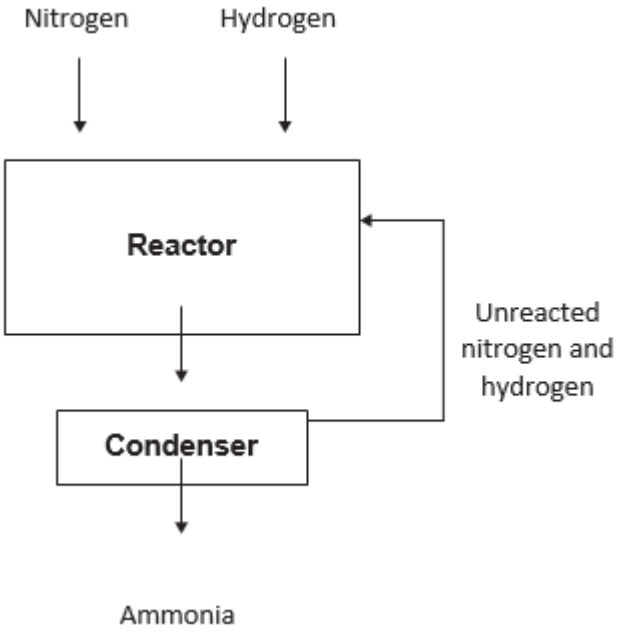
HABER PROCESS

Q1. In 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)

(b) The reactor contains iron.

Complete the sentence.

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

(1 mark)

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

_____

_____

_____

(1 mark)

(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.

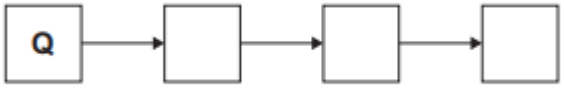
Q Nitrogen and hydrogen are mixed together.

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.

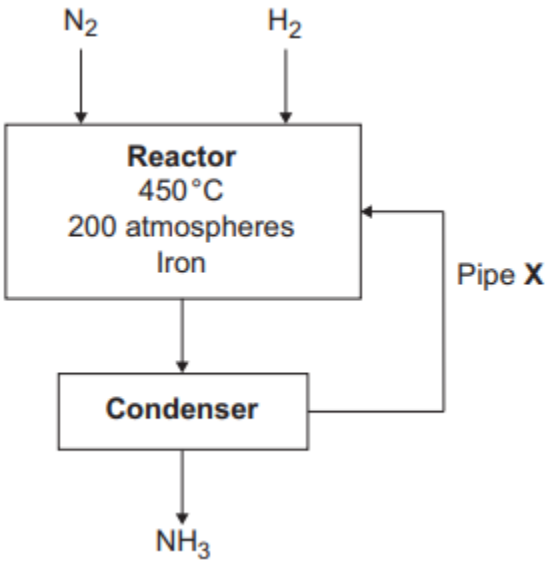
The first box has been done for you.



(2 marks)

Q2. The flow diagram shows the Haber process.

In the Haber process, ammonia (NH_3) is produced from nitrogen (N_2) and hydrogen (H_2).



(a) Which raw material is nitrogen obtained from?

_____

(1 mark)

(b) What is the purpose of Pipe X?

_____

_____

_____

(2 marks)

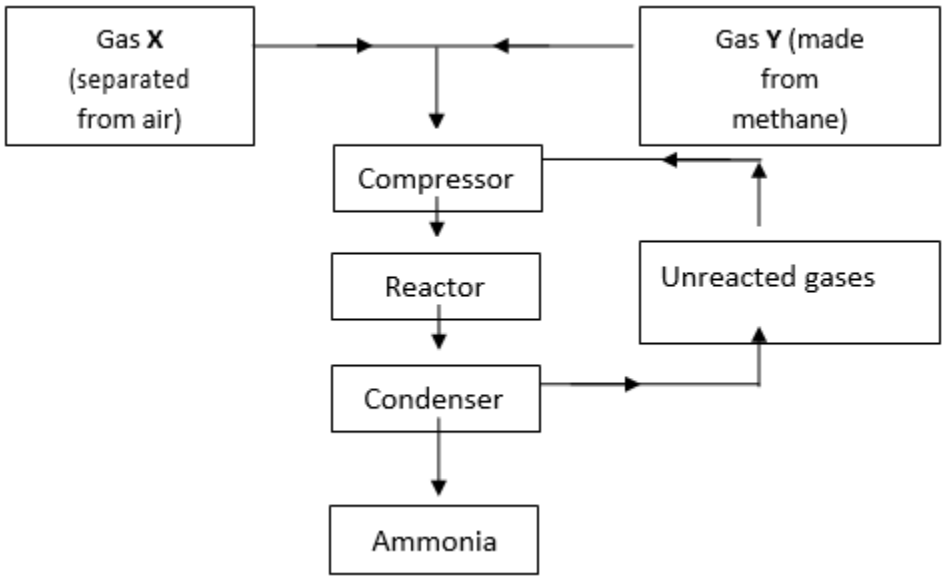
(c) Balance the chemical equation below.

N_2 + ...H_2 $\rightleftharpoons$ .....NH_3

(1 mark)

Q3. Ammonia is used in the production of fertilisers. The flow diagram shows the main stages in the manufacture of ammonia.

Study the flow diagram and then answer the questions.



(a)(i) Name gas **X** and name gas **Y**.

Gas **X** is …… Gas **Y** is ……

(2 marks)

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

In the condenser the mixture is

cooled
heated
oxidised

to separate ammonia as a liquid.

(1 mark)

(b) The ammonia is separated as a liquid from the unreacted gases.

Suggest two reasons why the unreacted gases are recycled.

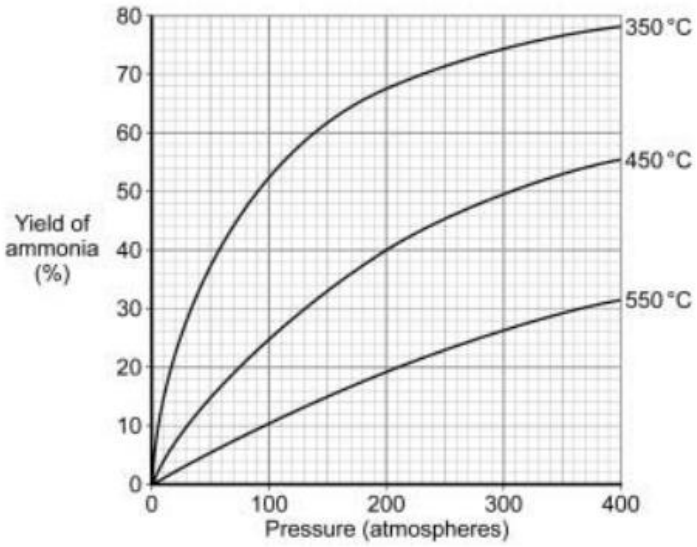
_____

_____

_____

(2 marks)

(c) The graph shows the percentage of ammonia made at different temperatures and pressures.
Study the graph and then answer the questions.



(i) Draw a ring around the correct answers to complete the sentence.

To make the greatest percentage yield of ammonia the temperature should be

low
medium
high

and the pressure should be

low.
medium.
high.

(2 marks)

(ii) What is the percentage yield of ammonia at a temperature of 450°C and at a pressure of 200 atmospheres?

_____

(1 mark)

(iii) Ammonia is often made at a temperature of 450°C and at a pressure of 200 atmospheres.
Suggest two reasons why it is economical to make ammonia using these conditions.

_____

_____

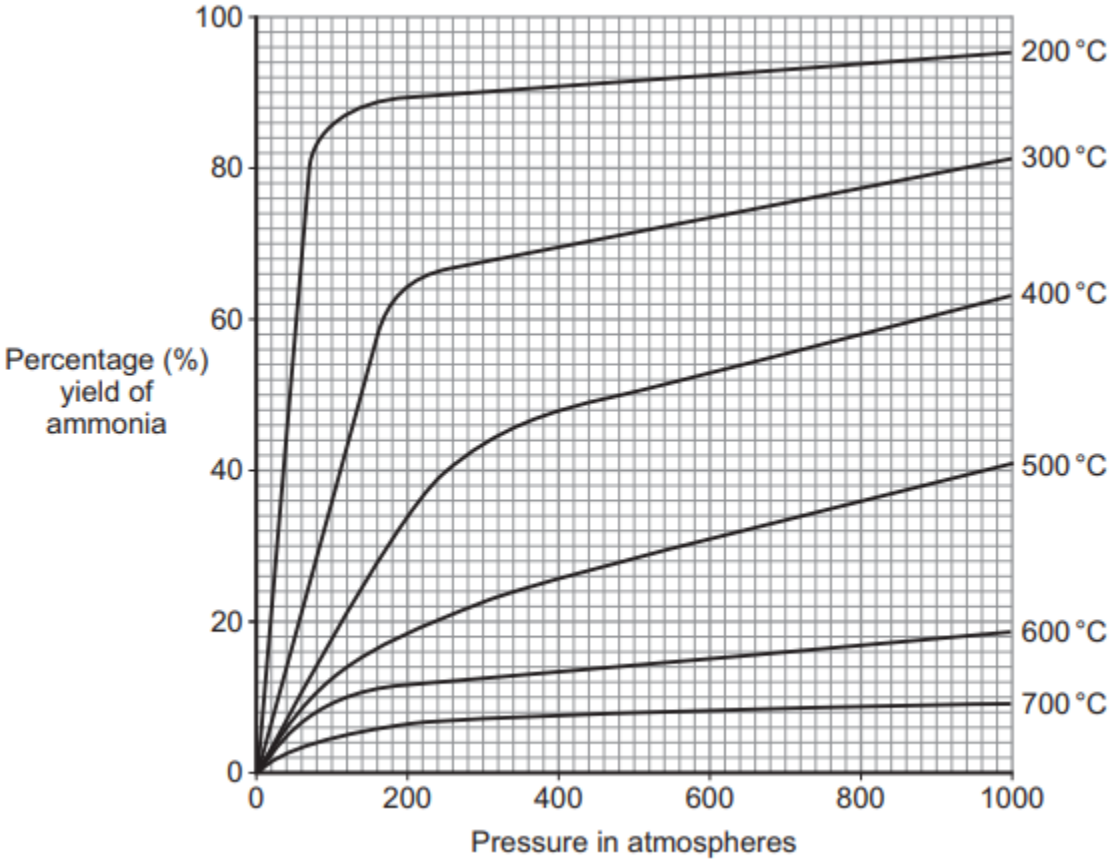
_____

_____

_____

(2 marks)

Q4. Figure shows how the equilibrium yield of ammonia changes with pressure at different temperatures.



(a)(i) Use the information in the figure to complete the sentence.

The temperature on the graph that gives the highest yield of ammonia is ..... °C.

(1 mark)

(ii) The temperature used in the Haber process for the production of ammonia is 450°C. Why is a temperature much lower than 450 °C not used for the Haber process?

_____

_____

(1 mark)

(iii) Use the information in the figure to answer this question.
Draw a ring around the pressure that gives the highest yield of ammonia.

100 **200** **300** **400**

(1 mark)

(iv) The pressure used in the Haber process for the production of ammonia is 200 atmospheres. Why is a pressure lower than 200 atmospheres not used for the Haber process?

_____

(1 mark)

(b) Explain how ammonia is separated from unreacted nitrogen and hydrogen in the Haber process.

_____

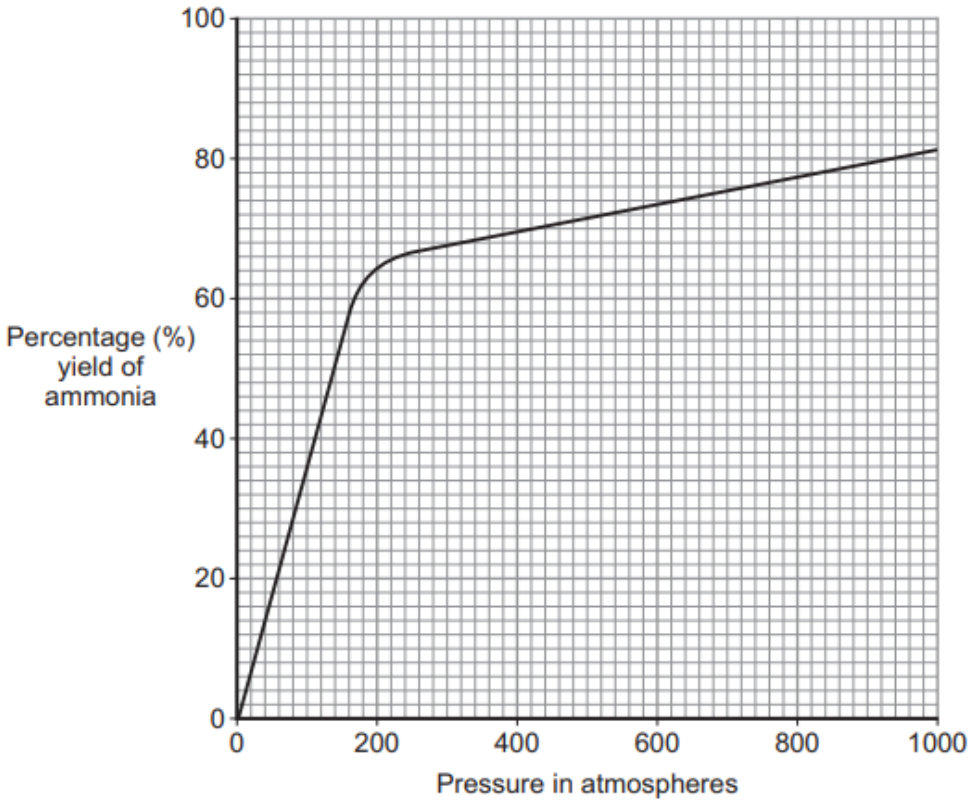
_____

_____

_____

(2 marks)

Q5. The figure shows how the yield of ammonia at 300 °C changes with pressure.



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

_____

_____

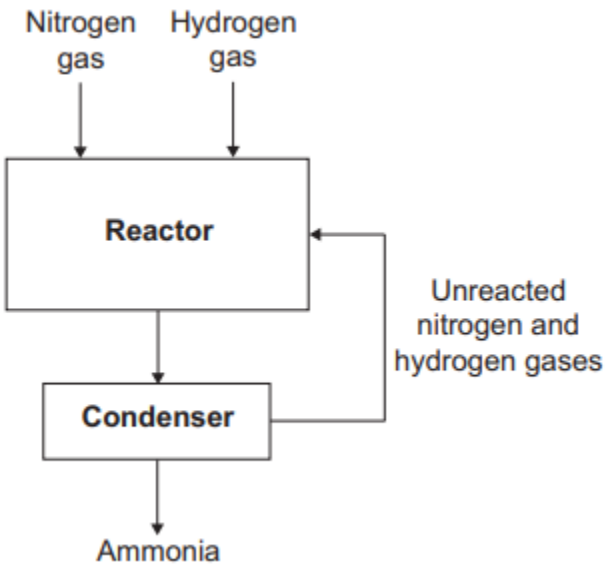
_____

_____

_____

(3 marks)

Q6. The figure represents the Haber process.



(a) How does the Haber process avoid wasting nitrogen and hydrogen?

_____

_____

(1 mark)

(b) 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.

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

_____

_____

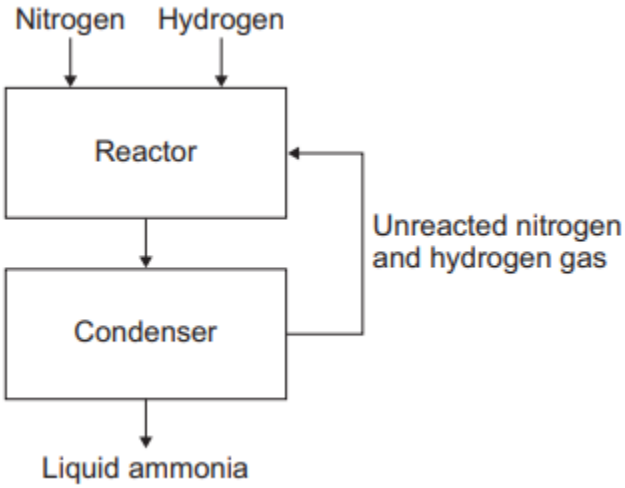
(1 mark)

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

_____

(1 mark)

Q7. The figure shows a flow diagram of the Haber process.
The Haber process produces ammonia from nitrogen and hydrogen.



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

air	limestone	natural gas

Hydrogen is obtained from ..... .

(1 mark)

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

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

25	100	450

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

(1 mark)

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

copper	iron	nickel

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

(1 mark)

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

Tick (✓) **one** box.

The catalyst lowers the activation energy.	☐
The catalyst gives the reactants extra energy.	☐
The catalyst increases the pressure in the reactor.	☐

(1 mark)

(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.

_____

_____

_____

_____

_____

(3 marks)

Total marks (38)