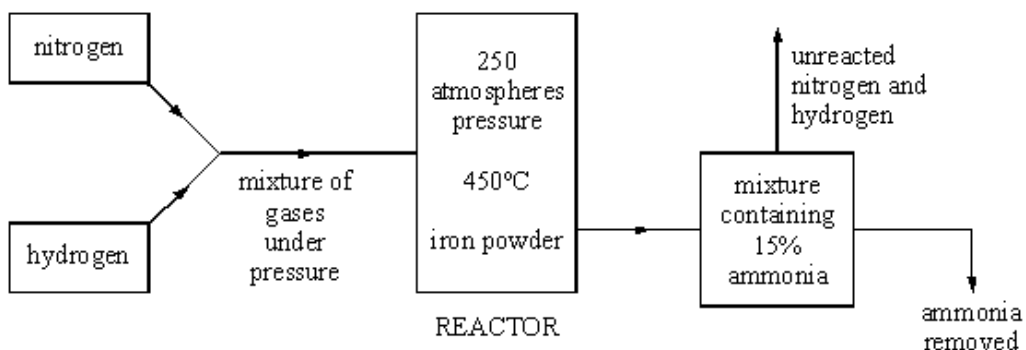


- Q1.** Ammonia is manufactured from nitrogen and hydrogen in the Haber Process. The diagram shows some details of the manufacturing process.



- (a) Nitrogen is obtained from the air.

From where is the hydrogen obtained?

.....

(1)

- (b) What happens to the unreacted nitrogen and hydrogen?

.....

.....

(1)

- (c) Ammonium nitrate is made from ammonia.

Farmers spread nitrates on to soil to make crops grow better.

The nitrates may get into people's bodies even if they do not eat the crops.

Explain how this can happen.

.....

.....

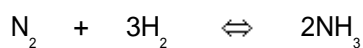
.....

(2)

(Total 4 marks)

##

Ammonia is manufactured by the Haber Process, where nitrogen and hydrogen react together as follows:



The reaction is reversible. A balance is eventually reached when ammonia is being formed at the same rate at which it is decomposing.

This point is called 'equilibrium'.

PRESSURE (ATM)	PERCENTAGE OF AMMONIA AT EQUILIBRIUM		
	100° C	300° C	500° C
25	91.7	27.4	2.9
100	96.7	52.5	10.6
400	99.4	79.7	31.9

- (a) (i) What is meant by a 'reversible reaction'?

.....  
 .....

(1)

- (ii) Which substances are present in the mixture at equilibrium?

.....

(1)

- (b) (i) Under what conditions shown in the table is the maximum yield of ammonia obtained?

.....  
 .....

(2)

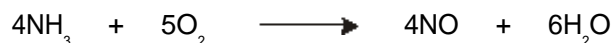
- (ii) The Haber Process is usually carried out at a higher temperature than that which would produce the maximum yield. Suggest why.

.....  
 .....  
 .....  
 .....

(2)

- (c) Ammonia can be converted into nitric acid in three stages:

Stage 1 Ammonia reacts with oxygen from the air to form nitrogen monoxide and water



Stage 2 On cooling, nitrogen monoxide reacts with oxygen from the air to form nitrogen dioxide.

Stage 3 Nitrogen dioxide reacts with water to form nitric acid and nitrogen monoxide.

- (i) Describe the conditions under which the reaction in Stage 1 takes place.

.....

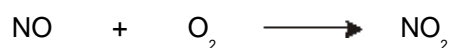
.....

.....

.....

(3)

- (ii) Balance the equation for the reaction at Stage 2.



(1)

- (iii) Balance the equation for the reaction at Stage 3.



(1)

- (d) The chemical plant for manufacturing ammonia is often on the same site as plants manufacturing nitric acid and fertilisers.

- (i) What advantages will this have for the manufacturing company?

.....

.....

.....

.....

(2)

- (ii) Briefly describe **two** important ways in which it is possible to reduce the environmental impact of such plants on the surrounding area.

1 .....

.....

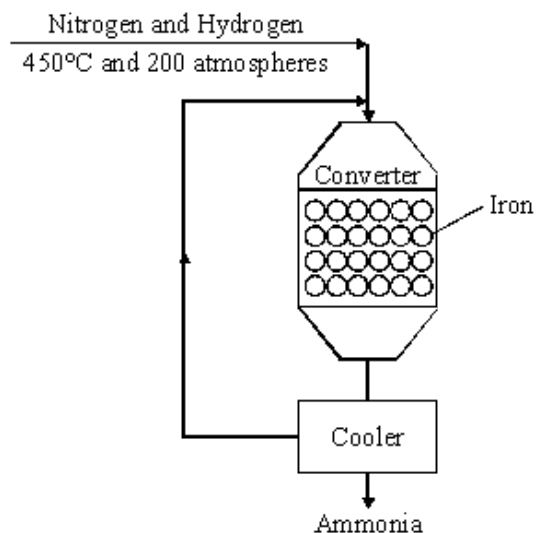
2 .....

.....

(2)

(Total 15 marks)

**Q3.** The diagram shows the final stages in the manufacture of ammonia.



(a) Why is iron used in the converter?

.....  
.....

(1)

(b) Write the word equation for the reaction in the converter.

..... + .....  $\rightleftharpoons$  .....

(1)

(c) The yield of ammonia is only about 15%.

(i) Why can the yield **not** be 100%?

.....  
.....

(1)

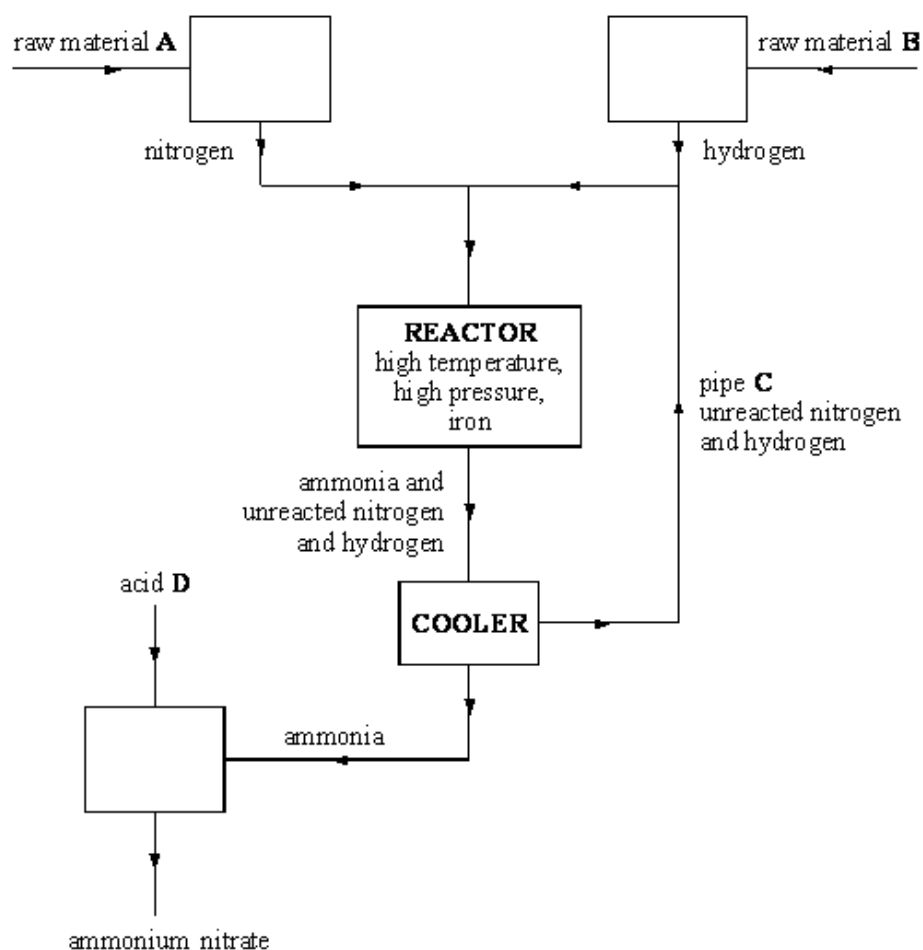
(ii) Describe what happens to the mixture of gases after it leaves the converter.

.....  
.....  
.....

(2)

(Total 5 marks)

**Q4.** The flow chart below shows the main stages in the production of ammonium nitrate.



- (i) Name the **two** raw materials shown in the flow chart as **A** and **B** by choosing words from the list.

**air                      coke                      limestone                      natural gas**

Raw material **A** .....

Raw material **B** .....

(2)

- (ii) Complete the word equation for the reaction which makes ammonia.

..... + ..... → ammonia

(1)

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

.....  
.....

(1)

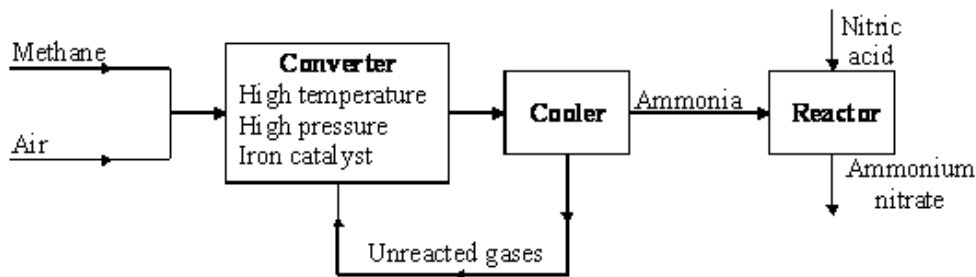
(iv) What is the purpose of pipe **C**?

.....  
.....

(1)

(Total 5 marks)

**Q5.** The flow diagram shows some stages in the manufacture of ammonium nitrate,  $\text{NH}_4\text{NO}_3$ .



(a) Which elements are obtained from the raw materials to make ammonia in the converter?

.....  
.....

(2)

(b) Suggest the purpose of the iron catalyst.

.....  
.....

(1)

(c) Farmers add ammonium nitrate to the soil. Explain why.

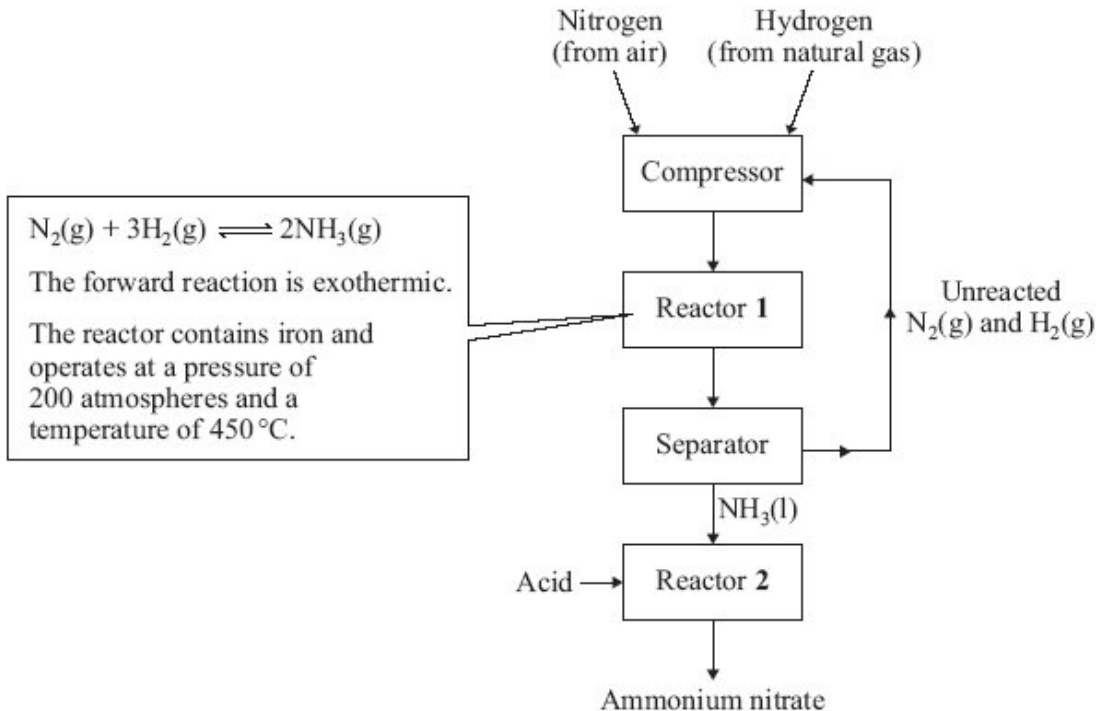
.....  
.....  
.....  
.....

(2)

(Total 5 marks)

- Q6.** 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 question.



- (a) What is the purpose of the iron in reactor 1?

.....  
.....

(1)

- (b) Explain why the best yield of ammonia at equilibrium is obtained:

- (i) at low temperature

.....  
.....

(1)

- (ii) at high pressure.

.....  
.....

(1)

- (c) The temperature used in reactor 1 is 450 °C.

Explain why a much lower temperature is **not** used.

.....  
.....

(1)

- (d) A mixture of ammonia, nitrogen and hydrogen leaves reactor 1.

In the separator, what is done to the mixture to separate the ammonia from the other gases?

.....

.....

(1)

(Total 5 marks)



