrophobic tail.

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Question			Answer/Indicative content	Marks	Guidance
		ii	hydrophobic end or tail is attracted to oil / hydrophobic end or tail forms intermolecular forces with oil / hydrophobic end or tail bonds to oil (1) hydrophilic end or head is attracted to water / hydrophilic end or head forms intermolecular forces with water / hydrophilic end or head bonds to water (1)	2	**if no other marks awarded allow** tail is surrounded by oil molecules and the head by water molecules **allow** sticks to or attached or joined or combines with as alternative to 'bonds', **but** the hydrophobic end goes into oil is **not** sufficient **ignore** hydrophilic head loves water / hydrophobic tail loves oil **ignore** idea s of repelling water / oil **all** marks can be awarded from a **labelled** diagram but to get two marks must clearly show bonding to rather than surrounded by  **allow** ecf from (i) for 1 mark e.g. hydrophobic head bonds to oil and hydrophilic tail bonds to water, if labels the wrong way round in (i) **Examiner's Comments** Good responses described that the hydrophilic head is attracted to, or bonds with, water and that the hydrophobic tail is attracted to, or bonds with, oil. Error carried forward was allowed if the labels were the wrong way round in part (i).
			Total	3	

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Question			Answer/Indicative content	Marks	Guidance
32	a		C_2H_6/H_6C_2 (1)	1	the numbers must clearly be subscripts **not** C^2H^6/C2H6 **Examiner's Comments** The molecular formula for compound B was usually correct.
	b		**B** contains carbon and hydrogen (1) only / AW (1) **C** contains oxygen / has oxygen in the formula / does not contain only carbon and hydrogen (1)	3	**allow** (formula) has only (1) H and C (1) the only is **not** an independent mark and must be linked to the carbon and hydrogen **not** contains carbon and hydrogen molecules / contains a mixture of carbon and hydrogen **not** hydro atoms but **ignore** for the third marking point **allow C** has three elements / **C** has three different atoms (1) **not C** contains oxygen molecules **Examiner's Comments** Most candidates explained that compound B is a hydrocarbon as it contains carbon and hydrogen only. They appreciated that compound C was not a hydrocarbon as it contained an oxygen atom. When candidates did not gain credit it was usually because they referred to B containing 'only carbon and hydrogen *molecules*'.
	c		**A** and **F** (1)	1	**both needed** **Examiner's Comments** A and F were usually correct.
			Total	5	

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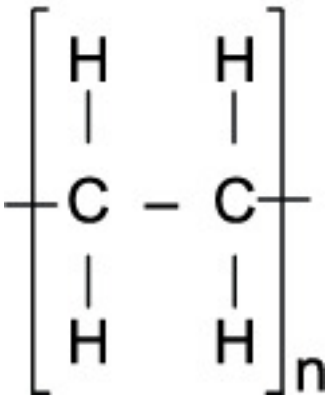
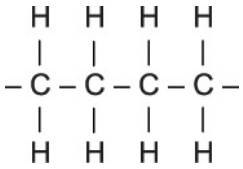
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Question			Answer/Indicative content	Marks	Guidance
33			C_3H_8 + 3½O_2 ? 3CO + 4H_2O formulae (1) balancing (1)	2	**allow** any correct multiple, including fractions **allow** = / ? instead of ? **not** and / & balancing mark is dependent on the correct formula **but allow** 1 mark for a balanced equation with minor errors of case, subscripts, superscripts, etc eg C_3H_8 + 3½O2 ? 3CO + 4H2O **Examiner's Comments** This question required candidates to write a balanced symbol equation for the incomplete combustion of propane in oxygen. This was a challenging equation for candidates. One mark was awarded for the correct reactants and products and 1 mark for the correct balancing. The balancing mark was dependent on the correct formulae, but 1 mark was allowed for a balanced equation with a minor error in subscripts or formulae. When candidates did not gain marks it was often because they wrote an incorrect formula for carbon monoxide, e.g. CO_2, or failed to balance the oxygen atoms on the left hand side of the equation.
			Total	2	

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Question			Answer/Indicative content	Marks	Guidance
34	a		(formula) does not contain **only** carbon and hydrogen / (formula) does contain oxygen (1)	1	**not** (formula) contains an oxygen molecule **Examiner's Comments** Most candidates appreciated that compound F was not a hydrocarbon as it contained an oxygen atom.
	b		**D** (1)	1	**Examiner's Comments** D was usually correct.
	c		**E** (1)	1	**Examiner's Comments** E was usually correct.
	d		 (1)	1	**allow**  or other carbon chain with even number of CH_2 units **Examiner's Comments** Many candidates drew the correct displayed formula for poly(ethene). To score the mark candidates needed to draw the basic covalent structure of the polymer, including the correct use of brackets and 'n' to indicate many repeat units. Credit was also given to candidates who drew 2 or more repeat units. Candidates need to ensure that they include the bonds at the side in the polymer structure to gain credit. Structures containing double bonds or only 3 bonds on carbon atoms did not gain marks.
			Total	**4**	

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Question			Answer/Indicative content	Marks	Guidance
35			poly(propenenitrile) (1)	1	**allow** polypropenenitile Examiner's Comments This question was about polymers and plastics and included a question that assessed the quality of written assessment. Only a small proportion of candidates could name the polymer formed. The most common answers were propene or poly(propene). A significant proportion of the candidates did not attempt this question.
			Total	1	
36			Level 3 (5-6 marks) Describes the process of fractional distillation and lists the fractions in correct order. Quality of written communication does not impede communication of the science at this level. Level 2 (3-4 marks) Describes the process of fractional distillation, but answer may be simplistic and lacking in detail OR lists the fractions in the correct order. Quality of written communication partly impedes communication of the science at this level. Level 1 (1-2 marks) Appreciates that fractional distillation works because of differences in boiling point. Quality of written communication impedes communication of the science at this level. Level 0 (0 marks) Insufficient or irrelevant science. Answer not worthy of credit.	6	This question is targeted at grades up to C. Indicative scientific points at levels 2 and 3 may include: • crude oil is heated • fractionating column has temperature gradient (cold at top and hot at bottom) • fractions containing mixtures of hydrocarbons are obtained • order of fractions, from top, is LPG, petrol, paraffin, heating oil, fuel oils, bitumen. **allow** higher level answers in terms of intermolecular forces and molecular size linked to boiling point Use the L1, L2, L3 annotations in scoris, do not use ticks. Examiner's Comments Many candidates could place the fractions in order of their boiling point and scored 4 marks. Fewer candidates considered the temperature gradient in the column and that the crude oil has to be heated.
			Total	6	

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Question			Answer/Indicative content	Marks	Guidance
37	a		A / D (1)	1	**allow** correct formula ticked, circled or underlined if answer line is blank **Examiner's Comments** Was well answered.
	b		3 / three (1)	1	**Examiner's Comments** Was well answered.
	c		chloroethene (1)	1	**Examiner's Comments** Candidates found it more difficult to identify the monomer that poly(chloroethene) is made from.
			Total	3	
38	a		**any one from:** contains oxygen (1) has other elements other than hydrogen or carbon / has atoms besides hydrogen and carbon (1) does not contain just carbon and hydrogen (1)	1	**allow** has O in the formula **allow** hydrocarbons contain hydrogen and carbon **only** **Examiner's Comments** This was well answered. A few candidates incorrectly wrote about the lack of a double bond.
	b		hydration (1)	1	**allow** other ways of indicating correct response eg ringing or ticking the correct answer but answer line takes precedence **Examiner's Comments** Many candidates chose ‘hydration’ as the correct description of the reaction.
			Total	2	

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Question			Answer/Indicative content	Marks	Guidance
39			hexane + oxygen ? carbon + water **or** hexane + oxygen ? carbon monoxide + water **or** hexane + oxygen ? carbon + carbon monoxide + water (1)	1	**allow** correct formula instead of names C_6H_{14}, O_2, C, H_2O and CO **allow** mix of names and correct formulae symbol equation, if given, does not need to be balanced **ignore** soot **not** '+ carbon dioxide' in products **not** '+ energy' Examiner's Comments Many candidates appreciated that incomplete combustion produces carbon monoxide and/or carbon in addition to water. Candidates who failed to gain credit usually included carbon dioxide as a product or used the word 'fuel 'instead of hexane.
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
40	a		**D** and **E** (1)	1	**both needed** Examiner's Comments Many candidates could interpret the displayed formulae and recognise that **D** and **E** both had five atoms in a molecule.
	b		**A** and **F** (1)	1	**both needed** Examiner's Comments Candidates found this question much more demanding than (a) and did not recognise that the molecules had to contain a carbon-carbon double bond. Only a small proportion of the candidates wrote **A** and **F**.
	c		**B** contains carbon and hydrogen (1) only / AW (1) **C** contains oxygen / has oxygen in the formula / does not contain only carbon and hydrogen (1)	3	**allow** (formula) has only (1) H and C (1) the only is **not** an independent mark and must be linked to the carbon and hydrogen **not** contains carbon and hydrogen molecules / contains a mixture of carbon and hydrogen **not** hydro atoms but **ignore** for the third marking point **allow C** has three elements / **C** has three different atoms (1) **not C** contains oxygen molecules Examiner's Comments Candidates often gave very good explanations as to why **B** was hydrocarbon and C was not. The idea that hydrocarbons contain only hydrogen and carbon was well known. A common misconception was to refer to the presence of carbon and hydrogen molecules in a hydrocarbon.
			Total	5	

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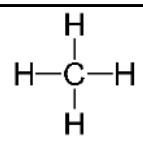
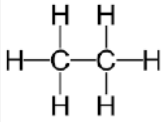
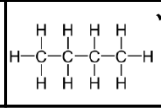
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Question			Answer/Indicative content	Marks	Guidance
41			C ✓	1(AO 2.1)	Examiner's Comments Higher ability candidates tended to recognise that option C was the only option to consist solely of hydrocarbons. For the others, choices were fairly evenly split between options A, B and D although, interestingly, far fewer went for option D.
			Total	1	
42			C ✓	1(AO 1.1)	Examiner's Comments Higher ability candidates realised that gases would have the weakest intermolecular forces, with the most popular alternative being bitumen.
			Total	1	
43			A ✓	1(AO 1.2)	Examiner's Comments Addition reactions were not well known. Most candidates assumed that the reaction would be a neutralisation.
			Total	1	

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<table>
<tr><th colspan="3">Question</th><th>Answer/Indicative content</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>44</td><td>a</td><td></td><td>
<table>
<tr><th>Name of alkane</th><th>Molecular formula</th><th>Structure</th></tr>
<tr><td>Methane</td><td>CH_4</td><td></td></tr>
<tr><td>Ethane</td><td>C_2H_6 ✓</td><td></td></tr>
<tr><td>Butane ✓</td><td>C_4H_{10}</td><td> ✓</td></tr>
</table>
</td><td>3(AO 1.1)</td><td><u>Examiner's Comments</u>

Molecular formula and structure were both exceptionally well done, with the most common mistake being to write the structure as an incorrect version of cyclobutane.

Naming was much more problematic. Most candidates assumed that alkane would be propane. A few realised that it would start with 'b' but wrote bromine. There was the usual crop of minor misspellings.</td></tr>
<tr><td></td><td>b</td><td></td><td>Hydrocarbon because
contains only carbon and hydrogen ✓

Saturated because
contains single (covalent) bonds <u>only</u> / AW ✓</td><td>2(AO 2.1)</td><td>ALLOW fits the general formula C_nH_{2n+2}
ALLOW has only H and C ✓

DO NOT ALLOW contains carbon and hydrogen molecules / contains a mixture of carbon and hydrogen

ALLOW does not have a double bond
IGNORE 'saturated because not an alkene / because all its carbons have 4 bonds

<u>Examiner's Comments</u>

Almost all candidates saw that there were two parts to this question and tried to answer both. Hydrogen and carbon were quoted by many, and a small minority went on to say 'only' and so gained credit.

Very, very few could explain what 'saturated' meant. Sometimes candidates got part way there with 'it contains single bonds' but again did not add the word 'only' which would have made it complete. 'Because it only contains two carbons' was not an uncommon incorrect response.</td></tr>
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Question			Answer/Indicative content	Marks	Guidance
	c		Ethane – bromine water remains orange / orange-brown ✓ Ethene – bromine water is decolourised / turns colourless ✓	2(AO 2.2)	IGNORE No change IGNORE turns clear / disappears Examiner's Comments Very few candidates knew what happens when bromine water is added. 'Water fizzes and bubbles with ethene' was a common incorrect response
	d		Alkene(s) ✓	1(AO 1.1)	Examiner's Comments The term alkenes was well known.
			Total	8	

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Question			Answer/Indicative content	Marks	Guidance
45	a		Z ✓	1(AO 2.1)	<u>Examiner's Comments</u> Higher ability candidates often realised that well Z had the lowest boiling point fraction but most candidates saw the largest number in the table and went for X.
	b		FIRST CHECK ANSWER ON ANSWER LINE If answer = 40.31(kg) award 2 marks $\frac{29}{100}$ x 139 ✓ = 40.31(kg) ✓	2(AO 2.2)	ALLOW 40.3 / 40 ✓✓ ALLOW ecf for one mark if 26% or 28% used (=36.14 or 38.92) ✓ <u>Examiner's Comments</u> Marks gained tended to be 2 or 0. Higher ability candidates answered correctly, many others added all the figures in the 'Oil Y' column to get, unsurprisingly, 100, then either calculated 139/100 or 139-100.
	c		$C_{16}H_{34}$ ✓	1(AO 2.1)	ALLOW $H_{34}C_{16}$ <u>Examiner's Comments</u> Higher ability candidates handled the formula with ease. Other candidates showed clear partial understanding with answers such as $C_{16}H_{2n+2}$ or $C_{16}H_{32+2}$.

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Question			Answer/Indicative content	Marks	Guidance
	d	i	**Any two from:** idea that decane boils / evaporates / turns into gaseous decane ✓ Idea that decane (vapour or gas) reacts / breaks down as it comes into contact with the porcelain chips ✓ Idea that large molecules of decane produce smaller molecules like ethene ✓	2(AO 1.2)	**ALLOW** passed over hot catalyst **ALLOW** liquid decane reacts with chips BOD Examiner's Comments This is another question where candidates were expected to explain a practical application, and few appeared comfortable with the task. The most common incorrect responses included 'decane reacts with the water and makes ethene', 'the porcelain turns into ethene', and 'the chips melt / give off a gas'.
		ii	C_6H_{14} ✓	1(AO 2.2)	**ALLOW** $H_{14}C_6$ **ALLOW** if the candidate tries to write an (erroneous) equation for cracking and gives it as a product Examiner's Comments Again, higher ability candidates handled this formula with ease. Others got most of the way there and gave answers such as C_6H_{18} or C_8H_{18}.
			Total	7	
46			(Condensation) polymer ✓	1(AO 1.1)	**ALLOW** polyamide / polypeptide **DO NOT ALLOW** addition polymer **DO NOT ALLOW** chain Examiner's Comments Candidates found this question challenging with only some of the higher ability candidates appreciating that Kevlar is a polymer molecule. Some others were heading more in the right direction when they suggested that it might be a giant structure. There was a wide variety of incorrect answers to this question with 'nanoparticle' being one of the more commonly seen responses.
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
47			C ✓	1(AO 1.1)	Examiner's Comments  Misconception A and B were both common misconceptions in this question.
			Total	1	
48			C ✓	1(AO 1.1)	Examiner's Comments Candidates found this question challenging but there was no pattern of incorrect responses.
			Total	1	
49			A ✓	1(AO 1.1)	Examiner's Comments  Misconception B and D were both common misconceptions in this question.
			Total	1	
50			C ✓	1(AO 1.1)	
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
51			(Condensation) polymer ✓	1(AO 1.1)	**ALLOW** polyamide / polypeptide **DO NOT ALLOW** addition polymer **DO NOT ALLOW** chain Examiner's Comments Many candidates correctly stated that Kevlar® is a polymer or polyamide. Polyester, alcohol and alkene were common incorrect responses.  **Misconception** **Addition** polymer was a common misconception
			Total	1	

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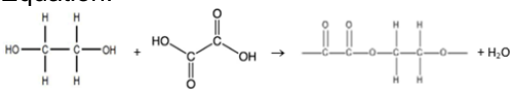
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Question			Answer/Indicative content	Marks	Guidance
52	a		Idea of swapping the position of boiling tube **X** and the boiling tube of limewater ✓ Idea that any liquid that condenses in boiling tube **X** must have come from the burning methane or not from the limewater ✓	2(AO 3.3b)	**ALLOW** idea that water condenses before the limewater is reached **ALLOW** idea of carrying out 2 experiments, one to test for carbon dioxide and one to test for water **for 2 marks** Examiner's Comments Higher ability candidates suggested swapping the position of boiling tube X and the boiling tube of limewater to make sure that any liquid that condenses in boiling tube X must have come from the burning methane and not from the limewater. Lower ability candidates misunderstood the question and focused on testing the condensed liquid to prove that it was water. Another common misconception was to suggest that the experiment needed to be a closed system to prevent water vapour / oxygen/carbon dioxide from the air affecting the results.

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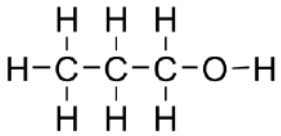
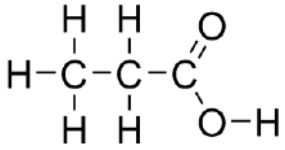
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Question			Answer/Indicative content	Marks	Guidance
	b		Type of polymerisation – condensation (polymerisation) ✓ Correct choice of ethane-1,2-diol and ethanedioic acid ✓ Equation:  Correct ester (link) formed ✓ Water molecule eliminated ✓	4(AO1 × 1.1) (AO1 × 3.1a) (AO2 × 2.1)	**ALLOW** mark for correct choice of monomers from correct reactant structures in an equation **ALLOW** mark for 'water' from an equation, even if incorrect Examiner's Comments Good responses to this question described the reaction of ethanedioic acid with ethane-1,2-diol in a condensation polymerisation reaction to form an ester and water. Many candidates gained 3 marks, but the fourth mark for drawing the correct ester link was less frequently given. Choosing ethene as one of the monomers was a common error.
	c	i	Carboxylic acids ✓	1(AO 1.1)	**IGNORE** carboxyl group Examiner's Comments Alkanes, amines and esters were common errors in this question.

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Question			Answer/Indicative content	Marks	Guidance
		ii	Alcohol **X**  ✓ Compound **Y**  ✓	2(AO 2.1)	**ALL** covalent bonds must be shown in both displayed formulae **BUT** **ALLOW** 1 mark if both displayed formulae are correct, but show '-OH' without covalent bond Examiner's Comments More candidates were able to correctly draw the structure of alcohol X than compound Y. Many candidates did not gain the mark for the displayed formula of the alcohol because they lacked the O-H bond. The question stated '**show all the covalent bonds**'. Lower ability candidates did not recall the carboxylic acid functional group, -COOH. Often the diagrams had two C-O bonds drawn (the oxygens had no other bonds). Other diagrams included C=OH or more than one C=O within the structure.
	d	i	4 / four ✓	1(AO 1.1)	Examiner's Comments Two and three were common errors in this question.
		ii	Amino acids ✓	1(AO 1.1)	Examiner's Comments Most candidates knew that the monomers in proteins are amino acids.
			Total	**11**	
53			**A** ✓	1 (AO1.1)	
			Total	**1**	
54			**C** ✓	1 (AO1.1)	
			Total	**1**	

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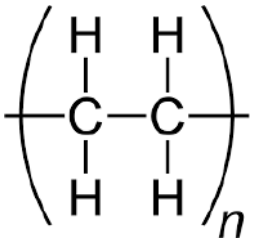
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Question			Answer/Indicative content	Marks	Guidance
55			C ✓	1 (AO1.1)	
			Total	1	
56			B ✓	1 (AO2.1)	
			Total	1	
57			B ✓	1 (AO2.2)	
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
58	a		**Any two from:** Have the same general formula / both have the formula C_nH_{2n+2} ✓ Idea that they differ from each other by CH_2 ✓ They are both saturated / idea that their carbon atoms are joined to each other by (only) single (covalent) bonds ✓	2 (AO1.1)	**ALLOW** have similar chemical properties **ALLOW** show trends in physical properties
	b	i	(Ethene) molecules have a (carbon to carbon) double bond / (Ethane) molecules do not have a (carbon to carbon) double bond or only have single bonds ✓	1 (AO2.2)	
		ii	 Single bond between the carbon atoms ✓ Single bonds to the side of each carbon atom ✓	2 (AO2.1)	

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Question			Answer/Indicative content	Marks	Guidance
	c		Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. **Level 3 (5–6 marks)** Describes how incomplete combustion of hydrocarbons such as propane happens. **AND** Describe the problems of incomplete combustion for campers, including a correct balanced symbol equation. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Describes how incomplete combustion of hydrocarbons such as propane happens. **AND** Attempts to describe the problems of incomplete combustion for campers. **OR** Includes a correct balanced symbol equation. *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **Level 1 (1–2 marks)** Describes how incomplete combustion of hydrocarbons such as propane happens. **OR** Attempts to describe the problems of incomplete combustion for campers. **OR** Attempts a correct balanced symbol equation. *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **0 marks** *No response or no response worthy of credit.*	6 (AO2 × 1.1) (AO4 × 2.1)	**AO1.1 Knowledge and understanding of why incomplete combustion happens** • Insufficient oxygen / air • This can happen if there is not enough ventilation, such as in a caravan • Not enough oxygen / air for complete combustion **AO2.1 Application of knowledge and understanding of sources of CO and the associated problems** • Carbon monoxide gas is produced, which is toxic • Carbon monoxide combines with haemoglobin / red blood cells • So less oxygen can be carried / there is a lack of oxygen to cells • Can cause unconsciousness / death • Carbon particles / soot produced • Cause blackening of the inside of the caravan • Less energy produced so wastes camping gas / fuel • • Takes longer to heat the caravan / to cook food **AO2.1 Application of knowledge and understanding to produce a balanced symbol equation** Eg $C_3H_8 + 3½O_2 \rightarrow 3CO + 4H_2O$ OR $C_3H_8 + 3O_2 \rightarrow 2CO + C + 4H_2O$ Other balanced equations are possible
			Total	**11**	

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Question			Answer/Indicative content	Marks	Guidance
59	a	i	Waxes and tar ✓	1 (AO2.1)	
		ii	Waxes and tar ✓	1 (AO2.1)	
	b	i	High temperature / catalyst ✓	1 (AO1.1)	**ALLOW** stated temperature above 500°C **IGNORE** temperature / heat without qualification **ALLOW** named catalyst eg zeolite / aluminium oxide / silicon oxide
		ii	product of cracking more in demand / makes up the shortfall / more useful ✓ gives examples from the table ✓	2 (AO2.1)	
	c		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 124.49(%) award 3 marks** 11,000,000 – 4,900,000 = 6.1×10^6 ✓ 6,100,000 ÷ 4,900,000 = 1.244897959 ✓ 1.244897959 × 100 = 124.49(%) ✓	3 (AO2×2.2) (AO1.2)	**ALLOW** ECF from calculation
			Total	**8**	
60			**A** ✓	1 (AO1.1)	
			Total	**1**	
61			**B** ✓	1 (AO1.1)	
			Total	**1**	
62			**D** ✓	1 (AO2.1)	
			Total	**1**	
63			**B** ✓	1 (AO2.2)	
			Total	**1**	

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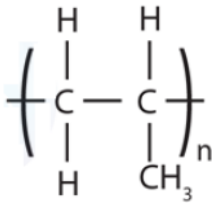
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Question			Answer/Indicative content	Marks	Guidance
64			B ✓	1 (AO1.1)	
			Total	1	
65			D ✓	1 (AO1.1)	
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
66	a	i	**A** and **D** ✓	1 (AO2.1)	**Both required for the mark**
		ii	**Any two from:** Have the same general formula / both have the formula C_nH_{2n+2} ✓ Idea that they differ from each other by CH_2 ✓ Both hydrocarbons with only single bonds / both saturated hydrocarbons ✓	2 (AO1.1)	**ALLOW** have similar chemical properties **ALLOW** show trends in physical properties **ALLOW** both hydrocarbons with no double bonds **ALLOW A** and **D** have the same functional group or no functional group / **B** and **C** have different functional groups (from **A** and **D**) **ALLOW** both (**A** and **D**) are alkanes / **C** is an alkene and **B** is a carboxylic acid
	b	i	 Correct structure ✓ Brackets and 'n' ✓	2 (AO2.1)	**ALLOW** structure of $-CH_3$ group shown **ALLOW** round or square brackets **Second marking point is dependent on correct structure**

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Question			Answer/Indicative content	Marks	Guidance
		ii	**Any one from:** Idea that in addition polymerisation monomers react together to form one large molecule / polymer whereas in condensation polymerisation one large molecule and a smaller molecule is formed ✓ A monomer (molecule) for addition polymerisation has one functional group whereas a monomer (molecule) for condensation polymerisation requires two different functional groups ✓ Addition polymerisation requires a catalyst (whereas condensation polymerisation can happen without a catalyst) / ORA ✓ Addition polymerisation requires high temperature (whereas condensation polymerisation can happen at room temperature) / ORA ✓ Addition polymerisation requires high pressure (whereas condensation polymerisation can happen at atmospheric pressure) / ORA ✓	1 (AO1.1)	**ALLOW** condensation polymerisation produces water (whereas addition polymerisation does not) **ALLOW** idea that addition polymerisation makes one product (whereas condensation polymerisation makes two products) / ORA **ALLOW** addition polymerisation requires (a monomer) with a C=C, but condensation polymerisation requires a -NH2 group and a-COOH group

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Question			Answer/Indicative content	Marks	Guidance
	c		Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. **Level 3 (5–6 marks)** Describes tests, the results, and identifies each of the three samples **AND** Includes correct balanced symbol equations for the reactions which occur. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Describes tests, the results, and identifies each of the three samples **OR** Describes a test and the result, to identify one of the three samples and attempts to identify the other two **AND** Includes a balanced symbol equation for the reaction which occurs. *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **Level 1 (1–2 marks)** Describes a test and the result, to identify one of the three samples. *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **0 marks** *No response or no response worthy of credit.*	6 (AO3 × 1.2) (AO3 × 2.2)	**AO1 Knowledge and understanding of alkanes, alkenes and acids** • Alkanes do not react with bromine water • Alkenes react with bromine water / bromine water is decolourised • Acids react with carbonates to give off carbon dioxide / fizzing observed **AO2 Application and knowledge of tests and results** • Add sodium carbonate (or any suitable carbonate) • Ethanoic acid effervesces • Pentane and pentene do not effervesce • ALLOW other suitable reactions, eg addition of a metal; ethanoic acid effervesces • ALLOW use of universal indicator to identify ethanoic acid • Add bromine water to separate samples of pentane and pentene and shake • With pentene bromine water changes from orange to colourless / bromine water is decolourised • With pentane and ethanoic acid bromine water stays orange **AO2.1 Application of knowledge and understanding to produce balanced symbol equations** $2CH_3COOH + Na_2CO_3 \rightarrow 2CH_3COONa + CO_2 + H_2O$ $C_5H_{10} + Br_2 \rightarrow C_5H_{10}Br_2$
			Total	11	

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