AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.10.4.1

The Haber process

Mark schemes and examiner comments

Tier	**Foundation**
Question groups	**18**
Available paper years	**2008–2025**

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.

4.10.4.1 The Haber process

Answer 01 · Mark scheme

Question 5

question	answers	extra information	mark
(a)(i)	nitrogen + hydrogen → ammonia	accept full correct balanced equation	1
(a)(ii)	reversible (reaction) (owtte)	do **not** allow just 'backwards' (unqualified)	1
(a)(iii)	catalyst / speed up reaction	accept to lower activation energy	1
(a)(iv)	boiling point		1
(a)(v)	recycled (owtte)		1
(b)(i)	used to make explosives (owtte) used to make medicines (owtte)		1
(b)(ii)	used to make fertilisers (owtte)		1
(c)(i)	sensible answers such as provides workers (owtte) good transport links	ignore reference to raw materials	1

continued…

4.10.4.1 The Haber process

CHY2F

Question 5 continued…

question	answers	extra information	mark
(c)(ii)	sensible idea		1
	linked reason		1
	idea	linked reason	
	eg escape of chemicals /fumes /waste gases / pollution	harmful to health / environmental damage owtte do **not** allow harmful / damage / smell (unqualified)	
	risk of explosion	because of high pressures / may endanger local people / dangerous	
	risk of fire	because of high temperatures / may endanger local people	
	noise	any detrimental effect on quality of life **or** night and day	
	lorries / traffic	danger / noise / pollution etc	
	unsightly	detrimental effect on quality of life / house prices / reduced tourism	
	uses a lot of land	loss of habitats	
total			10

4.10.4.1 The Haber process

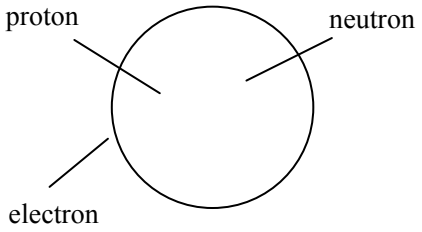
Answer 01 · Mark scheme

January 2008 | CHY2F | Original Q5 | Legacy

CHY2F

Answer 02 · Mark scheme

June 2008 | CHY2F | Original Q5 | Legacy

question	answers	extra information	mark
5(a)(i)		all three correct **2** marks one correct **1** mark	2
5(a)(ii)	14		1
5(b)	A		1
5(c)(i)	ammonia can break up to form nitrogen and hydrogen ammonia is made from nitrogen and hydrogen	list principle applies	2
5(c)(ii)	air		1
5(d)	ammonium nitrate		1
Total			**8**

4.10.4.1 The Haber process

Answer 02 · Mark scheme

June 2008 | CHY2F | Original Q5 | Legacy

COMPONENT NUMBER: CHY2F

COMPONENT NAME: Additional Science / Chemistry

STATUS: Final

DATE: June 2008

4.10.4.1 The Haber process

Answer 03 · Mark scheme

June 2009 | CHY2F | Original Q3 | Legacy

Question 3

question	answers	extra information	mark
3(a)	pressure		1
3(b)	nitrogen hydrogen		1 1
3(c)	cooled		1
3(d)	nitric		1
Total			**5**

4.10.4.1 The Haber process

Answer 03 · Mark scheme June 2009 | CHY2F | Original Q3 | Legacy

CHY2F

Answer 04 · Mark scheme January 2010 | CHY2F | Original Q2 | Legacy

Question 2

question	answers	extra information	mark
2(a)	fertilisers		1
2(b)	air		1
2(c)(i)	water **and** carbon monoxide on correct side of equation	accept H_2O for water and CO for carbon monoxide	1
2(c)(ii)	speeds up the reaction (owtte)	accept lowers the activation energy	1
2(d)	reversible reaction		1
2(e)(i)	10		1
2(e)(ii)	sulfuric water	accept H_2SO_4 accept H_2O / hydrogen oxide	1 1
Total			**8**

Answer 04 · Mark scheme January 2010 | CHY2F | Original Q2 | Legacy

CHY2F

4.10.4.1 The Haber process

Answer 05 · Mark scheme

June 2010 | CHY2F | Original Q6 | Legacy

Question 6

question	answers	extra information	mark
6(a)(i)	(nitrogen) + hydrogen → ammonia	accept H_2 and NH_3 ignore incorrect symbols ignore balancing	1
6(a)(ii)	any **one** from: • catalyst • to speed up the reaction • lower activation energy	 ignore causes reaction ignore heat / reference to particles 	1
6(a)(iii)	any **two** from: • cooled • ammonia condenses / turns into liquid • nitrogen and hydrogen do not condense / turn into liquid **or** nitrogen and hydrogen stay as gases	it = ammonia ignore references to boiling point if no marks awarded accept pass through / separated in condenser **or** unreacted nitrogen and hydrogen / gases recycled for **1** mark	2

Question 6 continues on the next page

4.10.4.1 The Haber process

CHY2F

Question 6 continued

question	answers	extra information	mark
6(b)	80	correct answer with or without working gains **2** marks ignore units if answer incorrect, evidence of correct *working* gains **1** mark eg 14 + (4 x 1) + 14 + (3 x 16) (= 70) **or** 2N + 4H +30	2
6(c)	fertiliser is **C** evidence of correct working	 examples of minimum correct working: 39/101 **or** 14/101 **or** 38.61/100 **or** 13.86/100	1 1
Total			**8**

4.10.4.1 The Haber process

Answer 05 · Mark scheme June 2010 | CHY2F | Original Q6 | Legacy

CHY2F

4.10.4.1 The Haber process

Answer 06 · Mark scheme

June 2011 | CHY2F | Original Q1 | Legacy

Question 1

question	answers	extra information	mark
1(a)(i)	NH_3		1
1(a)(ii)	electrons		1
1(a)(iii)	covalent		1
1(b)(i)	air natural gas		1 1
1(b)(ii)	reversible		1
1(b)(iii)	iron		1
1(c)	nitric acid		1
1(d)(i)	any **one** from: • lost jobs / unemployment • meant that they had to move away from Humberstone **or** no one lives there • loss of income (owtte)	 allow closed down the town ignore it closed the mine unless it is further qualified by some effect of this on the local community	1

Question 1 continues on the next page

4.10.4.1 The Haber process

Question 1 continued

question	answers	extra information	mark
1(d)(ii)	any **two** from: • less transport (costs) • less pollution / greenhouse gases / global warming <u>from transport</u> • cheaper to make in country than to import • not dependent on Chile for nitrate supplies **or** reliable source • provides employment to workers in Britain • good for British economy • raw materials readily available • continuous process	ignore reference to environment / ecofriendly allow smaller carbon footprint ignore reference to quicker	2
Total			**11**

4.10.4.1 The Haber process

Answer 06 · Mark scheme

June 2011 | CHY2F | Original Q1 | Legacy

CHY2F

4.10.4.1 The Haber process

Answer 07 · Mark scheme

June 2013 | CH3FP | Original Q1 | Legacy

Question 1

question	Answers	extra information	Mark
1(a)	reversible		1
1(b)	catalyst		1
1(c)	recycled	allow re-used	1
1(d)	(Q) S R P	allow **1** mark if one letter in correct place.	2
Total			**5**

4.10.4.1 The Haber process

Answer 08 · Mark scheme June 2014 | CH3FP | Original Q4 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
4(a)	⇌ ammonia	 allow NH_3	1 1	2 / 3.5.1b	E
4(b)	increases quickly at first *then slows* *at any number in range from 160 – 220 (atmospheres)*	 *ignore* levels off allow *rate of increase slows for first two marking points* *allow any number in range 60 – 66 (%)*	1 1 1	2 / 3.5	E
4(c)	(nitrogen and hydrogen) recycled	*allow (nitrogen and hydrogen) reused*	1	1 / 3.5.1b	E
4(d)(i)	*jobs lost*	accept mines closed **or** local economy damaged	1	3 / 3.5	E
4(d)(ii)	any **one** from: • *nitrates* / fertilisers cost less • more crops / food can be grown • food costs less • *nitrates / fertilisers more widely available*		1	3 / 3.5	E
Total			**8**		

4.10.4.1 The Haber process

Answer 08 · Mark scheme

June 2014 | CH3FP | Original Q4 | Legacy



4.10.4.1 The Haber process

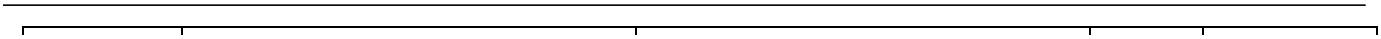
Answer 09 · Mark scheme June 2015 | CH3FP | Original Q4 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
4(a)	natural gas	allow correct answer shown in box if answer line blank	1	**AO1** 3.5.1.a
4(b)(i)	450	allow correct answer shown in box if answer line blank	1	**AO1** 3.5.1.b
4(b)(ii)	iron	allow correct answer shown in box if answer line blank	1	**AO1** 3.5.1.b
4(b)(iii)	The catalyst lowers the activation energy.		1	**AO1** 3.3.1.h
4(c)	(the gases are) cooled		1	**AO1/ AO2** 3.5.1.b
	ammonia condenses	allow ammonia liquefies	1	
	nitrogen and hydrogen are recycled	if no other mark awarded allow ammonia is separated for **1** mark	1	
Total			**7**	

4.10.4.1 The Haber process

Answer 09 · Mark scheme

June 2015 | CH3FP | Original Q4 | Legacy



4.10.4.1 The Haber process

Answer 10 · Mark scheme

June 2016 | CH2FP | Original Q6 | Legacy

Question	Answers	Extra information	Mark	AO / SpecRef
6(a)	endothermic		1	AO1 2.5.1d
6(b)	82 (%)	correct answer with working gains **3** marks if 17 or 34 not shown in working **max 2** marks accept 82.4 accept 82.35 to full calculator display (82.35294...) correctly rounded to at least 2 sf if no answer or incorrect answer, then (M_r =) 17 gains **1** mark **or** 14/17 gains **2** marks **OR** ($2M_r$ =) 34 gains **1** mark **or** 28/34 gains **2** marks **OR** 14/their M_r shown gains **1** mark **or** correct calculation of 14/their M_r gains **2** marks	3	AO2 2.3.3a, 2.3.1f
6(c)(i)	7 / seven		1	AO1 2.6.2d
6(c)(ii)	$H^+ + OH^- \rightarrow H_2O$		1	AO1 2.6.2e
6(c)(iii)	ammonium chloride	allow NH_4Cl ignore an incorrect formula	1	AO1 2.6.2b

Question 6 continues on the next page

Question 6 continued

Question	Answers	Extra information	Mark	AO / SpecRef
6(d)			6	2AO2 / 4AO3 2.6.2c

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.

0 marks	Level 1 (1–2 marks)	Level 2 (3–4 marks)	Level 3 (5–6 marks)
No relevant content.	Suggestion with a reference to a graph.	Suggestion with reasons referring to more than one graph.	Suggestion with reasons from all three graphs, and linking of ideas which may explain a compromise.

Examples of chemistry points made in response:

A reasonable suggested amount of fertiliser would be in the region of 200 kg (per ha). Accept any suggestion from about 180 kg (per ha) to 500 kg (per ha).

Yield:

- Using fertiliser improves yield.
- Yield improved most up to about 200 kg (per ha) of fertiliser.
- Yield only increased slightly above about 200 kg (per ha).

Profit:

- About 200 kg of fertiliser gives the most profit.
- Above about 200 kg (per ha) of fertiliser profit declines.

Run off:

- Run off is at low levels until about 300 kg (per ha) of fertiliser.
- Above about 300 kg (per ha) of fertiliser, run off increases.

Examples of linking of ideas:

- Overall 200 kg gives high crop yield and most profit.
- In conclusion 200 kg gives high crop yield and low run off.
- 200 kg gives most profit and low run off.

Examples of compromise:

- Profits go down after about 200 kg (per ha) of fertiliser because cost of fertiliser is not covered by increased yield.
- 200 kg gives the highest profit although it is not the highest yield.
- 500 kg gives the best yield but has the most runoff.

Total			13

4.10.4.1 The Haber process

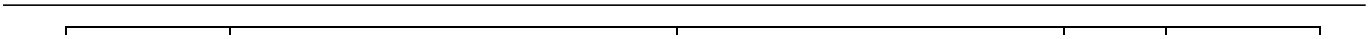
Answer 11 · Mark scheme June 2016 | CH3FP | Original Q4 | Legacy

Question	Answers	Extra information	Mark	AO / SpecRef
4(a)(i)	nitrogen: air hydrogen: natural gas		1 1	AO1 3.5.1a
4(a)(ii)	as a catalyst so the reaction speeds up	 allow lowers activation energy or so a lower temperature can be used	1 1	AO1/AO2 3.5.1b
4(a)(iii)	cooled ammonia condenses / liquefies	 allow nitrogen **and** hydrogen remain in the gaseous state	1 1	AO1/AO2 3.5.1b
4(a)(iv)	recycled	allow reused or returned to the reactor	1	AO1 3.5.1b
4(b)	reversible arrows hydrogen **and** ammonia		1 1	AO1 3.5.1b
Total			**9**	

4.10.4.1 The Haber process

Answer 11 · Mark scheme

June 2016 | CH3FP | Original Q4 | Legacy



4.10.4.1 The Haber process

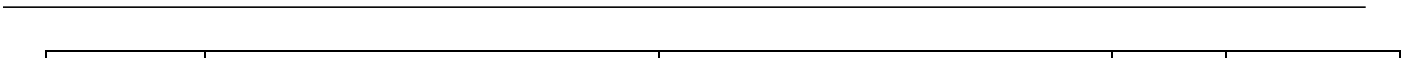
Answer 12 · Mark scheme June 2017 | CH3FP | Original Q3 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
3(a)(i)	air	allow air circled in the box	1	**AO1** 3.5.1.a
3(a)(ii)	tick (✓) by: lowers the activation energy		1	**AO1** 3.3.1h
3(a)(iii)	(gases) cooled (ammonia) condensed	 ignore turn to a liquid if no other mark, allow fractional distillation for 1 mark	1 1	**AO1** **AO2** 3.5.1b
3(b)	hydrogen ammonia	must be in correct order	1	**AO1** 3.5.1b
3(c)(i)	all points correctly plotted	allow 1 mark for **3** correct points allow +/- one small square	2	**AO2** 3.5.1b
3(c)(ii)	correctly drawn line		1	**AO2** 3.5.1b
3(c)(iii)	line extrapolated to at least 300°C 0.50 - 0.60		1 1	**AO2** 3.5.1b
3(c)(iv)	increases		1	**AO2** 3.5.1b
Total			**11**	

4.10.4.1 The Haber process

Answer 12 · Mark scheme

June 2017 | CH3FP | Original Q3 | Legacy



4.10.4.1 The Haber process

Answer 13 · Mark scheme June 2018 | 8462/2F | Original Q10

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.1	hydrogen	allow H_2	1	AO1 4.10.4.1
10.2	450 °C 200 atm / atmospheres	allow values in the range 400– 500 °C allow values in the range 150– 250 atm / atmospheres allow **1** mark if both values within range but no units given	1 1	AO1 4.10.4.1
10.3	ammonia has a higher boiling point	allow the other gases have lower boiling points ignore references to melting point	1	AO3 4.10.4.1

4.10.4.1 The Haber process

Answer 13 · Mark scheme

June 2018 | 8462/2F | Original Q10

Question	Answers		Mark	AO / Spec. Ref.
10.4	**Level 3:** Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.		5–6	AO2
	Level 2: Relevant points (reasons / causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.		3–4	AO1
	Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.		1–2	AO1
	No relevant content		0	
	Indicative content **changes** • carbon dioxide has decreased • oxygen has increased **processes** • volcanic activity released water vapour • the water vapour condensed to form oceans • carbon dioxide dissolved in oceans • carbonates produce sediments • carbon locked up in sedimentary rocks • algae and plants evolved / appeared • algae / plants absorbed carbon dioxide • by photosynthesis • which also released oxygen • carbon locked up in fossil fuels			4.9.1.2 4.9.1.3 4.9.1.4
10.5	any **one** from: • occurred 4.6 billion years ago • limited or no evidence	allow any indication of billions of years allow limited or no proof ignore there was nobody there	1	AO1 4.9.1.2
Total			**11**	

4.10.4.1 The Haber process

Answer 14 · Mark scheme June 2019 | 8462/2F | Original Q3

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	(equation contains a) ⇌ (symbol)	allow description of arrow / symbol	1	AO1 4.6.2.1
03.2	exothermic		1	AO1 4.6.2.2
03.3	to reduce costs to use less energy		1 1	AO3 4.6.1.4
03.4	(the world production of ammonia) increased (the increase was) not steady / linear	 do **not** accept decreases ignore levels off	1 1	AO2 4.10.4.1
03.5	the demand for food changed the world population changed		1 1	AO2 AO3 4.10.4.2
03.6	**C** and **D**		1	AO3 4.10.4.2
03.7	**D**		1	AO3 4.10.4.2
Total			**10**	

4.10.4.1 The Haber process

Answer 15 · Mark scheme

November 2020 | 8462/2F | Original Q1

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	(the reaction is) reversible	allow description of a reversible reaction	1	AO1 4.6.2.1 4.10.4.1
01.2	iron		1	AO1 4.10.4.1
01.3	activation energy with a catalyst		1	AO1 4.6.1.4 4.10.4.1
01.4	bar to 22 (%) labelled phosphorus / P bar to 25 (%) labelled potassium / K	allow a tolerance of ± ½ a small square if no other mark is awarded, allow **1** mark for two bars drawn to 22% and 25%	1 1	AO2 4.10.4.2
01.5	there are other elements in the fertiliser (besides phosphorus and potassium) **or** there is nitrogen in the fertiliser	allow there are other substances in the fertiliser (besides phosphorus and potassium)	1	AO3 4.10.4.2

4.10.4.1 The Haber process

Answer 15 · Mark scheme

Question 1 (continued)

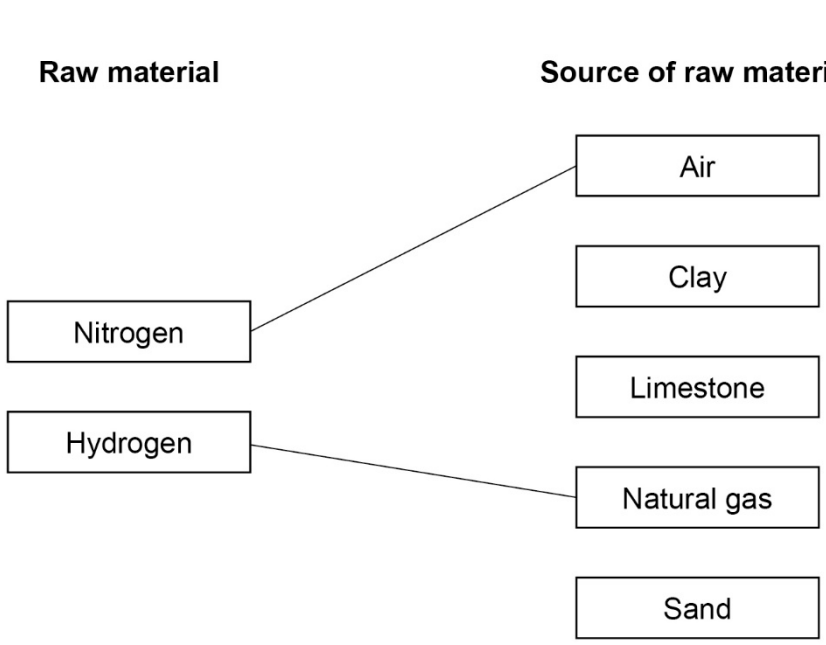
Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.6	B		1	AO3 4.10.4.2
01.7	B		1	AO2 4.10.4.2
Total			8	

4.10.4.1 The Haber process

Answer 16 · Mark scheme

June 2022 | 8462/2F | Original Q5

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	 do not accept more than one line from a box on the left		1 1	AO1 4.10.4.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	gas gas		1	AO1 4.10.4.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	there is one product		1	AO2 4.3.3.2 4.10.4.1

4.10.4.1 The Haber process

Answer 16 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	liquefied recycled	must be in this order	1 1	AO1 4.10.4.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.5	all six points plotted correctly line of best fit	allow a tolerance of ± ½ a small square allow **1** mark for four / five points plotted correctly	2 1	AO2 4.10.4.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.6	(percentage yield) increases		1	AO2 4.10.4.1

Total Question 5		10

4.10.4.1 The Haber process

Answer 17 · Mark scheme

June 2024 | 8462/2F | Original Q9

Question 9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.1	to recycle (remaining) nitrogen and hydrogen	allow to recycle unreacted gases allow to return nitrogen and hydrogen to the reactor	1	AO1 4.10.4.1

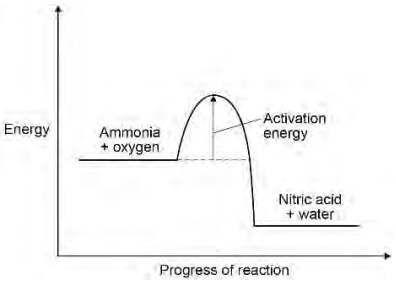
Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.2	iron	allow Fe	1	AO1 4.6.1.4 4.10.4.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.3	(test) glowing splint (result) (splint) relights	 MP2 is dependent upon MP1 being awarded	 1 1	AO1 4.8.2.2

4.10.4.1 The Haber process

Answer 17 · Mark scheme

June 2024 | 8462/2F | Original Q9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.4	labelled vertical arrow from dotted line to peak ammonia **and** oxygen on left **and** nitric acid **and** water on right	ignore arrow heads allow NH_3 for ammonia allow O_2 for oxygen allow HNO_3 for nitric acid allow H_2O for water an answer of  scores **2** marks	1 1	AO2 4.6.1.4 4.10.4.1 4.10.4.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.5	the line would reach a higher peak		1	AO1 4.6.1.4 4.10.4.1 4.10.4.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.6	fertilisers	allow explosives allow sports injury packs	1	AO3 4.10.4.1 4.10.4.2

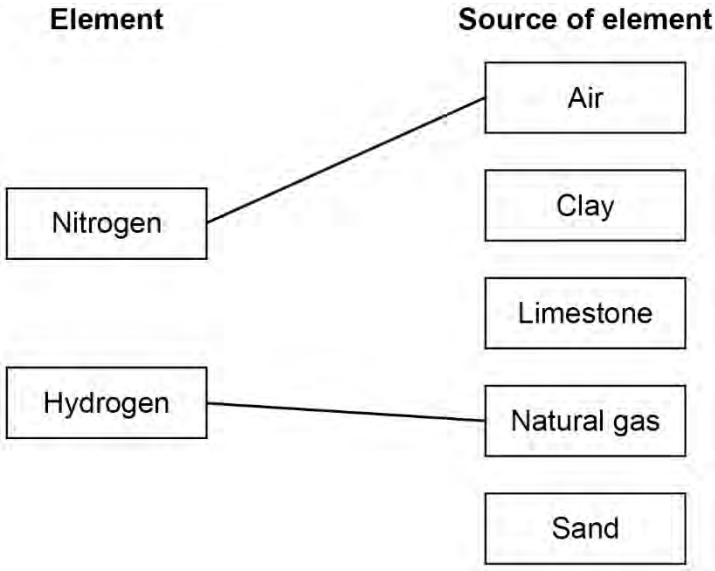
Total Question 9	8

4.10.4.1 The Haber process

Answer 18 · Mark scheme

June 2025 | 8462/2F | Original Q4

Question 4

Question	Answers	Mark	AO / Spec. Ref.
04.1	 do **not** accept more than one line from a box on the left	1 1	AO1 4.10.4.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	cooling		1	AO3 4.2.2.1 4.10.4.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	catalyst		1	AO1 4.10.4.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	(world production of ammonia) increased		1	AO3 4.10.4.1

4.10.4.1 The Haber process

Answer 18 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.5	(change in mass = 165 – 130 =) 35 (arbitrary units)		1	AO2 4.10.4.1
	(number of years = 2020 – 2000 =) 20		1	
	(mean change =) $\frac{35}{20}$	allow correct use of incorrectly determined change in mass and / or number of years	1	
	= 1.75 (arbitrary units per year)	allow 1.75 (arbitrary units per year) correctly rounded to at least 2 significant figures	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.6	change in world population		1	AO3 4.10.4.1 4.10.4.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.7	$Ca(NO_3)_2$		1	AO2 4.1.1.1 4.10.4.2
	$(NH_4)_2SO_4$		1	

Total Question 4	12

Answer 13 · Examiner comments

June 2018 | 8462/2F | Original Q10

Question 10 (standard demand)

10.1 27% of students realised that the other gas used in the Haber process is hydrogen.

10.2 Few knew the temperature and pressure used in the process. This was made even more challenging as they had to give the correct units as well. 12% of students achieved any marks for this question.

10.3 7% of students could explain why only the ammonia, and not the other gases, turn into a liquid because its boiling point is higher.

10.4 This was another 'extended response', 'level marked' question. This time there were three levels and the command word was 'explain'. Again, the question was marked holistically. Students were given information about the current atmosphere of Venus, believed to be similar to that on the early Earth, and the Earth's atmosphere today. Generally, a level 1 response used the percentages given to say in which direction the amounts of these gases had moved. Level 2 moved beyond this, giving an explanation in terms of one process, such as photosynthesis or dissolving in oceans. Level 3 responses usually gave more than one process, for example both of the processes mentioned above. Many students talked only about the changes in the last few centuries, which was not what the question was asking. 47% of students were able to reach level 2 or 3.

10.5 Few students seemed aware of the timescale under consideration here, namely the atmosphere of billions of years ago. A lack of evidence or proof was also accepted.

Use of statistics

Statistics used in this report may be taken from incomplete processing data. However, this data still gives a true account on how students have performed for each question.

Mark Ranges and Award of Grades

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

4.10.4.1 The Haber process

Answer 16 · Examiner comments June 2022 | 8462/2F | Original Q5

Question 5 (Low and standard demand)

05.1 Nearly 40% of the students gained two marks, with many of the remainder reversing the correct responses.

05.2 Over 40% of the students knew that nitrogen and hydrogen are both gases. Roughly the same number incorrectly selected an option that stated one of these elements is a gas and the other a liquid.

05.3 Fewer than 20% of the students gained a mark. A large majority thought that the reversibility of the reaction was linked to 100% atom economy.

05.4 Both evaporated and filtered were often seen. There was no obvious pattern in the responses and over 30% of the students gained both of the marks.

05.5 Around one-third of students obtained all three marks.
Over 50% of students plotted the points correctly but did not obtain the line of best fit mark. Common mistakes when drawing the line of best fit were to draw a straight line, a series of dot-to-dot straight lines, a very thick line or multiple lines.

05.6 About two-thirds of students realised that the percentage yield of ammonia would also increase.

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Question 9 (standard demand)

09.1 The role of the condenser and the importance of recycling unreacted gases in the Haber process is poorly understood with just over 5% of students gaining credit in this question. A large number of students stated that the ammonia or excess gases or gases alone were returned to the reactor. In addition, a number of students focused their answer on the condenser part of the flow chart and responded with the idea that uncondensed gases needed to be recycled.

09.2 Less than 25% of students correctly identified the catalyst used in the Haber process as iron, with copper, ammonia and hydrogen being frequently seen incorrect responses.

09.3 The test for oxygen gas is poorly understood with less than 25% of students being able to recall the correct test and its result. Many students referred to the splint being lit and then blown out or

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4.10.4.1 The Haber process

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attempted to describe a glowing splint as a small or dying flame. A correct test was needed to allow award of a mark for the test result. The correct test and result for hydrogen gas was frequently seen.

09.4 Over 25% of students either correctly labelled the products and reactants or correctly drew an arrow, labelled the activation energy, and gained one mark. A further 10% of students gained two marks by doing both correctly.

There were many variations of drawing and labelling the arrow for the activation energy. Some students mistakenly labelled the peak as being the activation energy or despite the dotted line drew the arrow too short or at an angle.

Many students incorrectly identified the reactants and products from the equation or used nitrogen, hydrogen, and ammonia from the previous question. Other students were unsure where the reactants and products would be located on a reaction profile diagram.

09.5 One in five students correctly identified that if there was no catalyst used in the reaction the peak would be higher. Many students misread the question and incorrectly answered that the peak would be lower.

09.6 One in six students were able to identify the use of ammonium nitrate in a fertiliser or NPK fertiliser. A small minority stated that it was used in farming or agriculture unqualified. Only a handful of students identified its use in explosives or sports injury packs. Many students misread the question and took salt from the stem of the question and answered in terms or flavouring or preserving food or using salt to de-ice roads.

4.10.4.1 The Haber process

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Question 4

04.1 Around 40% of students correctly identified both sources of the gases. There is a strongly held misconception that hydrogen comes from the air.

04.2 Nearly half of students understood that cooling occurs at point X in the diagram. The two distractors were both equally commonly seen.

04.3 Around half of students knew that iron was used as a catalyst in the Haber process.

04.4 Over 90% of students correctly identified the trend from the given data.

04.5 Nearly three fifths of students achieved all four marks on this scaffolded calculation. Taking the correct numbers from the table was the most common step where students did not gain credit.

04.6 About half of students scored the mark for this item. Change in amount of acid rain was the more common distractor seen.

04.7 Nearly 4 in 5 students correctly identified both compounds that contain nitrogen. Most of the remainder gained one of the two marks.