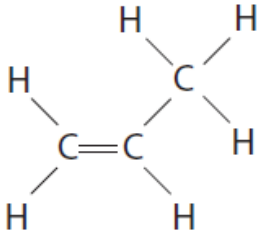
Question Number	Answer	Acceptable answers	Mark
1(a)	Any **two** from the following: • fuels can be in different states / specific example • different sized molecules(1) • different viscosities (1) • different boiling point / vaporisation temperatures (1) • different ease of ignition /some fuels more flammable (1) • different amounts of air / oxygen needed (1)	different {thickness/runniness} some burn easier than others	**(2)**

Question Number	Answer	Acceptable answers	Mark
1(b)	C		**(1)**

Question Number	Answer	Acceptable answers	Mark
1(c)	$2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$ • reactant formulae (1) • product formulae (1) • balancing correct formulae (1)	**Ignore** state symbols balancing multiples	**(3)**

Question Number		Indicative Content	Mark
QWC	***1(d)**	An evaluation including some of the following: **Advantages** • plenty of water / raw material • limited supplies of crude oil • hydrogen produces only water as waste • petrol produces carbon dioxide • carbon dioxide (emissions) may cause global warming **Disadvantages** • hydrogen has to be produced • requires energy / electricity to produce it • producing electricity from non-renewable sources produces carbon dioxide • expensive to produce • problems of storage of large volumes of flammable gas • stronger / heavier / bigger tanks needed • hydrogen a gas, petrol a liquid, hydrogen leaks more likely • limited outlets / conversion costs • shorter distance between refuelling	**(6)**
Level	**0**	No rewardable content	
1	**1 - 2**	• a limited description e.g. using petrol produces carbon dioxide which is a greenhouse gas. The only waste product from hydrogen is water • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy	
2	**3 - 4**	• a simple description e.g. hydrogen is produced by electrolysis of water but electricity is expensive and its production damages the environment unless it is produced from renewable resources. Hydrogen only produces water when it is burnt. • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy	
3	**5 - 6**	• a detailed description e.g. hydrogen is produced by electrolysis of water which is readily available but electricity is expensive and its production damages the environment unless it is produced from renewable resources. Hydrogen only produces water when it is burnt but petrol also produces carbon dioxide. Petrol is obtained from crude oil which is non-renewable. Hydrogen is a flammable gas which is difficult to store • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors	

Question Number	Answer	Acceptable answers	Mark
2(a)	C – CH_3CH_3		(1)

Question Number	Answer	Acceptable answers	Mark
2(b)		carbon skeleton correct including double bond (1) rest of molecule correct (1) allow CH_3	(2)

Question Number	Answer	Acceptable answers	Mark
2(c)	$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ • reactant formulae (1) • product formulae (1) • balancing of correct formulae (1)	accept multiples reject incorrect use of cases and non-subscripts	(3)

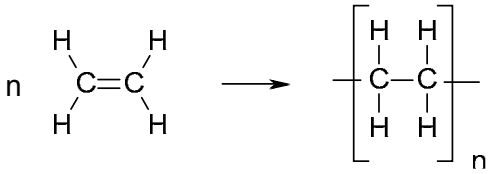
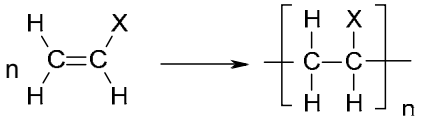
Question Number		Indicative content	Mark
QWC	***2(d)**	advantages • renewable / sustainable • more plants can be grown • crops use up carbon dioxide and produce oxygen when growing /photosynthesising • carbon neutral because the carbon produced during combustion is used when growing the plants • does not use up crude oil/non-renewable resources disadvantages • crops grown for bio-fuels use up land • land could otherwise be used to provide homes / less farmland available for growing food crops • lots of crops required to provide a small amount of bio-methane • bad season reduces availability • carbon emissions due to transport and production if qualified	(6)
Level	**0**	No rewardable content	
1	**1-**	• a limited description e.g. using bio-methane conserves fossil fuels and uses up carbon dioxide when plants are grown • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, puncuation and grammar are used with limited accuracy	
2	**3-**	• a simple description e.g. growing plants to produce bio-methane is sustainable and conserves fossil fuels but uses up lots of farm land which could be used to grow plants for food • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, puncuation and grammar are used with some accuracy	
3	**5 - 6**	• detailed description e.g growing plants remove carbon dioxide from the air during photosynthesis and conserves fossil fuels but lots of crops are required to make bio-methane and this uses up farm land which could otherwise be used to grow crops for food • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, puncuation and grammar are used with few errors	

Question Number	Answer	Acceptable answers	Mark
3(a)(i)	LPG, petrol and diesel		**(1)**

Question Number	Answer	Acceptable answers	Mark
3(a)(ii)	An explanation linking **two** of the following points • use of {fractions / large molecules / long chain hydrocarbons} of {less demand / less useful / lower value} / ORA (1) • to meet demand / small molecules needed (1)	**reject** useless use up excess kerosene / fuel oil and bitumen to make more petrol / LPG / alkenes	**(2)**

Question Number	Answer	Acceptable answers	Mark
3(b)	**B** the boiling point of the hydrocarbon increases		**(1)**

Question Number	Answer	Acceptable answers	Mark
3(c)(i)	C_2H_4		**(1)**

Question Number	Answer	Acceptable answers	Mark
3(c)(ii)	 (2) ignore n missing on polymer structure LHS (1) RHS (1) Allow:  (1) (where X could be CH_3 or similar)	n C_2H_4 → $(C_2H_4)_n$ (2) Note: Displayed formulae alkene with **C=C** polymer – single bonds between atoms with continuation bonds Allow any number of C_2H_4 on LHS **drawn out** with corresponding structure of polymer on RHS	**(2)**

Question Number	Answer	Acceptable answers	Mark
3(d)(i)	An explanation linking the following points • greenhouse gas / traps heat in atmosphere (1) • may lead to increasing global temperature / global warming (1)	traps infra-red radiation / **increases** greenhouse effect **reject** reference to UV melting {ice caps / glaciers} / climate change / sea-level rising / loss of habitats **reject** reference to ozone layer	**(2)**

Question Number	Answer	Acceptable answers	Mark
3(d)(ii)	An explanation linking **two** of the following points • sulfur dioxide formed (during combustion of fuel) (1) • sulfur dioxide {dissolves in rain / forms acid (rain)} (1) • an effect of acid rain e.g. harms {fish / plants / statues / buildings} / lowers pH of lakes (1)	SO_2 possible harm to human respiration	**(2)**

Question Number	Answer	Acceptable answers	Mark
4(a)(i)	A description including two of the following • dissolve the sugar/aqueous solution (1) • **warm**/ 25-40°C (1) • in absence of air / no oxygen/ anaerobic / attach airlock (1) • pH neutral / slightly acidic /4-7 • **sterile** conditions ignore any mention of pressure	ignore incorrect answers ignore heat / hot allow any temperature or range within 25-40 allowed ignore clean etc ignore 'optimum' {temp/pressure/pH}	**(2)**

Question Number	Answer	Acceptable answers	Mark
4(a)(ii)	**B** fractional distillation		**(1)**

Question Number	Answer	Acceptable answers	Mark
4(a)(iii)	$C_6H_{12}O_6 \rightarrow 2\ C_2H_5OH + 2\ CO_2$ (2) correct formulae (<u>with no others</u>) (1) balancing <u>the three</u> formulae (1) ignore state symbols	allow C_2H_6O/ CH_3CH_2OH for C_2H_5OH reject CO2 / CO^2 allow multiples	**(2)**

Question Number	Answer	Acceptable answers	Mark
4(b)(i)	Any two of • (reacts with) steam (1) • catalyst/phosphoric acid (1) • **<u>high temperature</u>** / 200°C - 450^{0}C (1) • **<u>high</u>** pressure/ 50-100 atm (1)	 allow reacts with water <u>ignore incorrect catalyst</u> ignore hot / heat	**(2)**

Question Number	Answer	Acceptable answers	Mark
4(b)(ii)	An explanation linking any three of LAND: country needs land for: farming / food / crops / homes /not enough land to grow sugar crop for fermentation (1) OIL SUPPLY: (reliable supply of) crude oil for **ethene** (1) SPEED: fermentation slow/batch; hydration continuous/ fast (1) PURITY: hydration makes {pure(r) ethanol / high concentration} (1) ATOM ECONOMY: higher atom economy for ethene process (1)	ignore incorrect responses ignore land needed for growing yeast ignore cheaper/ easier ignore yield	**(3)**

Question Number	Answer	Acceptable answers	Mark
5(a)	$C_2H_4 + H_2O \rightarrow C_2H_5OH$ C_2H_4 as **reactant** (1) rest of equation correct conditional on C_2H_4 as a reactant (1)	do not allow H2O / H^2O /lower case h/HOH allow C_2H_6O for ethanol ignore state symbols	**(2)**

Question Number	Answer	Acceptable answers	Mark
5(b)	A description including any two from • dissolve sugar in water /sugar solution (1) • (add) yeast (1) • warm / any temperature or range within 15 to 40°C (1) • anaerobic / {no/little} {air/oxygen} c enter the apparatus (1)	allow glucose solution ignore carbohydrate allow room temperature ignore heat unless specified temperature ignore optimum temperature do not allow just 'sealed container' ignore fractional distillation	**(2)**

Question Number	Answer	Acceptable answers	Mark
5(c)	An explanation linking Marking point 1 – sugar- one from • sugar obtained from {plants /crops/specific crop} (1) • (plenty of) land available to grow {plants /crops/specific crop} (for fermentation)(1) Marking point 2 - ethene • ethene obtained from {crude oil / fractional distillation /cracking} (1) Marking point 3 – cost/energy – one from • cannot afford to buy crude oil (1) • crude oil is too expensive (1) • more expensive to {use/buy/produce} ethene (1) • cheaper to use fermentation (1)	ignore answers that just repeat the information in the question ignore vague answers such as carbon neutral/environmentally friendly for marking point 1 **OR** 2, allow plants renewable/{crude oil/ethene} non-renewable (1) allow {little/no} {heat/energy} required for fermentation (1) allow {high temperature /high pressure} required for hydration of ethene (1)	**(3)**

Question Number	Answer	Acceptable answers	Mark
5(d)	An explanation including any two from • formulae differ by CH_2 • same general formula • all have {OH/hydroxyl group}	general formula is $C_nH_{2n+1}OH$ (2) allow increase by {CH_2/1 carbon **and** 2 hydrogens} do not allow incorrect general formula allow have similar **chemical** {reactions /properties}/same functional group/OH from an incorrect general formula ignore 'hydroxide'/all end in (an)ol /all alcohols ignore physical properties maximum (1) if hydroxide ions /carboxyl group	**(2)**