AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.10.4.1

The Haber process

Past-paper questions

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

Using this booklet

1. Answer the questions in order and show your working.
2. Original question numbers and marks are retained.
3. Print at actual size (100%) for measuring questions.
4. Use the companion answer booklet to check your work.

Name: _____ **Date:** _____

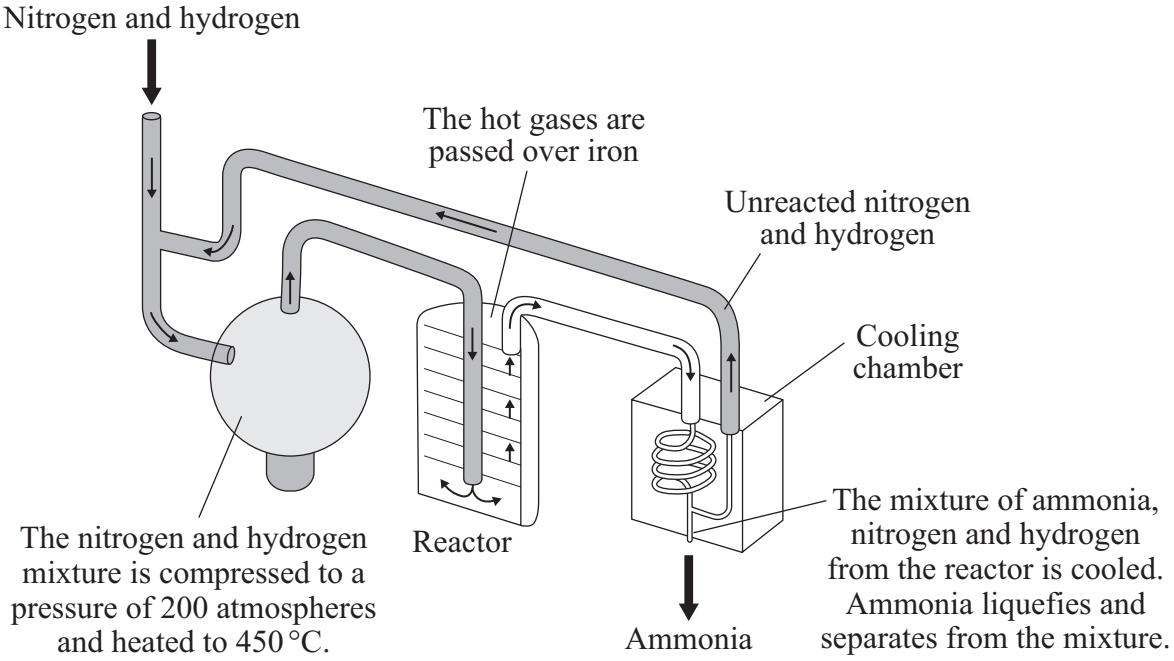
Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

4.10.4.1 The Haber process

Question 01

January 2008 | CHY2F | Original Q5 | Legacy

5 The Haber process is named after the German chemist, Fritz Haber.
The diagram shows the main stages in the Haber process.



(a) Use the diagram to help you to answer these questions.

(i) Complete the word equation for the reaction that takes place in the reactor.

nitrogen + ... ⇌ .....

(1 mark)

(ii) What does the symbol ⇌ mean?

.....

(1 mark)

(iii) What is the purpose of the iron in the reactor?

.....

(1 mark)

(iv) Ammonia is separated from unreacted nitrogen and hydrogen.
Draw a ring around the physical property that allows this separation to take place.

boiling point **density** **melting point**

(1 mark)

(v) What is done with the unreacted nitrogen and hydrogen?

.....

(1 mark)

4.10.4.1 The Haber process

Question 01 · continued

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(b) Some of the products that can be made from ammonia are:

- fertilisers
- dyes
- explosives
- medicines
- plastics

(i) The Haber process was invented a few years before the start of the First World War. It is thought that the First World War would have finished earlier if the Germans had **not** invented the Haber process.

Suggest why.

.....

.....

(1 mark)

(ii) The Haber process has helped to increase food production.

Explain why.

.....

.....

(1 mark)

(c) Factories that make ammonia are very large and operate night and day.

(i) Ammonia factories are often near towns.

Suggest why.

.....

(1 mark)

(ii) Suggest and explain **one** reason why local people might not want an ammonia factory near their town.

.....

.....

.....

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(2 marks)

10

4.10.4.1 The Haber process

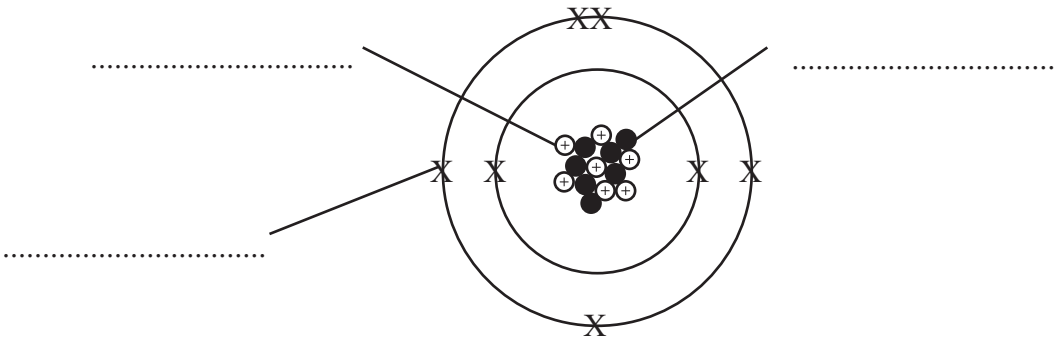
Question 02

June 2008 | CHY2F | Original Q5 | Legacy

5 (a) The diagram represents an atom of nitrogen.

5 (a) (i) Use words from the box to label the diagram.

electron	**neutron**	**nucleus**	**proton**



(2 marks)

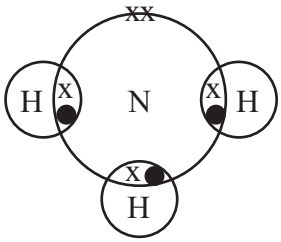
5 (a) (ii) Draw a ring around the mass number of this atom.

5 **7** **14** **21**

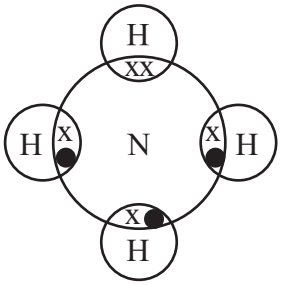
(1 mark)

5 (b) Nitrogen can react with hydrogen to make ammonia, NH_3.

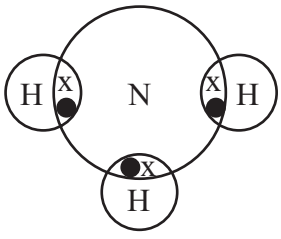
A



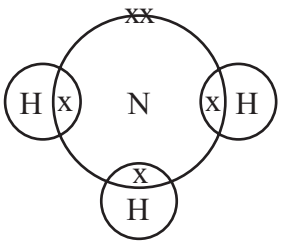
B



C



D



Which diagram, **A**, **B**, **C** or **D**, best represents an ammonia molecule?

(1 mark)

4.10.4.1 The Haber process

Question 02 · continued

for mark

5 (c) Ammonia is made using the Haber process. The word equation for this reaction is shown below.

nitrogen + hydrogen $\rightleftharpoons$ ammonia

5 (c) (i) Which **two** of the statements in the table do you know are true **only** by looking at the word equation?

Put a tick (✓) next to these **two** true statements.

Statement	(✓)
The reaction is very fast.	
Ammonia can break up to form nitrogen and hydrogen.	
Ammonia is made from nitrogen and hydrogen.	
The reaction that makes ammonia is endothermic.	

(2 marks)

5 (c) (ii) Draw a ring around the name of the raw material from which nitrogen is obtained.

air **methane** **oil** **water**

(1 mark)

5 (d) Some of the ammonia produced is neutralised by nitric acid to make a salt. This salt is used as a fertiliser.

Put a tick (✓) next to the name of the salt produced when ammonia is neutralised with nitric acid.

Name of salt	(✓)
ammonia nitrate	
ammonia nitride	
ammonium nitrate	
ammonium nitride	

(1 mark)

8

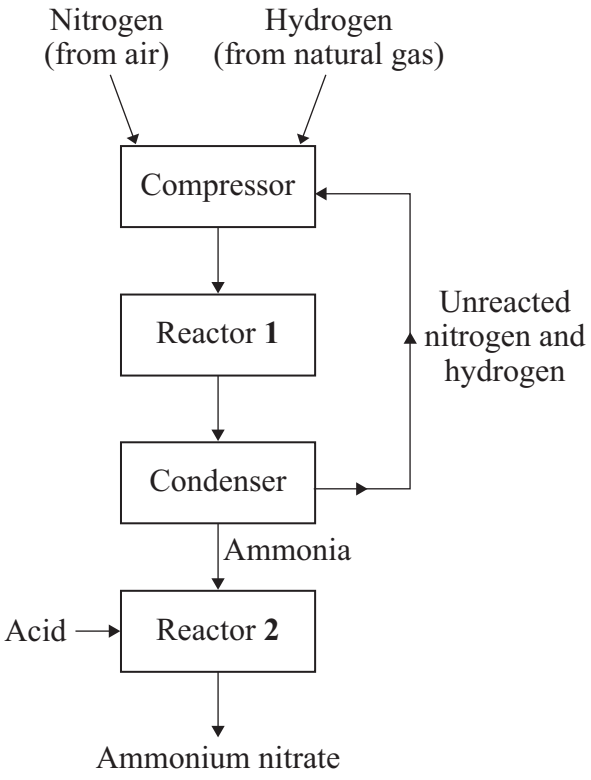
4.10.4.1 The Haber process

Question 03

June 2009 | CHY2F | Original Q3 | Legacy

3 Ammonium nitrate is an important chemical. The diagram shows the main stages in the manufacture of ammonium nitrate.

Study the diagram and then answer the questions.



Draw a ring around the correct answer in each box to complete the sentences.

3 (a) The compressor increases the [pressure / temperature / volume] to 200 atmospheres.

(1 mark)

3 (b) In reactor **1** ammonia is made by reacting [air / natural gas / nitrogen] with [air. / hydrogen. / natural gas.]

(2 marks)

4.10.4.1 The Haber process

Question 03 · continued

for mark

3 (c) In the condenser the mixture is | cooled / heated / reduced | and the ammonia is separated as a liquid. *(1 mark)*

3 (d) In reactor **2** ammonium nitrate is made by reacting ammonia with | hydrochloric / sulfuric / nitric | acid. *(1 mark)*

5

4.10.4.1 The Haber process

Question 04

January 2010 | CHY2F | Original Q2 | Legacy

2 Ammonium salts are used to help farmers grow crops.



2 (a) Use the correct word from the box to complete the sentence.

fertilisers	**insecticides**	**pesticides**

Ammonium salts contain nitrogen and are used by farmers as ..... to replace the nitrogen lost from the soil.

(1 mark)

2 (b) Ammonia is made by reacting nitrogen with hydrogen.

Draw a ring around the name of the raw material that provides the nitrogen.

air **crude oil** **water**

(1 mark)

2 (c) Methane and water react together to form the hydrogen.

methane and water → reactor containing a catalyst → hydrogen and carbon monoxide

2 (c) (i) Complete the word equation for this reaction.

methane + ... → hydrogen + ...

(1 mark)

4.10.4.1 The Haber process

Question 04 · continued

for mark

2 (c) (ii) How does the catalyst help this reaction?

.....

.....

(1 mark)

2 (d) The reaction between nitrogen and hydrogen to make ammonia can be represented by this equation.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

Draw a ring around the meaning of the symbol, $\rightleftharpoons$

endothermic reaction **precipitation reaction** **reversible reaction**

(1 mark)

2 (e) A solution of ammonia in water is alkaline.

2 (e) (i) Which **one** of these values could be the pH of this ammonia solution?

Draw a ring around your answer.

4 **7** **10**

(1 mark)

2 (e) (ii) The ammonium salt called ammonium sulfate can be made by reacting ammonia solution with an acid.

Use the correct words from the box to complete the sentences.

hydrochloric	**hydrogen**	**sulfuric**	**water**

Ammonia solution is reacted with ..... acid to make ammonium sulfate.

During the reaction the hydrogen ions from the acid react with hydroxide

ions from the alkali to make..... .

(2 marks)

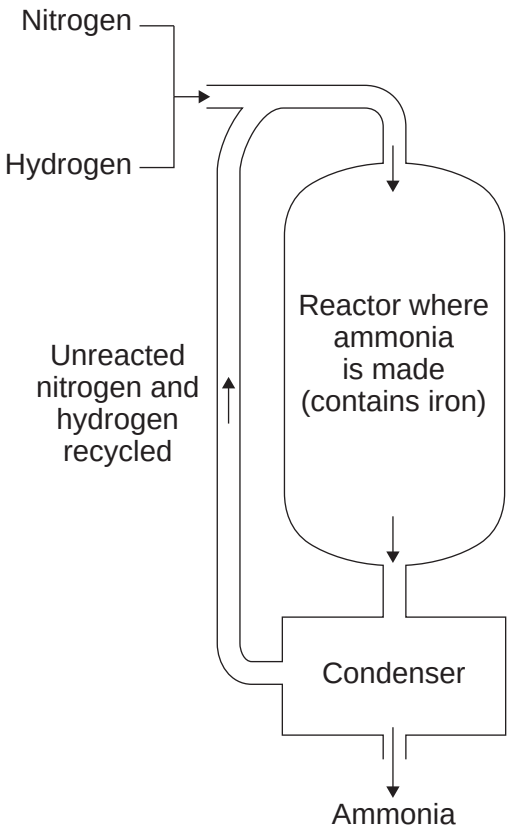
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4.10.4.1 The Haber process

Question 05

June 2010 | CHY2F | Original Q6 | Legacy

6 (a) The diagram shows how ammonia is made.



6 (a) (i) Complete the word equation for the reaction that takes place in the reactor.

nitrogen + ... → .....

(1 mark)

6 (a) (ii) Ammonia is made by passing nitrogen and hydrogen over hot iron.
Why is iron used in the reactor?

.....

.....

(1 mark)

6 (a) (iii) Explain how ammonia is separated from the unreacted nitrogen and hydrogen.

.....

.....

.....

.....

(2 marks)

4.10.4.1 The Haber process

Question 05 · continued

6 (b) Ammonia is used to make the fertiliser ammonium nitrate.

Calculate the relative formula mass (M_r) of ammonium nitrate, NH_4NO_3

Relative atomic masses (A_r): H = 1; N = 14; O = 16

.....

.....

.....

.....

Relative formula mass = ...

(2 marks)

6 (c) Another fertiliser is potassium nitrate, KNO_3

The relative formula mass (M_r) of potassium nitrate is 101.

Relative atomic masses (A_r): N = 14; O = 16; K = 39

The table shows the percentage by mass of potassium and nitrogen in four fertilisers, **A**, **B**, **C** and **D**.

Fertiliser	Percentage by mass of potassium (%)	Percentage by mass of nitrogen (%)
A	12.45	25.21
B	19.91	24.12
C	38.61	13.86
D	24.89	9.25

Which fertiliser, **A**, **B**, **C** or **D**, is potassium nitrate?

You **must** show your working to gain full marks.

.....

.....

.....

.....

Potassium nitrate is fertiliser ☐

(2 marks)

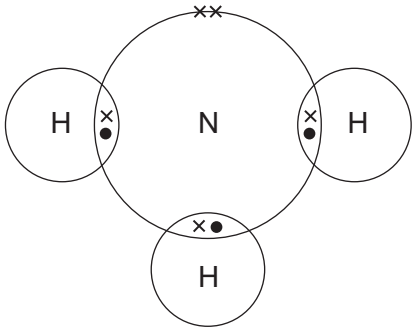
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4.10.4.1 The Haber process

Question 06

June 2011 | CHY2F | Original Q1 | Legacy

1 The diagram shows how the atoms are bonded in ammonia.



1 (a) Draw a ring around the correct answer.

1 (a) (i) The formula of an ammonia molecule is

NH^3 **N_3H** **NH_3**

(1 mark)

1 (a) (ii) The particles represented by the dots (•) and crosses (×) in the diagram are

electrons **neutrons** **protons**

(1 mark)

1 (a) (iii) The bonds between the nitrogen and hydrogen atoms in ammonia are

covalent **ionic** **metallic**

(1 mark)

4.10.4.1 The Haber process

Question 06 · continued

1 (b) Ammonia is made by reacting nitrogen with hydrogen in the Haber process.
The equation for this reaction is shown below.

nitrogen + hydrogen $\rightleftharpoons$ ammonia

1 (b) (i) Use words from the box to complete the sentences.

air	**limestone**	**iron ore**	**natural gas**

Nitrogen is obtained from ..... .

Hydrogen is obtained from ..... .

(2 marks)

1 (b) (ii) Draw a ring around the correct answer to complete the sentence.

The symbol $\rightleftharpoons$ means that the reaction is

exothermic.
endothermic.
reversible.

(1 mark)

1 (b) (iii) A catalyst is used in the Haber process.

Draw a ring around the name of this catalyst.

iron **magnesium** **sodium**

(1 mark)

1 (c) Ammonium nitrate is a fertiliser that can be made by reacting ammonia with an acid.

Draw a ring around the name of the acid used in this reaction.

hydrochloric acid **nitric acid** **sulfuric acid**

(1 mark)

Question 1 continues on the next page

4.10.4.1 The Haber process

Question 06 · continued

1 (d) Humberstone was a town in the desert of Northern Chile in South America. It was built for the people who worked in the nearby sodium nitrate mines.

The sodium nitrate was used as a fertiliser.

The sodium nitrate was exported by ship to countries all around the world.

Today the mines have closed and nobody lives in Humberstone.



One of the reasons for the mines closing was the invention of the Haber process.

Haber process factories can be built anywhere in the world.

1 (d) (i) How did the invention of the Haber process affect the people of Humberstone?

.....

.....

(1 mark)

1 (d) (ii) Suggest **two** advantages of making ammonium nitrate in the UK rather than importing sodium nitrate from Chile.

1 .....

.....

2 .....

.....

(2 marks)

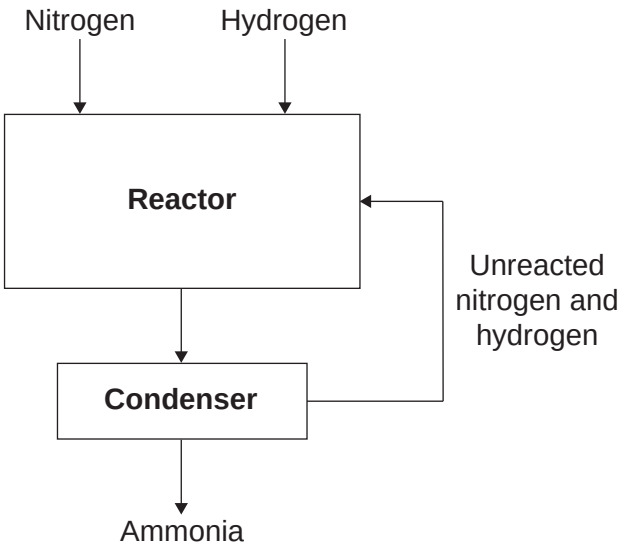
11

4.10.4.1 The Haber process

Question 07

June 2013 | CH3FP | Original Q1 | Legacy

1 The flow diagram shows the Haber process. In the Haber process ammonia is produced from nitrogen and hydrogen.



1 (a) The word equation for the production of ammonia is:

nitrogen + hydrogen $\rightleftharpoons$ ammonia

Draw a ring around the correct answer to complete the sentence.

The symbol $\rightleftharpoons$ in the word equation shows the reaction is

exothermic.
reversible.
slow.

(1 mark)

4.10.4.1 The Haber process

Question 07 · continued

1 (b) The reactor contains iron.

Complete the sentence.

The iron speeds up the reaction because it is a ..... .

(1 mark)

1 (c) What happens to the unreacted nitrogen and hydrogen?

.....

.....

(1 mark)

1 (d) The sentences describe how ammonia is produced in the Haber process.

The sentences are in the wrong order.

P Ammonia is separated as a liquid.

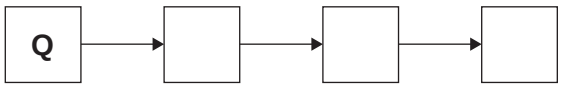
Q Nitrogen and hydrogen are mixed together.

R A mixture of gases enters the condenser.

S Nitrogen and hydrogen react to produce ammonia.

Complete the boxes below to show the correct order of the sentences.

The first box has been done for you.



(2 marks)

5

4.10.4.1 The Haber process

Question 08

June 2014 | CH3FP | Original Q4 | Legacy

4 In 1909 Fritz Haber invented a process to produce ammonia from nitrogen and hydrogen.

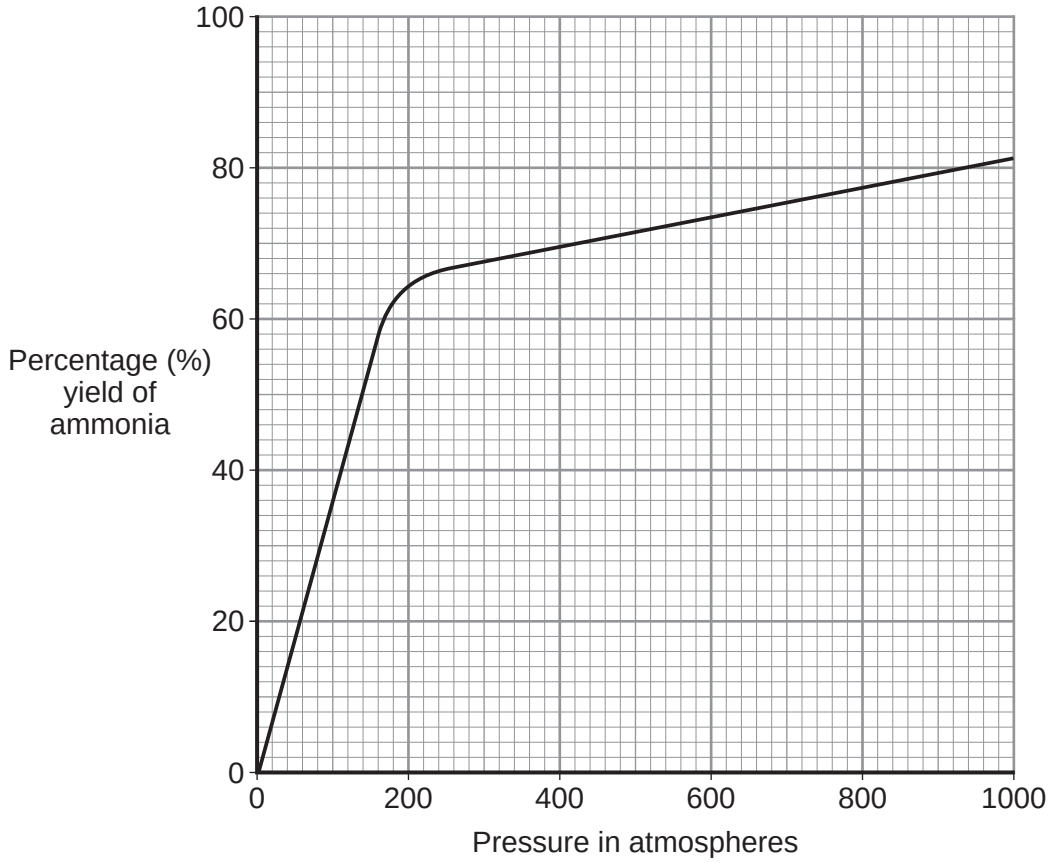
4 (a) Complete the word equation, showing that the reaction is reversible.

[2 marks]

nitrogen + hydrogen ....

4 (b) **Figure 3** shows how the yield of ammonia at 300 °C changes with pressure.

Figure 3



Describe how the yield of ammonia changes as the pressure increases.

[3 marks]

.....

.....

.....

.....

.....

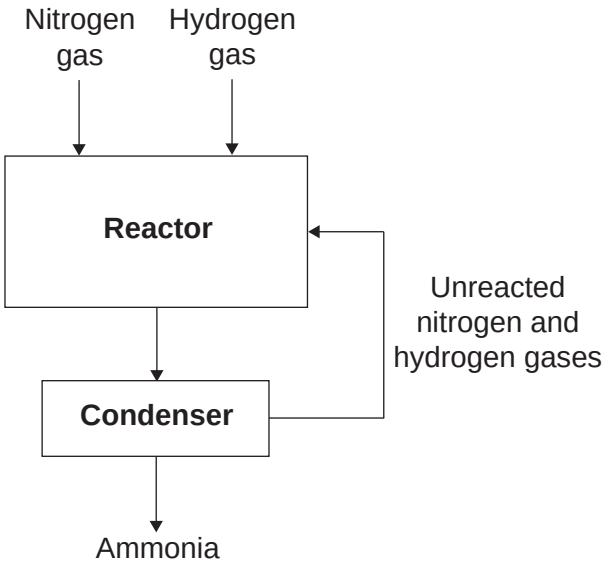
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4.10.4.1 The Haber process

Question 08 · continued

4 (c) **Figure 4** represents the Haber process.

Figure 4



How does the Haber process avoid wasting nitrogen and hydrogen?

[1 mark]

.....

.....

4 (d) Before the Haber process, nitrates had been mined in South America. Nitrates are used for making fertilisers.

The Haber process allowed nitrates to be produced on a large scale, anywhere in the world.

4 (d) (i) Suggest what effect the Haber process had on the miners in South America.

[1 mark]

.....

.....

4 (d) (ii) Suggest **one** advantage of producing nitrates on a large scale.

[1 mark]

.....

.....

8

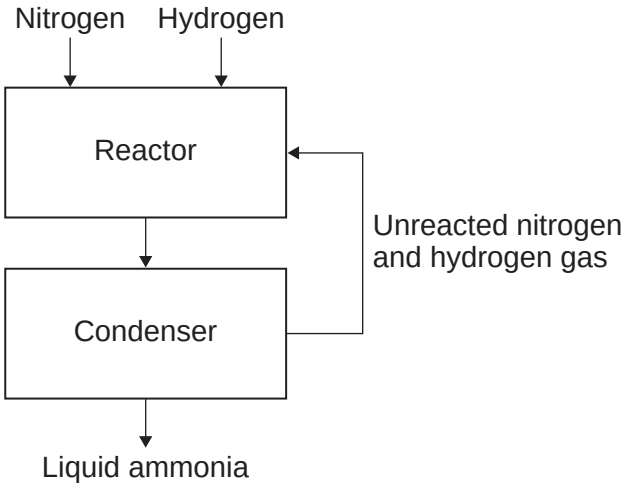
4.10.4.1 The Haber process

Question 09

June 2015 | CH3FP | Original Q4 | Legacy

4 **Figure 5** shows a flow diagram of the Haber process.
The Haber process produces ammonia from nitrogen and hydrogen.

Figure 5



4 (a) Use the correct answer from the box to complete the sentence.

[1 mark]

air	limestone	natural gas

Hydrogen is obtained from ..... .

4 (b) In the reactor, nitrogen and hydrogen at a high pressure are heated and passed over a catalyst.

4 (b) (i) Use the correct answer from the box to complete the sentence.

[1 mark]

25	100	450

The temperature in the reactor is ..... °C

4 (b) (ii) Use the correct answer from the box to complete the sentence.

[1 mark]

copper	iron	nickel

The catalyst used in the reactor is ..... .

4.10.4.1 The Haber process

Question 09 · continued

4 (b) (iii) How does a catalyst speed up a reaction?

[1 mark]

Tick (✓) **one** box.

The catalyst lowers the activation energy. ☐

The catalyst gives the reactants extra energy. ☐

The catalyst increases the pressure in the reactor. ☐

4 (c) A mixture of gases leaves the reactor.

The mixture contains ammonia, nitrogen and hydrogen.

Describe what happens to this mixture of gases in the condenser.

Use **Figure 5** to help you.

[3 marks]

.....

.....

.....

.....

.....

.....

7

4.10.4.1 The Haber process

Question 10

June 2016 | CH2FP | Original Q6 | Legacy

6 This question is about ammonia and fertilisers.

6 (a) Ammonia is produced by a reversible reaction.

The equation for the reaction is:

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

Complete the sentence.

[1 mark]

The forward reaction is exothermic, so the reverse reaction is _____ .

6 (b) Calculate the percentage by mass of nitrogen in ammonia (NH_3).
Relative atomic masses (A_r): H = 1; N = 14
You **must** show how you work out your answer.

[3 marks]

_____

_____

_____

_____

_____

_____

Percentage by mass of nitrogen = _____%

4.10.4.1 The Haber process

Question 10 · continued

6 (c) A neutral solution can be produced when ammonia reacts with an acid.

6 (c) (i) Give the pH of a neutral solution.

[1 mark]

pH _____

6 (c) (ii) Which of these ionic equations shows a neutralisation reaction?

[1 mark]

Tick (✓) **one** box.

$H^+ + OH^- \longrightarrow H_2O$ ☐

$NH_4^+ + OH^- \longrightarrow NH_4OH$ ☐

$H^+ + Cl^- \longrightarrow HCl$ ☐

$H^+ + H_2O \longrightarrow H_3O^+$ ☐

6 (c) (iii) Name the salt produced when ammonia reacts with hydrochloric acid.

[1 mark]

_____

Question 6 continues on the next page

Question 10 · continued

6 (d) **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**

Farmers use ammonium nitrate as a fertiliser for crops.

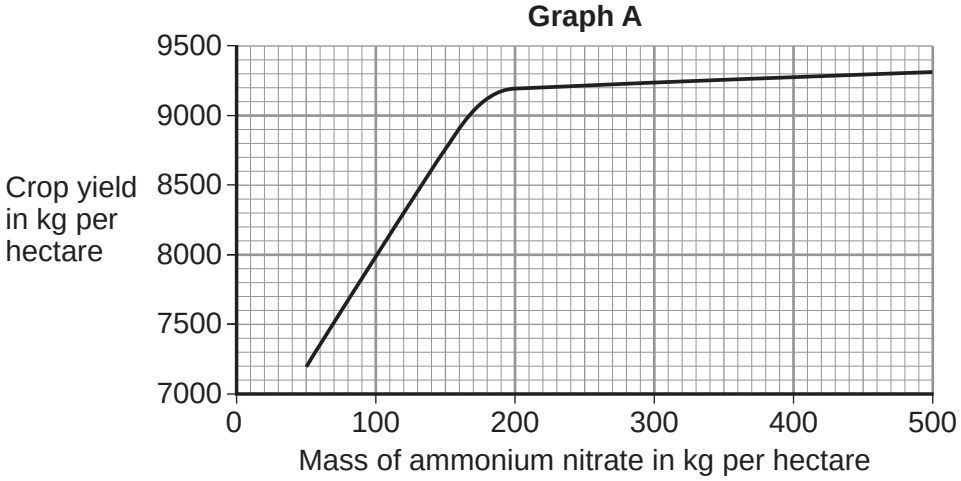
Rainwater dissolves ammonium nitrate in the soil.

Some of the dissolved ammonium nitrate runs off into rivers and lakes.

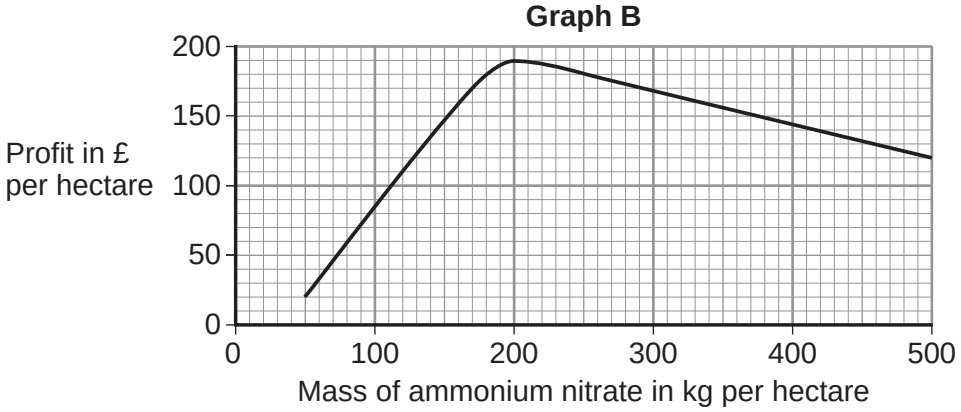
Figure 12 shows three graphs **A**, **B** and **C**. The graphs show information about the use of ammonium nitrate as a fertiliser. A hectare is a measurement of an area of land.

Figure 12

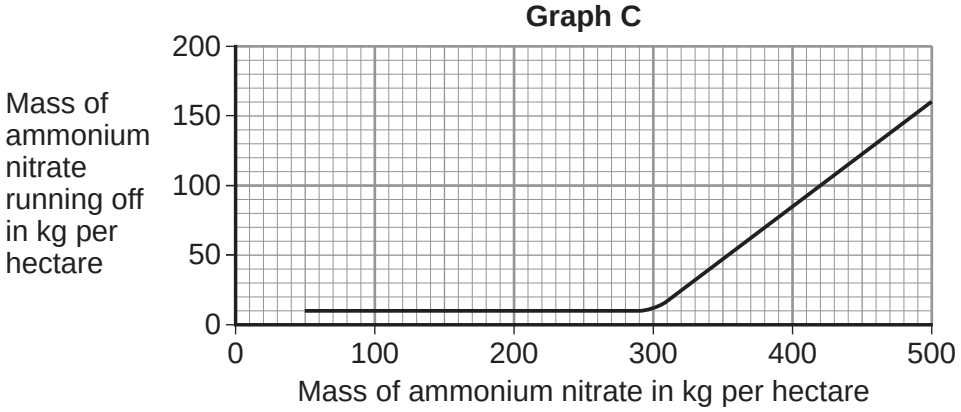
Graph A



Graph B



Graph C



4.10.4.1 The Haber process

Question 10 · continued

Suggest how much ammonium nitrate farmers should use per hectare.
Give reasons for your answer.
Use information from graphs **A**, **B** and **C**.

[6 marks]

Extra space

13

4.10.4.1 The Haber process

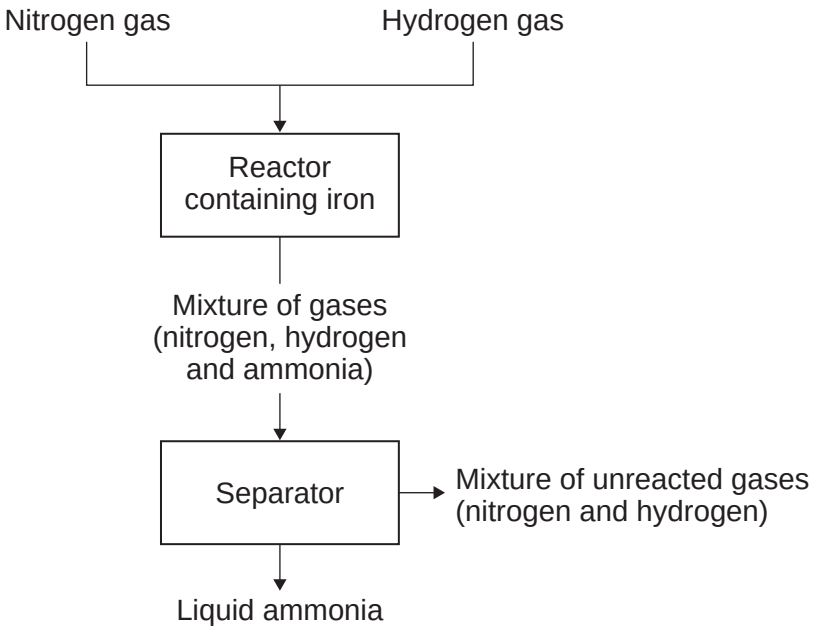
Question 11

June 2016 | CH3FP | Original Q4 | Legacy

4 This question is about the Haber process.

Figure 6 shows a flow diagram for the Haber process.

Figure 6



4 (a) (i) Nitrogen gas and hydrogen gas are obtained from different sources.
Draw **one** line from each gas to its source.

[2 marks]

Gas	Source
	Air
Nitrogen	Iron ore
Hydrogen	Limestone
	Natural gas

Question 4 continues on the next page

4.10.4.1 The Haber process

Question 11 · continued

4 (a) (ii) Explain why iron is used in the reactor for the Haber process.

[2 marks]

4 (a) (iii) Describe how the ammonia is separated from the other gases.

[2 marks]

4 (a) (iv) What happens to the mixture of unreacted gases (nitrogen and hydrogen)?

[1 mark]

4 (b) The reaction to produce ammonia is reversible.
Complete the word equation for this reaction.

[2 marks]

nitrogen + _____

9

4.10.4.1 The Haber process

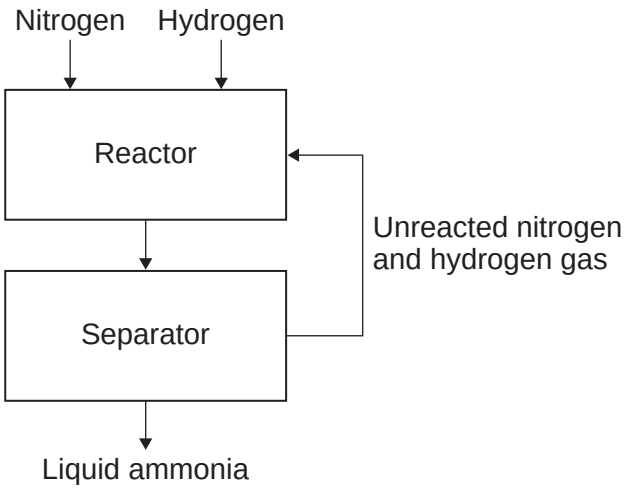
Question 12

June 2017 | CH3FP | Original Q3 | Legacy

3 This question is about the Haber process.

Figure 3 shows a flow diagram of the Haber process.

Figure 3



3 (a) (i) Use the correct answer from the box to complete the sentence.

[1 mark]

air	crude oil	natural gas	water

Nitrogen for the Haber process is obtained from _____ .

4.10.4.1 The Haber process

Question 12 · continued

3 (a) (ii) Iron is used as a catalyst in the reactor.

How does a catalyst speed up a reaction?

[1 mark]

Tick (✓) **one** box.

Changes the pressure in the reactor ☐

Lowers the activation energy ☐

Makes the particles move faster ☐

3 (a) (iii) Describe how the ammonia is separated from the other gases.

[2 marks]

_____

_____

_____

_____

3 (b) Complete the word equation for the reaction in the Haber process.

[1 mark]

nitrogen + _____ ⇌ _____

Question 3 continues on the next page

4.10.4.1 The Haber process

Question 12 · continued

3 (c) **Figure 4** shows how, in the Haber process, the rate of reaction changes as the temperature and pressure increase.

Figure 4

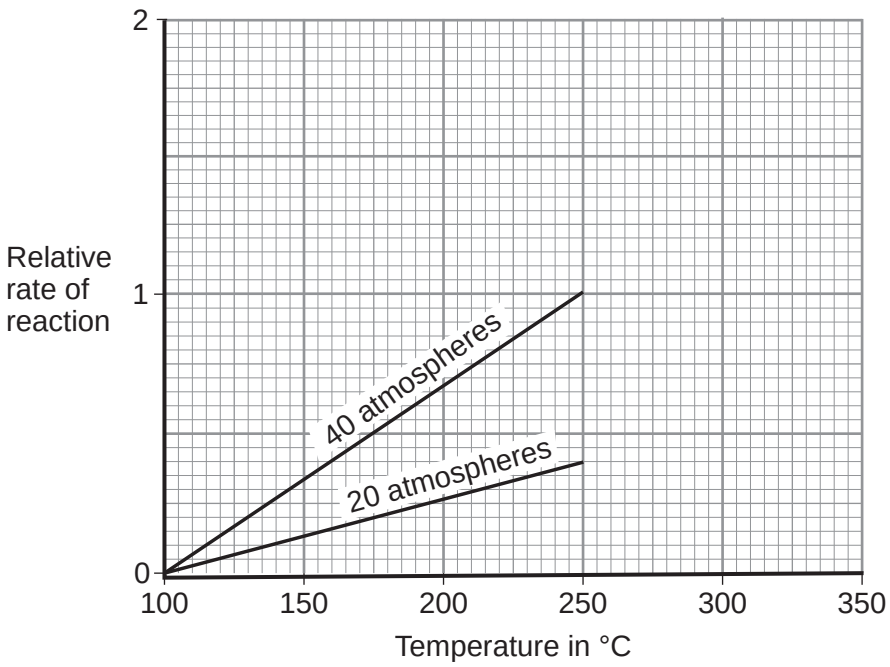


Table 1 shows the relative rate of reaction at 80 atmospheres at different temperatures.

Table 1

Temperature in °C	Relative rate of reaction
100	0.0
150	0.5
200	1.0
250	1.7
300	2.0

4.10.4.1 The Haber process

Question 12 · continued

3 (c) (i) Plot the data in **Table 1** on the graph in **Figure 4**.

[2 marks]

3 (c) (ii) Draw a straight line of best fit for the points you have plotted.

[1 mark]

3 (c) (iii) What is the relative rate of reaction at 20 atmospheres and 300 °C?

Show your working on **Figure 4**.

[2 marks]

Relative rate of reaction = _____

3 (c) (iv) Describe how the rate of reaction changes as the pressure increases.

[1 mark]

_____

_____

11

4.10.4.1 The Haber process

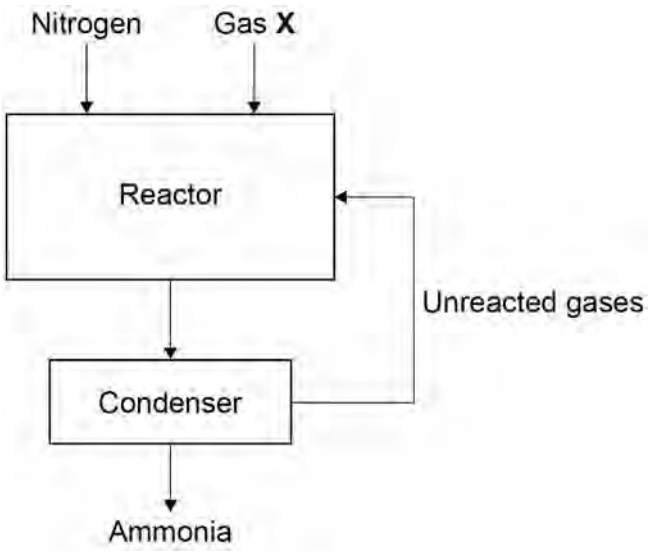
Question 13

June 2018 | 8462/2F | Original Q10

1 0 This question is about gases.

Figure 10 shows how nitrogen is used in the Haber Process to produce ammonia.

Figure 10



1 0 . 1 Gas **X** in **Figure 10** is obtained from methane.

Name gas **X**.

[1 mark]

_____

1 0 . 2 Give the approximate temperature and pressure used in the reactor.

[2 marks]

Temperature _____

Pressure _____

1 0 . 3 The mixture of gases from the reactor cools in the condenser.

Suggest why ammonia condenses but the other gases do not.

[1 mark]

_____

_____

4.10.4.1 The Haber process

Question 13 · continued

The Earth's early atmosphere was different to Earth's atmosphere today.

Scientists think that the Earth's early atmosphere was like the atmosphere found on Venus today.

Table 7 shows the amounts of carbon dioxide and oxygen in the atmospheres of Venus and Earth today.

Table 7

Gas	Percentage (%) in Venus' atmosphere today	Percentage (%) in Earth's atmosphere today
Carbon dioxide	96.50	0.04
Oxygen	0.00	20.95

1 0 . 4 The percentages of carbon dioxide and oxygen have changed from Earth's early atmosphere to Earth's atmosphere today.

Explain the processes that led to these changes.

[6 marks]

4.10.4.1 The Haber process

Question 13 · continued

June 2018 | 8462/2F | Original Q10

1 0 . 5 Why are scientists **not** certain about the percentage of each gas in the Earth's early atmosphere?

[1 mark]

4.10.4.1 The Haber process

Question 14

June 2019 | 8462/2F | Original Q3

0 3 Hydrogen is a raw material in the Haber process.

Hydrogen is produced from methane.

The word equation for the reaction is:

methane + steam ⇌ carbon monoxide + hydrogen

0 3 . 1 How can you tell that the reaction is reversible?

[1 mark]

0 3 . 2 The forward reaction is endothermic.

Name the type of energy change in the reverse reaction.

[1 mark]

0 3 . 3 A nickel catalyst is used in this reaction.

Why is a catalyst used in this reaction?

[2 marks]

Tick (✓) **two** boxes.

- To increase the temperature ☐
- To produce less carbon monoxide ☐
- To reduce costs ☐
- To use less energy ☐
- To use less methane ☐

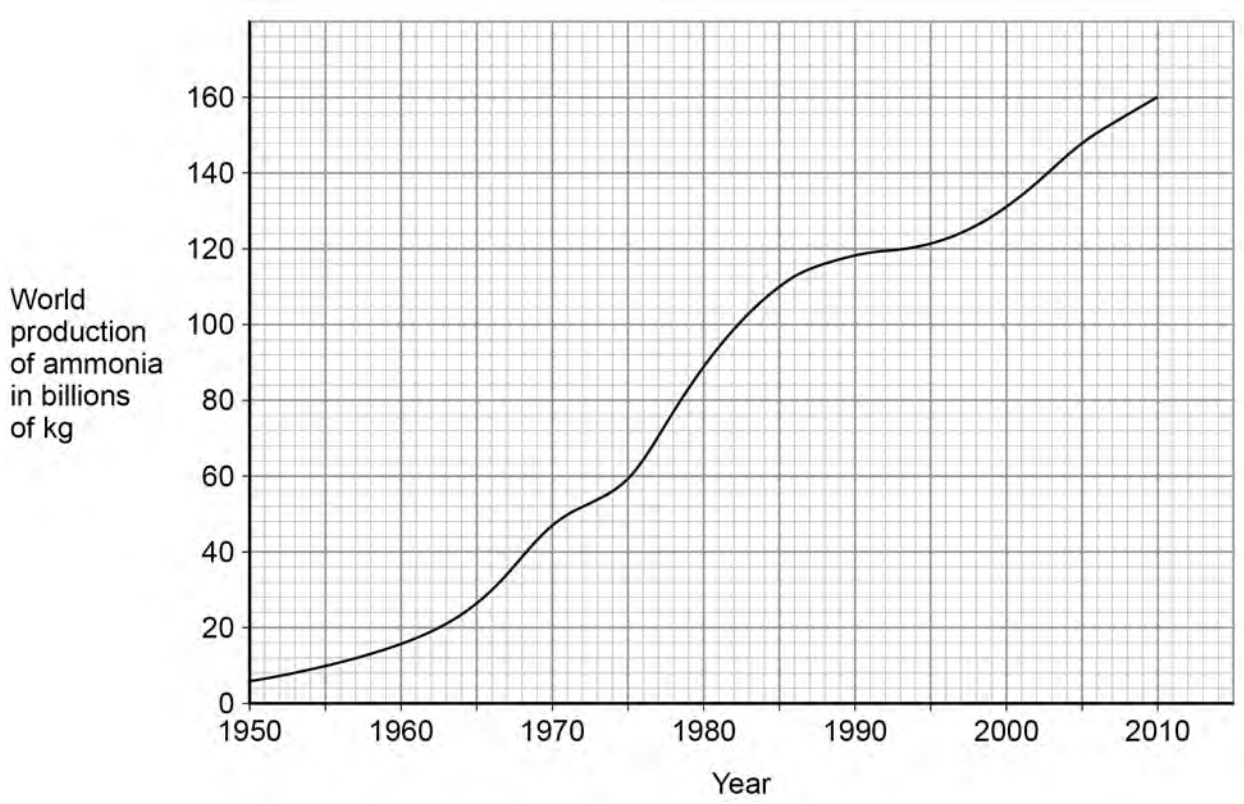
4.10.4.1 The Haber process

Question 14 · continued

0 3 . 4 The Haber process also uses nitrogen to produce ammonia.

Figure 1 shows how the world production of ammonia changed between 1950 and 2010.

Figure 1



Describe how the world production of ammonia changed between 1950 and 2010.

[2 marks]

4.10.4.1 The Haber process

Question 14 · continued

Most of the ammonia produced is used to make fertilisers.

0 3 . 5 Why did the world production of ammonia change between 1950 and 2010?

[2 marks]

Tick (✓) **two** boxes.

- The demand for food changed. ☐
- The demand for fuels changed. ☐
- The nitrogen percentage in air changed. ☐
- The number of cars changed. ☐
- The world population changed. ☐

Table 1 shows data about four fertilisers, **A**, **B**, **C** and **D**.

Table 1

Fertiliser	Percentage by mass of nitrogen (%)	Percentage by mass of phosphorus (%)	Percentage by mass of potassium (%)
A	35.0	0.0	0.0
B	21.2	0.0	0.0
C	21.2	23.5	0.0
D	0.0	0.0	52.3

4.10.4.1 The Haber process

Question 14 · continued

0 3 . 6 Which combination of fertilisers **A**, **B**, **C** and **D** provides **all** of the elements needed for an NPK fertiliser?

Use **Table 1**.

[1 mark]

Tick (✓) **one** box.

A and **C** ☐

A and **D** ☐

B and **C** ☐

C and **D** ☐

0 3 . 7 Which fertiliser is **not** made using ammonia?

Use **Table 1**.

[1 mark]

Tick (✓) **one** box.

A ☐

B ☐

C ☐

D ☐

10

4.10.4.1 The Haber process

Question 15

November 2020 | 8462/2F | Original Q1

0 1 This question is about ammonia and fertilisers.

Ammonia is produced from nitrogen and hydrogen.

A catalyst is used to speed up the reaction.

The word equation for the reaction is:

nitrogen + hydrogen ⇌ ammonia

0 1 . 1 What does the symbol ⇌ show about the reaction?

[1 mark]

0 1 . 2 Which catalyst is used when ammonia is produced from nitrogen and hydrogen?

[1 mark]

Tick (✓) **one** box.

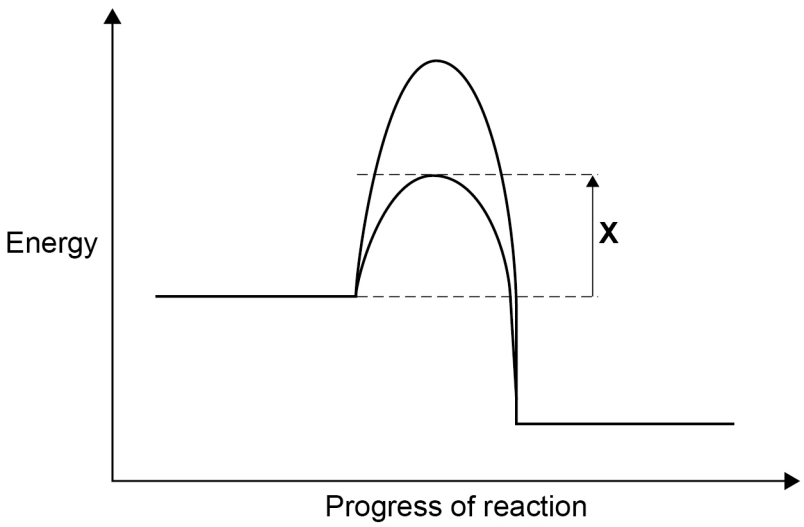
- Chlorine ☐
- Iron ☐
- Oxygen ☐

4.10.4.1 The Haber process

Question 15 · continued

0 1 . 3 **Figure 1** shows the reaction profile for the production of ammonia both with a catalyst and without a catalyst.

Figure 1



What is represented by label **X**?

[1 mark]

Tick (✓) **one** box.

- Activation energy with a catalyst ☐
- Activation energy without a catalyst ☐
- Overall energy change with a catalyst ☐
- Overall energy change without a catalyst ☐

4.10.4.1 The Haber process

Question 15 · continued

Ammonia is used to produce fertilisers.

NPK fertilisers contain the elements nitrogen, phosphorus and potassium.

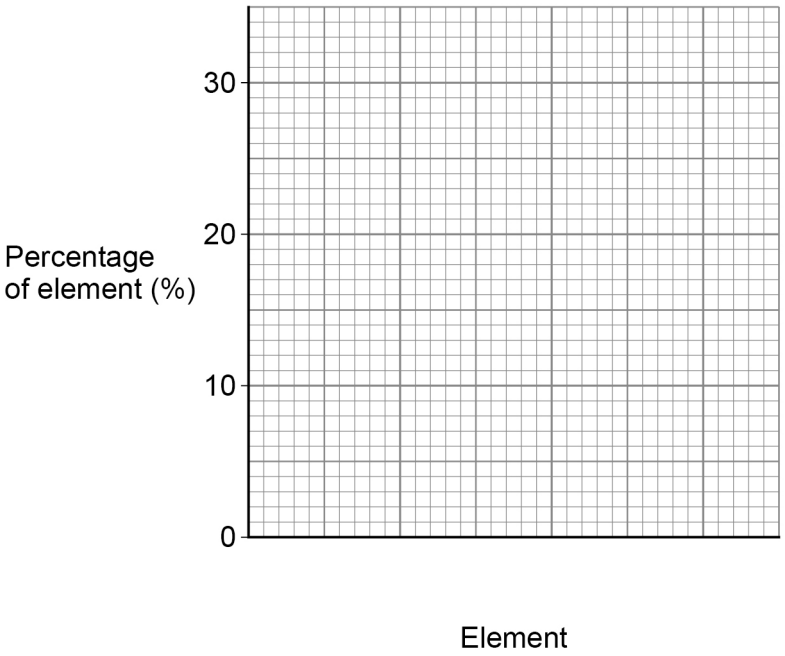
A fertiliser contains:

- 22% phosphorus
- 25% potassium.

0 1 . 4 Draw a bar chart on **Figure 2** to show the percentages of phosphorus and of potassium in this fertiliser.

[2 marks]

Figure 2



0 1 . 5 Why do the percentages of phosphorus and of potassium in this fertiliser **not** add up to 100%?

[1 mark]

Question 15 · continued

Fertilisers help plants grow by adding essential elements to soil.

Table 1 shows the percentages of nitrogen, phosphorus and potassium in four fertilisers, **A**, **B**, **C** and **D**.

Table 1

Fertiliser	Percentage (%) of essential element		
	Nitrogen (N)	Phosphorus (P)	Potassium (K)
A	14	0	39
B	25	16	23
C	21	23	0
D	21	0	0

0 1 . 6 Plants lacking essential elements do not grow well because:

- too little phosphorus can cause slow plant growth
- too little potassium can cause leaves to have brown edges.

Which fertiliser helps prevent slow plant growth **and** brown leaf edges?

Use **Table 1**.

[1 mark]

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

0 1 . 7 Which fertiliser has the greatest total percentage of essential elements?

Use **Table 1**.

[1 mark]

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

8

4.10.4.1 The Haber process

Question 16

June 2022 | 8462/2F | Original Q5

0 5 Ammonia is produced in the Haber process.

The raw materials for the Haber process are nitrogen and hydrogen.

0 5 . 1 Draw **one** line from each raw material to the source of that raw material.

[2 marks]

Raw material	Source of raw material
	Air
	Clay
Nitrogen	
	Limestone
Hydrogen	
	Natural gas
	Sand

0 5 . 2 What are the states of nitrogen and of hydrogen when used in the Haber process?

[1 mark]

Tick (✓) **one** box.

State of nitrogen	State of hydrogen	
Gas	Gas	☐
Gas	Liquid	☐
Liquid	Gas	☐
Liquid	Liquid	☐

4.10.4.1 The Haber process

Question 16 · continued

0 5 . 3 The word equation for the production of ammonia is:

nitrogen + hydrogen ⇌ ammonia

The atom economy of the reaction is 100%.

How does the word equation show that the atom economy is 100%?

[1 mark]

Tick (✓) **one** box.

The reaction is reversible. ☐

There are two reactants. ☐

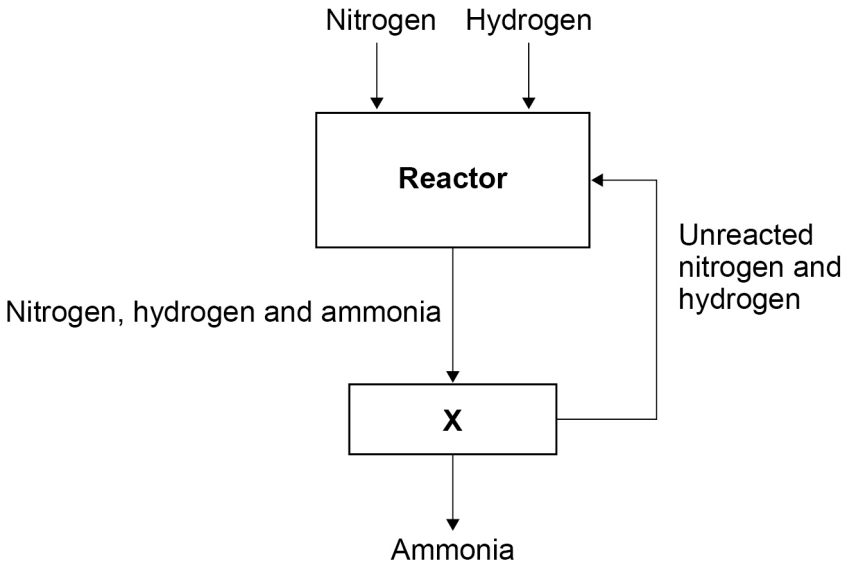
There is one product. ☐

4.10.4.1 The Haber process

Question 16 · continued

0 5 . 4 **Figure 5** represents the Haber process.

Figure 5



A mixture of nitrogen, hydrogen and ammonia enters **X**.

Complete the sentences.

Choose answers from the box.

[2 marks]

evaporated	**filtered**	**liquefied**	**recycled**

In **X**, the mixture is cooled.

The ammonia can be removed from **X** because the ammonia is

_____.

The unreacted nitrogen and hydrogen are

_____.

4.10.4.1 The Haber process

Question 16 · continued

Table 8 shows the percentage yield of ammonia at different pressures.

Table 8

Pressure in atmospheres	Percentage (%) yield of ammonia
50	20
100	33
150	44
200	52
250	59
300	64

4.10.4.1 The Haber process

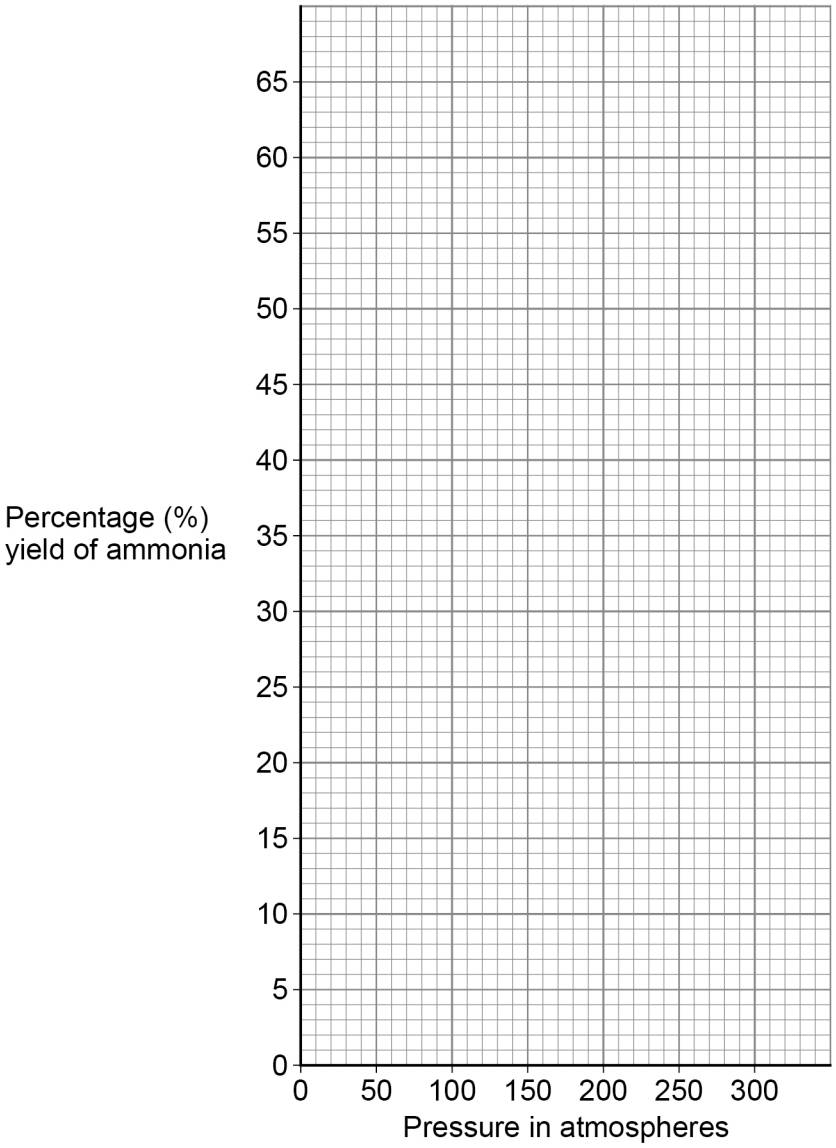
Question 16 · continued

0 5 . 5 Plot the data from **Table 8** on **Figure 6**.

Draw a line of best fit.

[3 marks]

Figure 6



0 5 . 6 What is the effect of increasing the pressure on the percentage yield of ammonia?

Use **Table 8**.

[1 mark]

10

4.10.4.1 The Haber process

Question 17

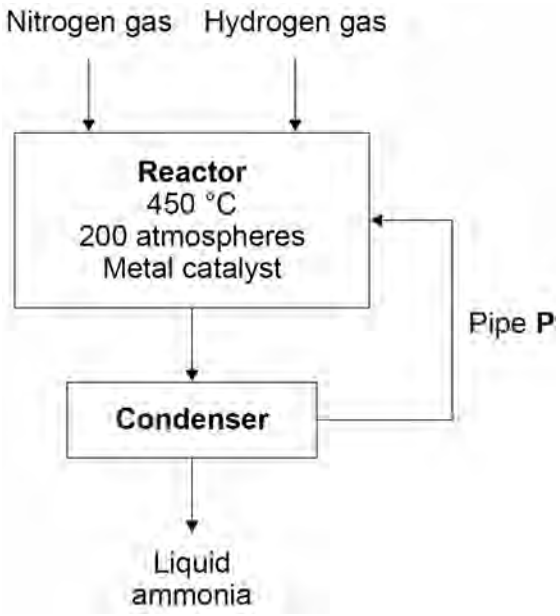
June 2024 | 8462/2F | Original Q9

0 9 This question is about ammonia and nitric acid.

In the Haber process ammonia is produced from nitrogen and hydrogen.

Figure 10 represents the Haber process.

Figure 10



0 9 . 1 Pipe **P** links the condenser to the reactor.

Why is the condenser linked to the reactor?

Use **Figure 10**.

[1 mark]

0 9 . 2 Which metal is used as a catalyst in this reaction?

[1 mark]

4.10.4.1 The Haber process

Question 17 · continued

Nitric acid is produced by reacting ammonia with oxygen.

The word equation for the production of nitric acid is:

ammonia + oxygen → water + nitric acid

Platinum is a catalyst in this reaction.

0 9 . 3 Describe the test for oxygen gas.

Give the result if oxygen gas is present.

[2 marks]

Test _____

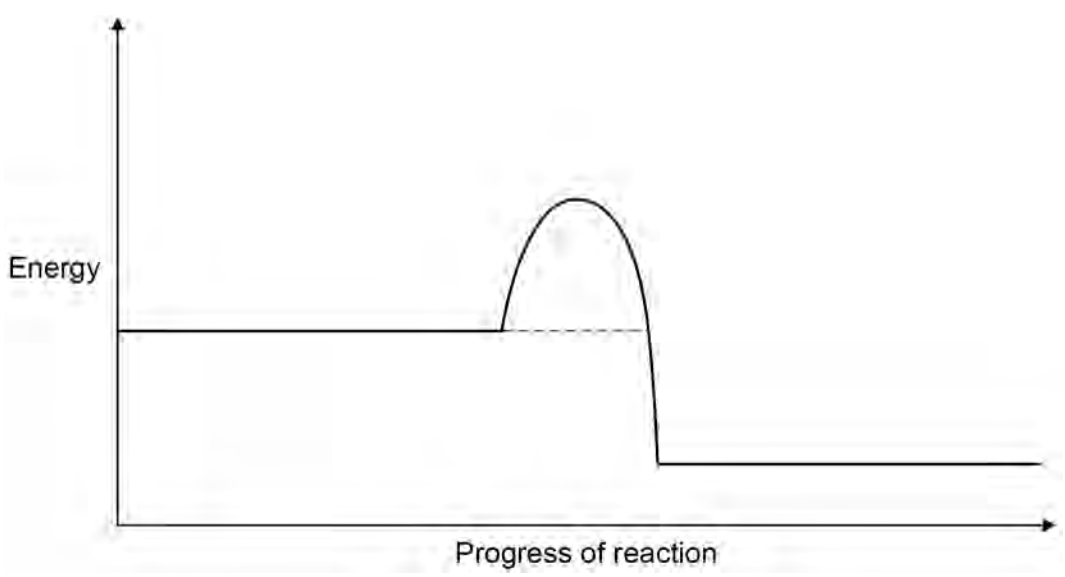
_____

Result _____

_____

Figure 11 represents the reaction profile of the catalysed reaction between ammonia and oxygen.

Figure 11



4.10.4.1 The Haber process

Question 17 · continued

0 9 . 4 Complete the reaction profile for the catalysed reaction in **Figure 11**.

You should:

- label the activation energy
- label the reactants and products, using the names of the reactants and products.

[2 marks]

0 9 . 5 How would **Figure 11** be different if **no** catalyst was used?

[1 mark]

Tick (✓) **one** box.

The final energy level would be higher. ☐

The final energy level would be lower. ☐

The line would reach a higher peak. ☐

The line would reach a lower peak. ☐

0 9 . 6 Ammonia and nitric acid react to produce the salt, ammonium nitrate.

Ammonium ions and nitrate ions both contain nitrogen.

Suggest **one** use of ammonium nitrate.

[1 mark]

_____

_____

8

4.10.4.1 The Haber process

Question 18

June 2025 | 8462/2F | Original Q4

0 4 Ammonia is produced in the Haber process.

The word equation for the reaction to produce ammonia is:

nitrogen + hydrogen ⇌ ammonia

0 4 . 1 Draw **one** line from each element to a source of that element.

[2 marks]

Element	Source of element
Nitrogen	Air
Hydrogen	Clay
	Limestone
	Natural gas
	Sand

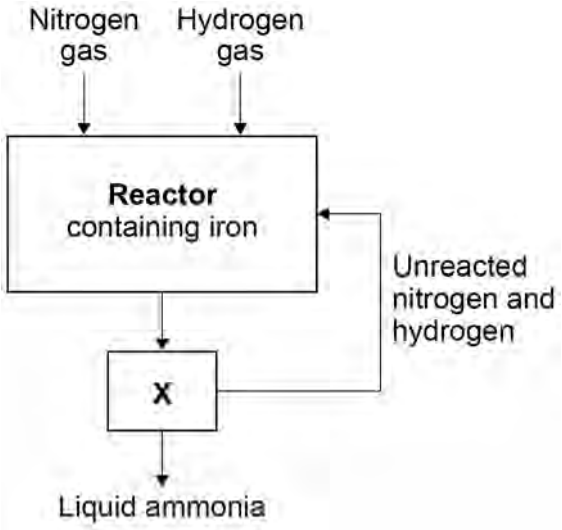
4.10.4.1 The Haber process

Question 18 · continued

Ammonia is a gas at room temperature.

Figure 3 shows how ammonia is produced from nitrogen and hydrogen.

Figure 3



0 4 . 2 Which process takes place at **X** in **Figure 3**?

[1 mark]

Tick (✓) **one** box.

Cooling ☐

Filtering ☐

Melting ☐

0 4 . 3 Complete the sentence.

Use **Figure 3**.

[1 mark]

The iron in the reactor is used as a _____.

4.10.4.1 The Haber process

Question 18 · continued

Table 1 shows the world production of ammonia between 1990 and 2020.

Table 1

Year	World production of ammonia in arbitrary units
1990	120
2000	130
2010	155
2020	165

0 4 . 4 How did the world production of ammonia change between 1990 and 2020?

Use **Table 1**.

[1 mark]

0 4 . 5 Determine the mean change in mass of ammonia produced per year between 2000 and 2020.

Use **Table 1** and the equation:

$$\text{mean change in mass produced per year} = \frac{\text{change in mass produced between 2000 and 2020}}{\text{number of years}}$$

[4 marks]

Change in mass = _____ arbitrary units

Number of years = _____

Mean change = _____ arbitrary units per year

4.10.4.1 The Haber process

Question 18 · continued

Most of the ammonia produced in the Haber process is used to make fertilisers.

0 4 . 6 Which is a reason for the change in the world production of ammonia shown in **Table 1**?

[1 mark]

Tick (✓) **one** box.

- Change in amount of acid rain ☐
- Change in global temperatures ☐
- Change in world population ☐

0 4 . 7 Fertilisers produced using ammonia contain nitrogen.

Which **two** compounds used in fertilisers contain nitrogen?

Use the periodic table.

[2 marks]

Tick (✓) **two** boxes.

- $Ca(NO_3)_2$ ☐
- $Ca_3(PO_4)_2$ ☐
- KCl ☐
- K_2SO_4 ☐
- $(NH_4)_2SO_4$ ☐

12