AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.7.1.2

Fractional distillation and petrochemicals

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**32**
Available paper years	**2007–2024**

Using this booklet

1. Booklet answer numbers match the question booklet.
2. Use the original question number within marking tables.
3. Examiner comments are included where available.

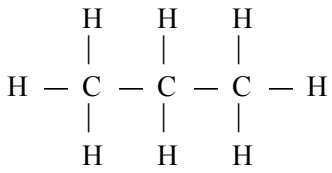
Name: _____ **Date:** _____

Where a precise marking extract is unavailable, the full source document is included in an appendix. Any missing mark scheme is explicitly identified.

4.7.1.2 Fractional distillation and petrochemicals

Answer 01 · Mark scheme January 2007 | CHY1H | Original Q5 | Legacy

Question 5

	answers	extra information	mark
(a)(i)	heat / evaporate the crude oil / change to gas or vapour	do **not** accept heat with catalyst	1
	cool / condense (hydrocarbons)	allow small molecules at top and / or large molecules at bottom	1
	at different temperatures / boiling points	if the answer describes cracking – no marks	1
(ii)	C_4H_{10}		1
(b)			1
(c)(i)	C_5 to C_8 fraction are fuels **or** easier to burn **or** petrol (fraction)	accept C_{21} to C_{24} fraction not useful as fuels do **not** accept produce more energy	1
(ii)	C_2H_4	do **not** accept C_4H_8	1

Continued on next page

4.7.1.2 Fractional distillation and petrochemicals

Answer 01 · Mark scheme

	answers	extra information	mark
(iii)	any **three** from: • use different / lighter crude oils • develop markets for low demand fractions • develop new techniques / equipment to use low demand fractions as fuels • cracking • convert low demand fractions to high demand fractions **or** bigger molecules to smaller molecules • develop alternative / bio fuels	do **not** accept price	3
total			10

4.7.1.2 Fractional distillation and petrochemicals

Answer 02 · Mark scheme March 2007 | CHY1A | Original Q3 | Legacy

Three	**A**	0	**3**
	B	5	**1**
	C	8	**2**
	D	70	**4**

Answer 03 · Mark scheme March 2007 | CHY1A | Original Q8 | Legacy

Eight	**3**	**2**	**3**	**3**

Answer 04 · Mark scheme June 2007 | CHY1A | Original Q6 | Legacy

Six	**4**	**4**	**3**	**3**

Answer 05 · Mark scheme November 2007 | CHY1A | Original Q1 | Legacy

One	**A**	condense	**2**
	B	vaporise	**1**
	C	viscous	**4**
	D	volatile	**3**

Answer 06 · Mark scheme January 2008 | CHY1H | Original Q6 | Legacy

No matching mark scheme was available in the supplied archive for this question.

Answer 07 · Mark scheme March 2008 | CHY1AP | Original Q2 | Legacy

Two	**A**	Hydrocarbons in the crude oil turn to vapour	**1**
	B	Hydrocarbons collected as gases	**2**
	C	Hydrocarbons with high boiling points	**3**
	D	Hydrocarbons condense to form liquids	**4**

	A	**B**	**C**	**D**

Answer 08 · Mark scheme March 2008 | CHY1AP | Original Q8 | Legacy

Eight	**2**	**2**	**1**	**1**

Answer 09 · Mark scheme June 2008 | CHY1AP | Original Q6 | Legacy

Six	**1**	**2**	**4**	**3**

4.7.1.2 Fractional distillation and petrochemicals

Answer 10 · Mark scheme March 2009 | CHY1AP | Original Q6 | Legacy

Six	**3**	**1**	**4**	**2**

Answer 11 · Mark scheme June 2009 | CHY1AP | Original Q5 | Legacy

Five	**3**	**3**	**1**	**2**

4.7.1.2 Fractional distillation and petrochemicals

Answer 12 · Mark scheme

Question 6

question	answers	extra information	mark
6(a)(i)	many ethene / molecules / monomers join to form a long hydrocarbon / chain / large molecule	accept double bonds open / break accept addition polymerisation ignore references to ethane correct equation gains **2** marks	1 1
6(a)(ii)	(can be deformed but) return to their original shape (when heated or cooled)	ignore 'it remembers its shape'	1
6(a)(iii)	cross links / extra bonds in PEX molecules / chains in PEX are held in position molecules / chains in PEX unable to slide past each other / move	it = PEX throughout accept inter-molecular bonds ignore inter-molecular forces accept rigid structure	1 1 1

Question 6 continues on the next page…

4.7.1.2 Fractional distillation and petrochemicals

Answer 12 · Mark scheme

June 2009 | CHY1H | Original Q6 | Legacy

CHY1H

Question 6 Continued

question	answers	extra information	mark
6(b)	any **four** from: • less (hydrocarbon) fuels used • less / no electrical energy used • reduce carbon / carbon dioxide emissions • reduce / no pollution by sulfur dioxide / acid rain • continuous process • conserve copper which is running out or only low-grade ores available • reduce the amount of solid waste rock that needs to be disposed • reduce the need to dig large holes (to extract copper ores)	ignore costs / sustainability / non-renewable allow less energy allow no electrolysis allow less global warming allow less / no transportation allow less waste allow less mining	4
Total			**10**

4.7.1.2 Fractional distillation and petrochemicals

Answer 13 · Mark scheme

November 2009 | CHY1AP | Original Q3 | Legacy

Three	**3**	**3**	**1**	**2**

4.7.1.2 Fractional distillation and petrochemicals

Answer 14 · Mark scheme

January 2010 | CHY1H | Original Q6 | Legacy

Question 6

question	answers	extra information	mark
6(a)	vaporise / evaporate different condensing points / temperatures	allow boil for vaporise accept condense at different levels ignore different size molecules or different densities mention of cracking = max **1** allow boils at different temperatures and condenses for **2** marks if no other marks awarded allow fractional distillation for **1** mark	1 1
6(b)(i)	3 (C_2H_4)	accept +C_4H_8	1
6(b)(ii)	(decane / naphtha / hydrocarbon) vaporise / evaporate (passed over) a catalyst / alumina / porous pot	allow crude oil allow boil for vaporise ignore other names of catalysts	1 1
6(c)	any **two** from: • alkanes / butane (molecules) do not have a (carbon carbon) double bond / are saturated / have (carbon carbon) single bonds • alkenes / ethene (molecules) have (carbon carbon) double bonds **or** are unsaturated • alkenes / ethene molecules are able to bond to other molecules	'they' must be clarified	2
6(d)	single bonds between carbon atoms the –CH_3 group appears on each pair of carbons on the 'chain'	— C – C — NB any double bonds = **0** marks	1 1
Total			**9**

4.7.1.2 Fractional distillation and petrochemicals

Answer 14 · Mark scheme January 2010 | CHY1H | Original Q6 | Legacy

CHY1H

Answer 15 · Mark scheme March 2010 | CHY1AP | Original Q5 | Legacy

Five	**3**	**3**	**1**	**3**

4.7.1.2 Fractional distillation and petrochemicals

Answer 16 · Mark scheme

June 2010 | CHY1H | Original Q6 | Legacy

Question 6

question	answers	extra information	mark
6(a)	it is a mixture (of hydrocarbons) **or** contains hydrocarbons with different boiling points	accept 'to separate (crude) oil (into fractions) **or** obtain the naphtha (fraction) accept to get useful products ignore removal of impurities	1
6(b)(i)	heat / vaporise	mention of hydrogen = max **1** accept thermal (decomposition) for heat allow boil do not allow temperatures below 100°C ignore steam	1
	catalyst	allow alumina / porous pot ignore other catalysts	1
6(b)(ii)	4 × C – H **and** C = C	ignore brackets with or without an 'n' before them do not allow poly(ethene)	1

Question 6 continues on the next page

4.7.1.2 Fractional distillation and petrochemicals

Answer 16 · Mark scheme

question	answers	extra information	mark
6(c)	any **four** from: **must** be at least **one** advantage and **one** disadvantage for all four marks <u>crops</u> advantages eg: • renewable (resource) / sustainable • low / less energy / fuel needed for process **or** lower temperature [ignore heat or quoted temperatures] • can use waste plant / crop material • carbon neutral • low safety risk (processes) • low technology disadvantages eg: • batch process / process is slow • many steps in the process • ethanol is impure / may contain water • food shortages • need very large areas of (arable) land to grow crops **or** can only grow in certain areas / climates • destruction of woodland / habitat • slow growth of crops • labour intensive a conclusion with a reasoned argument based on	ignore ideas about carbon dioxide formation / photosynthesis or cost / economics / environmentally friendly candidates are only awarded **1** mark if they use equivalent pairs of bulleted points <u>crude oil</u> disadvantages eg: • *non*-renewable (resource) / finite / running out • high / more energy needed for process **or** higher temperature • not carbon neutral **or** releases locked up carbon • high safety risk (process) • high technology • risk of major oil spillage • can be used to make other products advantages eg: • continuous process / process is fast • few steps in the process • ethanol is pure • ‘conserves’ food • can accept reverse arguments there must be at least one advantage and one disadvantage, however, a	4

4.7.1.2 Fractional distillation and petrochemicals

Answer 16 · Mark scheme

	valid advantages **and** disadvantages	matched pair, although only awarded one mark would allow the conclusion mark to be awarded	1
Total			**9**

4.7.1.2 Fractional distillation and petrochemicals

Answer 17 · Mark scheme

November 2010 | CHY1AP | Original Q7 | Legacy

Seven	**2**	**3**	**1**	**4**

4.7.1.2 Fractional distillation and petrochemicals

Answer 18 · Mark scheme

January 2011 | CHY1H | Original Q2 | Legacy

Question 2

question	answers	extra information	mark
2(a)	crude oil / it is evaporated / vaporised vapours / gases / fractions cool and condense (different) vapours / gases / fractions (condense) at different temperatures	ignore heated accept named fraction(s) accept (different) vapours / gases / fractions have different boiling points max **2** marks for description of laboratory method **or** mention of cracking	1 1 1
2(b)(i)	any **one** from: • range of boiling points • range of carbon atoms		1
2(b)(ii)	greater the number (of carbon atoms) the higher the boiling point	do **not** accept molecules / particles	1
2(c)(i)	burning / combustion	allow oxidation / redox	1
2(c)(ii)	any **two** from: • cracking / (thermal) decomposition • heat / vaporise • catalyst / aluminium oxide	reaction with hydrogen gains max of **1** mark only allow porous pot ignore names of other catalysts	2
Total			**8**

4.7.1.2 Fractional distillation and petrochemicals

Answer 18 · Mark scheme January 2011 | CHY1H | Original Q2 | Legacy

CHY1H

Answer 19 · Mark scheme March 2011 | CHY1AP | Original Q5 | Legacy

Five	**4**	**3**	**2**	**1**

Answer 20 · Mark scheme June 2011 | CHY1AP | Original Q4 | Legacy

Four	**4**	**2**	**2**	**2**

Answer 21 · Mark scheme November 2011 | CHY1AP | Original Q2 | Legacy

Two	**A** Hydrocarbons turn to vapour			**1**
	B Hydrocarbons cool			**3**
	C Hydrocarbons with low boiling points			**2**
	D Hydrocarbons condense to form liquids			**4**
	A	**B**	**C**	**D**

4.7.1.2 Fractional distillation and petrochemicals

Answer 22 · Mark scheme

January 2012 | CH1HP | Original Q7 | Legacy

Question 7

question	answers	extra information	mark
7(a)(i)	$C_{11}H_{24}$ it does not have a (carbon carbon) double bond **or** it has only single (carbon carbon) bonds.	 linked to first mark point accept it is an alkane **or** it is (a) saturated (hydrocarbon) accept converse statement	1 1
7(a)(ii)	ethene 4 x single C-H bonds 1 x double C=C bond ethanol 5 x single C-H bonds 1 x single C-C bond	 if additional bonds are given on water molecule then both ethene and ethanol must be correct for **1** mark	1 1
7(b)	Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information on page 2, and apply a 'best-fit' approach to the marking.		6

0 marks	Level 1 (1-2 marks)	Level 2 (3-4 marks)	Level 3 (5-6 marks)
No relevant content.	There is a simple description of advantages **and / or** disadvantages of environmental or economic or social factors why Brazil should produce ethanol from crude oil or from sugar cane. There is a weak or no conclusion.	There a clear description of advantages **and /or** disadvantages of environmental **and** economic or social factors why Brazil should produce ethanol from crude oil or from sugar cane. There is a conclusion based on the factors described.	There is a detailed description of the advantages **and / or** disadvantages of environmental **and** economic or social factors why Brazil should produce ethanol from crude oil or from sugar cane, considering both processes. There is a justified conclusion.

examples of the chemistry points made in the response			
Sugar cane Advantage **Environmental:** • it is renewable / sustainable • it grows absorbing CO_2 which makes it 'carbon neutral' **Economical / Social:** • growing it is labour intensive so provides (local, rural) employment • low amount of energy / fuel needed so process costs are low • simple / low technology process so process / investment costs are low Disadvantage **Environmental:** • destruction of habitats / biodiversity to provide land to grow sugar cane **Economical / Social:** • land should be used to grow food (shortage / cost / population increase) • growing or process is slow / batch / unreliable (crop failure)		**Crude oil** Disadvantage **Environmental:** • it is non-renewable / will run out • it contains 'locked up' carbon / CO_2 **or** when released increases global warming • destruction of marine habitats caused by accidents / spillages **Economical / Social:** • process requires small number of trained workers • high amount of energy / fuel needed so process costs are high • complex / high tech process so process / investment costs are high Advantage **Environmental:** • does not use land as it is offshore **Economical / Social:** • no loss of food crops • extracting or process is fast / continuous / reliable	
Total			**10**

UMS Conversion Calculator www.aqa.org.uk/umsconversion

4.7.1.2 Fractional distillation and petrochemicals

Answer 23 · Mark scheme

June 2012 | CH1HP | Original Q3 | Legacy

Question 3

question	answers	extra information	mark
3(a)(i)	(1) 5 3 (6) 4 2	all numbers in the correct order gains both marks any two numbers in the correct position gains **1** mark	2
3(a)(ii)	water	ignore formula if correct name given accept hydrogen oxide allow H_2O	1
	carbon dioxide	allow CO_2 accept carbon monoxide / CO **or** carbon / C	1

Question 3 continues on the next page . . .

CH1HP

Question 3 cont'd…

question	answers	extra information	mark
3(b)	Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. **Examiners should also refer to the information on page 2**, and apply a 'best-fit' approach to the marking.		6

0 marks	Level 1 (1-2 marks)	Level 2 (3-4 marks)	Level 3 (5-6 marks)
No relevant content.	There is a **basic** description of at least one advantage **or** one disadvantage caused by using plastic shopping bags made from poly(ethene).	There is a **clear** description of both an advantage **and** a disadvantage caused by using plastic shopping bags made from poly(ethene).	There is a **detailed** description of both advantages **and** disadvantages caused by using plastic shopping bags made from poly(ethene).

examples of the chemistry/social points made in the response:
ignore cost unqualified

Advantages:

- Simple properties eg strong / low density / water resistant
- Bags can be reused (for shopping) **or** another specified use eg bin liners
- Money charged for bags can go to good causes **or** encourage reuse
- Poly(ethene) bags can be recycled eg made into milk bottle crates
- Poly(ethene) bags can be burned to provide heat for buildings/generation of electricity
- New bags are now made that can biodegrade

Disadvantages:

- (Older) bags can take many years to biodegrade
- There is a shortage of landfill space
- Bags are made from (crude) oil which is a non-renewable resource/running out
- Large amounts of energy/fuel are used for the production of poly(ethene)
- Production of poly(ethene) releases carbon dioxide/causes global warming
- Specified issue caused by litter eg visual pollution or effect on wildlife
- Burning bags release carbon dioxide / causes global warming

Total			10

4.7.1.2 Fractional distillation and petrochemicals

Answer 23 · Mark scheme

June 2012 | CH1HP | Original Q3 | Legacy

CH1HP

4.7.1.2 Fractional distillation and petrochemicals

Answer 24 · Mark scheme

January 2013 | CH1HP | Original Q3 | Legacy

question	answers	extra information	mark
3(a)	heat to vaporise (the crude oil)	do **not** accept cracking / burning	1
	vapours condense		1
	at different temperatures	allow they have different boiling points	1
3(b)	(alkanes) are hydrocarbons **or** are compounds of hydrogen and carbon only		1
	alkanes are saturated **or** have only (carbon-carbon) single bonds	accept have no (carbon-carbon) double bonds accept general formula is C_nH_{2n+2} for **2** marks	1

CH1HP

question		mark
3(c) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response.		6

0 marks	Level 1 (1-2 marks)	Level 2 (3-4 marks)	Level 3 (5-6 marks)
No relevant content.	There is a basic description of at least one advantage or one disadvantage of extracting petroleum products from oil sands.	There is a clear description of an advantage and a disadvantage of extracting petroleum products from oil sands.	There is a detailed description of both advantages and disadvantages of extracting petroleum products from oil sands.

examples of the chemistry/environmental/economic/social points made in the response

Advantages:

- the oil sands are needed because crude oil is running out
- this crude oil is needed because demand is increasing
- the oil sands contain a large amount of crude oil
- the oil sands could improve Canada's economy
- the oil sands provide employment for a lot of people
- the trees / forest are used for wood products / fuel

Disadvantages:

- destruction of environment / habitats
- fewer trees / forests to absorb carbon dioxide
- specified pollution, for example, visual, noise, atmospheric (including dust), water (including river or drinking) with cause, e.g. gases/particulates from burning diesel
- large amounts of methane(natural gas) are used to provide energy
- energy / fuel needed for cracking and fractional distillation
- burning fuel releases carbon dioxide
- crude oil / natural gas contains locked up carbon
- crude oil is non-renewable

Total			**11**

4.7.1.2 Fractional distillation and petrochemicals

Answer 24 · Mark scheme

January 2013 | CH1HP | Original Q3 | Legacy

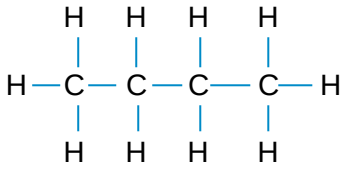
CH1HP

4.7.1.2 Fractional distillation and petrochemicals

Answer 25 · Mark scheme

June 2016 | CH1HP | Original Q2 | Legacy

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
2(a)(i)	high temperature catalyst or steam	allow heating / hot / 250-900 °C allow named catalyst eg zeolite, Al_2O_3, silica, ceramic allow in the absence of air / oxygen ignore any references to pressure	1 1	AO1 1.5.1a
2(a)(ii)	colourless	allow decolourised ignore clear / discoloured	1	AO1 1.5.1d
2(a)(iii)			1	AO2 1.4.2a
2(b)(i)	20.3(0) (kJ)	if answer incorrect allow **1** mark for 24.36/1.2	2	AO2 1.4.3b
2(b)(ii)	use a lid reduce energy / heat loss	allow insulate beaker or use draught shield ignore references to thermometer or repeats or distance of flame or loss of water vapour allow stir (1) to distribute energy / heat (1) allow use a metal can (1) as it's a better conductor (1)	1 1	AO3 4.3.2b/c/d
2(b)(iii)	carbon/soot (produced by) incomplete combustion	ignore tar, smoke allow from a limited supply of oxygen/air	1 1	AO1+AO2 1.4.3a/b
2(b)(iv)	hexane gives out the greatest energy (per 1.0 g) hexane produces the least smoke / carbon / soot	ignore more energy allow has the cleanest flame ignore less smoke / carbon / soot	1 1	AO3 1.4.2c; 1.4.3a/b

QWC Mark Scheme

<table>
<tr><th>Question</th><th>Answers</th><th>Extra information</th><th>Mark</th><th>AO / Spec. Ref.</th></tr>
<tr><td>2(c)</td><td></td><td></td><td>6</td><td rowspan="6">AO1+AO2+ AO3 1.1.3b; 1.4.1b/c; 1.4.3a/b/c/d ;1.7.2h/i</td></tr>
<tr><td colspan="4">Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information on page 5 and apply a ‘best-fit’ approach to the marking.</td></tr>
<tr><td colspan="4"><table>
<tr><th>0 marks</th><th>Level 1 (1–2 marks)</th><th>Level 2 (3–4 marks)</th><th>Level 3 (5–6 marks)</th></tr>
<tr><td>No relevant content</td><td>Statements made from the information that indicate whether at least one statement is an advantage or a disadvantage
or
a linked advantage or disadvantage</td><td>Descriptions of an advantage and a disadvantage with some use of their knowledge to add value.</td><td>Descriptions of advantages and disadvantages that are linked to their own knowledge.</td></tr>
</table></td></tr>
<tr><td colspan="4">Examples of the added value statements and links made in the response could include:
Note that link words are in bold; links can be either way round.
Accept reverse arguments and ignore cost throughout.

Advantages of using hydrogen:
• Combustion only produces water so causes no pollution
• Combustion does not produce carbon dioxide so this does not contribute to global warming or climate change
• Combustion does not produce sulfur dioxide so this does not contribute to acid rain
• Incomplete combustion of petrol produces carbon monoxide that is toxic
• Incomplete combustion of petrol produces particulates that contribute to global dimming
• Petrol comes from a non-renewable resource but there are renewable/other methods of producing hydrogen
• Hydrogen releases more energy so less fuel needed or more efficient

Disadvantages of using hydrogen:
• Hydrogen is a gas so is difficult to store or transfer to vehicles
• Hydrogen gas is very flammable so leaks cause a greater risk of explosion
• Most hydrogen is produced from fossil fuels which are running out
• Cannot be used in existing car engines so modification / development or replacement is needed
• Lack of filling stations so difficult to refuel your vehicle</td></tr>
</table>

Total			18

4.7.1.2 Fractional distillation and petrochemicals

Answer 26 · Mark scheme

June 2016 | CH1HP | Original Q4 | Legacy

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
4(a)(i)	add yeast		1	AO1
	and ferment **or** by fermentation	allow in a warm place **or** temperatures within the range 20-45°C **or** with an airlock/absence of air	1	1.5.3b
4(a)(ii)	by hydration with steam	allow react with/addition of steam	1	AO1 1.5.3a
	in the presence of a catalyst	ignore names of catalyst and any other conditions allow a correctly named catalyst e.g. phosphoric acid	1	
4(b)		"it" = crude oil		AO1+AO2 1.4; 1.4.3e
		allow the link pairs in either order		
		ignore cost throughout		
	Advantages			
	crude oil is reliable source of ethanol	**or** produces pure ethanol	1	
	because it is not affected by weather conditions or plant growth is affected by weather condition	so purification/separation is not required	1	
	or does not cause food shortages	**or** quick / continuous process		
	because farmland not used	whereas fermentation takes a long time/is a batch process		
	Disadvantages			
	crude oil is a non-renewable / finite resource	allow production of ethanol from crude oil uses more energy or a higher temperature or burns more fossil fuels	1	
	so it will run out / plants grow again	so releases more carbon dioxide or causes global warming (or an effect)	1	

4.7.1.2 Fractional distillation and petrochemicals

Answer 26 · Mark scheme

June 2016 | CH1HP | Original Q4 | Legacy

4(c)	heat (the mixture) ethanol has a lower boiling point than water **or** more ethanol than water vaporises **or** ethanol evaporates first or when the temperature reaches 78°C condense (the vapour)	 allow ethanol and water boil at different temperatures allow condense at different temperatures for the last two marking points if no other mark is awarded, allow repeat distillation or use fractional distillation apparatus for 1 mark	1 1 1	AO2 1.4.1 b; 1.5.3 b
Total			**11**	

4.7.1.2 Fractional distillation and petrochemicals

Answer 27 · Mark scheme June 2017 | CH1HP | Original Q5 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
5(a)(i)	any **one** from: • all these gases / hydrogen / methane / water vapour / ammonia may not have been in the Earth's early atmosphere • the conditions of the reaction were not like those on early Earth • many different amino acids are needed for life processes	ignore no proof / evidence **or** no one was there **or** references to religion **or** meteorites / comets. allow nobody knows what was in the Earth's early atmosphere allow very little (0.5%) in the Earth's early atmosphere allow nobody knows what the conditions were on early Earth allow only simple amino acids **/** glycine were produced	1	**AO3** 1.7.2d;e
5(a)(ii)	any **three** from: • used by plants / algae **or** for photosynthesis • absorbed / dissolved by oceans • locked up in sedimentary rocks / carbonates / limestone • locked up in fossil fuels	ignore volcanoes allow stored in for locked up allow stored in for locked up mention of respiration: maximum two marks	3	**AO1** 1.7.2f;g;h
5(b)(i)	helium / He **and** neon / Ne	both needed	1	**AO2** 1.7.2j

4.7.1.2 Fractional distillation and petrochemicals

Answer 27 · Mark scheme

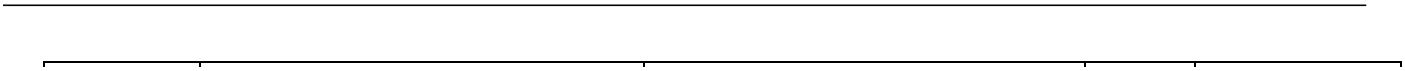
June 2017 | CH1HP | Original Q5 | Legacy

5(b)(ii)	carbon dioxide would be solid **or** would block pipes	ignore freezes allow forms dry ice	1	**AO3** 1.7.2j
5(b)(iii)	 the other gas is argon / Ar because they have similar boiling points **or** there is only 3 °C difference in boiling points	mark independently	 1 1	**AO2** 1.7.2j
5(c)	 **stage 1:** oxygen reacts with carbon so carbon content decreases **or** carbon forms carbon dioxide **stage 2:** (other metals added) to form an alloy so the steel has a specific property / specific use	mark independently allow because cast iron is (too) brittle allow to stop layers sliding allow because pure iron is (too) soft	 1 1 1 1	**AO1** **AO2** 1.3.2a;b;c
Total			**12**	

4.7.1.2 Fractional distillation and petrochemicals

Answer 27 · Mark scheme

June 2017 | CH1HP | Original Q5 | Legacy



4.7.1.2 Fractional distillation and petrochemicals

Answer 28 · Mark scheme

June 2019 | 8462/2H | Original Q1

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	a temperature between 400 (°C) and 500 (°C) inclusive	allow a temperature range entirely within 400 (°C) and 500 (°C) inclusive	1	AO3 4.7.1.2
01.2	(diesel oil has a) lower boiling point / range than heavy fuel oil (but diesel oil has a) higher boiling point / range than kerosene	ignore quoted values for boiling points ignore references to melting points ignore references to intermolecular forces or chain length allow temperature of vaporisation / condensation for boiling points throughout allow the boiling range (of diesel oil) is between those of heavy fuel oil and kerosene for **2** marks.	1 1	AO2 4.7.1.2
01.3	any **two** from: • (too) viscous • not (very) flammable • boiling point (too) high	ignore references to cost allow references to difficulty of flow allow references to difficulty of ignition / burning do **not** accept bitumen takes more energy to burn allow not (very) volatile	2	AO2 4.7.1.3
01.4	C_6H_{14}		1	AO2 4.7.1.1

4.7.1.2 Fractional distillation and petrochemicals

Answer 28 · Mark scheme

June 2019 | 8462/2H | Original Q1

01.5	high temperature any **one** from: • steam • catalyst	ignore references to pressure allow a quoted temperature above 320 °C ignore hot / heat ignore name of catalyst allow alumina allow aluminium oxide allow porous pot allow zeolite	1 1	AO1 4.7.1.4
01.6	greater demand (for smaller molecules) any **one** from: (because smaller molecules are) • more useful • better fuels • used to make alkenes • used to make polymers	allow converse argument for larger molecules allow a named polymer ignore plastics	1 1	AO1 4.7.1.4
01.7	C_3H_6		1	AO2 4.1.1.1 4.7.1.4
Total			**11**	

Answer 29 · Mark scheme

November 2021 | 8462/2H | Original Q2

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	all five points plotted correctly	allow a tolerance of ± ½ a small square allow **1** mark for three or four points plotted correctly	2	AO2 4.7.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	98 (°C)	allow a value in the range 92 to 104 (°C)	1	AO3 4.7.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	the boiling point is lower than 0 (°C)	allow the graph cannot show negative temperatures	1	AO3 4.7.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	gas	allow (g)	1	AO2 4.2.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.5	C_9H_{20}		1	AO2 4.7.1.1

Question 2 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.6	(nonane) has a higher boiling point	allow converse for the other alkanes	1	AO2 4.7.1.2
	(so nonane) condenses where the column has a higher temperature	allow (so nonane) collects where the column has a higher temperature	1	

Total			**8**

4.7.1.2 Fractional distillation and petrochemicals

Answer 30 · Mark scheme

November 2021 | 8462/2H | Original Q10

Question 10

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.1	(steam / catalytic) cracking	allow thermal decomposition	1	AO1 4.7.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.2	high temperature steam / catalyst	allow a temperature in the range 300 – 900 °C	1 1	AO1 4.7.1.4

Question 10 continued

Question	Answers	Mark	AO/ Spec. Ref
10.3	**Level 3:** Relevant points (reasons/causes) are identified, given in detail and logically linked to form a clear account.	5–6	AO2 4.6.1.3 4.6.2.4 4.6.2.6 4.6.2.7 4.7.2.2
	Level 2: Relevant points (reasons/causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.	3–4	
	Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.	1–2	
	No relevant content	0	
	Indicative content **Rate** • higher temperature gives higher rate • because more frequent collisions • higher pressure gives higher rate • because more frequent collisions • a catalyst can be used to give a higher rate • because the activation energy is reduced **Yield** • higher temperature gives lower yield • because the reaction is exothermic • higher pressure gives higher yield • because there are more molecules on left hand side **Other factors** • higher temperatures use more energy so costs increase • higher pressures use more energy so costs increase • higher pressures require stronger reaction vessels so costs increase **Compromise** • chosen temperature is a compromise between rate and yield • chosen temperature is a compromise between rate and cost (of energy used) • chosen pressure is a compromise between rate and cost (of energy used) • chosen pressure is a compromise between yield and cost (of energy used)		

Question 10 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.4	fermentation	allow ferment(ing)	1	AO1 4.7.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.5	warm anaerobic (conditions)	allow a value in the range 25 °C to 45 °C allow without oxygen / air	1 1	AO2 4.7.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.6	(conversion) 200 km = 200,000 m (moles =) $\frac{200000 \times 1.95 \text{ (mol)}}{1300}$ = 300 (mol)	 allow correct use of incorrect / no conversion for distance	1 1 1	AO2 4.7.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.7	$C_4H_9OH + 6\,O_2 \rightarrow 4\,CO_2 + 5\,H_2O$	allow $C_4H_{10}O$ for C_4H_9OH allow multiples allow **1** mark for $C_4H_9OH + O_2 \rightarrow CO_2 + H_2O$ with incorrect / no multipliers ignore state symbols	2	AO2 4.1.1.1 4.3.1.1 4.7.2.3

Total			17

4.7.1.2 Fractional distillation and petrochemicals

Answer 31 · Mark scheme

June 2022 | 8462/2H | Original Q4

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	crude oil is heated to vaporise (the hydrocarbons)		1	AO1 AO2 4.7.1.2
	there is a temperature gradient in the (fractionating) column	allow a (fractionating) column is cooler going up	1	
	(so) the gases condense at different levels **or** (so) lubricating oil condenses below naphtha (and petroleum gases do not condense)		1	
	(because of their) different boiling points		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	detergents		1	AO1 4.7.1.2
	solvents		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	$C_9H_{20} + 14\,O_2 \rightarrow 9\,CO_2 + 10\,H_2O$	allow multiples allow **1** mark for $C_9H_{20} + O_2 \rightarrow CO_2 + H_2O$ with incorrect / no multipliers	2	AO2 4.1.1.1 4.3.1.1 4.7.1.3

4.7.1.2 Fractional distillation and petrochemicals

Answer 31 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	(when burned sulfur impurities) produce sulfur dioxide		1	AO1 4.9.3.1 4.9.3.2
	(which) causes acid rain **or** (which) causes respiratory problems	allow specified effects of acid rain allow specified respiratory problems	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.5		allow converse statements		AO2 4.7.1.3
	as molecular size increases viscosity increases		1	
	(and) heavy fuel oil has larger molecules (than kerosene)		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.6	(name of process) cracking		1	AO1 4.7.1.4
	(conditions) high temperature	allow a stated temperature in the range 300 to 900 °C	1	
	steam / catalyst		1	

4.7.1.2 Fractional distillation and petrochemicals

Answer 31 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.7	C_7H_{14} and C_8H_{16}		1	AO2 4.7.1.4 4.7.2.1

Total Question 4		**16**

4.7.1.2 Fractional distillation and petrochemicals

Answer 32 · Mark scheme

June 2024 | 8462/2H | Original Q5

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	high temperatures (cause) nitrogen (from air) and oxygen (from air) to react	ignore pressure	1 1	AO1 4.9.3.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2		ignore references to water vapour		
	less climate change	allow less global warming allow an effect of climate change for climate change	1	AO1
	(because) no carbon dioxide (produced)		1	AO3 4.7.1.3 4.9.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	more oxides of nitrogen (produced)		1	AO1
	(so) more acid rain **or** (so) more respiratory problems	allow an effect of acid rain for acid rain allow a named respiratory problem for respiratory problems MP2 cannot be linked to an incorrect gas from MP1	1	AO3 4.7.1.3 4.9.3.2

4.7.1.2 Fractional distillation and petrochemicals

Answer 32 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	(volume of oxygen = $3.50 \times \frac{1}{2}$ =) 1.75 (dm^3)		1	AO2 4.3.5 4.9.1.1
	(volume of air =) $1.75 \times \frac{100}{20}$	allow correct use of an incorrectly determined volume of oxygen	1	
	= 8.75 (dm^3)		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.5	there is a temperature gradient in the (fractionating) column	allow the (fractionating) column gets cooler going up	1	AO1
	(so) kerosene condenses	allow (so) the hydrocarbons / vapours condense	1	AO2
	at the level (in the column) corresponding to kerosene's boiling point (range)	allow at the level (in the column) corresponding to the boiling point of the hydrocarbons / vapours for the award of 2 marks for MP2 and MP3, a reference to kerosene must be made	1	AO1 4.7.1.2

Total Question 5	12

4.7.1.2 Fractional distillation and petrochemicals

Answer 29 · Examiner comments November 2021 | 8462/2H | Original Q2

Question 2 (standard demand)

02.1 This was very well attempted and three quarters of students gained both marks.

02.2 Most students were able to determine the boiling point of heptane.

02.3 Two thirds of students identified that the *y*-axis did not fall below 0°C.

02.4 Just over two-thirds of students identified the gaseous nature of butane at 20°C.

02.5 More than three-quarters of students were able to apply the general formula to nonane.

02.6 Many students were able to state that nonane has a higher boiling point than the other alkanes in the table, but far fewer could use this to explain the condensing location in the column.

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Answer 30 · Examiner comments November 2021 | 8462/2H | Original Q10

Question 10 (standard, standard / high and high demand)

10.2 More than two thirds of students knew one condition (high temperature) and more than one third knew two.

10.3 There was a very wide range of marks but many did not score above Level 1. The main failure to reach Level 2 was that the question focuses on economics so that an answer which fails to mention energy, cost or a compromise in reaction conditions does not meet the level descriptor for Level 2. Similarly, the requirements for Level 3 were not usually met if the references did not mention the impact of reaction conditions on both rate and yield. Only a handful of students gave a Level 3 answer.

Answer 30 · Examiner comments

10.4 Fermentation was well known.

10.5 Around half of students scored one mark by extending their knowledge of fermentation to this unfamiliar context, 'warm' was seen much more often than 'anaerobic'.

10.6 This was completely correct in the responses of nearly half of students. Where a mark was not obtained, this was usually caused by a failure to convert kilometres to metres.

10.7 A challenging concluding equation with no scaffolding which students found difficult.

Concluding Remarks

There is still some evidence that command words are misunderstood or ignored. This limits the marks awarded, especially in extended response questions. This is particularly true where a command word demands a reasoned judgement.

Students seemed well prepared for questions based on Organic Chemistry and Chemistry of the Atmosphere. In this series they seemed less equipped to deal with Chemical Analysis, Rate of Reaction and some aspects of Using Resources.

There were a number of instances of key reagents, techniques and colour changes still not being well known.

4.7.1.2 Fractional distillation and petrochemicals

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website.

4.7.1.2 Fractional distillation and petrochemicals

Answer 31 · Examiner comments

June 2022 | 8462/2H | Original Q4

Question 4 (Standard, standard/high and high demand)

04.1 The vast majority of students wrote detailed answers to this question and the full range of marks was awarded although relatively few answers were awarded full marks. About 1 in 10 students scored all four marks, while a quarter scored three. Students often neglected to state the crude oil must be heated to begin the separation process. Some students failed to score the second marking point in the mark scheme because their description of a temperature gradient was not in the context of gases rising through a fractionating column or fractionating tower. A handful of students illustrated this idea by referring to a labelled diagram.

The idea of fractions collecting at different levels in the fractionating column was well understood but many described the collection of fractions without mentioning condensing and so could not access this mark. Some students incorrectly suggested that petroleum gases would condense at the top of the column. The idea that the separation of crude oil is based on differences in boiling points was an accessible mark but many failed to mention boiling points or simply quoted boiling point ranges from the table.

04.2 Just over a third of students were able to score both of the marks available in this multiple choice question. This suggests that the feedstock concept in the specification is not well known.

04.3 Nearly half of the students scored both marks by being able to write a correctly balanced equation for the combustion of nonane. Many were able to pick up one mark for writing the correct formulae for oxygen, carbon dioxide and water. Some students failed to score any marks because they included hydrocarbon molecules in their equation, perhaps confusing this combustion reaction with cracking. Students should be advised to take care when writing numbers in equations. A quickly written 14 sometimes looked like 19 and 19 H_2O was occasionally written by students who had double-counted the oxygen atoms in water. Similarly, excessively large subscript numbers and excessively small capital letters (especially O) are likely not to gain credit.

4.7.1.2 Fractional distillation and petrochemicals

Answer 31 · Examiner comments

June 2022 | 8462/2H | Original Q4

04.4 This question was generally well answered but some students stated that the combustion of sulfur would cause damage to the car engine while others appeared to confuse the effects of burning sulfur with a lack of oxygen and named the products of incomplete combustion. Some seemed to think that sulfur would be released into the air as a toxic gas but these students could still be credited for a description of the problems caused by sulfur dioxide. These problems were well known; acid rain or respiratory problems were common answers. Around 30% of the students gained both marks.

04.5 Most students scored at least one mark for this question, usually by giving a statement that heavy fuel oil has larger molecules. A relatively small proportion scored the first marking point in the mark scheme for stating the general relationship between molecular size and viscosity. A statement about heavy fuel oil being more viscous than kerosene was insufficient for credit because this repeated information given in the question. Nearly 30% of the students gained both of the marks.

04.6 The full range of marks was awarded. The name of the process was well known but a large proportion of students failed to mention either the high temperature or the use of steam or a catalyst and so gained only two of the three marks. Marks were awarded independently so even students who could not name the process could pick up two marks for correctly describing the conditions. Nearly half of the students gained all three marks here.

4.7.1.2 Fractional distillation and petrochemicals

Answer 32 · Examiner comments June 2024 | 8462/2H | Original Q5

Question 5 (standard and standard / high demand)

05.1 This was not well understood. Some students knew that nitrogen and oxygen were reacting together. However, some thought that nitrogen came from the fuel and some that oxygen is a product of combustion. Only a minority mentioned high temperature although many said, 'very hot'. About 15% scored both marks.

05.2 Some students stated that no carbon dioxide is produced when hydrogen burns. However, many simply described what carbon dioxide does to the environment, rather than stating that burning hydrogen instead of methane **reduces** the rate of climate change. Many referred to the greenhouse effect without referencing the effect on the environment, ie climate change. Around 40% scored both marks.

05.3 Most realised that increased levels of nitrogen oxides would be produced. Although there were some good descriptions of what nitrogen oxides do to the environment, very few said that those effects would be increased by burning hydrogen instead of methane, ie **more** acid rain etc. Many thought that nitrogen oxides are greenhouse gases rather than a precursor of acid rain. Some suggested more nitrogen was released to the atmosphere, rather than oxides of nitrogen. Less than 10% of students scored both marks, although more than half scored one.

05.4 Over one-third of students gained all three marks. However, some students appeared to believe that the other 80% of the air was hydrogen. Some tried to involve the relative atomic masses, even though these were not provided. A few unnecessarily converted the volume of hydrogen to moles and then the moles of oxygen to volume, not realising that the mole ratio is the volume ratio for gases. This did score full marks if correct.

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Answer 32 · Examiner comments June 2024 | 8462/2H | Original Q5

05.5 Most scored the mark for kerosene, or the vapours condensing, and many also described the temperature gradient correctly. Far fewer scored the mark for linking the height in the column to the boiling point and the condensation of kerosene. Most did not mention the height or level in the column, while others seem to think that a vapour only condenses at a temperature below, rather than at, its boiling point. A few students thought that kerosene was either a product of cracking, or a polymer. Just over 10% scored all the marks.